# HP Smart Array SAS Controllers for Integrity Servers Support Guide
HP-UX 11i v2 and 11i v3

Abstract

This document describes how to install, configure, and troubleshoot HP Smart Array SAS controllers on HP Integrity servers running HP-UX.

Contents

1 Controller overview

This chapter provides an overview of the features and physical characteristics of the HP Smart Array Serial-Attached SCSI (SAS) RAID controllers.

Smart Array P400 controller features

Board components and features

Two models of the HP Smart Array P400 Controller are available:

- AD348A has internal SAS connectors on the front of the board. See Figure 1.
- AD397A has connectors on the back of the board. See Figure 2 (page 7).

The two models have identical functionality.

Figure 1 HP AD348A Smart Array P400 controller with SAS connectors on front of board

1 SAS port 2I (internal), 4x wide SFF8484 connector.	**3** Connectors for cache module (also known as BBWC or array accelerator).	**5** Cache module, with a connector for the cable to the battery pack. The cache module must be installed on the controller before the controller is installed in a server, or the controller will not boot.
2 SAS port 1I (internal), 4x wide SFF8484 connector.	**4** Runtime LEDs. See "Smart Array P400 controller board runtime LEDs" (page 7).	

Figure 2 HP AD397A Smart Array P400 controller with SAS connectors on back of board

1	Connectors for cache module (also known as BBWC or array accelerator).	**3**	Runtime LEDs. See "Smart Array P400 controller board runtime LEDs".	**5**	Cache module, with a connector for the cable to the battery pack. The cache module must be installed on the controller before the controller is installed in a server, or the controller will not boot.
2	SAS port 1I (internal), 4x wide SFF8484 connector.	**4**	SAS port 2I (internal), 4x wide SFF8484 connector.		

Smart Array P400 controller board runtime LEDs

The Smart Array P400 Controller board has eight runtime LEDs that indicate activities and error conditions.

Figure 3 Smart Array P400 controller board runtime LEDs
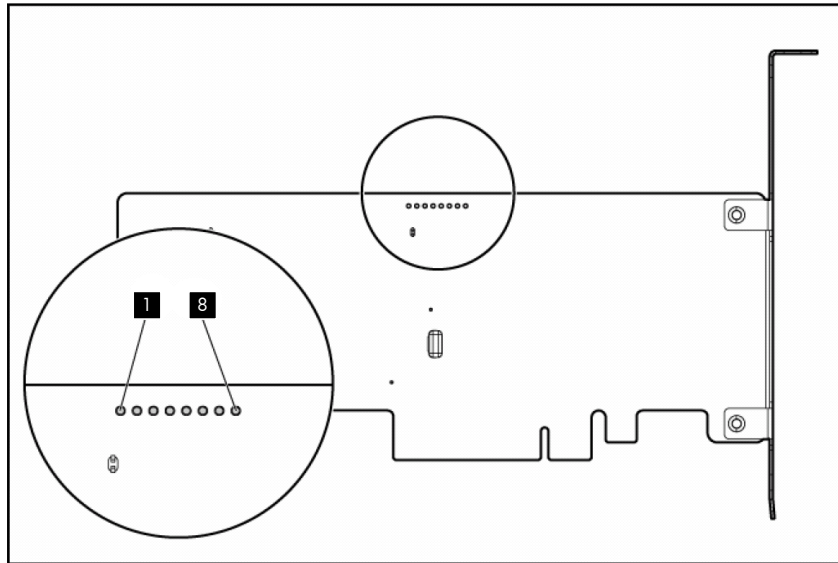
Table 1 Interpreting Smart Array P400 Runtime LEDs

LED ID	Color	Name	LED name and interpretation
1	Amber	CR14	Controller lockup LED.
2	Amber	CR13	Disk Failure LED. A physical disk connected to the controller has failed. See the Fault LED on each disk to determine the failed disk.
3	Green	CR3	Activity LED for SAS port 2I.
4	Green	CR8	Activity LED for SAS port 1I.
5	Green	CR5	Command Outstanding LED. The controller is working on a command from the host driver.
6	Green	CR6	Heartbeat LED. This LED flashes every 2 seconds to indicate controller health.
7	Green	CR4	Gas Pedal LED. This LED, with item 8 (CR7), indicates the amount of controller CPU activity. See Table 2.
8	Green	CR7	Idle Task LED. This LED, with item 7 (CR4), indicates the amount of controller CPU activity. See Table 2.

Table 2 Determining the P400 controller CPU activity level

LED 7 Status	LED 8 Status	Controller CPU activity level
Off	Flashing	0 to 25%
Flashing	Off	25 to 50%
On Steady	Off	50% to 75%
On steady	On Steady	75% to 100%

NOTE: During server power on, each runtime LED illuminates randomly until POST completes.

Smart Array P411 controller features

Board components and features

Figure 4 HP AM311A Smart Array 411 controller components
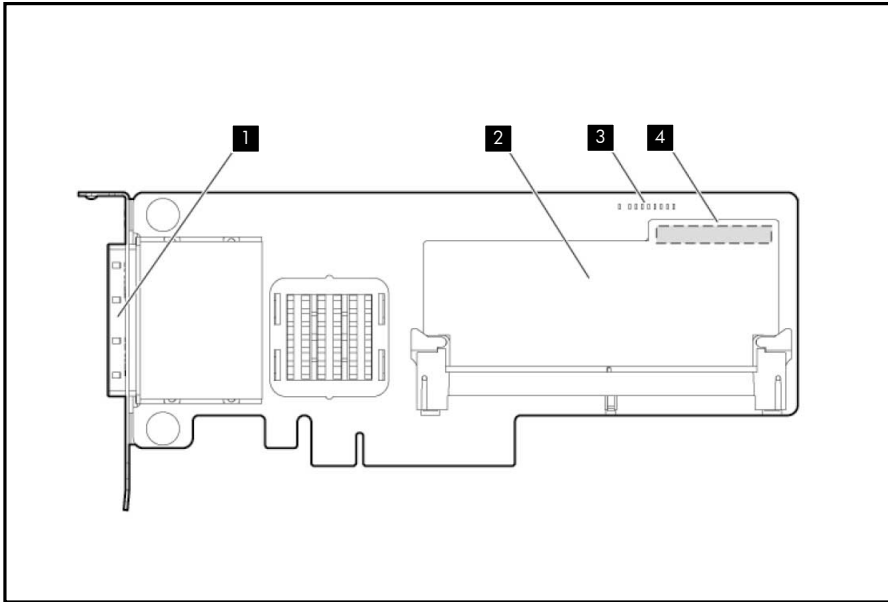
1. Connector for SAS miniports 1 and 2, each 4x wide.
2. Cache module (also known as array accelerator).
3. Status LEDs (runtime LEDs). To interpret the illumination pattern of these LEDs, see Table 3 (page 10).
4. (On rear of cache) Connector for the cable to an optional cache battery that upgrades the cache to BBWC.

Smart Array P411 controller board runtime LEDs

The Smart Array P411 Controller board has nine runtime LEDs that indicate activities and error conditions.

Figure 5 Smart Array P411 controller board runtime LEDs
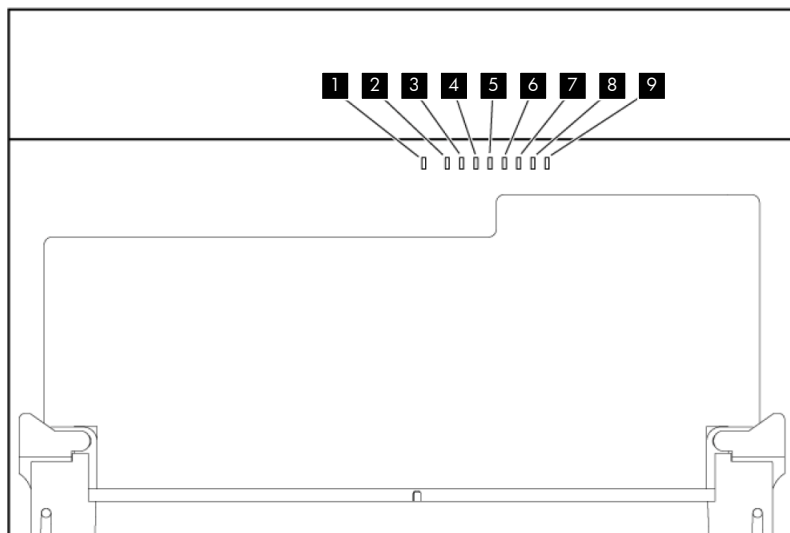
Table 3 Interpreting Smart Array 411 runtime LEDs

LED ID	Color	Name	LED name and interpretation
1	Amber	DS9	System Error LED. The controller ASIC has locked up and cannot process any commands.
2	Green	DS8	Idle Task LED. This LED, with item 3 (DS7), indicates the amount of controller CPU activity. See Table 6.
3	Green	DS7	Gas Pedal LED. This LED, with item 2 (DS8), indicates the amount of controller CPU activity. See Table 4.
4	Green	DS6	Controller Heartbeat LED. This LED flashes every two seconds to indicate controller health.
5	Green	DS5	Pending Command LED. Indicates that the controller is working on a command from the host driver.
6	Green	DS4	Activity LED for SAS port 1.
7	Green	DS3	Activity LED for SAS port 2.
8	Amber	DS2	Disk Failure LED. A physical disk connected to the controller has failed. See the Fault LED on each disk to determine the failed disk.
9	Amber	DS1	Diagnostics Error LED. One of the server diagnostics utilities has detected a controller error.

Table 4 Determining Smart Array P411 controller CPU activity level

DS7 (Gas Pedal) Status	DS8 (Idle Task) Status	Controller CPU activity level
Off	Flashing	0 to 25%
Flashing	Off	25 to 50%
On steadily	Off	50% to 75%
On steadily	On steadily	75% to 100%

NOTE: During server power on, each runtime LED illuminates randomly until POST completes.

Smart Array P700m controller features

Board components and features

Figure 6 HP 508226-B21 Smart Array P700m controller components
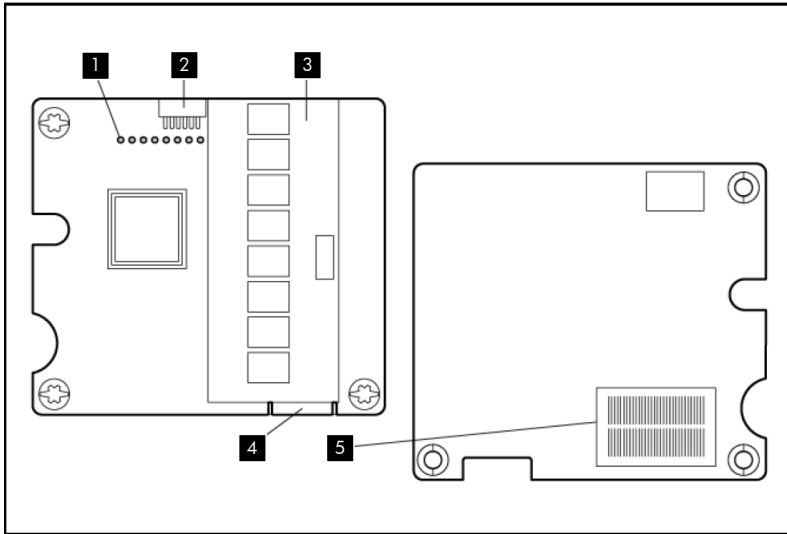
1. Status LEDs (runtime LEDs). To interpret the illumination pattern of these LEDs, see Table 5 (page 12).
2. Connector (not used on HP Integrity servers).
3. Cache module (also known as array accelerator).
4. Connector for the cable to an optional cache battery that upgrades the cache to BBWC. This connector is absent on some P700m models.
5. Mezzanine connector to system board.

Smart Array P700m controller board runtime LEDs

The Smart Array P700m Controller board has 10 runtime LEDs that indicate activities and error conditions.

Figure 7 Smart Array P700m controller board runtime LEDs
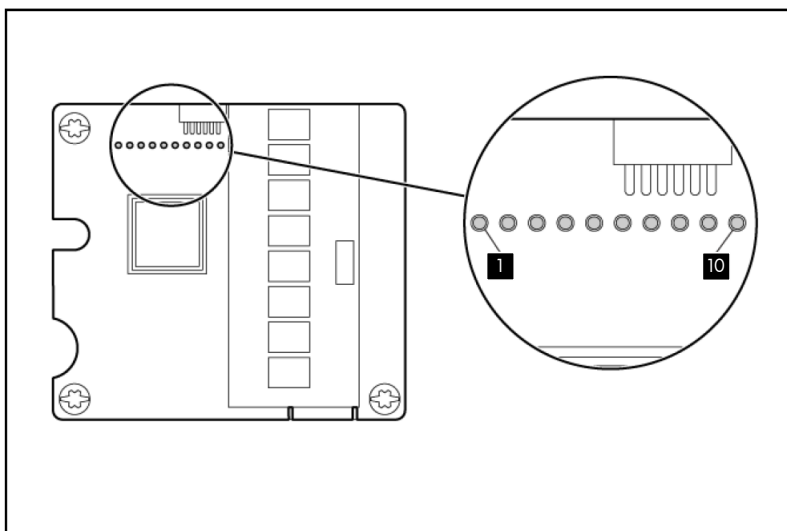
Table 5 Interpreting Smart Array P700m runtime LEDs

LED ID	Color	Name	LED name and interpretation
1	Amber	CR10	Thermal Alert LED. This LED is not used.
2	Amber	CR9	System Error LED. The controller ASIC has locked up and cannot process any commands.
3	Amber	CR1	Diagnostics Error LED. One of the server diagnostics utilities has detected a controller error.
4	Amber	CR2	Disk Failure LED. A physical disk connected to the controller has failed. See the Fault LED on each disk to determine the failed disk.
5	Green	CR3	Activity LED for SAS port 2.
6	Green	CR4	Activity LED for SAS port 1.
7	Green	CR5	Command Outstanding LED. Indicates that the controller is working on a command from the host driver.
8	Green	CR6	Controller Heartbeat LED. This LED flashes every two seconds to indicate controller health.
9	Green	CR7	Gas Pedal LED. This LED, with item 10 (CR8), indicates the amount of controller CPU activity. See Table 6.
10	Green	CR8	Idle Task LED. This LED, with item 9 (CR7), indicates the amount of controller CPU activity. See Table 6.

Table 6 Determining the Smart Array P700m controller CPU activity level

LED 9 (Gas Pedal) Status	LED 10 (Idle Task) Status	Controller CPU activity level
Off	Flashing	0 to 25%
Flashing	Off	25 to 50%
On Steady	Off	50% to 75%
On steady	On Steady	75% to 100%

NOTE: During server power on, each runtime LED illuminates randomly until POST completes.

Smart Array P711m controller features

Board components and features

Figure 8 HP 513778-B21 Smart Array P711m controller components
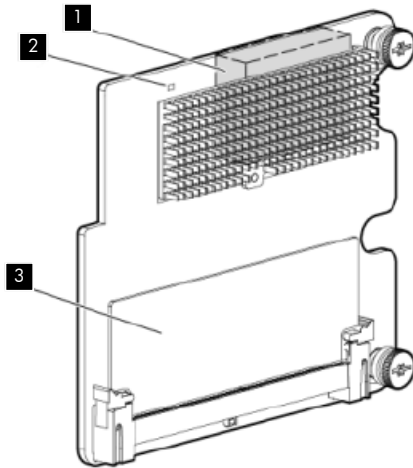
| 1 | Mezzanine connector to system board. | 2 | Status LED (runtime LED). | 3 | Cache module (also known as array accelerator). |

The Smart Array P711m Controller also includes an external capacitor pack (not shown), which provides approximately 80 seconds of backup power for the DDR cache memory. This provides sufficient duration to transfer the cached data from DDR memory to flash memory, where the data remains indefinitely or until a controller retrieves the data.

Smart Array P711m controller board runtime LED

The Smart Array P711m Controller board has one Controller Heartbeat LED (CR6). This LED flashes every two seconds to indicate controller health.

Figure 9 Smart Array P711m controller board runtime LED
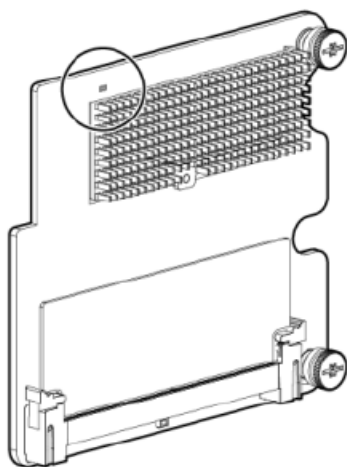
NOTE: During server power on, the runtime LED illuminates randomly until POST completes.

Smart Array P800 controller features

Board components and features

Figure 10 HP AD335A Smart Array P800 controller components
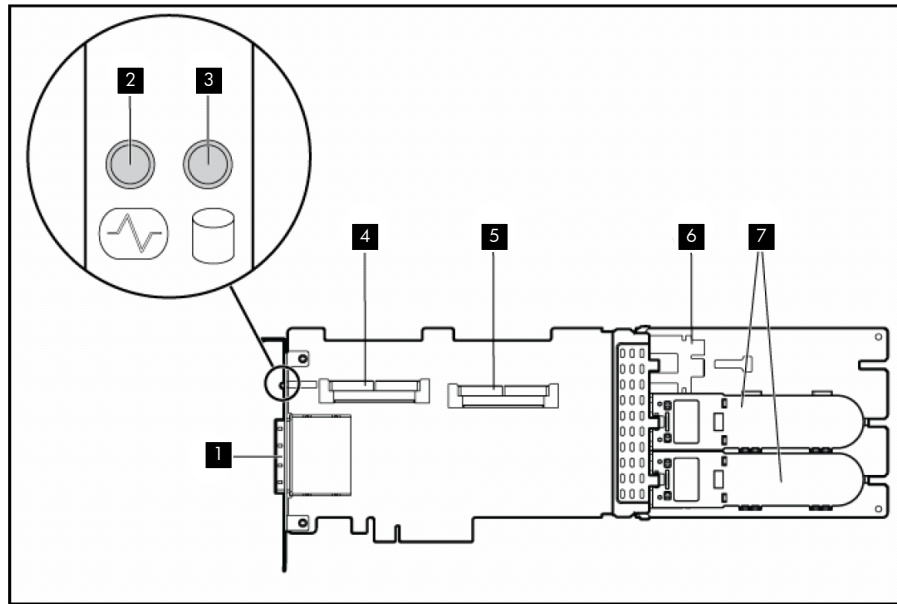
1	Connector for SAS miniports 1E and 2E (external), each 4x wide.	**4**	SAS port 3I (internal), 4x wide.	**6**	Cache module. (Also known as a BBWC or array accelerator.)
2	Heartbeat LED (flashes green when operating normally and amber if the controller as failed).	**5**	SAS port 4I (internal), 4x wide.	**7**	Batteries for cache module. (Two batteries are sufficient, but a third can be added to provide extra security from loss of system power.)
3	Activity LED for external ports.				

Smart Array P800 controller board runtime LEDs

The Smart Array P800 Controller board has 10 runtime LEDs that indicate activities and error conditions.

Figure 11 Smart Array P800 controller board runtime LEDs
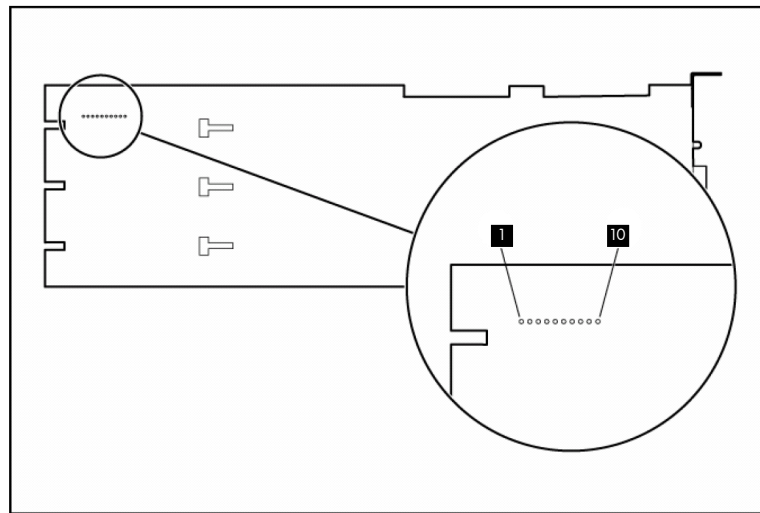
Table 7 Interpreting Smart Array P800 runtime LEDs

LED ID	Color	Name	LED name and interpretation
1	Green	CR502	Expander Heartbeat LED. This LED flashes every two seconds during normal operation. Abnormal conditions are indicated as follows: • If the LED glows steadily, the expander has an internal problem. • If the LED flashes twice per second, the NVRAM is corrupt. If an abnormal condition is indicated, the expander does not function.
2	Amber	CR510	System Error LED.
3	Amber	CR509	Diagnostics Error LED.
4	Amber	CR500	Disk Failure LED. A physical disk connected to the controller has failed. To determine the failed disk, see the Fault LED on each disk.
5	Green	CR508	Activity LED for SAS port 4I.
6	Green	CR507	Activity LED for SAS port 3I.
7	Green	CR506	Command Outstanding LED. Indicates that the controller is working on a command from the host driver.
8	Green	CR505	Controller Heartbeat LED. This LED flashes every two seconds to indicate controller health.
9	Green	CR504	Gas Pedal LED. This LED, with item 10 (CR503), indicates the amount of controller CPU activity. See Table 8.
10	Green	CR503	Idle Task LED. This LED, with item 7 (CR504), indicates the amount of controller CPU activity. See Table 8.

Table 8 Determining the Smart Array P800 controller CPU activity level

LED 9 (Gas Pedal) Status	LED 10 (Idle Task) Status	Controller CPU activity level
Off	Flashing	0 to 25%
Flashing	Off	25 to 50%
On Steady	Off	50% to 75%
On steady	On Steady	75% to 100%

NOTE: During server power on, each runtime LED illuminates randomly until POST completes.

Smart Array P812 controller features

Board components and features

Figure 12 HP AM312A Smart Array P812 controller components
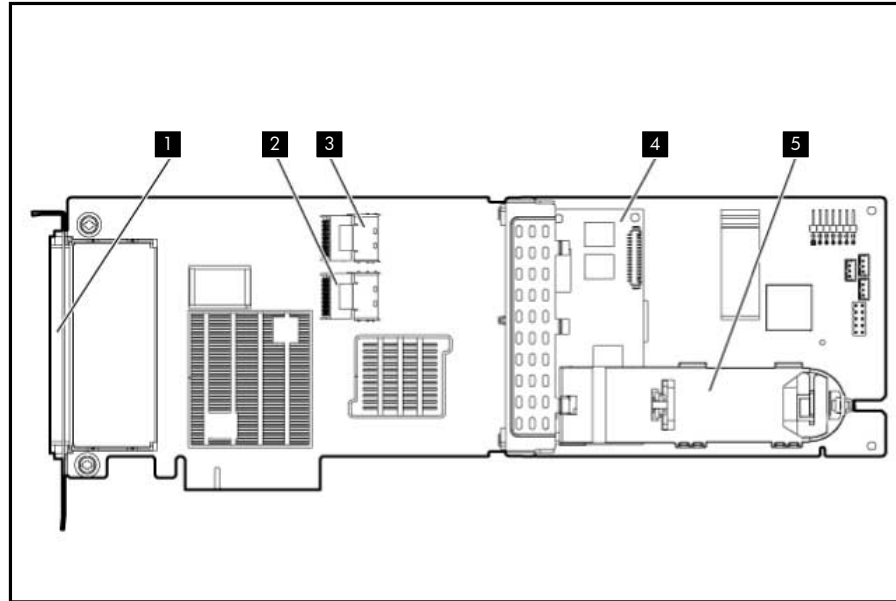
1 Ports 1E, 2E, 3E, and 4E (Mini SAS 4x connectors).	**3** Port 5I (Mini SAS 4i connector).	**5** Capacitor pack for cache module.
2 Port 6I (Mini SAS 4i connector).	**4** Cache module (Also known as array accelerator).	

Smart Array P812 controller board runtime LEDs

The Smart Array P812 Controller board has 10 runtime LEDs that indicate activities and error conditions.

Figure 13 Smart Array P812 controller board runtime LEDs
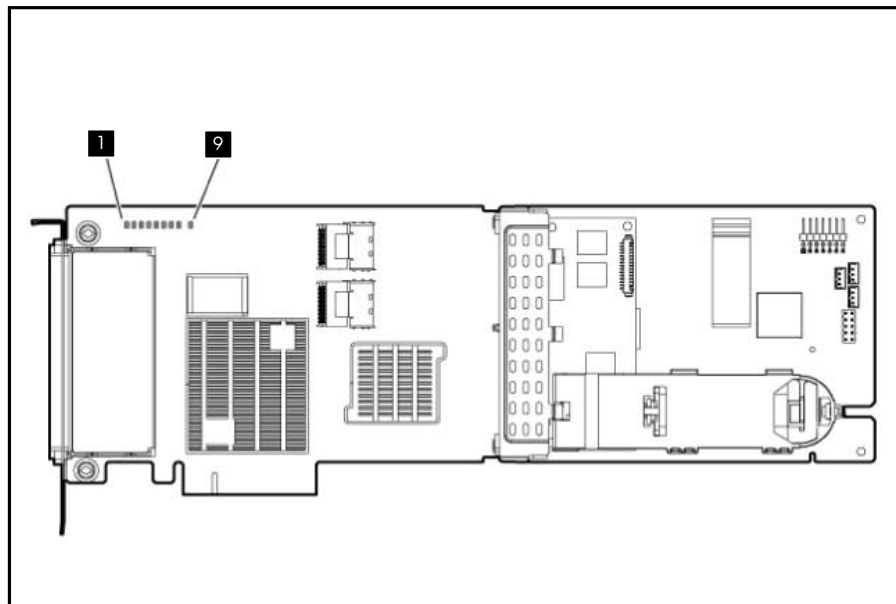
Table 9 Interpreting Smart Array P812 runtime LEDs

LED ID	Color	Name	LED name and interpretation
1	Green	CR76	Idle Task LED. This LED, with item 7 (CR504), indicates the amount of controller CPU activity. See Table 10.
2	Green	CR75	Gas Pedal LED. This LED, with item 10 (CR503), indicates the amount of controller CPU activity. See Table 10.
3	Green	CR74	Controller Heartbeat LED. This LED flashes every two seconds to indicate controller health.
4	Green	CR73	Pending Command LED. Indicates that the controller is working on a command from the host driver.
5	Green	CR72	Activity LED for SAS port 1.
6	Green	CR71	Activity LED for SAS port 2.
7	Amber	CR78	Disk Failure LED. A physical disk connected to the controller has failed. See the Fault LED on each disk to determine the failed disk.
8	Amber	CR77	Diagnostics Error LED. One of the server diagnostics has detected an error.
9	Green	CR82	MIPS Ready LED. The embedded SAS expander is active.

Table 10 Determining the Smart Array P812 controller CPU activity level

LED 2 (Gas Pedal) Status	LED 1 (Idle Task) Status	Controller CPU activity level
Off	Flashing	0 to 25%
Flashing	Off	25 to 50%
On Steady	Off	50% to 75%
On steady	On Steady	75% to 100%

NOTE: During server power on, each runtime LED illuminates randomly until POST completes.

Battery pack LEDs

The battery pack has four runtime LEDs that indicate battery readiness and error conditions.

Figure 14 Smart Array battery pack LEDs
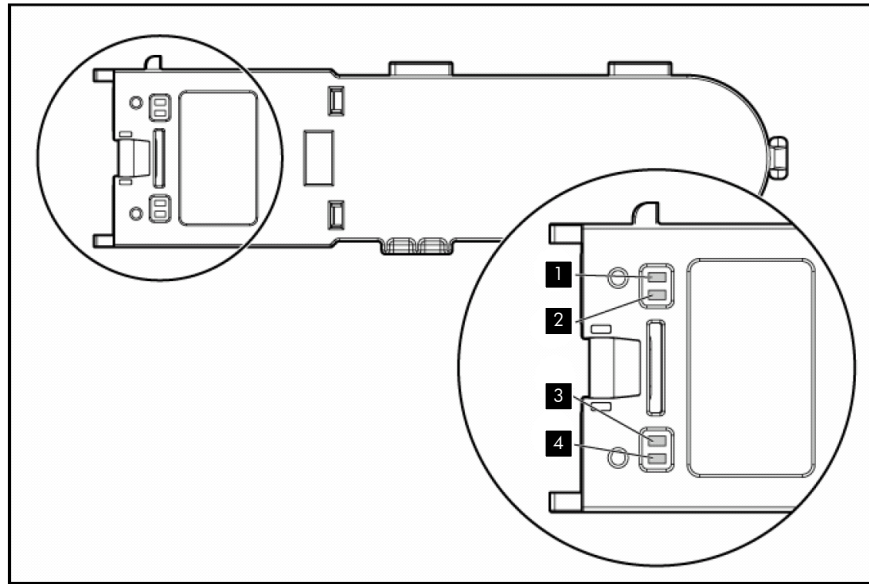
Table 11 Battery pack LEDs

LED	Color	Description
1	Green	System Power LED. This LED glows steadily when the system is powered on and 12 V system power is available. This power supply is used to maintain the battery charge and provide supplementary power to the cache microcontroller.
2	Green	Auxiliary Power LED. This LED glows steadily when 3.3 V auxiliary voltage is detected. The auxiliary voltage is used to preserve BBWC data and is available when system power cords are connected to a power supply.
3	Amber	Battery Health LED. See Table 12.
4	Green	BBWC Status LED. See Table 12.

Table 12 Interpreting battery pack LEDs

LED 3 State	LED 4 State	Interpretation
--	One flash every two seconds	The system is powered off and the cache contains data that has not yet been written to the drives. Restore system power as soon as possible to prevent data loss. Data preservation time is extended when 3.3 V auxiliary power is available, as indicated by LED 2. In the absence of auxiliary power, battery power preserves the data. A fully-charged battery can normally preserve data for two days. The battery lifetime also depends on the cache module size. For more information, see the controller QuickSpecs on the HP website at: http://www.hp.com
--	Flash twice, then pause	The cache microcontroller is waiting for the host controller to communicate.
--	One flash per second	The battery pack is below the minimum charge level and is being charged. Features that require a battery (such as write cache, capacity expansion, stripe size migration, and RAID migration) are unavailable until charging is complete. The recharge process takes between 15 minutes and 2 hours, depending on the initial capacity of the battery.
--	Steady glow	The battery pack is fully charged, and posted write data is stored in the cache.
--	Off	The battery pack is fully charged, and there is no posted write data in the cache.

Table 12 Interpreting battery pack LEDs *(continued)*

LED 3 State	LED 4 State	Interpretation
One flash per second	One flash per second	An alternating green and amber flash pattern indicates that the cache microcontroller is executing from within its boot loader and receiving new flash code from the host controller.
Steady glow	--	There is a short circuit across the battery terminals or in the battery pack. BBWC features are disabled until the battery pack is replaced. The life expectancy of a battery pack is typically more than three years.
One flash per second	--	There is an open circuit across the battery terminals or in the battery pack. BBWC features are disabled until the battery pack is replaced. The life expectancy of a battery pack is typically more than three years.

Flash-Backed Write Cache (FBWC) LEDs

The FBWC module has two single-color LEDs (green and amber). The LEDs are duplicated on the reverse side of the cache module to facilitate status viewing.

Table 13 Flash-Backed Write Cache LEDs

Green LED	Amber LED	Interpretation
Off	On	A backup is in progress.
Flashing (1 Hz)	On	A restore is in progress.
Flashing (1 Hz)	Off	The capacitor pack is charging.
On	Off	The capacitor pack has completed charging.
Flashing (2 Hz) Alternating with amber LED	Flashing (2 Hz) Alternating with green LED	One of the following conditions exists: • The charging process has timed out. • The capacitor pack is not connected.
On	On	The flash code image failed to load.
Off	Off	The flash code is corrupt.

Fault management features

The Smart Array Controllers and the HP-UX operating system support the following fault management and data reliability features that minimize the impact of disk drive defects on your systems:

Auto-Reliability Monitoring (ARM)   A firmware process that operates in the background, scanning physical disks for bad sectors in fault-tolerant logical drives. ARM also verifies the consistency of parity data in logical drives that use RAID 5 or RAID ADG. This process assures that you can recover data successfully if a disk fails. ARM operates when you select a fault-tolerant configuration.

Dynamic sector repair   Automatically remaps any sectors that have media faults detected during normal operation or by Auto-Reliability Monitoring.

S.M.A.R.T.   An industry-standard diagnostic and failure prediction feature of physical disks, developed by HP in collaboration with the disk drive industry. S.M.A.R.T. monitors factors that predict imminent physical disk failure due to mechanical causes, including the condition of the read/write head, the seek error rate, and the spin-up time. When a threshold value is exceeded for a factor, the disk sends an alert to the

controller that failure is imminent. Thus, you can back up data and replace the disk drive before failure occurs.

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

Drive failure alert features	Sends an alert message to Event Monitoring Services (EMS) when a physical disk or a logical drive fails.
Interim data recovery	Occurs if a disk fails in a fault-tolerant configuration.
Recovery ROM	A redundancy feature that ensures continuous system availability by providing a backup ROM. This feature protects against corruption of a ROM image.
	For example, if a power fluctuation occurs during a ROM upgrade, the ROM image could be corrupted. In this instance, the server restarts using the remaining good copy of the ROM image. When you upgrade the ROM, the inactive image (the one not being used by the system) is upgraded.
	There is not normally a noticeable difference in operation. However, when you use Recovery ROM for the first time, both ROM images are upgraded, causing a boot delay of about 60 seconds.

Fault management in supported RAID configurations

If a physical disk fails in RAID 1, 1+0, 5, 50, ADG, or 60, the system still processes I/O requests, but at a reduced performance level. Replace the failed physical disk as soon as possible to restore performance and full fault tolerance for the logical drive it belongs to.

The risk of continuing operations without replacing a failed physical disk varies depending on the RAID level that has been configured:

RAID 1	RAID 1 is configured with a single mirrored pair of disks. If one physical disk fails, the remaining disk in the mirrored pair can still provide all data.
RAID 1+0	A RAID 1+0 configuration has a minimum of four physical disks and the total number of physical disks is divisible by two to support mirrored pairs. In RAID 1+0, if a physical disk fails, the remaining disk in a mirrored pair still provides all data on the failed disk. Several physical disks in an array can fail without incurring data loss, as long as no two failed physical disks belong to the same mirrored pair.
RAID 5	A RAID 5 configuration has a minimum of three physical disks, plus one or more online spares; one disk is used for a single parity scheme to rebuild data if a physical disk fails. If a disk fails, data is recovered using a parity formula and is typically written to an online spare disk. If a second disk fails before the data from the initial disk failure is rebuilt on the online spare disk, the logical drive fails and data is lost.
RAID 50 (RAID 5+0)	RAID 50 is a RAID 0 array striped across RAID 5 parity groups. RAID 50 requires a minimum of six physical disks, plus one or more online spares. The RAID 0 striping provides increased read performance and fault tolerance. RAID 50 uses the RAID 5 single parity scheme to rebuild data if one physical disk fails per RAID 5 parity group.

	The rebuilt data is typically written to online spare physical disks. If a second physical disk fails before the data from the initial physical disk failure is rebuilt on the online spare disk, the logical drive fails and data is lost.
ADG (RAID 6)	An ADG configuration has a minimum of four physical disks, plus one or more online spares. ADG is similar to RAID 5, except that in an ADG configuration the parity data is duplicated on two physical disks instead of one. ADG uses this "distributed double parity" scheme to rebuild data if as many as two physical disks fail. If a third disk fails before the data is rebuilt on the online spare disks, the logical drive fails and data is lost.
RAID 60 (RAID 6+0)	Similar to RAID 50, RAID 60 is a RAID 0 array striped across RAID ADG elements. It uses the RAID ADG distributed double parity scheme to rebuild data if as many as two physical disks fail per RAID ADG parity group. The rebuilt data is typically written to online spare physical disks. If a third disk in an ADG parity group fails before the data is rebuilt on the online spare disks, the logical drive fails and data is lost.

For a detailed description of the RAID levels supported by Smart Array Controllers, see the *RAID Technology Overview* at http://www.hp.com/go/hpux-iocards-docs.

Click the link for your HP-UX version. The document is listed alphabetically in the "User guide" section.

For detailed information on the probability of a logical drive failure, see .

Choosing a RAID method

Use this table to select the best RAID method for your needs.

Table 14 Comparing RAID methods

RAID level	Fault tolerance	Minimum disks required*	Disk utilization	Read performance	Write performance
0	No	2	100%	High	High
1	Yes	2	50%	Intermediate	Intermediate
1+0	Yes	4	50%	Intermediate	Intermediate
5	Yes	3	67% to 94%	High	Low
50	Yes	6	67% to 94%	High	Low
ADG	Yes	4	50% to 88%	Intermediate	Low
60	Yes	8	50% to 88%	Intermediate	Low

* Does not include online spares.

Use this table to determine which RAID modes are supported by each Smart Array controller:

Table 15 Supported RAID modes, by controller

Controller	RAID 0	RAID 1	RAID 1+0	RAID 5	RAID 50	RAID ADG	RAID 60
P400	Yes	Yes	Yes	Yes		Yes	
P411	Yes	Yes	Yes	Yes			
P700m	Yes	Yes	Yes	Yes		Yes	
P711m	Yes	Yes		Yes	Yes	Yes	Yes

Table 15 Supported RAID modes, by controller *(continued)*

Controller	RAID 0	RAID 1	RAID 1+0	RAID 5	RAID 50	RAID ADG	RAID 60
P800	Yes	Yes	Yes	Yes		Yes	
P812	Yes	Yes	Yes	Yes	Yes	Yes	Yes

2 Installing the controller

This chapter describes a generic installation process for installing HP Smart Array SAS Controllers on HP-UX servers and updating the drivers and firmware for the storage system components. Procedures and recommendations might differ for individual controller models. Installation guides specific to each controller model are available on the HP website at http://www.hp.com/go/hpux-iocards-docs.

Click the link for your HP-UX version. Installation guides are listed alphabetically in the "Setup and install — general" section.

NOTE: If you purchased the Smart Array controller as a factory core I/O card or option, no installation is necessary.

If you purchased a Smart Array P400 Controller as an option kit upgrade, see the server-specific installation guide provided in the upgrade package.

Installation overview

To install your Smart Array Series Controller:
1. Plan your disk configurations. See "Choosing a RAID method" (page 21).
2. Check the installation prerequisites. See "Installation prerequisites" (page 23).
3. Install the software. See "Downloading software" (page 24) and "Installing software" (page 24).
4. Install the controller and connect internal disks. See "Installing the controller offline" (page 25).
5. Connect external disks, if applicable. See "Connecting external devices" (page 26).
6. Verify the controller firmware version and upgrade the controller firmware if necessary. See "Verifying and updating controller firmware offline" (page 26).
7. If you are installing a Smart Array P411 controller, determine whether the controller is in HBA mode or RAID mode; if necessary, change the mode to suit your configuration. For more information, see the *AM311A Smart Array P411/256 Controller for Integrity Servers Installation Guide*. This document is available on the HP website at http://www.hp.com/go/hpux-iocards-docs.
8. Verify the enclosure firmware version and upgrade the enclosure firmware if necessary. See "Verifying and updating enclosure firmware offline" (page 30).
9. Verify the disk firmware versions and upgrade the disk firmware if necessary. See "Confirming and updating physical disk firmware" (page 33).
10. Verify the installation. See "Verifying the installation" (page 33).
11. Configure the controller for boot support, if necessary. See "Configuring a Smart Array controller as a boot device " (page 37).

Installation prerequisites

Before installing the Smart Array Series Controller, the following hardware and software prerequisites must be met:
1. Confirm that your server and HP-UX operating system version are supported by the controller.

   Use the `swlist` command to determine the HP-UX version you are using. For example:

   ```
   # swlist | grep OE
     HPUX11i-DC-OE          B.11.31.1003    HP-UX Data Center Operating Environment
   ```

Table 16 Minimum Required HP-UX Versions for Smart Array SAS RAID Controllers

Controller	Operating System	Minimum Required Version
Smart Array P400	HP-UX 11i v2	B.11.23.0612
	HP-UX 11i v3	B.11.31.0709

Table 16 Minimum Required HP-UX Versions for Smart Array SAS RAID Controllers *(continued)*

Controller	Operating System	Minimum Required Version
Smart Array P411	HP-UX 11i v2	Not supported.
	HP-UX 11i v3	B.11.31.1005
Smart Array P700m	HP-UX 11i v2	B.11.23.0903
	HP-UX 11i v3	B.11.31.0903
Smart Array P711m	HP-UX 11i v2	Not supported.
	HP-UX 11i v3	B.11.31.1109
Smart Array P800	HP-UX 11i v2	B.11.23.0712
	HP-UX 11i v3	B.11.31.0712
Smart Array P812	HP-UX 11i v2	Not supported.
	HP-UX 11i v3	B.11.31.1005

For information about the supported server models and HP-UX versions, see the *HP Smart Array RAID Controllers Support Matrix* at http://www.hp.com/go/hpux-iocards-docs.

Click the link for your HP-UX version. Support Matrix documents are listed alphabetically in the "General reference" section.

2. Read the *RAID-01 (ciss) HP Smart Array Controller Release Notes* for your HP-UX version to check for any known problems, required patches, or other information needed for installation.
3. Make sure you have superuser (`root`) privileges.
4. Make sure the **/usr/sbin, /sbin**, and **/usr/bin** directories are in your PATH statement, by logging in as `root` and entering the following command:

   `# echo $PATH`

Downloading software

To locate and download the drivers, utilities, and manpages for the Smart Array series controllers:
1. Go to http://www.software.hp.com.
2. Search for **RAID-01**.
3. Click **Receive for Free**.
4. Sign in with your HP Passport account credentials, or create a new account.
5. In the Software Specifications section, select the HP-UX version that your system runs; then complete the required registration information, then click **Next**.
6. Click the depot that corresponds with the OS you are running to download the drivers, utilities, and manpages for the Smart Array Controllers.
7. In the Documents column next to the Download Software column, click **Download/Installation Instructions** to view instructions for using the `swinstall` tool to install the drivers, utilities, and manpages.

Installing software

The drivers, utilities, and manpages for the Smart Array Series Controllers are contained in the RAID-01 bundle located in the downloaded depot. See "Downloading software" (page 24). Follow the procedure in the Download/Installation Instructions to verify the download and install the bundle.

Installing the controller offline

To install a Smart Array controller on a server running HP-UX, follow the procedures in the HP-UX chapter of the installation guide for your controller. Installation guides are available on the HP website at http://www.hp.com/go/hpux-iocards-docs.

Click the link for your HP-UX version. Installation guides are listed alphabetically in the "Setup and install — general" section.

NOTE: If you purchased the Smart Array P400 Controller as an option kit upgrade, follow the installation instructions in the server-specific installation guide provided in the upgrade package.

Adding or replacing a Smart Array controller online

You can use Online Addition, Replacement, and Deletion (OL*) to replace some Smart Array controllers online in HP-UX systems that support OL*, without powering off and rebooting the system. (Some Smart Array controllers do not support this feature.) The server hardware uses per-slot power control and HP-UX OL* utilities to enable online addition or replacement of Smart Array Controller without adversely affecting other system components.

Table 17 Smart Array controller OL* support

Controller	Online Addition (OLA)	Online Replacement (OLR)	Online Deletion (OLD)
Smart Array P400	Because the Smart Array P400 is a core I/O controller, OL* is not supported.		
Smart Array P411	Not supported.	Not supported.	Not supported.
Smart Array P700m, Smart Array P711m	N/A. OL* cannot be used with server blades.		
Smart Array P800	Not supported.	Supported.	Supported.
Smart Array P812	Not supported.	Not supported.	Not supported.

During a Smart Array Controller online replacement operation, the system performs a Critical Resource Analysis (CRA), which checks all channels on the target controller for critical resources that become temporarily unavailable when the controller is shut down. If critical resources will be affected by the OL* procedure, you can replace the controller when the system is offline. See "Installing the controller offline" (page 25).

IMPORTANT: Other controllers (host bus adapters) and slots in the system can be dependent on the controller that is targeted for replacement. For example, if the target controller has multiple channels, suspending or deleting drivers for the target PCIe slot also suspends individual drivers for the multiple hardware paths on the controller installed in that PCI slot.

To replace a Smart Array controller online:

1. Confirm that you have the minimum `ciss` driver version to support OL* on your system.

   See the *HP Smart Array Controller Support Matrix* at http://www.hp.com/go/hpux-iocards-docs.

   Click the link for your HP-UX version. Support Matrix documents are listed alphabetically in the "General reference" section.

2. Confirm that the controller is in a slot that supports OL*.

   To determine the capabilities of the slots on your system, see the documentation for your server at http://www.hp.com/go/Integrity_Servers-docs.

3. To replace the controller, follow the procedures in the latest edition of the *Interface Card OL* Support Guide* for your HP-UX version at http://www.hp.com/go/hpux-core-docs.

   For instructions on opening the system enclosure and working with PCIe cards, see see the documentation for your server at http://www.hp.com/go/Integrity_Servers-docs.

   △ **CAUTION:** Electronic components can easily be damaged by small amounts of static electricity. To avoid damage, follow the guidelines in Appendix D (page 116).

4. When the operation is complete, confirm that the access panel or cover is correctly installed and secured.

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

Connecting external devices

Some Smart Array controllers are compatible with several HP external storage enclosures. For information on supported enclosures, see the *HP Smart Array RAID Controllers Support Matrix* at:

http://www.hp.com/go/hpux-iocards-docs

Click the link for your HP-UX version. Support Matrix documents are listed alphabetically in the "General reference" section.

For information on connecting an external enclosure, see the documentation for the enclosure.

For information on supported cable kits for external devices, see Appendix E (page 117).

Verifying and updating controller firmware offline

To verify that the correct adapter firmware version is installed before you boot the server, follow the procedures in this section. Firmware version requirements are found in the *HP Smart Array RAID Controllers Support Matrix* on the HP website at:

http://www.hp.com/go/hpux-iocards-docs

Click the link for your HP-UX version. Support Matrix documents are listed alphabetically in the "General reference" section.

⚠ **WARNING!** HP Smart Array controllers have specific adapter firmware version requirements for use in HP Integrity servers. To ensure that the correct firmware version is installed, follow the steps in this section.

After the initial installation, you can verify and update the controller firmware using `sautil`. See "Using sautil to check and update the controller firmware" (page 78).

Verifying the controller firmware

To verify the firmware image on the controller, use `saupdate` from the EFI Shell.

To verify the controller firmware with `saupdate`:

1. Prepare to run `saupdate` from the Offline Diagnostics CD or the EFI partition:
   - To run `saupdate` from the Offline Diagnostic CD:
     a. Place the Offline Diagnostic CD containing `saupdate.efi` in the CD drive before booting the system.
     b. Boot the system to the EFI Shell prompt.
     c. Locate the `cdrom` entry in the list of mapped devices, and change to the device by entering its associated `fs` number (for example, **fs0**) under EFI Shell prompt.
     d. If the EFI utility is not located in the root directory, move to the directory where the file is located.

        For example:

        ```
        fs0:\>cd \EFI\HP\TOOLS\IO_CARDS\SmartArray
        ```

   - To run `saupdate` from the EFI partition:
     a. Download the Smart Array EFI update utility `saupdate.efi` and copy it to the EFI partition.
     b. Boot the system to the EFI Shell and change directories to the EFI partition.
     c. If the EFI utility is not in the root directory, move to the directory where the file is located.

        For example:

        ```
        fs0:\>cd \EFI\HP\TOOLS\IO_CARDS\SmartArray
        ```

2. To display all detected Smart Array controllers and the active firmware versions, use `saupdate LIST`.

   For example:

   ```
   fs0:\EFI\TOOLS> saupdate list

   *******************************************************************************
                   Smart Array Offline Firmware Update Utility
                            Version 2.06.10.03

        (C) Copyright 2006 Hewlett-Packard Development Company, L.P.
   *******************************************************************************

        Seg   Bus  Dev  Func        Description          Version

         0    52    0    0      HP Smart Array P400       2.08
   ```

   In this example, the system contains one Smart Array P400 Controller at segment 0, bus 52, device 0, function 0, running firmware version 2.08.

3. Compare the installed firmware version to the minimum recommended firmware version found in the *HP Smart Array RAID Controllers Support Matrix* at http://www.hp.com/go/hpux-iocards-docs.

   Click the link for your HP-UX version. Support Matrix documents are listed alphabetically in the "General reference" section.

   If the controller firmware meets the minimum recommended version, no further action is necessary.

Downloading the firmware update

To locate and download firmware for the Smart Array controller:

1. Go to the Business Support Center, at http://www.hp.com/go/bizsupport.
2. Search for your controller model; for example, "Smart Array P800."
3. In the "Narrow search using only" section, click **Drivers and software**.
4. Locate and click the link for the firmware download package.

5. Review the installation instructions and release notes on the download page.
6. Download the firmware.
7. To install the firmware update, follow the procedures supplied with the update package.

Updating the controller firmware

> **NOTE:** The following is a generic procedure to update firmware from the EFI shell. HP recommends that you follow the procedures supplied with the update package to install the firmware update.

To update the firmware image on the controller, use `saupdate` from the EFI Shell.

To update the controller firmware with `saupdate`:

1. Prepare to run `saupdate` from the Offline Diagnostics CD or the EFI partition:
   - To run `saupdate` from the Offline Diagnostic CD:
     a. Download the firmware and copy it to the EFI partition.
     b. Place the Offline Diagnostic CD containing `saupdate.efi` in the CD drive before booting the system.
     c. Boot the system to the EFI Shell prompt.
     d. Locate the `cdrom` entry in the list of mapped devices, and change to the device by entering its associated `fs` number (for example, **fs0**) under EFI Shell prompt.
     e. If the EFI utility and firmware image files are not located in the root directory, move to the directory where these files are located, for example:

        `fs0:\> cd \EFI\HP\TOOLS\IO_CARDS\SmartArray`

   - To run `saupdate` from the EFI partition:
     a. Download the Smart Array EFI update utility `saupdate.efi` and copy it to the EFI partition.
     b. Download the firmware and copy it to the EFI partition.
     c. Boot the system to the EFI Shell and change directories to the EFI partition.

> **IMPORTANT:** The firmware image file and `saupdate.efi` must be located in the same directory. If they are not, copy them to the EFI partition and run the `saupdate` from there.

2. To update the firmware on the controller, use `saupdate UPDATE`.

   The syntax of the `saupdate UPDATE` command is as follows:

   `saupdate UPDATE <seg:bus:dev:func> <smartarray_firmware_file>`

   For example, to update the controller at segment 0, bus 52, device 0, function 0 from the example output above:

   `fs0:\> saupdate UPDATE 0:52:0:0 INCPTR.PAK`

   Replace INCPTR.PAK with the name of your firmware file.

   For example:

```
fs0:\EFI\TOOLS> saupdate update 0:52:0:0 INCPTR.PAK

*****************************************************************************
                  Smart Array Offline Firmware Update Utility
                              Version 2.06.10.03

          (C) Copyright 2006 Hewlett-Packard Development Company, L.P.
*****************************************************************************

 Updating controller in Seg: 0, Bus: 52, Dev: 0, Func: 0
 Current firmware version 2.06

     Percentage completed: 100%

     Activating firmware now, this may take several minutes.

     Resetting and reinitializing controller.

     Retrieving firmware version, this may take several minutes.

 Current controller firmware version is 2.08.
```

Verifying the firmware update

To verify that the firmware update was successful:

1. After updating the firmware, cycle the power on the system and on any external JBODS connected to the system.
2. To confirm that the correct firmware version is installed, use `saupdate list`. See "Verifying the controller firmware" (page 26).

   For example:

```
fs0:\EFI\TOOLS> saupdate list

*****************************************************************************
                  Smart Array Offline Firmware Update Utility
                              Version 2.06.10.03

          (C) Copyright 2006 Hewlett-Packard Development Company, L.P.
*****************************************************************************

     Seg   Bus   Dev   Func       Description          Version

      0    52    0     0      HP Smart Array P400      2.08
```

HELP or ?

To display usage text, program version number, and build date, use `HELP` or `?`:

Enter: `saupdate HELP`

or

`saupdate ?`

Error messages

The following error messages might appear when using `saupdate`:

- When keyword `LIST` or `UPDATE` is misspelled or extra parameters are specified:

  ```
  Error: Syntax Error

  Usage: saupdate LIST or saupdate UPDATE [ | all ]
  ```

- When the controller ID in the `saupdate UPDATE` command is not correct:

  ```
  No matching controller found
  ```

- When a firmware file does not exist in the `saupdate UPDATE` directory:

  ```
  INCPTR.BIN does not exist.
  File INCPTR.BIN: Not Found
  ```

- When an invalid or corrupted firmware file is specified in the `saupdate UPDATE` command:

  ```
  INCPTR.BIN does not exist.
  File INCPTR.BIN: invalid or corrupted
  ```

Verifying and updating enclosure firmware offline

To verify and update the firmware in an external enclosure, follow the procedures in this section.

After initial installation, you can verify and update the enclosure firmware online using `sautil`. See "Checking and updating SAS storage enclosure firmware online" (page 82).

Verifying the enclosure firmware

To verify the firmware image on the enclosure, use `saupdate` from the EFI Shell.

To verify the enclosure firmware with `saupdate`:

1. Prepare to run `saupdate` from the Offline Diagnostics CD or the EFI partition:

   - To run `saupdate` from the Offline Diagnostic CD:

     a. Place the Offline Diagnostic CD containing `saupdate.efi` in the CD drive before booting the system.

     b. Boot the system to the EFI Shell prompt.

     c. Locate the `cdrom` entry in the list of mapped devices, and change to the device by entering its associated `fs` number (for example, **fs0**) at the EFI Shell prompt.

     d. If the EFI utility is not located in the root directory, move to the directory where the file is located, for example:

     ```
     fs0:\> cd \EFI\HP\TOOLS\IO_CARDS\SmartArray
     ```

   - To run `saupdate` from the EFI partition:

     a. Download the SA EFI update utility `saupdate.efi` and copy it to the EFI partition.

     b. Boot the system to the EFI Shell and change directories to the EFI partition.

     c. If the EFI utility is not located in the root directory, move to the directory where the file is located, for example:

     ```
     fs0:\> cd \EFI\HP\TOOLS\IO_CARDS\SmartArray
     ```

2. • To display all detected Smart Array controllers along with the active firmware versions, use `saupdate LIST`.

   For example:

```
fs0:\EFI\TOOLS> saupdate list


************************************************************************
                Smart Array Offline Firmware Update Utility
                           Version 2.07.09.02

          (C) Copyright 2006 Hewlett-Packard Development Company, L.P.

    Seg  Bus  Dev  Func        Description              Version
     0    8    0    0          HP Smart Array P800       4.10

        External Enclosures Connected :
        Index      Description          Version
          2          MSA70              2.04
```

In this example, the system contains one MSA70 enclosure at segment 0, bus 8, device 0, function 0, index 2; enclosure firmware 2.04 is installed.

Downloading the enclosure firmware

To locate and download firmware for HP StorageWorks enclosures:
1. Go to the HP Software & Driver Downloads website at http://welcome.hp.com/country/us/en/support.html?pageDisplay=drivers.
2. Search for the name of your enclosure; for example, "MSA60" or "MSA70".
3. In the search results, click **Cross operating system (BIOS, Firmware, Diagnostics, etc.)**.
4. To download the firmware package, click **Download**.

Updating the enclosure firmware

NOTE: The following is a generic procedure to update firmware from the EFI shell. HP recommends that you follow the procedures supplied with the update package to install the firmware update.

To update the firmware image on the enclosure, use `saupdate` from the EFI Shell.

To update the enclosure firmware with `saupdate`:

1. Prepare to run `saupdate` from the Offline Diagnostics CD or the EFI partition:
   - To run `saupdate` from the Offline Diagnostic CD:
     a. Download the firmware and copy it to the EFI partition.
     b. Place the Offline Diagnostic CD containing `saupdate.efi` in the CD drive before booting the system.
     c. Boot the system to the EFI Shell prompt.
     d. Locate the `cdrom` entry in the list of mapped devices, and change to the device by entering its associated `fs` number (for example, **fs0**) under EFI Shell prompt.
     e. If the EFI utility and firmware image files are not located in the root directory, move to the directory where these files are located, for example:

        `fs0:\>` **`cd \EFI\HP\TOOLS\IO_CARDS\SmartArray`**

   - To run `saupdate` from the EFI partition:
     a. Download the Smart Array EFI update utility `saupdate.efi` and copy it to the EFI partition.
     b. Download the firmware and copy it to the EFI partition.
     c. Boot the system to the EFI Shell and change directories to the EFI partition.

   ⊙ **IMPORTANT:** The firmware image file and `saupdate.efi` must be located in the same directory. If they are not, copy them to the EFI partition and run the `saupdate` from there.

2. To update the firmware on the controller, use `saupdate UPDATE`:
   - To update a single enclosure, use this command:

     `saupdate UPDATE <seg:bus:dev:func:encl_index> <firmware_file>`

     For example, to update the enclosure at segment 0, bus 8, device 0, function 0, index 2 with the firmware file `VWG2_206.S3`:

```
fs0:\EFI\TOOLS> saupdate UPDATE 0:8:0:0:2 VWG2_206.S3

***********************************************************************
                  Smart Array Offline Firmware Update Utility
                             Version 2.07.09.02

              (C) Copyright 2006 Hewlett-Packard Development Company, L.P.
***********************************************************************

 Updating Enclosure in Seg: 0, Bus: 8, Dev: 0, Func: 0, Index: 2


      Sending Image Chunk No: 117 of 117

     Activating firmware now, this may take several minutes.

      Retrieving firmware version, this may take several minutes.

Current Enclosure Firmware version is 2.06
```

   - To update all attached enclosures, use this command:

     `saupdate UPDATE <seg:bus:dev:func>` `all_encl` `<firmware_file>`

Verifying the firmware update

1. After updating the firmware, cycle the power on the system and on any external JBODS connected to the system.

2. To confirm that the correct firmware version is installed, use `saupdate LIST`. See .

For example:

```
fs0:\EFI\TOOLS> saupdate list

**************************************************************************
                    Smart Array Offline Firmware Update Utility
                              Version 2.07.09.02

           (C) Copyright 2006 Hewlett-Packard Development Company, L.P.
**************************************************************************

    Seg  Bus  Dev  Func        Description              Version
      0    8    0     0          HP Smart Array P800      4.10

             External Enclosures Connected :
             Index        Description           Version
               2            MSA70                  2.06
```

HELP or ?

To display usage text, program version number, and build date, use `HELP` or `?`:

Enter `saupdate HELP`

or

`saupdate ?`

Verifying the installation

After the system reboots, verify that the installation was successful by following these steps:

1. Enter the `swlist` command:

   ```
   # swlist
   ```

   If the Smart Array Controller is installed correctly, the generated output looks similar to the following examples:

   For HP-UX 11i v3:

   ```
   RAID-01 B.11.31.0709.01    RAID SA; Supptd HW=A7143A/A9890A/A9891A
   ```

   For HP-UX 11i v2:

   ```
   RAID-01 B.11.23.0706    RAID SA; Supptd HW=A7143A/A9890A/A9891A
   ```

   The version string that appears indicates the version of the RAID-01 bundle installed on your server.

2. Enter the `ioscan -kfnd ciss` command:

   ```
   # ioscan -kfnd ciss
   ```

   If the Smart Array Controller software is installed correctly, the generated output looks similar to this:

   ```
   # ioscan -kfnd ciss
   Class    I H/W Path       Driver  S/W State  H/W Type    Description
   ======================================================================
   ext_bus  5 0/6/0/0/0/0/1/0/0/0  ciss   CLAIMED   INTERFACE   PCIe SAS SmartArray P400 RAID Controller
                        /dev/ciss5
   ```

   If the software is not installed correctly, reinstall it using `swinstall`. See .

Confirming and updating physical disk firmware

To confirm and update the firmware version on each physical disk in the SmartArray disk enclosure attached to the Smart Array Controller, use the `sautil` command.

You must log in as a superuser to run the `sautil` command.

Before running the `sautil` command to confirm or update physical disk firmware, you must know the device file name for the Smart Array Controller and the SCSI channel and SCSI ID for each physical disk attached to the Smart Array Controller.

Determining the Smart Array controller device file

Determine the device file name for the Smart Array Controller from the output of the `ioscan -kfnd ciss` command. An example of the `ioscan` output listing the Smart Array Controller device files follows.

```
# ioscan -kfnd ciss
Class     I  H/W Path          Driver   S/W State   H/W Type     Description
=========================================================================
ext_bus   5  0/6/0/0/0/0/1/0/0/0  ciss      CLAIMED     INTERFACE    PCIe SAS SmartArray P400 RAID Controller
                            /dev/ciss5
```

In the example, `/dev/ciss5` is the device file for the Smart Array P400 Controller.

Determining the Connector/Enclosure/Bay and firmware version for physical disks

You can determine the Connector/Enclosure/Bay and current firmware version for each physical disk attached to the Smart Array Controller by using the `sautil <device_file>` command (extensive output), or the `sautil <device_file> -s` command (shortened output).

The `sautil <device_file> -s` command displays an abbreviated list of information for the Smart Array Controller and connected devices, including a SAS/SATA DEVICE SUMMARY that lists the Connector/Enclosure/Bay for each physical disk attached to the Smart Array Controller. The firmware version installed on each physical disk is also included in the `sautil <device_file> -s` command output. For example:

```
# sautil /dev/ciss5 -s


*******************************************************************************
****                                                                     ****
****              S A U T I L   S u p p o r t   U t i l i t y             ****
****                                                                     ****
****            for the HP SmartArray RAID Controller Family             ****
****                                                                     ****
****                         version A.02.11                             ****
****                                                                     ****
****   (C) Copyright 2003-2006 Hewlett-Packard Development Company, L.P.  ****
*******************************************************************************



---- DRIVER INFORMATION -------------------------------------------------

  Driver State....................... READY

---- CONTROLLER INFORMATION ---------------------------------------------

  Controller Product Number.......... P400
  Controller Product Name............ HP PCIe SmartArray P400
  Hardware Path...................... 0/6/0/0/0/0/1/0/0/0
  Serial Number...................... PA5360BBFSW2ON
  Device File........................ /dev/ciss5
  Hardware Revision.................. 'B'
  Firmware Revision (in ROM)......... 2.08
  # of Logical Drives................ 1
  # of Physical Disks Configured..... 6
  # of Physical Disks Detected....... 8
```

```
---- ARRAY ACCELERATOR (CACHE) INFORMATION ------------------------------------

  Array Accelerator Board Present?.... yes
  Cache Configuration Status.......... cache enabled
  Cache Ratio......................... 50% Read / 50% Write
  Total Cache Size (MB)............... 208
  Battery Pack Count.................. 1
  Battery Status (pack #1)............ ok


---- LOGICAL DRIVE SUMMARY -----------------------------------------------------

      #   RAID      Size        Status

      0   ADG       15360 MB    OK


---- SAS/SATA DEVICE SUMMARY ---------------------------------------------------

  Location  Ct Enc Bay       WWID            Type        Capacity Status

  internal  1I   1  12  0x500000e01117c732  DISK        36.4 GB   OK
  internal  1I   1  11  0x500000e01115c352  DISK        36.4 GB   OK
  internal  1I   1  10  0x5000c5000032b839  DISK        36.4 GB   OK
  internal  1I   1   9  0x5000c5000030b0c5  DISK        36.4 GB   OK
  internal  2I   1  16  0x500000e011213482  DISK        36.4 GB   OK
  internal  2I   1  15  0x5000c500002084c9  DISK        73.4 GB   OK
  internal  2I   1  14  0x5000c5000030b9c9  DISK        36.4 GB   UNASSIGNED
  internal  2I   1  13  0x500000e01118a7a2  DISK        36.4 GB   UNASSIGNED


---- SAS/SATA ENCLOSURE SUMMARY ------------------------------------------------

  Location  Ct   Enc  Expander_count    Bay_count     SEP_count

  internal  1I   1    0                 4             1
  internal  2I   1    0                 4             1


---- SAS/SATA DEVICE 1I:1:12:0x500000e01117c732 [DISK] ----------------------

  Connector Location.............................. internal
  Connector....................................... 1I
  Enclosure....................................... 1
  Bay............................................. 12
  WWID............................................ 0x500000e01117c732
  Device Type..................................... DISK
  Disk Capacity................................... 36.4 GB
  Device Status................................... OK
  Device Vendor ID................................ HP
  Device Product ID............................... DG036A8B5B
  Device Serial Number............................ B2G2P55001SF0519
  Device Firmware Version......................... HPD4


---- SAS/SATA DEVICE 1I:1:11:0x500000e01115c352 [DISK] ----------------------

  Connector Location.............................. internal
  Connector....................................... 1I
  Enclosure....................................... 1
  Bay............................................. 11
  WWID............................................ 0x500000e01115c352
  Device Type..................................... DISK
  Disk Capacity................................... 36.4 GB
  Device Status................................... OK
  Device Vendor ID................................ HP
  Device Product ID............................... DG036A8B5B
  Device Serial Number............................ B2G2P55001H70519
  Device Firmware Version......................... HPD4
```

```
     ---- SAS/SATA DEVICE 1I:1:10:0x5000c5000032b839 [DISK] --------------------

        Connector Location............................... internal
        Connector........................................ 1I
        Enclosure........................................ 1
        Bay.............................................. 10
        WWID............................................. 0x5000c5000032b839
        Device Type...................................... DISK
        Disk Capacity.................................... 36.4 GB
        Device Status.................................... OK
        Device Vendor ID................................. HP
        Device Product ID................................ DG036A8B53
        Device Serial Number............................. 3LC03L7Z0000854051PK
        Device Firmware Version.......................... HPD4


     ---- SAS/SATA DEVICE 1I:1:9:0x5000c5000030b0c5 [DISK] ----------------------

        Connector Location............................... internal
        Connector........................................ 1I
        Enclosure........................................ 1
        Bay.............................................. 9
        WWID............................................. 0x5000c5000030b0c5
        Device Type...................................... DISK
        Disk Capacity.................................... 36.4 GB
        Device Status.................................... OK
        Device Vendor ID................................. HP
        Device Product ID................................ DG036A8B53
        Device Serial Number............................. 3LC01ZT100008524EDM6
        Device Firmware Version.......................... HPD3


     ---- SAS/SATA DEVICE 2I:1:16:0x500000e011213482 [DISK] ---------------------

        Connector Location............................... internal
        Connector........................................ 2I
        Enclosure........................................ 1
        Bay.............................................. 16
        WWID............................................. 0x500000e011213482
        Device Type...................................... DISK
        Disk Capacity.................................... 36.4 GB
        Device Status.................................... OK
        Device Vendor ID................................. HP
        Device Product ID................................ DG036A8B5B
        Device Serial Number............................. B2G2P55003940521
        Device Firmware Version.......................... HPD4


     ---- SAS/SATA DEVICE 2I:1:15:0x5000c500002084c9 [DISK] ---------------------

        Connector Location............................... internal
        Connector........................................ 2I
        Enclosure........................................ 1
        Bay.............................................. 15
        WWID............................................. 0x5000c500002084c9
        Device Type...................................... DISK
        Disk Capacity.................................... 73.4 GB
        Device Status.................................... OK
        Device Vendor ID................................. HP
        Device Product ID................................ DG072A8B54
        Device Serial Number............................. 3LB02D5200008523E7Z1
        Device Firmware Version.......................... HPD4


     ---- SAS/SATA DEVICE 2I:1:14:0x5000c5000030b9c9 [DISK] ---------------------

        Connector Location............................... internal
        Connector........................................ 2I
        Enclosure........................................ 1
        Bay.............................................. 14
        WWID............................................. 0x5000c5000030b9c9
```

```
     Device Type.................................... DISK
     Disk Capacity.................................. 36.4 GB
     Device Status.................................. UNASSIGNED
     Device Vendor ID............................... HP
     Device Product ID.............................. DG036A8B53
     Device Serial Number........................... 3LC01ZTE00008524EDPX
     Device Firmware Version........................ HPD4


     ---- SAS/SATA DEVICE 2I:1:13:0x500000e01118a7a2 [DISK] ----------------------

     Connector Location............................. internal
     Connector...................................... 2I
     Enclosure...................................... 1
     Bay............................................ 13
     WWID........................................... 0x500000e01118a7a2
     Device Type.................................... DISK
     Disk Capacity.................................. 36.4 GB
     Device Status.................................. UNASSIGNED
     Device Vendor ID............................... HP
     Device Product ID.............................. DG036A8B5B
     Device Serial Number........................... B2G2P55001W50520
     Device Firmware Version........................ HPD4

     ********************************************************************************
     ****                          End of SAUTIL Output                        ****
     ********************************************************************************
```

In this example, the `SAS/SATA DEVICE SUMMARY` lists the Connector/Enclosure/Bay for each physical disk attached to the Smart Array Controller. The information provided for each of the physical disks, following the `SAS/SATA DEVICE SUMMARY`, indicates that all physical disks have firmware version `HPD4` installed except for `1I:1:9`, which has version `HPD3`.

Configuring a Smart Array controller as a boot device

This section describes the additional steps you must follow to enable your system to boot from logical drives on a Smart Array Series Controller.

NOTE: To create logical drives, use ORCA. See .

Planning to install HP-UX on a logical drive

On each Smart Array Controller, you can set up any number of its logical drives as boot devices. For example, if you have two controllers in a system, and each controller has three logical drives configured on it, you can set up two logical drives on one controller as boot devices and all three logical drives on the other controller as boot devices, giving you a total of five boot devices.

Before a Smart Array Controller can be set up as a boot device, the following dependencies must be met:

- You must have the correct version of the product dependent code (PDC) or system firmware installed. For information on the firmware versions needed for each of the supported HP-UX systems, see the , see the *HP Smart Array RAID Controllers Support Matrix* at http:// www.hp.com/go/hpux-iocards-docs. If you do not have the correct PDC or system firmware version, contact your HP representative.

- You must have the recommended version of the Smart Array controller firmware installed. For information, see .

- HP strongly recommends having an alternate boot device available.

Before you set up a Smart Array Controller as a boot device, consider the following:

- When you use a Smart Array logical drive as a boot device running HP-UX, you are limited in the configuration tasks you can perform with the `saconfig` configuration utility. The

`saconfig` utility sees the logical drive as being in use, so configuration changes affecting that drive are not allowed until the drive is no longer the boot device.

- When you are not using a logical drive as a boot device, if you clear the controller's configuration the logical drive is also deleted. If you want a logical drive to remain set up as a boot device, configure a logical drive and then complete the entire boot setup process again.

- If you have trouble accessing RAID boot data, only limited troubleshooting tools are available. HP recommends booting from an alternative boot media and using STM and `sautil` online tools. For more information, see Chapter 4: "Troubleshooting" (page 59).

Configuring a logical drive offline using ORCA

Smart Array controllers support Option ROM Configuration for Arrays (ORCA) on HP Integrity servers. ORCA is a menu-driven system for creating, editing, and deleting logical drives.

To access ORCA, follow the procedures in the installation guide for your controller. Installation guides are available on the HP website at:

http://www.hp.com/go/hpux-iocards-docs

Click the link for your HP-UX version. Installation guides are listed alphabetically in the "Setup and install — general" section.

(!) **IMPORTANT:**

ORCA appearance, functionality, and keystrokes are not the same for all Smart Array controllers. This section provides a generic procedure using a P400 controller as an example. Always follow the on-screen prompts when using ORCA.

Figure 15 ORCA Main Menu Screen


```
Option Rom Configuration for Arrays, version  2.84
Copyright 2005 Hewlett-Packard Development Company, L.P.

Controller: HP Smart Array P400, slot 6




                    +------------Main Menu--------------+
                    | Create Logical Drive              |
                    | View Logical Drive                |
                    | Delete Logical Drive              |
                    | Select as Boot Controller         |
                    +-----------------------------------+




<Enter> to create a new logical drive
<UP/DOWN ARROW> to select main menu option; <ESC> to exit
Note: For more configuration options use the HP Array Configuration Utility  _
```

To create a logical drive using ORCA:

1. Select **Create Logical Drive**. The screen displays a list of available (unconfigured) physical drives and the valid RAID options for the system.
2. Use the arrow keys, space bar, and **Tab** key to navigate around the screen and set up the logical drive, including an online spare drive if one is required.

NOTE: You cannot use ORCA to configure a logical drive using RAID 0; you must use RAID 1+0 or higher. To configure a RAID 0 logical drive online, use the `saconfig` command. For more information, see "Configuring a logical drive" (page 46).

NOTE: You cannot use ORCA to configure a single spare drive to be shared among several arrays. To configure shared spare drives, use the `saconfig` command. See "Adding a spare disk drive" (page 50).

3. To accept the settings, press **Enter**.
4. To confirm the settings and save the configuration, press **F8**. After several seconds, the Configuration Saved screen appears.
5. To continue, press **Enter**.
6. Create another logical drive by repeating steps 1-5 if necessary.

For more information on using ORCA, see "Using ORCA" (page 53).

3 Configuration

This chapter explains how to use the `saconfig` command to configure Smart Array SAS Controllers.

NOTE: Command outputs are similar for different Smart Array SAS controllers, so in most cases the example output is shown for only one controller model. If the difference between controllers is significant for a specific command, separate examples from each controller type are provided.

Planning the RAID configuration

If you do not know how you want to configure RAID on your system, follow these steps before proceeding to "The saconfig configuration CLI" (page 40):

1. Determine the RAID level you want to use for each logical drive.

    See "Fault management in supported RAID configurations" (page 20) and "Choosing a RAID method" (page 21).

2. Determine and record the physical disk configuration, and use this to assign disks to logical drives.

    When you assign disks to logical drives, consider:

    *   Distributing one or more logical drives across controller channels. This protects against a cable disconnection and distributes the I/O load across the channels. You can support different RAID levels across multiple channels.

    *   Using one or more online spare disk drives. Spare drives provide extra protection if there is a disk failure beyond the fault tolerance protection offered by the RAID configuration. Spare drive capacity is held in reserve and is not available except when needed to back up a failed physical drive.

3. Select a stripe size.

    In most cases, the default stripe size provides the best performance. Use a smaller size only if you know your data is always written in smaller blocks.

    For RAID 0, 1 and 1+0 the default stripe size is 128 KB. For RAID 5, 50, ADG, and 60, the default stripe size is 16 KB.

4. Determine the logical drive configuration. Consider the following:

    *   Only logical drives can be accessed by HP-UX. Physical disks cannot be accessed by HP-UX. Each logical drive is recognized as a very large SCSI disk.

    *   Do not include physical disks of different capacities in the same logical drive.

    *   HP-UX recognizes Smart Array logical drives as disks, so you can use the LVM to configure them as physical volumes. You can then partition the drive into separate logical volumes.

        ◦   For more information about LVM for HP-UX 11i v2, see *Managing Systems and Workgroups: A Guide for HP-UX System Administrators*.

        ◦   For more information about LVM for HP-UX 11i v3, see *HP-UX System Administrator's Guide (volume 3): Logical Volume Management*.

        These documents are available on the HP website at www.hp.com/go/hpux-core-docs

The saconfig configuration CLI

Use the `saconfig` command to:

*   Configure logical drives
*   Set RAID levels

- Set the stripe size on a RAID logical drive
- Set up online spare disk drives
- Delete logical drives
- Clear the current configuration
- Specify the percentage of the cache used for read caching
- Auto-fail missing disks at boot time
- Create multiple logical drives in an array
- Perform RAID level migration
- Perform stripe size migration
- Extend the capacity of a logical drive
- Expand the capacity of an array
- Change the expand priority
- Change the rebuild priority

To run the `saconfig` command, you must log in as a superuser .

To display the `saconfig` help screen with command options and syntax, enter `saconfig` without any options. Example 1 and Example 2 (page 44) show the help screens.

Example 1 The saconfig help screen for HP-UX 11i v3

```
# saconfig

No device file specified

******************************************************************************
******************************************************************************
****                                                                      ****
****                    S A C O N F I G   U t i l i t y                    ****
****                                                                      ****
****             for the HP SmartArray RAID Controller Family             ****
****                                                                      ****
****                          version A.01.20                             ****
****                                                                      ****
****   (C) Copyright 2003-2007 Hewlett-Packard Development Company, L.P.   ****
******************************************************************************

Usage:

To display configuration

 saconfig /dev/cissX

To display configuration with persistent device files

 saconfig /dev/cissX -N

To create logical drive

 saconfig /dev/cissX -R <RAID level> [-S <Stripe size (KB)>]
  -p <physical_drive_id> [-p <physical_drive_id> ... ]
  [-s <physical_drive_id>] [-c <capacity (GB)>]

 RAID level can be 0, 1, 1+0, 5, or ADG.

 For RAID 0, 1, and 1+0, stripe size can be 8, 16, 32, 64,
 128, or 256 (default is 128).

 For RAID 5 and ADG, stripe size can be 8, 16, 32, or 64
 (default is 16).
        "<physical_drive_id>" is:
            <channel_id>:<target_id> of the SCSI physical disk, e.g., 4:12
          OR
            <connector>:<enclosure>:<bay> of the SAS/SATA physical disk,
            e.g., 2I:1:10
          OR
            <wwid> of the SAS/SATA physical disk, e.g., 0x500000e010f16432

To delete logical drive

 saconfig /dev/cissX -D <Logical drive #>

To clear configuration

 saconfig /dev/cissX -D all


To add spare drive to existing logical drive

 saconfig /dev/cissX -A <Logical drive #> -s <physical_drive_id>

To delete a spare drive of a logical drive

 saconfig /dev/cissX -D <Logical drive #> -s <physical_drive_id>

To delete all spare drives of a logical drive

 saconfig /dev/cissX -D <Logical drive #> -s all

To change the expand priority of controller to low, medium, or high
```

```
   saconfig /dev/cissX -e <expand_priority>

To change the rebuild priority of controller to low, medium, or high

 saconfig /dev/cissX -r <rebuild_priority>

To specify the percentage of total cache size to be used for read caching

 saconfig /dev/cissX -C <read_caching_percentage>

 Read caching percentage can be 0, 25, 50, 75, or 100.

To enable or disable auto-fail missing disks at boot

 saconfig /dev/cissX -F on|off

To identify (light LED) SAS/SATA physical drives

 saconfig /dev/cissX -I -p <physical_drive_id>
   [-p <physical_drive_id> ... ]

To identify SAS/SATA physical drives constituting a logical drive

 saconfig /dev/cissX -I -l <Logical drive #>

To extend the capacity of the specified logical drive up to larger
capacity.  The capacity is in GB.

 saconfig /dev/cissX -E <Logical drive #> -c <capacity (GB)>

To expand the specified logical drive and others in an array by
physical drive(s)

 saconfig /dev/cissX -E <Logical drive #> -p <physical_drive_id>
   [-p <physical_drive_id> ... ]

To perform RAID level [with Stripe size (KB)] migration on the specified
logical drive.  The stripe size is in KB.

 saconfig /dev/cissX -M <Logical drive #> -R <RAID level>
   [-S <Stripe size (KB)>]

To perform Stripe size migration on the specified logical drive.
The stripe size is in KB.

 saconfig /dev/cissX -M <Logical drive #> -S <Stripe size (KB)>
```

NOTE: In HP-UX 11i v3, the -N option causes saconfig to display persistent device file information. If you do not specify the -N option, saconfig displays legacy device file information. This provides backward compatibility with previous versions of HP-UX. For more information about persistent device files in HP-UX 11i v3, see the intro(7) manpage.

Example 2 The saconfig help screen for HP-UX 11i v2

```
# saconfig
No device file specified

*******************************************************************************
****                                                                       ****
****                    S A C O N F I G   U t i l i t y                     ****
****                                                                       ****
****              for the HP SmartArray RAID Controller Family             ****
****                                                                       ****
****                          version A.01.18                              ****
****                                                                       ****
****   (C) Copyright 2003-2006 Hewlett-Packard Development Company, L.P.    ****
*******************************************************************************

Usage:

To display configuration

 saconfig /dev/cissX

To create logical drive

 saconfig /dev/cissX -R <RAID level> [-S <Stripe size (KB)>]
  -p <physical_drive_id> [-p <physical_drive_id> ... ]
  [-s <physical_drive_id>] [-c <capacity (GB)>]

 RAID level can be 0, 1, 1+0, 5, or ADG.

 For RAID 0, 1, and 1+0, stripe size can be 8, 16, 32, 64,
128, or 256 (default is 128).

 For RAID 5 and ADG, stripe size can be 8, 16, 32, or 64
 (default is 16).
        "<physical_drive_id>" is:
            <channel_id>:<target_id> of the SCSI physical disk, e.g., 4:12
          OR
            <connector>:<enclosure>:<bay> of the SAS/SATA physical disk,
            e.g., 2I:1:10
          OR
            <wwid> of the SAS/SATA physical disk, e.g., 0x500000e010f16432

To delete logical drive

 saconfig /dev/cissX -D <Logical drive #>

To clear configuration

 saconfig /dev/cissX -D all


To add spare drive to existing logical drive

 saconfig /dev/cissX -A <Logical drive #> -s <physical_drive_id>

To delete a spare drive of a logical drive

 saconfig /dev/cissX -D <Logical drive #> -s <physical_drive_id>

To delete all spare drives of a logical drive

 saconfig /dev/cissX -D <Logical drive #> -s all

To change the rebuild priority for the logical drives

 saconfig /dev/cissX -r <rebuild_priority>

To specify the percentage of total cache size to be used for read caching

 saconfig /dev/cissX -C <read_caching_percentage>
```

```
   Read caching percentage can be 0, 25, 50, 75, or 100.

To enable or disable auto-fail missing disks at boot

 saconfig /dev/cissX -F on|off

To identify (light LED) SAS/SATA physical drives

 saconfig /dev/cissX -I -p <physical_drive_id>
   [-p <physical_drive_id> ... ]

To identify SAS/SATA physical drives constituting a logical drive

 saconfig /dev/cissX -I -l <Logical drive #>

To extend the capacity of the specified logical drive up to larger
capacity.  The capacity is in GB.

 saconfig /dev/cissX -E <Logical drive #> -c <capacity (GB)>

To expand the specified logical drive and others in an array by
physical drive(s)

 saconfig /dev/cissX -E <Logical drive #> -p <physical_drive_id>
   [-p <physical_drive_id> ... ]

To perform RAID level [with Stripe size (KB)] migration on the specified
logical drive.  The stripe size is in KB.
 saconfig /dev/cissX -M <Logical drive #> -R <RAID level>
   [-S <Stripe size (KB)>]

To perform Stripe size migration on the specified logical drive.
The stripe size is in KB.
 saconfig /dev/cissX -M <Logical drive #> -S <Stripe size (KB)>
```

To view the `saconfig` manpage for more information, see saconfig(I).

Before running `saconfig` to configure the storage devices connected to a Smart Array Controller, you must know the device file name for the Smart Array Controller. See "Determining the Smart Array controller device file" (page 34).

Displaying the Smart Array controller configuration

To display the physical disks connected to a Smart Array Controller and configured logical drives and spare drives, use the `saconfig /dev/cissX` command. Replace `X` with the device file number for the Smart Array Controller.

The Connector/Enclosure/Bay, WWID, size, and status of each physical disk attached to the Smart Array Controller is included in the `saconfig /dev/cissX` output. If logical drives are configured on the Smart Array Controller, a detailed description of those drives appears:

```
# saconfig /dev/ciss5

******************** SmartArray RAID Controller /dev/ciss5 ********************

Auto-Fail Missing Disks at Boot     = enabled
Cache Configuration Status          = cache enabled
Cache Ratio                         = 50% Read / 50% Write

---------- PHYSICAL DRIVES ----------

Location  Ct Enc Bay      WWID            Size       Status

Internal  1I   1  12  0x500000e01117c732  36.4 GB    OK
Internal  1I   1  11  0x500000e01115c352  36.4 GB    OK
Internal  1I   1  10  0x5000c5000032b839  36.4 GB    OK
Internal  1I   1   9  0x5000c5000030b0c5  36.4 GB    OK
Internal  2I   1  16  0x500000e011213482  36.4 GB    OK
Internal  2I   1  15  0x5000c500002084c9  73.4 GB    OK
Internal  2I   1  14  0x5000c5000030b9c9  36.4 GB    UNASSIGNED
```

```
Internal  2I   1  13  0x500000e01118a7a2  36.4 GB    UNASSIGNED

---------- LOGICAL DRIVE 0 ----------

Device File     = c5t0d0
RAID Level      = 5
Size            = 15360 MB
Stripe Size     = 64 KB
Status          = OK

Participating Physical Drive(s):

Ct  Enc  Bay        WWID
1I    1   12  0x500000e01117c732
1I    1   11  0x500000e01115c352
1I    1   10  0x5000c5000032b839
1I    1    9  0x5000c5000030b0c5
2I    1   16  0x500000e011213482
2I    1   15  0x5000c500002084c9

Participating Spare Drive(s):

None
```

In this example, eight physical disks are attached to the Smart Array Controller (`/dev/ciss5`).

Configuring a logical drive

To configure a logical drive, use the following command:

`saconfig /dev/cissX -R <RAID level> [-S <Stripe size (KB)>] -p <physical drive id> [-p <physical drive id> ... ] [-s <physical drive id>] [-c <capacity (GB)>]`

Where:

`-R <RAID level>`	The RAID level to be configured on the logical drive. For information on the RAID levels supported by each Smart Array controller, see "Supported RAID modes, by controller" (page 21).
`[-S <Stripe size (KB)>]`	The stripe size (KB) to be configured on the logical drive. For RAID 0, 1, and 1+0, the options are: • 8 KB • 16 KB • 32 KB • 64 KB • 128 KB • 256 KB The default stripe size is 128 KB if the `-S` option is not used. For RAID 5, 50, ADG, and 60, the options are: • 8 KB • 16 KB • 32 KB • 64 KB The default stripe size is 16 KB if the `-S` option is not used.
`-p <physical drive id> [-p <physical drive id>...]`	The physical disks included in the logical drive. Each physical disk is identified by Connector/Enclosure/Bay or WWID. Obtain this information from the output of the

	saconfig `<dev_file>` command, as described in "Displaying the Smart Array controller configuration" (page 45).
`[-s <physical drive id>]`	Configures a physical disk as a spare. The physical disk is identified by Connector/Enclosure/Bay or WWID. Obtain this information from the output of the saconfig `<dev_file>` command, as described in "Displaying the Smart Array controller configuration" (page 45).
`[-c <capacity (GB)>]`	Specifies the size in GB of the logical drive to be created. If this option is omitted, the maximum capacity or the remaining capacity is applied to the logical drive.

In the following example, a logical drive is configured on the Smart Array Controller with the device filename `ciss5`. The RAID level is set at 1, the stripe size is set at 64 KB, and two physical disks (identified by `2I:1:13` and `2I:1:14`) are configured as a logical drive. Another physical disk (identified by `2I:1:15`) is configured as a spare for that logical drive:

```
# saconfig /dev/ciss5 -R 1 -S 64 -p 2I:1:13 -p 2I:1:14 -s 2I:1:15
Logical drive 0 created
Rebuild Priority is set to High
```

Use the saconfig `/dev/cissX` command to confirm the configuration:

```
# saconfig /dev/ciss5

******************** SmartArray RAID Controller /dev/ciss5 ********************

Auto-Fail Missing Disks at Boot    = enabled
Cache Configuration Status         = cache enabled
Cache Ratio                        = 25% Read / 75% Write

---------- PHYSICAL DRIVES ----------

Location  Ct Enc Bay      WWID               Size        Status

Internal  1I   1  12   0x500000e01117c732   36.4 GB     UNASSIGNED
Internal  1I   1  11   0x500000e01115c352   36.4 GB     UNASSIGNED
Internal  1I   1  10   0x5000c5000032b839   36.4 GB     UNASSIGNED
Internal  1I   1   9   0x5000c5000030b0c5   36.4 GB     UNASSIGNED
Internal  2I   1  16   0x500000e011213482   36.4 GB     UNASSIGNED
Internal  2I   1  15   0x5000c500002084c9   73.4 GB     SPARE
Internal  2I   1  14   0x5000c5000030b9c9   36.4 GB     OK
Internal  2I   1  13   0x500000e01118a7a2   36.4 GB     OK

---------- LOGICAL DRIVE 0 ----------

Device File    = c5t0d0
RAID Level     = 1+0
Size           = 34700 MB
Stripe Size    = 64 KB
Status         = OK

Participating Physical Drive(s):

Ct  Enc  Bay        WWID
2I    1   14   0x5000c5000030b9c9
2I    1   13   0x500000e01118a7a2

Participating Spare Drive(s):

Ct  Enc  Bay        WWID
2I    1   15   0x5000c500002084c9
```

NOTE: When RAID 1 is configured on two physical disks, the saconfig /dev/cissX command output displays the RAID level as 1+0.

Deleting a logical drive

To delete a logical drive that has been configured on a Smart Array Controller, use the command `saconfig /dev/cissX -D <Logical drive #>`.

The following example deletes logical drive 0 from the Smart Array Controller with the device filename `ciss7`:

```
# saconfig /dev/ciss7 -D 0
Are you sure you want to delete logical drive 0 on
SmartArray RAID controller /dev/ciss7? (y/[n]): y
Logical drive 0 deleted
```

⚠ **WARNING!**   All data on the specified logical drive and the physical disks included in that logical drive is lost when you enter the `saconfig /dev/cissX -D <Logical drive #>` command.

Deleting logical drives when multiple logical drives share physical disks

To avoid fragmentation when multiple logical drives share one or more physical disks, you must delete the drives in reverse order of the logical drive number, from highest to lowest.

To determine the drive numbers, use the `saconfig /dev/cissX` command.

Example 3 shows the `saconfig /dev/cissX` command output for three logical drives that share one physical disk:

Example 3 Using saconfig to determine logical drive numbers

```
# saconfig /dev/ciss4

---------- LOGICAL DRIVE 0 1 ----------

Device File     = c4t0d0
RAID Level      = 0
Size            = 20479 MB
Stripe Size     = 128 KB
Status          = OK

Participating Physical Drive(s):

Ct   Enc  Bay         WWID
1E    1    9   0x500000e015141982 2

Participating Spare Drive(s):

None

---------- LOGICAL DRIVE 1 ----------

Device File     = c4t0d1
RAID Level      = 0
Size            = 20479 MB
Stripe Size     = 128 KB
Status          = OK

Participating Physical Drive(s):

Ct   Enc  Bay         WWID
1E    1    9   0x500000e015141982

Participating Spare Drive(s):

None

---------- LOGICAL DRIVE 2 ----------

Device File     = c4t0d2
RAID Level      = 0
Size            = 20479 MB
Stripe Size     = 128 KB
Status          = OK

Participating Physical Drive(s):

Ct   Enc  Bay         WWID
1E    1    9   0x500000e015141982

Participating Spare Drive(s):

None
```

1 Logical drive number.   **2** List of physical disks participating in the logical drive.

In Example 3, logical drives 0, 1, and 2 are located on the physical disk 0x500000e015141982. To delete logical drive 1, you must delete logical drive 2. To delete logical drive 0, you must delete logical drive 2, then delete logical drive 1.

If you delete a logical drive out of order, the command fails with an error:

```
# saconfig /dev/ciss4 -D 0
Deleting logical drive 0 will cause gap
saconfig (/dev/ciss4): Current driver state is READY

# saconfig /dev/ciss4 -D 1
Deleting logical drive 1 will cause gap between logical drives 0 and 2
saconfig (/dev/ciss4): Current driver state is READY
```

Example 4 Deleting multiple logical drives in reverse drive number order

```
# saconfig /dev/ciss4 -D 2
Are you sure you want to delete logical drive 2 on SmartArray RAID controller
/dev/ciss4? (y/[n]): y
Logical drive 2 deleted

# saconfig /dev/ciss4 -D 1
Are you sure you want to delete logical drive 1 on SmartArray RAID controller
/dev/ciss4? (y/[n]): y
Logical drive 1 deleted

# saconfig /dev/ciss4 -D 0
Are you sure you want to delete logical drive 0 on SmartArray RAID controller
/dev/ciss4? (y/[n]): y
Logical drive 0 deleted
```

Clearing the logical drive configuration

⚠ **WARNING!** All data on the logical drives and the physical disks connected to the specified Smart Array Controller is lost when you enter the `saconfig /dev/cissX -D all` command.

To clear all logical drives that are configured from the physical disks attached to a Smart Array Controller, use the `saconfig /dev/cissX -D all` command.

For example:

```
# saconfig /dev/ciss7 -D all
Are you sure you want to clear configuration on
SmartArray RAID controller /dev/ciss7? (y/[n]): y
Logical drive 0 deleted
Logical drive 1 deleted
Configuration cleared
```

Adding a spare disk drive

To add a spare physical disk to an existing logical drive, use the `saconfig /dev/cissX -A <Logical drive #> -s <physical drive id>` command.

For example:

```
# saconfig /dev/ciss5 -A 0 -s 2I:1:16
Spare drive 2I:1:16 added to Logical drive 0
```

You can add multiple spare physical disks to a logical drive, depending on the number of physical disks in the array that are not in use.

Deleting a spare disk drive

To delete a spare physical disk from an existing logical drive, use the `saconfig /dev/cissX -D <Logical Drive #> -s <physical drive id>` command.

For example:

```
# saconfig /dev/ciss5 -D 0 -s 2I:1:16
Spare drive 2I:1:16 deleted from Logical drive 0
```

The following example deletes all spare disks of logical drive 0 at once:

```
# saconfig /dev/ciss7 -D 0 -s all
All spare drives are deleted from logical drive 0
```

Changing the rebuild priority of a logical drive

To set the rebuild priority of logical drives, use the `saconfig /dev/cissX -r <low | medium | high>` command.

For example:

```
# saconfig /dev/ciss5 -r high
```

In this example, the rebuild priority is set to high for the logical drives under controller `ciss5`.

Specifying the percentage of cache used for read caching

To specify a percentage of cache to be used exclusively for read caching, use the `saconfig /dev/cissX -C <read_caching_percentage>` command.

For example:

```
# saconfig /dev/ciss5 -C 100
Read cache percentage changed to 100%
```

You can set the `<read_caching_percentage>` to 0, 25, 50, 75, or 100 percent of the cache.

Auto-fail missing disks at boot

To enable or disable auto-fail of missing disks at boot, use the `saconfig /dev/cissX -F on|off` command.

For example:

```
# saconfig /dev/ciss5 -F on
Auto-fail missing disks enabled
```

Creating multiple logical drives in an array

To create multiple logical drives in an array, use the command:

```
saconfig /dev/cissX -R <RAID level> -p <physical drive id> [-p <physical
drive id> ...]-c <capacity in GB>
```

For example:

```
# saconfig /dev/ciss5 -R ADG -p 1I:1:9 -p 1I:1:10 -p 1I:1:11 -p 1I:1:12 -c 10
Logical drive 0 created
Rebuild priority is set to High
```

NOTE: If you do not specify a capacity using -c `<capacity in GB>`, the maximum capacity or the remaining capacity in the array is applied to the logical drive.

Performing RAID level migration

To migrate an existing logical drive to a different RAID level, use the command:

```
saconfig /dev/cissX -M <Logical drive #> -R <RAID level> [-S <Stripe
size (KB)>]
```

For example:

```
# saconfig /dev/ciss5 -M 0 -R 5
Logical drive 0 migrated from ADG to 5
```

Migrating a logical drive to a different RAID level does not change its capacity.

NOTE: If you do not specify a stripe size using -S `<Stripe size (KB)>`, the default stripe size is used.

For information on the RAID levels supported by each Smart Array controller, see "Supported RAID modes, by controller" (page 21).

Performing stripe size migration

To perform a migration of a logical drive to a different stripe size, use the command:

```
saconfig /dev/cissX -M <Logical drive #> -S <Stripe size (KB)>
```

For example:

```
# saconfig /dev/ciss5 -M 0 -S 64
Logical drive 0 migrated from stripe 16 to 64 KB
```

Extending the capacity of a logical drive

⚠ **WARNING!**   The logical drive capacity specified with option c must be larger than the existing capacity, or data loss occurs.

To extend the capacity of a logical drive in an array by adding storage space from existing physical disks, use the command:

```
saconfig /dev/cissX -E <Logical drive #> -c <capacity in GB>
```

For example:

```
# saconfig /dev/ciss5 -E 0 -c 15
Logical drive 0 extended from 10.0 GB to 15 GB in capacity
```

Expanding the capacity of an array

To add physical disks to an array, use capacity expansion. The number of logical drives that exists in the array before the expansion remains the same, and the capacity of each logical drive that exists in the array remains unchanged. Expansion only increases the amount of free space in the array.

To expand the capacity of an array by adding physical disks, use the command:

```
saconfig /dev/cissX –E <Logical drive #> -p <physical drive id> [-p
<physical drive id>...]
```

For example:

```
# saconfig /dev/ciss5 -E 0 -p 2I:1:16 -p 2I:1:14
Logical drive 0 expanded from 4 to 6 physical drives
```

NOTE: You can specify any logical drive in an array with -E <Logical drive #> to expand the array. The data in all logical drives in the array is redistributed to make use of the added physical disk space.

Changing the expand priority

To change the expand priority of the controller to low, medium, or high, use the following command:

```
saconfig /dev/cissX -e [low|medium|high]
```

Where:

cissX   The device file for the Smart Array controller.

[low|medium|high]   The priority level of the capacity expansion.

When you create a logical drive after the controller configuration is cleared, or after the last logical drive is deleted, the expand priority of the controller defaults to "medium." You can use saconfig with the -e option to change the expand priority.

The expand priority setting applies to both "Extending the capacity of a logical drive" and "Expanding the capacity of an array."

Using ORCA

HP Smart Array controllers include ORCA, a menu-driven, ROM-based offline configuration utility. You can use ORCA to create, view, and delete logical drives before loading an operating system.

To access ORCA, follow the procedures in the installation guide for your controller. Installation guides are available on the HP website at:

http://www.hp.com/go/hpux-iocards-docs

Click the link for your HP-UX version. Installation guides are listed alphabetically in the "Setup and install — general" section.

> **IMPORTANT:** ORCA appearance, functionality, and keystrokes are not the same for all Smart Array controllers. This section provides a generic procedure using a typical Smart Array controller as an example. Always follow the on-screen prompts when using ORCA.

Creating a logical drive

To create a logical drive using ORCA:

1. From the Main Menu, select "Create Logical Drive." A screen similar to the following appears:

2. Select the physical disks to be included in the logical drive in the Available Physical Drives section.
3. To select the Raid Configurations section and select the RAID type for the logical drive, press **Tab**.

> **NOTE:** You cannot use ORCA to configure a single spare drive to be shared among several arrays. To configure shared spare drives, use the `saconfig` command. See "Adding a spare disk drive" (page 50).

For a summary of the important features of the RAID configurations that are supported by the Smart Array Controllers, see "Fault management in supported RAID configurations" (page 20). For information to help you determine which option is best for your computing environment, see "Choosing a RAID method" (page 21).

4. To select the Spare section and assign spare disks, as needed, press **Tab**.
5. To create the logical drive, press **Enter**. A summary of your choices appears:

```
Option Rom Configuration for Arrays, version  2.38
Copyright 2005 Hewlett-Packard Development Company, L.P.

Controller: HP Smart Array P600
Direct-Attached Storage


      +--------------------------------------------------------+
      ! You have selected a logical drive with a total         !
      ! data size of 69.4 GB and RAID 5 fault tolerance.        !
      !                                                        !
      ! Press <F8> to save the configuration                   !
      ! Press <ESC> to cancel                                  !
      +--------------------------------------------------------+




<F8> to save the configuration
<ESC> to cancel
```

6. To save the configuration, press **F8**.

    A confirmation screen appears:

```
Option Rom Configuration for Arrays, version  2.38
Copyright 2005 Hewlett-Packard Development Company, L.P.

Controller: HP Smart Array P600
Direct-Attached Storage




           +------------------------------------------+
           !            Configuration saved            !
           !                                          !
           !         Press <Enter> to continue         !
           +------------------------------------------+




<Enter> to continue
```

7. To acknowledge that the configuration was saved and return to the ORCA Main Menu, press
    Enter.

Deleting a logical drive

⚠ **WARNING!**   Back up all necessary data before deleting the logical drive. When you delete a
logical drive, data on the drive is not preserved.

To delete a logical drive using ORCA:

1. From the Main Menu, select "Delete Logical Drive."

    A screen similar to the following appears:

```
Option Rom Configuration for Arrays, version  2.38
Copyright 2005 Hewlett-Packard Development Company, L.P.

Controller: HP Smart Array P600
Direct-Attached Storage
+--------------------------Available Logical Drives--------------------------+
! Logical Drive # 1, RAID   5,    69.4 GB,                         OK         !
+---------------------------------------------------------------------------+








<F8> to delete the logical drive
<UP/DOWN ARROW> to scroll; <ESC> to return
```

2. Select a logical drive to be deleted.

3. To delete the logical drive, press **F8**.

   A warning and confirmation screen appears:

```
Option Rom Configuration for Arrays, version  2.38
Copyright 2005 Hewlett-Packard Development Company, L.P.

Controller: HP Smart Array P600
Direct-Attached Storage


    +------------------------------------------+
    :                   Warning                 :
    : This will result in complete data loss    :
    : for this logical drive.                   :
    :                                           :
    : You have selected to delete logical drive :
    : # 1, RAID 5 , 69.4GB with 3 physical drive(s) :
    :                                           :
    : Press <F3> to delete the logical drive    :
    : Press <ESC> to cancel                     :
    +------------------------------------------+

<F3> to delete the logical drive
<ESC> to cancel
```

4. After you carefully review your selection, press **F3** to delete the logical drive.

   A confirmation screen appears.

```
Option Rom Configuration for Arrays, version  2.38
Copyright 2005 Hewlett-Packard Development Company, L.P.

Controller: HP Smart Array P600
Direct-Attached Storage




        +----------------------------------+
        :         Configuration saved       :
        :                                   :
        :      Press <Enter> to continue    :
        +----------------------------------+




<Enter> to continue
```

5. To acknowledge that the configuration was saved and return to the ORCA Main Menu, press **Enter**.

Moving disks and arrays to different positions or controllers

You can move disks and arrays to different positions or controllers. The following movements are supported for physical disks and arrays:

- To a different ID position on the same controller.
- To a Smart Array controller of the same type, on the same server or on a different server; for example, from one P400 to another.
- To a Smart Array controller of a different type, on the same server or on a different server; for example, from a P400 to a P800.

ⓘ **IMPORTANT:** When you move an array, the disks must remain in the same order.

Prerequisites

Before moving a disk or array on a Smart Array Series Controller, be sure the following hardware and software prerequisites are met:

1. Review the documentation for the volume manager or other product that is managing the disks you are moving. The volume manager or other product might have additional prerequisites or procedures that you must follow.

   - For LVM or Veritas Volume Manager (VxVM) documentation, see the documents at www.hp.com/go/hpux-core-docs.
   - For other products, see the documentation provided by the manufacturer.

2. If you are moving the disks or array to a different server, confirm that the new server has enough empty bays to hold the disks that you are moving.

⚠ **IMPORTANT:** To move an array to another controller, you must move all disks in the array at the same time, and the disks must remain in the same order.

3. Confirm that the array has no failed or missing disks, and that no spare disk in the array is acting as a replacement for a failed disk.

   To check the status of disks in the array, use the `sautil` command. See "The sautil <device_file> command" (page 63).

4. Confirm that the controller is not currently running a rebuild, capacity expansion, capacity extension, RAID level migration, or stripe size migration.

   To check the status of the Smart Array controller, use the `saconfig <device file>` command. See "Displaying the Smart Array controller configuration" (page 45)

5. Confirm that the latest adapter firmware is installed.

   - To determine the recommended adapter firmware, see the *HP Smart Array RAID Controllers Support Matrix* on the HP website at

     http://www.hp.com/go/hpux-iocards-docs.

   - To update the adapter firmware online, follow the steps in "Updating the Smart Array controller firmware online" (page 79).

   - To update the adapter firmware offline, follow the steps in "Verifying and updating controller firmware offline" (page 26).

Moving disks to a different location or controller on the same server

To move disks to different controller positions or controllers:

1. Confirm that the prerequisites have been met. See "Prerequisites."
2. Label the disks and make note of their positions.

⚠ **IMPORTANT:** If you are moving an array, the disks must remain in the same order.

3. Back up all the data in the array.
4. Shut down and power off the system.
5. Move the disks.
6. Power on the system.
7. If you moved a boot device, configure the system to enable booting to the device in the new position:

   - To configure boot options offline using EFI utilities, see the documentation for your server on the HP website at http://www.hp.com/go/Integrity_Servers-docs.

   - To configure boot options online, use the `setboot(1M)` command.

     For more information, see the `setboot(1M)` manpage.

8. Check /var/adm/syslog/syslog.log for the following messages:

    ```
    CISS: RAID SA controller on hardware path <hw1> has detected the
    removal of a physical disk

    CISS: RAID SA controller on hardware path <hw2> has detected the
    insertion of a physical disk
    ```

    (!) **IMPORTANT:**   If these messages are not present, the disk movement was not successful. Power off the system and return the disks to their original locations. You might need to restore the data from backup media.

9. To verify the new disk configuration, use ORCA or `sautil`.

    See "Using ORCA" (page 53) and "The sautil <device_file> command" (page 63).

Moving disks to a controller on a different server

To move disks from one server (the "source system") to a Smart Array controller on a different server (the "destination system"):

1. Confirm that the prerequisites have been met. See "Prerequisites."
2. Label the disks and make note of their positions.

    (!) **IMPORTANT:**   If you are moving an array, the disks must remain in the same order.

3. Back up all the data in the array.
4. Shut down and power off the source system.
5. Shut down and power off the destination system, if necessary:

    *   If you are moving a boot disk *and* you want to boot the destination server from that disk, shut down and power off the destination system.

    *   If you are not moving a boot disk, do not shut down the destination system.

6. Move the disks.
7. Power on the source system.
8. Power on the destination system and set the boot options, if necessary.
9. If you moved a boot device to the destination system, configure the system to enable booting to the new device:

    *   To configure boot options offline using EFI utilities, see the documentation for your server on the HP website at http://www.hp.com/go/Integrity_Servers-docs.

    *   To configure boot options online, use the `setboot(1M)` command.

        For more information, see the `setboot(1M)` manpage.

10. Check /var/adm/syslog/syslog.log files on the source and destination systems.

    *   On the source system, look for this message:

        ```
        CISS: RAID SA controller on hardware path <hw1> has detected the
        removal of a physical disk
        ```

    *   On the destination system, look for this message:

        ```
        CISS: RAID SA controller on hardware path <hw2> has detected the
        insertion of a physical disk
        ```

    (!) **IMPORTANT:**   If these messages are not present, the disk movement was not successful. Power off the system and return the disks to their original locations. You might need to restore the data from backup media.

11. If you did not power off the destination system, use the `sautil <device_file> reset_ctlr` command to make the new disks or array visible on the server.

    See "The sautil command" (page 60).

12. To verify the new disk configuration, use ORCA or `sautil`.

    See "Using ORCA" (page 53) and "The sautil <device_file> command" (page 63).

4 Troubleshooting

This chapter describes diagnostic and troubleshooting tools for Smart Array Series Controllers.

NOTE: Command outputs are similar for different Smart Array SAS controllers, so in most cases the example output is shown for only one controller model. If the difference between controllers is significant for a specific command, separate examples from each controller type are provided.

HP Support Tools Manager

HP STM is a software application you can run from the console to obtain status and descriptive information about HP Smart Array Controllers. You can also use STM to diagnose problems.

You must use STM C.46.00 or later with Smart Array Controllers on HP-UX 11i v2 (September 2004) or later.

For more information about STM and other diagnostic tools, see the HP website at www.hp.com/go/hpux-core-docs.

Event Monitoring Service

EMS notifies you when an event occurs on the system.

A hardware event monitor monitors hardware for unusual behavior (an *event*) and sends a message to EMS, which notifies you of the event and provides suggestions for correcting the problem. EMS is available for the Smart Array Controller.

For more information about how hardware monitors work, see the HP website at www.hp.com/go/hpux-core-docs.

Offline Diagnostics Environment

ODE supports Smart Array Controllers. ODE is an offline support tool for troubleshooting systems that are running without an operating system or systems that cannot be tested using online tools. The offline environment is also useful for testing a system before it boots.

ODE provides a user-friendly interface for diagnostics and utilities developed to run in this environment. ODE has a distributed architecture consisting of several modules. Each module has a specific function and uses well defined protocols to communicate with the other modules.

You can use ODE with a command line interface or a menu interface. Use the command line interface to select specific tests and utilities to perform on a specific hardware module.

Use the menu-driven interface to specify the hardware module to be tested. It automatically selects and performs the necessary tests.

ODE consists of:

- A test controller, which acts as the user interface and launches the execution of test modules.
- Test modules, which consist of diagnostic or utility programs that execute in ODE. These modules exercise or diagnose user specified hardware units.
- A system library (SysLib), which consists of a set of common routines for use by the test controller and test modules. These routines perform I/O, string parsing, and system control.

For more information about ODE, see the HP website at www.hp.com/go/hpux-core-docs.

PCI Error Recovery

The PCI Error Recovery feature provides the ability to detect, isolate, and recover from a PCI error, avoiding a system crash. PCI Error Recovery is included with the HP-UX 11i v2 and 11i v3 operating systems, and is enabled by default.

NOTE: PCI Error Recovery is not supported on all platforms. To determine if PCI Error Recovery is supported on your system, see the *PCI Error Recovery Support Matrix* at http://www.hp.com/go/hpux-iocards-docs.

With the PCI Error Recovery feature enabled, if an error occurs on a PCI bus containing an I/O card that supports PCI Error Recovery, the following events occur:

- The PCI bus is quarantined to isolate the system from I/O and to prevent the error from damaging the system.
- The PCI Error Recovery feature attempts to recover from the error and reinitialize the bus so I/O can resume.

If the PCI Error Recovery feature is disabled and an error occurs on a PCI bus, a Machine Check Abort (MCA) or a High Priority Machine Check (HPMC) occurs, the system crashes.

For more information about PCI Error Recovery, see the documents in the PCI Error Recovery section at http://www.hp.com/go/hpux-iocards-docs.

The sautil command

This section focuses on `sautil` command options that are used for online troubleshooting of the HP Smart Array Controller.

Before troubleshooting with the `sautil` command, run STM. The STM diagnostic information augments the information provided by the `sautil` command. See "HP Support Tools Manager" (page 59).

To run the `sautil` command, you must log in as a superuser.

To display the `sautil` help screen with command options and syntax, enter the `sautil` command without any options. For example:

Example 5 The sautil help screen

```
# sautil

*******************************************************************************
****                                                                       ****
****              S A U T I L   S u p p o r t   U t i l i t y              ****
****                                                                       ****
****            for the HP SmartArray RAID Controller Family              ****
****                                                                       ****
****                         version A.02.13                              ****
****                                                                       ****
****   (C) Copyright 2003-2007 Hewlett-Packard Development Company, L.P.   ****
*******************************************************************************


Usage:
  sautil <device_file>  [-s]
         <device_file>  download_ctlr_fw <fw_image>
         <device_file>  download_dev_fw  <fw_image> <physical_drive_id>
         <device_file>  download_encl_fw  <fw_image> <encl_physical_drive_id>
         <device_file>  reset_ctlr
         <device_file>  scan
         <device_file>  start_recovery
         <device_file>  accept_media_xchg <logical_drive_number>
         <device_file>  set_transfer_rate <rate>
         <device_file>  stat
         <device_file>  clear_stat
         <device_file>  get_trace_buf
         <device_file>  get_fw_err_log [-raw]
         <device_file>  clear_fw_err_log
         <device_file>  get_disk_err_log <physical_drive_id> [-raw]
         <device_file>  get_pci_header
         <device_file>  read_regs
         <device_file>  vpd
                        run_startup_script

  where "<device_file>" is the controller's device file, e.g., /dev/ciss5
        "-s" (optional) displays a shorter output
        "<fw_image>" is the firmware image file to download
        "<physical_drive_id>" is:
             <channel_id>:<target_id> of the SCSI physical disk, e.g., 4:12
           OR
             <connector>:<enclosure>:<bay> of the SAS/SATA physical disk,
             e.g., 2I:1:10
           OR
             <wwid> of the SAS/SATA physical disk, e.g., 0x500000e010f16432
        "<encl_physical_drive_id>" is the physical_drive_id of an enclosure.
        "-raw" (optional) displays the raw data buffer
        "<rate>" is auto, async, sync, ultra, ultra-2 (or ultra-160 for
              controllers that support Ultra-320).
              "set_transfer_rate" option applies to
              RAID160/6402/6404 controllers only.

Notes:
  - You must be a privileged user to execute this command. See privileges(5)
    for more information on privileged users.
  - See sautil(1M) for tool details.
```

NOTE: In HP-UX 11i v3, the `-N` option causes `sautil` to display persistent device file information. If you do not specify the `-N` option, `sautil` displays legacy device file information. This provides backward compatibility with previous versions of HP-UX. For more information about persistent device files in HP-UX 11i v3, see the `intro(7)` manpage.

To update Smart Array Controller firmware, use the following command:

sautil *<device_file>* download_ctlr_fw *<fw_image>*

This command option is described in "Using sautil to check and update the controller firmware" (page 78).

To update physical disk firmware, use the following command:

sautil *<device_file>* **download_dev_fw** *<fw_image>* *<physical drive id>*

This command option is described in "Confirming and updating physical disk firmware" (page 33).

To update the firmware of an external enclosure attached to a Smart Array controller, use the following command:

sautil *<device_file>* **download_encl_fw** *<fw_image>*

This command option is described in "Checking and updating SAS storage enclosure firmware online" (page 82).

The sautil *<device_file>* reset_ctlr command resets the Smart Array Controller.

Situations that might require a controller reset include the following:

- When logical drives on the replacement controller are not detected after OLR of a Smart Array controller.

- When logical drives are not detected on a disk enclosure with an existing RAID configuration after the enclosure was hot added.

The sautil *<device_file>* start_recovery command causes the Smart Array controller to rebuild logical drives that are in READY FOR RECOVERY OPERATION state. Logical drives in this state transition to RECOVERING. Heavy I/O to the controller can delay this transition. There is no adverse impact if you use this option when no logical drives are in READY FOR RECOVERY OPERATION state.

The following sautil troubleshooting command options, included in the sautil help screen and detailed in the sautil manpages, are intended for use by HP support personnel. Detailed knowledge of the Smart Array Controller driver and firmware is required to interpret the output of the following command options:

- # **sautil** *<device_file>* **stat**

- # **sautil** *<device_file>* **clear_stat**

- # **sautil** *<device_file>* **get_trace_buf**

- # **sautil** *<device_file>* **get_fw_err_log** **[-raw]**

- # **sautil** *<device_file>* **clear_fw_err_log**

- # **sautil** *<device_file>* **get_disk_err_log** *<physical drive id>* **[-raw]**

- # **sautil** *<device_file>* **get_pci_header**

- # **sautil** *<device_file>* **read_regs**

The following sautil command options are useful for troubleshooting a Smart Array Controller:

- # **sautil** *<device_file>*

- # **sautil** *<device_file>* **scan**

- # **sautil** *<device_file>* **accept_media_xchg** *<logical_drive_number>*

- # **sautil** *<device_file>* **set_transfer_rate** *<rate>*

- # **sautil** **run_startup_script**

These sautil command options are described in the following sections, and in the sautil manpages.

The sautil <device_file> command

To view detailed information on the HP Smart Array controller, configured logical drives, and devices attached to the controller, use the `sautil <device_file>` command output.

The `-s` option provides a shorter and less detailed output. For an example of the `sautil <device_file> -s` command output, see "Confirming and updating physical disk firmware" (page 33).

NOTE: For troubleshooting, use the `sautil <device_file>` command.

Following is an example of the output of the `sautil <device_file>` command for a Smart Array P800 controller:

Example 6 Typical `sautil` `<device_file>` **command output**

```
# sautil /dev/ciss3

*****************************************************************************
****                                                                    ****
****                S A U T I L   S u p p o r t   U t i l i t y          ****
****                                                                    ****
****            for the HP SmartArray RAID Controller Family            ****
****                                                                    ****
****                        version A.02.13                             ****
****                                                                    ****
****    (C) Copyright 2003-2007 Hewlett-Packard Development Company, L.P.   ****
*****************************************************************************



---- DRIVER INFORMATION ---------------------------------------------------

  Driver State........................ READY

---- CONTROLLER INFORMATION -----------------------------------------------

  Controller Product Number........... P800
  Controller Product Name............. HP PCIe SmartArray P800
  Hardware Path....................... 0/6/0/0/0/0/1/0/0/0
  Serial Number....................... P98690D9SU40R7
  Device File......................... /dev/ciss3
  Hardware Revision................... 'D'
  Boot Block Revision................. 0.02
  Firmware Revision (running)......... 4.10
  Firmware Revision (in ROM).......... 4.10
  Firmware Revision (inactive)........ 5.01
  # of Logical Drives................. 10
  # of Physical Disks Configured...... 54
  # of Physical Disks Detected........ 58
  Logical Drive Rebuild Priority...... 118 (high)
  Array Capacity Expansion Priority... 64  (medium)
  Auto-Fail Missing Disks at Boot..... enabled
  SCSI Transfer Detection Mode........ Auto Detect


---- ARRAY ACCELERATOR (CACHE) INFORMATION --------------------------------

  Array Accelerator Board Present?.... yes
  Cache Configuration Status.......... cache enabled
  Cache Ratio......................... 50% Read / 50% Write
  Total Cache Size (MB)............... 456
    Read Cache........................ 228
    Write Cache....................... 228
    Transfer Buffer................... 000
  Battery Pack Count.................. 2
  Battery Status (pack #1)............ ok
  Battery Status (pack #2)............ ok


---- LOGICAL DRIVE SUMMARY ------------------------------------------------

      #    RAID      Size          Status

      0    0       751610 MB       OK
      1    0        10239 MB       OK
      2    0        10239 MB       OK
      3    0         3072 MB       OK
      4    0       209925 MB       OK


---- SAS/SATA DEVICE SUMMARY ----------------------------------------------

  Location  Ct Enc Bay      WWID            Type      Capacity Status

  internal  3I  1   4  0x5000c5000148e709  DISK       73.4 GB  OK
```

```
      internal  3I  1  3  0x5000c500014b62a1  DISK      73.4 GB  OK
      internal  3I  1  2  0x5000c500014aca69  DISK      73.4 GB  OK
      internal  3I  1  1  0x5000c500014b6145  DISK      73.4 GB  OK
      external  2E  1  1  0x5000c50005962f7d  DISK      73.4 GB  OK
      external  2E  1  2  0x5000c50005962a09  DISK      73.4 GB  OK
      external  2E  1  3  0x5000c50005961095  DISK      73.4 GB  OK
      external  2E  1  4  0x5000c500052d0589  DISK      73.4 GB  OK
      external  2E  1  5  0x5000c500052d7595  DISK      73.4 GB  OK
      external  1E  1  1  0x5000c500052d45f9  DISK      73.4 GB  OK
      external  1E  1  2  0x5000c500052d6989  DISK      73.4 GB  OK
      external  1E  1  3  0x5000c500052d6335  DISK      73.4 GB  OK
      external  1E  1  4  0x5000c500052d5175  DISK      73.4 GB  OK
      external  1E  1  5  0x5000c500052d636d  DISK      73.4 GB  OK
      external  1E  1  0  0x50001c1071540025  SES        0.0 GB  FAILED
      external  2E  1  0  0x5001438000328825  SES        0.0 GB  FAILED
      internal      0  0  0x500110a0004af23e  SES        0.0 GB  FAILED


  ---- SAS/SATA ENCLOSURE SUMMARY ------------------------------------------------

    Location  Ct   Enc  Expander_count   Bay_count    SEP_count

    internal  4I   1    0                4            1
    internal  3I   1    0                4            1
    external  2E   1    1                25           1
    external  1E   1    1                25           1


  ---- LOGICAL DRIVE 0 -----------------------------------------------------------

    Logical Drive Device File........... c3t0d0
    Fault Tolerance Mode................ RAID 0 (no fault tolerance)
    Logical Drive Size.................. 751610 MB
    Logical Drive Status................ OK
    # of Participating Physical Disks... 50

    Participating Physical Disk(s)...... Ct:Enc:Bay:WWID
                                         2E:1:1:0x5000c50005962f7d
                                         2E:1:2:0x5000c50005962a09
                                         2E:1:3:0x5000c50005961095
                                         2E:1:4:0x5000c500052d0589
                                         2E:1:5:0x5000c500052d7595
                                         1E:1:1:0x5000c500052d45f9
                                         1E:1:2:0x5000c500052d6989
                                         1E:1:3:0x5000c500052d6335
                                         1E:1:4:0x5000c500052d5175
                                         1E:1:5:0x5000c500052d636d

    Participating Spare Disk(s)......... Ct:Enc:Bay:WWID
                                         none

    Stripe Size......................... 128 KB
    Logical Drive Cache Status.......... cache enabled
    Configuration Signature............. 0x0
    Media Exchange Detected?............ no


  ---- LOGICAL DRIVE 1 -----------------------------------------------------------

    Logical Drive Device File........... c3t0d1
    Fault Tolerance Mode................ RAID 0 (no fault tolerance)
    Logical Drive Size.................. 10239 MB
    Logical Drive Status................ OK
    # of Participating Physical Disks... 1

    Participating Physical Disk(s)...... Ct:Enc:Bay:WWID
                                         3I:1:4:0x5000c5000148e709

    Participating Spare Disk(s)......... Ct:Enc:Bay:WWID
                                         none

    Stripe Size......................... 128 KB
```

```
  Logical Drive Cache Status.......... cache enabled
  Configuration Signature............. 0xA0008383
  Media Exchange Detected?............ no



---- LOGICAL DRIVE 2 ----------------------------------------------------------

  Logical Drive Device File........... c3t0d2
  Fault Tolerance Mode................ RAID 0 (no fault tolerance)
  Logical Drive Size.................. 10239 MB
  Logical Drive Status................ OK
  # of Participating Physical Disks... 1

  Participating Physical Disk(s)...... Ct:Enc:Bay:WWID
                                       3I:1:4:0x5000c5000148e709


  Participating Spare Disk(s)......... Ct:Enc:Bay:WWID
                                       none

  Stripe Size......................... 128 KB
  Logical Drive Cache Status.......... cache enabled
  Configuration Signature............. 0xA0008383
  Media Exchange Detected?............ no



---- LOGICAL DRIVE 3 ----------------------------------------------------------

  Logical Drive Device File........... c3t0d7
  Fault Tolerance Mode................ RAID 0 (no fault tolerance)
  Logical Drive Size.................. 3072 MB
  Logical Drive Status................ OK
  # of Participating Physical Disks... 1

  Participating Physical Disk(s)...... Ct:Enc:Bay:WWID
                                       3I:1:4:0x5000c5000148e709


  Participating Spare Disk(s)......... Ct:Enc:Bay:WWID
                                       none

  Stripe Size......................... 128 KB
  Logical Drive Cache Status.......... cache enabled
  Configuration Signature............. 0xA0008383
  Media Exchange Detected?............ no



---- LOGICAL DRIVE 4 ----------------------------------------------------------

  Logical Drive Device File........... c3t1d1
  Fault Tolerance Mode................ RAID 0 (no fault tolerance)
  Logical Drive Size.................. 209925 MB
  Logical Drive Status................ OK
  # of Participating Physical Disks... 3

  Participating Physical Disk(s)...... Ct:Enc:Bay:WWID
                                       3I:1:3:0x5000c500014b62a1
                                       3I:1:2:0x5000c500014aca69
                                       3I:1:1:0x5000c500014b6145


  Participating Spare Disk(s)......... Ct:Enc:Bay:WWID
                                       none

  Stripe Size......................... 128 KB
  Logical Drive Cache Status.......... cache enabled
  Configuration Signature............. 0xA0008383
  Media Exchange Detected?............ no



---- SAS/SATA DEVICE 3I:1:4:0x5000c5000148e709 [DISK] -----------------------

  Connector Location............................. internal
  Connector...................................... 3I
```

```
Enclosure...................................... 1
Bay............................................ 4
WWID........................................... 0x5000c5000148e709
Device Type.................................... DISK
Disk Capacity.................................. 73.4 GB
Device Status.................................. OK
Device Vendor ID............................... HP
Device Product ID.............................. DH072ABAA6
Device Serial Number........................... 3PD0AX1R00009742F8JK
Device Firmware Version........................ HPD2
Reserved Area (cfg/status info)................ 33554.4 KB (33.6 MB)
Block Size (bytes/sector)...................... 512 bytes
M&P Data Stamped?.............................. yes
Last Failure Reason............................ none

Physical Disk Flags:
  Disk present and operational................. yes
  Non-disk device detected..................... no

  S.M.A.R.T. supported......................... yes
  S.M.A.R.T. errors (in factory M&P data)...... no
  S.M.A.R.T. enabled........................... yes
  S.M.A.R.T. errors (in powerup M&P data)...... no
  Attached to external connector............... no
  Configured in a logical drive................ yes
  Configured as a spare disk................... no
  Disk write cache enabled at spin up.......... no

  Supports redundant controller operation...... no
  Disk write cache enabled in current page..... no
  Disk write cache disabled in default page.... yes




---- SAS/SATA DEVICE 3I:1:3:0x5000c500014b62a1 [DISK] ----------------------

  Connector Location............................. internal
  Connector...................................... 3I
  Enclosure...................................... 1
  Bay............................................ 3
  WWID........................................... 0x5000c500014b62a1
  Device Type.................................... DISK
  Disk Capacity.................................. 73.4 GB
  Device Status.................................. OK
  Device Vendor ID............................... HP
  Device Product ID.............................. DH072ABAA6
  Device Serial Number........................... 3PD0AL1Z000097420160
  Device Firmware Version........................ HPD2
  Reserved Area (cfg/status info)................ 33554.4 KB (33.6 MB)
  Block Size (bytes/sector)...................... 512 bytes
  M&P Data Stamped?.............................. yes
  Last Failure Reason............................ none

  Physical Disk Flags:
    Disk present and operational................. yes
    Non-disk device detected..................... no

    S.M.A.R.T. supported......................... yes
    S.M.A.R.T. errors (in factory M&P data)...... no
    S.M.A.R.T. enabled........................... yes
    S.M.A.R.T. errors (in powerup M&P data)...... no
    Attached to external connector............... no
    Configured in a logical drive................ yes
    Configured as a spare disk................... no
    Disk write cache enabled at spin up.......... no

    Supports redundant controller operation...... no
    Disk write cache enabled in current page..... no
    Disk write cache disabled in default page.... yes
```

```
---- SAS/SATA DEVICE 3I:1:2:0x5000c500014aca69 [DISK] -----------------------

   Connector Location................................ internal
   Connector......................................... 3I
   Enclosure......................................... 1
   Bay............................................... 2
   WWID.............................................. 0x5000c500014aca69
   Device Type....................................... DISK
   Disk Capacity..................................... 73.4 GB
   Device Status..................................... OK
   Device Vendor ID.................................. HP
   Device Product ID................................. DH072ABAA6
   Device Serial Number.............................. 3PD0BCSS00009742GMA1
   Device Firmware Version........................... HPD2
   Reserved Area (cfg/status info)................... 33554.4 KB (33.6 MB)
   Block Size (bytes/sector)......................... 512 bytes
   M&P Data Stamped?................................. yes
   Last Failure Reason............................... none

   Physical Disk Flags:
     Disk present and operational.................... yes
     Non-disk device detected........................ no

     S.M.A.R.T. supported............................ yes
     S.M.A.R.T. errors (in factory M&P data)......... no
     S.M.A.R.T. enabled.............................. yes
     S.M.A.R.T. errors (in powerup M&P data)......... no
     Attached to external connector................. no
     Configured in a logical drive.................. yes
     Configured as a spare disk..................... no
     Disk write cache enabled at spin up............ no

     Supports redundant controller operation........ no
     Disk write cache enabled in current page....... no
     Disk write cache disabled in default page...... yes




---- SAS/SATA DEVICE 3I:1:1:0x5000c500014b6145 [DISK] -----------------------

   Connector Location................................ internal
   Connector......................................... 3I
   Enclosure......................................... 1
   Bay............................................... 1
   WWID.............................................. 0x5000c500014b6145
   Device Type....................................... DISK
   Disk Capacity..................................... 73.4 GB
   Device Status..................................... OK
   Device Vendor ID.................................. HP
   Device Product ID................................. DH072ABAA6
   Device Serial Number.............................. 3PD0AL1600009742GNNF
   Device Firmware Version........................... HPD2
   Reserved Area (cfg/status info)................... 33554.4 KB (33.6 MB)
   Block Size (bytes/sector)......................... 512 bytes
   M&P Data Stamped?................................. yes
   Last Failure Reason............................... none

   Physical Disk Flags:
     Disk present and operational.................... yes
     Non-disk device detected........................ no

     S.M.A.R.T. supported............................ yes
     S.M.A.R.T. errors (in factory M&P data)......... no
     S.M.A.R.T. enabled.............................. yes
     S.M.A.R.T. errors (in powerup M&P data)......... no
     Attached to external connector................. no
     Configured in a logical drive.................. yes
     Configured as a spare disk..................... no
     Disk write cache enabled at spin up............ no
```

```
   Supports redundant controller operation........ no
   Disk write cache enabled in current page....... no
   Disk write cache disabled in default page...... yes




---- SAS/SATA DEVICE 2E:1:1:0x5000c50005962f7d [DISK] -----------------------

  Connector Location.............................. external
  Connector....................................... 2E
  Enclosure....................................... 1
  Bay............................................. 1
  WWID............................................ 0x5000c50005962f7d
  Device Type..................................... DISK
  Disk Capacity................................... 73.4 GB
  Device Status................................... OK
  Device Vendor ID................................ HP
  Device Product ID............................... DH072ABAA6
  Device Serial Number............................ 3PD0LTCN000098047WWK
  Device Firmware Version......................... HPD2
  Reserved Area (cfg/status info)................. 33554.4 KB (33.6 MB)
  Block Size (bytes/sector)....................... 512 bytes
  M&P Data Stamped?............................... yes
  Last Failure Reason............................. none

  Physical Disk Flags:
    Disk present and operational.................. yes
    Non-disk device detected...................... no

    S.M.A.R.T. supported.......................... yes
    S.M.A.R.T. errors (in factory M&P data)....... no
    S.M.A.R.T. enabled............................ yes
    S.M.A.R.T. errors (in powerup M&P data)....... no
    Attached to external connector................ yes
    Configured in a logical drive................. yes
    Configured as a spare disk.................... no
    Disk write cache enabled at spin up........... no

    Supports redundant controller operation....... no
    Disk write cache enabled in current page...... no
    Disk write cache disabled in default page..... yes




---- SAS/SATA DEVICE 2E:1:2:0x5000c50005962a09 [DISK] -----------------------

  Connector Location.............................. external
  Connector....................................... 2E
  Enclosure....................................... 1
  Bay............................................. 2
  WWID............................................ 0x5000c50005962a09
  Device Type..................................... DISK
  Disk Capacity................................... 73.4 GB
  Device Status................................... OK
  Device Vendor ID................................ HP
  Device Product ID............................... DH072ABAA6
  Device Serial Number............................ 3PD0KY2A00009802DRNR
  Device Firmware Version......................... HPD2
  Reserved Area (cfg/status info)................. 33554.4 KB (33.6 MB)
  Block Size (bytes/sector)....................... 512 bytes
  M&P Data Stamped?............................... yes
  Last Failure Reason............................. none

  Physical Disk Flags:
    Disk present and operational.................. yes
    Non-disk device detected...................... no

    S.M.A.R.T. supported.......................... yes
    S.M.A.R.T. errors (in factory M&P data)....... no
```

```
      S.M.A.R.T. enabled.............................. yes
      S.M.A.R.T. errors (in powerup M&P data)........ no
      Attached to external connector................. yes
      Configured in a logical drive.................. yes
      Configured as a spare disk..................... no
      Disk write cache enabled at spin up............ no

      Supports redundant controller operation........ no
      Disk write cache enabled in current page....... no
      Disk write cache disabled in default page...... yes




   ---- SAS/SATA DEVICE 2E:1:3:0x5000c50005961095 [DISK] ----------------------

   Connector Location.............................. external
   Connector....................................... 2E
   Enclosure....................................... 1
   Bay............................................. 3
   WWID............................................ 0x5000c50005961095
   Device Type..................................... DISK
   Disk Capacity................................... 73.4 GB
   Device Status................................... OK
   Device Vendor ID................................ HP
   Device Product ID............................... DH072ABAA6
   Device Serial Number............................ 3PD0KY280000980363WY
   Device Firmware Version......................... HPD2
   Reserved Area (cfg/status info)................. 33554.4 KB (33.6 MB)
   Block Size (bytes/sector)....................... 512 bytes
   M&P Data Stamped?............................... yes
   Last Failure Reason............................. none

   Physical Disk Flags:
      Disk present and operational................. yes
      Non-disk device detected..................... no

      S.M.A.R.T. supported......................... yes
      S.M.A.R.T. errors (in factory M&P data)...... no
      S.M.A.R.T. enabled........................... yes
      S.M.A.R.T. errors (in powerup M&P data)...... no
      Attached to external connector............... yes
      Configured in a logical drive................ yes
      Configured as a spare disk................... no
      Disk write cache enabled at spin up.......... no

      Supports redundant controller operation...... no
      Disk write cache enabled in current page..... no
      Disk write cache disabled in default page.... yes




   ---- SAS/SATA DEVICE 2E:1:4:0x5000c500052d0589 [DISK] ----------------------

   Connector Location.............................. external
   Connector....................................... 2E
   Enclosure....................................... 1
   Bay............................................. 4
   WWID............................................ 0x5000c500052d0589
   Device Type..................................... DISK
   Disk Capacity................................... 73.4 GB
   Device Status................................... OK
   Device Vendor ID................................ HP
   Device Product ID............................... DH072ABAA6
   Device Serial Number............................ 3PD0HEDC000097487BP2
   Device Firmware Version......................... HPD2
   Reserved Area (cfg/status info)................. 33554.4 KB (33.6 MB)
   Block Size (bytes/sector)....................... 512 bytes
   M&P Data Stamped?............................... yes
   Last Failure Reason............................. none
```

```
Physical Disk Flags:
  Disk present and operational.................. yes
  Non-disk device detected...................... no

  S.M.A.R.T. supported.......................... yes
  S.M.A.R.T. errors (in factory M&P data)....... no
  S.M.A.R.T. enabled............................ yes
  S.M.A.R.T. errors (in powerup M&P data)....... no
  Attached to external connector................ yes
  Configured in a logical drive................. yes
  Configured as a spare disk.................... no
  Disk write cache enabled at spin up........... no

  Supports redundant controller operation....... no
  Disk write cache enabled in current page...... no
  Disk write cache disabled in default page..... yes




---- SAS/SATA DEVICE 2E:1:5:0x5000c500052d7595 [DISK] ----------------------

  Connector Location............................ external
  Connector..................................... 2E
  Enclosure..................................... 1
  Bay........................................... 5
  WWID.......................................... 0x5000c500052d7595
  Device Type................................... DISK
  Disk Capacity................................. 73.4 GB
  Device Status................................. OK
  Device Vendor ID.............................. HP
  Device Product ID............................. DH072ABAA6
  Device Serial Number.......................... 3PD0J3G900009748WPXF
  Device Firmware Version....................... HPD2
  Reserved Area (cfg/status info)............... 33554.4 KB (33.6 MB)
  Block Size (bytes/sector)..................... 512 bytes
  M&P Data Stamped?............................. yes
  Last Failure Reason........................... none

  Physical Disk Flags:
    Disk present and operational................ yes
    Non-disk device detected.................... no

    S.M.A.R.T. supported........................ yes
    S.M.A.R.T. errors (in factory M&P data)..... no
    S.M.A.R.T. enabled.......................... yes
    S.M.A.R.T. errors (in powerup M&P data)..... no
    Attached to external connector.............. yes
    Configured in a logical drive............... yes
    Configured as a spare disk.................. no
    Disk write cache enabled at spin up......... no

    Supports redundant controller operation..... no
    Disk write cache enabled in current page.... no
    Disk write cache disabled in default page... yes




---- SAS/SATA DEVICE 1E:1:1:0x5000c500052d45f9 [DISK] ----------------------

  Connector Location............................ external
  Connector..................................... 1E
  Enclosure..................................... 1
  Bay........................................... 1
  WWID.......................................... 0x5000c500052d45f9
  Device Type................................... DISK
  Disk Capacity................................. 73.4 GB
  Device Status................................. OK
  Device Vendor ID.............................. HP
  Device Product ID............................. DH072ABAA6
  Device Serial Number.......................... 3PD0E4D100009748YDE4
```

```
Device Firmware Version........................... HPD2
Reserved Area (cfg/status info).................. 33554.4 KB (33.6 MB)
Block Size (bytes/sector)........................ 512 bytes
M&P Data Stamped?................................ yes
Last Failure Reason.............................. INIT REQUEST SENSE FAILED

Physical Disk Flags:
  Disk present and operational................... yes
  Non-disk device detected....................... no

  S.M.A.R.T. supported........................... yes
  S.M.A.R.T. errors (in factory M&P data)........ no
  S.M.A.R.T. enabled............................. yes
  S.M.A.R.T. errors (in powerup M&P data)........ no
  Attached to external connector................. yes
  Configured in a logical drive.................. yes
  Configured as a spare disk..................... no
  Disk write cache enabled at spin up............ no

  Supports redundant controller operation........ no
  Disk write cache enabled in current page....... no
  Disk write cache disabled in default page...... yes




---- SAS/SATA DEVICE 1E:1:2:0x5000c500052d6989 [DISK] -----------------------

  Connector Location............................. external
  Connector...................................... 1E
  Enclosure...................................... 1
  Bay............................................ 2
  WWID........................................... 0x5000c500052d6989
  Device Type.................................... DISK
  Disk Capacity.................................. 73.4 GB
  Device Status.................................. OK
  Device Vendor ID............................... HP
  Device Product ID.............................. DH072ABAA6
  Device Serial Number........................... 3PD0J53F00009748XRKF
  Device Firmware Version........................ HPD2
  Reserved Area (cfg/status info)................ 33554.4 KB (33.6 MB)
  Block Size (bytes/sector)...................... 512 bytes
  M&P Data Stamped?.............................. yes
  Last Failure Reason............................ INIT RESET RECOVERY ABORTED

  Physical Disk Flags:
    Disk present and operational................. yes
    Non-disk device detected..................... no

    S.M.A.R.T. supported......................... yes
    S.M.A.R.T. errors (in factory M&P data)...... no
    S.M.A.R.T. enabled........................... yes
    S.M.A.R.T. errors (in powerup M&P data)...... no
    Attached to external connector............... yes
    Configured in a logical drive................ yes
    Configured as a spare disk................... no
    Disk write cache enabled at spin up.......... no

    Supports redundant controller operation...... no
    Disk write cache enabled in current page..... no
    Disk write cache disabled in default page.... yes




---- SAS/SATA DEVICE 1E:1:3:0x5000c500052d6335 [DISK] -----------------------

  Connector Location............................. external
  Connector...................................... 1E
  Enclosure...................................... 1
  Bay............................................ 3
  WWID........................................... 0x5000c500052d6335
```

```
        Device Type................................... DISK
        Disk Capacity................................. 73.4 GB
        Device Status................................. OK
        Device Vendor ID.............................. HP
        Device Product ID............................. DH072ABAA6
        Device Serial Number.......................... 3PD0J4A000009748XQZG
        Device Firmware Version....................... HPD2
        Reserved Area (cfg/status info)............... 33554.4 KB (33.6 MB)
        Block Size (bytes/sector)..................... 512 bytes
        M&P Data Stamped?............................. yes
        Last Failure Reason........................... INIT RESET RECOVERY ABORTED

        Physical Disk Flags:
          Disk present and operational................ yes
          Non-disk device detected.................... no

          S.M.A.R.T. supported........................ yes
          S.M.A.R.T. errors (in factory M&P data)..... no
          S.M.A.R.T. enabled.......................... yes
          S.M.A.R.T. errors (in powerup M&P data)..... no
          Attached to external connector............. yes
          Configured in a logical drive.............. yes
          Configured as a spare disk................. no
          Disk write cache enabled at spin up........ no

          Supports redundant controller operation.... no
          Disk write cache enabled in current page... no
          Disk write cache disabled in default page.. yes




    ---- SAS/SATA DEVICE 1E:1:4:0x5000c500052d5175 [DISK] -----------------------

      Connector Location............................ external
      Connector..................................... 1E
      Enclosure..................................... 1
      Bay........................................... 4
      WWID.......................................... 0x5000c500052d5175
      Device Type................................... DISK
      Disk Capacity................................. 73.4 GB
      Device Status................................. OK
      Device Vendor ID.............................. HP
      Device Product ID............................. DH072ABAA6
      Device Serial Number.......................... 3PD0H0E700009748WS5P
      Device Firmware Version....................... HPD2
      Reserved Area (cfg/status info)............... 33554.4 KB (33.6 MB)
      Block Size (bytes/sector)..................... 512 bytes
      M&P Data Stamped?............................. yes
      Last Failure Reason........................... INIT RESET RECOVERY ABORTED

      Physical Disk Flags:
        Disk present and operational................ yes
        Non-disk device detected.................... no

        S.M.A.R.T. supported........................ yes
        S.M.A.R.T. errors (in factory M&P data)..... no
        S.M.A.R.T. enabled.......................... yes
        S.M.A.R.T. errors (in powerup M&P data)..... no
        Attached to external connector............. yes
        Configured in a logical drive.............. yes
        Configured as a spare disk................. no
        Disk write cache enabled at spin up........ no

        Supports redundant controller operation.... no
        Disk write cache enabled in current page... no
        Disk write cache disabled in default page.. yes




    ---- SAS/SATA DEVICE 1E:1:0:0x50001c1071540025 [SES] -----------------------
```

```
Connector Location................................ external
Connector......................................... 1E
Enclosure......................................... 1
Bay............................................... 0
WWID.............................................. 0x50001c1071540025
Device Type....................................... SES
Disk Capacity..................................... 0.0 GB
Device Status..................................... FAILED
Device Vendor ID.................................. HP
Device Product ID................................. MSA70
Device Serial Number.............................. SGA728007J
Device Firmware Version........................... 1.42
Reserved Area (cfg/status info)................... 0.0 KB (0.0 MB)
Block Size (bytes/sector)......................... 0 bytes
M&P Data Stamped?................................. yes
Last Failure Reason............................... NON DISK DEVICE

Physical Disk Flags:
   Disk present and operational................... no
   Non-disk device detected....................... yes

   S.M.A.R.T. supported........................... no
   S.M.A.R.T. errors (in factory M&P data)........ no
   S.M.A.R.T. enabled............................. no
   S.M.A.R.T. errors (in powerup M&P data)........ no
   Attached to external connector................. yes
   Configured in a logical drive.................. no
   Configured as a spare disk..................... no
   Disk write cache enabled at spin up............ no

   Supports redundant controller operation........ no
   Disk write cache enabled in current page....... no
   Disk write cache disabled in default page...... no




 ---- SAS/SATA DEVICE 2E:1:0:0x5001438000328825 [SES] ------------------------

   Connector Location............................. external
   Connector...................................... 2E
   Enclosure...................................... 1
   Bay............................................ 0
   WWID........................................... 0x5001438000328825
   Device Type.................................... SES
   Disk Capacity.................................. 0.0 GB
   Device Status.................................. FAILED
   Device Vendor ID............................... HP
   Device Product ID.............................. MSA70
   Device Serial Number........................... SGA72800DF
   Device Firmware Version........................ 1.50
   Reserved Area (cfg/status info)................ 0.0 KB (0.0 MB)
   Block Size (bytes/sector)...................... 0 bytes
   M&P Data Stamped?.............................. yes
   Last Failure Reason............................ NON DISK DEVICE

   Physical Disk Flags:
      Disk present and operational................ no
      Non-disk device detected.................... yes

      S.M.A.R.T. supported........................ no
      S.M.A.R.T. errors (in factory M&P data)..... no
      S.M.A.R.T. enabled.......................... no
      S.M.A.R.T. errors (in powerup M&P data)..... no
      Attached to external connector.............. yes
      Configured in a logical drive............... no
      Configured as a spare disk.................. no
      Disk write cache enabled at spin up......... no

      Supports redundant controller operation..... no
      Disk write cache enabled in current page.... no
```

```
                Disk write cache disabled in default page...... no




         ---- SAS/SATA DEVICE :0:0:0x500110a0004af23e [SES] --------------------------

           Connector Location............................. internal
           Connector......................................
           Enclosure...................................... 0
           Bay............................................ 0
           WWID........................................... 0x500110a0004af23e
           Device Type.................................... SES
           Disk Capacity.................................. 0.0 GB
           Device Status.................................. FAILED
           Device Vendor ID............................... HP
           Device Product ID.............................. P800
           Device Serial Number........................... P98690D9SU40R7
           Device Firmware Version........................ 1.01
           Reserved Area (cfg/status info)................ 0.0 KB (0.0 MB)
           Block Size (bytes/sector)...................... 0 bytes
           M&P Data Stamped?.............................. yes
           Last Failure Reason............................ NON DISK DEVICE

           Physical Disk Flags:
             Disk present and operational................. no
             Non-disk device detected..................... yes

             S.M.A.R.T. supported......................... no
             S.M.A.R.T. errors (in factory M&P data)...... no
             S.M.A.R.T. enabled........................... no
             S.M.A.R.T. errors (in powerup M&P data)...... no
             Attached to external connector............... no
             Configured in a logical drive................ no
             Configured as a spare disk................... no
             Disk write cache enabled at spin up.......... no

             Supports redundant controller operation...... no
             Disk write cache enabled in current page..... no
             Disk write cache disabled in default page.... no




         *****************************************************************************
         ****                      End of SAUTIL Output                          ****
         *****************************************************************************
```

Logical drive state definitions

The status column of the Logical Drive Summary in the sautil *<device_file>* command output
example indicates the logical drive state. Logical drive states provide useful troubleshooting
information.

To interpret logical drive status, use the following logical drive state definitions. Logical drive state
definitions are also included in the sautil manpage.

OK   All physical disks in the logical drive are operational.

FAILED   Possible causes are as follows:

                              •   Multiple physical disks in a fault-tolerant (RAID 1, 1+0,
                                  5, ADG) logical drive have failed.

                              •   One or more disks in a RAID 0 logical drive have
                                  failed.

                              •   Cache data loss has occurred.

	• An array expansion was aborted.
	• The logical drive is temporarily disabled because another logical drive on the controller had a missing disk at power on.
USING INTERIM RECOVERY MODE	Also known as a "degraded" state. A physical disk in a fault tolerant logical drive has failed. For RAID 1, 1+0 or 5, data loss can result if a second disk fails. For RAID ADG, data loss can result if two additional disks fail.
READY FOR RECOVERY OPERATION	A replacement disk is present, but the rebuild has not started yet; for example, because another logical drive might be rebuilding. The logical drive also returns to this state if the rebuild is aborted due to unrecoverable read errors from another disk.
RECOVERING	Physical disks in this logical drive are being rebuilt.
WRONG PHYSICAL DISK WAS REPLACED	When the logical drive was in a degraded state, the system was powered off and a disk other than the failed disk was replaced.
PHYSICAL DISK(S) NOT PROPERLY CONNECTED	When the system was powered off, disks were removed. Any other logical drives are held in a temporary `FAILED` state when this occurs.
EXPANDING	The data in the logical drive is being reorganized because:
	• Physical disks have been added to the array (capacity expansion).
	• The stripe size is being changed (stripe size migration).
	• The RAID level is being changed (RAID level migration).
NOT YET AVAILABLE	A capacity expansion operation is in progress (or is queued up) that will make room on the disks for this new logical drive. Until room is made on the physical disks, the newly configured logical drive cannot be read or written.
QUEUED FOR EXPANSION	The logical drive is waiting to undergo data reorganization (see `EXPANDING`). Possible causes for the delay are a rebuild or expansion operation that might be in progress.

Physical disk state definitions

The Status column of the SCSI Device Summary in the `sautil <device_file>` command output example also provides useful troubleshooting information. To interpret the status of physical disks, use the following physical disk state definitions. The physical disk state definitions are also included in the `sautil` manpage.

OK	The physical disk is configured in one or more logical drives and is operational.
SPARE	The physical disk is configured as a spare disk.
UNASSIGNED	The physical disk has not been configured in any logical drives.
FAILED	The configured physical disk has failed.

NOTE: The state of a SAS SES (storage enclosure processor) device is always FAILED. This is because the enclosure is not a DISK device. It does not indicate that the enclosure has failed. To confirm this, review the description for the physical device in the `sautil <device_file>` command output. The "Last Failure Reason" for the enclosure will be "NON DISK DEVICE."

The sautil <device_file> scan command

To instruct the Smart Array Controller to rescan all SCSI buses, use the `sautil <device_file>`
`scan` command. For example, when you hot-plug a physical disk into the system's internal drive
bay, run a scan.

The sautil <device_file> accept_media_xchg <logical_drive_number> command

You can use the `sautil <device_file> accept_media_xchg <logical_drive_number>`
command to instruct the Smart Array Controller to do the following:
1. Set the state of the specified failed logical drive to `OK`.
2. Set the states of failed physical disks that have been hot-plug-replaced to `OK`.

△ **CAUTION:** This option preserves the RAID configuration, logical drive configurations, and controller
settings. If more disks failed than the RAID level can accommodate, data on the failed logical drive
might be compromised. If data is compromised, you must restore the data from backup media.

In the following example, logical drive 0 accepts a media exchange.

```
# sautil /dev/ciss5 accept_media_xchg 0


********************************************************************************
****                                                                        ****
****              S A U T I L    S u p p o r t    U t i l i t y             ****
****                                                                        ****
****            for the HP SmartArray RAID Controller Family               ****
****                                                                        ****
****                          version A.02.11                              ****
****                                                                        ****
****   (C) Copyright 2003-2006 Hewlett-Packard Development Company, L.P.    ****
********************************************************************************



---- DRIVER INFORMATION --------------------------------------------------

  Driver State...................... READY

---- CONTROLLER INFORMATION ----------------------------------------------

  Controller Product Number........... P400
  Controller Product Name............. HP PCIe SmartArray P400
  Hardware Path...................... 0/6/0/0/0/0/1/0/0/0
  Device File....................... /dev/ciss5

---- ACCEPT MEDIA EXCHANGE -----------------------------------------------

  Logical drive specified: 0

      WARNING: The status of logical drive 0 will be set to "OK". The
               status of all physical disks that have been replaced on this
               logical drive will also be set to "OK".

               While this option preserves the RAID configuration (logical
               drive configurations, controller settings, etc.), data on the
               failed logical drive may have already been compromised. If
               more disks have failed than the RAID level can accommodate,
               you will need to restore your data from backup media.

      Are you sure you want to continue (y/n)? y


********************************************************************************
****                        End of SAUTIL Output                           ****
********************************************************************************
```

The sautil <device_file> set_transfer_rate <rate> command

To set the Smart Array Controller SCSI transfer rate to a lower speed than the controller normally allows, use the `sautil <device_file> set_transfer_rate <rate>` command. Valid arguments for `<rate>` are as follows:

- `auto`
- `async`
- `sync`
- `ultra`
- `ultra-2`
- `ultra-160`

The sautil <device_file> run_startup_script command

To recreate the (`/dev/cissX`) device files, use the `sautil <device_file> run_startup_script` command to run the Smart Array Controller startup script.

Using sautil to check and update the controller firmware

To confirm and update the firmware version installed on the Smart Array Controller, use the `sautil` command. HP recommends that you install the latest supported firmware version.

NOTE: This section of the HP Smart Array Controller Support Guide focuses on the `sautil` command options used to confirm or change the Smart Array Controller firmware. Other `sautil` command options listed in the `sautil` help screen and detailed in the `sautil` manpages are described in .

To run the `sautil` command, you must log in as a superuser.

Before running the `sautil` command to confirm or update the controller firmware, you must know the device file name for the Smart Array Controller.

Determining the Smart Array series controller device file

You can determine the device file for the Smart Array Controller from the output of the `ioscan -kfnd ciss` command. An example of the `ioscan` output listing the Smart Array Controller device files follows:

```
# ioscan -kfnd ciss
Class     I H/W Path        Driver  S/W State  H/W Type    Description
=====================================================================================
ext_bus   5 0/6/0/0/0/0/1/0/0/0  ciss    CLAIMED    INTERFACE   PCIe SAS SmartArray P400 RAID Controller
                           /dev/ciss5
```

In the example, `/dev/ciss5` is the device file for Smart Array P400 Controller.

Determining the Smart Array series controller firmware version

You can determine the firmware version in the ROM on the Smart Array Controller by using either the `sautil <device_file>` command (extensive output), or the `sautil <device_file> -s` command (shortened output).

An example of the `sautil <device_file>` command output is provided in .

To provide an abbreviated listing of information for the Smart Array Controller and all connected devices, including the firmware version in ROM, enter the `sautil <device_file> -s` command. For example:

```
# sautil /dev/ciss5 -s

*****************************************************************************
****                                                                    ****
```

```
****          S A U T I L   S u p p o r t   U t i l i t y          ****
****                                                                ****
****          for the HP SmartArray RAID Controller Family          ****
****                                                                ****
****                        version A.02.11                         ****
****                                                                ****
****   (C) Copyright 2003-2006 Hewlett-Packard Development Company, L.P.   ****
************************************************************************



---- DRIVER INFORMATION -------------------------------------------------

  Driver State...................... READY

---- CONTROLLER INFORMATION ---------------------------------------------

  Controller Product Number.......... P400
  Controller Product Name............ HP PCIe SmartArray P400
  Hardware Path...................... 0/6/0/0/0/0/1/0/0/0
  Serial Number...................... PA5360BBFSW2ON
  Device File........................ /dev/ciss5
  Hardware Revision.................. 'B'
  Firmware Revision (in ROM)......... 2.08
  # of Logical Drives............... 2
  # of Physical Disks Configured..... 4
  # of Physical Disks Detected....... 4

o
o (content has been omitted)
o


************************************************************************
****                     End of SAUTIL Output                      ****
************************************************************************
```

In this example, the Smart Array Controller /dev/ciss5 has ROM firmware revision 2.08.

Updating the Smart Array controller firmware online

The sautil command syntax for updating Smart Array Controller firmware is:

#**sautil *<device_file>* download_ctlr_fw *<fw_image>***

where:

<device_file>   The controller device file. Determine the device file for the Smart Array
                Controller by running the ioscan -kfnd ciss command as described in
                .

<fw_image>   The file path for the firmware version you want to install on the Smart Array
                Controller.

When you enter the sautil *<device_file>* download_ctlr_fw *<fw_image>* command,
the installed firmware version is listed with the firmware version contained in *<fw_image>*. You
can proceed with the download or cancel:

```
# sautil /dev/ciss5 download_ctlr_fw INCPTR.PAK


************************************************************************
****                                                                ****
****          S A U T I L   S u p p o r t   U t i l i t y          ****
****                                                                ****
****          for the HP SmartArray RAID Controller Family          ****
****                                                                ****
****                        version A.02.11                         ****
****                                                                ****
****   (C) Copyright 2003-2006 Hewlett-Packard Development Company, L.P.   ****
************************************************************************
```

```
---- DRIVER INFORMATION ---------------------------------------------------

  Driver State...................... READY

---- CONTROLLER INFORMATION -----------------------------------------------

  Controller Product Number.......... P400
  Controller Product Name............ HP PCIe SmartArray P400
  Hardware Path...................... 0/6/0/0/0/0/1/0/0/0
  Device File........................ /dev/ciss5

---- FIRMWARE DOWNLOAD -----------------------------------------------------

  ** You are downloading the firmware image "INCPTR.PAK"
  ** to the controller "/dev/ciss5".

  Retrieving firmware image file from disk................... [Done]

  Validating the file's signature and size.................. [Done]

  Retrieving the firmware revision string from ROM........... [Done]

  Retrieving the firmware revision string from the file...... [Done]

      Current Revision (in ROM)....... 2.06
      New Revision (in file).......... 2.08

      WARNING: The firmware download process may take several minutes to
               complete. All I/O to this controller will be temporarily
               halted during this time.

      Are you sure you want to continue (y/n)? y

  Preparing for download.................................... [Done]

  Sending the new firmware to the controller................ [Done]

  Activating the new firmware............................... [Done]

  Resetting the controller.................................. [Done]

  Retrieving the firmware revision string from ROM........... [Done]

      Current Revision (in ROM)....... 2.08

  FIRMWARE DOWNLOAD WAS SUCCESSFUL!


  ***************************************************************************
  ****                      End of SAUTIL Output                      ****
  ***************************************************************************
```

Updating physical disk firmware online

The sautil physical disk firmware update command syntax is:

#sautil *<device_file>* download_dev_fw *<fw_image>* *<physical drive id>*

Where:

<device_file>	The controller device file. Determine the Smart Array Controller device file by entering the ioscan -kfn command as illustrated in "Determining the Smart Array controller device file" (page 34).
<fw_image>	The file path for the firmware version you want to install on the physical disk. For access to the physical disk firmware image update file, contact your HP representative.
<physical drive id>	Either the Connector:Enclosure:Bay or WWID of the physical disk where you want to change the firmware. You can determine the

Connector:Enclosure:Bay or WWID for each physical disk connected
to the Smart Array Controller from the SAS/SATA DEVICE
SUMMARY in the output of the sautil *<device_file>* command,
or from the sautil *<device_file>* -s command.

When you enter the following command,

sautil *<device_file>* download_dev_fw *<fw_image>* *<physical drive id>*

the installed physical disk firmware version is listed with the firmware version in *<fw_image>*.
You can proceed with the download or cancel, as follows:

```
# sautil /dev/ciss5 download_dev_fw DG036A8B53.HPD4.frm 0x5000c5000030b0c5


*****************************************************************************
****                                                                   ****
****              S A U T I L   S u p p o r t   U t i l i t y           ****
****                                                                   ****
****           for the HP SmartArray RAID Controller Family            ****
****                                                                   ****
****                        version A.02.11                            ****
****                                                                   ****
****   (C) Copyright 2003-2006 Hewlett-Packard Development Company, L.P.  ****
*****************************************************************************


---- DRIVER INFORMATION --------------------------------------------------

  Driver State........................ READY

---- CONTROLLER INFORMATION ----------------------------------------------

  Controller Product Number.......... P400
  Controller Product Name............ HP PCIe SmartArray P400
  Hardware Path...................... 0/6/0/0/0/0/1/0/0/0
  Device File........................ /dev/ciss5

---- FIRMWARE DOWNLOAD ----------------------------------------------------

  ** You are downloading the firmware image "DG036A8B53.HPD4.frm"
  ** to the physical disk "0x5000c5000030b0c5" (channel:ID)
  ** connected to the controller "/dev/ciss5".

  Verifying that the specified target disk is valid......... [Done]

  Retrieving firmware image file from disk.................. [Done]

  Validating the file's signature and size................. [Done]

  Retrieving the firmware revision string from ROM.......... [Done]

      Current Revision (in ROM)....... HPD3

      WARNING: The firmware download process may take several minutes to
               complete. All I/O to this controller will be temporarily
               halted during this time.

      Are you sure you want to continue (y/n)? y

  Preparing for download................................... [Done]

  Sending the new firmware to the disk..................... [Done]

  Resetting the controller................................. [Done]

  Retrieving the firmware revision string from ROM.......... [Done]

      Current Revision (in ROM)....... HPD4

  FIRMWARE DOWNLOAD WAS SUCCESSFUL!
```

```
********************************************************************************
****                        End of SAUTIL Output                           ****
********************************************************************************
```

In this example, the physical disk (`1I:1:9` or `0x5000c5000030b0c5`) firmware is updated from `HPD3` to `HPD4`.

NOTE: Repeat this procedure for each physical disk where you want to update the firmware.

Checking and updating SAS storage enclosure firmware online

To confirm and update the firmware version of SAS storage enclosure attached to the Smart Array controller, use the `sautil` command.

To run the `sautil` command, you must log in as a superuser.

Before running the `sautil` command to confirm or update SAS storage enclosure firmware, you must know the device file name for the Smart Array controller and the physical drive ID for the SAS storage enclosure (SES device) attached to the Smart Array controller.

Determining the Smart Array controller device file

To determine the device file name for the Smart Array controller, use the `ioscan -kfnd ciss` command. For example:

```
# ioscan -kfnd ciss
Class     I  H/W Path        Driver  S/W State  H/W Type    Description
=============================================================================
ext_bus   3  0/6/0/0/0/1/0/0/0  ciss    CLAIMED    INTERFACE   PCIe SAS SmartArray P800 RAID Controller
                           /dev/ciss3
```

In this example, `/dev/ciss3` is the device file for the Smart Array controller.

Determining the physical drive ID and firmware version for SAS storage enclosures

To determine the physical drive ID of the SAS storage enclosures (SES devices), use the `sautil <device_file>` command (extensive output), or the `sautil <device_file> -s` command (shortened output).

To display an abbreviated list of information for the Smart Array Controller and all connected devices, enter `sautil <device_file> -s`.

The SAS/SATA DEVICE SUMMARY lists the physical drive ID for each disk device and SES device. It can be represented as Connector:Enclosure:Bay, such as: 1E:1:0 or WWID, such as: 0x500000e010f16432. The command output also shows the firmware version installed on each SES device. For example:

```
# sautil /dev/ciss3 -s

********************************************************************************
****                                                                       ****
****           S A U T I L   S u p p o r t   U t i l i t y                  ****
****                                                                       ****
****           for the HP SmartArray RAID Controller Family                ****
****                                                                       ****
****                        version A.02.13                                ****
****                                                                       ****
****  (C) Copyright 2003-2007 Hewlett-Packard Development Company, L.P.     ****
********************************************************************************


---- DRIVER INFORMATION -------------------------------------------------------

  Driver State....................... READY

---- CONTROLLER INFORMATION ---------------------------------------------------

  Controller Product Number.......... P800
  Controller Product Name............ HP PCIe SmartArray P800
```

```
   Hardware Path....................... 0/6/0/0/0/0/1/0/0/0
   Serial Number....................... P98690D9SU40R7
   Device File......................... /dev/ciss3
   Hardware Revision................... 'D'
   Firmware Revision (in ROM).......... 4.10
   # of Logical Drives................. 10
   # of Physical Disks Configured...... 54
   # of Physical Disks Detected........ 58


---- ARRAY ACCELERATOR (CACHE) INFORMATION ----------------------------------

   Array Accelerator Board Present?.... yes
   Cache Configuration Status.......... cache enabled
   Cache Ratio......................... 50% Read / 50% Write
   Total Cache Size (MB)............... 456
   Battery Pack Count.................. 2
   Battery Status (pack #1)............ ok
   Battery Status (pack #2)............ ok


---- LOGICAL DRIVE SUMMARY --------------------------------------------------

        #    RAID     Size        Status

        0    0       839702 MB    OK
        1    0        10239 MB    OK
        2    0        10239 MB    OK
        3    0        10239 MB    OK
        4    0        10239 MB    OK
        5    0        10239 MB    OK
        6    0        10239 MB    OK
        7    0         3072 MB    OK
        8    0         3072 MB    OK
        9    0       209925 MB    OK


---- SAS/SATA DEVICE SUMMARY ------------------------------------------------

   Location  Ct Enc Bay      WWID           Type     Capacity Status

   internal  4I  1   8   0x500000e015b2bfd2  DISK      36.4 GB  UNASSIGNED
   internal  4I  1   7   0x500000e015b2d982  DISK      36.4 GB  UNASSIGNED
   internal  4I  1   6   0x500000e015b2f352  DISK      36.4 GB  UNASSIGNED
   internal  4I  1   5   0x500000e015b30a22  DISK      36.4 GB  UNASSIGNED
   internal  3I  1   4   0x5000c5000148e709  DISK      73.4 GB  OK
   internal  3I  1   3   0x5000c500014b62a1  DISK      73.4 GB  OK
   internal  3I  1   2   0x5000c500014aca69  DISK      73.4 GB  OK
   internal  3I  1   1   0x5000c500014b6145  DISK      73.4 GB  OK
   external  2E  1   1   0x5000c50005962f7d  DISK      73.4 GB  OK
   external  2E  1   2   0x5000c50005962a09  DISK      73.4 GB  OK
   external  2E  1   3   0x5000c50005961095  DISK      73.4 GB  OK
   external  2E  1   4   0x5000c500052d0589  DISK      73.4 GB  OK
   external  2E  1   5   0x5000c500052d7595  DISK      73.4 GB  OK
   external  2E  1   6   0x5000c5000596267d  DISK      73.4 GB  OK
   external  2E  1   7   0x5000c500052d32ed  DISK      73.4 GB  OK
   external  2E  1   8   0x5000c500052d2991  DISK      73.4 GB  OK
   external  2E  1   9   0x5000c500052c4939  DISK      73.4 GB  OK
   external  2E  1  10   0x5000c500052d8e91  DISK      73.4 GB  OK
   external  2E  1  11   0x5000c500052d5215  DISK      73.4 GB  OK
   external  2E  1  12   0x5000c500052d46cd  DISK      73.4 GB  OK
   external  2E  1  13   0x5000c5000594e865  DISK      73.4 GB  OK
   external  2E  1  14   0x5000c50005961885  DISK      73.4 GB  OK
   external  2E  1  15   0x5000c500059621b1  DISK      73.4 GB  OK
   external  2E  1  16   0x5000c5000594ad55  DISK      73.4 GB  OK
   external  2E  1  17   0x5000c5000595ec55  DISK      73.4 GB  OK
   external  2E  1  18   0x5000c50005961b4d  DISK      73.4 GB  OK
   external  2E  1  19   0x5000c50001453f31  DISK      73.4 GB  OK
   external  2E  1  20   0x5000c500014975a9  DISK      73.4 GB  OK
   external  2E  1  21   0x5000c50001494559  DISK      73.4 GB  OK
   external  2E  1  22   0x5000c5000149f175  DISK      73.4 GB  OK
   external  2E  1  23   0x5000c5000148a17d  DISK      73.4 GB  OK
```

```
external  2E  1  24  0x5000c5000149c6b1  DISK       73.4 GB  OK
external  2E  1  25  0x5000c5000147ab29  DISK       73.4 GB  OK
external  1E  1   1  0x5000c500052d45f9  DISK       73.4 GB  OK
external  1E  1   2  0x5000c500052d6989  DISK       73.4 GB  OK
external  1E  1   3  0x5000c500052d6335  DISK       73.4 GB  OK
external  1E  1   4  0x5000c500052d5175  DISK       73.4 GB  OK
external  1E  1   5  0x5000c500052d636d  DISK       73.4 GB  OK
external  1E  1   6  0x5000c500052e9b81  DISK       73.4 GB  OK
external  1E  1   7  0x5000c500052d812d  DISK       73.4 GB  OK
external  1E  1   8  0x5000c500052d8225  DISK       73.4 GB  OK
external  1E  1   9  0x5000c500052d542d  DISK       73.4 GB  OK
external  1E  1  10  0x5000c500052d619d  DISK       73.4 GB  OK
external  1E  1  11  0x5000c50005962041  DISK       73.4 GB  OK
external  1E  1  12  0x5000c50005961bf1  DISK       73.4 GB  OK
external  1E  1  13  0x5000c5000594e761  DISK       73.4 GB  OK
external  1E  1  14  0x5000c50005963851  DISK       73.4 GB  OK
external  1E  1  15  0x5000c50005962f95  DISK       73.4 GB  OK
external  1E  1  16  0x5000c50005961695  DISK       73.4 GB  OK
external  1E  1  17  0x5000c500059622ad  DISK       73.4 GB  OK
external  1E  1  18  0x5000c50005962d61  DISK       73.4 GB  OK
external  1E  1  19  0x5000c500014527c1  DISK       73.4 GB  OK
external  1E  1  20  0x5000c500014521b9  DISK       73.4 GB  OK
external  1E  1  21  0x5000c50001494ded  DISK       73.4 GB  OK
external  1E  1  22  0x500000e01226e532  DISK       73.4 GB  OK
external  1E  1  23  0x5000c5000144b329  DISK       73.4 GB  OK
external  1E  1  24  0x5000c50001452b7d  DISK       73.4 GB  OK
external  1E  1  25  0x5000c500014526ed  DISK       73.4 GB  OK
external  1E  1   0  0x50001c1071540025  SES         0.0 GB  FAILED
external  2E  1   0  0x5001438000328825  SES         0.0 GB  FAILED
internal      0   0  0x500110a0004af23e  SES         0.0 GB  FAILED


---- SAS/SATA ENCLOSURE SUMMARY -------------------------------------------------

   Location  Ct   Enc  Expander_count   Bay_count    SEP_count

   internal  4I   1    0                4            1
   internal  3I   1    0                4            1
   external  2E   1    1                25           1
   external  1E   1    1                25           1


---- SAS/SATA DEVICE 4I:1:8:0x500000e015b2bfd2 [DISK] -----------------------

   Connector Location................................ internal
   Connector....................................... 4I
   Enclosure....................................... 1
   Bay............................................. 8
   WWID............................................ 0x500000e015b2bfd2
   Device Type..................................... DISK
   Disk Capacity................................... 36.4 GB
   Device Status................................... UNASSIGNED
   Device Vendor ID................................ HP
   Device Product ID............................... DG036A9BB6
   Device Serial Number............................ B3G5P7503FK10720
   Device Firmware Version......................... HPD0


---- SAS/SATA DEVICE 4I:1:7:0x500000e015b2d982 [DISK] -----------------------

   Connector Location................................ internal
   Connector....................................... 4I
   Enclosure....................................... 1
   Bay............................................. 7
   WWID............................................ 0x500000e015b2d982
   Device Type..................................... DISK
   Disk Capacity................................... 36.4 GB
   Device Status................................... UNASSIGNED
   Device Vendor ID................................ HP
   Device Product ID............................... DG036A9BB6
   Device Serial Number............................ B3G5P7503FNE0720
   Device Firmware Version......................... HPD0
```

```
---- SAS/SATA DEVICE 4I:1:6:0x500000e015b2f352 [DISK] -----------------------

   Connector Location............................. internal
   Connector...................................... 4I
   Enclosure...................................... 1
   Bay............................................ 6
   WWID........................................... 0x500000e015b2f352
   Device Type.................................... DISK
   Disk Capacity.................................. 36.4 GB
   Device Status.................................. UNASSIGNED
   Device Vendor ID............................... HP
   Device Product ID.............................. DG036A9BB6
   Device Serial Number........................... B3G5P7503FR80720
   Device Firmware Version........................ HPD0


---- SAS/SATA DEVICE 4I:1:5:0x500000e015b30a22 [DISK] -----------------------

   Connector Location............................. internal
   Connector...................................... 4I
   Enclosure...................................... 1
   Bay............................................ 5
   WWID........................................... 0x500000e015b30a22
   Device Type.................................... DISK
   Disk Capacity.................................. 36.4 GB
   Device Status.................................. UNASSIGNED
   Device Vendor ID............................... HP
   Device Product ID.............................. DG036A9BB6
   Device Serial Number........................... B3G5P7503FVV0720
   Device Firmware Version........................ HPD0


---- SAS/SATA DEVICE 3I:1:4:0x5000c5000148e709 [DISK] -----------------------

   Connector Location............................. internal
   Connector...................................... 3I
   Enclosure...................................... 1
   Bay............................................ 4
   WWID........................................... 0x5000c5000148e709
   Device Type.................................... DISK
   Disk Capacity.................................. 73.4 GB
   Device Status.................................. OK
   Device Vendor ID............................... HP
   Device Product ID.............................. DH072ABAA6
   Device Serial Number........................... 3PD0AX1R00009742F8JK
   Device Firmware Version........................ HPD2


---- SAS/SATA DEVICE 3I:1:3:0x5000c500014b62a1 [DISK] -----------------------

   Connector Location............................. internal
   Connector...................................... 3I
   Enclosure...................................... 1
   Bay............................................ 3
   WWID........................................... 0x5000c500014b62a1
   Device Type.................................... DISK
   Disk Capacity.................................. 73.4 GB
   Device Status.................................. OK
   Device Vendor ID............................... HP
   Device Product ID.............................. DH072ABAA6
   Device Serial Number........................... 3PD0AL1Z000097420160
   Device Firmware Version........................ HPD2


---- SAS/SATA DEVICE 3I:1:2:0x5000c500014aca69 [DISK] -----------------------

   Connector Location............................. internal
   Connector...................................... 3I
   Enclosure...................................... 1
   Bay............................................ 2
```

```
   WWID............................................ 0x5000c500014aca69
   Device Type..................................... DISK
   Disk Capacity................................... 73.4 GB
   Device Status................................... OK
   Device Vendor ID................................ HP
   Device Product ID............................... DH072ABAA6
   Device Serial Number............................ 3PD0BCSS00009742GMA1
   Device Firmware Version......................... HPD2


   ---- SAS/SATA DEVICE 3I:1:1:0x5000c500014b6145 [DISK] ----------------------

   Connector Location.............................. internal
   Connector....................................... 3I
   Enclosure....................................... 1
   Bay............................................. 1
   WWID............................................ 0x5000c500014b6145
   Device Type..................................... DISK
   Disk Capacity................................... 73.4 GB
   Device Status................................... OK
   Device Vendor ID................................ HP
   Device Product ID............................... DH072ABAA6
   Device Serial Number............................ 3PD0AL1600009742GNNF
   Device Firmware Version......................... HPD2


   ---- SAS/SATA DEVICE 2E:1:1:0x5000c50005962f7d [DISK] ----------------------

   Connector Location.............................. external
   Connector....................................... 2E
   Enclosure....................................... 1
   Bay............................................. 1
   WWID............................................ 0x5000c50005962f7d
   Device Type..................................... DISK
   Disk Capacity................................... 73.4 GB
   Device Status................................... OK
   Device Vendor ID................................ HP
   Device Product ID............................... DH072ABAA6
   Device Serial Number............................ 3PD0LTCN000098047WWK
   Device Firmware Version......................... HPD2


   ---- SAS/SATA DEVICE 2E:1:2:0x5000c50005962a09 [DISK] ----------------------

   Connector Location.............................. external
   Connector....................................... 2E
   Enclosure....................................... 1
   Bay............................................. 2
   WWID............................................ 0x5000c50005962a09
   Device Type..................................... DISK
   Disk Capacity................................... 73.4 GB
   Device Status................................... OK
   Device Vendor ID................................ HP
   Device Product ID............................... DH072ABAA6
   Device Serial Number............................ 3PD0KY2A00009802DRNR
   Device Firmware Version......................... HPD2


   ---- SAS/SATA DEVICE 2E:1:3:0x5000c50005961095 [DISK] ----------------------

   Connector Location.............................. external
   Connector....................................... 2E
   Enclosure....................................... 1
   Bay............................................. 3
   WWID............................................ 0x5000c50005961095
   Device Type..................................... DISK
   Disk Capacity................................... 73.4 GB
   Device Status................................... OK
   Device Vendor ID................................ HP
   Device Product ID............................... DH072ABAA6
   Device Serial Number............................ 3PD0KY280000980363WY
   Device Firmware Version......................... HPD2
```

```
---- SAS/SATA DEVICE 2E:1:4:0x5000c500052d0589 [DISK] -----------------------

  Connector Location.............................. external
  Connector....................................... 2E
  Enclosure....................................... 1
  Bay............................................. 4
  WWID............................................ 0x5000c500052d0589
  Device Type..................................... DISK
  Disk Capacity................................... 73.4 GB
  Device Status................................... OK
  Device Vendor ID................................ HP
  Device Product ID............................... DH072ABAA6
  Device Serial Number............................ 3PD0HEDC000097487BP2
  Device Firmware Version......................... HPD2


---- SAS/SATA DEVICE 2E:1:5:0x5000c500052d7595 [DISK] -----------------------

  Connector Location.............................. external
  Connector....................................... 2E
  Enclosure....................................... 1
  Bay............................................. 5
  WWID............................................ 0x5000c500052d7595
  Device Type..................................... DISK
  Disk Capacity................................... 73.4 GB
  Device Status................................... OK
  Device Vendor ID................................ HP
  Device Product ID............................... DH072ABAA6
  Device Serial Number............................ 3PD0J3G900009748WPXF
  Device Firmware Version......................... HPD2


---- SAS/SATA DEVICE 2E:1:6:0x5000c5000596267d [DISK] -----------------------

  Connector Location.............................. external
  Connector....................................... 2E
  Enclosure....................................... 1
  Bay............................................. 6
  WWID............................................ 0x5000c5000596267d
  Device Type..................................... DISK
  Disk Capacity................................... 73.4 GB
  Device Status................................... OK
  Device Vendor ID................................ HP
  Device Product ID............................... DH072ABAA6
  Device Serial Number............................ 3PD0LTG6000098047SR2
  Device Firmware Version......................... HPD2


---- SAS/SATA DEVICE 2E:1:7:0x5000c500052d32ed [DISK] -----------------------

  Connector Location.............................. external
  Connector....................................... 2E
  Enclosure....................................... 1
  Bay............................................. 7
  WWID............................................ 0x5000c500052d32ed
  Device Type..................................... DISK
  Disk Capacity................................... 73.4 GB
  Device Status................................... OK
  Device Vendor ID................................ HP
  Device Product ID............................... DH072ABAA6
  Device Serial Number............................ 3PD0E3Y800009748VDT3
  Device Firmware Version......................... HPD2


---- SAS/SATA DEVICE 2E:1:8:0x5000c500052d2991 [DISK] -----------------------

  Connector Location.............................. external
  Connector....................................... 2E
  Enclosure....................................... 1
  Bay............................................. 8
```

```
    WWID............................................. 0x5000c500052d2991
    Device Type...................................... DISK
    Disk Capacity.................................... 73.4 GB
    Device Status.................................... OK
    Device Vendor ID................................. HP
    Device Product ID................................ DH072ABAA6
    Device Serial Number............................. 3PD0G9HB00009745TPAR
    Device Firmware Version.......................... HPD2


    ---- SAS/SATA DEVICE 2E:1:9:0x5000c500052c4939 [DISK] -----------------------

    Connector Location............................... external
    Connector........................................ 2E
    Enclosure........................................ 1
    Bay.............................................. 9
    WWID............................................. 0x5000c500052c4939
    Device Type...................................... DISK
    Disk Capacity.................................... 73.4 GB
    Device Status.................................... OK
    Device Vendor ID................................. HP
    Device Product ID................................ DH072ABAA6
    Device Serial Number............................. 3PD0HLJH00009747PC85
    Device Firmware Version.......................... HPD2


    ---- SAS/SATA DEVICE 2E:1:10:0x5000c500052d8e91 [DISK] ----------------------

    Connector Location............................... external
    Connector........................................ 2E
    Enclosure........................................ 1
    Bay.............................................. 10
    WWID............................................. 0x5000c500052d8e91
    Device Type...................................... DISK
    Disk Capacity.................................... 73.4 GB
    Device Status.................................... OK
    Device Vendor ID................................. HP
    Device Product ID................................ DH072ABAA6
    Device Serial Number............................. 3PD0J1KL000097488C2V
    Device Firmware Version.......................... HPD2


    ---- SAS/SATA DEVICE 2E:1:11:0x5000c500052d5215 [DISK] ----------------------

    Connector Location............................... external
    Connector........................................ 2E
    Enclosure........................................ 1
    Bay.............................................. 11
    WWID............................................. 0x5000c500052d5215
    Device Type...................................... DISK
    Disk Capacity.................................... 73.4 GB
    Device Status.................................... OK
    Device Vendor ID................................. HP
    Device Product ID................................ DH072ABAA6
    Device Serial Number............................. 3PD0HTNC000097487Y6U
    Device Firmware Version.......................... HPD2


    ---- SAS/SATA DEVICE 2E:1:12:0x5000c500052d46cd [DISK] ----------------------

    Connector Location............................... external
    Connector........................................ 2E
    Enclosure........................................ 1
    Bay.............................................. 12
    WWID............................................. 0x5000c500052d46cd
    Device Type...................................... DISK
    Disk Capacity.................................... 73.4 GB
    Device Status.................................... OK
    Device Vendor ID................................. HP
    Device Product ID................................ DH072ABAA6
    Device Serial Number............................. 3PD0HD7N00009748WP46
    Device Firmware Version.......................... HPD2
```

```
---- SAS/SATA DEVICE 2E:1:13:0x5000c5000594e865 [DISK] ----------------------

  Connector Location.............................. external
  Connector....................................... 2E
  Enclosure....................................... 1
  Bay............................................. 13
  WWID............................................ 0x5000c5000594e865
  Device Type..................................... DISK
  Disk Capacity................................... 73.4 GB
  Device Status................................... OK
  Device Vendor ID................................ HP
  Device Product ID............................... DH072ABAA6
  Device Serial Number............................ 3PD0LB960000980364LV
  Device Firmware Version......................... HPD2


---- SAS/SATA DEVICE 2E:1:14:0x5000c50005961885 [DISK] ----------------------

  Connector Location.............................. external
  Connector....................................... 2E
  Enclosure....................................... 1
  Bay............................................. 14
  WWID............................................ 0x5000c50005961885
  Device Type..................................... DISK
  Disk Capacity................................... 73.4 GB
  Device Status................................... OK
  Device Vendor ID................................ HP
  Device Product ID............................... DH072ABAA6
  Device Serial Number............................ 3PD0LVC2000098047R4V
  Device Firmware Version......................... HPD2


---- SAS/SATA DEVICE 2E:1:15:0x5000c500059621b1 [DISK] ----------------------

  Connector Location.............................. external
  Connector....................................... 2E
  Enclosure....................................... 1
  Bay............................................. 15
  WWID............................................ 0x5000c500059621b1
  Device Type..................................... DISK
  Disk Capacity................................... 73.4 GB
  Device Status................................... OK
  Device Vendor ID................................ HP
  Device Product ID............................... DH072ABAA6
  Device Serial Number............................ 3PD0L9D2000098047SEF
  Device Firmware Version......................... HPD2


---- SAS/SATA DEVICE 2E:1:16:0x5000c5000594ad55 [DISK] ----------------------

  Connector Location.............................. external
  Connector....................................... 2E
  Enclosure....................................... 1
  Bay............................................. 16
  WWID............................................ 0x5000c5000594ad55
  Device Type..................................... DISK
  Disk Capacity................................... 73.4 GB
  Device Status................................... OK
  Device Vendor ID................................ HP
  Device Product ID............................... DH072ABAA6
  Device Serial Number............................ 3PD0LCA0000098033RPZ
  Device Firmware Version......................... HPD2


---- SAS/SATA DEVICE 2E:1:17:0x5000c5000595ec55 [DISK] ----------------------

  Connector Location.............................. external
  Connector....................................... 2E
  Enclosure....................................... 1
  Bay............................................. 17
```

```
    WWID............................................. 0x5000c5000595ec55
    Device Type...................................... DISK
    Disk Capacity.................................... 73.4 GB
    Device Status.................................... OK
    Device Vendor ID................................. HP
    Device Product ID................................ DH072ABAA6
    Device Serial Number............................. 3PD0LHSA0000980365RU
    Device Firmware Version.......................... HPD2


    ---- SAS/SATA DEVICE 2E:1:18:0x5000c50005961b4d [DISK] ----------------------

    Connector Location............................... external
    Connector........................................ 2E
    Enclosure........................................ 1
    Bay.............................................. 18
    WWID............................................. 0x5000c50005961b4d
    Device Type...................................... DISK
    Disk Capacity.................................... 73.4 GB
    Device Status.................................... OK
    Device Vendor ID................................. HP
    Device Product ID................................ DH072ABAA6
    Device Serial Number............................. 3PD0LSP100009802BSDS
    Device Firmware Version.......................... HPD2


    ---- SAS/SATA DEVICE 2E:1:19:0x5000c50001453f31 [DISK] ----------------------

    Connector Location............................... external
    Connector........................................ 2E
    Enclosure........................................ 1
    Bay.............................................. 19
    WWID............................................. 0x5000c50001453f31
    Device Type...................................... DISK
    Disk Capacity.................................... 73.4 GB
    Device Status.................................... OK
    Device Vendor ID................................. HP
    Device Product ID................................ DH072ABAA6
    Device Serial Number............................. 3PD07LEY000097402WSR
    Device Firmware Version.......................... HPD2


    ---- SAS/SATA DEVICE 2E:1:20:0x5000c500014975a9 [DISK] ----------------------

    Connector Location............................... external
    Connector........................................ 2E
    Enclosure........................................ 1
    Bay.............................................. 20
    WWID............................................. 0x5000c500014975a9
    Device Type...................................... DISK
    Disk Capacity.................................... 73.4 GB
    Device Status.................................... OK
    Device Vendor ID................................. HP
    Device Product ID................................ DH072ABAA6
    Device Serial Number............................. 3PD0AR1900009742SB8X
    Device Firmware Version.......................... HPD2


    ---- SAS/SATA DEVICE 2E:1:21:0x5000c50001494559 [DISK] ----------------------

    Connector Location............................... external
    Connector........................................ 2E
    Enclosure........................................ 1
    Bay.............................................. 21
    WWID............................................. 0x5000c50001494559
    Device Type...................................... DISK
    Disk Capacity.................................... 73.4 GB
    Device Status.................................... OK
    Device Vendor ID................................. HP
    Device Product ID................................ DH072ABAA6
    Device Serial Number............................. 3PD0A8XN00009742T4U0
    Device Firmware Version.......................... HPD2
```

```
---- SAS/SATA DEVICE 2E:1:22:0x5000c5000149f175 [DISK] ----------------------

  Connector Location.............................. external
  Connector....................................... 2E
  Enclosure....................................... 1
  Bay............................................. 22
  WWID............................................ 0x5000c5000149f175
  Device Type..................................... DISK
  Disk Capacity................................... 73.4 GB
  Device Status................................... OK
  Device Vendor ID................................ HP
  Device Product ID............................... DH072ABAA6
  Device Serial Number............................ 3PD0BG0700009742T2HN
  Device Firmware Version......................... HPD2


---- SAS/SATA DEVICE 2E:1:23:0x5000c5000148a17d [DISK] ----------------------

  Connector Location.............................. external
  Connector....................................... 2E
  Enclosure....................................... 1
  Bay............................................. 23
  WWID............................................ 0x5000c5000148a17d
  Device Type..................................... DISK
  Disk Capacity................................... 73.4 GB
  Device Status................................... OK
  Device Vendor ID................................ HP
  Device Product ID............................... DH072ABAA6
  Device Serial Number............................ 3PD0A2XR00009742ED0J
  Device Firmware Version......................... HPD2


---- SAS/SATA DEVICE 2E:1:24:0x5000c5000149c6b1 [DISK] ----------------------

  Connector Location.............................. external
  Connector....................................... 2E
  Enclosure....................................... 1
  Bay............................................. 24
  WWID............................................ 0x5000c5000149c6b1
  Device Type..................................... DISK
  Disk Capacity................................... 73.4 GB
  Device Status................................... OK
  Device Vendor ID................................ HP
  Device Product ID............................... DH072ABAA6
  Device Serial Number............................ 3PD0BAMX00009742FABC
  Device Firmware Version......................... HPD2


---- SAS/SATA DEVICE 2E:1:25:0x5000c5000147ab29 [DISK] ----------------------

  Connector Location.............................. external
  Connector....................................... 2E
  Enclosure....................................... 1
  Bay............................................. 25
  WWID............................................ 0x5000c5000147ab29
  Device Type..................................... DISK
  Disk Capacity................................... 73.4 GB
  Device Status................................... OK
  Device Vendor ID................................ HP
  Device Product ID............................... DH072ABAA6
  Device Serial Number............................ 3PD0AA6V00009742ELCK
  Device Firmware Version......................... HPD2


---- SAS/SATA DEVICE 1E:1:1:0x5000c500052d45f9 [DISK] -----------------------

  Connector Location.............................. external
  Connector....................................... 1E
  Enclosure....................................... 1
  Bay............................................. 1
```

```
   WWID............................................ 0x5000c500052d45f9
   Device Type...................................... DISK
   Disk Capacity.................................... 73.4 GB
   Device Status.................................... OK
   Device Vendor ID................................. HP
   Device Product ID................................ DH072ABAA6
   Device Serial Number............................. 3PD0E4D100009748YDE4
   Device Firmware Version.......................... HPD2


   ---- SAS/SATA DEVICE 1E:1:2:0x5000c500052d6989 [DISK] -----------------------

   Connector Location............................... external
   Connector........................................ 1E
   Enclosure........................................ 1
   Bay.............................................. 2
   WWID............................................. 0x5000c500052d6989
   Device Type...................................... DISK
   Disk Capacity.................................... 73.4 GB
   Device Status.................................... OK
   Device Vendor ID................................. HP
   Device Product ID................................ DH072ABAA6
   Device Serial Number............................. 3PD0J53F00009748XRKF
   Device Firmware Version.......................... HPD2


   ---- SAS/SATA DEVICE 1E:1:3:0x5000c500052d6335 [DISK] -----------------------

   Connector Location............................... external
   Connector........................................ 1E
   Enclosure........................................ 1
   Bay.............................................. 3
   WWID............................................. 0x5000c500052d6335
   Device Type...................................... DISK
   Disk Capacity.................................... 73.4 GB
   Device Status.................................... OK
   Device Vendor ID................................. HP
   Device Product ID................................ DH072ABAA6
   Device Serial Number............................. 3PD0J4A000009748XQZG
   Device Firmware Version.......................... HPD2


   ---- SAS/SATA DEVICE 1E:1:4:0x5000c500052d5175 [DISK] -----------------------

   Connector Location............................... external
   Connector........................................ 1E
   Enclosure........................................ 1
   Bay.............................................. 4
   WWID............................................. 0x5000c500052d5175
   Device Type...................................... DISK
   Disk Capacity.................................... 73.4 GB
   Device Status.................................... OK
   Device Vendor ID................................. HP
   Device Product ID................................ DH072ABAA6
   Device Serial Number............................. 3PD0H0E700009748WS5P
   Device Firmware Version.......................... HPD2


   ---- SAS/SATA DEVICE 1E:1:5:0x5000c500052d636d [DISK] -----------------------

   Connector Location............................... external
   Connector........................................ 1E
   Enclosure........................................ 1
   Bay.............................................. 5
   WWID............................................. 0x5000c500052d636d
   Device Type...................................... DISK
   Disk Capacity.................................... 73.4 GB
   Device Status.................................... OK
   Device Vendor ID................................. HP
   Device Product ID................................ DH072ABAA6
   Device Serial Number............................. 3PD0J4AC00009748XQ9C
   Device Firmware Version.......................... HPD2
```

```
---- SAS/SATA DEVICE 1E:1:6:0x5000c500052e9b81 [DISK] -----------------------

  Connector Location............................. external
  Connector...................................... 1E
  Enclosure...................................... 1
  Bay............................................ 6
  WWID........................................... 0x5000c500052e9b81
  Device Type.................................... DISK
  Disk Capacity.................................. 73.4 GB
  Device Status.................................. OK
  Device Vendor ID............................... HP
  Device Product ID.............................. DH072ABAA6
  Device Serial Number........................... 3PD0E4H700009749B2F1
  Device Firmware Version........................ HPD2


---- SAS/SATA DEVICE 1E:1:7:0x5000c500052d812d [DISK] -----------------------

  Connector Location............................. external
  Connector...................................... 1E
  Enclosure...................................... 1
  Bay............................................ 7
  WWID........................................... 0x5000c500052d812d
  Device Type.................................... DISK
  Disk Capacity.................................. 73.4 GB
  Device Status.................................. OK
  Device Vendor ID............................... HP
  Device Product ID.............................. DH072ABAA6
  Device Serial Number........................... 3PD0J2T600009748XRPT
  Device Firmware Version........................ HPD2


---- SAS/SATA DEVICE 1E:1:8:0x5000c500052d8225 [DISK] -----------------------

  Connector Location............................. external
  Connector...................................... 1E
  Enclosure...................................... 1
  Bay............................................ 8
  WWID........................................... 0x5000c500052d8225
  Device Type.................................... DISK
  Disk Capacity.................................. 73.4 GB
  Device Status.................................. OK
  Device Vendor ID............................... HP
  Device Product ID.............................. DH072ABAA6
  Device Serial Number........................... 3PD0J2Q600009748WTEC
  Device Firmware Version........................ HPD2


---- SAS/SATA DEVICE 1E:1:9:0x5000c500052d542d [DISK] -----------------------

  Connector Location............................. external
  Connector...................................... 1E
  Enclosure...................................... 1
  Bay............................................ 9
  WWID........................................... 0x5000c500052d542d
  Device Type.................................... DISK
  Disk Capacity.................................. 73.4 GB
  Device Status.................................. OK
  Device Vendor ID............................... HP
  Device Product ID.............................. DH072ABAA6
  Device Serial Number........................... 3PD0HGT4000097487XGJ
  Device Firmware Version........................ HPD2


---- SAS/SATA DEVICE 1E:1:10:0x5000c500052d619d [DISK] -----------------------

  Connector Location............................. external
  Connector...................................... 1E
  Enclosure...................................... 1
  Bay............................................ 10
```

```
   WWID........................................... 0x5000c500052d619d
   Device Type.................................... DISK
   Disk Capacity.................................. 73.4 GB
   Device Status.................................. OK
   Device Vendor ID............................... HP
   Device Product ID.............................. DH072ABAA6
   Device Serial Number........................... 3PD0HH8200009748YCU8
   Device Firmware Version........................ HPD2


  ---- SAS/SATA DEVICE 1E:1:11:0x5000c50005962041 [DISK] ---------------------

   Connector Location............................. external
   Connector...................................... 1E
   Enclosure...................................... 1
   Bay............................................ 11
   WWID........................................... 0x5000c50005962041
   Device Type.................................... DISK
   Disk Capacity.................................. 73.4 GB
   Device Status.................................. OK
   Device Vendor ID............................... HP
   Device Product ID.............................. DH072ABAA6
   Device Serial Number........................... 3PD0LT1C000098047SY5
   Device Firmware Version........................ HPD2


  ---- SAS/SATA DEVICE 1E:1:12:0x5000c50005961bf1 [DISK] ---------------------

   Connector Location............................. external
   Connector...................................... 1E
   Enclosure...................................... 1
   Bay............................................ 12
   WWID........................................... 0x5000c50005961bf1
   Device Type.................................... DISK
   Disk Capacity.................................. 73.4 GB
   Device Status.................................. OK
   Device Vendor ID............................... HP
   Device Product ID.............................. DH072ABAA6
   Device Serial Number........................... 3PD0LSQF000098047S79
   Device Firmware Version........................ HPD2


  ---- SAS/SATA DEVICE 1E:1:13:0x5000c5000594e761 [DISK] ---------------------

   Connector Location............................. external
   Connector...................................... 1E
   Enclosure...................................... 1
   Bay............................................ 13
   WWID........................................... 0x5000c5000594e761
   Device Type.................................... DISK
   Disk Capacity.................................. 73.4 GB
   Device Status.................................. OK
   Device Vendor ID............................... HP
   Device Product ID.............................. DH072ABAA6
   Device Serial Number........................... 3PD0KAE800009748XSBC
   Device Firmware Version........................ HPD2


  ---- SAS/SATA DEVICE 1E:1:14:0x5000c50005963851 [DISK] ---------------------

   Connector Location............................. external
   Connector...................................... 1E
   Enclosure...................................... 1
   Bay............................................ 14
   WWID........................................... 0x5000c50005963851
   Device Type.................................... DISK
   Disk Capacity.................................. 73.4 GB
   Device Status.................................. OK
   Device Vendor ID............................... HP
   Device Product ID.............................. DH072ABAA6
   Device Serial Number........................... 3PD0LTD3000098037EAR
   Device Firmware Version........................ HPD2
```

```
---- SAS/SATA DEVICE 1E:1:15:0x5000c50005962f95 [DISK] ----------------------

   Connector Location............................. external
   Connector...................................... 1E
   Enclosure...................................... 1
   Bay............................................ 15
   WWID........................................... 0x5000c50005962f95
   Device Type.................................... DISK
   Disk Capacity.................................. 73.4 GB
   Device Status.................................. OK
   Device Vendor ID............................... HP
   Device Product ID.............................. DH072ABAA6
   Device Serial Number........................... 3PD0LRXH000098047XYB
   Device Firmware Version........................ HPD2


---- SAS/SATA DEVICE 1E:1:16:0x5000c50005961695 [DISK] ----------------------

   Connector Location............................. external
   Connector...................................... 1E
   Enclosure...................................... 1
   Bay............................................ 16
   WWID........................................... 0x5000c50005961695
   Device Type.................................... DISK
   Disk Capacity.................................. 73.4 GB
   Device Status.................................. OK
   Device Vendor ID............................... HP
   Device Product ID.............................. DH072ABAA6
   Device Serial Number........................... 3PD0LV9700009750F7B6
   Device Firmware Version........................ HPD2


---- SAS/SATA DEVICE 1E:1:17:0x5000c500059622ad [DISK] ----------------------

   Connector Location............................. external
   Connector...................................... 1E
   Enclosure...................................... 1
   Bay............................................ 17
   WWID........................................... 0x5000c500059622ad
   Device Type.................................... DISK
   Disk Capacity.................................. 73.4 GB
   Device Status.................................. OK
   Device Vendor ID............................... HP
   Device Product ID.............................. DH072ABAA6
   Device Serial Number........................... 3PD0LSWP000098047TKR
   Device Firmware Version........................ HPD2


---- SAS/SATA DEVICE 1E:1:18:0x5000c50005962d61 [DISK] ----------------------

   Connector Location............................. external
   Connector...................................... 1E
   Enclosure...................................... 1
   Bay............................................ 18
   WWID........................................... 0x5000c50005962d61
   Device Type.................................... DISK
   Disk Capacity.................................. 73.4 GB
   Device Status.................................. OK
   Device Vendor ID............................... HP
   Device Product ID.............................. DH072ABAA6
   Device Serial Number........................... 3PD0LS2D000098047X8Z
   Device Firmware Version........................ HPD2


---- SAS/SATA DEVICE 1E:1:19:0x5000c500014527c1 [DISK] ----------------------

   Connector Location............................. external
   Connector...................................... 1E
   Enclosure...................................... 1
   Bay............................................ 19
```

```
    WWID............................................ 0x5000c500014527c1
    Device Type..................................... DISK
    Disk Capacity................................... 73.4 GB
    Device Status................................... OK
    Device Vendor ID................................ HP
    Device Product ID............................... DH072ABAA6
    Device Serial Number............................ 3PD08RVZ00009741C8J6
    Device Firmware Version......................... HPD2


    ---- SAS/SATA DEVICE 1E:1:20:0x5000c500014521b9 [DISK] ----------------------

    Connector Location.............................. external
    Connector....................................... 1E
    Enclosure....................................... 1
    Bay............................................. 20
    WWID............................................ 0x5000c500014521b9
    Device Type..................................... DISK
    Disk Capacity................................... 73.4 GB
    Device Status................................... OK
    Device Vendor ID................................ HP
    Device Product ID............................... DH072ABAA6
    Device Serial Number............................ 3PD08DAV00009741C8SQ
    Device Firmware Version......................... HPD2


    ---- SAS/SATA DEVICE 1E:1:21:0x5000c50001494ded [DISK] ----------------------

    Connector Location.............................. external
    Connector....................................... 1E
    Enclosure....................................... 1
    Bay............................................. 21
    WWID............................................ 0x5000c50001494ded
    Device Type..................................... DISK
    Disk Capacity................................... 73.4 GB
    Device Status................................... OK
    Device Vendor ID................................ HP
    Device Product ID............................... DH072ABAA6
    Device Serial Number............................ 3PD0B2JE00009742F15X
    Device Firmware Version......................... HPD2


    ---- SAS/SATA DEVICE 1E:1:22:0x500000e01226e532 [DISK] ----------------------

    Connector Location.............................. external
    Connector....................................... 1E
    Enclosure....................................... 1
    Bay............................................. 22
    WWID............................................ 0x500000e01226e532
    Device Type..................................... DISK
    Disk Capacity................................... 73.4 GB
    Device Status................................... OK
    Device Vendor ID................................ HP
    Device Product ID............................... DG072A9BB7
    Device Serial Number............................ B365P6601NUL0623
    Device Firmware Version......................... HPD0


    ---- SAS/SATA DEVICE 1E:1:23:0x5000c5000144b329 [DISK] ----------------------

    Connector Location.............................. external
    Connector....................................... 1E
    Enclosure....................................... 1
    Bay............................................. 23
    WWID............................................ 0x5000c5000144b329
    Device Type..................................... DISK
    Disk Capacity................................... 73.4 GB
    Device Status................................... OK
    Device Vendor ID................................ HP
    Device Product ID............................... DH072ABAA6
    Device Serial Number............................ 3PD090J0000097402VWB
    Device Firmware Version......................... HPD2
```

```
---- SAS/SATA DEVICE 1E:1:24:0x5000c50001452b7d [DISK] ----------------------

   Connector Location.............................. external
   Connector....................................... 1E
   Enclosure....................................... 1
   Bay............................................. 24
   WWID............................................ 0x5000c50001452b7d
   Device Type..................................... DISK
   Disk Capacity................................... 73.4 GB
   Device Status................................... OK
   Device Vendor ID................................ HP
   Device Product ID............................... DH072ABAA6
   Device Serial Number............................ 3PD090TT00009741CABT
   Device Firmware Version......................... HPD2


---- SAS/SATA DEVICE 1E:1:25:0x5000c500014526ed [DISK] ----------------------

   Connector Location.............................. external
   Connector....................................... 1E
   Enclosure....................................... 1
   Bay............................................. 25
   WWID............................................ 0x5000c500014526ed
   Device Type..................................... DISK
   Disk Capacity................................... 73.4 GB
   Device Status................................... OK
   Device Vendor ID................................ HP
   Device Product ID............................... DH072ABAA6
   Device Serial Number............................ 3PD08ZG600009741HYC7
   Device Firmware Version......................... HPD2


---- SAS/SATA DEVICE 1E:1:0:0x50001c1071540025 [SES] ------------------------

   Connector Location.............................. external
   Connector....................................... 1E
   Enclosure....................................... 1
   Bay............................................. 0
   WWID............................................ 0x50001c1071540025
   Device Type..................................... SES
   Disk Capacity................................... 0.0 GB
   Device Status................................... FAILED
   Device Vendor ID................................ HP
   Device Product ID............................... MSA70
   Device Serial Number............................ SGA728007J
   Device Firmware Version......................... 1.42


---- SAS/SATA DEVICE 2E:1:0:0x5001438000328825 [SES] ------------------------

   Connector Location.............................. external
   Connector....................................... 2E
   Enclosure....................................... 1
   Bay............................................. 0
   WWID............................................ 0x5001438000328825
   Device Type..................................... SES
   Disk Capacity................................... 0.0 GB
   Device Status................................... FAILED
   Device Vendor ID................................ HP
   Device Product ID............................... MSA70
   Device Serial Number............................ SGA72800DF
   Device Firmware Version......................... 1.50


---- SAS/SATA DEVICE :0:0:0x500110a0004af23e [SES] --------------------------

   Connector Location.............................. internal
   Connector.......................................
   Enclosure....................................... 0
   Bay............................................. 0
```

```
WWID.......................................... 0x500110a0004af23e
Device Type................................... SES
Disk Capacity................................. 0.0 GB
Device Status................................. FAILED
Device Vendor ID.............................. HP
Device Product ID............................. P800
Device Serial Number.......................... P98690D9SU40R7
Device Firmware Version....................... 1.01



******************************************************************************
****                       End of SAUTIL Output                          ****
******************************************************************************
```

In this example, the SAS/SATA DEVICE SUMMARY lists the physical drive ID for each physical disk and SES device connected to the Smart Array controller. The information provided for each physical disk and SES device following the SAS/SATA DEVICE SUMMARY indicates that the enclosure (SES device) 1E:1:0 / 0x50001c1071540025 has firmware 1.42 and the enclosure (SES device) 2E:1:0 / 0x500143800328825 has firmware 1.50.

NOTE: The status of a SAS SES device is always FAILED. The FAILED status does not indicate that the enclosure is not functioning. It means that it is not a DISK. In the information provided for each physical device and SES device in the `sautil <device_file>` command output, the "Last Failure Reason" for the SES device is "NON DISK DEVICE."

Updating SAS storage enclosure firmware

The sautil SAS storage enclosure firmware update command syntax is:

`sautil <device_file> download_encl_fw <fw_image> <encl_physical_drive_id>`

Where:

<device_file>	The controller device file. See "Determining the Smart Array controller device file" (page 82).
<fw_image>	The file path of the firmware version you want to install on the enclosure. For access to the enclosure firmware image update file, contact your HP representative.
<encl_physical_drive_id>	The physical ID of the enclosure where you want to change the firmware, in Connector:Enclosure/Bay or WWID format. You can determine this information from the SAS/SATA DEVICE SUMMARY sections of the `sautil <device_file>` or `sautil <device_file> -s` command output.

△ **CAUTION:** The firmware download process can take 10 to 15 minutes to complete. During this time, all I/Os to the controller are temporarily halted, including I/Os to internal disks and other enclosures. If the controller has a boot logical drive configured, use `saupdate` to update the enclosure firmware offline.

For example:
```
# sautil /dev/ciss3 download_encl_fw vw_199cg.s3r 2E:1:0
******************************************************************************
****                                                                     ****
****             S A U T I L   S u p p o r t   U t i l i t y             ****
****                                                                     ****
****          for the HP SmartArray RAID Controller Family              ****
****                                                                     ****
****                        version A.02.13                             ****
****                                                                     ****
****  (C) Copyright 2003-2007 Hewlett-Packard Development Company, L.P.   ****
******************************************************************************
```

```
---- DRIVER INFORMATION -------------------------------------------------------

  Driver State....................... READY

---- CONTROLLER INFORMATION ---------------------------------------------------

  Controller Product Number.......... P800
  Controller Product Name............ HP PCIe SmartArray P800
  Hardware Path...................... 0/6/0/0/0/0/1/0/0/0
  Device File........................ /dev/ciss3

---- FIRMWARE DOWNLOAD --------------------------------------------------------

  ** You are downloading the firmware image "vw_199cg.s3r"
  ** to the enclosure "2E:1:0" (channel:ID)
  ** connected to the controller "/dev/ciss3".

  Verifying that the specified target enclosure is valid..... [Done]

  Retrieving firmware image file from disk................... [Done]

  Validating the file's signature and size................... [Done]

  Retrieving the firmware revision string from ROM........... [Done]

      Current Revision (in ROM)....... 1.50

      WARNING: The firmware download process may take 10+ minutes to
               complete. All I/O to this controller will be temporarily
               halted during this time.

      Are you sure you want to continue (y/n)? y

  Preparing for download..................................... [Done]

  Sending the new firmware to the enclosure.................. [Done]

  Flashing the enclosure with the new firmware............... [Done]

  Resetting the controller................................... [Done]

  Retrieving the firmware revision string from ROM........... [Done]

      Current Revision (in ROM)....... 1.99

  FIRMWARE DOWNLOAD WAS SUCCESSFUL!


*******************************************************************************
****                        End of SAUTIL Output                          ****
*******************************************************************************
```

In this example, the firmware of the enclosure (SES device) at 2E:1:0 is updated from version 1.50 to 1.99.

Repeat this procedure for each enclosure where you want to update the firmware.

5 Support and other resources

About this document

This document describes how to configure and troubleshoot HP Smart Array SAS Controllers in HP Integrity servers.

Intended audience

This document is for system and network administrators responsible for installing, configuring, and managing fault tolerant data storage. Administrators must know operating system concepts, commands, and configuration. Administrators also must know proper electrostatic discharge (ESD) safety procedures for installing the controller hardware.

This document is not a tutorial.

Typographic conventions

This document uses the following typographical conventions:

`%`, `$`, or `#`	A percent sign represents the C shell system prompt. A dollar sign represents the system prompt for the Bourne, Korn, and POSIX shells. A number sign represents the superuser prompt.
`Command`	A command name or qualified command phrase.
`Computer output`	Text displayed by the computer.
`ENVIRONMENT VARIABLE`	The name of an environment variable, for example, `PATH`.
`User input`	Commands and other text that you type.
WARNING	A warning calls attention to important information that if not understood or followed will result in personal injury or nonrecoverable system problems.
CAUTION	A caution calls attention to important information that if not understood or followed will result in data loss, data corruption, or damage to hardware or software.
IMPORTANT	This alert provides essential information to explain a concept or to complete a task
NOTE	A note contains additional information to emphasize or supplement important points of the main text.

Related information

Additional information about the HP Smart Array Series Controller Family can be found at http://www.hp.com/go/hpux-iocards-docs.

Other documents in this collection include:

- *HP RAID Technology Overview*
- *HP Smart Array RAID Controllers Support Matrix*
- *RAID-01 (ciss) Mass Storage Driver Release Notes*

HP encourages your comments

HP encourages your comments concerning this document. We are committed to providing documentation that meets your needs. Send any errors found, suggestions for improvement, or compliments to netinfo_feedback@cup.hp.com.

Include the document title, manufacturing part number, and any comment, error found, or suggestion for improvement you have concerning this document.

A Physical disk installation and replacement

This appendix discusses the procedure for replacing physical disks in an array.

Overview

When a physical disk fails, the logical drive it belongs to is affected. Each logical drive connected to a Smart Array Controller can be configured with a different RAID level. Logical drives can be affected differently by a physical disk failure, depending on their configured RAID level.

The effects of physical disk failure for each RAID level are:

RAID 0   Cannot tolerate disk drive failure. If any physical disk in the array fails, the logical drive also fails.

RAID 1   Tolerates one physical disk failure.

RAID 1+0   Tolerates multiple physical disk failures if no failed disks are mirrored to one another.

RAID 5   Tolerates one physical disk failure.

RAID 50   Tolerates one physical disk failure per RAID 5 parity group.

RAID ADG   Tolerates simultaneous failure of two physical disks.

RAID 60   Tolerates simultaneous failure of two physical disks per RAID ADG parity group.

If more physical disks fail than the RAID level supports, fault tolerance is compromised and the logical drive fails. All requests from the operating system are rejected with unrecoverable errors. For steps to recover from this situation, see "Compromised fault tolerance" (page 104).

SAS physical disk failure indicators (for internal disks connected to Smart Array controllers)

The LEDs on the front of each physical disk are visible through the front of the server. When a physical disk is configured as part of an array and is attached to a powered-on controller, you can determine the status of the disk from the illumination pattern of the LEDs.

Figure 16 SAS Physical Disk Status LED Indicators
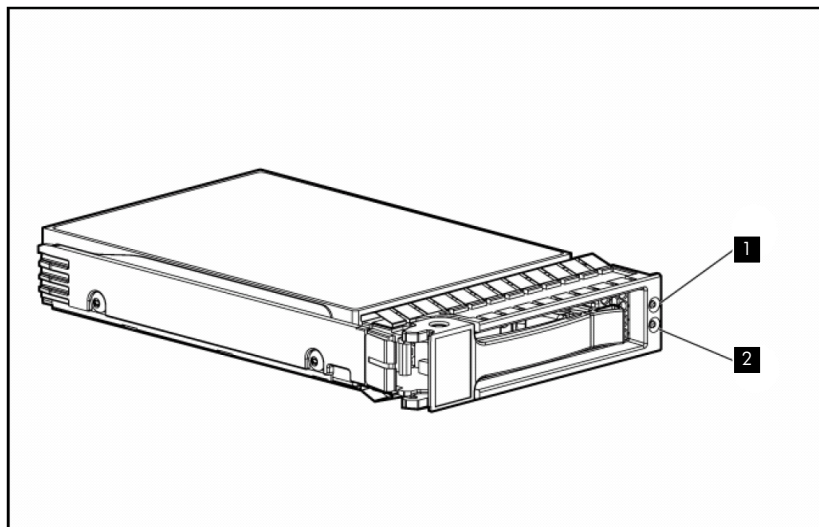
Table 18 SAS physical disk LED illumination patterns

Fault/ID LED (1) Amber/Blue	Online LED (2) Green	Interpretation
Alternating amber and blue	On, off, or flashing	The disk has failed, or a predictive failure alert has been received for this disk; it also has been selected by a management application.
Steady blue	On, off, or flashing	The disk is operating normally and it has been selected by a management application.
Amber, flashing once per second	On	A predictive failure alert has been received for this disk. Replace the disk as soon as possible.
Off	On	The disk is online but is not active.
Amber, flashing once per second	Flashing once per second	The drive is part of an array that is undergoing capacity expansion or stripe migration, but a predictive failure alert has been received for this drive. To minimize the risk of data loss, do not replace the drive until the expansion or migration is complete. **Do not remove the disk. Removing the disk can terminate the current operation and cause data loss.**
Off	Flashing once per second	The disk is rebuilding, or it is part of an array that is undergoing capacity expansion or stripe migration. **Do not remove the disk. Removing the disk can terminate the current operation and cause data loss.**
Amber, flashing once per second	Flashing irregularly	The disk is active but a predictive failure alert has been received for this disk. Replace the disk as soon as possible.
Off	Flashing irregularly	The disk is active and is operating normally.
Steady amber	Off	A critical fault condition has been identified for this disk, and the controller has placed it offline. Replace the disk as soon as possible.
Amber, flashing once per second	Off	A predictive failure alert has been received for this disk. Replace the disk as soon as possible.
Off	Off	The disk is offline, is a spare, or is not configured as part of an array.

Other ways to identify a failed physical disk

Other ways to recognize that a physical disk has failed are as follows:

- The amber LED lights up on the front of supported StorageWorks disk enclosures if failed drives are inside.

   NOTE: Other problems such as fan failure, redundant power supply failure, or over-temperature conditions also cause this LED to light.

- EMS sends an alert message when physical or logical drive failure occurs. For more information, see "Event Monitoring Service" (page 59).

Confirming physical disks failures using sautil

To confirm physical disk failures, use the `sautil <device_file>` command.

The `LOGICAL DRIVE SUMMARY` section of the `sautil <device_file>` command output lists the status of logical drives known to the RAID firmware.

The `SCSI DEVICE SUMMARY` section of the `sautil <device_file>` command output lists configured disks and unassigned disks known to the RAID firmware.

The `LOGICAL DRIVE` sections of the `sautil <device_file>` command output provide additional information on each logical drive.

For example, in the following `sautil <device_file>` command output excerpt, spare disk
`1I:1:10` is being substituted for failed disk `1I:1:11`, which is why the logical drive is in the
`RECOVERING` state.

```
---- LOGICAL DRIVE SUMMARY ----------------------------------------------

    #   RAID    Size        Status

    0   1+0     34700 MB    RECOVERING


---- SAS/SATA DEVICE SUMMARY --------------------------------------------

 Location  Ct Enc Bay      WWID               Type        Capacity Status

 internal  1I  1  12  0x500000e01117c732  DISK        36.4 GB  OK
 N/A       1I  1  11  0x500000e01115c352  N/A         N/A      FAILED
 internal  1I  1  10  0x5000c5000032b839  DISK        36.4 GB  SPARE (activated)
 internal  1I  1   9  0x5000c5000030b0c5  DISK        36.4 GB  UNASSIGNED
 internal  2I  1  16  0x500000e011213482  DISK        36.4 GB  UNASSIGNED
 internal  2I  1  15  0x5000c500002084c9  DISK        73.4 GB  UNASSIGNED
 internal  2I  1  14  0x5000c5000030b9c9  DISK        36.4 GB  UNASSIGNED
 internal  2I  1  13  0x500000e01118a7a2  DISK        36.4 GB  UNASSIGNED


---- SAS/SATA ENCLOSURE SUMMARY -----------------------------------------

 Location  Ct   Enc  Expander_count   Bay_count    SEP_count

 internal  1I   1    0                4            1
 internal  2I   1    0                4            1


---- LOGICAL DRIVE 0 ----------------------------------------------------

 Logical Drive Device File........... c5t0d0
 Fault Tolerance Mode................ RAID 1+0 (Disk Mirroring)
 Logical Drive Size.................. 34700 MB
 Logical Drive Status................ OK
 # of Participating Physical Disks... 2

 Participating Physical Disk(s)...... Ct:Enc:Bay:WWID
                                      1I:1:12:0x500000e01117c732
                                      1I:1:11:0x500000e01115c352 <-- NOT RESPONDING

 Participating Spare Disk(s)......... Ct:Enc:Bay:WWID
                                      1I:1:10:0x5000c5000032b839 <-- activated for 1I:1:11:0x500000e01115c352


 Stripe Size......................... 128 KB
 Logical Drive Cache Status.......... cache enabled
 Configuration Signature............. 0xA00148CC
 Media Exchange Detected?............ no
```

For more information about the `sautil` command, see .

Compromised fault tolerance

Compromised fault tolerance commonly occurs when more physical disks have failed than the fault
tolerance method can support. When fault tolerance fails, the logical volume also fails and
unrecoverable disk error messages are returned to the host. Data loss is likely to occur.

For example, suppose one drive fails in an array configured with RAID 5 fault tolerance while
another drive in the same array is still being rebuilt. If the array has no online spare, the logical
drive fails.

Compromised fault tolerance can also be caused by non disk problems, such as temporary power
loss to a storage system or a faulty cable. In such cases, the physical disks do not need to be
replaced. However, data can still be lost, especially if the system is busy when the problem occurs.

Recovering from fault tolerance failures

When fault tolerance has been compromised, inserting replacement disks does not improve the
condition of the logical drive. Instead, if your screen displays unrecoverable error messages, follow
these steps to recover data:

1. Power off the server, and then power it back on.

    In some cases, a marginal drive will work long enough to enable you to make copies of
    important files.

2. Make copies of important data if possible.

3. Replace failed disks.
4. After the failed disks are replaced, if fault tolerance is compromised, power the disk enclosure off and back on again.
5. If you were not able to recover your data using the power-cycling procedure, you must restore your data from backup media.

   Run the `sautil <device_file> accept_media_xchg <logical_drive_number>` command on the affected logical drive. This restores the logical drive's configuration.
6. Restore your data from backup media.

   See "The sautil <device_file> accept_media_xchg <logical_drive_number> command" (page 77).

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

Physical disk replacement

If you insert a hot-pluggable disk into a drive bay while the system power is on, disk activity in the array pauses for a second or two while the new drive is spinning up. When the disk has achieved its normal spin rate, data recovery to the replacement disk begins (as indicated by the flashing Online/Activity LED on the replacement drive) if the array is in a fault-tolerant configuration.

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

Factors to consider before replacing physical disks

Before replacing a degraded disk:

- Confirm that the array has a current, valid backup.

- Confirm that the replacement disk is of the same type (SAS or SATA) as the degraded disk.

- Use replacement disks that have a capacity at least as great as that of the smallest disk in the array. The controller immediately fails disks that have insufficient capacity.

△ **CAUTION:** A disk that was previously failed by the controller can seem to be operational after the system is power cycled, or (for a hot-pluggable disk) if a disk is removed and reinserted. However, continued use of the disk can result in data loss. Replace the disk as soon as possible.

① **IMPORTANT:** In systems that use external data storage, be sure that the server is the first unit to be powered off and the last to be powered on. Taking this precaution ensures that the system does not erroneously mark the drives as failed when the server is powered on.

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

- Do not remove a degraded disk if another disk in the array is offline (the Online/Activity LED is off). In this situation, no other disk in the array can be removed without data loss. The following cases are exceptions:
    - When RAID 1+0 is used, disks are mirrored in pairs. Several disks can be in a failed condition simultaneously (and they can all be replaced simultaneously) without data loss, as long as no two failed disks belong to the same mirrored pair.
    - When RAID 6 (ADG) is used, two disks can fail simultaneously (and be replaced simultaneously) without data loss.
    - If the offline disk is a spare, the degraded disk can be replaced.
- Do not remove a second disk from an array until the first failed or missing disk is replaced and the rebuild process is complete. (The rebuild is complete when the Online/Activity LED on the front of the drive stops flashing.) The following cases are exceptions:
    - In RAID 1+0 configurations, any disks that are not mirrored to other removed or failed disks can be simultaneously replaced offline without data loss.
    - In RAID 50 configurations, disks are arranged in parity groups. You can replace several disks simultaneously, if the disks belong to different parity groups. Do not replace more than one disk at a time from the same parity group.
    - In RAID 6 (ADG) configurations, any two disks in the array can be replaced simultaneously.
    - In RAID 60 configurations, disks are arranged in parity groups. You can replace several disks simultaneously, if no more than two of the disks being replaced belong to the same parity group. Do not replace more than two disks at a time from the same parity group.
- Replacement disks must have a capacity no less than that of the smallest disk in the array. Disks with insufficient capacity are failed immediately by the controller, before data recovery begins.

Automatic data recovery (rebuild)

When a physical disk is replaced, the controller gathers fault tolerance data from the remaining disks in the array. This data is then used to rebuild the missing data from the failed disk onto the replacement disk.

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

If more than one disk 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.

If another disk in the array fails when fault tolerance is unavailable during rebuild, a fatal system error can occur. If this happens, all data on the array is lost. However, in the following cases, failure of another disk does not lead to a fatal system error:

- Failure after activation of a spare disk.
- Failure of a disk that is not mirrored to another failed disk (in a RAID 1+0 configuration).
- Failure of a second disk in a RAID ADG configuration.

Time required for a rebuild

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

- Priority that the rebuild is given over normal I/O operations
- Amount of I/O activity during the rebuild operation.
- Rotational speed of the hard disks.

- Availability of drive cache.
- Brand, model, and age of the disks.
- Amount of unused capacity on the disks.
- Number of disks in the array (for RAID 5 and RAID ADG).

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

When automatic data recovery finishes, the Online/Activity LED of the replacement disk stops flashing at 1 Hz and begins to glow steadily (if the disk is inactive) or flash irregularly (if the disk is active).

△ **CAUTION:** If the Online/Activity LED on the replacement drive does not light up while the corresponding LEDs on other drives in the array are active, the rebuild process has abnormally terminated. The amber Fault LED of one or more disks might also be illuminated. See "Abnormal termination of a rebuild" to determine what action you must take.

Abnormal termination of a rebuild

If the Online/Activity LED on the replacement disk ceases to be illuminated even while other disks in the array are active, the rebuild process has abnormally terminated.

Table 19 Indications and Causes of Abnormal Rebuild Termination

Case	Observed condition	Cause of abnormal termination
1	None of the disks in the array has an illuminated amber Fault LED.	One of the disks in the array has experienced an uncorrectable read error.
2	The replacement disk has an illuminated amber Fault LED.	The replacement disk has failed.
3	One of the other disks in the array has an illuminated amber Fault LED.	The disk with the illuminated Fault LED has now failed.

Each of these situations requires a different remedial action, as described in the following sections.

Case 1: an uncorrectable read error has occurred

If an uncorrectable read error has occurred:
1. Back up as much data as possible from the logical drive.

⚠ **WARNING!** Do not remove the disk that has the media error. This causes the logical drive to fail, which could result in data loss.

2. Restore data from the backup. Writing data to the location of the unreadable sector often eliminates the error.
3. Remove and reinsert the replacement disk. This restarts the rebuild process.

If the rebuild process still terminates abnormally:
1. Delete and recreate the logical drive.
2. Restore data from the backup.

Case 2: the replacement disk has failed

Verify that the replacement disk is of the correct capacity and is a supported model. If these factors are not the cause of the problem, use a different disk as the replacement.

Case 3: another disk in the array has failed

A disk that has recently failed can sometimes be made temporarily operational again by cycling the server power:

1. Shut down and power off the server.
2. Remove the replacement physical disk (the one undergoing a rebuild), and reinstall the disk that is being replaced.
3. Power on the server.

If the newly failed disk seems to be operational again:

1. Back up unsaved data.
2. Remove the disk that was to be replaced, and reinstall the replacement disk. The rebuild process restarts.
3. When the rebuild process finishes, replace the newly failed disk.

If the newly failed disk has not become operational:

1. Remove the disk that was to be replaced, and reinsert the replacement physical disk.
2. Replace the newly failed disk.
3. Restore data from backup.

B Logical drive failure probability

This appendix discusses the probability of logical drive failure.

RAID level and probability of drive failure

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

- A RAID 0 logical drive fails if only one physical disk fails.
- A RAID 1+0 logical drive fails under the following conditions:
  — The maximum number of physical disks that can fail without causing failure of the logical drive is n/2, where n is the number of physical disks in the array. This maximum is reached only if no failed disk is mirrored to any other failed disk. In practice, a logical drive usually fails before this maximum is reached. As the number of failed disks increases, it becomes increasingly likely that a newly failed disk is mirrored to a previously failed disk.
  — The failure of only two physical disks can cause a logical drive to fail if the two disks are mirrored to each other. The risk of this occurring decreases as the number of mirrored pairs in the array increases.
- A RAID 5 logical drive (with no online spare) fails if two physical disks fail.
- A RAID 50 logical drive (with no online spare) fails if two physical disks fail in the same RAID 5 parity group.
- A RAID ADG logical drive (with no online spare) fails when three physical disks fail.
- A RAID 60 logical drive (with no online spare) fails when three physical disks fail in the same RAID ADG parity group.

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

Figure 17 provides quantitative information about logical drive failure. The data for this graph is calculated from the mean time between failure (MTBF) value for a typical physical disk, assuming that no online spares are present. If an online spare is added to a fault-tolerant RAID configuration, the probability of logical drive failure decreases.

Figure 17 Relative probability of logical drive failure
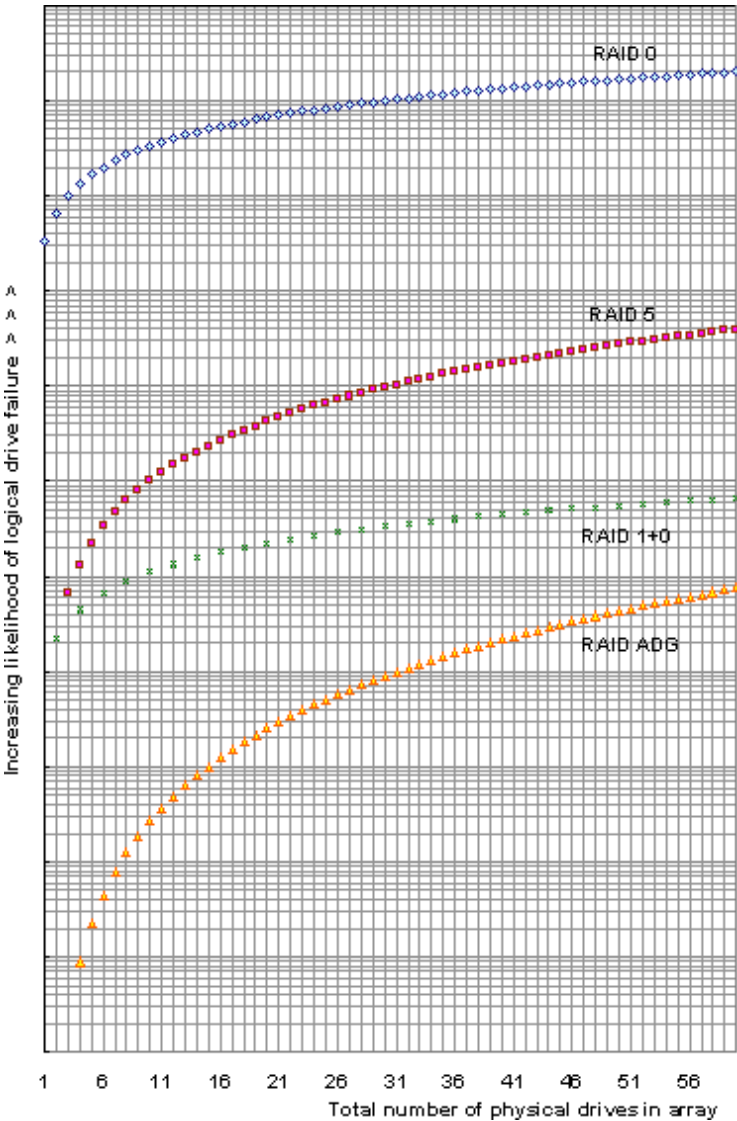
C Power-on Self Test (POST) error codes

This appendix lists the error codes that can be returned by HP Smart Array Controller Option ROM during Power-On Self Test (POST), and provides details of corrective actions you can take.

POST error codes

The Smart Array Controller provides diagnostic error messages to the server BIOS at reboot. Many of these POST messages are self-explanatory and suggest corrective actions for troubleshooting. Detailed information and corrective actions are listed in Table 20.

The Level column in Table 20 indicates the severity of the error:

None	No **F1** prompt is triggered.
Informational	An **F1** prompt is triggered, unless a POST prompt timeout is configured.
Critical	The controller always requests the System ROM to display the **F1** prompt, although this can still be disabled through system configuration.

Table 20 Smart Array controller POST error codes

Error code	Description	Level	Corrective action
1713	Slot z Drive Array Controller - Redundant ROM Reprogramming Failure.	Critical	Replace the controller if this error persists after restarting the system.
1714	Slot z Drive Array Controller - Redundant ROM Checksum Error.	Critical	Backup ROM has been activated. Check firmware version.
1715	Slot z Drive Array Controller – Memory Error(s) Occurred Warning: Corrected Memory Error(s) were detected during Controller memory self-test…	Critical	Replace the controller if this error persists.
1720	Slot z Drive Array - S.M.A.R.T. Hard Drive Detects Imminent Failure Port 1I: Box 1: Bay 2	Informational	Note the physical disk that has been identified as failing.
1721	Slot z Drive Array - Drive Parameter Tracking Predicts Imminent Failure. The following drives should be replaced when conditions permit: Port 1I: Box 1: Bays 2, 3.	Informational	Note the physical disks that have been identified as failing.
1724	Slot z Drive Array - Physical Drive Position Change(s) Detected - Logical drive configuration has automatically been updated.	Informational	None.
1726	Slot z Drive Array - Array Accelerator Memory Size Change Detected. Array Accelerator configuration has automatically been updated.	Informational	None.
1727	Slot z Drive Array - New Logical Drive(s) Attachment Detected. (if more than 32 logical drives are configured, this will be followed by:) Auto-configuration failed: Too many logical drives.	Critical if lost logical drives; otherwise Informational	Reduce the number of logical drives in the system. See Chapter 3: "Configuration" (page 40).
1728	Slot z Drive Array - Abnormal Shut-Down 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.	Critical	Data loss may have occurred. Contact your HP support representative for assistance.

Table 20 Smart Array controller POST error codes *(continued)*

Error code	Description	Level	Corrective action
1729	Slot z Drive Array – Disk Performance Optimization Scan in Progress RAID 4/5/ADG performance may be higher after completion.	None	None.
1764	Slot z Drive Array - Capacity Expansion Process is Temporarily Disabled (followed by one of the following): • Expansion will resume when Array Accelerator has been reattached. • Expansion will resume when Array Accelerator has been replaced. • Expansion will resume when Array Accelerator RAM allocation is successful. • Expansion will resume when Array Accelerator battery reaches full charge. • Expansion will resume when Automatic Data Recovery has been Completed.	Informational or None	No F1 prompt if disable reason is "rebuild running."
1768	Slot z Drive Array resuming Logical Drive Capacity Expansion process.	None	None.
1769	Slot z Drive Array - Drive(s) Disabled due to Failure During Expansion (possibly followed by one of the following additional details:) • Array Accelerator Removed or Failed; Expansion Progress Data Lost. • Expansion Progress Data Could Not Be Read From Array Accelerator. • Expansion Aborted due to Unrecoverable Drive Errors. • Expansion Aborted due to Array Accelerator Errors.	Critical	Press **F1** to continue with logical drives disabled. See Chapter 4 (page 59). Press **F2** to accept data loss and to re-enable logical drives. **Warning:** Pressing **F2** causes unrecoverable data loss. Be sure you have a valid, current backup of the affected logical drives before selecting this option.
1770	Slot z Drive Array – Critical Drive Firmware Problem Detected - Please upgrade firmware on the following drive(s) using Options ROMPaq (available from www.hp.com): Port 1I: Box 1: Bay 1	Informational	Upgrade the firmware of the affected drive.
1774	Slot z Drive Array - Obsolete Data found in Array Accelerator. Data Found in Array Accelerator was Older Than Data Found on Drives Obsolete Data has been Discarded	Informational	None.
1775	Slot z Drive Array - Storage Enclosure Cabling Problem Detected. OUT port of this box is attached to OUT port of previous box. Turn system and storage box power OFF and check cables. Drives in this box and connections beyond it will not be available until the cables are attached correctly. Port 1I: Box 2	Informational	Correct the cabling problem identified in the error message.
1778	Slot z Drive Array resuming Automatic Data Recovery process.	None	None.
1779	Slot z Drive Array -Replacement drive(s) detected OR previously failed drive(s) now appear to be operational: Port 2I: Box 1: Bay 2	Critical	Restore data from backup if replacement drives have been installed.

Table 20 Smart Array controller POST error codes *(continued)*

Error code	Description	Level	Corrective action
1783	Slot z Drive Array Controller Failure (might be followed by an exclamation point, and one or more of the following:) • [Board ID not programmed (replace ROMs or replace controller)] • [I2C read error] • [Image checksum error] • [Inconsistent volume count] • [Inconsistent volume count (B)] • [Unexpected hardware revision] • [Incorrect EEPROM type] • [Init failure (cmd=##h, err=##h)] • [Command failure (cmd=##h, err=##h)] • [Self-test failure (ErrCode=####h)] • [I2C NVRAM reconfiguration failure] • [PCI bridge missing] • [PCI bridge disabled; check System ROM version] • [Board ID not programmed]	Critical	Contact your HP support representative for assistance.
1784	Slot z Drive Array Drive Failure The following disk drive(s) should be replaced: Port 1I: Box 1: Bay 3	Informational	Replace the indicated disk.
1785	Slot z Drive Array not Configured (followed by one of the following:) • No drives detected. • Array Accelerator Memory Size Increased - Run System Configuration Utility. • SAS Cable(s) Attached to Wrong SAS Port Connector(s). Turn system power OFF and swap SAS port connectors to prevent data loss. • Drive positions cannot be changed during Capacity Expansion. • 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. • 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. To avoid data loss turn system power OFF and reattach drives to the original controller. • Configuration information indicates drives were configured on a controller with a newer firmware version. To avoid data loss, reattach drives to original controller or upgrade controller firmware.	Informational or Critical	Follow the instructions in the error message to correct the error condition.

Table 20 Smart Array controller POST error codes *(continued)*

Error code	Description	Level	Corrective action
1786	Slot z Drive Array Recovery Needed. The following disk drive(s) need Automatic Data Recovery (Rebuild): Port 1I: Box 2: Bay 5 Select "F1" to continue with recovery of data to drive(s). Select "F2" to continue without recovery of data to drive(s). OR Slot 1 Drive Array Recovery Needed The following disk drive(s) need Automatic Data Recovery (Rebuild): Port 2I: Box 1: Bay 4 Automatic Data Recovery previously Aborted! Select "F1" to retry Automatic Data Recovery. Select "F2" to continue without starting Automatic Data Recovery.	Informational	Follow the instructions in the error message to correct the error condition.
1787	Slot z Drive Array Operating in Interim Recovery Mode. The following disk drive(s) should be replaced: Port 1I: Box 3: Bay 1	Informational	Replace the indicated disk.
1788	Slot z Drive Array Reports Incorrect Drive Replacement. The following disk drive(s) should have been replaced: Port 1I: Box 2: Bay 1 The following SCSI drive(s) were incorrectly replaced: Port 2I: Box 1: Bay 3	Informational	Press **F1** to continue. The drive array remains disabled. Press **F2** to reset configuration - all data will be lost. **Warning:** Pressing **F2** erases all data in the array. Be sure you have a valid, current backup of the affected logical drives before selecting this option.
1789	Slot z Drive Array Physical Drive(s) Not Responding. Check cables or replace the following physical drive(s): Port 1I: Box 1: Bay 8	Informational	Press **F1** to continue. The drive array remains disabled. Press **F2** to fail drives that are not responding. Interim Recovery Mode is enabled if configured for fault tolerance.
1792	Slot z Drive Array - Valid Data Found in Array Accelerator. Data will automatically be written to drive array.	None	None.
1793	Slot z Drive Array – Data in Array Accelerator has been Lost Array Accelerator Battery Depleted (Error message 1794 will also be displayed.)	Critical	The cache battery was depleted before the system was returned to a state where the cached data could be written to the array. Data loss may occur.
1794	Slot z Drive Array - Array Accelerator Battery Charge Low. Array Accelerator Posted-Write Cache is temporarily disabled. Array Accelerator will be reenabled when battery reaches full charge (or: Array Accelerator batteries have failed and should be replaced)	Informational if battery bad; otherwise None	Replace the cache battery, if necessary.

Table 20 Smart Array controller POST error codes *(continued)*

Error code	Description	Level	Corrective action
1795	Slot z Drive Array - Array Accelerator Configuration Error. Data does not correspond to this drive array Array Accelerator is temporarily disabled.	Critical	Check the array configuration.
1796	Slot z Drive Array - Array Accelerator is Not Responding. Array Accelerator is temporarily disabled.	Critical	Check the cache module, and replace if necessary.
1797	Slot z Drive Array - Array Accelerator Read Error Occurred. Data in Array Accelerator has been lost. Array Accelerator is disabled.	Critical	The cache module has failed. Contact your HP service representative for assistance.
1798	Slot z Drive Array - Array Accelerator Self-Test Error Occurred. Array Accelerator is disabled.	Critical	The cache module has failed. Contact your HP service representative for assistance.
1799	Slot z Drive Array - Drive(s) Disabled due to Array Accelerator Data Loss.	Critical	Press **F1** to continue with logical drives disabled. See Chapter 4 (page 59). Press **F2** to accept data loss and re-enable logical drives. **Warning:** Pressing **F2** erases all data in the array. Be sure you have a valid, current backup of the affected logical drives before selecting this option.
1799	179A-Slot z Drive Array – Array Accelerator is disabled Unknown Problem Code). Array accelerator is temporarily (permanently) disabled.	Critical	The cache module has failed. Contact your HP service representative for assistance.

D Electrostatic discharge

This appendix discusses how to prevent damage to your server due to Electrostatic Discharge (ESD).

Handling parts

To prevent damage to your server, you must take precautions when setting up the server or handling parts. A discharge of static electricity from a finger or other conductor can damage system boards or other static-sensitive devices. This type of damage can reduce the life expectancy of the device.

To prevent electrostatic damage:

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

Grounding

Use the following grounding methods when handling or installing electrostatic-sensitive parts:

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

E Cable kits

This appendix provides details on the internal and external cable kits available for HP Smart Array SAS controllers.

Table 21 Internal SAS cable kits

Description	Part Number
Multilane A cable	389647-B21
Host fan cable	389650-B21
Target fan cable	389653-B21
Multilane B cable	389659-B21
Multilane 76-cm (30-in) cable	389662-B21
Multilane 48-cm (19-in) cable	391330-B21

Table 22 External SAS cable kits

Type of Cable	Length	Part Number
External SAS	1.0 m (3.3 ft)	389665-B21
External SAS	2.0 m (6.6 ft)	389668-B21
External SAS	4.0 m (13 ft)	389671-B21
External SAS	6.0 m (20 ft)	389674-B21

NOTE: All HP cables are keyed so they cannot be installed incorrectly.

You can order additional cables from an authorized HP reseller or authorized HP service provider. If the cable that you need is not listed here, or if you need additional ordering information, see the HP website at http://www.hp.com.

F Controller specifications

This appendix provides specification details for HP Smart Array SAS Controllers.

Table 23 Smart Array P400 controller specifications

Dimensions (excluding bracket)	16.8 cm x 7.0 cm x 1.8 cm (6.61 in x 2.75 in x 0.7 in)
Power required	Approximately 14W
Time required to recharge battery	15 minutes to 2 hours, depending on initial battery charge level
Duration of battery backup	More than two days if the battery is fully-charged and less than three years old
Battery life expectancy	More than three years
Operating temperature range	10° to 55° C (50° to 131° F)
Storage/Shipping temperature range	-30° to 60° C (-22° to 140° F)
Operating relative humidity (noncondensing)	10% to 90% (Storage/Shipping 5% to 90%)
RAID levels supported	0, 1, 1+0, 5, 6 (ADG)
Type of edge connector	PCIe x8 (fits in slots that have a physical size of x8 or greater; operates at the speed rating of the slot, up to a maximum of x8)
PCI Express support	2.5 Gb/s PCI Express
PCI Express transfer rate	2.0 GB/s peak bandwidth
Number of SAS ports	Two internal wide ports; each port has four 1x connectors
SAS transfer rate	1.2 GB/s per wide port peak bandwidth
Drive types supported	3.0 Gb/s SAS
Cache size	256 MB (approximately 48 MB is used by the onboard processor)

Table 24 Smart Array P411 controller specifications

Dimensions (excluding bracket)	Low Profile PCIe Form Factor 19.05 cm x 24.13 cm x 5.72 cm (7.5 in x 9.5 in x 2.25 in)
Disk drive and enclosure protocol support - transfer rate	6Gb/s SAS (Serial Attached SCSI) 3Gb/s SATA (Serial AT Attachment)
SAS connectors	2 external (Mini SAS) x8 wide port connectors
Data transfer method	x8 5G PCIe 2.0 Express (4 GB/s maximum bandwidth)
Memory bus speed	DDR2-800 MHz with 40 bit or 72-bit wide bus provides up to 4.2 GB/s maximum bandwidth
PCI	PCIe Express Gen 2.0
Simultaneous drive transfer ports	2 x4 Wide SAS Ports
SAS port link rate	24 Gb/s per x4 wide port connector (4 x 6 Gb/s)
Software upgradeable firmware	Yes
Cache memory	40-bit 256 MB Read/Write ECC protected cache; transportable with battery backed upgrade
Logical drives supported	Up to 64 logical drives
Maximum capacity	100TB (100 x 1TB)

Table 24 Smart Array P411 controller specifications *(continued)*

	NOTE: Support for greater than 2TB in a single logical drive.
Memory addressing	64-bit, supporting servers memory space greater than 4 GB
RAID levels supported	RAID 5 (Distributed Data Guarding) RAID 1+0 (Striping & Mirroring) RAID 0 (Striping)
Upgradeable firmware	Upgradeable Firmware with Recovery ROM feature
Cache size	256 MB (approximately 48 MB is used by the onboard processor)

Table 25 Smart Array P700m controller specifications

Card type	Type I, 4-port, PCIe mezzanine board
Dimensions (excluding bracket)	11.3 cm x 10.0 cm x 2.0 cm (4.5 in x 4.0 in x 0.8 in)
Maximum power required	Approximately 9.30 W
Time required to recharge battery	15 minutes to 2 hours, depending on initial battery charge level
Duration of battery backup	More than 2 days, with fully-charged batteries that are less than 3 years old
Battery life expectancy	More than three years
Spare battery part number	• 452348-B21 (for HP Integrity BL860c servers) • 383280-B21 (for HP Integrity BL870c servers)
Operating temperature range	10° to 55° C (50° to 131° F)
Storage/Shipping temperature range	-30° to 60° C (-22° to 140° F)
Operating relative humidity (noncondensing)	10% to 90% (Storage/Shipping 5% to 90%)
RAID levels supported	0, 1, 1+0, 5, 6 (ADG)
Maximum number of physical drives (using all four ports)	108 external
Maximum number of logical drives	32
PCI Express transfer rate	Up to 2 GB/s in each direction
Number of SAS ports	Two external; each port has four 1x links
SAS transfer rate	Up to 1.2 GB/s per port in each direction
Drive types supported	3.0 Gb/s SAS
Cache size	512 MB (approximately 64 MB is used by the onboard processor)

Table 26 Smart Array P711m controller specifications

Card type	Type I, 4-port, PCIe mezzanine board
Dimensions (excluding bracket)	10.1 cm x 11.4 cm x 2 cm (4 in x 4.5 in x 0.8 in)
Maximum power required	Approximately 14 W
Operating temperature range	10° to 55° C (50° to 131° F)
Storage/Shipping temperature range	-30° to 60° C (-22° to 140° F)
Operating relative humidity (noncondensing)	10% to 90% (Storage/Shipping 5% to 90%)
RAID levels supported	0, 1, 5, 6 (ADG), 5+0, 6+0

Table 26 Smart Array P711m controller specifications *(continued)*

Maximum number of physical drives (using all four ports)	108 external
Maximum number of logical drives	512 external
Memory bus speed	DDR2-800 (6.4 GiB/s maximum bandwidth)
Number of SAS ports	Four (4) 2x connectors external
SAS port link rate	6Gb/s per physical link
Disk drive and enclosure protocol support	SAS protocol: 6 Gb/s, 3 Gb/s, or 1.5 Gb/s SATA protocol: 3 Gb/s or 1.5 Gb/s
Cache module	72-bit wide, 1-GB FBWC (112 MB is used by the onboard processor)

Table 27 Smart Array P800 controller specifications

Card type	Full-Size PCIe
Dimensions (excluding bracket)	31.1 cm × 11.1 cm × 1.2 cm (12.3 in × 4.4 in × 0.5 in)
Maximum power required	Approximately 25W
Time required to recharge battery	15 minutes to 2 hours, depending on initial battery charge level
Duration of battery backup	More than 2 days, with fully-charged batteries that are less than 3 years old
Battery life expectancy	More than three years
Spare battery part number	398648-001
Operating temperature range	10° to 55° C (50° to 131° F)
Storage/shipping temperature range	-30° to 60° C (-22° to 140° F)
Operating relative humidity (noncondensing)	10% to 90% (Storage/shipping 5% to 90%)
RAID levels supported	0, 1, 1+0, 5, 6 (ADG)
Maximum number of physical drives (using all four ports)	108 (8 can be connected internally, and the remaining 100 can be connected externally by using expanders)
Maximum number of logical drives	32
Capacity	• Up to 5.8 TB of external storage per PCI slot with 4 HP StorageWorks MSA50 enclosures and 40 x 146 GB SFF SAS hard drives. • Up to 28.8 TB of external storage per PCI slot with 8 HP StorageWorks MSA60 enclosures and 96 x 300 GB 3.5" SAS hard drives • Up to 14.6 TB of external storage per PCI slot with 4 HP StorageWorks MSA70 enclosures and 100 x 146 GB SFF SAS hard drives
Type of edge connector	PCIe x8
PCI Express support	2.5 Gb/s PCI Express
PCI Express transfer rate	Up to 2 GB/s in each direction
Number of SAS ports	Two internal, two external; each port has four 1x links
SAS transfer rate	Up to 1.2 GB/s per port in each direction
Drive types supported	3.0 Gb/s SAS
Cache size	512 MB (approximately 48 MB is used by the onboard processor)

Table 28 Smart Array P812 controller specifications

Dimensions (excluding bracket)	Full-height, full-length PCI Express 12.3 in x 4.4 in x 0.5 in (31.1 cm x 11.1 cm x 1.2 cm)
PCI label	PCIe2 x8 (i.e., x8 mechanical, up to x8 electrical)
PCI link rate	x8 5 GT/s PCI Express (4 GB/s maximum bandwidth in each direction)
SAS/SATA connectivity	2 Mini SAS 4i connectors 4 Mini SAS 4x connectors
SAS/SATA link rate	SAS protocol: 6 Gb/s, 3 Gb/s, or 1.5 Gb/s SATA protocol: 3 Gb/s or 1.5 Gb/s
RAID cache	1 GB capacity (not all of which is available for user data) 64-bit data width with 8-bit error correcting code (ECC) Flash-backed on power loss Tether to capacitor pack Removable
RAID cache bus speed	DDR2-800 (6.4 GiB/s maximum bandwidth)
Software upgradeable firmware	Yes
Maximum drive count	100 drives
System memory addressing	64-bit, supporting servers memory space greater than 4 GB
Maximum capacity	108 drives (e.g., 108 TB with 108 x 1 TB SATA 3.5" MDL HDD)
RAID support	RAID 6 (Advanced Data Guarding) RAID 60 RAID 5 (Distributed Data Guarding) RAID 50 RAID 1+0 (Striping & Mirroring) RAID 1 (Mirroring) RAID 0 (Striping)
Upgradeable firmware	Flashable ROM with redundant firmware images

G 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 (for example, personal computers). The FCC requires devices in both classes to bear a label indicating the interference potential of the device as well as additional operating instructions for the user.

FCC rating label

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

Class A equipment

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

Class B equipment

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

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

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

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

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

- Hewlett-Packard Company
  P. O. Box 692000, Mail Stop 530113
  Houston, Texas 77269-2000

- 1-800-HP-INVENT (1-800-474-6836). (For continuous quality improvement, calls may be recorded or monitored.)

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

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

- 1281- 514-3333

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

Modifications

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

Cables

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

Canadian notice

Class A equipment

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

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

Class B equipment

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

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

European Union regulatory notice

This product complies with the following EU Directives:

- Low Voltage Directive 2006/95/EC
- EMC Directive 2004/108/EC

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

This compliance is indicated by the following conformity marking placed on the product:

CE

This marking is valid for non-Telecom products and EU harmonized Telecom products (e.g. Bluetooth).

CE(xxxx∗)①

This marking is valid for EU non-harmonized Telecom products.

* Notified body number (used only if applicable—refer to the product label)

Hewlett-Packard GmbH, HQ-TRE, Herrenberger Strasse 140, 71034 Boeblingen, Germany

BSMI notice

警告使用者:

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

Chinese notice

Class A equipment

声明
此为 A 级产品，在生活环境中，该产品可能会造成无线电干扰。在这种情况下，可能需要用
户对其干扰采取可行的措施。

Japanese Class A 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。

Korean notice

Class A equipment

A급 기기 (업무용 방송통신기기)	이 기기는 업무용(A급)으로 전자파적합등록을 한 기기이오니 판매자 또는 사용자는 이 점을 주의하시기 바라며, 가정 외의 지역에서 사용하는 것을 목적으로 합니다.

Class B equipment

B급 기기 (가정용 방송통신기기)	이 기기는 가정용(B급)으로 전자파적합등록을 한 기기로서 주로 가정에서 사용하는 것을 목적으로 하며, 모든 지역에서 사용할 수 있습니다.

Battery replacement notice

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

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

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

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

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

Taiwan battery recycling notice

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

廢電池請回收

H Frequently asked questions

H.1 How many Smart Array Controllers can I install in my server?

The maximum number of controllers is restricted to the number of PCIe slots not used for other peripherals. The power rating of the server also limits the number of controllers. For example, each Smart Array P400 Controller requires 14 W, and each Smart Array P800 Controller requires 25 W. The server must be capable of supplying adequate power to each controller. For more information about system power, see the documentation for your server.

H.2 Does the Smart Array P400 Controller support tape and CD drives?

No.

H.3 Can I use third-party (non-HP) devices with Smart Array SAS Controllers?

No.

H.4 Why do the activity LEDs light up on some disks when my server is idle?

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

H.5 What is RAID ADG?

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

RAID ADG provides an extremely high level of fault tolerance and can sustain two simultaneous disk failures without downtime or data loss. This fault tolerance level is useful for mission-critical data. For more information, see the *RAID Technology Overview*, at:

http://docs.hp.com/en/netcom.html#Smart%20Array%20%28RAID%29

H.6 What does the `auto-fail missing disks at boot` option do?

The `auto-fail missing disks at boot` option controls the power-on behavior of the HP-UX RAID controller when configured disks are missing. Auto-fail is enabled when the first logical drive is created by the `saconfig` utility. You can disable it with the `saconfig -F` command.

As an example, consider the following scenario:

- The boot volume is on a RAID logical drive.

- The server is powered off.

- The cable for an enclosure containing configured disks is accidentally disconnected from the controller.

- Disks belonging to the boot volume are still connected to the controller.

- The server is then powered on.

If auto-fail is enabled in this scenario:

- During POST, the controller fails the missing disks.

- Non-fault-tolerant logical drives are listed as FAILED.

- Fault-tolerant logical drives transition to Interim Recovery (degraded) mode or to FAILED depending on the number of disks the logical drive is missing.

The server then begins booting HP-UX.

During boot, the `ciss init` script detects the degraded/failed logical drives and generates an error that instructs you to run `sautil`. The `sautil` utility displays the degraded/failed logical drives and failed disks. At this point, you can power off the server, reconnect the disks, and boot again; or reconnect the disks and run the `sautil accept_media_xchange` command to change the disks and logical drives back to OK state. For more information,

see "The sautil <device_file> accept_media_xchg <logical_drive_number> command" (page 77).

If auto-fail is disabled in the previous scenario, select one of the following options when the Smart Array POST error is displayed:

1. Power off the server and reconnect the disks, and then power on the server.

2. Press **F1**.

   The controller temporarily disables all logical drives, including the intact boot volume. The server fails to boot.

3. Press **F2**.

   The server takes the same actions as a system with auto-fail enabled, as previously described.

For more information, see Appendix C (page 111).

I Acronyms used in this document

ADG	Advanced Data Guarding
ARM	Auto Reliability Monitoring
ASIC	Application-Specific Integrated Circuit
BBWC	Battery-Backed Write Cache
BIOS	Basic Input-Output System
CISS	Compaq Intelligent Storage System
CPU	Command Processing Unit
CRA	Critical Resource Analysis
EFI	Extensible Firmware Interface
EMS	Event Monitoring System
ESD	Electro-Static Discharge
FBWC	Flash-Backed Write Cache
HPMC	High Priority Machine Check
I/O	Input/Output
JBOD	Just a Bunch Of Disks
LED	Light-Emitting Diode
LVM	Logical Volume Manager
MCA	Machine Check Abort
MTBF	Mean Time Between Failure
NVRAM	Non-Volatile Random Access Memory
ODE	Offline Diagnostics Environment
OL*	Online Addition, Replacement, and Deletion
OLA	Online Addition
OLD	Online Deletion
OLR	Online Replacement
ORCA	Option ROM Configuration for Arrays
PCI	Peripheral Component Interconnect
PCIe	Peripheral Component Interconnect Express
PDC	Product Dependent Code
POSIX	Portable Operating System Interface for UniX
POST	Power-On Self Test
RAID	Redundant Array of Independent Disks or Redundant Array of Inexpensive Disks
RFI/EMI	Radio Frequency Interference/Electro-Magnetic Interference
ROM	Read-Only Memory
S.M.A.R.T.	Self-Monitoring, Analysis, and Reporting Technology
SAS	Serial-Attached SCSI
SATA	Serial Advanced Technology Attachment
SCSI	Small Computer System Interface
SES	SCSI Enclosure Services
STM	Support Tools manager
VxVM	Veritas Volume Manager
WWID	World-Wide Identifier

Glossary

array
A set of physical disks configured into logical drives. Arrayed disks have significant performance and data protection advantages over nonarrayed disks.

array accelerator
A component of some Smart Array Series controllers that dramatically improves disk read and write performance by providing a buffer. Data integrity is protected by a backup battery and ECC memory.

array capacity expansion
See capacity expansion.

Array Configuration Utility (ACU)
A configuration utility useful for novices and experienced RAID users.

Array Diagnostic Utility (ADU)
A diagnostic tool that collects comprehensive information about array controllers in a server and lists any problems detected.

Auto-Reliability Monitoring (ARM)
Also known as surface analysis. A fault management feature that scans physical disks for bad sectors. Data in the faulty sectors remaps to good sectors. Also checks parity data consistency for disks in RAID 5 or RAID ADG configurations. Operates as a background process.

Automatic Data Recovery
A process that reconstructs data from a failed disk and writes it to a replacement disk. Automatic Data Recovery time depends on several factors, but you should allow at least 15 minutes per gigabyte. Also known as rebuild.

cache
A high-speed memory component used to store data temporarily for rapid access.

capacity expansion
The addition of physical disks to an existing disk array, and the redistribution of existing logical drives and data over the enlarged array. The size of the logical drives does not change. Also known as an array capacity expansion.

capacity extension
The enlargement of a logical drive without disruption of data. Before capacity extension can occur, there must be free space in the array. If necessary, create free space by deleting a logical drive or by carrying out a capacity expansion. Also known as a logical drive capacity extension.

CISS
Command Interface for SCSI-3 Support Specification.

controller duplexing
A type of fault tolerance that requires two Smart Array Series controllers. Each controller has its own set of disks, and the disk sets have identical data. When one controller fails, the other takes over the servicing of requests. Controller duplexing can be done with LVM MirrorDisk/UX.

data guarding
See RAID.

data striping
Writing data to logical drives in interleaved chunks (by byte or by sector). Data striping improves system performance.

drive mirroring
See RAID.

Error Correction and Checking (ECC) memory
A type of memory that checks and corrects single-bit or multibit memory errors (depending on configuration) without causing the server to halt or to 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, including controller duplexing and software-based RAID.

flashing
Updating the flash memory on a system. Flash memory is nonvolatile memory used to hold control code such as BIOS information. Flash memory is very fast because it can be rewritten block by block, rather than byte by byte.

hot spare
See online spare.

interim data recovery
If a disk fails in RAID 1, 1+0, 5, or ADG, the system still processes I/O requests, but at a reduced performance level.

logical drive
A group of physical disks, or part of a group, that behaves as one storage unit. Each constituent physical disk contributes the same storage volume to the total volume of the logical drive. A logical drive has performance advantages over individual physical disks. Also known as a logical volume.

logical drive capacity extension	See capacity extension.
online spare	A disk in a fault-tolerant system that normally contains no data. When another disk in the array fails, the controller rebuilds the data that was on the failed disk to the online spare. Also known as a hot spare.
PCIe	An enhanced PCI bus that enables operation at 266 MHz, equivalent to a data throughput of 2.5 GB/s.
rebuild	See Automatic Data Recovery.
Redundant Array of Independent Disks (RAID)	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+0 (disk mirroring) duplicates data from one disk onto a second disk. RAID 5 (distributed data guarding) distributes parity data across all disks in the array, and uses the parity data and data on remaining disks to reconstruct data from a failed disk. RAID ADG (advanced data guarding) is similar to RAID 5, but uses two independent sets of parity data.
SCSI ID	A unique ID number assigned to each SCSI device connected to a SCSI bus. 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.
Self-Monitoring, Analysis, and Reporting Technology (S.M.A.R.T.)	Technology co-developed by HP and the physical disk industry that provides warning of imminent disk failure. S.M.A.R.T. enables HP to offer Pre-Failure Warranty replacement of physical disks. S.M.A.R.T. supersedes the disk parameter tracking feature that was previously used, because the self-monitoring routines used in S.M.A.R.T. are more accurate than the disk parameter tracking tests. The self-monitoring routines are customized for each specific disk type and have direct access to internal performance, calibration, and error measurements.
Simple Network Management Protocol (SNMP)	Governs network management and the monitoring of network devices and functions.
Single-Ended (SE)	A type of SCSI signaling that enables a maximum transfer rate of 40 MB/s. Conforms to the Wide-Ultra SCSI standard. Now being phased out in favor of LVD technology.
spare	See online spare.
striping	See data striping.
surface analysis	See Auto-Reliability Monitoring.