

Dell PowerEdge RAID
Controller (PERC) S110

User's Guide



Notes, Cautions, and Warnings



NOTE: A NOTE indicates important information that helps you make better use of your computer.



CAUTION: A CAUTION indicates potential damage to hardware or loss of data if instructions are not followed.



WARNING: A WARNING indicates a potential for property damage, personal injury, or death.

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Overview

The Dell PowerEdge RAID Controller (PERC) S110 is targeted as a low-cost RAID solution for Dell PowerEdge value systems.

The PERC S110 solution has the following characteristics:

- Supports SATA hard disk drives (HDD) and SATA solid state drives (SSD)
- Runs from the I/O Controller HUB (ICH) or Platform Controller Hub (PCH) chipset on the platform system board and requires no additional hardware
- Supports up to four physical drives
- Supports software RAID levels 0, 1, 5, and 10
- Supports Unified Extensible Firmware Interface (UEFI) and Human Interface Infrastructure (HII) for managing the PERC S110
- Allows SATA HDDs and SATA SSDs to co-exist on a single controller
- Supports physical disks of the same type (SATA HDD, SATA SSD) but of same or different capacities
- Allows virtual disks to be at different RAID levels on the same controller, but not supported on the same group of physical disks



NOTE: The PERC S110 is an integral component of the system board and does not require separate installation.

This document is intended for use by system administrators and technicians who are familiar with the storage system installation and configuration.

Prerequisites for configuring and using the controller include familiarity with:

- Servers and computer networks
- RAID technology
- SATA storage-interface technology

Platform Requirements for the PERC S110 Controller

Processor

x86, 32-bit compatible processor greater than 500 MHz.

Memory

512MB or greater.

Physical Disk

At least one SATA hard disk drive (HDD) or SATA solid state drive (SSD).



NOTE: The PERC S110 controller supports cabled configurations of up to four SATA HDD or four SATA SSD physical disks.

- SATA-II HDD physical disks can be used with a PERC S110 adapter.
- SATA-II SSD physical disks can be used with a PERC S110 adapter.

Operating Systems

- Microsoft Windows Server 2012 R2
- Microsoft Windows Server 2012
- Microsoft Windows Server 2008 R2 (64-bit), including Hyper-V virtualization
- Microsoft Windows Server 2008 (64-bit), including Hyper-V virtualization
- Microsoft Windows Server 2008 (32-bit)



NOTE: For the latest list of supported operating systems and driver installation instructions, see the system documentation at dell.com/support/manuals. For specific operating system service pack requirements, see the **Get drivers and downloads** section of the system documentation page at dell.com/support.

Supported Devices

PERC S110 adapter supports Dell-supported SATA-based tape devices and SATA optical disk devices.



NOTE: The PERC S110 adapter supports system boot to a tape using an internal Dell RD1000 tape device. Select **Continue** while in the **BIOS Configuration Utility** (<Ctrl><R>) for RD1000 to remain first in the boot order. The RD1000 option goes to the end of the boot order listing if <Ctrl><Alt> is selected and you would not be able to boot to it.

Related Documentation

- For all storage controllers and PCIe SSD documentation, go to dell.com/storagecontrollermanuals.
- For all Dell OpenManage documentation, go to dell.com/openmanagemanuals.
- For all operating system documentation, go to dell.com/operatingsystemmanuals.
- For all PowerEdge documentation, go to dell.com/poweredgemanuals.
- For all PowerVault documentation, go to dell.com/powervaultmanuals.

Features

The features of the Dell PowerEdge PERC S110 RAID Controller are described in this section.



NOTE: Background Array Scan (BAS), Background virtual disk initialization (BGI), Consistency check (CC), and Online Capacity Expansion/Reconfigure (OCE/Reconfigure) run only on the operating system.

Automatic Virtual Disk Rebuild

Rebuilds a redundant virtual disk automatically when a failure is detected, if a hot spare is assigned for this capability.

Background Array Scan (BAS)

Verifies and corrects correctable media errors on mirror, volume, or parity data for virtual disks. BAS starts automatically after a Virtual Disk is created while in the OS.

Background Virtual Disk Initialization (BGI)

The background initialization of a redundant virtual disk creates the parity data that allows the virtual disk to maintain its redundant data and survive a physical disk failure.

Since background initialization helps the controller to identify and correct problems that might occur with the redundant data at a later time, background initialization is similar to a consistency check.

Background initialization allows a redundant virtual disk to be used immediately. Data is lost if a physical disk fails before the completion of a BGI.



NOTE: Although a BGI is software-initiated at the PERC S110 BIOS Configuration Utility, the PERC S110 adapter drivers must be loaded before the BGI runs.

Boot Support for RAID Levels

This feature allows boot support for volume, RAID 0, RAID 1, RAID 5, and RAID 10.

RAID Technology - Understanding Disk Arrays and Virtual Disks

The Dell PowerEdge PERC S110 RAID Controller allows:

- SATA HDD, and/or SATA SSD physical disks to co-exist on a single controller.
- Physical disks of the same type (SATA HDD, SATA SSD) but of different capacities.
- Virtual disks to be at different RAID levels on the same controller, but not supported on the same group of physical disks.

RAID Controller Features of the PERC S110 Adapter

Boot Support for Degraded Virtual Disks

Enables the system to boot from degraded redundant virtual disks (RAID 1, RAID 5, or RAID 10).

Cache Support for Virtual Disks

Supports these cache options:

- Read Ahead/Write Back
- No Read Ahead/Write Back
- Read Ahead/Write Through
- No Read Ahead/Write Through.

The PERC S110 uses part of system memory for cache.

Checkpointing

Allows different types of checkpointing (background initialization, consistency check, and rebuild) to resume at the last point following a restart.

After the system restarts, background checkpointing resumes at its most-recent checkpoint.

Command Queuing

Command queuing is a command protocol used by SATA physical disks that are supported by the PERC S110.

Command queuing allows the host to issue multiple input/output requests to a disk simultaneously. The disk can then decide in which order to process the commands to achieve maximum performance.

Consistency Check (CC)

A consistency check is a background operation that verifies and corrects the mirror or parity data for fault-tolerant physical disks. It is recommended that you periodically run a consistency check on the physical disks.

By default, a consistency check corrects mirror or parity inconsistencies. After the data is corrected, the data on the primary physical disk in a mirror set is assumed to be the correct data and is written to the secondary physical disk in the mirror set.

A consistency check cannot be user-initiated in the PERC S110 adapter utility. However, a consistency check can be user-initiated when using Dell OpenManage Server Administrator Storage Management.

Disk Initialization

For physical disks, initialization writes metadata to the physical disk, so that the controller can use the physical disk.

Fault Tolerance

The following fault tolerance features are available with the PERC S110, in order to prevent data loss in case of a failed physical disk:

- Physical disk failure detection (automatic).
- Virtual disk rebuild using hot spares (automatic, if the hot spare is configured for this functionality).
- Parity generation and checking (RAID 5 only).
- Hot-swap manual replacement of a physical disk without rebooting the system (only for systems with a backplane that allows hot-swapping).

If one side of a RAID 1 (mirror) fails, data can be rebuilt by using the physical disk on the other side of the mirror.

If a physical disk in RAID 5 fails, parity data exists on the remaining physical disks, which can be used to restore the data to a new replacement physical disk configured as a hot spare.

If a physical disk fails in RAID 10, the virtual disk remains functional and data is read from the surviving mirrored physical disk(s). A single disk failure in each mirrored set can be sustained, depending on how the mirrored set fails.

Mirror Rebuilding

A RAID mirror configuration can be rebuilt after a new physical disk is inserted and the physical disk is designated as a hot spare. The system does not have to be rebooted.

Online Capacity Expansion/Reconfigure (OCE/Reconfigure)

OCE/Reconfigure is a process that allows you to add storage capacity to an existing virtual disk. In most cases additional storage capacity can be added without taking the system offline. However, if an additional physical disk needs to be added and the system does not support hot-swapping, the system must be turned off.

OCE/Reconfigure enables you to increase the total storage capacity of a virtual disk by integrating unused storage with the virtual disk.

Data can be accessed while the physical disks are added (if a system has hot-swap capability) and while data on the virtual disk is being redistributed.

For volume and RAID 1, OCE/Reconfigure expands the virtual disk by using the available space of the physical disks that are already members of the virtual disk. For RAID 0, RAID 5 and RAID 10, additional capacity can be attained by adding physical disks to the virtual disk.

Physical Disks (General)

The PERC S110 supports up to four SATA HDD or SSD physical disks.



NOTE: The physical disks in a virtual disk must be the same interface and drive type (HDD or SSD). For example, you cannot mix a HDD and SSD physical disk, in the same virtual disk.

A maximum of four physical disks can be used for RAID 0 and RAID 5. A maximum of two physical disks can be used for RAID 1. A maximum of four physical disks can be used for RAID 10.

If a physical disk fails during system startup, the controller identifies the failed physical disk as follows:

- At the PERC S110 adapter utility by highlighting the failed physical disk in a virtual disk in red.
- In a brief warning at the **Dell Inc. PERC S110 Controller BIOS** screen, the virtual disk(s) found are **Degraded** and/or **Failed**. This alerts the user to the failed physical disk(s).
- At Dell OpenManage Server Administrator Storage Management.
- With a bi-color Status LED on each physical disk. The green element of the Status LED is off, while the amber element flashes on and off.



NOTE: PERC S110 adapter supports HDD physical disks of capacity 2TB and greater.

Physical Disk Hot-Swapping (Hot-Swap Capability)

Hot-swap (hot-plug) capability is the manual substitution of a physical disk for another one while the host system is powered on.

If a system supports hot-swapping, physical disks can be plugged into a system's backplane while the controller is operating, without causing the controller to reset.



CAUTION: A physical disk can be hot-swapped from a system only if the system has a **PERC S110** adapter and a backplane that supports hot-swapping.



NOTE: If a system's physical disks are accessible only when the system's cover is removed, the physical disks cannot be hot-swapped. The physical disks must be located on the backplane (behind the removable front panel) and accessible externally.



NOTE: When replacing physical disks in a virtual disk that has already been created, make sure that SATA HDD physical disks are replaced with SATA HDD physical disks, and that SATA SSD physical disks are replaced with SATA SSD physical disks.



NOTE: When hot-swapping a physical disk, make sure that the new disk is of equal or greater capacity to the physical disk that is being replaced.

Physical Disk Roaming

The controller supports moving a physical disk from one backplane slot or cable connection to another (on the same controller). The controller automatically recognizes the repositioned physical disk and logically places it in the proper order.



WARNING: A virtual disk is lost if you perform disk roaming while an OCE/Reconfigure is running at Storage Management.



NOTE: For more information on how to open the system and add parts, see the Owner's Manual, available on the Dell Support website at dell.com/support/manuals.

Perform the following steps for physical disk roaming:



NOTE: These steps do not apply to systems that have a backplane with hot-swap capability.

- 1 Turn off the power to the system, physical disks, and system components.
- 2 Disconnect the power cables from the system.
- 3 Move the physical disks to different slots on the backplane or to different cable connections.
- 4 Perform a safety check. Make sure the physical disks are inserted properly.
- 5 Connect the power cables and power up the system.



NOTE: The controller detects the RAID configuration from the configuration data on the physical disks.

Storage Port (Storport) Driver Support

For Microsoft Windows Server 2008 and later versions, the **Storport** driver improves throughput and miniport driver interfaces.

Virtual Disks (General)

Up to eight virtual disks are supported.

The PERC S110 adapter allows:

- Creating virtual disks of different RAID levels on a single controller.



NOTE: Mixing RAID levels on the same physical disk is not allowed.

- Building different virtual disks with different characteristics for different applications.

The PERC S110 adapter does not allow:

- Creating a virtual disk from a mix of different type of physical disks. For example, a RAID 10 virtual disk cannot be created from two SATA-II HDD physical disks and a SATA SSD physical disk. All the physical disks must be of the same drive type (HDD or SSD).
- Selecting a physical disk as a dedicated hot spare if the physical disk is a different type from the physical disk or disks.

A virtual disk refers to data storage created by the controller from one or more physical disks. Although a virtual disk can be created from several physical disks, it is seen by the operating system as a single disk.

The capacity of a virtual disk can be expanded online for any RAID level, without rebooting the operating system.

Virtual Disk Migration

The PERC S110 controller supports automatic virtual disk migration from one PERC S100 or PERC S110 adapter to another PERC S110 adapter.



CAUTION: The virtual disk is lost if you perform a virtual disk migration during an OCE/Reconfigure.



NOTE: Backup virtual disk data before migrating virtual disks.




NOTE: Ensure that all physical disks that are part of the virtual disk are migrated. Virtual disks in optimal and degraded state will be automatically migrated. A virtual disk in an offline state should not be migrated.




NOTE: A bootable virtual disk cannot be migrated between dissimilar system models.

Migrating a Virtual Disk

- 1 Turn-off the system that contains the source controller.
- 2 Turn-off the target system if the system does not support hot-insert of physical disks.
- 3 Move the appropriate physical disks from the source controller to the target controller in the target system. Physical disks do not have to be inserted into the same slots in the target system.
- 4 If the target system was turned-off, turn-on the system.

 **CAUTION:** The BIOS Configuration Utility (<CTRL><R>) pauses, and prompts for action, for the degraded virtual disk(s), if a "pause if degraded" option is enabled in the BIOS Configuration Utility (<CTRL><R>).

 **CAUTION:** After the migration occurs, make sure that all of the physical disks have been migrated and are present in the appropriate virtual disks.

Virtual Disk RAID Levels

Virtual disks can be created at different RAID levels.

Virtual Disk Transformation

Virtual disk transformation can consist of:


- Capacity expansion, using OCE/Reconfigure (to allocate additional virtual disk space on the original physical disks or after additional physical disks are added).
- Rebuilding (rebuilding data on a virtual disk consists of using an available hot spare or backup physical disk).

Read, Write, and Cache Policy

Table 2-1 indicates the read, write, and cache policies that are supported by the PERC S110 adapter.

Table 2-1. Read, Write, and Cache Policy for the PERC S110

Category	Supported by PERC S110 adapter
Cache Settings	Yes
Read Ahead/Write Back	Yes
No Read Ahead/Write Back	Yes
Read Ahead/Write Through	Yes
No Read Ahead/Write Through	Yes

 **CAUTION:** The current default for Write-Cache mode enablement is Write Through, No Read Ahead (WT, NRA). To enable Write Back (WB), a UPS is recommended.


Installing the Drivers

The Dell PowerEdge PERC S110 RAID Controller requires controller drivers to operate with the supported operating systems.

The installation method for the PERC S110 card drivers is dependent on the type of system that you have and the type of Microsoft Windows operating system that is installed in the system.

Summary of Installation Procedure for Windows Server 2008, 2008 R2, 2012, and 2012 R2 on 12G Systems


- 1 Download the PERC S110 card drivers. See "Downloading the Microsoft Windows Drivers" on page 18.
- 2 Set the SATA Controller to RAID Mode. See "Setting the SATA Controller to RAID Mode" on page 19.
- 3 Initialize physical disks. See "Initializing Physical Disks (as required)" on page 19.
- 4 Create a bootable virtual disk. See "Creating a Bootable Virtual Disk" on page 19.
- 5 Check controller options and the boot list priority. See "Checking Controller Options and the Boot List Priority" on page 19.
- 6 If applicable, change the boot priority list for devices. See "Change the Boot Priority List for Devices (If Applicable)" on page 20.
- 7 Install the controller Drivers during the operating system installation. See "Installing the Controller Drivers During the Operating System Installation" on page 21.
- 8 For all Dell 12th generation (12G) systems that support Microsoft Windows Server 2012 R2, you need to additionally install `bccfg3.sys` drivers manually. See "Installing `bccfg3.sys` Drivers" on page 22.

-  **NOTE:** This step is also applicable for the Dell PowerEdge R220 systems that support Microsoft Windows Server 2012, Microsoft Windows Server 2012 R2, and Microsoft Windows Server 2008 R2 SP1 operating systems.

Pre-Installation Requirements for the Controller Drivers

- Make sure that your system has the latest BIOS and firmware updates from the Dell Support website at dell.com/support/manuals.
- Perform the pre-installation procedures before you install the controller drivers and the operating system.
- When you are ready to install the controller drivers and operating system see "Installing the Controller Drivers During the Operating System Installation" on page 21.

Downloading the Microsoft Windows Drivers


- 1 Go to dell.com/support.
- 2 Enter your system **Service Tag** and click on **Submit**.
The **Product Support** page is displayed.
- 3 Click on **Get drivers and downloads**.
- 4 Click on **View All Drivers** tab.
The **Drivers and Downloads** window is displayed.
- 5 Choose the applicable operating system.
- 6 Expand the **SAS RAID** category.
- 7 Select **Download File** for the appropriate controller driver.
 -  **NOTE:** Load a blank optical medium (CD-ROM or DVD) in your system.
- 8 Use the blank optical medium to burn the ISO image.
- 9 Download the files for the PERC S110 to a CD-ROM, DVD, or USB flash drive.

Pre-Installation Procedures for the Controller Drivers

Setting the SATA Controller to RAID Mode

Confirm or change configuration settings at the *Dell PowerEdge System* window

- 1 Boot the system. When the **Dell Power-On Self-Test (POST)** screen appears, press <F2>.
- 2 When the **Dell PowerEdge System** window appears, scroll to **SATA Settings** and press <Enter>. At the sub-screen, confirm that the **SATA Controller** is set to a RAID mode.

 **NOTE:** If necessary, use the space bar to change the setting.

- 3 Press <Esc> to exit.
- 4 Press <Esc> again. The following occurs:
 - If no change was made at step 2, the boot sequence continues.
 - If a change was made at step 2, a dialog box appears. Select **Save Changes and Exit**. Press <Enter>. The boot sequence continues.

Initializing Physical Disks (as required)

See "Initializing Physical Disks" on page 26.


Creating a Bootable Virtual Disk

See "Creating Virtual Disks" on page 27.

Checking Controller Options and the Boot List Priority

- 1 At the **Virtual Disks** field, make sure the bootable virtual disk created is the first virtual disk listed.

If the bootable virtual disk is not the first virtual disk listed, see "Swapping two Virtual Disks" on page 31.

 **NOTE:** If Non-RAID virtual disks are used (and appear in the **Virtual Disks** list), the **Swap Two Virtual Disks** option is enabled only if the system contains a RAID Capable physical disk.

- 2 Select **Continue to Boot** and press <Enter>.
- 3 Proceed with "Installing the Controller Drivers During the Operating System Installation" on page 21.

Change the Boot Priority List for Devices (If Applicable)

To change the order of the devices (CD-ROM, optical DVD, and so on), perform the following:



NOTE: If the PERC BIOS Configuration utility is open, select **Continue to Boot**, then press <Enter>. Press <Ctrl><Alt><Delete> to reboot the system.

- 1 Boot the system. When the **POST** screen appears, press <F2>.
- 2 At the **Dell PowerEdge System** screen, use the arrow keys to scroll to **Boot Sequence**. Press <Enter>.
- 3 Make sure that **Hard drive C:** is the first device listed.
- 4 To change the sequence of other devices:
 - Use the <+> key to move devices up, or the <-> key to move devices down.
 - Use the space bar to enable or disable a device.
- 5 Press <Esc> to exit.
- 6 Press <Esc> again. Select **Save Changes and Exit** and press <Enter>.
- 7 Proceed with "Installing the Controller Drivers During the Operating System Installation" on page 21

Installing the Controller Drivers During the Operating System Installation



CAUTION: The latest firmware, drivers and applications must be installed whenever the controller software is upgraded. A previous version of the driver might not work with the latest controller software and vice versa.

- 1 Reboot the system. When the POST screen appears press <F11>.
- 2 Insert the Windows operating system media into the optical drive of the system.
- 3 When the BIOS boot manager or boot device menu appears, select the text that begins with **Embedded SATA...** and press <Enter>.
- 4 Install the applicable Microsoft Windows operating system, using the on-screen instructions.
- 5 At the **Select the driver to be installed** window a **Load Driver** sub-screen appears. Perform the following:
 - a Insert the CD-ROM, DVD, or USB flash drive that contains the files copied at "Downloading the Microsoft Windows Drivers" on page 18.
 - b Click **Browse**.
 - c At the **Browse to folder** window, access the directory that contains the controller driver files. Locate and select the files.
 - d Click **OK**.
- 6 At the next **Select the driver to be installed** window, select **Dell PERC S110**. Click **Next** to load the driver files.
- 7 From the list at the **Select the operating system you want to install** window, select the applicable operating system. Click **Next**.
- 8 Perform the remaining operating system installation instructions. Some of the windows require user-specific password and system information. As required, contact your IT administrator for assistance.



NOTE: When the operating system installation process is complete, remove the installation media inserted in step 5.

Installing bccfg3.sys Drivers

Follow the procedure below to install the **bccfg3.sys** driver:

- 1 After you install the operating system on the Dell PowerEdge systems with the S110 card, navigate to the **Computer Management** window.
- 2 Select the **Other Devices**, right click on **RAIDCORE Configuration SCSI Processor Device**.
A list of options are displayed.
- 3 Click **Update Driver Software**.
The **Update Driver Software - RAIDCORE Configuration SCSI Processor Device** window is displayed.
- 4 Select the **Browse my computer for driver software** tab.
- 5 Select the folder that contains drivers for your hardware and click **OK**.
- 6 Click **Next**.



NOTE: If your system supports OpenManage v7.4 and later, the **bccfg.sys** driver is installed automatically.

Performing the PERC S110 Adapter Management Setup Procedure

The PERC S110 management setup procedure is described in Dell OpenManage Server Administrator Storage Management. To set up a PERC S110 on your system, see the Storage Management procedures located at the Dell Support website at dell.com/support/manuals.

RAID Configuration and Management

The Dell PowerEdge PERC S110 RAID Controller is configured by using the PERC S110 BIOS Configuration Utility. The utility is accessed at system startup, when you are prompted to press <Ctrl><R>.



NOTE: To configure the PERC S110 with Dell OpenManage Server Administrator Storage Management, see the Dell Support website at dell.com/support/manuals.



NOTE: The PERC BIOS Configuration Utility can be accessed and configured without the operating system and controller drivers being installed.

Configuring the Controller: Using the PERC BIOS Configuration Utility

PERC BIOS Configuration Utility Operations

- **Accessing the PERC BIOS Configuration Utility**
Describes how to log onto the PERC Virtual Disk Management utility.
- **Understanding the Text Colors in the PERC BIOS Configuration Utility**
Describes the status of the physical disks and virtual disks, based on the color-highlighted text.
- **Initializing Physical Disks**
Describes how to initialize a physical disk for data storage.
- **Creating Virtual Disks**
Describes how to create a virtual disk from the connected physical disks.
- **Deleting Virtual Disks**
Deletes one or more virtual disks that are configured for the controller.
- **Swapping two Virtual Disks**
Swaps virtual disks to enable them to load in any order.

- **Managing Hot Spares**
Enables you to create or delete a global or dedicated hot spare(s).
- **Viewing Physical Disk Details**
Enables you to view detailed information about any connected physical disk.
- **Viewing Virtual Disk Details**
Enables you to view detailed information about any virtual disk.
- **Rescanning Disks**
Rescans the disks to detect new or removed physical disks or virtual disks.
- **Controller Options**
Changes the selected controller options, such as booting and virtual disk warnings.
- **Continuing to Boot**
Enables the system to continue booting after you use the PERC BIOS Configuration Utility.

Accessing the PERC BIOS Configuration Utility

- 1 Boot the system and wait until the message **Press <Ctrl><R> to Configure** appears.
- 2 Press <Ctrl><R>.

You have a maximum of three seconds to press <Ctrl><R>, or the system's boot process continues.



CAUTION: If SATA Controller is not set to RAID Mode, data might be destroyed. Make sure to backup all data before changing modes.



NOTE: If the PERC BIOS Configuration Utility does not appear and your system uses a PERC S110, press <F2> to access the Dell system BIOS. At the **SATA Settings** field, make sure that **SATA Controller** is set to **RAID Mode**. If the settings are correct and the PERC BIOS Configuration Utility still does not appear contact Dell support at dell.com/support.

The utility contains these fields:

- An information field (yellow or red text): Located below the window name and the current build number.
- **Virtual Disks:** Displays the virtual disks that have been created and information about them: virtual disk number, RAID level, virtual disk size, virtual disk status, and caching mode status.
- **Main Menu:** Indicates the main PERC BIOS Configuration Utility operations.
- **Physical Disks:** Displays information about the physical disks or Advanced Technology Attachment Packet Interface (ATAPI) devices.
- **Available Keys:** Indicates the keyboard keys to use to select a line of text or perform an operation.



NOTE: For a more information about virtual disk and physical disk states, see "Disk States - Virtual and Physical Disks" on page 59.



NOTE: The first virtual disk listed in **Virtual Disks** must be the bootable virtual disk. The system can boot only when the bootable virtual disk is at the first position in the list.

Understanding the Text Colors in the PERC BIOS Configuration Utility

Text within the PERC BIOS Configuration Utility is color-coded, as follows:

- **White text:** Indicates an available option or informational text.
- **Black text, yellow highlighting:** Indicates an option or device for which you might take action.
- **Yellow text:** Indicates information about the yellow-highlighted option.
- **Green text:** Indicates an item that has been selected.
- **Light blue text:** Indicates that the item cannot be selected.
- **Magenta text:** Indicates items that are related to hot spares or boot options.
- **Red text:** Indicates a failed virtual or physical disk or a warning. For example, informational text might be red if an option is not available.

Initializing Physical Disks

New physical disks must be converted to RAID Capable disks before they can be used. Converting a disk to a RAID Capable disk writes controller configuration information to the physical disk.

Physical disks with the following statuses can be initialized:

- **Non-RAID** — A physical disk that was configured by a non-PERC S110.
- **Ready** — Contains no stored data but has PERC S110 configuration information.

Physical disks that are **Online** cannot be converted to Non-RAID or RAID Capable disks.

- 1 Power-up the system to start booting.
- 2 When prompted, press the <Ctrl> <R> keys to access the PERC BIOS Configuration Utility.
- 3 At the **Main Menu** field use the arrow keys to select the **Initialize Physical Disk(s)** option.
- 4 Press <Enter>.
- 5 Use the arrow keys to select **Convert to RAID Capable Disk** or **Convert to Non-RAID**.
- 6 Press <Enter>.
- 7 Use the arrow keys to select a physical disk. Press <Insert> to select the physical disk, or press the <A> key to choose all selectable physical disks.



NOTE: You can select and initialize multiple physical disks. There is no need to initialize one physical disk at a time.

- 8 Press <Enter> to convert selected Physical disk(s) to Non-RAID or RAID Capable disk(s).



NOTE: After a physical disk is converted to Non-RAID, it appears as Non-RAID in the **Physical Disks** field of the PERC S110 BIOS Configuration Utility. A Non-RAID virtual disk is also created and appears in the **Virtual Disks** field.

- 9 A dialog box appears, warning that any data on the physical disk will be permanently lost if it is initialized. Press the <C> key to continue with initialization or press <Esc> to cancel.

Initialization takes 10–15 seconds per physical disk. A status indicator shows which physical disk is being initialized. When initialization is complete, the status indicator turns off, and all channels are re-scanned automatically.



CAUTION: If a physical disk has a virtual disk on it, the physical disk cannot be selected for initialization. To initialize the physical disk anyway, make sure to delete the virtual disk. Be sure you want to initialize the physical disk, because all data on it (including PERC S110 configuration information) is deleted.



NOTE: When Non-RAID physical disks are installed in the system, their associated Non-RAID virtual disks must be deleted in order to use the physical disks with the PERC S110. Deleting the Non-RAID virtual disks converts the Non-RAID physical disks to RAID Capable disks and changes their state to **Ready**.



NOTE: Continue with the next procedure, Creating Virtual Disks.

Creating Virtual Disks

You can create virtual disks after the physical disks are converted to RAID Capable disks, especially if the virtual disk is a bootable virtual disk for your system. If you have not decided what RAID level to use, see the *RAID Technology Guide*, located on the Dell Support website at dell.com/support/manuals.

More Information

When creating virtual disks, consider whether or not the virtual disk capacity needs to be expanded in the future.

For a Microsoft Windows operating system, format the virtual disks with New Technology File System (NTFS). Microsoft Corporation provides a utility (diskpart.exe) that can dynamically extend an NTFS file system onto any unused adjacent space.

Note also that using a single partition per virtual disk makes expansion much easier.



NOTE: The diskpart.exe utility version depends on which version of the Windows operating system is running.



NOTE: The diskpart.exe utility can be found on the CD for some versions of the Windows operating systems, or on the Microsoft Corporation website (microsoft.com) for other versions. Use the correct version for your operating system.

Before you Begin

- At any point in this procedure, return to a prior state by pressing <Esc>.
- A maximum of eight virtual disks can be created with the PERC BIOS Configuration Utility.



NOTE: Mixing of RAID levels is not allowed on same physical disk(s).



NOTE: The Create Virtual Disk operation is not selectable when there is no available capacity on the physical disks.

- 1 Power-up the system to start booting.
- 2 When prompted, press the <Ctrl> <R> keys to access the PERC BIOS Configuration Utility.
- 3 At the **Main Menu** field, use the arrow keys to select **Create Virtual Disk**. Press <Enter>.
- 4 At the **Physical Disks** field, select the physical disk(s) on which to create a virtual disk:
 - a For each physical disk, press the <Insert> key to select the physical disk. (The physical disks can be inserted in any order.)
 - b After selecting the physical disk(s) to be included in the virtual disk, press <Enter>.
- 5 At the **User Input** field, use the arrow keys to select a virtual disk type (RAID level). Press <Enter>. (Only the virtual disk types that can be created with the selected physical disk(s) that are indicated; they are highlighted in white text).
- 6 If hot spares are applicable:
 - a At the **User Input** field, use the arrow keys to select a dedicated hot spare. Press <Enter>.



NOTE: A hot spare can be assigned after a virtual disk is created, by selecting the **Manage Hot Spare(s)** option.

- b At the **Physical Disks** field, select the physical disk to use as a hot spare (if applicable). Press <Insert> to select it.
- c Press <Enter> to add the hot spare. Press the <C> key to confirm the change.

- 7 Select a size for the virtual disk, depending on the available free space of the physical disks. (Virtual disk size changes are displayed at the **Create Virtual Disk** and **User Input** fields.)



NOTE: The maximum size of the virtual disk is affected by the available free space of the physical disks and by the RAID level that you select.

- 8 After you choose the virtual disk size, press <Enter>.
- 9 At the **User Input** field, select a **Caching Mode**. Press <Enter>.
- 10 Press the <C> key to confirm that you want to create the virtual disk.
- 11 At the **Main Menu** field, perform other operations or select **Continue to Boot** and press <Enter>.



NOTE: The boot virtual disk must be the first virtual disk listed in the **Virtual Disks** field. If necessary, use the **Swap Two Virtual Disks** option to place the bootable virtual disk in the first position.






Selection of Virtual Disk Sizes

- To Create A Virtual Disk Size of < 2.199 TB
 - a Use the <Page Up> or <Page Down> keys to select a size in large increments
or
Use the up arrow or down arrow keys to select a size in small increments.
 - b Continue with "Creating Virtual Disks" on page 27.
- To Create A Virtual Disk Size of > 2.199 TB
 - a Press the <Page Up> or the up arrow key to increase the virtual disk size.
 - b At the maximum size, a dialog box appears in the **User Input** field. It inquires if you want to limit the size of the virtual disk or exceed the normal maximum size.
 - c Press <Esc> to create a larger virtual disk.
 - d Press the <Page Up> or the up arrow key, until the desired or maximum available size has been attained.
 - e Continue with "Creating Virtual Disks" on page 27.



NOTE: When physical disks of different capacities are used, the maximum size of the virtual disk is limited by the size of the physical disk with the smallest capacity.

Deleting Virtual Disks

-  **CAUTION:** Although any virtual disk in the `Virtual Disks` field can be deleted, including the first-listed virtual disk in the field, do not delete the first-listed virtual disk. It may be the system's bootable virtual disk. Deleting the bootable virtual disk erases the operating system and the controller drivers.
-  **CAUTION:** When a physical disk is removed from a system, the current PERC S110 adapter configuration information (metadata) remains on the disk. If the removed physical disk causes a virtual disk to fail, and the virtual disk is then deleted and a Rescan is performed, re-inserting the physical disk causes the PERC S110 BIOS Configuration Utility to merge the re-inserted physical disk's configuration information with the existing configuration information. The previously deleted virtual disk re-appears in the PERC S110 BIOS Configuration Utility.
-  **CAUTION:** Make sure that all physical disks that are part of a virtual disk are in the system before you delete the virtual disk.
- 1 Power-up the system to start booting.
 - 2 When prompted, press the <Ctrl><R> keys to access the PERC BIOS Configuration Utility.
 - 3 At the `Main Menu` field, select `Delete Virtual Disk(s)`. Press <Enter>.
 - 4 Perform one of the following:
 - Select each virtual disk in the `Virtual Disks` field that you want to delete. Press <Insert> to confirm each selection.
OR
 - Press <A> to select all virtual disks for deletion.
-  **NOTE:** The text color of the selected virtual disk(s) changes to green.
- 5 Press <Enter>.
-  **CAUTION:** A dialog box appears, describing the consequences of deleting the selected virtual disk(s). Deleting a virtual disk permanently destroys all data that is on the virtual disk, as well as the virtual disk itself. This action cannot be undone.
- 6 Press the <C> key to confirm the deletion.

Swapping two Virtual Disks

Use the **Swap Two Virtual Disks** option of the PERC BIOS Configuration Utility to arrange virtual disks in a different order.



CAUTION: Do not swap the first-listed virtual disk at **Virtual Disks** if it is the system's bootable virtual disk. The bootable virtual disk must always be the first-listed virtual disk at **Virtual Disks**.

Before you Begin

- The **Swap Two Virtual Disks** option is enabled only if there is at least one initialized physical disk in the system. For example, if all the physical disks in the system are Non-RAID, the **Swap Two Virtual Disks** option is disabled.
- It is recommended that the bootable virtual disk be a redundant virtual disk-type, such as RAID 1, RAID 5, or RAID 10, to preserve data in case a physical disk in the virtual disk fails. As required, swap that virtual disk into the first position at **Virtual Disks**, if it is not already virtual disk 1. See the **Swap Two Virtual Disks** option below.
- The boot device and the boot order are user-selectable.
- The swap feature is available only with the PERC BIOS Configuration Utility.



NOTE: Only two virtual disks can be swapped at a time.

- 1 Power-up the system to start booting.
- 2 When prompted, press the <Ctrl><R> keys to access the PERC BIOS Configuration Utility.
- 3 At the **Main Menu** field, select **Swap Two Virtual Disks**. Press <Enter>.
- 4 Use the arrow keys to highlight a virtual disk at the **Virtual Disk** field. Press <Insert>.
- 5 Use the arrow keys to highlight another virtual disk. Press <Insert>.
- 6 Press <Enter> to swap the virtual disks.

Managing Hot Spares

This option enables you to create a hot spare from a selected physical disk, or to delete a hot spare.



NOTE: A hot spare can be created only if a physical disk is in **Ready** or **Normal** status at the **Physical Disks** field. If the physical disk is in **Online** status, it is being used by a virtual disk and cannot be selected as a hot spare.

Create a Global Hot Spare

- 1 Power-up the system to start booting.
- 2 When prompted, press the <Ctrl><R> keys to access the PERC BIOS Configuration Utility.
- 3 At the **Main Menu** field, select **Manage Hot Spare(s)**. Press <Enter>.
- 4 Select **Assign Global Hot Spare(s)**. Press <Enter>.
- 5 Use the up or down arrow key to select a physical disk(s) for use as a global hot spare(s). Press <Insert>.
- 6 Press <Enter> to add the global hot spare.
- 7 Press the <C> key to confirm the action.

Create a Dedicated Hot Spare

- 1 Power-up the system to start booting.
- 2 When prompted, press the <CTRL><R> keys to access the PERC S110 BIOS Configuration Utility.
- 3 At the **Main Menu** field, select **Manage Hot Spare(s)**. Press <Enter>.
- 4 Select **Assign Dedicated Hot Spare(s)**. Press <Enter>.
- 5 Use the up or down arrow key to select a virtual disk for assigning a dedicated hot spare(s). Press <Insert>.
- 6 Use the up or down arrow key to select a physical disk(s) for use as a dedicated hot spare(s). Press <Insert>.
- 7 Press <Enter> to add the dedicated hot spare.
- 8 Press the <C> key to confirm the action.

Delete a Hot Spare

- 1 Power-up the system to start booting.
- 2 When prompted, press the <Ctrl><R> keys to access the PERC BIOS Configuration Utility.
- 3 At the **Main Menu** field, select **Manage Hot Spare(s)**. Press <Enter>.
- 4 Select **Unassign Hot Spare(s)**. Press <Enter>.
- 5 Use the up or down arrow key to select the physical disk(s) to delete as a hot spare(s). Press <Insert>.
- 6 Press <Enter> to delete the hot spare.
- 7 Press the <C> key to confirm the action.

Viewing Physical Disk Details

- 1 Power-up the system to start booting.
- 2 When prompted, press the <Ctrl><R> keys to access the PERC BIOS Configuration Utility.
- 3 At the **Main Menu** field, select **View Physical Disk Details**. Press <Enter>.
- 4 Use the arrow keys to choose a physical disk.
- 5 Physical disk information is displayed at the top of the window:
 - Physical disk number
 - Channel number
 - Physical disk size
 - Physical disk status: **Non-RAID/Ready/Online**
 - Amount of free space
 - Manufacturer and model number
 - World Wide Address
 - SATA Cache Policy (Enabled or Disabled)
 - S.M.A.R.T. State: Error (if a disk with a S.M.A.R.T. error is discovered)
- 6 When finished, press <Esc> to return to the main window.

Viewing Virtual Disk Details

- 1 Power-up the system to start booting.
- 2 When prompted, press the <Ctrl><R> keys to access the PERC BIOS Configuration Utility.
- 3 At the **Main Menu** field, select **View Virtual Disk Details**. Press <Enter>.
- 4 Use the arrow keys to choose a virtual disk.
- 5 Virtual disk information is displayed at the top of the window and in the **Virtual Disks** field:
 - Virtual disk number
 - RAID level
 - Size
 - Status (**Read Ahead/Write Back, No Read Ahead/Write Back, Read Ahead/Write Through, No Read Ahead/Write Through**)
- 6 When finished, press <Esc> to return to the main window.



NOTE: The **Physical Disks** field indicates the physical disks that are in the virtual disk, highlighted by green text.

Rescanning Disks

This option enables you to rescan all channels and detect new or removed physical disks or virtual disks.

- To perform a rescan, select **Rescan Disks** from the **Main Menu** field and press <Enter>. (The activity indicator, in the information field at the top of the window, spins while the physical disks are being pooled).
- The **Rescan Disks** option rescans all the channels, searches for new or removed physical disks, and re-reads the configuration information from each physical disk.



NOTE: Sometimes when a physical disk has failed, it can be brought online through a rescan.

Controller Options

The **Controller Options** feature enables you to select INT 13 boot support and select whether the boot process pauses when an error occurs. The boot process pauses when **Pause if...** is enabled and a virtual disk becomes **Degraded** or has **Failed**. Press <Enter> to continue booting.

View the error message on the window. If **Pause...** is **OFF**, the error message is displayed briefly, but the system continues to boot.

- 1 At the **Main Menu** field, use the arrow key to select **Controller Options**. Press <Enter>.
- 2 At the **Controller Options** field, use the up or down arrow keys to scroll to the desired controller option.
 - **Pause if Degraded**

When **ON**, the BIOS stops booting when a degraded virtual disk is found.

Press <Enter> to toggle between **ON** and **OFF**.
 - **Pause if Failed**

When **ON**, the BIOS stops booting when a failed virtual disk is found.

Press <Enter> to toggle between **ON** and **OFF**.
- 3 Press <Esc> to return to the main window.

Continuing to Boot

After using the PERC BIOS Configuration Utility, return the system to its normal booting process by selecting **Continue to Boot** in the **Main Menu** field and pressing <Enter>.

Configuring the Controller: Using the DELL PERC S110 Configuration Utility

The DELL PERC S110 Configuration Utility uses a technology called UEFI Human Interface Infrastructure (HII) to allow the configuration and management of RAID controller, among other devices. The HII interface is independent of the operating system.

The following sections provide information about using the DELL PERC S110 Configuration Utility.

To enter the DELL PERC S110 Configuration Utility:

- 1 Turn on the system.
- 2 During startup, press <F2> to enter the System Setup.
The System Setup Main Menu lists separate Configuration Utility entries for each RAID controller in the system.
- 3 Use the arrow keys or mouse to select the DELL PERC S110 Configuration Utility for configuring the S110 RAID controller. Press <Enter> or click on the mouse to access the management menus for the controller.



NOTE: Ensure that the System BIOS is updated before using the DELL PERC S110 Configuration Utility for configuration tasks.

To exit the **DELL PERC S110 Configuration Utility**, press <Esc> or click **Back** at any browser screen until you return to the **System Setup Main Menu**.

Configuration Options

There are three main Configuration Option menus available in the DELL PERC S110 Configuration Utility:

- **Controller Management:** To manage controller properties and perform other high-level controller functions such as converting physical disks to Non-RAID or RAID Capable disks and rescanning physical and virtual disks.
- **Virtual Disk Management:** To create/delete virtual disks and manage virtual disk properties.
- **Physical Disk Management:** To display physical disk properties and perform operations such as assign/un-assign hot spares and converting physical disks to Non-RAID or RAID Capable disks.



NOTE: The help text for all of the options can be viewed by clicking **Help** on the top right-hand corner of the browser screen. Help text for individual option menus can also be viewed by simply scrolling down on each option.

Controller Management

The Controller Management menu can be used to perform the following controller-level functions. Each of these functions is its own selectable menu option.

- **View Controller Information:** To display information about the controller.
- **Change Controller Properties:** To update controller properties and/or restore factory defaults for the controller:
 - a** Set Bootable Device
 - b** Enable BIOS Stop On Error
- **Convert to Non-RAID Disk:** To convert the RAID Capable physical disks to Non-RAID physical disks.
- **Convert to RAID Capable Disk:** To convert the physical disks to RAID Capable physical disks.
- **Rescan Disks:** To rescan the physical disks to detect and display new or removed physical disks or virtual disks.





NOTE: The help text for all of the options can be viewed by clicking **Help** on the top right-hand corner of the browser screen. Help text for individual option menus can also be viewed by simply scrolling down on each option.

Virtual Disk Management

The Virtual Disk Management menu can be used to create and manage virtual disks on the controller. The following functions can be performed under Virtual Disk Management. Each of these functions is its own selectable menu option.

- **Create Virtual Disk:** To create a virtual disk by selecting the RAID level, physical disks, and virtual disk parameters.
- **Manage Virtual Disk Properties:** To display and manage virtual disk properties, view associated physical disks and manage dedicated hot spares.
- **Select Virtual Disk Operations:** To select and execute a delete virtual disk operation.
- **View Virtual Disk Properties:** To display virtual disk properties, including cache policies, for a selected virtual disk and list the associated physical disks.


 **NOTE:** If the controller does not support a feature or if the feature is supported but not applicable to specific configurations, then few virtual disk management menu options are disabled.


 **NOTE:** The help text for all of the options can be viewed by clicking **Help** on the top right-hand corner of the browser screen. Help text for individual option menus can also be viewed by scrolling down on each option.


Physical Disk Management

The Physical Disk Management menu can be used to view and manage physical disks on the controller. The following functions can be performed under Physical Disk Management. Each of these functions is its own selectable menu option.

- **View Physical Disk Properties:** To display information about the physical disk including its state.
- **Select Physical Disk Operations:** To select and execute physical disk operations including assign/un-assign hot spare and convert physical disks to Non-RAID or RAID Capable disks.
- **View Global Hot Spares:** To display the assigned global hot spares on the controller.

 **NOTE:** If the controller does not support a feature or if the feature is supported but not applicable to specific configuration, then few physical disk management menu options are disabled.

 **NOTE:** The help text for all of the options can be viewed by clicking **Help** on the top right-hand corner of the browser screen. Help text for individual option menus can also be viewed by simply scrolling down on each option.

 **NOTE:** The PERC S110 adapter supports Dell-supported SATA-based tape devices. With the S110 controller, system can boot to a tape device using an internal Dell RD1000 tape device. Once configured to boot to a tape device, press <Esc> or click **Back** on any browser screen until you return to the System Setup Main Menu and exit normally to continue to boot to a tape device. The RD1000 option goes to the end of the boot order listing, if <Ctrl><Alt> is selected and you would not be able to boot to RD1000.

Troubleshooting

To get help with your Dell PowerEdge PERC S110 RAID Controller, contact your Dell Technical Service representative or access the Dell Support website at dell.com/support.

The chapter discusses four major categories of troubleshooting:

- Normal tasks that cannot be performed during system startup
- Warning messages that might appear at the **Dell Inc. PERC S110 BIOS Controller** screen
- Functions that cannot be performed with virtual disks
- Functions that cannot be performed with physical disks

System Startup Problems

Use the following procedures to troubleshoot potential PERC S110-related causes for system startup problems.

System does not Boot

Controller mode is set Incorrectly at System Setup

- 1 At system startup, when the **Dell Power-On Self-Test (POST)** screen appears, press <F2> to enter the **Dell Inc. PowerEdge BIOS** screen.
- 2 Scroll to **SATA Settings**. Press <Enter> and make sure that the **SATA Controller** is set to a RAID mode.



NOTE: Data might be lost when switching from **RAID Mode** to **ATA Mode** or **AHCI Mode**.

Boot Mode, Boot Sequence, and/or Boot Sequence Retry are set Incorrectly

- 1 At system startup, when the Dell POST screen appears, press <F2> to enter the **Dell Inc. PowerEdge BIOS** screen.
- 2 Scroll to **Boot Settings**. Press <Enter> and make sure that **Boot Mode** is set to **BIOS**.

- 3 Scroll to **Boot Sequence**. Press <Enter> and make sure that **Hard drive C: (* PERC S110)** is the first device listed.
* The variable text displayed here might be: **Embedded SATA 1, Slot 1, or Integrated SAS**.
- 4 Scroll to **Boot Sequence Retry**. Make sure that the setting is **Enabled**.
- 5 Press <Esc> to exit and continue booting.



NOTE: If changes are made at the Dell Inc. PowerEdge BIOS screen, a dialog box appears and asks you to save your changes and then exit.

Bootable Virtual Disk is in a Failed State

- 1 Press <Ctrl><Alt> to restart.
- 2 After the system restarts, press <Ctrl><R>. Check the status of the bootable virtual disk at the **Virtual Disk** field, or by highlighting **View Virtual Disks Details** and pressing <Enter>.
- 3 Check for missing or offline physical disks.

The Boot Order is Incorrect for a Bootable Virtual Disk

- 1 When prompted at system startup, press <Ctrl><R> to access the PERC BIOS Configuration Utility.
- 2 Check **Virtual Disks** and make sure that the bootable virtual disk is the first virtual disk listed.
- 3 As required, use the **Swap Two Virtual Disks** option to reposition the virtual disks.

The Boot Order for Non-RAID Virtual Disk when Rebooted

A Non-RAID virtual disk is no longer in the first position in the PERC BIOS Configuration Utility list after the system is rebooted.



NOTE: When booting from a Non-RAID virtual disk, creating a virtual disk in Dell OpenManage Server Administrator Storage Management changes the virtual disk order and displaces the bootable Non-RAID virtual disk from the first position. PERC S110 then attempts to boot from the first virtual disk.



NOTE: A Non-RAID virtual disk can be created from Non-RAID physical disks (which are physical disks initialized at a non-PERC S110).

- 1 When prompted at system startup, press <Ctrl><R> to access the PERC BIOS Configuration Utility.

- 2 Check **Virtual Disks** and determine if the bootable Non-RAID virtual disk is no longer in the first position.
- 3 Use the **Swap Two Virtual Disks** option to swap the virtual disks and place the bootable Non-RAID virtual disk in the first position of the **Virtual Disks** field.

The PERC BIOS Configuration Option does not Display

The PERC S110 mode is Set Incorrectly in the System BIOS

See "Controller mode is set Incorrectly at System Setup" on page 39 for the correct SATA Setting.

Warning Messages: Dell Inc. PERC S110 Adapter BIOS Screen

The Dell Inc. PERC S110 Controller BIOS screen is one of the first screens to appear during your system's boot sequence. If the system's virtual disks were in **Normal** or **Ready** status before a system boot, the boot sequence continues normally to the Microsoft Windows Server 2008 operating system.

But, if a virtual disk is in **Degraded** or **Failed** status, or if specific options in the **Controller Options** field were changed previously at the PERC BIOS Configuration Utility, the following warning messages appear during the boot sequence. For other issues, see "Other Errors Appearing on the BIOS" on page 44.

WARNING: Found Virtual Disks that are Degraded

This warning message appears when at least one virtual disk is in a **Degraded** state and **Pause if Degraded** is set to **ON** at the PERC BIOS Configuration Utility.

The following message appears after the warning is displayed:

```
--- Press <Enter> to continue, or <CTRL><R> to enter  
setup ---
```

Press <Enter> to allow the operating system to continue with the boot sequence, or press <CTRL><R> to enter into the PERC BIOS Configuration Utility to investigate the cause of the **Degraded** virtual disk.

To investigate the cause, check for the following:

- Whether a physical disk in the virtual disk has failed or has gone offline. Check the status at the **Physical Disks** field. A **Degraded** status depends on the RAID level of the virtual disk and the number of physical disks that have failed:
 - For a virtual disk at RAID 1 or RAID 5, a single physical disk failure causes a **Degraded** status.
 - For a virtual disk at RAID 10, the failure of a physical disk in each of the mirror sets creates a **Degraded** status for the RAID 10. The failure of two physical disks in the same mirror set creates a **Failed** status for the RAID 10.
- Whether the controller has failed, due to a firmware failure or a component failure. A failed controller causes a virtual disk not to boot.

For the virtual disk to recover from **Degraded** status, the failed physical disk must be replaced and the virtual disk must be rebuilt, using Dell OpenManage Server Administrator Storage Management. When the rebuild operation is completed, the virtual disk status changes from **Degraded** to **Ready**. For a description of the rebuild function, see Storage Management, located on the Dell Support website at dell.com/support/manuals.

WARNING: Found Virtual Disks that are Failed

This warning message appears when at least one virtual disk is in a **Failed** state and **Pause if Failed** is set to **ON** at the PERC BIOS Configuration Utility.

The following message appears after the warning is displayed:

```
--- Press <Enter> to continue, or <Ctrl><R> to enter  
setup ---
```

Press <Enter> to allow the operating system to continue its boot, or press <Ctrl><R> to enter into the PERC BIOS Configuration Utility to investigate the cause of the **Failed** virtual disk.



NOTE: A boot virtual disk that is in a **Failed** state prevents the operating system from booting.

To investigate the cause, check for the following:

- Determine if a single or multiple physical disks in a non-redundant virtual disk have failed. If yes, data is lost. Recover the lost data from a backup storage source.
- Determine if two or more physical disks in a redundant virtual disk have failed. If yes, data is lost. Recover the lost data from a backup storage source.



NOTE: For RAID 10, if a single physical disk fails in each mirrored set, the redundant virtual disk goes to a **Degraded** status but data is not lost. If two physical disks fail in one of the mirrored sets, the redundant virtual disk goes to a **Failed** status and data is lost.

WARNING: Found Virtual Disks that are Degraded and Failed

This warning message appears when multiple virtual disks are in **Degraded** and **Failed** state and **Pause if Degraded** or **Pause if Failed** are set to **ON** at the PERC BIOS Configuration Utility.

The following message appears after the warning is displayed:

```
--- Press <Enter> to continue, or <Ctrl><R> to enter
setup ---
```

Press <Enter> to allow the operating system to continue its boot, or press <Ctrl><R> to enter into the PERC BIOS Configuration Utility to investigate the cause of the **Degraded** and **Failed** virtual disks.



NOTE: A boot virtual disk that is in a **Failed** state prevents the operating system from booting.

To investigate the cause, check for the following:

- Whether the virtual disk is in **Degraded** status because one of the physical disks of a RAID 1 or RAID 5 virtual disk has failed, or one of the physical disks of a RAID 10 virtual disk has failed.
Press <Ctrl><R> and verify if the physical disks are offline or missing. Remove and replace a failed physical disk. A second physical disk failure could cause a **Degraded** virtual disk to change to **Failed** status.
- Whether the virtual disk is in a **Failed** status because one or more of the physical disks have failed.
Press <Ctrl><R> and verify if the physical disks are offline or missing. Remove and replace the failed physical disk or disks.

Other Errors Appearing on the BIOS

S110 does not Display Greater than Eight Virtual Disks in the BIOS Configuration Utility (<CTRL><R>)

Likely Cause: The function is not supported.

Corrective Action: Remove all physical disks except for the last one(s) added. Then proceed with deleting the virtual disks that are not needed. Remember to take account of the virtual disks that are currently being used.

Unable to Delete Virtual Disks when there are more than Eight Virtual Disks Present in the System.

Likely Cause: The function is not supported.

Corrective Action: Remove all physical disks except for the last one(s) added. Then proceed with deleting the virtual disks that are not needed. Remember to take account of the virtual disks that are currently being used.

Virtual Disk Rebuild Status in the BIOS Configuration Utility (<CTRL><R>)

Likely Cause: Rebuild is not supported in the BIOS Configuration Utility (<CTRL><R>).

Corrective Action: Boot to a supported operating system. Rebuild starts. To view rebuild status, install a supported storage application.

Virtual Disk-Related Errors

Failure States

Whether a virtual disk is marked as **Failed** or **Degraded** depends upon what RAID level virtual disk it is, and how many physical disks of the virtual disk have failed.

If a rescan of all channels is performed after disconnecting a physical disk, the state of every virtual disk using the disconnected physical disk changes from the **Ready** state to either the **Failed** or **Degraded** state, depending on the virtual disk's RAID level.

For additional information about rescanning to update storage configuration changes, see the OpenManage documentation available on the Dell Support website at dell.com/support/manuals.

Failure Status by Virtual Disk RAID Level

RAID 1, RAID 5

- Degraded: A single physical disk fails.

RAID 10

- Degraded: A single physical disk fails in one or more of the mirrored sets.

Volume, RAID 0

- Failed: A single physical disk fails.

RAID 1 or RAID 5

- Failed: Two or more physical disks fail.

RAID 10

- Failed: Two physical disks in a mirrored set fail.

Use the following information as guidelines to troubleshoot the controller.

Fail to Create a Virtual Disk

The user might not be able to create the virtual disks and may be prompted with **The physical disk is not displayed** error message due to the following:

- The controller cannot communicate with the physical disks.
- A cable might be loose or defective.
- The physical Disk might be a SAS drive.

Re-seat the physical disks in the backplane and check their cables.

Insufficient free space available on the selected physical disks

There must be sufficient available free space on the physical disk(s) used by the virtual disk.

Incorrect number of physical disks selected for the desired RAID level

See "Understanding RAID Levels" in the *RAID Technology Guide*, located on the Dell Support website at dell.com/support/manuals, for a description of RAID levels and the allowable number of physical disks used with each RAID level.

The desired physical disk is unavailable

Determine whether the physical disk:

- Is a dedicated hot spare and unavailable for use in another virtual disk.
- Is full or has insufficient available capacity.

The system already has a maximum of eight virtual disks

Delete unused virtual disks.

 **CAUTION: Deleting a virtual disk destroys all data on the virtual disk.**

Virtual Disk is in the Failed State

The virtual disk has lost one or more physical disks

Replace the failed physical disk(s) and restore the data from a backup storage source.

A physical disk in the virtual disk has failed or has been removed

- Re-install the original physical disk if it was inadvertently removed. Perform a rescan.
- Check the status of the physical disks in the virtual disk. Replace any failed disk(s), if necessary. Restore the data from a backup storage source.

After any change, perform a rescan to verify if the disk is still in a **Failed** state.

The virtual disk has lost the maximum allowable physical disks per RAID level

One or more physical disks have failed.

- If the virtual disk is non-redundant, the failure of a single physical disk can cause the virtual disk to fail.
- If the virtual disk is redundant, two or more physical disks have failed and the virtual disk cannot be rebuilt.

Create a new virtual disk. Restore the data from a backup storage source.

A Virtual Disk is in a Degraded State

A physical disk was removed

- Install the original physical disk, if it was inadvertently removed, or replace it with a new or used physical disk.
- Initialize a new physical disk. Perform a **Rescan** for all physical disks that are replaced.
- If the physical disk was not removed, check that its cables are correctly installed.

Physical or mechanical problems with the physical disk

- Check if the physical disk in the virtual disk has failed.
- If a physical disk was recently removed and replaced, check that it is correctly positioned in the backplane. Check the cable connections at the physical disk and at the motherboard. Perform a rescan.

The virtual disk has lost redundancy

- One or more physical disks in the virtual disk have failed. Due to the failed physical disk or disks, the virtual disk is no longer maintaining redundant (mirrored or parity) data. The failure of an additional physical disk results in lost data.
- Replace the physical disk or disks. Rebuild the physical disk using Storage Management. See the applicable Storage Management screen, located on the Dell Support website at dell.com/support/manuals.

Corrupted metadata in the virtual disk

- 1** Delete the virtual disk that has the failed metadata.
- 2** Assign the physical disk as a hot spare to rebuild a redundant virtual disk.
- 3** To create a non-redundant virtual disk, delete and rebuild the data on a virtual disk, and restore the data from a backup storage source.

Cannot Assign a Dedicated Hot Spare to a Virtual Disk

The RAID level does not allow a dedicated hot spare to be created

Hot spares cannot be created for Volume or RAID 0 virtual disks.

The designated physical disk does not have sufficient capacity to be a dedicated hot spare

The capacity of the physical disk selected to be a dedicated hot spare must be equal to or larger than the capacity of the smallest physical disk in the virtual disk. For example, if the physical disk selected for a dedicated hot spare is 160 GB, and the physical disks in the virtual disk are 80 GB, 160 GB, and 500 GB, a dedicated hot spare can be assigned. That is because the physical disk selected for the dedicated hot spare is larger than the smallest (80 GB) physical disk in the virtual disk.

The physical disk is already part of a virtual disk

A dedicated hot spare cannot be assigned to another virtual disk.

The physical disks are of different types

The physical disk used as a dedicated hot spare must be the same type as the physical disks that are already part of the virtual disk. For example, if a virtual disk consists of SATA-II physical disks, the dedicated hot spare must be a SATA-II physical disk.

Cannot Create a Global Hot Spare

There are no empty physical disks available or the physical disks have not been converted to RAID Capable disks

Install additional physical disks and convert them to RAID Capable disks. If existing physical disks are **Non-RAID** they need to be converted to RAID Capable disks.



WARNING: When a physical disk is converted to RAID Capable disks, all data on the physical disk is lost.



NOTE: A physical disk with a **Non-RAID** status can be converted to RAID Capable disks, if desired, but it is no longer **Non-RAID** (Converting to RAID Capable disk adds PERC S110 configuration information to the physical disk.)

The physical disk is already part of a virtual disk

A hot spare cannot be selected if it is already part of an existing virtual disk.

The physical disk assigned as the global hot spare has failed

When prompted at system startup, press <Ctrl><R> to access the PERC BIOS Configuration Utility.

At the PERC BIOS Configuration Utility, select **View Virtual Disk Details** and press <Enter>. Determine whether the physical disk that is designated as the global hot spare has a status of **Failed**.

- Check to see if the physical disk is malfunctioning or is physically disconnected.
- Select another physical disk as the global hot spare.

The physical disk assigned as the global hot spare is missing

- Check to see if the physical disk was removed from the backplane or cable connection, or whether the cables from the controller to the physical disk are disconnected or faulty.
- Perform a rescan to verify that the physical disk is still missing.

Physical Disk-Related Errors

The Physical Disk Fails

A physical disk is not visible in the PERC BIOS Configuration Utility or is offline

- Check that the cables are properly connected.
- Check that the physical disk is installed properly in the system's backplane.
- Check the system's backplane for damage.
- Reinstall the physical disk and make sure that it is seated correctly in the system's backplane.
- Check if the Physical Disk might be a SAS drive.
- Perform a **Rescan**, to (a) update the status of storage devices attached to the controller, or (b) fix an error caused by deleting or initializing a virtual disk.
- A physical disk is highlighted red at the PERC BIOS Configuration Utility.
- Replace the physical disk. Depending on the RAID level of the virtual disk, data might be lost.
- Perform a rescan to confirm that the new disk was discovered.

A Dedicated Hot Spare Fails

The controller cannot communicate with the hot spare

- Check that the cable from the controller to the physical disk is connected properly.
- Make sure that the physical disk is still assigned as a global or dedicated hot spare.
- Check if the physical disk assigned as the hot spare has failed.

The dedicated spare is not visible in the PERC BIOS Configuration Utility or is offline.

The Wrong Physical Disk was Removed

A physical disk has been removed from a virtual disk

The removal of one physical disk from a virtual disk causes:

- A Volume or RAID 0 virtual disk to change to **Failed** status.
- A RAID 1 and RAID 5 virtual disk to change to **Degraded** status.
- A RAID 10 virtual disk to change to **Degraded** status (when a physical disk is removed from one of the mirrored sets).

Re-insert the removed physical disk and perform a **Rescan** of the virtual disk.

Cannot Initialize a Physical Disk

The physical disk cannot be initialized

Check whether or not the physical disk is:

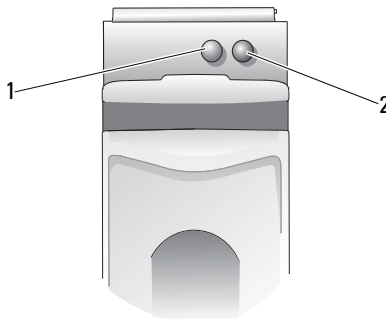
- Already a member of a virtual disk.
- Currently a global or dedicated hot spare.
- Reporting an **Offline** state.

Only physical disks that are **Ready** can be initialized.

Disk Carrier LED Indicators

The LED on the physical disk carrier indicates the state of each physical disk. Each disk carrier in your enclosure has two LEDs: an activity LED (green) and a status LED (bicolor, green/amber) as shown in Figure 5-1. The activity LED is active whenever a disk is being accessed while the status LED indicates a disk is being spun up, rebuilding, or in a faulty state.

Figure 5-1. Disk Carrier LED Indicators



1 activity LED

2 status LED



NOTE: To enable the status LEDs, system needs to have the operating system and the OpenManage 7.0 (or higher) management utility installed and running. Status LED is not supported before the operating system is installed.

Fail to Create a Virtual Disk(s) or Perform Online Capacity Expansion / Reconfigure on a Virtual Disk(s)

Cannot create a virtual disk on selected physical disks

Check whether these physical/virtual disks were migrated from a legacy controller with mixed RAID levels. If so, creating additional virtual disk(s) on these physical disk(s) is not allowed.

Cannot perform an Online Capacity Expansion on a virtual disk. Check whether these physical/virtual disks were migrated from a legacy controller with mixed RAID levels. If so, Online Capacity Expansion / Reconfigure by adding physical disk on such a set of physical disks is not allowed.

Status LED

Status LED is not working

Make sure the system is booted to the operating system. Install Dell Open Manage Server Administrator management utility version 7.0 (or higher).

Appendix A

Controller Specifications

This section contains information about the Dell PowerEdge PERC S110 RAID Controller specifications:

- Technical specifications
- Read, write, and cache policy
- Physical and virtual disk tasks
- Virtual disk specifications
- Supported RAID levels

Technical Specifications

Table 1-1. Specifications for the PERC S110 adapter

Specification	PERC S110 adapter
SAS technology	No
SATA technology	Yes
SATA SSD technology	Yes
Support for x8 PCI-E Host Interface	No
I/O Controller	Intel X79 chipset
Communication to the system	Integrated
Communication to end devices	SATA links
SAS connectors	No
SATA connectors	Discrete on the motherboard
Lead-free	Yes
Supported operating systems	Microsoft Windows Server 2008 Family, Microsoft Windows Server 2008 R2

Table 1-1. Specifications for the PERC S110 adapter

Specification	PERC S110 adapter
Dell-compliant SATA compatibility	Yes
Dell-compliant SAS compatibility	No
Dell-supported direct-connected end devices	Dell-compliant physical disks
*SMART error support through management applications	Yes NOTE: SMART drives are not allowed in VD configuration.
Backplane supported systems	Yes
Software-based RAID	Volume, RAID 1, RAID 0, RAID 5, RAID 10
Maximum number of virtual disks	8
Support for internal tape drive	Yes
Support for hot spare	Yes
Maximum number of hot spares	Varies with the number of free disks in the system

Controller Tasks

Table 1-2 indicates the tasks that are supported or not supported by the PERC S110 adapter at the PERC BIOS Configuration Utility.

Table 1-2. PERC S110 Adapter Tasks

PERC S110 Adapter Tasks	Supported by PERC S110 Adapter
Enable alarm	No
Disable alarm	No
Quiet alarm	No
Test alarm	No
Set check consistency rate	No
Rescan controller	Yes
Create virtual disk	Yes

Physical Disk Tasks

Table 1-3 indicates the physical disk tasks that are supported/not supported by the controllers at the PERC BIOS Configuration Utility.

Table 1-3. Physical Disk Tasks

Physical Disk Task Name	Supported by PERC S110 adapter
Blink/Unblink	Only with a system that has a PERC S110 adapter and a backplane
NOTE: Installing Open Manage Storage Services (OMSS) 7.0.0 or higher enables status LED support.	
Assign and unassign hot spare	Yes

Virtual Disk Tasks

Table 1-4 indicates the virtual disk tasks that are supported/not supported by the controllers at the PERC BIOS Configuration Utility.

Table 1-4. Virtual Disk Tasks

Virtual Disk Task Name	Supported by PERC S110 adapter
Assign and unassign dedicated hot spare	Yes
Create virtual disk	Yes
Reconfigure	Yes
Delete (any) virtual disk	Yes
Start a check consistency	Yes
Cancel check consistency	Yes
Initialize virtual disk	No (if using the PERC S110 BIOS Configuration Utility) Yes (if doing a BGI in Storage Management)

Virtual Disk Specifications

Table 1-5 indicates the virtual disk specifications that apply to the PERC S110 adapter.

Table 1-5. Virtual Disk Specifications for the PERC S110 adapter

Virtual Disk Specification	Value
Maximum number of virtual disks per controller	8
Minimum virtual disk size	102 MB
Maximum virtual disk size	No maximum size; there may be operating system size limitations
Maximum number of physical disks per virtual disk	4
Maximum number of virtual disks per physical disk	8
Maximum number of physical disks that can be concatenated	N/A
Maximum number of physical disks in a Volume	1
Maximum number of physical disks in a RAID 0	4
Maximum number of physical disks in a RAID 1	2
Maximum number of physical disks in a RAID 5	4
Maximum number of physical disks in a RAID 10	4
Minimum number of physical disks that can be concatenated	N/A
Minimum number of physical disks in a Volume	1
Minimum number of physical disks in a RAID 0	2
Minimum number of physical disks in a RAID 1	2
Minimum number of physical disks in a RAID 5	3
Minimum number of physical disks in a RAID 10	4

Appendix B

About RAID

A RAID disk array is a group of independent physical disks that provide high performance by increasing the number of drives used for saving and accessing data. A RAID disk subsystem improves I/O performance and data availability. The physical disks appear to the host system either as a single storage unit or multiple logical units. Data throughput improves because several disks are accessed simultaneously. RAID systems also improve data storage availability and fault tolerance. Data loss caused by a physical disk failure can be recovered by rebuilding missing data from the remaining physical disks containing data or parity.



NOTE: When a physical disk in a RAID 0 virtual disk fails, data is lost because there is no redundancy for this RAID level. However, when a physical disk in a RAID 1, RAID 5, or RAID 10 fails, data is preserved because there is redundancy with these RAID levels.

RAID Levels and Characteristics

Volume (can be created only using the PERC S110 BIOS Configuration Utility. Dell OpenManage Server Administrator Storage Management can manage a Volume but cannot create it.)

A virtual disk type that links available space on a single physical disk and forms a single logical volume on which data is stored.

- Concatenation allows access to a single physical disk.
- Concatenation does not provide performance benefits or data redundancy.
- When a physical disk in a concatenated virtual disk fails, data is lost from that virtual disk. Because there is no redundancy, data can be restored only from a backup.

Understanding RAID Levels

A PERC S110 adapter supports the following RAID levels:

RAID 0 (striping)

Provides the highest performance, but no data redundancy. Data in the virtual disk is striped (distributed) across two or more physical disks.

RAID 0 virtual disks are useful for holding information, such as the operating system paging file, where performance is extremely important but redundancy is not.

RAID 1 (mirroring)

Mirrors data on one physical disk to another, to provide basic redundancy.

In the event of a single physical disk failure a second copy of the data exists, which can be used to restore the data to a new, replacement physical disk.

Useful when only two physical disks are available, and when data integrity is more important than storage capacity.

RAID 10 (striped mirror sets)

Combines mirrored and striped sets; data is striped across mirrored sets of physical disks.

RAID 10 allows multiple physical disk failures, up to one failed physical disk in each mirror that has been striped.

In the event of a single physical disk failure (per mirror set) a second copy of the data exists, which can be used to restore the data to a new, replacement physical disk.

- Offers better performance than a simple mirror because of the additional physical disks.
- Requires twice the disk space of RAID 0 to offer redundancy.
- When a physical disk in a RAID 10 virtual disk fails, the virtual disk is still functional. Data is read from the surviving mirrored disk.

RAID 5 (striping with parity)

Stripes data, as well as parity, across all physical disks in the virtual disk. Parity information is interspersed across the virtual disk.

In the event of a single physical disk failure, parity data exists on the remaining physical disks, which can be used to restore the data to a new, replacement physical disk.

- Offers exceptional read performance, as well as redundancy.
- Requires only one extra physical disk to offer redundancy.
- For most systems with three or more physical disks this is the best choice as a RAID level.

Supported RAID Levels

Table 1-1 indicates the RAID levels that are supported by the PERC S110 adapter.

Table 1-1. Supported RAID Levels for the PERC S110 adapter

RAID Level	Supported by PERC S110 adapter
Volume	Yes (only when using the PERC Virtual Disk Management Utility)
RAID 0	Yes
RAID 1	Yes
RAID 5	Yes
RAID 10	Yes

Disk States - Virtual and Physical Disks

The following disk states provide information about the statuses that appear at the PERC BIOS Configuration Utility.

Physical Disk States

- **ATAPI:** Indicates a peripheral device (CD-ROM, DVD, or tape drive) instead of a physical disk. An ATAPI device cannot be initialized or added to a virtual disk.
- **Online:** The physical disk has been converted to RAID Capable and is part of a virtual disk.
- **Ready:** The physical disk has been converted to RAID Capable but is not currently used in a virtual disk.
- **Failed:** A failed physical disk appears as **Failed** only when (a) **View Virtual Disk Details** is selected, and (b) the virtual disk to which the physical disk belongs is selected. The **Failed** status is reported only when the physical disk is part of a virtual disk.

- **Hot Spare:** A physical disk that is assigned as a dedicated or global hot spare.

Virtual Disk States

- **Degraded:** A physical disk in a redundant virtual disk has failed. Additional failures might result in loss of data.
- **Failed:** One or more physical disks have failed. The virtual disk has gone offline. The virtual disk cannot restore the data.
- **Non-RAID:** A Non-RAID physical disk is automatically linked to a Non-RAID virtual disk for use with a PERC S110 adapter.
- **Normal:** A virtual disk has been created and its preparation process has been completed.
- **Ready:** A redundant virtual disk has been created, and is ready for additional preparation.

Understanding Physical Disks

Physical Disk States

Within the management applications, physical disks can be part of one or more virtual disks and can exist in the states indicated:

Table 1-2. Minimum and Maximum Physical Disk Configurations

RAID Level	Minimum Number of Physical Disks	Maximum Number of Physical Disks
RAID 0	2	4
RAID 1	2	2
RAID 10	4	4
RAID 5	3	4

Rescanning Physical Disks for Changes in State

The physical disk information displayed at the PERC BIOS Configuration Utility is the state of the physical disks when they were last scanned. If a rescan has not been performed, the information displayed is the state of the physical disks at boot time.

Every time a physical disk is connected or disconnected while online, a rescan is performed. A rescan is automatically performed when Dell OpenManage Server Administrator Storage Management detects that a physical disk has been added or removed.

Dedicated Hot Spares

A dedicated hot spare is a backup physical disk for the redundant virtual disk to which it is assigned. The physical disk that is used as a dedicated hot spare cannot be a member of an existing virtual disk. When the hot spare is activated, it becomes the receptacle for the data from the failed physical disk member of the volume, without interrupting the system or requiring your intervention.

A dedicated hot spare can be assigned to any redundant virtual disk, and up to four hot spares can be assigned to a virtual disk. However, a dedicated hot spare cannot be assigned while a task is running on the virtual disk.

A global hot spare can be assigned when a virtual disk is created in the PERC BIOS Configuration Utility. A global hot spare can be added at any time when Storage Management is used.

If there is enough space available on the dedicated hot spare, and a disk failure occurs, the rebuild process for the virtual disk starts automatically.

Dedicated hot spare assignments do not apply to a non-redundant virtual disk.



NOTE: A virtual disk is marked **Failed** or **Degraded** if a physical disk reports a **Failed** state, or if the SAS/SATA cable to the physical disk or power cable is disconnected.

A dedicated hot spare is often preferred to a global hot spare, especially for critical data. This is because a dedicated hot spare guarantees that the virtual disk has a backup physical disk assigned exclusively to it in case of a failure.

For additional information, see "Managing Hot Spares" on page 32.

Global Hot Spares

A global hot spare is a backup physical disk that can be used by any redundant virtual disk. It is not assigned (dedicated) to any specific virtual disk.

Virtual disks can typically be rebuilt by using a global spare disk, as long as the global hot spare is not already part of the virtual disk and has enough available capacity. Unlike a dedicated hot spare, a global hot spare can be assigned at anytime, even while tasks are running on virtual disks.

If there is enough space available on the global hot spare, and a disk failure occurs, the rebuild process for the virtual disk starts automatically.

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Glossary

ADAPTER — An adapter enables the system to access peripheral devices by converting the protocol of one bus or interface to another. An adapter may also provide specialized function. For example, a RAID controller is a type of adapter that provides RAID functions. Adapters may reside on the system board or be an add-in card. Other examples of adapters include network and SCSI adapters.

AHCI — A programming specification which defines the operation of Serial ATA host controllers (also known as host bus adapters) in a non-implementation-specific manner. The specification describes a system memory structure for computer hardware vendors to exchange data between host system memory and attached storage-devices.

ATA (ADVANCED TECHNOLOGY ATTACHMENT) — A standard interface for connecting a system's storage devices, such as CD-ROMs and hard-drives.

ATAPI (ATA PACKET INTERFACE) — An interface standard that defines the packet protocol between a system and its internal storage peripherals, such as CD-ROM, DVD, or tape drives. ATAPI provides the command set for controlling the devices via an IDE interface.

BACKGROUND INITIALIZATION — Background initialization is the automatic check for media errors on physical disks. It ensures that striped data segments are the same on all physical disks in a virtual disk. The difference between a background initialization and a consistency check is that a background initialization is automatic for new virtual disks. The operation starts automatically after you create the disk.

BAS (BACKGROUND ARRAY SCAN) — Background Array Scan is a background operation which gets executed every 100ms. that verifies and corrects the mirror, volume or parity data for virtual disks. BAS starts automatically after a Virtual Disk is created.

BIOS (BASIC INPUT/OUTPUT SYSTEM) CONFIGURATION UTILITY — An alternate name for the PERC S110 BIOS Configuration utility. The utility appears during system startup when <Ctrl><R> are pressed.

CACHE — Fast memory that holds recently accessed data. Using cache speeds subsequent access to the same data. It is most often applied to processor-memory access but also can be used to store a copy of data accessible over a network. When data is read from or written to main memory, a copy is also saved in cache memory with the associated main memory address. The cache memory software monitors the addresses of subsequent reads to see if the required data is already stored in cache memory. If it is already in cache memory (a cache hit), it is read from cache memory

immediately and the main memory read is aborted (or not started). If the data is not cached (a cache miss), it is fetched from main memory and saved in cache memory.

CACHING — The process of utilizing a high speed memory buffer, referred to as a cache, in order to speed up the overall read or write performance. This cache can be accessed at a higher speed than a disk subsystem. To improve read performance, the cache usually contains the most recently accessed data, as well as data from adjacent disk sectors. To improve write performance, the cache may temporarily store data in accordance with its Write-Cache Enable policies. See the definition of Write-Cache Enable for more information.

CHANNEL — A link that transports data point-to-point.

CONSISTENCY CHECK — An operation to verify that all stripes in a virtual disk with a redundant RAID level are consistent and to automatically fix any errors. For RAID 5 arrays, a consistency check verifies correct parity data for each stripe. For RAID 1 and RAID 10 arrays, this operation verifies correct mirror data for each stripe.

CONTROLLER — A chip that controls the transfer of data between the microprocessor and memory or between the microprocessor and a peripheral device such as a physical disk or the keyboard. In Storage Management, the hardware or logic that interacts with storage devices to write and retrieve data and perform storage management. RAID controllers perform RAID functions such as striping and mirroring to provide data protection.

DISK — A non-volatile, randomly addressable, rewriteable mass storage device, including both rotating magnetic and optical storage devices and solid-state storage devices, or non-volatile electronic storage elements.

DISK ARRAY — A grouping of physical disks that are connected to the RAID controller. The RAID controller can group physical disks on one or more channels into an array.

DISK GROUP — A logical grouping of disks attached to a RAID controller on which one or more virtual disks can be created.

DISK MIGRATION — Disk migration refers to moving a virtual disk or a hot spare from one controller to another by detaching the physical disks and re-attaching them to the new controller.

DISK ROAMING — Moving disks from one slot to another on a controller.

DISTRIBUTED PARITY — Parity involves an extra bit added to a byte or word to reveal errors in storage (in RAM or disk) or transmission. Parity is used to generate a set of redundancy data from two or more parent data sets. The redundancy data can be used to rebuild one of the parent data sets. In distributed parity, the parity data are distributed among all the physical disks in the system. If a single physical disk fails, it can be rebuilt from the parity of the applicable data on the remaining physical disks.

FAILED PHYSICAL DISK — A physical disk that has ceased to function, that consistently functions improperly, or that is inaccessible.

FAULT TOLERANCE — Fault tolerance is the capability of the disk subsystem to undergo a single drive failure for the physical disks in a virtual disk without compromising data integrity and processing capability. The PERC S110 adapter provides this support through redundant virtual disks in RAID levels 1, 5 and 10. Fault tolerance is often associated with system availability because it allows the system to be available during drive failures. In case a disk fails, the PERC S110 adapter supports hot spare disks and the auto-rebuild feature.

FIRMWARE — Software stored in read-only memory (ROM) or Programmable ROM (PROM). Firmware is often responsible for the behavior of a system when it is first turned on. A typical example would be a monitor program in a system that loads the full operating system from disk or from a network and then passes control to the operating system.

FORMAT — The process of writing a specific value to all data fields on a physical disk, to map out unreadable or bad sectors. Because most physical disks are formatted when manufactured, formatting is usually done only if a physical disk generates many media errors.

GB — Acronym for gigabyte(s). A gigabyte equals 1,024 megabytes or 1,073,741,824 bytes (2^{30} bytes).

GPT (GUID PARTITION TABLE) — A standard for the layout of the partition table on a physical hard disk.

GLOBALLY UNIQUE IDENTIFIER (GUID) — A unique reference-number identifier used in software applications.

HBA (HOST BUS ADAPTOR) — An adaptor card that includes the I/O logic, software and processing to manage the transfer of information between the host system and devices connected to it.

HOST SYSTEM — Any system on which the RAID controller is installed. Mainframes, workstations, and personal systems can all be considered host systems.

HOT SPARE — An idle, powered on, stand-by physical disk ready for immediate use in case of disk failure. It does not contain any user data. A hot spare can be dedicated to a single redundant virtual disk or it can be part of the global hot-spare pool for all virtual disks controlled by the controller. When a disk fails, the PERC S110 adapter automatically replaces and rebuilds the data from the failed physical disk to the hot spare. Data can be rebuilt only from virtual disks with redundancy (RAID levels 1, 5, or 10; not RAID 0), and the hot spare must have sufficient capacity. If the hot spare is designated as having enclosure affinity, it attempts to rebuild any failed disks on the backplane within which it resides before rebuilding any other on other backplanes.

HOT SWAP — Replacement of a failed component while the system is running and operating normally.

INITIALIZATION — The process of writing zeros to the data fields of a virtual disk and, in fault tolerant RAID levels, generating the corresponding parity to put the virtual disk in a Ready state. Initialization generates parity information, so that the virtual disk is redundant. Virtual disks can work without initialization, but they are not truly redundant until initialization is performed.

INT 13h — A DOS interrupt used to activate seek, read, write and format disk functions. The Int 13h interface supports physical disks that contain up to an approximate maximum disk space of 8.45 GB.

JBOD (JUST A BUNCH OF DISKS [DRIVES]) — A storage subsystem that uses a single or multiple, independent disk drives.

LED (LIGHT EMITTING DIODE) — An electronic device that illuminates when powered.

LOAD BALANCING — Load balancing is a method of spreading work between two or more computers, network links, CPUs, physical disk drives, or other resources. Load balancing is used to maximize resource use, throughput, or response time. In the controllers, the balancing service is performed by the firmware. You can choose between a single path for load balancing, and a “round-robin” load balancing scheme. In single path, the firmware can detect multiple paths to a device, and use only a single path for I/O activity to that device. The secondary path is used if a failure is detected on the primary path. If load balancing is enabled for the controller, the firmware implements a round-robin scheme to issue I/Os to the redundant path device. The round-robin scheme issues one I/O down one path, and the other I/O down the second path, and so on. There is no restriction on firmware regarding which path to choose first. If load balancing is disabled, the firmware can use any one of the available paths to issue I/Os, and it should continue to use the same path for all further I/O activity. On reboot or path failure, the firmware again chooses any available path.

MB — Acronym for megabyte(s). The term megabyte means 1,048,576 bytes (2^{20} bytes); however, when referring to hard drive storage, the term is often rounded to mean 1,000,000 bytes.

MIRRORING — The process of providing complete redundancy using two physical disks, by maintaining an exact copy of one physical disk’s data on the second physical disk. If one physical disk fails, the contents of the other physical disk can be used to maintain the integrity of the system and to rebuild the failed physical disk.

NAS (NETWORK ATTACHED STORAGE) — A server that runs an operating system for handling files, and which is accessible directly on a LAN by using protocols like TCP/IP.

NCQ (NATIVE COMMAND QUEUING) — A command protocol for Serial ATA, that allows multiple, outstanding commands to be active on a drive at the same time.

NON-RAID CONFIGURATION — Non-RAID data is data that already exists on a replacement physical disk. The Non-RAID physical disk must be initialized before it can be used with the PERC S110 adapter.

NON-REDUNDANT VIRTUAL DISK — A non-redundant virtual disk is one which does not have redundant data on physical disks that can be used to rebuild a failed physical disk. A RAID 0 virtual disk consists of data striped across the physical disks, without disk mirroring or parity to provide redundancy. This provides for high data throughput but offers no protection in case of a physical disk failure.

Ns — Acronym for nanosecond(s), one billionth of a second.

NTFS (NEW TECHNOLOGY FILE SYSTEM) — The file system used by Microsoft Windows operating systems.

OCE/RECONFIGURE (ONLINE CAPACITY EXPANSION/RECONFIGURE) — Operation to add capacity to an existing virtual disk by adding an additional physical disk while the host system is active, and without affecting data availability.

OFFLINE — A physical disk is offline when it is part of a virtual disk but its data is not accessible to the virtual disk.

ONLINE — An online device is a device that is accessible.

PARITY — An extra bit added to a byte or word to reveal errors in storage (in RAM or disk) or transmission. Parity is used to generate a set of redundancy data from two or more parent data sets. The redundancy data can be used to rebuild one of the parent data sets. However, parity data does not fully duplicate the parent data sets. In RAID, this method is applied to entire physical disks or stripe elements across all physical disks in a virtual disk. Parity consists of dedicated parity, in which the parity of the data on two or more physical disks is stored on an additional physical disk, and distributed parity, in which the parity data are distributed among all the physical disks in the system. If a single physical disk fails, it can be rebuilt from the parity of the applicable data on the remaining physical disks.

PARTITION — A logical structure on a contiguous segment of storage on a physical disk or virtual disk that is recognizable by an operating system.

PCIe (PERIPHERAL COMPONENT INTERCONNECT EXPRESS) — A high-speed peripheral interconnect that can accommodate gigabit and chip-to-chip transfers.

PERC S110 BIOS CONFIGURATION — The PERC S110 BIOS Configuration configures and maintains RAID virtual disks, and manages the RAID system. Because the utility resides in the controller BIOS, its operation is independent of the operating system. The PERC S110 BIOS Configuration Utility, accessed by pressing <Ctrl><R> at system startup, is built on elements called controls. Each control

performs a function. The functions include procedures you can use to configure physical disks and virtual disks. The PERC S110 BIOS Configuration Utility differs from the Dell Inc. system BIOS, which contains the BIOS settings for each Dell platform and is accessed by pressing <F2> during system startup.

PHYSICAL DISK — A non-volatile, randomly-addressable device for storing data. Physical disks are rewriteable and commonly referred to as disk drives.

PNP (PLUG AND PLAY) — A technology that allows automatic recognition of interface cards and devices when plugged into a PC.

PORT — A connection point to a RAID controller, disk drive, enclosure, or another device.

RAID (REDUNDANT ARRAY OF INDEPENDENT DISKS) — An array of multiple independent physical disks managed together to yield higher reliability and/or performance exceeding that of a single physical disk. The virtual disk appears to the operating system as a single storage unit. I/O is expedited because several disks can be accessed simultaneously. Redundant RAID levels (RAID levels 1, 5, and 10) provide data protection.

RAID LEVELS — A set of techniques applied to the physical disks in a virtual disk to deliver higher data availability, and/or performance characteristics to host environments. Each virtual disk must have a RAID level assigned to it.

RAID MANAGEMENT UTILITY — A RAID management utility (PERC S110 BIOS Configuration Utility) is used to configure physical disks and virtual disks. Use the PERC S110 BIOS Configuration Utility if the operating system has not yet been installed on the controller.

REBUILD — The regeneration of all data to a replacement disk in a redundant virtual disk (RAID levels 1, 5, and 10) after a physical disk failure. A disk rebuild normally occurs without interrupting normal operations on the affected virtual disk, though some degradation of performance of the disk subsystem can occur.

REDUNDANCY — The provision of multiple interchangeable components to perform a single function to cope with failures and errors. Common forms of hardware redundancy are disk mirroring, implementations of parity disks, or distributed parity.

REDUNDANT VIRTUAL DISK — A redundant virtual disk is one which has redundant data on physical disks that can be used to rebuild a failed physical disk. A virtual disk can use disk striping across the physical disks, disk mirroring or parity to provide redundancy. This offers protection in case of a physical disk failure.

REPLACEMENT DISK — A physical disk that replaces a failed physical disk in a virtual disk.

SAN (STORAGE AREA NETWORK) — A high-performance, typically enterprise-level network that attaches disk storage subsystems to servers. The storage devices are

accessible to multiple hosts at the same time.

SAS (SERIAL ATTACHED SCSI) — SAS is a serial, point-to-point, enterprise-level device interface that leverages the proven Small Computer System Interface (SCSI) protocol set. The SAS interface provides improved performance, simplified cabling, smaller connectors, lower pin count, and lower power requirements when compared to parallel SCSI.

SATA (SERIAL ADVANCED TECHNOLOGY ATTACHMENT) — A physical storage interface standard, is a serial link that provides point-to-point connections between devices. The thinner serial cables allow for better airflow within the system and permit smaller chassis designs. The PERC S110 adapter leverage a common electrical and physical connection interface that is compatible with Serial ATA technology.

SCSI (SMALL COMPUTER SYSTEM INTERFACE) — A standard that allows multiple devices to be connected in a daisy-chain format. The fastest hard-drives are SCSI-based, rather than IDE-based.

SPANNING — The method by which nested RAID levels (such as RAID 10) are constructed from multiple sets of basic, or single RAID types. For example, a RAID 10 is made up of multiple sets of RAID 1 arrays where each RAID 1 set is considered a span. Data is then striped (RAID 0) across the RAID 1 spans to create a RAID 10 virtual disk. Spanning is generally used when referencing these nested RAID levels.

SPARE — A physical disk available to replace another physical disk in case that physical disk fails.

SSD (SOLID STATE DISK) — A high-performance storage media that contains no moving parts. It contains a memory board, a memory board bus, a CPU, and a battery card.

STORPORT — The Storport driver has been designed to replace SCSIport and work with Windows 2003 and beyond. In addition, it offers better performance for newer RAID controller protocols (like SAS), provides higher I/O throughput rates, improves manageability, and has an upgraded miniport interface. For example, while SCSIport allows a maximum of 254 commands per controller, Storport allows 254 commands per logical unit number (LUN).

STORAGE ARRAYS — A storage entity that is managed entirely by storage management software. A storage array consists of a collection of physical components (drives, controllers, fans, and power supplies) and logical components (such as virtual disks). A storage array can span multiple physical enclosures.

STRIPING — Disk striping writes data across all physical disks in a virtual disk. Each stripe consists of consecutive virtual disk data addresses that are mapped in fixed-size units to each physical disk in the virtual disk using a sequential pattern. For example, if the virtual disk includes five physical disks, the stripe writes data to physical disks one through five without repeating any of the physical disks. The amount of space consumed by a stripe is the same on each physical disk. The portion of a stripe that resides on a physical disk is a stripe element. Striping by itself does not provide data redundancy. Striping in combination with parity does provide data redundancy.

TB (TERABYTE) — One thousand gigabytes (approximately one trillion bytes).

TRANSFORMATION — A transformation can mean: (1) Capacity expansion, using OCE/Reconfigure (adding more physical disks to a virtual disk and increasing the storage capacity of the virtual disk or virtual disks), or (2) Rebuilding (rebuilding data on the virtual disk from a redundant virtual disk or from a hot spare or backup physical disk).

VIRTUAL DISK — A virtual disk refers to storage created by a RAID controller from one or more physical disks. Although a virtual disk may be created from several physical disks, it is seen by the operating system as a single disk. Depending on the RAID level used, the virtual disk may retain redundant data in case of a disk failure.

WRITE-CACHE ENABLE — In Write-cache enable mode, the controller sends a data transfer completion signal to the host when the controller cache has received all the data in a disk write transaction. The VD cache is disabled by default, but can be enabled by the user through the user interface. The risk of using Write-cache enable is that the cached data can be lost if there is a power failure before it is written to the storage device. This risk can be mitigated by using a Uninterrupted Power Supply (UPS) on PERC S110 system. A UPS is recommended for use if the cache is enabled.

WRITE-CACHE DISABLE — In Write-Through caching mode, the controller sends a data transfer completion signal to the host when the disk subsystem has received all the data and has completed the write transaction to the disk.

WHQL (WINDOWS HARDWARE QUALITY LABS) — A Microsoft Corporation facility that provides testing services for non-Microsoft hardware and device drivers, to ensure compliance and compatibility with Microsoft operating systems.