

**Oracle® Storage 12 Gb SAS PCIe RAID
HBA, Internal: 16 Port and 2 GB Memory
Installation Guide For HBA Model
7116970**

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Contents

Using This Documentation	9
1 HBA Overview	11
Ship Kit Contents	11
HBA Features	11
Operating System and Technology Requirements	12
System Interoperability	13
Host Platform Support	13
Storage System Support	14
Software Support	14
2 Hardware Installation and Removal	15
Observing ESD and Handling Precautions	15
Best Practices for HBA Installation	16
Installing the HBA	16
▼ To Prepare for Hardware Installation	16
▼ To Install the HBA	17
▼ To Connect the HBA to Internal Storage Devices	18
▼ To Complete the Installation	19
Next Steps	19
Removing the HBA	19
▼ To Remove the HBA	20
3 Creating a Bootable Drive in a Preboot Environment	21
About Creating a Bootable Drive in a Preboot Environment	21
Utilities Overview	22
Methods for Creating a Bootable Drive	22
Creating a Bootable Drive (SPARC)	22

▼ To Create a Bootable Drive (SPARC)	23
Using the pc1i Utility to Create a Bootable Drive (SPARC)	23
Importing an Existing Logical Drive Configuration (SPARC)	27
Creating a Bootable Drive (x86)	28
▼ To Create a Bootable Drive (x86)	28
Using the LSI MegaRAID Configuration Utility Menu to Create a Bootable Logical Drive (x86)	28
Validating the Label of the HBA Logical Drive	43
▼ To Verify That the Label of a Logical Drive Is Valid	44
Next Steps	46
Installing the Oracle Solaris OS	46
▼ To Prepare to Install the Oracle Solaris OS	46
▼ To Install the Oracle Solaris OS	46
Next Steps	47
4 HBA Software Installation	49
Installing the Utility for BIOS and Firmware Updates and RAID Configuration	49
Installing Diagnostic Software	50
Diagnostic Support for the Oracle Solaris OS	50
Diagnostic Support for All Other Supported Operating Systems	50
Installing Drivers	51
Installing Drivers For the Oracle Solaris OS	51
▼ Installing Drivers For All Other Supported Operating Systems	52
5 Important Information and Known Issues	53
Usable Capacity Reduction Is Possible Only With a RAID Level Migration	53
Mixing Drive Types on the HBA Might Cause Slow Repair of a Degraded Logical Drive	53
HBA Product Accessibility	54
HBA Hardware Accessibility	54
Oracle ILOM Accessibility	54
BIOS Accessibility	56
Documentation Accessibility	56
Diversity and Inclusion	57
A HBA Specifications	59
Physical Dimensions	59

Environmental Requirements	59
Fault Tolerance	60

Using This Documentation

- **Overview** – Describes how to install and remove the Oracle Storage 12 Gb SAS PCIe RAID HBA, Internal: 16 Port and 2 GB Memory.
- **Audience** – Technicians, system administrators, and authorized service providers
- **Required knowledge** – Advanced experience troubleshooting and replacing hardware

Product Documentation Library

Documentation and resources for this product and related products are available at https://docs.oracle.com/cd/E87591_01/index.html.

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◆◆◆ CHAPTER 1

HBA Overview

This chapter provides an overview of the Oracle Storage 12 Gigabit (Gb) Serial Attached SCSI (SAS) PCI Express (PCIe) RAID host bus adapter (HBA), Internal: 16 Port and 2 Gigabytes (GB) Memory, which uses Broadcom technology. The chapter also describes the various operating systems, host platforms, storage, and infrastructure configurations that support the HBA.

This chapter contains the following topics:

- [“Ship Kit Contents” on page 11](#)
- [“HBA Features” on page 11](#)
- [“Operating System and Technology Requirements” on page 12](#)
- [“System Interoperability” on page 13](#)

Ship Kit Contents

- Oracle Storage 12 Gb SAS PCIe RAID HBA, Internal: 16 Port and 2 GB Memory, with a standard, low-profile bracket installed
- *Accessing Documentation* document

HBA Features

The Oracle Storage 12 Gb SAS PCIe RAID HBA, Internal: 16 Port and 2 GB Memory (part number: 7116970) is a low-profile, PCI Express 3.0 RAID controller that supports 16 internal 12 Gb/s SAS connectors through four internal mini-SAS HD ports. The 16 connectors on the board enable direct connection to all internal drives, and eliminate the need for a SAS expander. Data that is cached on the HBA is protected, in the event of a power failure.

The HBA supports the following features.

TABLE 1 HBA Features

Feature	Description
Ports	Four SAS3, x4 internal mini-SAS HD ports, 16 total phys
Host interface	PCIe, as defined in the <i>PCI Express Card Specification</i> , version 3.0
Target interface	SAS3 12-Gb/s
Lane width	PCIe 3.0 x8 lane width up to 8 Gt/s per lane
Performance	High, through the MegaRAID Firmware Interface (MFI) architecture
Throughput	High throughput and low CPU utilization to offload the host processor
Boot support	For all supported operating systems (OSs) (see Table 2, “Supported Operating System/Technology Versions ,” on page 13)
Power consumption	Maximum 25 Watts
Diagnostic support	Provided by Oracle VTS
Oracle Solaris Dynamic Reconfiguration	Supported
PCIe Single Root I/O Virtualization (SR-IOV)	Supported
MSI-X	Supported
PCIe hot-plug and hot-swap capabilities	Supported
RAID	<ul style="list-style-type: none"> ■ Full-featured, hardware-based RAID implementation ■ A RAID on CHIP (ROC) controller, supporting a hardware RAID acceleration engine with a capacity of 2 GB, DDR-3 cache memory, and power fail backup support ■ Integrated SAS/SMP/STP/SSP protocol support ■ 12 Gb/s SAS interface supporting 6 and 3 Gb/s SAS ■ Data striping across multiple drives ■ Data mirroring or parity block for backing up data ■ Support for RAID levels 0, 1, 5, 6, 10, 50, and 60, with 2 GB data cache, and with accelerated XOR on RAID 5 and 6 ■ Built-in flash controller for direct flash backup from DDR memory ■ User-configurable rebuild rate

Operating System and Technology Requirements

The HBA requires the operating system (OS) and technology levels, at minimum, listed in [Table 2, “Supported Operating System/Technology Versions ,”](#) on page 13.

Note - If you need to contact Oracle Support, first verify that you have a supported OS installed on the host system, and install the latest HBA driver, utility, and firmware versions. Updating the system and HBA to the latest OS, driver, utility, and firmware versions might address the issue, preventing the need to contact Oracle Support about an issue that has already been fixed.

TABLE 2 Supported Operating System/Technology Versions

Operating System/Technology	Recommended Versions (minimum)
Oracle Solaris OS for the x86 (64-bit) platform	<ul style="list-style-type: none"> ■ Oracle Solaris 11.4 with SRU 16 ■ Oracle Solaris 11.3 with SRU 23 <p>To obtain the latest SRUs, go to https://support.oracle.com</p>
Oracle Virtual Machine (VM) Technology	Oracle VM 3.4.6
Linux OS (64-bit)	<ul style="list-style-type: none"> ■ Oracle Linux 8.4 with Red Hat Compatible Kernel (RHCK) and Unbreakable Enterprise Kernel (UEK) Release 6 (R6) ■ Oracle Linux 7.7 with RHCK and UEK Release 5
Microsoft Windows OS (64-bit)	<ul style="list-style-type: none"> ■ Window Server 2019 ■ Windows Server 2016
VMware Technology	<ul style="list-style-type: none"> ■ VMware ESXi 6.5 U1

System Interoperability

This section provides host platform, storage, and software support information. This section contains the following topics:

- [“Host Platform Support” on page 13](#)
- [“Storage System Support” on page 14](#)
- [“Software Support” on page 14](#)

Host Platform Support

The HBA is supported by the platforms listed in [Table 3, “Platform Support,” on page 13](#). For the latest information, see your system product notes and server platform product web pages.

TABLE 3 Platform Support

Platform	Supported OS/Technology
Oracle x86 Servers:	
Oracle Server X8-2, X8-2L, and X8-8	Oracle Solaris, Oracle VM, Windows, Linux
Oracle Server X7-2, X7-2L, and X7-8	Oracle Solaris, Oracle VM, Windows, Linux
Oracle Server X7-2c	Oracle Solaris, Oracle VM, Windows, Linux
Oracle SPARC Servers:	
Oracle SPARC T8-2	Oracle Solaris

Storage System Support

Internal disk drives are the only storage supported by the HBA.

Software Support

Install, Flash, and BIOS configuration utilities are provided. The HBA uses the MegaRAID Firmware Interface (MFI) architecture for all major operating systems, which allows for thinner drivers for better performance. To obtain a device driver that supports your operating system, go to: <https://www.broadcom.com/support/oem/oracle/>

Use the StorCLI utility to manage the HBA upon installation. For more information, go to: <https://www.broadcom.com/support/oem/oracle/>

◆◆◆ CHAPTER 2

Hardware Installation and Removal

This chapter describes how to install and remove the HBA. For detailed instructions, see your storage system installation or service guide and the installation guide for the storage devices to be connected to the HBA.

This chapter contains the following topics:

- [“Observing ESD and Handling Precautions” on page 15](#)
- [“Installing the HBA” on page 16](#)
- [“Next Steps” on page 19](#)
- [“Removing the HBA” on page 19](#)

Observing ESD and Handling Precautions



Caution - Damage to the HBA can occur as the result of careless handling or electrostatic discharge (ESD). Always handle the HBA with care to avoid damage to electrostatic-sensitive components.

To minimize the possibility of ESD-related damage, use both a workstation antistatic mat and an ESD wrist strap. You can get an ESD wrist strap from any reputable electronics store or from Oracle as part number 250-1007.

Observe the following precautions to avoid ESD-related problems:

- Leave the HBA in its antistatic bag until you are ready to install it in the system.
- Always use a properly fitted and grounded wrist strap or other suitable ESD protection when handling the HBA and observe proper ESD grounding techniques.
- Always hold the HBA by the metal enclosure.
- Place the HBA on a properly grounded antistatic work surface pad when it is out of its protective antistatic bag.

Best Practices for HBA Installation

Follow these general best practices for installing and configuring the HBA:

- If more than one HBA model is present in the configuration, enable only the OptionROM (OpROM) for the first HBA seen in the boot sequence. There is a limited amount of space for OpROMs; therefore, do *not* unnecessarily enable all OpROMs, as space usage issues might occur.
- When installing the HBA, be sure to also install the latest version of the command-line utility available from the manufacturer's web site. Keep the HBA utilities, firmware, and drivers up-to-date, and update them in that order.

Installing the HBA

This section provides the following procedures:

- [“To Prepare for Hardware Installation” on page 16](#)
- [“To Install the HBA” on page 17](#)
- [“To Connect the HBA to Internal Storage Devices” on page 18](#)
- [“To Complete the Installation” on page 19](#)

▼ To Prepare for Hardware Installation

1. **Read and observe the safety information for this product.**

See the *Oracle Storage Safety and Compliance Guide* at: https://docs.oracle.com/cd/F34208_01/html/F34241/index.html.

2. **Familiarize yourself with the physical features of the HBA and the RAID levels that it supports.**

3. **Ensure that you have the right quantity of initialized disk drives for the RAID level you want to use for the arrays.**

For optimal performance, use drives of the same type, speed, and size when you create virtual drives. You can use different-sized disk drives in the array, but the array will be limited to the capacity of the smallest and slowest disk drive.

For more information, refer to the *12 Gb/s MegaRAID SAS Software User's Guide* at: <https://www.broadcom.com/support/oem/oracle/>

4. **Ensure that you have the proper cables for the HBA and the internal disk drives.**
Use only Oracle-provided SAS cables (provided with your Oracle system at time of purchase). Cable connectors are keyed so that you cannot insert them incorrectly.
5. **Unpack the box containing the HBA in a static-free environment and inspect it for damage.**

Note - Leave the HBA in the protective bag until you are ready to install it. If there is damage, contact Oracle customer support.

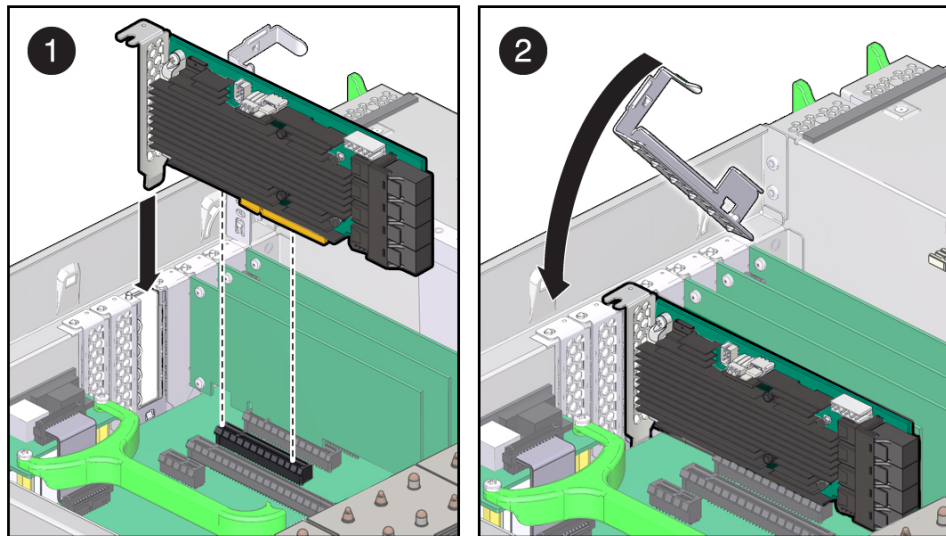
6. **Refer to your system installation guide or service manual for instructions on how to remove the system cover, disconnect the AC power cords, and turn off power from the system, if required.**

▼ To Install the HBA

1. **Attach an antistatic wrist strap and remove the HBA from its protective bag.**
See [“Observing ESD and Handling Precautions” on page 15](#).
2. **Refer to the installation guide or service manual for your particular system for instructions on how to locate an available PCIe slot in the system.**
3. **Align the PCIe bus connector of the HBA to the PCIe slot.**

Note - Some PCIe slots support PCIe graphics cards only; if the HBA is installed in one of those PCIe slots, the HBA will not function.

4. **Press down gently and firmly to seat the HBA in the PCIe slot, and then secure the bracket to the system chassis with the retention clip (see the following figure).**



Note - The configuration of the enclosure might not be the same as shown in this illustration.

▼ To Connect the HBA to Internal Storage Devices

1. **Install and configure the SAS devices in the system.**
For more information, see the documentation for the devices.
2. **Connect the SFF-8643 x4 Mini SAS HD connector on one end of the SAS cable to an internal port.**
Use only Oracle-provided SAS cables (provided with your Oracle system at time of purchase).

▼ To Complete the Installation

1. Replace the system cover and reconnect the AC power cords, if required, as described in the system documentation.
2. If you needed to turn the system power off to install the HBA, power on the system.

Note - If you do need to return power to the system, ensure that the power is turned on to the SAS devices before or at the same time that the power is turned on to the host system. If the system is powered up before these devices, the devices might not be recognized.

3. If you need to install an operating system (OS) on your system, complete the procedures in [Chapter 3, “Creating a Bootable Drive in a Preboot Environment ”](#) and then go to the next step.
4. If you already have an OS installed on an x86 system, do the following:
 - a. Go to the Oracle support area of the Broadcom web site (<https://www.broadcom.com/support/oem/oracle/>) and download the storCLI utility, along with supporting documentation.
 - b. Install the storCLI utility on the system that will manage your storage.
 - c. From the storCLI utility, create logical drives for the HBA.

Next Steps

If you are using the Oracle Solaris OS, the installation is complete. You can obtain the latest SRUs for the Oracle Solaris OS at: <http://support.oracle.com>

If you are using the Windows operating system, install the Windows HBA driver, as described in [Chapter 4, “HBA Software Installation”](#).

For all other operating systems, the installation is complete.

Removing the HBA

If you need to remove the HBA from the system, follow the procedure in this section.

▼ To Remove the HBA

1. **Prepare your operating system for HBA removal.**
2. **Attach an antistatic wrist strap.**
See [“Observing ESD and Handling Precautions”](#) on page 15.
3. **Refer to the service manual for your specific system to remove the system cover, power down the system, and remove AC power cords from the system, if required.**
4. **Refer to the service manual for your specific system to locate the HBA in the chassis of the system.**
5. **Disengage the retention clip that secures the HBA to the chassis of the system and pull up carefully to unseat the HBA from the PCIe slot.**
6. **Detach all cables from the HBA.**
7. **Refer to the service manual for your specific system to reattach the system cover, reinstall AC power cords to the system, and power on the system, as necessary.**

Creating a Bootable Drive in a Preboot Environment

This chapter describes how to use the HBA as your boot device prior to installing an operating system (OS) on the system.

Note - If you are installing the HBA into a system that already has an OS installed, do not perform any tasks in this chapter. Instead, complete the HBA installation, as described in [“To Complete the Installation” on page 19](#).

This chapter contains the following topics:

- [“About Creating a Bootable Drive in a Preboot Environment ” on page 21](#)
- [“Creating a Bootable Drive \(SPARC\)” on page 22](#)
- [“Creating a Bootable Drive \(x86\)” on page 28](#)
- [“Validating the Label of the HBA Logical Drive” on page 43](#)
- [“Installing the Oracle Solaris OS” on page 46](#)
- [“Next Steps” on page 47](#)

About Creating a Bootable Drive in a Preboot Environment

As an installation option, you can choose to install the HBA into a system that does not yet have an OS installed. With this installation option, if you plan to use the HBA as your boot device, you can create a logical drive for the HBA to enable you to boot from the HBA. On a SPARC system, you would perform these actions using the Preboot Command-Line Interface (pccli) utility. On an x86 system, you would do so using the Unified Extensible Firmware Interface (UEFI) MegaRAID Configuration menu of the BIOS Setup Utility (UEFI booting).

This section contains the following topics:

- [“Utilities Overview” on page 22](#)

- [“Methods for Creating a Bootable Drive” on page 22](#)

Utilities Overview

You can specify the HBA to be your boot device by using one of these utilities:

- **pcLi utility** - A utility that you can run on SPARC systems. You can access this utility by issuing a break at a remote console. This utility is an implementation of RAID commands that you can execute from the Open Boot PROM (OBP) environment. Creating a logical drive through the pcLi utility enables the HBA to expose the drive to the system.

The command-set of the pcLi utility is identical to the command-set of the storcli utility. Therefore, to help determine the syntax and structure of the pcLi commands referenced in this chapter, review the equivalent storcli commands, as described in the *MegaRAID SAS Software User's Guide*, located at: <https://www.broadcom.com/support/oem/oracle/>

- **LSI MegaRAID Configuration Utility menu of the BIOS Setup Utility** – A utility that you can run on an x86 system. You can access this utility by pressing F2, when prompted during bootup, and then using the right arrow key to navigate to the Advanced tab, and then to the LSI MegaRAID Configuration Utility menu option, near the bottom of the screen. The MegaRAID Configuration Utility menu provides a standard environment for booting an operating system, managing physical disks and RAID volumes, and running preboot applications.

Methods for Creating a Bootable Drive

You must perform different procedures in this chapter, based on the type of system in which you are installing the HBA:

- **If you are installing the HBA into a SPARC system**, go to [“Creating a Bootable Drive \(SPARC\)” on page 22](#).
- **If you are installing the HBA into an x86 system**, go to [“Creating a Bootable Drive \(x86\)” on page 28](#).

Creating a Bootable Drive (SPARC)

This section describes how to create or import a logical drive and then create an alias for that drive on a SPARC system. You can then use the logical drive as your boot drive upon which to install the Oracle Solaris OS.

If you are an x86 system user, do not perform the steps in this section. Instead, go to [“Creating a Bootable Drive \(x86\)”](#) on page 28.

This section contains the following topics:

- [“To Create a Bootable Drive \(SPARC\)”](#) on page 23
- [“Using the `pcLi` Utility to Create a Bootable Drive \(SPARC\)”](#) on page 23
- [“Importing an Existing Logical Drive Configuration \(SPARC\)”](#) on page 27

▼ To Create a Bootable Drive (SPARC)

● Do one of the following:

- **Create a logical drive, as described in [“Using the `pcLi` Utility to Create a Bootable Drive \(SPARC\)”](#) on page 23.**

Or:

- **Import a logical drive configuration from a different MegaRAID controller, as described in [“Importing an Existing Logical Drive Configuration \(SPARC\)”](#) on page 27.**

Using the `pcLi` Utility to Create a Bootable Drive (SPARC)

This section describes how to use the `pcLi` utility to create a logical drive on a SPARC system prior to installing the Oracle Solaris operating system (OS). This section contains the following topics:

- [“To Prepare to Use the `pcLi` Utility”](#) on page 23
- [“To Create a Logical Drive With the `pcLi` Utility”](#) on page 25
- [“To Create an Alias for a Bootable Drive \(SPARC\)”](#) on page 26

▼ To Prepare to Use the `pcLi` Utility

1. Open an `xterm` or a `gnome terminal` window.

`pcLi` commands can produce large amounts of detailed output. The `xterm` and `gnome terminal` windows provide scroll bar functionality, which helps when viewing such output.

Note - If you do not have access to a terminal window with scroll bars, such as the `xterm` or `gnome` windows, you can use the `pccli` pagination feature. This feature enables you to specify a number of lines to be printed on the screen before pausing, at which time you must hit a key to continue. For example, the following `pccli` command prints 20 lines at a time to the screen: `{0}`

```
ok ok cli show page 20
```

2. **Enter the OBP environment by issuing a break from a remote console.**
3. **Use the `show-devs` command to list the device paths on the system and select the device path for the HBA.**

```
{0} ok show-devs
<...>
/pci@1e,600000/pci@0/pci@3/LSI,mrsas@0
/pci@1e,600000/pci@0/pci@3/LSI,mrsas@0/disk
/pci@1e,600000/pci@0/pci@3/LSI,mrsas@1
<...>
```

4. **Use the `select-dev` command to select the HBA on which the `pccli` commands that you issue will operate.**

```
{0} ok " /pci@1e,600000/pci@0/pci@3/LSI,mrsas@0" select-dev
```

You have now selected the HBA upon which all `pccli` commands will operate. This means you do not need to specify the HBA in any `pccli` command that you issue, unlike with the `storcli` utility. For example, if you issue the `pccli` command, `show`, the command automatically applies to the selected HBA. However, the equivalent command through the `storcli` utility would apply only to the card that you specify (the `0` card, as shown here):

SPARC `pccli`: `{0} ok cli show`

`storcli`: `storcli /c0 show`

5. **Review the following table for useful `pccli` commands.**

pccli Command	Description
<code>cli /c0/eall/sall show</code>	Lists all physical drives.
<code>cli add</code>	Creates a RAID logical drive.
<code>cli /c0/vX del</code>	Deletes a logical drive.
<code>cli /c0/vall show</code>	Displays information about logical drives.
<code>cli show</code>	Displays HBA configuration information.

<code>pcli</code> Command	Description
<code>cli /c0/vall show</code>	Lists all logical drives.

You are now ready to use the `pcli` commands to create a logical drive, or MegaRAID virtual drive, on the HBA.

▼ To Create a Logical Drive With the `pcli` Utility

1. Use the `/c0/eall/sall show` command to list all the physical drives attached to the HBA.

Drives attached directly to the HBA are assigned an Enclosure Device ID number of 252 (only eight physical drives can be attached in this way). Drives connected to the HBA through a SAS expander or an external enclosure are assigned different Enclosure Device ID values. In the following example, the physical drive listed in the output is attached directly to the HBA (Enclosure Device ID value of 252).

```
{0} ok cli /c0/eall/sall show
```

```
Drive Information :
```

```
=====
```

```
-----
EID:SlT DID State DG      Size Intf Med SED PI SeSz   Model          Sp
-----
252:0   41 UGood  0 557.861 GB SAS  HDD N  N  512B   ST360057SSUN600G U
252:1   25 UGood  0 557.861 GB SAS  HDD N  N  512B   ST360057SSUN600G U
-----
```

2. Use the `add` command to create a logical drive (MegaRAID virtual disk) from the physical disks.

```
{0} ok cli add vd r0 drives=252:0 -- for RAID 0, with Enclosure #252 and Slot 0 --
{0} ok cli add vd r1 drives=252:0,1 -- for RAID 1, with Enclosure #252 and Slots 0 and 1
--
```

3. Use the `format(1M)` utility to label the physical disks from which you created the logical drive.

All disks used by the HBA must be labeled, or contain a volume table of contents (VTOC). If you attempt to use an unlabeled disk with the HBA, the disk might not be recognized by the OS or the OS installation itself might fail. For more information about labeling disks, see the documentation for the physical disks.

4. **Create an alias for the drive, as described in “[To Create an Alias for a Bootable Drive \(SPARC\)](#)” on page 26.**

▼ To Create an Alias for a Bootable Drive (SPARC)

After you have created a bootable drive, as described in “[To Create a Logical Drive With the `pci` Utility](#)” on page 25, you can create an alias for that drive. The alias helps to simplify the process of booting the drive.

1. **Issue the `show-disks` command to list the disks on the system.**

Note that, as shown in the following example, you can determine the HBA drives by looking for the `LSI,mrsas@number` label, where *number* is 0 for the first HBA detected, and increments for each additional HBA detected.

```
{0} ok show-disks
<...>
a) /pci@1e,600000/pci@0/pci@3/LSI,mrsas@0/disk
b) /pci@1e,600000/pci@0/pci@3/LSI,mrsas@1/disk
c) /pci@1e,600000/pci@0/pci@3/LSI,mrsas@2/disk
<...>
q) NO SELECTION
Enter Selection, q to quit:
```

2. **Select the bootable drive for which you want to create an alias.**

```
a) /pci@1e,600000/pci@0/pci@3/LSI,mrsas@0/disk
b) /pci@1e,600000/pci@0/pci@3/LSI,mrsas@1/disk
c) /pci@1e,600000/pci@0/pci@3/LSI,mrsas@2/disk
<...>
q) NO SELECTION
Enter Selection, q to quit: c
/pci@1e,600000/pci@0/pci@3/LSI,mrsas@2/disk has been selected.
```

3. **Use the `nvalias alias-name HBA-drive-path` command to create an alias for the bootable drive that you selected in the previous step (you can press `Ctrl+Y` to paste the device path).**

In the following example, the alias name is `mydev`.

```
{0} ok nvalias mydev /pci@1e,600000/pci@0/pci@3/LSI,mrsas@2/disk
```

4. **You can now boot from the bootable drive by using the `boot alias-name` command.**

```
{0} ok boot mydev
```

5. **To optionally add the bootable drive to the boot-device list and then automatically boot from the drive by controlling the boot device order, issue the following commands, as shown.**

```
{0} ok printenv boot-device  
boot-device = disk0 disk1  
{0} ok setenv boot-device mydev disk0  
boot-device = mydev disk0
```

In this example, the mydev alias is set as disk0, the first disk in the boot device list. This results in the automatic booting of the bootable drive, /pci@1e,600000/pci@0/pci@3/LSI,mrsas@2/disk.

6. **Validate the label of the bootable drive that you created (see [“Validating the Label of the HBA Logical Drive” on page 43](#)).**

Importing an Existing Logical Drive Configuration (SPARC)

Instead of creating a logical drive, as described in [“Using the pci Utility to Create a Bootable Drive \(SPARC\)” on page 23](#), you might need to import an existing logical drive (MegaRAID virtual disk) configuration from a different MegaRAID controller. To import an existing configuration, complete the procedures in this section.

▼ To Import an Existing Logical Drive Configuration From a Different Controller (SPARC)

Note - Only MegaRAID logical drives can be imported; Integrated RAID (IR) logical drives cannot be imported.

1. **Use the `/c0/fall show` command to display any foreign logical volumes which might exist.**

Note - A foreign logical volume is a logical volume created on a different controller, and then the logical volume disks are moved to this controller. Do not use foreign logical volumes without explicit consent from the administrator of the foreign logical volumes.

2. **Use the `/c0/fforeign-logical-volume-number import` command to import the logical drive to the HBA.**

In the example below, the foreign logical volume, 2, is specified for importing.

```
{0} ok cli /c0/f2 import
```

Creating a Bootable Drive (x86)

This section describes how to create or import a logical drive and then make that drive bootable on an x86 system. You can then use the logical drive as your boot drive on which you can install an OS.

▼ To Create a Bootable Drive (x86)

- **Create a new logical drive by performing the steps in [“Using the LSI MegaRAID Configuration Utility Menu to Create a Bootable Logical Drive \(x86\)”](#) on page 28.**

Using the LSI MegaRAID Configuration Utility Menu to Create a Bootable Logical Drive (x86)

This section describes how to use the LSI MegaRAID Configuration Utility menu in the BIOS Setup Utility to create a logical drive on an x86 system. You can then define the logical drive as bootable, and install an operating system onto that logical drive.

Before performing the procedures in this section, verify the firmware level on the HBA and perform any firmware updates, as necessary. For information about updating firmware, see [Chapter 4, “HBA Software Installation”](#).

Perform the following procedures, in the order listed, to create a logical drive on an x86 system:

- [“To Verify the Drives and Their Slots \(x86\)” on page 29](#)
- [“To Create a Logical Drive \(x86\)” on page 32](#)
- [“To Confirm the Logical Drive Creation \(x86\)” on page 38](#)

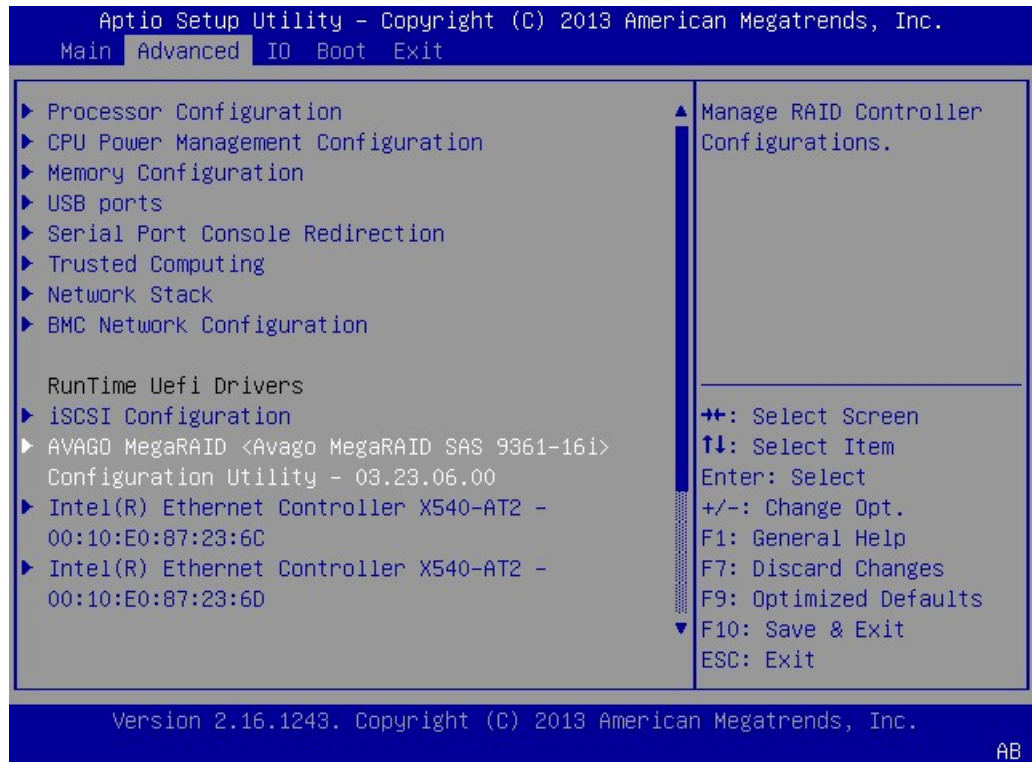
▼ To Verify the Drives and Their Slots (x86)

This procedure helps you identify drives to be used in a logical drive configuration.

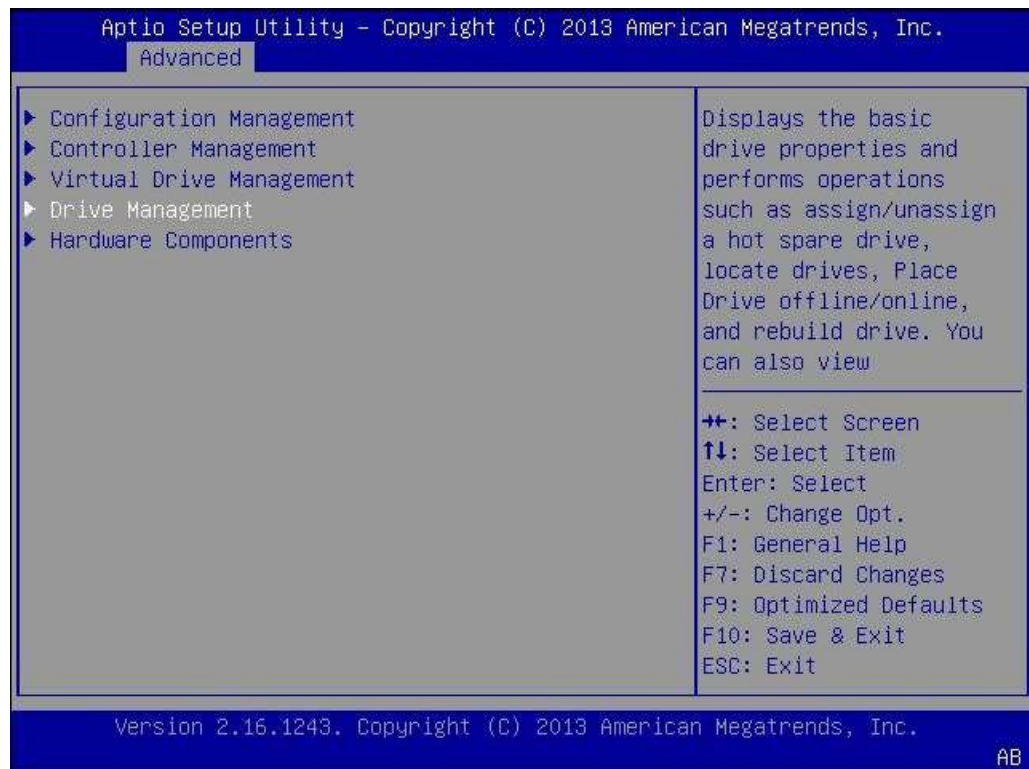
- 1. Access the system console from the Oracle Integrated Lights Out Manager (ILOM) software or Video Graphics Array (VGA) video port.**
- 2. Initiate a system boot.**

During the boot process, the BIOS initialization banner lists information about the discovered SAS adapters and devices that are attached to the discovered HBAs in the system.
- 3. Press F2 during the boot process, when prompted, to launch the BIOS Setup Utility, and then use the right arrow key to navigate to the Advanced menu.**

4. Use the arrow keys to navigate to the LSI MegaRAID Configuration Utility menu option, and press Enter.

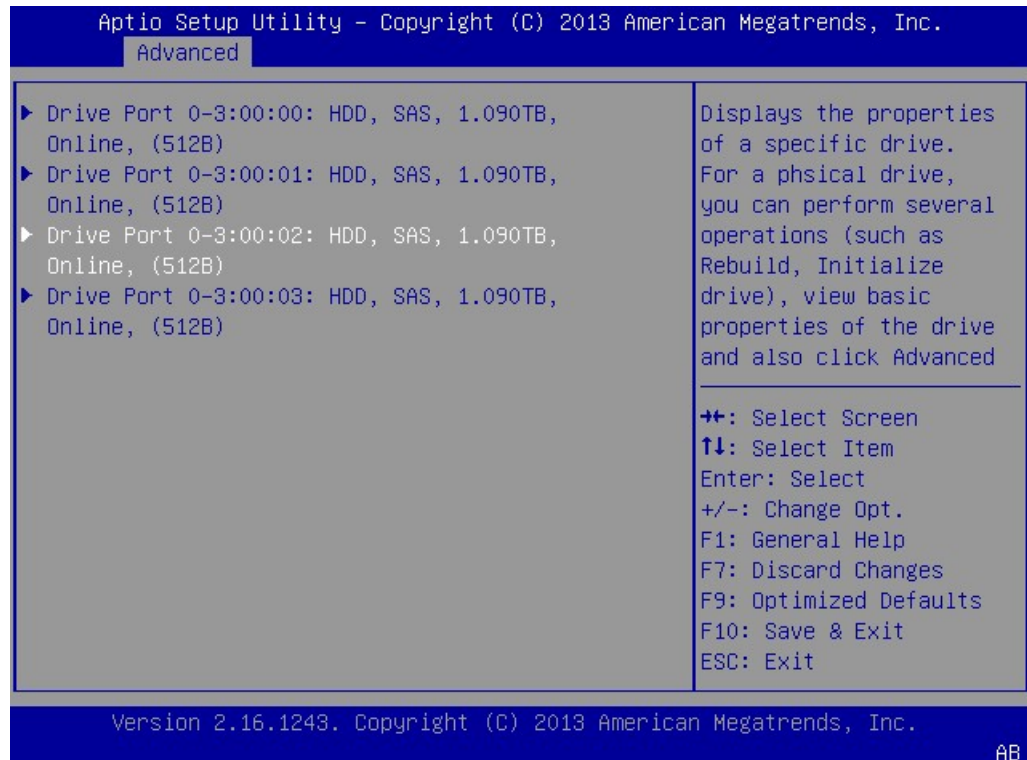


5. From the menu options that are displayed, use the arrow keys to navigate to the Drive Management menu option, and press Enter.



6. From the page that is displayed, review the attached drives and note their respective slots for future reference.

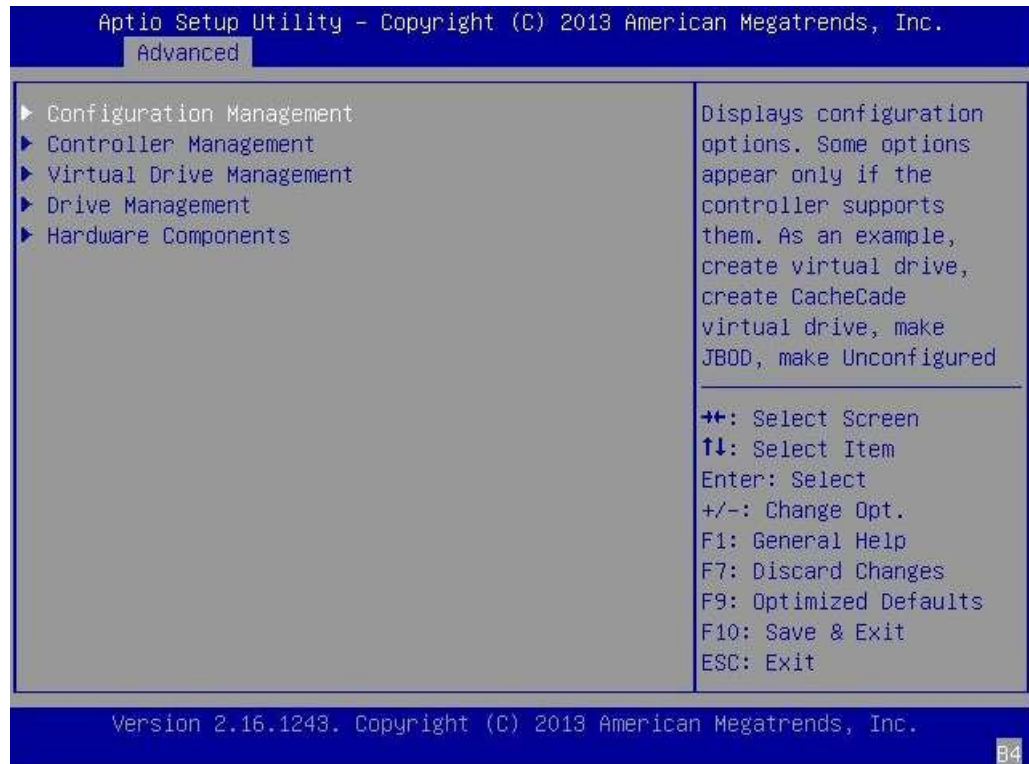
In the following example, there are four drives in slots 0, 1, 2, and 3. Slots 2 and 3 are not currently used (indicated by the Unconfigured Good text). You can use Unconfigured Good drives to be part of your logical drive configuration.



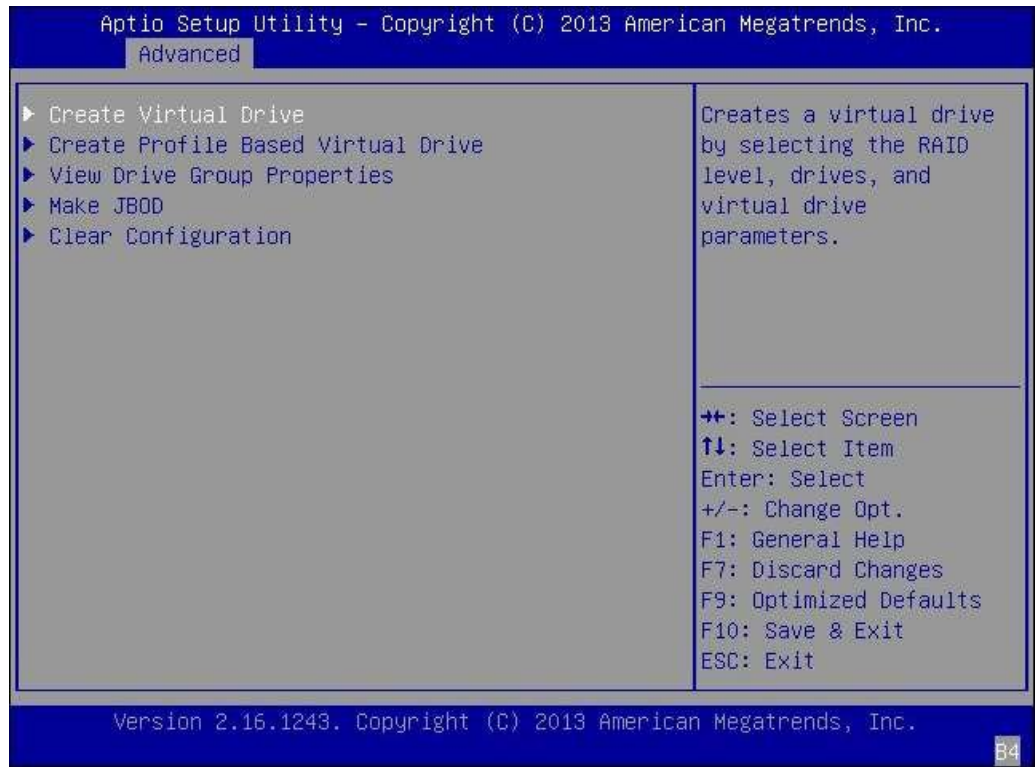
▼ To Create a Logical Drive (x86)

After you have verified which drives are available for logical drive configuration, as described in [“To Verify the Drives and Their Slots \(x86\)”](#) on page 29, you can use those drives to create a logical drive. In the following procedure, drives 2 and 3 (3:00:02, 3:00:03) are being used to create a RAID 1 volume.

1. From the Drive Management screen that is displaying the attached drives, press the Esc key to return to the previous menu, use the arrow keys to navigate to the Configuration Management menu option, and press Enter.

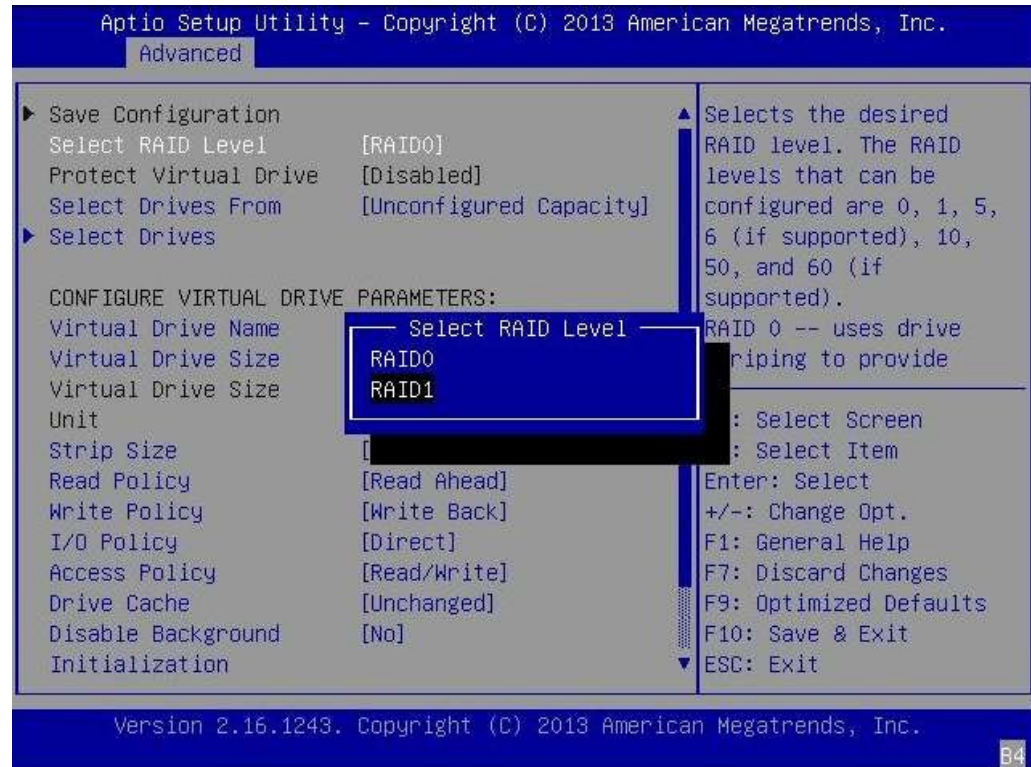


2. From the page that is displayed, use the arrow keys to navigate to the Create Virtual Drive menu option, and press Enter.

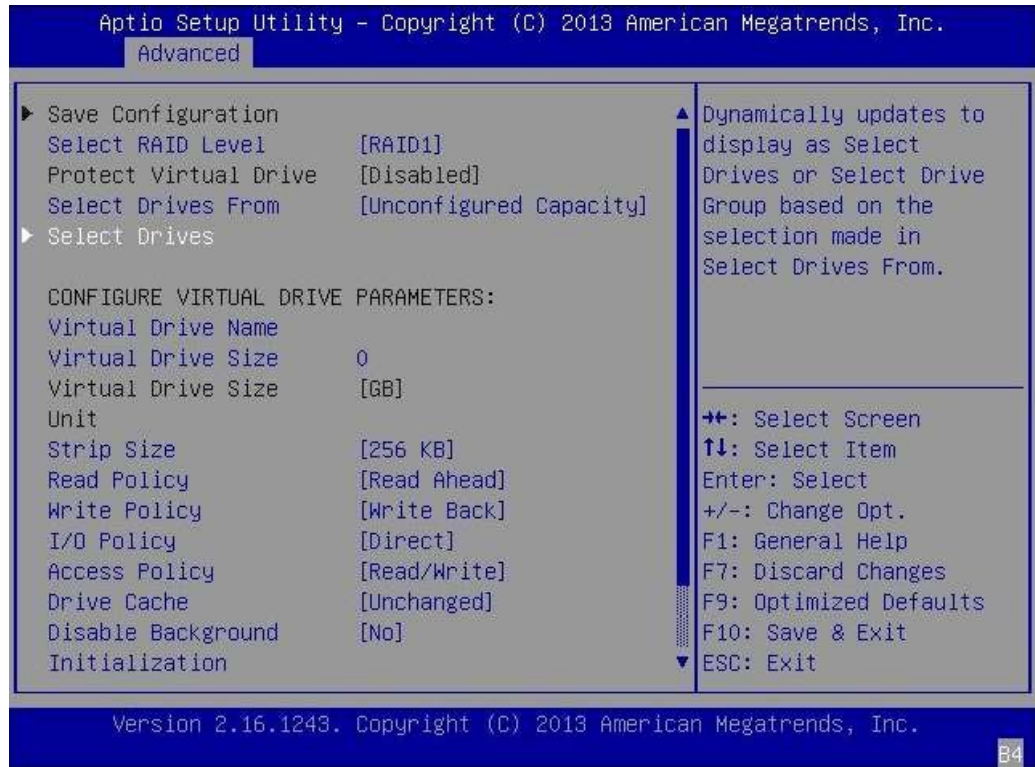


3. From the page that is displayed, navigate to the Select RAID Level field, press Enter to display the Select RAID Level popup window, choose the RAID level that you want, based on your requirements, and press Enter.

In the following example, the RAID 1 level is selected.

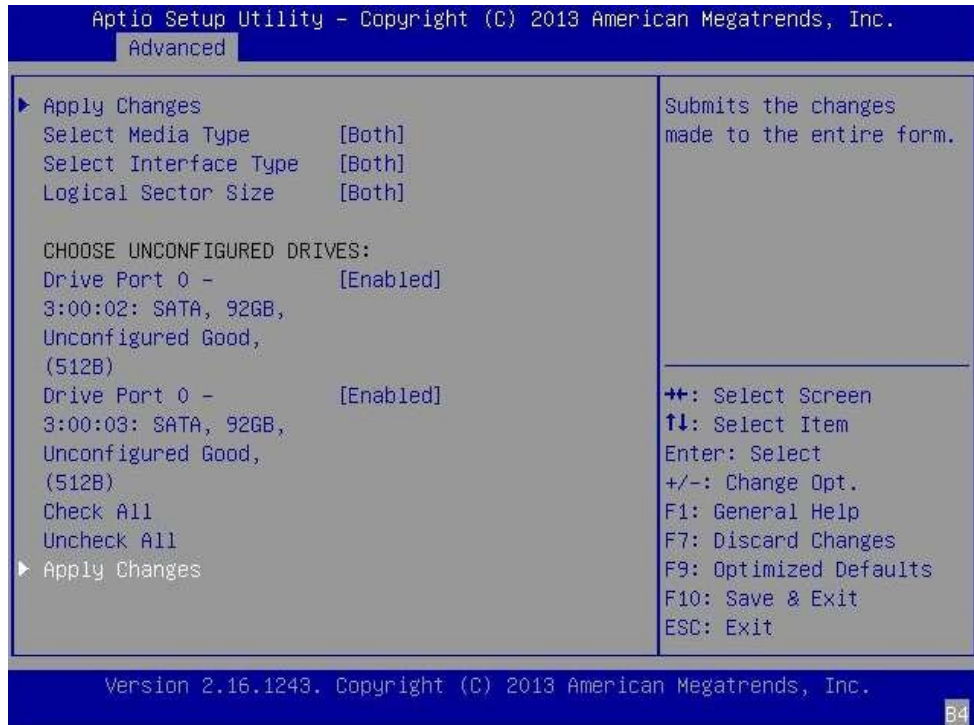


4. Use the arrow keys to navigate to the Select Drives field, and press Enter.



5. For each drive that you want in the RAID volume configuration, do the following:
 - a. Use the arrow keys to navigate to the drive.
 - b. Use the arrow keys to navigate to the Enabled or Disabled field associated with the drive, and press Enter.
 - c. From the popup window that is displayed, use the arrow keys to navigate to the Enabled field, and press Enter.

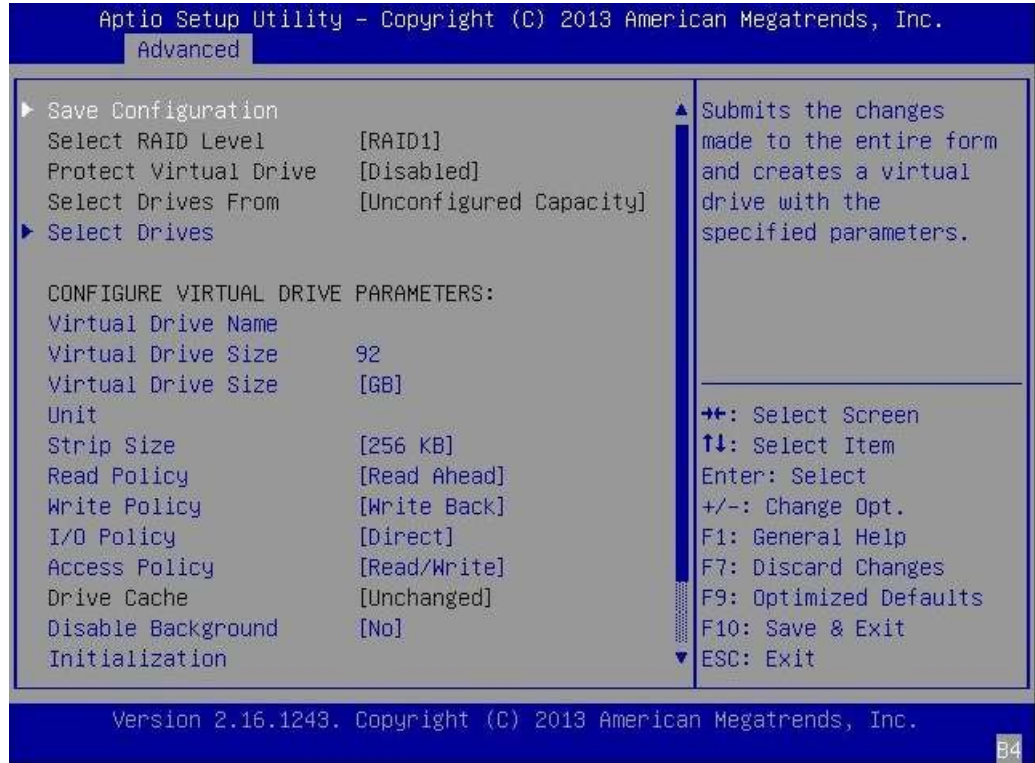
The drive is now listed as Enabled. In the following example, drives 2 and 3 are enabled.



6. **After you have enabled all the drives that you want to be part of the logical drive, use the arrow keys to navigate to the Apply Changes field on the same page, and press Enter.**

The logical drive is now created with the drives that you enabled, and the Confirmation page is displayed.

7. Press Enter on the Confirmation page to return to the Create Virtual Drive page.



8. Complete the steps in [“To Confirm the Logical Drive Creation \(x86\)” on page 38.](#)

▼ To Confirm the Logical Drive Creation (x86)

Before You Begin Before performing this procedure, verify the drives and their slots (see [“To Verify the Drives and Their Slots \(x86\)” on page 29](#)) and create a logical drive (see [“To Create a Logical Drive \(x86\)” on page 32](#)).

1. On the Create Virtual Drive page, optionally make any changes that you would like (such as defining a drive name), and press Enter at the Save the Configuration field to save the new configuration.

The Save Configuration confirmation page is displayed.



2. **Confirm the drive creation by doing the following:**
 - a. **Use the arrow keys to navigate to the Confirm field, and press Enter.**

- b. From the popup window, change the value of the Confirm field to Enabled, and press Enter.

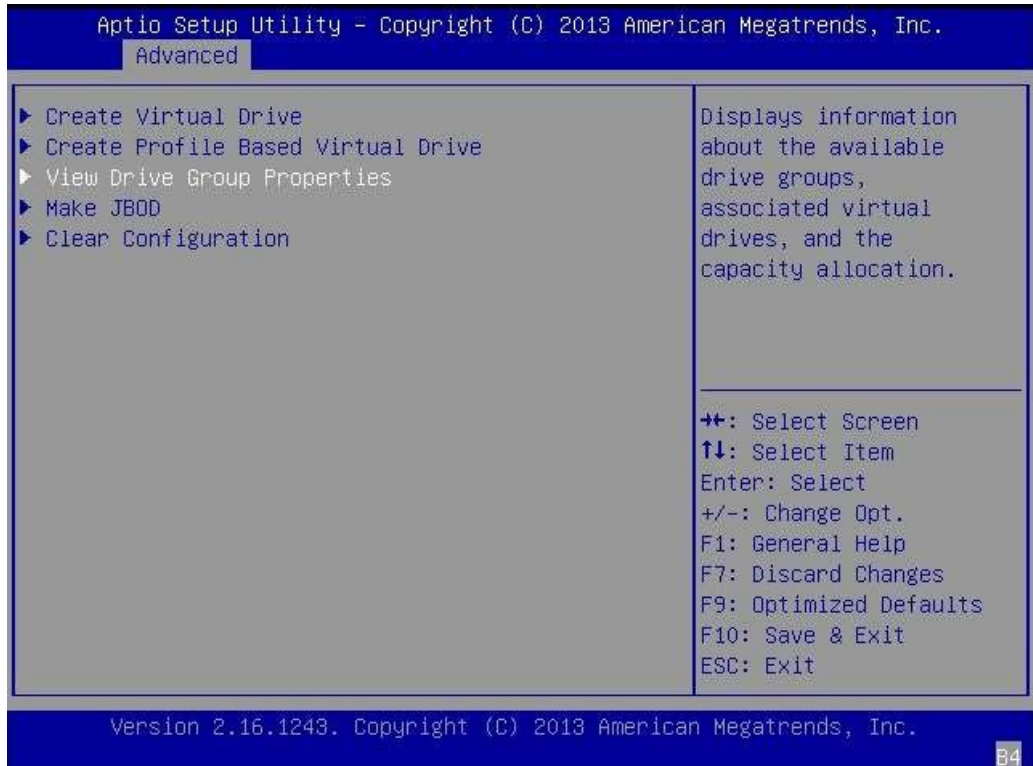


- c. Use the arrow key to navigate to the Yes field, and press Enter.



3. At the page that is displayed, press Enter to complete the virtual drive creation. A message is displayed, stating that the virtual drive creation was successful and that all free unconfigurable space has been used.

4. To verify that the logical drive (virtual drive) was created, press the Esc key to return to the Configuration Utility menu, use the arrow keys to navigate to the View Drive Group Properties menu option, and press Enter.



5. Review the logical drive information on the page that is displayed.

In the following example, Drive Group 2, Virtual Drive 4 has been created.

```

Aptio Setup Utility - Copyright (C) 2013 American Megatrends, Inc.
  Advanced
-----
Drive Group          Drive Group #0          Displays associated
Capacity Allocation  [Virtual Drive 0:      virtual drives for the
                    OL65_BIOS, RAID0,    drive group and any
                    200GB, Optimal]  available free capacity.
Protected           No
Drive Group          Drive Group #1
Capacity Allocation  [Virtual Drive 3:      chorne_S12_UEFI,
                    RAID0, 278GB, Optimal]
Protected           No
Drive Group          Drive Group #2
Capacity Allocation  [Virtual Drive 4:      RAID1, 92GB, Optimal]
Protected           No
-----
++: Select Screen
↑↓: Select Item
Enter: Select
+/-: Change Opt.
F1: General Help
F7: Discard Changes
F9: Optimized Defaults
F10: Save & Exit
ESC: Exit
-----
Version 2.16.1243. Copyright (C) 2013 American Megatrends, Inc.
  B4

```

6. **Exit the BIOS Setup Utility and reboot to install an OS on that logical drive or to manipulate the boot drive.**

For information about verifying the label of the newly created logical drive, see [“To Verify That the Label of a Logical Drive Is Valid”](#) on page 44.

For information about installing the Oracle OS, see [“Installing the Oracle Solaris OS”](#) on page 46.

Validating the Label of the HBA Logical Drive

With this HBA, no drives will be visible to the OS until you have created at least one logical drive. This section describes how to verify that the logical drive you created for the HBA has a

valid Oracle Solaris label, and therefore can be recognized by the OS. Sometimes, logical drives need to be relabeled using the `format` command (for SPARC systems) or the `fdisk` command (for x86 systems) in order to be recognized.

▼ To Verify That the Label of a Logical Drive Is Valid

Note - For your reference, this section provides an example procedure for a SPARC system that runs the Oracle Solaris OS. For an x86 system that runs the supported OS, you would use the `fdisk` command for that OS to verify the label of a disk. For more information about labeling disks using the `fdisk` command, see the documentation for your OS.

1. Become a root user and issue the `format` command.

```
# format
Searching for disks...done
AVAILABLE DISK SELECTIONS:
 0. c1t0d0 <DEFAULT cyl 24611 alt 2 hd 27 sec 107>
   /pci@0,0/pci1022,7450a/pci17c2,10@4/sd@0,0
 1. c1t1d0 <DEFAULT cyl 24810 alt 2 hd 27 sec 107>
   /pci@0,0/pci1022,7450a/pci17c2,10@4/sd@1,0
 2. c3t8d0 <DEFAULT cyl 24619 alt 2 hd 27 sec 107>
   /pci@0,0/pci1022,7450b/pci1000,10c0@1,1/sd@8,0
 3. c3t9d0 <DEFAULT cyl 24619 alt 2 hd 27 sec 107>
   /pci@0,0/pci1022,7450b/pci1000,10c0@1,1/sd@9,0
 4. c3t10d0 <DEFAULT cyl 24619 alt 2 hd 27 sec 107>
   /pci@0,0/pci1022,7450b/pci1000,10c0@1,1/sd@a,0
 5. c3t11d0 <DEFAULT cyl 24619 alt 2 hd 27 sec 107>
   /pci@0,0/pci1022,7450b/pci1000,10c0@1,1/sd@b,0
 6. c3t12d0 <DEFAULT cyl 24619 alt 2 hd 27 sec 107>
   /pci@0,0/pci1022,7450b/pci1000,10c0@1,1/sd@c,0
 7. c3t13d0 <DEFAULT cyl 24619 alt 2 hd 27 sec 107>
   /pci@0,0/pci1022,7450b/pci1000,10c0@1,1/sd@d,0
Specify disk (enter its number):
```

2. When prompted, type the number of the disk drive that is attached to the HBA card you just installed, and press `Enter`.

The Format menu is displayed.

```
# format
Searching for disks...done
AVAILABLE DISK SELECTIONS:
```

```

0. c1t0d0 <DEFAULT cyl 24611 alt 2 hd 27 sec 107>
  /pci@0,0/pci1022,7450@a/pci17c2,10@4/sd@0,0
1. c1t1d0 <DEFAULT cyl 24810 alt 2 hd 27 sec 107>
  /pci@0,0/pci1022,7450@a/pci17c2,10@4/sd@1,0
2. c3t8d0 <DEFAULT cyl 24619 alt 2 hd 27 sec 107>
  /pci@0,0/pci1022,7450@b/pci1000,10c0@1,1/sd@8,0
3. c3t9d0 <DEFAULT cyl 24619 alt 2 hd 27 sec 107>
  /pci@0,0/pci1022,7450@b/pci1000,10c0@1,1/sd@9,0
4. c3t10d0 <DEFAULT cyl 24619 alt 2 hd 27 sec 107>
  /pci@0,0/pci1022,7450@b/pci1000,10c0@1,1/sd@a,0
5. c3t11d0 <DEFAULT cyl 24619 alt 2 hd 27 sec 107>
  /pci@0,0/pci1022,7450@b/pci1000,10c0@1,1/sd@b,0
6. c3t12d0 <DEFAULT cyl 24619 alt 2 hd 27 sec 107>
  /pci@0,0/pci1022,7450@b/pci1000,10c0@1,1/sd@c,0
7. c3t13d0 <DEFAULT cyl 24619 alt 2 hd 27 sec 107>
  /pci@0,0/pci1022,7450@b/pci1000,10c0@1,1/sd@d,0
Specify disk (enter its number): 2
selecting c3t8d0
[disk formatted]

```

3. Type **q** at the two prompts to quit the test and the Format menu.

```

analyze> q
FORMAT MENU:
  disk - select a disk
  type - select (define) a disk type
  partition - select (define) a partition table
  current - describe the current disk
  format - format and analyze the disk
  fdisk - run the fdisk program
  repair - repair a defective sector
  label - write label to the disk
  analyze - surface analysis
  defect - defect list management
  backup - search for backup labels
  verify - read and display labels
  save - save new disk/partition definitions
  inquiry - show vendor, product and revision
  scsi - independent SCSI mode selects
  cache - enable, disable or query SCSI disk cache
  volname - set 8-character volume name
  !<cmd> - execute <cmd>, then return
  quit
format> q
#

```

Next Steps

If you are installing the HBA in a SPARC system, install the Oracle Solaris OS, as described in [“Installing the Oracle Solaris OS” on page 46](#).

If you are installing the HBA in an x86 system, install a supported OS (for a list of supported operating systems, see [“Operating System and Technology Requirements” on page 12](#)). If you plan to install the Oracle Solaris OS on a system, follow the instructions in [“Installing the Oracle Solaris OS” on page 46](#).

Installing the Oracle Solaris OS

You can install the Oracle Solaris 11.4 with SRU 16, at minimum, on the bootable drive that you created or imported, as described in this chapter. This section provides the following procedures:

- [“To Prepare to Install the Oracle Solaris OS” on page 46](#)
- [“To Install the Oracle Solaris OS” on page 46](#)

▼ To Prepare to Install the Oracle Solaris OS

- Create a bootable drive upon which to install the Oracle Solaris OS, as described in this chapter.

▼ To Install the Oracle Solaris OS

1. **Obtain the Oracle Solaris 11.4 OS, at minimum, from the Oracle download site:**
<http://www.oracle.com/technetwork/server-storage/solaris11/overview/index.html>
2. **Perform a normal installation, as described in Oracle's Solaris 11.4 installation documentation.**
3. **Obtain the latest SRUs for the Oracle Solaris 11.4 OS, as required for your hardware platform. The HBA requires SRU 16, at minimum, to work on x86 systems with the Oracle Solaris 11.4 OS.**

You can obtain these Oracle Solaris SRUs at the My Oracle Support web site:

<https://support.oracle.com>

4. Reboot the system.

reboot

The system can now see, and boot from, the RAID volume on which you installed the Oracle Solaris OS.

Next Steps

Continue with the HBA installation, as described in [“To Complete the Installation” on page 19](#).

HBA Software Installation

After you have completed the HBA hardware installation and powered on the system, follow the instructions in this chapter to install any HBA utilities, firmware, and operating system (OS)-specific drivers, in that order, that might be required by the HBA.

Note - Software listed in this chapter as being located at the Oracle designated web site will only be available at the web site if required by the HBA.

This chapter contains the following topics:

- [“Installing the Utility for BIOS and Firmware Updates and RAID Configuration” on page 49](#)
- [“Installing Diagnostic Software” on page 50](#)
- [“Installing Drivers” on page 51](#)

Installing the Utility for BIOS and Firmware Updates and RAID Configuration

The HBA can be configured for RAID levels 0, 1, 5, 6, 10, 50, and 60. Use the StorCLI RAID configuration utility, a command-line interface (CLI) utility, to create RAID volumes for the HBA. You can also use the StorCLI utility to update the BIOS and firmware for the HBA. The utility provides support for the following functions:

- Discover local and remote hosts, HBAs, targets, and LUNs
- Reset HBAs
- Set HBA driver parameters
- Update firmware
- Enable or disable the system BIOS
- Run diagnostic tests on HBAs
- Manage out-of-band HBAs
- Manage local and in-band remote HBAs

The StorCLI utility, and its associated documentation, are available for download at the Oracle designated web site:

<https://www.broadcom.com/support/oem/oracle/>

Installing Diagnostic Software

This section contains the following topics:

- “Diagnostic Support for the Oracle Solaris OS” on page 50
- “Diagnostic Support for All Other Supported Operating Systems” on page 50

Diagnostic Support for the Oracle Solaris OS

In an Oracle Solaris OS environment, diagnostic support for the HBA is included in the Oracle VTS software. The Oracle VTS software is available for download at: <https://support.oracle.com/>

For information about the Oracle VTS software, see the Oracle VTS documentation at: <http://docs.oracle.com/cd/E19719-01/index.html>

The Oracle VTS software supports the following functions:

- Connectivity verification
- Firmware version and checksum test
- Self-test
- Loopback tests
 - External
 - Internal, single-bit
 - Mailbox

Diagnostic Support for All Other Supported Operating Systems

Diagnostic support for the HBA with all supported operating systems other than the Oracle Solaris OS is available through the StorCLI command-line interface (CLI) utility. This utility supports the following functions:

- Connectivity verification
- FCode, EFI, and firmware version information
- Link status, including topology, data rate, and statistics
- Attached devices list
- Firmware update utilities

▼ To Install Diagnostic Support Utilities for Supported OSES Other Than the Oracle Solaris OS

1. **Go to the Emulex (now Broadcom) support site for Oracle at:**
<https://www.broadcom.com/support/oem/oracle/>
2. **Click the type of HBA, and then click the model number of the HBA for which you want to install diagnostic software.**
3. **In the Utilities section, click the diagnostic support utility for the OS that you want, and download the diagnostic utility to a local file system.**
4. **Install the diagnostic utility as described in the Emulex documentation, located on the Emulex web site: <https://www.broadcom.com/support/oem/oracle/>**

Installing Drivers

This section contains the following topics:

- [“Installing Drivers For the Oracle Solaris OS” on page 51](#)
- [“Installing Drivers For All Other Supported Operating Systems” on page 52](#)

Installing Drivers For the Oracle Solaris OS

The latest driver (lsrc) for this HBA is included as part of the Oracle Solaris 11.4 OS with SRU 16, if the Oracle Solaris OS is ordered. You can obtain the latest version of the Oracle Solaris OS at:

<http://www.oracle.com/technetwork/server-storage/solaris11/overview/index.html>

You can obtain the latest Oracle Solaris SRUs at the My Oracle Support web site:

<https://support.oracle.com>

Before downloading any SRUs, install the utilities and then the firmware, in that order, for the HBA.

▼ Installing Drivers For All Other Supported Operating Systems

If drivers for specific operating systems are required by the HBA, the drivers will be available for download at the Emulex (now Broadcom) support site for Oracle. Before installing any drivers, install the utilities and then the firmware, in that order, for the HBA. For more information about installing utilities and firmware, see “[Installing the Utility for BIOS and Firmware Updates and RAID Configuration](#)” on page 49.

1. **After installing the utilities and the latest firmware for the HBA, go to the Emulex (now Broadcom) support site for Oracle at:**
<https://www.broadcom.com/support/oem/oracle/>
2. **Click the type of HBA, and then click the model number of the HBA for which you want to install a driver.**
3. **In the Driver section, click the OS driver that you want, and download the driver files to a local file system.**
4. **Install the driver for OS, as described in the Emulex documentation, located on the Emulex web site:**<https://www.broadcom.com/support/oem/oracle/>

Important Information and Known Issues

This chapter provides supplementary and workaround information for the HBA. Specific bug identification numbers are provided for service personnel.

This chapter contains the following topics:

- [“Usable Capacity Reduction Is Possible Only With a RAID Level Migration” on page 53](#)
- [“Mixing Drive Types on the HBA Might Cause Slow Repair of a Degraded Logical Drive” on page 53](#)
- [“HBA Product Accessibility” on page 54](#)
- [“Diversity and Inclusion ” on page 57](#)

Usable Capacity Reduction Is Possible Only With a RAID Level Migration

Bug ID: 30706613

Issue: Removing a drive from any redundant RAID level forces that RAID volume into a degraded state. You can only remove a redundant RAID level drive, such as a RAID 5 drive, in conjunction with a RAID level migration.

Workaround: None. This is expected behavior of RAID volumes.

Mixing Drive Types on the HBA Might Cause Slow Repair of a Degraded Logical Drive

Bug ID: 26220425

Issue:

When mixing both solid state drives (SSDs) and hard disk drives (HDDs) on the HBA, global hot spares are used to repair degraded logical drives, regardless of the drive type (SSD or HDD). This behavior occurs due to the importance of fixing a degraded logical drive over preserving performance-related rules on drive mixing. Therefore, if the only global hot spare available is a different drive type from a degraded logical drive, it might result in using a slower drive to repair that degraded logical drive.

Workaround:

Use dedicated hot spares tied to logical drives that match the drive type: SSD or HDD

HBA Product Accessibility

Oracle strives to make its products, services, and supporting documentation usable and accessible to the disabled community. To that end, products, services, and documentation include features that make the product accessible to users of assistive technology.

For more information about Oracle's commitment to accessibility, go to <http://www.oracle.com/us/corporate/accessibility/index.html>.

HBA Hardware Accessibility

Oracle Storage 12 Gb SAS PCIe RAID HBA, Internal: 16 Port and 2 GB Memory Oracle Storage 12 Gb SAS PCIe RAID HBA, Internal: 16 Port and 2 GB Memory hardware has color-coded labels, component touch points, and status indicators (LEDs) that provide information about the system. These labels, touch points, and indicators can be inaccessible features for sight-impaired users. The product's HTML documentation provides context and descriptive text available to assistive technologies to aid in interpreting status and understanding the system.

You can also use the built-in Oracle Integrated Lights Out Manager (ILOM) to obtain information about the system. Oracle ILOM provides a browser-based interface (BUI) and a command-line interface (CLI) that support assistive technologies for real-time viewing of system status, indicator interpretation, and system configuration. For details, see [Broken Link \(Target ID: GSCYR\)](#).

Oracle ILOM Accessibility

You can use the Oracle ILOM BUI to monitor and manage the server hardware. The Oracle ILOM BUI does not require a special accessibility mode; rather, its accessibility features are

always available. The BUI was developed using standard HTML and JavaScript and its features conform to accessibility guidelines.

To navigate a BUI page and select items or enter commands, use standard keyboard inputs, such as the Tab key to go to a selection, or the up and down arrow keys to scroll through the page. You can use standard keyboard combinations to make menu selections.

For example, using the Oracle ILOM Open Problems BUI page, you can identify faulted memory modules (DIMMs) or processors (CPUs) that would otherwise be identified by a lighted LED indicator on the motherboard. Likewise, you can use the Oracle ILOM BUI to monitor the hardware power states that are also indicated by flashing LED indicators on the hardware.

The Oracle ILOM CLI is an alternative and equivalent way to access the Oracle ILOM BUI features and functionality. Because the operating systems that run on the Oracle server hardware support assistive technologies to read the content of the screen, you can use the CLI as an equivalent means to access the color-based, mouse-based, and other visual-based utilities that are part of the BUI. For example, you can use a keyboard to enter CLI commands to identify faulted hardware components, check system status, and monitor system health.

You can use the Oracle ILOM Remote Console Plus to access both a text-based serial console and a graphics-based video console that enable you to remotely redirect host server system keyboard, video, mouse, and storage devices. Note, however, that the Oracle ILOM Java Remote Console Plus does not support scaling of the video frame within the Java application. You need to use assistive technology to enlarge or reduce the content in the Java Remote Console Plus display.

As an alternative method to using the BIOS Setup Utility to configure BIOS settings, Oracle ILOM provides a set of configurable properties that can help you manage the BIOS configuration parameters on an Oracle x86 server. Using Oracle ILOM, you can do the following:

- Back up a copy of the BIOS configuration parameters to an XML file using the Oracle ILOM BUI.
- Edit the XML file using a standard XML editor. The BIOS XML tags correlate directly to the BIOS screen labels.
- Restore the XML file of the backed up or edited configuration parameters to BIOS.

The BUI and CLI methods for using Oracle ILOM are described in the accessible HTML documentation for Oracle ILOM at <http://www.oracle.com/goto/ilom/docs>.

BIOS Accessibility

When viewing BIOS output from a terminal using the serial console redirection feature, some terminals do not support function key input. However, BIOS supports the mapping of function keys to Control key sequences when serial redirection is enabled. Descriptions of the function key to Control key sequence mappings are provided in the product documentation, typically within the server Service Manual. You can navigate the BIOS Setup Utility by using either a mouse or keyboard commands.

As an alternative method of configuring BIOS settings using the BIOS Setup Utility screens, Oracle ILOM provides a set of configurable properties that can help you manage the BIOS configuration parameters on an Oracle x86 server. For more information, see [Broken Link \(Target ID: GSCYR\)](#).

BIOS information and its functions are typically documented in the Oracle Storage 12 Gb SAS PCIe RAID HBA, Internal: 16 Port and 2 GB Memory Service Manual or Installation Guide.

Documentation Accessibility

Documentation for Oracle hardware is provided in HTML and PDF formats. The HTML documents are accessible using standard operating system controls and assistive technology. PDF documents are also provided, but are not an accessible format. PDF documents are considered support documents because the PDF content is available in accessible HTML format.

Product documentation provides figures, other types of images, and screenshots that do not rely on color for interpretation. Within the figures, callouts indicate the referenced component information. The callouts are mapped within a table to provide text descriptions of the referenced parts of the figures. In addition, alternative text is provided for all tables and images that provides the context of the information and images.

Note that screen readers might not always correctly read the code examples in the documentation. The conventions for writing code require that closing braces should appear on an otherwise empty line. However, some screen readers might not always read a line of text that consists solely of a bracket or brace.

The documentation might contain links to web sites of other companies and organizations that Oracle does not own or control. Oracle neither evaluates nor makes any representations regarding the accessibility of these web sites.

You can access the accessible HTML documentation for Oracle Storage 12 Gb SAS PCIe RAID HBA, Internal: 16 Port and 2 GB Memory products at http://docs.oracle.com/cd/E87344_01/index.html.

Diversity and Inclusion

Oracle is fully committed to diversity and inclusion. Oracle respects and values having a diverse workforce that increases thought leadership and innovation. As part of our initiative to build a more inclusive culture that positively impacts our employees, customers and partners, we are working to remove insensitive terms from our products and documentation. We are also mindful of the necessity to maintain compatibility with our customers' existing technologies, and the need to ensure continuity of service as Oracle's offerings and industry standards evolve. Because of these technical constraints, our effort to remove insensitive terms is ongoing and will take time and external cooperation.

◆ ◆ ◆ **A P P E N D I X A**

HBA Specifications

This appendix contains the specifications for the HBA.

This appendix contains the following topics:

- [“Physical Dimensions” on page 59](#)
- [“Environmental Requirements” on page 59](#)
- [“Fault Tolerance” on page 60](#)

Physical Dimensions

The HBA card size is as follows:

- Height: 94.31 mm (2.731 inches)
- Length: 167.64 mm (6.6 inches)

Environmental Requirements

[Table 4, “HBA Environmental Requirements,” on page 59](#) lists the HBA environmental requirements.

TABLE 4 HBA Environmental Requirements

Specification	Operating	Non-Operating
Temperature	0° to 55° C, non-condensing	-40° C to 70° C, non-condensing
Humidity	10% to 90% RH, non-condensing, 27° C max wet bulb	93% RH, non-condensing, 38° C max wet bulb
Altitude	3000 m	12,000 m
Vibration	0.20 G in all axes swept for 5-500 Hz sine	1.0 G in all axes 5-500-5 Hz sine
Shock	5 G, 11 ms half-sine	30 G, 11 ms half-sine

Fault Tolerance

The following table lists the fault tolerance features for the HBA.

TABLE 5 Fault Tolerance Features

Specification	HBA Support
Support for SMART	Yes
Drive failure detection	Automatic
Drive rebuild using hot spares	Automatic
Parity generation and checking	Yes

Note - The Self Monitoring Analysis and Reporting Technology (SMART) detects up to 70 percent of all predictable drive failures. In addition, SMART monitors the internal performance of all motors, heads, and drive electronics.
