Sun Storage 16 Gb Fibre Channel PCIe Universal Host Bus Adapter, QLogic Installation Guide For HBA Model 7101674

Part No: E24460-10
October 2021

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Contents

Using This Documentation

- **Overview** – Describes how to troubleshoot and maintain the universal host bus adapter
- **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/E24651_01/index.html.

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♦ ♦ ♦ CHAPTER 1

Universal HBA Overview

This chapter provides a basic overview of Oracle's Sun Storage 16 Gb Fibre Channel (FC) PCIe Universal Host Bus Adapter (HBA), which is a low-profile, dual-port PCIe HBA that uses Marvell, formerly QLogic, technology. This chapter also describes the various operating systems, host platforms, storage, and infrastructure configurations that support the universal HBA, and lists the universal HBA environmental requirements.

This chapter contains the following sections:

Kit Contents

- Sun Storage 16 Gb Fibre Channel PCIe Universal Host Bus Adapter, QLogic, with a low-profile bracket installed
- Standard PCIe bracket
- *Accessing Documentation* document
- China RoHS Material Disclosure

Universal HBA Features and Specifications

Oracle's Sun Storage 16 Gb Fibre Channel (FC) PCIe Universal host bus adapter (HBA) (part number 7101674) is a standalone, PCIe low-profile universal HBA that uses Marvell, formerly

QLogic, technology. The HBA is considered universal because it is a configurable board that enables you to change its operating protocol mode from a two-port 16 Gb FC HBA to a two-port 10 GbE Fibre Channel over Ethernet (FCoE) Converged Network Adapter. The universal HBA has four possible configurations:

- **10 GbE FCoE Copper** — This configuration provides twin-ax copper cable connectivity and 10 GbE FCoE HBA functionality. No optical transceiver modules are installed in, nor provided with, this configuration of the universal HBA.
- **16 Gb FC SW (shortwave) Optical** — This configuration requires installing 16 Gb FC shortwave optical transceiver modules in the SFP+ connector of the universal HBA, enabling 16 Gb Fibre Channel HBA functionality.
- **10 GbE FCoE SR (short-range) Optical** — This configuration requires installing 10 GbE short-range optical transceiver modules in the SFP+ connectors of the universal HBA, enabling 10 GbE FCoE Converged Network Adapter functionality.
- **16 Gb FC LW (longwave) Optical**—This configuration requires installing 16Gb FC long-range optical transceiver modules in the SFP+ connectors of the universal HBA, enabling 16 Gb FC HBA functionality.

Note - If you are using the Universal HBA in an FCoE Converged Network Adapter configuration, keep in mind that Link Aggregation Control Protocol (LACP) cannot be used on the same port as FCoE or iSCSI.

Table 1, “Universal Host Bus Adapter Features and Specifications,” on page 12 lists the features and specifications of the universal HBA. For a list of supported operating systems, see Table 2, “Supported Operating System/Technology Versions (Minimum) ,” on page 14.

TABLE 1 Universal Host Bus Adapter Features and Specifications

Feature	Description
Form factor	Standard low-profile form factor
Connector types	Small form-factor pluggable plus (SFP+) cages that can be connected with twin-ax cabling from supported switch manufacturers (See “Switch Compatibility” on page 16), or can have the following transceivers: ■ SFP+ 16 Gb FC shortwave (part number 7101676) ■ SFP+ 10 GbE FCoE short-range (part number 7101678) ■ SFP+ 16 Gb FC longwave (part number 7101680)
PCIe specification compliance	PCI Express Base Specification Revision 3.0
Lanes	■ PCI Express Gen 2 x8 ■ PCI Express Gen 3 x4 (x8 Mechanical)
PCIe hot-plug and hot-swap functionality	Supported
Maximum power consumption	Approximately 24 Watts
Solaris Dynamic Reconfiguration	Supported
FCoE full offload in hardware	Supported

Feature	Description
Boot support	Fibre Channel, Fibre Channel over Ethernet, and Ethernet for all operating systems (See "Boot Support" on page 15)
Test suite	Provided by Oracle VTS software
Receive side scaling (RSS)	Supported
MSI-X	Supported
Fibre Channel support	■ Dual-port Fibre Channel with 16/8/4 auto negotiation ■ Topologies supported: FC-SW switched fabric (N_Port), FC-AL arbitrated loop (not supported at 16 Gb) (NL_ Port), and Point-to-point (N_Port) ■ Dual-port Fibre Channel over Ethernet
FC and FCoE compatibility	■ Fibre Channel Physical and Signaling (FC-PH, FC-PH2, FC-PH3) ■ Fibre Channel Generic Services (FC-GS-3) ■ Fibre Channel Framing and Signaling (FC-FS) ■ Fibre Channel Physical Interface (FC-Pl) ■ Fibre Channel Tape and Medium Changers (FC-Tape) ■ Fibre Channel Protocol for SCSI (FCP-3-SCSI) ■ Fibre Channel Switch Fabric (FC-SW-4) ■ Fibre Channel Protocol for SCSI Support (FC-FCP, FC-FCP2) ■ FMA support ■ FC and FCoE boot code for all supported operating systems **Note -** Link Aggregation Control Protocol (LACP) cannot be used on the same port as FCoE or iSCSI.
Ethernet and NIC support	Standard Ethernet and Enhanced Ethernet: ■ IEEE 802.1Q VLAN ■ IEEE 802.1p and 802.1D ■ IEEE 802.3x ■ IEEE 802.1Qbb ■ IEEE 802.1Qaz ■ DCBX CEE Rev 1.01 Controller hardware support: ■ Jumbo frames support for frame sizes of at least 9 KB ■ Hardware TCP/UDP checksum generation ■ Hardware IPv4/IPv6 checksum offload ■ Hardware large segmentation offload ■ Hardware Header and Data Split ■ Full-duplex operation is supported ■ Up to 128 MAC addresses ■ Unicast and multicast address filtering ■ VMware NetQueue ■ Packet filtering based on MAC address or VLAN tag ■ Microsoft receive side scaling (RSS) ■ NIC teaming

Feature	Description
	■ PCI hot-plug functionality ■ Pre-boot eXecution environment (PXE) boot ■ iSCSI boot

Operating System and Technology Requirements

The universal HBA requires the operating system (OS) and technology versions listed in Table 2, “Supported Operating System/Technology Versions (Minimum) ,” on page 14, at minimum.

TABLE 2 Supported Operating System/Technology Versions (Minimum)

Operating System/ Technology	Supported Versions (minimum)
Oracle Solaris OS	■ Oracle Solaris 10 1/13 for the x86 (64-bit) platform (+ patches 149168-07 and 149176-11) ■ Oracle Solaris 10 1/13 for the SPARC platform (+ patches 149167-07 and 149175-11) ■ Oracle Solaris 11.1 for the x86 (64-bit) platform (+ SRU 13.4) ■ Oracle Solaris 11.1 for the SPARC platform (+ SRU 13.4) ■ Oracle Solaris 11.2 for the x86 (64-bit) and SPARC platforms ■ Oracle Solaris 11.3 for the x86 (64-bit) and SPARC platforms ■ Oracle Solaris 11.4 for the x86 (64-bit) and SPARC platforms with SRU 16 To obtain the latest patches and SRUs, go to: `https://support.oracle.com`
Oracle Linux OS	■ 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
SUSE Linux OS	■ SUSE Linux Enterprise Server (SLES) 10 SP4 ■ SLES 11 SP2
Red Hat Linux OS	■ Red Hat Enterprise Linux (RHEL) 5.89 (64-bit) ■ RHEL 6.4 (64-bit)
Microsoft Windows OS	■ Window Server 2019 ■ Windows Server 2016 ■ Windows Server 2012 ■ Windows Server 2008 SP2+ (64-bit) ■ Windows Server 2008 R2 including SP1 (64-bit)
VMware technology	■ VMware ESXi 6.5 U1 ■ VMware ESX/ESXi 5.1 ■ VMware ESX/ESXi 5.0

Boot Support

FC SAN and FCoE SAN booting through the universal HBA is supported, as listed in Table 3, “Universal HBA Boot Support,” on page 15.

TABLE 3 Universal HBA Boot Support

Operating System/Technology	FC SAN Boot Support	FCoE SAN Boot Support
Oracle Solaris 10 1/13	Yes	No
Oracle Solaris 11.1, 11.2, 11.3, 11.4	Yes	No
Oracle Linux 5.9 and later	No	No
Oracle Linux 6.4 and later	No	No
RHEL 5.9 and later	Yes†	Yes†
RHEL 6.4 and later	Yes†	Yes†
SLES 10 SP4 and later	Yes†	Yes†
SLES 11 SP2 and later	Yes†	Yes†
Windows Server 2008 SP2+	Yes†	Yes†
Windows Server 2008 R2	Yes†	Yes†
Windows Server 2012 and later	Yes†	Yes†

†While using the Driver Update disk during the installation process. Driver Update is available at the Oracle support area of the Marvell, formerly QLogic, web site: http://driverdownloads.qlogic.com/QLogicDriverDownloads_UI/Oracle_Search.aspx

System Interoperability

This section provides information about platforms and switches that are compatible with the universal host bus adapter. This sections contains the following topics:

Host Platform Support

The universal HBA is supported by the platforms listed in Table 4, “Platform Support,” on page 16. For the most up-to-date information about supported platforms, see your system product notes and web pages.

For information about the supported OS/technology versions, see Table 2, “Supported Operating System/Technology Versions (Minimum) ,” on page 14.

TABLE 4 Platform Support

Platform	Supported OS/Technology
Oracle's SPARC Servers	
Fujitsu M10-1, M10-4, and M10-4S	Oracle Solaris
Fujitsu M10 PCI Expansion Unit	Oracle Solaris
SPARC T4-1 and T4-2	Oracle Solaris
SPARC T5-2, T5-4, and T5-8	Oracle Solaris
SPARC T7-1, T7-2, and T7-4	Oracle Solaris
SPARC M5-32 and M6-32	Oracle Solaris
SPARC M7-8 and M7-16	Oracle Solaris
SPARC 7-2 and 7-2L	Oracle Solaris
Oracle SuperCluster M6-32	Oracle Solaris
Oracle's x86 Servers	
Sun Server X4-2, X4-2L, X4-4, and X4-8	Oracle Solaris, Windows, Oracle Linux, VMware
Oracle Server X5-2, X5-2L, X5-4, and X5-8	Oracle Solaris, Windows, Oracle Linux, VMware
Oracle Server X6-2 and X6-2L	Oracle Solaris, Windows, Oracle Linux, VMware
Oracle Server X7-2, X7-2L, and X7-8	Oracle Solaris, Windows, Oracle Linux, VMware
Oracle Server X8-2, X8-2L, and X8-8	Oracle Solaris, Windows, Oracle Linux, VMware
Oracle Exalytics In-Memory Machine X4-4 and X5-4	Oracle Solaris, Windows, Oracle Linux, VMware
Zero Data Loss Recovery Appliance X4, X5, and X6	Oracle Solaris, Windows, Oracle Linux, VMware
Oracle's Telco Servers	
Netra SPARC T4-1	Oracle Solaris
Netra SPARC S7-2	Oracle Solaris
Netra X4270 M3	Oracle Solaris, Windows, Oracle Linux, VMware
Netra Server X3-2 and X5-2	Oracle Solaris, Windows, Oracle Linux, VMware

Switch Compatibility

Note - For technical support issues with any switches, refer to the product documentation or contact the switch manufacturer.

The universal HBA supports connecting to any 16 Gb/s Fibre Channel (FC) switch and all Fibre Channel Over Internet (FCoE) switches from any vendor that follows standard FC specifications, and follows 10GbE NIC/FCoE specifications, with the following considerations:

- Direct Access Storage for FC is supported with COMSTAR.
- FC-SW switched fabric is supported when the HBA is connected to a 16 Gb/s FC switch.

- FC point-to-point (FC-P2P) (N_Port) is supported.
- FC-AL is not supported at 16 Gb/s or faster.
- An FCoE-capable switch is always required for FCoE connections.

Note - This documentation lists switches that are specifically *not* supported by the universal HBA, when applicable.

Note - If you are using a switch to connect to the Universal HBA in CNA Operating Protocol Mode, keep in mind that Link Aggregation Control Protocol (LACP) cannot be used on the same port as FCoE or iSCSI.

Storage Support

This section lists the supported arrays and tape storage devices that can connect to the universal HBA through a supported switch (see "Switch Compatibility" on page 16). This section provides the following topics:

Array Storage Support

The universal HBA supports connecting to, via a supported switch, the following storage devices:

- Oracle ZFS Storage ZS3-2, ZS3-4, ZS3-BA, ZS4-4
- Oracle ZFS Storage Appliance Racked System ZS4-4
- Oracle ZFS Backup Appliance
- Oracle FS1-2 Flash Storage System
- Oracle's Sun Storage 2540 M2 Array
- Oracle's Sun Storage 6180 Array
- Oracle's Sun Storage 6540 Array
- Oracle's StorageTek 6580, 6780 with 8 Gbps FC host interface cards
- Oracle's Pillar Axiom 600 storage system
- Oracle's Sun Storage 7110, 7210, 7310, 7410 unified storage systems
- Oracle's Sun ZFS Storage 7120, 7320, 7420, 7720 appliances

Tape Storage Support

The universal HBA supports connecting to, via a supported switch, the following tape storage devices:

- Oracle's StorageTek SL24 Tape Autoloader
- Oracle's StorageTek SL48 Tape Library
- Oracle's StorageTek SL500 Modular Library
- Oracle's StorageTek SL3000 Modular Library
- Oracle's StorageTek SL8500 Modular Library
- Oracle's StorageTek Virtual Tape Library: VTL Value and VTL Value Plus
- Oracle's StorageTek T10000B, T10000C Tape Drives
- Oracle's StorageTek 9840C Tape Drive
- Oracle's StorageTek 9840D Tape Drive
- IBM LTO4
- IBM LTO5
- HP LTO4
- HP LTO5
- StorageTek Virtual Storage Manager 7

Environmental Requirements

The universal HBA environmental requirements are listed in Table 5, “Universal Host Bus Adapter Environmental Requirements,” on page 18.

TABLE 5 Universal Host Bus Adapter Environmental Requirements

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

♦ ♦ ♦ CHAPTER 2

Universal HBA Installation and Removal

This chapter describes how to install and remove the universal host bus adapter. Refer to your system installation or service manual for detailed instructions.

This chapter contains the following sections:

Observing ESD and Handling Precautions

Caution - Damage to the universal HBA can occur as the result of improper handling or electrostatic discharge (ESD). Always handle the universal HBA with care to avoid damage to the electrostatically 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 universal 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 universal HBA, and observe proper ESD grounding techniques.
- Hold the universal HBA by the edge of the printed circuit board (PCB), not the connectors or heatsink.
- Place the universal HBA on a properly grounded antistatic work surface pad when it is out of its protective antistatic bag.

First Time Setup

Table 6, “First Time Setup Tasks,” on page 20 lists the tasks, in the order in which the tasks must be performed, to set up a new universal HBA for the first time.

TABLE 6 First Time Setup Tasks

Task	Sections That Cover How to Do This
Prepare for hardware installation.	■ “Preparing for Installation” on page 20 ■ “To Replace the PCI Bracket” on page 23 ■ “Installing and Removing SFP+ Optical Transceiver Modules” on page 21 ■ “Best Practices For HBA Installation” on page 25
Install the universal HBA into the system.	“To Install the Universal HBA” on page 27
Connect the cables to the universal HBA.	■ “To Connect the Copper Cables” on page 28 ■ “To Connect the Optical Cables” on page 30
Apply power to the system, if needed.	“To Apply Power” on page 31
Determine the current operating protocol mode of the universal HBA.	“Determining and Changing the Current Operating Protocol Mode” on page 36

Preparing for Installation

If you choose to configure the universal HBA so that the HBA is connected to SFP+ optical transceiver modules (see “Universal HBA Features and Specifications” on page 11), you must install the optical transceiver modules before you install the universal HBA into the system.

If you choose to configure the universal HBA using the 10 GbE FCoE Copper configuration, however, you do not need to perform the steps in “Installing and Removing SFP+ Optical Transceiver Modules” on page 21.

This section explains how to optionally replace the standard PCI bracket on the universal HBA, and describes how to install and remove an optical transceiver module. The section contains the following topics:

- “To Replace the PCI Bracket” on page 23.
- “Installing and Removing SFP+ Optical Transceiver Modules” on page 21.
- “Best Practices For HBA Installation” on page 25

Installing and Removing SFP+ Optical Transceiver Modules

This section describes how to install and remove SFP+ optical transceiver modules to and from the SFP+ cages on the universal HBA. You might need to perform these procedures if you want to replace the PCI bracket on the universal HBA (see "To Replace the PCI Bracket" on page 23), or if you want to change the configuration of the universal HBA (see "Universal HBA Features and Specifications" on page 11 and "Determining and Changing the Current Operating Protocol Mode" on page 36). After making these changes, you can install the hardware into the system, as described in "To Install the Universal HBA" on page 27.

This section contains the following topics:

▼ To Install an SFP+ Optical Transceiver Module

To change the configuration of the universal HBA, the first step is to connect an SFP+ optical transceiver module to one of the SFP+ cages of the universal HBA. The functionality of the universal HBA changes, based on the optical transceiver module that you install and based on your manual configuration (described in a later chapter). The supported transciever modules follow:

- **16 Gb FC SFP+ SW Optic Modules, QLogic** (Oracle part number: 7101676) – Enables 16 Gb FC HBA functionality.
- **10 GbE FCoE SR XCVR Modules, QLogic** (Oracle part number: 7101678) – Enables 10 GbE FCoE Converged Network Adapter functionality.
- **Sun Storage 16 Gb FC SFP+ LW Optic Modules, QLogic** (Oracle part number: 7101680) – Enables 16 Gb FC HBA functionality.

Note - Only supported transceiver modules are allowed. If invalid or unapproved transceivers are installed and the board is booted, unpredictable performance results could occur, and the board will no longer be supported until you replace the invalid transcievers with the supported transceivers.

Follow these guidelines whenever you install or remove an SFP+ module:

- Do not remove the dust plugs from the modules or the rubber caps from the fiber-optic cable until you are ready to connect the cable. The plugs and caps protect the module ports and cables from contamination and ambient light.

- Removing and installing an SFP+ module can shorten its useful life. Do not remove and insert any module more often than is absolutely necessary.
- To prevent ESD damage, follow the guidelines listed in “Observing ESD and Handling Precautions” on page 19.

If the SFP+ cages on the universal HBA are not empty, refer to“To Remove an SFP+ Optical Transceiver Module ” on page 22 for instructions on removing the modules or copper cables from the universal HBA. Then, follow the steps below to install each optical module in the universal HBA:

1. **Remove the SFP+ optical transceiver module from its packaging.**
2. **Remove the protective end cap.**
3. **Pull the locking handle into the full horizontal position until you feel the handle click into position.**
4. **Holding the SFP+ module by the edges, align the SFP+ module with the slot in the universal HBA and slide the module into the opening.**
5. **Applying even pressure at both corners of the SFP+ module, push the module until it is firmly seated in the slot.**

   You will hear a click when the module is firmly seated in the slot.
6. **Lift the locking handle up and push it closed to lock the SFP+ module in place.**

   If you do not plan to connect cables immediately, replace the dust covers or caps.

Note - If you pull the locking handle down when the optical transceiver module is installed, you must remove the module entirely and reinstall it. The handle operates an internal lock. Pulling the handle down can disconnect the optical transceiver module, even though it may appear to be connected.

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7. **Continue to “To Install the Universal HBA” on page 27.**

▼ To Remove an SFP+ Optical Transceiver Module

1. **Disconnect the optical cable from the SFP+ optical transceiver cage of the universal HBA.**
2. **Pull the locking handle down into the full horizontal position to unlock the module.**

3. **Grasp the module by both corners and pull the SFP+ module to disengage it from the SFP+ cage.**

4. **Pull the module out until it is free of the slot.**

5. **Insert a protective end cap into the optical cage of the SFP+ module.**

6. **Push the locking handle back into its vertical position.**

7. **Place the module in its original packaging, antistatic bag, or other protective environment.**

▼ To Replace the PCI Bracket

The universal host bus adapter (HBA) comes with a low-profile PCI bracket installed. This bracket is approximately 3.11 in. (7.9 cm) long. A standard mounting bracket, which is approximately 4.75 in. (12.06 cm), is provided in the ship kit box. You might need to perform the procedure in this section if the system in which you plan to install the universal HBA requires a standard mounting bracket.

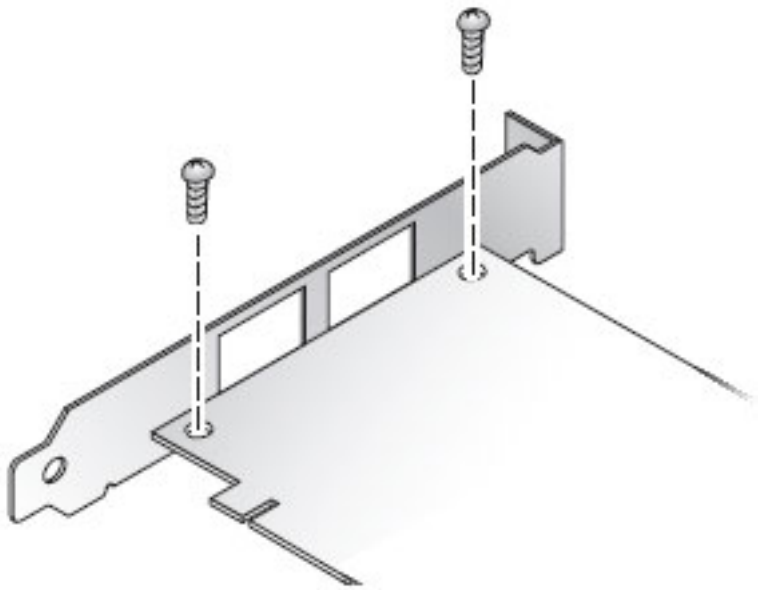
If you do not know which PCI bracket you need to install, refer to your system documentation.

1. **Attach an ESD strap to your wrist, as described in "Observing ESD and Handling Precautions" on page 19.**

2. **Remove all SFP+ modules from the universal HBA, if any are installed (for instructions, see "To Remove an SFP+ Optical Transceiver Module " on page 22).**

Caution - Replacement of SFP+ modules with supported modules from Oracle does not void the warranty. Replacement of SFP+ modules with non-Oracle supported modules will void the warranty or serviceability of the universal HBA.

3. **Remove the mounting bracket screws from the universal HBA.**



4. **Remove the bracket and store it for future use.**

5. **Align the mounting bracket tabs of the replacement bracket with the holes in the universal HBA.**

   Ensure that the LEDs are properly aligned with the holes in the bracket.

   Note - Do not to push the bracket past the grounding tabs of the transceiver housing.

6. **Replace the screws that attach the universal HBA to the bracket.**

7. **Reinstall the SFP module(s), if removed in earlier in this procedure (for instructions, see “To Install an SFP+ Optical Transceiver Module” on page 21).**

Best Practices For HBA Installation

Before installing the universal HBA into the system, review the best practices in this section to avoid potential issues:

General Best Practices

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

- Spread the I/O load amongst multiple HBAs and multiple ports to avoid bottlenecks and promote higher availability.
- Use fixed link speeds instead of auto-negotiation wherever possible. While the universal HBA supports auto-negotiation, auto-negotiation slows things down in the event of a fabric rebuild.
- Do not configure both tape devices and disks on the same universal HBA port, even if using a switch and zoning.
- If more than one of a given HBA model is present in the configuration, enable only the OpROM for the first HBA seen in the boot sequence. There is a limited amount of space for OpROMs, so do *not* unnecessarily enable all OpROMs, as space usage issues might occur.
- When installing the universal HBA, be sure to also install the latest version of the command-line utility available from the manufacturer's website (See "Installing the CLI for Updating the BIOS and FCode" on page 60). Keep the universal HBA utilities, firmware, and drivers up-to-date, and update them in that order.

Best Practices For Switches and Zoning

Follow these best practices for switches and zoning in your environment:

- FC-SW configurations: check with the switch manufacturer for optimal configuration recommendations, including zoning.
- Note that FC-AL is not supported at 16Gb/s or faster. Use FC-P2P instead.
- Use single initiator hard zoning to do the following:
  - Avoid Registered State Change Notification (RSCN) storms.
  - Shield devices from indiscriminate SCSI inquiries.

    - Provide security by avoiding inappropriate access.
- Use meaningful names for zones, and document the entire configuration.
- Use only FCP-2 (also called FC-TAPE or FCP Error Recovery) with tape and/or sequential devices. While FCP-2 might not cause problems for hard disk drives (HDDs), FCP-2 is a sequence-level error recovery mechanism that is irrelevant to HDDs.
- If using FC tape backups, place tape ports and backup servers on the same FC switch to avoid tying up inter-switch links (ISLs).
- SAN switches can be a major source of disruption if you do not take extreme care with respect to configuration. Do not perform updates to switch OSes and/or firmware, or enable new features on SAN switches, until you have first tried the updated switches in a test configuration. The universal HBA might not support newer switch features, and switch OS and/or firmware updates might require changes to, and/or restoration of, switch configuration settings.

Best Practices For Booting From SAN (BFS) Configurations

If you plan to install a Boot From SAN (BFS) HBA, follow these best practices:

- Use the QLogic Legacy BIOS to set up the boot LUN (HBA configuration and Selectable Boot Option in `Fast!Util` utility). Confirm that the BIOS loads and lists the correct LUN at the BIOS banner, as UEFI will use this same LUN.
- Some devices and operating systems do not yet support UEFI-based BIOS and can boot only from the Legacy BIOS boot mode. However, many servers with UEFI firmware allow you to enable a legacy BIOS compatibility mode.
- Legacy BIOS issues - many tweaks and patches have been added over the years to resolve various issues, and not all were done with the larger ecosystem (many different types of servers, HBAs, OSes, and so on) in mind.
- Secure Boot (a UEFI-specific feature) can help you control the boot process, preventing unauthorized code from running.
- Larger devices (>2TB) require the use of a GUID Partition Table (GPT) instead of a Master Boot Record (MBR). GPT is the standard for EFI; it can be implemented in legacy BIOSes, but it is more difficult to set up. Therefore, booting from LUNs >2TB in size is only supported with EFI. Booting from LUNs >2TB Is not supported with legacy BIOSes.
- Disable OpROM and BIOS for all HBA cards except the one connected to the boot device.
- When installing a Boot From SAN (BFS) HBA, configure a single connection to a single SAN target/LUN, install the boot OS, and get that working before installing other HBAs and storage. If the configuration is complex, finding the root cause for any BFS issues becomes far more complicated.
- Once BFS is installed and working, make sure the universal HBA driver and firmware are at the latest revision levels. If required, configure a multipath connection, and perhaps one or more alternate boot LUNs.

Best Practices For Testing the Environment

Test the storage enivornment by doing the following:

- Boot the OS on the host server, and then disable the primary path to the SAN boot device to validate the multipath connection.
- Physically pull the cable from the system.
- Intentionally disrupt zoning at the FC switch that you plan to attach to the universal HBA.
- If you have installed any alternate boot LUNs, try to boot from those (after disrupting the primary connection(s)).
- Make sure the boot LUN is set as the first boot device in the system BIOS/UEFI settings.

Installing the Hardware

Follow the procedures in this section to install the hardware:

- "To Install the Universal HBA" on page 27
- "Connecting the Cables" on page 28
- "To Apply Power" on page 31

▼ To Install the Universal HBA

1. **If the system in which you are installing the universal HBA is running the Oracle Solaris OS, install the two driver patches or SRU for your platform, as described in "Driver Software for the Oracle Solaris OS" on page 55.**
2. **Attach an ESD wrist strap to your wrist (see "Observing ESD and Handling Precautions" on page 19).**
3. **Refer to your system installation or service manual to determine an appropriate PCI Express slot in which to install the universal host bus adapter.**
4. **Refer to your system documentation to shut down, power off, and unplug the system, if required.**
5. **Remove the system case and the blank panel from an empty PCI Express slot.**
6. **Insert the universal HBA into an empty PCI Express x8 or larger slot.**

7. **Press down firmly on the universal HBA until the universal HBA is seated in its slot.**

8. **Secure the mounting bracket of the universal HBA to the case with the panel screw or clip.**

9. **Replace the system case and tighten the case screws.**

   The universal HBA is now installed and ready for the optical or copper cables to be connected (see "Connecting the Cables" on page 28).

Note - Do not power on the system until after you connect the cables.

Connecting the Cables

Attach the type of cable that is appropriate for the current configuration of the universal HBA:

- For the 10 GbE FCoE Copper configuration, install a twinax copper cable (refer to "To Connect the Copper Cables" on page 28).
- For the optical configuration, install an optical cable (refer to "To Connect the Optical Cables" on page 30).

▼ To Connect the Copper Cables

Note - This section applies only to the universal HBA in its 10 GbE FCoE Copper configuration. Copper cables only support CNA mode; they do not support FC Only mode. For all other configurations, see "To Connect the Optical Cables" on page 30 for instructions on connecting the optical cable.

When connecting a twin-ax copper cable to the universal HBA in the 10 GbE FCoE Copper configuration, be sure to use only SFP+ direct attach twin-ax cables that are supported by the switches listed in "Switch Compatibility" on page 16.

The following table lists cables that can be used with the universal HBA in the 10 GbE FCoE Copper configuration.

Brocade Part Number	Oracle Part Number	Cable Description
SN-TWX-0101	SG-XSWBROSFP+1MIPK	Brocade Twinax, 1 meter, 1 pack, SN
SN-TWX-0108	SG-XSWBROSFP+1M8PK	Brocade Twinax, 1 meter, 8 pack, SN

Brocade Part Number	Oracle Part Number	Cable Description
SN-TWX-0301	SG-XSWBROSFP+3M1PK	Brocade Twinax, 3 meter, 1 pack, SN
SN-TWX-0308	SG-XSWBROSFP+3M8PK	Brocade Twinax, 3 meter, 8 pack, SN
SN-TWX-0501	SG-XSWBROSFP+5M1PK	Brocade Twinax, 5 meter, 1 pack, SN
SN-TWX-0508	SG-XSWBROSFP+5M8PK	Brocade Twinax, 5 meter, 8 pack, SN

Note - It is not necessary to power down the system before disconnecting or connecting a copper cable. The universal HBA supports hot-plug capability.

You can connect one or two approved copper cables to the universal HBA. Perform the following steps for each copper cable that you connect to the universal HBA:

1. **Insert one end of the copper cable into an empty SFP+ cage on the universal HBA.**

   Confirm that the cable is fully inserted and engaged.

   The following figure shows how to connect the universal HBA with copper cables (one cable per port).

2. **Insert the other end of the copper cable into an empty SFP+ cage on a supported switch.**

Note - Link Aggregation Control Protocol (LACP) cannot be used on the same port as FCoE or iSCSI.

3. **Follow the procedures in Chapter 3, "Operating Protocol Mode Configuration" to determine the current operating protocol mode of the universal HBA, and to then configure the system software to recognize that operating mode.**

4. **If the system is powered down, apply power to the system, as described in "To Apply Power" on page 31.**

▼ To Connect the Optical Cables

Note - This section applies only to universal HBA configurations that use optical transceiver modules. If the universal HBA is configured in the 10 GbE FCoE Copper configuration, see "To Connect the Copper Cables" on page 28.

When connecting an optical cable to the universal host bus adapter, be sure to use multi-mode fiber-optic cable, intended for short-wave lasers, that adheres to the specifications listed in Table 1, "Universal Host Bus Adapter Features and Specifications," on page 12 in "Universal HBA Features and Specifications" on page 11 for short wave or short-range optical module configurations.

You can connect one or two optical cables to the universal HBA. Perform the following steps for each optical cable that you connect to the universal HBA:

1. **Connect one end of the fiber-optic cable to an LC connector on the universal HBA.**

   The following figure shows how to connect two fiber-optic cables to the dual-port HBA (one cable per port).

2. **Connect the other end of the cable to a supported switch or storage device.**

Note - It is not necessary to power down the system before disconnecting or connecting an optical cable. The universal HBA supports hot-plug capability.

Note - Link Aggregation Control Protocol (LACP) cannot be used on the same port as FCoE or iSCSI.

3. **Follow the procedures in Chapter 3, "Operating Protocol Mode Configuration" to determine the current operating protocol mode of the universal HBA, and to then configure the system software to recognize that operating mode.**

4. **If the system is powered down, apply power to the system, as described in "To Apply Power" on page 31.**

▼ To Apply Power

Note - Before you apply power to the system, read Chapter 3, "Operating Protocol Mode Configuration", which describes how to change the operating protocol mode of the universal HBA. It is important to perform the steps in Chapter 3, "Operating Protocol Mode Configuration" prior to applying power to the system to prevent potential configuration errors.

If the system was powered down prior to installing the universal HBA, power it on as follows:

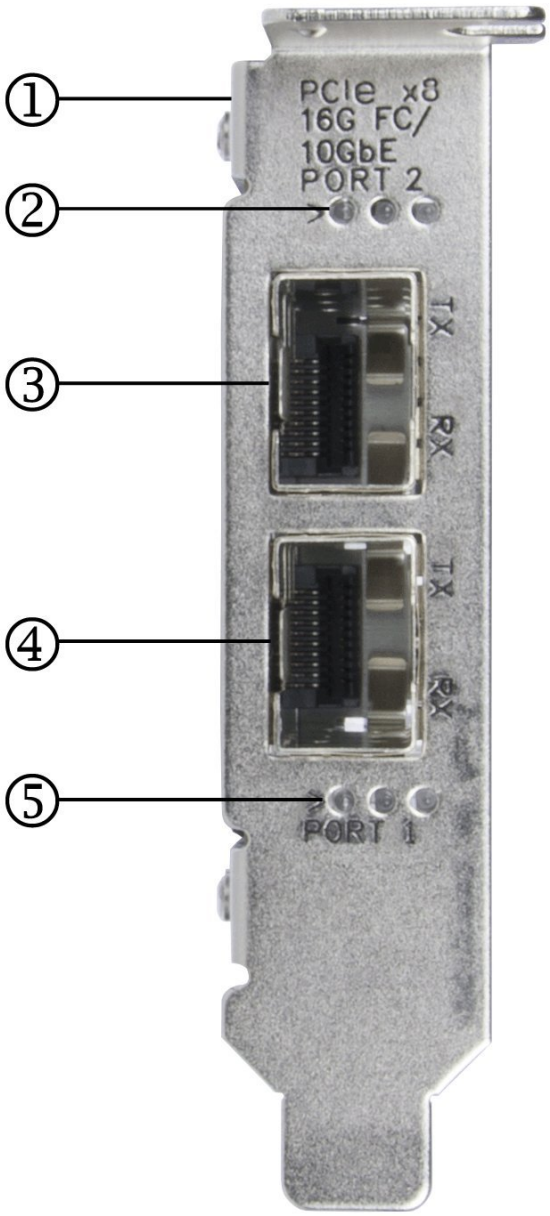
1. **Verify that the universal HBA is securely installed in the system.**

2. **Verify that the correct data cable is attached.**

3. **Refer to your system installation or service manual to determine how to power on the system.**

4. **Observe the light-emitting diode (LED) status (for 16 Gb, 8 Gb, or 4 Gb FC) to verify that the universal HBA is operating.**

The green LEDs can be seen through openings in the mounting bracket of the universal HBA.



Callout	Description
1	Low profile mounting bracket (standard)
2	Port 2 LEDs
3	Port 2 LC Connector
4	Port 1 LC Connector
5	Port 1 LEDs

Understanding LED Status Indicators

The Port 1 and Port 2 LED status indications vary depending on the operating protocol mode of the universal HBA (see “Determining and Changing the Current Operating Protocol Mode” on page 36):

- Table 7, “Universal Host Bus Adapter LED Status Indicators for CNA Mode,” on page 33 summarizes the LED status indications for CNA mode. The Mode, Activity, and Link LED columns in the table correspond to the LEDs in the figure from left to right.
- Table 8, “Universal Host Bus Adapter LED Status Indicators for Fibre Channel Only Mode ,” on page 33 summarizes the LED status indications for Fibre Channel (FC) Only mode. The 16 Gb, 8 Gb, and 4 Gb columns in the table correspond to the LEDs in the figure from left to right.

TABLE 7 Universal Host Bus Adapter LED Status Indicators for CNA Mode

Mode LED	Activity LED	Link LED	Activity
Off	Off	Off	Power off
On	Off	Off	Power on (no link)
On	On	On	Power on, 10 GbE link established, no activity
On	Flashing	On	10 GbE link established; transmit and receive Ethernet and/or storage activity
On	Slow flashing, alternating with Link LED	Slow flashing, alternating with Activity LED	Beaconing

TABLE 8 Universal Host Bus Adapter LED Status Indicators for Fibre Channel Only Mode

16 Gb FC LED (Amber)	8 Gb FC LED (Green)	4 Gb FC LED (Amber)	Activity
Off	Off	Off	Power off
On	On	On	Power on (before firmware initialization)

16 Gb FC LED (Amber)	8 Gb FC LED (Green)	4 Gb FC LED (Amber)	Activity
Flashing	Flashing	Flashing	Power on (after firmware initialization)
Flashing in sequence	Flashing in sequence	Flashing in sequence	Firmware fault
Off	Off	On or Flashing	4 Gb link established (on) and active (flashing)
Off	On or Flashing	Off	8 Gb link established (on) and active (flashing)
On or Flashing	Off	Off	16 Gb link established (on) and active (flashing)
Flashing	Off	Flashing	Beaconing

Removing the Hardware

The following instructions describe how to remove the universal HBA. Refer to your system installation or service manual for detailed removal instructions.

The following steps summarize the hardware removal process:

1. Halt the operating system and remove power from the system.
2. Remove the universal HBA hardware.

▼ To Remove the Universal Host Bus Adapter

1. **Attach an ESD strap to your wrist (see “Observing ESD and Handling Precautions” on page 19).**
2. **Refer to your system documentation to shut down, power off, and unplug the system.**
3. **Disconnect all cables.**
4. **Unscrew the case screws and remove the system case.**
5. **Remove the mounting bracket of the universal HBA from the system by unscrewing the panel screw or removing the clip, whichever is being used.**

   You can now remove the universal HBA.

♦ ♦ ♦ CHAPTER 3

Operating Protocol Mode Configuration

This chapter describes how to identify the current operating protocol mode of the universal HBA and how to change the universal HBA operating protocol mode, if needed. If you choose to change the HBA from its base version to another configuration, use the information in this chapter to manually configure the system to recognize the new operating protocol mode that corresponds to the configuration of the universal HBA. In addition, this chapter provides information about SR-IOV/FC-IOR support.

This chapter contains the following sections:

About the Operating Protocol Mode

The universal HBA has two operating protocol modes:

- Fibre Channel (FC) Only
- Converged Network Adapter (CNA) (or, FCoE)

The operating protocol mode determines how the system recognizes the universal HBA configuration that you choose to implement.

Whenever you change the configuration of the universal HBA, you must ensure that the correct operating protocol mode (FC Only or CNA) is associated with the new universal HBA configuration on the system. Table 9, "Required Adapter Operating Protocol Mode for Each Configuration," on page 35 shows the correct operating protocol mode that is associated with each configuration of the universal HBA.

TABLE 9 Required Adapter Operating Protocol Mode for Each Configuration

Universal HBA Configuration	Operating Protocol Mode
10 GbE FCoE Copper	CNA

Universal HBA Configuration	Operating Protocol Mode
16 Gb FC SW Optical	FC Only
10 GbE FCoE SR Optical	CNA
16 Gb FC LW Optical	FC Only

Note - Link Aggregation Control Protocol (LACP) cannot be used on the same port as FCoE or iSCSI.

Determining and Changing the Current Operating Protocol Mode

As described in "About the Operating Protocol Mode" on page 35, one of the two operating protocol modes (FC only, CNA) is associated with each universal HBA configuration. After you configure the universal HBA into one of the valid configuration options described in "Universal HBA Features and Specifications" on page 11, you must verify that the correct operating protocol mode is associated with the new universal HBA configuration.

If the correct operating protocol mode is associated with the current configuration of the universal HBA, you do not need to perform any further steps. Otherwise, you must manually change the operating protocol mode on the system to the correct mode.

To determine and change the operating protocol mode associated with your universal HBA configuration, use one of the following tools:

- BIOS utility for legacy x86 systems – See "To Determine and Change the Operating Protocol Mode Using the Fast!UTIL Utility" on page 37.
- UEFI utilty for x86 systems – See "To Determine and Change the Operating Protocol Mode Using the UEFI Setup Menus" on page 42.
- FCode for Oracle SPARC systems – See "To Determine and Change the Operating Protocol Mode Using the `FCode` Utility" on page 45.
- QLogic QConvergeConsole CLI management tool – See "To Determine and Change the Operating Protocol Mode Using the QConvergeConsole Interactive CLI" on page 47 .
- QLogic QConvergeConsole GUI management tool—See "To Determine and Change the Operating Protocol Mode Using the QConvergeConsole GUI" on page 50.

The information in this section is correct as of the July 2013 release. For the latest information, refer to the documentation for the management tool that you are using:

- BIOS Fast!UTIL utility (legacy x86 servers): `Readme` file

- UEFI (new x86 servers) – x86 server documentation
- FCode (Oracle SPARC servers) – `Readme` file
- QConvergeConsole GUI management tool – Online Help
- QConvergeConsole CLI management tool – *QConvergeConsole CLI User's Guide*, located at the QLogic web site.

Using the Fast!UTIL Utility to Determine and Change the Operating Protocol Mode

This section contains the following topics:

▼ To Determine and Change the Operating Protocol Mode Using the Fast!UTIL Utility

This procedure describes how to determine and change the operating protocol mode of the universal HBA using the BIOS Fast!UTIL utility on legacy x86 systems.

1. **During system power-on initiation, press `Ctrl-Q`.**

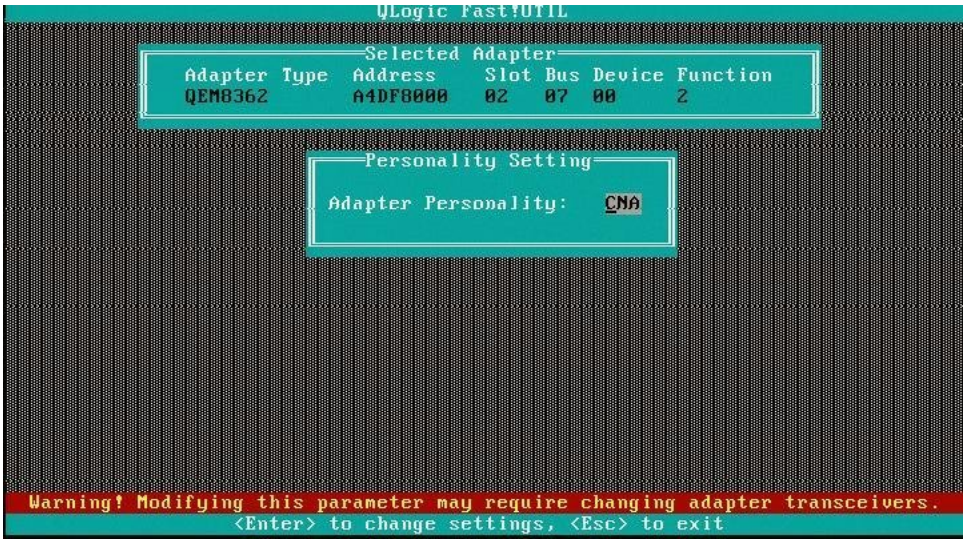
The QLogic *Fast!*UTIL menu appears, as shown in the following two figures.

2. **When the Fast!UTIL utility begins, select the universal HBA.**

3. **From the Options menu, select `Personality Setting`, and then press Enter.**

4. **The current operating protocol mode of the universal HBA (either FC or CNA) is displayed.**

If the current operating protocol mode is correct, skip to step 6. If the current operating protocol mode is incorrect, continue to step 5.



5. **Press Enter to change the operating protocol mode (The Enter key toggles the operating protocol mode between FC and CNA.), or press the Esc key to keep the displayed mode.**

   If you set the operating protocol mode to CNA, and you plan to Preboot Execution Environment (PXE) boot, you must manually enable PXE booting. For more information, go to "To Configure PXE Booting" on page 41

6. **Press the Esc key to exit the Setup Menu, and then reboot the system.**

▼ To Configure PXE Booting

If you have set the operating protocol mode of the Universal HBA to CNA, and you plan to use the HBA as your PXE boot device, you must follow the instructions in the BIOS Fast!UTIL utility *Readme* file to configure PXE booting. This procedure describes how to access the BIOS Fast!UTIL utility *Readme* file in order to configure PXE:

1. **Go to the Oracle support area of the QLogic Web site at:**

   `http://driverdownloads.qlogic.com/QLogicDriverDownloads_UI/Oracle_Search.aspx`

2. **From the guided search selection boxes, choose the following:**

   - First box – Converged Network Adapters
   - Middle box – 7101674
   - Last box - The operating system used by your system.

3. **Click Go.**

4. **From the page that is displayed, scroll down to the Boot Code table and click Multi-boot Image for Universal HBA.**

   An End User Software License Agreement is displayed.

5. **Review the End User Software License Agreement, and click I Agree.**

   The multi-boot image `.zip` file is downloaded to your system.

6. **After the download is completed, navigate to the location of the `.zip` file on your system, and extract the files from the `.zip` file.**

   You can now access the directories and files, including a PXE directory, from the `.zip` file.

7. **Navigate to the PXE directory, and double-click on the `Readme.txt` file to open the file.**

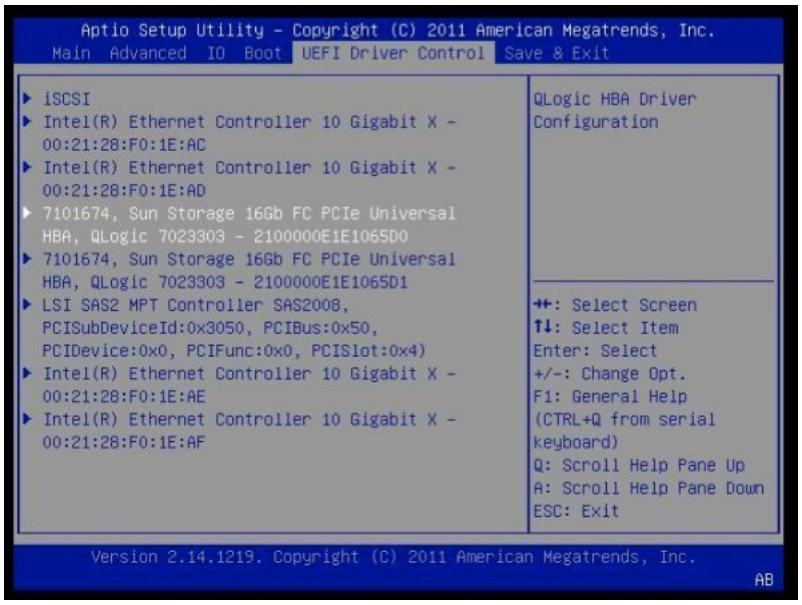
8. **Follow the procedure in the System Configuration section of the `Readme.txt` file.**

▼ To Determine and Change the Operating Protocol Mode Using the UEFI Setup Menus

This procedure describes how to determine and change the operating protocol mode of the universal HBA using the UEFI utility on x86 systems:

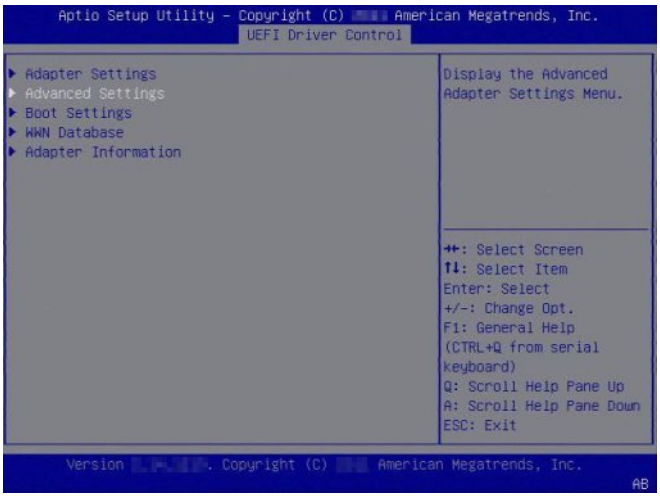
1. **From the system, enter the UEFI setup menu.**

2. **Select the UEFI Driver Control tab, as shown in the following figure.**

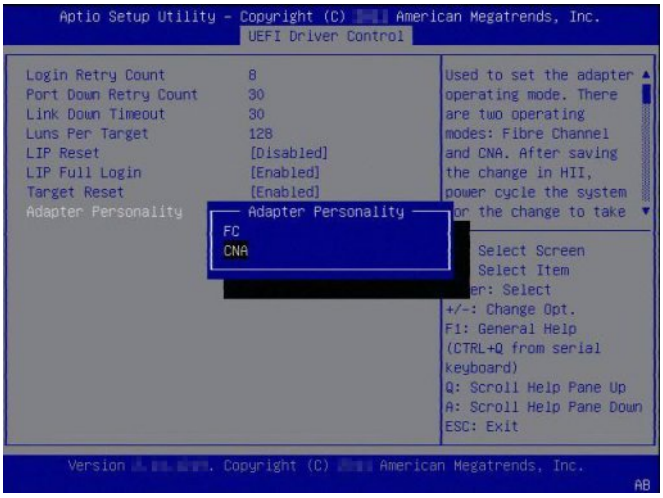


3. **On the left side of the screen, select the universal HBA.**

4. **Select Advanced Settings, as shown in the following figure.**



5. **Select Adapter Personality (operating protocol mode), and then select the mode (FC or CNA) as required, as shown in the following figure.**



6. **Exit the UEFI menu with Save and Reset.**

7. **Reboot the system that has the universal HBA installed.**

▼ To Determine and Change the Operating Protocol Mode Using the FCode Utility

This procedure describes how to determine and change the operating protocol mode of the universal HBA using the FCode utility on Oracle SPARC systems.

1. **Type the `show-disks` command at the ok prompt to list the QLogic FC/FCoE device path.**

```
{0} ok show-disks
a) /pci@400/pci@2/pci@0/pci@f/pci@0/usb@0,2/hub@2/hub@3/storage@2/disk
b) /pci@400/pci@2/pci@0/pci@4/SUNW,qlc@0,1/fp@0,0/disk
c) /pci@400/pci@1/pci@0/pci@4/SUNW,qlc@0/fp@0,0/disk
d) /pci@400/pci@1/pci@0/pci@0/pci@0/usb@0,2/hub@3/storage@2/disk
e) /iscsi-hba/disk
q) NO SELECTION
```

2. **Type the `select` command at the ok prompt to select the first port of the universal host bus adapter.**

   Depending on what you select, you might see ouput similar to one of the following examples.

```
{0} ok select /pci@400/pci@1/pci@0/pci@4/SUNW,qlc@0
QLogic QLE8362 FC Host Adapter FCode(SPARC): 4.02b1 2012-06-25 08:51
ISP Firmware version 6.00.12
```

```
{0} ok select /pci@400/pci@2/pci@0/pci@4/SUNW,qlc@0
7101674, Sun Storage 16Gb FC PCIe Universal HBA, QLogic 7023303
ISP Firmware version 6.06.02
```

3. **Type the `set-personality` command at the ok prompt to change the operating protocol mode of the universal HBA.**

   The following example shows the mode being changed (in this case, from FC to CNA):

```
{0} ok set-personality
Current Personality : FC
Do you want to change it? (y/n) y
Choose Personality :
```

```
0 - FC
1 - CNA
enter: 1
.
{0} ok reset-all
```

Determining and Changing the Operating Protocol Mode Using the QConvergeConsole CLI

Note - For detailed information on installing the QConvergeConsole CLI utility, see the QConvergeConsole CLI User's Guide.

The QLogic QConvergeConsole command-line interface (CLI) utility is used to configure and manage QLogic Fibre Channel adapters, Intelligent Ethernet adapters, and converged network adapters within SANs. The QConvergeConsole CLI has two modes of operation: noninteractive mode and interactive mode.

Noninteractive mode uses a CLI, in which you type a complete command-line with switches and associated settings at the operating system prompt. Interactive mode uses a menu-driven interface that prompts you to select information from menus to perform the desired operation.

Note - The QConvergeConsole CLI is case-sensitive.

▼ To Determine and Change the Operating Protocol Mode Using the QConvergeConsole Noninteractive CLI

Follow these instructions to determine and change the operating protocol mode of the universal HBA using the QConvergeConsole CLI in noninteractive mode in the Windows, Linux, or Oracle Solaris OS.

1. **Open an operating system shell.**
2. **(Optional) Issue the following command to display the current operating protocol mode of the universal HBA:**

   `qaucli -pc` *hba-instance* **`--info`**

   Where *hba-instance* is the HBA instance number of the universal HBA. To discover the instance number of the universal HBA, you can issue the `-g` command.
3. **Issue the following command to change the operating protocol mode of the universal HBA:**

`qaucli -pc` *hba-instance* **`--type`** *mode*

Where:

hba-instance is the HBA instance number of the universal HBA. To discover the instance number of the universal HBA, you can issue the `-g` command.

mode is one of the following:

- `fco` or `0` to change the operating protocol mode to Fibre Channel only.
- `cna` or `1` to change the operating protocol mode to CNA.

Note - You need to perform this procedure on only one port (or, instance) of the universal HBA.

4. **Repeat step 1 through step 3 for all universal HBAs, and then perform a full power reboot of the system in which the universal HBAs are installed.**

Note - For systems that have hot-plug/hot swap capability, instead of initiating a full power reboot of the system, you can perform a hot-plug out and hot-plug in of the card.

▼ To Determine and Change the Operating Protocol Mode Using the QConvergeConsole Interactive CLI

Follow the instructions in this section to determine and change the operating protocol mode of the universal HBA using the QConvergeConsole CLI in interactive mode.

Note - The examples in this procedure are for a universal HBA in FC-only mode. Any additional steps that are required for a universal HBA in CNA mode are noted in the procedure.

1. **Start the QConvergeConsole CLI in interactive mode using the method specified below for your operating system:**

- Windows – Do one of the following:
  - Double-click the QConvergeConsole CLI icon on the desktop.
  - Click Start, point to All Programs, point to QLogic Management Suite, and then click QConvergeConsole CLI.
  - Open a command prompt in the installation directory (the default is: `C:\Program Files \QLogic Corporation\QConvergeConsoleCLI`), and then issue the following command: `qaucli`

- Linux – Issue the following command: `qaucli`
- Oracle Solaris – Issue the following command: `qaucli`

The Main Menu appears:

```
Main Menu
1:  Adapter Information
2:  Adapter Configuration
3:  Adapter Updates
4:  Adapter Diagnostics
5:  Adapter Statistics
6:  Refresh
7:  Help
8:  Exit

Please Enter Selection:
```

2. **In CNA mode, type `1` or in FC mode, type `2` to select the Adapter Configuration menu option.**

```
Main Menu
1:  Adapter Information
2:  Adapter Configuration
3:  Adapter Updates
4:  Adapter Diagnostics
5:  Adapter Statistics
6:  Refresh
7:  Help
8:  Exit

Please Enter Selection: 2
```

When the universal HBA is in FC mode, the Adapter Configuration menu[1] appears with the menu options shown in the following step.

3. **At the Adapter Configuration menu, type `13` to select the Personality (operating protocol mode) menu option**

```
Fibre Channel Adapter Configuration
1:  Adapter Alias
2:  Adapter Port Alias
3:  HBA Parameters
```

[1]The menu title is “FCoE Converged Network Adapter (CNA) Configuration” if the current personality of the universal HBA is CNA.

```
 4:  Target Persistent Binding
 5:  Boot Devices Configuration
 6:  Virtual Ports (NPIV)
 7:  Target Link Speed (iiDMA)
 8:  Driver Parameters
 9:  Selective LUNs
10:  QoS
11:  Export (Save) Configuration
12:  Generate Reports
13:  Personality
(p or 0: Previous Menu; m or 98: Main Menu; ex or 99: Quit)
Please Enter Selection:13
```

Note - If the universal HBA is in CNA mode, additional selections appear on the Main Menu. If in CNA mode, type `1` at the Main Menu to select CNA Configuration, and then type **`1`** again to select the CNA FCoE Configuration menu option. This takes you to the Converged Network Adapter (CNA) FCoE Configuration menu. At this point, you would type **`11`**, instead of **`13`** as described in this step.

The Adapter Selection menu[2] appears.

4. **To select the universal HBA, type the number of the universal HBA.**
   In the following example, the only universal HBA is number 1:

```
1: HBA Model: QLE8362 SN: AFE1224F05264
      Port   2 WWPN: 21-00-00-0E-1E-08-F2-11 SFP not installed
      Port   1 WWPN: 21-00-00-0E-1E-08-F2-10 SFP not installed
(p or 0: Previous Menu; m or 98: Main Menu; ex or 99: Quit)
Please Enter Selection: 1
```

   A prompt appears to verify the personality change[3].

5. **At the prompt, type `y` to accept, or `n` to cancel.**

```
Change personality to CNA? (y/n): y
```

   A message confirms the change.

6. **Follow the instructions in the message to complete the operating protocol mode change for the universal HBA.**
   The following is an example of an instructional message:

[2]The displayed information reflects a CNA if the current personality of the universal HBA is CNA.

[3]This prompt is “Change personality to FC Only?” if the current personality of the universal HBA is CNA.

```
Personality type of HBA instance 1 (QLE8362) has been changed successfully.
Please power cycle machine. Make sure to change the SFP module to a compatible
one (FC) before reboot.
```

Note - For systems that have hot-plug/hot swap capability, instead of initiating a full power reboot of the system, you can perform a hot-plug out and hot-plug in of the card.

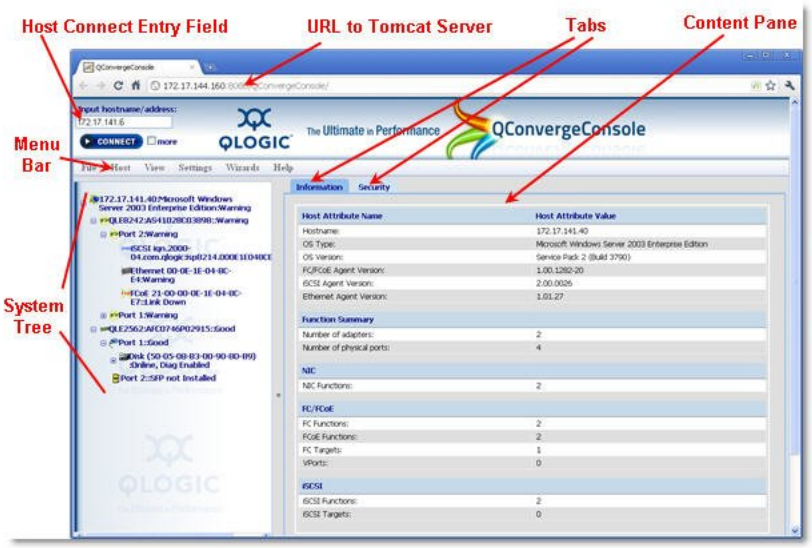
▼ To Determine and Change the Operating Protocol Mode Using the QConvergeConsole GUI

The QLogic QConvergeConsole GUI utility is a browser-based client/server application that allows centralized management and configuration of QLogic adapters within the SAN. For QLogic QConvergeConsole GUI installation and management instructions, see the `ReadMe` file included in the QCC GUI installation package. Additionally, a QLogic QConverge Console GUI User's Guide is available at the Oracle support area of the QLogic web site.

Follow these instructions to determine and change the operating protocol mode of the universal HBA:

1. **Open a web browser.**
2. **In the address bar of the browser, specify the server where QConvergeConsole is installed:**
   - Remote server: `http://<server-IP-address>:8080/QConvergeConsole/`
   - Local server: `http:localhost:8080/QConvergeConsole/`

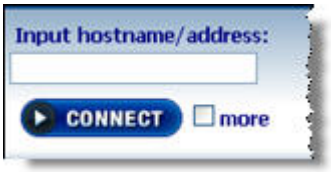
The QConvergeConsole main window is displayed, the following figure shows an example of the QConvergeConsole main screen and identifies the main parts of the screen.



3. **Connect to the host containing the universal HBA as follows:**

   a. **Locate the Input hostname/address field in the upper-left corner of the QConvergeConsole screen.**

   b. **In the Input hostname/address field, enter the name or IP address of the host, as shown in the following figure.**

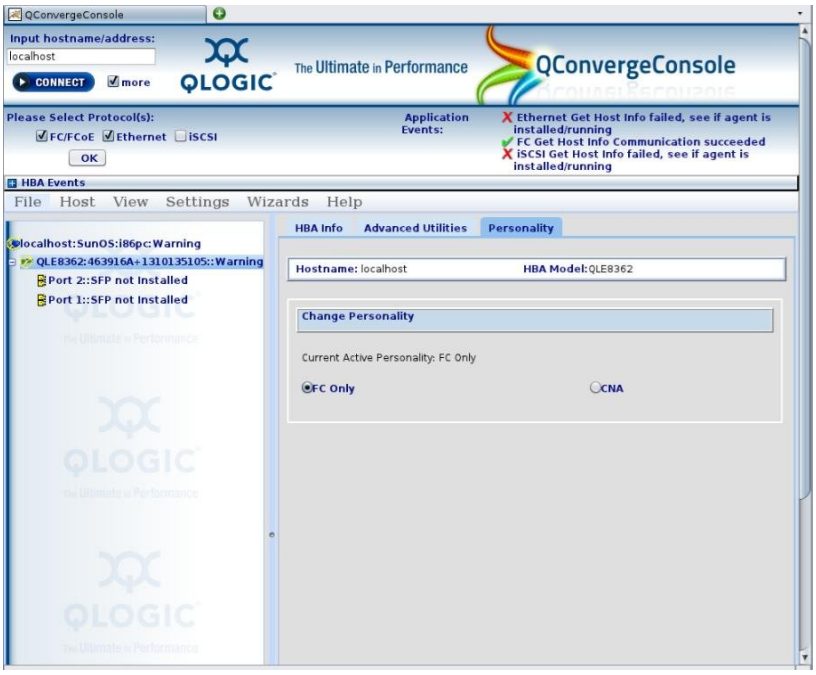


   c. **Click Connect to initiate the connection.**

   When the connection is complete, the host and its HBAs are displayed in the system tree.

Note - To allow Oracle Solaris 10 hosts to connect to an Oracle Solaris 11 host, the `netservices open` command must be issued on the Oracle Solaris 11 host after each reboot of the Oracle Solaris 11 host. However, connections can be made to Oracle Solaris 10 hosts from either Oracle Solaris 10 or Oracle Solaris 11 without needing to issue the `netservices open` command on either host.

d. In the system tree, select the universal HBA on the host, and then select the Personality (operating protocol mode) tab, as shown in the following figure.



4. **Set the personality (operating protocol mode) of the universal HBA by selecting FC Only for Fibre Channel, or CNA for converged network adapter.**

5. **Click Save to save the new settings.**

6. **Close the QConvergeConsole and reboot the system that has the universal HBA installed for the change to take effect.**

Note - For systems that have hot-plug/hot swap capability, instead of initiating a full power reboot of the system, you can perform a hot-plug out and hot-plug in of the card.

SR-IOV/FC-IOR Support

Support for Solaris SR-IOV and FC-IOR is available with this CNA, subject to the following limitations.

TABLE 10 SR-IOV and FC-IOR Support Limitations

Use	Non-SR-IOV Mode	SR-IOV with a SPARC Server Running Oracle Solaris 11 OS	SR-IOV with a SPARC Server Running Oracle Sola OS
FC 16 Gb/s	Supported	Supported	T5: Supported, see next section M-Series: Limited to VF support in guest domains
FCoE 10 Gb/s	Supported	Not Supported	Not Supported
NIC 10 Gb/s	Supported	Not Supported	Not Supported

Running Oracle Solaris 10 in an SR-IOV root or I/O domain is an unsupported configuration. To adjust the configuration so that it is supported, do the following:

- If running Oracle Solaris 10 in an SR-IOV root domain, update the root domain to the latest Oracle Solaris 11 release. Otherwise, move the SR-IOV physical function to an Oracle Solaris 11 domain to bring the root domain into compliance for support.
- If running Oracle Solaris 10 in an SR-IOV I/O domain, update the I/O domain to the latest Oracle Solaris 11 release. If this is not possible, switch the SR-IOV I/O devices to virtual I/O devices. Making either of these changes brings the configuration into compliance for support.

Direct any questions about Solaris SR-IOV/FC-IOR functionality to your Oracle Solaris Support Representative.

♦ ♦ ♦ CHAPTER 4

Software Installation

After you have completed the hardware installation and powered on the system, you can install the universal HBA driver and any other required utilities specific to your operating system, as described in this chapter.

This chapter contains the following sections:

Driver Software for the Oracle Solaris OS

Before using the universal HBA, update the universal HBA driver software for the Oracle Solaris OS with the following SRU version or patches:

- Oracle Solaris 11.4 for the SPARC and x86 platforms - SRU 16
- Oracle Solaris 11.1 OS for the SPARC and x86 platforms - SRU 13.4
- Oracle Solaris 10 1/13 OS for the SPARC platform - Patches 149167-07 and 149175-11
- Oracle Solaris 10 1/13 OS for the x86 platform - Patches 149168-07 and 149176-11

The latest available SRU versions and patches are located at: `http://support.oracle.com/`

Oracle Solaris Diagnostic Support

Diagnostic support for the universal HBA is included in the Oracle VTS software. The Oracle VTS software is available for download at: http://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 `qlctest` utility, which is part of the Oracle VTS software, supports the following functions:

- Connectivity verification
- Firmware version and checksum test
- Self-test
- Loopback tests
  - External (all universal HBAs (in FC mode only) present in the system)

    Note - OM3 loopback cables, or better, are required at 16 Gb/s for the unviersal HBA.

  - Internal, single-bit
  - Internal, 10-bit
  - Mailbox

Installing Software for the Red Hat and SUSE Linux OSes

Before using the universal HBA, check for the latest drivers at the Oracle support area of the Marvell, formerly QLogic, web site. The drivers and utilities, as well as *ReadMe* guides, are located at: http://driverdownloads.qlogic.com/QLogicDriverDownloads_UI/Oracle_Search.aspx

For diagnostic support, you might need to rebuild the Linux driver. Before rebuilding the drivers for Linux, you must have the required Linux OS installed on the hard disk. The driver and utilities are available for download at the Oracle support area of the QLogic web site.

▼ To Install Universal HBA Software for the Red Hat and SUSE Linux OSes

1. **Go to the Oracle support area of the Marvell, formerly QLogic, web site at: http://driverdownloads.qlogic.com/QLogicDriverDownloads_UI/Oracle_Search.aspx**
2. **Perform a search for the universal HBA by using the universal HBA part number (7101674).**
3. **Click the Linux Driver section and locate the driver version that you want to download.**

   If the universal HBA is running in CNA/FCoE mode, you might need to update both the FC and FCoE driver and the network driver that are available in this section.
4. **Click the driver version that you want to download, and then click Download Now.**
5. **Save the file to a directory on the hard disk of the system.**
6. **Follow the installation instructions in the Readme file associated with the driver to complete the driver installation.**
7. **Repeat steps 1 through 6 for any additional Linux drivers and utilities that your system requires.**

Installing Software for the VMware Technology

Before using the universal HBA, check the Oracle support area of the Marvell, formerly QLogic, web site for the latest drivers. The drivers and utilities, as well as their associated *Readme* files, are located at: http://driverdownloads.qlogic.com/QLogicDriverDownloads_UI/Oracle_Search.aspx

▼ To Install the Universal HBA Software for the VMware Technology

1. **Go to the Oracle support area of the Marvell, formerly QLogic, web site at: http://driverdownloads.qlogic.com/QLogicDriverDownloads_UI/Oracle_Search.aspx**

2. **Perform a search for the universal HBA by using the HBA part number (7101674).**

3. **Click the VMware Driver section and locate the driver version that you want to download.**

   If the universal HBA is running in CNA/FCoE mode, you might need to update both the FC and FCoE driver and the network driver that are available in this section.

4. **Click the driver version that you want to download, and then click Download Now.**

5. **Save the file to a directory on the hard disk of the system.**

6. **Follow the installation instructions in the *Readme* file associated with the driver to complete the driver installation.**

7. **Repeat steps 1 through 6 for any additional VMware drivers and utilities that you require.**

Installing Software for the Windows OS

Before using the universal HBA, check the Oracle support area of the Marvell, formerly QLogic, web site for the latest drivers. The drivers and utilities, as well as their associated *Readme* files, are located at: `http://driverdownloads.qlogic.com/QLogicDriverDownloads_UI/Oracle_Search.aspx`

▼ To Install the Universal HBA Software for the Windows OS

1. **Go to the Oracle support area of the Marvell, formerly QLogic, web site at: `http://driverdownloads.qlogic.com/QLogicDriverDownloads_UI/Oracle_Search.aspx`**

2. **Perform a search for the universal HBA by using the HBA part number (7101674).**

3. **Click the Windows Driver section and locate the driver version that you want to download.**

   If the universal HBA is running in CNA/FCoE mode, you might need to update both the FC/FCoE driver and the network driver that are available in this section.

4. **Click the driver version that you want to download, and then click Download Now.**
5. **Save the file to a directory on the hard disk of the system.**
6. **Follow the installation instructions in the *Readme* file associated with the driver to complete the driver installation.**
7. **Repeat steps 1 through 6 for any additional Windows drivers and utilities that you require.**

Diagnostic Support for the Oracle Solaris, Red Hat, SUSE Linux, and Windows OSes

Diagnostic support for the universal host bus adapter is available through the Marvell, formerly QLogic, QConvergeConsole graphical user interface (GUI) utility or QConvergeConsole command-line interface (CLI) utility. These utilities support the following functions:

- Connectivity verification
- BIOS, FCode, EFI, and firmware version information
- Link status, including topology, data rate, and statistics
- Vital product data (VPD) information
- Attached devices list
- Option ROM, NVRAM update utilities
- Loopback test
- Read/Write Buffer test

▼ To Install Diagnostic Support for Oracle Solaris, Red Hat, and SUSE Linux OSes

1. **Go to the Oracle support area of the Marvell, formerly QLogic, web site at:**

   `http://driverdownloads.qlogic.com/QLogicDriverDownloads_UI/Oracle_Search.aspx`
2. **Perform a search for the universal HBA by using the HBA part number (7101674).**
3. **At the bottom of the table, in the Software for row, click Linux.**

4. **Locate the QConvergeConsole CLI or QConvergeConsole GUI utility.**
5. **Click the utility name to to save the installation file to your local file system.**
6. **Click the Read Me link for additional information.**

Installing the CLI for Updating the BIOS and FCode

If you need to update the Fibre Channel BIOS and FCode, you can do so by using the Marvell, formerly QLogic, QConvergeConsole command-line interface (CLI).

If you have not done so already, you can download the QConvergeConsole CLI tool from the Software section in the Oracle support area of the Marvell web site:

`http://driverdownloads.qlogic.com/QLogicDriverDownloads_UI/Oracle_Search.aspx`

Follow the installation instructions in the `README.TXT` file. Installation instructions are also available in the QLogic user's guides for those tools, which can also be found in the Oracle support area of the QLogic web site.

For instructions on how to update the BIOS and FCode, see the *QConvergeConsole CLI User's Guide* in the Software section in the Oracle support area of the QLogic web site.

Updating the Universal HBA Firmware

This section describes how to update the universal HBA firmware.

Note - When updating firmware, do not interrupt the process. Prior to the firmware update, stop all other HBA-related operations, including I/O, diagnostics, and inquiries (even on the PCI bus). You can resume any HBA-related operations after the firmware update is fully complete.

▼ To Update the Universal HBA Firmware

1. **Obtain the image file from the Marvell, formerly QLogic, web site at: `http://driverdownloads.qlogic.com/QLogicDriverDownloads_UI/Oracle_Search.aspx`**

   The image file is in `zip` format, and named as follows:

`Oracle_qle83xx_imgx.xx.xxriscy.yy.yy`

Where `x.xx.xx` and `y.yy.yy` are version numbers.

For example: **`Oracle_qle83xx_img2.02.24risc5.00.41`**

2. **Unzip the image file that you downloaded in step 1, and save the `.bin` file to a local directory.**

3. **From a terminal window, navigate to the directory where the `.bin` file is located, and run the QConvergeConsole command-line interface utility by typing `qaucli` at the command line.**

   The Main Menu of the QConvergeConsole utility is displayed.

4. **From the Main menu, type `3` to select the Adapter Updates menu option.**

```
QConvergeConsole

CLI - Version 1.1.0 (Build 9)

Main Menu

1:  Adapter Information
2:  Adapter Configuration
3:  Adapter Updates
4:  Adapter Diagnostics
5:  Adapter Statistics
6:  Refresh
7:  Help
8:  Exit

Please Enter Selection: 3
```

5. **From the Fibre Channel Adapter Update menu that is displayed, type `1` to select the Flash Update menu option.**

```
QConvergeConsole

CLI - Version 1.1.0 (Build 9)

Fibre Channel Adapter Update

1:  Flash Update
2:  Paramaters Update
3:  Paramaters Template Update
```

```
4:  Firmware Preload Update
5:  FC Serdes Table Update

(p or 0: Previous Menu; m or 98: Main Menu; ex or 99: Quit)

Please Enter Selection: 1
```

6. **From the Flash Update menu that is displayed, select the universal HBA and type the name of the flash `.bin` file from step 2.**

```
QConvergeConsole

CLI - Version 1.1.0 (Build 9)

Flash Update

1: HBA Model: QLE8362  SN: 040200A+1231081525
 Port   1 WWPN: 21-00-00-0E-1E-10-51-10 Online
 Port   2 WWPN: 21-00-00-0E-1E-10-51-11 SFP not installed


(p or 0: Previous Menu; m or 98: Main Menu; ex or 99: Quit)
Please Enter Selection: 1
Enter a file name or Hit <RETURN> to abort: hld20224.bin
```

The QConvergeConsole utility displays the flash image file name before proceeding.

7. **At the prompt, do one of the following:**

   - **If the image fileversion shown on the screen is correct, type `1` to proceed with the operation.**
   - **If the image file version is incorrect, type `2` to cancel the operation and type the correct `.bin` file..**

```
QConvergeConsole

CLI - Version 1.1.0 (Build 9)


Updating the flash image from the current version v020199
to the new version v020224

Do you want to proceed with the operation?
```

```
1: Yes
2: No

Please Enter Selection: 1
```

8. **At the prompt, do one of the following:**

   - **Type `1` to activate the firmware immediately.**
   - **Type `2` if you do not want to activate the new firmware immediately.**

```
QConvergeConsole

CLI - Version 1.1.0 (Build 9)


Flash Update: Confirm adapter reset

Activate new firmware after upgrade is complete?

1: Yes
2: No

Please Enter Selection: 1
```

9. **Wait until you see a message that the flash update is complete.**

```
Validating Flash Image File... Success
Updating Flash on HBA port(s) - QLE8362. Please wait...
Updating Adapter FC Boot Code... Success
Updating Adapter NIC Boot Code... Success
Updating Adapter FCoE Boot Code... Success
Updating Adapter CRBInit... Success
Updating Adapter BootLoader... Success
Updating Adapter PEGTune ... Success
Updating Adapter FCoE FW... Success
Updating Adapter FC FW... Success
Updating Adapter NIC/CNA FW... Success
Updating Adapter NIC/CNA VPD... Success
Updating Adapter FC VPD... Success
Updating Adapter FC VPD... Success
Flash update complete. Changes have been saved to the HBA port(s).
Hit <Enter> to continue:
```

The firmware is now successfully updated.

♦ ♦ ♦ CHAPTER 5

Important Information and Known Issues

This chapter provides supplementary and workaround information for the universal HBA. Specific Change Request (CR) identification numbers are provided for service personnel.

This chapter contains the following topics:

Link Aggregation Control Protocol (LACP) Cannot Be Used In Certain Conditions

Bug 18707752

Conditions:

- System Platform: All supported systems using the Oracle Solaris driver
- Operating Protocol Mode of Universal HBA: FC, CNA
- Environment: Universal HBA connected directly to supported storage

Issue:

LACP cannot be used on the same port as FCoE or iSCSI.

Workaround:

None.

Perform a One-Time Firmware Update For FC SR-IOV Support

CR 19725764

Conditions:

- Operating System: Oracle Solaris
- Operating Protocol Mode: CNA and HBA
- Environment: Universal HBA installed in a SPARC system, requiring FC SR-IOV functionality

Issue:

If you have installed the universal HBA in a SPARC system that requires Fibre Channel (FC) Single Root-I/O Virtualization (SR-IOV), or FC SR-IOV, support, you must update the universal HBA firmware to version 7.03.00, at minimum. You only need to perform this FC SR-IOV-specific firmware update one time. For future firmware updates, you can return to the usual firmware update procedure, as described in "Updating the Universal HBA Firmware" on page 60.

Workaround:

Perform the one-time, FC SR-IOV firmware update:

1. Go to the Oracle support area of the QLogic web site at:

   `http://driverdownloads.qlogic.com/QLogicDriverDownloads_UI/Oracle_Search.aspx`
2. Search for the universal HBA by using the HBA part number (7101674).
3. Navigate to the Boot Code table, and locate the Multi-Boot Image Update Kit for Universal `part-number` (7101674) HBA.
4. Click the update kit name to save the installation file to your local file system.
5. Click the Read Me link, and follow the installation instructions in the Read Me file.

`vpd r/w failed` Error Messages Are Displayed

CR 19154195

Conditions:

- Operating System: Oracle Enterprise Linux 5.9 operating system (OS) with Unbreakable Enterprise Kernel (UEK) 3
- Operating Protocol Mode: CNA and HBA
- Environment: Universal HBA installed in an x86 system, during functional check procedures

Issue:

After upgrading the Oracle Linux OS to UEK 3, you might receive “vpd r/w failed” messages upon issuing functional check commands, such as `dmesg` and `lspci`.

Workaround:

None. Ignore these messages as they do not adversely affect the functionality of the universal HBA.

Cannot Boot Net Over DHCP Through the Universal HBA

CR 16232596

Conditions:

- Operating System: Oracle Solaris for the SPARC environment
- Operating Protocol Mode: CNA
- Boot Device: Boot net through the universal HBA
- Environment: OBP prompt

Issue:

When using the universal HBA in CNA mode on a SPARC system to boot net over DHCP, the operation might time out during the process with the following messages:

```
0} ok boot net:dhcp -sv
Boot device:
/pci@400/pci@1/pci@0/pci@4/SUNW,qle@0:dhcp File
and args: -sv
Requesting Internet Address for 0:e:1e:10:18:30
Requesting Internet Address for 0:e:1e:10:18:30
Requesting Internet Address for 0:e:1e:10:18:30
Timed out waiting for TFTP reply
Timed out waiting for TFTP reply
```

The boot net over DHCP process fails.

Workaround:

If you are stuck in this time out situation, send a break at the command line.

For future boot net booting at the OBP prompt, do not use DHCP booting. Instead, use RARP booting, as shown in the following screen.

```
0} ok boot net -v
Boot device:
/pci@400/pci@1/pci@0/pci@4/SUNW,qle@0 File
and args: -v
Requesting Internet Address for 0:e:1e:10:18:30
Using RARP/BOOTPARAMS...
```

To avoid this situation in the future, update the universal HBA firmware to the latest version, as described in “Updating the Universal HBA Firmware” on page 60.

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

Sun Storage 16 Gb Fibre Channel PCIe Univeral Host Bus Adapter, QLogic 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: GSCZF)**.

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: GSCZF)**.

BIOS information and its functions are typically documented in the Sun Storage 16 Gb Fibre Channel PCIe Univeral Host Bus Adapter, QLogic 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 Sun Storage 16 Gb Fibre Channel PCIe Univeral Host Bus Adapter, QLogic products at `https://docs.oracle.com/cd/E24651_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.

Glossary

A

ASIC application-specific integrated circuit

B

BIOS Basic Input Output System

C

CENELEC European Committee for Electrotechnical Standardization

CLI command line interface

CNA converged network adapter

D

DAC direct-attach copper

DAS direct-attached storage

DCR direct connecting receptacle

DHHS Department of Health and Human Services

E

ECC Error Checking and Correction

EE Enhanced Ethernet

EEPROM electrically erasable programmable read-only memory

ESD electrostatic discharge

F

FC Fibre Channel

FCoE Fibre Channel over Ethernet

G

Gb gigabit

GbE gigabit Ethernet

GUI graphical user interface

H

HBA host bus adapter

I

IEEE Institute of Electrical and Electronics Engineers

IP internet protocol

iSCSI internet Small Computer System Interface

L

LED light emitting diode

LP low-profile

LUN logical unit number

M

MAC media access control

MSI-X message signaled interrupts - extended

N

NIC networking interface card

O

OFC optical fiber cable

OS operating system

P

PCI Peripheral Component Interconnect

PCIe Peripheral Component Interconnect Express

POST power-on self test

R

RAM random access memory

RH relative humidity

RoHS Restriction of Hazardous Substances Directive

S

SAN storage area network

SFP+ enhanced small form factor pluggable transceiver

SR short range

SW short wave

T

TOR top of rack

U

UCNA universal converged network adapter

V

VLAN virtual local area network

W

WWN world wide name

WWPN world wide port name