Broadcom MegaRAID® and HBA Tri-Mode Storage Adapters

User Guide

Version 1.0

March 24, 2017

MR-HBA-94xx-UG100

For a comprehensive list of changes to this document, see the Revision History.

Corporate Headquarters
San Jose, CA

Website
www.broadcom.com

Table of Contents

Chapter 1: Broadcom MegaRAID® and HBA Tri-Mode Storage Adapters

1.1 Introduction

This document is the primary reference and user guide for the Broadcom MegaRAID® Storage Adapters, which are based on the SAS3516 and SAS3508 Tri-Mode ROCs (RAID on Chip), and for the Broadcom HBA Tri-Mode Storage Adapters, which are based on the SAS3416 and SAS3408 Tri-Mode IOC (IO controller) devices. This document contains the complete installation instructions and specifications for the following Tri-Mode storage adapters:

- MegaRAID 9440-8i (model number 50008)
- MegaRAID 9460-16i (model number 50011)
- MegaRAID 9460-8i (model number 50011)
- MegaRAID 9480-8i8e (model number 50031)
- HBA 9400-16i (model number 50008)
- HBA 9400-8i (model number 50008)
- HBA 9400-16e (model number 50013)
- HBA 9400-8e (model number 50013)

1.2 Overview

The MegaRAID and HBA adapters, based on the SAS3516, SAS3508, SAS3416 or SAS3408 Tri-mode controllers, are high-performance PCIe-to-SATA/SAS/PCIe (Tri-Mode) adapters. Broadcom Tri-Mode SerDes Technology enables operation of SATA, SATA or PCIe (NVMe) storage devices in a single drive bay. A single controller can operate in all three modes concurrently: SATA, SATA or PCIe/NVMe.

The Tri-Mode adapters provide the following storage interface data transfer rates:

- SAS data transfer rates of 12, 6, and 3Gb/s per lane
- SATA transfer rates at 6 and 3Gb/s data transfer rates per lane
- NVMe data transfer rates of 8, 5, and 2.5 Gb/s.

The adapters negotiate between the speeds and the protocols to recognize and concurrently interface with any of these three types of storage devices. The following table summarizes many of key features of the MegaRAID Tri-Mode Storage Adapters.

Table 1 MegaRAID Tri-Mode Storage Adapters

Controllers	9460-16i	9460-8i	9480-8i8e	9440-8i
Ports	16 internal	8 internal	8 internal 8 external	8 internal
I/O Processor / SAS Controller	SAS3516	SAS3508	SAS33516	SAS3408
Form Factor	LP-MD2	LP-MD2	LP-MD2	LP-MD2
Storage Interface Connectors	Four SFF-8643 x4	Two SFF-8643 x4	Two SFF-8643 x4 Two SFF-8644 x4	Two SFF-8643 x4
Host Interface	x8 PCIe 3.1	x8 PCIe 3.1	x8 PCIe 3.1	x8 PCIe 3.1

Table 1 MegaRAID Tri-Mode Storage Adapters (Continued)

Controllers	9460-16i	9460-8i	9480-8i8e	9440-8i
Storage Interface	SAS, SATA, and PCIe (NVMe)	SAS, SATA, and PCIe (NVMe)	SAS, SATA, and PCIe (NVMe)[a]	SAS, SATA, and PCIe (NVMe)
Cache Memory	4GB 2133MHz DDR4 SDRAM	2GB 2133MHz DDR4 SDRAM	4GB 2133MHz DDR4 SDRAM	N/A
Cache Protection	Yes	Yes	Yes	N/A
Super Capicator	CVPM05 module	CVPM05 module	CVPM05 module	N/A

a. NVMe is supported for internal connection only.

The following table summarizes many of the key features of the HBA Tri-Mode Storage Adapters.

Table 2 HBA Tri-Mode Storage Adapters

Controllers	9400-16i	9400-8i	9400-16e	9400-8e
Ports	16 internal	8 internal	16 external	8 external
I/O Processor	SAS3416	SAS3408	SAS3416	SAS3408
Form Factor	LP-MD2	LP-MD2	LP-MD2	LP-MD2
Storage Interface Connectors	Four SFF-8643 x4	Two SFF-8643 x4	Four SFF-8644 x4	Two SFF-8644 x4
Host Interface	x8 PCIe 3.1	x8 PCIe 3.1	x8 PCIe 3.1	x8 PCIe 3.1
Storage Interface	SAS, SATA, and PCIe (NVMe)	SAS, SATA, and PCIe (NVMe)	SAS and SATA	SAS and SATA

Chapter 2: Features

2.1 RAID Features

The following list includes some of the primary RAID features supported by the MegaRAID Tri-Mode Storage Adapters. For a full description of the RAID features, refer to the *12Gb/s MegaRAID SAS Software User Guide*, which is located at http://www.broadcom.com/support/download-search.

- RAID levels 0, 1, 5, and 6
- RAID spans 10, 50, and 60
- SDS Personality with EPD and JBOD
- Online Capacity Expansion (OCE) Online RAID Level Migration (RLM)
- Auto resume after loss of system power during array rebuild or reconstruction (RLM)
- Single controller Multipathing
- Load balancing
- Configurable stripe size up to 1MB
- Fast initialization for quick array setup
- Check Consistency for background data integrity
- SSD Support with SSD Guard™ technology
- Patrol read for media scanning and repairing
- 64 logical drive support
- DDF compliant Configuration on Disk (COD)
- S.M.A.R.T. support
- Global and dedicated Hot Spare with Revertible Hot Spare support
- Automatic rebuild
- Enclosure affinity
- Emergency SATA hot spare for SAS arrays
- Enclosure management
- SES (inband)
- SGPIO (sideband)
- Databolt™ bandwidth optimizer technology support for compatible expander-based enclosures
- Shield state drive diagnostic technology

2.2 Operating System Support

The Tri-Mode adapters support the operating systems in the following list. For specific version information, refer to the *MegaRAID SAS Device Driver Installation User Guide*, which is located at http://www.broadcom.com/support/download-search.

- Microsoft Windows
- VMware vSphere/ESXi
- Red Hat Linus
- SuSe Linux
- Ubuntu Linux
- Oracle Linux

- CentOS Linux
- Debian Linux
- Fedora
- FreeBSD
- Oracle support

NOTE Contact Oracle for Oracle Solaris driver software or support.

The firmware and drivers are routinely updated and made available on the Support and Download center. Visit http://www.broadcom.com/support/download-search and download the latest firmware and driver for the controller.

2.3 PCIe Host Interface

The Tri-Mode adapters have eight PCIe PHYs, which provide host-side maximum transmission and reception rates of 64 Gb/s (8 Gb/s per PHY). The Tri-Mode controller uses a packet-based communication protocol to communicate over the serial interconnect. Other PCIe host interface features include:

- Eight PCIe Host Lane Interface
- PCIe Hot Plug
- Power management
  - Supports the PCI Bus Power Management Interface Specification Revision 1.2
  - Supports Active State Power Management, including the L0 states, by placing links in a power-saving mode during times of no link activity
- Error handling
- High bandwidth per pin with low overhead and low latency
- Lane reversal and polarity inversion
- Single-phy (one-lane) link transfer rate of 8GT/s, 5GT/s, and 2.5GT/s in each direction
- Eight-lane aggregate bandwidth of up to 8 GB/s (8000 MB/s)
- Support of x8, x4, x2, and x1 link widths

2.4 LED Management

The internal Tri-Mode adapters offers LED management support for both SAS/SATA and NVMe backplanes. External connect adapters offer enclosure LED management support for enclosure implementations through SCSI Enclosure Services (SES). Refer to Chapter 4, Mid-Plane Management for more information.

2.5 Tri-Mode Storage Interface Features

The Tri-Mode Adapter's storage interface supports concurrent operation with SAS, SATA and PCIe (NVMe) devices to provide a fully functional solution for any storage environment.

- PCIe (NVMe) Interface Features
  - Up to eight x2 or four x4 NVMe direct attach drive support
  - 2.5 Gb/s, 5 Gb/s, and 8 Gb/s
- SAS Interface Features
  - SAS data transfers at 12Gb/s, 6Gb/s, and 3Gb/s

  - DataBolt technology on all SAS phys
  - Serial, point-to-point, enterprise-level storage interface
  - Wide ports that contain multiple phys
  - Narrow ports that contain a single phy
  - SAS phy power management
- SATA Interface Features
  - SATA and STP data transfers at 6Gb/s and 3Gb/s
  - Addressing of multiple SATA targets through an expander

Chapter 3: Tri-Mode Storage Interface

The Tri-Mode Storage Adapters can direct attach to SAS, SATA or NVMe drives either using SFF-8680 or SFF-8639(U.2) bays. The following direct attach options are supported by the Tri-Mode Storage Adapters:

- SFF-8680 Bay: One Phy
  - x1 SAS
  - x1 SATA
- SFF-8680 Bay: Two Phys
  - x2 SAS (Multi Link)
  - Two x1 SAS (Dual port using MPIO)
- SFF-8639 (U.2) Bay: One, Two, or Four Phys
  - x4 NVMe
  - x2 NVMe

The Tri-Mode Storage Adapters also support enclosure connectivity through SAS expanders and PCIe Switches. See the "Configuration Scenario" section for more information on storage connectivity options.

NOTE Carefully assess any decision to mix SAS, SATA, and NVMe drives within the same *virtual drive*. Although you can mix drives, the practice is discouraged.

3.1 SAS/SATA Support

The Tri-Mode Storage Adapters support internal and external storage devices, which allows you to use a system that supports enterprise-class SAS drives and desktop-class SATA III drives.

The SAS3516 and SAS3416 Tri-Mode controllers have 16 tri-mode PHYs and the SAS3516 and SAS3508 Tri-Mode controllers have eight tri-mode PHYs. The PHYs are managed in groups of eight by dedicated hardware in ascending PHY order. PHYs 0 to 7 are managed by one dedicated instance of the SAS PHY management hardware, and PHYs 8 to 15 are managed by a separate instance of the SAS PHY management hardware. These SAS PHY management hardware instances, or SAS cores, cannot communicate with each other.

When you configure a wide port, the connections must be attached exclusively to PHYs that are all managed by the same SAS core. If they are not managed by the same SAS core, then unexpected controller and host behavior will occur. By default, the connectors are mapped as shown in the figures in the following list:

- MegaRAID 9460-16i – Figure 9.1, MegaRAID 9460-16i Tri-Mode Adapter – Board Layout, and Jumper and Connector Information
- MegaRAID 9460-8i – Figure 9.1, MegaRAID 9460-16i Tri-Mode Adapter – Board Layout, and Jumper and Connector Information
- MegaRAID 9480-8i8e – Figure 9.3, MegaRAID 9480-8i8e Tri-Mode Storage Adapter – Board Layout, and Jumper and Connector Information
- MegaRAID 9440-8i – Figure 9.4, MegaRAID SAS 9440-8i Tri-Mode Storage Adapter – Board Layout, and Jumper and Connector Information
- HBA 9400-16i – Figure 9.5, HBA 9400-16i Tri-Mode Storage Adapter – Board Layout, and Jumper and Connector Information
- HBA 9400-8i – Figure 9.5, HBA 9400-16i Tri-Mode Storage Adapter – Board Layout, and Jumper and Connector Information
- HBA 9400-16e – Figure 14, Card Layout of the HBA 9400-16e Tri-Mode Storage Adapter
- HBA 9400-8e – Figure 14, Card Layout of the HBA 9400-16e Tri-Mode Storage Adapter

The following table indicates the connector to SAS core mapping for each board.

Table 3 Board Port to SAS Port Associations

Board	Connector 0 SAS Ports 0-3	Connector 1 SAS Ports 4-7	Connector 2 SAS Ports 8-11	Connector 3 SAS Ports 12-15
9460-16i	SAS Core 1	SAS Core 1	SAS Core 0	SAS Core 0
9460-8i	SAS Core 0	SAS Core 0	N/A	N/A
9480-8i8e	SAS Core 0	SAS Core 0	SAS Core 1	SAS Core 1
9440-8i	SAS Core 0	SAS Core 0	N/A	N/A
9400-16i	SAS Core 1	SAS Core 1	SAS Core 0	SAS Core 0
9400-8i	SAS Core 0	SAS Core 0	N/A	N/A
9400-16e	SAS Core 1	SAS Core 1	SAS Core 0	SAS Core 0
9400-8e	SAS Core 0	SAS Core 0	N/A	N/A

Ports 0-7 can be configured as eight separate ports or combined into one or more groups called wide ports (one x4, two x4s, one x8, and so on). Similarly, ports 8-15 can be configured as eight separate ports or combined into one or more wide-ports. A single wide port cannot combine individual ports or PHYs sourced by different SAS cores.

When you configure a boot-device in a multi-path environment, the target must be connected to one or more ports on the same SAS core with AutoPortConfig enabled. The boot device appears to the host system as a single device on the active path. A different controller is managed by the multi-path environment as the passive path.

When you configure data-storage devices in a multi-path environment, the rule for creating wide ports applies, but multiple ports from different SAS cores can be connected to the data-storage devices. The multi-path environment manages data-storage devices that are presented by the controller more than once.

3.2 NVMe Support

This section applies to NVMe drive connections only. Users of SAS or SATA will see no difference in behavior compared to previous generation devices.

The following table shows how many of each type of NVMe drive or each PCIe switch can be connected to each Tri-Mode adapter.

Table 4 Number of NVMe Devices Supported for Each Adapter

Adapter	x4 PCIe (NVMe)	x2 PCIe (NVMe)
9460-16i	4	8
9460-8i	2	4
9480-8i8e	2[a]	4
9440-8i	2	4
9400-16i	4	8
9400-8i	2	4
9400-16e[a]	N/A	N/A
9400-8e[a]	N/A	N/A

a. NVMe supported for internal connection only

The tri-mode device interface contains a SAS core and a PCIe Device Bridge (PDB). The PDB enables the NVMe drive interface connections and each PDB can support direct connect to NVMe devices or to x4 PCIe switches. The SAS3516 device has 16 Tri-Mode SerDes or PHYs and the SAS3508 device has 8 Tri-Mode SerDes or PHYs. PHYs 0-7 are managed by one PDB and PHYs 8-15 are managed by a second PDB. The PDBs cannot communicate with each other. This means that a PCIe port of greater than one lane must be attached exclusively to PHYs that are all managed by the same PDB and must be comprised of adjacent lanes.

The following table shows how the controller lanes are mapped to the miniSAS-HD connectors on the adapter. By default, the connectors are mapped as shown in the following figures:

- 9460-16i – Figure 8, Card Layout for the MegaRAID 9460-16i Tri-Mode Storage Adapter
- 9460-8i – Figure 8, Card Layout for the MegaRAID 9460-16i Tri-Mode Storage Adapter
- 9480-8i8e – Figure 10, Card Layout for the MegaRAID 9480-8i8e Tri-Mode Storage Adapter
- 9440-8i – Figure 11, Card Layout for the MegaRAID 9440-8i Tri-Mode Storage Adapter
- 9400-16i – Figure 12, Card Layout of the HBA SAS 9400-16i Storage Adapter
- 9400-8i – Figure 12, Card Layout of the HBA SAS 9400-16i Storage Adapter
- 9400-16e – Figure 14, Card Layout of the HBA 9400-16e Tri-Mode Storage Adapter
- 9400-8e – Figure 14, Card Layout of the HBA 9400-16e Tri-Mode Storage Adapter

The following table indicates how the connectors map to the PDB for each board.

Table 5 Board Lanes-to-PDB Core Associations

Board	Connector 0 Lanes 7, 5, 3, 1	Connector 1 Lanes 6, 4, 2, 0	Connector 2 Lanes 7, 5, 3, 1	Connector 3 Lanes 6, 4, 2, 0
9460-16i	PDB 1	PDB 1	PDB 0	PDB 0
9460-8i	PDB 0	PDB 0	N/A	N/A
9480-8i8e[a]	PDB 0	PDB 0	N/A	N/A
9440-8i	PDB 0	PDB 0	N/A	N/A
9400-16i	PDB 1	PDB 1	PDB 0	PDB 0
9400-8i	PDB 0	PDB 0	N/A	N/A
9400-16e[a]	N/A	N/A	N/A	N/A
9400-8e[a]	N/A	N/A	N/A	N/A

a. NVMe Connect not supported for external connections

The following tables indicate options to connect NVMe drives to the Tri-Mode storage adapters. The connectors are labeled on the board as C0, C1, C2, and C3. The even PCIe lanes are routed to the odd connectors and the odd PCIe lanes are routed to the even connectors. For more information about connecting to NVMe or PCIe devices, see Chapter 5, Cables and Cabling Configurations.

The following tables demonstrate NVMe/PCIe storage connectivity options for the Tri-Mode adapters. For mixed-mode topologies of both NVMe/PCIe and SAS/SATA, source PCIe off one group of eight PHYs (single PDB) and SAS/SATA off of the other set of eight PHYs (single SAS core).

Table 6 PDB1 NVMe Connection Options for 16-Port Internal Adapters

PDB1/SAS Core 1							
C1 L0	C0 L1	C1 L2	C0 L3	C1 L0	C0 L1	C1 L2	C0 L3
x4 NVMe DA or PCIe Switch				x4 NVMe DA or PCIe Switch			
x4 NVMe DA							
x2 NVMe DA		x2 NVMe DA		x2 NVMe DA		x2 NVMe DA	

Table 7 PDB0 NVMe Connection Options for 16-Port Internal Adapters

PDB0/SAS Core 0							
C3 L0	C2 L1	C3 L2	C2 L3	C3 L0	C2 L1	C3 L2	C2 L3
x4 NVMe DA or PCIe Switch				x4 NVMe DA or PCIe Switch			
x2 NVMe DA		x2 NVMe DA		x2 NVMe DA		x2 NVMe DA	

For 8-port internal adapters, Connector 0 and Connector 1 are associated with PDB0 instead of PDB1, as in the case of the 16-port adapters. The following table shows the connections options for 8-port adapters.

Table 8 PDB0 NVMe Connection Options for 8-Port Internal Adapters

PDB0/SAS Core 0							
C1 L0	C0 L1	C1 L2	C0 L3	C1 L0	C0 L1	C1 L2	C0 L3
x4 NVMe DA or PCIe Switch				x4 NVMe DA or PCIe Switch			
x2 NVMe DA		x2 NVMe DA		x2 NVMe DA		x2 NVMe DA	

3.3 Common REFCLK Support

For connections requiring a common REFCLK, one REFCLK is supplied per connector. For x4 NVMe or PCIe switch connections, the REFCLK sourced by each connector directly clocks each attached x4 PCIe connection. To directly attach x2 NVMe drives that require a common REFCLK, where more than one drive is sourced from a single connector, take care to properly fan-out the shared REFCLK on the backplane.

Chapter 4: Mid-Plane Management

The SFF-8448 standard defines how to detect whether the mid-plane supports SGPIO or 2Wire (I^2C) for SAS/SATA usage. SFF-9402 is a superset of SFF-8448, adding PCIe-defined side-band signal, which means that SAS/SATA users see no change in mid-plane management detection when using Tri-Mode storage adapters.

The following table describes the behavior of these signals in each mode of operation.

Name	Setting	Description
BP_TYPE	0 = SGPIO 1 = 2Wire	BP_TYPE follows SFF-8448 defined behavior. Additionally, SGPIO is not available when using drives that require shared REFCLK. Therefore mid-planes must be set to 2Wire when using shared REFCLK.
CNTRLR_TYPE/CPRSNT#	If BP_TYPE = 0: CNTRLR_TYPE = BP_TYPE If BP_TYPE = 1: 0 = x4 NVMe drive 1 = x4 NVME drive not in place or using in SAS mode	CONTRLR_TYPE is an open drain driven signal when operating in SAS/SATA mode. When operating in PCIe (NVMe) mode and BP_TYPE indicates 2Wire, the signal indicates the connected component is an x4-capable PCIe interface.

For PCIe or NVMe connections requiring shared REFCLK, it is not possible to use SGPIO for mid-plane management. As shown in the connector tables in Chapter 3, Tri-Mode Storage Interface, REFCLK shares the same signal as SGPIO on the Mini SAS HD connector. Because they share the same signals, mid-plane management, specifically LED management, needs to be done over the I^2C or 2Wire signals.

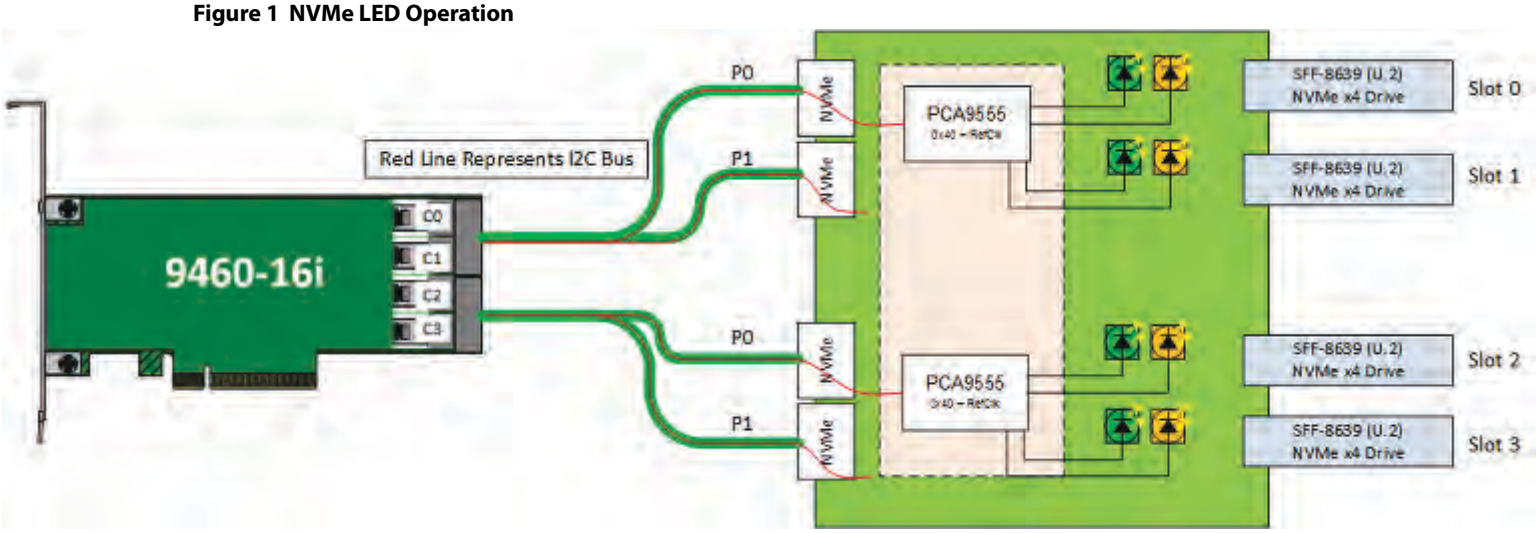
4.1 SAS/SATA LED Operation

SAS/SATA LED management is supported by SGPIO. The functionality is described in SFF-8485 specification. A SAS/SATA backplane pulls BP_TYPE low, indicating to the controller that SGPIO is in use.

4.2 NVMe LED Operation

The adapter provides LED operation for NVMe devices based on the Virtual Pin Port (VPP) over I2C definition. Standard VPP implementation calls for one PCA9555 targets per two devices. For each drive pair, the adapter expects to see one PCA9555 target responding to address 0x40 on each pair of NVMe drives. Each leg of the U.2 Enabler cable needs to connect to adjacent drives, otherwise the LEDs might not work properly. It does not matter which leg of the cable is plugged into which connector pair as long as adjacent pairs are used. The following figure shows expected connections to NVMe drives using VPP over I2C for LED management.

Figure 1 NVMe LED Operation



Chapter 5: Cables and Cabling Configurations

5.1 x4 PCIe (NVMe) Storage Interface Cabling

Direct attach connections to backplanes that support x4 NVMe U.2 drives or to a x4 PCIe switch attach require use of the U.2 Enabler Cable. The U.2 Enabler Cable provides proper REFCLK pairing and shielding and enables the adapter to support VPP over I2C for LED management. The U.2 Enabler Cable has a 1x8 Mini SAS HD connector on the PCIe adapter side and provides connections to either OCuLink, SlimLine or Mini SAS HD for the backplane NVMe connection. The following figure hows an example of a U.2 Enabler Cable.

Figure 2 U.2 Enabler Cable 1 x8 Mini SAS HD (Adapter Side) to 2 x4 SlimLine

You must pick the proper cable for the given backplane type and connectors. The correct choice is especially important for backplanes that use Mini SAS HD for the NVMe connectors. Many of these backplanes use an older legacy-recommended pinout for the NVMe connector instead of a connector pinout based on the SFF-9402 specification. Most backplanes that use either OCuLink or SlimLine follow the SFF-9402 specification. The pinout recommended in the PCIe OCuLink Specification is equivalent to that recommended for SFF-9402. Verify the connector pinout for the backplane targeted to make sure the proper cable is used when connecting to NVMe drives.

5.2 Backplanes with Mini SAS HD Connectors

Many Grantley and Purley generation backplanes that support NVMe use white Mini SAS HD connectors to indicate which connectors are for NVMe and which are for SAS/SATA. The backplanes have the protocol screen printed on the backplane near the connectors. The following table provides the legacy PCIe Mini SAS HD connector pinout that you may use on Mini SAS HD based NVMe backplanes.

Table 9 Legacy PCIe Over Mini SAS HD Backplane Connector pinout

Pin	Description		Pin	Description
D1	BMC_SMB_CLK		B1	GND
D2	BMC_SMB_DAT		B2	PE_RST_N
D3	GND		B3	GND
D4	TX0_P		B4	RX0_P
D5	TX0_N		B5	RX0_N
D6	GND		B6	GND
D7	TX2_P		B7	RX2_P
D8	TX2_N		B8	RX2_N
D9	GND		B9	GND
C1	CPU_SMB_CLK		A1	PCIE_CLK_100M_N
C2	CPU_SMB_DAT		A2	PCIE_CLK_100M_P
C3	GND		A3	GND
C4	TX1_P		A4	RX1_P
C5	TX1_N		A5	RX1_N
C6	GND		A6	GND
C7	TX3_P		A7	RX3_P
C8	TX3_N		A8	RX3_N
C9	GND		A9	GND

NOTE TX signals indicate outputs from backplane connector; RX signals indicate inputs to backplane connector.

NOTE The pinout in this table is not the pinout used on the Broadcom Tri-Mode adapter. For Tri-Mode versatility (support for SAS and NVMe), the adapters follow the SFF-9402 pinout.

5.3 Backplanes with OCuLink or SlimLine Connectors

The preferred connector to use for NVMe backplane connectors is either OCuLink or SlimLine. This approach enables a straightforward keying mechanism to prevent connecting NVMe drives with standard 12 Gb/s SAS cables.

Backplanes using OCuLink connectors should follow the PCI Express OCuLink Specification. This pinout is also equivalent to the SFF-9402 specification recommendations. Verify the backplane connector pinout to make sure you use proper cabling to the NVMe drive. See the PCI Express OCuLink Specification and the SFF-9402 specification for backplane NVMe connector pinout information.

Chapter 6: Configuration Scenarios

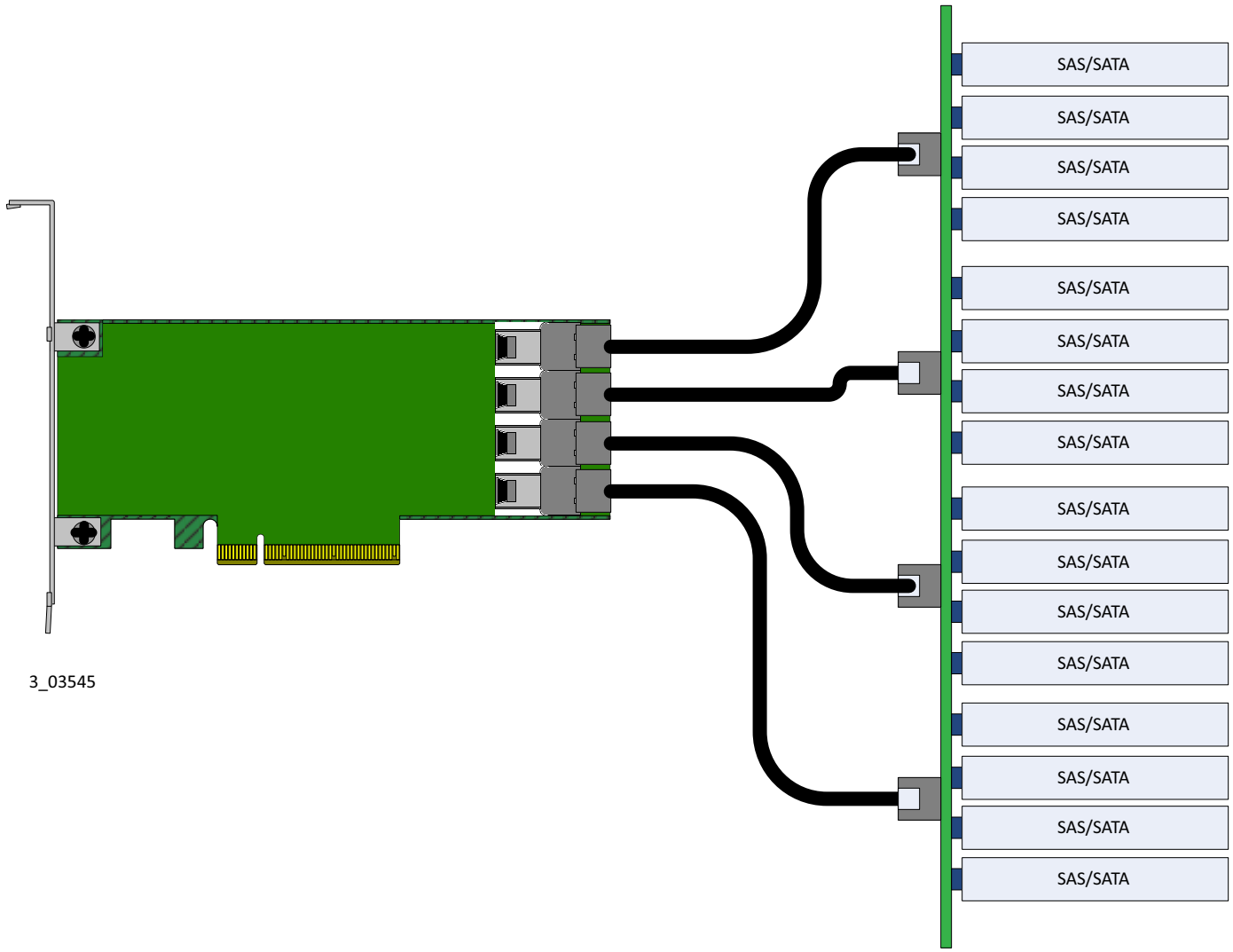
The following section describes various configuration scenarios for the internal port count boards. This list of scenarios is not exhaustive, but it shows some of the different options available. Each scenario includes a view of the cabling between the adapter and the mid-plane.

6.1 SAS/SATA Connect

The Tri-Mode adapters support connections to SAS/SATA drives or SAS expanders using standard 12Gb/s SAS cables. The adapter supports connections to both single-ported and dual-ported SAS drives. See Section 3.1, SAS/SATA Support for more information on using wide port SAS connections on 16-port adapters.

The following figure shows a typical direct attach SAS/SATA configuration. Using expanders, the number of drives attached to a single adapter can be increased.

Figure 3 Standard 12 Gb/s SAS Cable Attach

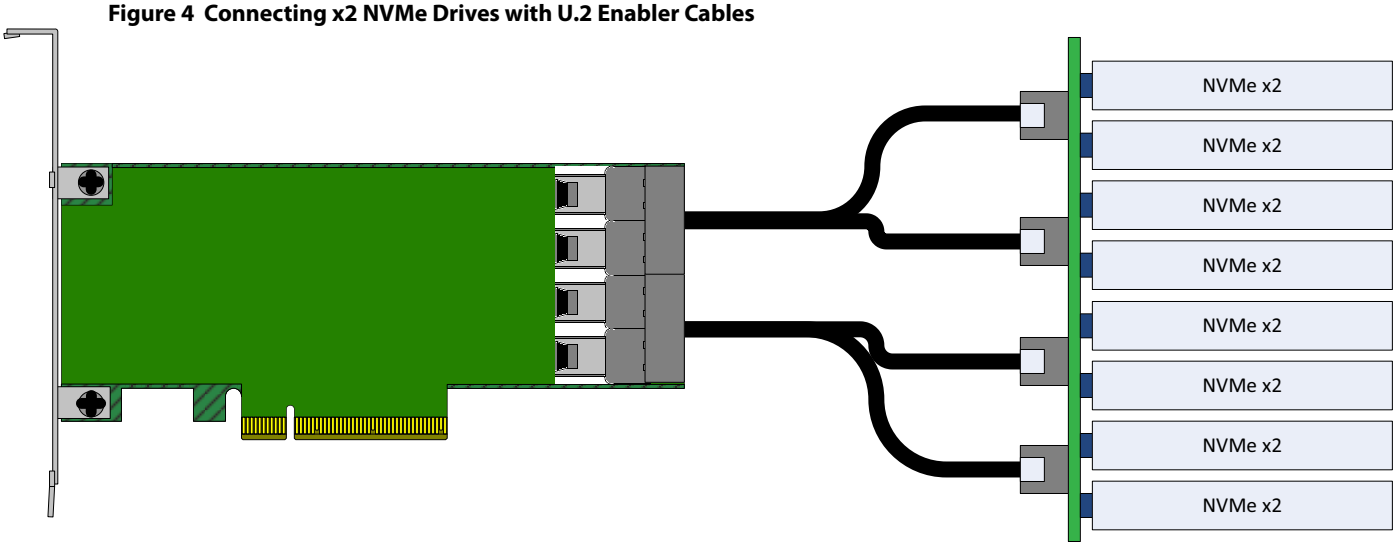


6.2 x2 NVMe Direct Attach

The following figure shows eight x2 NVMe drives attaching directly to the adapter. Each drive must be connected using adjacent lanes and stay within the same PCIe Device Bridge (PDB). Refer to Section 3.2, NVMe Support, for more information on PDB and connector arrangement. Avoid improper connection scenarios by designing the backplane NVMe connectors based on the SFF-9402 pin-out standard and using the available U.2 Enabler Cables described in Chapter 5, Cables and Cabling Configurations.

One REFCLK is supplied per connector. To directly attach x2 NVMe where more than one drive is sourced from a single connector, take care to properly fan-out the shared REFCLK on the backplane.

Figure 4 Connecting x2 NVMe Drives with U.2 Enabler Cables

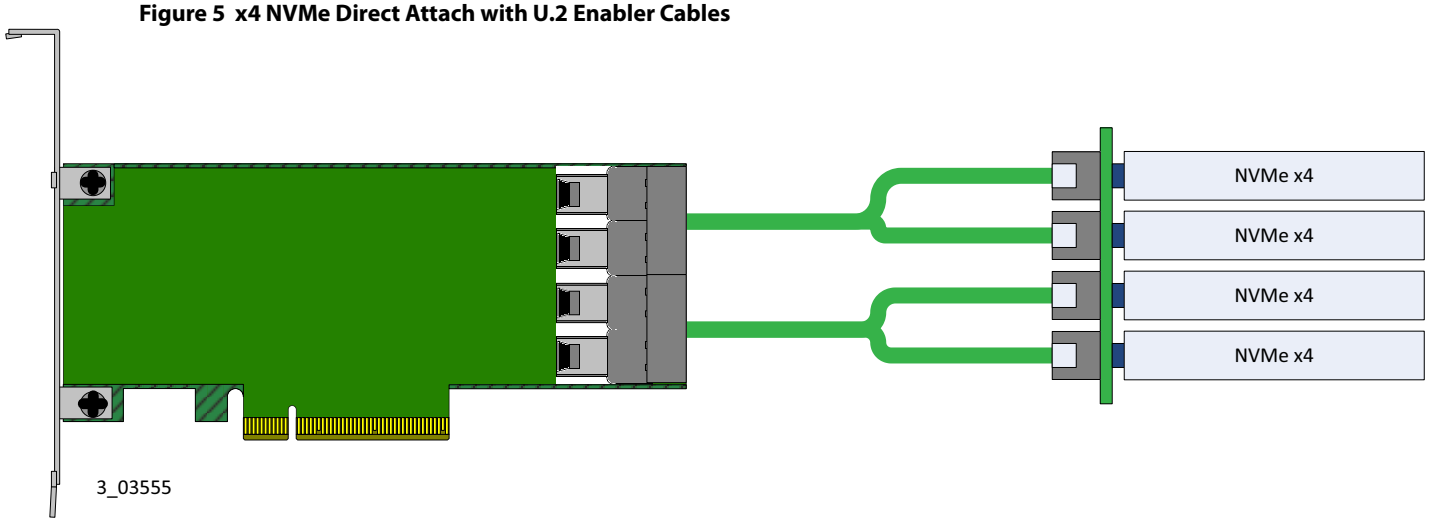


3_03549

6.3 x4 NVMe Direct Attach

The following figure shows attaching four x4 NVMe drives directly to the adapter. Each drive must be connected using adjacent lanes and stay within the same PCIe Device Bridge (PDB). Connectors 0 and 1 can connect to two x4 NVMe drives and connectors 2 and 3 can connector to two x4 NVMe drives. See Table 5, Board Lanes-to-PDB Core Associations for more information on PDB and connector arrangement. Avoid improper connection scenarios by designing the backplane NVMe connectors based on the SFF-9402 pin-out standard and using the available U.2 Enabler Cables described in Chapter 5, Cables and Cabling Configurations.

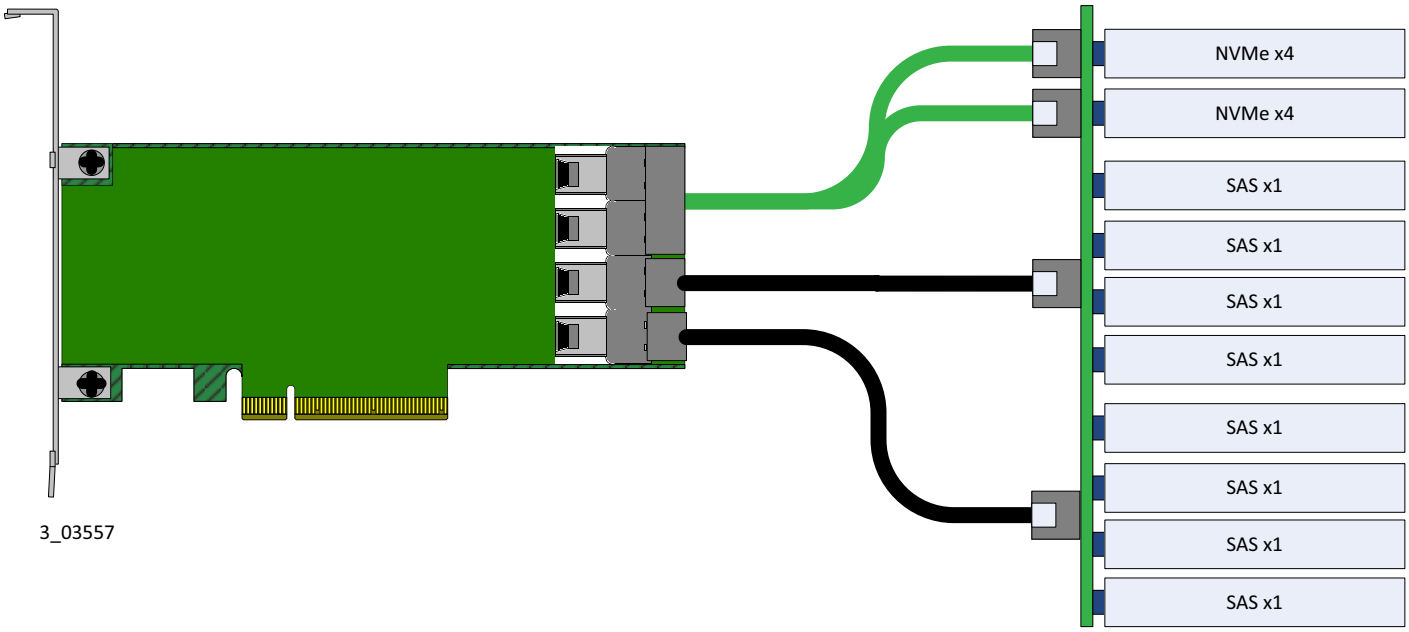
Figure 5 x4 NVMe Direct Attach with U.2 Enabler Cables



6.4 x4 NVMe and x1 SAS Direct Attach

The following figure shows two x4 NVMe drives and eight x1 SAS attaching directly to the adapter. The x4 NVMe drives require use of the U.2 Enabler Cable described in Chapter 5, Cables and Cabling Configurations, and the SAS drives use standard 12Gb/s SAS cables. Each x4 NVMe drive must be connected using adjacent lanes within a single PDB. The figure shows using connectors 0 and 1 for the NVMe connections and connectors 2 and 3 for the SAS connections. This arrangement can be reversed, so that connectors 2 and 3 are used for the NVMe connections and connectors 0 and 1 are used for the SAS connections.

Figure 6 x4 NVMe and x1 SAS Direct Attach



Chapter 7: CacheVault Data Protection

The MegaRAID Tri-Mode Adapters support data retention by using NAND flash memory down on the adapter, backed up by a Cache-Vault Power Module 05 (CVPM05).

NOTE The 9440-8i Tri-Mode iMR Adapter and the HBAs do not support CacheVault Data Protection.

The CVPM05 module is a super-capacitor pack that provides power for the backup of your data in case of host power loss or server failure. The CVPM05 module is connected to the controller remotely by cable. The data is backed up to the NAND flash memory available on the MegaRAID storage adapter.

In the event of host power loss or server failure, any data available in the cache is offloaded to the on-board NAND memory. During this process, the necessary components needed for offload are powered by the CVPM03 power module.

NOTE You cannot hot-plug CVPM05 modules. Removing or inserting a CVPM05 module with the adapter powered on might damage the board and the super-capacitor functionality. To attach or remove a CVPM05 module from an adapter, you must fully power down the adapter before you attach the module to or remove the module from its mating connector.

For more information on installation of the CVPM05 module, refer to the *CacheVault Power Module 05 (CVPM05) Getting Started Guide* available at http://www.broadcom.com/support/download-search.

Chapter 8: Adapter Installation Instructions

8.1 Hardware Installation

This section provides detailed instructions on how to install your Tri-Mode Storage Adapter.

NOTE The figure in this section shows the installation of the MegaRAID 9480-8i8e Tri-Mode storage adapter in a PCIe slot. You can install other Tri-Mode storage adapters in the same way.

To install the adapter, follow these steps:

1. **Unpack your Tri-Mode storage adapter.**

   Unpack and remove the adapter. Inspect it for damage. If it appears damaged, contact your Avago Customer and Technical Support representative.

   ATTENTION To avoid the risk of data loss, back up your data before you change your system configuration.

2. **Turn off the power to the system.**

   Turn off the power to the computer, and disconnect the AC power cord. Remove the computer cover. Refer to the system documentation for instructions. Before you install the controller, make sure that the computer is disconnected from the power and from any networks.

   CAUTION Disconnect the computer from the power supply and from any networks to which you will install the adapter, or you risk damaging the system or experiencing electrical shock.

3. **Review the adapter jumpers and connectors.**

   The jumpers are set at the factory, and you usually do not need to change them. See Chapter 9, Broadcom MegaRAID and HBA Tri-Mode Storage Adapter Characteristics, for diagrams of the Tri-Mode Adapters that show their jumpers and connectors.

4. **Check the mounting bracket on the adapter.** If required for your system, replace the full-height mounting bracket that ships on the adapter with the low-profile bracket supplied. Complete the following steps to attach the short bracket.
   a. Using a #1 Phillips screwdriver that is ESD safe, remove the two Phillips screws that connect the full-profile bracket to the board. Unscrew the two screws located at the top and bottom edges of the board. Avoid touching any board components with the screwdriver or the bracket.
   b. Remove the full-profile bracket. Do not damage the adapter.
   c. Place the adapter on top of the low-profile bracket. Position the bracket so that the screw holes in the tabs align with the openings in the board.
   d. Using a #1 Phillips torque screwdriver that is ESD safe, set to a maximum torque of 4.8 ± 0.5 inch-pounds. Replace the two Phillips screws removed in step a.

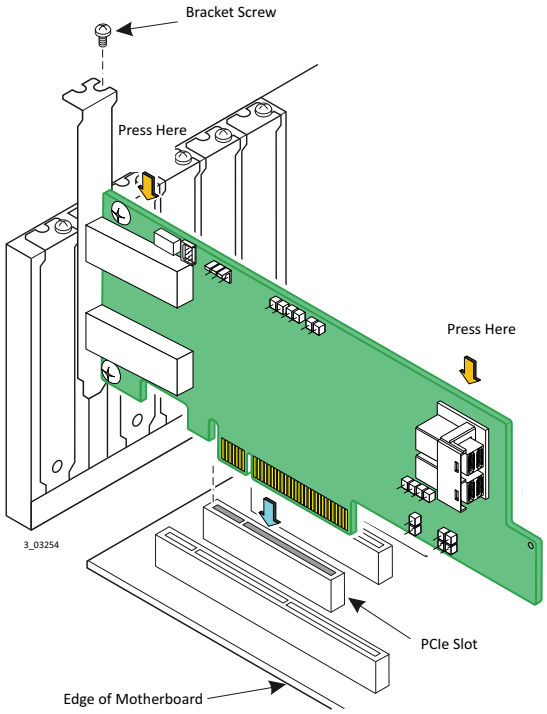
      ATTENTION Exceeding this torque specification can damage the board, connectors, or screws, and can void the warranty on the board.

      ATTENTION Damage caused to the board as a result of changing the bracket can void the warranty on the board. Adapters returned without a bracket mounted on the board will be returned without return merchandise authorization (RMA) processing.

5. **Insert the Tri-Mode adapter into an available PCIe slot.** Select a PCIe slot, and align the controller's PCIe bus connector to the slot, as shown in the following figure. Press down gently, but firmly, to make sure that the card is seated correctly in the slot. Secure the bracket to the computer chassis with the bracket screw.

   NOTE Adapters with an x8 host interface can operate in x8 or x16 slots. However, some x16 PCIe slots support only PCIe graphics cards; an adapter installed in one of these slots will not function. Refer to the guide for your motherboard for information about the PCIe slot.

Figure 7 Installing the MegaRAID 9480-8i8e Tri-Mode Storage Adapter in a PCIe Slot



6. **Configure and install the SAS, SATA, and NVMe devices in the host computer case.**

   Refer to the documentation for the devices for any pre-installation configuration requirements.

7. **Connect the Tri-Mode adapter to the devices.**

   For SAS/SATA connections, connect standard 12Gb/s SAS cables with an internal Mini SAS HD connector on one end to connect to the controller and the appropriate connector on the other end to attach to the backplane or SAS/SATA devices.

   For NVMe connections, special cables are needed depending on the type of NVMe drive in use. The adapter connector's pin definitions follow the SFF-9402 specification and cables must support this connector pin definition. For more information on types of cables needed for NVMe connectivity, see Chapter 5, Cables and Cabling Configurations.

   CAUTION For NVMe connections to a SFF-8639 (U.2) bay or connections to a PCIe switch, use only approved cables with REFCLK forwarded on the proper pins. Improperly connecting a standard 12G SAS cable to a SFF-8639 bay could damage the PCIe storage adapter and the drive.

   The maximum cable length is 1 meter (39.37 in.). A single wide port SAS or multi-lane NVMe device cannot connect to PHYs controlled by different SAS cores or PDBs. See Chapter 3, Tri-Mode Storage Interface for more information.

8. **Turn on the power to the system.**

   Reinstall the computer cover, and reconnect the AC power cords. Turn on power to the host computer. Make sure that the power is turned on to the storage devices before or at the same time that the power is turned on to the host computer. If the computer is powered on before these devices, the devices might not be recognized

   During boot, a BIOS message appears. The firmware takes several seconds to initialize. The configuration utility prompt times out after several seconds. The second portion of the BIOS message shows the adapter controller number, firmware version, and cache SDRAM size. The numbering of the controllers follows the PCI slot scanning order used by the host motherboard.

9. **Run the WebBIOS Configuration Utility.**

   Run the WebBIOS Configuration Utility to configure the drive groups and the virtual drives. When the message Press CTRL+H for WebBIOS appears on the screen, immediately press Ctrl+H to run the utility.

10. **Install the operating system driver.**

    The Tri-Mode adapters can operate under various operating systems. To operate under these operating systems, you must install the software drivers. The firmware and drivers are routinely updated and made available on the Support and Download center. Please visit http://www.broadcom.com/support/download-search and download the latest firmware and driver for the controller.

The hardware installation of your Tri-Mode storage adapter is complete.

Chapter 9: Broadcom MegaRAID and HBA Tri-Mode Storage Adapter Characteristics

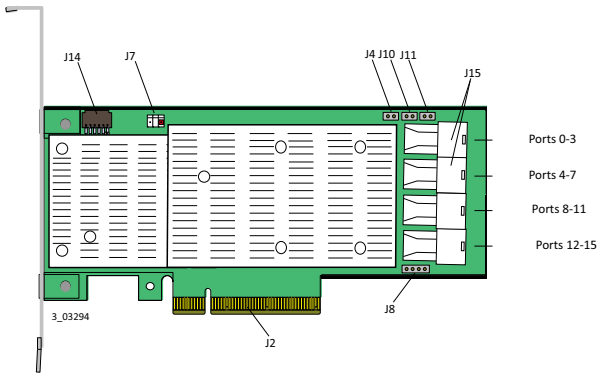
9.1 MegaRAID 9460-16i Tri-Mode Adapter – Board Layout, and Jumper and Connector Information

The MegaRAID 9460-16i Tri-Mode storage adapter is a 6.127" x 2.712" (155.65 mm x 68.90 mm) board. The component height on the top and bottom of the adapter complies with the PCIe specification. This subsection provides the board layout, and the connector and jumper information for the MegaRAID 9460-16i Tri-Mode storage adapter.

The following figure shows the jumpers and the connectors on the MegaRAID 9460-16i storage adapter.

NOTE Pin 1 on the headers and connectors is highlighted in red in this figure.

Figure 8 Card Layout for the MegaRAID 9460-16i Tri-Mode Storage Adapter



The following table describes the jumpers and the connectors on the MegaRAID 9460-16i storage adapter.

Table 10 Jumpers and Connectors

Jumper/Connector	Type	Description
J2	Standard edge card connector	The interface between the storage adapter and the host system. Along with the PCIe interface, this connector provides power to the board and an I^2C interface connected to the I^2C bus for the Intelligent Platform Management Interface (IPMI).
J4	Default Serial boot ROM (SBR) header	2-pin connector Reserved for Broadcom use.
J7	RAID Premium Key Feature header	3-pin connector Reserved for Broadcom use.
J8	On-board Serial Universal Asynchronous Receiver/Transmitter (UART) connector	4-pin connector Reserved for Broadcom use.
J10	Global hard disk drive (HDD) activity LED header	2-pin connector Connects to an LED that indicates activity on the drives connected to the controller.

Table 10 Jumpers and Connectors (Continued)

Jumper/Connector	Type	Description
J11	Global drive fault LED header	2-pin connector Connects to an LED that indicates whether a drive is in a fault condition
J14	CacheVault Power Module interface	9-pin connector Connects the storage adapter to a CacheVault power module.
J15	Quad x4 SAS Port 0 through Port 15 internal connector	Four SFF-8643 mini-SAS HD-4i internal connectors Connects the controller by cable to SAS drives or SATA drives.

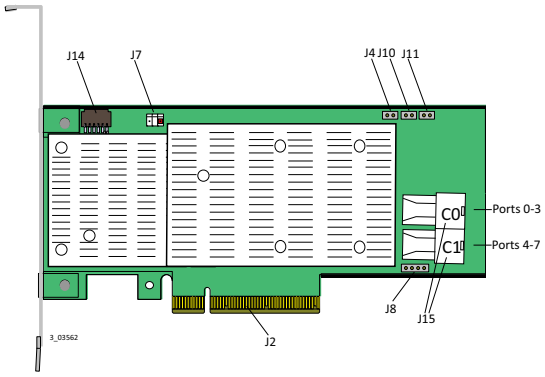
9.2 MegaRAID 9460-8i Tri-Mode Storage Adapter – Board Layout, and Jumper and Connector Information

The MegaRAID 9460-8i Tri-Mode storage adapter is a 6.127″ x 2.712″ (155.65 mm x 68.90 mm) board. The component height on the top and bottom of the adapter complies with the PCIe specification. This subsection provides the board layout, and the connector and jumper information for the MegaRAID 9460-8i Tri-Mode storage adapter.

The following figure shows the jumpers and the connectors on the MegaRAID 9460-8i storage adapter.

NOTE Pin 1 on the headers and connectors is highlighted in red in this figure.

Figure 9 Card Layout for the MegaRAID 9460-8i Tri-Mode Storage Adapter



The following table describes the jumpers and the connectors on the MegaRAID 9460-8i storage adapter.

Table 11 Jumpers and Connectors

Jumper/Connector	Type	Description
J2	Standard edge card connector	The interface between the storage adapter and the host system. Along with the PCIe interface, this connector provides power to the board and an I^2C interface connected to the I^2C bus for the Intelligent Platform Management Interface (IPMI).
J4	Default Serial boot ROM (SBR) header	2-pin connector Reserved for Broadcom use.
J7	RAID Premium Key Feature header	3-pin connector Reserved for Broadcom use.
J8	On-board Serial Universal Asynchronous Receiver/Transmitter (UART) connector	4-pin connector Reserved for Broadcom use.
J10	Global hard disk drive (HDD) activity LED header	2-pin connector Connects to an LED that indicates activity on the drives connected to the controller.
J11	Global drive fault LED header	2-pin connector Connects to an LED that indicates whether a drive is in a fault condition
J14	CacheVault Power Module interface	9-pin connector Connects the storage adapter to a CacheVault power module.
J15	Dual x4 SAS Port 0 through Port 7 internal connector	Two SFF-8643 mini-SAS HD-4i internal connectors Connects the controller by cable to SAS drives or SATA drives.

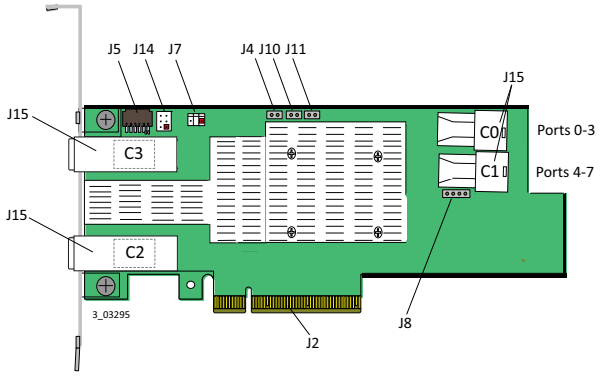
9.3 MegaRAID 9480-8i8e Tri-Mode Storage Adapter – Board Layout, and Jumper and Connector Information

The MegaRAID 9480-8i8e Tri-Mode storage adapter is a 6.600" x 2.712" (167.65 mm x 68.90 mm) board. The component height on the top and bottom of the adapter complies with the PCIe specification. This subsection provides the board layout, and the connector and jumper information for the MegaRAID 9480-8i8e Tri-Mode storage adapter.

The following figure shows the jumpers and the connectors on the controller.

NOTE Pin 1 on the headers and connectors is highlighted in red in this figure.

Figure 10 Card Layout for the MegaRAID 9480-8i8e Tri-Mode Storage Adapter



The following table describes the jumpers and the connectors on the MegaRAID 9480-8i8e storage adapter.

Table 12 Jumpers and Connectors

Jumper/Connector	Type	Description
J2	Standard edge card connector	The interface between the adapter and the host system. Along with the PCIe interface, this connector provides power to the board and an I^2C interface connected to the I^2C bus for the Intelligent Platform Management Interface (IPMI).
J4	Mode Select header	2-pin connector Reserved for Broadcom use.
J5	LED Child Card header	6-pin header Connects to an I2C-based I/O expander that is used to control up to 16 individual LEDs (one per drive), indicating either drive activity or drive status. Additionally, in this I/O expander mode, the buzzer enable signal is routed to the connector, which allows for off-card audible alarms to be created.
J7	Advanced software options hardware key header	2-pin header (middle pin not populated) Enables support for selected advanced features, such as Recovery, CacheCade, FastPath, and SafeStore disk encryption. Refer to the *MegaRAID Advanced Services Hardware Key Quick Installation Guide* for more information.
J8	On-board Serial Universal Asynchronous Receiver/Transmitter (UART) connector	4-pin connector Reserved for Broadcom use.
J10	Global drive fault LED header	2-pin connector Connects to an LED that indicates activity on the drives connected to the controller.
J11	Global hard disk drive (HDD) activity LED header	2-pin connector Connects to an LED that indicates activity on the drives connected to the controller.
J14	CacheVault Power Module interface	9-pin connector Connects the storage adapter to a super-capacitor to provide power to back up your data in case of host power loss or server failure.

Table 12 Jumpers and Connectors (Continued)

Jumper/Connector	Type	Description
J15	SAS Port 0 through Port 7 internal connector	SFF-8643 mini-SAS HD-x2 4i internal connector Connects the controller by cable to SAS drives or SATA drives.
	SAS Port 8 through Port 11 external connector	One SFF-8644 mini-SAS HD-4e external connector Connects the controller by cable to an enclosure containing SAS drives or SATA drives.
	SAS Port 12 through Port 15 external connector	One SFF-8644 mini-SAS HD-4e external connector Connects the adapter by cable to an enclosure containing SAS drives or SATA drives.

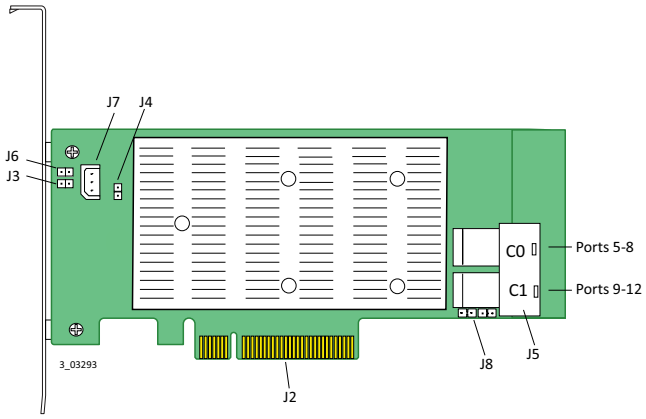
9.4 MegaRAID SAS 9440-8i Tri-Mode Storage Adapter – Board Layout, and Jumper and Connector Information

The MegaRAID 9440-8i Tri-Mode storage adapter is a 6.127" x 2.712" (155.65 mm x 68.90 mm) board. The component height on the top and bottom of the adapter complies with the PCIe specification. This subsection provides the board layout, and the connector and jumper information for the MegaRAID 9440-8i Tri-Mode storage adapter.

The following figure shows the jumpers and the connectors on the controller.

NOTE Pin 1 is highlighted in red in this figure.

Figure 11 Card Layout for the MegaRAID 9440-8i Tri-Mode Storage Adapter



The following table describes the jumpers and the connectors on the MegaRAID 9440-8i Tri-Mode storage adapter.

Table 13 Jumpers and Connectors

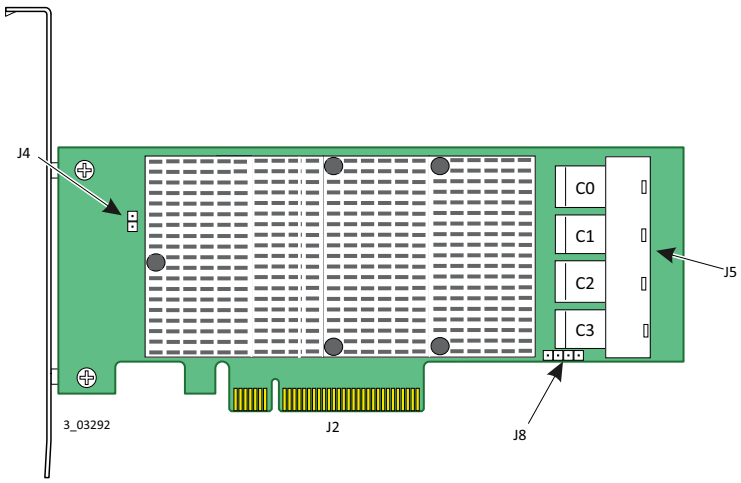
Jumper/Connector	Type	Description
J2	Standard edge card connector	The interface between the adapter and the host system Along with the PCIe interface, this connector provides power to the board and an I^2C interface connected to the I^2C bus for the Intelligent Platform Management Interface (IPMI).
J3	Global drive fault LED header	2-pin connector Connects to an LED that indicates activity on the drives connected to the controller.
J4	Default Serial boot ROM (SBR) header	2-pin connector Reserved for Broadcom use.
J5	Dual x4 SAS Port 0 through Port 7 internal connector	Two SFF-8643 mini-SAS HD-4i internal connectors Connects the controller by cable to SAS drives or SATA drives.
J6	Global hard disk drive (HDD) activity LED header	2-pin connector Connects to an LED that indicates activity on the drives connected to the controller.
J7	RAID Premium Key Feature header	3-pin header Enables support for selected advanced features, such as Recovery, CacheCade®, FastPath, and SafeStore™ disk encryption. Refer to the *MegaRAID Advanced Services Hardware Key Quick Installation Guide* for more information.
J8	On-board Serial Universal Asynchronous Receiver/Transmitter (UART) connector	4-pin port Reserved for Broadcom use.

9.5 HBA 9400-16i Tri-Mode Storage Adapter – Board Layout, and Jumper and Connector Information

The HBA 9400-16i Tri-Mode storage adapter is a 6.127 in. × 2.712 in. (155.65 mm × 68.90 mm) board. The component height on the top and bottom of the HBA Tri-Mode storage adapter complies with the PCIe specification. This subsection provides the board layout, and the connector and jumper information for the HBA 9400-16i Tri-Mode storage adapter.

The following figure shows the HBA board layout for the HBA 9400-16i storage adapter.

Figure 12 Card Layout of the HBA SAS 9400-16i Storage Adapter



The following table describes the jumpers and the connectors on the HBA 9400-16i Tri-Mode storage adapter.

Table 14 Jumpers and Connectors

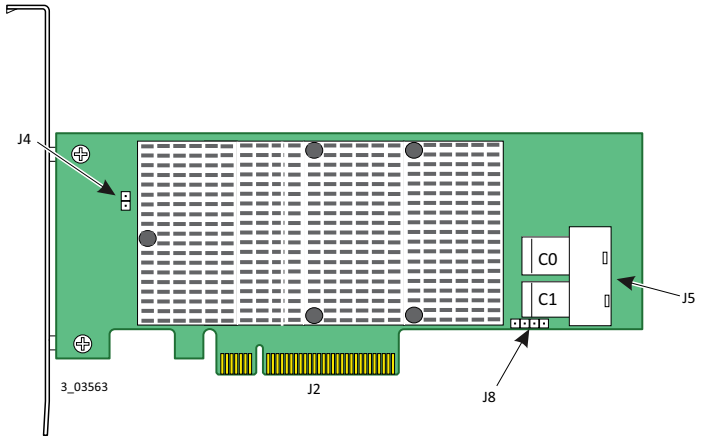
Jumper/Connector	Type	Description
J2	Standard board edge connector	PCIe x8 board edge connector Along with the PCIe interface, this connector provides power to the board and an I^2C interface connected to the I^2C bus for the Intelligent Platform Management Interface (IPMI).
J4	Mode select header	2-pin connector Reserved for Broadcom use.
J5	Quad x4 SAS Port 0 through Port 15 internal connector	Four SFF-8643 Mini-SAS HD internal connectors Connects the controller by cable to SAS drives or SATA drives.
J8	On-board Serial Universal Asynchronous Receiver/Transmitter (UART) connector	4-pin connector Reserved for Broadcom use.

9.6 HBA 9400-8i Tri-Mode Storage Adapter – Board Layout, and Jumper and Connector Information

The HBA 9400-8i Tri-Mode storage adapter is a 6.127 in. × 2.712 in. (155.65 mm × 68.90 mm) board. The component height on the top and bottom of the HBA Tri-Mode storage adapter complies with the PCIe specification. This subsection provides the board layout, and the connector and jumper information for the HBA 9400-8i Tri-Mode storage adapter.

The following figure shows the HBA board layout for the HBA 9400-16i storage adapter.

Figure 13 Card Layout of the HBA SAS 9400-8i Storage Adapter



The following table describes the jumpers and the connectors on the HBA 9400-8i Tri-Mode storage adapter.

Table 15 Jumpers and Connectors

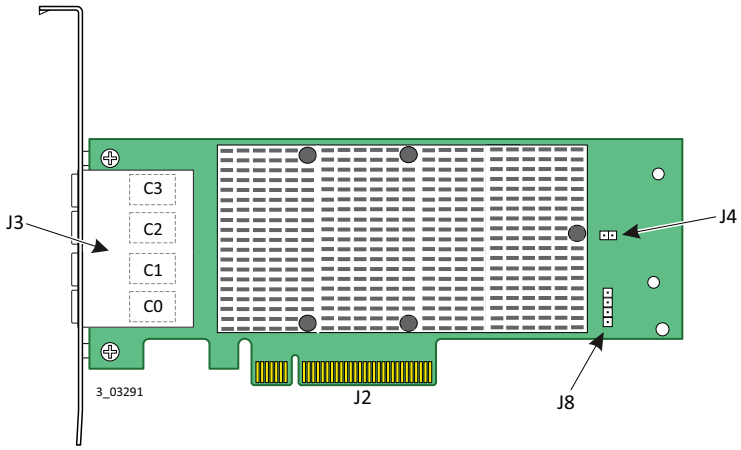
Jumper/Connector	Type	Description
J2	Standard board edge connector	PCIe x8 board edge connector Along with the PCIe interface, this connector provides power to the board and an I^2C interface connected to the I^2C bus for the Intelligent Platform Management Interface (IPMI).
J4	Mode select	2-pin connector Reserved for Broadcom use.
J5	Dual x4 SAS Port 0 through Port 7 internal connector	Two SFF-8643 Mini-SAS HD internal connectors Connects the controller by cable to SAS drives or SATA drives.
J8	On-board Serial Universal Asynchronous Receiver/Transmitter (UART) connector	4-pin connector Reserved for Broadcom use.

9.7 HBA 9400-16e Tri-Mode Storage Adapter – Board Layout, and Jumper and Connector Information

The HBA 9400-16e Tri-Mode storage adapter is a 6.600 in. × 2.712 in. (167.65 mm × 68.90 mm) board. The component height on the top and bottom of the HBA complies with the PCIe specification. The following figure shows the HBA 9400-16e board layout. This subsection provides the board layout, and the connector and jumper information for the HBA 9400-16e Tri-Mode storage adapter.

The following figure shows the HBA board layout for the HBA 9400-16e storage adapter.

Figure 14 Card Layout of the HBA 9400-16e Tri-Mode Storage Adapter



The following table describes the jumpers and the connectors on the HBA 9400-16e Tri-Mode storage adapter.

Table 16 Jumpers and Connectors

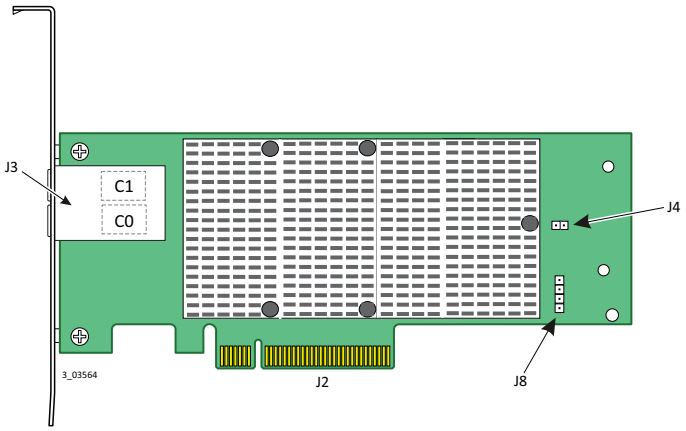
Jumper/Connector	Type	Description
J2	Standard board edge connector	PCIe x8 board edge connector Along with the PCIe interface, this connector provides power to the board and an I^2C interface connected to the I^2C bus for the Intelligent Platform Management Interface (IPMI).
J3	Quad x4 SAS Port 0 through Port 15 external connectors	Four SFF-8644 Mini SAS HD external connectors Connects the controller by cable to SAS drives or SATA drives.
J4	Mode select	2-pin connector Reserved for Broadcom use.
J8	On-board Serial Universal Asynchronous Receiver/Transmitter (UART) connector	4-pin connector Reserved for Broadcom use.

9.8 HBA 9400-8e Tri-Mode Storage Adapter – Board Layout, and Jumper and Connector Information

The HBA 9400-8e Tri-Mode storage adapter is a 6.600 in. × 2.712 in. (167.65 mm × 68.90 mm) board. The component height on the top and bottom of the HBA complies with the PCIe specification. The following figure shows the HBA 9400-8e board layout. This subsection provides the board layout, and the connector and jumper information for the HBA 9400-8e Tri-Mode storage adapter.

The following table describes the jumpers and the connectors on the HBA 9400-8e Tri-Mode storage adapter.

Figure 15 Card Layout of the HBA 9400-8e Tri-Mode Storage Adapter



The following table describes the jumpers and the connectors on the HBA 9400-8e Tri-Mode storage adapter.

Table 17 Jumpers and Connectors

Jumper/Connector	Type	Description
J2	Standard board edge connector	PCIe x8 board edge connector Along with the PCIe interface, this connector provides power to the board and an I^2C interface connected to the I^2C bus for the Intelligent Platform Management Interface (IPMI).
J3	Quad x4 SAS Port 0 through Port 7 external connectors	Two SFF-8644 Mini SAS HD external connectors Connects the controller by cable to SAS drives or SATA drives.
J4	Mode select	2-pin connector Reserved for Broadcom use.
J8	On-board Serial Universal Asynchronous Receiver/Transmitter (UART) connector	4-pin connector Reserved for Broadcom use.

Chapter 10: Tri-Mode Storage Adapter Technical Specifications

10.1 Thermal and Atmospheric Requirements for the MegaRAID 9440-16i Tri-Mode Storage Adapter

For the MegaRAID 9440-16i Tri-Mode storage adapter, the operating (thermal and atmospheric) conditions are as follows:

- Relative humidity range is 20 percent to 80 percent non-condensing
- Airflow must be at least 200 linear feet per minute (LFPM) to avoid operating the board components above their maximum rated junction temperatures
- Temperature range: 10°C to +55°C

The parameters for the non-operating (such as storage and transit) environment for these controllers are as follows:

- Relative humidity range is 5 percent to 95 percent non-condensing.
- Temperature range: –40°C to +70°C

10.2 Power Supply Requirements for the MegaRAID 9440-16i Tri-Mode Storage Adapter

All power is supplied to the MegaRAID 9440-16i Tri-Mode storage adapter through the PCIe 3.3V rails and the 12V rail. Onboard switching regulator circuitry operating from the 3.3V rails and the 12V rail provides the necessary voltages. The following states describe the typical and worst case current consumption of the controller.

Typical power is measured with maximum I/O traffic, typical silicon process material, and nominal voltages operating the card at an ambient temperature of 45°C degrees with required airflow.

The supply voltages supplied by the PCIe edge connector are 12V ± 8 percent and 3.3V ± 9 percent.

The following table describes the typical power consumption of the adapter.

Table 18 Typical Power Consumption for the MegaRAID 9440-16i Tri-Mode Storage Adapter

Power Mode	Typical Power
3.3V Supply	1.6W
+ 12 Supply	8.42W
3.3V Auxillary Supply	0.03W
Total Power	10.05W

10.3 Thermal and Atmospheric Requirements for MegaRAID 9460-8i Tri-Mode Storage Adapters

For the MegaRAID 9460-8i Tri-Mode Storage Adapter, the operating (thermal and atmospheric) conditions are as follows:

- Relative humidity range is 20 percent to 80 percent non-condensing

- Airflow must be at least 250 linear feet per minute (LFPM) to avoid operating the board components above their maximum rated junction temperatures
- Temperature range: 10 °C to +55 °C (with or without the CVFM05 module attached)

NOTE To maximize the lifespan of the CVPM module, keep the ambient temperature as low as possible.

The parameters for the non-operating (such as storage and transit) environment for these controllers are as follows:

- Relative humidity range is 5 percent to 95 percent non-condensing.
- Temperature range: –40 °C to +70 °C

10.4 Power Supply Requirements for the MegaRAID 9460-8i Tri-Mode Storage Adapter

All power is supplied to the MegaRAID 9460-8i Tri-Mode Storage Adapter through the PCIe 3.3V rails and the 12V rail. Onboard switching regulator circuitry operating from the 3.3V rails and the 12V rail provides the necessary voltages. The following states describe the typical power consumption of the controller.

Typical power is measured with maximum I/O traffic, typical silicon process material, and nominal voltages operating the card at an ambient temperature of 45°C degrees with required airflow.

The supply voltages supplied by the PCIe edge connector are 12V ± 8 percent and 3.3V ± 9 percent.

The following table describes the typical power consumption of the adapter.

Table 19 Typical Power Consumption for the MegaRAID 9460-8i Tri-Mode Storage Adapter

Power Mode	Typical Power
3.3V Supply	0.28W
+ 12 Supply	13.80W
3.3V Auxillary Supply	0.08W
Total Power	14.16W

During the transparent learn cycle, the CacheVault power module consumes up to an additional 6W. The power for the learn cycle is supplied from the PCIe 3.3V rail.

10.5 Thermal and Atmospheric Requirements for the MegaRAID 9460-16i Tri-Mode Storage Adapter

For the MegaRAID 9460-16i Tri-Mode storage adapter, the operating (thermal and atmospheric) conditions are as follows:

- Relative humidity range is 20 percent to 80 percent non-condensing
- Airflow must be at least 250 linear feet per minute (LFPM) to avoid operating the board components above their maximum rated junction temperatures
- Temperature range: 10°C to +55°C (with or without the CVFM05 module attached)

NOTE To maximize the lifespan of the CVPM module, keep the ambient temperature as low as possible.

The parameters for the non-operating (such as storage and transit) environment for these controllers are as follows:

- Relative humidity range is 5 percent to 95 percent non-condensing.
- Temperature range: –40°C to +70°C

10.6 Power Supply Requirements for the MegaRAID 9460-16i Tri-Mode Storage Adapter

All power is supplied to the MegaRAID 9460-16i Tri-Mode storage Adapter through the PCIe 3.3V rails and the 12V rail. Onboard switching regulator circuitry operating from the 3.3V rails and the 12V rail provides the necessary voltages. The following states describe the typical power consumption of the controller.

Typical power is measured with maximum I/O traffic, typical silicon process material, and nominal voltages operating the card at an ambient temperature of 45°C degrees with required airflow.

The supply voltages supplied by the PCIe edge connector are 12V ± 8 percent and 3.3V ± 9 percent.

The following table describes the typical power consumption of the adapter.

Table 20 Typical Power Consumption for the MegaRAID 9460-16i Tri-Mode Storage Adapter

Power Mode	Typical Power
3.3V Supply	0.28W
+ 12 Supply	16.7W
3.3V Auxillary Supply	0.08W
Total Power	17.02W

During the transparent learn cycle, the CacheVault Power Module consumes up to an additional 6W. The power for the learn cycle is supplied from the PCIe 3.3V rail.

10.7 Thermal and Atmospheric Requirements for the MegaRAID 9480-8i8e Tri-Mode Storage Adapter

For the MegaRAID 9480-8i8e Tri-Mode storage adapter, the operating (thermal and atmospheric) conditions are as follows:

- Relative humidity range is 20 percent to 80 percent non-condensing
- Airflow must be at least 200 linear feet per minute (LFPM) to avoid operating the board components above their maximum rated junction temperatures
- Temperature range: 10°C to +55°C (with or without the CVFM05 module attached)

NOTE To maximize the lifespan of the CVPM module, keep the ambient temperature as low as possible.

The parameters for the non-operating (such as storage and transit) environment for these controllers are as follows:

- Relative humidity range is 5 percent to 95 percent non-condensing.
- Temperature range: –40°C to +70°C

10.8 Power Supply Requirements for the MegaRAID 9480-8i8e Tri-Mode Storage Adapter

All power is supplied to the MegaRAID 9480-8i8e Tri-Mode storage adapter through the PCIe 3.3V rails and the 12V rail. Onboard switching regulator circuitry operating from the 3.3V rails and the 12V rail provides the necessary voltages. The following states describe the typical power consumption of the controller.

Typical power is measured with maximum I/O traffic, typical silicon process material, and nominal voltages operating the card at an ambient temperature of 45°C degrees with required airflow.

The supply voltages supplied by the PCIe edge connector are 12V ± 8 percent and 3.3V ± 9 percent.

The following table describes the typical power consumption of the adapter.

Table 21 Typical Power Consumption for the MegaRAID 9480-8i8e Tri-Mode Storage Adapter

Power Mode	Typical Power
3.3V Supply	0,20W
+ 12 Supply	17.48W
3.3V Auxillary Supply	0.03W
Total Power	17.71W

During the transparent learn cycle, the CacheVault power module consumes up to an additional 6W. The power for the learn cycle is supplied from the PCIe 3.3V rail.

10.9 Thermal and Atmospheric Requirements for the 9400-16i Tri-Mode Storage Adapter

For the 9400-16i Tri-Mode storage adapter, the operating (thermal and atmospheric) conditions are as follows:

- Relative humidity range is 20 percent to 80 percent non-condensing
- Airflow must be at least 200 linear feet per minute (LFPM) to avoid operating the board components above their maximum rated junction temperatures
- Temperature range: 10°C to +55°C

The parameters for the non-operating (such as storage and transit) environment for these controllers are as follows:

- Relative humidity range is 5 percent to 95 percent non-condensing.
- Temperature range: –40°C to +70°C

10.10 Power Supply Requirements for the 9400-16i Tri-Mode Storage Adapter

All power is supplied to the 9400-16i Tri-Mode storage adapter through the PCIe 3.3V rails and the 12V rail. Onboard switching regulator circuitry operating from the 3.3V rails and the 12V rail provides the necessary voltages. The following states describe the typical power consumption of the controller.

Typical power is measured with maximum I/O traffic, typical silicon process material, and nominal voltages operating the card at an ambient temperature of 45°C degrees with required airflow.

The supply voltages supplied by the PCIe edge connector are 12V ± 8 percent and 3.3V ± 9 percent.

The following table describes the typical power consumption of the adapter.

Table 22 Typical Power Consumption for the 9400-16i Tri-Mode Storage Adapter

Power Mode	Typical Power
3.3V Supply	1.6W
+ 12 Supply	10.32W
3.3V Auxillary Supply	0.03W
Total Power	11.95W

10.11 Thermal and Atmospheric Requirements for the 9400-8i Tri-Mode Storage Adapter

For the 9400-8i Tri-Mode storage adapter, the operating (thermal and atmospheric) conditions are as follows:

- Relative humidity range is 20 percent to 80 percent non-condensing
- Airflow must be at least 200 linear feet per minute (LFPM) to avoid operating the board components above their maximum rated junction temperatures
- Temperature range: 10°C to +55°C

The parameters for the non-operating (such as storage and transit) environment for these controllers are as follows:

- Relative humidity range is 5 percent to 95 percent non-condensing.
- Temperature range: –40°C to +70°C

10.12 Power Supply Requirements for the 9400-8i Tri-Mode Storage Adapter

All power is supplied to the 9400-8i Tri-Mode storage adapter through the PCIe 3.3V rails and the 12V rail. Onboard switching regulator circuitry operating from the 3.3V rails and the 12V rail provides the necessary voltages. The following states describe the typical power consumption of the controller.

Typical power is measured with maximum I/O traffic, typical silicon process material, and nominal voltages operating the card at an ambient temperature of 45°C degrees with required airflow.

The supply voltages supplied by the PCIe edge connector are 12V ± 8 percent and 3.3V ± 9 percent.

The following table describes the typical power consumption of the adapter.

Table 23 Typical Power Consumption for the 9400-8i Tri-Mode Storage Adapter

Power Mode	Typical Power
3.3V Supply	1.6W
+ 12 Supply	8.42W
3.3V Auxillary Supply	0.03W
Total Power	10.05W

10.13 Thermal and Atmospheric Requirements for the 9400-16e Tri-Mode Storage Adapter

For the 9400-16e Tri-Mode storage adapter, the operating (thermal and atmospheric) conditions are as follows:

- Relative humidity range is 20 percent to 80 percent non-condensing
- Airflow must be at least 200 linear feet per minute (LFPM) to avoid operating the board components above their maximum rated junction temperatures
- Temperature range: 10°C to +55°C

The parameters for the non-operating (such as storage and transit) environment for these controllers are as follows:

- Relative humidity range is 5 percent to 95 percent non-condensing
- Temperature range: –40°C to +70°C

10.14 Power Supply Requirements for the 9400-16e Tri-Mode Storage Adapter

All power is supplied to the 9400-16e Tri-Mode Storage Adapter through the PCIe 3.3V rails and the 12V rail. Onboard switching regulator circuitry operating from the 3.3V rails and the 12V rail provides the necessary voltages. The following states describe the typical power consumption of the controller.

Typical power is measured with maximum I/O traffic, typical silicon process material, and nominal voltages operating the card at an ambient temperature of 45°C degrees with required airflow.

The supply voltages supplied by the PCIe edge connector are 12V ± 8 percent and 3.3V ± 9 percent.

The following table describes the typical power consumption of the adapter.

Table 24 Typical Power Consumption for the 9400-16e Tri-Mode Storage Adapter

Power Mode	Typical Power
3.3V Supply	1.33W
+ 12 Supply	9.82W
3.3V Auxillary Supply	0.03W
Total Power	11.18W

10.15 Thermal and Atmospheric Requirements for the 9400-8e Tri-Mode Storage Adapter

For the 9400-8ei Tri-Mode storage adapter, the operating (thermal and atmospheric) conditions are as follows:

- Relative humidity range is 20 percent to 80 percent non-condensing
- Airflow must be at least 200 linear feet per minute (LFPM) to avoid operating the board components above their maximum rated junction temperatures
- Temperature range: 10°C to +55°C

The parameters for the non-operating (such as storage and transit) environment for these controllers are as follows:

- Relative humidity range is 5 percent to 95 percent non-condensing.
- Temperature range: –40°C to +70°C

10.16 Power Supply Requirements for the 9400-8e Tri-Mode Storage Adapter

All power is supplied to the 9400-8e Tri-Mode storage adapter through the PCIe 3.3V rails and the 12V rail. Onboard switching regulator circuitry operating from the 3.3V rails and the 12V rail provides the necessary voltages. The following states describe the typical power consumption of the controller.

Typical power is measured with maximum I/O traffic, typical silicon process material, and nominal voltages operating the card at an ambient temperature of 45°C degrees with required airflow.

The supply voltages supplied by the PCIe edge connector are 12V ± 8 percent and 3.3V ± 9 percent.

The following table describes the typical power consumption of the adapter.

Table 25 Typical Power Consumption for the 9400-8e Tri-Mode Storage Adapter

Power Mode	Typical Power
3.3V Supply	1.33W
+ 12 Supply	8.12W
3.3V Auxillary Supply	0.03W
Total Power	9.48W

Chapter 11: Marks, Certifications. Compliance and Safety Characteristics

11.1 Marks, Certifications and Compliance

The design and implementation of the Tri-Mode storage adapters minimize electromagnetic emissions, susceptibility to radio frequency energy, and the effects of electrostatic discharge. The Tri-Mode storage adapters show the following marks and certifications:

- CE mark
- RCM mark
- FCC Self-Certification logo
- Canadian Compliance Statement
- KCC
- Taiwan BSMI
- Japan VCCI
- CISPR Class B

The following hardware is compliant with CSA C22.2 No. 60950-1-07 2nd Edition 2014-10, UL 60950-1 2nd Edition 2014-10-14, UL file number E257743:

- MegaRAID 9440-16i (model number 50008)
- MegaRAID 9460-16i (model number 50011)
- MegaRAID 9460-8i (model number 50011)
- MegaRAID 9480-8i8e (model number 50031)
- HBA 9400-16i (model number 50008)
- HBA 9400-8i (model number 50008)
- HBA 9400-16e (model number 50013)
- HBA 9400-8e (model number 50013)

11.2 Safety Characteristics

All Tri-Mode storage adapters meet or exceed the requirements of UL flammability rating 94 V0. Each bare board is also marked with the supplier name or trademark, type, and UL flammability rating. For the boards installed in a PCI Express bus slot, all voltages are lower than the SELV 42.4V limit.

Revision History

pub-005851, Version 1.0, March 24, 2017

Initial document release.


BROADCOM