



Broadcom® 96xx PCIe 4.0, 24G SAS MegaRAID™ and eHBA Tri-Mode Storage Adapters

**User Guide
Version 2.0**

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Broadcom PCIe 4.0, 24G SAS MegaRAID and eHBA Tri-Mode Storage Adapters

This document is the primary reference and user guide for the Broadcom® PCIe 4.0, 24G SAS MegaRAID™ tri-mode storage adapters and enhanced HBA (eHBA) tri-mode storage adapters, based on the Broadcom PCIe 4.0, 24G SAS tri-mode controllers. This document contains the complete installation instructions and specifications for the following tri-mode storage adapters, referred to as adapters.

- MegaRAID 9670W-16i
- MegaRAID 9670-24i
- MegaRAID 9660-16i
- eHBA 9620-16i
- eHBA 9600-24i
- eHBA 9600-16i
- eHBA 9600-8i8e
- eHBA 9600W-16e
- eHBA 9600-16e

Overview

The adapters, based on a 24G SAS tri-mode controller, are high-performance PCIe-to-SATA/SAS/PCIe (tri-mode) storage adapters. Broadcom tri-mode SerDes technology enables operation of SAS, SATA, or PCIe (NVMe) storage devices in a single drive bay. A single controller can operate in all three modes concurrently: SAS, SATA, and PCIe/NVMe. The adapters negotiate between the speeds and the protocols to recognize and concurrently interface with these three storage devices types.

The adapters provide the following storage interface data transfer rates:

- SAS data transfer rates of 22.5Gb/s, 12Gb/s, 6Gb/s, and 3Gb/s per phy
- SAS data transfer rates of 12Gb/s, 6Gb/s, and 3Gb/s per phy
- PCIe (NVMe) data transfer rates of 16 GT/s, 8 GT/s, 5 GT/s, and 2.5 GT/s per lane

The following tables summarize key adapter features.

Table 1: MegaRAID Tri-Mode Storage Adapter and eHBA 9620-16i Features

| Adapter | 9670W-16i | 9670-24i | 9660-16i | 9620-16i |
|-------------------|---|---|---|----------------------------|
| Ports | 16 internal | 24 internal | 16 internal | 16 internal |
| I/O Processor | SAS4116W | SAS4124 | SAS4116 | SAS4016 |
| Host Interface | x16 PCIe 4.0 | x8 PCIe 4.0 | x8 PCIe 4.0 | x8 PCIe 4.0 |
| Storage Interface | SAS, SATA, and PCIe (NVMe) | SAS, SATA, and PCIe (NVMe) | SAS, SATA, and PCIe (NVMe) | SAS, SATA, and PCIe (NVMe) |
| Form Factor | FH-MD2 | FH-MD2 | LP-MD2 | LP-MD2 |
| RAID Levels | 0, 1, 5, and 6 | 0, 1, 5, and 6 | 0, 1, 5, and 6 | 0 and 1 |
| Cache Memory | 8 GB, dual channel, 3200 MT/s, DDR4 SDRAM | 8 GB, single channel, 3200 MT/s, DDR4 SDRAM | 4 GB, single channel, 3200 MT/s, DDR4 SDRAM | — |

| Adapter | 9670W-16i | 9670-24i | 9660-16i | 9620-16i |
|------------------------------|-----------------|-------------------|-----------------|-----------------|
| Storage Interface Connectors | Two SFF-8654 x8 | Three SFF-8654 x8 | Two SFF-8654 x8 | Two SFF-8654 x8 |
| Cache Protection | Yes | Yes | Yes | — |
| Energy Backup | CVPM05 module | CVPM05 module | CVPM05 module | — |

Table 2: eHBA Tri-Mode Storage Adapter Features

| Adapter | 9600-24i | 9600-16i | 9600-8i8e | 9600W-16e | 9600-16e |
|------------------------------|----------------------------|----------------------------|------------------------------------|---------------------|---------------------|
| Ports | 24 internal | 16 internal | 8 internal 8 external | 16 external | 16 external |
| I/O Processor | SAS4024 | SAS4016 | SAS4016 | SAS4016W | SAS4016W |
| Host Interface | x8 PCIe 4.0 | x8 PCIe 4.0 | x8 PCIe 4.0 | x16 PCIe 4.0 | x8 PCIe 4.0 |
| Form Factor | LP-MD2 | LP-MD2 | LP-MD2 | LP-MD2 | LP-MD2 |
| Storage Interface | SAS, SATA, and PCIe (NVMe) | SAS, SATA, and PCIe (NVMe) | SAS, SATA, and PCIe (NVMe) | SAS, SATA, and PCIe | SAS, SATA, and PCIe |
| Storage Interface Connectors | Three SFF-8654 x8 | Two SFF-8654 x8 | One SFF-8654 x8 Two SFF-8674 x4 | Four SFF-8674 x4 | Four SFF-8674 x4 |

Features

RAID and eHBA Features

The following sections list primary RAID and eHBA features that the adapters support. For a full description of the RAID features, refer to the *MegaRAID Tri-Mode Software User Guide*, located at <http://www.broadcom.com/support/download-search>.

MegaRAID 9670W-16i, 9670-24i, and 9660-16i Adapter RAID Features

The MegaRAID 9670W-16i, MegaRAID 9670-24i, and MegaRAID 9660-16i adapters support the following RAID features.

- RAID levels 0, 1, 5, and 6
- RAID spans 10, 50, and 60
- SAS/SATA drives: 240
- NVMe SSDs: 32
- JBOD physical drive (PD) state for SDS environments
- Online Capacity Expansion (OCE)
- Auto resume after loss of system power during array rebuild or OCE
- Single controller multipathing
- Load balancing
- 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
- Sixty-four virtual drive support
- Disk data format (DDF)-compliant Configuration on Disk (COD)
- Self-Monitoring, Analysis, and Reporting Technology (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 support:
 - Universal Backplane Management (UBM)
 - SES (inband)
 - SGPIO (sideband)
 - VPP
- DataBolt bandwidth optimizer technology support for compatible expander-based enclosures
- Shield state drive diagnostic technology
- MegaRAID SafeStore™ software for SED key management

MegaRAID 9620-16i eHBA Features

The MegaRAID 9620-16i adapter supports the following features.

- RAID levels 0 and 1
- RAID span 10
- SAS/SATA drives: 32
- NVMe SSDs: 32
- JBOD PD state for SDS environments
- Single controller multipathing
- Load balancing
- 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
- Four virtual drive support
- DDF-compliant COD
- S.M.A.R.T support
- Global and dedicated hot spare with revertible hot spare support:
 - Automatic rebuild
 - Emergency SATA hot spare for SAS arrays
- Enclosure management support:
 - Universal Backplane Management (UBM)
 - SES (inband)
 - SGPIO (sideband)
 - VPP
- DataBolt bandwidth optimizer technology support for compatible expander-based enclosures
- Shield state drive diagnostic technology
- MegaRAID SafeStore software for SED key management

eHBA 9600 Adapter Features

The eHBA 9600 adapters support the following eHBA features.

- SAS/SATA devices: 240
- NVMe SSDs: 32
- Shingled magnetic recording (SMR) drive support
- Multi-actuator (MA) drive support

Operating System Support

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

- Microsoft Windows
- VMware vSphere/ESXi
- Red Hat Enterprise Linux
- SuSE Linux
- Ubuntu Linux
- Citrix XenServer
- CentOS Linux
- Debian Linux
- Oracle Enterprise Linux
- Fedora
- FreeBSD

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

PCIe Host Interface

The adapter's PCIe 4.0 host interface provides maximum transmission and reception rates of up to 128 GT/s (16GB/s per lane). The tri-mode controller uses a packet-based communication protocol to communicate over the serial interconnect. Other PCIe host interface features include the following:

- Eight-lane or 16-lane PCIe host 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 16 GT/s, 8 GT/s, 5 GT/s, and 2.5 GT/s in each direction
- Eight-lane aggregate bandwidth of up to 16GB/s (16,000 MB/s)
- Sixteen-lane aggregate bandwidth of up to 32GB/s (32,000 MB/s)
- Support of x16, x8, x4, x2, and x1 link widths

LED Management

The internal adapters offer LED management support for SAS/SATA backplanes and (PCIe) NVMe backplanes. External connect adapters offer enclosure LED management support for enclosure implementations through SES. See [Backplane Management](#) for more information.

Tri-Mode Storage Interface Features

The 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 sixteen x1, eight x2, or four x4 NVMe direct-attach drive support
 - Data transfer at 16 GT/s, 8 GT/s, 5 GT/s, and 2.5 GT/s
 - Independent resets and configuration
 - Common reference clock and separate reference clock independent SSC (SRIS) support
- SAS features:

- SAS data transfers at 22.5Gb/s, 12Gb/s, and 6Gb/s
- DataBolt technology on all SAS phys to improve performance
- 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
- Data transfer by using SCSI information units
- T10 data protection management
- Support for persistent connection capability
- Support for SPL-3 initiate close capability
- Configurable Rx and Tx polarity inversion
- Configurable phy-to-disk mapping
- Configurable SSC
- SATA interface features:
 - SATA and STP data transfers at 6Gb/s
 - Addressing of multiple SATA targets through an expander

Tri-Mode Storage Interface

The tri-mode interface groups phys into two CSW blocks that contain 16 phys each. Depending on the adapter, either one or both CSW blocks are used for the storage interface. Limitations exist on how the phys can be grouped to create wide ports for SAS/SATA or multilane ports for PCIe.

The following table indicates how the connectors map to the phys within each CSW. Card layout figures in [Broadcom MegaRAID and eHBA Tri-Mode Storage Adapter Characteristics](#) show the connector designations for each adapter.

Table 3: Adapter Connector-to-CSW Port Associations

| Adapter | Connector 0 | Connector 1 | Connector 2 | Connector 3 |
|-----------|-------------|-------------|-------------|-------------|
| 9670W-16i | CSW1[0:7] | CSW1[8:15] | — | — |
| 9670-24i | CSW0[0:7] | CSW1[0:7] | CSW0[8:15] | — |
| 9660-16i | CSW0[0:7] | CSW1[0:7] | — | — |
| 9620-16i | CSW1[8:15] | CSW0[8:15] | — | — |
| 9600-24i | CSW1[8:15] | CSW0[8:15] | CSW1[0:7] | — |
| 9600-16i | CSW1[8:15] | CSW0[8:15] | — | — |
| 9600-8i8e | CSW1[0:7] | CSW0[12:15] | CSW0[8:11] | — |
| 9600W-16e | CSW0[12:15] | CSW0[8:11] | CSW0[4:7] | CSW0[0:3] |
| 9600-16e | CSW0[12:15] | CSW0[8:11] | CSW0[4:7] | CSW0[0:3] |

The internal adapters can direct attach to SAS, SATA, or NVMe drives. The internal and external adapters support drive attach through PCIe switches or expanders.

NOTE

Carefully assess any decision to mix SAS and SATA drives within the same virtual drive (VD). Although you can mix drives, the practice is discouraged.

MegaRAID does not permit mixing SAS and NVMe drives or SATA and NVMe drives within the same VD. To mix NVMe and SAS/SATA drives on a MegaRAID adapter, you must configure the drives in separate VDs.

The following sections describe the connector options for a single direct-attach type solution. Adhere to the same guidelines if you combine device types.

SAS/SATA Support

The storage interface is comprised of either 24 phys or 16 phys, depending on the adapter. Dedicated SAS phy management hardware manages the phys in groups of eight within each CSW: CSW0[0:7], CSW0[8:15], CSW1[0:7], and CSW1[8:15]. Depending on the adapter, one or more of these CSW groups are used for the SAS/SATA interfaces and these SAS phy management hardware instances cannot communicate with each other.

When you configure a wide port, the connections must attach exclusively to phys all managed by the same CSW group. If the ports are not managed by the same CSW group, unexpected controller and host behavior occurs. You can create combinations of a x1 to x8 wide link within CSW0[0:7], CSW0[8:15], CSW1[0:7], or CSW1[8:15]. You cannot create a wide link by spanning RX/TX pairs between CSW0 and CSW1 or between phys 8:15 and 0:7 within the same CSW group.

PCIe (NVMe) Support

The following table shows how many NVMe drives or Broadcom PEX88000-series switches can directly attach to each adapter. The 9600W-16e adapter, 9600-16e adapter, and 9600-8i8e adapter (external ports) do not support direct attach to NVMe drives. The expected topology for these adapters is a typical JBOF scenario that uses a switch to connect the NVMe drives.

NOTE

Connected NVMe drives must support End to End CRC (ECRC).

Table 4: NVMe Device or PCIe Switch Direct-Attach Options Supported for Each Adapter

| Adapter | x4 NVMe Drives | x2 NVMe Drives | x1 NVMe Drives | x16 Switch | x8 Switches | x4 Switches |
|------------------------|----------------|----------------|----------------|------------|-------------|-------------|
| 9670W-16i | 4 | 8 | 16 | 1 | 2 | 4 |
| 9670-24i | 6 | 12 | 24 | 1 | 3 | 6 |
| 9660-16i | 4 | 8 | 16 | 0 | 2 | 4 |
| 9620-16i | 4 | 8 | 16 | 0 | 2 | 2 |
| 9600-24i | 6 | 12 | 24 | 0 | 3 | 6 |
| 9600-16i | 4 | 8 | 16 | 0 | 2 | 4 |
| 9600-8i8e ^a | 2 | 4 | 8 | 0 | 2 | 4 |
| 9600W-16e | 0 | 0 | 0 | 1 | 2 | 4 |
| 9600-16e | 0 | 0 | 0 | 1 | 2 | 4 |

The adapter phys are grouped into two CSWs: CSW1[0:15] and CSW0[0:15]. Depending on the adapter, 8 or 16 of these phys are used consecutively for the PCIe host interface and the remaining tri-mode phys are available for connection to any supported SAS, SATA, or PCIe (NVMe) storage devices. The following tables indicate supported topologies. Typical backplane designs naturally align to these topology rules, but you must take care not to design anything atypical that might interfere with the adapter's operation.

Table 5: 9670W-16i Adapter PCIe Topology Configuration Combinations

| Connector 0 | | | | | | | | Connector 1 | | | | | | | |
|-------------|---|----|---|----|---|----|---|-------------|----|----|----|----|----|----|----|
| CSW1[0:7] | | | | | | | | CSW1[8:15] | | | | | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| x16 | | | | | | | | | | | | | | | |
| x8 | | | | | | | | x8 | | | | | | | |
| x8 | | | | | | | | x4 | | | | x4 | | | |
| x4 | | | | x4 | | | | x4 | | | | x4 | | | |
| x8 | | | | | | | | x2 | | x2 | | x2 | | x2 | |
| x4 | | | | x4 | | | | x2 | | x2 | | x2 | | x2 | |
| x2 | | x2 | | x2 | | x2 | | x2 | | x2 | | x2 | | x2 | |
| x8 | | | | | | | | x1 | x1 | x1 | x1 | x1 | x1 | x1 | |
| x4 | | | | x4 | | | | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 |

a. Only internal internal ports support direct-attach NVMe drives.

| Connector 0 | | | | | | | | Connector 1 | | | | | | | |
|-------------|----|----|----|----|----|----|----|-------------|----|----|----|----|----|----|----|
| CSW0[0:7] | | | | | | | | CSW1[8:15] | | | | | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 |
| x4 | | | | x4 | | | | x8 | | | | | | | |
| x2 | | x2 | | x2 | | x2 | | x8 | | | | | | | |
| x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x8 | | | | | | | |
| x2 | | x2 | | x2 | | x2 | | x4 | | | | x4 | | | |
| x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x4 | | | | x4 | | | |

Table 6: 9660-16i Adapter PCIe Topology Configuration Combinations

| Connector 0 | | | | | | | | Connector 1 | | | | | | | | |
|-------------|----|----|----|----|----|----|----|-------------|----|----|----|----|----|----|----|----|
| CSW0[0:7] | | | | | | | | CSW1[0:7] | | | | | | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| x8 | | | | | | | | x8 | | | | | | | | |
| x8 | | | | | | | | x4 | | | | x4 | | | | |
| x4 | | | | x4 | | | | x4 | | | | x4 | | | | |
| x8 | | | | | | | | x2 | | x2 | | x2 | | x2 | | |
| x4 | | | | x4 | | | | x2 | | x2 | | x2 | | x2 | | |
| x2 | | x2 | | x2 | | x2 | | x2 | | x2 | | x2 | | x2 | | |
| x8 | | | | | | | | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 |
| x4 | | | | x4 | | | | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 |
| x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | |
| x4 | | | | x4 | | | | x8 | | | | | | | | |
| x2 | | x2 | | x2 | | x2 | | x8 | | | | | | | | |
| x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x8 | | | | | | | | |
| x2 | | x2 | | x2 | | x2 | | x4 | | | | x4 | | | | |
| x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x4 | | | | x4 | | | | |

Table 7: 9670-24i Adapter PCIe Topology Configuration Combinations

| Connector 0 | | | | | | | | Connector 1 | | | | | | | | Connector 2 | | | | | | | |
|-------------------------------|---|----|----|----|----|----|----|-------------|--|----|--|----|--|----|--|-------------------------------|----|----|----|----|----|----|----|
| CSW0[8:15] | | | | | | | | CSW1[0:7] | | | | | | | | CSW1[0:7] | | | | | | | |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | | | | | | | | | 00 | 11 | 22 | 33 | 44 | 55 | 66 | 77 |
| x16 (paired with Connector 2) | | | | | | | | x8 | | | | | | | | x16 (paired with Connector 0) | | | | | | | |
| x16 (paired with Connector 2) | | | | | | | | x4 | | | | x4 | | | | x16 (paired with Connector 0) | | | | | | | |
| x16 (paired with Connector 2) | | | | | | | | x2 | | x2 | | x2 | | x2 | | x16 (paired with Connector 0) | | | | | | | |

| Connector 0 | | | | | | | | Connector 1 | | | | | | | | Connector 2 | | | | | | | | | | | | | |
|--|---|----|----|----|----|----|----|-------------|----|----|----|----|----|----|----|-------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|----|
| CSW0[8:15] | | | | | | | | CSW1[0:7] | | | | | | | | CSW1[0:7] | | | | | | | | | | | | | |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | | | | | | | | | 00 | 11 | 22 | 33 | 44 | 55 | 66 | 77 | | | | | | |
| x16 (paired with Connector 2) | | | | | | | | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x16 (paired with Connector 0) | | | | | | | | | | | | | |
| Use any row from the previous 9660-16i Adapter PCIe Topology Configuration Combinations table. | | | | | | | | | | | | | | | | x8 | | | | | | | | | | | | | |
| Use any row from the previous 9660-16i Adapter PCIe Topology Configuration Combinations table. | | | | | | | | | | | | | | | | x4 | | | | x4 | | | | | | | | | |
| Use any row from the previous 9660-16i Adapter PCIe Topology Configuration Combinations table. | | | | | | | | | | | | | | | | x2 | | x2 | | x2 | | x2 | | | | | | | |
| Use any row from the previous 9660-16i Adapter PCIe Topology Configuration Combinations table. | | | | | | | | | | | | | | | | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 |

Table 8: 9600-16i Adapter and 9620-16i Adapter PCIe Topology Configuration Combinations

| Connector 0 | | | | | | | | Connector 1 | | | | | | | |
|-------------|----|----|----|----|----|----|----|-------------|----|------|------|------|------|------|------|
| CSW1[8:15] | | | | | | | | CSW0[8:15] | | | | | | | |
| | | | | | | | | 88 | 99 | 1010 | 1111 | 1212 | 1313 | 1414 | 1515 |
| x8 | | | | | | | | x8 | | | | | | | |
| x8 | | | | | | | | x4 | | | | x4 | | | |
| x4 | | | | x4 | | | | x4 | | | | x4 | | | |
| x8 | | | | | | | | x2 | | x2 | | x2 | | x2 | |
| x4 | | | | x4 | | | | x2 | | x2 | | x2 | | x2 | |
| x2 | | x2 | | x2 | | x2 | | x2 | | x2 | | x2 | | x2 | |
| x8 | | | | | | | | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 |
| x4 | | | | x4 | | | | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 |
| x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 |
| x4 | | | | x4 | | | | x8 | | | | | | | |
| x2 | | x2 | | x2 | | x2 | | x8 | | | | | | | |
| x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x8 | | | | | | | |
| x2 | | x2 | | x2 | | x2 | | x4 | | | | x4 | | | |
| x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x4 | | | | x4 | | | |

Table 9: 9600-24i Adapter PCIe Topology Configuration Combinations

| Connector 0 | | | | | | | | Connector 1 | | | | | | | | Connector 2 | | | | | | | |
|-------------|----|----|----|----|----|----|----|-------------|----|----|----|----|----|----|----|---|----|----|----|----|----|----|----|
| CSW1[8:15] | | | | | | | | CSW0[8:15] | | | | | | | | CSW1[0:7] | | | | | | | |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| x8 | | | | | | | | x8 | | | | | | | | x8 | | | | | | | |
| x8 | | | | | | | | x4 | | | | x4 | | | | x4 | | | | x4 | | | |
| x4 | | | | x4 | | | | x2 | | x2 | | x2 | | x2 | | x2 | | x2 | | x2 | | x2 | |
| x8 | | | | | | | | x2 | | x2 | | x2 | | x2 | | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 |
| x4 | | | | x4 | | | | x2 | | x2 | | x2 | | x2 | | Combine with any of the first four configurations in this column. | | | | | | | |
| x2 | | x2 | | x2 | | x2 | | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | Combine with any of the first four configurations in this column. | | | | | | | |
| x8 | | | | | | | | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | Combine with any of the first four configurations in this column. | | | | | | | |
| x4 | | | | x4 | | | | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | Combine with any of the first four configurations in this column. | | | | | | | |
| x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x8 | | | | | | | | Combine with any of the first four configurations in this column. | | | | | | | |
| x4 | | | | x4 | | | | x8 | | | | | | | | Combine with any of the first four configurations in this column. | | | | | | | |
| x2 | | x2 | | x2 | | x2 | | x8 | | | | | | | | Combine with any of the first four configurations in this column. | | | | | | | |
| x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x4 | | | | x4 | | | | Combine with any of the first four configurations in this column. | | | | | | | |
| x2 | | x2 | | x2 | | x2 | | x4 | | | | x4 | | | | Combine with any of the first four configurations in this column. | | | | | | | |
| x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | x4 | | | | x4 | | | | Combine with any of the first four configurations in this column. | | | | | | | |

Table 10: 9600W-16e Adapter and 9600-16e Adapter PCIe Topology Configuration Combinations

| Connector 0 | | | | Connector 1 | | | | Connector 2 | | | | Connector 3 | | | |
|-------------|----|----|----|-------------|---|----|----|-------------|---|---|---|-------------|---|---|---|
| CSW0[12:15] | | | | CSW0[8:11] | | | | CSW0[4:7] | | | | CSW0[0:3] | | | |
| 12 | 13 | 14 | 15 | 8 | 9 | 10 | 11 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 |
| x16 | | | | | | | | | | | | | | | |
| x8 | | | | | | | | x8 | | | | | | | |
| x4 | | | | x4 | | | | x4 | | | | x4 | | | |

Table 11: 9600-8i8e Adapter PCIe Topology Configuration Combinations

| Connector 0 | | | | | | | | Connector 1 | | | | Connector 2 | | | |
|-------------|----|----|----|----|----|----|----|-------------|----|----|----|-------------|---|----|----|
| CSW1[0:7] | | | | | | | | CSW0[12:15] | | | | CSW0[8:11] | | | |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 12 | 13 | 14 | 15 | 8 | 9 | 10 | 11 |
| x8 | | | | | | | | x8 | | | | | | | |
| x4 | | | | x4 | | | | x4 | | | | x4 | | | |
| x2 | | x2 | | x2 | | x2 | | — | | | | | | | |
| x1 | x1 | x1 | x1 | x1 | x1 | x1 | x1 | — | | | | | | | |

Common REFCLK Support

The adapter uses x8 SFF-8654 (SlimSAS) connectors. Each connector is divided into two quadrants. For connections that require a common REFCLK, one REFCLK is supplied for each quadrant. For x4 NVMe or PCIe switch connections, the REFCLK sourced by each quadrant directly clocks each attached x4 PCIe connection.

To directly attach x2 or x1 NVMe drives that require a common REFCLK, where more than one drive is sourced from a single quadrant, you must properly fan out the shared REFCLK on the backplane. For x2 and x1 NVMe connections, use SRIS-enabled drives to avoid fanning the clock out on the backplane.

Backplane Management

The SFF-8448 standard defines how to detect whether the backplane supports a SGPIO or two-wire interface (I²C) for SAS/SATA usage. SFF-9402 is a superset of SFF-8448, adding the PCIe-defined sideband signal, which means that SAS/SATA users see no change in backplane management detection when using the adapters.

Universal Backplane Management

The adapters provide LED operation and other backplane management of NVMe only, SAS/SATA only, or mixed-protocol backplanes based on the SFF-TA-1005 specification. SFF-TA-1005 is an industry-standard backplane management specification commonly known as Universal Backplane Management (UBM). As long as the backplane management controller is designed in accordance with the UBM specification, the adapter automatically detects the backplane type and functions appropriately.

The adapter supports the industry-standard *SFF-TA-1005 Specification for Universal Backplane Management (UBM)*. UBM provides the following key features:

- Reports the backplane capabilities, including the following:
 - NVMe drive widths
 - Common REFCLK or separate REFCLK support
 - Maximum speeds
 - Designed slot power
- Supports cable order independence, that is, the drive LED control and slot ID are not dependent on cable order.
- Enables drive hot plug insertion through control of PERST# timing.

For existing SAS/SATA backplanes, if BP_TYPE = 0, the adapter uses SGPIO for legacy backplane management. Refer to the SFF-8485 specification for functionality details. Design new backplanes with the industry-standard SFF-TA-1005 (UBM) specification for backplane management.

Virtual Pin Port Management

Broadcom requires new designs to enable UBM for backplane management. The adapter maintains support for Virtual Pin Port (VPP) backplane management for legacy implementations. The adapters provide LED operation for NVMe devices based on the VPP over I²C definition. Standard VPP implementation calls for one PCA9555 target 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.

Sideband Signals

The internal adapters have one or two x8 SFF-8654 connectors. Each x8 connector provides two sets of sidebands. This section describes the sideband signals usage. The following table defines the sideband signal's pins on the SFF-8654 connector. The last column in the table indicates the strength of the pull-up resistor or pull-down resistor values on the adapter. See [Table 13, Sideband Management Pin Settings](#), for the signal descriptions, and see [Table 14, Internal x8 SFF-8654 Connector Pinout](#), for a complete connector pinout.

Table 12: Sideband Signal Pinout

| Connector A Side | Connector B Side | Sideband or Vendor Specific Pin Number | UBM Assignments | Direction | Resistor Value |
|------------------|------------------|--|-----------------|-----------|------------------|
| A8 | A26 | 7 | BP_TYPE | Input | 100 kΩ pull-down |
| A9 | A27 | 4 | 2W_RESET# | Output | 2.0 kΩ pull-up |

| Connector A Side | Connector B Side | Sideband or Vendor Specific Pin Number | UBM Assignments | Direction | Resistor Value |
|------------------|------------------|--|------------------------------|--------------|----------------|
| A10 | A28 | 3 | GND | — | — |
| A11 | A29 | + | REFCLK+ | Output | — |
| A12 | A30 | – | REFCLK- | Output | — |
| B8 | B26 | 0 | 2W_CLK | Input/Output | 2.0 kΩ pull-up |
| B9 | B27 | 1 | 2W_DATA | Input/Output | 2.0 kΩ pull-up |
| B10 | B28 | 2 | GND | — | — |
| B11 | B29 | 5 | PERST# | Input/Output | 2.0 kΩ pull-up |
| B12 | B30 | 6 | C_TYPE, D_INPL#, CHANGE_DET# | Input/Output | 10 kΩ pull-up |

The following table describes the sideband signal pin settings.

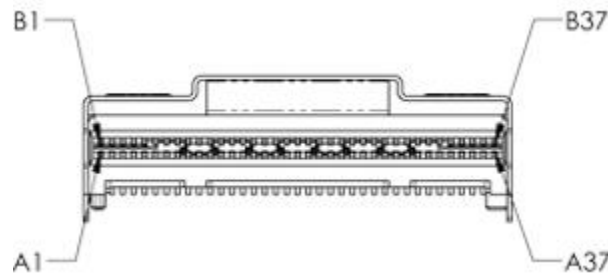
Table 13: Sideband Management Pin Settings

| Pin Name | Settings | Description |
|------------------------------|--|---|
| BP_TYPE | <ul style="list-style-type: none"> 0: SGPIO 1: Two-wire interface | Indicates if the backplane uses SGPIO or two-wire interface for management. To maintain backwards compatibility with SPGIO-based backplanes, the adapter has a weak pull-down to default to SGPIO if the backplane does not explicitly drive the signal. |
| 2W_RESET# | <ul style="list-style-type: none"> 0: Reset is asserted 1: Reset is not asserted | Optional reset driven by the host if the UBM target reports that the target can be reset. |
| REFCLK+/- | — | PCIe REFCLK HCSL 100-MHz clock driven by the device side ports to PCIe devices that require REFCLK. If D_INPL# is 0 and BP_TYPE is 1, the adapter enables the REFCLK outputs for that quad of high-speed lanes. When BP_TYPE is 0 or the UBM Clock Routing bit on the backplane is 0, this output is turned off. |
| 2W_CLK | — | The two-wire interface clock signal. |
| 2W_DATA | — | The two-wire interface data signal. |
| PERST# | <ul style="list-style-type: none"> 0: Reset is asserted 1: Reset is not asserted | The adapter drives the PCIe RESET# signal. This signal uses a clamp to ground so that the signal on the adapter powers up LOW until backplane detection warrants the release of this signal for open-drain use. This method ensures that PERST# does not deassert until the directly connected NVMe drive is successfully detected. |
| C_TYPE, D_INPL#, CHANGE_DET# | — | Open collector/drain input or output signal. <ul style="list-style-type: none"> C_TYPE. If BP_TYPE is 0, the adapter drives this signal LOW. If BP_TYPE is 1, this signal adheres to the SFF-8448 requirement to drive this signal to 1 in response to floating the signal. Because this signal is an open drain signal, <i>driving</i> to 1 is when a pull-up resistor pulls this signal HIGH. D_INPL#. When C_TYPE is HIGH, the backplane pulls this signal to ground to indicate an NVMe device is connected and a two-wire interface backplane management target might be on the sideband's two-wire interface. CHANGE_DET#. If D_INPL# is 0 and a UBM FRU device is discovered on the two-wire interface, the UBM FRU data can inform the adapter that the device is CHANGE_DET# feature capable. The adapter can rely on this signal as the CHANGE_DET# signal as described in the UBM specification. In this mode, the UBM controller drives this signal LOW to assert CHANGE_DET#. |

Cables and Cabling Configurations

The internal adapter follows the SFF-9402 standard for connector signal assignments. Each x8 connector includes eight PCIe transmit and receive lanes and two sets of sidebands designated as A and B, in accordance with the SFF-9402 specification. The following figure shows the x8 SFF-8654 pin designations.

Figure 1: x8 SFF-8654 Pin Designations



The following table defines the adapter's internal x8 SFF-8654 connector pinouts.

Table 14: Internal x8 SFF-8654 Connector Pinout

| Pin | Name | Pin | Name |
|-----|----------------------|-----|------------------------|
| A1 | GND | B1 | GND |
| A2 | PERp0, RX0+ | B2 | PETp0, TX0+ |
| A3 | PERn0, RX0- | B3 | PETn0, TX0- |
| A4 | GND | B4 | GND |
| A5 | PERp1, RX1+ | B5 | PETp1, TX1+ |
| A6 | PERn1, RX1- | B6 | PETn1, TX1- |
| A7 | GND | B7 | GND |
| A8 | BP_TYPEA | B8 | 2W-CLKA, SClockA |
| A9 | 2W_RESETA, SDataOutA | B9 | 2W-DATAA, SloadA |
| A10 | GND | B10 | GND |
| A11 | REFCLKA+ | B11 | PERSTA#, SDataInA |
| A12 | REFCLKA- | B12 | CPRSNTA#, CNTRLR_TYPEA |
| A13 | GND | B13 | GND |
| A14 | PERp2, RX2+ | B14 | PETp2, TX2+ |
| A15 | PERn2, RX2- | B15 | PETn2, TX2- |
| A16 | GND | B16 | GND |
| A17 | PERp3, RX3+ | B17 | PETp3, TX3+ |
| A18 | PERn3, RX3- | B18 | PETn3, TX3- |
| A19 | GND | B19 | GND |
| A20 | PERp0, RX4+ | B20 | PETp0, TX4+ |

| Pin | Name | Pin | Name |
|-----|----------------------|-----|------------------------|
| A21 | PERn0, RX4- | B21 | PETn0, TX4- |
| A22 | GND | B22 | GND |
| A23 | PERp1, RX5+ | B23 | PETp1, TX5+ |
| A24 | PERn1, RX5- | B24 | PETn1, TX5- |
| A25 | GND | B25 | GND |
| A26 | BP_TYPEB | B26 | 2W-CLKB, SClockB |
| A27 | 2W_RESETB, SDataOutB | B27 | 2W-DATAB, SLoadB |
| A28 | GND | B28 | GND |
| A29 | REFCLKB+ | B29 | PERSTB#, SDataInB |
| A30 | REFCLKB- | B30 | CPRSNTB#, CNTRLR_TYPEB |
| A31 | GND | B31 | GND |
| A32 | PERp2, RX6+ | B32 | PETp2, TX6+ |
| A33 | PERn2, RX6- | B33 | PETn2, TX6- |
| A34 | GND | B34 | GND |
| A35 | PERp3, RX7+ | B35 | PETp3, TX7+ |
| A36 | PERn3, RX7- | B36 | PETn3, TX7- |
| A37 | GND | B37 | GND |

Storage Interface Cabling

Choose the proper cable for the given backplane type and connectors. The correct choice is especially important for backplanes that use SFF-8643 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 SFF-8612 or SFF-8654 connectors follow the SFF-9402 specification. The pinout recommended in the *PCI Express OCUlink Specification* is equivalent to that recommended for SFF-9402. Verify the connector pinout for the intended backplane to make sure the proper cable is used when connecting to NVMe drives.

Broadcom provides the following cables to use for the adapter. Use the MPN listed to order a cable from Broadcom. If you source your own cables, use the Broadcom part number from the following table, and the drawings and pinouts in [Cable Drawings and Pinouts](#).

Table 15: Internal Adapter Cables

| MPN | Broadcom Cable Part No. | Cable Description | Backplane Connector |
|-------------|-------------------------|-----------------------------------|-------------------------------|
| 05-60001-00 | 5067-6865 | x8 8654 to 2x4 8612, AltWiring 1M | Two x4 SFF-8612 (OCuLink) |
| 05-60002-00 | 5067-6862 | x8 8654 to 2x4 8643 (W), SMC 1M | Two x4 SFF-8643 (mini-SAS HD) |
| 05-60003-00 | 5067-6866 | x8 8654 to 2x4 8643, 9402 SAS 1M | Two x4 SFF-8643 (mini-SAS HD) |
| 05-60004-00 | 5067-6103 | x8 8654 to 2x4 8654, 9402 1M | Two x4 SFF-8654 (SlimSAS) |
| 05-60005-00 | 5067-6682 | x8 8654 to 2xU.2 Direct, 1M | Two U.2 SFF-8639 |
| 05-60006-00 | 5067-7542 | x8 8654 to 8xU.3 Direct, 1M | Eight U.3 SFF-8639 |
| 05-60007-00 | 5067-6869 | x8 8654 to 1x8 8654, 9402 1M | One x8 SFF-8654 (SlimSAS) |

Table 16: Adapter Broadcom Cable Use Cases

| MPN | Type | Description |
|-------------|-------------------|---|
| 05-60001-00 | SAS/SATA and NVMe | Use for backplanes with x4 SFF-8612 connectors with pinouts that follow the SFF-9402 specification. |
| 05-60002-00 | NVMe | Specialty cable that provides NVMe connections for SuperMicro Purley backplanes. This cable has white SFF-8643 connectors to indicate that it must connect to the white SFF-8643 connectors on the SuperMicro Purley backplanes. |
| 05-60003-00 | SAS/SATA | Use for traditional SAS/SATA connections. Usually backplanes designed to support SAS/SATA only or are double plumbed for U.2 and SAS/SATA drives use SFF-8643 connectors. |
| 05-60004-00 | SAS/SATA and NVMe | Use for backplanes with x4 SFF-8654 connectors with pinouts that follow the SFF-9402 specification. |
| 05-60005-00 | NVMe | Enables direct connect from the adapter to a U.2 NVMe drive. Use for proof-of-concept type applications. |
| 05-60006-00 | SAS/SATA and NVMe | Enables direct connect from the adapter to a U.3 NVMe or SAS/SATA drive. This cable does not send a PCIe REFCLK or PERST# to each drive connector; that is, the U.3 drive must support SRIS and not require PERST#. Use for proof-of-concept type applications. |
| 05-60007-00 | SAS/SATA and NVMe | Use for backplanes with x8 SFF-8654 connectors with pinouts that follow the SFF-9402 specification. |

Backplane Connectors

The SFF-8612 or SFF-8654 connectors are the preferred connectors to use for the NVMe backplane or multiprotocol backplanes, based on the SFF-TA-1001 universal bay definition.

Backplanes that use 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. Refer to the *PCI Express OCUlink Specification* and the SFF-9402 specification for backplane NVMe connector pinout information.

External Adapter Connector Pinout

External adapters support SAS and PCIe connections. The PCIe cable specification swaps lanes 0 and 1 compared to the SAS specification. For PCIe connections, this swap means the external pinout must place lanes 0 and 1 on the same pins as the JBOF. This swap does not impact SAS connections because lane ordering does not impact SAS designs.

For external PCIe JBOF connections, as defined by the *PCI Express External Cabling Specification*, the adapter does not connect REFCLK and PERST#. The adapter only supports an SRIS-capable endpoint, that is, no REFCLK. The JBOF handles the drive (connected to the JBOF switch) start-of-day reset, hot insertion, and clocking requirements.

The adapter expects a local (single master) two-wire bus connection to the cable or active module's EEPROM. A cable requires a local EEPROM on each end to identify cable properties, such as length, loss budget, ganging, and so on. The adapter supports no direct communication to the enclosure over two-wire. SES performs enclosure management.

The following table shows the cable pinout for the cable that Broadcom provides for the external adapter. See [Cable Drawings and Pinouts](#) for drawings and pinouts of each listed cable. Use the drawings if you source your own cables.

Table 17: External Adapter Cable Pinout

| Pin | Signal | Pin | Signal |
|-----|-------------|-----|-------------|
| A1 | No Connect | C1 | CMICK |
| A2 | CINT# | C2 | CMIDAT |
| A3 | GND | C3 | GND |
| A4 | PERp0, RX0+ | C4 | PETp0, TX0+ |
| A5 | PERn0, RX0- | C5 | PETn0, TX0- |
| A6 | GND | C6 | GND |
| A7 | PERp3, RX3+ | C7 | PETp3, TX3+ |
| A8 | PERn3, RX3- | C8 | PETn3, TX3- |
| A9 | GND | C9 | GND |
| B1 | PWR | D1 | PWR |
| B2 | CBLPRSNT# | D2 | MGTPWR |
| B3 | GND | D3 | GND |
| B4 | PERp1, RX1+ | D4 | PETp1, TX1+ |
| B5 | PERn1, RX1- | D5 | PETn1, TX1- |
| B6 | GND | D6 | GND |
| B7 | PERp2, RX2+ | D7 | PETp2, TX2+ |
| B8 | PERn2, RX2- | D8 | PETn2, TX2- |
| B9 | GND | D9 | GND |

Broadcom provides the following cable to use for external adapters. Use the MPN listed to order the cable from Broadcom. If you source your own cables, use the Broadcom part number from the following table, and the drawings and pinouts in [Cable Drawings and Pinouts](#).

Table 18: External Adapter Cable

| MPN | Broadcom Cable Part No. | Cable Description | Backplane Connector |
|-------------|-------------------------|------------------------------|---------------------|
| 05-60009-00 | 5067-9643 | G4/S4 x4 8644 to x4 8644, 3M | Two x4 SFF-8674 |

CacheVault Data Protection

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

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 connects to the controller remotely by cable. The data is backed up to the NAND flash memory available on the MegaRAID storage adapter.

NOTE

If you do not use the remote mount board or clip included with the CacheVault kit, do not damage the CVPM05 module when mounting in the system. For more information on mounting the CVPM05 module, refer to *CVPM02, CVPM05 Power Modules | CVFM04 Cache Module MegaRAID CacheVault Protection Products User Guide*.

In the event of host power loss or server failure, any data available in the cache is offloaded to the onboard NAND memory. During this process, the CVPM05 power module powers the necessary components needed for offload.

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 Getting Started Guide* available at <http://www.broadcom.com/support/download-search>.

Adapter Security

The adapters provide two security features to protect your system from malicious activity.

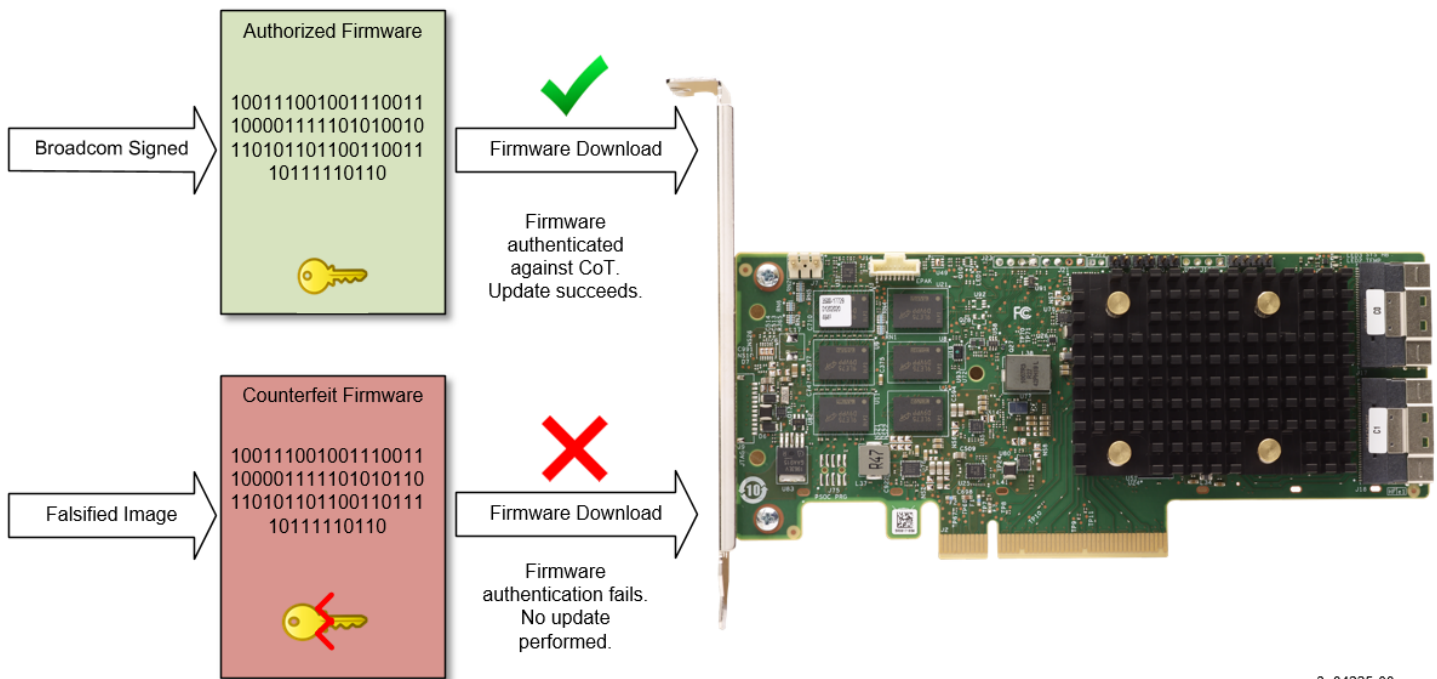
- Hardware secure boot – Permits only authenticated firmware to execute on the adapter
- Device authentication – Enables another entity in the server to authenticate the adapter

The following sections provide details about each security feature.

Hardware Secure Boot

Hardware secure boot permits only authenticated firmware to execute on the adapter. The adapter boots from an internal boot ROM, which establishes the initial root of trust (RoT). Hardware secure boot authenticates and builds a chain of trust (CoT) with succeeding firmware images by using the RoT, meaning only authorized firmware executes on the adapter.

Figure 2: Authenticated Firmware Example



3_04225-00

Hardware secure boot requires that each image be signed with a valid digital signature; otherwise, the image is considered invalid and does not execute. The adapter ships with a valid signed firmware image. All Broadcom supplied firmware includes a valid digital signature; therefore, the hardware secure boot process is transparent unless the adapter encounters a counterfeit image. If the adapter downloads a counterfeit image, the image authentication fails and the download utility, such as StorCLI2, displays the appropriate failure messages. Contact Broadcom Technical Support for assistance.

Device Authentication

Device authentication allows the adapter to prove its unique device identity to another entity in the server as part of a platform attestation implementation. The adapter proves its unique device identity with a device ID certificate and a challenge protocol.

The device authentication process includes a platform RoT device (a baseboard management controller [BMC] or a discreet component) and the adapter (the attested device). The platform RoT device requests the device certificate from the controller on the adapter for authentication. If the device authentication process fails, the platform RoT device operates in accordance with its platform security policy.

Device Certificate

The controller on the adapter uses a device certificate and associated certificate chain to present evidence of its device identity. The certificate chain is based on the X.509 v3 standards and the *Security Protocol and Data Model (SPDM) Specification*, version 1.1.0.

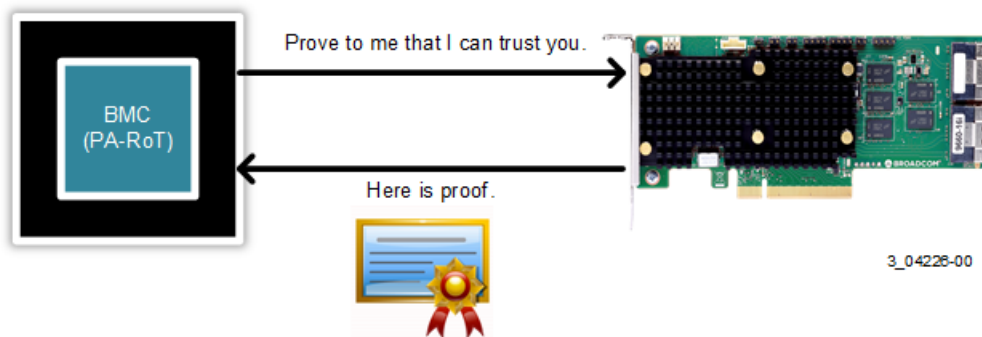
The device certificate contains identifying information about the controller, including the device serial number. The private key of a parent and intermediate signing certificate signs the device certificate. The device certificate cannot be modified after manufacture.

Broadcom manufacturing provisions each board with its device certificate. Every 96xx adapter manufactured is provisioned with a certificate chain. When the SPDM `GET_CERTIFICATE` command queries the controller, the controller returns the device certificate chain, which includes a hash of the root certificate.

Attestation Procedure

Attestation is the process in which the server's BMC, or other discrete logic, challenges the adapter for proof of authenticity. Using attestation in the server is optional. The adapter functions without performing attestation. If attestation fails, the adapter continues to function normally. You must determine the next steps for your system if the adapter fails attestation.

Figure 3: Attestation Procedure Example



To support attestation, you must obtain the external root certificate authority to configure the platform RoT (such as BMC). You can download the external root certificate from [Support Documents and Downloads](#).

SPDM Capabilities

Security Protocol and Data Model (SPDM) Specification v1.1.0 enables the Requester (BMC/discrete logic) and the Responder (adapter) to exchange keys to enable encryption support for the management interface information exchange. By default, if the Requester asks, the adapter enables authenticated encryption of the management interface. This process occurs dynamically between the Requester and Responder as part of the attestation procedure and requires no change to the adapter's settings.

The following table lists the SPDM v1.1 endpoint CAPABILITIES response message flags. Flags listed as supported respond to the `GET_CAPABILITIES` request message.

Table 19: SPDM CAPABILITIES Response Message Support

| CAPABILITIES Response Flags Field | Value |
|-----------------------------------|-------|
| CACHE_CAP | 0 |
| CERT_CAP | 1 |
| CHAL_CAP | 1 |
| MEAS_CAP | 10 |
| MEAS_FRESH_CAP | 0 |
| ENCRYPT_CAP | 1 |
| MAC_CAP | 1 |
| MUT_AUTH_CAP | 1 |
| KEY_EX_CAP | 1 |
| PSK_CAP | 00 |
| ENCAP_CAP | 1 |
| HBEAT_CAP | 1 |
| KEY_UPD_CAP | 1 |
| HANDSHAKE_IN_THE_CLEAR_CAP | 0/1 |
| PUB_KEY_ID_CAP | 0 |

The adapter supports SPDM mutual authentication. The HANDSHAKE_IN_THE_CLEAR_CAP capability bit is shown as 0/1 because the value is subject to negotiation. The firmware sets the HANDSHAKE_IN_THE_CLEAR_CAP bit to 0, but the firmware can set the bit to 1 if the Requester sets the bit to 1. While the adapter supports all capabilities listed in the previous table, the Requester might not support the same capabilities. The adapter correctly negotiates its capabilities with that of the Requester. Refer to the *StorCLI2 Utility User Guide* for additional security command information.

Adapter Installation Instructions

Use the following steps to install the adapter:

1. Unpack your adapter.

Unpack and remove the adapter. Inspect the adapter for damage. If it appears damaged, contact Broadcom Technical Support.

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 adapter, 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 connectors. See [Broadcom MegaRAID and HBA Tri-Mode Storage Adapter Characteristics](#) for descriptions of the adapters that show their connectors.

4. Check the mounting bracket on the adapter.

If required for your system, replace the full-profile mounting bracket that ships on the adapter with the low-profile bracket supplied. Complete the following steps to attach the low-profile bracket.

- Using a No. 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.
- Remove the full-profile bracket. Do not damage the adapter.
- 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.
- Using a No. 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.

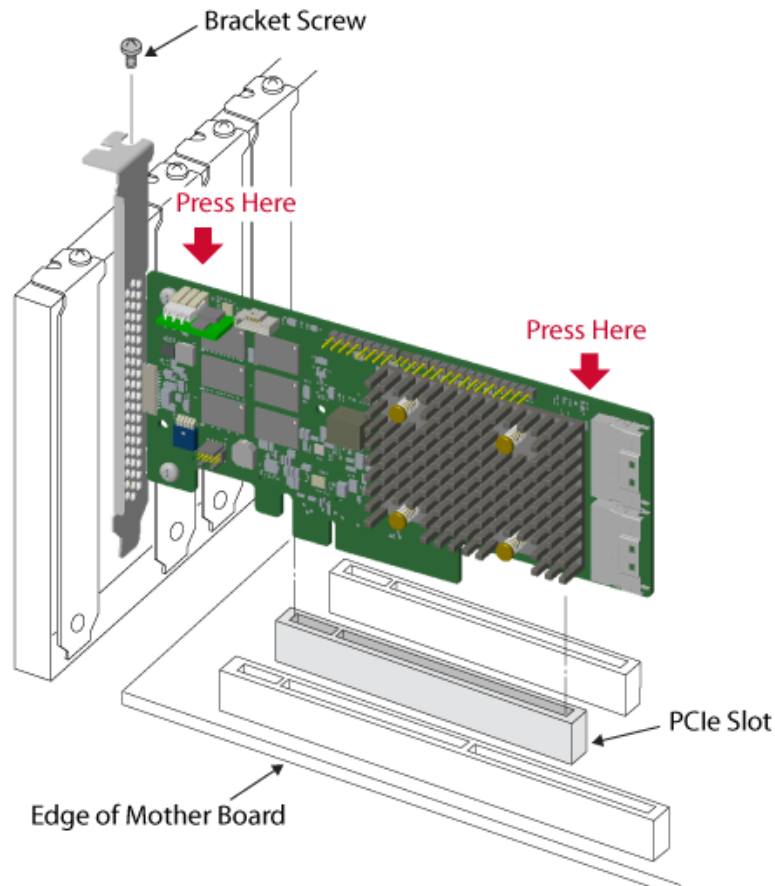
ATTENTION

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 sent back without return merchandise authorization (RMA) processing.

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

NOTE

Adapters with a 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 slots.

Figure 4: Installing an Adapter in a PCIe Slot

6. Configure and install the SAS, SATA, and PCIe (NVMe) devices in the host computer case.

Refer to documentation for the devices for any preinstallation configuration requirements.

7. Connect the adapter to the devices. Connect the appropriate cable with the connectors on one end to connect to the adapter and the appropriate connector on the other end to attach to the backplane connector.

The maximum cable length is 1 meter (39.37 in.). A single wide-port SAS or multilane PCIe (NVMe) device cannot connect to phys controlled by different CSWs. See [Tri-Mode Storage Interface](#) for more information.

8. Provide the required airflow for the installed adapter. See [Operating and Nonoperating Conditions](#) to find the adapter's cooling requirements.

9. Turn on the power to the system. Reinstall the computer cover, and reconnect the AC power cords. 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. Turn on power 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 adapters follows the PCIe slot scanning order used by the host motherboard.

10. **Choose the correct storage profile.** Refer to the *MegaRAID Tri-Mode Software User Guide* and *LSI® Storage Authority Software User Guide* for details about setting up your adapter.
11. **Install the operating system driver.** The 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. Visit <http://www.broadcom.com/support/download-search>, and download the latest firmware and driver for the adapter.

The hardware installation of your adapter is complete.

Broadcom MegaRAID and HBA Tri-Mode Storage Adapter Characteristics

MegaRAID 9670W-16i Adapter – Connector and LED Designations

The adapter is a 6.127 in. × 4.376 in. (155.65 mm × 111.15 mm) board. The component height on the top and bottom of the adapter complies with the PCIe specification.

The following table describes the headers and connectors on the adapter.

Table 20: Headers and Connectors

| Connector | Type | Description |
|-----------|---|--|
| J2 | Standard edge card connector | The interface between the storage adapter and the host system. With the PCIe interface, this connector provides power to the board and an I ² C interface connected to the I ² C bus for the Intelligent Platform Management Interface (IPMI). |
| J4 | Default SBR header | 2-pin connector. Reserved for Broadcom use. |
| J7 | Advanced software options hardware key header | 2-pin connector. Enables support for selected advanced features. |
| J8 | Onboard serial UART connector | 4-pin connector. Reserved for Broadcom use. |
| J10 | Global HDD activity LED header | 2-pin connector. Connects to an LED that indicates activity on the drives connected to the adapter. |
| 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 adapter to a CacheVault power module. |
| J17, J18 | Storage interface connectors | Two SFF-8654 8-port internal connectors. Connect the adapter by cable to the storage devices. |

The following table describes the LEDs on the adapter.

Table 21: LED Designations

| LED | Type | Description |
|------|-----------------------------------|---|
| LED2 | Yellow controller overtemperature | Stays on solid to indicate that the SAS4116W RoC temperature sensor is over the temperature threshold. When the device is in the proper temperature range, this LED is off. |
| LED3 | Green system heartbeat | Indicates that the SAS4116W RoC ASIC is operating normally. This LED blinks at 1 Hz. |
| LED4 | Green write pending | Indicates the cache is dirty, that is, not yet saved to the storage devices. |
| LED5 | Yellow supercap fault | Indicates that the CacheVault power module is in fault state or is overtemperature. When the energy pack is in the FAULT condition, this LED is on. |
| LED6 | Green ONFI activity | Indicates when the ONFI is active for cache offload or recovery. |

MegaRAID 9670-24i Adapter – Connector and LED Designations

The adapter is a 6.127 in. × 4.376 in. (155.65 mm × 111.15 mm) board. The component height on the top and bottom of the adapter complies with the PCIe specification.

The following table describes the headers and connectors on the adapter.

Table 22: Headers and Connectors

| Connector | Type | Description |
|----------------|---|--|
| J2 | Standard edge card connector | The interface between the storage adapter and the host system. With the PCIe interface, this connector provides power to the board and an I ² C interface connected to the I ² C bus for the Intelligent Platform Management Interface (IPMI). |
| J4 | Default SBR header | 2-pin connector. Reserved for Broadcom use. |
| J7 | Advanced software options hardware key header | 2-pin connector. Enables support for selected advanced features. |
| J8 | Onboard serial UART connector | 4-pin connector. Reserved for Broadcom use. |
| J10 | Global HDD activity LED header | 2-pin connector. Connects to an LED that indicates activity on the drives connected to the adapter. |
| 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 adapter to a CacheVault power module. |
| J17, J18, J100 | Storage interface connectors | Three SFF-8654 8-port internal connectors. Connect the adapter by cable to the storage devices. |
| J29 | Auxiliary power connector | 6-pin connector. |

The following table describes the LEDs on the adapter.

Table 23: LED Designations

| LED | Type | Description |
|-------|-----------------------------------|--|
| LED 2 | Yellow controller overtemperature | Stays on solid to indicate that the SAS4124 RoC temperature sensor is over the temperature threshold. When the device is in the proper temperature range, this LED is off. |
| LED 3 | Green system heartbeat | Indicates that the SAS4124 RoC ASIC is operating normally. This LED blinks at 1 Hz. |
| LED 4 | Green write pending | Indicates the cache is dirty, that is, not yet saved to the storage devices. |
| LED 5 | Yellow supercap fault | Indicates that the CacheVault power module is in fault state or is overtemperature. When the energy pack is in the FAULT condition, this LED is on. |
| LED 6 | Green ONFI activity | Indicates when the ONFI is active for cache offload or recovery. |

Auxiliary Power Connector

The MegaRAID 9670-24i adapter supports the *PCI Express Card Electromechanical Specification* defined 2×3 auxiliary power connector. Connect the auxiliary power connector if the slot cannot supply the required power as defined in

MegaRAID Tri-Mode Storage Adapter Power Supply Requirements. The power check algorithm detects if auxiliary power is connected to the adapter. If auxiliary power is connected, the power check is bypassed and the card is fully enabled. The auxiliary power connector's pin definition meets the PCIe CEM specification and the following table is included for reference. The following figure shows the connector's pin designations.

Figure 5: Auxiliary Power Connector

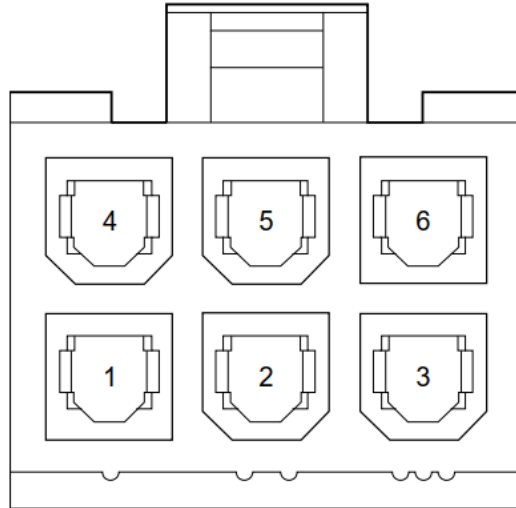


Table 24: Auxiliary Power Connector Pin Definition

| Pin | Signal |
|-----|--------|
| 1 | +12V |
| 2 | +12V |
| 3 | +12V |
| 4 | Ground |
| 5 | Sense |
| 6 | Ground |

MegaRAID 9660-16i Adapter – Connector and LED Designations

The 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 adapter complies with the PCIe specification.

The following table describes the headers and connectors on the adapter.

Table 25: Headers and Connectors

| Connector | Type | Description |
|-----------|---|--|
| J2 | Standard edge card connector | The interface between the storage adapter and the host system. With the PCIe interface, this connector provides power to the board and an I ² C interface connected to the I ² C bus for the Intelligent Platform Management Interface (IPMI). |
| J4 | Default SBR header | 2-pin connector. Reserved for Broadcom use. |
| J7 | Advanced software options hardware key header | 2-pin connector. Enables support for selected advanced features. |
| J8 | Onboard serial UART connector | 4-pin connector. Reserved for Broadcom use. |
| J10 | Global HDD activity LED header | 2-pin connector. Connects to an LED that indicates activity on the drives connected to the adapter. |
| 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 adapter to a CacheVault power module. |
| J17, J18 | Storage interface connectors | Two SFF-8654 8-port internal connectors. Connect the adapter by cable to the storage devices. |

The following table describes the LEDs on the adapter. These LEDs reside on the nonheat-sink side of the board.

Table 26: LED Designations

| LED | Type | Description |
|------|-----------------------------------|---|
| LED2 | Yellow controller overtemperature | Stays on solid to indicate that the SAS4116 device temperature sensor is over the temperature threshold. When the device is in the proper temperature range, this LED is off. |
| LED3 | Green system heartbeat | Indicates that the SAS4116 RoC ASIC is operating normally. This LED blinks at 1 Hz. |
| LED4 | Green write pending | Indicates the cache is dirty, that is, not yet saved to the storage devices. |
| LED5 | Yellow supercap fault | Indicates that the CacheVault power module is in fault state or is overtemperature. When the energy pack is in the FAULT condition, this LED is on. |
| LED6 | Green ONFI activity | Indicates when the ONFI is active for cache offload or recovery. |

eHBA 9620-16i Adapter – Connector and LED Designations

The 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 adapter complies with the PCIe specification.

The following table describes the headers and connectors on the adapter.

Table 27: Headers and Connectors

| Connector | Type | Description |
|-----------|-----------------------------------|--|
| J2 | Standard edge card connector | The interface between the storage adapter and the host system. With the PCIe interface, this connector provides power to the board and an I ² C interface connected to the I ² C bus for the Intelligent Platform Management Interface (IPMI). |
| J4 | Default SBR header | 2-pin connector. Reserved for Broadcom use. |
| J8 | Onboard serial UART connector | 4-pin connector. Reserved for Broadcom use. |
| J10 | Global HDD activity LED header | 2-pin connector. Connects to an LED that indicates activity on the drives connected to the adapter. |
| 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 adapter to a CacheVault power module. |
| J17, J18 | Storage interface connectors | Two SFF-8654 8-port internal connectors. Connect the adapter by cable to the storage devices. |

The following table describes the LEDs on the adapter.

Table 28: LED Designations

| LED | Type | Description |
|-------|-----------------------------------|---|
| LED 2 | Yellow controller overtemperature | Stays on solid to indicate that the SAS4116 device temperature sensor is over the temperature threshold. When the device is in the proper temperature range, this LED is off. |
| LED 3 | Green system heartbeat | Indicates that the SAS4116 RoC ASIC is operating normally. This LED blinks at 1 Hz. |

eHBA 9600-24i Adapter – Connector and LED Designations

The 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 adapter complies with the PCIe specification.

The following table describes the connectors on the adapter.

Table 29: Headers and Connectors

| Connector | Type | Description |
|---------------|-------------------------------|--|
| J2 | Standard edge card connector | The interface between the storage adapter and the host system. With the PCIe interface, this connector provides power to the board and an I ² C interface connected to the I ² C bus for the IPMI. |
| J4 | Default SBR header | 2-pin connector. Reserved for Broadcom use. |
| J8 | Onboard serial UART connector | 4-pin connector. Reserved for Broadcom use. |
| J17, J18, J26 | Storage interface connectors | Three SFF-8654 8-port internal connectors. Connect the adapter by cable to the storage devices. |

The following table describes the LEDs on the adapter.

Table 30: LED Designations

| LED | Type | Description |
|------|----------------------------|--|
| LED2 | Yellow IOC overtemperature | Stays on solid to indicate that the SAS4024 IOC temperature sensor is over the temperature threshold. When the device is in the proper temperature range, this LED is off. This LED resides on the nonheat-sink side of the board. |
| LED3 | Green system heartbeat | Indicates that the SAS4024 IOC is operating normally. This LED resides on the nonheat-sink side of the board. |

eHBA 9600-16i Adapter – Connector and LED Designations

The 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 adapter complies with the PCIe specification.

The following table describes the connectors on the adapter.

Table 31: Headers and Connectors

| Connector | Type | Description |
|-----------|-------------------------------|--|
| J2 | Standard edge card connector | The interface between the storage adapter and the host system. With the PCIe interface, this connector provides power to the board and an I ² C interface connected to the I ² C bus for the IPMI. |
| J4 | Default SBR header | 2-pin connector. Reserved for Broadcom use. |
| J8 | Onboard serial UART connector | 4-pin connector. Reserved for Broadcom use. |
| J17, J18 | Storage interface connectors | Two SFF-8654 8-port internal connectors. Connect the adapter by cable to the storage devices. |

The following table describes the LEDs on the adapter.

Table 32: LED Designations

| LED | Type | Description |
|------|----------------------------|--|
| LED2 | Yellow IOC overtemperature | Stays on solid to indicate that the SAS4016 IOC temperature sensor is over the temperature threshold. When the device is in the proper temperature range, this LED is off. This LED resides on the nonheat-sink side of the board. |
| LED3 | Green system heartbeat | Indicates that the SAS4016 IOC is operating normally. This LED resides on the nonheat-sink side of the board. |

eHBA 9600-8i8e Adapter – Connector and LED Designations

The adapter is a 6.600 in. × 2.707 in. (167.65 mm × 68.77 mm) board. The component height on the top and bottom of the adapter complies with the PCIe specification.

The following table describes the connectors on the adapter.

Table 33: Headers and Connectors

| Connector | Type | Description |
|-----------|-------------------------------|--|
| J2 | Standard edge card connector | The interface between the storage adapter and the host system. With the PCIe interface, this connector provides power to the board and an I ² C interface connected to the I ² C bus for the IPMI. |
| J4 | Default SBR header | 2-pin connector. Reserved for Broadcom use. |
| J8 | Onboard serial UART connector | 4-pin connector. Reserved for Broadcom use. |
| J26 | Storage interface connector | One SFF-8654 8-port internal connector. Connect the adapter by cable to the storage devices. |
| J163, J28 | Storage interface connectors | Two SFF-8674 4-port external connectors. |

The following table describes the LEDs on the adapter.

Table 34: LED Designations

| LED | Type | Description |
|------|----------------------------|--|
| LED2 | Yellow IOC overtemperature | Stays on solid to indicate that the SAS4016 IOC temperature sensor is over the temperature threshold. When the device is in the proper temperature range, this LED is off. This LED resides on the nonheat-sink side of the board. |
| LED3 | Green system heartbeat | Indicates that the SAS4016 IOC is operating normally. This LED resides on the nonheat-sink side of the board. |

eHBA 9600W-16e Adapter – Connector and LED Designations

The adapter is a 6.600 in. × 2.707 in. (167.65 mm × 68.77 mm) board. The component height on the top and bottom of the adapter complies with the PCIe specification.

The following table describes the headers and connectors on the adapter.

Table 35: Connectors

| Connector | Type | Description |
|---------------------|-------------------------------|---|
| J2 | Standard board edge connector | PCIe x8 board edge connector. With the PCIe interface, this connector provides power to the board and an I ² C interface connected to the I ² C bus for the IPMI. |
| J4 | Default SBR header | 2-pin connector. Reserved for Broadcom use. |
| J8 | Onboard serial UART connector | 4-pin connector. Reserved for Broadcom use. |
| J164, J28, J29, J30 | Storage interface connectors | Four SFF-8674 external connectors. Connect the adapter by cable to the storage devices. |

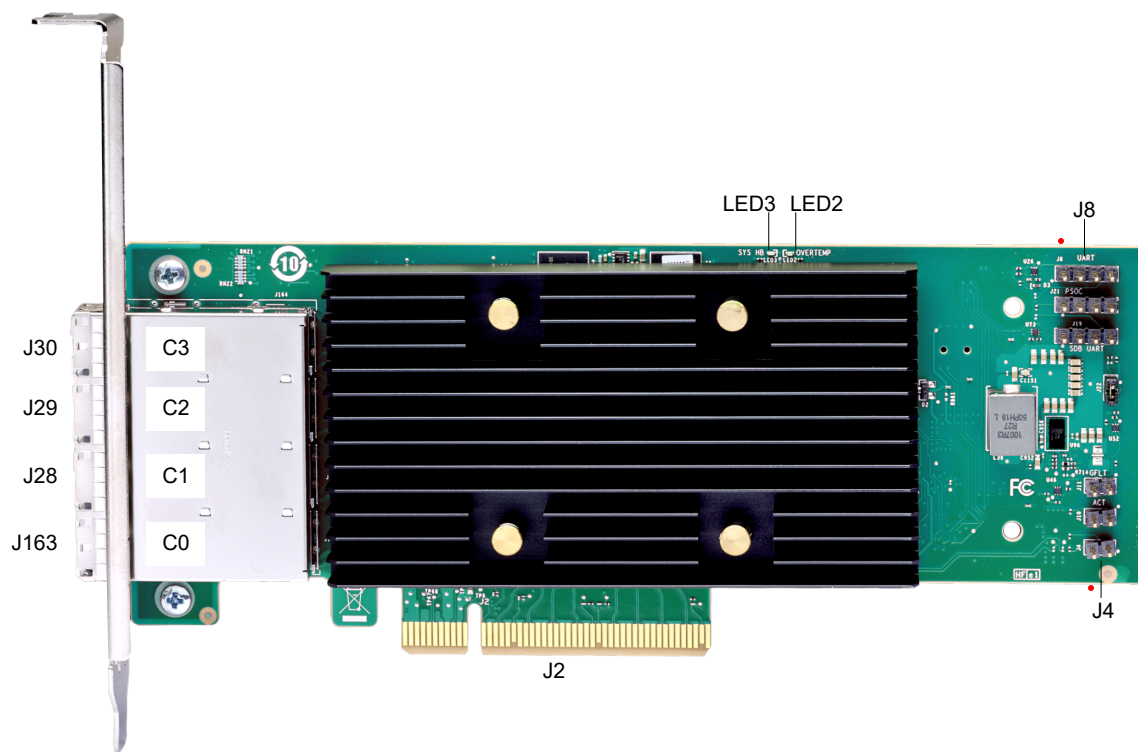
The following table describes the LEDs on the adapter.

Table 36: LED Designations

| LED | Type | Description |
|------|----------------------------|---|
| LED2 | Yellow IOC overtemperature | Stays on solid to indicate that the SAS4016W IOC temperature sensor is over the temperature threshold. When the device is in the proper temperature range, this LED is off. |
| LED3 | Green system heartbeat | Indicates that the SAS4016W IOC is operating normally. |

eHBA 9600-16e Adapter – Connector and LED Designations

The adapter is a 6.600 in. × 2.707 in. (167.65 mm × 68.77 mm) board. The component height on the top and bottom of the adapter complies with the PCIe specification.

Figure 6: Card Layout of the eHBA 9600-16e Storage Adapter

The following table describes the headers and connectors on the adapter.

Table 37: Connectors

| Connector | Type | Description |
|-----------|-------------------------------|---|
| J2 | Standard board edge connector | PCIe x8 board edge connector. With the PCIe interface, this connector provides power to the board and an I ² C interface connected to the I ² C bus for the IPMI. |
| J4 | Default SBR header | 2-pin connector. Reserved for Broadcom use. |
| J8 | Onboard serial UART connector | 4-pin connector. Reserved for Broadcom use. |

| Connector | Type | Description |
|---------------------|------------------------------|--|
| J30, J29, J28, J163 | Storage interface connectors | Four SFF-8674 external connectors. Connect the adapter by cable to the storage devices. |

The following table describes the LEDs on the adapter.

Table 38: LED Designations

| LED | Type | Description |
|------|----------------------------|--|
| LED2 | Yellow IOC overtemperature | Stays on solid to indicate that the SAS4016 IOC temperature sensor is over the temperature threshold. When the device is in the proper temperature range, this LED is off. |
| LED3 | Green system heartbeat | Indicates that the SAS4016 IOC is operating normally. |

Tri-Mode Storage Adapter Technical Specifications

Operating and Nonoperating Conditions

The following table lists the operating (thermal and atmospheric) conditions and nonoperating (such as storage and transit) environment for the storage adapters. The minimum airflow, measured as linear feet per minute (LFPM) at 55°C, must be met to avoid operating the controller's processor and board components above their maximum junction temperatures.

Table 39: Operating and Nonoperating Conditions

| Adapter | Operating Conditions | | | Nonoperating Environment | |
|-----------|---|--------------|--------------------------------|---|-------------------|
| | Relative Humidity Range (Noncondensing) | Minimum LFPM | Temperature Range ^a | Relative Humidity Range (Noncondensing) | Temperature Range |
| 9670W-16i | 5% to 90% | 200 | 0°C to +55°C | 5% to 95% | -40°C to +70°C |
| 9670-24i | 5% to 90% | 200 | 0°C to +55°C | 5% to 95% | -40°C to +70°C |
| 9660-16i | 5% to 90% | 250 | 0°C to +55°C | 5% to 95% | -40°C to +70°C |
| 9620-16i | 5% to 90% | 150 | 0°C to +55°C | 5% to 95% | -40°C to +70°C |
| 9600-24i | 5% to 90% | 150 | 0°C to +55°C | 5% to 95% | -40°C to +70°C |
| 9600-16i | 5% to 90% | 150 | 0°C to +55°C | 5% to 95% | -40°C to +70°C |
| 9600-8i8e | 5% to 90% | 200 | 0°C to +55°C | 5% to 95% | -40°C to +70°C |
| 9600W-16e | 5% to 90% | 200 | 0°C to +55°C | 5% to 95% | -40°C to +70°C |
| 9600-16e | 5% to 90% | 200 | 0°C to +55°C | 5% to 95% | -40°C to +70°C |

Tri-Mode Storage Adapter Power Supply Requirements

All power is supplied to the tri-mode storage adapter through the PCIe 3.3V rails (3.3V ± 9%) and the 12V rail (12V ± 8%). Onboard switching regulator circuitry operates from the 3.3V rails and the 12V rail provides the necessary voltages.

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 with required airflow.

The system might transmit a PCI Set Slot Power Limit Message that indicates the maximum amount of power that the adapter might use. During the start-up procedure, the adapter's power consumption is limited to 25W because the storage phys are not enabled until the Auto Port Enable procedure begins. When this procedure begins, the adapter's power check algorithm compares the power allocated by the SET_SLOT_POWER_LIMIT message to the adapter's slot power requirement. If the SET_SLOT_POWER_LIMIT message indicates that the slot's power budget is at or greater than the adapter's requirement, Auto Port Enable proceeds. Refer to *SAS95xx Adapters and SAS96xx Adapters Slot Power Limit Settings Specification* for more information on slot power requirements.

In the case that no SET_SLOT_POWER_LIMIT message is received by the time Auto Port Enable is to start, the adapter continues with port enable. You must make sure enough power is available to the slot if the SET_SLOT_POWER_LIMIT message is not used. For adapters with auxiliary power connectors, the slot power check is bypassed if the auxiliary power connector is connected. For more information on the auxiliary power connector see [Auxiliary Power Connector](#).

a. For adapters with a CVPM, this range applies with or without the CVPM attached.

MegaRAID Tri-Mode Storage Adapter Power Supply Requirements

The following table describes the typical power consumption of the MegaRAID adapters.

Table 40: MegaRAID Tri-Mode Storage Adapter Typical Power Consumption

| Adapter | Typical Power (W) |
|-----------|-------------------|
| 9670W-16i | 28 |
| 9670-24i | 28 |
| 9660-16i | 20 |

During the transparent learn cycle, the CacheVault power module consumes up to an additional 8W. The PCIe 3.3V rail supplies the power for the learn cycle.

eHBA Tri-Mode Storage Adapter Power Supply Requirements

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

Table 41: eHBA Tri-Mode Storage Adapter Typical Power Consumption

| Adapter | Typical Power (W) |
|-----------|-------------------|
| 9620-16i | 17 |
| 9600-24i | 20 |
| 9600-16i | 17 |
| 9600-8i8e | 17 |
| 9600W-16e | 20 |
| 9600-16e | 17 |

Overtemperature Behavior

The adapter supports the following temperature threshold events to alert of overtemperature situations when sufficient airflow is not provided. If supported, the system can use the events generated in the Persistent Event Log (PEL) to manage fan speed and mitigate overtemperature conditions. While these events assist in managing overtemperature conditions, potential damage can occur if sufficient airflow is not provided to the adapter.

Table 42: Temperature Threshold Events

| Condition | RoC or IOC Junction Temperature (°C) | Result |
|-----------|--------------------------------------|--|
| Warning | 105 | Generate a PEL event. |
| Critical | 107 | Generate a PEL event and decrease device-side ports to their slowest operating speed. The junction temperature must return to 104°C, or lower, to resume normal operation. |
| Fatal | 115 | Generate a PEL event and fault the adapter. The junction temperature must return to 104°C, or lower, and the adapter must be reset to resume normal operation. |

Marks, Certifications, Compliance, and Safety Characteristics



Marks, Certifications, and Compliance







The design and implementation of the adapters minimize electromagnetic emissions, susceptibility to radio frequency energy, and the effects of electrostatic discharge. The following adapters show the marks and certifications included in [Table 44, Adapter Marks and Certifications](#).

Table 43: Adapter Models

| Adapter | Model Number |
|--|--------------|
| MegaRAID 9670W-16i | 50113 |
| MegaRAID 9660-16i | 50107 |
| eHBA 9600-24i eHBA 9600-16i HBA 9620-16i | 50111 |
| eHBA 9600 8i8e | 50145 |
| eHBA 9600W-16e | 50108 |
| eHBA 9600-16e | 50118 |

Table 44: Adapter Marks and Certifications

| Mark | Symbol | Description |
|-------------------------------|---|---|
| Australia and New Zealand RCM |  | Meets the following standards: <ul style="list-style-type: none"> AS/NZS CISPR 32 CISPR 32:2015, Class A AS/NZS CISPR 32:2015, Class A |
| Canada EMC | CANADA ICES-003 CLASS A CANADA NMB-003 CLASSE A CAN ICES-3 (A)/NMB-3 (A) | Meets the following standards: <ul style="list-style-type: none"> ICES-003:2016 Issue 6: 2016, Class A CAN/CSA CISPR 22-10 CISPR 22:2008 |
| Europe (CE) |  | Meets the following standards: <ul style="list-style-type: none"> EN 55024, EN 55032, EN 55035 EN 55032:2015 +AC:2016, Class A EN 55024:2010 +A1:2015 EN 55035:2017 +A11:2020 |

| Mark | Symbol | Description |
|---------------------------------|---|--|
| Korea (RRL) |  | <p>xxxxx = model number Meets the KN32/KN35 testing requirements.</p> |
| Taiwan (BSMI) |  | <p>Meets the following standards:</p> <ul style="list-style-type: none"> • CNS 13438 • CNS15663 |
| USA / Canada Safety (UL Listed) |  | <p>For use with UL listed ITE equipment only. Meets the following standards:</p> <ul style="list-style-type: none"> • UL 62368-1, Second Edition • CAN/CSA C22.2 No. 62368-1-14 |
| CB Scheme Safety | — | <p>Meets the following standards:</p> <ul style="list-style-type: none"> • IEC 62368-1:2014 (Second edition) • EN 62368-1:2014+A11: 2017 |
| Japan (VCCI) |  | <p>Meets the following standards:</p> <ul style="list-style-type: none"> • V-3/2015.04, Class A • V-4/2012.04 • VCCI-CISPR 32:2016 • CISPR 32:2015 |
| USA / Canada (FCC) |  | <p>Meets the following standards:</p> <ul style="list-style-type: none"> • 47 CFR FCC Part 15, Subpart B, Class A • ANSI C63.4:2014 • CISPR 32:2008 |
| Morocco (CMIM) |  | <p>Meets the following standards:</p> <ul style="list-style-type: none"> • EN 55024, EN 55032, EN 55035 • EN 55032:2015 +AC:2016, Class A • EN 55024:2010 +A1:2015 • EN 55035:2017 +A11:2020 |
| Country of Origin | Made in XXXX | XXXX indicates the country of origin. |

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 PCIe bus slot, all voltages are lower than the SELV 42.4V limit.

Cable Drawings and Pinouts

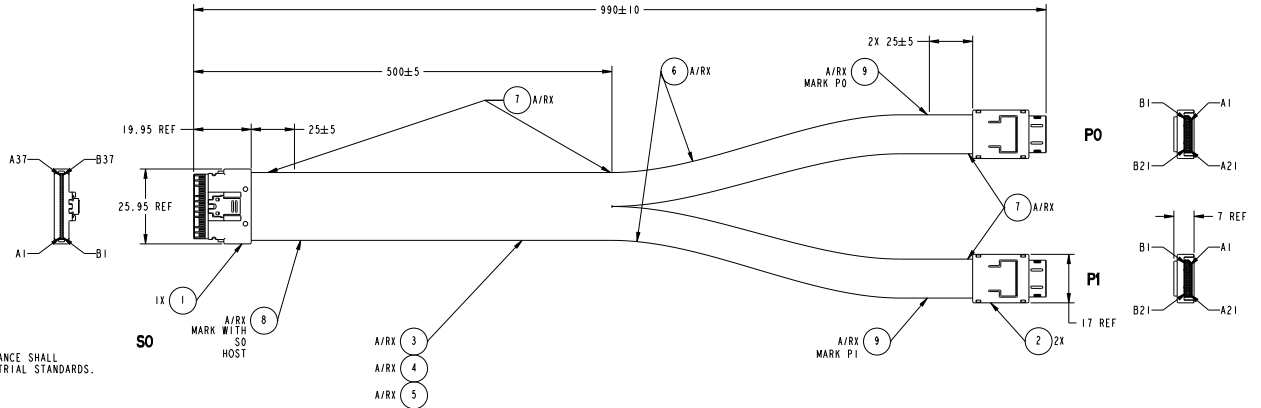
Use the cable drawings and pinouts in this appendix if your design requires you to design your own cables.

Cable 05-60001-00

The following figure shows the drawing and pinout for Broadcom cable, 05-60001-00, a x8 SFF-8654 to 2 x4 SFF-8612 connection.

Figure 7: Cable 05-60001-00 Drawing and Pinout

| REVISIONS | | | | |
|-----------|--------|---|---------|----------|
| REV | ECO | DESCRIPTION | DATE | APPROVED |
| 001 | | PRELIMINARY RELEASE | 26FEB18 | |
| 002 | 175141 | UPDATE WIRE GAUGE AND IMPEDANCE TOLERANCE ITEM 3, REVISE MARKING REQUIREMENTS NOTE 3. | 21NOV19 | |



- NOTES:**
- DRAWING NOT TO SCALE.
 - ELECTRICAL AND MECHANICAL PERFORMANCE SHALL MEET PCIe GEN 4 AND SAS 4.0 INDUSTRIAL STANDARDS.
 - MARK LABEL (ITEM 8) WITH:
SLIMSAS Y (PCIe)
BROADCOM PART NUMBER
BROADCOM REVISION-XXX
DATE CODE DD/MM/YY
SECONDARY MARKING WITH MANUFACTURER PART NUMBER AND REVISION ACCEPTABLE.
 - SEE CABLE WIRING TABLE AND RELATED NOTES.

| ITEM | CALLOUT | DESCRIPTION | QUANTITY | NOTES |
|------|-----------|--|----------|------------|
| 9 | LABEL | LABEL, 40X14MM, WHITE, R2, HF | A/R | |
| 8 | LABEL | LABEL, 70X28MM, WHITE, R2, HF | A/R | SEE NOTE 3 |
| 7 | TAPE | ACETATE TAPE: W=1 INCH | A/R | |
| 6 | SLEEVING | EXPANDO TUBE: OD=7MM, GREEN, VW-1, HF | A/R | |
| 5 | SLEEVING | EXPANDO TUBE: OD=10MM, GREEN, VW-1, HF | A/R | |
| 4 | WIRE | UL1061, STRANDED | A/R | SEE NOTE 4 |
| 3 | CABLE | SAS CABLE: UL20744, 28-32AWG, 92.5(2) ±10% DIFF, SAS4, PCIe GEN 4, VW-1, NATURAL, HF | A/R | |
| 2 | CONNECTOR | SFF-8612, 42P, STRAIGHT, ACTIVE LATCH, X4, SAS 4.0, PCIe GEN 4 | 2 | SEE NOTE 4 |
| 1 | CONNECTOR | SFF-8654, 74P, STRAIGHT, X8, SAS 4.0, PCIe GEN 4 | 1 | SEE NOTE 4 |

| APPROVALS | DATE | UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN MILLIMETERS. | BROADCOM® | | | |
|-------------|---------|--|--|--|--|--|
| DESIGNED BY | 06FEB18 | TOLERANCES: X, Y, Z: 0.2 MM X, Y, Z: 0.15 MM X, Y, Z: 0.050 MM ANGLES: ±0.5° | TITLE: CABLE, SFF-8654 X8 TO 2X SFF-8612 X4, PCIe, 1M SCALE: 1:500 SIZE: D DRG NO.: 5067-6865 REV: 002 SHEET: | | | |
| APPROVED BY | 26FEB18 | | | | | |

| CONNECTOR | SIGNAL | CONNECTOR | PIN/PAD | CONNECTOR | PIN/PAD | CONNECTOR | SIGNAL | WIRE/CABLE | NOTES |
|-----------|--------|-----------|---------|--------------|---------|-----------|--------|------------|-------|
| NC | | SO HOST | A1 | P0 BACKPLANE | B1 | NC | | | |
| GND | | | A2 | | B2 | GND | ITEM 3 | | |
| Rx0+ | | | A3 | | B3 | Tx0+ | ITEM 3 | | |
| Rx0- | | | A4 | | B4 | Tx0- | ITEM 3 | | |
| GND | | | A5 | | B5 | GND | ITEM 3 | | |
| Rx1+ | | | A6 | | B6 | Tx1+ | ITEM 3 | | |
| Rx1- | | | A7 | | B7 | Tx1- | ITEM 3 | | |
| GND | | | A8 | | B8 | GND | ITEM 3 | | |
| SB7A | | | | | | NC | | NOTE 2 | |
| SB4A | | | A9 | | B10 | CWAKE# | ITEM 4 | NOTE 1 | |
| SB3A | | | A10 | | B9 | CBL_ID | ITEM 4 | NOTE 1 | |
| SB3A | | | A10 | | B11 | GND | ITEM 3 | | |
| SBA+ | | | A11 | | B12 | REFCLK+ | ITEM 3 | | |
| SBA- | | | A12 | | B13 | REFCLK- | ITEM 3 | | |
| GND | | | A13 | | B14 | GND | ITEM 3 | | |
| Rx2+ | | | A14 | | B15 | Tx2+ | ITEM 3 | | |
| Rx2- | | | A15 | | B16 | Tx2- | ITEM 3 | | |
| GND | | | A16 | | B17 | GND | ITEM 3 | | |
| Rx3+ | | | A17 | | B18 | Tx3+ | ITEM 3 | | |
| Rx3- | | A18 | B19 | Tx3- | ITEM 3 | | | | |
| GND | | A19 | B20 | GND | ITEM 3 | | | | |
| NC | | | B21 | NC | | | | | |
| NC | | | A1 | NC | | | | | |
| GND | | B1 | A2 | GND | ITEM 3 | | | | |
| Tx0+ | | B2 | A3 | Rx0+ | ITEM 3 | | | | |
| Tx0- | | B3 | A4 | Rx0- | ITEM 3 | | | | |
| GND | | B4 | A5 | GND | ITEM 3 | | | | |
| Tx1+ | | B5 | A6 | Rx1+ | ITEM 3 | | | | |
| Tx1- | | B6 | A7 | Rx1- | ITEM 3 | | | | |
| GND | | B7 | A8 | GND | ITEM 3 | | | | |
| SB0A | | B8 | A9 | SCL | ITEM 4 | NOTE 1 | | | |
| SB1A | | B9 | A10 | SDA | ITEM 4 | NOTE 1 | | | |
| SB2A | | B10 | A11 | GND | ITEM 3 | | | | |
| SB5A | | B11 | A12 | PERST# | ITEM 3 | | | | |
| SB6A | | B12 | A13 | D_INPL# | ITEM 3 | | | | |
| GND | | B13 | A14 | GND | ITEM 3 | | | | |
| Tx2+ | | B14 | A15 | Rx2+ | ITEM 3 | | | | |
| Tx2- | | B15 | A16 | Rx2- | ITEM 3 | | | | |
| GND | | B16 | A17 | GND | ITEM 3 | | | | |
| Tx3+ | | B17 | A18 | Rx3+ | ITEM 3 | | | | |
| Tx3- | | B18 | A19 | Rx3- | ITEM 3 | | | | |
| GND | | B19 | A20 | GND | ITEM 3 | | | | |
| NC | | | A21 | NC | | | | | |

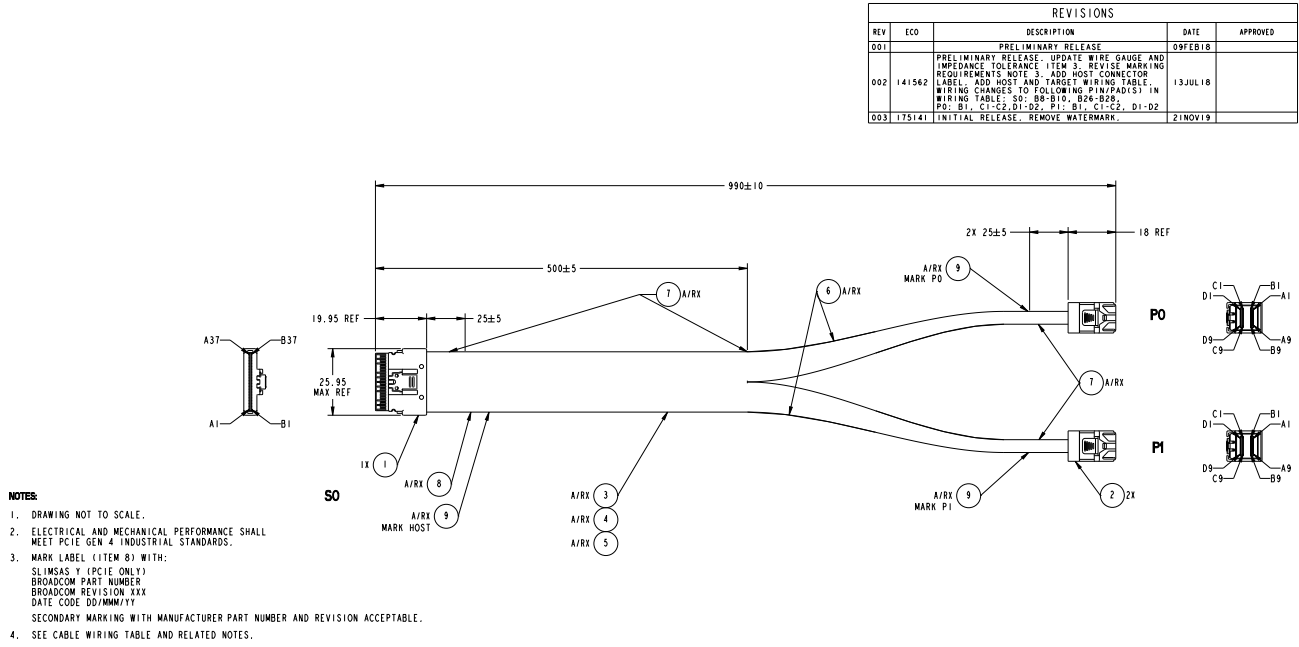
| CONNECTOR | SIGNAL | CONNECTOR | PIN/PAD | CONNECTOR | PIN/PAD | CONNECTOR | SIGNAL | WIRE/CABLE | NOTES |
|-----------|--------|-----------|---------|--------------|---------|-----------|--------|------------|-------|
| NC | | SO HOST | A19 | P1 BACKPLANE | B1 | NC | | | |
| GND | | | A20 | | B2 | GND | ITEM 3 | | |
| Rx4+ | | | A21 | | B3 | Tx0+ | ITEM 3 | | |
| Rx4- | | | A22 | | B4 | Tx0- | ITEM 3 | | |
| GND | | | | | B5 | GND | ITEM 3 | | |
| Rx5+ | | | A23 | | B6 | Tx1+ | ITEM 3 | | |
| Rx5- | | | A24 | | B7 | Tx1- | ITEM 3 | | |
| GND | | | A25 | | B8 | GND | ITEM 3 | | |
| SB7B | | | A26 | | | NC | | NOTE 3 | |
| SB4B | | | A27 | | B10 | CWAKE# | ITEM 4 | NOTE 1 | |
| SB3B | | | A28 | | B9 | CBL_ID | ITEM 4 | NOTE 1 | |
| SB3B | | | A28 | | B11 | GND | ITEM 3 | | |
| SB0+ | | | A29 | | B12 | REFCLK+ | ITEM 3 | | |
| SB0- | | | A30 | | B13 | REFCLK- | ITEM 3 | | |
| GND | | | A31 | | B14 | GND | ITEM 3 | | |
| Rx6+ | | | A32 | | B15 | Tx2+ | ITEM 3 | | |
| Rx6- | | | A33 | | B16 | Tx2- | ITEM 3 | | |
| GND | | | A34 | | B17 | GND | ITEM 3 | | |
| Rx7+ | | | A35 | | B18 | Tx3+ | ITEM 3 | | |
| Rx7- | | | A36 | | B19 | Tx3- | ITEM 3 | | |
| GND | | | A37 | | B20 | GND | ITEM 3 | | |
| NC | | | | | B21 | NC | | | |
| NC | | | | | A1 | NC | | | |
| GND | | | B19 | | A2 | GND | ITEM 3 | | |
| Tx4+ | | | B20 | | A3 | Rx0+ | ITEM 3 | | |
| Tx4- | | | B21 | | A4 | Rx0- | ITEM 3 | | |
| GND | | | B22 | | A5 | GND | ITEM 3 | | |
| Tx5+ | | | B23 | | A6 | Rx1+ | ITEM 3 | | |
| Tx5- | | | B24 | | A7 | Rx1- | ITEM 3 | | |
| GND | | | B25 | | A8 | GND | ITEM 3 | | |
| SB0B | | | B26 | | A9 | SCL | ITEM 4 | NOTE 1 | |
| SB1B | | | B27 | | A10 | SDA | ITEM 4 | NOTE 1 | |
| SB2B | | | B28 | | A11 | GND | ITEM 3 | | |
| SB5B | | | B29 | | A12 | PERST# | ITEM 3 | | |
| SB6B | | | B30 | | A13 | D_INPL# | ITEM 3 | | |
| GND | | | B31 | | A14 | GND | ITEM 3 | | |
| Tx6+ | | | B32 | | A15 | Rx2+ | ITEM 3 | | |
| Tx6- | | B33 | A16 | Rx2- | ITEM 3 | | | | |
| GND | | B34 | A17 | GND | ITEM 3 | | | | |
| Tx7+ | | B35 | A18 | Rx3+ | ITEM 3 | | | | |
| Tx7- | | B36 | A19 | Rx3- | ITEM 3 | | | | |
| GND | | B37 | A20 | GND | ITEM 3 | | | | |
| NC | | | A21 | NC | | | | | |

- NOTES:**
- END TO END RESISTANCE OF INDICATED CONNECTION SHALL BE 750 MILLIOHM MAX.
 - SHORT PIN/PAD S0-A8 TO S0-B9. NO DIRECT CONNECT S0-A8 TO CONNECTOR P0.
 - SHORT PIN/PAD S0-A26 TO S0-B27. NO DIRECT CONNECT S0-A26 TO CONNECTOR P1.

Cable 05-60002-00

The following figure shows the drawing and pinout for Broadcom cable, 05-60002-00, a x8 SFF-8654 to 2 x4 SFF-8643 connection. Use this cable for NVMe connections on SuperMicro Purley backplanes.

Figure 8: Cable 05-60002-00 Drawing and Pinout



| REVISIONS | | | | |
|-----------|--------|--|---------|----------|
| REV | ECO | DESCRIPTION | DATE | APPROVED |
| 001 | | PRELIMINARY RELEASE | 09FEB18 | |
| 002 | 141562 | PRELIMINARY RELEASE. UPDATE WIRE GAUGE AND IMPEDANCE TOLERANCE. ITEM 3. REVISE MARKING REQUIREMENTS NOTE. ADD HOST CONNECTOR LABEL. ADD HOST AND TARGET WIRING TABLE. WIRING CHANGES TO FOLLOWING PIN/PADS IN WIRING TABLE: S0: B9-B10, B4-B26; PO: B1, C1-C2, D1-D2; P1: B1, C1-C2, D1-D2 | 13JUL18 | |
| 003 | 175141 | INITIAL RELEASE. REMOVE WATERMARK. | 21NOV19 | |

- NOTES:**
- DRAWING NOT TO SCALE.
 - ELECTRICAL AND MECHANICAL PERFORMANCE SHALL MEET PCIe GEN 4 INDUSTRIAL STANDARDS.
 - MARK LABEL (ITEM 8) WITH:
SLIMSAS Y (PCIe ONLY)
BROADCOM PART NUMBER
BROADCOM REVISION XXX
DATE CODE DD/MM/YY
SECONDARY MARKING WITH MANUFACTURER PART NUMBER AND REVISION ACCEPTABLE.
 - SEE CABLE WIRING TABLE AND RELATED NOTES.

| ITEM | CALLOUT | DESCRIPTION | QUANTITY | NOTES |
|------|-----------|--|----------|------------|
| 9 | LABEL | LABEL, 40X14MM, WHITE, R2, HF | A/R | |
| 8 | LABEL | LABEL, 70X26MM, WHITE, R2, HF | A/R | SEE NOTE 3 |
| 7 | TAPE | ACETATE TAPE: W:1 INCH | A/R | |
| 6 | SLEEVING | EXPANDO TUBE: OD=7MM, GREEN, VW-1, HF | A/R | |
| 5 | SLEEVING | EXPANDO TUBE: OD=10MM, GREEN, VW-1, HF | A/R | |
| 4 | WIRE | UL1061, STRANDED | A/R | SEE NOTE 4 |
| 3 | CABLE | SAS CABLE: UL20744, 28-32AWG, 92 SC ±10% DIFF, PCIe GEN 4, VW-1, NATURAL, HF | A/R | SEE NOTE 4 |
| 2 | CONNECTOR | SFF-8643, 36P, STRAIGHT, X4, WHITE, SHORT, PCIe GEN 4 | 2 | SEE NOTE 4 |
| 1 | CONNECTOR | SFF-8654, 74P, STRAIGHT, X8, SAS 4.0, PCIe GEN 4 | 1 | SEE NOTE 4 |

| APPROVALS | DATE | UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS. | BROADCOM® | |
|--|---------|--|---|-----|
| APPROVED BY | 05FEB18 | TOLERANCES: X, Y, Z ± 0.25 MM X, Y, Z ± 0.15 MM X, Y, Z ± 0.25 MM | TITLE | |
| APPROVED BY | 09FEB18 | ANGLES ± 0.250 MM | CABLE, SFF-8654 X8 TO 2X SFF-8643 X4 (W), 1M | |
| <small>Company Confidential © Copyright Broadcom Limited All rights reserved. No copy or use is permitted without the express written permission of Broadcom Limited. The purchaser is responsible for verifying that the dimensions of the product meet the requirements of the drawing when the dimensions from their part of the.</small> | | | SIZE | REV |
| SCALE 1:500 | | | DWG NO. 5067-6862 | 003 |

| CONNECTOR SIGNAL | CONNECTOR (HOST) | PIN/PAD | CONNECTOR (TARGET) | PIN/PAD | CONNECTOR SIGNAL | WIRE/CABLE |
|------------------|------------------|---------|--------------------|---------|------------------|----------------|
| GND | S0 | A1 | P0 | D3 | GND | ITEM 3 |
| Rx0+ | | A2 | | D4 | Tx0+ | ITEM 3 |
| Rx0- | | A3 | | D5 | Tx0- | ITEM 3 |
| GND | | A4 | | C3/D6 | GND | ITEM 3, NOTE 2 |
| Rx1+ | | A5 | | C4 | Tx1+ | ITEM 3 |
| Rx1- | | A6 | | C5 | Tx1- | ITEM 3 |
| GND | | A7 | | C6 | GND | ITEM 3 |
| SB7A | | A8 | | | NC | NOTE 3 |
| SB4A | | A9 | | | NC | NOTE 3 |
| SB3A | | A10 | | A3 | GND | ITEM 3 |
| SB4+ | | A11 | | A2 | REFCLK+ | ITEM 3 |
| SB4- | | A12 | | A1 | REFCLK- | ITEM 3 |
| GND | | A13 | | D6 | GND | ITEM 3 |
| Rx2+ | | A14 | | D7 | Tx2+ | ITEM 3 |
| Rx2- | | A15 | | D8 | Tx2- | ITEM 3 |
| GND | | A16 | | D9/C6 | GND | ITEM 3, NOTE 2 |
| Rx3+ | | A17 | | C7 | Tx3+ | ITEM 3 |
| Rx3- | | A18 | | C8 | Tx3- | ITEM 3 |
| GND | | A19 | | C9 | GND | ITEM 3 |
| GND | | B1 | | B3 | GND | ITEM 3 |
| Tx0+ | | B2 | | B4 | Rx0+ | ITEM 3 |
| Tx0- | | B3 | | B5 | Rx0- | ITEM 3 |
| GND | | B4 | | B6/A3 | GND | ITEM 3, NOTE 2 |
| Tx1+ | | B5 | | A4 | Rx1+ | ITEM 3 |
| Tx1- | | B6 | | A5 | Rx1- | ITEM 3 |
| GND | | B7 | | A6 | GND | ITEM 3 |
| SB0A | | B8 | | D1 | 2W_CLK | ITEM 4, NOTE 1 |
| SB1A | | B9 | | D2 | 2W_SDA | ITEM 4, NOTE 1 |
| SB2A | | B10 | | | NC | SHORT TO GND |
| SB5A | | B11 | | B2 | PERST# | ITEM 4, NOTE 1 |
| SB6A | | B12 | | | NC | SHORT TO GND |
| GND | | B13 | | B6 | GND | ITEM 3 |
| Tx2+ | | B14 | | B7 | Rx2+ | ITEM 3 |
| Tx2- | | B15 | | B8 | Rx2- | ITEM 3 |
| GND | | B16 | | B9/A6 | GND | ITEM 3, NOTE 2 |
| Tx3+ | | B17 | | A7 | Rx3+ | ITEM 3 |
| Tx3- | | B18 | | A8 | Rx3- | ITEM 3 |
| GND | | B19 | | A9 | GND | ITEM 3 |
| | | | | C1 | NC | |
| | | | | C2 | NC | |
| | | | | B1 | NC | |

| CONNECTOR SIGNAL | CONNECTOR (HOST) | PIN/PAD | CONNECTOR (TARGET) | PIN/PAD | CONNECTOR SIGNAL | WIRE/CABLE |
|------------------|------------------|---------|--------------------|---------|------------------|----------------|
| GND | S0 | A19 | P1 | D3 | GND | ITEM 3 |
| Rx4+ | | A20 | | D4 | Tx0+ | ITEM 3 |
| Rx4- | | A21 | | D5 | Tx0- | ITEM 3 |
| GND | | A22 | | C3/D6 | GND | ITEM 3, NOTE 2 |
| Rx5+ | | A23 | | C4 | Tx1+ | ITEM 3 |
| Rx5- | | A24 | | C5 | Tx1- | ITEM 3 |
| GND | | A25 | | C6 | GND | ITEM 3 |
| SB7B | | A26 | | | NC | NOTE 5 |
| SB4B | | A27 | | | NC | NOTE 5 |
| SB3B | | A28 | | A3 | GND | ITEM 3 |
| SB4+ | | A29 | | A2 | REFCLK+ | ITEM 3 |
| SB4- | | A30 | | A1 | REFCLK- | ITEM 3 |
| GND | | A31 | | D6 | GND | ITEM 3 |
| Rx6+ | | A32 | | D7 | Tx2+ | ITEM 3 |
| Rx6- | | A33 | | D8 | Tx2- | ITEM 3 |
| GND | | A34 | | D9/C6 | GND | ITEM 3, NOTE 2 |
| Rx7+ | | A35 | | C7 | Tx3+ | ITEM 3 |
| Rx7- | | A36 | | C8 | Tx3- | ITEM 3 |
| GND | | A37 | | C9 | GND | ITEM 3 |
| GND | | B19 | | B3 | GND | ITEM 3 |
| Tx4+ | | B20 | | B4 | Rx0+ | ITEM 3 |
| Tx4- | | B21 | | B5 | Rx0- | ITEM 3 |
| GND | | B22 | | B6/A3 | GND | ITEM 3, NOTE 2 |
| Tx5+ | | B23 | | A4 | Rx1+ | ITEM 3 |
| Tx5- | | B24 | | A5 | Rx1- | ITEM 3 |
| GND | | B25 | | A6 | GND | ITEM 3 |
| SB0B | | B26 | | D1 | 2W_CLK | ITEM 4, NOTE 1 |
| SB1B | | B27 | | D2 | 2W_SDA | ITEM 4, NOTE 1 |
| SB2B | | B28 | | | NC | SHORT TO GND |
| SB5B | | B29 | | B2 | PERST# | ITEM 4, NOTE 1 |
| SB6B | | B30 | | | NC | SHORT TO GND |
| GND | | B31 | | B6 | GND | ITEM 3 |
| Tx6+ | | B32 | | B7 | Rx2+ | ITEM 3 |
| Tx6- | | B33 | | B8 | Rx2- | ITEM 3 |
| GND | | B34 | | B9/A6 | GND | ITEM 3, NOTE 2 |
| Tx7+ | | B35 | | A7 | Rx3+ | ITEM 3 |
| Tx7- | | B36 | | A8 | Rx3- | ITEM 3 |
| GND | | B37 | | A9 | GND | ITEM 3 |
| | | | | C1 | NC | |
| | | | | C2 | NC | |
| | | | | B1 | NC | |

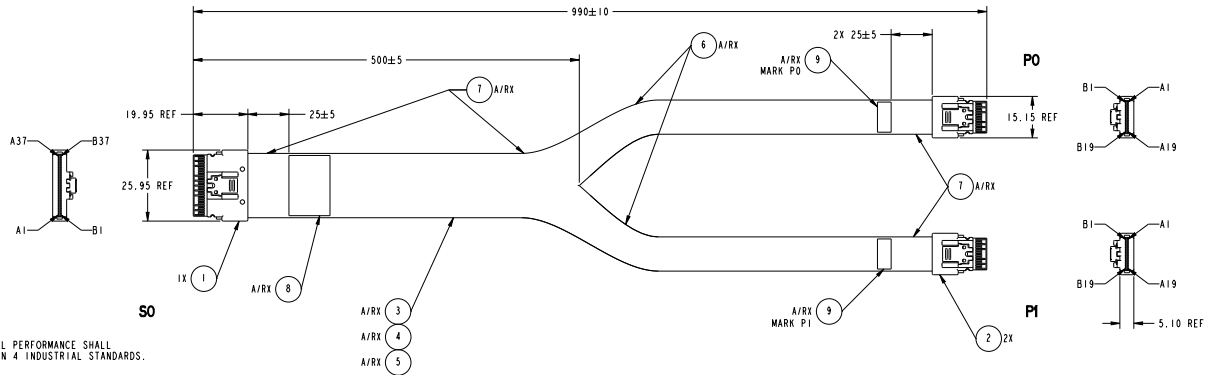
- NOTES:**
- END TO END RESISTANCE OF INDICATED CONNECTION SHALL BE 750 MILLIOHM MAX.
 - CONNECT SHIELD OF DIFFERENTIAL PAIR TO INDICATED PIN/PAD AND SHORT TO SECOND INDICATED PIN/PAD.
 - SHORT PIN/PAD S0-A8 TO S0-B9. NO DIRECT CONNECT S0-A8 TO CONNECTOR P0.
 - DELETED
 - SHORT PIN/PAD S0-A26 TO S0-B27. NO DIRECT CONNECT S0-A26 TO CONNECTOR P1.
 - DELETED

Cable 05-60004-00

The following figure shows the drawing and pinout for Broadcom cable, 05-60004-00, a x8 SFF-8654 to 2 x4 SFF-8654 connection.

Figure 10: Cable 05-60004-00 Drawing and Pinout

| REVISIONS | | | | |
|-----------|-----|-----------------|---------|----------|
| REV | ECO | DESCRIPTION | DATE | APPROVED |
| 001 | | INITIAL RELEASE | 02JAN18 | |



- NOTES:**
- DRAWING NOT TO SCALE.
 - ELECTRICAL AND MECHANICAL PERFORMANCE SHALL MEET SAS 4.0 AND PCIe GEN 4 INDUSTRIAL STANDARDS.
 - MARK LABEL (ITEM 8) WITH:
SFF-9402 SLIMSAS Y (PCIe & SAS)
PART NUMBER
REVISION XXX
DATE CODE DD/MM/YY
 - SEE CABLE WIRING TABLE.

| ITEM | CALCOUT | DESCRIPTION | QUANTITY | NOTES |
|------|-----------|--|----------|----------------|
| 9 | LABEL | LABEL, 40X14MM, WHITE, R2, HF | | A/R |
| 8 | LABEL | LABEL, 70X26MM, WHITE, R2, HF | | A/R SEE NOTE 3 |
| 7 | TAPE | ACETATE TAPE, #C1 INCH | | A/R |
| 6 | SLEEVING | EXPANDO TUBE: OD=2MM, GREEN, VW-1, HF | | A/R |
| 5 | SLEEVING | EXPANDO TUBE: OD=10MM, GREEN, VW-1, HF | | A/R |
| 4 | WIRE | UL1061, 32AWG, STRANDED | | A/R |
| 3 | CABLE | SAS CABLE: UL20744, 32AWG, 85OHM DIFF, SAS4, PCIe GEN 4, VW-1, NATURAL, HF | | A/R |
| 2 | CONNECTOR | SFF-8654, 38P, STRAIGHT, X4, SAS 4.0, PCIe GEN 4 | 2 | SEE NOTE 4 |
| 1 | CONNECTOR | SFF-8654, 74P, STRAIGHT, X8, SAS 4.0, PCIe GEN 4 | 1 | SEE NOTE 4 |

| APPROVALS | DATE | UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN MILLIMETERS. | BROADCOM® | |
|---|---------|---|-----------|--|
| DESIGNED BY | 27DEC17 | X.X ± 0.2 MM X.XX ± 0.15 MM X.XXX ± 0.050 MM ANGLES ± 1° | TITLE | CABLE, SFF-8654 X8 TO 2X SFF-8654 X4, 1M |
| APPROVED BY | 02JAN18 | | SCALE | 1:500 |
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| | | | REV | 001 |
| | | | SHEET | |

| CONNECTOR SIGNAL | CONNECTOR | PIN/PAD | CONNECTOR | PIN/PAD | CONNECTOR SIGNAL | WIRE/CABLE |
|------------------|-----------|---------|-----------|---------|------------------|----------------|
| GND | SO | A1 | PO | B1 | GND | ITEM 3 |
| Rx0+ | | A2 | | B2 | Tx0+ | ITEM 3 |
| Rx0- | | A3 | | B3 | Tx0- | ITEM 3 |
| GND | | A4 | | B4 | GND | ITEM 3 |
| Rx1+ | | A5 | | B5 | Tx1+ | ITEM 3 |
| Rx1- | | A6 | | B6 | Tx1- | ITEM 3 |
| GND | | A7 | | B7 | GND | ITEM 3 |
| SB7A | | A8 | | B8 | SB7 | ITEM 4 |
| SB4A | | A9 | | B9 | SB4 | ITEM 4 |
| GND(SB3A) | | A10 | | B10 | GND(SB3) | ITEM 3 |
| SB4+ | | A11 | | B11 | SB4+ | ITEM 3 |
| SB4- | | A12 | | B12 | SB4- | ITEM 3 |
| GND | | A13 | | B13 | GND | ITEM 3 |
| Rx2+ | | A14 | | B14 | Tx2+ | ITEM 3 |
| Rx2- | | A15 | | B15 | Tx2- | ITEM 3 |
| GND | | A16 | | B16 | GND | ITEM 3 |
| Rx3+ | | A17 | | B17 | Tx3+ | ITEM 3 |
| Rx3- | | A18 | | B18 | Tx3- | ITEM 3 |
| GND | | A19 | | B19 | GND | ITEM 3, NOTE 1 |
| GND | | B1 | | A1 | GND | ITEM 3 |
| Tx0+ | | B2 | | A2 | Rx0+ | ITEM 3 |
| Tx0- | | B3 | | A3 | Rx0- | ITEM 3 |
| GND | | B4 | | A4 | GND | ITEM 3 |
| Tx1+ | | B5 | | A5 | Rx1+ | ITEM 3 |
| Tx1- | | B6 | | A6 | Rx1- | ITEM 3 |
| GND | | B7 | | A7 | GND | ITEM 3 |
| SB0A | | B8 | | A8 | SB0 | ITEM 4 |
| SB1A | | B9 | | A9 | SB1 | ITEM 4 |
| GND(SB2A) | | B10 | | A10 | GND(SB2) | ITEM 3 |
| SB5A | | B11 | | A11 | SB5 | ITEM 3 |
| SB6A | | B12 | | A12 | SB6 | ITEM 3 |
| GND | | B13 | | A13 | GND | ITEM 3 |
| Tx2+ | | B14 | | A14 | Rx2+ | ITEM 3 |
| Tx2- | | B15 | | A15 | Rx2- | ITEM 3 |
| GND | | B16 | | A16 | GND | ITEM 3 |
| Tx3+ | | B17 | | A17 | Rx3+ | ITEM 3 |
| Tx3- | | B18 | | A18 | Rx3- | ITEM 3 |
| GND | | B19 | | A19 | GND | ITEM 3, NOTE 1 |

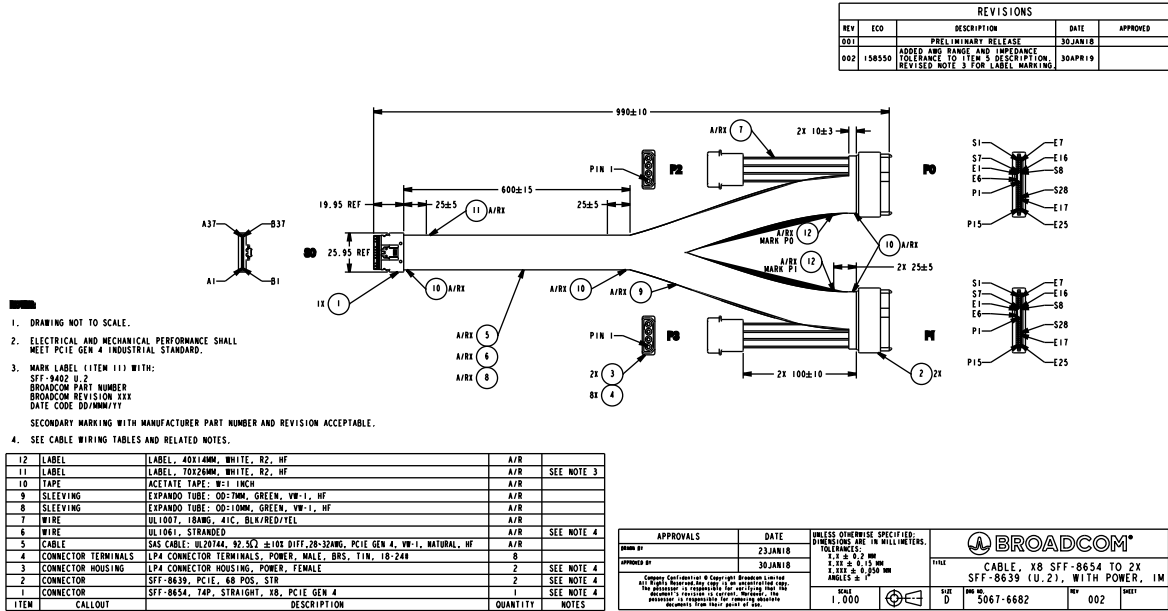
- NOTES:**
- PIN/PAD ON CONNECTOR SO SHARED ON CONNECTORS PO AND PI.

| CONNECTOR SIGNAL | CONNECTOR | PIN/PAD | CONNECTOR | PIN/PAD | CONNECTOR SIGNAL | WIRE/CABLE |
|------------------|-----------|---------|-----------|---------|------------------|----------------|
| GND | SO | A19 | PI | B1 | GND | ITEM 3 |
| Rx4+ | | A20 | | B2 | Tx0+ | ITEM 3 |
| Rx4- | | A21 | | B3 | Tx0- | ITEM 3 |
| GND | | A22 | | B4 | GND | ITEM 3 |
| Rx5+ | | A23 | | B5 | Tx1+ | ITEM 3 |
| Rx5- | | A24 | | B6 | Tx1- | ITEM 3 |
| GND | | A25 | | B7 | GND | ITEM 3 |
| SB7B | | A26 | | B8 | SB7 | ITEM 4 |
| SB4B | | A27 | | B9 | SB4 | ITEM 4 |
| GND(SB3B) | | A28 | | B10 | GND(SB3) | ITEM 3 |
| SB8+ | | A29 | | B11 | SB4+ | ITEM 3 |
| SB8- | | A30 | | B12 | SB4- | ITEM 3 |
| GND | | A31 | | B13 | GND | ITEM 3 |
| Rx6+ | | A32 | | B14 | Tx2+ | ITEM 3 |
| Rx6- | | A33 | | B15 | Tx2- | ITEM 3 |
| GND | | A34 | | B16 | GND | ITEM 3 |
| Rx7+ | | A35 | | B17 | Tx3+ | ITEM 3 |
| Rx7- | | A36 | | B18 | Tx3- | ITEM 3 |
| GND | | A37 | | B19 | GND | ITEM 3 |
| Tx4+ | | B19 | | A1 | GND | ITEM 3, NOTE 1 |
| Tx4- | | B20 | | A2 | Rx0+ | ITEM 3 |
| GND | | B21 | | A3 | Rx0- | ITEM 3 |
| Tx5+ | | B22 | | A4 | GND | ITEM 3 |
| Tx5- | | B23 | | A5 | Rx1+ | ITEM 3 |
| GND | | B24 | | A6 | Rx1- | ITEM 3 |
| SB0B | | B25 | | A7 | GND | ITEM 3 |
| SB0B | | B26 | | A8 | SB0 | ITEM 4 |
| SB1B | | B27 | | A9 | SB1 | ITEM 4 |
| GND(SB2B) | | B28 | | A10 | GND(SB2) | ITEM 3 |
| SB5B | | B29 | | A11 | SB5 | ITEM 3 |
| SB6B | | B30 | | A12 | SB6 | ITEM 3 |
| GND | | B31 | | A13 | GND | ITEM 3 |
| Tx6+ | | B32 | | A14 | Rx2+ | ITEM 3 |
| Tx6- | | B33 | | A15 | Rx2- | ITEM 3 |
| GND | | B34 | | A16 | GND | ITEM 3 |
| Tx7+ | | B35 | | A17 | Rx3+ | ITEM 3 |
| Tx7- | | B36 | | A18 | Rx3- | ITEM 3 |
| GND | | B37 | | A19 | GND | ITEM 3 |

Cable 05-60005-00

The following figure shows the drawing and pinout for Broadcom cable, 05-60005-00, a x8 SFF-8654 to 2 U.2 SFF-8639 connection.

Figure 11: Cable 05-60005-00 Drawing and Pinout



| CONNECTOR SIGNAL | CON | PIN/PAD | CONNECTOR | PIN/PAD | CONNECTOR SIGNAL | WIRE/CABLE |
|------------------|-----|---------|-----------|---------|------------------|----------------|
| GND | S0 | A1 | P0 | E15 | GND | ITEM 5 |
| Rx0+ | | A2 | | E14 | PERP0 | ITEM 5 |
| Rx0- | | A3 | | E13 | PER0 | ITEM 5 |
| GND | | A4 | | E12/S22 | GND | ITEM 5, NOTE 1 |
| Rx1+ | | A5 | | S21 | PER0 | ITEM 5 |
| Rx1- | | A6 | | S20 | PER0 | ITEM 5 |
| GND | | A7 | | S19 | GND | ITEM 5 |
| Sb7A | | A8 | | NC | NC | NOTE 2 |
| Sb8A | | A9 | | NC | NC | |
| GND/Sb3A | | A10 | | E9 | GND | ITEM 5 |
| SbA+ | | A11 | | E7 | REFCLK+ | ITEM 5 |
| SbA- | | A12 | | E8 | REFCLK- | ITEM 5 |
| GND | | A13 | | S28 | GND | ITEM 5 |
| Rx2+ | | A14 | | S27 | PER02 | ITEM 5 |
| Rx2- | | A15 | | S26 | PER02 | ITEM 5 |
| GND | | A16 | | E22/S25 | GND | ITEM 5, NOTE 1 |
| Rx3+ | | A17 | | E21 | PER03 | ITEM 5 |
| Rx3- | | A18 | | E20 | PER03 | ITEM 5 |
| GND | | A19 | | E19 | GND | ITEM 5 |
| GND | | B1 | | E9 | GND | ITEM 5 |
| Tx0+ | | B2 | | E10 | PE10 | ITEM 5 |
| Tx0- | | B3 | | E11 | PE10 | ITEM 5 |
| GND | | B4 | | E12/S14 | GND | ITEM 5, NOTE 1 |
| Tx1+ | | B5 | | S17 | PE10 | ITEM 5 |
| Tx1- | | B6 | | S18 | PE10 | ITEM 5 |
| GND | | B7 | | S19 | GND | ITEM 5 |
| Sb0A | | B8 | | E23 | SMCLK | ITEM 6, NOTE 4 |
| Sb1A | | B9 | | E24 | SMDAT | ITEM 6, NOTE 4 |
| GND/Sb2A | | B10 | | E22 | GND | ITEM 6, NOTE 4 |
| Sb3A | | B11 | | E5 | PERST0 | ITEM 6, NOTE 4 |
| Sb6A | | B12 | | P4 | IFDET0 | ITEM 6, NOTE 4 |
| GND | | B13 | | S22 | GND | ITEM 5 |
| Tx2+ | | B14 | | S23 | PE12p | ITEM 5 |
| Tx2- | | B15 | | S24 | PE12a | ITEM 5 |
| GND | | B16 | | S25/S28 | GND | ITEM 5, NOTE 1 |
| Tx3+ | | B17 | | E17 | PE13 | ITEM 5 |
| Tx3- | | B18 | | E18 | PE13 | ITEM 5 |
| GND | | B19 | | E19 | GND | ITEM 5 |

- CONNECT SHIELD OF DIFFERENTIAL PAIR TO INDICATED PIN/PAD AND SHORT TO SECOND INDICATED PIN/PAD.
- SHORT PIN/PAD S0-A8 TO S0-B9. NO DIRECT CONNECT S0-A8 TO CONNECTOR P0.
- SHORT PIN/PAD S0-A26 TO S0-B21. NO DIRECT CONNECT S0-A26 TO CONNECTOR P1.
- END TO END RESISTANCE OF INDICATED CONNECTION SHALL BE 750 MILLIOM MAX.

| CONNECTOR SIGNAL | CON | PIN/PAD | CONNECTOR | PIN/PAD | CONNECTOR SIGNAL | WIRE/CABLE |
|------------------|-----|---------|-----------|---------|------------------|----------------|
| GND | S0 | A19 | P1 | E15 | GND | ITEM 5 |
| Rx4+ | | A20 | | E14 | PERP0 | ITEM 5 |
| Rx4- | | A21 | | E13 | PER0 | ITEM 5 |
| GND | | A22 | | E12/S22 | GND | ITEM 5, NOTE 1 |
| Rx5+ | | A23 | | S21 | PER0 | ITEM 5 |
| Rx5- | | A24 | | S20 | PER0 | ITEM 5 |
| GND | | A25 | | S19 | GND | ITEM 5 |
| Sb7B | | A26 | | NC | NC | NOTE 3 |
| Sb8B | | A27 | | NC | NC | |
| GND/Sb3B | | A28 | | E9 | GND | ITEM 5 |
| SbB+ | | A29 | | E7 | REFCLK+ | ITEM 5 |
| SbB- | | A30 | | E8 | REFCLK- | ITEM 5 |
| GND | | A31 | | S28 | GND | ITEM 5 |
| Rx6+ | | A32 | | S27 | PER02 | ITEM 5 |
| Rx6- | | A33 | | S26 | PER02 | ITEM 5 |
| GND | | A34 | | S25/S22 | GND | ITEM 5, NOTE 1 |
| Rx7+ | | A35 | | E21 | PER03 | ITEM 5 |
| Rx7- | | A36 | | E20 | PER03 | ITEM 5 |
| GND | | A37 | | E19 | GND | ITEM 5 |
| GND | | B19 | | E9 | GND | ITEM 5 |
| Tx4+ | | B20 | | E10 | PE10 | ITEM 5 |
| Tx4- | | B21 | | E11 | PE10 | ITEM 5 |
| GND | | B22 | | E12/S14 | GND | ITEM 5, NOTE 1 |
| Tx5+ | | B23 | | S17 | PE10 | ITEM 5 |
| Tx5- | | B24 | | S18 | PE10 | ITEM 5 |
| GND | | B25 | | S19 | GND | ITEM 5 |
| Sb0B | | B26 | | E23 | SMCLK | ITEM 6, NOTE 4 |
| Sb1B | | B27 | | E24 | SMDAT | ITEM 6, NOTE 4 |
| GND/Sb2B | | B28 | | E22 | GND | ITEM 6, NOTE 4 |
| Sb5B | | B29 | | E5 | PERST0 | ITEM 6, NOTE 4 |
| Sb6B | | B30 | | P4 | IFDET0 | ITEM 6, NOTE 4 |
| GND | | B31 | | S22 | GND | ITEM 5 |
| Tx6+ | | B32 | | S23 | PE12p | ITEM 5 |
| Tx6- | | B33 | | S24 | PE12a | ITEM 5 |
| GND | | B34 | | S25/S28 | GND | ITEM 5, NOTE 1 |
| Tx7+ | | B35 | | E17 | PE13 | ITEM 5 |
| Tx7- | | B36 | | E18 | PE13 | ITEM 5 |
| GND | | B37 | | E19 | GND | ITEM 5 |

| CONNECTOR | PIN/PAD | CONNECTOR SIGNAL | NOTES |
|-----------|---------|------------------|--------|
| P0/P1 | S1 | GND | GROUND |
| | S4 | GND | GROUND |
| | S5 | GND | GROUND |
| | S8 | GND | GROUND |
| | S11 | GND | GROUND |
| | S14 | GND | GROUND |
| | S5 | GND | GROUND |
| | P6 | GND | GROUND |
| | P12 | GND | GROUND |

ALL PIN/PAD SHALL BE CONNECTED TO COMMON INDIVIDUAL CONNECTOR GROUND

| POWER CONNECTOR | PIN SYMBOL | CONNECTOR | PIN SYMBOL | WIRE COLOR | |
|-----------------|------------|-----------|------------|---------------|--------------|
| P2 | 1 | I2V | P0 | P13, P14, P15 | YELLOW |
| | 2 | GND | | P12 | ITEM 7 BLACK |
| | 3 | GND | | P6 | ITEM 7 BLACK |
| | 4 | 5V | | P7, P8, P9 | ITEM 7 RED |
| P3 | 1 | I2V | P1 | P13, P14, P15 | YELLOW |
| | 2 | GND | | P12 | ITEM 7 BLACK |
| | 3 | GND | | P6 | ITEM 7 BLACK |
| | 4 | 5V | | P7, P8, P9 | ITEM 7 RED |

| CONNECTOR | PIN/PAD | CONNECTOR SIGNAL | NOTES |
|-----------|---------|------------------|---|
| P0/P1 | S2 | S0T+ | NO CONNECT |
| | S3 | S0T- | NO CONNECT |
| | S5 | S0R- | PIN/PAD SHALL NOT BE CONNECTED VIA CONNECTOR INTERNALS NOR VIA WIRE |
| | S6 | S0R+ | |
| | S9 | S1T+ | |
| | S10 | S1T- | |
| | S12 | S1R- | |
| | S13 | S1R+ | |
| | S15 | RSVD | |
| | E1 | REFCLK+ | |
| | E2 | REFCLK- | |
| | E3 | 3.3Vaux | |
| | E4 | ePERST0 | |
| | E6 | RSVD | |
| | E16 | RSVD | |
| | E25 | DualPortLeaR | |
| | P1 | RSVD | |
| | P2 | sPCIeRs1 | |
| | P3 | RSVD | |
| | P10 | PRST0 | |
| | P11 | Activity | |

Cable 05-60006-00

The following figure shows the drawing and pinout for Broadcom cable, 05-60006-00, a x8 SFF-8654 to x8 U.3 SFF-8639 connection.

Figure 12: Cable 05-60006-00 Drawing and Pinout

| REVISIONS | | | | |
|-----------|-------|--|---------|----------|
| REV | ECO | DESCRIPTION | DATE | APPROVED |
| 001 | | PRELIMINARY RELEASE | 12APR18 | |
| 002 | 14709 | PRELIMINARY RELEASE, REVISE CONN P10-P17 PIN 1 LOCATION, REVISE ITEM 7 DESCRIPTION, REVISE NOTE 3, REVISE MAIN AND DETAIL A VIEWS. | 12OCT18 | |
| 003 | 17514 | CHANGE NOTE 3 MARKING FROM U.3A1 TO SAS24A. | 21NOV19 | |

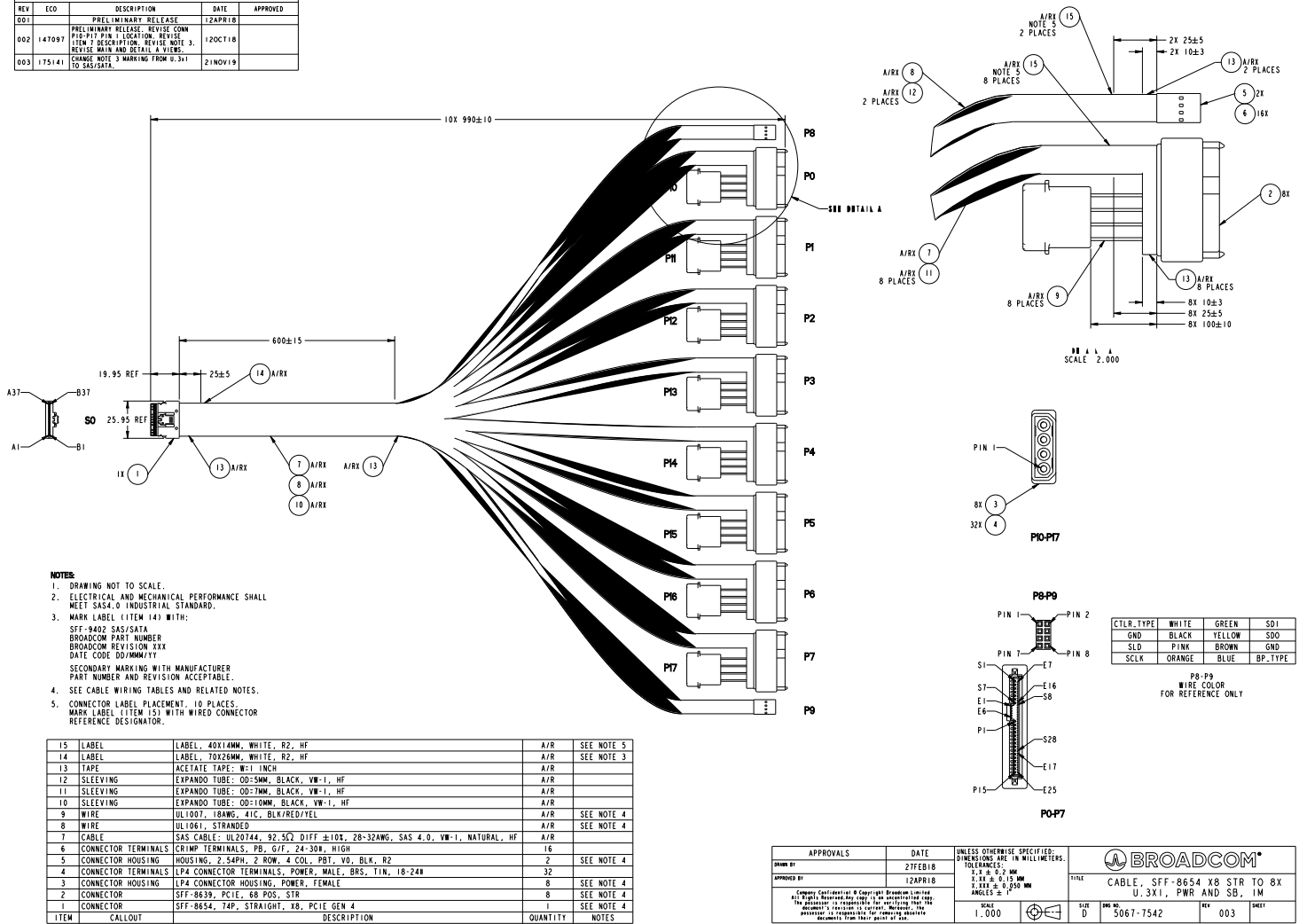


Table with 7 columns: CONNECTOR, SIGNAL, CONNECTOR, PIN/PAD, CONNECTOR, PIN/PAD, SIGNAL, WIRE/CABLE, NOTES. Contains pin configurations for S0, P0, and P10 connectors.

Table with 7 columns: CONNECTOR, SIGNAL, CONNECTOR, PIN/PAD, CONNECTOR, PIN/PAD, SIGNAL, WIRE/CABLE, NOTES. Contains pin configurations for S0, P3, and P13 connectors.

Table with 7 columns: CONNECTOR, SIGNAL, CONNECTOR, PIN/PAD, CONNECTOR, PIN/PAD, SIGNAL, WIRE/CABLE, NOTES. Contains pin configurations for S0, P1, and P11 connectors.

Table with 7 columns: CONNECTOR, SIGNAL, CONNECTOR, PIN/PAD, CONNECTOR, PIN/PAD, SIGNAL, WIRE/CABLE, NOTES. Contains pin configurations for S0, P4, and P14 connectors.

Table with 7 columns: CONNECTOR, SIGNAL, CONNECTOR, PIN/PAD, CONNECTOR, PIN/PAD, SIGNAL, WIRE/CABLE, NOTES. Contains pin configurations for S0, P2, and P12 connectors.

Table with 7 columns: CONNECTOR, SIGNAL, CONNECTOR, PIN/PAD, CONNECTOR, PIN/PAD, SIGNAL, WIRE/CABLE, NOTES. Contains pin configurations for S0, P5, and P15 connectors.

Table with 7 columns: CONNECTOR, SIGNAL, CONNECTOR, PIN/PAD, CONNECTOR, PIN/PAD, SIGNAL, WIRE/CABLE, NOTES. Contains pin configurations for S0, P6, and P16 connectors.

Table with 4 columns: CONNECTOR, PIN/PAD, CONNECTOR, SIGNAL, NOTES. Lists signals like S9-S28 and their corresponding connector pins, including notes about ground connections.

Table with 7 columns: CONNECTOR, SIGNAL, CONNECTOR, PIN/PAD, CONNECTOR, PIN/PAD, SIGNAL, WIRE/CABLE, NOTES. Contains pin configurations for S0, P7, and P17 connectors.

Table with 7 columns: CONNECTOR, SIGNAL, CONNECTOR, PIN/PAD, CONNECTOR, PIN/PAD, SIGNAL, WIRE/CABLE, NOTES. Lists signals SB7A-SB6B and their corresponding connector pins.

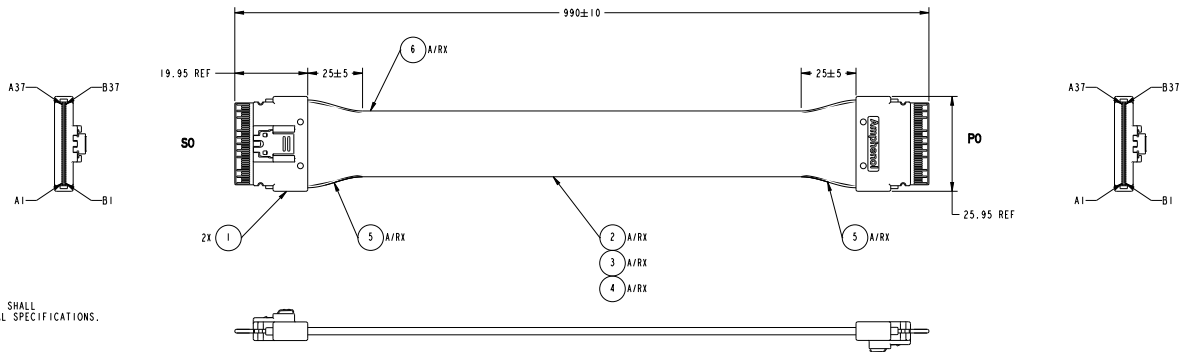
- NOTES: 1. END TO END RESISTANCE OF INDICATED CONNECTION SHALL BE 750 MILLIOHM MAX. 2. SHARED PIN/PAD ON HOST (S0) CONNECTOR. 3. SHARED PIN/PAD ON INDICATED TARGET (P0-P7) CONNECTOR. 4. SHORT PIN/PAD P1 TO P2 OF INDICATED TARGET (P0-P7) CONNECTOR. NO CONNECT TO OTHER CONNECTORS.

Cable 05-60007-00

The following figure shows the drawing and pinout for Broadcom cable, 05-60007-00, a x8 SFF-8654 to x8 SFF-8654 connection.

Figure 13: Cable 05-60007-00 Drawing and Pinout

| REVISIONS | | | | |
|-----------|--------|---|---------|----------|
| REV | ECO | DESCRIPTION | DATE | APPROVED |
| 001 | | PRELIMINARY RELEASE | 01MAY18 | |
| 002 | 175141 | ADD WIRE GAUGE AND IMPEDANCE TOLERANCE. ITEM 2. REVISE MARKING REQUIREMENTS NOTE 3. | 21NOV19 | |



- NOTES:**
- DRAWING NOT TO SCALE.
 - ELECTRICAL AND MECHANICAL PERFORMANCE SHALL MEET SAS 4.0 AND PCIe GEN 4 INDUSTRIAL SPECIFICATIONS.
 - MARK LABEL (ITEM 6) WITH:
SFF-9402 SAS4/PCIe 4
BROADCOM PART NUMBER
BROADCOM REVISION XXX
DATE CODE DD/MM/YY
SECONDARY MARKING WITH MANUFACTURER PART NUMBER AND REVISION ACCEPTABLE.
 - SEE CABLE WIRING TABLE AND RELATED NOTES.

| 6 | LABEL | LABEL, TOX26MM, WHITE, R2, HF | A/R | SEE NOTE 3 |
|------|-----------|---|----------|------------|
| 5 | TAPE | ACETATE TAPE: W=1 INCH | A/R | |
| 4 | SLEEVING | EXPANDO TUBE: OD=10MM, GREEN, VW-1, HF | A/R | |
| 3 | WIRE | UL1061, STRANDED | A/R | |
| 2 | CABLE | SAS CABLE: UL20744, 28-32AWG, 92.5C2 ±10% DIFF, SAS4, PCIe GEN 4, VW-1, NATURAL, HF | A/R | SEE NOTE 4 |
| 1 | CONNECTOR | SFF-8654, 74P, STRAIGHT, X8, STANDARD, SAS 4.0, PCIe GEN 4 | 2 | SEE NOTE 4 |
| ITEM | CALLOUT | DESCRIPTION | QUANTITY | NOTES |

| APPROVALS | DATE | UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS. TOLERANCES: | BROADCOM® | | |
|-------------|---------|--|--|--|--|
| DRAWN BY | ISFEB18 | 1.3 ± 0.2 MM | TITLE: CABLE, SFF-8654 TO SFF-8654, X8, STRAIGHT, 1M SCALE: 2.000 SIZE: D DWG NO: 5067-6869 REV: 002 SHEET: | | |
| APPROVED BY | 01MAY18 | 0.15 ± 0.15 MM | | | |
| | | 0.25 ± 0.25 MM | | | |

| CONNECTOR SIGNAL | CONNECTOR | PIN/PAD | CONNECTOR | PIN/PAD | CONNECTOR SIGNAL | WIRE/CABLE | NOTES |
|------------------|-----------|---------|-----------|---------|------------------|------------|--------|
| GND | S0 | A1 | P0 | B1 | GND | ITEM 3 | |
| Rx0+ | | A2 | | B2 | Tx0+ | ITEM 3 | |
| Rx0- | | A3 | | B3 | Tx0- | ITEM 3 | |
| GND | | A4 | | B4 | GND | ITEM 3 | |
| Rx1+ | | A5 | | B5 | Tx1+ | ITEM 3 | |
| Rx1- | | A6 | | B6 | Tx1- | ITEM 3 | |
| GND | | A7 | | B7 | GND | ITEM 3 | |
| SB7A | | A8 | | B8 | SB7A | ITEM 4 | NOTE 1 |
| SB4A | | A9 | | B9 | SB4A | ITEM 4 | NOTE 1 |
| GND/SB3A | | A10 | | B10 | GND/SB3A | ITEM 3 | |
| SB4+ | | A11 | | B11 | SB4+ | ITEM 3 | |
| SB4- | | A12 | | B12 | SB4- | ITEM 3 | |
| GND | | A13 | | B13 | GND | ITEM 3 | |
| Rx2+ | | A14 | | B14 | Tx2+ | ITEM 3 | |
| Rx2- | | A15 | | B15 | Tx2- | ITEM 3 | |
| GND | | A16 | | B16 | GND | ITEM 3 | |
| Rx3+ | | A17 | | B17 | Tx3+ | ITEM 3 | |
| Rx3- | | A18 | | B18 | Tx3- | ITEM 3 | |
| GND | | A19 | | B19 | GND | ITEM 3 | |
| Rx4+ | | A20 | | B20 | Tx4+ | ITEM 3 | |
| Rx4- | | A21 | | B21 | Tx4- | ITEM 3 | |
| GND | | A22 | | B22 | GND | ITEM 3 | |
| Rx5+ | | A23 | | B23 | Tx5+ | ITEM 3 | |
| Rx5- | | A24 | | B24 | Tx5- | ITEM 3 | |
| GND | | A25 | | B25 | GND | ITEM 3 | |
| SB7B | | A26 | | B26 | SB7B | ITEM 4 | NOTE 1 |
| SB4B | | A27 | | B27 | SB4B | ITEM 4 | NOTE 1 |
| GND/SB3B | | A28 | | B28 | GND/SB3B | ITEM 3 | |
| SB8+ | | A29 | | B29 | SB8+ | ITEM 3 | |
| SB8- | | A30 | | B30 | SB8- | ITEM 3 | |
| GND | | A31 | | B31 | GND | ITEM 3 | |
| Rx6+ | | A32 | | B32 | Tx6+ | ITEM 3 | |
| Rx6- | | A33 | | B33 | Tx6- | ITEM 3 | |
| GND | | A34 | | B34 | GND | ITEM 3 | |
| Rx7+ | | A35 | | B35 | Tx7+ | ITEM 3 | |
| Rx7- | | A36 | | B36 | Tx7- | ITEM 3 | |
| GND | | A37 | | B37 | GND | ITEM 3 | |

- NOTES:**
- END TO END RESISTANCE OF INDICATED CONNECTION SHALL BE 750 MILLIOHM MAX.

| CONNECTOR SIGNAL | CONNECTOR | PIN/PAD | CONNECTOR | PIN/PAD | CONNECTOR SIGNAL | WIRE/CABLE | NOTES |
|------------------|-----------|---------|-----------|---------|------------------|------------|--------|
| GND | S0 | B1 | P0 | A1 | GND | ITEM 3 | |
| Tx0+ | | B2 | | A2 | Rx0+ | ITEM 3 | |
| Tx0- | | B3 | | A3 | Rx0- | ITEM 3 | |
| GND | | B4 | | A4 | GND | ITEM 3 | |
| Tx1+ | | B5 | | A5 | Rx1+ | ITEM 3 | |
| Tx1- | | B6 | | A6 | Rx1- | ITEM 3 | |
| GND | | B7 | | A7 | GND | ITEM 3 | |
| SB0A | | B8 | | A8 | SB0A | ITEM 4 | NOTE 1 |
| SB1A | | B9 | | A9 | SB1A | ITEM 4 | NOTE 1 |
| GND/SB2A | | B10 | | A10 | GND/SB2A | ITEM 3 | |
| SB5A | | B11 | | A11 | SB5A | ITEM 3 | |
| SB6A | | B12 | | A12 | SB6A | ITEM 3 | |
| GND | | B13 | | A13 | GND | ITEM 3 | |
| Tx2+ | | B14 | | A14 | Rx2+ | ITEM 3 | |
| Tx2- | | B15 | | A15 | Rx2- | ITEM 3 | |
| GND | | B16 | | A16 | GND | ITEM 3 | |
| Tx3+ | | B17 | | A17 | Rx3+ | ITEM 3 | |
| Tx3- | | B18 | | A18 | Rx3- | ITEM 3 | |
| GND | | B19 | | A19 | GND | ITEM 3 | |
| Tx4+ | | B20 | | A20 | Rx4+ | ITEM 3 | |
| Tx4- | | B21 | | A21 | Rx4- | ITEM 3 | |
| GND | | B22 | | A22 | GND | ITEM 3 | |
| Tx5+ | | B23 | | A23 | Rx5+ | ITEM 3 | |
| Tx5- | | B24 | | A24 | Rx5- | ITEM 3 | |
| GND | | B25 | | A25 | GND | ITEM 3 | |
| SB0B | | B26 | | A26 | SB0B | ITEM 4 | NOTE 1 |
| SB1B | | B27 | | A27 | SB1B | ITEM 4 | NOTE 1 |
| GND/SB2B | | B28 | | A28 | GND/SB2B | ITEM 3 | |
| SB5B | | B29 | | A29 | SB5B | ITEM 3 | |
| SB6B | | B30 | | A30 | SB6B | ITEM 3 | |
| GND | | B31 | | A31 | GND | ITEM 3 | |
| Tx6+ | | B32 | | A32 | Rx6+ | ITEM 3 | |
| Tx6- | | B33 | | A33 | Rx6- | ITEM 3 | |
| GND | | B34 | | A34 | GND | ITEM 3 | |
| Tx7+ | | B35 | | A35 | Rx7+ | ITEM 3 | |
| Tx7- | | B36 | | A36 | Rx7- | ITEM 3 | |
| GND | | B37 | | A37 | GND | ITEM 3 | |

Revision History

Version 2.0, August 30, 2022

- Updated the resistor values in [Sideband Signals](#).
- Revised Typical Power values in [MegaRAID Tri-Mode Storage Adapter Power Supply Requirements](#) and [eHBA Tri-Mode Storage Adapter Power Supply Requirements](#).
- Changed SFF-8644 instances to SFF-8674.

Preliminary, Version 1.1, June 13, 2022

- Revised the NVMe SSD count in [MegaRAID 9670W-16i, 9670-24i, and 9660-16i Adapter RAID Features](#).
- Updated the 05-60006-00 description in [Storage Interface Cabling](#).
- Added [Overtemperature Behavior](#).
- Updated the Adapter Marks and Certifications table in [Marks, Certifications, and Compliance](#).
- Added the eHBA 9600-8i8e adapter.
- Renamed HBA to eHBA.

Preliminary, Version 1.0, March 8, 2022

- Updated the 9670-24i and 9600-24i adapters in the NVMe Device or PCIe Switch Direct-Attach Options Supported for Each Adapter table in [PCIe \(NVMe\) Support](#).
- Updated the following tables in [PCIe \(NVMe\) Support](#):
 - 9670-24i Adapter PCIe Topology Configuration Combinations
 - 9600-24i Adapter PCIe Topology Configuration Combinations
- Updated [External Adapter Connector Pinout](#).
- Added board layout images.
- Updated [Tri-Mode Storage Adapter Power Supply Requirements](#).
- Updated the values regarding the CacheVault power module in [MegaRAID Tri-Mode Storage Adapter Power Supply Requirements](#).

Advance, Version 0.2, March 19, 2021

- Changed the 9660-16i cache memory description in the MegaRAID Tri-Mode Storage Adapter Features table in [Overview](#).
- Updated the drive descriptions in the HBA Tri-Mode Storage Adapter Features table in [Overview](#).
- Revised [eHBA 9600 Adapter Features](#).
- Added a note to [PCIe \(NVMe\) Support](#).
- Added [Adapter Security](#).
- Added the MegaRAID 9670-24i adapter.

Advance, Version 0.1, April 27, 2020

Initial document release.

