Intel® RAID Adapters RS3P4TF160F and RS3P4MF088F

Hardware User Guide

A document providing an overview of product features, specification data, and hardware installation instructions.

Rev. 1.3

February 2023

<Blank page>

Document Revision History

Date	Revision	Changes
April 2021	1.0	Initial release.
June 2021	1.1	• Added Intel® RAID Adapter RS3P4MF088F. • Removed support for the Intel® RAID Expander RES3FV288. • Added support for the cable with iPN CYPCBLSLSLX8L. • Added support for the kit cables with iPN CYPCBLSLHD. • Removed limitation for SAS.SATA drive support at launch. • Minor changes throughout the document for clarity.
March 2022	1.2	• Added support for the Intel® Server Systems R2000WF and R1000WF Families. • Corrected cable names on figures 9 and 10. • Removed safety page. • Updated the safety and regulatory section. • Added Intel® RAID Maintenance Free Backup AXXRMFBU7 section. • Updated link on product support collaterals section. • Added more details on the connector type added in table 1 and figures. • Corrected the backplane drawing on figure 10. • Added the self-encrypting drive support section. • Grammar and format edits throughout the document.
Feb 2023	1.3	• Added support for mid-plane swith on RS3P4TF160F • Removed entries showing NVMe* drive support for the RS3P4MF088F RAID adapter • Corrected server names

Disclaimers

Intel technologies' features and benefits depend on system configuration and may require enabled hardware, software, or service activation. Performance varies depending on system configuration. No computer system can be absolutely secure. Check with your system manufacturer or retailer or learn more at Intel.com.

No license (express or implied, by estoppel or otherwise) to any intellectual property rights is granted by this document.

Intel disclaims all express and implied warranties, including without limitation, the implied warranties of merchantability, fitness for a particular purpose, and non-infringement, as well as any warranty arising from course of performance, course of dealing, or usage in trade.

The products and services described may contain defects or errors known as errata, which may cause deviations from published specifications. Current characterized errata are available on request.

You may not use or facilitate the use of this document in connection with any infringement or other legal analysis concerning Intel products described herein. You agree to grant Intel a non-exclusive, royalty-free license to any patent claim thereafter drafted which includes subject matter disclosed herein.

Intel, the Intel logo, are trademarks of Intel Corporation in the U.S. and/or other countries.

*Other names and brands may be claimed as the property of others.

Warnings

Heed safety instructions: Before working with your server product, whether you are using this guide or any other resource as a reference, pay close attention to the safety instructions. You must adhere to the assembly instructions in this guide to ensure and maintain compliance with existing product certifications and approvals. Use only the described, regulated components specified in this guide. Use of other products/components will void the UL listing and other regulatory approvals of the product and will most likely result in noncompliance with product regulations in the region(s) in which the product is sold.

System power on/off: The power button DOES NOT turn off the system AC power. To remove all power from the system, you must unplug the AC power cord from the electrical outlet. Make sure that the AC power cord is unplugged before you open the chassis, add, or remove any components.

Hazardous conditions, devices, and cables: Hazardous electrical conditions may be present on power, telephone, and communication cables. Turn off the server and disconnect the power cord, telecommunications systems, networks, and modems attached to the server before opening it. Otherwise, personal injury or equipment damage can result.

Installing or removing jumpers: A jumper is a small plastic-encased conductor that slips over two jumper pins. Some jumpers have a small tab on top that you can grip with your fingertips or with a pair of fine needle nosed pliers. If your jumpers do not have such a tab, take care when using needle-nosed pliers to remove or install a jumper; grip the narrow sides of the jumper with the pliers, never the wide sides. Gripping the wide sides can damage the contacts inside the jumper, causing intermittent problems with the function controlled by that jumper. Take care to grip with, but not squeeze, the pliers or other tool you use to remove a jumper, or you may bend or break the pins on the board.

Electrostatic discharge (ESD) and ESD protection: ESD can damage disk drives, boards, and other parts. We recommend that you perform all procedures in this chapter only at an ESD workstation. If one is not available, provide some ESD protection by wearing an anti-static wrist strap attached to chassis ground, any unpainted metal surface on your server when handling parts.

ESD and handling boards: Always handle boards carefully. They can be extremely sensitive to ESD. Hold boards only by their edges. After removing a board from its protective wrapper or from the server, place the board component side up on a grounded, static-free surface. Use a conductive foam pad if available but not the board wrapper. Do not slide board over any surface.

Table of Contents

List of Figures

List of Tables

1. Introduction

1.1 About this Document

RAID stands for redundant array of inexpensive disks. This document provides an overview of product features, specification data, and hardware installation instructions for the Intel® RAID Adapters RS3P4TF160F and RS3P4MF088F.

1.1.1 Document Organization

This document includes the following chapters and appendix:

- Introduction. Reference documents and online articles available.
- Product Overview. A product overview of the features set and support specifications.
- Tri-Mode Intel® RAID Adapters General Features. A description of the features that are common for the products covered by this user guide.
- Tri-Mode Intel® RAID Adapters Detailed Characteristics. Details on the characteristics for each of the products covered by this user guide.
- Connectivity and Drive Support. Description of what drives are supported by the products covered by this user guide and the way to connect them.
- Hardware Installation. Support for the installation of these RAID adapters on the Intel server systems in these products are supported.
- Safety and Regulatory (Class A). Lisf of individual component-level certifications with which the Intel RAID products comply.
- Intel® RAID Maintenance Free Backup AXXRMFBU7. Details of the Intel RAID Maintenance Free Backup AXXRMFBU7 accessory option.
- Appendix A. Glossary. Definitions for specialized concepts and acronyms used in this user guide.

1.2 Product Support Collaterals

The following document is available for download and is useful for setting up and using the Intel RAID adapters described in this user guide.

Document Title	Description
Intel® RAID Software User Guide for full featured and entry-level RAID controllers	This document provides information on RAID card setup and usage of the supported RAID utility software. Available for download at: • https://www.intel.com/content/www/us/en/support/articles/000005760/server-products/sasraid.html.

In addition to this user guide, Intel provides documentation, device driver updates, and utilities that may be necessary and/or useful for operation and support of this product. Additional product support collaterals can be downloaded from the following Intel webpages:

For general Intel RAID product documentation, hardware and software user guides, go to the Intel webpage: https://www.intel.com/content/www/us/en/support/articles/000055582/server-products/sasraid.html.

For Intel RAID product warranty information, firmware, device drivers, configuring and troubleshooting guides, go to the Intel webpage: https://www.intel.com/content/www/us/en/support/topics/raid-bios-firmware.html.

2. Product Overview

The Intel RAID Adapters RS3P4TF160Fand RS3P4MF088F are part of the second generation of tri-mode Intel RAID adapters. This new generation provides the capability of creating RAID configurations with Serial Attached SCSI (SAS) drives and/or Serial Advanced Technology Attachment (SATA) drives, and/or Non-Volatile Memory Express* (NVMe*) drives, with a x8 Peripheral Component Interconnect Express* (PCIe*) 4.0 host interface.

The Intel RAID Adapters RS3P4TF160F and RS3P4MF088F are high-performance, intelligent adapters with RAID control capability. They provide reliability, high-performance, and fault-tolerant drive subsystem management. Secure boot is another new feature, which increases security since it allows only authenticated firmware to execute on the adapter.

To address the needs for internal and external drive connectivity solutions, two tri-mode Intel RAID adapters for PCIe 4.0 are available:

- **Intel® RAID Adapter RS3P4TF160F** – Full featured tri-mode RAID adapter with 16 internal ports
- **Intel® RAID Adapter RS3P4MF088F** – Full featured tri-mode RAID adapter with 8 internal and 8 external ports

Note: The tri-mode Intel RAID adapters are designed to work on systems configured for optimized UEFI boot mode. No built-in configuration utility exists for these adapters when the system is configured for legacy boot mode. No boot support is available if used on systems configured for legacy boot mode.

The Intel RAID Adapters RS3P4TF160F and RS3P4MF088F include a SAS interface and an NVMe* interface. Both share the SFF-8654 8i connector by multiplexing the data and sideband signals. Compared with the previous generation of Intel RAID adapters, the new tri-mode family offers increased performance by reducing latency, reducing power consumption, increasing IOPS, increasing queue depth, and increasing cache memory.

Additionally, the new PCIe 4.0 interface doubles the host bandwidth. It offers a variety of NVMe* drive configurations, including direct attach, through switch, x4 and x2 connections; also support for common clock and SRIS NVMe* type drives.

Although the Intel RAID Adapters RS3P4TF160F and RS3P4MF088F can be installed on many different server systems, these were designed for the M50CYP and R2000WF server Families. This guide refers to these specific server systems.

Note: On the Intel Server Systems R2000WF and R1000WF, only the SAS and SATA drives are supported.

3. Tri-Mode Intel® RAID Adapters General Features

3.1 General Features Overview

The tri-mode Intel RAID adapters offer interfaces for SAS and for a Non-Volatile Memory Express (NVMe*). By using the proper cables, it is possible to connect NVMe*-only drives, SAS / SATA drives, or a mix of them.

3.2 SAS Interface

Serial Attached SCSI (SAS) is a point-to-point, enterprise-level device interface that leverages the proven Small Computer System Interface (SCSI) protocol set. SAS is a convergence of the advantages of Serial Advanced Technology Attachment (SATA), SCSI, and fiber channel, combined with the mainstay of the enterprise and high-end workstation storage markets.

The SAS interface uses the SCSI commands set to ensure reliable data transfers while providing the connectivity and flexibility of point-to-point serial data transfers. The serial transmission of SCSI commands eliminates clock skew challenges. Compared to the original parallel SCSI, the SAS interface provides improved performance, simplified cabling, smaller connectors, and lower pin count and power requirements.

SAS adapters leverage a common electrical and physical connection interface that is compatible with SATA technology. The SAS protocols and the SATA III protocols use a common thin, 7-wire connector. The SAS / SATA III connector and cable are easier to manipulate, allow connections to smaller devices, and do not inhibit airflow. The point-to-point SATA III architecture eliminates inherent difficulties created by the legacy ATA primary / secondary architecture while maintaining compatibility with existing ATA firmware.

The support for SAS drives is automatic, the controller detects the drive type, there is no need to switch profiles or IDs.

3.2.1 SAS Features

The characteristics of the SAS interface are:

- SAS interface supports the following:
  - 12 Gb/s, 6 Gb/s, and 3 Gb/s SAS data transfers per PHY.
  - SMP communicating topology management information.
  - SSP-enabling communication with other SAS devices.
  - STP-enabling communication with SATA devices through an attached expander.
- Provides a serial, point-to-point, enterprise-level storage interface.
- Simplifies cabling between devices.
- Provides a scalable interface that supports up to 240 devices using expanders.
- Supports x2 through x8 wide ports that consist of two, four, or eight PHYs within a single port.
- Supports narrow ports consisting of a single PHY.
- Transfers data by using SCSI information units.

3.2.2 SATA III Features

The SAS interface is compatible with SATA and it has the following characteristics:

- Supports the following:
  - SATA III data transfers up to 6 Gb/s.
  - STP data transfers up to 6 Gb/s.
- Provides a serial, point-to-point storage interface.
- Simplifies cabling between devices.
- Eliminates the primary / secondary construction used in parallel ATA.
- Permits addressing of multiple SATA targets through an expander.

3.3 Non-Volatile Memory Express* (NVMe*) interface

NVMe* is a host controller interface to accelerate the transfer of data with solid-state drives (SSDs) by using multiple PCIe connections. Benefits of are increased bandwidth (up to 16 Gb/s per lane with PCIe 4.0), lower latency, increased efficiency, lower CPU utilization with multiple long command queues, and lower power requirements.

The support for NVMe* drives is automatic, the controller detects the drive type, there is no need to switch profiles or IDs.

3.3.1 NVMe* Interface Features

The NVMe* drive interface has the following characteristics.

- Supports the following:
  - Data transfers of 16 Gb/s per lane (64 Gb/s when 4 PCIe 4.0 lanes are being used).
  - *PCI Bus Power Management Interface Specification* (revision 1.2).
  - Active state power management, states, by placing links in a power-saving mode during times of no link activity.
- Supports PCIe hot plug.
- Supports error handling.
- Provides high bandwidth per pin with low overhead and low latency.
- Supports lane reversal and polarity inversion.
- Two or four PCIe lanes per drive.
- Common clock and SRIS drive support.

3.4 Flexibility Features

The tri-mode Intel RAID adapters have the next flexibility characteristics.

3.4.1 Drive Roaming

Drive roaming occurs when, once a VD is already set up, some or all the drives that are part of this VD are manually changed to different ports on the same adapter. When this happens, the adapter detects the RAID configuration from the configuration data on the drives.

Configuration data is saved in both the NVRAM on the RAID adapter and on the drives attached to the adapter. This feature maintains the integrity of the data on each drive, even if the drives have changed their physical device ID. More information on how to use the drive roaming feature can be found on the *Intel® RAID Software User Guide for full featured and entry-level RAID controllers*.

3.4.2 Drive Migration

The tri-mode Intel RAID adapters allow to move one VD from one adapter to another, this is called drive migration. In other words, drive migration is the transfer of a set of drives in an existing configuration from one adapter to another. To achieve this, these conditions must be met:

1. If the source and the destination RAID controllers do not belong to the same family generation, only forward compatibility is allowed. Meaning, the destination RAID controller must be of the same family as the source or newer.
2. The destination RAID controller cannot have an existing RAID configuration.
3. To keep migrated VD consistent (given that it was consistent before the migration), the VD must be set to hidden before the migration.

More information on how to use the drive migration feature can be found on the *Intel® RAID Software User Guide for full featured and entry-level RAID controllers*.

3.5 Safety Characteristics

All the tri-mode Intel RAID adapters meet or exceed the requirements of UL flammability rating 94 V0. Each baseboard is also marked with the supplier's name or trademark, type, and UL flammability rating.

3.6 Tri-Mode Intel® RAID Adapters Feature Set

The following table describes the feature set of the tri-mode Intel RAID adapters.

Table 1. Tri-Mode Intel® RAID Adapter Feature Set

Feature	Intel® RAID Adapter RS3P4TF160F	Intel® RAID Adapter RS3P4MF088F
I/O processor	Broadcom* SAS3916 PCIe RAID on-Chip (ROC)	Broadcom SAS3916 PCIe RAID On-Chip (ROC)
RAID levels	0, 1, 5, 6, 10, 50, 60	0, 1, 5, 6, 10, 50, 60
JBOD mode or pass-thru mode (SAS / SATA)	Yes	Yes
Cache memory	8 GB DDR4 at 2133 MHz	8 GB DDR4 at 2133 MHz
Form factor	MD2 (PCIe card)	MD2 (PCIe card)
Drive interface connectors	2 internal SFF-8654 female (SlimSAS* 8i)	1 internal SFF-8654 female (SlimSAS 8i), 2 external SFF-8644 female
PCI Express* interface	x8 PCIe 4.0. PCIe performance up to 16 GT/s per lane.	x8 PCIe 4.0. PCIe performance up to 16 GT/s per lane.
Data transfer rates	12, 6, and 3 Gbps per port SAS, 6 and 3 Gbps per port SATA and 16 Gbps per lane NVMe*	12, 6, and 3 Gbps per port SAS, 6 and 3 Gbps per port SATA
Maximum operating temperature (chassis internal)	55 °C	55 °C
Operating system	Microsoft Windows*, Linux* (SUSE*, Red Hat*)	Microsoft Windows, Linux (SUSE, Red Hat)
Drive types	SAS, SATA, NVMe*	SAS, SATA
Maximum direct-attach NVMe* drives supported	4	0[3]
Maximum NVMe* drives supported through switches[2]	24	0
Maximum SAS / SATA devices supported[1]	240	240
Maximum virtual drives	64	64
Advanced array configuration and management utilities	Yes	Yes
Support for global hot spares and dedicated hot spares	Yes	Yes
Support for user-defined strip sizes: 64, 128, 256, 512, or 1024 KB	Yes	Yes
Advanced array configuration and management utilities offer these capabilities: • Online capacity expansion • Online RAID level migration • Drive migration • Drive roaming • No reboot necessary after expansion • Media scan	Yes	Yes
User-specified rebuild rate (specifying the percentage of system resources to use from 0% to 100%)	Yes	Yes
Non-volatile random access memory (NVRAM) of 32 KB for storing RAID system configuration information; the MegaRAID* SAS firmware is stored in flash ROM for easy upgrade.	Yes	Yes
Support for Intel® RAID Maintenance Free Backup Unit (RMFBU). Used to save RAID cache if an unexpected power loss occurs.	Yes Intel accessory AXXRMFBU7 (option)	Yes Intel accessory AXXRMFBU7 (option)
Self-encrypting drive support, SAS and SATA	TCG Enterprise only	TCG Enterprise only
Self-encrypting drive support, NVMe*	TCG Enterprise and OPAL	TCG Enterprise and OPAL
SSD cache support	No	No

Feature	Intel® RAID Adapter RS3P4TF160F	Intel® RAID Adapter RS3P4MF088F
Snapshot recovery	No	No
Audible alarm for failure alert	No	No
MTBF(hours)	>3,000,000	>3,000,000
Standard warranty	3 years, AWR options	3 years, AWR options

Notes: [1] Devices include drives and expanders. Drives on dual-ported backplanes count twice. [2] This feature is not supported at launch. [3] Due to NVMe* clocking requirements, two cables must be connected between the RAID adapter and the backplane. Since this adapter only has one internal connector, x4 direct-attach NVMe* drives are not supported.

3.7 Secure Boot

The Intel RAID Adapters RS3P4TF160F and RS3P4MF088F include a hardware secure boot feature. This provides advanced security, allowing only authenticated firmware to be executed. Intel provides the signed firmware images using hardware secure boot transparent to customers, while providing confidence in the security.

3.8 Data Protection Features

The next table describes the data protection features of the tri-mode Intel RAID adapters.

Table 2. Data Protection Features

Feature	Intel® RAID Adapter RS3P4TF160F	Intel® RAID Adapter RS3P4MF088F
Online capacity extension	Yes	Yes
Distributed sparing	Yes	Yes
Background consistency checking	Yes	Yes
Patrol read for media functionality	Yes	Yes
SMART support	Yes	Yes
Enclosure management	Yes	Yes
RAID support before operating system loaded	Yes	Yes
Write back cache with optional protection	Yes	Yes
Intel® RAID management software	Yes	Yes
Hot-spare support, global and dedicated	Yes	Yes
Self-encrypting drive (SED) support	Yes[1]	Yes[1]

Note: [1] This is a built-in feature, PFK is not required.

3.8.1 Self-Encrypting Drive Support

The Intel RAID Adapters RS3P4TF160F and RS3P4MF088F include support for self-encrypting drive (SED), which provides protection for data at rest. This support is built-in and does not require to install any keys (PFK) to enable it.

The SED support for SAS and SATA drives is only for drives compliant with the TCG Enterprise Storage Security Subsystem Class. The SED support for NVMe* drives is for drives compliant with the TCG Enterprise or the OPAL Storage Security Subsystem Class.

Consult with the drive manufacturer the TCG Storage Subsystem Class for the drives to make sure it is compatible.

3.9 Fault Tolerance Features

The next table describes the fault-tolerant features of the tri-mode Intel RAID adapters.

Table 3. Fault-Tolerant Features

Specification	Intel® RAID Adapter RS3P4TF160F	Intel® RAID Adapter RS3P4MF088F
Support for SMART[1]	Yes	Yes
Drive failure detection	Automatic	Automatic
Drive rebuilt using hot spares	Automatic	Automatic
Parity generation and checking	Yes	Yes

Note: [1] The self-monitoring analysis and reporting technology (SMART) detects up to 70% of all predictable drive failures. In addition, SMART monitors the internal performance of all motors, heads, and drive electronics.

3.10 Array Performance Features

The next table describes the array performance features of the tri-mode Intel RAID adapters.

Table 4. Array Performance Features

Specification	Intel® RAID Adapter RS3P4TF160F	Intel® RAID Adapter RS3P4MF088F
PCIe* host data transfer rate	16 GT/s per lane	16 GT/s per lane
Drive data transfer rate	12, 6, 3 Gb/s (SAS) 6,3,1.5 Gb/s (SATA) 16 Gb/s per lane (NVMe*)	12, 6, 3 Gb/s (SAS) 6,3,1.5 Gb/s (SATA)
Maximum scatter / gather I/O	80 elements	80 elements
Maximum size of I/O requests	6.4 MB in 64-KB strips	6.4 MB in 64-KB strips
Maximum queue tags per drive	As many as the drive can accept	As many as the drive can accept
Strip sizes	64 KB, 128 KB, 256 KB, 512 KB, or 1 MB	64 KB, 128 KB, 256 KB, 512 KB, or 1 MB

3.11 Drive Support Limits

The next table describes the SAS / SATA drive support limits of the tri-mode Intel RAID adapters.

Table 5. SAS / SATA Drive Support Limits

Specification	Intel® RAID Adapter RS3P4TF160F	Intel® RAID Adapter RS3P4MF088F
Maximum virtual drives per adapter	240	240
Maximum drive groups per adapter	240	240
Maximum virtual drives per drive group	16	16
Maximum drives per drive group	32	32
Maximum physical devices per adapter	240	240
Maximum hot spares per adapter	64	64
Maximum spans per virtual drive	8	8
Maximum enclosures	16	16

3.12 Over Temperature Protection

The tri-mode Intel RAID adapters are designed to operate at a maximum internal chassis temperature of 55 °C, with a minimum of 200 LFM airflow. This ensures that the internal ROC IC operates at less than 105 °C. If for any reason there's an overheating, the internal ROC overtemperature protection circuitry operates as described next:

- If the ROC reaches 110 °C, the overtemperature LED is turned on, I/O is throttled and the event "MR_EVT_CTRL_TEMP_ABOVE_OPTIMAL_RANGE" is registered in the adapter's log.
- If the ROC temperature goes down below 105 °C (mostly due to I/O throttling), the over temperature LED is turned off. The event "MR_EVT_CTRL_TEMP_WITHIN_OPTIMAL_RANGE" is registered in the adapter's log and I/O throttling is turned off.
- If the ROC reaches 116 °C, the overtemperature LED continues to light, I/O continues to throttle, the event "MR_EVT_CTRL_TEMP_CRITICAL" is registered in the adapter's log. Then, after 10 seconds of operation, the cache is flushed, pending I/Os are completed and the ROC enters the "Montask" state, in which state all I/Os stop except through the UART debugging interface.

3.13 UART Interface

The tri-mode Intel RAID adapters include a UART interface for special debugging purposes. The UART connector debug port requires a special cable and Intel support to gather detailed ROC / IOC status. The UART connector uses the layout shown in the following table.

Table 6. UART Connector Pinout

Pin	Function
1[1]	UART_TX
2	Gnd
3	UART_RX
4	1.8 V

Note 1: Pin 1 has a square solder mask, while the other pins have a round solder mask.

The default communication parameters are 921,600 b/s, 8-bit characters, no parity bit, one stop bit, and no XON / XOFF flow control.

3.14 Optional Intel® RAID Maintenance Free Backup Unit (RMFBU)

To protect the integrity of cached data on the Intel RAID adapter during a power loss event, the tri-mode Intel RAID Adapters RS3P4TF160F and RS3P4MF088F support the Intel Maintenance Free Backup Unit AXXRMFBU7 accessory kit (also referred to as RMFBU in this document). During a power loss event, this optional accessory provides back-up power to the Intel RAID adapter, allowing the adapter to offload the data stored in the onboard cache to its onboard non-volatile NAND flash.

Benefits of the RMFBU option include:

- Capacitor technology has a longer usable life span than batteries; also, reduces maintenance and replacement costs.
- Capacitors do not have the chemical volatility of batteries, which carry a risk of exothermic events.
- RMFBU options do not require the comprehensive certifications needed for batteries for import and export.
- The RMFBU can constantly maintain the RAID volume in write-back mode even when doing learn cycles.
- The recharge rate of the super capacitor is minutes as compared to hours for a battery.

See Chapter 8 for additional RMFBU information.

4. Tri-Mode Intel® RAID Adapters Detailed Characteristics

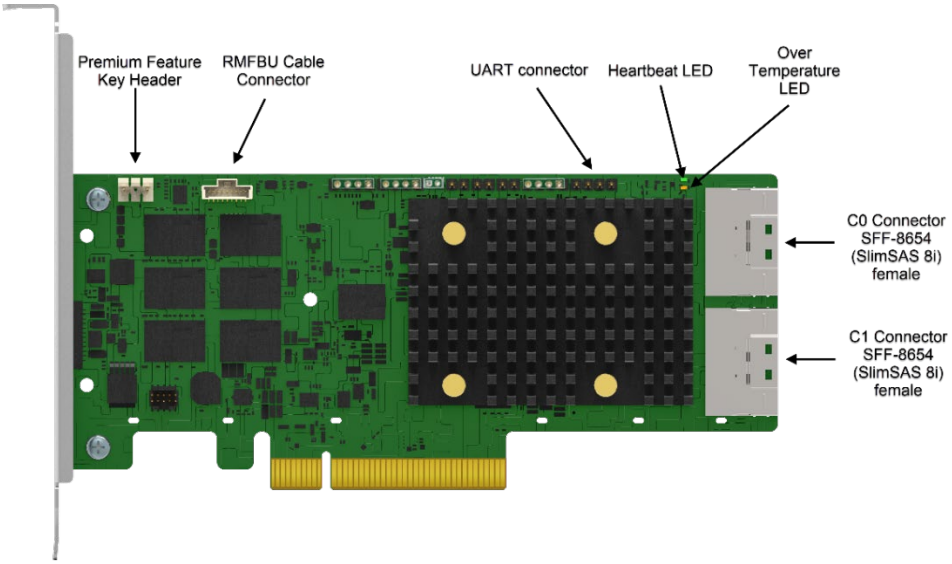
4.1 Intel® RAID Adapter RS3P4TF160F Description

The Intel RAID Adapter RS3P4TF160F is a full featured tri-mode RAID adapter with 16 internal ports based on the Broadcom* SAS3916 RAID-on-chip (ROC). It supports RAID levels 0, 1, 5, 6, 10, 50, and 60; it includes 8 GB of 72-bit cache memory DDR4 at 2133 MHz.

It has an x8 PCI Express (PCIe) 4.0. PCIe interface and it supports up to 240 physical SAS / SATA devices, and up to 240 virtual drives. It also supports up to 4 direct attach Non-Volatile Memory Express (NVMe*) drives. The next figures describe the connectors for this adapter.

Note: Physical SAS / SATA devices include expanders and, if dual-ported backplanes are being used, each drive counts twice.

Front side



Back side

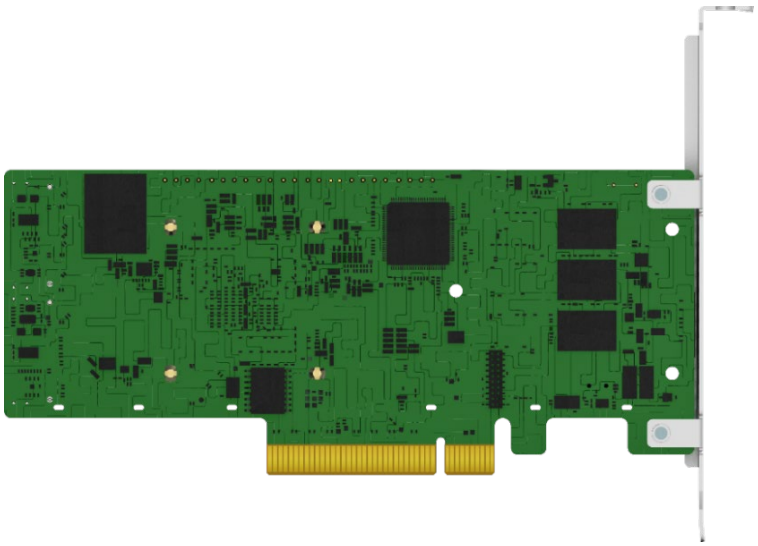


Figure 1. Intel® RAID Adapter RS3P4TF160F Layout

4.1.1 Intel® RAID Adapter RS3P4TF160F Dimensions

The next figure shows the Intel RAID Adapter RS3P4TF160F dimensions in millimeters, without the PCI bracket.

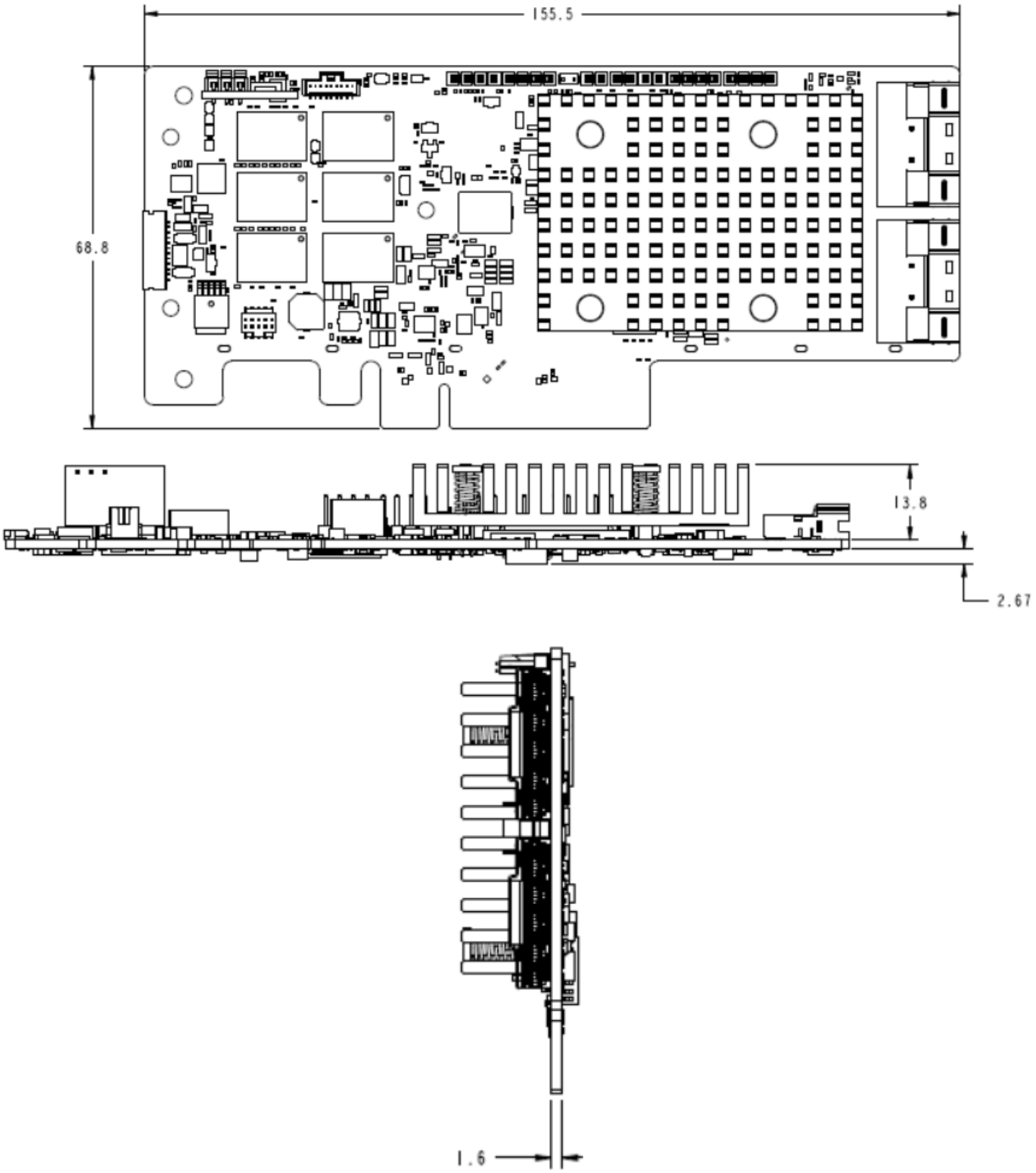


Figure 2. Intel® RAID Adapter RS3P4TF160F Dimensions

4.1.2 Intel® RAID Adapter RS3P4TF160F Electrical, Thermal, and Atmospheric Requirements

List of operating conditions for the Intel RAID Adapter RS3P4TF160F:

- Power supply voltage at the 12V rail (from PCI edge connector): 12 V ± 8%.
- Power supply voltage at the 3.3V rail (from PCI edge connector): 3.3 V ± 9%.
- Relative humidity range is 5% to 90% non-condensing.
- Temperature range is 0 °C to +55 °C (with or without the RMFBU adapter attached).

The following list shows the non-operating conditions (while in storage or in transit) for the Intel RAID Adapter RS3P4TF160F:

- Relative humidity range is 5 % to 95% non-condensing.
- Temperature range is -45 °C to +105 °C without backup battery unit.
- Temperature range is 0 °C to +70 °C with backup battery unit.

4.1.3 Intel® RAID Adapter RS3P4TF160F Power Consumption

The following table describes the power consumption of the Intel RAID Adapter RS3P4TF160F under the following states:

- **State 1:** While sitting idle at the EFI shell.
- **State 2:** During a drive stress test.

Table 7. Intel® RAID Adapter RS3P4TF160F Power Consumption

Power Mode	State 1	State 2	
	Typical	Typical	RMFBU Learn
3.3 V supply	0.01 W	0.22 W	6 W
+ 12 supply	10.76 W	15.56 W	
Total power	10.77 W	15.78 W	6 W

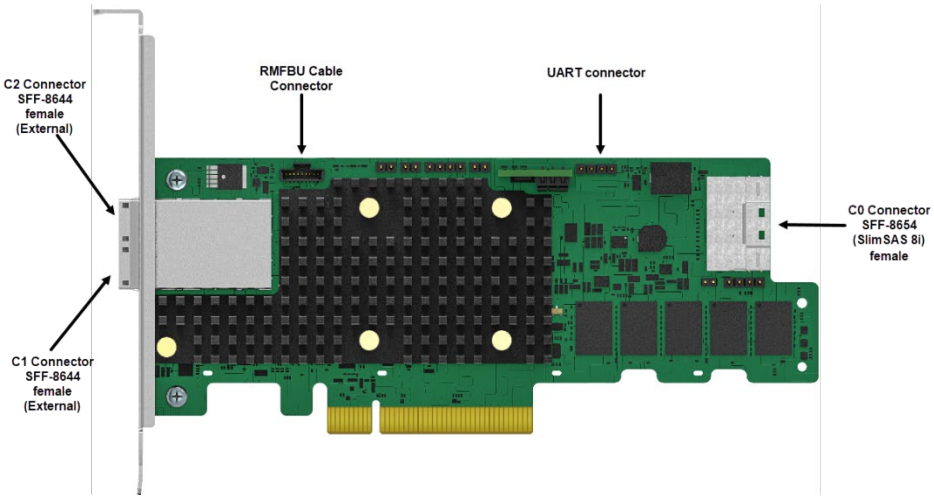
4.2 Intel® RAID Adapter RS3P4MF088F Description

The Intel RAID Adapter RS3P4MF088F is a full featured tri-mode RAID adapter with 8 internal ports and 8 external ports, based on the Broadcom SAS3916 RAID-on-chip (ROC).

It supports RAID levels 0, 1, 5, 6, 10, 50, and 60; it also, includes 8 GB of 72-bit cache memory DDR4 at 2133 MHz. It has an x8 PCIe 4.0. PCIe interface, it supports up to 240 physical SAS / SATA devices and up to 240 virtual drives. The next figures describe the connectors for this adapter.

Note: Physical SAS / SATA devices include expanders and, if dual-ported backplanes are being used, each drive counts twice.

Top side



Bottom side

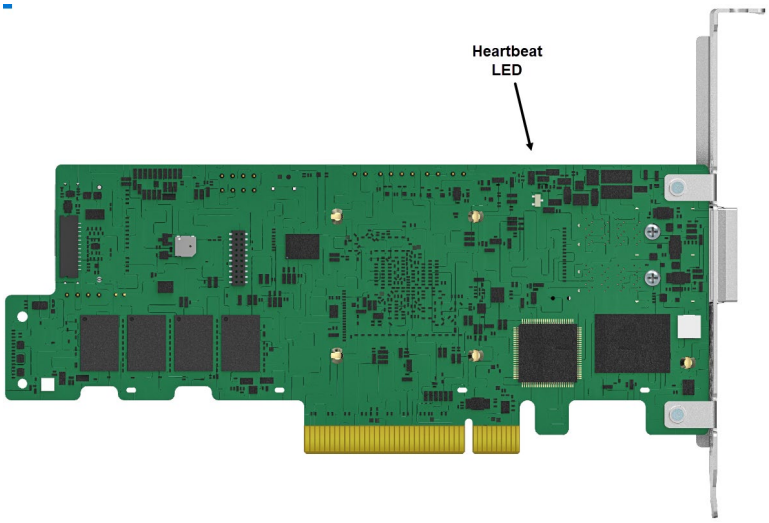


Figure 3. Intel® RAID Adapter RS3P4MF088F Layout

4.2.1 Intel® RAID Adapter RS3P4MF088F Dimensions

The next figures show the Intel RAID Adapter RS3P4MF088F dimensions in millimeters, without the PCI bracket.

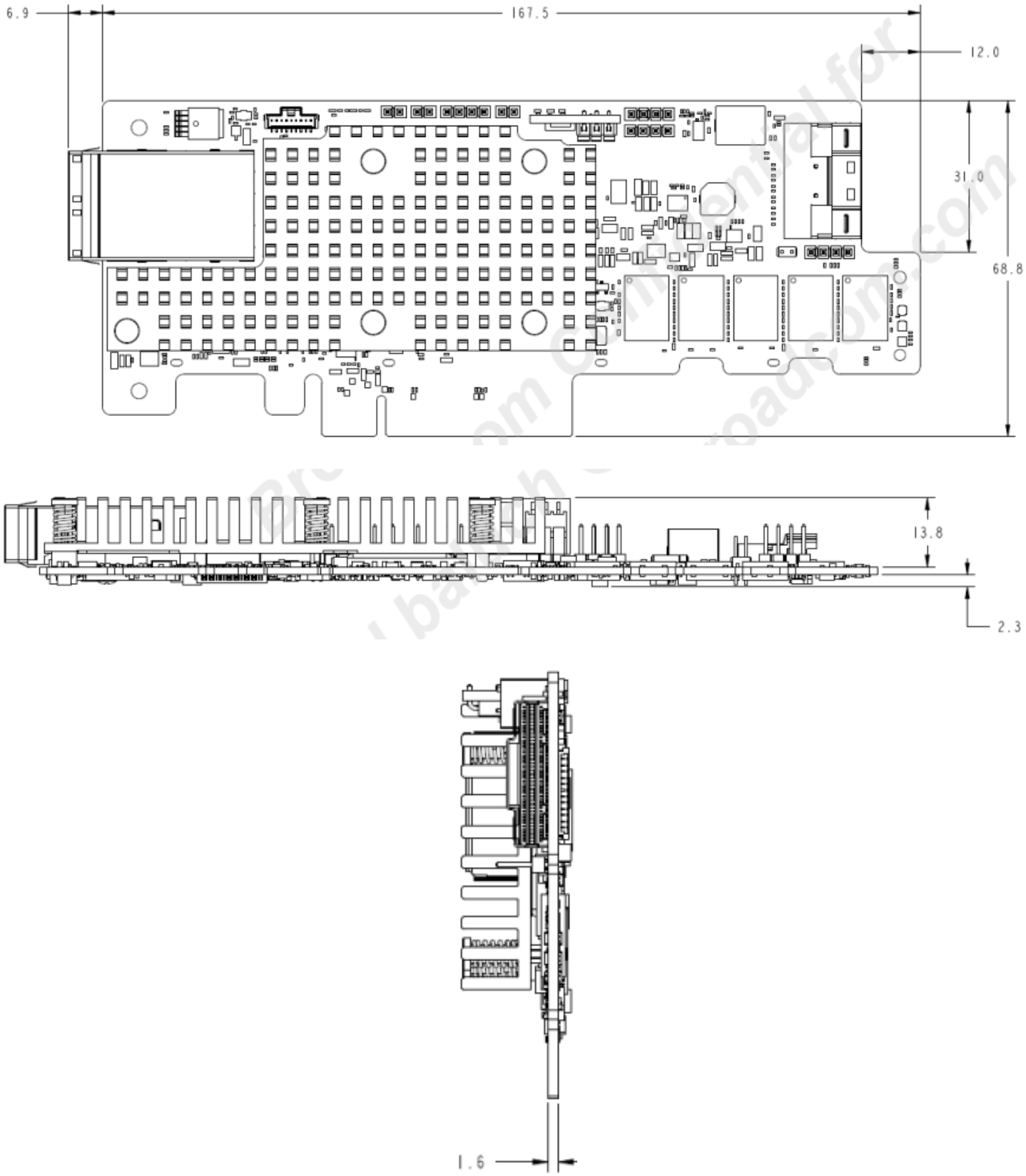


Figure 4. Intel® RAID Adapter RS3P4MF088F Dimensions

4.2.2 Intel® RAID Adapter RS3P4MF088F Electrical, Thermal, and Atmospheric Requirements

This is a list of the operating conditions for the Intel RAID Adapter RS3P4MF088F:

- Power supply voltage at the 12 V rail (from PCI edge connector): 12V ± 8%.
- Power supply voltage at the 3.3 V rail (from PCI edge connector): 13.3V ± 9%.
- Relative humidity range is 20% to 80% non-condensing.
- Temperature range is 0 °C to +55 °C (with or without the RMFBU Adapter attached).

The following list shows the non-operating conditions (while in storage or in transit) for the Intel RAID Adapter RS3P4MF088F:

- Relative humidity range is 5% to 90% non-condensing.
- Temperature range is -45 °C to +105 °C without backup battery unit.
- Temperature range is 0 °C to +70 °C with backup battery unit.

4.2.3 Intel® RAID Adapter RS3P4MF088F Power Consumption

The following table describes the power consumption of the Intel RAID Adapter RS3P4MF088F under the following states:

- **State 1:** While sitting idle at the DOS prompt or the EFI shell.
- **State 2:** During a drive stress test; average over 20 minutes of sustained operation.

Table 8. Intel® RAID Adapter RS3P4MF088F Consumption

Power Mode	State 1	State 2	
	Typical	Typical	RMFBU Learn
3.3 V supply	0.23 W	0.20 W	6 W
+ 12 supply	16.40 W	17.48 W	
3.3 V auxiliary supply	0.07 W	0.03 W	
Total power	16.70 W	17.71 W	6 W

5. Connectivity and Drive Support

The Intel RAID Adapters RS3P4TF160F and RS3P4MF088F have standard female SFF-8654 (SlimSAS* 8i) connectors to connect internal drives.

Each connector supports up to two direct-attach Non-Volatile Memory Express (NVMe*) drives (Intel RAID Adapter RS3P4TF160F only) or up to 8 direct-attach SAS / SATA drives.

Using PCI Express (PCIe) switches can increase the number of supported NVMe* drives; and using SAS expanders can increase the number of supported SAS / SATA drives.

5.1 Connector Pinout

The tri-mode Intel RAID adapters have standard female SFF-8654 (SlimSAS 8i) connectors to connect drive cables. The connector pinout follows the SFF-9402 specifications. SFF-9402 defines how to share sideband signals between SAS and PCIe.

When SAS / SATA drives are connected either as a direct attach through an SFF-8680 bay or through an enclosure, existing 12 Gb/s SAS cables and mid-plane connector designs are supported by these Intel RAID adapters. The next figure shows the pinout for the female SFF-8654 connectors on the adapters cards.

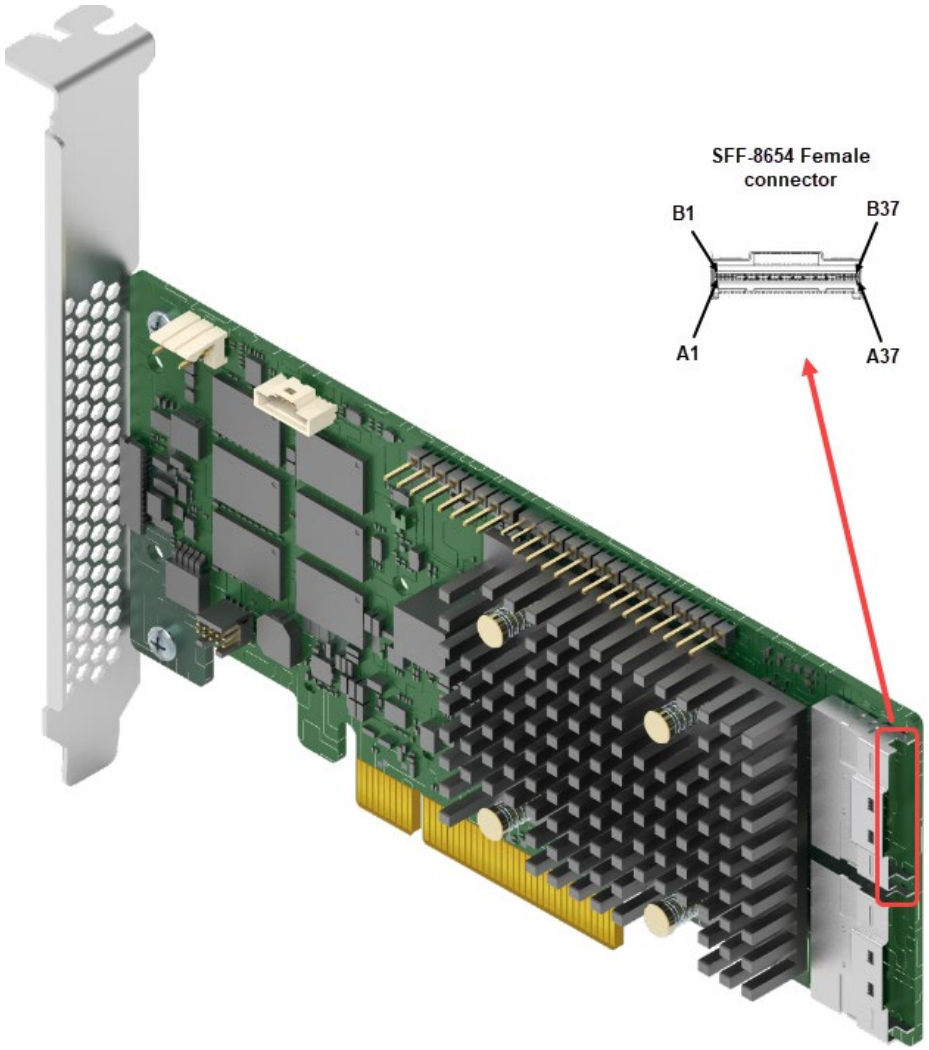


Figure 5. Intel® RAID Adapter RS3P4TF160F's SFF-8654 Connector

Table 9. SFF-8654 Connector Pinout

Pin #	Signal Name	Pin #	Signal 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+
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+	**B35B**	PETp3, TX7+
A36	PERn3, RX7-	**36B**	PETp3, TX7+
A37	GND	**B37**	GND

5.2 SAS / SATA Drive Support

The Intel RAID Adapters RS3P4TF160F and RS3P4MF088F support the *ANSI Serial Attached SCSI standard*, (version 3.0). In addition, the adapters support the SATA III protocol defined by the *Serial ATA specification (SAS)* (version 3.0). Supporting both the SAS interface and the SATA interface, the SAS adapter is a versatile adapter that provides the backbone of both server and high-end workstation environments.

Each port on these Intel RAID adapters supports SAS devices, SATA devices, or both, through the following protocols:

- **SAS Serial SCSI Protocol (SSP).** Enables communication with other SAS devices
- **SATA.** Enables communication with other SATA devices.
- **Serial Management Protocol (SMP).** Communicates topology management information directly with an attached SAS expander device.
- **Serial Tunneling Protocol (STP).** Enables communication with SATA devices through an attached expander.

SAS technology brings a wealth of options and flexibility with the use of SAS devices and SATA devices within the same storage infrastructure. However, SAS devices and SATA devices bring individual characteristics that make each one a more suitable choice depending on the requirements of the given operating environment and storage needs. The tri-mode Intel RAID adapters provide the flexibility to combine these two storage technologies on the same adapter and within the same enclosure.

Note: Combining SAS drives and SATA drives within the same virtual drive is allowed on some adapters but Intel discourages this practice.

The recommended cables for SAS / SATA support are contained in the **i**PN **CYPCBLSLHDKIT** kit. This kit includes one 660-mm long SlimSAS to 2x mini-SAS HD and one 860-mm long SlimSAS to 2x mini-SAS HD.

The next figure shows the connection diagram between the Intel RAID Adapter RS3P4TF160F and the backplanes. This connection diagram applies for SAS / SATA drives in the Intel Server System M50CYP2UR and the Intel Server System R2000WF and R1000WF families.

Similarly to the Intel RAID Adapter RS3P4TF160F, the Intel RAID Adapter RS3P4MF088F connects to the backplane but considering only one connector (C0) and only one backplane.

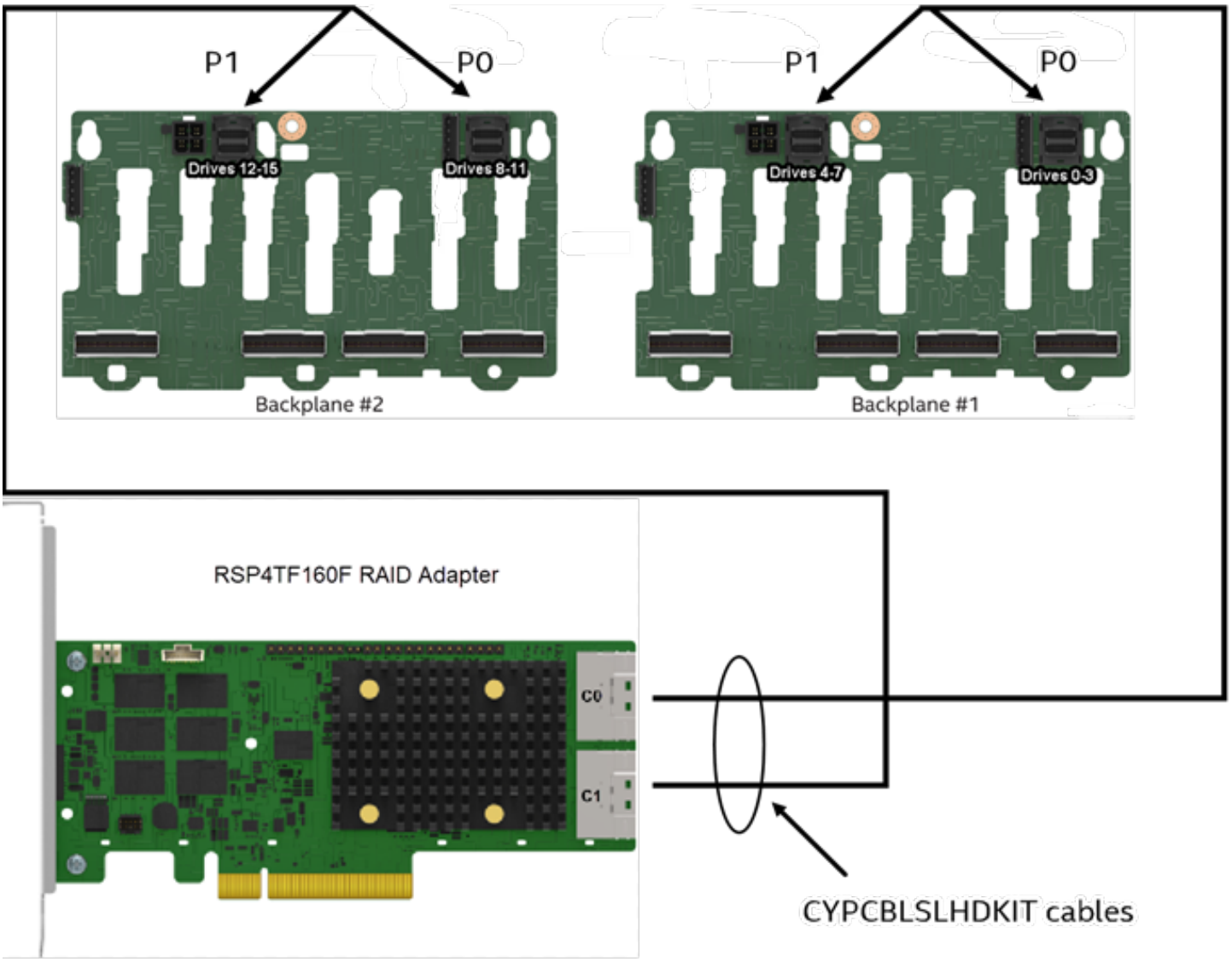


Figure 6. How to connect the Intel® RAID Adapter RS3P4TF160F Card to the Intel® Server R1208WF family System Backplane Backplane for SAS / SATA support.

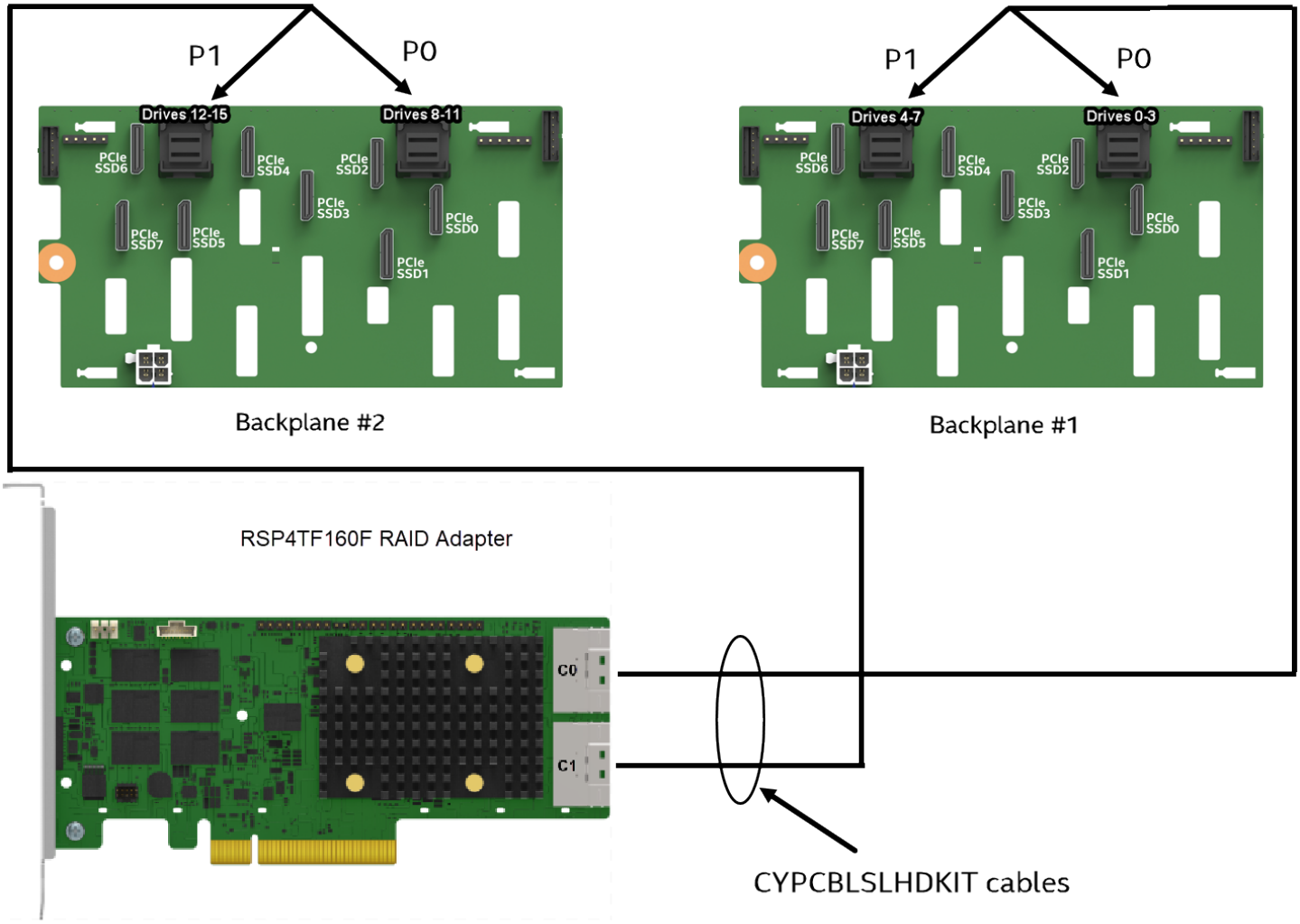
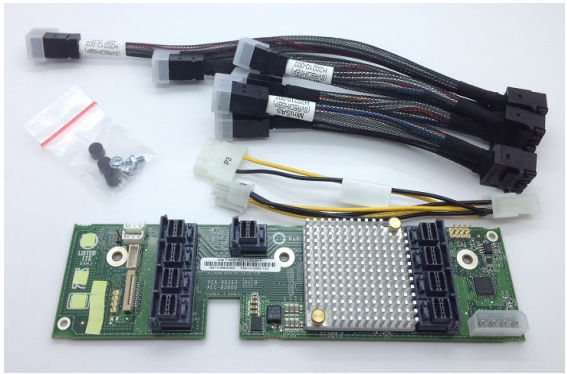


Figure 7. How to connect the Intel® RAID Adapter RS3P4TF160F Card to the Intel® Server R1208WF family System Backplane for SAS/SATA support.

5.2.1 Intel® 12 Gb/s SAS 3.0 Expander Support

For system configurations that require more physical SAS / SATA drives than the adapter's number of ports, the tri-mode Intel RAID adapters can support the expander described in the following table.

Table 10. Supported Intel® Storage Expander Options

Intel Product Code	Product Description
iPC – RES3TV360  **Intel® Storage Expander RES3TV360**	**SAS 3.0 12 Gb/s expander** • Featuring 6 Gbps data aggregation for 12 Gbps data transfer with 6 Gb/s devices. • Internal mount mid-plane form factor. • 36 internal ports supporting point-to-point 12, 6, and 3 Gb/s data transfer rates. • RA 4-pin power connector. • Mini-SAS HD connectors (SFF-8643). **Kit includes:** (1) SAS expander card; (1) 130 mm power cable; (1 set) expander-to-backplane cables: (4) HD-HD 165 mm, (1) HD-HD 300 mm, (1) HD-HD 250 mm, (3) rubber pads, and mounting screws.

5.2.2 SAS Expander Configuration for the Intel® RAID Adapter RS3P4TF160F

The SAS ports of the Intel RAID Adapter RS3P4TF160F are divided into two separate SAS domains: domain 1 and domain 2. One or two SAS connectors within a common domain can be cabled to a single SAS expander card when cabling the Intel RAID adapter to a SAS expander.

Note: Mixing SAS ports from different domains to a single SAS expander card is not supported.

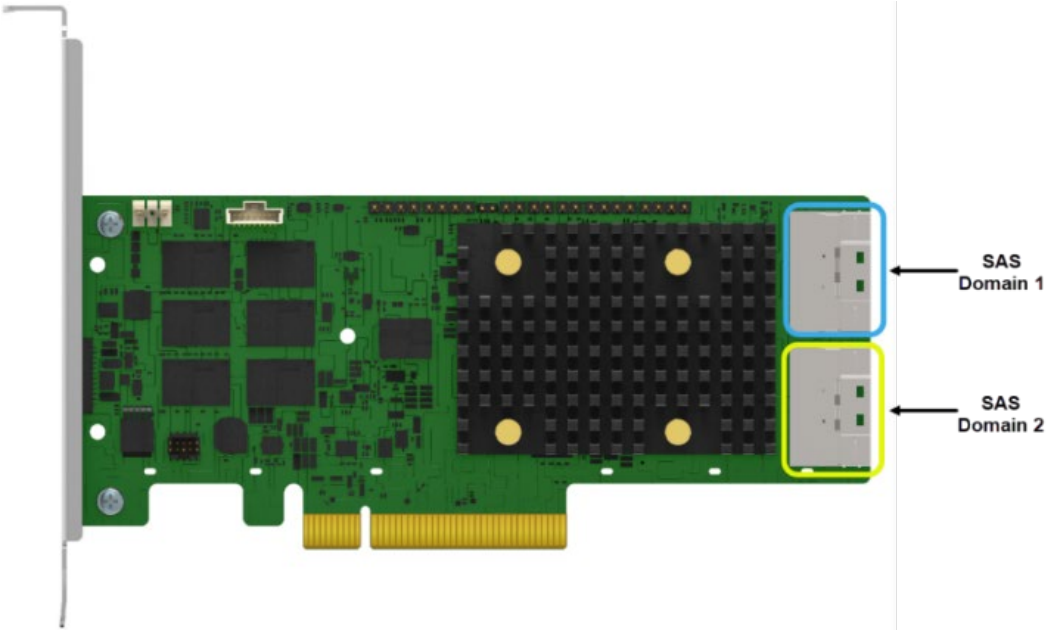


Figure 8. Intel® RAID Adapter RS3P4TF160F SAS Port Domain Identification

Compatible Intel storage expanders supporting SAS devices include several multiport mini-SAS HD connectors (SFF-8643). Some are used as output connectors to a backplane while others are used as input connectors from the RAID adapter. The following diagrams identify the connector types for each supported SAS expander card.

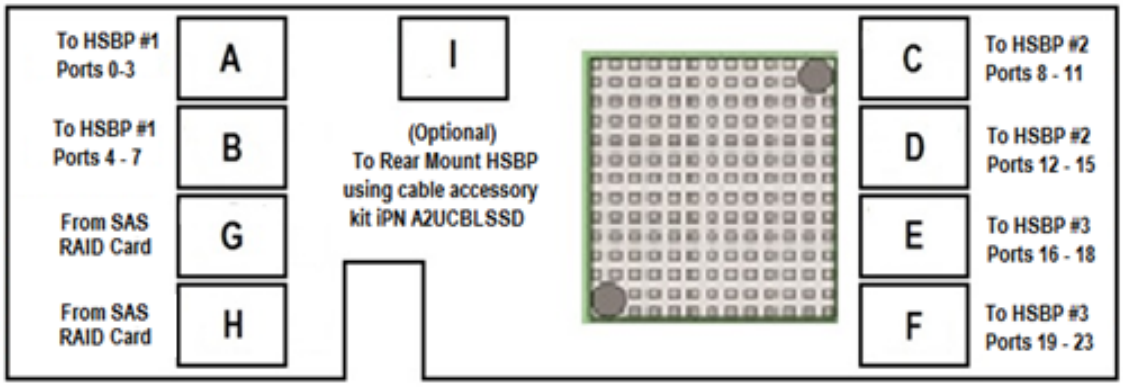


Figure 9. SAS Ports for the RES3TV360

Notes about input cable configuration:

- The SAS expander cards identified above can support one (1) or two (2) input SAS port cables.
- When routing two (2) input SAS port cables from the Intel RAID adapter, use cables from the same SAS domain, as illustrated in Figure 8.

5.3 NVMe* Drive Support

The Intel RAID Adapter RS3P4TF160 can support a variety of NVMe* drive configurations, including direct-attach and through switch. The support for NVMe* drives is limited to the U.2 (SFF-8639) form factor, connected through a supported backplane. The next sections explain the different support models.

5.3.1 X4, direct-attach connection.

Using this connection, the RAID controller connects directly to a HSBP using the supported cables. By using a X4, direct-attach connection, up to 4 NVMe* drives per RAID controller can be connected. The RAID controller dedicates 4 PCIe lanes per drive, obtaining full bandwidth from the RAID controller to the drives.

The RAID controller connects to the backplane using an SFF-8654 8i to SFF-8654 8i cable. The recommended cable kit is **iPN CYPCBLSLSLX8** (the kit contains two cables, one that is 860 mm long and one that is 1000 mm long).

Note: Both cables must be connected, even if only one or two NVMe* drives are being installed for clocking purposes.

Note: The Intel Server Systems R2000WF and R1000WF Families have no NVMe* drive support.

The next figures show how to connect the Intel® RAID Adapter RS3P4TF160F to the Intel® Server System backplanes.

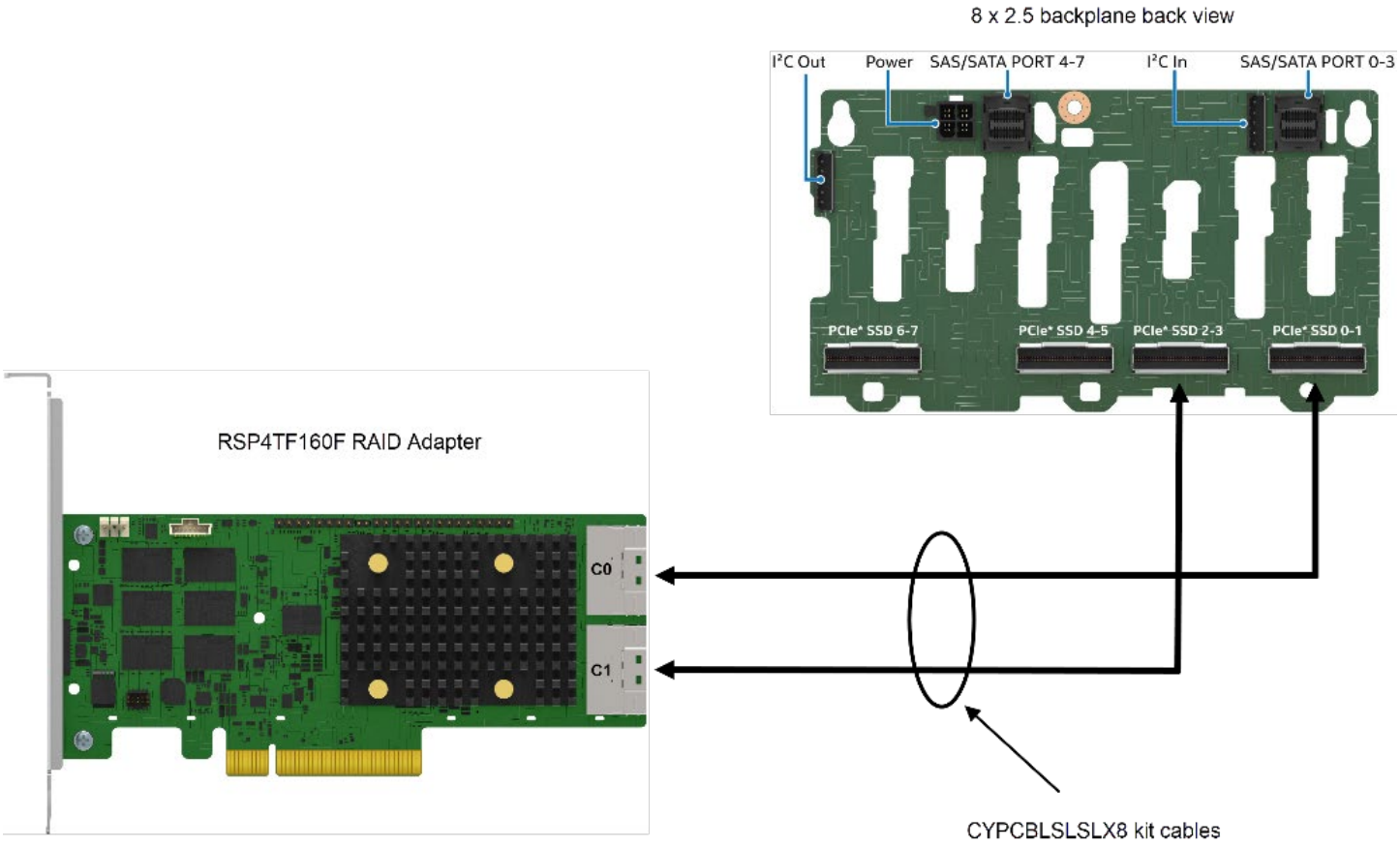


Figure 10. How to connect the Intel® RAID Adapter RS3P4TF160F to the Intel® M50CYP2UR208 Server System backplane using the NVMe* x4 direct-attach connection.

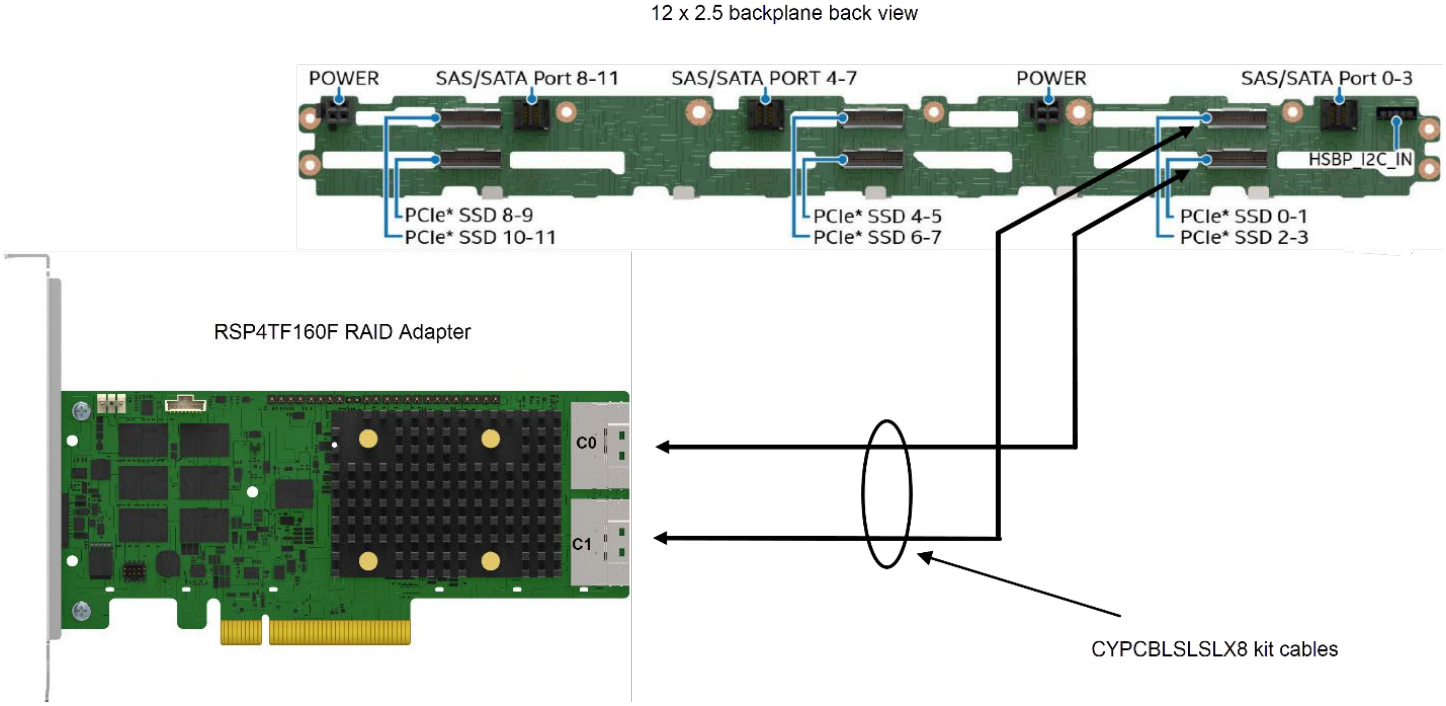


Figure 11. How to connect the Intel® RAID Adapter RS3P4TF160F to the Intel® M50CYP1UR212 Server System backplane using the NVMe* x4 direct-attach connection.

5.3.2 Through-switch, X4 connection.

To increase the NVMe* drive count supported by the RAID adapter, the Mid-Plane switch (IPC CYPSWITCHMP) can be used. This switch has a 1:3 fan-out per NVMe* port, allowing up to 12 NVMe* drives per RAID controller, using 4 PCIe lanes per drive between the switch and the backplane. Up to two RS3P4TF160F + CYPSWITCHMP can be installed to allow up to 24 drives. Only the M50CYP2UR208 system supports the mid-plane switch.

Note: RAID virtual drives cannot be created across multile RAID controllers.

A special firmware must be installed on the Mid-Plane switch to optimize the communication with the RS3P4TF160F adapter, the firmware package has detailed installation instructions and it can be found in the following link: ***https://www.intel.com/content/www/us/en/download/766822*.**

The minimum RAID controller firmware version to allow this connection is 5.200.02-3618, which can be found on the Intel Download Center, under Firmware Package for Intel® RAID Adapter RS3P4TF160F and RS3P4MF088F.

Once this special firmware is installed, the CYPSWITCHMP mid-plane switch will operate as 4 virtual switches, 4-to-12 lanes each (see below diagram). Take that into consideration when distributing the drives among the virtual switches in case of less than 12 drives are installed, to ensure optimal use of bandwidth.

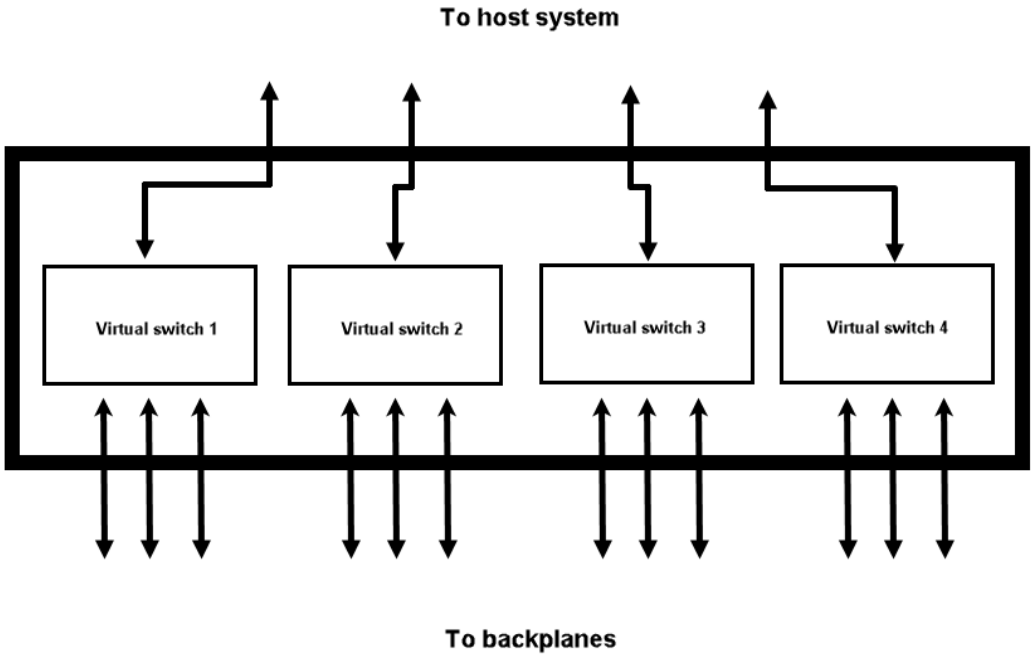


Figure 12. CYPSWITCHMP switch diagram.

The next figures show how to connect the data and I2C cables for this configuration. Note that if a single mid-plane switch is to be installed, it should go on the right side of the chassis and the CYPCBLSLAIC2RV cable kit must be used for the connection between the switch and the RAID adapter.

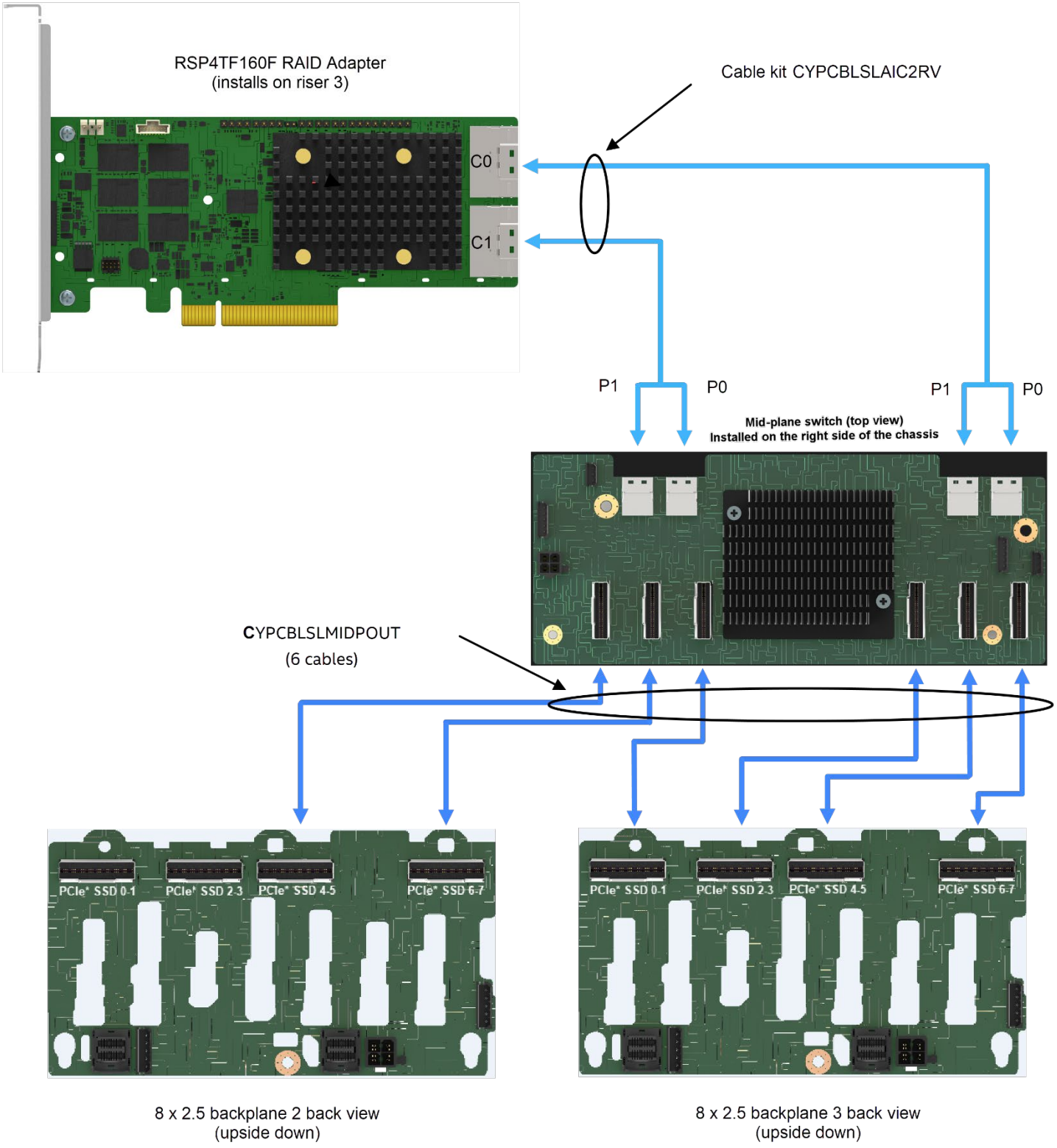


Figure 13. Data Cable Connection Diagram for a single Intel® RAID Adapter RS3P4TF160F Card, CYPSWITCHMP switch, and system backplane.

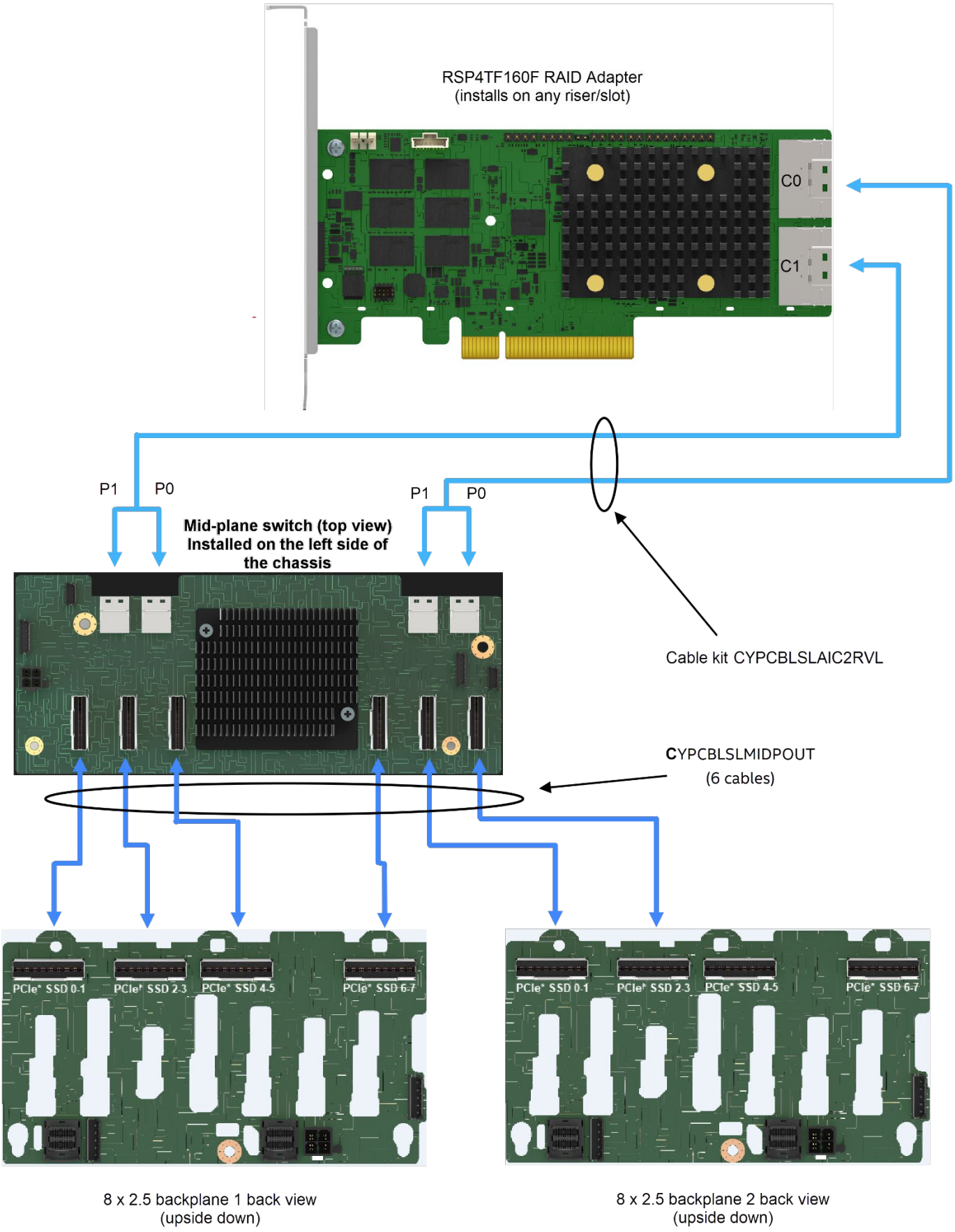


Figure 14. Data Cable Connection Diagram for the second Intel® RAID Adapter RS3P4TF160F Card, CYPSWITCHMP switch, and system backplane.

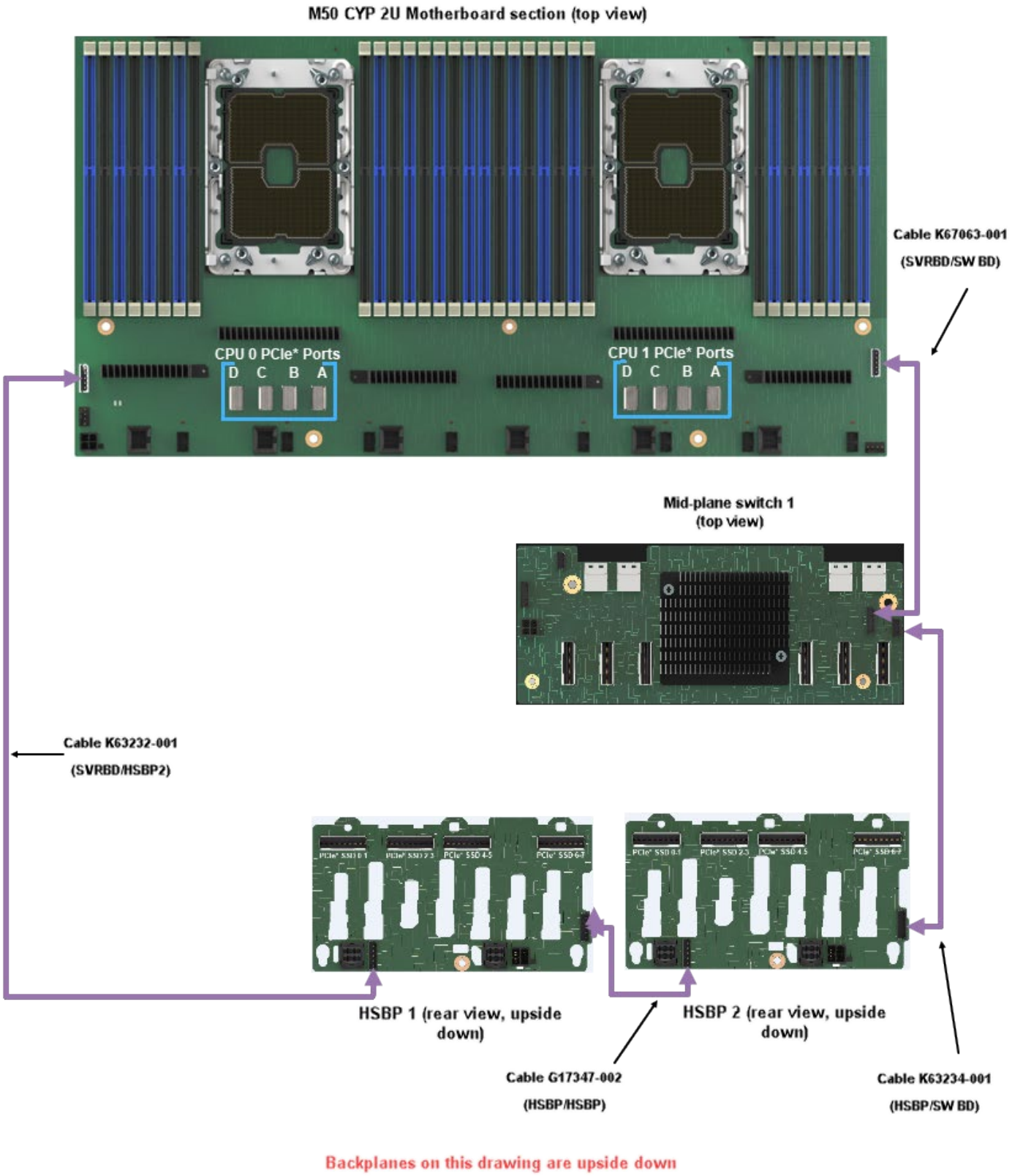


Figure 15. I2C cable connection diagram for a single CYPSWITCHMP mid-plane switch configuration.

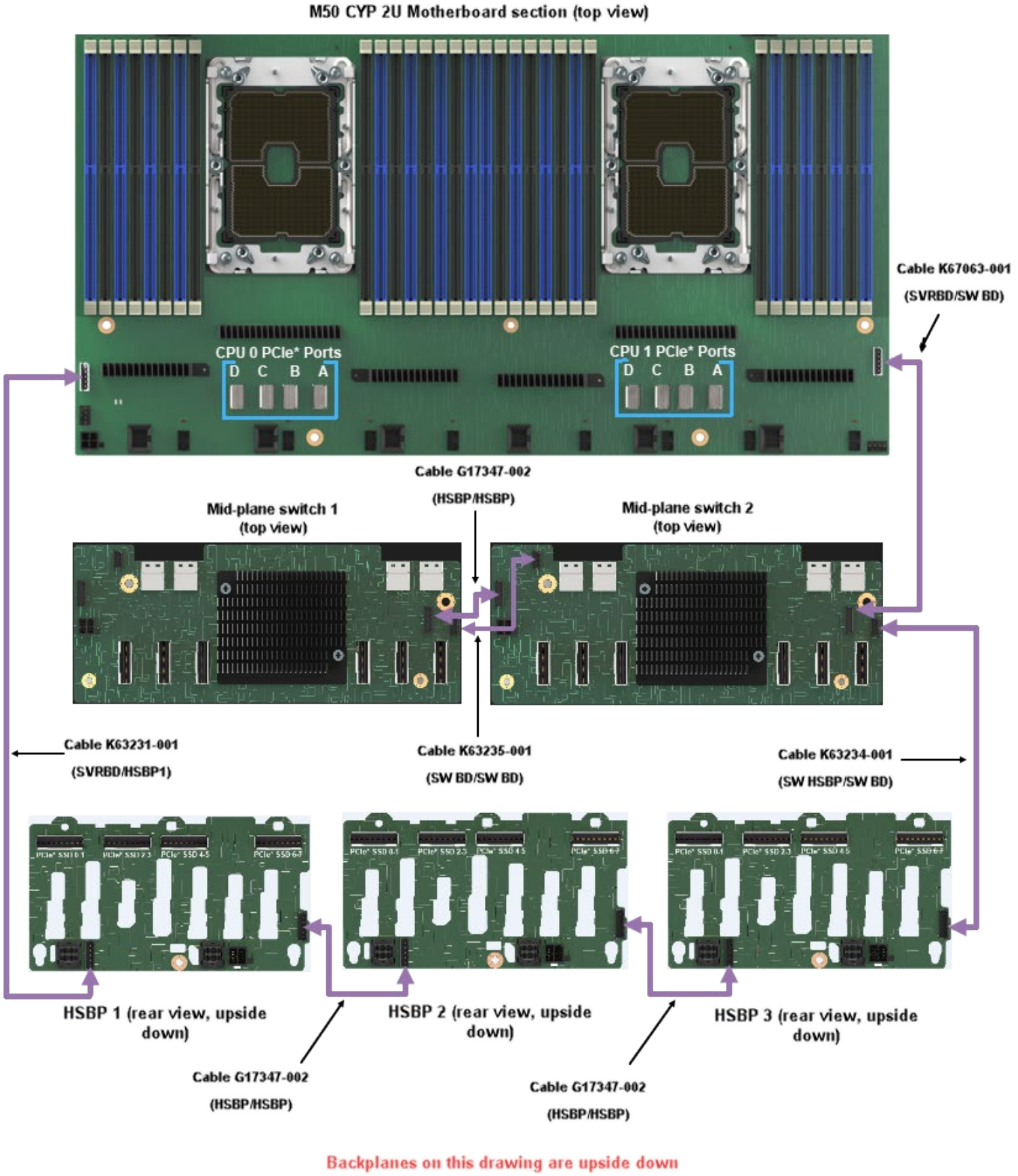


Figure 16. I2C cable connection diagram for a two CYPSWITCHMP mid-plane switch configuration.

6. Hardware Installation

Warnings

Heed safety instructions: Before working with your server product, whether you are using this guide or any other resource as a reference, pay close attention to the safety instructions. You must adhere to the assembly instructions in this guide to ensure and maintain compliance with existing product certifications and approvals. Use only the described, regulated components specified in this guide. Use of other products/components will void the UL listing and other regulatory approvals of the product and will most likely result in noncompliance with product regulations in the region(s) in which the product is sold.

System power on/off: The power button **does not** turn off the system AC power. To remove power from the system, you must unplug all AC power cords from the server system before you open the chassis, add, or remove any components.

Hazardous conditions, devices, and cables: Hazardous electrical conditions may be present on power, telephone, and communication cables. Turn off the server and disconnect the power cord, telecommunications systems, networks, and modems attached to the server before opening it. Otherwise, personal injury or equipment damage can result.

Installing or removing jumpers: A jumper is a small plastic encased conductor that slips over two jumper pins. Some jumpers have a small tab on top that you can grip with your fingertips or with a pair of fine needle nosed pliers. If your jumpers do not have such a tab, take care when using needle nosed pliers to remove or install a jumper; grip the narrow sides of the jumper with the pliers, never the wide sides. Gripping the wide sides can damage the contacts inside the jumper, causing intermittent problems with the function controlled by that jumper. Take care to grip with, but not squeeze, the pliers or other tool you use to remove a jumper, or you may bend or break the pins on the board.

Electrostatic Discharge (ESD)

Electrostatic discharge can cause damage to your computer or the components within it. ESD can occur without the user feeling a shock while working inside the system chassis or while improperly handling electronic devices like processors, memory or other storage devices, and add-in cards.

Intel recommends the following steps be taken when performing any procedures described within this document or while performing service to any computer system.

- Where available, all system integration and/or service should be performed at a properly equipped ESD workstation.
- Wear ESD protective gear like a grounded antistatic wrist strap, sole grounders, and/or conductive shoes.
- Wear an anti-static smock or gown to cover any clothing that may generate an electrostatic charge.
- Remove all jewelry.
- Disconnect all cables and cords attached to the server before performing any integration or service.
- Touch any unpainted metal surface of the chassis before performing any integration or service.
- Hold all circuit boards and other electronic components by their edges only.
- After removing electronic devices from the system or from their protective packaging, place them component side up on to a grounded anti-static surface or conductive foam pad. **Do not** place electronic devices on to the outside of any protective packaging.

6.1 Intel® RAID Adapter Installation

6.1.1 Requirements

The following items are required to install an Intel RAID adapter:

- Intel RAID adapter
- Server system based on an Intel server board with support for an Intel RAID adapter
- Internal SAS / SATA / NVMe* data cables
- Compatible drives

6.1.2 Packing List

1. Intel RAID adapter
2. Low profile mounting bracket
3. Attention document

Note: Intel RAID products do not include SAS / SATA / NVMe* data cables. If appropriate data cables are not included with the system, they must be purchased separately. Refer to your server system configuration guide or contact your Intel representative for more information.

6.1.3 Installation Instructions

The Intel RAID adapters can be installed on many different systems. The following instructions show how to install an Intel RAID adapter on an Intel® Server System M50CYP2UR.

1. Unpack the Intel RAID adapter. Inspect it for damage. If it appears damaged, contact the corresponding Intel Customer and Technical Support representative.
2. Turn off the power of the computer and disconnect the AC power cord.
3. Remove the computer cover. Refer to the system documentation for instructions.
4. Remove the riser card assembly (the adapter can be installed on any riser card assembly).
    A. Loosen the screws.
    B. Pull up the riser bracket.

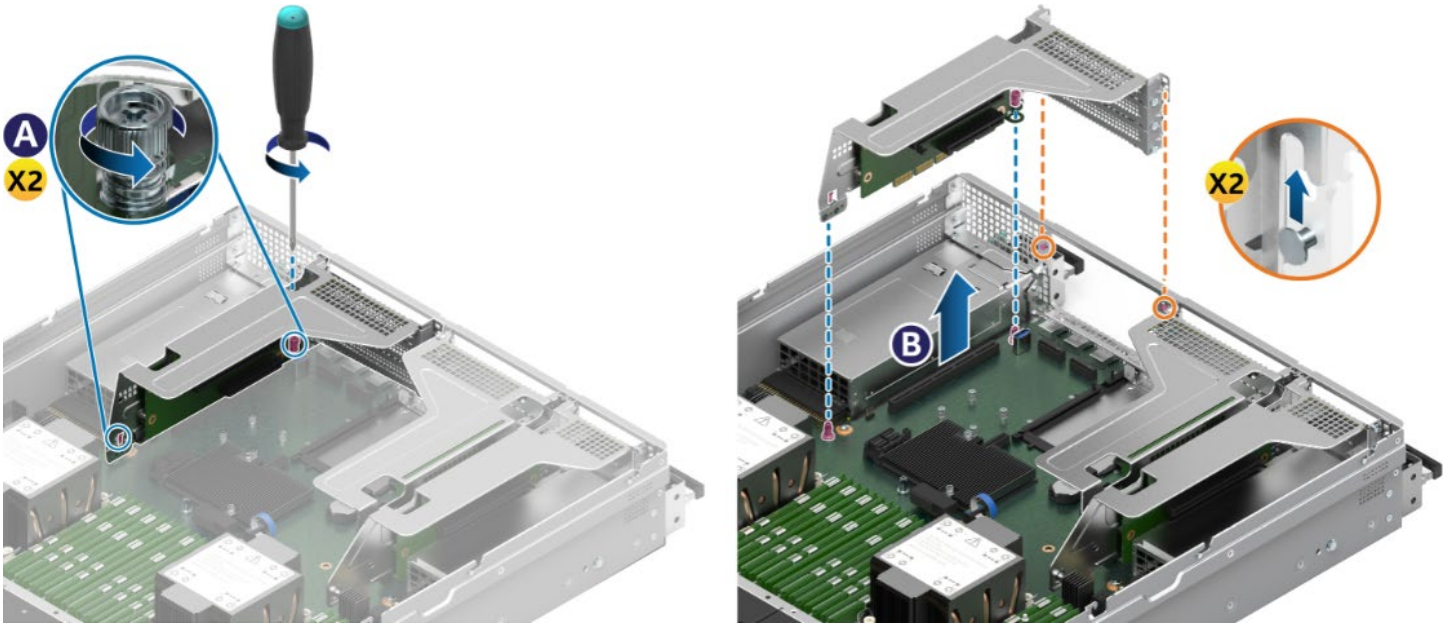


Figure 17. RAID Adapter Card Installation (Riser Card Assembly Removal)

5. Install the RAID adapter.
    A. Remove the screw.
    B. Remove the filler panel.
    C. Insert the adapter in the desired slot. Press down gently, but firmly to make sure that the card is seated correctly in the slot. Secure the bracket with the bracket screw.
    D. Secure the RAID card with the screw.

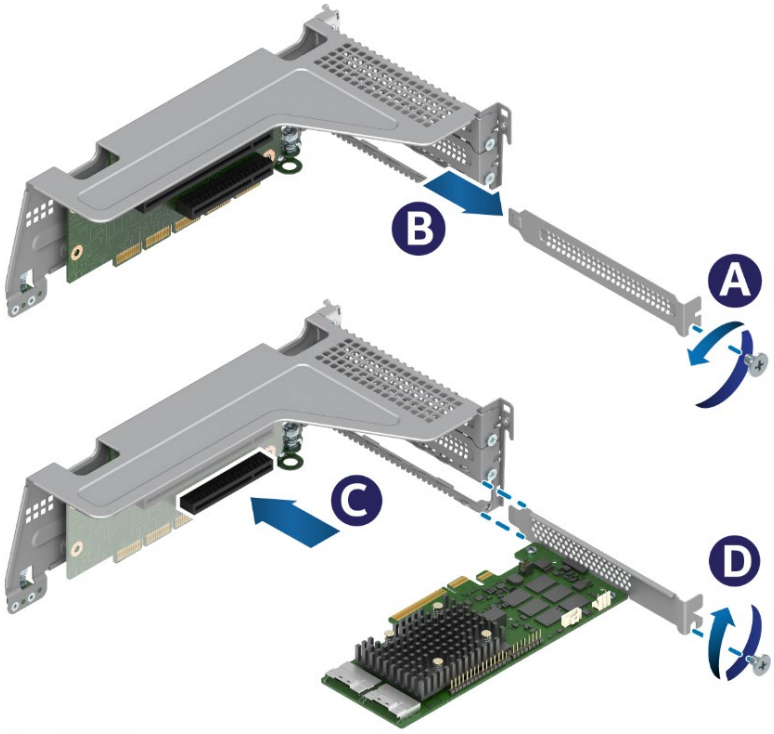


Figure 18. RAID Adapter Installation (Insert Adapter in Slot)

    E. Insert back the riser card assembly, press down gently but firmly.
    F. Secure the riser card assembly using the screws.

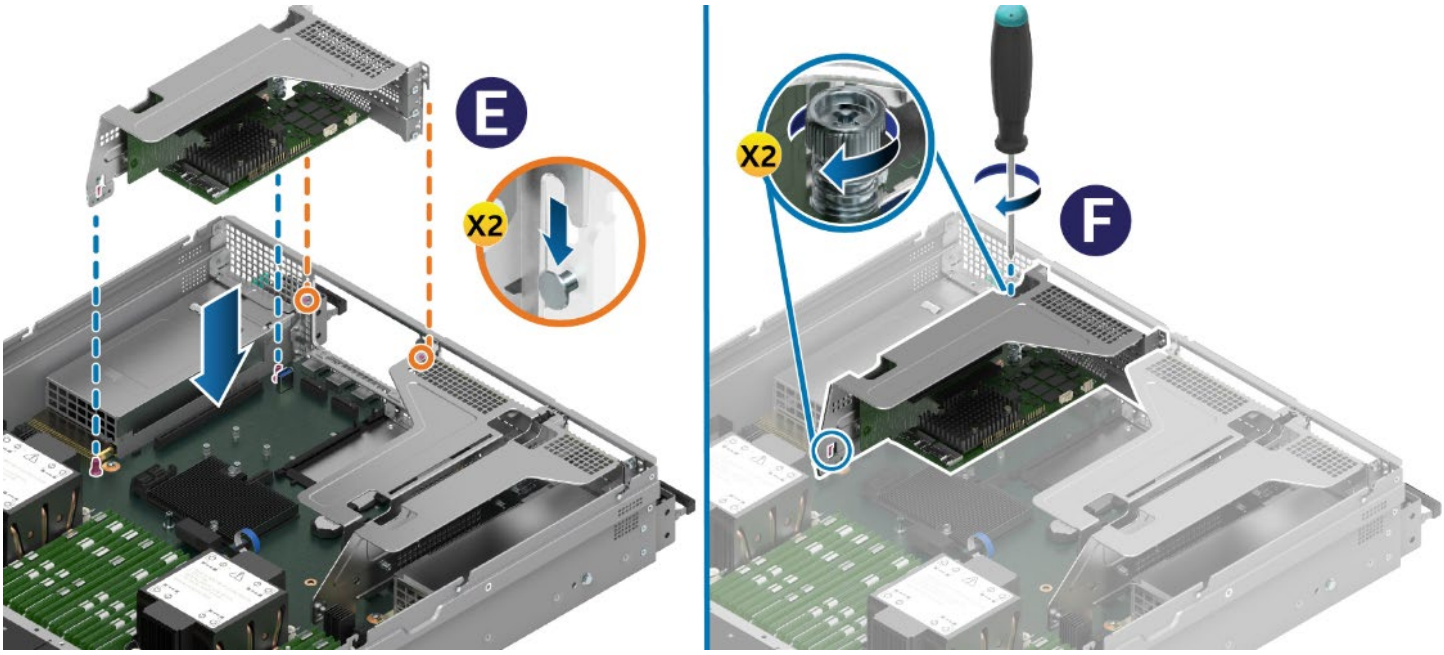


Figure 19. RAID Adapter Card Installation (Riser Card Assembly Installation)

6. Install SAS / SATA / NVMe* drives in the host computer backplane. Refer to the documentation for the devices for any preinstallation configuration requirements.
7. Connect internal SAS / SATA / NVMe* data cables to the backplane
8. Carefully route data cables back to the Intel RAID adapter.
9. Connect the data cables to the RAID adapter card.
10. Reinstall the computer cover, and reconnect the AC power cords to the system.

The hardware installation is now complete, and the Intel RAID adapter is ready to be configured. For complete Intel RAID Adapter configuration information, refer to the *Intel® RAID Software User Guide for full featured and entry-level RAID controllers* available to download from the Intel Support page: http://support.intel.com.

7. Safety and Regulatory (Class A)

Intel RAID products typically have a variety of individual component-level certifications (listed in Section 7.1, Section 7.2, and Section 7.3). However, final regulatory compliance is based on the combination of the RAID card being within an Intel server system.

About the applications of these Intel RAID products, the user must consider the following points:

- **Intended Application.** Intel RAID products are evaluated as information technology equipment (ITE) as part of Intel server chassis systems. These products are intended to be part of Intel server systems to be installed in offices, schools, computer rooms, and similar commercial-type locations.
- **Non-ITE Application.** The suitability of this product for other product categories and environments (such as: medical, industrial, telecommunications, NEBS, residential, alarm systems, test equipment, and others) may require further evaluation.

7.1 Product Safety Compliance

7.1.1 USA / Canada Safety (UL-Listed)

- UL 60950-1, second edition, 2014-10-14 (Information Technology Equipment - Safety -Part 1: General Requirements).
- CAN/CSA C22.2 No. 60950-1-07, second edition, 2014-10 (Information Technology Equipment - Safety -Part 1: General Requirements).
- UL 62368-1, second edition.
- CAN/CSA C22.2 No. 62368-1-14.

7.1.2 CB Scheme Safety

- IEC 60950-1:2005 (second edition) + Am 1:2009 + Am 2:2013.
- IEC 62368-1:2014 (second edition).
- EN 60950-1: 2006 + A11: 2009 + A1: 2010 + A12: 2011 + A2: 2013.
- EN 62368-1:2014+A11: 2017.

7.1.3 Taiwan (BSMI)

- CNS 13438.
- CNS15663.

7.1.4 Morocco (CMIM)

- EN55022/EN55024 EN55032.
- EN 55032:2015 +AC:2016, Class B.
- EN 50022:2010 +AC:2011, Class B.
- EN 55024:2010 +A1:2015.

7.2 Product EMC Compliance – Class A Compliance

7.2.1 USA / Canada (FCC)

- 47 CFR FCC, Part 15, Subpart B, Class B.
- ANSI C63.4:2014.
- CISPR 32:2008.

7.2.2 CB Scheme Safety

- EN 55022/EN55024 EN55032.
- EN 55032:2015 +AC:2016, Class B.
- EN 50022:2010 +AC:2011, Class B.
- EN 55024:2010 +A1:2015.

7.2.3 KC Certification (Korea)

- Meets the KN32/KN35 testing requirements.

7.2.4 VCCI Emissions (Japan)

- V-3/2015.04, Class B.
- V-4/2012.04.
- VCCI-CISPR 32:2016.
- CISPR 32:2015.

7.2.5 Australia and New Zealand RCM

- AS/NZS CISPR 32.
- CISPR 32:2015, Class B.
- AS/NZS CISPR 32:2015, Class B.

7.3 Product Environmental Compliance

Intel has a system in place to restrict the use of banned substances in accordance with worldwide regulatory requirements. A material declaration data sheet is available for Intel products. For more reference on material restrictions and compliance, view Intel's Environmental Product Content Specification at http://supplier.intel.com/ehs/environmental.html.

- **European Directive 2002/95/EC** (Europe).
- **Restriction of Hazardous Substances** (RoHS).
    - Threshold limits and banned substances are the following.
        - Quantity limit of 0.1% by mass (1000 PPM) for:
            - Lead.
            - Mercury
            - Hexavalent Chromium.
            - Polybrominated Biphenyls Diphenyl Ethers (PBB/PBDE).
        - Quantity limit of 0.01% by mass (100 PPM) for:
            - Cadmium.
- **California Code of Regulations**, Title 22, Division 4.5, Chapter 33:
    - Best Management Practices for Perchlorate Materials.
- **China** – Restriction of Hazardous Substances (China RoHS).
- **WEEE Directive** (Europe).
- **Packaging Directive** (Europe).
- **REACH Directive** (Europe).

8. Intel® RAID Maintenance Free Backup AXXRMFBU7

8.1 Intel® RAID Maintenance Free Backup AXXRMFBU7

Intel RAID adapters provide reliability, high performance, and fault-tolerant disk subsystem management. A complete fault-tolerant strategy requires protection of all data, including the unwritten cached data in the RAID card's RAM cache. If power is lost, the data in the RAM cache is lost. To avoid losing this data, a RAID Maintenance Free Backup Unit (RMFBU) can be added to the configuration.

During normal system operation, the RMFBU monitors the voltage level of the DRAM of the Intel RAID adapter. If the voltage drops below a predefined level due to an AC power failure or brief power outage, the RMFBU protects the integrity of the cached data by providing sufficient back-up power to offload the data from the RAID RAM to the NAND flash. When the voltage level returns to an acceptable level, the RAID RAM is recovered from flash, and all pending writes to storage devices are completed without losing any data.

The cache memory available on Intel RAID adapters can improve the overall system performance. Writing data to the adapter's cache memory is much faster than writing data to a storage device. Write operations appear to complete very quickly at the software-application level. Intel RAID adapters write the cached data to the storage device when system activity is low or when the cache is getting full.

The risk of using write-back cache is that the cached data can be lost if the AC power fails before it is written to the storage device. This risk factor is eliminated when the Intel RAID adapter has an RMFBU installed. In addition, the RMFBU provides an alternative to using an uninterruptible power supply (UPS) or can act as a second level of fault tolerance when used with a UPS.

Furthermore, the RMFBU eliminates the need for lithium ion (Li-Ion) batteries traditionally used to protect DRAM cache memory on PCI RAID adapters. Meaning, this is a greener and lower total cost cache protection solution. Also, the RMFBU has built-in functionality to charge the capacitor adapter automatically and to communicate status information such as voltage, temperature, and current to the host server system.

The Intel RAID Maintenance Free Backup AXXRMFBU7 is a kit consisting of an FBU345 super capacitor bank, a plastic bracket to attach the super capacitor bank to the chassis, and two extender cables (one 605 mm long and the other 930 mm long).

The FBU345 consists of a bank of electric double-layer capacitors (EDLC) or super capacitors that are capable of storing a high amount of electric energy while active. If a power failure occurs, the FBU345 provides the power needed for the data offload. It also has an over-temperature detection circuitry and a discharge circuitry. This circuitry discharges the capacitors while disconnected from the RAID adapter or when the system on which it is installed on is turned off.

8.2 FBU345 Specifications and Layout

Table 11 shows the specifications for the FBU345 supercap. Figure 15 shows the same device followed by its dimensions and pin description.

Table 11. FBU345 Specifications

Item	Value
Super capacitor adapter operating temperature	0–55 °C
Super capacitor adapter storage temperature	0–70 °C
Rated voltage	13.5 VDC
Surge voltage	14.25 VDC
Super capacitor adapter capacity	7.6 F
Rated energy	0.04 Wh
Super capacitor adapter charge time	Approximately 2 minutes
Super capacitor adapter shelf life	3 years

Item	Value
Super capacitor adapter operational life	Intel provides a three-year warranty on the Intel RAID Maintenance Free Backup AXXRMFBU7.
Maximum equivalent series resistance (ESR)	190 mOhm
Weight	46 g

The FBU345 is extremely sensitive to the high operating temperature, and excessive heat may shorten its life. The over temperature detection circuitry sends an event to the RAID adapter when the operating temperature is over 55 °C, which gets registered in the adapter's log file.

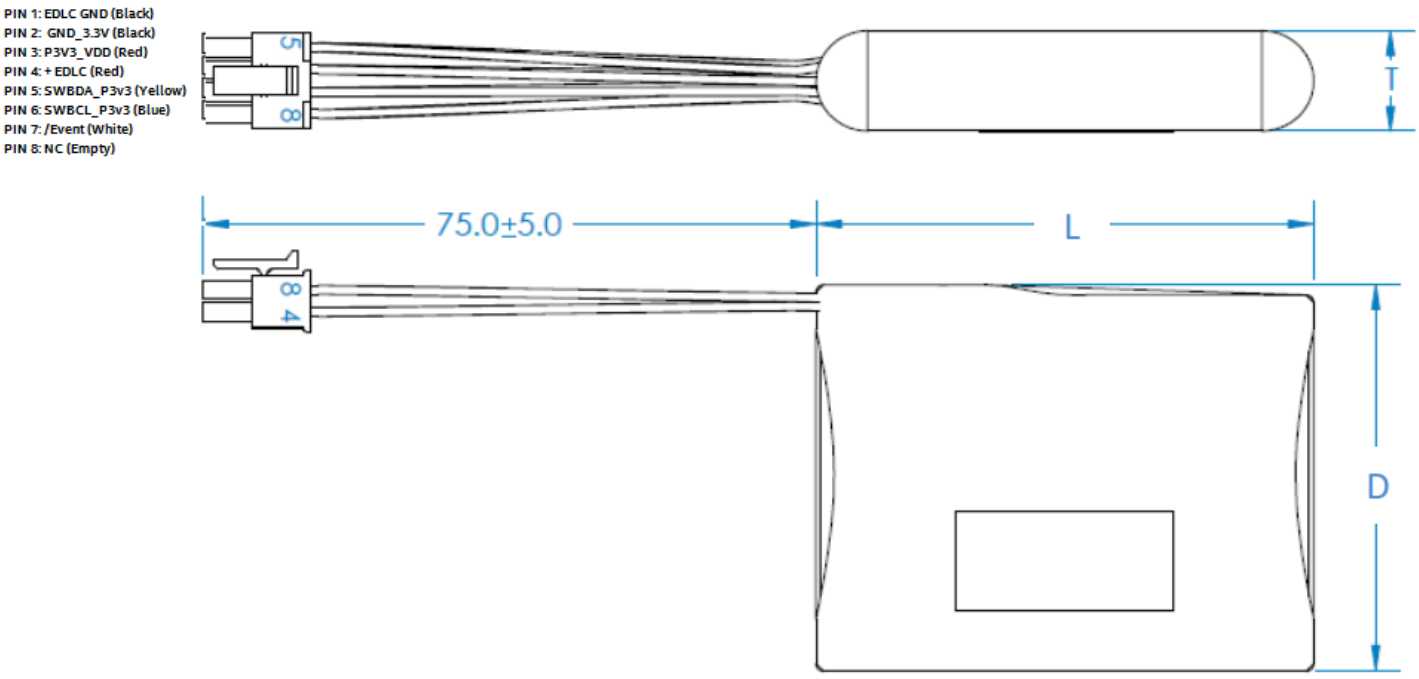


Figure 20. FBU345 Layout

Table 12. FBU345 Dimensions

Width (D)	51.0 +/- 1.0 mm
Length (L)	64.0 +/- 1.0 mm
Height T	13.1 +/- 0.4 mm

Table 13. Pin Description

Pin #	Signal	Color
1	EDLC GND	Black
2	GND_ 3.3V	Black
3	P3V3_VDD	Red
4	+EDLC	Red
5	SWBDA_P3V3	Yellow
6	SWBCL_P3V3	Blue
7	/Event	White
8	NC	Empty

8.2.1 Extender Cable

The extender cable has an 8-pin Molex 43020-0601* connector on one end and, on the other end, a 9-pin Molex 501330-0900* connector. Two versions of the cable are included in the kit (one 605 mm long and the other 930 mm long). The routing of the cable is shown in Figure 16.

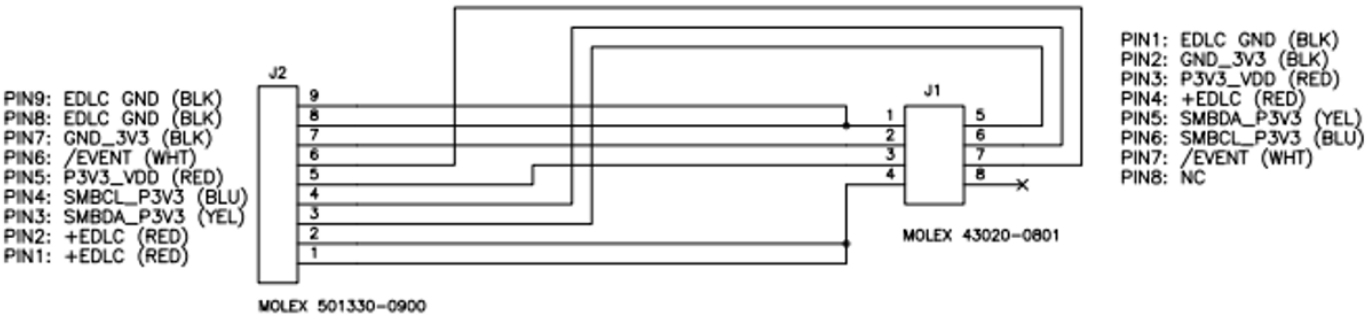


Figure 21. Extender Cable Pinout

8.3 Intel® RAID Maintenance Free Backup Unit Installation

The mounting hardware included with the Intel RAID Maintenance Free Backup AXXRMFBU7 accessory kit is designed to be compatible for installation into a supported Intel pedestal and rack mount server system. An alternate attachment method may be needed when installing this accessory into a non-Intel chassis.

Intel recommends using industrial-grade Velcro* or other industrial adhesive material as an acceptable option. Refer to the server chassis documentation or discuss an appropriate attachment method with the server chassis manufacturer to ensure that the attachment mechanism complies with the chassis requirements.

8.3.1 Super Cap Assembly into the Holder

The RMFBU plastic case needs to have the latch installed and the super cap bank needs to be assembled with the RMFBU plastic case before attaching it on the mounting bracket.

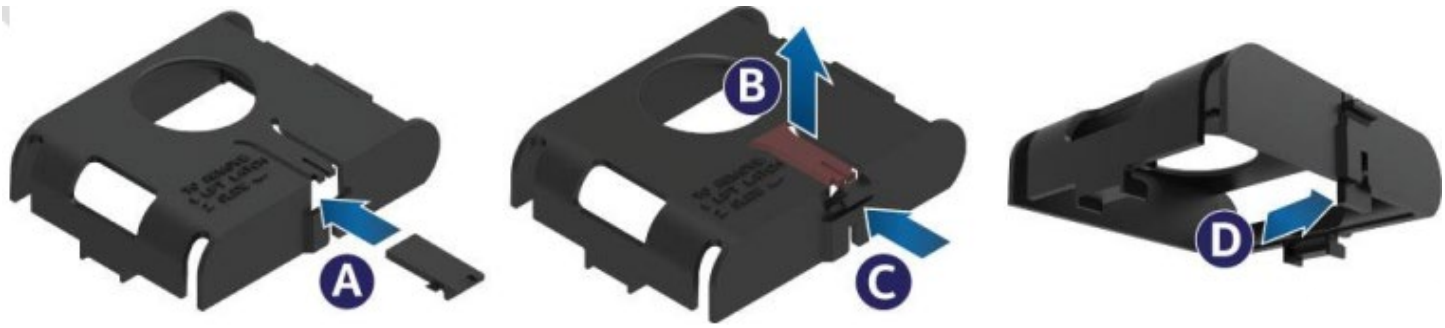


Figure 22. Latch Installation on the Plastic Case

1. Insert the latch in the opening on the plastic case (see Letter A).
2. Lift the latch holder slightly up (see Letter B) and insert the opening notch until it clicks (see Letter C).
3. Bring the latch down until it is aligned vertically (see Letter D).

Figure 23. Super Cap Bank Insertion

4. Insert the super cap bank inside the plastic case with the cable protruding out. Choose the opening in the plastic case for the cable closest to RAID module where the cable is going to be connected to.

8.3.2 Super Cap Assembly Installation in the Intel® Server System M50CYP2UR's Server Chassis

The RMFBU mounting bracket can be installed in the same area inside the chassis as the midplane or SAS interposer. Or it can be installed on top of both sides of the air duct (left side and right side).

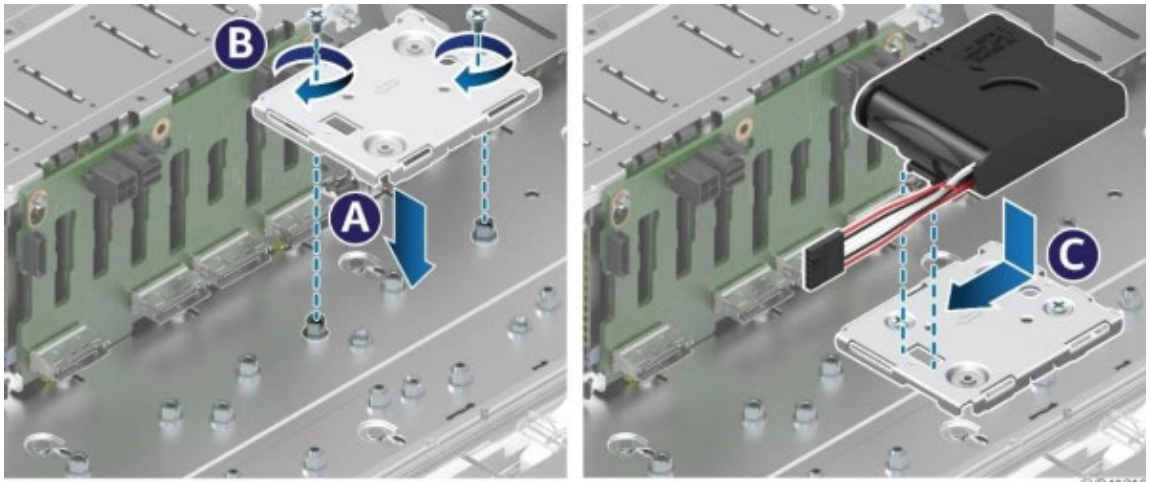


Figure 24. Installation on the Server Chassis

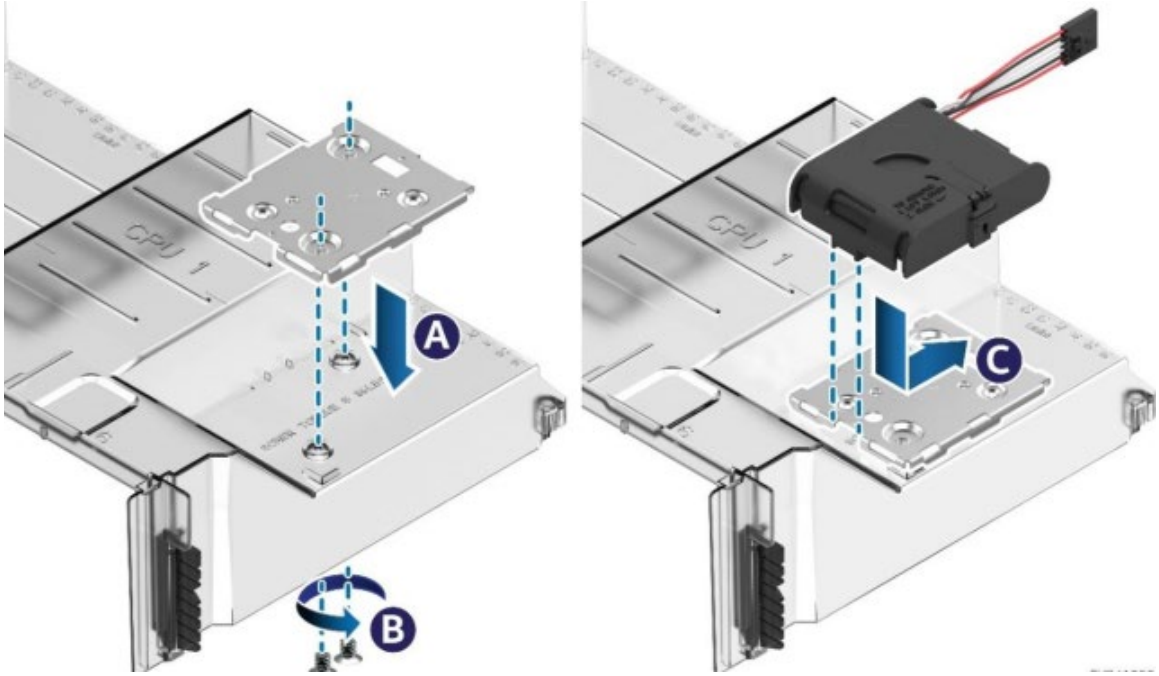


Figure 25. Installation on the Air Duct

1. Power off the system and disconnect the power cables.
2. Remove the system top cover.
3. Remove the air duct
4. Remove the cable clip, if installed, by unfastening the two screws holding the clip to the chassis.
5. Align the two screw holes of the RMFBU mounting bracket with the matching threaded holes on the base of the chassis or on the top of the air duct (see Letter A).
6. Secure the RMFBU mounting bracket to the chassis or to the air duct using two screws (see Letter B). Tighten to 5 in-lb.
7. Slide the RMFBU assembly in the direction as indicated on the mounting bracket (see Letter C) until the latch locks in place.
8. Attach all the connectors as required.
9. Reinstall the air duct.
10. Reinstall the system top cover.
11. Carefully route the extender cable to the Intel RAID adapter and attach the cable to the matching connector. Use the appropriate cable (605 mm or 930 mm long) that best fits.

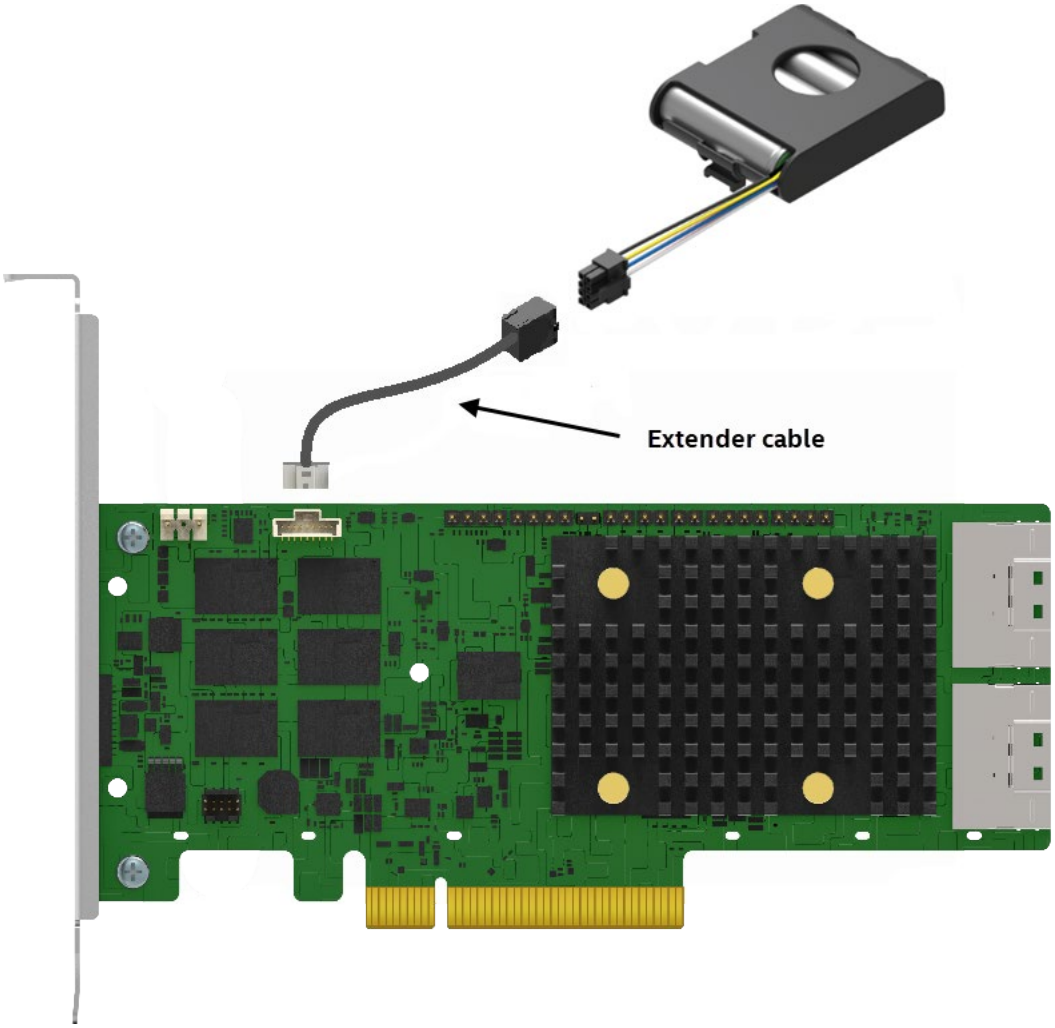


Figure 26. Intel® RAID Maintenance Free Backup AXXRMFBU7 Connection to the Intel® RAID Adapter

8.4 Mean Time Between Failures (MTBF) in the Intel® RAID Maintenance Free Backup AXXRMFBU7

The Intel RAID Maintenance Free Backup AXXRMFBU7 is extremely sensitive to temperature. Although the heat produced by itself is negligible, the heat from other components located near this unit can affect it significantly. The following table shows MTBF information calculated at different temperatures.

Table 14. MTBF Information Calculated at Different Temperatures for the Intel® RAID Maintenance Free Backup Unit

Intel® RAID Maintenance Free Backup AXXRMFBU7			
Temperature (Celsius degrees)	55	40	30
MTBF (hours)	10,152.28.	19,493,177.	28,169,014.

8.5 Intel® RAID Maintenance Free Backup Unit Monitoring

Three different utilities can be used to monitor the RMFBU: StorCLI, RAID Web Console 3, and the Human Interface Infrastructure (HII). This section only describes how to use HII for this purpose. For details on how to monitor using the other utilities, consult the *Intel® RAID Utilities User Guide*.

8.5.1 How to use the Human Interface Infrastructure to Monitor the RMFBU

The HII can be used to configure disk arrays and logical drives. The HII is independent of the operating system and can be accessed at server startup through the BIOS setup utility. The HII can only be accessed when the system is configured for UEFI boot mode. The HII can also be used to monitor the MFBU.

Note: Refer to the *Intel® RAID Software User Guide for full featured and entry-level RAID controllers* for more information on the HII.

To view the RMFBU information, do the following:

1. At boot, press the **<F2>** key when prompted and enter the **BIOS setup utility**.
2. Navigate to **Main > Advanced > PCI Configuration > UEFI Option ROM Control.**
3. Look for the RAID card under the **Storage Controlle**r list.
4. Press **<Enter>** to get into the **Main Menu** for the **HII Configuration Utility**.

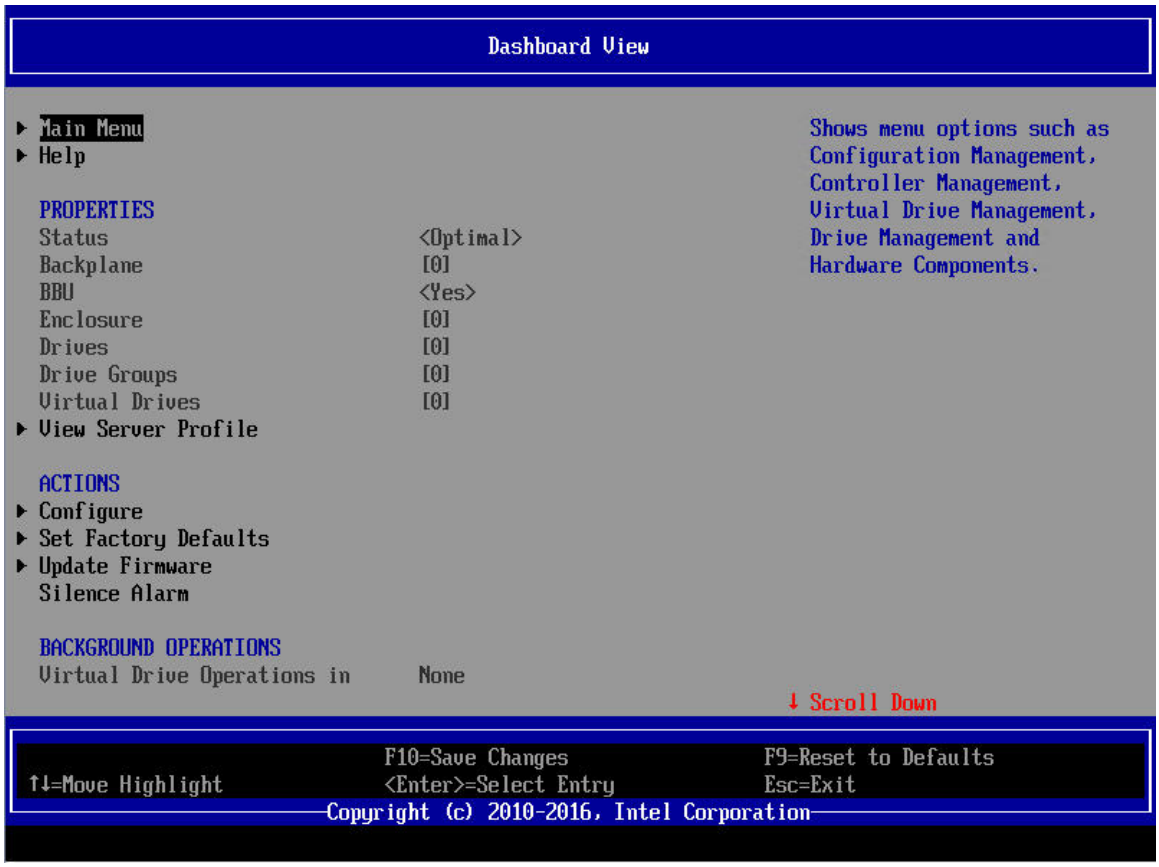


Figure 27. HII Dashboard View Screen

5. Enter the **Main Menu** and select **Hardware Components** to go to the **Hardware Components** screen.

Figure 28. HII Hardware Components Screen

6. The Hardware Components Screen shows the Battery Status. Select the **Battery Management** option.

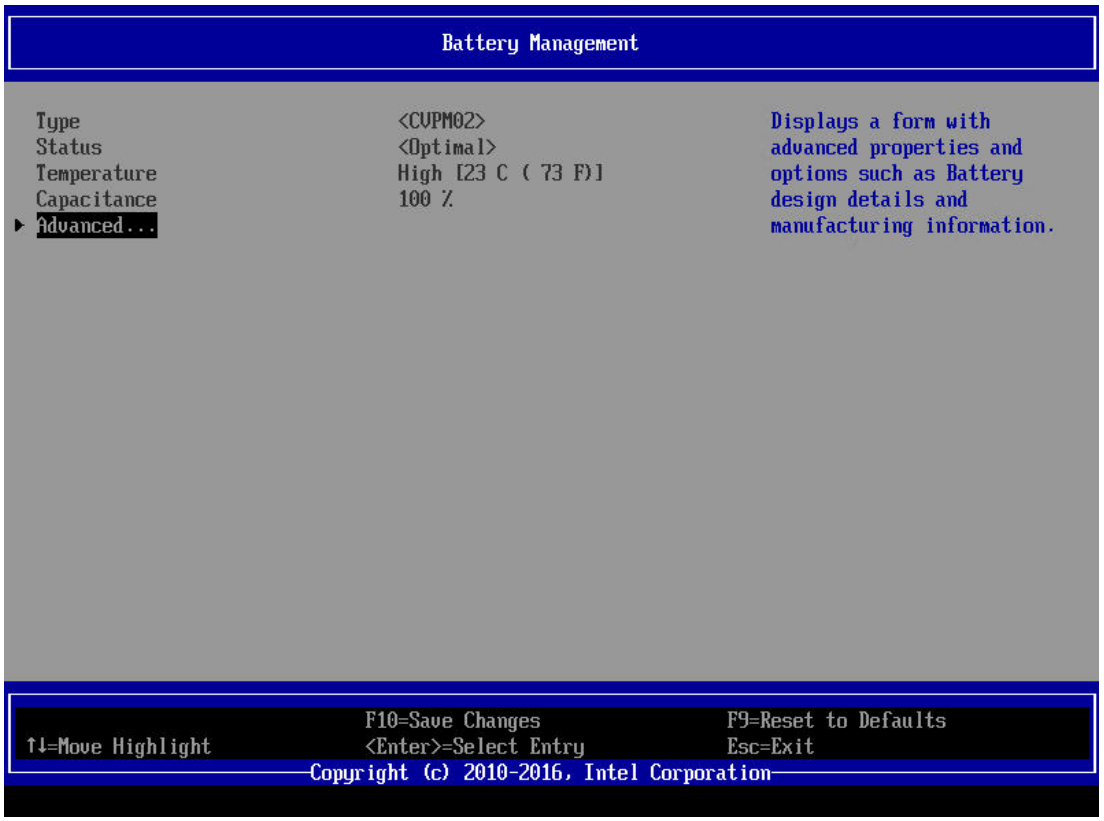


Figure 29. HII Battery Management Screen

7. The **Battery Management** screen contains the following information:

Table 15. Battery Management

Battery type	A string that identifies the RMFBU type.
Battery status	The status of the RMFBU, normally it should be optimal.
Temperature	The current temperature of the battery pack or supercap
Capacitance	With time, the capacitance decreases, this field shows the current capacitance of the battery pack or supercap.

8. Select the **Advanced** field at the bottom of the **Battery Management Screen**.

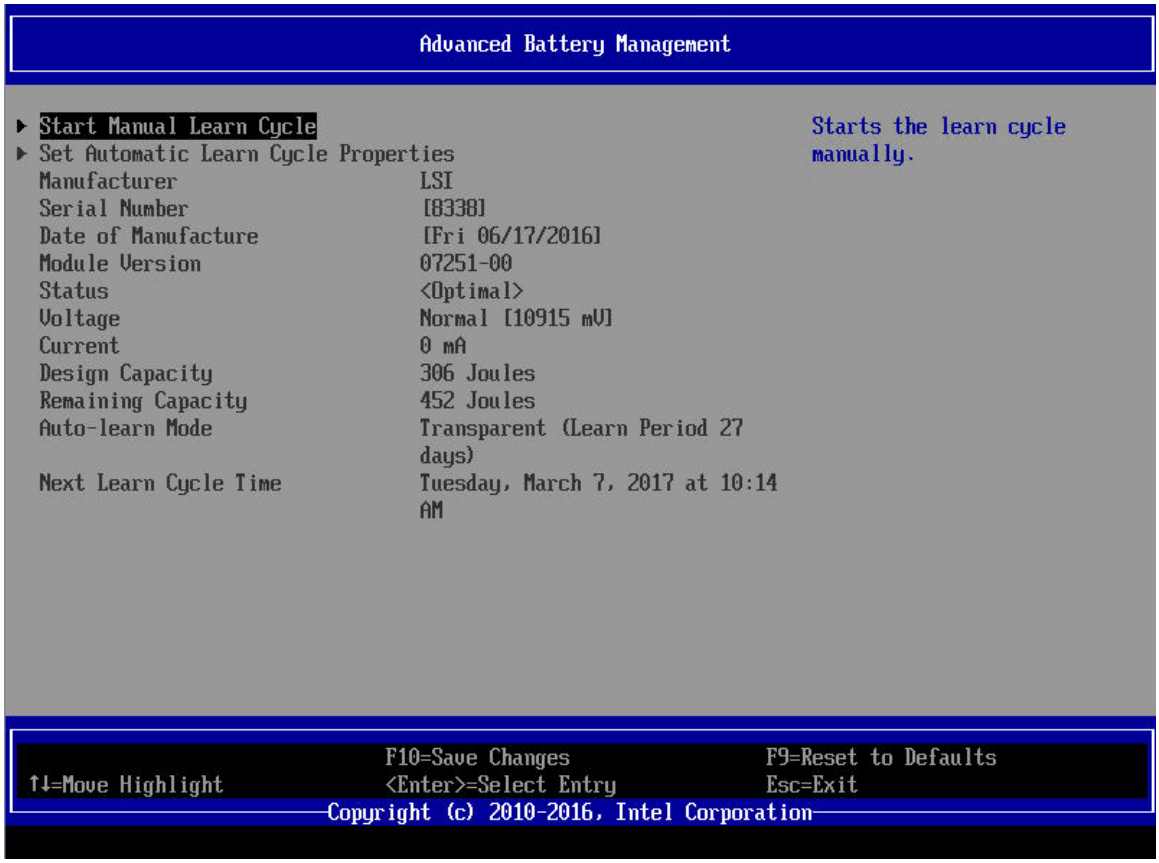


Figure 30. HII Advanced Battery Management Screen

9. The **Battery Management Screen** contains the following information:

Table 16. Battery Management Information Screen Information

Manufacturer	The manufacturer of the RMFBU unit.
Serial number	The serial number of the RMFBU unit.
Date of manufacture	The date of manufacture of the RMFBU unit.
Adapter version	The identifier of the version of the firmware that controls the RMFBU.
Status	The current status of the RMFBU. Normally, it should be optimal.
Voltage	The current voltage of the RMFBU unit.
Current	The amount of current being delivered by the RMFBU.
Design capacity	The original capacitance that was intended for the supercap.
Remaining capacity	The capacitance left in the supercap.
Auto-learn mode	The learning mode currently set for the RMFBU.
Next learn cycle time	The time and date for the next learn cycle.

Appendix A. Glossary

Term	Description
BIOS	Acronym for basic input/output system. Software that provides basic read/write capability. Usually kept as firmware (ROM-based). The system BIOS on the motherboard of a computer boots and controls the system. The BIOS on the host adapter acts as an extension of the system BIOS.
Configuration	Refers to the way a computer is set up, the combined hardware components (computer, monitor, keyboard, and peripheral devices) that make up a computer system, or the software settings that allow the hardware components to communicate with each other.
Device driver	A program that permits a microprocessor (through the operating system) to direct the operation of a peripheral device.
Domain validation	A software procedure in which a host queries a device to determine its ability to communicate at the negotiated data rate.
DRAM cache memory	Dynamic random access memory (DRAM) is a type of memory typically used for data or program code that a computer processor needs to function. DRAM is a common type of random access memory (RAM) used in personal computers (PCs), workstations, and servers.
Drive group	A group of physical drives that combines the storage space on the drives into a single segment of storage space. A hot spare drive does not actively participate in a drive group.
EEPROM	Acronym for electronically erasable programmable read-only memory. It is a memory chip that typically stores configuration information, as it provides stable storage for long periods without electricity and can be reprogrammed. See NVRAM.
EDLC	Electric Double-Layer Capacitors
External SAS device	A SAS device installed outside the computer cabinet. These devices are connected using specific types of shielded cables.
Fusion-MPT architecture	Acronym for Fusion-Message Passing Technology architecture. Fusion-MPT consists of several main elements: Fusion-MPT firmware, the Fiber Channel and SCSI hardware, and the operating system-level drivers that support these architectures. Fusion-MPT architecture offers a single binary, operating system driver that supports both Fiber Channel and SCSI devices.
Host	The computer system in which a RAID controller is installed. It uses the RAID controller to transfer information to and from devices attached to the SCSI bus.
Host adapter board	A circuit board or circuit that provides a device connection to the computer system.
Hot spare	An idle, powered on, standby drive that is ready for immediate use if a drive failure occurs. A hot spare does not contain any user data. A hot spare can be dedicated to a single redundant array or it can be part of the global hot-spare pool for all arrays managed by the controller. When a drive fails, the controller firmware automatically replaces and rebuilds the data from the failed drive to the hot spare. Data can be rebuilt only from virtual drives with redundancy (RAID levels 1, 5, 6, 10, 50, and 60; not RAID level 0), and the hot spare must have sufficient capacity.
Internal SAS device	A SAS device installed inside the computer cabinet. These devices are connected by using a shielded cable.
Main memory	The part of computer memory that is directly accessible by the CPU (usually synonymous with RAM).
NVRAM	Acronym for non-volatile random access memory. An EEPROM (electronically erasable read-only memory) chip that stores configuration information. See EEPROM.
PCI	Acronym for peripheral component interconnect. A high-performance, local bus specification that allows the connection of devices directly to computer memory. The PCI Local Bus allows transparent upgrades from 32-bit data path at 33 MHz to 64-bit data path at 33 MHz, and from 32-bit data path at 66 MHz to 64-bit data path at 66 MHz.
PCIe*	Acronym for Peripheral Component Interconnect Express*. A high-performance, local bus specification that allows the connection of devices directly to computer memory. PCIe is a two-way, serial connection that transfers data on two pairs of point-to-point data lines. PCIe goes beyond the PCI specification in that it is intended as a unifying I/O architecture for various systems: desktops, workstations, mobile, server, communications, and embedded devices.
Peripheral devices	A piece of hardware (such as a video monitor, drive, printer, or CD-ROM) used with a computer and under the control of the computer. SCSI peripherals are controlled through an Intel® RAID controller (host adapter).
PFK	Product Feature Key. A device that unlocks some additional features on the product

Term	Description
PHY	The interface required to transmit and receive data packets transferred across the serial bus. Each PHY can form one side of the physical link in a connection with a PHY on a different SAS device. The physical link contains four wires that form two differential signal pairs. One differential pair transmits signals, while the other differential pair receives signals. Both differential pairs operate simultaneously and allow concurrent data transmission in both, the receive and the transmit directions.
RAID	Acronym for redundant array of independent disks (originally Redundant Array of Inexpensive Disks). An array (group) of multiple independent drives managed together to yield higher reliability, performance, or both exceeding that of a single drive. The RAID array appears to the controller as a single storage unit. I/O is expedited because several drives can be accessed simultaneously. Redundant RAID levels (RAID levels 1, 5, 6, 10, 50, and 60) provide data protection.
RAID levels	A set of techniques applied to drive groups to deliver higher data availability, performance characteristics, or both to host environments. Each virtual drive must have a RAID level assigned to it.
RMFBU	Refers to the Intel® Maintenance Free Backup Unit AXXRMFBU7 accessory kit.
SAS	Acronym for Serial Attached SCSI. A serial, point-to-point, enterprise-level device interface that leverages the proven SCSI protocol set. The SAS interface provides improved performance, simplified cabling, smaller connections, lower pin count, and lower power requirements when compared to parallel SCSI. SAS controllers leverage a common electrical and physical connection interface that is compatible with Serial ATA. The SAS controllers support the ANSI *Serial Attached SCSI Standard, Version 2.0*. In addition, the controller supports the Serial ATA III (SATA III) protocol defined by the *Serial ATA Specification, Version 3.0*. Supporting both the SAS interface and the SATA III interface, the SAS controller is a versatile controller that provides the backbone of both server and high-end workstation environments. Each port on the SAS RAID controller supports SAS devices, SATA devices, or both.
SAS device	Any device that conforms to the SAS standard and is attached to the SAS bus by a SAS cable. This includes SAS RAID controllers (host adapters) and SAS peripherals.
SATA	Acronym for Serial Advanced Technology Attachment. A physical storage interface standard, SATA is a serial link that provides point-to-point connections between devices. The thinner serial cables allow for better airflow within the system and permit smaller chassis designs.
SMART	Self-monitoring analysis and reporting technology.
SRIS	Separate Reference Clock with Independent Spread. Refers to a PCIe device using an independent clock signal.
SSP	Acronym for Serial SCSI Protocol. SSP enables communication with other SAS devices. Each PHY on the SAS controller can function as an SSP initiator.
STP	SATA Tunneling Protocol. Protocol to allow SATA communication through SAS expanders.
StorCLI	Command line software tool to manage RAID hardware, physical and virtual drives.
Stripe	The portion of a stripe that resides on a single drive.
Stripe size	The total drive space consumed by a stripe not including a parity drive. For example, if a stripe contains 64 KB of drive space and has 16 KB of data residing on each drive, the stripe size is 64 KB and the strip size is 16 KB. A larger stripe size produces improved read performance, especially if most of the reads are sequential. For mostly random reads, select a smaller stripe size.
Striping	Drive striping writes data across two or more drives. Each stripe spans two or more drives but consumes only a portion of each drive. Each drive, therefore, may have several stripes. The amount of space consumed by a stripe is the same on each drive that is included in the stripe. The portion of a stripe that resides on a single drive is a strip, also known as a stripe element. Striping by itself does not provide data redundancy; striping in combination with parity provides data redundancy.
Strip size	The drive space consumed by a strip. For example, if a stripe contains 64 KB of drive space and has 16 KB of data residing on each drive, the stripe size is 64 KB and the strip size is 16 KB. The stripe depth is four (four drives in the stripe).