Intel® Integrated RAID Module RMS3AC160

Hardware User Guide

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

Rev 1.0
April 2016

Intel Server Boards and Systems

Document Revision History

Date Published	Revision	Revision Change Description
Apr 2016	1.0	Initial release

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Preface

This document provides an overview of product features, specification data, and hardware installation instructions for the Intel® Integrated RAID Module RMS3AC160.

Document Organization

This document includes the following chapters and glossary:

- **Chapter 1 – Product Overview** – provides a product overview of the features set and support specifications
- **Chapter 2 – General Feature Overview**
- **Chapter 3 – Hardware Installation** – provides the product installation instructions
- **Chapter 4 – Safety and Regulatory**
- **Chapter 5 – Intel® RAID Maintenance Free Backup Unit AXXRMFBU6** – provides a general overview for the Intel® RAID Maintenance Free Backup Unit AXXRMFBU6 accessory option
- **Glossary of Terms**

Reference Documents and Online Articles

The following documents are available for download and will be useful to setting up and using your Intel RAID controller.

Document Title	Description
Intel® RAID Software Users Guide	Article ID: 000005760 .A document that provides information on RAID Card Setup and usage of supported RAID utility software
What to Do when Unable to Enter BIOs Or Intel® RAID BIOS Console During Boot for Intel® Server Boards	Article ID: 000059999- If the Intel or OEM logo screen displays during POST, the BIOS entry or Intel® RAID BIOS console command prompts are not visible. To gain access to these prompts, you need to disable the logo screen.
12 Gbps SAS or 6G SATA Data Transfer Controller Support for Intel RAID Controllers	Article ID# 000008025 - How and where the controller supports 12-Gbps SAS (6G SATA) data transfers
TA-1085—4Kn and 512e Advanced Format with Intel® RAID and Server Boards Advanced Format 4K Sector Drive Support for Intel RAID Controllers	Article ID# 000006173 - TA-1085—4Kn and 512e Advanced Format with Intel® RAID and Server Boards
Intel® RAID Controller Premium Feature Key Training	This document explains the different Feature Key options, their benefits, usage, and installation guide. http://www.intelserveredge.com/assets/intel_pfk_training_v4.pdf

Product Support Collaterals

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 the product described herein. Additional product support collaterals can be downloaded from the following Intel web sites:

For product documentation, go to the following Intel web site:
http://www.intel.com/support/go/RMS3AC160

For product device drives and other software utilities, go to the following Intel web site:
https://downloadcenter.intel.com/product/91066

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1. Product Overview

The Intel® Integrated RAID Module RMS3AC160 is a 16-port SAS/SATA mezzanine type RAID module capable of supporting up to 240 SAS drives.

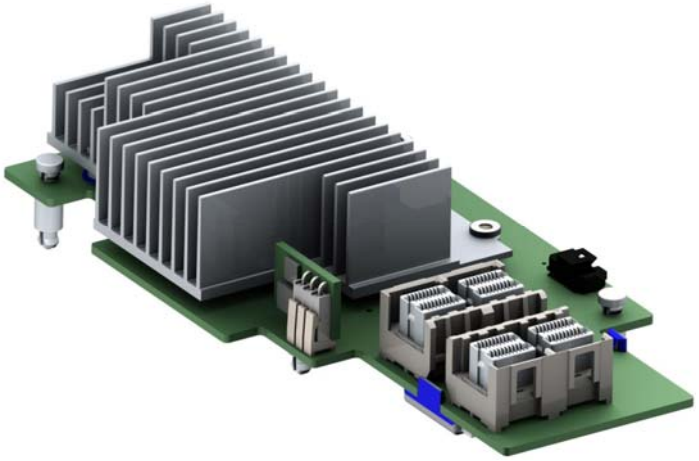


Figure 1. Intel® Integrated RAID Module RMS3AC160

As a mezzanine type add-in module, it is only compatible with Intel® Server Boards and Systems that include an on-board high density 80-pin SAS module connector, as illustrated below.

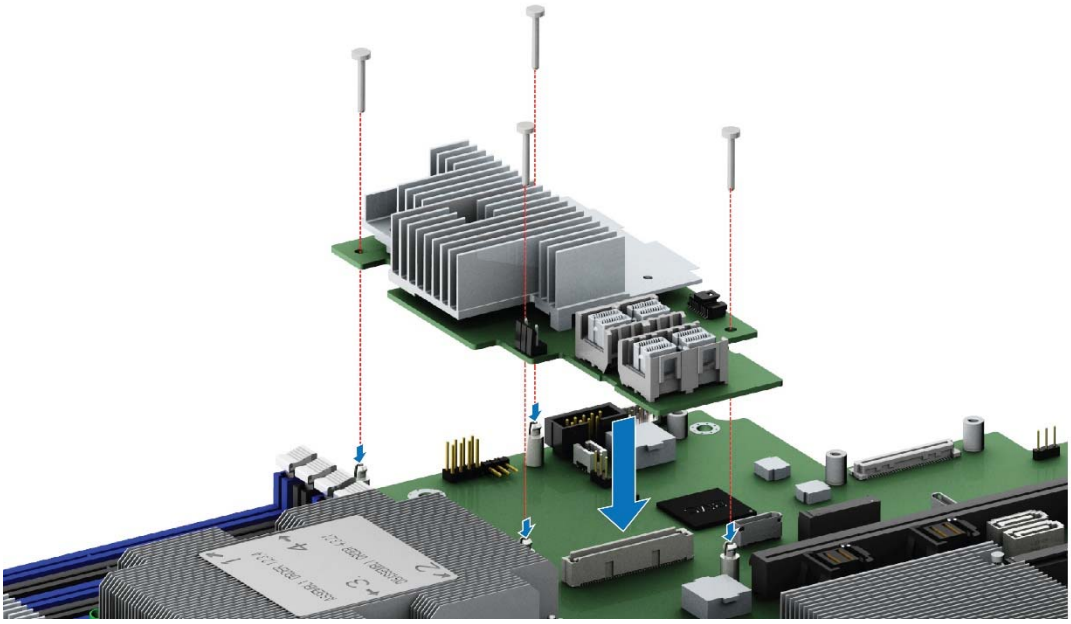
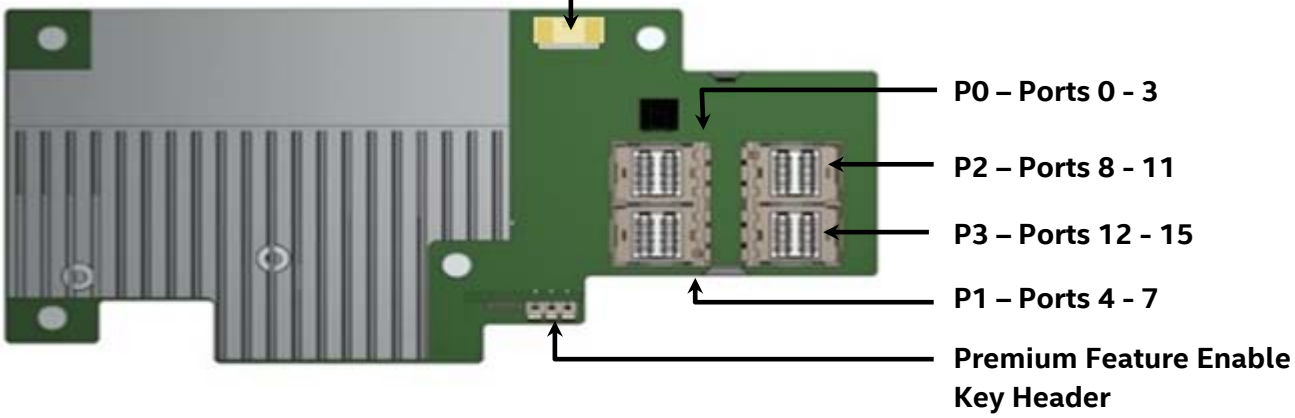


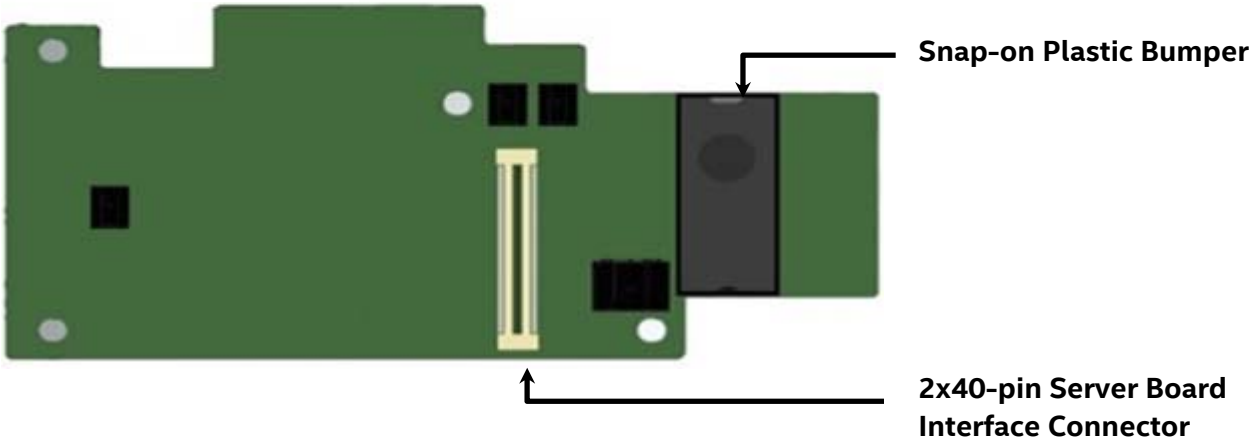
Figure 2. Mezzanine Add-in Card Placement On Server Board

1.1 RAID Module Layout

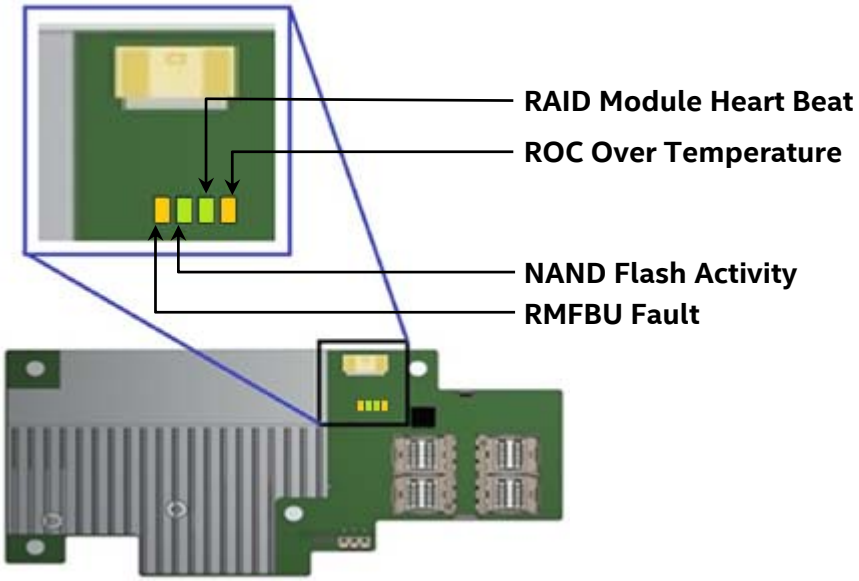
Top Side



Bottom Side



RAID Module LEDs



See section 2.4 for additional information

1.2 Feature Set

Feature	RMS3AC160
I/O Processor	Broadcom* SAS3316 PCIe* RAID On-Chip (ROC)
RAID Levels	0,1,5,6,10, 50, 60
Cache Memory	2 GB DDR3 at 1866 MHz
Form Factor	Modular Mezzanine
Drive Interface Connectors	4 internal 4-port Mini-SAS HD SFF8643 connectors
PCIe* Interface	x8 PCI Express* 3.0. PCIe Performance uo to 8 GT/s per lane
Data Transfer Rates	12, 6, & 3 Gbps per port SAS and 6 & 3 Gbps per port SATA
Operating Temperature	Maximum ambient: 55°C
Operating System	Microsoft Window*, Linux* (SuSE*, Red Hat*) Solaris* FreeBSD*
Drive Types	**SAS** 12, 6, & 3 Gbps **SATA** 6 & 3 Gbps
Maximum Physical Devices	240
Maximum Array Volumes	64
Advanced array configuration and management utilities	Yes
Support for global hot spares and dedicated hot spares	Yes
Support for user-defined strip sizes: 8, 16, 32, 64, 128, 256, 512, or 1024 KB	Yes
Advanced array configuration and management utilities offer these capabilities: • Online capacity expansion to add space to an existing drive or a new drive • Online RAID level migration • Drive migration • Drive roaming • No reboot necessary after expansion • Load balancing • Media scan	Yes
User-specified rebuild rate (specifying the percentage of system resources to use from 0 percent to 100 percent)	Yes
Nonvolatile 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
Support for RAID Maintenance Free Backup Unit (RMFBU). Used to save RAID Cache in event of unexpected power loss	Yes Intel accessory **AXXRMFBU6** – (Option)
Self-Encrypting Drive Support	Intel accessory **AXXRPFKDE2** (Disk Encryption) upgrade key enables SafeStore® Encryption Services with Instant Secure Erase and Local Key Management (Option)
SSD Cache Support	Intel accessory **AXXRPFKSSD2** (SSD Cache) upgrade key enables Solid State Drives to be used as super-sized cache by the RAID controller (Option)
Snapshot Recovery	Intel accessory **AXXRPFKSNSH** (Snapshot Recovery) upgrade key enables Snapshot functionality. Snapshot allows recovery of deleted, modified, or corrupted data from disk in minutes (Option)
Standard Warranty	3 years, AWR options

1.3 Data Protection Features

Feature	RMS3AC160
On-line Capacity Extension	Yes
Distributed Sparing	Yes
Background Consistency Checking	Yes
Patrol Read for Media Functionality	Yes
S.M.A.R.T Support	Yes
Enclosure Management	Yes
RAID Support Before Operating System Loaded	Yes
Write Back Cache with optional Protection	Yes
Intel® RAID Management Software	Yes
Enclosure Management	Yes
RAID Support Before Operating System Loaded	Yes
Write Back Cache with optional Protection	Yes
Hot-Spare Support, Global & Dedicated	Yes

1.4 Fault Tolerance Features

Specification	RMS3AC160
Support for SMART[A]	Yes
Drive failure detection	Automatic
Drive rebuild using hot spares	Automatic
Parity generation and checking	Yes

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

1.5 Array Performance Features

Specification	RMS3AC160
PCI Express host data transfer rate	8GT/s per lane
Drive data transfer rate	12Gb/s per lane
Maximum scatter/gather I/O	80 elements
Maximum size of I/O requests	6.4 MB in 64-KB strips
Maximum queue tags per drive	As many as the drive can accept
Strip sizes	8 KB, 16 KB, 32 KB, 64 KB, 128 KB, 256 KB, 512 KB, or 1 MB
Maximum number of concurrent commands	255

1.6 Drive Support Limits

Specification	RMS3AC160
Maximum virtual drives per controller	64
Maximum drive groups per controller	128
Maximum virtual drives per drive group	16
Maximum drives per drive group	32
Maximum drives per controller	240
Maximum hot spares per controller	240
Maximum spans per virtual drive	8
Maximum enclosures	16 per port

The limits identified in the previous table are dependent on how many physical devices are connected to the RAID controller. Although it is possible to have up to 16 virtual drives per drive group, and up to 128 drive groups on the controller, a limit of 64 virtual drives exists on this controller.

These RAID controllers support 64-bit logical block addressing (LBA), which makes it possible to connect a large number of drives to the RAID controller, directly and through expanders. However, the actual number of drives that you can attach depends on the limits listed in this table rather than by actual RAID volume capacity.

1.7 RAID Controller Specifications

The following table lists the specifications for the Intel® Integrated RAID Module RMS3AC160

Specification	RMS3AC160
SAS controller and processor	Broadcom* SAS3316 ROC Controller
Operating voltage	+3.3 V, +12 V
Card size	RMS3AC160: Mezzanine port PCI Express card size (64.39 mm x 139.16 mm)
Array interface to the host	PCIe Rev. 3.0
PCI Express bus data transfer rate	Up to 8GT/s per lane x8 lane width
Serial port	4-pin RS232-compatible connector (for manufacturing use only)
SAS ports	4 internal 4-port Mini-SAS HD SFF8643 connectors
Cache configuration	2 GB – DDR3 @ 1866 MHz with Intel® RAID Maintenance Free Backup support.
Size of flash ROM for firmware	16 MB
NVRAM	32 KB for storing RAID configurations

1.8 SAS/SATA Standards and Communication Protocols

The Intel® Integrated RAID Module RMS3AC160 supports the ANSI *Serial Attached SCSI standard, version 3.0*. In addition, the controller supports the SATA III protocol defined by the *Serial ATA specification, version 3.0*. Supporting both the SAS interface and the SATA interface, the SAS controller is a versatile controller that provides the backbone of both server and high-end workstation environments.

Each port on your RAID controller supports SAS devices, SATA devices, or both, by using the following protocols:

- SAS Serial SCSI Protocol (SSP), which enables communication with other SAS devices
- SATA, which enables communication with other SATA devices
- Serial Management Protocol (SMP), which communicates topology management information directly with an attached SAS expander device
- Serial Tunneling Protocol (STP), which 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 Intel® RMS3AC160 RAID Module provides the flexibility to combine these two storage technologies on the same controller and within the same enclosure. However combining SAS drives and SATA drives with the same virtual drive is not supported.

1.9 Safety Characteristics

All 12Gb/s Intel® RAID Controllers 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.

1.10 Electrical Characteristics

1.10.1 Operating and Nonoperating Conditions for the Intel® RAID Module

Operating (thermal and atmospheric) limits are as follows:

- Relative humidity range is 20 percent to 80 percent noncondensing.
- Airflow must be at least 200 linear feet per minute (LFPM) to avoid operating the SAS3316 processor above the maximum ambient temperature.
- Temperature range: +10°C to +55°C without battery backup unit
- Temperature range: +10°C to +45°C with battery backup unit

Non-operating (such as storage and transit) limits are as follows:

- Relative humidity range is 5 percent to 90 percent noncondensing.
- Temperature range: –40°C to +70°C without battery backup unit
- Temperature range: 0°C to +45°C with battery backup unit

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

To protect the integrity of cached data on the Intel® Integrated RAID Module during a power loss event, the Intel® Integrated RAID Module RMS3AC160 provides support for the Intel® Maintenance Free Backup Unit (RMFBU – Intel Accessory Kit **AXXRMFBU6**). During a power loss event, this optional accessory provides back-up power to the RAID Module, allowing the controller to offload the data stored in the its onboard cache to its on-board non-volatile NAND flash.

Benefits of the RMFBU option include:

- Capacitor technology has a longer usable life span than batteries, and 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 required of batteries in order to import and export them
- 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 5 for additional RMFBU information.

2. General Feature Overview

2.1 Benefits of the SAS Interface

SAS is a serial, point-to-point, enterprise-level device interface that leverages the proven SCSI protocol set. SAS is a convergence of the advantages of SATA, SCSI, and Fibre Channel, and it is the mainstay of the enterprise and high-end workstation storage markets.

The SAS interface uses the proven SCSI command 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. The SAS interface provides improved performance, simplified cabling, smaller connectors, lower pin count, and lower power requirements when compared to the original parallel SCSI.

SAS controllers leverage a common electrical and physical connection interface that is compatible with Serial ATA (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 master-slave architecture, while maintaining compatibility with existing ATA firmware.

2.2 Summary of 12Gb/s Intel® RAID Controller Characteristics

2.2.1 SAS Features

- Support for12 Gb/s, 6Gb/s, and 3Gb/s SAS data transfers per PHY.
- Support for SMP to communicate topology-management information.
- Support for SSP to enable communication with other SAS devices.
- Support for STP to enable communication with SATA devices through an attached expander.
- Provide a serial, point-to-point, enterprise-level storage interface.
- Simplify cabling between devices.

- Provide a scalable interface that supports up to 240 devices through the use of expanders.
- Support wide ports that consist of two, three, or four PHYs within a single quad port.
- Support narrow ports consisting of a single PHY.
- Transfer data by using SCSI information units.

2.2.2 SATA III Features

- Support SATA III data transfers of 6Gb/s
- Support STP data transfers of 6Gb/s.
- Provide a serial, point-to-point storage interface.
- Simplify cabling between devices.
- Eliminate the master-slave construction used in parallel ATA.
- Permit addressing of multiple SATA targets through an expander.

2.2.3 Usability Features

- Drive spin-up sequencing control
- Provide one LED signal to indicate link activity for all PHYs
- Support for the internal SAS Sideband signal SFF-8485 (SGPIO) interface

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Note: LED signals indicate an error condition or drive activity. RAID controllers support different blink patterns for these LEDs, depending on the user configuration and storage enclosure. For information about the LED blink patterns, contact your storage enclosure manufacturer.

2.2.4 Flexibility Features

- Flash ROM interface, a nonvolatile static RAM (NVSRAM) interface
- Flexible programming interface to tune I/O performance
- Permit mixed connections to SAS targets or SATA III targets
- Leverage compatible connectors for SAS connections and SATA III connections
- Permit grouping of up to eight PHYs into a single SAS wide port
- Permit programming of the World Wide Name

2.2.5 Drive Roaming

Drive roaming occurs when the drives are changed to different ports on the same controller. When the drives are placed on different channels, the controller detects the RAID configuration from the configuration data on the drives.

Configuration data is saved in both the NVRAM on the RAID controller and on the drives attached to the controller. This action maintains the integrity of the data on each drive, even if the drives have changed their physical device ID.

Note: If a drive that is being rebuilt is moved, the rebuild operation restarts; it does not resume from the stopping point.

Follow these steps to use the drive roaming feature:

1. Turn off the power to the server and all drives, enclosures, and system components. Disconnect the power cords from the system.
2. Move the drives to different positions on the backplane to change the targets
3. Determine the SAS target requirements
4. Perform a safety check
   a) Make sure that the drives are inserted correctly
   b) Close the cabinet of the host system
5. Reconnect the power cords to the system

6. Turn on the power to the system

The controller then detects the RAID configuration from the configuration data on the drives.

2.2.6 Drive Migration

Drive migration is the transfer of a set of drives in an existing configuration from one controller to another. The drives must remain on the same channel and must be reinstalled in the same order as in the original configuration. The controller to which you migrate the drives cannot have an existing configuration.

Note: Partial configurations, which include individual virtual drives, can be migrated.

Note: Drive roaming and drive migration cannot be supported at the same time.

Follow these steps to migrate drives:

1. Make sure that you clear the configuration on the system to which you migrate the drives to prevent a configuration data mismatch between the drives and the NVRAM.

Note: When drives are migrated, move only the drives that make up the virtual drive (not all of the drives in a drive group), so that you do not see an NVRAM mismatch error (provided a configuration is on the destination controller). The NVRAM mismatch error appears only if you move all of the drives to the other controller.

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2. Turn off power to the server and all drives, enclosures, and system components. Disconnect the power cords from the systems.
3. Either remove the SAS cable connectors from the internal drives, or remove the shielded cables from the external drives that you want to migrate.
   a) Make sure that pin 1 on the cable matches pin 1 on the connector.
   b) Make sure that the SAS cables conform to all SAS specifications.
4. Remove the drives from the first system, and insert them into the drive bays on the second system.
5. Connect the SAS cables to the drives in the second system.
6. Determine the SAS target requirements.
7. Perform a safety check.
   a) Make sure that all of the cables are attached correctly.
   b) Make sure that the RAID controller is installed correctly.
   c) Close the cabinet of the host system.
8. Reconnect the power cords to the system.
9. Turn on the power to the system.

The controller detects the RAID configuration from the configuration data on the drives.

2.3 Intel® 12 Gb/s SAS 3.0 Expander Support

For system configurations that require more than 16 physical drives, the Intel® Integrated RAID Module RMS3AC160 has support for the following Intel® RAID Expanders:

Intel Product Code	Product Description
iPC – RES3FV288  Intel® SAS Expander RES3FV288	**SAS 3.0 12 Gb/s expander** • Featuring 6Gbps data aggregation for 12Gbps data transfer with 6Gb/s devices • Low Profile MD2 PCIe* add-in card form factor • 28 internal ports and 8 external ports • Power from PCIe x1 • HD Mini-SAS 8643 Connectors Kit includes: (1) SAS Expander card, (2) HD-HD 250mm Expander-to-RAID card cables, PCI brackets for Low profile and Full height
iPC – RES3TV360  Intel® SAS Expander RES3TV360	**SAS 3.0 12 Gb/s expander** • Featuring 6Gbps data aggregation for 12Gbps data transferwith 6Gb/s devices • Internal mount mid-plane form factor • 36 internal ports supporting point-to-pont 12, 6, and 3 Gb/s data transfer rates • RA 4-pin power connector • HD Mini-SAS 8643 Connectors **Kit includes:** (1) SAS expander card; (1) 130mm Power cable; (1 set) Expander-to-backplane cables: (4) HD-HD 165mm, (1) HD-HD 300mm, (1) HD-HD 250mm; (3) Rubber Pads; mounting screws

Figure 3. Supported Intel SAS Expander Options

2.3.1 SAS Expander Configuration

The SAS ports of the RAID Controller are divided into two separate domains: Domain 1 and Domain 2. When cabling the RAID Controller to a SAS Expander, one or both 4-port connectors within a common domain can be cabled to a single SAS Expander Card. **Mixing SAS ports from different Domains to a single SAS Expander card cannot be supported.**

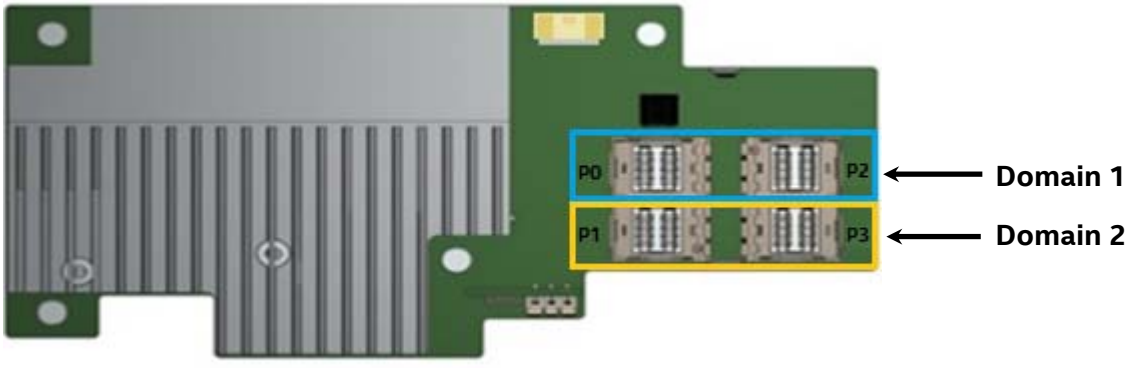
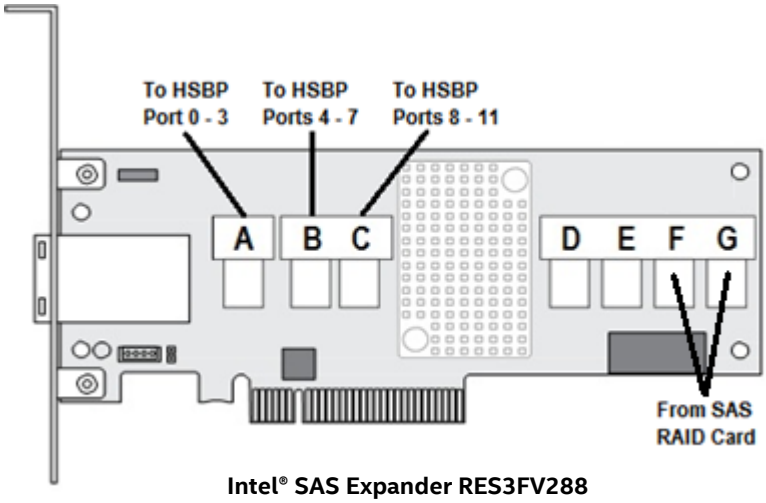
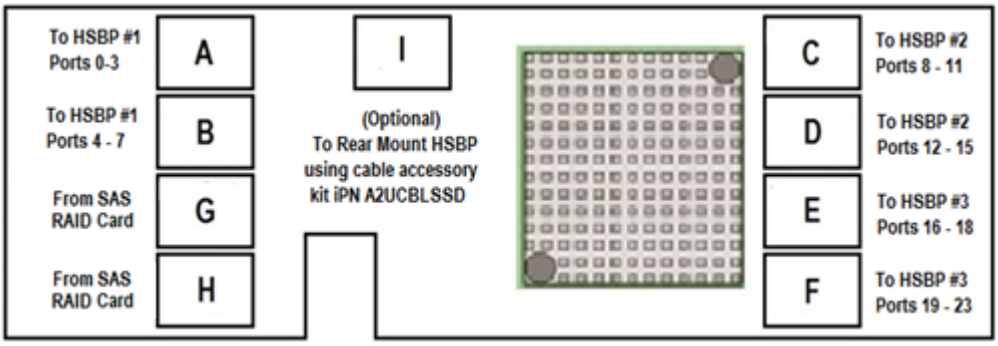


Figure 4. SAS Expander Support – RAID Controller SAS Port Domain Identifcation

Supported Intel SAS Expanders include several multiport mini-SAS HD (8643) connectors. Some are used as Output connectors to a backplane, while others are used as Input connectors from the RAID Controller. The following diagrams identify the connector types for each supported SAS expander card.



Intel® SAS Expander RES3FV288



Intel® SAS Expander RES3TV360

Input Cable Configuration NOTES:

The SAS Expander cards identified above can support one or two Input SAS Port cables

When routing two Input SAS Port cables from the RAID Controller, they must be from the same SAS Domain as illustrated on the previous page

2.4 RAID Module LEDs

The RAID module includes a bank of four LEDs as shown in the following illustration.

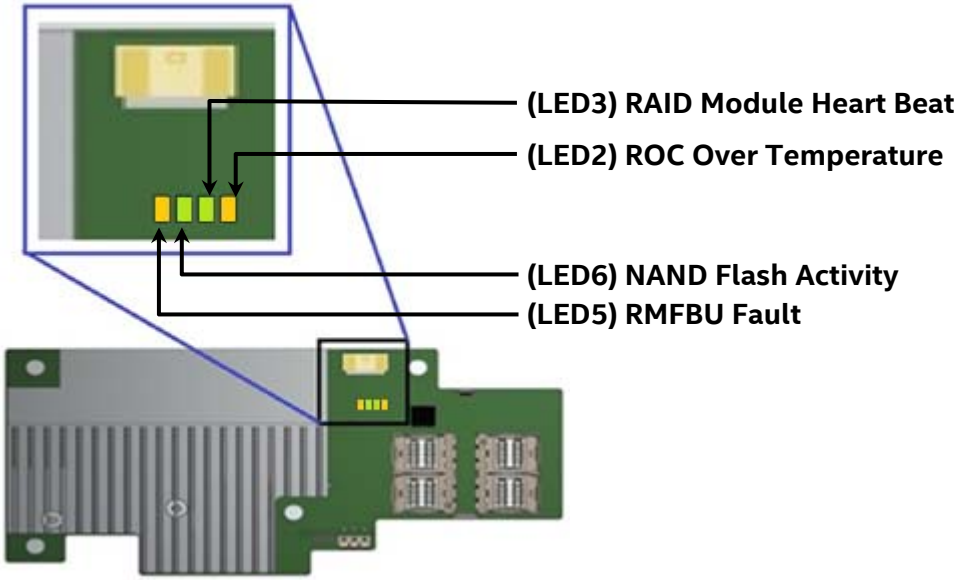


Figure 5. SAS Module LED Identification

2.4.1 (*LED2 – Amber*) RAID On Chip (ROC) Over Temperature LED

LED State	LED State Descriptions
OFF	Status = OK
ON (Amber)	• Thermal limit of ROC was reached • FW Faulted and didn't load properly • FW missing

2.4.2 *(LED3 – Green)* RAID Module Heart Beat LED

LED State	LED State Descriptions
OFF	RAID Module firmware is not running
Steady Flash (Green)	Firmware is OK and is operational
Irregular Flash (Green)	Firmware has faulted

2.4.3 (*LED 5 – Amber*) RMFBU Fault LED

LED State	LED State Descriptions
OFF	• Status = OK, Installed RMFBU has no issue • No RMFBU installed
ON (Amber)	An RMFBU Error has been detected

2.4.4 (*LED 6 – Green*) NAND Flash Activity LED

LED State	LED State Descriptions
OFF	Status = OK, no Cache off-load activity detected
ON (Green)	• Cache off-load in progress • Data restore in progress

3. 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.

3.1 RAID Module Installation

3.1.1 Requirements

The following items are required to install an Intel® RAID Module:

- Intel® RAID Module
- Intel server board based server system with support for an Intel Integrated RAID Module
- Internal SAS/SATA data cables
- SAS drives or SATA drives

3.1.2 Packing List

1 – Intel Integrated RAID Module w/snap-on bumper (Pre-Installed)
4 – White Plastic Barrel Stand-offs
4 – White Plastic Locking Pins
1 – Attention Document
1 – Warranty Document

Note: Intel RAID Products do not include SAS / SATA data cables. Appropriate SAS / SATA data cables may be included with your server system or must be purchased separately.

3.1.3 Installation Instructions

1. Unpack the Intel® RAID Module.
   Unpack and remove your RAID module. Inspect it for damage. If it appears damaged, contact your Intel Customer and Technical Support representative.
2. Turn off the power to the computer, and disconnect the AC power cord.
3. Remove the computer cover. Refer to the system documentation for instructions.

4. Install the barrel standoffs.
   a) Locate the 80-pin SAS module connector on your server board. See your server board documentation.
   b) Insert the barrel standoffs into the matching holes in the server board.

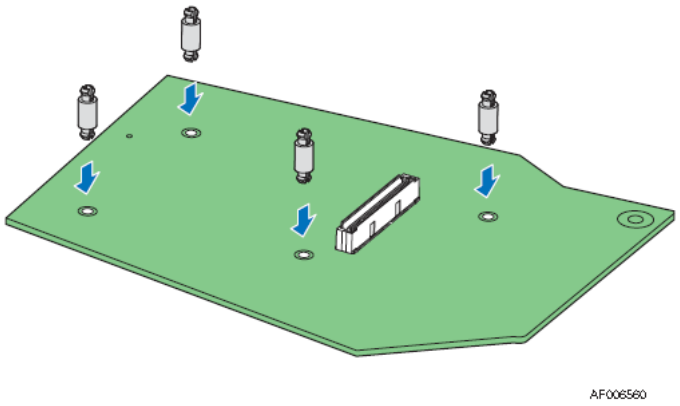


Figure 6. Barrel Standoff Placement and Installation

5. Install the RAID module.
   a) Align the module mounting holes over the barrel stand-offs
   b) Press down firmly until the module connector is fully engaged with the matching connector on the server board and the module is firmly seated over each barrel standoff.

c) Insert a locking pin into each barrel standoff

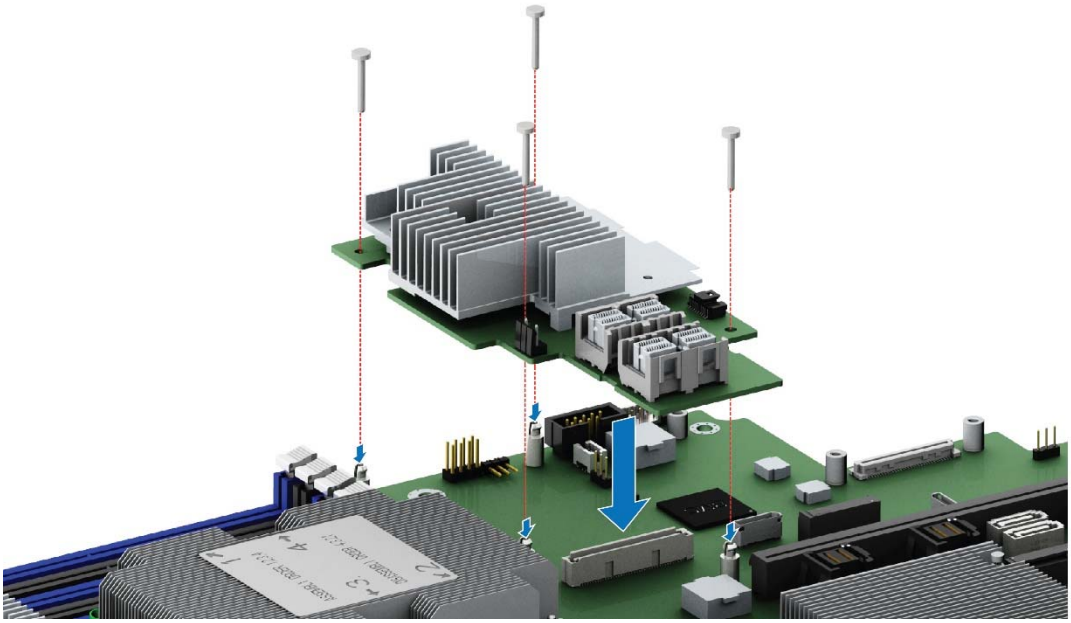


Figure 7. RAID Module Placement and Installation

6. Install SAS and / or SATA drives in the host computer case. Refer to the documentation for the devices for any pre-installation configuration requirements.
7. Connect internal SAS / SATA data cables to appropriate Drives/Backplane/or Expander card
8. Carefully route SAS / SATA data cables back to the Intel RAID Module
9. Attach SAS / SATA data cables to the Intel RAID Module
10. Reinstall the computer cover, and reconnect the AC power cords to the system

The hardware installation is now complete and the Intel RAID Module is ready to be configured. For complete Intel RAID module configuration information, refer to the ***Intel® RAID Software Users Guide*** available to download from the following Intel Web Site:

http://www.intel.com/support/go/RMS3AC160

3.2 Intel® RAID Maintenance Free Backup Unit Installation

The mounting hardware included with Intel® Accessory Kit AXXRMFBU6 is specifically designed to be compatible for installation in to a supported Intel pedestal and rack mount server system. If installing this accessory into a non-Intel chassis, it may be necessary to utilize an alternate attachment method. Intel recommends using industrial-grade Velcro* or other industrial adhesive material as an acceptable option. Refer to your server chassis documentation or discuss an appropriate attachment method with your server chassis manufacturer to ensure the attachment mechanism complies with the chassis requirements.

1. Place the super capacitor module and the plastic holder front-side-up on a flat, clean, static-free surface.
2. Press the super capacitor module into the plastic holder until the module clicks firmly into place, as shown in the following figure (for reference only, actual shape of the product may vary from the figure).

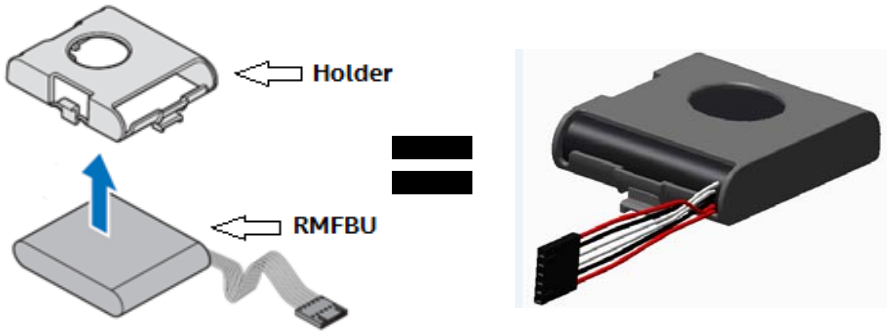


Figure 8. RMFBU Mounting Assembly (Example)

3. Identify the mounting location for the RMFBU Assembly
4. A) In a compatible Intel Server system, align the tabs on the holder with the holes on the mounting plate and slide the holder until it clicks and locks into place.

2U System – Air Duct RMFBU Mounting Plate

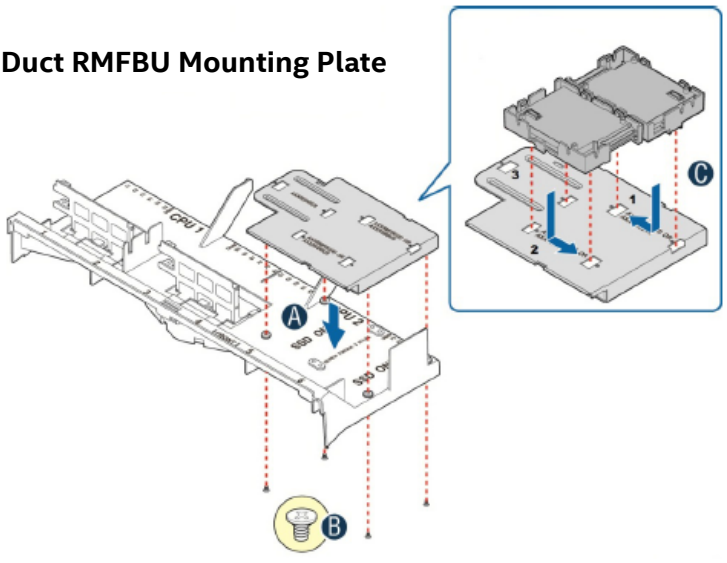


Figure 9. RMFBU Assembly Installation (example)

B) In a non-Intel chassis, apply adhesive material to the RMFBU assembly and affix to desired mounting location within the chassis.

5. Carefully route the RMFBU cable to the Intel RAID Module and attach the cable to the matching connector

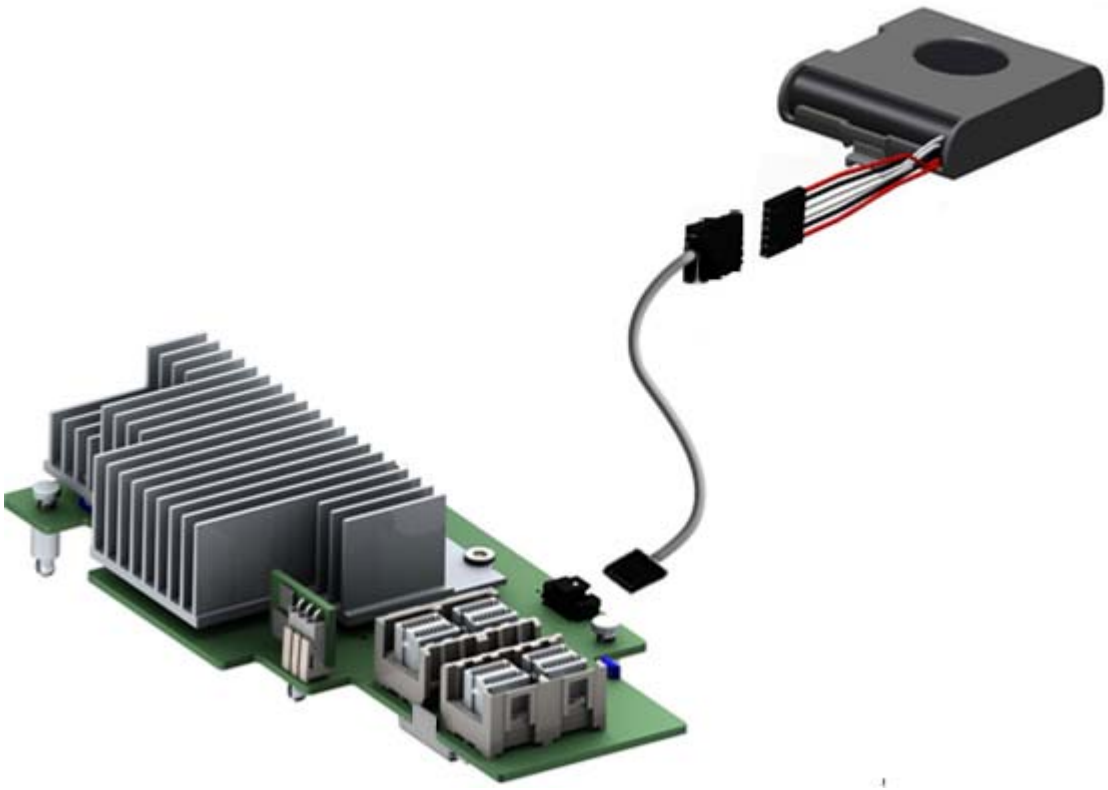


Figure 10. RMFBU Cable to RAID Module Attachment

4. Safety and Regulatory (Class A)

Intel RAID products typically have a variety of individual component level certifications; however final regulatory compliance is based on the combination of the RAID card being integrated within an Intel Server System.

Intended Application – The RAID products are evaluated as Information Technology Equipment (ITE) as part of Intel's server chassis systems. These products are intended to be integrated into Intel server systems that will be installed in offices, schools, computer rooms, and similar commercial type locations. The suitability of this product for other product categories and environments (such as: medical, industrial, telecommunications, NEBS, residential, alarm systems, test equipment, etc.), other than an ITE application, may require further evaluation. Product Safety and EMC Compliance noted below is based on the RAID product integrated into an Intel server.

4.1 Product Safety Compliance

- UL60950 – CSA 60950(USA / Canada)
- EN60950 (Europe)
- IEC60950 (International)
- CB Certificate & Report, IEC60950 (report to include all country national deviations)
- CE - Low Voltage Directive 2006/95/EC (Europe)

4.2 Product EMC Compliance – Class A Compliance

- FCC /ICES-003 - Emissions (USA/Canada) Verification
- CISPR 22 – Emissions (International)
- EN55022 - Emissions (Europe)
- EN55024 - Immunity (Europe)
- CE – EMC Directive 2004/108 EC (Europe)
- VCCI Emissions (Japan)
- AS/NZS 3548 Emissions (Australia / New Zealand)
- BSMI CNS13438 Emissions (Taiwan)
- KC Certification (Korea)

4.3 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 you can view Intel's Environmental Product Content Specification at http://supplier.intel.com/ehs/environmental.htm.

- Europe - European Directive 2002/95/EC
    - o Restriction of Hazardous Substances (RoHS)
      Threshold limits and banned substances are noted below.
      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)

5. Intel® RAID Maintenance Free Backup Unit AXXRMFBU6

5.1 About the Intel® RAID Maintenance Free Backup Unit AXXRMFBU6

Intel® RAID Controllers and Intel® Integrated RAID Modules 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 Controller or Intel® Integrated RAID Module. 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 Controllers and Intel® Integrated RAID Modules can improve the overall system performance. Writing data to the controller's cache memory is much faster than writing it to a storage device. Write operations appear to complete very quickly at the software application level. The Intel® Integrated RAID Module writes 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® Integrated RAID Module has an RMFBU installed. In addition, the Intel® RAID Maintenance Free Backup Unit provides an alternative to using an uninterruptible power supply (UPS) or it can act as a second level of fault tolerance when used with a UPS. Furthermore, it eliminates the need for lithium ion (Li-ion) batteries traditionally used to protect DRAM cache memory on PCI RAID controllers. Therefore this is a greener and lower total cost cache protection solution.

The RMFBU has built-in functionality to charge the capacitor module automatically and to communicate status information such as voltage, temperature, and current to the host server system.

5.2 Monitoring the Intel® RAID Maintenance Free Backup Unit

Multiple utilities are available to display and configure the RMFBU.

Note: This section describes only the RMFBU related features of the utility programs. For complete information on these utilities, see the Intel® RAID Software User's Guide.

5.2.1 Monitoring the RMFBU with the Intel® RAID BIOS Configuration Utility

The Intel® RAID BIOS Console can be used to configure disk arrays and logical drives. It is independent of the operating system and can be accessed at server start-up by pressing <Ctrl>+<R>.

Note: Please reference the ***Intel® RAID Software Users Guide*** for more information on the Intel® RAID BIOS Console

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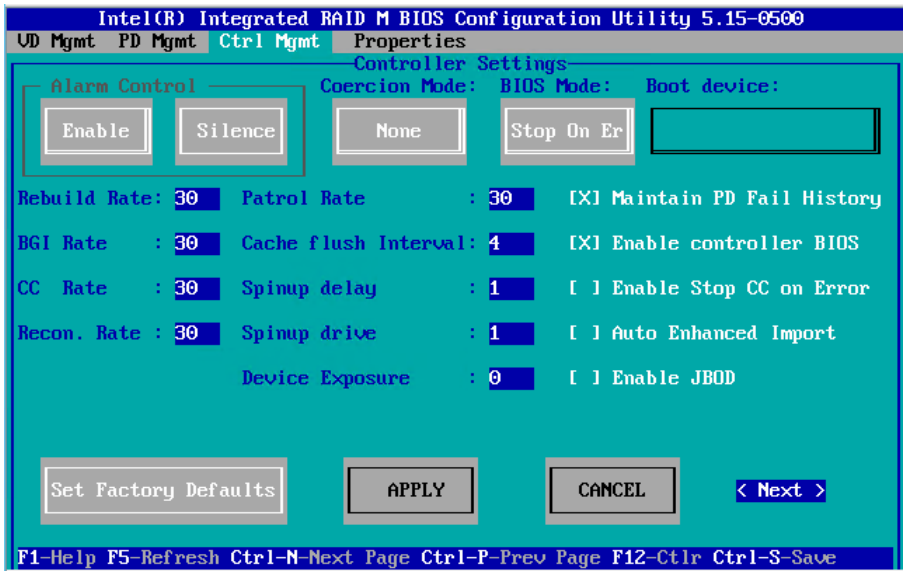
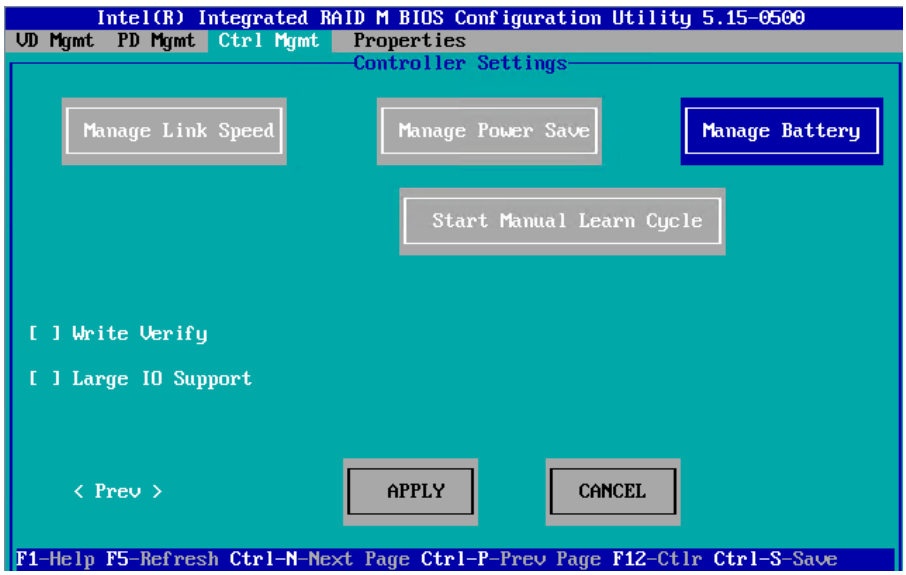
To view the RMFBU information, do the following:

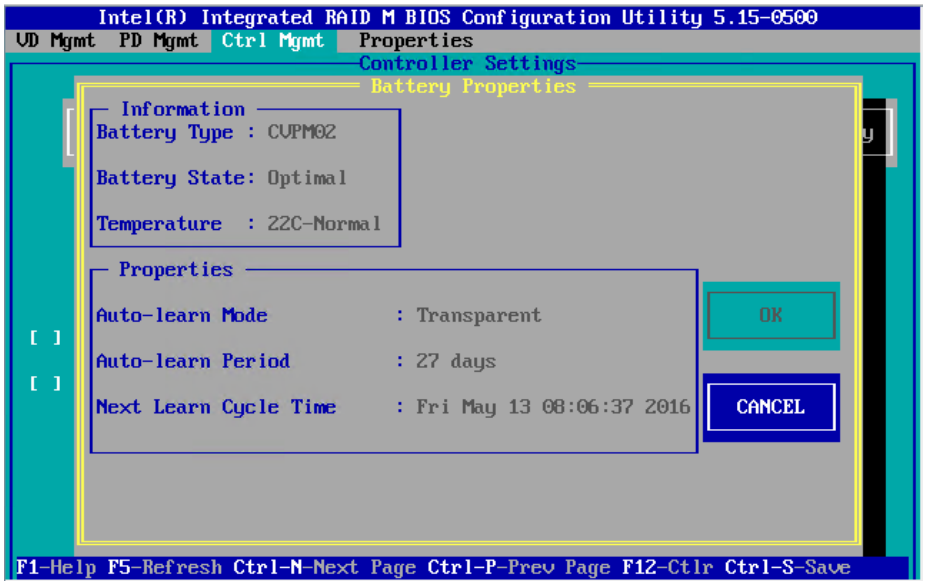
1. At boot, press **<Ctrl>+<R>** keys when prompted
2. Once the Intel® RAID BIOS Console loads and the main menu is displayed, select the ***Ctrl Mgmt*** page
3. Using the tab key, select **Next** and press the **<Enter>** key to view the second page of ***Ctrl Mgmt***



4. Enter the ***Manage Battery*** field at the top right of the 2nd page of the ***Ctrl Mgmt*** screen



5. The **Battery Properties** screen contains the following information:
   - Battery Type
   - Battery Status
   - Temperature
   - Learn Mode
   - Learn Period
   - Next Learn Time



5.3 RAID Maintenance Free Backup Unit Specifications

5.3.1 RMFBU Specifications

Table 19. RMFBU6 Specifications

Specifications	RMFBU5
Super Capacitor Module Operating Environment	-40°C to 55°C
Super Capacitor Module Storage Temperature	-40°C to 70°C
Fast Charge Rate	500 mA
Super Capacitor Module Voltage	Nominal Voltage: 13.2 V
Super Capacitor Module Capacity	6.4 F
Super Capacitor Module Mechanical	65 mm x 52 mm
RMFBU5 Cache Off-load Module Mechanical	45 mm x 42 mm
Super Capacitor Module Charge Time	Typical: Approximately 2 minutes
Super Capacitor Module Shelf Life	3 years
Super Capacitor Module Operational Life	Intel provides a three year warranty on the Intel® RAID Maintenance Free Backup Unit AXXRMFBU5.
Smart Monitoring	Temperature is monitored using the I^2C interface.

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 your 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.
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.
external SAS device	A SAS device installed outside the computer cabinet. These devices are connected using specific types of shielded cables.
Fusion-MPT architecture	An acronym for Fusion-Message Passing Technology architecture. Fusion-MPT consists of several main elements: Fusion-MPT firmware, the Fibre 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 Fibre 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 integrated circuit that provides a device connection to the computer system.
hot spare	An idle, powered on, standby drive that is ready for immediate use in case of drive failure. 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 nonvolatile 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.

Term	Description
PCI Express	Acronym for peripheral component interconnect Express. A high-performance, local bus specification that allows the connection of devices directly to computer memory. PCI Express is a two-way, serial connection that transfers data on two pairs of point- to-point data lines. PCI Express 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).
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 SATA 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.
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.
SMP	Acronym for Serial Management Protocol. SMP communicates topology management information directly with an attached SAS expander device. Each PHY on the controller can function as an SMP initiator.
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	Acronym for Serial Tunneling Protocol. STP enables communication with a SATA device through an attached expander. Each PHY on the SAS controller can function as an STP initiator.
strip	The portion of a stripe that resides on a single drive.

Term	Description
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). You can specify strip sizes of 8 KB, 16 KB, 32 KB, 64 KB, 128 KB, 256 KB, 512 KB, or 1 MB.