Intel® Server System R1000SPO Product Family

Technical Product Specification

A document providing an overview of product features, functions, architecture, and support specifications

Revision 1.0

March 2016

Intel® Server Boards and Systems

Revision History

Date	Revision Number	Modifications
January 2016	0.7	First preliminary version
March 2016	1.0	First External Public Release Changes: • Updated Illustrations • Appendix E - Added High Temperature Ambient Information • Section 3.3.4 - Added Holdup time for Fixed Power Supply • Section 3.2.3 - Added Information for Power Distribution Board • Added Glossary • Removed – AXXPRAIL from supported Rail kits • Updated Copyright data • Table 2 - Added info about PCIe riser slot

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1. Introduction

This Technical Product Specification (TPS) provides system level information for the Intel® Server System R1000SPO product family.

This document describes the embedded functionality and available features of the integrated server system which includes: the chassis layout, system boards, power subsystem, cooling subsystem, storage subsystem options, and available installable options. Note that some system features are provided as configurable options and may not be included standard in every system configuration offered. Please reference *the Intel® Server Board* S1200SP *Product Family Configuration Guide* for a list of configurable options.

Server board specific detail can be obtained by referencing the *Intel® Server Board* S1200SP *Technical Product Specification*.

NOTE: Some of the documents listed in the following table are classified as "Intel Confidential". These documents are made available under a Non-Disclosure Agreement (NDA) with Intel and must be ordered through your local Intel representative.

Table 1. Reference Documents

Document Title	Document Classification
Intel® Server Board S1200SP Family BMC EPS 1.1	Intel Confidential
Intel® Server Board S1200SP Family BIOS EPS v1.0	Intel Confidential
Intel® Xeon® Processor E3-1200 v5 Product Family Datasheet	Intel Confidential
Intel® Ethernet Controller I210: Datasheet	
Intel® Server Board S1200SP Family Technical Product Specification 1.0	

1.1 Chapter Outline

This document is divided into the following chapters:

- Chapter 1 – Introduction
- Chapter 2 – Product Family Overview
- Chapter 3 – System Power
- Chapter 4 – Thermal Management
- Chapter 5 – System Storage and Peripherals Drive Bay Overview
- Chapter 6 – Storage Controller Options Overview
- Chapter 7 – Front Control Panel and I/O Panel Overview
- Chapter 8 – PCIe* Riser Card Support
- Chapter 9 – Intel® I/O Module Support
- Chapter 10 – Basic and Advanced Server Management Features
- Appendix A – Integration and Usage Tips
- Appendix B – POST Code Diagnostic LED Decoder
- Appendix C – POST Code Errors
- Appendix D – System Configuration Tables for Thermal Compatibility
- Appendix E – High Temperature Ambient Info
- Glossary

1.2 Server Board Use Disclaimer

Intel Corporation server boards support add-in peripherals and contain a number of high-density VLSI and power delivery components that need adequate airflow to cool. Intel ensures through its own chassis development and testing that when Intel® server building blocks are used together, the fully integrated system will meet the intended thermal requirements of these components. It is the responsibility of the system integrator who chooses not to use Intel-developed server building blocks to consult vendor datasheets and operating parameters to determine the amount of airflow required for their specific application and environmental conditions. Intel Corporation cannot be held responsible if components fail or the server board does not operate correctly when used outside any of their published operating or non-operating limits.

1.3 Product Errata

Shipping product may have features or functionality that may deviate from published specifications. These deviations are generally discovered after the product has gone into formal production. Intel terms these deviations as product Errata. Known product Errata will be published in the Monthly Specification Update for the given product family which can be downloaded from the following Intel web site:

http://www.intel.com/support

2. Product Family Overview

The Intel® Server System R1000SPO product family offers a variety of system options to meet the varied configuration requirements of entry level computing environments, and includes several available 1U rack mount server systems. Each integrated system within this product family is configured around the Intel® Server Board S1200SPO.

This chapter provides a high-level overview of the system features and available options as supported in different system models within this product family. Greater detail for each major sub-system, feature, or option is provided in the following chapters.

Table 2. Intel® Server System R1000SPO Product Family Feature Set

Feature	Description
Chassis Type	1U Rack Mount Chassis
Server Board	Intel® Server Board S1200SP – (Intel product code - S1200SPO)
Processor Support	▪ One LGA1151 (Socket H4) processor socket ▪ Support for one Intel® Xeon® E3-1200 V5 processor without processor graphics (GT0 or 4+0) ▪ Maximum supported Thermal Design Power (TDP) of up to 80 W. ▪ 8 GT/s point-to-point DMI 3.0 interface to PCH
Memory	▪ Two memory channels, four memory DIMM Slots (Two memory DIMMs per channel) ▪ Support for 2133 MT/s Unbuffered DIMMs (UDIMM DDR4 ECC memory)
Chipset	Intel® C236 Platform Controller Hub (PCH) chipset
External I/O connections	▪ 1x DB-15 video connector ▪ Two Gigabit Ethernet Ports ▪ Dedicated RJ-45 server management port ▪ Two USB 2.0 connectors on back panel ▪ Two USB 3.0 connectors on back panel ▪ Two USB 3.0 connectors on front panel
Internal I/O connectors / headers	▪ One Type-A USB 2.0 connector ▪ One 2x5 pin connector providing front panel support for two USB 2.0 ports ▪ One 2x10 pin connector providing front panel support for two USB 2.0 / 3.0 ports
Intel® I/O Module Accessory Options	The server board includes a proprietary on-board connector allowing for the installation of a variety of available Intel® I/O modules. An installed I/O module can be supported in addition to standard on-board features and add-in PCIe* cards. The Following Intel® I/O Modules are supported: ▪ AXX4P1GBPWLIOM – Quad port 1GbE I/O based on Intel® Ethernet Controller I350 ▪ AXX10GBNIAIOM – Dual SFP+ port 10GbE based on Intel® 82599 10 Gigabit Ethernet Controller ▪ AXX10GBTWLIOM3 – Dual RJ-45 port 10G BASE-T based on Intel® Ethernet Controller X540
System Fans	▪ Three managed 40mm single rotor system fans ▪ One power supply fan for each installed power supply module
Riser Card Support	▪ One x16 PCIe* 3.0 Riser Card H87808-XXX on a x8 Riser slot (slot-6)
Video	▪ Integrated 2D video controller ▪ 16 MB DDR3 Memory

Feature	Description
On-board storage controllers and options	▪ 8x SATA connectors up to 6Gbps ▪ 1x SATADOM connector (SATA port 4) ▪ 1x 75 pin connector for M.2 SATA SSD (2242 form factor) ▪ Embedded Software SATA RAID o Intel® RSTe 4 SW RAID through onboard SATA connectors provides SATA RAID 0/1/10/5. o Intel® Embedded Server RAID Technology II through onboard SATA connectors provides SATA RAID 0/1/10 and optional RAID 5 support provided by the Intel® RAID Activation Key RKSATA8R5.
Security	Intel® Trusted Platform Module (TPM) 1.2 based on LPC
Server Management	▪ Integrated Baseboard Management Controller, IPMI 2.0 compliant ▪ Support for Intel® Server Management Software ▪ On-board RJ45 management port ▪ Advanced Server Management via an Intel® Remote Management Module 4 Lite (Accessory Option)
Power Supply Options	▪ The server system supports two options for Power Supply: o 1 x 350w Power Supply (Fixed) o 2 x 450w Power Supply Modules (Redundant, Hot-Swap capable)
Storage Bay Options	**Hot Swap Backplane Options:** **NOTE**: All available backplane options have support for SAS 3.0 (12 Gb/sec) ▪ 4 x 3.5” SAS/SATA backplane ▪ 8 x 2.5” SAS/SATA backplane **Storage Bay Options:** ▪ 4 x 3.5” SAS/SATA hot swap drive bays + front panel I/O ▪ 8 x 2.5” SAS/SATA hot swap drive bays + front panel I/O
Supported Rack Mount Kit Accessory Options	▪ AXXVPSRAIL - Value Plus Short Rail

2.1 Operating System Support

As of this writing, the Intel® Server System R1000SPO product family provides support for the following operating systems. This list will be updated as new operating systems are validated by Intel.

Table 3. Operating System Support List

Operating System	Operating System Validation Level (P)
Windows Server 2012* R2 with Hyper-Vx64 & EFI	P1
Red Hat Enterprise Linux* 7.0 with KVM x64 & UEFI	P1
SuSE Linux Enterprise Server* 12 with XEN x64	P1
Red Hat Enterprise Linux 6U5 with KVM x64 & UEFI	P2
VMWare ESXi* 5.5 U3	P2
SuSE Linux Enterprise Server 11 SP4 with XEN x64	P2
Windows Server 2008 R2 SP1	P2
Windows 7*	P2
Ubuntu* 14.04	P2
FreeBSD* 10.1	P3
CentOS* 7.0	P3

Table 4. Operating System Validation Levels

Operating System Validation Levels	P1	P2	P3
Basic Installation testing	Yes	Yes	Yes
Test all on-board I/O features in all modes	Yes		
Adapter\Peripheral Compatibility & Stress testing	Yes		
Technical Support Level	T1	T2	T3

See the following sections for additional information regarding validation levels and technical support levels as referenced in Table 4.

2.1.1 OS Validation Levels

Basic installation testing is performed with each supported operating system. The testing validates that the system can install the operating system and that the base hardware feature set is functional. A small set of peripherals is used for installation purposes only. Add-in adapter cards are not tested.

Adapter compatibility validation (CV) testing uses test suites to gain an accurate view of how the server performs with a wide variety of adapters under the primary supported operating systems. These tests are designed to show hardware compatibility between the cards and the server platform and include functional testing only. No heavy stressing of the systems or the cards is performed for CV testing.

Stress Testing uses configurations that include add-in adapters in all available slots for a 48-hour (two-day), or a 72-hour (three-day) test run without injecting errors. Each configuration passes an installation test and a Network/Disk Stress test. Any fatal errors that occur require a complete test restart.

2.1.2 OS Technical Support Levels

T1: Intel will provide support for issues involving the installation and/or functionality of a specified operating system as configured with or without supported adapters and/or peripherals.

T2: Intel will provide and test operating system drivers for each of the server board's integrated controllers, provided that the controller vendor has a driver available upon request. Vendors will not be required by Intel to develop drivers for operating systems that they do not already support. Intel will NOT provide support for issues related to the use of any add-in adapters or peripherals installed in the server system when an operating system that received only basic installation testing is in use.

T3: Intel will not provide technical support for an open source operating system. All questions and issues related to an open source operating system must be submitted to and supported by the open source community supporting the given operating system.

2.2 System Features Overview

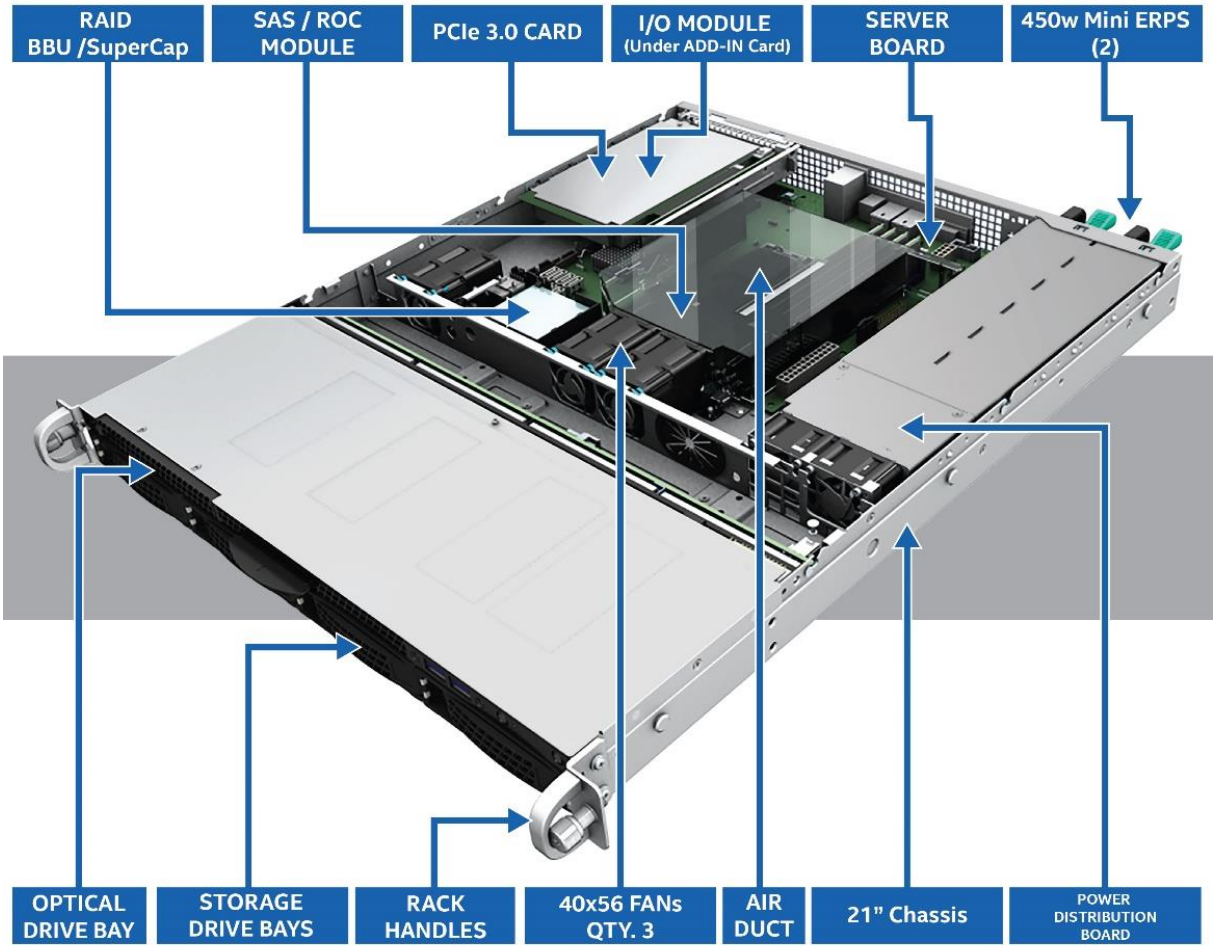


Figure 1. System Components Overview

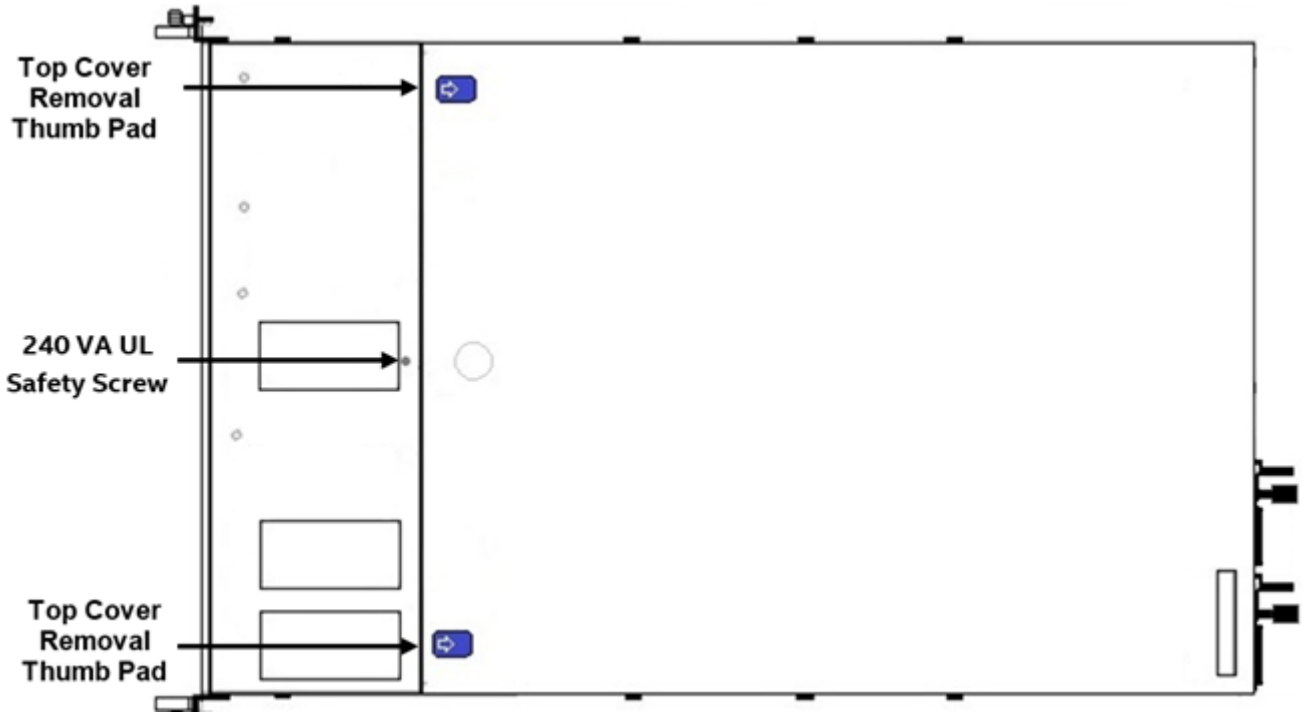


Figure 2. Top Cover Features

2.3 Server Board Features Overview

The following illustration provides a general overview of the server board, identifying key feature and component locations. Please refer to *Intel® Server Board S1200SP Technical Product Specification* for more information.

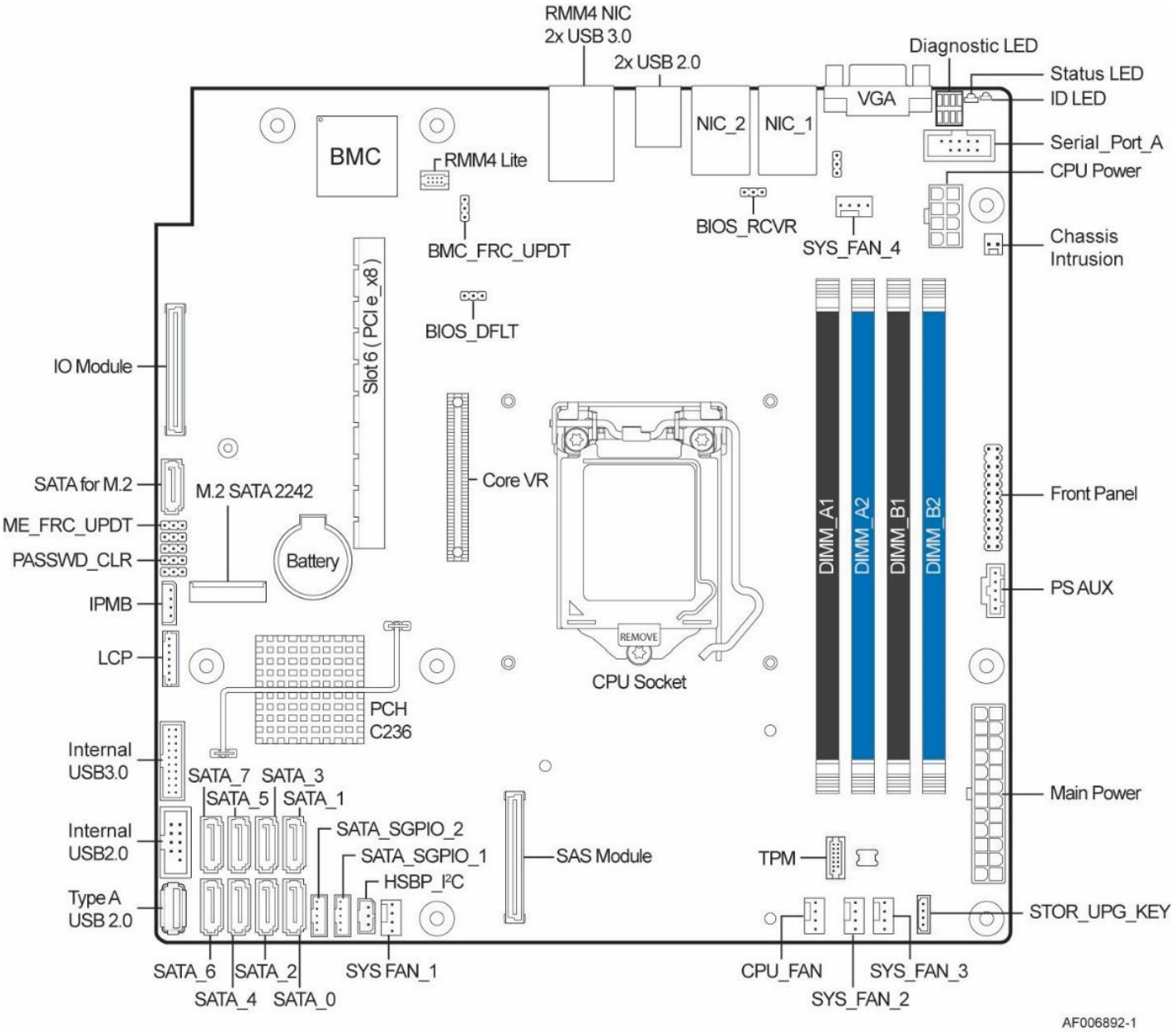


Figure 3. Server Board Features

The server board includes several LEDs to identify system status. The following illustrations define supported LEDs and identify their location.

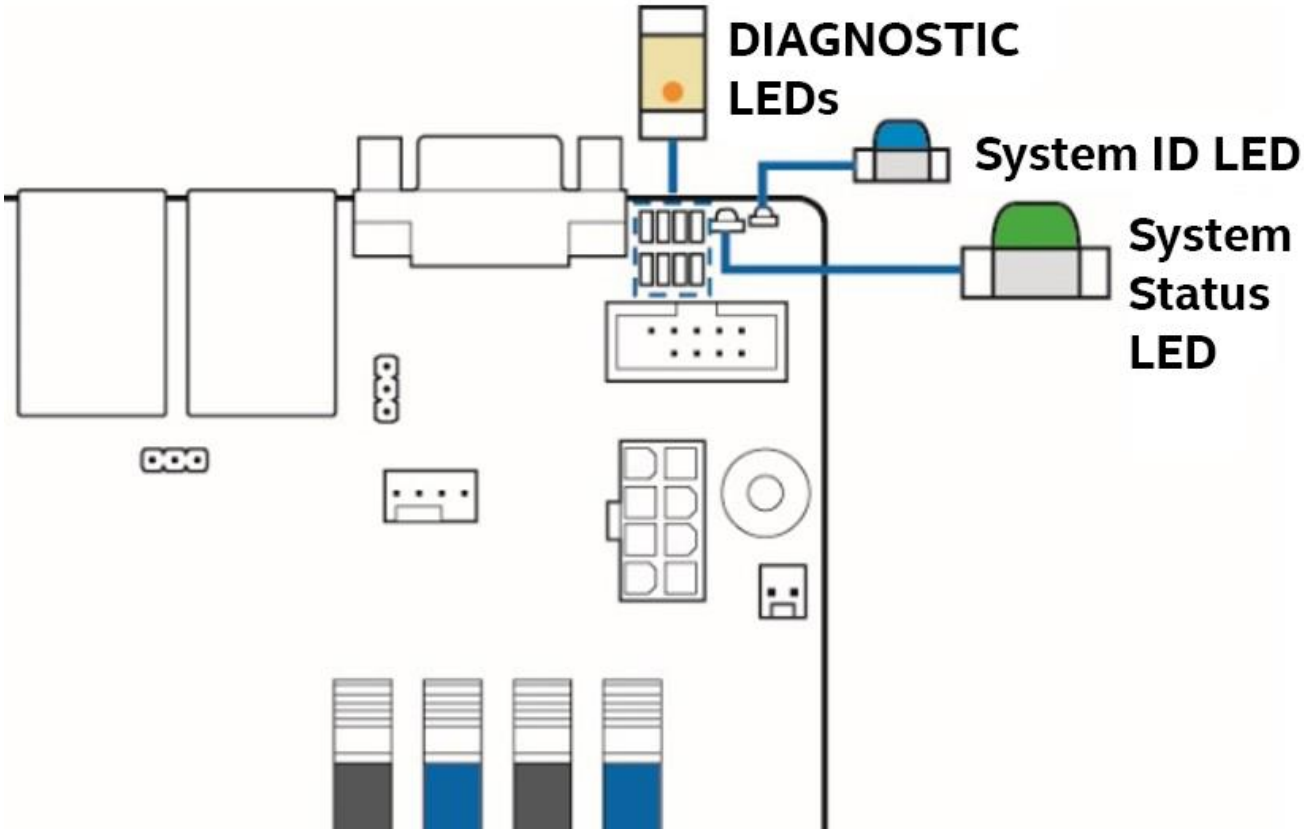


Figure 4. On-board Diagnostic LEDs

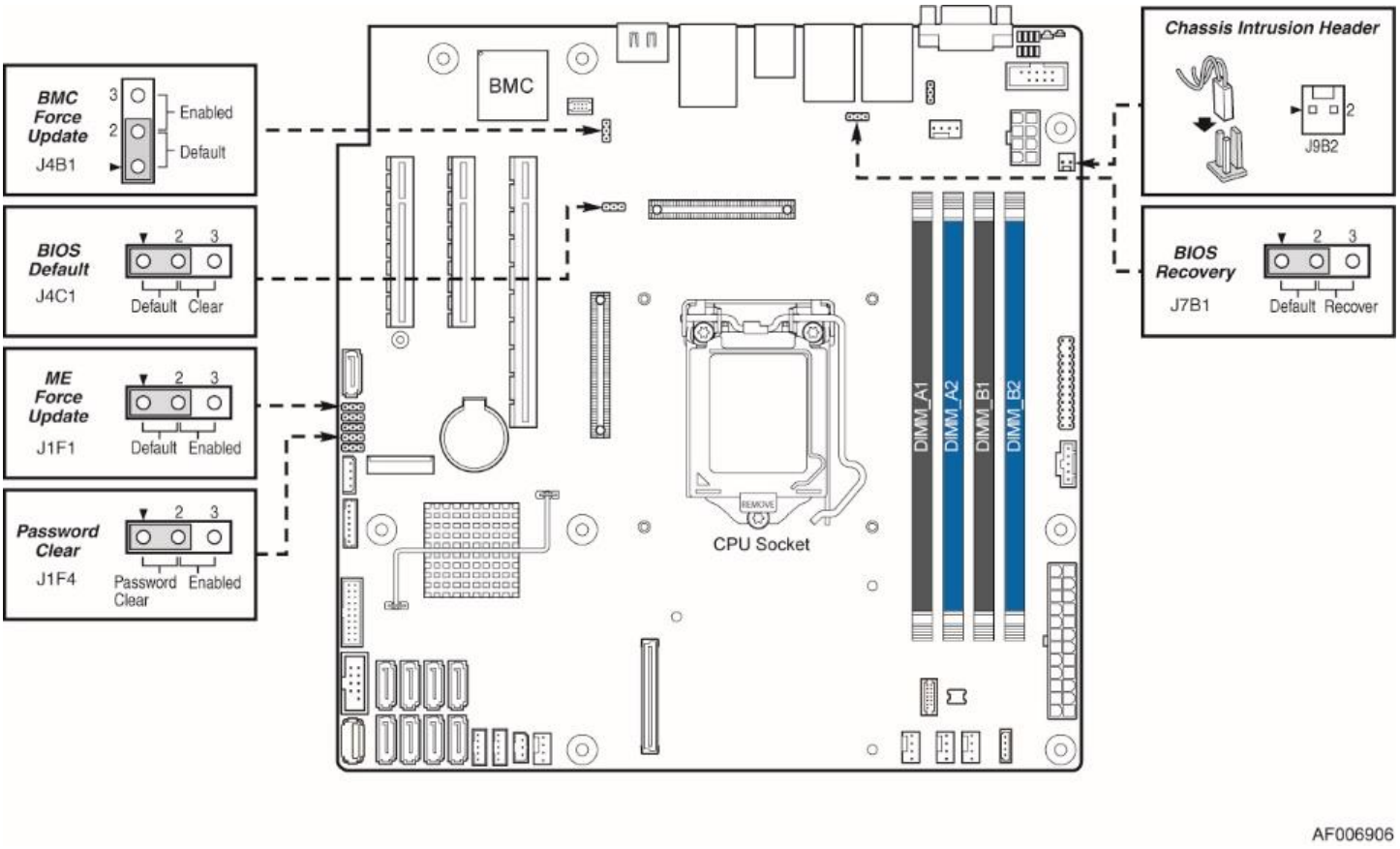


Figure 5. System Reset and Configuration Jumpers

2.4 Back Panel Features

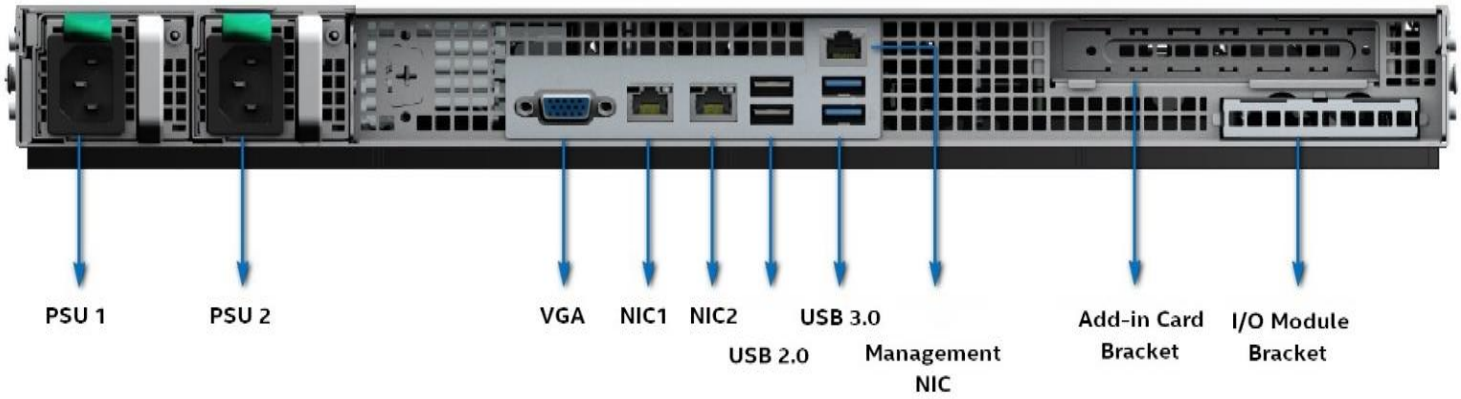
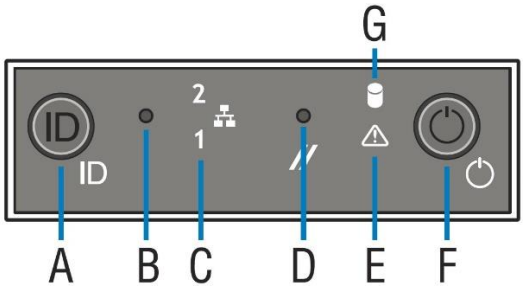


Figure 6. Back Panel Features

2.5 Front Control Panel



Label	Description
A	System ID Button w/Integrated LED
B	NMI Button (recessed, tool required for use)
C	NIC 1 & 2 Activity LEDs
D	System Cold Reset Button (recessed, tool required for use)
E	System Status LED
F	Power Button w/Integrated LED
G	Drive Activity LED

Figure 7. Front Control Panel Options

2.6 Front Drive Bay Options

Figure 8. 3.5" Drive Bay – 4 Drive Configuration (Model R1304SPxxxxx)

Figure 9. 2.5" Drive Bay – 8 Drive Configuration (Model R1208SPxxxxx)

2.7 Locking Front Bezel

The optional front bezel is made of Black molded plastic and uses a snap-on design. When installed, its design allows for maximum airflow to maintain system cooling requirements. The front bezel includes a keyed locking mechanism which can be used to prevent unauthorized access to installed storage devices and front I/O ports.

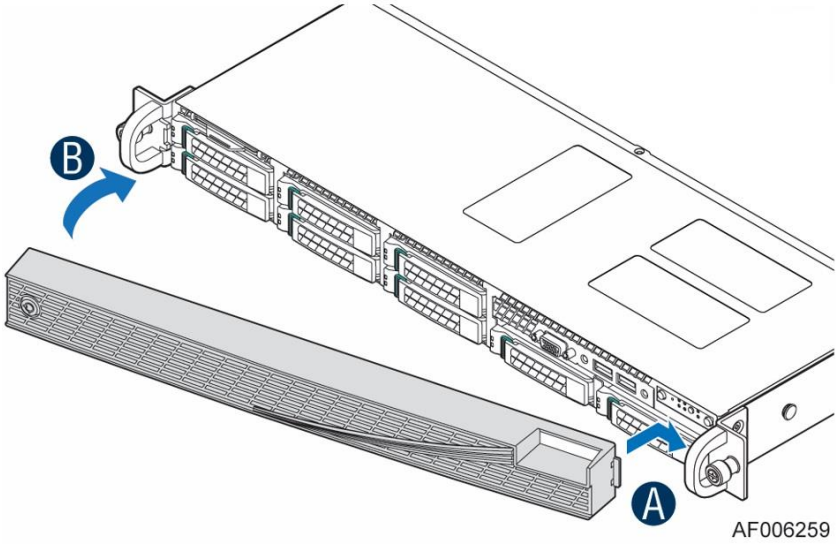


Figure 10. Front Bezel

(Intel Product Order Code – A1UBEZEL)

The face of the bezel assembly includes snap-in identification badge options and a wave feature option to allow for customization.

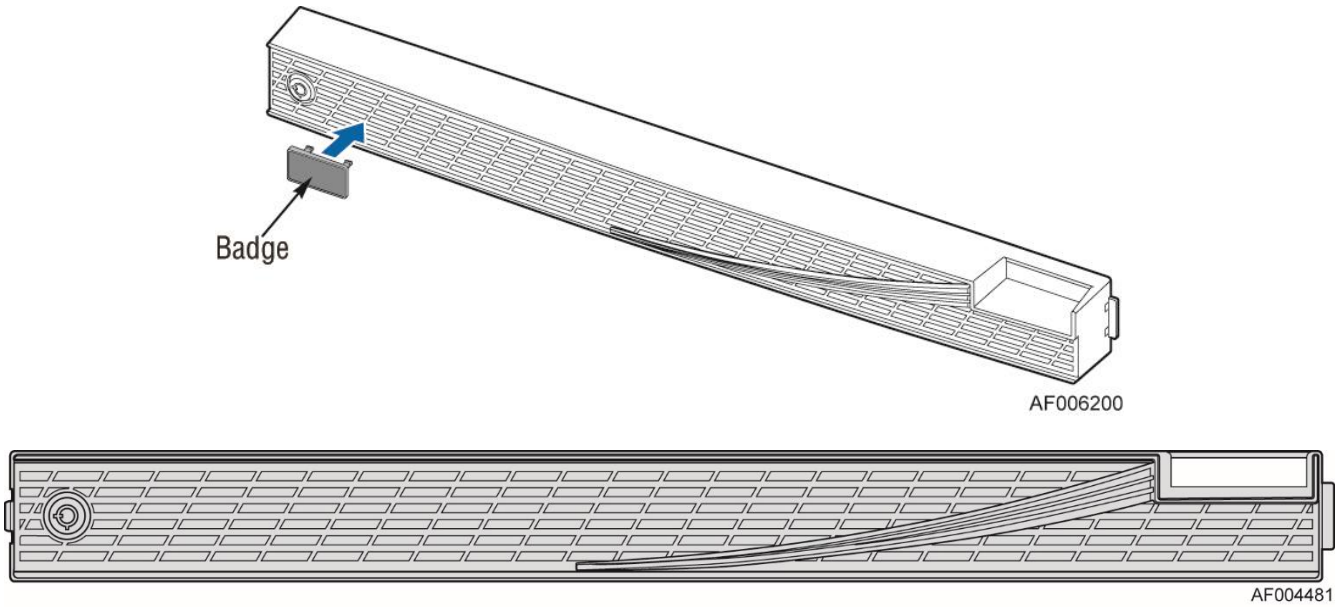


Figure 11. Front Bezel Accessory with Optionally Installed Wave Feature

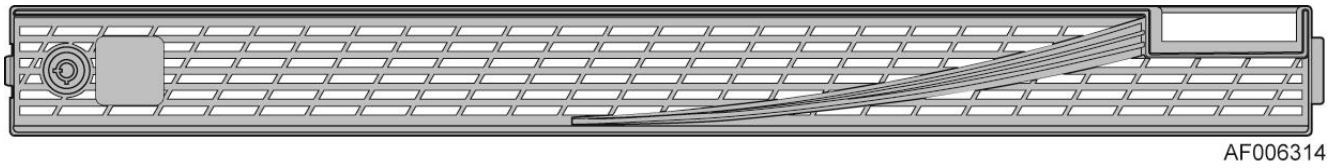


Figure 12. Front Bezel Accessory with Optionally Installed Wave and ID Badge (1)

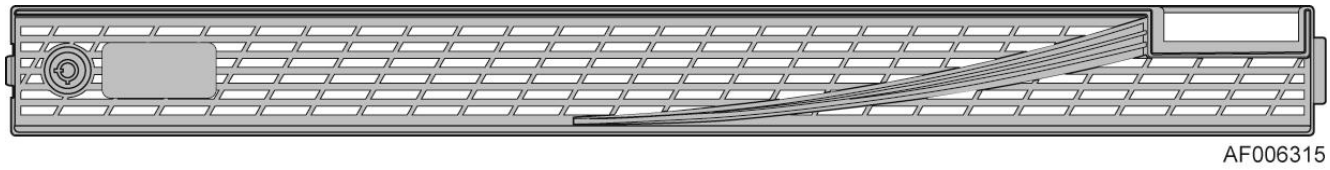


Figure 13. Front Bezel Accessory with Optionally Installed Wave and ID Badge (2)

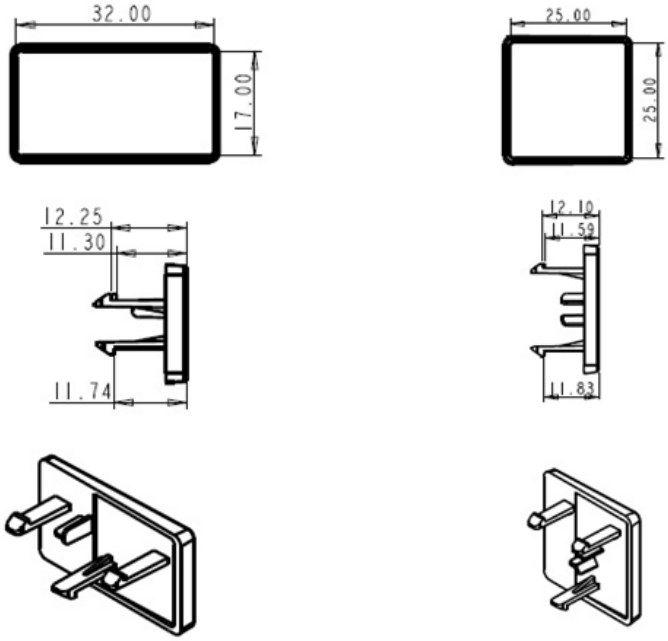


Figure 14. Front Bezel Accessory ID Badge Mechanical Drawings

2.8 System Dimensions

2.8.1 Chassis Dimensions

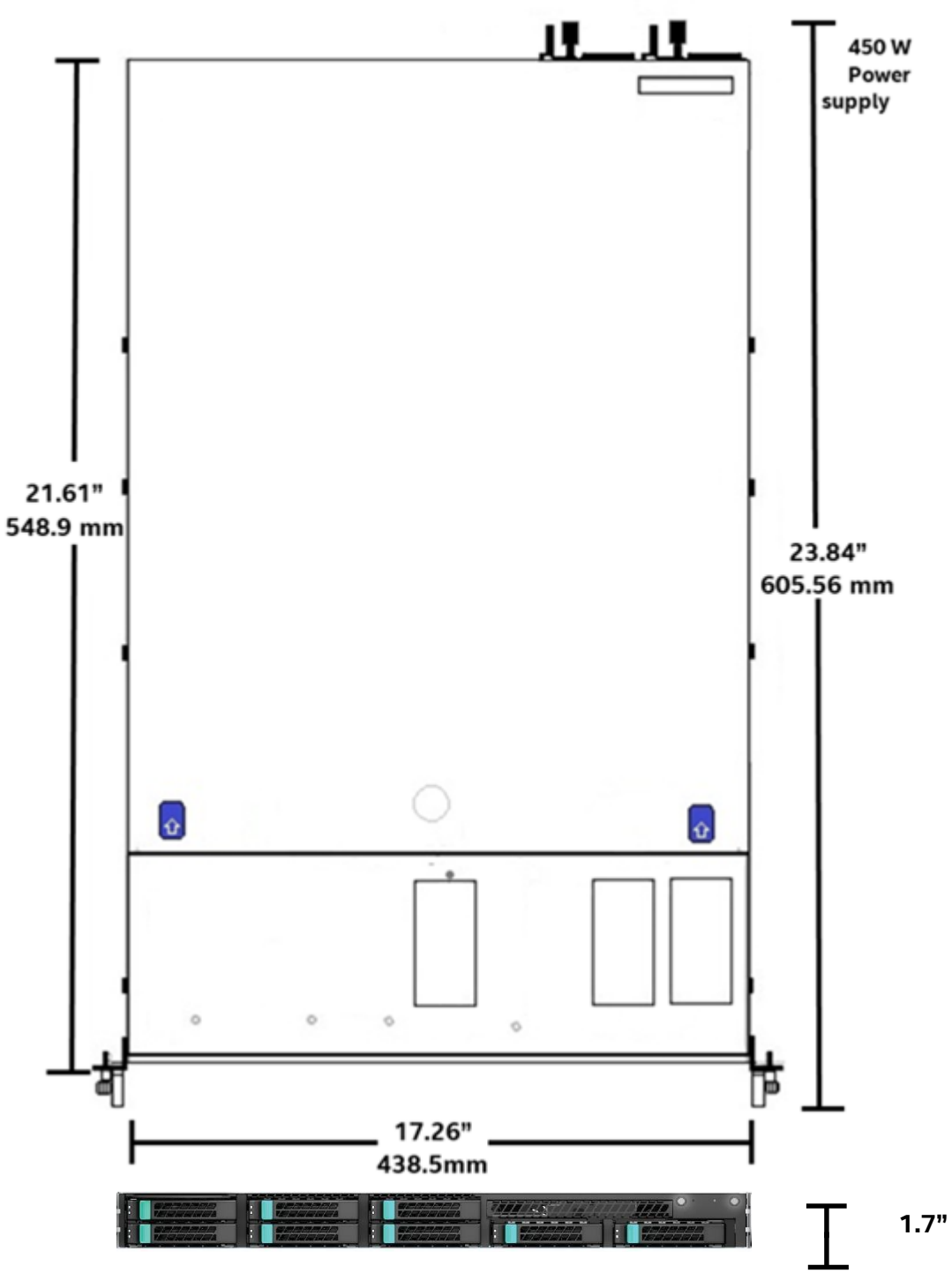


Figure 15. Chassis Dimensions

2.8.2 Label Emboss Dimensions

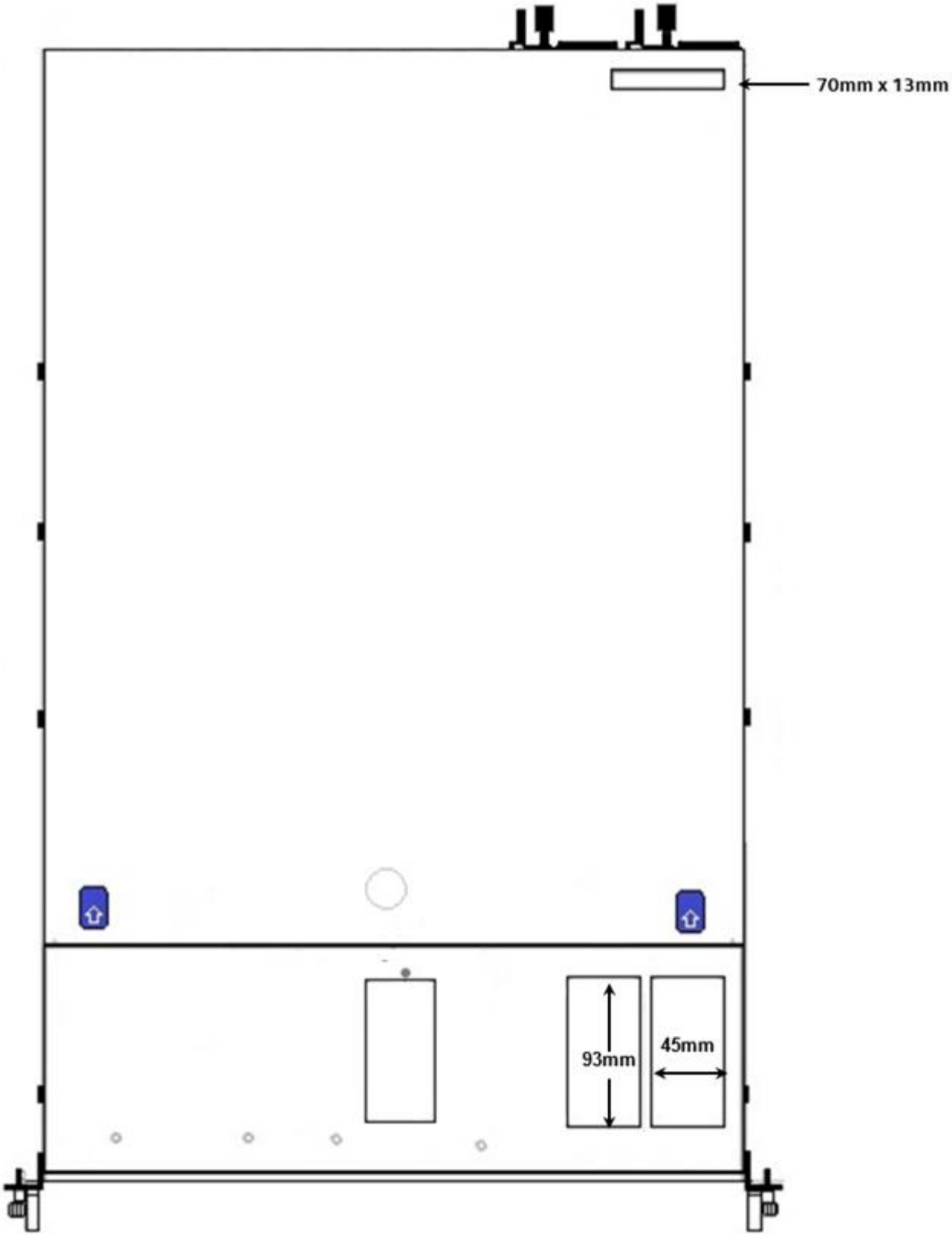


Figure 16. Label Emboss Dimensions

2.8.3 Pull-out Tab Label Emboss Dimensions

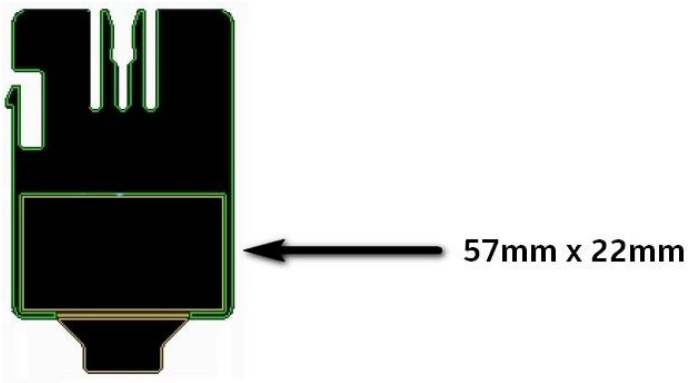


Figure 17. Pull-out Tab Label Emboss Dimensions

2.9 Available Rack Mounting Kit Options

Advisory Note – Available rack and cabinet mounting kits are not designed to support shipment of the server system while installed in a rack. If you chose to do so, Intel advises you verify your shipping configuration with appropriate shock and vibration testing, before shipment. Intel does not perform shipping tests which cover the complex combination of unique rack offerings and custom packaging options.

Caution: Exceeding the rail kit's specified maximum weight limit or misalignment of the server in the rack may result in failure of the rack rails, resulting in damage to the system or personal injury. Two people or the use of a mechanical assist tool to install and align the server into the rack is highly recommended.

Available Rack mounting kits:

- **AXXVPSRAIL –** Vale plus short rail
  - 424mm max travel length
  - 129 lbs. (59 Kg) max support weight
  - Front and rear mounting bracket adjustment distance: 609mm to 705mm
  - Stab-in system install
  - x8 #10-32 screws to mount rail kit on rack flange (screw kit come with rail kit assembling)
  - No cable management arm support

2.10 System Level Environmental Limits

The following table defines the system level operating and non-operating environmental limits.

Table 5. System Environmental Limits Summary

Parameter		Limits
Temperature	Operating	**ASHRAE Class A2** – Continuous Operation. 10º C to 35º C (50º F to 95º F) with the maximum rate of change not to exceed 10°C per hour **ASHARE Class A3** – Includes operation up to 40°C for up to 900 hours per year. **Refer to Appendix E for detailed guidance.**
	Shipping	-40º C to 70º C (-40º F to 158º F)
Altitude	Operating	Support operation up to 3050m with ASHRAE class de-ratings.
Humidity	Shipping	50% to 90%, non-condensing with a maximum wet bulb of 28° C (at temperatures from 25° C to 35° C)
Shock	Operating	Half sine, 2 g, 11 mSec
	Unpackaged	Trapezoidal, 25 g, velocity change is based on packaged weight
	Packaged	ISTA (International Safe Transit Association) Test Procedure 3A 2008
Vibration	Unpackaged	5 Hz to 500 Hz 2.20 g RMS random
	Packaged	ISTA (International Safe Transit Association) Test Procedure 3A 2008
AC-DC	Voltage	90 V to 132 V and 180 V to 264 V
	Frequency	47 Hz to 63 Hz
	Source Interrupt	No loss of data for power line drop-out of 12 mSec
	Surge Non-operating and operating	Unidirectional
	Line to earth Only	AC Leads 2.0 kV I/O Leads 1.0 kV DC Leads 0.5 kV
ESD	Air Discharged	12.0 kV
	Contact Discharge	8.0 kV
Acoustics Sound Power Measured	Power in Watts	<300 W ≥300 W ≥600 W ≥1000 W
	Servers/Rack Mount Sound Power Level (in BA)	7.0 7.0 7.0 7.0

2.11 System Packaging

The original Intel packaging, in which the server system is delivered, is designed to provide protection to a fully configured system and was tested to meet ISTA (International Safe Transit Association) Test Procedure 3A (2008). The packaging was also designed to be re-used for shipment after system integration has been completed.

The original packaging includes – a small inner box for ship along accessories, the outer shipping main box, and various protective inner packaging components. The boxes and packaging components are designed to function together as a protective packaging system. When reused, all of the original packaging material must be used, including both boxes and each inner packaging component. In addition, all inner packaging components MUST be reinstalled in the proper location to ensure adequate protection of the system for subsequent shipment.

Please refer to the Intel® Server System R1000SPO Product Family System Integration and Service Guide for complete packaging assembly instructions.

NOTE: The design of the inner packaging components does not prevent improper placement within the packaging assembly. There is only one correct packaging assembly that will allow the package to meet the ISTA (International Safe Transit Association) Test Procedure 3A (2008) limits.

Failure to follow the specified packaging assembly instructions may result in damage to the system during shipment.

2.11.1 Intel Product Weight Information

Table 6. Intel Product Weight Information

Product code	Net Weight（kg）	Gross Weight（kg）	Net Weight (Lbs.)	Gross Weight (Lbs.)
R1304SPOSHBN	7.77	11.6	17.1	25.6
R1304SPOSHOR	8.87	12.8	19.6	28.2
R1208SPOSHOR	9.09	13	20	28.7
E1304SPOSHON	8.99	12.8	19.8	28.2

NOTE: An L6 system does not include processors, memory, drives, or add-in cards. It is the system configuration as shipped from Intel. Integrated system weights (System configurations that include the items above) will vary depending on the final system configuration. For the 1U product family, a fully integrated un-packaged system can weigh up to 40 Lbs. (18+ Kg).

3. System Power

This chapter provides a high level overview of the features and functions related to system power.

3.1 Power Supply Configurations

Systems within this product family are offered with options to support a single fixed mount 350 watt power supply or dual 450 watt power supply modules. Dual power supply configurations support the following power configurations: 1+0 (single), and 1+1 (redundant).

1+1 redundant power is supported if the total system power draw remains below the maximum power capacity of a single power supply module. If a power supply fails, the remaining power supply will allow the system to remain fully operational. The power supplies are hot swap capable allowing the failed power supply to be replaced without powering down the system.

In dual power supply configured systems, the power supplies are modular, allowing for tool-less insertion and extraction from a bay in the back of the chassis. When inserted, the card edge connector of the power supply mates blindly to a matching slot connector on the Power Distribution Board (PDB).

Figure 18. 350W AC Fixed Power Supply

Figure 19. 450W AC Power Supply

3.2 Power Supply Module Options

There are two power supply options available for this server product family: 350W AC (fixed mount) and 450W AC (Module).

3.2.1 Power Supply Module Efficiency

The following tables provide the required minimum efficiency level at various loading conditions. These are provided at three different load levels: 100%, 50%, and 20%.

The AC power supply efficiency is tested over an AC input voltage of 230 VAC.

Table 7. 350 Watt AC Power Supply Efficiency (Gold)

Loading	Efficiency
20% of maximum	85%
50% of maximum	88%
100% of maximum	85%

Table 8. 450 Watt AC Power Supply Efficiency (Gold)

Loading	Efficiency
20% of maximum	88%
50% of maximum	92%
100% of maximum	88%

3.2.2 Power Supply Module Mechanical Overview

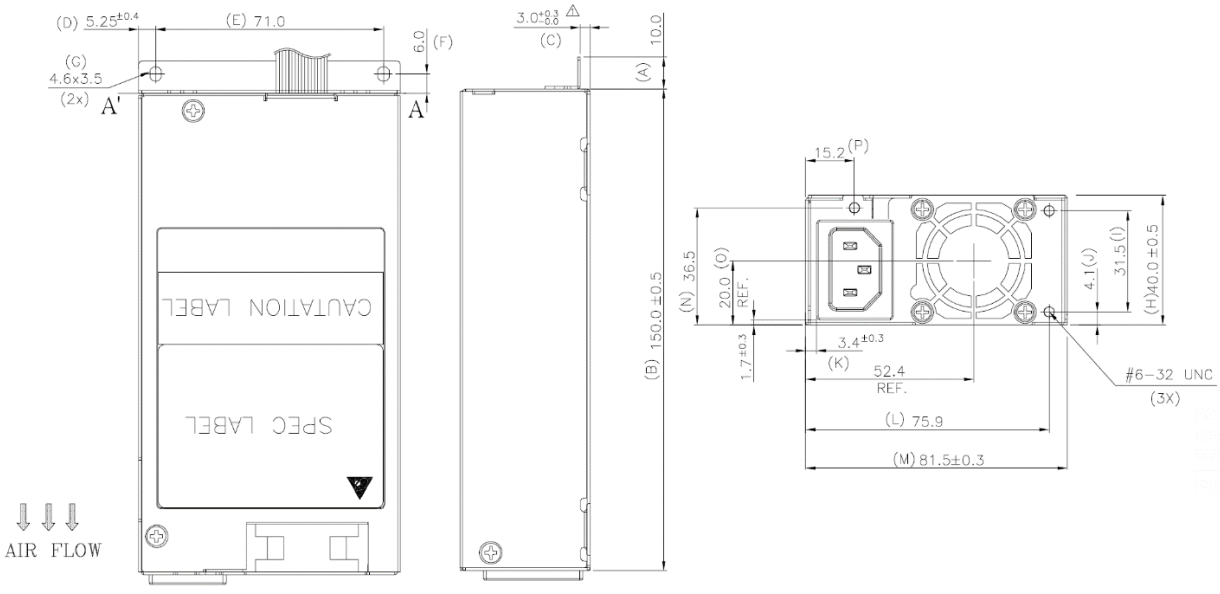


Figure 20. 350W Power Supply Mechanical Drawings

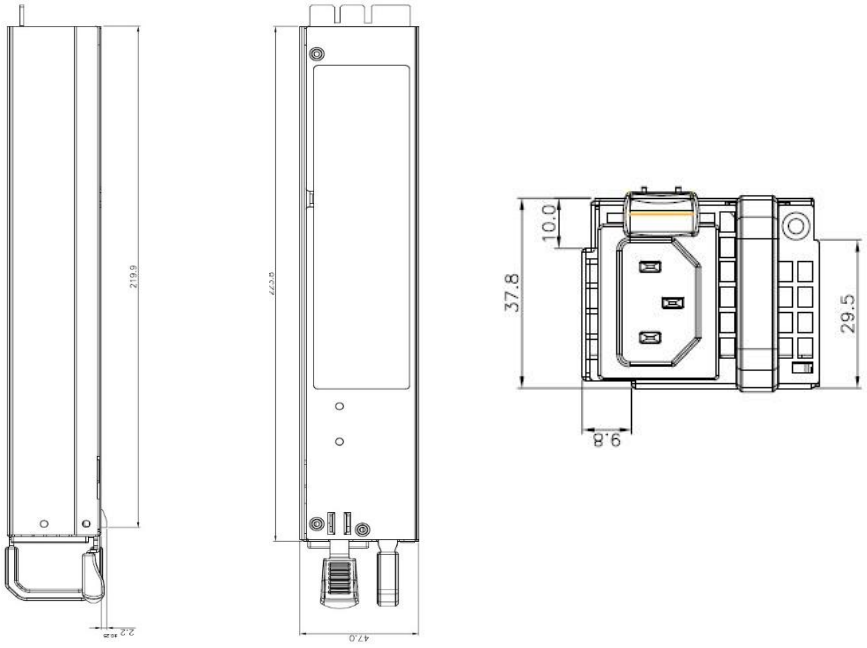


Figure 21. 450W Power Supply Mechanical drawings

3.2.3 Power distribution board

The dual power supply configuration option for the Intel® Server System R1000SPO product family incorporates a Power Distribution Board (PDB), and is where the Redundant Power Supply modules are attached. The Connections for Server Board power, communications for power supply monitoring, power for the Backplane and Optical Disk Drive, come from the Power Distribution Board. For connector pinout and power supply monitoring details, please refer to the Intel® Server Board S1200SP Product Family Technical Product Specification. The PDB is designed to plug directly to the output connector of the power supply and it contains two DC/DC power converters to produce other required voltages.

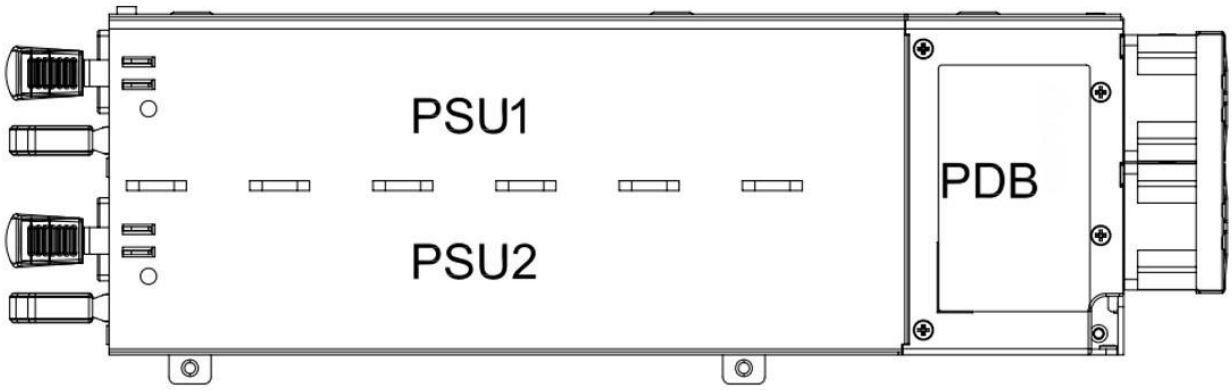


Figure 22. Power Distribution Board

3.2.4 Power Cord Specification Requirements

The AC power cord used must meet the specification requirements listed in the following table.

Table 9. AC Power Cord Specifications

Cable Type	SJT
Wire Size	16 AWG
Temperature Rating	105ºC
Amperage Rating	13 A
Voltage Rating	125 V

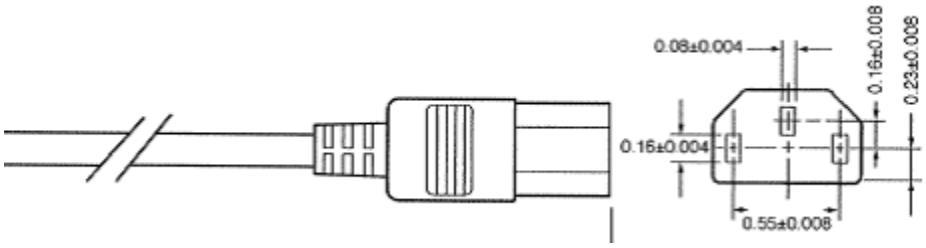


Figure 23. AC Power Cord

3.3 AC Power Supply Input Specifications

The following sections provide the AC Input Specifications for systems configured with AC power supply modules.

3.3.1 Power Factor

The power supply must meet the power factor requirements stated in the Energy Star* Program Requirements for Computer Servers. These requirements are stated below.

Output power (350w PSU)	20% load	50% load	100% load
Power factor	0.8	0.9	0.98

Output power (450w PSU)	20% load	50% load	100% load
Power factor	0.8	0.9	0.95

3.3.2 AC Input Voltage Specification

The power supply must operate within all specified limits over the following input voltage range. Harmonic distortion of up to 10% of the rated line voltage must not cause the power supply to go out of specified limits. Application of an input voltage below 85VAC shall not cause damage to the power supply, including a blown fuse.

Table 10. Input Voltage Range – 350W Power Supply

PARAMETER	MIN	RATED	MAX	Max Input AC Current
Line Voltage (110)	90V_{rms}	100-127 V_{rms}	140V_{rms}	6 A_{rms}[1]
Line Voltage (220)	180V_{rms}	200-240 V_{rms}	264V_{rms}	3 A_{rms}[2]
Frequency	47 Hz	50/60Hz	63 Hz	
DC Voltage	237VDC	250VDC	262VDC	

1. Maximum input current at low input voltage range shall be measured at 90VAC, at max load.
2. Maximum input current at high input voltage range shall be measured at 180VAC, at max load.

Table 11. AC Input Voltage Range – 450W Power Supply

PARAMETER	MIN	RATED	VMAX	Start-up VAC	Power-off VAC
Voltage (110)	90 V_{rms}	100-127 V_{rms}	140 V_{rms}[1]	85VAC +/-4VAC	70VAC +/-5VAC
Voltage (220)	180 V_{rms}	200-240 V_{rms}	264 V_{rms}[2]		
Frequency	47 Hz	50/60 Hz	63 Hz[3]		

1. Maximum input current at low input voltage range shall be measured at 90VAC, at max load.
2. Maximum input current at high input voltage range shall be measured at 180VAC, at max load.
3. This requirement is not to be used for determining agency input current markings.

3.3.3 AC Line Isolation Requirements

The power supply shall meet all safety agency requirements for dielectric strength. Transformers' isolation between primary and secondary windings must comply with the 3000Vac (4242Vdc) dielectric strength criteria. If the working voltage between primary and secondary dictates a higher dielectric strength test voltage the highest test voltage should be used. In addition the insulation system must comply with reinforced insulation per safety standard IEC 950. Separation between the primary and secondary circuits, and primary to ground circuits, must comply with the IEC 950 spacing requirements.

3.3.4 AC Line Dropout / Holdup

An AC line dropout is defined to be when the AC input drops to 0VAC at any phase of the AC line for any length of time. An AC line dropout for less than 12ms shall not cause tripping of control signals or protection circuits. If the AC dropout lasts longer than the holdup time the power supply should recover and meet all turn on requirements. The power supply shall meet the AC dropout requirement over rated AC voltages and frequencies. A dropout of the AC line for any duration shall not cause damage to the power supply.

Table 12. AC Line Holdup Time – 350W Power supply

Loading	Holdup time
75%	12msec

Table 13. AC Line Holdup Time – 450W Power Supply

Loading	Holdup time
75%	12msec
100%	10msec

3.3.5 AC Line Fuse

The power supply shall have one line fused in the **single line fuse** on the line (Hot) wire of the AC input. The line fusing shall be acceptable for all safety agency requirements. The input fuse shall be a slow blow type. AC inrush current shall not cause the AC line fuse to blow under any conditions. All protection circuits in the power supply shall not cause the AC fuse to blow unless a component in the power supply has failed. This includes DC output load short conditions.

3.3.6 AC Line Transient Specification

AC line transient conditions shall be defined as “sag” and “surge” conditions. “Sag” conditions are also commonly referred to as “brownout”, these conditions will be defined as the AC line voltage dropping below nominal voltage conditions. “Surge” will be defined to refer to conditions when the AC line voltage rises above nominal voltage.

Table 14. AC Line Sag Transient Performance – 350W Power Supply

AC Line Sag (10sec interval between each sagging)				
Duration	**Sag**	**Operating AC Voltage**	**Line Frequency**	**Performance Criteria**
Continuous	10%	Nominal AC Voltage ranges	50/60Hz	No loss of function or performance
1 to 12ms	100%	Nominal AC Voltage ranges	50/60Hz	No loss of function or performance
> 12ms	>30%	Nominal AC Voltage ranges	50/60Hz	Loss of function acceptable, self-recoverable

Table 15. AC Line Surge Transient Performance – 350W Power Supply

AC Line Surge				
Duration	**Surge**	**Operating AC Voltage**	**Line Frequency**	**Performance Criteria**
Continuous	10%	Nominal AC Voltages	50/60Hz	No loss of function or performance
0 to ½ AC cycle	30%	Nominal AC Voltages	50/60Hz	No loss of function or performance

Table 16. AC Line Sag Transient Performance – 450W Power Supply

AC Line Sag (10sec interval between each sagging)				
Duration	**Sag**	**Operating AC Voltage**	**Line Frequency**	**Performance Criteria**
0 to 1/2 AC cycle	95%	Nominal AC Voltage ranges	50/60Hz	No loss of function or performance
> 1 AC cycle	>30%	Nominal AC Voltage ranges	50/60Hz	Loss of function acceptable, self-recoverable

Table 17. AC Line Surge Transient Performance – 450W Power Supply

AC Line Surge				
Duration	**Surge**	**Operating AC Voltage**	**Line Frequency**	**Performance Criteria**
Continuous	10%	Nominal AC Voltages	50/60Hz	No loss of function or performance
0 to ½ AC cycle	30%	Mid-point of nominal AC Voltages	50/60Hz	No loss of function or performance

3.3.7 Susceptibility Requirements

The power supply shall meet the following electrical immunity requirements when connected to a cage with an external EMI filter which meets the criteria defined in the SSI document EPS Power Supply Specification. For further information on Intel standards please request a copy of the Intel Environmental Standards Handbook.

Table 18. Performance Criteria

Level	Description
A	The apparatus shall continue to operate as intended. No degradation of performance.
B	The apparatus shall continue to operate as intended. No degradation of performance beyond spec limits.
C	Temporary loss of function is allowed provided the function is self-recoverable or can be restored by the operation of the controls.

3.3.8 Electrostatic Discharge Susceptibility

The power supply shall comply with the limits defined in EN 55024: 1998/A1: 2001/A2: 2003 using the IEC 61000-4-2: Edition 1.2: 2001-04 test standard and performance criteria B defined in Annex B of CISPR 24.

3.3.9 Fast Transient/Burst

The power supply shall comply with the limits defined in EN55024: 1998/A1: 2001/A2: 2003 using the IEC 61000-4-4: Second edition: 2004-07 test standard and performance criteria B defined in Annex B of CISPR 24.

3.3.10 Radiated Immunity

The power supply shall comply with the limits defined in EN55024: 1998/A1: 2001/A2: 2003 using the IEC 61000-4-3: Edition 2.1: 2002-09 test standard and performance criteria A defined in Annex B of CISPR 24.

3.3.11 Power Recovery

The power supply shall recover automatically after an AC power failure. AC power failure is defined to be any loss of AC power that exceeds the dropout criteria.

3.3.12 Voltage Interruptions

The power supply shall comply with the limits defined in EN55024: 1998/A1: 2001/A2: 2003 using the IEC 61000-4-11: Second Edition: 2004-03 test standard and performance criteria C defined in Annex B of CISPR 24.

3.3.13 Protection Circuits

Protection circuits inside the power supply cause only the power supply's main outputs to shut down. If the power supply latches off due to a protection circuit tripping, an AC cycle OFF for 15 seconds and a PSON# cycle HIGH for one second reset the power supply.

3.3.13.1 Over-current Protection (OCP)

The power supply shall have current limit to prevent the outputs from exceeding the values shown in table below. If the current limits are exceeded the power supply shall shutdown and latch off. The latch will be cleared by toggling the PSON# signal or by an AC power interruption. The power supply shall not be damaged from repeated power cycling in this condition. 5VSB will be auto-recovered after removing OCP limit.

Table 19. Over Current Protection – 350W Power Supply

Output Voltage	Continuous Load	
	Current Limit MIN	Current Limit MAX
+12V1	18.2A	20A
+12V2	18.2A	20A
+5V	19.2A	24A
+3.3V	12A	15A
-12V		4A
+5VSB		4.5A

Table 20. Over Current Protection – 450 Watt Power Supply

Output	Min OCP	Max OCP
+12V	40 A	54 A
5Vstby	3.6A~8A	

3.3.13.2 Over-voltage Protection (OVP)

The power supply over voltage protection shall be locally sensed. The power supply shall shutdown and latch off after an over voltage condition occurs. This latch shall be cleared by an AC power interruption. The values are measured at the output of the power supply's connectors. The voltage shall never exceed the maximum levels when measured at the power connectors of the power supply connector during any single point of fail. The voltage shall never trip any lower than the minimum levels when measured at the power connector. 12VSB will be auto-recovered after removing OVP limit.

Table 21. Over Voltage Protection - 350W Power Supply

Output Voltage	OVP MIN (V)	OVP MAX (V)
+3.3V	3.7	4.5
+5V	5.7	6.5
+12V1/+12V2	13.3	15.6
-12V	-13.3	-15.6
+5VSB	5.7	6.5

Table 22. Over Voltage Protection (OVP) Limits – 750W Power Supply

OUTPUT VOLTAGE	PROTECTION POINT [V]
+12 V	13.6V ~ 15.0V
5VSB	5.6V ~ 6.5V

3.3.13.3 Over-temperature Protection (OTP)

The power supply will be protected against over temperature conditions caused by loss of fan cooling or excessive ambient temperature. In an OTP condition the PSU will shut down. When the power supply temperature drops to within specified limits, the power supply shall restore power automatically, while the 12VSB remains always on. The OTP circuit must have built in margin such that the power supply will not oscillate on and off due to temperature recovering condition. The OTP trip level shall have a minimum of 4°C of ambient temperature margin.

3.3.14 Power Supply Status LED

There is a single bi-color LED to indicate the power supply status on the Redundant Power Supply Modules. The LED operation is defined in the following table.

Table 23. LED Indicators

Power Supply Condition	LED State
Output ON and OK	GREEN
No AC power to all power supplies	OFF
AC present / Only 12VSB on (PS off) or PS in Cold redundant state	1Hz Blink GREEN
AC cord unplugged or AC power lost; with a second power supply in parallel still with AC input power.	AMBER
Power supply warning events where the power supply continues to operate; high temp, high power, high current, slow fan.	1Hz Blink Amber
Power supply critical event causing a shutdown; failure, OCP, OVP, Fan Fail	AMBER
Power supply FW updating	2Hz Blink GREEN

3.4 Server Board Power Connectors

The server board provides several connectors to provide power to various system options. The following sub-sections will provide the pin-out definition; and a brief usage description for each.

The main power supply connection uses an SSI-compliant 2x12 pin connector.

Two additional power-related connectors also exist:

- One SSI-compliant 2x4 pin power connector to provide 12-V power to the CPU voltage regulators and memory.
- One SSI-compliant 1x5 pin connector to provide monitoring of the power supply.

The following tables define the pin-out for the connectors:

Table 24. Main Power Connector Pin-out

Pin	IO	Signal Name	Pin	IO	Signal Name
1	PWR	+3.3V	**13**	PWR	+3.3V
2	PWR	+3.3V	**14**	PWR	-12V (NA for most designs)
3	GND	GND	**15**	GND	GND
4	PWR	+5V	**16**	I	PS_ON#
5	GND	GND	**17**	GND	GND
6	PWR	+5V	**18**	GND	GND
7	GND	GND	**19**	GND	GND
8	O	PWR_GD	**20**	NC	NC
9	PWR	SB5V	**21**	PWR	+5V
10	PWR	+12V	**22**	PWR	+5V
11	PWR	+12V	**23**	PWR	+5V
12	PWR	+3.3V	**24**	GND	GND

Table 25. CPU Power Connector Pin-out

Pin	IO	Signal Name	Pin	IO	Signal Name
1	GND	GND	**5**	PWR	P12V1
2	GND	GND	**6**	PWR	P12V1
3	GND	GND	**7**	PWR	P12V2
4	GND	GND	**8**	PWR	P12V2

Table 26. PMBUS SSI Connector Pin-out (PS_AUX)

Pin	IO	Signal Name
1	**I**	**PMBUS_CLK**
2	**IO**	**PMBUS_DATA**
3	**O**	**IRQ_PMBUS_ALERT_N**
4	**GND**	**GND Return Sense**
5	**I**	**P3V3 Sense**

4. Thermal Management

The fully integrated system is designed to operate at external ambient temperatures of between 10°C and 35°C. Working with integrated platform management, several features within the system are designed to move air in a front to back direction, through the system and over critical components to prevent them from overheating and allow the system to operate with best performance.

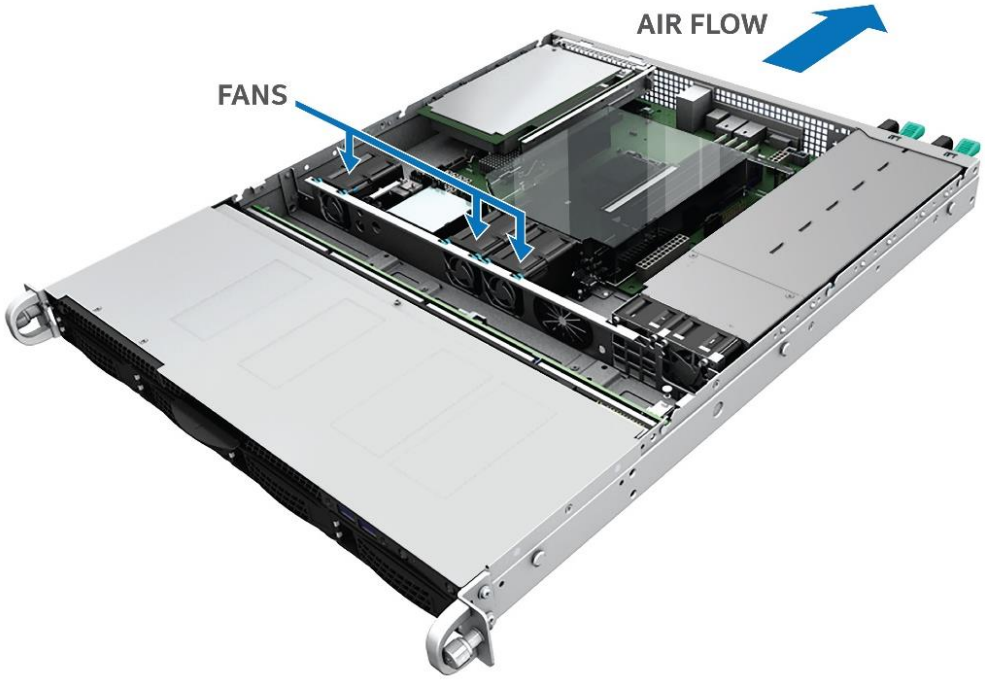


Figure 24. System Air Flow and Fan Identification

The following table provides air flow data associated with one of the system models within this 1U product family, and is provided for reference purposes only. The data was derived from actual wind tunnel test methods and measurements using fully configured (worst case) system configurations. Lesser system configurations may produce slightly different data results. In addition, the CFM data was derived using server management utilities that utilize platform sensor data, and may vary slightly from the data listed in the tables.

Table 27. System Volumetric Air Flow

4X3.5" Front End			
All System Fan	**PSU Fan**	**w/o PSU(CFM)**	**w/ PSU(CFM)**
100%	Auto	42.6	44.19
85%		35.3	37.2
75%		31.1	32.4
65%		26.7	27.6
55%		22.3	22.7
45%		18.1	18.2
35%		13.5	14.0
20%		7.5	7.7

The Intel® Server System R1000SPO product family is thermally designed and developed in compliance with ASHRAE Class A2 environment guidance; however, there is extra thermal margin for all components in the system, so ASHRAE Class A3 environment conditions can be thermally supported.

Note: ASHARE Class A3 – Includes operation up to 40°C for up to 900 hours per year. Refer to Appendix E for detailed HTA guidance.

The installation and functionality of several system components are used to maintain system thermals. They include three managed 40mm single rotor system fans, fans integrated into each installed power supply module, an air duct, populated drive carriers, and a CPU heat sink. Drive carriers can be populated with a storage device (SSD or Hard Disk Drive) or supplied drive blank.

4.1 Thermal Operation and Configuration Requirements

To keep the system operating within supported maximum thermal limits, the system must meet the following operating and configuration guidelines:

- The system is designed for sustained operation on ambient temperature up to 35°C (ASHRAE Class A2)
- All externally accessed drive bays must be populated. Drive carriers can be populated with a storage device (SSD or HDD) or supplied drive blank
- When the system is operating, the air duct must be installed at all times
- The system top cover must be installed at all times when the system is in operation in order to have proper air flow

4.2 Thermal Management Overview

In order to maintain the necessary airflow within the system, all of the previously listed components need to be properly installed. For best system performance, the external ambient temperature should remain below 35°C and all system fans (all rotors) should be operational.

NOTE: All system fans are controlled independent of each other. The fan control system may adjust fan speeds for different fans based on increasing/decreasing temperatures in different thermal zones within the chassis.

In the event that system temperatures should continue to increase with the system fans operating at their maximum speed, platform management may begin to throttle bandwidth of either the memory subsystem or the processors or both, in order to keep components from overheating and keep the system operational. Throttling of these subsystems will continue until system temperatures are reduced below preprogrammed limits.

The power supply will be protected against over temperature conditions caused by excessive ambient temperature. In an over-temperature protection condition, the power supply module will shut down.

4.2.1 Fan Speed Control

The baseboard management controller (BMC) supports monitoring and control of fan speed (RPM). Each fan is associated with a fan speed sensor that detects fan failure.

The system fans are divided into fan domains, each of which has a separate fan speed control signal and a separate configurable fan control policy. A fan domain can have a set of temperature and fan sensors associated with it. These are used to determine the current fan domain state.

A fan domain has three states:

- The sleep and boost states have fixed (but configurable through OEM SDRs) fan speeds associated with them
    - The nominal state has a variable speed determined by the fan domain policy. An OEM SDR record is used to configure the fan domain policy

The fan domain state is controlled by several factors. They are listed below in order of precedence, high to low:

- Boost
    - Associated fan is in a critical state or missing. The SDR describes which fan domains are boosted in response to a fan failure or removal in each domain. If a fan is removed when the system is in 'Fans-off' mode it will not be detected and there will not be any fan boost till system comes out of 'Fans-off; mode.
    - Any associated temperature sensor is in a critical state. The SDR describes which temperature threshold violations cause fan boost for each fan domain.
    - The BMC is in firmware update mode, or the operational firmware is corrupted.
    - If any of the above conditions apply, the fans are set to a fixed boost state speed.
- Nominal
    - A fan domain's nominal fan speed can be configured as static (fixed value) or controlled by the state of one or more associated temperature sensors.

4.2.2 Programmable Fan PWM Offset

The system provides a BIOS Setup option to boost the system fan speed by a programmable positive offset or a "Max" setting. Setting the programmable offset causes the BMC to add the offset to the fan speeds to which it would otherwise be driving the fans. The Max setting causes the BMC to replace the domain minimum speed with alternate domain minimums that also are programmable through SDRs.

This capability is offered to provide system administrators the option to manually configure fan speeds in instances where the fan speed optimized for a given platform may not be sufficient when a high end add-in adapter is configured into the system. This enables easier usage of the fan speed control to support Intel as well as third party chassis and better support of ambient temperatures higher than 35°C.

4.2.3 Fan Domains

System fan speeds are controlled through pulse width modulation (PWM) signals, which are driven separately for each domain by integrated PWM hardware. Fan speed is changed by adjusting the duty cycle, which is the percentage of time the signal is driven high in each pulse.

The BMC controls the average duty cycle of each PWM signal through direct manipulation of the integrated PWM control registers.

The same device may drive multiple PWM signals.

4.2.4 Nominal Fan Speed

A fan domain's nominal fan speed can be configured as static (fixed value) or controlled by the state of one or more associated temperature sensors.

OEM SDR records are used to configure which temperature sensors are associated with which fan control domains and the algorithmic relationship between the temperature and fan speed. Multiple OEM SDRs can reference or control the same fan control domain; and multiple OEM SDRs can reference the same temperature sensors.

The PWM duty-cycle value for a domain is computed as a percentage using one or more instances of a stepwise linear algorithm and a clamp algorithm. The transition from one computed nominal fan speed (PWM value) to another is ramped over time to minimize audible transitions. The ramp rate is configurable by means of the OEM SDR.

Multiple stepwise linear and clamp controls can be defined for each fan domain and used simultaneously. For each domain, the BMC uses the maximum of the domain's stepwise linear control contributions and the sum of the domain's clamp control contributions to compute the domain's PWM value, except that a stepwise linear instance can be configured to provide the domain maximum.

Hysteresis can be specified to minimize fan speed oscillation and to smooth fan speed transitions. If a Tcontrol SDR record does not contain a hysteresis definition, for example, an SDR adhering to a legacy format, the BMC assumes a hysteresis value of zero.

4.2.5 Thermal and Acoustic Management

This feature refers to enhanced fan management to keep the system optimally cooled while reducing the amount of noise generated by the system fans. Aggressive acoustics standards might require a trade-off between fan speed and system performance parameters that contribute to the cooling requirements and primarily memory bandwidth. The BIOS, BMC, and SDRs work together to provide control over how this trade-off is determined.

This capability requires the BMC to access temperature sensors on the individual memory DIMMs. Additionally, closed-loop thermal throttling is only supported with buffered DIMMs.

4.2.6 Thermal Sensor Input to Fan Speed Control

The BMC uses various IPMI sensors as input to the fan speed control. Some of the sensors are IPMI models of actual physical sensors whereas some are "virtual" sensors whose values are derived from physical sensors using calculations and/or tabular information.

The following IPMI thermal sensors are used as input to fan speed control:

- Front Panel Temperature Sensor[1]
- CPU Margin Sensors[2,4,5]
- DIMM Thermal Margin Sensors[2,4]
- Exit Air Temperature Sensor[1, 7, 9]
- PCH Temperature Sensor[3,5]
- Add-In Intel SAS Module Temperature Sensors[6]
- PSU Thermal Sensor[3, 8]
- CPU VR Temperature Sensors[5]
- DIMM VR Temperature Sensors[5]
- BMC Temperature Sensor[3, 6]
- Global Aggregate Thermal Margin Sensors [7]

- Hot Swap Backplane Temperature Sensors
- I/O Module Temperature Sensor (With option installed)
- Intel® SAS Module (With option installed)

Notes:

1. For fan speed control in Intel chassis
2. Temperature margin from throttling threshold
3. Absolute temperature
4. PECI value or margin value
5. On-die sensor
6. On-board sensor
7. Virtual sensor
8. Available only when PSU has PMBus
9. Calculated estimate

A simple model is shown in the following figure which gives a high level representation of how the fan speed control structure creates the resulting fan speeds

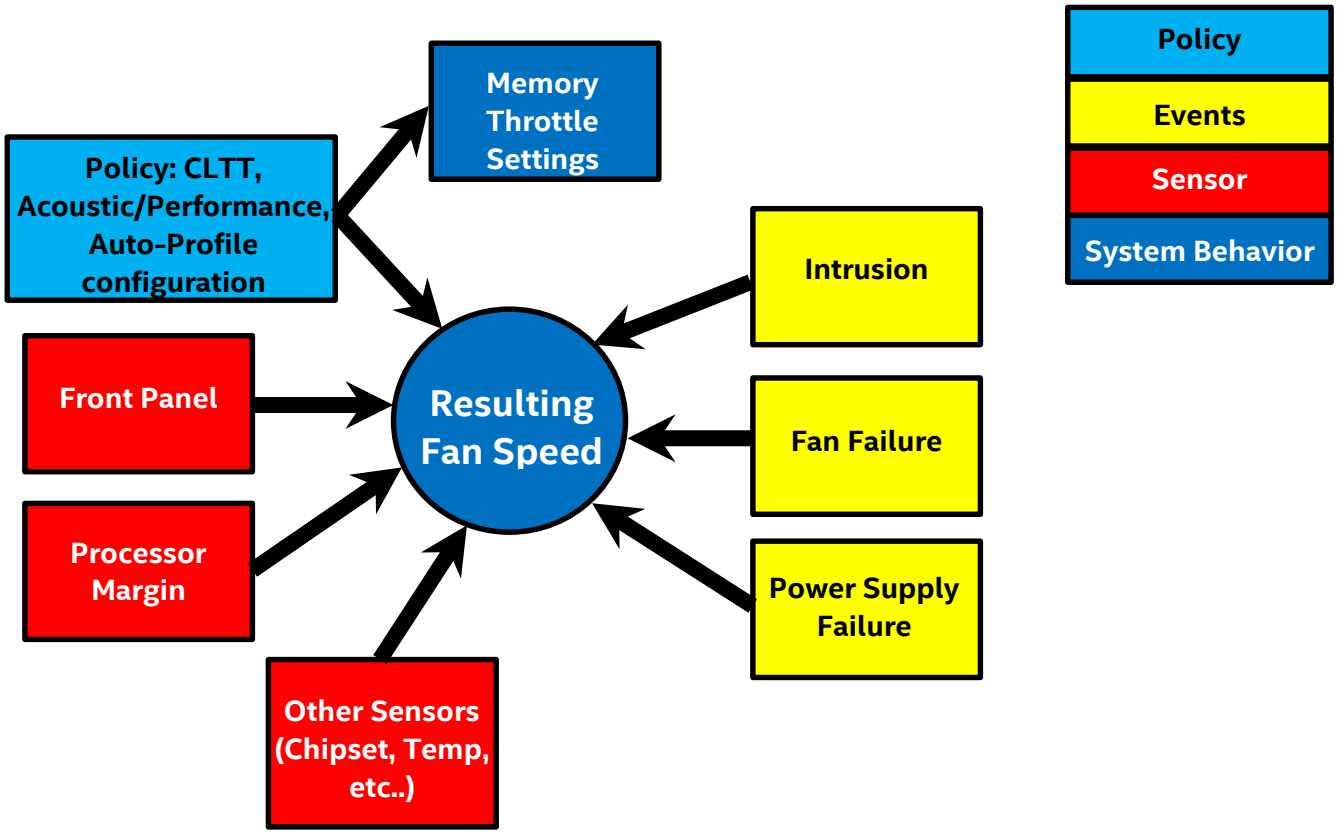


Figure 25. Fan Control Model

4.3 System Fans

Three single rotor 40 x 56mm system fans, and dedicated fans for the installed power supply modules provide the primary airflow for the system.

The system includes three system fans (see Figure 26). The fans are held in place by fitting them over mounting pins coming up from the chassis base.

The Fixed Power Supply option of this product family comes with a dedicated fan inside the Power Supply Module.

The dual Power Supply Option integrates a Power supply Cage with a fixed single rotor 40x56mm fan for each Power Supply Module. They are responsible for airflow through the power supply module. The fans are managed by the fan control system. Should a fan fail, the power supply will shut down.

Figure 26. System Fans

- System fans are NOT hot-swap capable
- Each fan and is designed for tool-less insertion and extraction from the system. For instructions on fan replacement, please refer to the *Intel® Server System R1000SPO System Integration and Service Guide*
- Each fan and incorporates vibration dampening features used to minimize fan vibration affects within the chassis
- Fan speed for each fan is controlled by integrated platform management as controlled by the integrated BMC on the server board. As system thermals fluctuate high and low, the integrated BMC firmware will increase and decrease the speeds to specific fans to regulate system thermals.
- Each fan has a tachometer signal for each rotor that allows the Integrated BMC to monitor their status.
- Each fan has a 4-pin wire harness that connects to a matching connector on the server board.

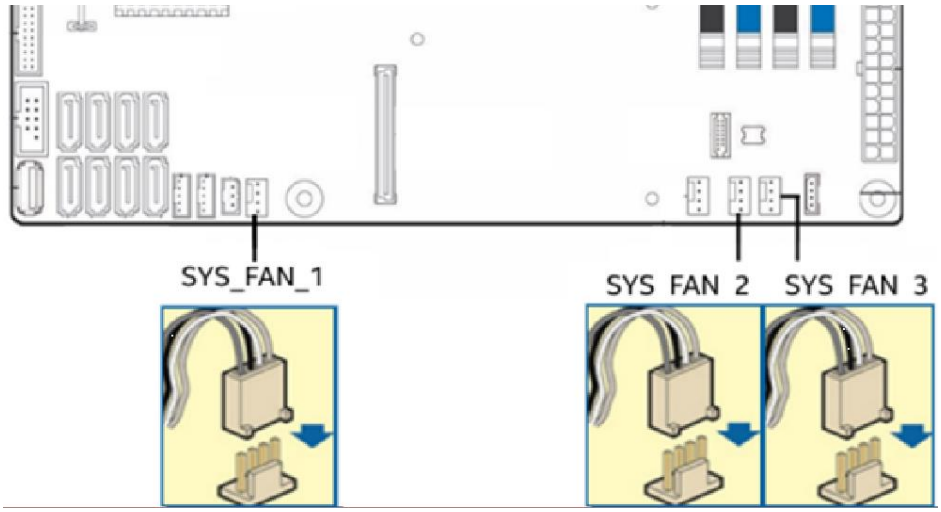


Figure 27. System Fan Connector Locations on Server Board

Table 28. System Fan Connector Pin-out

Pin	Signal Name	Type	Description
1	Ground	GND	Ground is the power supply ground
2	12V	Power	Power supply 12 V
3	Fan Tach Fan PWM	In Out	FAN_TACH signal is connected to the BMC to monitor the fan speed FAN_PWM signal to control fan speed
4	Fan PWM Fan Tach	Out In	FAN_PWM signal to control fan speed FAN_TACH signal is connected to the BMC to monitor the fan speed

5. System Storage and Peripheral Drive Bay Overview

The Intel® Server System R1000SPO product family has support for a variety of different storage options, including:

- Up to 8 x 2.5” hot swap SAS or SATA drives (hard disk or SSD)
- Up to 4 x 3.5” hot swap SAS or SATA hard disk drives or 2.5” SSDs
- SATA Slim-line Optical Drive support
- SATADOM Support on SATA port 4
- Internally mounted Low Profile M.2 Solid State Device (M.2 SSD)

Support for different storage and peripheral options will vary depending on the system model and/or available accessory options installed. This section will provide an overview of each available option.

5.1 Front Mount Drive Support

The 1U product family provides options to support either 8x2.5” or 4x3.5” front mounted drives. Both system options provide front panel I/O and front control panel support.

Figure 28. 8x2.5" Drive Bay Configuration (Model R1208xxxxx)

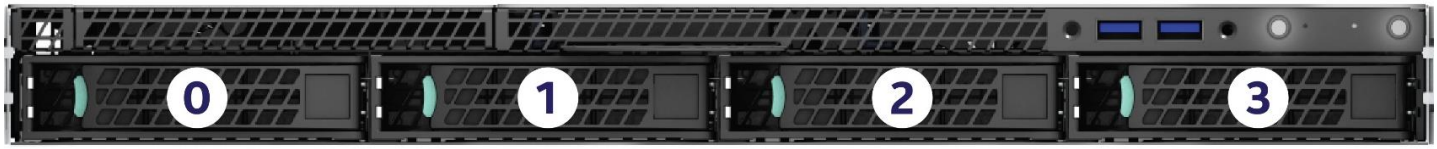


Figure 29. 4x3.5" Drive Bay Configuration (Model R1304WTxxxx)

5.2 System Fan RVI and Hard Disk Drive Storage Performance

Hard disk drive storage technology, which utilizes the latest state-of-the-art track density architectures, are susceptible to the effects of system fan rotational vibration interference (RVI) within the server system. As system fan speeds increase to their upper limits (>80% PWM or > 19,320 RPM), hard disk drive performance can be impacted.

Intel publishes a list of supported hard drives on its Tested Hardware and OS List (THOL). In general, unless identified in the NOTES column in the THOL, all listed hard drives have been tested to meet Intel performance targets when the systems fans are operating above 80% PWM and/or the system is operating at or below the platform ambient thermal limit of 35°C (95°F).

The THOL may also list hard drives that are only recommended for use in non-extreme operating environments, where the ambient air is at or below 20°C (68°F) and /or the hard drives are installed in system configurations where the system fans regularly operate below 80% PWM. Hard drives that require these support criteria for a given system will include an “Environmental Limitation” tag and message in the THOL “NOTES” column for that device. Using these drives in the more extreme operating environments puts these devices at higher risk of performance degradation.

Intel recommends the following general support guidelines for server systems configured with hard drive storage technology:

- Avoid sustained server operation in extreme operating environments. Doing so will cause the system fans to operate at their upper speed limits and produce higher levels of RVI which could affect hard drive performance.

NOTE: Solid State Drive (SSD) performance is not impacted by the effects of system fan RVI.

5.3 Hot Swap Drive Carriers

Each SAS/SATA hard disk drive or SSD that interfaces with a backplane is mounted to a hot swap drive carrier. Drive carriers include a latching mechanism used to assist with drive extraction and drive insertion.

Figure 30. Hot Swap Storage Device Carrier Removal

NOTE: To ensure proper system air flow requirements, all front drive bays must be populated with a drive carrier. Drive carriers must be installed with either a drive or supplied drive blank.

There are drive carriers to support 2.5” devices and 3.5” devices. To maintain system thermals, all drive bays must be populated with a drive carrier mounted with a hard disk drive, SSD, or supplied drive blank. Drive blanks used with the 3.5” drive carrier can also be used to mount a 2.5” SSD into it as shown below.

Figure 31. 2.5" SSD mounted to 3.5" Drive Tray

NOTE: Due to degraded performance and reliability concerns, the use of the 3.5” drive blank as a 2.5” device bracket is intended to support SSD type storage devices only. Installing a 2.5” hard disk drive into the 3.5” drive blank cannot be supported.

Each drive carrier includes separate LED indicators for drive Activity and drive Status. Light pipes integrated into the drive carrier assembly direct light emitted from LEDs mounted next to each drive connector on the backplane to the drive carrier faceplate, making them visible from the front of the system.

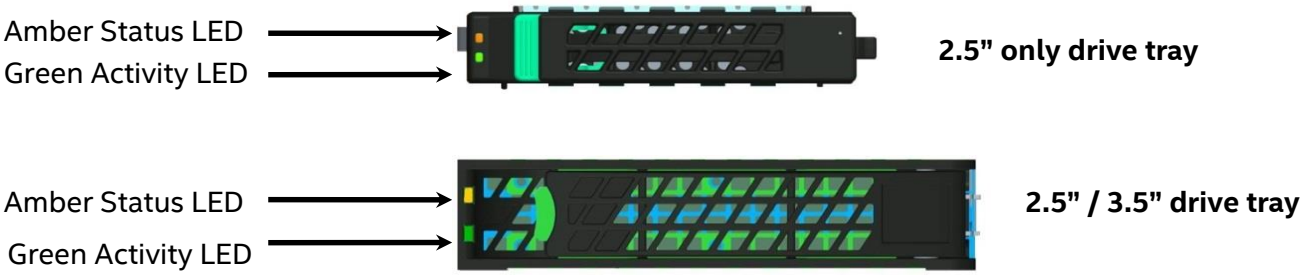


Figure 32. Drive Tray LED Identification

Table 29. Drive Status LED States

Amber	Off	No access and no fault
	Solid On	Hard Drive Fault has occurred
	Blink	RAID rebuild in progress (1 Hz), Identify (2 Hz)

Table 30. Drive Activity LED States

	Condition	Drive Type	Behavior
Green	Power on with no drive activity	SAS	LED stays on
		SATA	LED stays off
	Power on with drive activity	SAS	LED blinks off when processing a command
		SATA	LED blinks on when processing a command
	Power on and drive spun down	SAS	LED stays off
		SATA	LED stays off
	Power on and drive spinning up	SAS	LED blinks
		SATA	LED stays off

NOTE: The drive activity LED is driven by signals coming from the drive itself. Drive vendors may choose to operate the activity LED different from what is described in the table above. Should the activity LED on a given drive type behave differently than what is described, customers should reference the drive vendor specifications for the specific drive model to determine what the expected drive activity LED operation should be.

5.4 Storage Backplane Options

The 1U system has support for two backplane options.

For 2.5” drives:

- 8 x 2.5” drive (SAS/SATA) backplane

For 3.5” drives:

- 4 x 3.5 SAS/SATA backplane

All available backplane options mount directly to the back of the drive bay as shown in the following illustration.

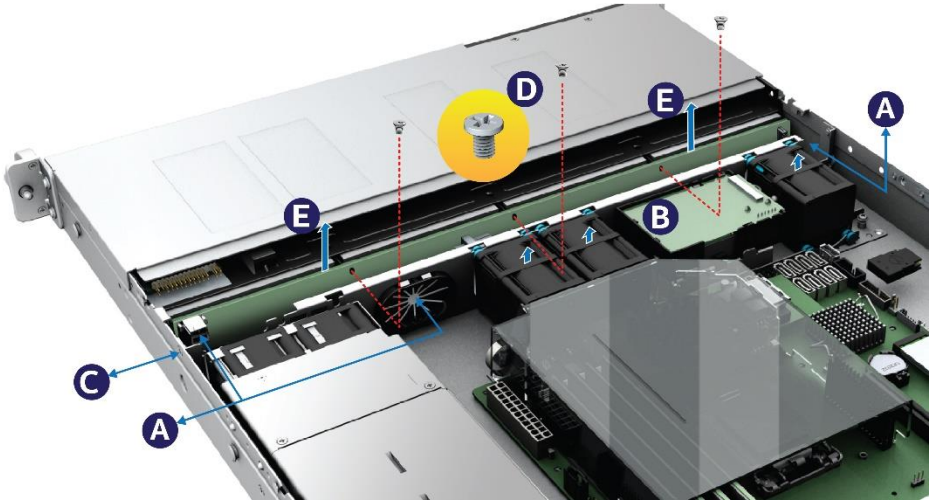


Figure 33. Backplane Installation

NOTE: For details on the istallation/removal of the Backplane, please refer to the Intel® Server System R1000SPO Product Family System Integration and Service Guide.

All available SAS/SATA compatible backplanes include the following common features:

- 12 Gb SAS and 6Gb SAS/SATA
- 29-pin SFF-8680 12 Gb rated drive interface connectors, providing both power and I/O signals to attached devices
- Hot swap support for SAS/SATA devices
- I2C interface from a 3-pin connector for device status communication to the BMC over slave SMBus
- LEDs to indicate drive activity and status for each attached device

5.4.1 I2C Functionality

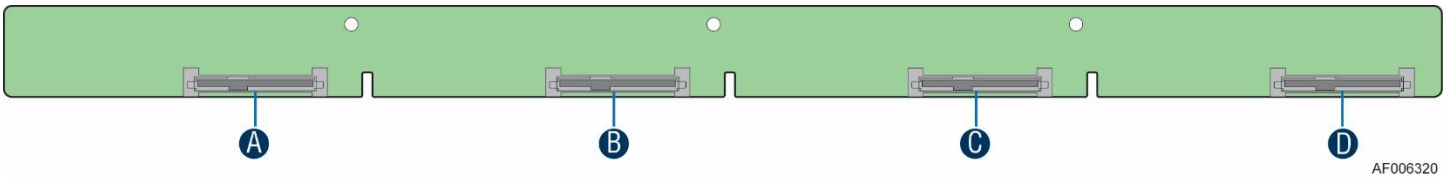
The microcontroller has a master/slave I2C connection to the server board BMC. The microcontroller is not an IPMB compliant device. The BMC will generate SEL events by monitoring registers on the HSBP microcontroller for DRIVE PRESENCE, FAULT, and RAID REBUILD in progress.

5.4.2 4 x 3.5” Drive Hot-Swap Backplane Overview

Intel Spare Product Code: **FXX35HSCAR**

The 3.5” drive system SKUs within the product family will ship with a 4x drive backplane capable of supporting 12 Gb/sec SAS and 6 Gb/sec SAS / SATA drives. Both hard disks and Solid State Drives (SSDs) can be supported within a common backplane. Each backplane can support either SATA or SAS devices. However, mixing of SATA and SAS devices within a common hot swap backplane is not supported. Supported devices are dependent on the type of host bus controller driving the backplane, SATA only or SAS.

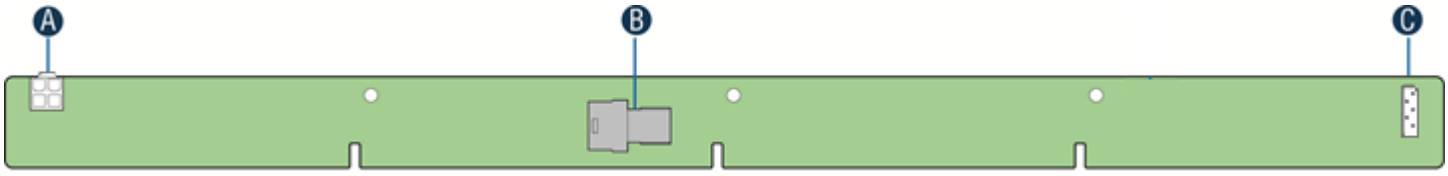
The front side of the backplane includes 4 x 29-pin drive interface connectors, each capable of supporting 12 Gb SAS or 6 Gb SAS/SATA. The connectors are numbered 0 thru 3. Signals for all four drive connectors are routed to a single multi-port mini-SAS HD connector on the back side of the backplane.



Label	Description
A	HDD_0
B	HDD_1
C	HDD_2
D	HDD_3

Figure 34. 4 x 3.5" Drive Hot-Swap Backplane – front view

On the backside of the backplane are several connectors. The following illustration identifies each.



Label	Description
A	Power connector
B	SAS/SATA Ports 0-3 Mini-SAS HD cable connector
C	I2C connector

Figure 35. 4 x 3.5" Drive Hot-Swap Backplane – rear view

A – Power Connector – The backplane includes a 2x2 connector supplying power to the backplane. Power is routed to the backplane via a power cable harness from the Power Supply Modules.

B – Multi-port Mini-SAS Cable Connector – The backplane includes one multi-port mini-SAS cable connector providing data signals for four SAS/SATA drives on the backplane. A cable can be routed from matching connectors on the server board or add-in SAS/SATA RAID cards.

C – I2C Cable Connector – The backplane includes a 1x3 cable connector used as a management interface to the server board.

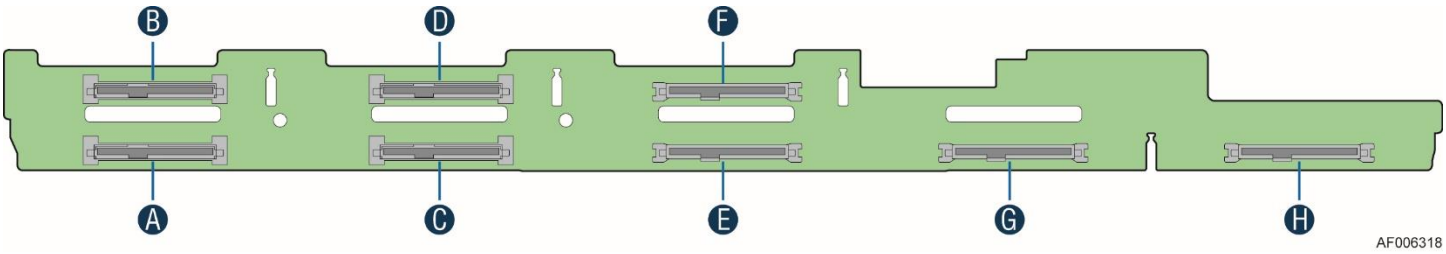
5.4.3 8 x 2.5" Drive SAS Backplane

Intel Spare Product Code: **F1U8X25S3HSBP**

The 2.5" drive system SKU will ship with a 8x drive backplane capable of supporting 12 Gb/sec SAS and 6 Gb/sec SAS / SATA drives. Both hard disks and Solid State Devices (SSDs) can be supported within a common backplane. Each backplane can support either SATA or SAS devices. However, mixing of SATA and SAS devices within a common hot swap backplane is not supported. Supported devices are dependent on the type of host bus controller driving the backplane, SATA only or SAS.

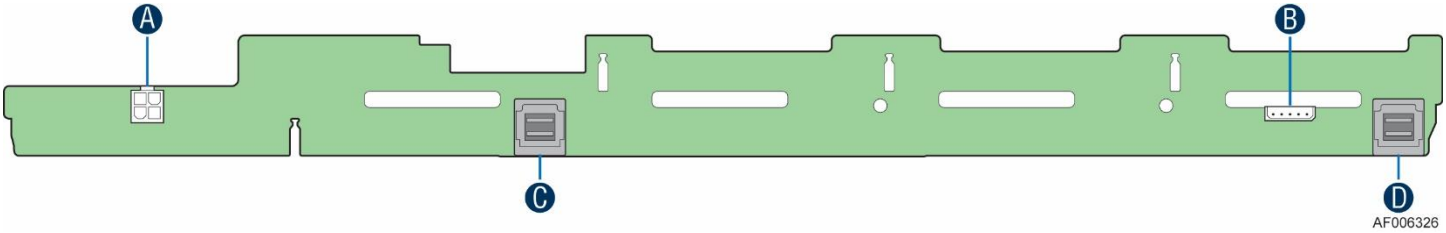
The front side of the backplane includes 8 x 29-pin drive interface connectors, each capable of supporting 12 Gb SAS or 6 Gb SAS/SATA. The connectors are numbered 0 thru 7. Data signals for each set of four drive connectors (0-3 and 4-7), are routed to separate multi-port mini-SAS HD connectors on the back side of the backplane.

Figure 36. 8 x 2.5" Drive SAS/SATA Backplane – front view



Label	Description
A	HDD_0
B	HDD_1
C	HDD_2
D	HDD_3
E	HDD_4
F	HDD_5
G	HDD_6
H	HDD_7

On the backside of each backplane are several connectors. The following illustration identifies each.



Label	Description
A	Power connector
B	I2C-In cable connector – From Server board
C	SAS/SATA Ports 4-7 Mini-SAS HD cable connector
D	SAS/SATA Ports 0-3 Mini-SAS HD cable connector

Figure 37. 8 x 2.5" Drive SAS/SATA Backplane – rear view

A – Power Connector – The backplane includes a 2x2 connector supplying power to the backplane. Power is routed to the backplane via a power cable harness from the Power Supply Modules.

PIN	SIGNAL	SIGNAL	PIN
1	GND	P12V	3
2	GND	P12V	4

B – I2C Cable Connectors – The backplane includes a 1x3 cable connector used as a management interface to the server board.

C and D – Multi-port Mini-SAS Cable Connectors – The backplane includes two multi-port mini-SAS cable connectors, each providing data signals for four SAS/SATA drives on the backplane. Cables can be routed from matching connectors on the server board or add-in SAS/SATA RAID cards.

5.5 M.2 SSD Support

The system provides support for a SATA M.2 SSD storage device. A 22x42mm 75-pin connector labeled “M.2 SATA” at the left of the battery section of the server board is used to connect this small flash storage device. In order to use an M.2 device, a SATA cable needs to be connected between any of the SATA connectors (SATA-0 to SATA-7, recommend SATA-7 for better cable routing) and the SATA connector (black) next to the jumpers. See illustration below. This cable needs to be purchased separately.

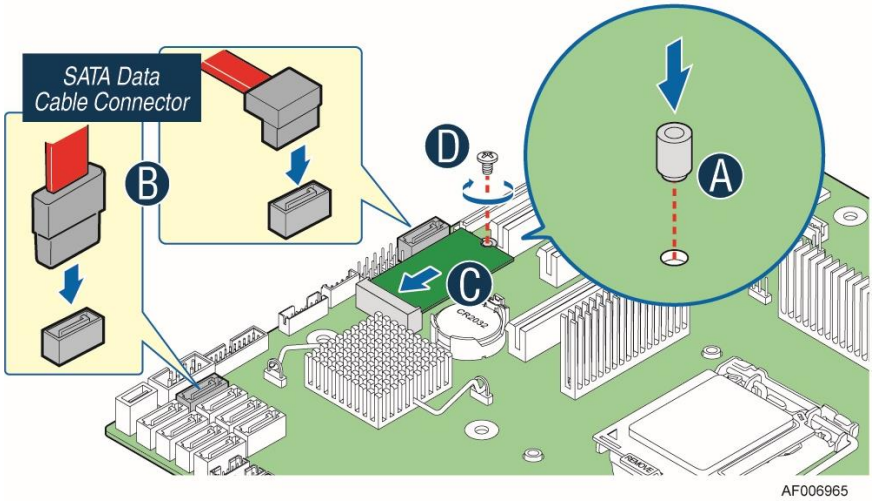


Figure 38. Installing M.2 Device

Visit https://serverconfigurator.intel.com for a list of supported devices.

5.6 SATA DOM Support

The SATA-4 connector on the server board is designed to be compatible with SATADOM devices.

Table 31. SATA/SATADOM capable Connector Pin-out

Pin	IO	Signal Name
MH1	PWR	GND
1	GND	GND
2	I	SATA_TX_P
3	I	SATA_TX_N
4	GND	GND
5	O	SATA_RX_N
6	O	SATA_RX_P
7	PWR	GND
MH2	PWR	P5V (For Apacer* SATADOM) GND (For SATA)

Visit https://serverconfigurator.intel.com for a list of supported SATA DOM devices.

6. Storage Controller Options Overview

The server platform supports different embedded and add-in SAS/SATA controller options to provide a larger number of possible storage configurations. This section will provide an overview of the different options available.

6.1 Embedded SATA/SATA RAID Support

The Intel® Server System R1000SPO product family provides an embedded SATA host controller that supports independent DMA operation on up to eight ports and supports data transfer rates of up to 6.0 Gb/s (600 MB/s). The SATA controller contains two modes of operation – a legacy mode using I/O space, and an AHCI mode using memory space. Software that uses legacy mode will not have AHCI capabilities. The Intel® C230 series chipset supports the Serial ATA Specification, Revision 3.0. The Intel® C230 series also supports several optional sections of the Serial ATA II: Extensions to Serial ATA 1.0 Specification, Revision 1.0 (AHCI support is required for some elements).

The server board also offers hardware support for Advanced Host Controller Interface (AHCI), a standardized programming interface for SATA host controllers. Platforms supporting AHCI may take advantage of performance features such as no master/slave designation for SATA devices—each device is treated as a master—and hardware assisted native command queuing. AHCI also provides usability enhancements such as Hot-Plug. AHCI requires appropriate software support (for example, an AHCI driver) and for some features, hardware support in the SATA device or additional platform hardware.

The Intel® Server System R1000SPO product family includes support for two embedded software RAID options:

- Intel® Embedded Server RAID Technology 2 (ESRT2) based on LSI* MegaRAID SW RAID technology
- Intel® Rapid Storage Technology (RSTe)

Using the <F2> BIOS Setup Utility, accessed during system POST, options are available to enable/disable SW RAID, and select which embedded software RAID option to use.

6.1.1.1 Intel® Rapid Storage Technology Enterprise

The server board provides support for Intel® Rapid Storage Technology enterprise, providing both AHCI (see above for details on AHCI) and integrated RAID functionality. The industry-leading RAID capability provides high-performance RAID functionality on up to 8 SATA ports of the server board on the following configurations:

- **RAID Level 0** – Non-redundant striping of drive volumes with performance scaling of up to 6 drives, enabling higher throughput for data intensive applications such as video editing.
- Data security is offered through **RAID Level 1**, which performs mirroring.
- **RAID Level 10** provides high levels of storage performance with data protection, combining the fault-tolerance of RAID Level 1 with the performance of RAID Level 0. By striping RAID Level 1 segments, high I/O rates can be achieved on systems that require both performance and fault-tolerance. RAID Level 10 requires 4 hard drives, and provides the capacity of two drives.
- **RAID Level 5** provides highly efficient storage while maintaining fault-tolerance on 3 or more drives. By striping parity, and rotating it across all disks, fault tolerance of any single drive is achieved while only consuming 1 drive worth of capacity. That is, a 3 drive RAID 5 has the capacity of 2 drives, or a 4 drive RAID 5 has the capacity of 3 drives. RAID 5 has high read transaction rates, with a medium write

rate. RAID 5 is well suited for applications that require high amounts of storage while maintaining fault tolerance.

RSTe RAID support is provided to allow multiple RAID levels to be combined on a single set of hard drives, such as RAID 0 and RAID 1 on two disks. Other RAID features include hot-spare support, and SMART alerting. Software components include an Option ROM for pre-boot configuration and boot functionality, a Microsoft Windows* compatible driver, and a user interface for configuration and management of the RAID capability of the Intel® C230 series chipset.

6.1.1.2 Intel® Embedded Server RAID Technology 2 (ESRT2)

Features of the embedded software RAID option Intel® Embedded Server RAID Technology 2 (ESRT2) include the following:

- Based on LSI* MegaRAID* Software Stack
- Software RAID with system providing memory and CPU utilization
- Supported RAID Levels – 0, 1, 10
- RAID 5 support is provided when an upgrade key RKSATA8R5 is installed. RAID 5 under legacy BIOS mode is not supported.
- Open Source Compliance = Binary Driver (includes Partial Source files) or Open Source using MDRAID layer in Linux*
- OS Support = Microsoft Windows 2012*, Microsoft Windows 2008*, RHEL*, SLES, and other Linux* variants using partial source builds
- Utilities = Microsoft Windows* GUI and CLI, Linux* GUI and CLI, DOS CLI, and EFI CLI

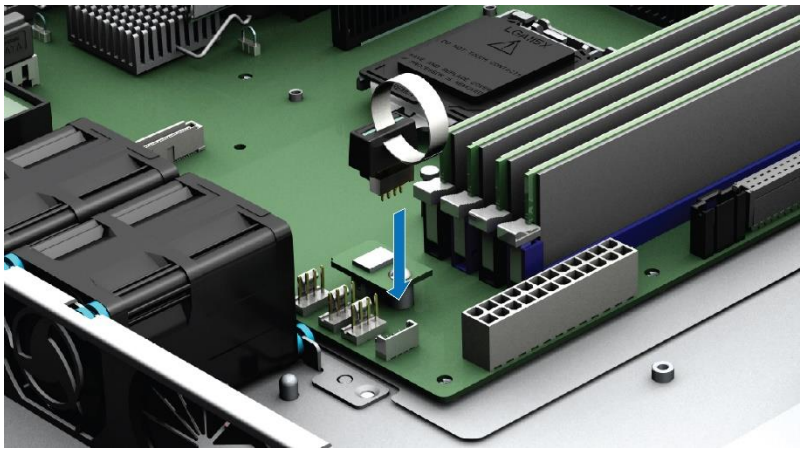


Figure 39. Intel® Raid Upgrade Key

6.2 Intel® Integrated RAID Module Support

The Intel® Server System R1000SPO product family provides a high density 80-pin connector labeled *SAS_MOD* for the installation of an optional Intel® SAS/ROC Mezzanine Integrated RAID Module.

Features of this option include:

- SKU options to support full or entry level hardware RAID
- 6Gb SAS/SATA ROC/IOC (LSI* 2208 and 2308)
- 12Gb SAS ROC/IOC (LSI* 3008 and 3108)
- 4 or 8 ports and SAS/SATA or SATA
- SKU options to support 512MB or 1GB embedded memory
- Intel® designed flash plus optional support for Intel® RAID Maintenance Free Backup Units (AXXRMFBU5)

NOTE: RAID configurations cannot span across the embedded and add-in AHCI SATA controllers.

For supported SAS modules, refer to the document *Intel® Server Boards S1200SP Configuration Guide and Spares/Accessories List*

6.2.1 Intel® RAID Maintenance Free Backup Unit (RMFBU) Support

The Intel® Server System R1000SPO product family has support for an Intel® RAID Maintenance Free Backup Unit (RMFBU).

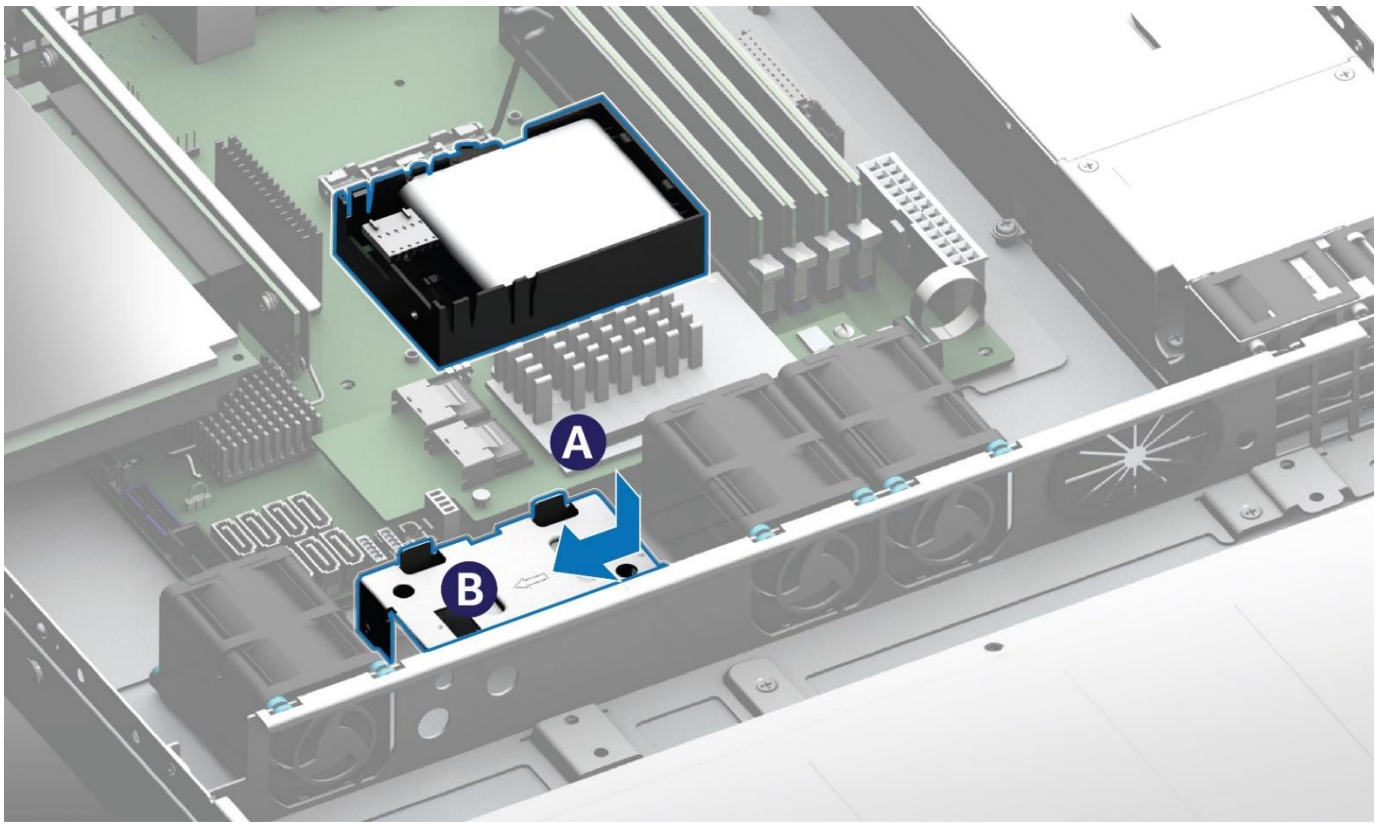


Figure 40. Intel® RAID Maintenance Free Backup Unit

7. Front Control Panel and I/O Panel Overview

All system configurations include a Control Panel and I/O Panel on the front of the system.

7.1 I/O Panel Features

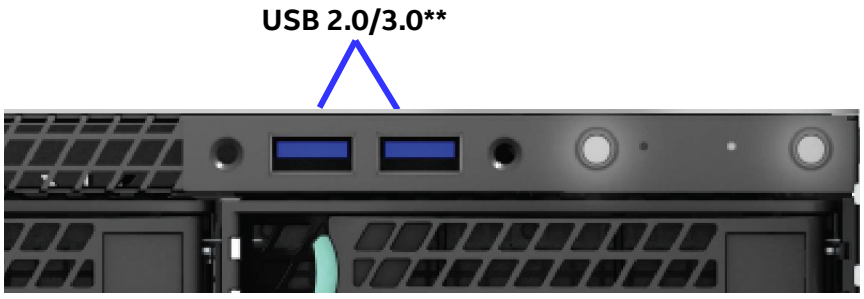


Figure 41. Front I/O Panel Features

USB 2.0/3.0 Ports –The front I/O panel includes two USB 2.0/3.0 ports. The USB ports are cabled to a Blue 2x5 connector on the server board labeled “Internal_USB3.0”.

**** NOTE**: Due to signal strength limits associated with USB 3.0 ports cabled to a front panel, some marginally compliant USB 3.0 devices may not be supported from these ports. In addition, server systems based on the Intel® Server Board S1200SP cannot be USB 3.0 certified with USB 3.0 ports cabled to a front panel.

7.2 Control Panel Features

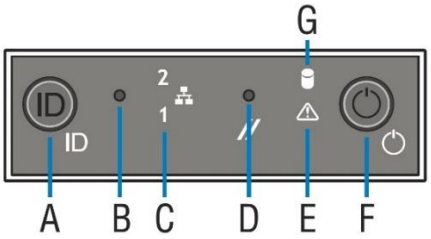


Figure 42. Front Panel LEDs and Buttons

The system includes a front panel that provides button system controls and LED indicators for several system features. This section will provide a description for each front control panel feature.

Table 32. Front Control Panel Buttons And Indicators

Label	Description
A	System ID Button w/Integrated LED
B	NMI Button (recessed, tool required for use)
C	NIC 1 & 2 Activity LEDs
D	System Cold Reset Button (recessed, tool required for use)
E	System Status LED
F	Power Button w/Integrated LED
G	Drive Activity LED

7.2.1 System Status LED

NOTE: The Status LED is controlled by the BMC but the BIOS informs the BMC of the state to which the Status LED should be set.

The System Status LED has specific states that are described in the following table but the actual state of the Status LED is indicative of one or more of the conditions listed. When multiple conditions are indicated to the BMC, the BMC reflects in the Status LED the highest severity of the conditions which have been reported to it. There are also conditions for which the BIOS is not responsible which may set the Status LED to the same or higher level of severity.

Table 33. System Status LED Indicator States

LED color state	LED Activity	State	BIOS Status description
Off	Off	System is not operating.	System AC power is off.
Green	Solid On	System is operating normally.	System is running (in S0 State) and no error conditions affecting the Status LED have been observed.
Green	Blink	System is operating in a degraded state although still functional, *or* system is operating in a redundant state but with an impending failure warning.	1. Unable to use all of the installed memory (one or more DIMMs failed/disabled but functional memory remains available). 2. Correctable memory error threshold has been reached for a failing DDR4 DIMM in memory Sparing Mode, causing Loss of Redundancy. 3. Uncorrectable memory error has occurred in memory Mirroring Mode, causing Loss of Redundancy. 4. Correctable memory error threshold has been reached for a failing DDR4 DIMM when the system is operating in fully redundant RAS Mirroring Mode.
Amber	Blink	System is operating in a degraded state with an impending failure warning, although still functioning.	Correctable memory error threshold has been reached for a failing DDR4 DIMM when the system is operating in a non-redundant mode.
Amber	Solid On	Critical/Fatal – system is halted.	1. Fatal Error in processor initialization. o Processor family not identical o Processor model not identical o Processor core/thread counts not identical o Processor cache size not identical o Unable to synchronize processor frequency o Unable to synchronize QPI Link frequency 2. Uncorrectable memory error in a non-redundant mode.

The BMC-detected states are included in the LED states. For fault states that are monitored by the BMC sensors, the contribution to the LED state follows the associated sensor state, with priority given to the most critical asserted state.

When the server is powered down (transitions to the DC-off state or S5), the BMC is still on standby power and retains the sensor and front panel status LED state established before the power-down event.

When AC power is first applied to the system, the status LED turns solid amber and then immediately changes to green blinking to indicate that the BMC is booting. Upon completing the BMC boot, the status LED will be solid green if there are no errors/abnormal conditions in the system. Please refer to the System Status LED states information in Table 33 for more details.

Table 34. Front panel LED indication of BMC state

State	Chassis ID (Blue)	Status LED	Comment
BMC/Video memory test failed	Solid Blue	Solid Amber	Non-recoverable condition. Contact your Intel representative for information on replacing this motherboard.
Both Universal Bootloader (u-Boot) images bad	Blink Blue 6Hz	Solid Amber	Non-recoverable condition. Contact your Intel representative for information on replacing this motherboard
BMC in u-Boot	Blink Blue 3Hz	Blink Green 1Hz	Blinking green indicates degraded state (no manageability), blinking blue indicates u-Boot is running but has not transferred control to BMC Linux*. Server will be in this state 6-8 seconds after BMC reset while it pulls the Linux* image into flash
BMC Booting Linux*	Solid Blue	Solid Green	Solid green with solid blue after an AC cycle/BMC reset, indicates that the control has been passed from u-Boot to BMC Linux* itself. It will be in this state for ~10-~20 seconds.
Normal operation	Off	Solid Green	Indicates BMC Linux* has booted and manageability functionality is up and running. Fault/Status LEDs operate as per usual.

8. PCIe* Riser Card Support

The system includes a riser card slot on the server board. This section will provide an overview and description of the server board features and architecture supporting it.

NOTE: **The riser card slot is specifically designed to support riser cards only.** Attempting to install a PCIe* add-in card directly into a riser card slot on the server board may damage the server board, the add-in card, or both.

The system supports a single slot PCIe* x16 (16 lanes, x16 slot) riser card. The riser card is mounted to a bracket assembly which is inserted into the riser card slot on the server board.

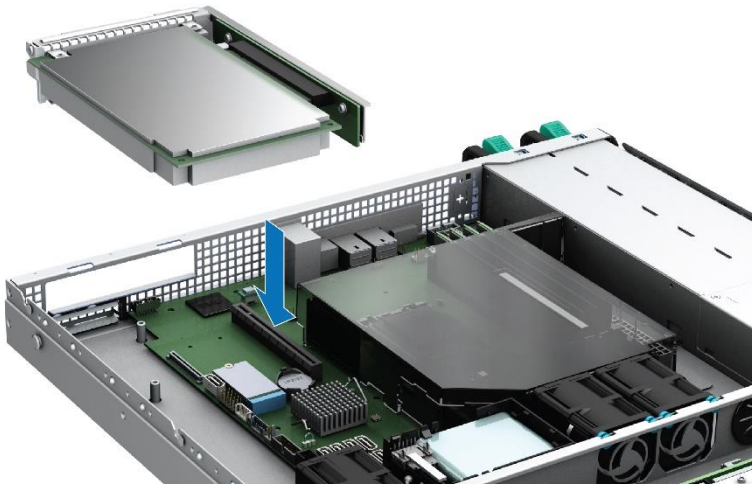


Figure 43. Add-in Card Support

The riser card assembly has support for a single full height, half-length PCIe* add-in card.

NOTE: Add-in cards that exceed the PCI specification for ½ length PCI add-in cards (167.65mm or 6.6in) may interfere with other installed devices on the server board.

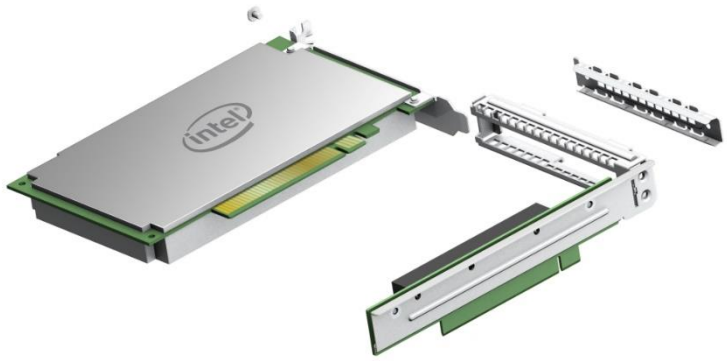


Figure 44. Riser Card Assembly

9. Intel® I/O Module Support

To broaden the standard on-board feature set, the server board provides support for one of several available Intel® I/O Module options. The I/O module attaches to a high density 80-pin connector on the server board (labeled “IO_Module”) and is supported by x8 PCIe Gen3 signals from the IIO module of the CPU 1 processor.

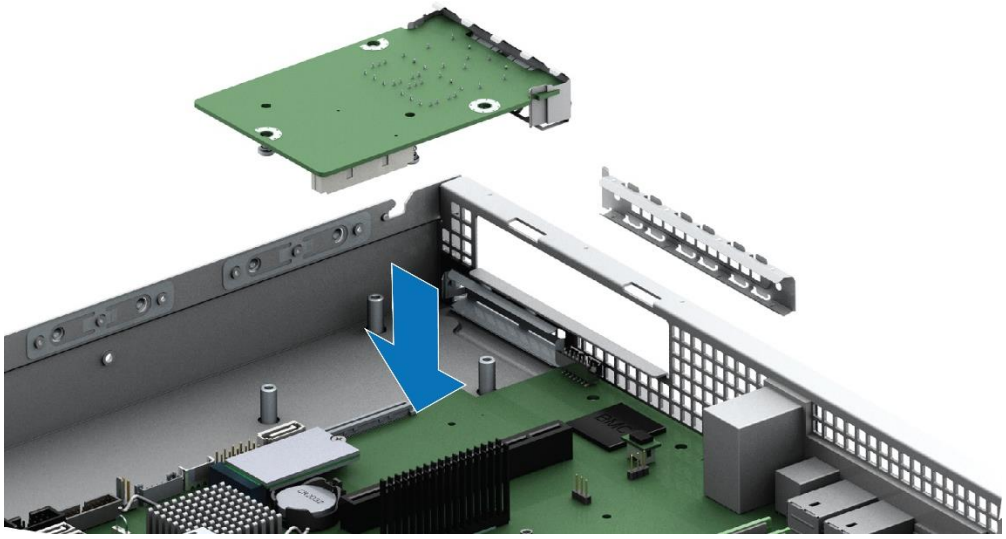


Figure 45. Intel® I/O Module Placement

Supported I/O modules include:

Table 35. Supported Intel® I/O Modules

Intel® I/O Module AXX10GBTWLIOM3	Dual RJ-45 port 10G BASE-T I/O expansion module, based on Intel® Ethernet Controller X540
Intel® I/O Module AXX10GBNIAIOM	Dual SFP+ port 10GbE IO module based on Intel® 82599 10 Gigabit Ethernet Controller
Intel® I/O Module AXX4P1GBPWLIOM	Quad port 1GbE I/O expansion module based on Intel® Ethernet Controller I350

10. Basic and Advanced Server Management Features

The integrated BMC has support for basic and advanced server management features. Basic management features are available by default. Advanced management features are enabled with the addition of an optionally installed Remote Management Module 4 Lite (RMM4 Lite) key.

Table 36. Intel® Remote Management Module 4 (RMM4) Options

Intel Product Code	Description	Kit Contents	Benefits
AXXRMM4LITE	Intel® Remote Management Module 4 Lite	RMM4 Lite Activation Key	Enables KVM & media redirection

When the BMC FW initializes, it attempts to access the Intel® RMM4 lite. If the attempt to access Intel® RMM4 lite is successful, then the BMC activates the A*dvanced* features.

The following table identifies both Basic and Advanced server management features.

Table 37. Basic and Advanced Server Management Features Overview

Feature	Basic	Advanced w/RMM4 Lite Key
IPMI 2.0 Feature Support	X	X
In-circuit BMC Firmware Update	X	X
FRB 2	X	X
Chassis Intrusion Detection	X	X
Fan Redundancy Monitoring	X	X
Hot-Swap Fan Support	X	X
Acoustic Management	X	X
Diagnostic Beep Code Support	X	X
Power State Retention	X	X
ARP/DHCP Support	X	X
PECI Thermal Management Support	X	X
E-mail Alerting	X	X
Embedded Web Server	X	X
SSH Support	X	X
Integrated KVM		X
Integrated Remote Media Redirection		X
Lightweight Directory Access Protocol (LDAP)	X	X
Intel® Intelligent Power Node Manager Support	X	X
SMASH CLP	X	X

10.1 IPMI 2.0 Features

- Baseboard management controller (BMC)
- IPMI Watchdog timer
- Messaging support, including command bridging and user/session support
- Chassis device functionality, including power/reset control and BIOS boot flags support
- Event receiver device: The BMC receives and processes events from other platform subsystems.
- Field Replaceable Unit (FRU) inventory device functionality: The BMC supports access to system FRU devices using IPMI FRU commands.
- System Event Log (SEL) device functionality: The BMC supports and provides access to a SEL.
- Sensor Data Record (SDR) repository device functionality: The BMC supports storage and access of system SDRs.
- Sensor device and sensor scanning/monitoring: The BMC provides IPMI management of sensors. It polls sensors to monitor and report system health.
- IPMI interfaces
  - Host interfaces including system management software (SMS) with receive message queue support, and server management mode (SMM)
  - IPMB interface
  - LAN interface that supports the IPMI-over-LAN protocol Remote Management Control Protocol (RMCP, RMCP+)
- Serial-over-LAN (SOL)
- ACPI state synchronization: The BMC tracks ACPI state changes that are provided by the BIOS.
- BMC self-test: The BMC performs initialization and run-time self-tests and makes results available to external entities.

Please refer to the *Intelligent Platform Management Interface Specification Second Generation v2.0* for more details.

10.2 Non-IPMI Features

The BMC supports the following non-IPMI features. This list does not preclude support for future enhancements or additions.

- In-circuit BMC firmware update
- Fault resilient booting (FRB): FRB2 is supported by the watchdog timer functionality.
- Chassis intrusion detection
- Basic fan speed control using Control version 2 SDRs
- Fan redundancy monitoring and support
- Power supply redundancy monitoring and support
- Hot-swap fan support
- Acoustic management: Support for multiple fan profiles
- Signal testing support: The BMC provides test commands for setting and getting platform signal states.
- The BMC generates diagnostic beep codes for fault conditions.
- System GUID storage and retrieval

- Front panel management: The BMC controls the system status LED and chassis ID LED. It supports secure lockout of certain front panel functionality and monitors button presses. The chassis ID LED is turned on using a front panel button or a command.
- Power state retention
- Power fault analysis
- Intel® Light-Guided Diagnostics
- Power unit management: Support for power unit sensor. The BMC handles power-good dropout conditions.
- DIMM temperature monitoring: New sensors and improved acoustic management using closed-loop fan control algorithm taking into account DIMM temperature readings.
- Address Resolution Protocol (ARP): The BMC sends and responds to ARPs (supported on embedded NICs).
- Dynamic Host Configuration Protocol (DHCP): The BMC performs DHCP (supported on embedded NICs).
- Platform environment control interface (PECI) thermal management support
- E-mail alerting
- Embedded web server:
- Integrated KVM
- Integrated Remote Media Redirection
- Lightweight Directory Access Protocol (LDAP) support
- Intel® Intelligent Power Node Manager support

On the server board the Intel® RMM4 Lite key is installed at the following location.

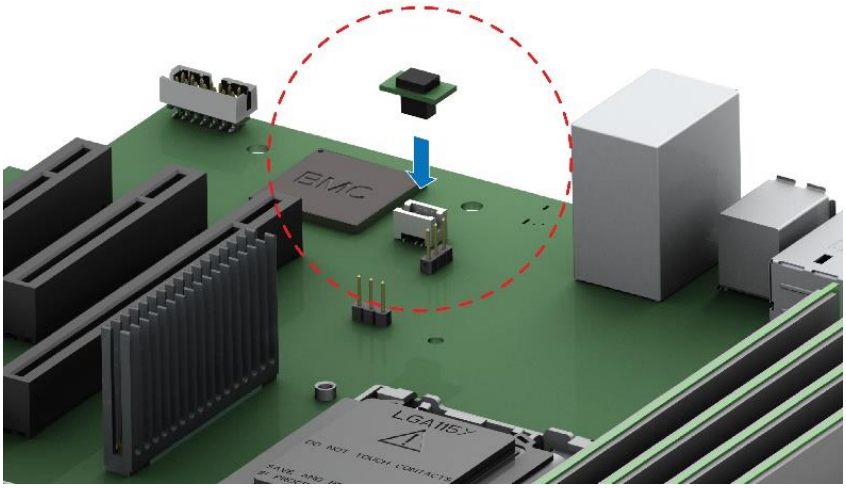


Figure 46. Intel® RMM4 Lite Activation Key Installation

10.2.1 Dedicated Management Port

The server board includes a dedicated 1GbE RJ45 Management Port. The management port is active with or without the RMM4 Lite key installed.

10.2.2 Embedded Web Server

BMC Base manageability provides an embedded web server and an OEM-customizable web GUI which exposes the manageability features of the BMC base feature set. It is supported over all on-board NICs that

have management connectivity to the BMC as well as an optional dedicated add-in management NIC. At least two concurrent web sessions from up to two different users is supported. The embedded web user interface shall support the following client web browsers:

- Microsoft Internet Explorer 9.0*
- Microsoft Internet Explorer 10.0*
- Mozilla Firefox 24*
- Mozilla Firefox 25*

The embedded web user interface supports strong security (authentication, encryption, and firewall support) since it enables remote server configuration and control. The user interface presented by the embedded web user interface, shall authenticate the user before allowing a web session to be initiated. Encryption using 128-bit SSL is supported. User authentication is based on user id and password.

The GUI presented by the embedded web server authenticates the user before allowing a web session to be initiated. It presents all functions to all users but grays-out those functions that the user does not have privilege to execute. For example, if a user does not have privilege to power control, then the item shall be displayed in grey-out font in that user's UI display. The web GUI also provides a launch point for some of the advanced features, such as KVM and media redirection. These features are grayed out in the GUI unless the system has been updated to support these advanced features. The embedded web server only displays US English or Chinese language output.

Additional features supported by the web GUI includes:

- Presents all the Basic features to the users
- Power on/off/reset the server and view current power state
- Displays BIOS, BMC, ME and SDR version information
- Display overall system health.
- Configuration of various IPMI over LAN parameters for both IPV4 and IPV6
- Configuration of alerting (SNMP and SMTP)
- Display system asset information for the product, board, and chassis.
- Display of BMC-owned sensors (name, status, current reading, enabled thresholds), including color-code status of sensors.
- Provides ability to filter sensors based on sensor type (Voltage, Temperature, Fan and Power supply related)
- Automatic refresh of sensor data with a configurable refresh rate
- On-line help
- Display/clear SEL (display is in easily understandable human readable format)
- Supports major industry-standard browsers (Microsoft Internet Explorer* and Mozilla Firefox*)
- The GUI session automatically times-out after a user-configurable inactivity period. By default, this inactivity period is 30 minutes.
- Embedded Platform Debug feature - Allow the user to initiate a "debug dump" to a file that can be sent to Intel for debug purposes.
- Virtual Front Panel. The Virtual Front Panel provides the same functionality as the local front panel. The displayed LEDs match the current state of the local panel LEDs. The displayed buttons (for example, power button) can be used in the same manner as the local buttons.

- Display of ME sensor data. Only sensors that have associated SDRs loaded will be displayed.
- Ability to save the SEL to a file
- Ability to force HTTPS connectivity for greater security. This is provided through a configuration option in the UI.
- Display of processor and memory information as is available over IPMI over LAN.
- Ability to get and set Node Manager (NM) power policies
- Display of power consumed by the server
- Ability to view and configure VLAN settings
- Warn user the reconfiguration of IP address will cause disconnect.
- Capability to block logins for a period of time after several consecutive failed login attempts. The lock-out period and the number of failed logins that initiates the lock-out period are configurable by the user.
- Server Power Control – Ability to force into Setup on a reset
- System POST results – The web server provides the system's Power-On Self-Test (POST) sequence for the previous two boot cycles, including timestamps. The timestamps may be viewed in relative to the start of POST or the previous POST code.
- Customizable ports – The web server provides the ability to customize the port numbers used for SMASH, http, https, KVM, secure KVM, remote media, and secure remote media.

For additional information, reference the Intel® Remote Management Module 4 and Integrated BMC Web Console Users Guide.

10.2.3 Advanced Management Feature Support (RMM4 Lite)

The integrated baseboard management controller has support for advanced management features which are enabled when an optional Intel® Remote Management Module 4 Lite (RMM4 Lite) is installed. The Intel RMM4 add-on offers convenient, remote KVM access and control through LAN and internet. It captures, digitizes, and compresses video and transmits it with keyboard and mouse signals to and from a remote computer. Remote access and control software runs in the integrated baseboard management controller, utilizing expanded capabilities enabled by the Intel RMM4 hardware.

Key Features of the RMM4 add-on are:

- KVM redirection from either the dedicated management NIC or the server board NICs used for management traffic; up to two KVM sessions
- Media Redirection – The media redirection feature is intended to allow system administrators or users to mount a remote IDE or USB CDROM, floppy drive, or a USB flash disk as a remote device to the server. Once mounted, the remote device appears just like a local device to the server allowing system administrators or users to install software (including operating systems), copy files, update BIOS, or boot the server from this device.
- KVM – Automatically senses video resolution for best possible screen capture, high performance mouse tracking and synchronization. It allows remote viewing and configuration in pre-boot POST and BIOS setup.

10.2.3.1 Keyboard, Video, Mouse (KVM) Redirection

The BMC firmware supports keyboard, video, and mouse redirection (KVM) over LAN. This feature is available remotely from the embedded web server as a Java applet. This feature is only enabled when the Intel® RMM4

lite is present. The client system must have a Java Runtime Environment (JRE) version 6.0 or later to run the KVM or media redirection applets.

The BMC supports an embedded KVM application (*Remote Console*) that can be launched from the embedded web server from a remote console. USB1.1 or USB 2.0 based mouse and keyboard redirection are supported. It is also possible to use the KVM-redirection (KVM-r) session concurrently with media-redirection (media-r). This feature allows a user to interactively use the keyboard, video, and mouse (KVM) functions of the remote server as if the user were physically at the managed server. KVM redirection console supports the following keyboard layouts: English, Dutch, French, German, Italian, Russian, and Spanish.

KVM redirection includes a “soft keyboard” function. The “soft keyboard” is used to simulate an entire keyboard that is connected to the remote system. The “soft keyboard” functionality supports the following layouts: English, Dutch, French, German, Italian, Russian, and Spanish.

The KVM-redirection feature automatically senses video resolution for best possible screen capture and provides high-performance mouse tracking and synchronization. It allows remote viewing and configuration in pre-boot POST and BIOS setup, once BIOS has initialized video.

Other attributes of this feature include:

- Encryption of the redirected screen, keyboard, and mouse
- Compression of the redirected screen.
- Ability to select a mouse configuration based on the OS type.
- Supports user definable keyboard macros.

KVM redirection feature supports the following resolutions and refresh rates:

- 640x480 at 60Hz, 72Hz, 75Hz, 85Hz, 100Hz
- 800x600 at 60Hz, 72Hz, 75Hz, 85Hz
- 1024x768 at 60Hx, 72Hz, 75Hz, 85Hz
- 1280x960 at 60Hz
- 1280x1024 at 60Hz
- 1600x1200 at 60Hz
- 1920x1080 (1080p),
- 1920x1200 (WUXGA)
- 1650x1080 (WSXGA+)

10.2.3.2 Remote Console

The Remote Console is the redirected screen, keyboard and mouse of the remote host system. To use the Remote Console window of your managed host system, the browser must include a Java* Runtime Environment plug-in. If the browser has no Java support, such as with a small handheld device, the user can maintain the remote host system using the administration forms displayed by the browser.

The Remote Console window is a Java Applet that establishes TCP connections to the BMC. The protocol that is run over these connections is a unique KVM protocol and not HTTP or HTTPS. This protocol uses ports #7578 for KVM, #5120 for CDROM media redirection, and #5123 for Floppy/USB media redirection. When encryption is enabled, the protocol uses ports #7582 for KVM, #5124 for CDROM media redirection, and #5127 for Floppy/USB media redirection. The local network environment must permit these

connections to be made, that is, the firewall and, in case of a private internal network, the NAT (Network Address Translation) settings have to be configured accordingly.

10.2.3.3 Performance

The remote display accurately represents the local display. The feature adapts to changes to the video resolution of the local display and continues to work smoothly when the system transitions from graphics to text or vice-versa. The responsiveness may be slightly delayed depending on the bandwidth and latency of the network.

Enabling KVM and/or media encryption will degrade performance. Enabling video compression provides the fastest response while disabling compression provides better video quality.

For the best possible KVM performance, a 2Mb/sec link or higher is recommended.

The redirection of KVM over IP is performed in parallel with the local KVM without affecting the local KVM operation.

10.2.3.4 Security

The KVM redirection feature supports multiple encryption algorithms, including RC4 and AES. The actual algorithm that is used is negotiated with the client based on the client's capabilities.

10.2.3.5 Availability

The remote KVM session is available even when the server is powered-off (in stand-by mode). No re-start of the remote KVM session shall be required during a server reset or power on/off. A BMC reset (for example, due to a BMC Watchdog initiated reset or BMC reset after BMC FW update) will require the session to be re-established.

KVM sessions persist across system reset, but not across an AC power loss.

10.2.3.6 Usage

As the server is powered up, the remote KVM session displays the complete BIOS boot process. The user is able interact with BIOS setup, change and save settings as well as enter and interact with option ROM configuration screens.

At least two concurrent remote KVM sessions are supported. It is possible for at least two different users to connect to same server and start remote KVM sessions.

10.2.3.7 Force-enter BIOS Setup

KVM redirection can present an option to force-enter BIOS Setup. This enables the system to enter F2 setup while booting which is often missed by the time the remote console redirects the video.

10.2.3.8 Media Redirection

The embedded web server provides a Java applet to enable remote media redirection. This may be used in conjunction with the remote KVM feature, or as a standalone applet.

The media redirection feature is intended to allow system administrators or users to mount a remote IDE or USB CD-ROM, floppy drive, or a USB flash disk as a remote device to the server. Once mounted, the remote device appears just like a local device to the server, allowing system administrators or users to install software (including operating systems), copy files, update BIOS, and so on, or boot the server from this device.

The following capabilities are supported:

- The operation of remotely mounted devices is independent of the local devices on the server. Both remote and local devices are useable in parallel.
- Either IDE (CD-ROM, floppy) or USB devices can be mounted as a remote device to the server.
- It is possible to boot all supported operating systems from the remotely mounted device and to boot from disk IMAGE (*.IMG) and CD-ROM or DVD-ROM ISO files. See the Tested/supported Operating System List (Table 3) for more information.
- Media redirection supports redirection for both a virtual CD device and a virtual Floppy/USB device concurrently. The CD device may be either a local CD drive or else an ISO image file; the Floppy/USB device may be a local Floppy drive, a local USB device, or a disk image file.
- The media redirection feature supports multiple encryption algorithms, including RC4 and AES. The actual algorithm that is used is negotiated with the client based on the client's capabilities.
- A remote media session is maintained even when the server is powered-off (in standby mode). No restart of the remote media session is required during a server reset or power on/off. An BMC reset (for example, due to an BMC reset after BMC FW update) will require the session to be re-established
- The mounted device is visible to (and useable by) managed system's OS and BIOS in both pre-boot and post-boot states.
- The mounted device shows up in the BIOS boot order and it is possible to change the BIOS boot order to boot from this remote device.
- It is possible to install an operating system on a bare metal server (no OS present) using the remotely mounted device. This may also require the use of KVM-r to configure the OS during install.

USB storage devices will appear as floppy disks over media redirection. This allows for the installation of device drivers during OS installation.

If either a virtual IDE or virtual floppy device is remotely attached during system boot, both the virtual IDE and virtual floppy are presented as bootable devices. It is not possible to present only a single-mounted device type to the system BIOS.

Availability

The default inactivity timeout is 30 minutes and is not user-configurable. Media redirection sessions persist across system reset but not across an AC power loss or BMC reset.

Network Port Usage

The KVM and media redirection features use the following ports:

- 5120 – CD Redirection
- 5123 – FD Redirection
- 5124 – CD Redirection (Secure)
- 5127 – FD Redirection (Secure)
- 7578 – Video Redirection
- 7582 – Video Redirection (Secure)

For additional information, reference the Intel® Remote Management Module 4 and Integrated BMC Web Console Users Guide.

Appendix A: Integration and Usage Tips

This section provides a list of useful information that is unique to the Intel® Server System R1000SPO Product Family and should be kept in mind while configuring your server system.

- When adding or removing components or peripherals from the server board, you must remove the AC power cord. With AC power plugged into the server board, 5-V standby is still present even though the server board is powered off.
- This server board supports the Intel® Xeon® Processor E3-1200 V5 product family with a Thermal Design Power (TDP) of up to and including 80 Watts. Previous generation Intel® Xeon® processors are not supported.
- On the back edge of the server board are EIGHT (2 rows of 4) diagnostic LEDs that display a sequence of POST codes during the boot process. If the server board hangs during POST, the LEDs display the last POST event run before the hang.
- Only ECC Unbuffered DDR4 DIMMs (UDIMMs) are supported on this Product Family.
- Clear CMOS with the AC power cord plugged in. Removing AC power before performing the CMOS Clear operation causes the system to automatically power up and immediately power down after the CMOS Clear procedure is followed and AC power is re-applied. If this happens, remove the AC power cord, wait 30 seconds, and then re-connect the AC power cord. Power up the system and proceed to the **<F2>** BIOS Setup Utility to reset the desired settings.
- Normal BMC functionality is disabled with the Force BMC Update jumper set to the “enabled” position (pins 2-3). You should never run the server with the Force BMC Update jumper set in this position and should only use the jumper in this position when the standard firmware update process fails. This jumper must remain in the default (disabled) position (pins 1-2) when the server is running normally.
- Make sure the recovery jumper is placed on pins 1-2, before a normal BIOS update procedure.

Appendix B: POST Code Diagnostic LED Decoder

As an aid to assist in trouble shooting a system hang that occurs during a system's Power-On Self-est (POST) process, the server board includes a bank of eight (2 rows of 4) POST Code Diagnostic LEDs on the back edge of the server board.

During the system boot process, Memory Reference Code (MRC) and System BIOS execute a number of memory initialization and platform configuration processes, each of which is assigned a specific hex POST code number. As each routine is started, the given POST code number is displayed to the POST Code Diagnostic LEDs on the back edge of the server board.

During a POST system hang, the displayed post code can be used to identify the last POST routine that was run prior to the error occurring, helping to isolate the possible cause of the hang condition.

Each POST code is represented by eight LEDs; four Green and four Amber. The POST codes are divided into two groups, an upper nibble and a lower nibble. The upper nibble bits are represented by Amber Diagnostic LEDs #4, #5, #6, #7. The lower nibble bits are represented by Green Diagnostics LEDs #0, #1, #2 and #3. If the bit is set in the upper and lower nibbles, the corresponding LED is lit. If the bit is clear, the corresponding LED is off.

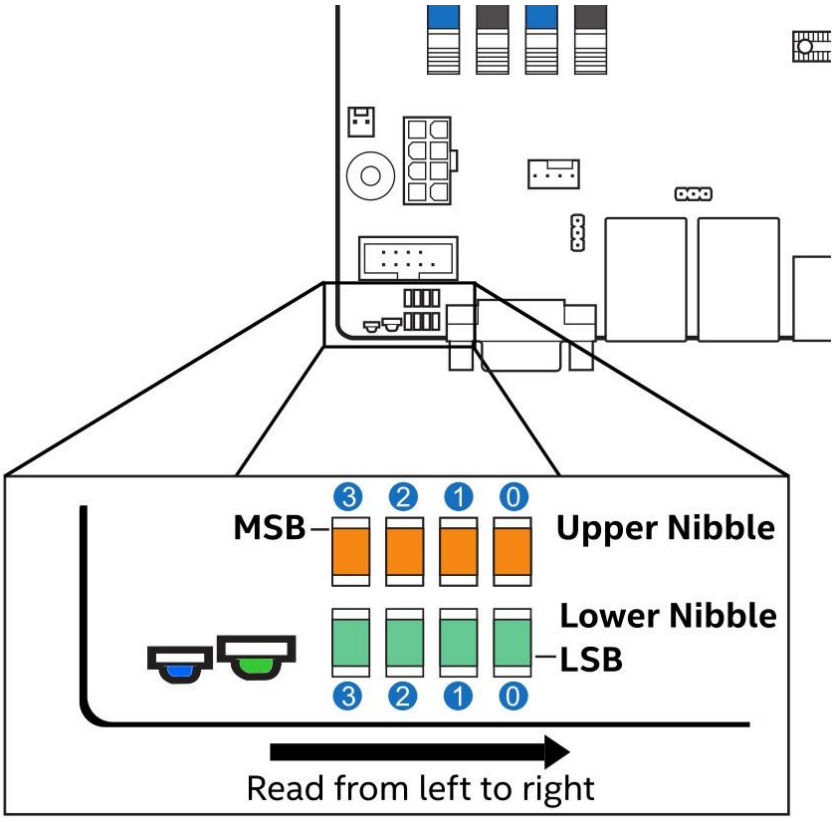


Figure 47. POST Diagnostic LED Location

In the following example, the BIOS sends a value of ACh to the diagnostic LED decoder. The LEDs are decoded as follows:

Table 38. POST Progress Code LED Example

	LED #3 8h (MSB)	LED #2 4h	LED #1 2h	LED #0 1h (LSB)	
LED Status	ON	off	ON	off	Upper Nibble: Ah
	ON	ON	off	off	Lower Nibble: Ch
	8h (MSB) LED #3	4h LED #2	2h LED #1	1h (LSB) LED #0	POST CODE: ACh

Note: Upper nibble bits = 1010b = Ah; Lower nibble bits = 1100b = Ch; the two are concatenated as ACh

The following table provides a list of all POST progress codes.

Table 39. POST Progress Codes

Diagnostic LED Decoder						
	LED #	LED 3	LED 2	LED 1	LED 0	
Checkpoint	Upper Nibble	8h (MSB)	4h	2h	1h (LSB)	Description
	Lower Nibble	8h (MSB)	4h	2h	1h (LSB)	
SEC Phase						
01h	Upper Nibble	off	off	off	off	First POST code after CPU reset
	Lower Nibble	off	off	off	ON	
02h	Upper Nibble	off	off	off	off	Microcode load begin
	Lower Nibble	off	off	ON	off	
03h	Upper Nibble	off	off	off	off	CRAM initialization begin
	Lower Nibble	off	off	ON	ON	
04h	Upper Nibble	off	off	off	off	Pei Cache When Disabled
	Lower Nibble	off	ON	off	off	
05h	Upper Nibble	off	off	off	off	SEC Core At Power On Begin.
	Lower Nibble	off	ON	off	ON	
06h	Upper Nibble	off	off	off	off	Early CPU initialization during Sec Phase.
	Lower Nibble	off	ON	ON	off	
07h	Upper Nibble	off	off	off	off	Early SB initialization during Sec Phase.
	Lower Nibble	off	ON	ON	ON	
08h	Upper Nibble	off	off	off	off	Early NB initialization during Sec Phase.
	Lower Nibble	ON	off	off	off	

Diagnostic LED Decoder						
	LED #	LED 3	LED 2	LED 1	LED 0	
Checkpoint	Upper Nibble	8h (MSB)	4h	2h	1h (LSB)	Description
	Lower Nibble	8h (MSB)	4h	2h	1h (LSB)	
09h	Upper Nibble	off	off	off	off	End Of Sec Phase.
	Lower Nibble	ON	off	off	ON	
0Eh	Upper Nibble	off	off	off	off	Microcode Not Found.
	Lower Nibble	ON	ON	ON	off	
0Fh	Upper Nibble	off	off	off	off	Microcode Not Loaded.
	Lower Nibble	ON	ON	ON	ON	
PEI Phase						
10h	Upper Nibble	off	off	off	ON	PEI Core
	Lower Nibble	off	off	off	off	
11h	Upper Nibble	off	off	off	ON	CPU PEIM
	Lower Nibble	off	off	off	ON	
15h	Upper Nibble	off	off	off	ON	NB PEIM
	Lower Nibble	off	ON	off	ON	
19h	Upper Nibble	off	off	off	ON	SB PEIM
	Lower Nibble	ON	off	off	ON	
MRC Process Codes – MRC Progress Code Sequence is executed						
PEI Phase continued…						
31h	Upper Nibble	off	off	ON	ON	Memory Installed
	Lower Nibble	off	off	off	ON	
32h	Upper Nibble	off	off	ON	ON	CPU PEIM (Cpu Init)
	Lower Nibble	off	off	ON	off	
33h	Upper Nibble	off	off	ON	ON	CPU PEIM (Cache Init)
	Lower Nibble	off	off	ON	ON	
4Fh	Upper Nibble	off	ON	off	off	Dxe IPL started
	Lower Nibble	ON	ON	ON	ON	
DXE Phase						
60h	Upper Nibble	off	ON	ON	off	DXE Core started
	Lower Nibble	off	off	off	off	
61h	Upper Nibble	off	ON	ON	off	DXE NVRAM Init
	Lower Nibble	off	off	off	ON	
62h	Upper Nibble	off	ON	ON	off	SB RUN Init
	Lower Nibble	off	off	ON	off	

Diagnostic LED Decoder						
	LED #	LED 3	LED 2	LED 1	LED 0	
Checkpoint	Upper Nibble	8h (MSB)	4h	2h	1h (LSB)	Description
	Lower Nibble	8h (MSB)	4h	2h	1h (LSB)	
63h	Upper Nibble	off	ON	ON	off	DXE CPU Init
	Lower Nibble	off	off	ON	ON	
65h	Upper Nibble	off	ON	ON	off	DXE CPU BSP Select
	Lower Nibble	off	ON	off	ON	
66h	Upper Nibble	off	ON	ON	off	DXE CPU AP Init
	Lower Nibble	off	ON	ON	off	
68h	Upper Nibble	off	ON	ON	off	DXE PCI Host Bridge Init
	Lower Nibble	ON	off	off	off	
69h	Upper Nibble	off	ON	ON	off	DXE NB Init
	Lower Nibble	ON	off	off	ON	
6Ah	Upper Nibble	off	ON	ON	off	DXE NB SMM Init
	Lower Nibble	ON	off	ON	off	
70h	Upper Nibble	off	ON	ON	ON	DXE SB Init
	Lower Nibble	off	off	off	off	
71h	Upper Nibble	off	ON	ON	ON	DXE SB SMM Init
	Lower Nibble	off	off	off	ON	
72h	Upper Nibble	off	ON	ON	ON	DXE SB devices Init
	Lower Nibble	off	off	ON	off	
78h	Upper Nibble	off	ON	ON	ON	DXE ACPI Init
	Lower Nibble	ON	off	off	off	
79h	Upper Nibble	off	ON	ON	ON	DXE CSM Init
	Lower Nibble	ON	off	off	ON	
80h	Upper Nibble	ON	off	off	off	DXE BDS Started
	Lower Nibble	off	off	off	off	
81h	Upper Nibble	ON	off	off	off	DXE BDS connect drivers
	Lower Nibble	off	off	off	ON	
82h	Upper Nibble	ON	off	off	off	DXE PCI Bus begin
	Lower Nibble	off	off	ON	off	
83h	Upper Nibble	ON	off	off	off	DXE PCI Bus HPC Init
	Lower Nibble	off	off	ON	ON	
84h	Upper Nibble	ON	off	off	off	DXE PCI Bus enumeration
	Lower Nibble	off	ON	off	off	

Diagnostic LED Decoder						
	LED #	LED 3	LED 2	LED 1	LED 0	
Checkpoint	Upper Nibble	8h (MSB)	4h	2h	1h (LSB)	Description
	Lower Nibble	8h (MSB)	4h	2h	1h (LSB)	
85h	Upper Nibble	ON	off	off	off	DXE PCI Bus resource requested
	Lower Nibble	off	ON	off	ON	
86h	Upper Nibble	ON	off	off	off	DXE PCI Bus assign resource
	Lower Nibble	off	ON	ON	off	
87h	Upper Nibble	ON	off	off	off	DXE CON_OUT connect
	Lower Nibble	off	ON	ON	ON	
88h	Upper Nibble	ON	off	off	off	DXE CON_IN connect
	Lower Nibble	ON	off	off	off	
89h	Upper Nibble	ON	off	off	off	DXE SIO Init
	Lower Nibble	ON	off	off	ON	
8A	Upper Nibble	ON	off	off	off	DXE USB start
	Lower Nibble	ON	off	ON	off	
8B	Upper Nibble	ON	off	off	off	DXE USB reset
	Lower Nibble	ON	off	ON	ON	
8C	Upper Nibble	ON	off	off	off	DXE USB detect
	Lower Nibble	ON	ON	off	off	
8D	Upper Nibble	ON	off	off	off	DXE USB enable
	Lower Nibble	ON	ON	off	ON	
90h	Upper Nibble	ON	off	off	ON	DXE IDE begin
	Lower Nibble	off	off	off	off	
91h	Upper Nibble	ON	off	off	ON	DXE IDE reset
	Lower Nibble	off	off	off	ON	
92h	Upper Nibble	ON	off	off	ON	DXE IDE detect
	Lower Nibble	off	off	ON	off	
93h	Upper Nibble	ON	off	off	ON	DXE IDE enable
	Lower Nibble	off	off	ON	ON	
94h	Upper Nibble	ON	off	off	ON	DXE SCSI begin
	Lower Nibble	off	ON	off	off	
95h	Upper Nibble	ON	off	off	ON	DXE SCSI reset
	Lower Nibble	off	ON	off	ON	
96h	Upper Nibble	ON	off	off	ON	DXE SCSI detect
	Lower Nibble	off	ON	ON	off	

Diagnostic LED Decoder						
	LED #	LED 3	LED 2	LED 1	LED 0	
Checkpoint	Upper Nibble	8h (MSB)	4h	2h	1h (LSB)	Description
	Lower Nibble	8h (MSB)	4h	2h	1h (LSB)	
97h	Upper Nibble	ON	off	off	ON	DXE SCSI enable
	Lower Nibble	off	ON	ON	ON	
98h	Upper Nibble	ON	off	off	ON	DXE verifying SETUP password
	Lower Nibble	ON	off	off	off	
99h	Upper Nibble	ON	off	off	ON	DXE SETUP start
	Lower Nibble	ON	off	off	ON	
9Ah	Upper Nibble	ON	off	off	ON	DXE SETUP input wait
	Lower Nibble	ON	off	ON	off	
9Bh	Upper Nibble	ON	off	off	ON	DXE Ready to Boot
	Lower Nibble	ON	off	ON	ON	
9Ch	Upper Nibble	ON	off	off	ON	DXE Legacy Boot
	Lower Nibble	ON	ON	off	off	
9Dh	Upper Nibble	ON	off	off	ON	DXE Exit Boot Services
	Lower Nibble	ON	ON	off	ON	
C0h	Upper Nibble	ON	ON	off	off	RT Set Virtual Address Map Begin
	Lower Nibble	off	off	off	off	
C1h	Upper Nibble	ON	ON	off	off	RT Set Virtual Address Map End
	Lower Nibble	off	off	off	ON	
C2h	Upper Nibble	ON	ON	off	off	DXE Legacy Option ROM init
	Lower Nibble	off	off	ON	off	
C3h	Upper Nibble	ON	ON	off	off	DXE Reset system
	Lower Nibble	off	off	ON	ON	
C4h	Upper Nibble	ON	ON	off	off	DXE USB Hot plug
	Lower Nibble	off	ON	off	off	
C5h	Upper Nibble	ON	ON	off	off	DXE PCI BUS Hot plug
	Lower Nibble	off	ON	off	ON	
C6h	Upper Nibble	ON	ON	off	off	DXE NVRAM cleanup
	Lower Nibble	off	ON	ON	off	
C7h	Upper Nibble	ON	ON	off	off	DXE Configuration Reset
	Lower Nibble	off	ON	ON	ON	
00h	Upper Nibble	off	off	off	off	INT19
	Lower Nibble	off	off	off	off	

Diagnostic LED Decoder						
	LED #	LED 3	LED 2	LED 1	LED 0	
Checkpoint	Upper Nibble	8h (MSB)	4h	2h	1h (LSB)	Description
	Lower Nibble	8h (MSB)	4h	2h	1h (LSB)	
S3 Resume						
40h	Upper Nibble	off	ON	off	off	S3 Resume PEIM (S3 started)
	Lower Nibble	off	off	off	off	
41h	Upper Nibble	off	ON	off	off	S3 Resume PEIM (S3 boot script)
	Lower Nibble	off	off	off	ON	
42h	Upper Nibble	off	ON	off	off	S3 Resume PEIM (S3 Video Repost)
	Lower Nibble	off	off	ON	off	
43h	Upper Nibble	off	ON	off	off	S3 Resume PEIM (S3 OS wake)
	Lower Nibble	off	off	ON	ON	
BIOS Recovery						
46h	Upper Nibble	off	ON	off	off	PEIM which detected forced Recovery condition
	Lower Nibble	off	ON	ON	off	
47h	Upper Nibble	off	ON	off	off	PEIM which detected User Recovery condition
	Lower Nibble	off	ON	ON	ON	
48h	Upper Nibble	off	ON	off	off	Recovery PEIM (Recovery started)
	Lower Nibble	ON	off	off	off	
49h	Upper Nibble	off	ON	off	off	Recovery PEIM (Capsule found)
	Lower Nibble	ON	off	off	ON	
4Ah	Upper Nibble	off	ON	off	off	Recovery PEIM (Capsule loaded)
	Lower Nibble	ON	off	ON	off	

POST Memory Initialization MRC Diagnostic Codes

There are two types of POST Diagnostic Codes displayed by the MRC during memory initialization; Progress Codes and Fatal Error Codes.

The MRC Progress Codes are displays to the Diagnostic LEDs that show the execution point in the MRC operational path at each step.

Table 40. MRC Progress Codes

Diagnostic LED Decoder						
	LED #	LED 3	LED 2	LED 1	LED 0	
Checkpoint	Upper Nibble	8h (MSB)	4h	2h	1h (LSB)	Description
	Lower Nibble	8h (MSB)	4h	2h	1h (LSB)	
MRC Progress Codes						
B0h	Upper Nibble	ON	off	ON	ON	Detect DIMM population
	Lower Nibble	off	off	off	off	
B1h	Upper Nibble	ON	off	ON	ON	Set DDR4 frequency
	Lower Nibble	off	off	off	ON	
B2h	Upper Nibble	ON	off	ON	ON	Gather remaining SPD data
	Lower Nibble	off	off	ON	off	
B3h	Upper Nibble	ON	off	ON	ON	Program registers on the memory controller level
	Lower Nibble	off	off	ON	ON	
B4h	Upper Nibble	ON	off	ON	ON	Evaluate RAS modes and save rank information
	Lower Nibble	off	ON	off	off	
B5h	Upper Nibble	ON	off	ON	ON	Program registers on the channel level
	Lower Nibble	off	ON	off	ON	
B6h	Upper Nibble	ON	off	ON	ON	Perform the JEDEC defined initialization sequence
	Lower Nibble	off	ON	ON	off	
B7h	Upper Nibble	ON	off	ON	ON	Train DDR4 ranks
	Lower Nibble	off	ON	ON	ON	
B8h	Upper Nibble	ON	off	ON	ON	Initialize CLTT/OLTT
	Lower Nibble	ON	off	off	off	
B9h	Upper Nibble	ON	off	ON	ON	Hardware memory test and init
	Lower Nibble	ON	off	off	ON	
BAh	Upper Nibble	ON	off	ON	ON	Execute software memory init
	Lower Nibble	ON	off	ON	off	
BBh	Upper Nibble	ON	off	ON	ON	Program memory map and interleaving
	Lower Nibble	ON	off	ON	ON	
BCh	Upper Nibble	ON	off	ON	ON	Program RAS configuration
	Lower Nibble	ON	ON	off	off	
BFh	Upper Nibble	ON	off	ON	ON	MRC is done
	Lower Nibble	ON	ON	ON	ON	

Memory Initialization at the beginning of POST includes multiple functions, including: discovery, channel training, validation that the DIMM population is acceptable and functional, initialization of the IMC and other hardware settings, and initialization of applicable RAS configurations.

When a major memory initialization error occurs and prevents the system from booting with data integrity, a beep code is generated, the MRC will display a fatal error code on the diagnostic LEDs, and a system halt command is executed. Fatal MRC error halts do NOT change the state of the System Status LED, and they do NOT get logged as SEL events. The following table lists all MRC fatal errors that are displayed to the Diagnostic LEDs.

Table 41. POST Progress LED Codes

Diagnostic LED Decoder						
	LED #	**LED 3**	**LED 2**	**LED 1**	**LED 0**	
Checkpoint	**Upper Nibble**	**8h (MSB)**	**4h**	**2h**	**1h (LSB)**	**Description**
	Lower Nibble	**8h (MSB)**	**4h**	**2h**	**1h (LSB)**	
MRC Fatal Error Codes						
E8h	**Upper Nibble**	ON	ON	ON	off	No usable memory error 01h = No memory was detected from the SPD read, or invalid config that causes no operable memory.
	Lower Nibble	ON	off	off	off	02h = Memory DIMMs on all channels of all sockets are disabled due to hardware mem-test error. 3h = No memory installed. All channels are disabled.
E9h	**Upper Nibble**	ON	ON	ON	off	Memory is locked by Intel® Trusted Execution Technology and is inaccessible
	Lower Nibble	ON	off	off	ON	
EAh	**Upper Nibble**	ON	ON	ON	off	DDR4 channel training error 01h = Error on read DQ/DQS (Data/Data Strobe) init 02h = Error on Receive Enable
	Lower Nibble	ON	off	ON	off	3h = Error on Write Leveling 04h = Error on write DQ/DQS (Data/Data Strobe
EBh	**Upper Nibble**	ON	ON	ON	off	Memory test failure 01h = Software mem-test failure. 02h = Hardware mem-test failed.
	Lower Nibble	ON	off	ON	ON	03h = Hardware Mem-test failure in Lockstep Channel mode requiring a channel to be disabled. This is a fatal error which requires a reset and calling MRC with a different RAS mode to retry.

Diagnostic LED Decoder						
	LED #	**LED 3**	**LED 2**	**LED 1**	**LED 0**	**Description**
Checkpoint	**Upper Nibble**	**8h (MSB)**	**4h**	**2h**	**1h (LSB)**	
	Lower Nibble	**8h (MSB)**	**4h**	**2h**	**1h (LSB)**	
EDh	**Upper Nibble**	ON	ON	ON	off	DIMM configuration population error 01h = Different DIMM types (UDIMM, RDIMM, LRDIMM) are detected installed in the system. 02h = Violation of DIMM population rules.
	Lower Nibble	ON	ON	off	ON	03h = The 3rd DIMM slot cannot be populated when QR DIMMs are installed. 04h = UDIMMs are not supported in the 3rd DIMM slot. 05h = Unsupported DIMM Voltage.
EFh	**Upper Nibble**	ON	ON	ON	off	Indicates a CLTT table structure error
	Lower Nibble	ON	ON	ON	ON	

Appendix C: POST Code Errors

Most error conditions encountered during POST are reported using POST Error Codes. These codes represent specific failures, warnings, or are informational. POST Error Codes may be displayed in the Error Manager Display screen, and are always logged to the System Event Log (SEL). Logged events are available to System Management applications, including Remote and Out of Band (OOB) management.

There are exception cases in early initialization where system resources are not adequately initialized for handling POST Error Code reporting. These cases are primarily Fatal Error conditions resulting from initialization of processors and memory, and they are handed by a Diagnostic LED display with a system halt.

The following table lists the supported POST Error Codes. Each error code is assigned an error type which determines the action the BIOS will take when the error is encountered. Error types include Minor, Major, and Fatal. The BIOS action for each is defined as follows:

- **Minor:** The error message is displayed on the screen or on the Error Manager screen, and an error is logged to the SEL. The system continues booting in a degraded state. The user may want to replace the erroneous unit. The POST Error Pause option setting in the BIOS setup does not have any effect on this error.
- **Major:** The error message is displayed on the Error Manager screen, and an error is logged to the SEL. The POST Error **Pause** option setting in the BIOS setup determines whether the system pauses to the Error Manager for this type of error so the user can take immediate corrective action or the system continues booting.

  Note that for 0048 “Password check failed”, the system halts, and then after the next reset/reboot will displays the error code on the Error Manager screen.
- **Fatal:** The system halts during post at a blank screen with the text **“Unrecoverable fatal error found. System will not boot until the error is resolved”** and **“Press <F2> to enter setup”** The POST Error Pause option setting in the BIOS setup does not have any effect with this class of error.

  When the operator presses the **F2** key on the keyboard, the error message is displayed on the Error Manager screen, and an error is logged to the SEL with the error code. The system cannot boot unless the error is resolved. The user needs to replace the faulty part and restart the system.

NOTE: The POST error codes in the following table are common to all current generation Intel server platforms. Features present on a given server board/system will determine which of the listed error codes are supported

Table 42. POST Error Codes and Messages

Error Code	Error Message	Response
0012	System RTC date/time not set	Major
0048	Password check failed	Major
0140	PCI component encountered a PERR error	Major
0141	PCI resource conflict	Major
0146	PCI out of resources error	Major
0191	Processor core/thread count mismatch detected	Fatal
0192	Processor cache size mismatch detected	Fatal
0194	Processor family mismatch detected	Fatal

Error Code	Error Message	Response
0195	Processor Intel(R) QPI link frequencies unable to synchronize	Fatal
0196	Processor model mismatch detected	Fatal
0197	Processor frequencies unable to synchronize	Fatal
5220	BIOS Settings reset to default settings	Major
5221	Passwords cleared by jumper	Major
5224	Password clear jumper is Set	Major
8130	Processor 01 disabled	Major
8131	Processor 02 disabled	Major
8160	Processor 01 unable to apply microcode update	Major
8161	Processor 02 unable to apply microcode update	Major
8170	Processor 01 failed Self Test (BIST)	Major
8171	Processor 02 failed Self Test (BIST)	Major
8180	Processor 01 microcode update not found	Minor
8181	Processor 02 microcode update not found	Minor
8190	Watchdog timer failed on last boot	Major
8198	OS boot watchdog timer failure	Major
8300	Baseboard management controller failed self test	Major
8305	Hot Swap Controller failure	Major
83A0	Management Engine (ME) failed self test	Major
83A1	Management Engine (ME) Failed to respond.	Major
84F2	Baseboard management controller failed to respond	Major
84F3	Baseboard management controller in update mode	Major
84F4	Sensor data record empty	Major
84FF	System event log full	Minor
8500	Memory component could not be configured in the selected RAS mode	Major
8501	DIMM Population Error	Major
8520	DIMM_A1 failed test/initialization	Major
8521	DIMM_A2 failed test/initialization	Major
8523	DIMM_B1 failed test/initialization	Major
8524	DIMM_B2 failed test/initialization	Major
8540	DIMM_A1 disabled	Major
8541	DIMM_A2 disabled	Major
8543	DIMM_B1 disabled	Major
8544	DIMM_B2 disabled	Major
8560	DIMM_A1 encountered a Serial Presence Detection (SPD) failure	Major
8561	DIMM_A2 encountered a Serial Presence Detection (SPD) failure	Major
8563	DIMM_B1 encountered a Serial Presence Detection (SPD) failure	Major
8564	DIMM_B2 encountered a Serial Presence Detection (SPD) failure	Major
8604	POST Reclaim of non-critical NVRAM variables	Minor
8605	BIOS Settings are corrupted	Major
8606	NVRAM variable space was corrupted and has been reinitialized	Major
8607	Recovery boot has been initiated. **NOTE**: The Primary BIOS image may be corrupted or the system may hang during POST. A BIOS update is required.	Fatal

Error Code	Error Message	Response
92A3	Serial port component was not detected	Major
92A9	Serial port component encountered a resource conflict error	Major
A000	TPM device not detected.	Minor
A001	TPM device missing or not responding.	Minor
A002	TPM device failure.	Minor
A003	TPM device failed self-test.	Minor
A100	BIOS ACM Error	Major
A421	PCI component encountered a SERR error	Fatal
A5A0	PCI Express component encountered a PERR error	Minor
A5A1	PCI Express component encountered an SERR error	Fatal
A6A0	DXE Boot Services driver: Not enough memory available to shadow a Legacy Option ROM.	Minor

POST Error Beep Codes

The following table lists the POST error beep codes. Prior to system video initialization, the BIOS uses these beep codes to inform users on error conditions. The beep code is followed by a user-visible code on the POST Progress LEDs.

Table 43. POST Error Beep Codes

Beeps	Error Message	POST Progress Code	Description
1	USB device action	N/A	Short beep sounded whenever USB device is discovered in POST, or inserted or removed during runtime.
1 long	Intel® TXT security violation	0xAE, 0xAF	System halted because Intel® Trusted Execution Technology detected a potential violation of system security.
3	Memory error	Multiple	System halted because a fatal error related to the memory was detected.
3 long and 1	CPU mismatch error	0xE5, 0xE6	System halted because a fatal error related to the CPU family/core/cache mismatch was detected.
The following Beep Codes are sounded during BIOS Recovery.			
2	BIOS Recovery started	N/A	Recovery boot has been initiated.
4	BIOS Recovery failure	N/A	BIOS recovery has failed. This typically happens so quickly after recovery us initiated that it sounds like a 2-4 beep code.

The Integrated BMC may generate beep codes upon detection of failure conditions. Beep codes are sounded each time the problem is discovered, such as on each power-up attempt, but are not sounded continuously. Codes that are common across all Intel server boards and systems that use same generation chipset are listed in the following table. Each digit in the code is represented by a sequence of beeps whose count is equal to the digit.

Table 44. Integrated BMC Beep Codes

Code	Associated Sensors	Reason for Beep
1-5-2-1	No CPUs installed or first CPU socket is empty.	CPU1 socket is empty, or sockets are populated incorrectly CPU1 must be populated before CPU2.
1-5-2-4	MSID Mismatch	MSID mismatch occurs if a processor is installed into a system board that has incompatible power capabilities.
1-5-4-2	Power fault	DC power unexpectedly lost (power good dropout) – Power unit sensors report power unit failure offset
1-5-4-4	Power control fault (power good assertion timeout).	Power good assertion timeout – Power unit sensors report soft power control failure offset
1-5-1-2	VR Watchdog Timer sensor assertion	VR controller DC power on sequence was not completed in time.
1-5-1-4	Power Supply Status	The system does not power on or unexpectedly powers off and a Power Supply Unit (PSU) is present that is an incompatible model with one or more other PSUs in the system.

Appendix D: System Cable Routing Diagrams

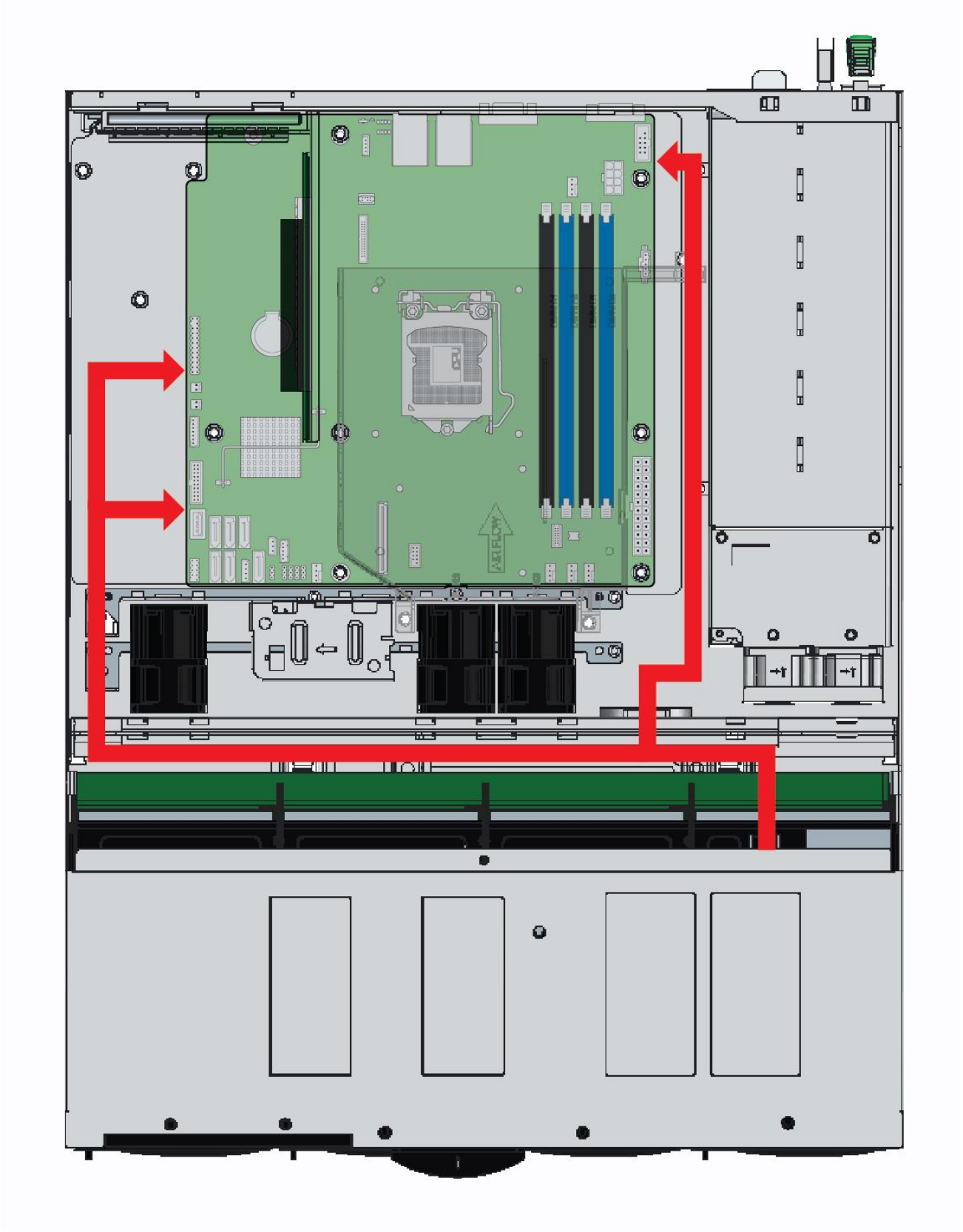


Figure 48. Internal Cable Routing

Appendix E: High Temperature Ambient Info

The system can operate in an environment that complies with ASHARE Class A3 specification with no hardware configuration limitation. However, there are limitations regarding the time that the system can operate in such situation.

The ASHARE Class A3 specification includes operation of the system in an environment with a temperature of 40°C for up to 900 hours per year. The use beyond this limits may impact system reliability.

The following notes communicate support criteria associated with specific configurations identified in the following table. Each relevant note to a configuration is identified by reference number in the table.

1. The 27°C configuration alone is limited to elevations of 900m or less. Altitudes higher than 900m need to be de-rated to ASHRAE Class 2 levels.
2. To support system fan redundancy, the system must be configured with two power supplies to maintain sufficient cooling. Concurrent system and power supply fan failures is not supported.
3. Processor and memory throttling may occur which may impact system performance. CPU reliability is not impacted.
4. In fan fail mode, Intel® I/O Modules AXX10GBTWLIOM and AXX2FDRIBIOM are only supported in the specified base system model configured with 120W processors and DRx4 memory.
5. Use of the designated PCIe* slot is limited to add-in cards that have a limit of 55°C local ambient temperature and air flow requirements of 200 LFM or less. Please refer to the add-in card specs for air flow requirements.
6. For ASHRAE Class 3 and Class 4 support, the following power supply margining is required to meet thermal specifications:
a) For dual power supply configurations, the power budget must fit within a single power supply rated load and be installed in a dual configuration, or
b) For single power supply configurations, the power budget must be sized with 30% margin to single power supply rated load.
7. The system only supports PCIe* SSD Add-in Card FF devices which have operational temperature limits of 55°C local ambient temperature and 300LFM.
8. The Intel® RAID Maintenance Free Backup Unit (AXXRMFBUx) can support a case temperature of up to 45°C with the system operating in normal mode and up to 55°C with the system operating in a fan fail mode. Excursions over these specs may result in a reliability impact.
9. M.2 drives may see performance impact under heavy work load
10. Light workload is assuming 70% write, 30% read, 100% Random, 100% access, 8kb transfer rate, I/O "delay" of 8ms
11. M.2 drives may see a slight performance impact under light workloads.

Thermal Configuration Table

"●" = Full Support without limitation
"4.5" (Cell with number) = Conditional support with limitation
" " (Blank) = Not supported

ASHRAE (See Note 1)	Classifications	27°C	A2	A3
	Maximum Ambient Temperature	27°C(1)	35°C	40°C
	Altitude in meters	900	900	900
Power Supply (See Note 6)	450W AC	●	●	●
	350W AC	●	●	●
Intel® Xeon® E3 Processors (See Note 3)	E3-1280V5 4+0 80W TDP	●	●	●
	E3-1270V5 4+0 80W TDP	●	●	●
	E3-1240V5 4+0 80W TDP	●	●	●
	E3-1230V5 4+0 80W TDP	●	●	●
	E3-1220V5 4+0 80W TDP	●	●	●
	E3-1260LV5 4+0 45W TDP	●	●	●
	E3-1240LV5 4+0 25W TDP	●	●	●
Memory Type	DDR4 UDIMM-up to 2133MHz	●	●	●
Add-in Cards (See note 5)	On Riser Card	●	●	●
SAS and I/O Modules (See Note 4)	Intel® Integrated RAID Modules (Mezzanine cards)	●	●	●
	AXX10GBTWLIOM3 - Dual 10GBASE-T I/O Module	●	●	●
	AXX4P1GBPWLIOM - Quad Port 1GbE I/O Module	●	●	●
	AXX10GBNIAIOM - Dual SFP+ port 10GbE I/O Module	●	●	●
Battery Backup (See note 8)	BBU (rated to 45°C)	●	●	●
	RMFBU (rated to 55°C)	●	●	●
	Cache Offload Module (rated to 55°C)	●	●	●
2.5" SSD on front edge	Rated to 60°C	●	●	●
	Rated to 70°C	●	●	●
PCIe* SSD AIC FF(DC P3700/P3500) (See note 7)	1.6TB/2TB	●	●	●
	800GB	●	●	●
	600GB	●	●	●
	400GB	●	●	●
	200GB	●	●	●
Chipset	C230 Series Chipset up to 5.9W TDP	●	●	●
NIC	NIC chip up to 0.74W	●	●	●
M.2 full TDP	ADATA* M.2 SATA SSD 128GB	●	●	●
	Plextor* M.2 SATA SSD 64GB	●	●	●
	Other Non-Intel M.2 SSD	10	10	10
M.2 Typical OS Workload [10]	ADATA* M.2 SATA SSD 128GB	●	●	●
	Plextor* M.2 SATA SSD 64GB	●	●	●
	Other Non-Intel M.2 SSD	12	12	12

Glossary

Acronym	Definition
TPS	Technical Product Specification
NDA	Non-Disclosure Agreement
I/O	Input/Output
VLSI	Very Large Scale Integration
TDP	Thermal Design Power
PCH	Platform Hub Controller
DMI	Direct Media Interface
PCIe*	Peripheral Component Interconnect Express*
SFP+	Enhanced Small Form-Factor Pluggable
DIMM	Dual In-line Memory Module
RAID	Redundant Array of Independent Disks
TPM	Trusted Platform Module
IPMI	Intelligent Platform Management Interface
SAS	Serial Attached SCSI
SATA	Serial Advanced Technology Attachment
EFI	Extended Firmware Interface
UEFI	Unified Extended Firmware Interface
OS	Operating System
CV	Compatibility Validation
NMI	Non-Maskable Interrupt
NIC	Network Interface Card
ISTA	International Safe Transit Association
PDB	Power Distribution Board
VAC	Voltage Alternating Current
VDC	Voltage Direct Current
SSI	Server System Infrastructure Forum
EPS	External Product Specification
OCP	Over-Current Protection
OVP	Over Voltage Protection
OTP	Over Temperature Protection
PS	Power Supply
CFM	Cubic Feet per minute
LFM	Linear feet per minute
HTA	High Temperature Ambient
BMC	Baseboard Management Controller
SDR	Sensor Data Record
SSD	Solid State Drive
HDD	Hard Disk Drive
PWM	Pulse Width Modulation
BIOS	Basic Input-Output System

Acronym	Definition
PMBUS	Power Management Bus
SATADOM	SATA Disk On a Module
RVI	Rotational Vibration Interference
THOL	Tested Hardware and operating list
HSBP	Hot-Swap Backplane
AHCI	Advanced Host Controller Interface
ESRT2	Embedded Server RAID Technology 2
RSTE	Intel® Rapid Storage Technology enterprise
USB	Universal Serial Bus
KVM	Keyboard, Video and Mouse Interface
RMM4	Remote Management Module
FRU	Field Replaceable Unit
SEL	System Event Log
SMS	System Management Software
RMCP	Remote Management Control Protocol
SMN	Server Management Mode
FRB	Fault Resilient Booting
DHCP	Dynamic Host Configuration Protocol
PECI	Platform Environment Control Interface
LDAP	Lightweight Directory Access Protocol
SSL	Secure Socket Layer
SMTP	Simple Mail Transfer Protocol
SNMP	Simple Network Management Protocol
VLAN	Virtual Local Area Network
POST	Power-On Self Test
FW	Firmware
AIC	Add-in Card

NOTES