Intel® Server Board S2600WF Product Family

Technical Product Specification

An overview of product features, functions, architecture, and support specifications.

Rev 1.3

August 2018

Intel® Server Products and Solutions

<Blank Page>

Document Revision History

Date	Revision	Description of Change
July 2017	1.0	Production release.
October 2017	1.1	Updated all tables from Appendix B and Appendix C. Updated Product Architecture Overview. Updated S2600WF Architecture Block Diagram. Added Intel® QAT information: • Server Board Product Family Feature Set • Architecture Board Diagram • Added 6.1 section Intel® QuickAssist Technology Support • Added S2600WFQ Architecture Block Diagram
November 2017	1.2	Updated Trusted Platform Module (China version) iPC AXXTPMCHNE8 on table Intel® Server Board S2600WF product family feature set. Added section: 3.3.1.12 Trusted Platform Module (TPM) on 3.3.1 Supported Technologies. Added TPM definition on Glossary section.
August 2018	1.3	Updated Disclaimers page. Corrected wording and typos.

Disclaimers

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

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

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

The products described may contain design defects or errors known as errata which may cause the product to deviate from published specifications. Current characterized errata are available on request.

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

Copies of documents which have an order number and are referenced in this document may be obtained by calling 1-800-548-4725 or by visiting www.intel.com/design/literature.htm.

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

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

Table of Contents

List of Figures

List of Tables

1. Introduction

This Technical Product Specification (TPS) provides a high level overview of the features, functions, architecture and support specifications of the Intel® Server Board S2600WF product family.

Note: This document includes several references to Intel websites where additional product information can be downloaded. However, these public Intel sites will not include content for products in development. Content for these products will be available on the public Intel web sites after their public launch.

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.

For more in-depth technical information, refer to the documents in Table 1.

Table 1. Reference documents

Document Title	Document Classification
Intel® Servers System BMC Firmware EPS for Intel® Xeon® processor Scalable Family	Intel Confidential
Intel® Server System BIOS EPS for Intel® Xeon® processor Scalable Family	Intel Confidential
Intel® C62x Series Chipset Platform Controller Hub External Design Specification	Intel Confidential
Intel® Xeon® processor Scalable family Server Processor External Design Specification Doc ID: 546831, 546833, 546834, 546832	Intel Confidential
Intel® Ethernet Connection X557-AT2 Product Brief	Public

1.1 Intel 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 operating environment. Intel Corporation cannot be held responsible if components fail or the server board does not operate correctly when used outside any of its published operating or non-operating limits.

1.2 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 http://www.intel.com/support.

2. Server Board Family Overview

The Intel® Server Board S2600WF is a monolithic printed circuit board assembly with features that are intended for high density 1U and 2U rack mount servers. This server board is designed to support the Intel® Xeon® processor Scalable family. Previous generation Intel® Xeon® processors are not supported.

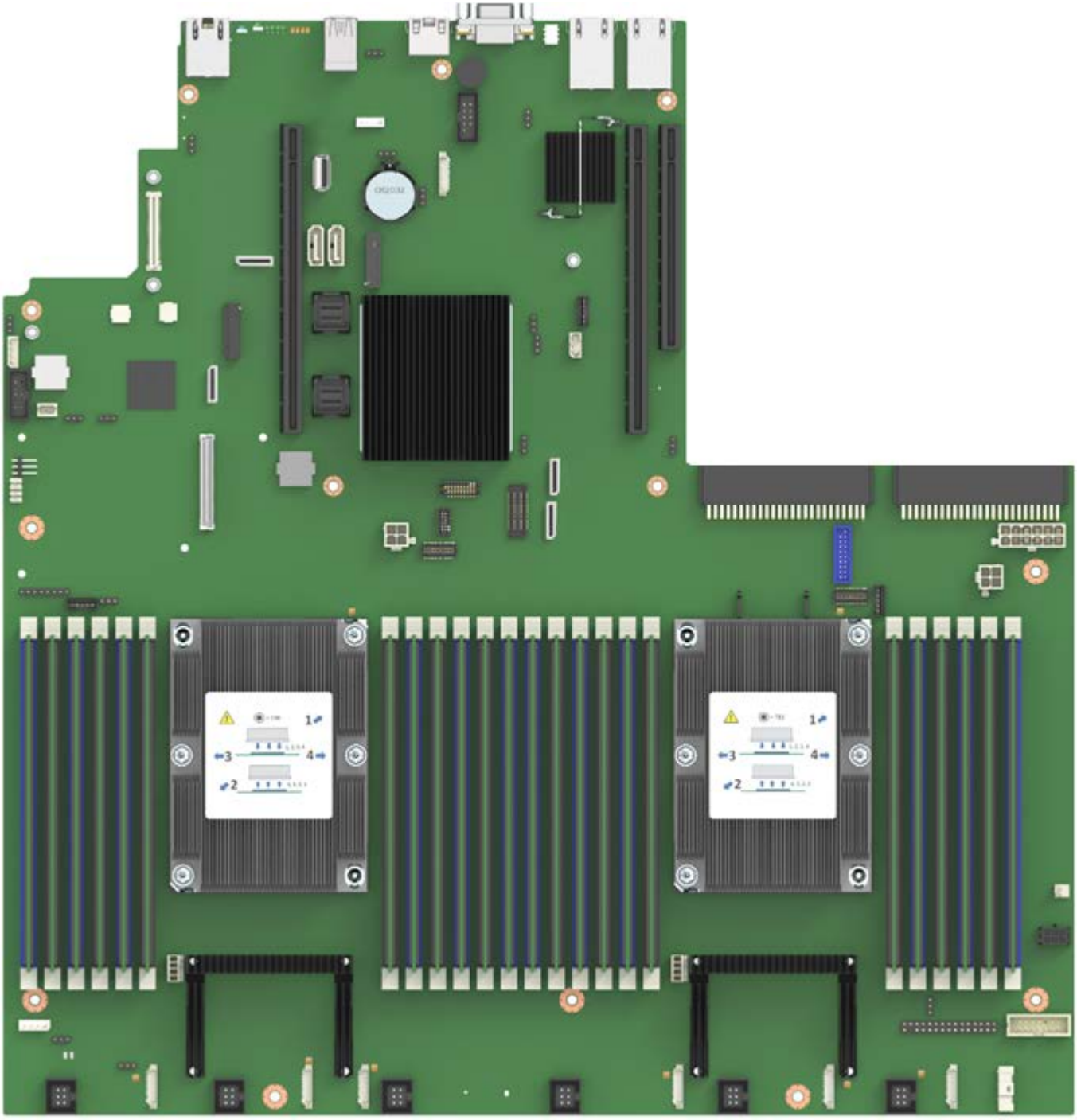


Figure 1. Intel® Server Board S2600WF

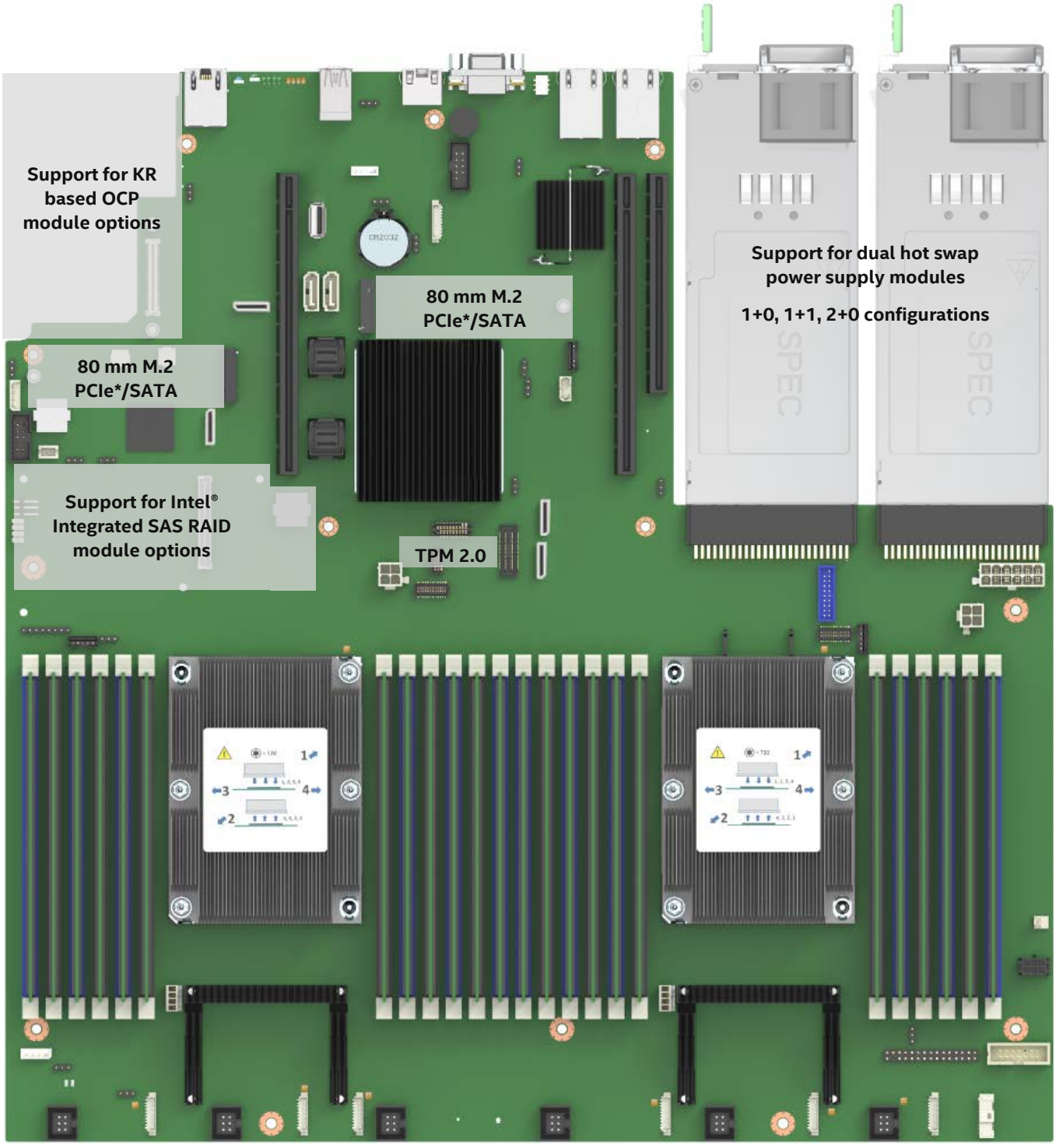


Figure 2. Intel® Server Board S2600WF with available onboard options

2.1 Server Board Family Feature Set

Table 2 lists the server board product family feature set.

Table 2. Intel® Server Board S2600WF product family feature set

Intel® Server Board Feature	S2600WFT	S2600WF0	S2600WFQ
Processor	• (2) – LGA3647-0 (Socket P) processor sockets • Supports (1) or (2) processors from the Intel® Xeon® processor Scalable family (Platinum, Gold, Silver, and Bronze). Note: Previous generation Intel® Xeon® processors are not supported. • Maximum supported Thermal Design Power (TDP) of up to 205 W (board only) • Note: Intel® Server Systems based on this server board family may support a lower maximum Thermal Design Power (TDP). See the appropriate Intel® System TPS for maximum supported TDP.		
Memory	• (24) – total DIMM slots o (12) – DIMM slots per processor, (6) – memory channels per processor o (2) – DIMMs per channel • Registered DDR4 (RDIMM), Load Reduced DDR4 (LRDIMM) • Memory capacity o Up to 1.5 TB for Gold and Platinum CPUs o Up to 768 GB for Silver and Bronze CPUs • Memory data transfer rates o Up to 2666 MT/s at (1) and (2) DIMMs per channel (dependent on processor) • DDR4 standard voltage of 1.2 V		
Intel® C62x Series Chipset	Intel® C624 Chipset	Intel® C624 Chipset	Intel® C628 Chipset
Intel® Quick Assist Technology	No	No	Yes
Intel® Omni-Path Fabric	Supported	Supported	Supported
Onboard LAN	Dual Port RJ45 10 GbE	No	No
OCP Module Support	• Dual Port 10Gb RJ45 – iPC 557T2OCPG1P5 • Dual Port SFP+ – iPC 527DA2OCPG1P5	• Quad Port 1Gb RJ45 – iPC I357T4OCPG1P5 • Quad Port SFP+ – iPC X527DA4OCPG1P5 • Dual Port 10Gb RJ45 – iPC X557T2OCPG1P5 • Dual Port SFP+ – iPC X527DA2OCPG1P5	• Quad Port 1Gb RJ45 – iPC I357T4OCPG1P5 • Quad Port SFP+ – iPC X527DA4OCPG1P5 • Dual Port 10Gb RJ45 – iPC X557T2OCPG1P5 • Dual Port SFP+ – iPC X527DA2OCPG1P5
Intel® Integrated SAS Module	Supported	Supported	Supported
Onboard PCIe* NVMe	• (4) – OCuLink connectors • Intel® VMD support • Intel® RSTe/Intel® VROC support (accessory option)	• (4) – OCuLink connectors • Intel® VMD support • Intel® RSTe/Intel® VROC support (accessory option)	• (2) – OCuLink connectors • Intel® VMD support • Intel® RSTe/Intel® VROC support (accessory option)

Intel® Server Board Feature	S2600WFT	S2600WF0	S2600WFQ
Onboard SATA	• 12 x SATA 6 Gbps ports (6 Gb/s, 3 Gb/s and 1.5 Gb/s transfer rates supported) o (2) – single port 7-pin SATA connectors o (2) – M.2 connectors – SATA / PCIe* o (2) – 4-port mini-SAS HD (SFF-8643) connectors • Embedded SATA Software RAID o Intel® RSTe 5.0 o Intel® Embedded Server RAID Technology 2 1.60 with optional RAID 5 key support		• 4 x SATA 6 Gbps ports (6 Gb/s, 3 Gb/s and 1.5 Gb/s transfer rates supported) o (2) – single port 7-pin SATA connectors o (2) – M.2 connectors – SATA/PCIe* • Embedded SATA Software RAID o Intel® RSTe 5.0 **Note**: 4-port mini-SAS HD connectors are present on S2600WFQ but are not configured as SATA; these cables are used only for Intel® QAT.
Riser Card	Concurrent support for up to three riser cards • Riser #1 – PCIe* 3.0 x24 (CPU1 x16, CPU2 x8) – 2 and 3 slot riser card options available • Riser #2 – PCIe* 3.0 x24 (CPU2 x24) – 2 and 3 slot riser card options available • Riser #3 (2U systems only) – PCIe* 3.0 (CPU 2 x12) – 2 slot riser card available		
Video	• Integrated 2D video controller • 16MB of DDR4 video memory • (1) – DB-15 external connector • (1) – 14-pin internal connector for optional front panel video support		
USB	• (3) – external USB 3.0 ports • (1) – internal type-A USB 2.0 port • (1) – internal 20-pin connector for optional 2x USB 3.0 port front panel support • (1) – internal 10-pin connector for optional 2x USB 2.0 port front panel support		
Serial Port	• (1) – external RJ-45 serial-A port connector • (1) – internal DH-10 serial-B port header for optional front or rear serial port support		
Server Management	• Integrated baseboard management controller, IPMI 2.0 compliant • Support for Intel® Server Management software • Dedicated onboard RJ45 management port • Advanced server management via Intel® RMM4 Lite – iPC AXXRMM4LITE2 (accessory option)		
Security	• Trusted platform module 2.0 (Rest of World) – iPC AXXTPMENC8BPP (accessory option) • Trusted platform module 2.0 (China Version) – iPC AXXTPMCHNE8 (accessory option)		
System Fan	• (6) – system fans supported in two different connector formats: hot swap (2U) and cabled (1U) o (6) – 10-pin managed system fan headers (sys_fan 1-6) – used for 1U system configuration o (6) – 6-pin hot swap capable managed system fan connectors (sys_fan 1-6) – used for 2U system configuration		

2.2 Server Board Component/Feature Identification

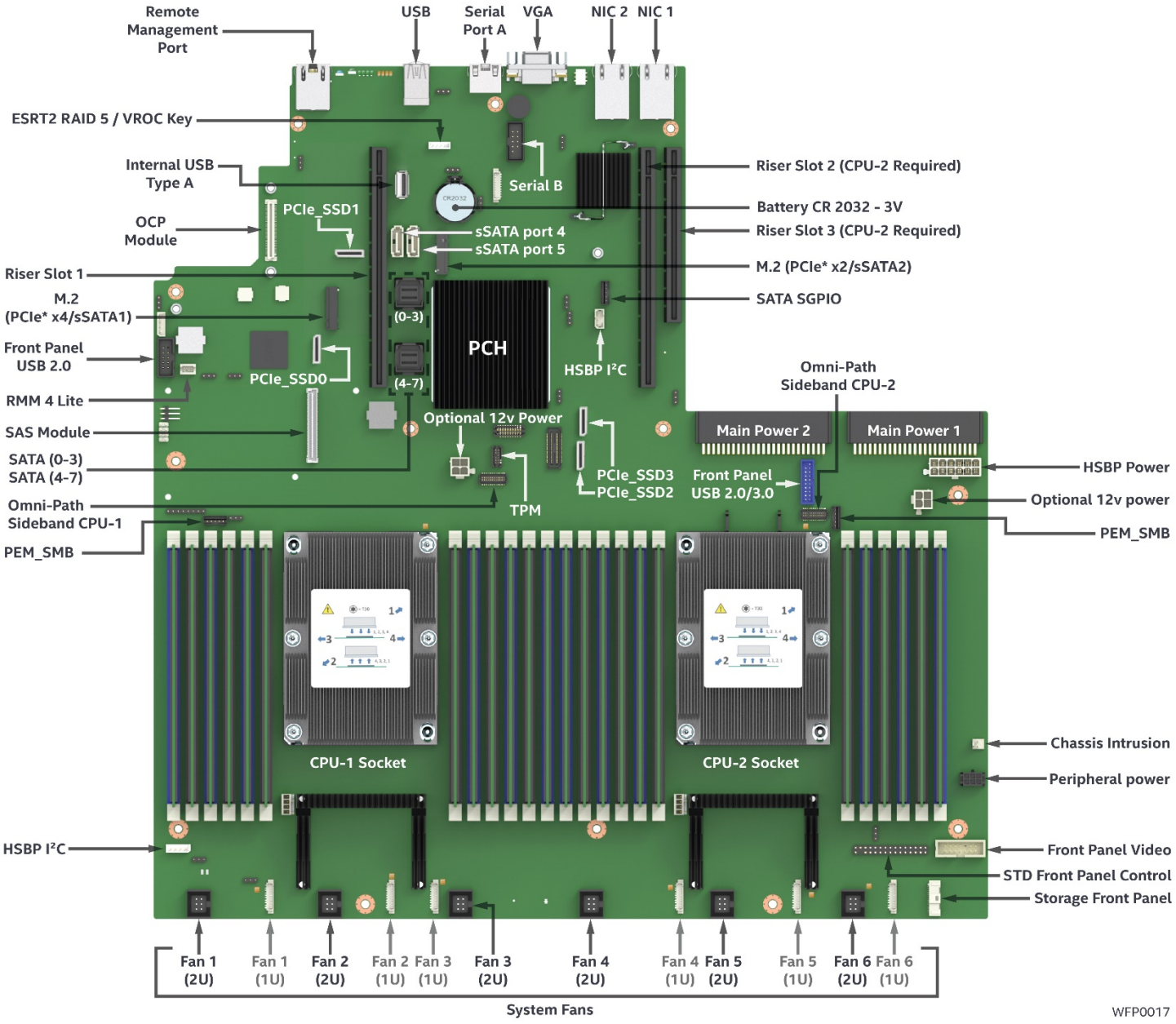
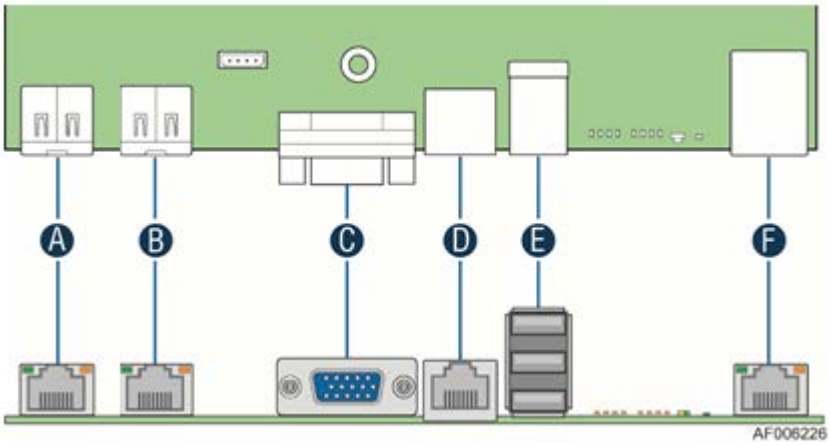


Figure 3. Server board component/feature identification

Note: Intel® Server Board S2600WFT shown. Some features may not be present on Intel® Server Boards S2600WF0 and/or S2600WFQ.



A – RJ45 network port – NIC #1
B – RJ45 network port – NIC #2
C – Video
D – RJ45 serial A port
E – Stacked 3-port USB 3.0
F – RJ45 dedicated management port

Figure 4. Intel® Server Board S2600WF external I/O connector layout

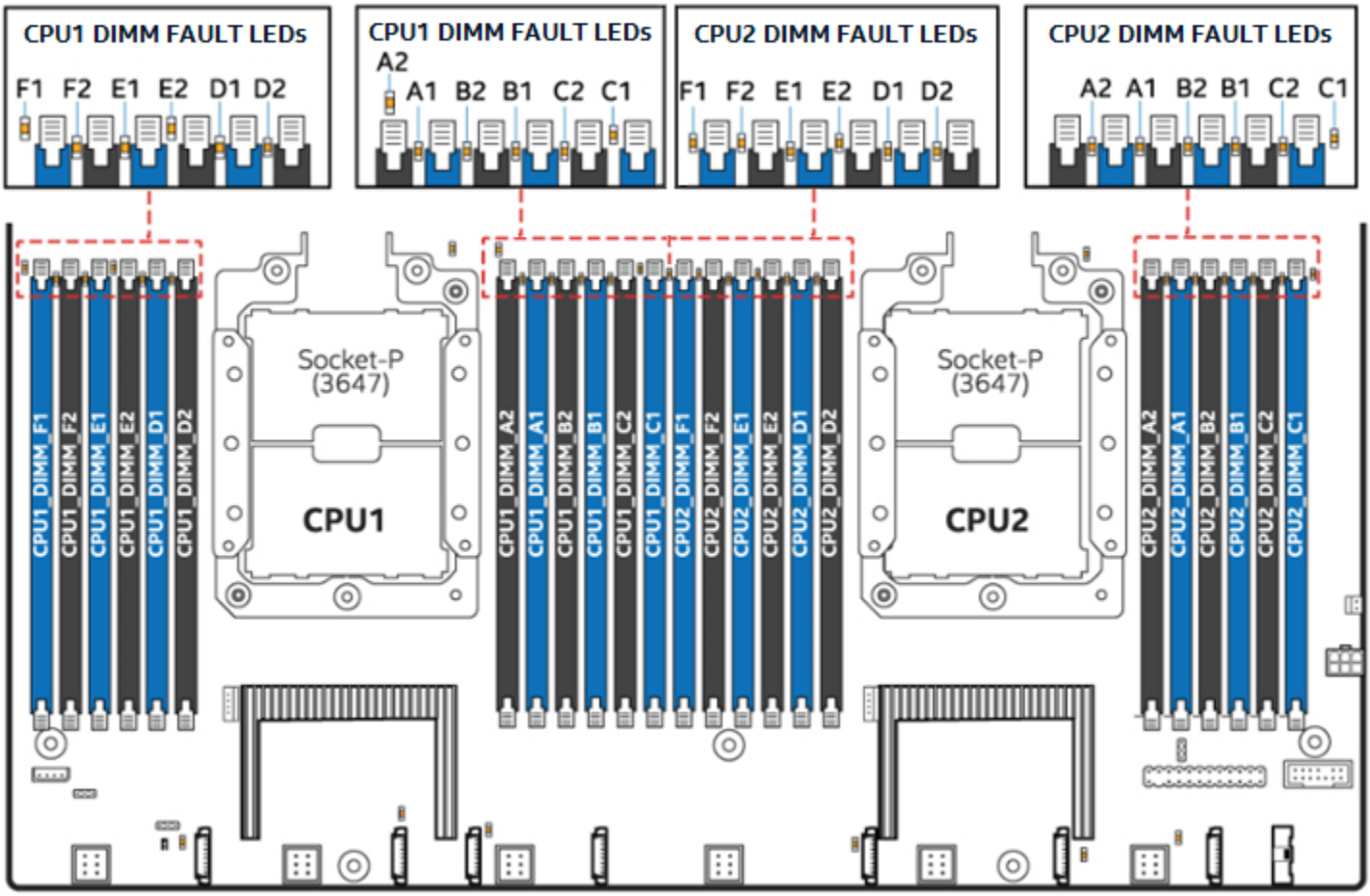


Figure 5. Intel® Light Guided Diagnostics - DIMM fault LEDs

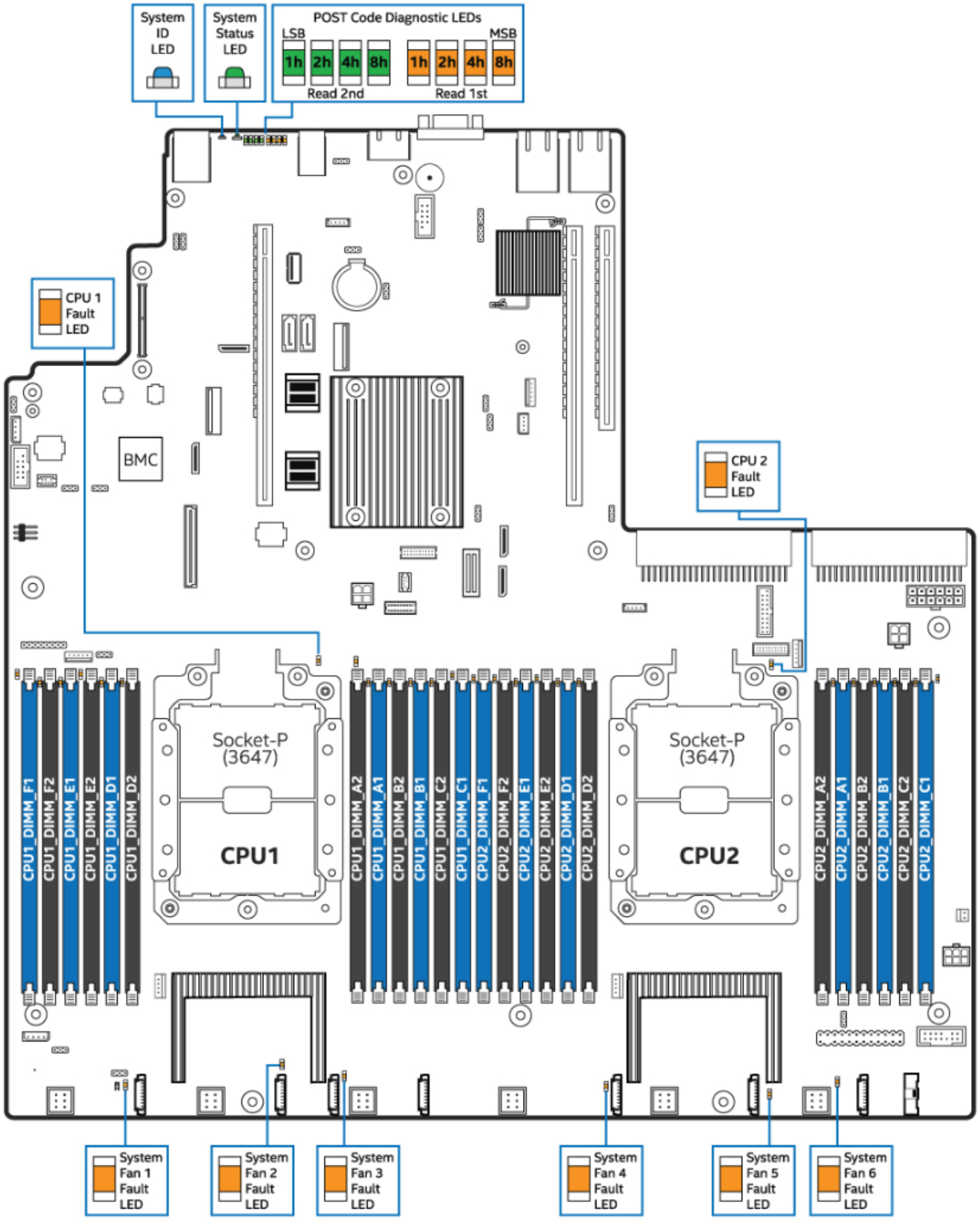


Figure 6. Intel® Light Guided Diagnostic – LED identification

Note: See Appendix B for POST Code Diagnostic LED decoder information.

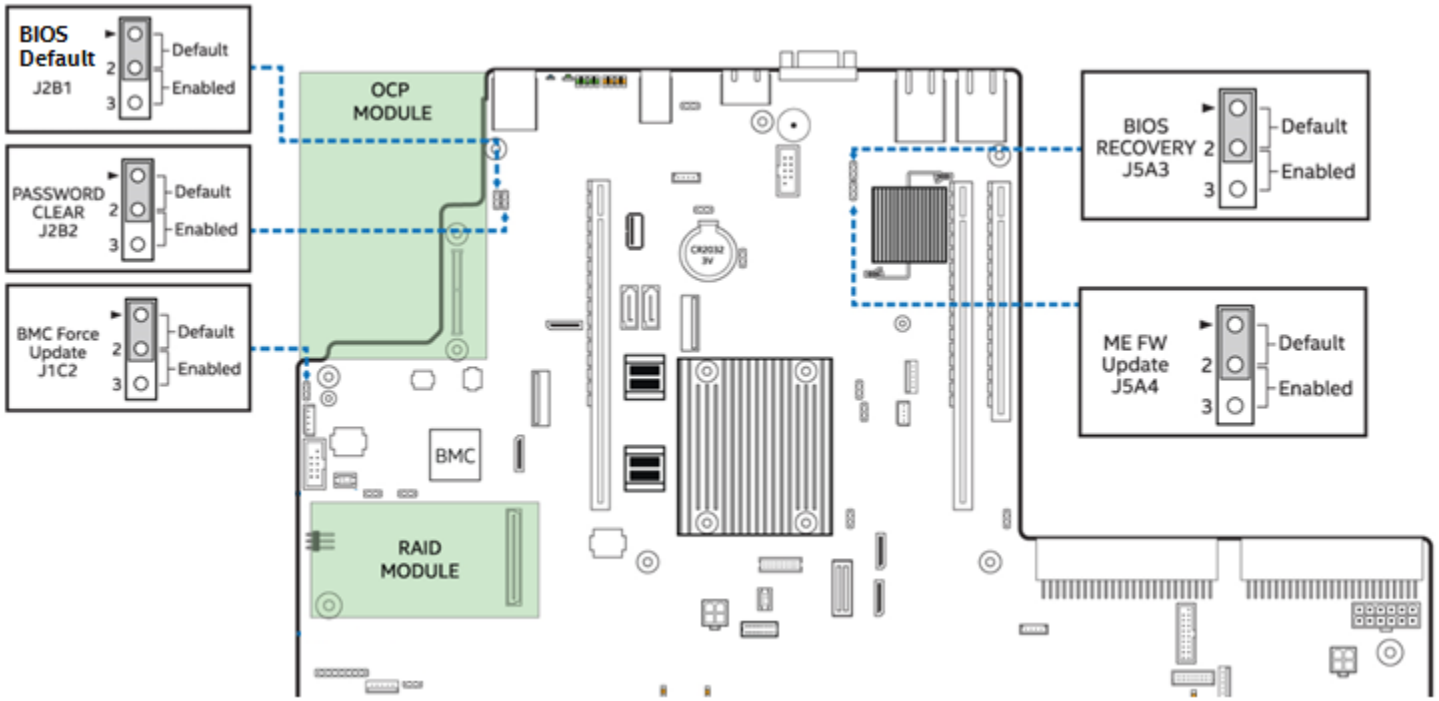


Figure 7. Board configuration and recovery jumpers

For more information on reset and recovery jumpers, see Section 11.

2.3 Server Board Mechanical Drawings

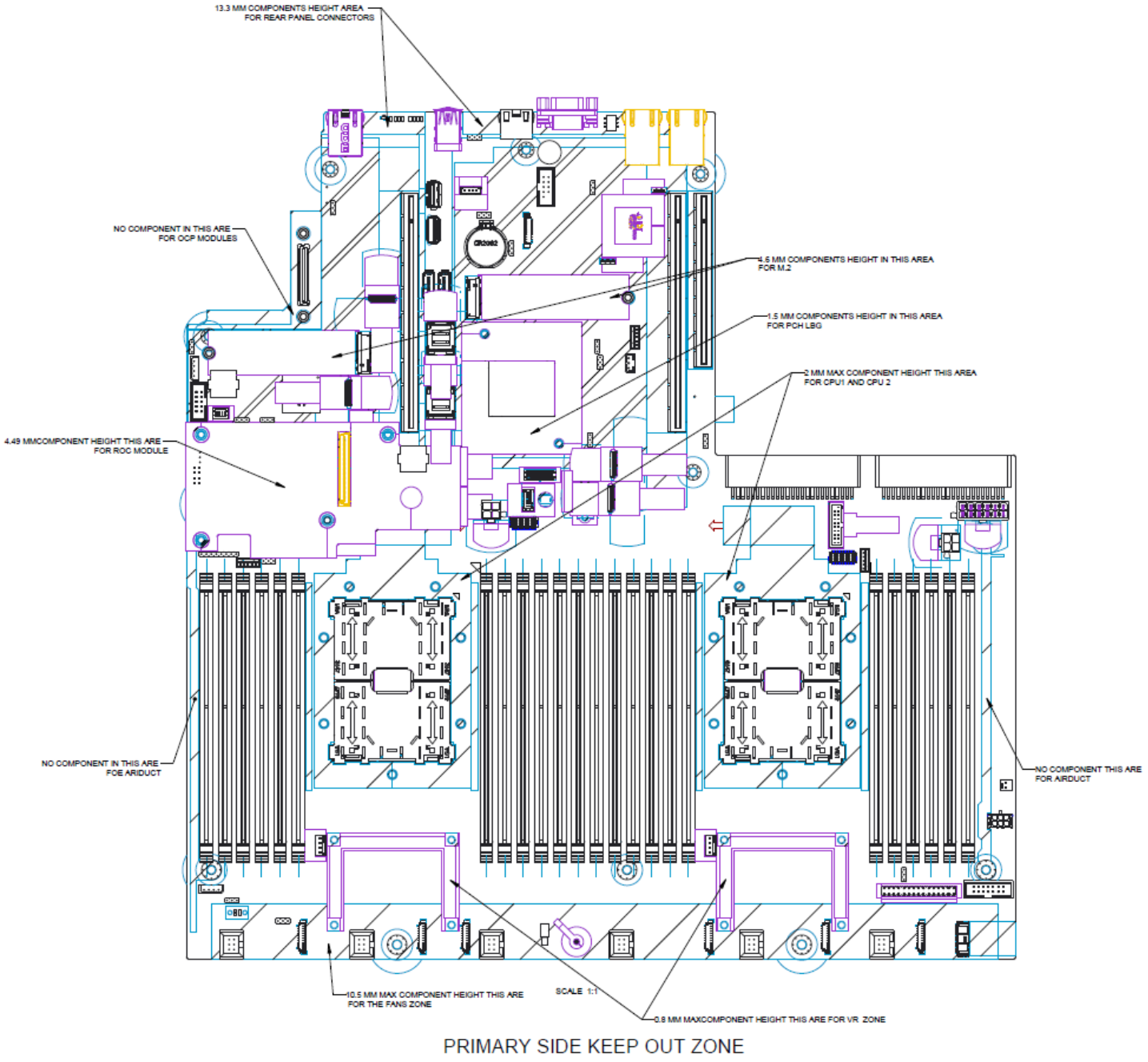


Figure 8. Intel® Server Board S2600WF primary side keepout zone

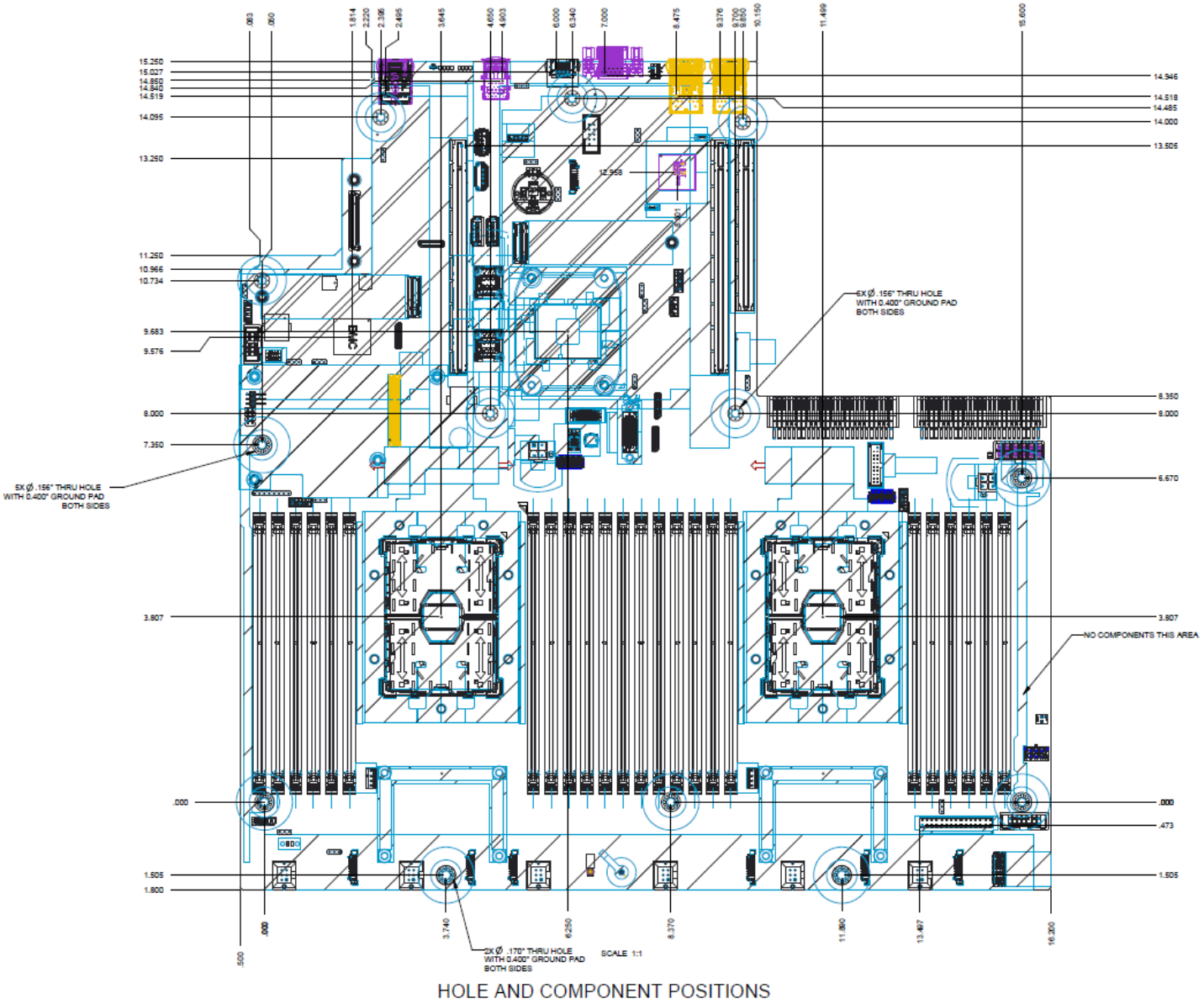


Figure 9. Intel® Server Board S2600WF hole and component positions

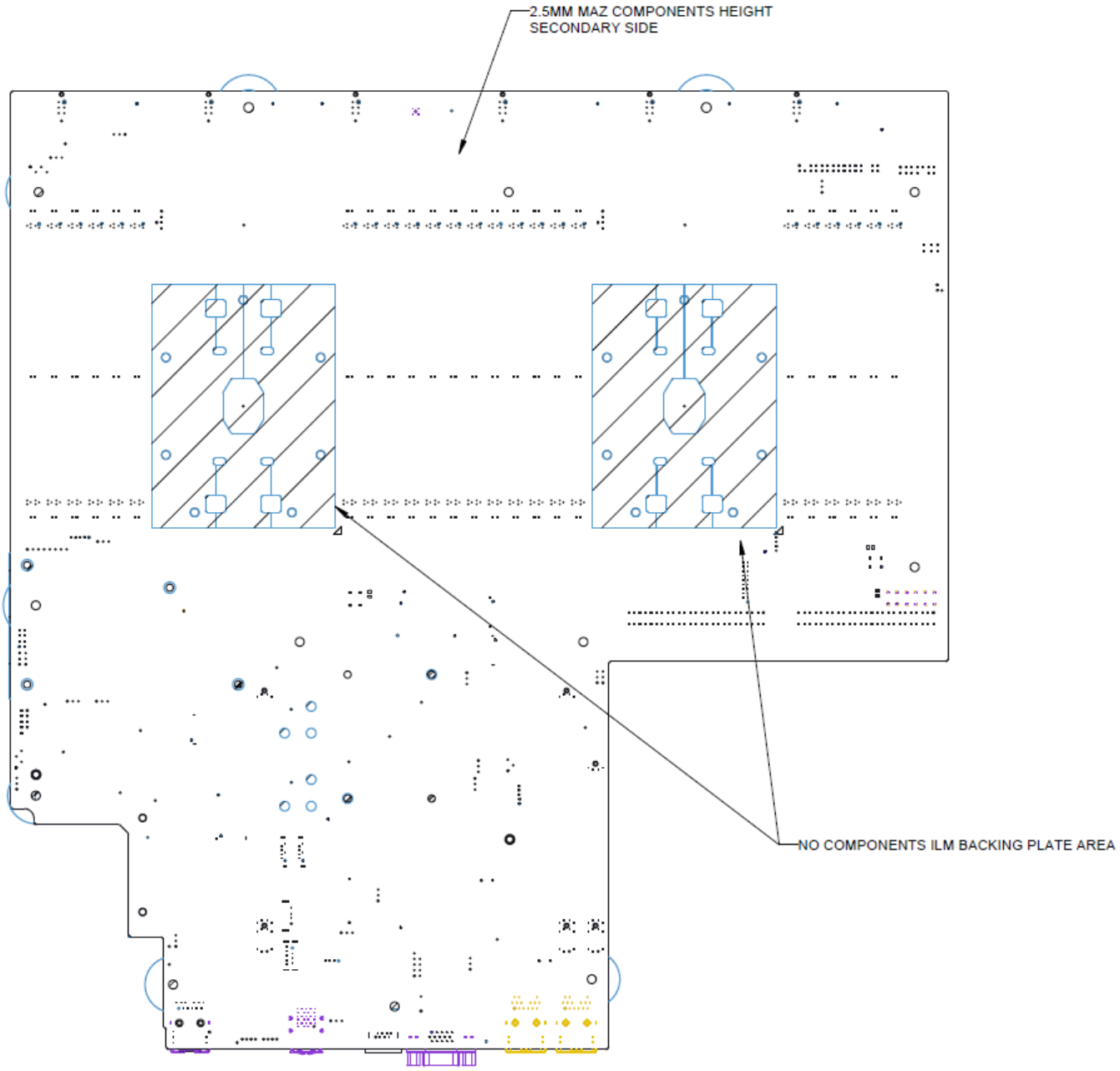


Figure 10. Intel® Server Board S2600WF secondary side keepout zone

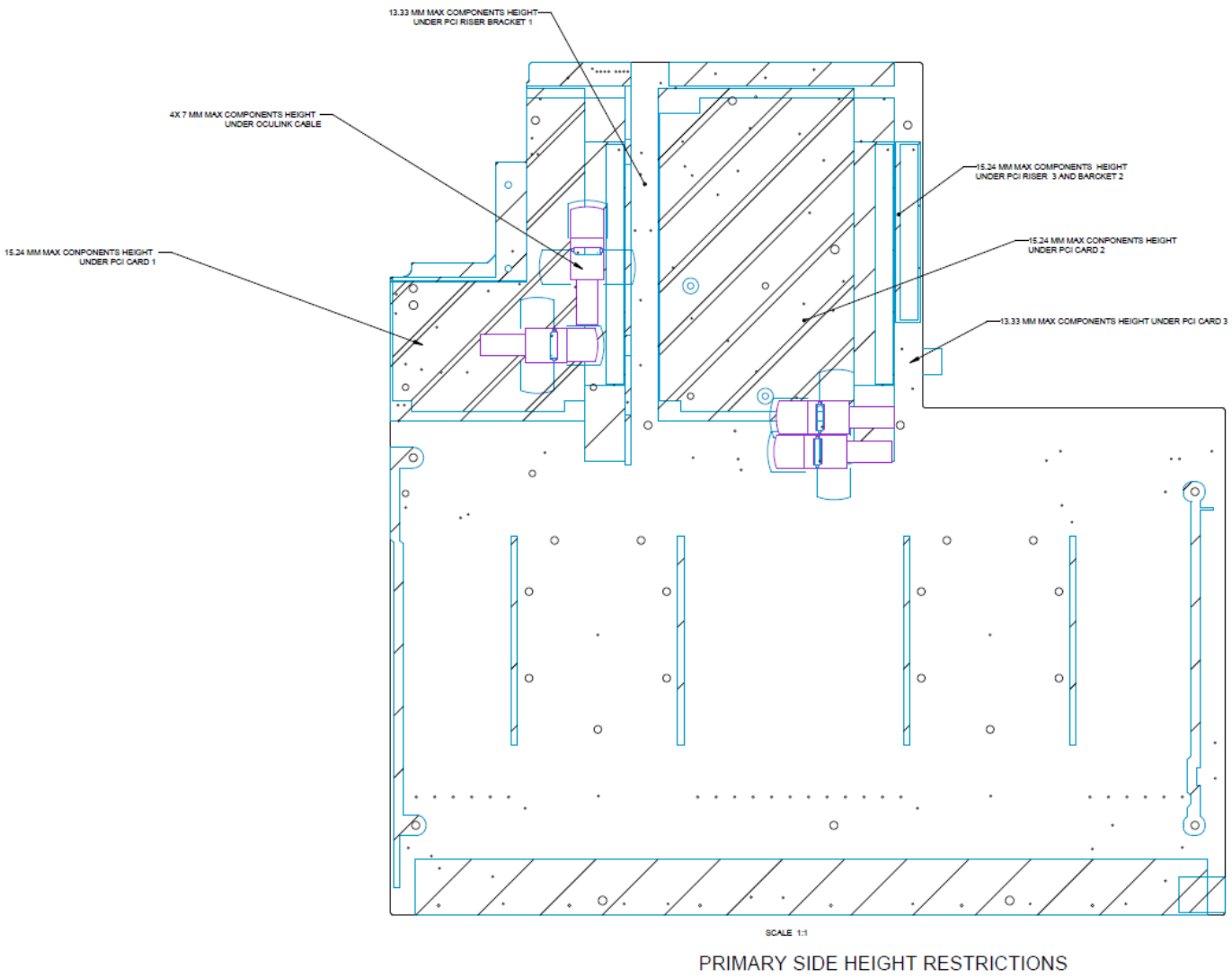


Figure 11. Intel® Server Board S2600WF primary side height restrictions

2.4 Product Architecture Overview

The architecture of Intel® Server Board S2600WF product family is developed around the integrated features and functions of the Intel® Xeon® processor Scalable family, the Intel® C620 series chipset (PCH), Intel® Ethernet Controller X557-AT2 (S2600WFT only), and the ASPEED* AST2500 baseboard management controller (BMC).

Figure 12 provides an overview of the server board architecture, showing the features and interconnects of each of the major sub-system components.

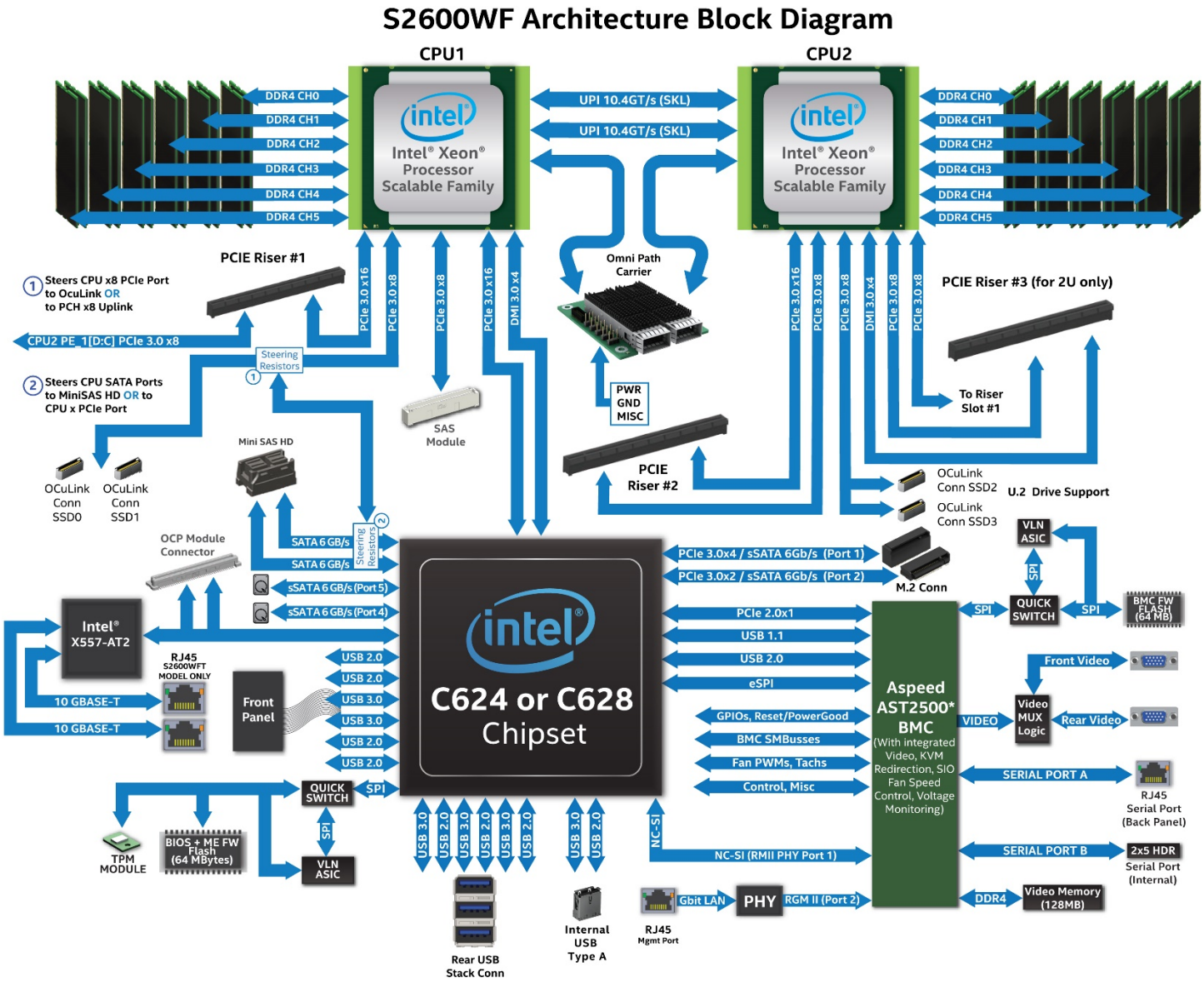


Figure 12. Intel® Server Board S2600WF product family architectural block diagram

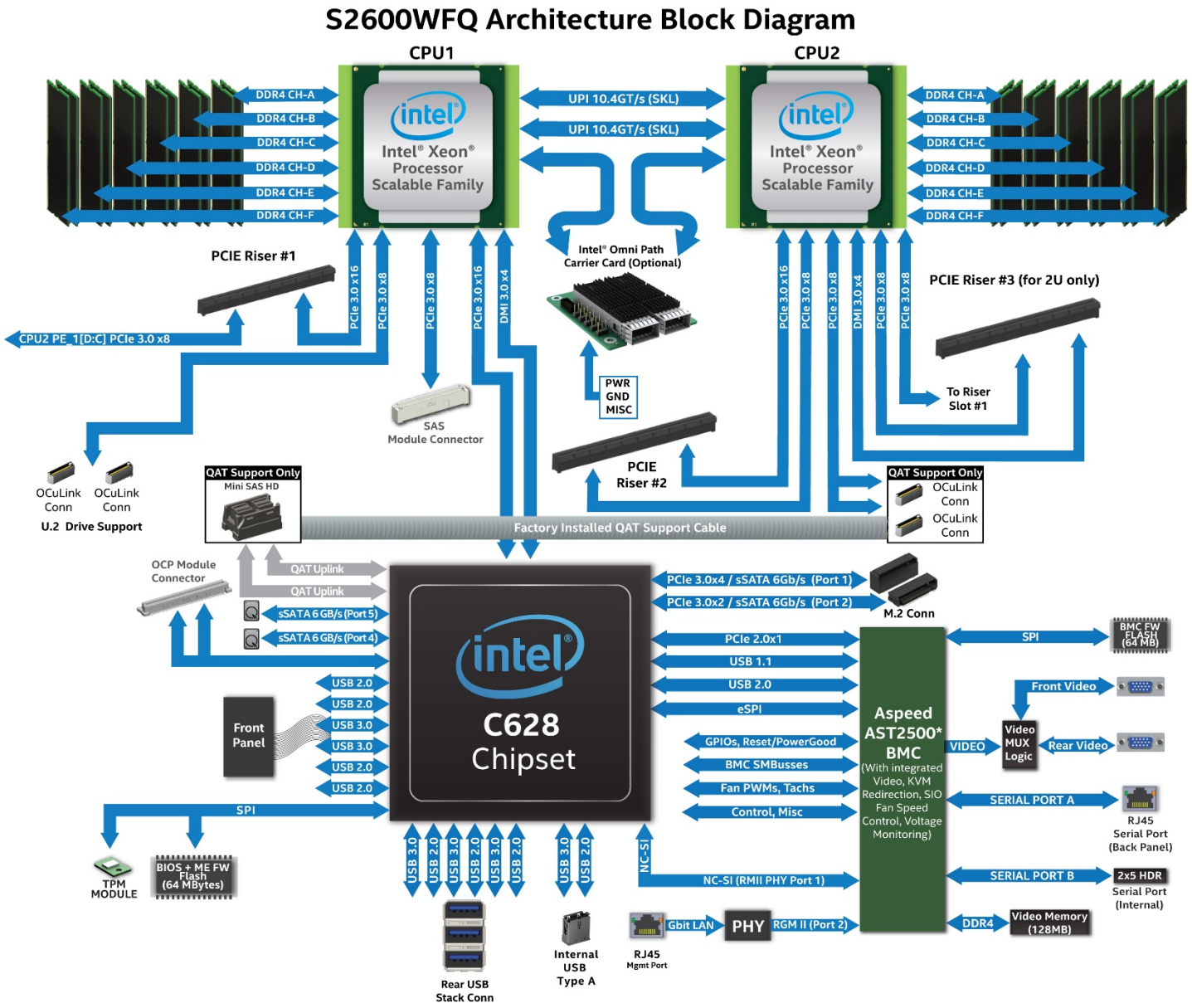


Figure 13. Intel® Server Board S2600WFQ architectural block diagram

2.5 System Software Stack

The server board includes a system software stack that consists of the bystem BIOS, BMC firmware, Intel® Management Engine (Intel® ME) firmware, and field replacement unit (FRU) and sensor data record (SDR) data. Together, they configure and manage features and functions of the server system.

Many features and functions of the server system are managed jointly by the system BIOS and the BMC firmware, including:

- IPMI watchdog timer
- Messaging support, including command bridging and user/session support
- BIOS boot flags support
- Event receiver device – The BMC receives and processes events from the BIOS.
- Serial-over-LAN (SOL)
- ACPI state synchronization – The BMC tracks ACPI state changes that are provided by the BIOS.

- Fault resilient booting (FRB) – Fault resistant boot level 2 (FRB-2) is supported by the watchdog timer functionality.
- 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.
- DIMM temperature monitoring – New sensors and improved acoustic management using closed-loop fan control algorithm taking into account DIMM temperature readings.
- Integrated KVM
- Integrated remote media redirection
- Intel® Intelligent Power Node Manager support
- Sensor and SEL logging additions/enhancements (e.g., additional thermal monitoring capability)
- Embedded platform debug feature, which allows capture of detailed data for later analysis by Intel

A complete system software stack is pre-programmed on the server board during the board assembly process, making the server board functional at first power on. However, to ensure the most reliable system operation, it is highly recommended to check http://downloadcenter.intel.com for the latest available system updates.

System updates can be performed in a number of operating environments, including the UEFI shell using the UEFI-only system update package (SUP), or under different operating systems using the Intel® One Boot Flash Update (Intel® OFU) utility.

As part of the initial system integration process, system integrators must program system configuration data onto the server board using the FRUSDR utility to ensure the embedded platform management subsystem is able to provide the best performance and cooling for the final system configuration. The FRUSDR utility is included in the SUP and OFU packages. For additional information, see Section 2.5.2.

Refer to the following Intel documents for more indepth information about the system software stack and their functions:

- *Intel® Server Board S2600 Family BIOS External Product Specification* – Intel NDA Required
- *Intel® Server System Integrated Baseboard Management Controller (BMC) Firmware External Product Specification for Intel® Servers Systems supporting the Intel® Xeon® processor Scalable family* – Intel NDA Required

2.5.1 Hot Keys Supported During POST

Certain hot keys are recognized during power-on self-test (POST). A hot key is a key or key combination that is recognized as an unprompted command input, where the operator is not prompted to press the hot key. In most cases, hot keys are recognized even while other processing is in progress.

The BIOS supported hot keys are only recognized by the system BIOS during the system boot time POST process. Once the POST process has completed and hands off the system boot process to the operating system, BIOS supported hot keys are no longer recognized.

Table 3 provides a list of available POST hot keys along with a description for each.

Table 3. POST hot keys

Hot Key	Function
<F2>	Enter the BIOS setup utility
<F6>	Pop-up BIOS boot menu
<F12>	Network boot
<Esc>	Switch from logo screen to diagnostic screen
<Pause>	Stop POST temporarily

2.5.1.1 POST Logo/Diagnostic Screen

If quiet boot is enabled in the BIOS setup utility, a splash screen is displayed with the standard Intel logo screen or a customized original equipment manufacturer (OEM) logo screen if one is present in the designated flash memory location. By default, quiet boot is enabled in the BIOS setup utility and the logo screen is the default POST display. However, the pressing **<Esc>** hides the logo screen and displays the diagnostic screen instead.

If a logo is not present in the BIOS flash memory space, or if quiet boot is disabled in the system configuration, the POST diagnostic screen is displayed with a summary of system configuration information. The POST diagnostic screen is purely a text mode screen, as opposed to the graphics mode logo screen.

If console redirection is enabled in the BIOS setup utility, the quiet boot setting is disregarded and the text mode diagnostic screen is displayed unconditionally. This is due to the limitations of console redirection, which transfers data in a mode that is not graphics-compatible.

2.5.1.2 BIOS Boot Pop-Up Menu

The BIOS boot specification (BBS) provides a boot pop-up menu that can be invoked by pressing the **<F6>** key during POST. The BBS pop-up menu displays all available boot devices. The boot order in the pop-up menu is not the same as the boot order in the BIOS setup utility. The pop-up menu simply lists all of the available devices from which the system can be booted, and allows a manual selection of the desired boot device.

When an administrator password is installed in the BIOS setup utility, the administrator password is required to access the boot pop-up menu. If a user password is entered, the user is taken directly to the boot manager in the BIOS setup utility only allowing booting in the order previously defined by the administrator.

2.5.1.3 Entering BIOS Setup

To enter the BIOS setup utility using a keyboard (or emulated keyboard), press the **<F2>** function key during boot time when the OEM or Intel logo screen or the POST diagnostic screen is displayed.

The following instructional message is displayed on the diagnostic screen or under the quiet boot logo screen:

```
Press <F2> to enter setup, <F6> Boot Menu, <F12> Network Boot
```

Note: With a USB keyboard, it is important to wait until the BIOS discovers the keyboard and beeps; until the USB controller has been initialized and the keyboard activated, key presses are not read by the system.

When the BIOS setup utility is entered, the main screen is displayed initially. However, if a serious error occurs during POST, the system enters the BIOS setup utility and displays the error manager screen instead of the main screen.

For additional BIOS setup utility information, refer to *Intel® Server Board S2600 Family BIOS Setup User Guide*.

2.5.1.4 BIOS Update Capability

To bring BIOS fixes or new features into the system, it is necessary to replace the current installed BIOS image with an updated one. The BIOS image can be updated using a standalone IFLASH32 utility in the UEFI shell or using the OFU utility program under a supported operating system. Full BIOS update instructions are provided with update packages downloaded from the Intel website.

2.5.1.5 BIOS Recovery

If a system is unable to boot successfully to an OS, hangs during POST, or even hangs and fails to start executing POST, it may be necessary to perform a BIOS recovery procedure to replace a defective copy of the primary BIOS

The BIOS provides three mechanisms to start the BIOS recovery process, which is called recovery mode:

- The recovery mode jumper causes the BIOS to boot in recovery mode.
- At power on, if the BIOS boot block detects a partial BIOS update was performed, the BIOS automatically boots in recovery mode.
- The BMC asserts the recovery mode general purpose input/output (GPIO) in case of partial BIOS update and FRB-2 timeout.

The BIOS recovery takes place without any external media or mass storage device as it uses a backup BIOS image inside the BIOS flash in recovery mode.

Note: The recovery procedure is included here for general reference. However, if in conflict, the instructions in the BIOS release notes are the definitive version.

When the BIOS recovery jumper is set, the BIOS begins by logging a recovery start event to the system event log (SEL). It then loads and boots with a backup BIOS image residing in the BIOS flash device. This process takes place before any video or console is available. The system boots to the embedded UEFI shell, and a recovery complete event is logged to the SEL. From the UEFI shell, the BIOS can then be updated using a standard BIOS update procedure defined in update instructions provided with the system update package downloaded from the Intel website. Once the update has completed, switch the recovery jumper back to its default position and power cycle the system.

If the BIOS detects a partial BIOS update or the BMC asserts recovery mode GPIO, the BIOS boots in recovery mode. The difference is that the BIOS boots up to the error manager page in the BIOS setup utility. In the BIOS Setup utility, a boot device, shell or Linux*, for example, could be selected to perform the BIOS update procedure under shell or OS environment.

Note: Before attempting a recovery boot, it is highly advisable to reference the *BIOS Release Notes* to verify the proper recovery procedure.

2.5.2 Field Replaceable Unit (FRU) and Sensor Data Record (SDR) Data

As part of the initial system integration process, the server board/system must have the proper FRU and SDR data loaded. This ensures that the embedded platform management system is able to monitor the appropriate sensor data and operate the system with best cooling and performance. Once the system integrator has performed an initial FRU SDR package update, subsequent auto-configuration occurs without the need to perform additional SDR updates or provide other user input to the system when any of the following components are added or removed:

- Processor
- Memory
- OCP module
- Integrated SAS RAID module
- Power supply
- Fan
- Intel® Xeon Phi™ co-processor PCIe* card
- Hot swap backplane
- Front panel

Note: The system may not operate with best performance or best/appropriate cooling if the proper FRU and SDR data is not installed.

2.5.2.1 Loading FRU and SDR Data

The FRU and SDR data can be updated using a standalone FRUSDR utility in the UEFI shell, or can be done using the OFU utility program under a supported operating system. Full FRU and SDR update instructions are provided with the appropriate system update package (SUP) or OFU utility which can be downloaded from http://downloadcenter.intel.com.

3. Processor Support

The server board includes two Socket-P LGA3647 processor sockets compatible with the Intel® Xeon® processor Scalable family (standard and fabric options) and supports processor thermal design power (TDP) of up to 205 W.

Note: Previous-generation Intel® Xeon® processors and their supported CPU heat sinks are not compatible on server boards described in this document.

Note: The server board is capable of supporting processors with a maximum 205 W TDP. However, TDP support may vary depending on the cooling capabilities of the chosen server chassis. Check the server chassis or server system product specifications to determine maximum supported processor TDP.

Visit http://www.intel.com/support for a complete list of supported processors.

3.1 Processor Socket and Processor Heat Sink Module (PHM) Assembly

This generation server board introduces the concept of the processor heat sink module (PHM). Figure 14 identifies each component associated with the processor assembly. The illustration does not represent the processor installation process.

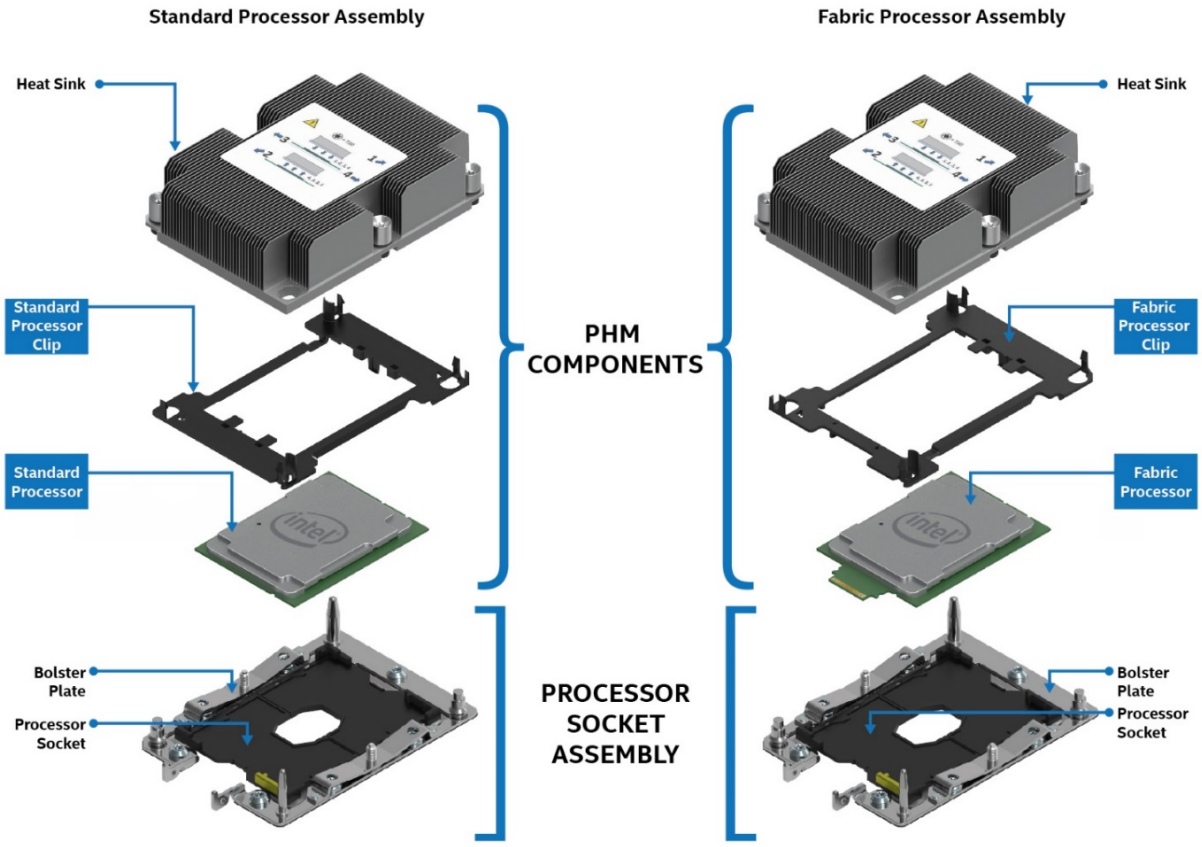


Figure 14. Processor heat sink module (PHM) components and processor socket reference diagram

Processor installation requires that the processor be attached to the processor heat sink prior to installation onto the server board.as shown in Figure 15.

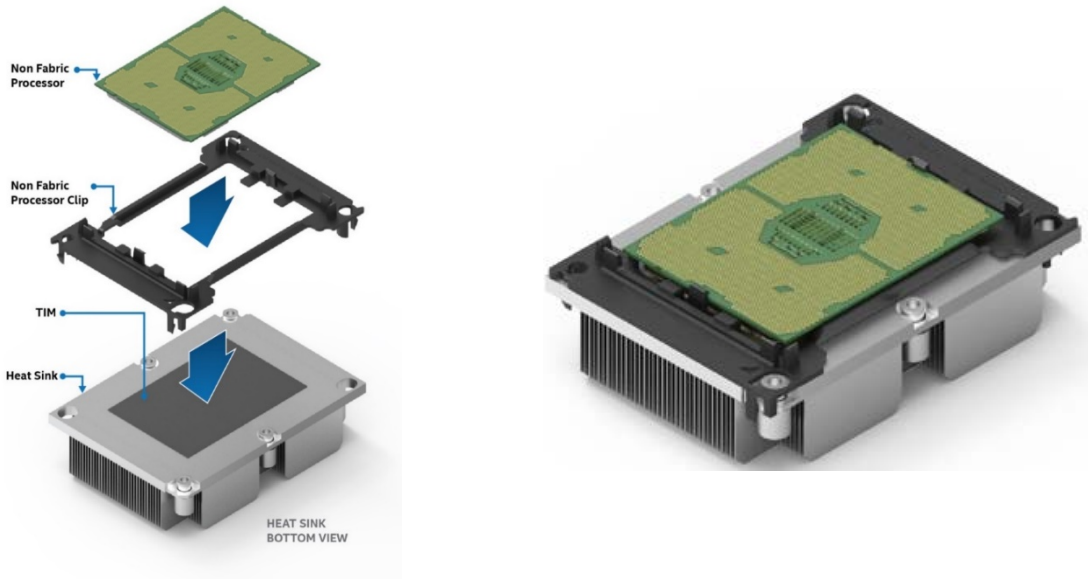


Figure 15. Processor attached to the processor heat sink installation

Two bolster plate guide pins of different sizes allows the PHM to be installed only one way onto the processor socket assembly (see Figure 14).

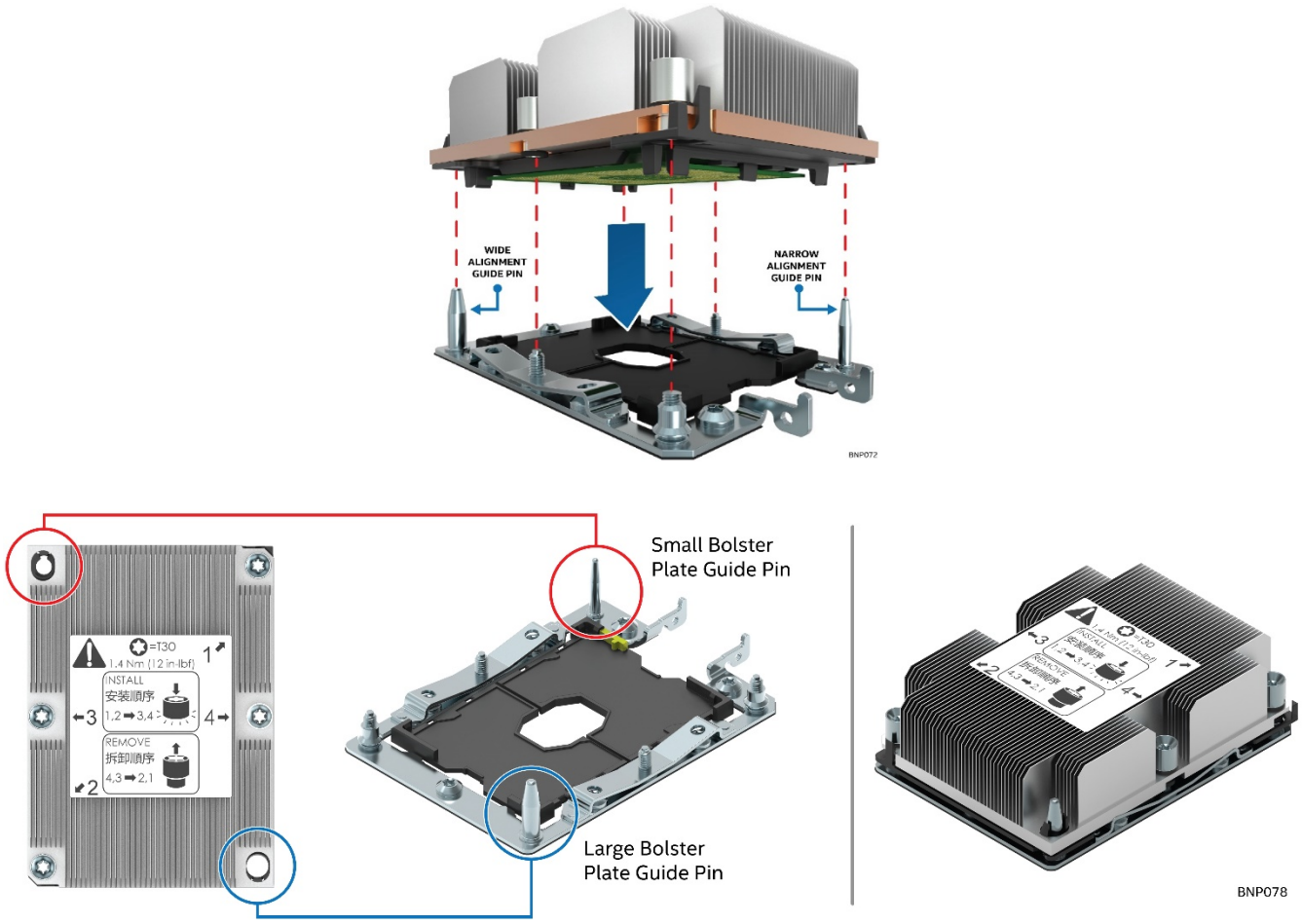


Figure 16. PHM to CPU socket orientation and alignment features

The PHM is properly installed when it is securely seated over the two bolster plate guide pins and sits evenly over the processor socket as shown in Figure 16. Once the PHM is properly seated over the processor socket assembly, the four heat sink Torx* screws must be tightened in the order specified on the label affixed to the top side of the processor heat sink.

Caution: Failure to tighten the heat sink screws in the specified order may cause damage to the processor socket assembly. Heat sink screws should be tightened to 12 in-lbs torque.

Note: For detailed processor assembly and installation instructions, refer to the appropriate Intel product family *System Integration and Service Guide*.

To protect the pins within a processor socket from being damaged, server boards with no processor or heat sink installed must have a plastic cover installed over each processor socket, as shown in Figure 17. Processor socket covers must be removed before processor installation (Figure 17 – B).

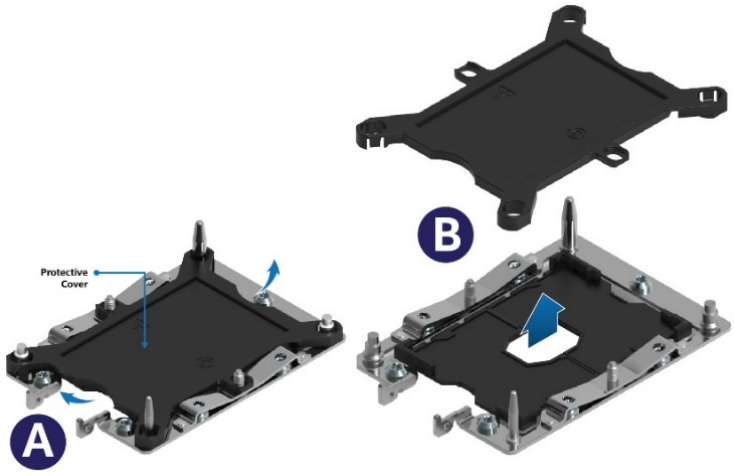


Figure 17. Processor socket assembly and protective cover

3.2 Processor Thermal Design Power (TDP) Support

To allow optimal operation and long-term reliability of Intel® processor-based systems, the processor must remain within the defined minimum and maximum case temperature (T_{CASE}) specifications. Thermal solutions not designed to provide sufficient thermal capability may affect the long-term reliability of the processor and system. The server board described in this document is designed to support the Intel® Xeon® processor Scalable family TDP guidelines up to and including 205 W.

Disclaimer Note: Intel® server boards 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 meets 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 the specific application and environmental conditions. Intel cannot be held responsible if components fail or the server board does not operate correctly when used outside any of its published operating or non-operating limits.

3.3 Intel® Xeon® Processor Scalable Family Overview

The Intel® Server Board S2600WF product family supports for the Intel® Xeon® processor Scalable family:

- Intel® Xeon® Bronze XXXX processor
- Intel® Xeon® Silver XXXX processor
- Intel® Xeon® Gold XXXX processor
- Intel® Xeon® Platinum XXXX processor

Table 4. Intel® Xeon® processor Scalable family feature comparison

Feature	81xx Platinum	61xx Gold	51xx Gold	41xx Silver	31xx Bronze
# of Intel® UPI Links	3	3	2	2	2
Intel UPI Speed	10.4 GT/s	10.4 GT/s	10.4 GT/s	9.6 GT/s	9.6 GT/s
Supported Topologies	2S-2UPI 2S-3UPI 4S-2UPI 4S-3UPI 8S- 3UPI	2S-2UPI 2S-3UPI 4S-2UPI 4S-3UPI	2S-2UPI 4S-2UPI	2S-2UPI	2S-2UPI
Node Controller Support	Yes	Yes	No	No	No
# of Memory Channels	6	6	6	6	6
Maximum DDR4 Speed	2666	2666	2400	2400	2133
Memory Capacity	768 GB 1.5 TB (select SKUs)	768 GB 1.5 TB (select SKUs)	768 GB 1.5 TB (select SKUs)	768 GB	768 GB
RAS Capability	Advanced	Advanced	Advanced	Standard	Standard
Intel® Turbo Boost Technology	Yes	Yes	Yes	Yes	No
Intel® HT Technology	Yes	Yes	Yes	Yes	No
Intel® AVX-512 ISA Support	Yes	Yes	Yes	Yes	Yes
Intel® AVX-512 - # of 512b FMA Units	2	2	1	1	1
# of PCIe* Lanes	48	48	48	48	48

The Intel® Xeon® processor Scalable family combines several key system components into a single processor package, including the CPU cores, Integrated Memory Controller (IMC), and Integrated IO Module (IIO).

The processor core features and technologies include:

- Intel® Ultra Path Interconnect (Intel® UPI) – up to 10.4 GT/s
- Intel® Speed Shift Technology
- Intel® 64 Architecture
- Enhanced Intel SpeedStep® Technology
- Intel® Turbo Boost Technology 2.0
- Intel® Hyper-Threading Technology (Intel® HT Technology)
- Intel® Virtualization Technology (Intel® VT-x)
- Intel® Virtualization Technology for Directed I/O (Intel® VT-d)
- Execute Disable Bit
- Intel® Trusted Execution Technology (Intel® TXT)
- Intel® Advanced Vector Extensions (Intel® AVX-512)
- Intel® Advanced Encryption Standard New Instructions (Intel® AES-NI)

The processor uncore featuresand technologies include:

- Up to 48 PCIe* lanes 3.0 lanes per CPU – 79GB/s bi-directional pipeline
- 6 channels DDR4 memory support per CPU
- On package integration of next generation Intel® Omni-Path Fabric Controller (select SKUs)
- DMI3/PCIe* 3.0 interface with a peak transfer rate of 8.0 GT/s
- Non-transparent bridge (NTB) enhancements – 3 full duplex NTBs and 32 MSI-X vectors
- Intel® Volume Management Device (Intel® VMD) – manages CPU attached NVMe* SSDs
- Intel® QuickData Technology
- Support for Intel® Node Manager 4.0

3.3.1 Supported Technologies

3.3.1.1 Intel® 64 Instruction Set Architecture

64-bit memory extensions to the IA-32 architecture. Further details on Intel 64 architecture and programming model can be found at http://developer.intel.com/technology/intel64/.

3.3.1.2 Intel® Hyper-Threading Technology (Intel® HT Technology)

The processor supports Intel® HT Technology, which allows an execution core to function as two logical processors. While some execution resources such as caches, execution units, and buses are shared, each logical processor has its own architectural state with its own set of general-purpose registers and control registers. This feature must be enabled via the BIOS and requires operating system support.

3.3.1.3 Enhanced Intel SpeedStep® Technology

Processors in the Fifth Generation Intel® Core™ Processor Family support Enhanced Intel SpeedStep® Technology. The processors support multiple performance states, which allows the system to dynamically adjust processor voltage and core frequency as needed to enable decreased power consumption and decreased heat production. All controls for transitioning between states are centralized within the processor, allowing for an increased frequency of transitions for more effective operation.

The Enhanced Intel SpeedStep Technology feature may be enabled/disabled by an option on the Processor Configuration Setup screen. By default Enhanced Intel SpeedStep Technology is enabled. If Enhanced Intel SpeedStep Technology is disabled, then the processor speed is set to the processor's maximum TDP core frequency (nominal rated frequency).

3.3.1.4 Intel® Turbo Boost Technology 2.0

Intel® Turbo Boost Technology is featured on all processors in the Fifth Generation Intel® Core™ Processor Family. Intel Turbo Boost Technology opportunistically and automatically allows the processor to run faster than the marked frequency if the processor is operating below power, temperature, and current limits. This results in increased performance for both multi-threaded and single-threaded workloads.

3.3.1.5 Intel® Virtualization Technology for IA-32, Intel® 64 and Intel® Architecture (Intel® VT-x)

Intel® Virtualization Technology for IA-32, Intel® 64 and Intel® Architecture (Intel® VT-x) provides hardware support in the core to improve performance and robustness for virtualization. Intel VT-x specifications and functional descriptions are included in the Intel 64 and IA-32 Architectures Software Developer's Manual.

3.3.1.6 Intel® Virtualization Technology for Directed I/O (Intel® VT-d)

Intel® Virtualization Technology for Directed I/O (Intel® VT-d) provides hardware support in the core and uncore implementations to improve I/O virtualization performance and robustness.

3.3.1.7 Execute Disable Bit

Execute Disable Bit functionality can help prevent certain classes of malicious buffer overflow attacks when combined with a supporting operating system. This allows the processor to classify areas in memory by where application code can execute and where it cannot. When malicious code attempts to insert code in the buffer, the processor disables code execution, preventing damage and further propagation.

3.3.1.8 Intel® Trusted Execution Technology for servers (Intel® TXT)

Intel® TXT defines platform-level enhancements that provide the building blocks for creating trusted platforms. The Intel TXT platform helps to provide the authenticity of the controlling environment such that those wishing to rely on the platform can make an appropriate trust decision. The Intel TXT platform determines the identity of the controlling environment by accurately measuring and verifying the controlling software.

3.3.1.9 Intel® Advanced Vector Extensions 512 (Intel AVX-512)

The base of the 512-bit single instruction multiple data (SIMD) instruction extensions are referred to as Intel® AVX-512 foundation instructions. They include extensions of the Intel® Advanced Vector Extensions (Intel® AVX) family of SIMD instructions but are encoded using a new scheme with support for 512-bit vector registers, up to 32 vector registers in 64-bit mode, and conditional processing using opmask registers.

3.3.1.10 Intel® Advanced Encryption Standard New Instructions (Intel® AES-NI)

Intel® Advanced Encryption Standard New Instructions (Intel® AES-NI) is a set of instructions implemented in all processors in the Fifth Generation Intel® Core™ Processor Family. This feature adds AES instructions to accelerate encryption and decryption operations used in the Advanced Encryption Standard. The Intel AES-NI feature includes six additional SIMD instructions in the Intel® Streaming SIMD Extensions (Intel® SSE) instruction set.

The BIOS is responsible in POST to detect whether the processor has the Intel AES-NI instructions available. Some processors may be manufactured without Intel AES-NI instructions.

The Intel AES-NI instructions may be enabled or disabled by the BIOS. Intel AES-NI instructions are enabled unless the BIOS has explicitly disabled them.

3.3.1.11 Intel® Intelligent Power Node Manager 4.0

The Intel® ME on the Intel® C620 series chipset supports Intel® Intelligent Power Node Manager technology. The Intel ME/Intel® Node Manager (Intel® NM) combination is a power and thermal control capability on the platform, which exposes external interfaces that allow IT (through external management software) to query the Intel ME about platform power capability and consumption, thermal characteristics, and specify policy directives (that is, set a platform power budget). Intel ME enforces these policy directives by controlling the power consumption of underlying subsystems using available control mechanisms (such as processor P/T states). The determination of the policy directive is done outside of Intel ME either by intelligent management software or by the IT operator.

Below are the some of the applications of Intel Intelligent Power Node Manager technology:

- **Platform power monitoring and limiting** – The Intel ME/Intel NM monitors platform power consumption and holds average power over duration. It can be queried to return actual power at any given instance. The power limiting capability is to allow external management software to address key IT issues by setting a power budget for each server.
- **Inlet air temperature monitoring** – The Intel ME/Intel NM monitors server inlet air temperatures periodically. If there is an alert threshold in effect, then Intel ME/Intel NM issues an alert when the inlet (room) temperature exceeds the specified value. The threshold value can be set by policy.

- **Memory subsystem power limiting** – The Intel ME/Intel NM monitors memory power consumption. Memory power consumption is estimated using average bandwidth utilization information.
- **Processor power monitoring and limiting** – The Intel ME/Intel NM monitors processor or socket power consumption and holds average power over duration. It can be queried to return actual power at any given instant. The monitoring process of the Intel ME is used to limit the processor power consumption through processor P-states and dynamic core allocation.
- **Core allocation at boot time** – Restrict the number of cores for OS/VMM use by limiting how many cores are active at boot time. After the cores are turned off, the CPU limits how many working cores are visible to the BIOS and OS/VMM. The cores that are turned off cannot be turned on dynamically after the OS has started. It can be changed only at the next system reboot.
- **Core allocation at run-time** – This particular use case provides a higher level processor power control mechanism to a user at runtime, after booting. An external agent can dynamically use or not use cores in the processor subsystem by requesting Intel ME/Intel NM to control them, specifying the number of cores to use or not use.

For additional information, visit http://www.intel.com/content/www/us/en/data-center/data-center-management/node-manager-general.html.

3.3.1.12 Trusted Platform Module (TPM)

Trusted Platform Module is bound to the platform and connected to the PCH via the LPC bus or SPI bus. The TPM provides the hardware-based mechanism to store or 'seal' keys and other data to the platform. It also provides the hardware mechanism to report platform attestations

3.3.2 Intel® Xeon® Processor Scalable Family with Integrated Intel® Omni-Path Fabric

The Intel® Xeon® processor Scalable family includes SKUs which include an integrated Intel® Omni-Path Host Fabric Interface (Intel® OP HFI) connector.

Table 5. Intel® Xeon® processor Scalable family with integrated Intel® OP HFI features

Feature	81XXF Platinum	61XXF Gold
# of Cores	≥ 24	< 24
# of Intel® OP HFI Ports	1	1
# of Intel® UPI Links	2	2
Intel® UPI Speed	10.4 GT/s	10.4 GT/s
Supported Topologies	2S-2UPI	2S-2UPI
Node Controller Support	No	No
# of Memory Channels	6	6
Max DDR4 Speed	2666	2666
Memory Capacity	768 GB 1.5 TB (select SKUs)	768 GB 1.5 TB (select SKUs)
RAS Capability	Standard	Standard
Intel® Turbo Boost	Yes	Yes
Intel® HT Technology	Yes	Yes
Intel® AVX-512 ISA Support	Yes	Yes
Intel® AVX-512 - # of 512b FMA Units	2	2
# of PCIe* Lanes	48	48

The current fabric port count is one port per processor socket. Each Intel OP HFI port supports four lanes of 25 Gbps, providing 100 Gbps of bandwidth in a single direction.

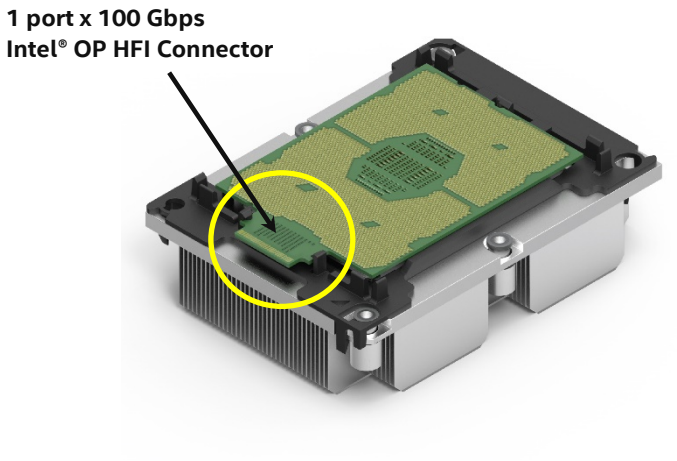


Figure 18. Intel® OP HFI connector location

Fabric processor support is a multi-chip package (MCP) option, where the processor Intel OP HFI connector is cabled to an IFT carrier board installed into in any available PCIe* add-in card slot or within the OCP module bay. A second cable carrying Intel Omni-Path side band signals is connected between the IFT carrier board and sideband connectors on the server board. External cables attach the IFT carrier board to an external Intel Omni-Path Switch.

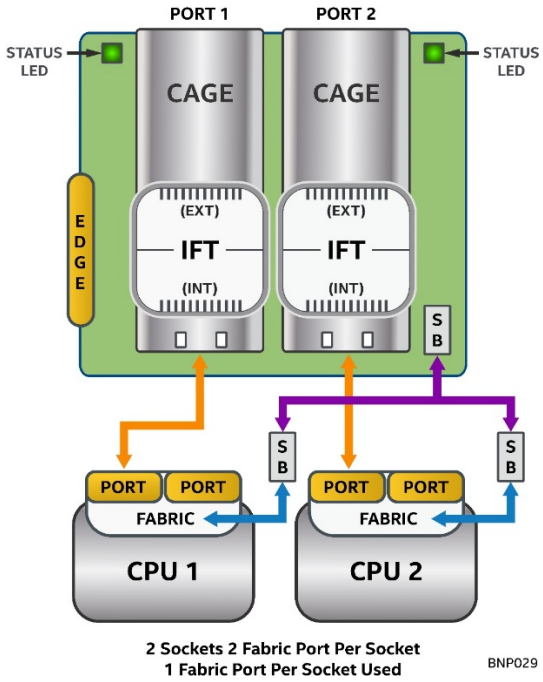


Figure 19. Multi-chip package (MCP)

The following figure illustrates two supported dual processor configurations with one or two fabric processors. In the diagram, each processor HFI connector is cabled to a QSFP28 interface card

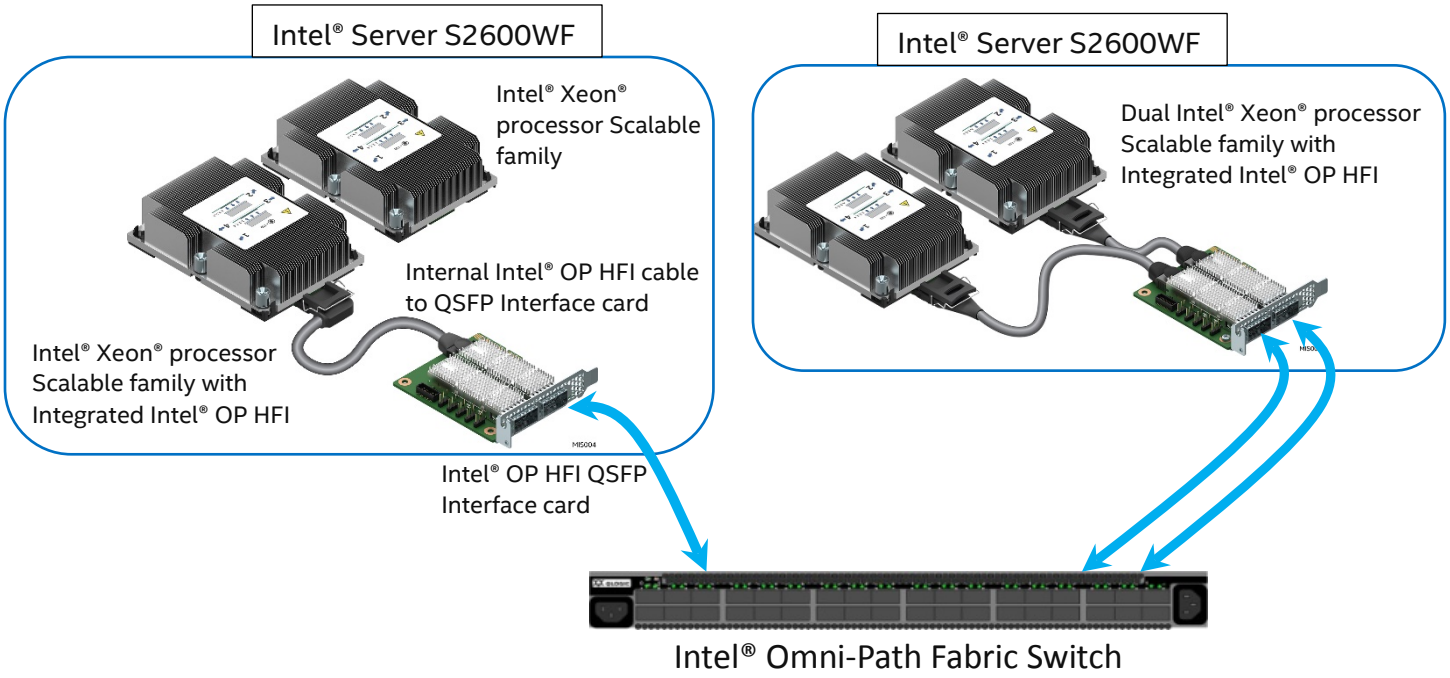


Figure 20. Dual processor configurations with one or two fabric processors

3.3.3 Intel®Omni-Path IFT Carrier Accessory Kits

All necessary components to support up to two fabric processors are included in orderable accessory kits (AWF1PFABKITM and AWF1PFABKITP).

Intel Product Code (iPC)	Description	Accessory Kit Contents
AWF1PFABKITM	Intel IFT Carrier Kit – Mezzanine	1 – Dual port IFT Carrier Mezzanine Card 1 – Internal Omni-Path Cable (CPU1) 1 – Internal Omni-Path Cable (CPU2) 1 – Internal Omni-Path Sideband Cable 2 – Fabric Processor Carriers
AWF1PFABKITP	Intel IFT Carrier Kit – PCIe*	1 – Dual Port IFT Carrier PCIe Add-in Card 1 – Internal Omni-Path Cable (CPU1) 1 – Internal Omni-Path Cable (CPU2) 1 – Internal Omni-Path Sideband Cable 2 – Fabric Processor Carriers

Two options for the IFT carrier card are offered:

- Mezannine – Mounted directly to the server board in the designated OCP module mounting location.
- PCIe add-in card – Installed to any available riser slot 2 PCIe add-in slot.

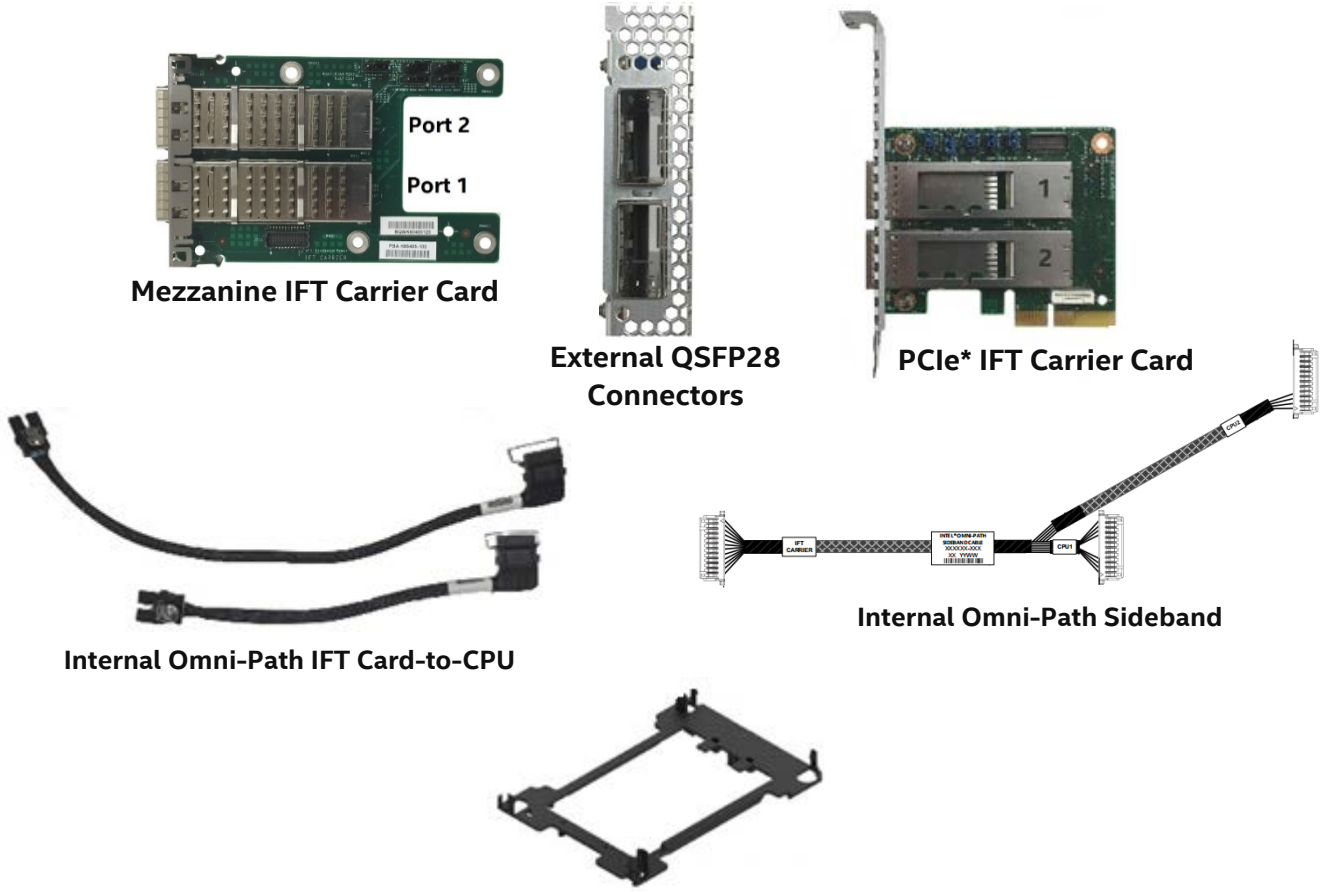


Figure 21. Intel® Omni-Path IFT Carrier Accessory Kit components

The sideband cable connects the IFT carrier board to each fabric processor sideband connector on the server board. The sideband connectors are shown in Figure 22.

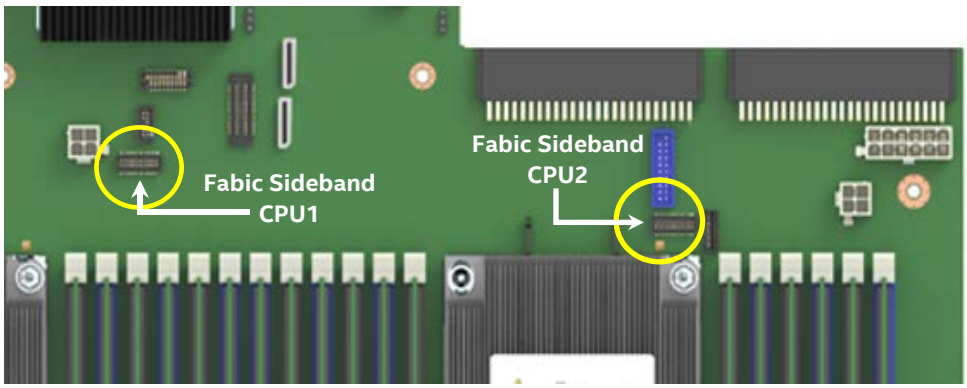


Figure 22. Server board sideband connectors

Each IFT carrier port has one green status LED as shown in Figure 23

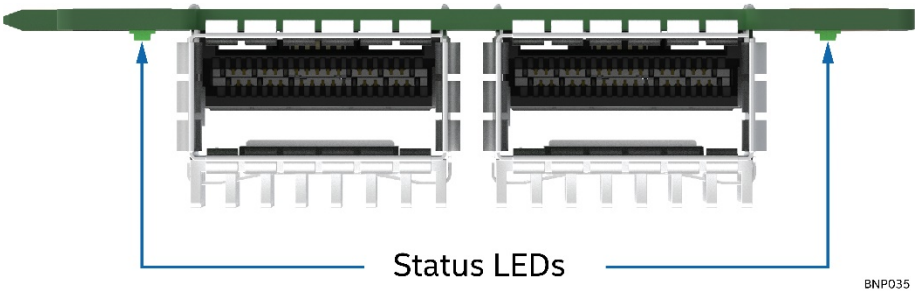


Figure 23. IFT carrier board – rear view

Table 6. IFT carrier LED functionality

LED State	Description
Off	No link
Blinking slowly	Link established but not activated by management
Solid on	Link activated by management; but no traffic is present
Steady blinking	Traffic is present

For external connection, the IFT carrier includes two QSFP+28 style connectors. The signal definition of these connectors consists of the high speed diff pairs, miscellaneous sideband signals, and 3.3 V power. The 3.3 V power is used for the active logic within the QSFP+ modules. As noted in Table 7, QSFP+ modules have four power classes that control how much power the active logic in the cable can consume.

Table 7. Power level classification for QSFP+ modules

Power Level Class	Max Power (W)
1	1.5
2	2.0
3	2.5
4	3.5

The server board has support for processor configurations where one or two installed processors may have an Intel OP HFI. In dual processor configurations, with at least one processor having support for Intel OP HFI, the following population rules apply:

- The base SKU number of both processor types must be the same.
  - Example: Intel® Xeon® Platinum 8160F (Intel OP HFI) + Intel Xeon Platinum 8160 (non-fabric)
  - Example: Intel Xeon Gold 6140F (Intel OP HFI) + Intel Xeon Gold 6140F (Intel OP HFI)

There is no restriction on which processor socket is populated with the fabric processor and which processor socket is populated with the matching non-fabric processor.

Table 8. Supported processor mixing – fabric vs non-fabric processors

CPU Socket 1	CPU Socket 2	Platform Expected Behavior
Processor	Processor	Boot to OS
Processor	Fabric Processor	Boot to OS
Fabric Processor	Processor	Boot to OS
Fabric Processor	Fabric Processor	Boot to OS

3.4 Processor Population Rules

Note: The server board may support dual-processor configurations consisting of different processors that meet the defined criteria below; however, Intel does not perform validation testing of this configuration. In addition, Intel does not guarantee that a server system configured with unmatched processors will operate reliably. The system BIOS does attempt to operate with processors which are not matched but are generally compatible. For optimal system performance in dual-processor configurations, Intel recommends that identical processors be installed.

When using a single processor configuration, the processor must be installed into the processor socket labeled “CPU_1”.

Note: Some server board features may not be functional unless a second processor is installed (see Figure 12).

When two processors are installed, the following population rules apply:

- Both processors must have the same number of cores.
- Both processors must have the same cache sizes for all levels of processor cache memory.
- Both processors must support identical DDR4 memory frequencies.
- Both processors must have identical extended family, extended model, processor type, family code and model number.
- Processors with FPGA and processors with Intel® Omni-Path Fabric cannot be mixed.

Processors with different core frequencies can be mixed in a system, given that the prior rules are met. If this condition is detected, all processor core frequencies are set to the lowest common denominator (highest common speed) and an error is reported.

Processor stepping within a common processor family can be mixed as long as it is listed in the processor specification updates published by Intel. Mixing of steppings is only validated and supported between processors that are plus or minus one stepping from each other.

3.5 Processor Initialization Error Summary

Table 9 describes mixed processor conditions and recommended actions for all Intel® server boards and Intel server systems designed around the Intel® Xeon® processor E5-2600 v5 product family and Intel® C620 chipset architecture. The errors fall into one of the following categories:

- **Fatal**: If the system cannot boot, POST halts and display the following message:

  ```
  Unrecoverable fatal error found. System will not boot until the error is
     resolved
  Press <F2> to enter setup
  ```

  When the **<F2>** key on the keyboard is pressed, the error message is displayed on the error manager screen and an error is logged to the system event log (SEL) with the POST error code.

  The “POST Error Pause” option setting in the BIOS setup does not have any effect on this error.

  If the system is not able to boot, the system generates a beep code consisting of three long beeps and one short beep. The system cannot boot unless the error is resolved. The faulty component must be replaced.

The system status LED is set to a steady amber color for all fatal errors that are detected during processor initialization. A steady amber system status LED indicates that an unrecoverable system failure condition has occurred.

- **Major**: An error message is displayed to the error manager screen and an error is logged to the SEL. If the BIOS setup option "Post Error Pause" is enabled, operator intervention is required to continue booting the system. If the BIOS setup option "POST Error Pause" is disabled, the system continues to boot.
- **Minor**: An error message may be displayed to the screen or to the BIOS setup error manager and the POST error code 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.

Table 9. Mixed processor configurations error summary

Error	Severity	System Action when BIOS Detects the Error Condition
Processor family not identical	Fatal	• Halts at POST code `0xE6`. • Halts with three long beeps and one short beep. • Takes fatal error action (see above) and does not boot until the fault condition is remedied.
Processor model not identical	Fatal	• Logs the POST error code into the SEL. • Alerts the BMC to set the system status LED to steady amber. • Displays `0196: Processor model mismatch detected` message in the error manager. • Takes fatal error action (see above) and does not boot until the fault condition is remedied.
Processor cores/threads not identical	Fatal	• Halts at POST code `0xE5`. • Halts with three long beeps and one short beep. • Takes fatal error action (see above) and does not boot until the fault condition is remedied.
Processor cache or home agent not identical	Fatal	• Halts at POST code `0xE5`. • Halts with three long beeps and one short beep. • Takes fatal error action (see above) and does not boot until the fault condition is remedied.
Processor frequency (speed) not identical	Fatal	If the frequencies for all processors can be adjusted to be the same: • Adjusts all processor frequencies to the highest common frequency. • Does not generate an error – this is not an error condition. • Continues to boot the system successfully. If the frequencies for all processors cannot be adjusted to be the same: • Logs the POST error code into the SEL. • Alerts the BMC to set the system status LED to steady amber. • Does not disable the processor. • Displays `0197: Processor speeds unable to synchronize` message in the error manager. • Takes fatal error action (see above) and does not boot until the fault condition is remedied
Processor Intel® UPI link frequencies not identical	Fatal	If the link frequencies for all Intel® Ultra Path Interconnect (Intel® UPI) links can be adjusted to be the same: • Adjusts all Intel UPI interconnect link frequencies to highest common frequency. • Does not generate an error – this is not an error condition. • Continues to boot the system successfully. If the link frequencies for all Intel UPI links cannot be adjusted to be the same: • Logs the POST error code into the SEL. • Alerts the BMC to set the system status LED to steady amber. • Does not disable the processor. • Displays `0195: Processor Intel(R) UPI link frequencies unable to synchronize` message in the error manager. • Takes fatal error action (see above) and does not boot until the fault condition is remedied.

Error	Severity	System Action when BIOS Detects the Error Condition
Processor microcode update failed	Major	• Logs the POST error code into the SEL. • Displays `816x: Processor 0x unable to apply microcode update` message in the error manager or on the screen. • Takes major error action. The system may continue to boot in a degraded state, depending on the "POST Error Pause" setting in setup, or may halt with the POST error code in the error manager waiting for operator intervention.
Processor microcode update missing	Minor	• Logs the POST error code into the SEL. • Displays `818x: Processor 0x microcode update not found` message in the error manager or on the screen. • The system continues to boot in a degraded state, regardless of the "POST Error Pause" setting in setup.

4. System Memory

This chapter describes the architecture that drives the memory sub-system, supported memory types, memory population rules, and supported memory reliability, accessibility, and serviceability (RAS) features.

4.1 Memory Subsystem Architecture

Figure 24. Memory subsystem architecture

Note: This generation server board supports DDR4 memory only.

The Intel® Server Board S2600WF supports up to 24 DDR4 DIMMs, 12 per processor. Each installed processor supports six memory channels via two integrated memory controllers (IMC). On the server board, memory channels are assigned an identifier letter A through F, with each memory channel supporting two DIMM slots.

The server board supports the following:

- DDR4 DIMMs only.
- Registered DIMMs (RDIMMs), Load Reduced DIMMs (LRDIMMs), and NVDIMMs (Non-Volatile Dual Inline Memory Module).
- Only Error Correction Code (ECC) enabled RDIMMs or LRDIMMs.
- Only RDIMMs and LRDIMMs with integrated Thermal Sensor On Die (TSOD).
- DIMM sizes of 4 GB, 8 GB, 16 GB, 32 GB, 64 GB and 128 GB depending on ranks and technology.
- Maximum DIMM speeds dependent on the processor SKU installed in the system:
    - Intel® Xeon® Platinum 81xx processor – Max. 2666 Mega Transfers/second (MT/s)
    - Intel® Xeon® Gold 61xx processor – Max. 2666 MT/s
    - Intel® Xeon® Gold 51xx processor – Max. 2400 MT/s
    - Intel® Xeon® Silver processor – Max. 2400 MT/s
    - Intel® Xeon® Bronze processor – Max. 2133 MT/s
- DIMMs organized as Single Rank (SR), Dual Rank (DR), or Quad Rank (QR)
    - RDIMMS – Registered DIMMS – SR/DR/QR, ECC only
    - LRDIMMs – Load Reduced DIMMs – QR only, ECC only
    - Maximum of 8 logical ranks per channel
    - Maximum of 10 physical ranks loaded on a channel

4.2 Supported Memory

Table 10.DDR4 RDIMM and LRDIMM support

Type	Ranks Per Dimm and Data Width	DIMM Capacity (GB)		Speed (MT/s); Voltage (V); Slots per Channel (SPC) & DIMMs per Channel (DPC)	
				2Slots per Channel	
		DRAM Density		1DPC	2DPC
		4Gb	8Gb	1.2V	1.2V
RDIMM	SRx4	8GB	16GB	2666	2666
RDIMM	SRx8	4GB	8GB		
RDIMM	DRx8	8GB	16GB		
RDIMM	DRx4	16GB	32GB		
RDIMM 3DS	QRx4	N/A	2H-64GB		
	8Rx4	N/A	4H-128GB		
LRDIMM	QRx4	32GB	64GB		
LRDIMM 3DS	QRx4	N/A	2h-64GB		
	8Rx4	N/A	4H-128GB		

4.3 Memory Slot Identification and Population Rules

Note: Although mixed DIMM configurations may be functional, Intel only supports and performs platform validation on systems that are configured with identical DIMMs installed.

On the Intel® Server Board S2600WF, a total of 24 DIMM slots are provided – 2 CPUs, 6 Memory Channels/CPU, 2 DIMMs/Channel. Figure 25 identifies all DIMM slots on the server board.

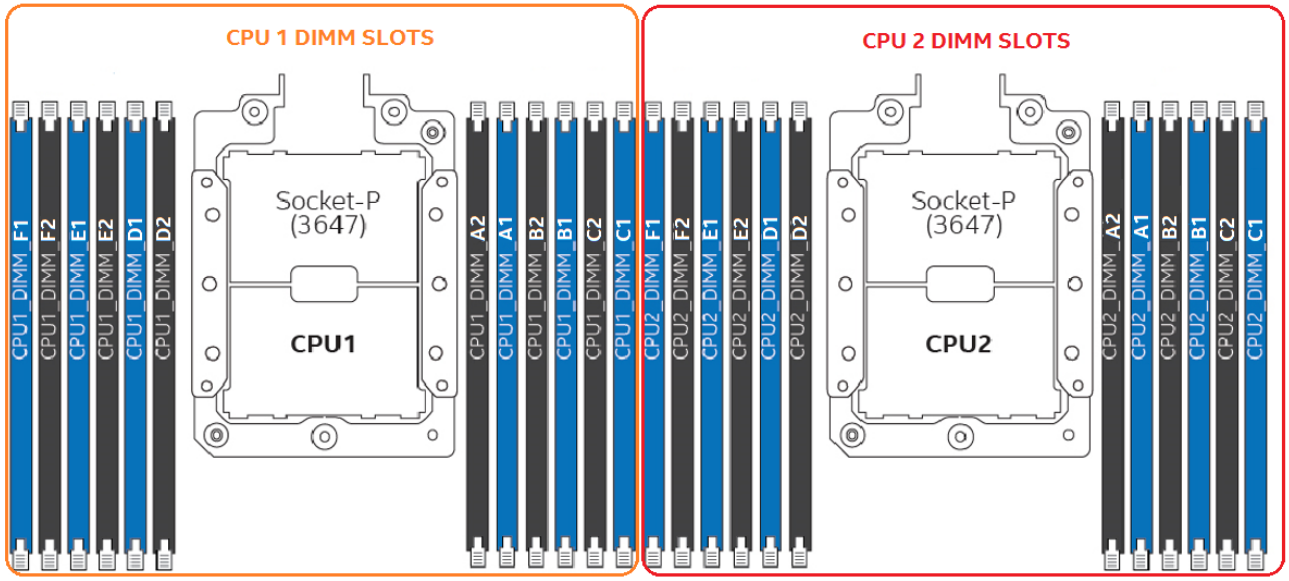


Figure 25. Intel® Server Board S2600WF memory slot layout

The following memory population rules apply when installing DIMMs:

- Each installed processor provides six channels of memory. Memory channels from each processor are identified as Channels A – F.
- Each memory channel supports two DIMM slots, identified as slots 1 and 2.
    - On the server board, each DIMM slot is labeled by CPU #, memory channel, and slot # such as CPU1_DIMM_A2 and CPU2_DIMM_A2.
- DIMM population rules require that DIMMs within a channel be populated starting with the blue DIMM slot or DIMM farthest from the processor in a “fill-farthest” approach.
- When only one DIMM is used for a given memory channel, it must be populated in the blue DIMM slot (furthest from the CPU).
- Mixing of DDR4 DIMM types (RDIMM, LRDIMM, 3DS RDIMM, 3DS LRDIMM, NVDIMM) within a channel socket or across sockets produces a Fatal Error Halt during memory initialization.
- Mixing DIMMs of different frequencies and latencies is not supported within or across processor sockets. If a mixed configuration is encountered, the BIOS attempts to operate at the highest common frequency and the lowest latency possible.
- When populating a quad-rank DIMM with a single- or dual-rank DIMM in the same channel, the quad-rank DIMM must be populated farthest from the processor. Incorrect DIMM placement results in an MRC error code. A maximum of 8 logical ranks can be used on any one channel, as well as a maximum of 10 physical ranks loaded on a channel.
- To install three quad-rank LRDIMMs on the same channel, they must be operated with rank multiplication as RM = 2. This makes each LRDIMM appear as a dual-rank DIMM with ranks twice as large.
- The memory slots associated with a given processor are unavailable if the corresponding processor socket is not populated.
- A processor may be installed without populating the associated memory slots, provided a second processor is installed with associated memory. In this case, the memory is shared by the processors. However, the platform suffers performance degradation and latency due to the remote memory.
- Processor sockets are self-contained and autonomous. However, all memory subsystem support (such as memory RAS and error management) in the BIOS setup are applied commonly across processor sockets.
- For multiple DIMMs per channel:
    - For RDIMM, LRDIMM, 3DS RDIMM, 3DS LRDIMM; always populate DIMMs with higher electrical loading in slot1, followed by slot 2.

4.3.1 DIMM Population Guidelines for Best Performance

Processors within the Intel Xeon processor Scalable family include two integrated memory controllers (IMC), each supporting three memory channels.

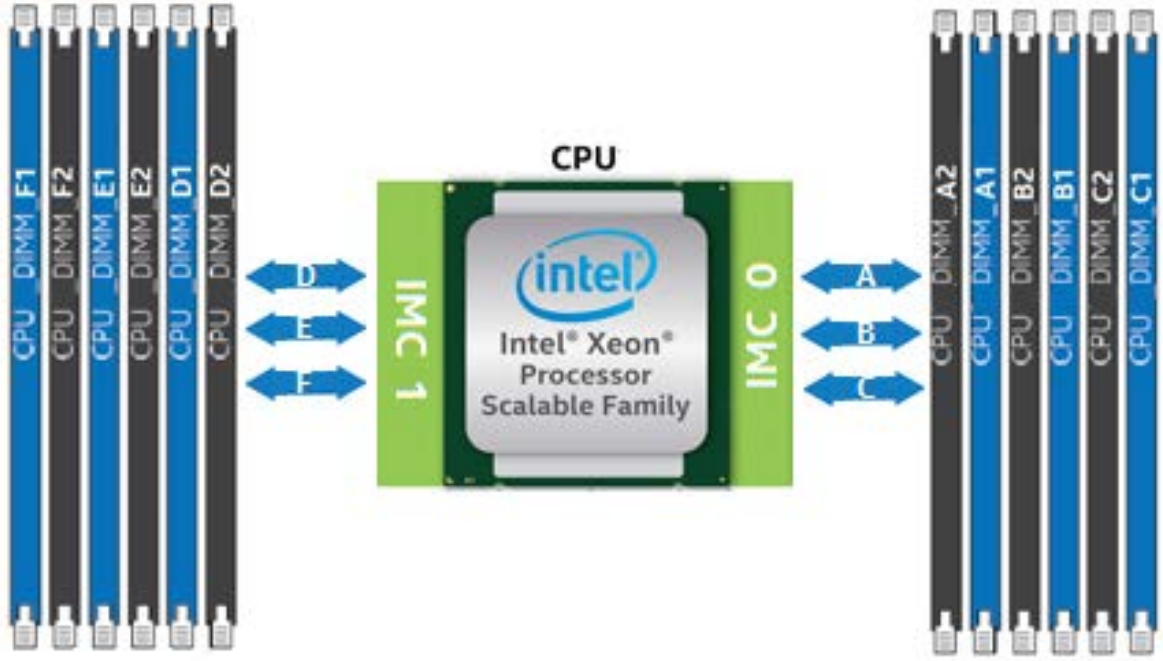


Figure 26. DIMM population diagram

For best performance, each processor should have matching DIMM configurations and DIMMs should be populated using the following guidelines:

- 1 DIMM to 3 DIMM configurations – DIMMs should be populated to DIMM slot 1 (blue slots) of channels A thru C.
- 4 DIMM configurations – DIMMs should be populated to DIMM slot 1 (blue slots) of channels A, B, D, and E.
- 5 DIMM configurations – Not recommended. This is an unbalanced configuration that yields less than optimal performance.
- 6 DIMM configurations – DIMMs should be populated to DIMM slot1 (blue slots) of all channels.
- 7 DIMM configurations – Not recommended. This is an unbalanced configuration that yields less than optimal performance.
- 8 DIMM configurations – DIMMs should be populated to DIMM slots 1 and 2 of channels A, B, D, and E.
- 9 DIMM, 10, DIMM, and 11 DIMM configurations – Not recommended. These are an unbalanced configurations that yield less than optimal performance.
- 12 DIMM configurations – DIMMs are populated to all DIMM slots.

4.4 Memory RAS Features

Supported memory RAS features are dependent on the level of processor installed. Each processor level within the Intel Xeon processor Scalable family has support for either standard or advanced memory RAS features as defined in Table 11.

Table 11. Memory RAS features

RAS Feature	Description	Standard	Advanced
Device Data Correction	x8 Single Device Data Correction (SDDC) via static virtual lockstep (Applicable to x8 DRAM DIMMs)	√	√
	Adaptive Data Correction (SR) (Applicable to x4 DRAM DIMMs)	√	√
	x8 Single Device Data Correction + 1 bit (SDDC+1) (Applicable to x8 DRAM DIMMs)		√
	SDDDC + 1, and ADDDC (MR) + 1 (Applicable to x4 DRAM DIMMs)		√
DDR4 Command/Address Parity Check and Retry	DDR4 Command/Address Parity Check and Retry: Is a DDR4 technology based CMD/ADDR parity check and retry with following attributes: • CMD/ADDR Parity error “address“ logging • CMD/ADDR Retry	√	√
DDR4 Write Data CRC Protection	DDR4 Write Data CRC Protection detects DDR4 data bus faults during write operation.	√	√
Memory Demand and Patrol Scrubbing	Demand scrubbing is the ability to write corrected data back to the memory once a correctable error is detected on a read transaction. Patrol scrubbing proactively searches the system memory, repairing correctable errors. Prevents accumulation of singlebit errors.	√	√
Memory Mirroring	Full Memory Mirroring: An intra IMC method of keeping a duplicate (secondary or mirrored) copy of the contents of memory as a redundant backup for use if the primary memory fails. The mirrored copy of the memory is stored in memory of the same processor socket's IMC. Dynamic (without reboot) failover to the mirrored DIMMs is transparent to the OS and applications.	√	√
	Address Range/Partial Memory Mirroring: Provides further intra socket granularity to mirroring of memory by allowing the firmware or OS to determine a range of memory addresses to be mirrored, leaving the rest of the memory in the socket in non-mirror mode.		√
Sparing • Rank Level Memory Sparing • Multi-rank Level Memory Sparing	Dynamic fail-over of failing Ranks to spare Ranks behind the same memory controller DDR ranks.	√	√
	With Multi Rank up to two ranks out of a maximum of eight ranks can be assigned as spare ranks.	√	√
iMC’s Corrupt Data Containment	Corrupt Data Containment is a process of signaling error along with the detected UC data. iMC's patrol scrubber and sparing engine have the ability to poison the UC data.	√	√
Failed DIMM Isolation	Ability to identify a specific failing DIMM thereby enabling the user to replace only the failed DIMM(s). In case of uncorrected error and lockstep mode, only DIMM-pair level isolation granularity is supported.	√	√
Memory Disable and Map Out for FRB	Allows memory initialization and booting to OS even when memory fault occurs.	√	√
Post Package Repair	Starting with DDR4 technology there is an additional capability available known as PPR (Post Package Repair). PPR offers additional spare capacity within the DDR4 DRAM that can be used to replace faulty cell areas detected during system boot time.	√	√

Note: RAS features may not be supported on all SKUs of a processor type.

4.4.1 DIMM Populations Rules and BIOS Setup for Memory RAS

- Memory sparing and memory mirroring options are enabled in BIOS setup.
- Memory sparing and memory mirroring options are mutually exclusive. Only one operating mode may be selected in BIOS setup.
- If a RAS mode has been enabled, and the memory configuration is not able to support it during boot, the system will fall back to independent channel mode and log and display errors.
- Rank sparing mode is only possible when all channels that are populated with memory that meet the reaquirement of having at least two single-rank or double-rank DIMMs installed, or at least one quad-rank DIMM installed, on each populated channel.
- Memory mirroring mode requires that for any channel pair that is populated with memory, the memory population on both channels of the pair must be identically sized.

5. PCIe* Support

The PCI Express* (PCIe*) interface of the Intel® Server Board S2600WF product family is fully compliant with the PCIe Base Specification, Revision 3.0 supporting the following PCIe bit rates: Gen 3.0 (8.0 GT/s), Gen 2.0 (5.0 GT/s), and Gen 1.0 (2.5 GT/s).

For specific board features and functions supported by the PCIe sub-system, see Chapter 6. Table 12 provides the PCIe port routing information from each processor:

Table 12. CPU - PCIe* port routing

CPU 1		CPU 2	
PCI Ports	**Onboard Device**	**PCI Ports**	**Onboard Device**
Port DMI 3 - x4	Chipset	Port DMI 3 - x4	Riser Slot #3
Port 1A - x4	Riser Slot #1	Port 1A - x4	Riser Slot #2
Port 1B - x4	Riser Slot #1	Port 1B - x4	Riser Slot #2
Port 1C – x4	Riser Slot #1	Port 1C – x4	Riser Slot #1
Port 1D – x4	Riser Slot #1	Port 1D – x4	Riser Slot #1
Port 2A - x4	Chipset (PCH) - uplink	Port 2A - x4	Riser Slot #2
Port 2B - x4	Chipset (PCH) - uplink	Port 2B - x4	Riser Slot #2
Port 2C - x4	Chipset (PCH) - uplink	Port 2C - x4	Riser Slot #2
Port 2D - x4	Chipset (PCH) - uplink	Port 2D - x4	Riser Slot #2
Port 3A - x4	SAS Module	Port 3A - x4	OCuLink PCIe_SSD2
Port 3B - x4	SAS Module	Port 3B - x4	OCulink PCIe_SSD3
Port 3C - x4	OCuLink PCIe_SSD0	Port 3C - x4	Riser Slot #3
Port 3D -x4	OCuLInk PCIe_SSD1	Port 3D -x4	Riser Slot #3

5.1.1 PCIe* Enumeration and Allocation

The BIOS assigns PCI bus numbers in a depth-first hierarchy, in accordance with the PCI Local Bus Specification, Revision 3.0. The bus number is incremented when the BIOS encounters a PCI-PCI bridge device.

Scanning continues on the secondary side of the bridge until all subordinate buses are assigned numbers. PCI bus number assignments may vary from boot to boot with varying presence of PCI devices with PCI-PCI bridges.

If a bridge device with a single bus behind it is inserted into a PCI bus, all subsequent PCI bus numbers below the current bus are increased by one. The bus assignments occur once, early in the BIOS boot process, and never change during the pre-boot phase.

The BIOS resource manager assigns the PIC-mode interrupt for the devices that are accessed by the legacy code. The BIOS ensures that the PCI BAR registers and the command registers for all devices are correctly set up to match the behavior of the legacy BIOS after booting to a legacy OS. Legacy code cannot make any assumption about the scan order of devices or the order in which resources are allocated to them. The BIOS automatically assigns IRQs to devices in the system for legacy compatibility. A method is not provided to manually configure the IRQs for devices.

5.1.2 Non-Transparent Bridge

The PCIe Non-Transparent Bridge (NTB) acts as a gateway that enables high performance, low latency communication between two PCIe Hierarchies, such as a local and remote system. The NTB allows a local

processor to independently configure and control the local system and provides isolation of the local host memory domain from the remote host memory domain, while enabling status and data exchange between the two domains. The NTB is discovered by the local processor as a Root Complex Integrated Endpoint (RCiEP).

Figure 27 shows two systems that are connected through an NTB. Each system is a completely independent PCIe hierarchy. The width of the NT Link can be x16, x8, or x4 at the expense of other PCIe root ports. Only Port A can be configured as an NT port.

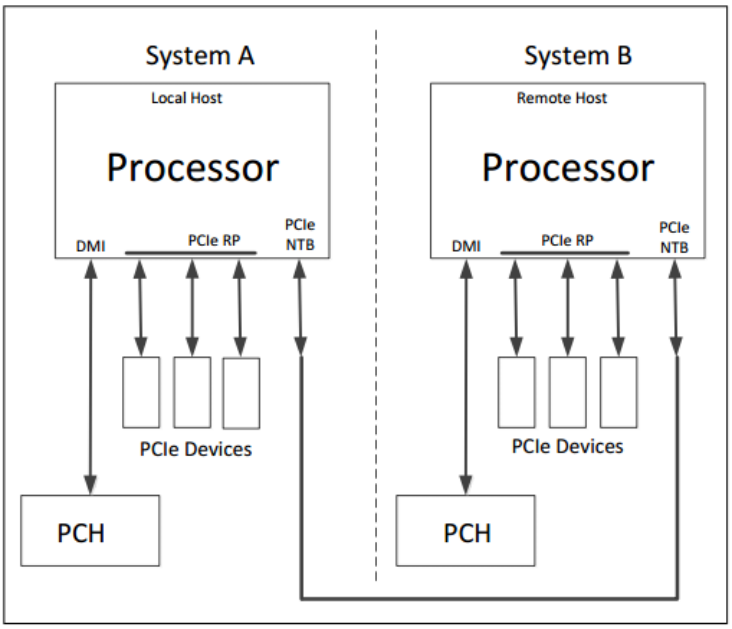


Figure 27. Two systems connected through an NTB

The specified processor family supports the following NTB features.

The NTB only supports one configuration/connection model:

- NT Port attached to another NT Port of the same component type and generation
- The NTB provides Direct Address Translation between the two PCIe Hierarchies through two separate regions in Memory Space. Accesses targeting these Memory addresses are allowed to pass through the NTB to the remote system. This mechanism enables the following transactions flows through the NTB:
    - Both Posted Mem Writes and Non-Posted Mem Read transactions across the NTB
    - Peer-to-Peer Mem Read and Write transactions to and from the NTB

In addition, the NTB provides the ability to interrupt a processor in the remote system through a set of Doorbell registers. A write to a Doorbell register in the local side of the NTB will generate an interrupt to the remote processor. Since the NTB is designed to be symmetric, the converse is also true.

For additional information, refer to the Processor Family External Design Specification (EDS).

6. System I/O

The server board input/output features are provided via the embedded features and functions of several onboard components including: the Integrated I/O Module (IIO) of the Intel® Xeon® processor, the Intel® C620 series chipset (PCH), and the I/O controllers embedded within the Aspeed* AST2500 management controller. See Figure 12 for an overview of the features and interconnects of each of the major sub-system components. Server board I/O features include:

- Intel® QuickAssist Technology (Intel® QAT) support (S2600WFQ only)
- PCIe* riser card and add-in card support
- Intel® Ethernet Network Adapter for OCP* support
- Intel® Integrated RAID Module support
- Onboard storage subsystem
- External I/O port support

6.1 Intel® QuickAssist Technology (Intel® QAT) Support

This section provides a high level overview for Intel QAT and its support on the Intel® Server Board S2600WF product family. For more information about this technology, visit http://www.intel.com/content/www/us/en/embedded/technology/quickassist/overview.html.

Note: For the Intel Server Board S2600WF product family, only the S2600WFQ SKU supports Intel QAT.

Intel QAT provides security and compression acceleration capabilities used to improve performance and efficiency across the data center.

Intel QAT supports the following:

- Cryptographic capabilities: 100 Gb/s IPSec & SSL
  - Symmetric ciphers: (AES, AES-XTS, 3DES/DES, RC4, Kasumi, Snow3G, ZUC)
  - Message digest/hash (MD5, SHA1, SHA2, SHA3)
  - Authentication (HMAC, AES-XCBC)
  - Authenticated encryption (AES-GCM, AES-CCM)
- Asymmetric (public key) cryptographic capabilities
  - Modular exponentiation for Diffie-Hellman (DH)
  - RSA key generation, encryption/decryption and digital signature generation/verification. RSA(2K Keys) up to 100K Ops/sec
  - DSA parameter generation and digital signature generation/verification
  - Elliptic curve cryptography: ECDSA, ECDH
- Compression/decompression (deflate) up to 100Gb/s

On the Intel Server Board S2600WFQ, there are three Intel QAT engines incorporated into the Intel C628 chipset with a dedicated x16 PCIe* 3.0 link that allows for up to 100 Gbps aggregated bandwidth.

Intel QAT bandwidth can be increased to 150 Gbps with the addition of an optional Intel QAT bridge cable connected between the onboard mini-SAS HD connectors for SATA Ports 0-3 and 4-7, and two of the onboard PCIe x4 OCuLink connectors as shown in Figure 28.

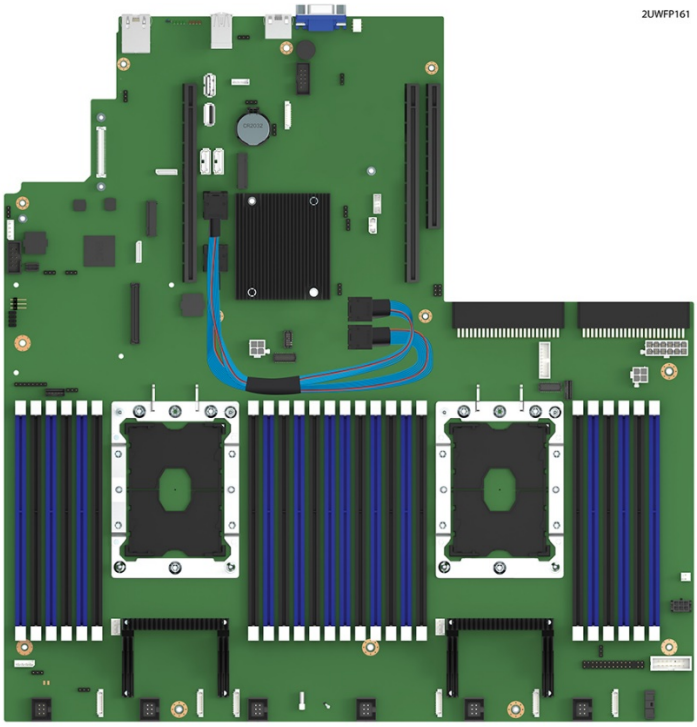


Figure 28. Intel® QAT cable

When the PCH detects the link, it uses the additional x4 PCIe 3.0 uplink from each of the two OCuLink onboard connectors.

Note: For Intel Server Board S2600WFQ, the Intel QAT cable is included with the board and is not available for sale separately.

Intel QAT support requires that a driver be loaded for the installed operating system. Visit http://downloadcenter.intel.com to download the latest available drivers.

6.2 PCIe* Add-in Card Support

The server board provides three riser card slots identified as: Riser Slot #1, Riser Slot #2, and Riser Slot #3. Per the PCIe specification, each riser card slot can support a maximum 75 W of power. The PCIe bus lanes for each riser card slot is supported by each of the two installed processors. Table 13, Table 14, and Table 15 provide the PCIe* bus routing for all supported risers cards.

Note: The riser card slots are 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.

Note: A dual processor configuration is required when using Riser Slot #2 and Riser Slot #3, as well as the bottom add-in card slot for 2U riser cards installed in Riser Slot #1.

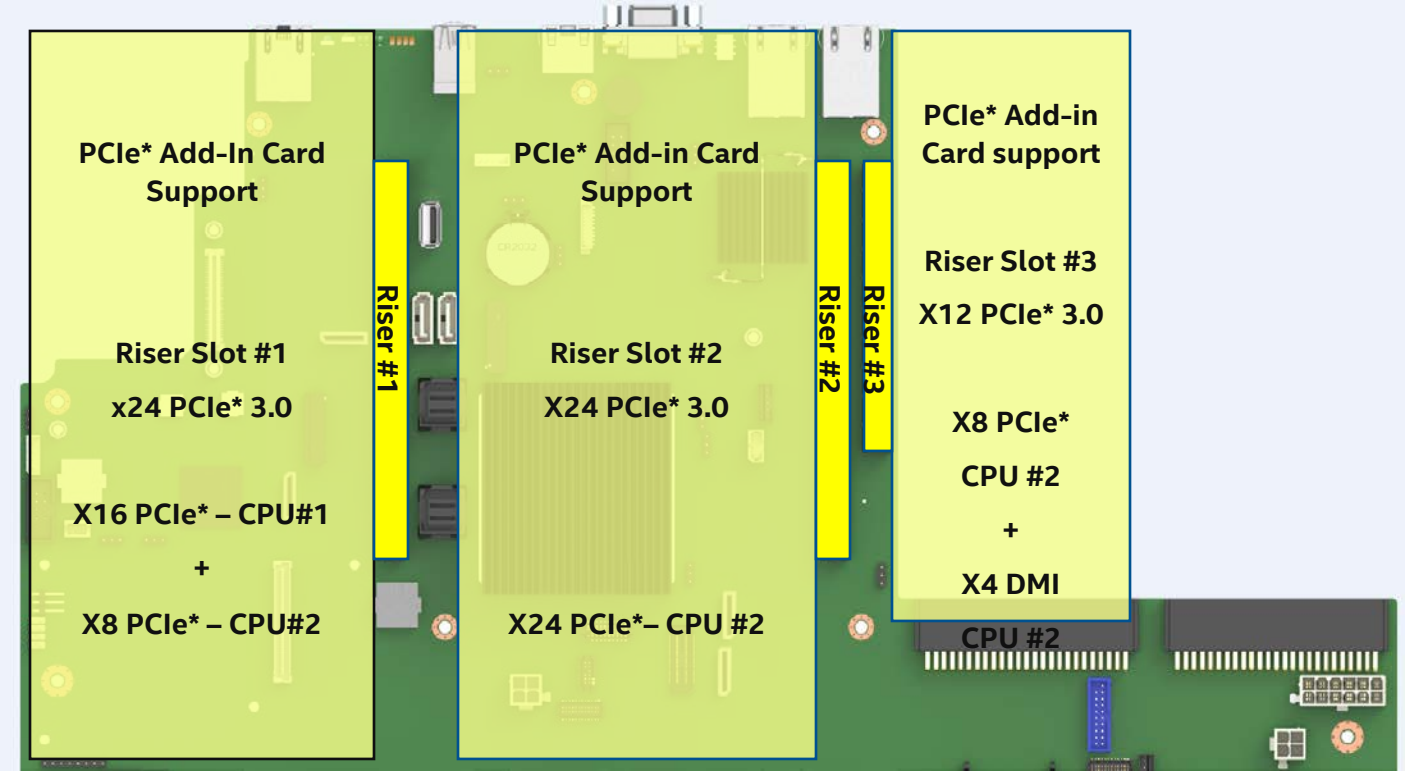


Figure 29. PCIe* add-in card support

Table 13. Riser slot #1 PCIe* root port mapping

PCIe* Slot	2U – 3-Slot Riser Card iPC – A2UL8RISER2	2U – 2-Slot Riser Card iPC – A2UL16RISER2
Top	CPU #1 – Ports 1A and 1B (x8 elec, x16 mech)	CPU #1 – Ports 1A thru 1D (x16 elec, x16 mech)
Middle	CPU #1 – Ports 1C and 1D (x8 elec, x16 mech)	N/A
Bottom	CPU #2 – Ports 1C and 1D (x8 elec, x8 mech)	CPU #2 – Ports 1C and 1D (x8 elec, x8 mech)

Table 14. Riser slot #2 PCIe* root port mapping

PCIe* Slot	2U – 3-Slot Riser Card iPC – A2UL8RISER2	2U – 2-Slot Riser Card iPC – A2UL16RISER2
Top	CPU #2 – Ports 2A and 2B (x8 elec, x16 mech)	CPU #2 – Ports 2A thru 2D (x16 elec, x16 mech)
Middle	CPU #2 – Ports 2C and 2D (x8 elec, x16 mech)	N/A
Bottom	CPU #2 – Ports 1A and 1B (x8 elec, x8 mech)	CPU #2 – Ports 1A and 1B (x8 elec, x8 mech)

Table 15. Riser slot #3 PCIe* root port mapping

PCIe* Slot	2U – Low Profile Riser Card iPC – A2UX8X4RISER	Notes
Top	CPU #2 – DMI x4 (x4 elec, x8 mech)	Low profile cards only.
Bottom	CPU #2 – Ports 3C and 3D (x8 elec, x8 mech)	Low profile cards only.

6.2.1 Riser Slot #1 and Riser Slot #2 Riser Card Options

Several multi-slot PCI riser card options are available for this server product family. Available riser cards for riser slots #1 and #2 are common between the two slots.

6.2.1.1 1U One-Slot PCIe Riser Card (iPC – F1UL16RISER3APP)

Each riser card assembly has support for a single full height, ½ length PCIe add-in card. However, riser card #2 may be limited to ½ length, ½ height add-in cards if either of the two mini-SAS HD connectors on the server board are used.

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.

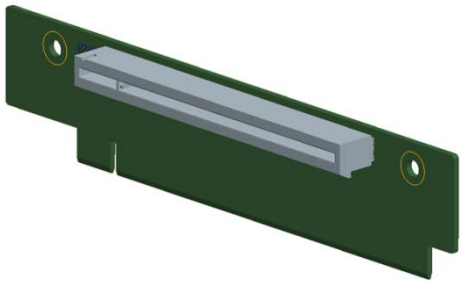


Figure 30. 1U one-slot PCIe* riser card (iPC – F1UL16RISER3APP)

Table 16. One-slot PCIe* riser card slot description

Slot #	Description
Slot-1	PCIe x16 elec, x16 mechanical

6.2.1.2 2U Three-Slot PCIe Riser Card (iPC – A2UL8RISER2)

Each riser card assembly has support for up to two full height full length add-in cards (top and middle slots) and one full height ½ length add-in card (bottom slot).

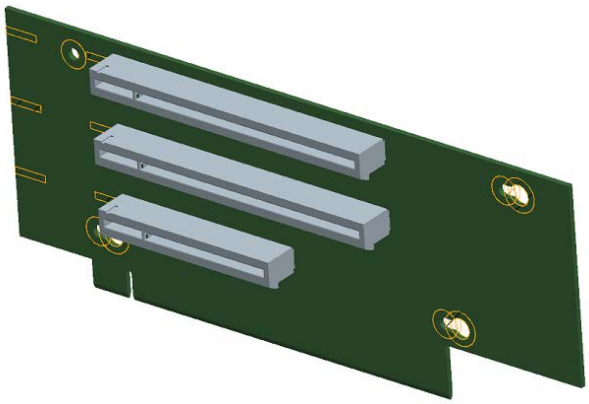


Figure 31. 2U three-slot PCIe* riser card (iPC – A2UL8RISER2)

Table 17. Three-slot PCIe* riser card slot description

Slot #	Description
Slot-1 (top)	PCIe x8 elec, x16 mechanical
Slot-2 (middle)	PCIe x8 elec, x16 mechanical
Slot-3 (bottom)	PCIe x8 elec, x8 mechanical

6.2.1.3 2U Two-Slot PCIe Riser Card (iPC – A2UL16RISER2)

Each riser card assembly has support for one full height full length add-in card (top slot) and one full height ½ length add-in card (bottom slot).

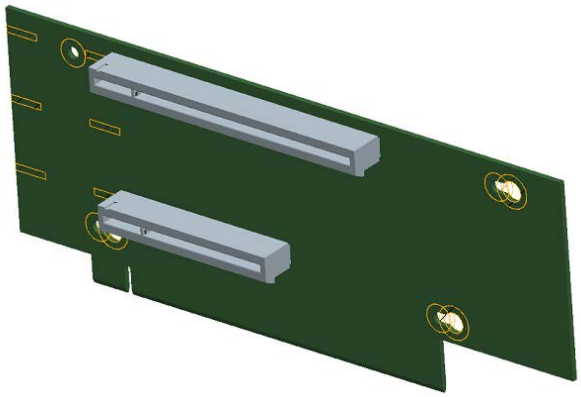


Figure 32. 2U two-slot PCIe* riser card (iPC – A2UL16RISER2)

Table 18. Two-slot PCIe* riser card slot description

Slot #	Description
Slot-1 (top)	PCIe x16 elec, x16 mechanical
Slot-2 (bottom)	PCIe x8 elec, x8 mechanical

6.2.2 Riser Slot #3 Riser Card Option (iPC – A2UX8X4RISER)

Riser slot #3 is provided to support up to two additional PCIe add-in card slots for 2U server configurations. The available riser card option is designed to support low profile add-in cards only.

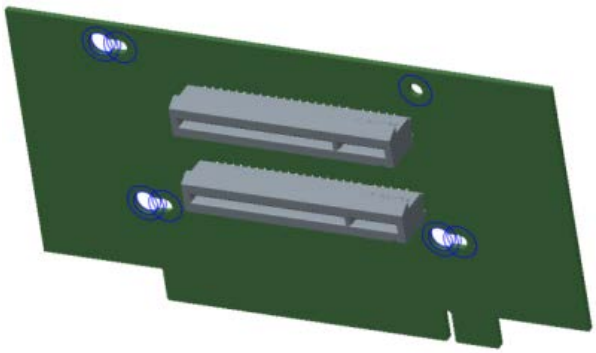


Figure 33. Low profile riser card (iPC – A2UX8X4RISER)

Table 19. Low profile riser card slot description

Slot #	Description
Slot-1 (top)	PCIe x4 elec, x8 mechanical
Slot-2 (bottom)	PCIe x8 elec, x8 mechanical

6.2.3 Intel® Ethernet Network Adapter for OCP* Support

The Intel Server Board S2600WF product family offers a line of LAN KR OCP mezzanine modules that follow the OCP 2.0 form factor.

The optional OCP mezzanine module can be installed onto the connector labeled “OCP_IO_Module” on the server board, as shown in Figure 34.

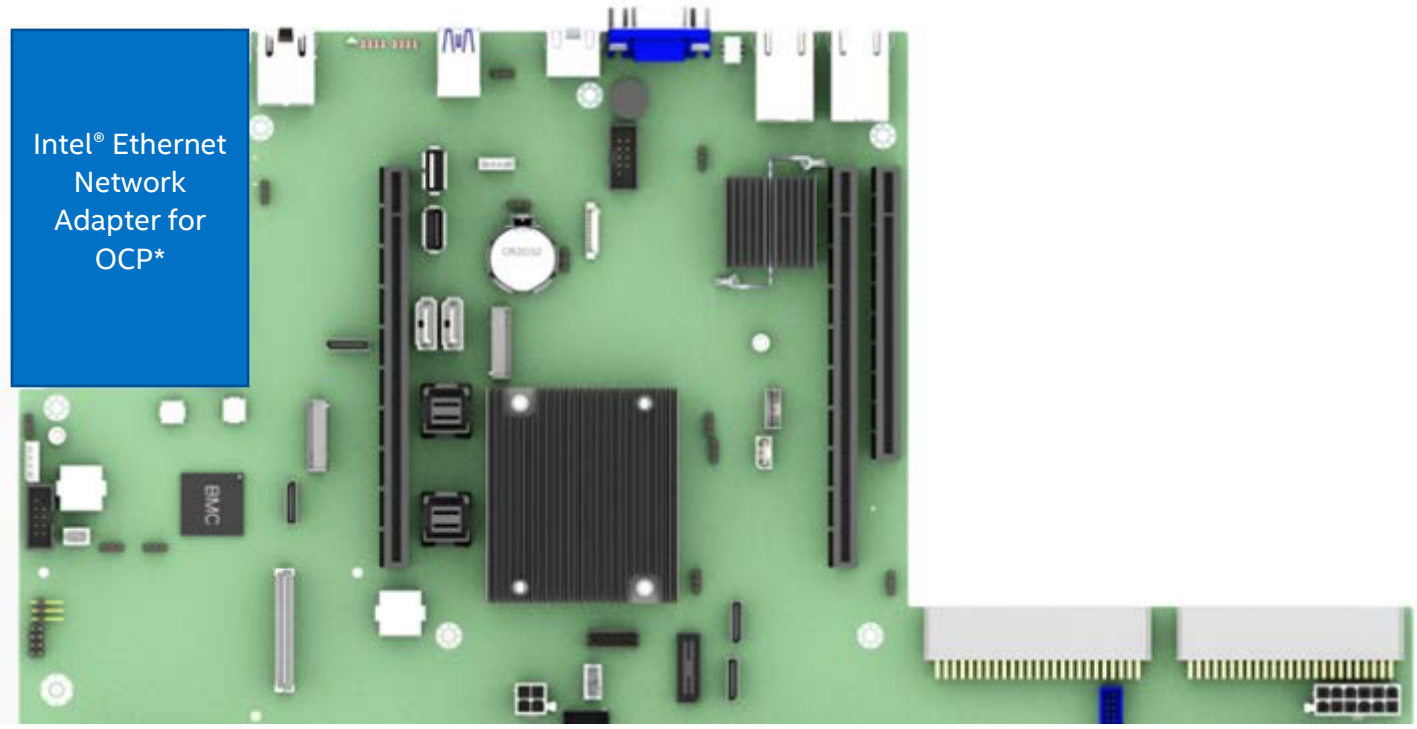


Figure 34. Intel® Ethernet Network Adapter for OCP* connector

Table 16 lists the supported OCP modules:

Table 20. Supported Intel® Ethernet Network Adapters for OCP*

Description	iPC
Quad Port, 1GB, RJ45	I357T4OCPG1P5
Quad Port, SFP+	X527DA4OCPG1P5
Dual Port, SFP+ (Intel® Server Board S2600WFT only)	X527DA2OCPG1P5
Dual Port, 10Gb RJ45 (Intel Server Board S2600WFT only)	X557T2OCPG1P5

Note: The dual-port SFP+ and dual-port 10 Gb RJ45+ modules are only supported on the Intel Server Board S2600WFT.

6.2.4 Intel® Integrated RAID Module Support

The server board has support for many Intel and non-Intel PCIe add-in 12 Gb RAID adapters that can be installed in available PCIe add-in cards slots. For system configurations with limited add-in card slot availability, an optional Intel® Integrated RAID mezzanine module can be installed onto a high-density, 80-pin connector labeled "SAS Module" on the server board.

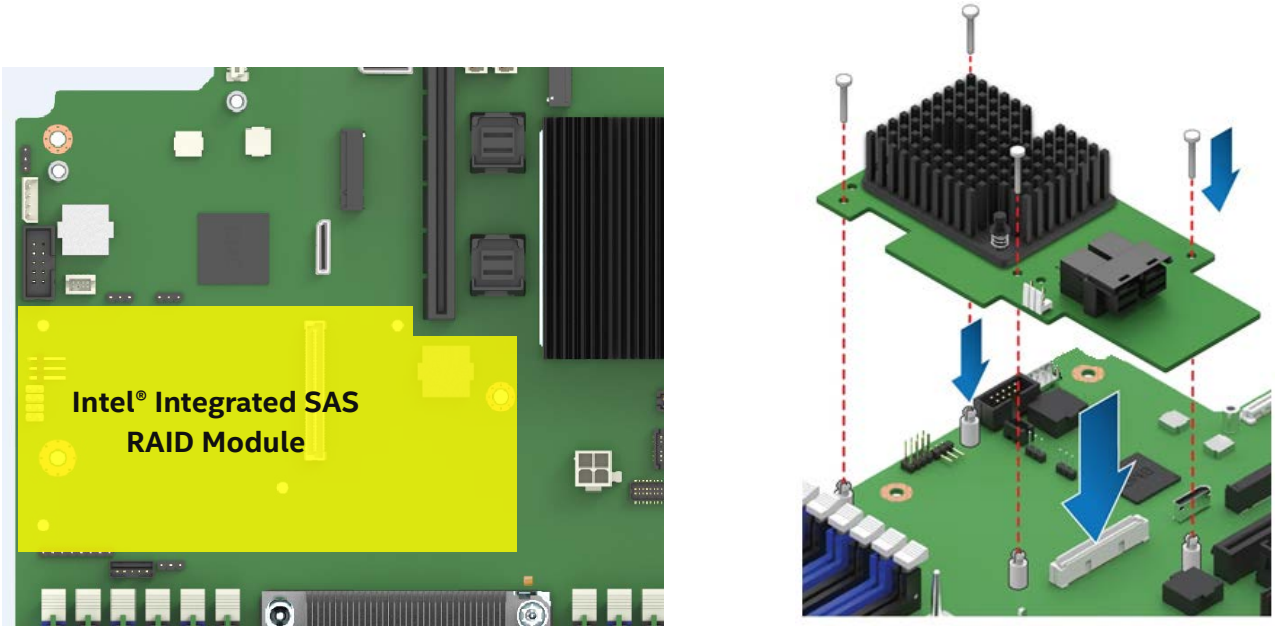


Figure 35. Intel® Integrated RAID module

For a list of supported Intel Integrated RAID module options, visit the Intel® Server Configurator Tool at https://serverconfigurator.intel.com.

6.3 Onboard Storage Subsystem

The Intel Server Board S2600WF product family includes support for many storage related technologies and onboard features to support a wide variety of storage options. These include:

- (2) – M.2 PCIe*/SATA
- (4) – PCIe* OCuLink
- Intel® Volume Management Device (Intel® VMD) for NVMe*
- Intel® Virtual RAID on CPU (Intel® VROC) for NVMe
- (2) – 7-pin single port SATA
- (2) – Mini-SAS HD (SFF-8643) 4-port SATA (S2600WFT and S2600WF0 boards only)
- Onboard SATA RAID aptions
    - o Intel® Rapid Storage Technology enterprise (Intel® RSTe) 5.0 for SATA
    - o Intel® Embedded Server RAID Technology 2 (Intel® ESRT2) v1.60 for SATA

The following sections provide an overview of each option.

6.3.1 M.2 SSD Support

The Intel Server Board S2600WF product family includes two M.2 SSD connectors labeled "M2_x4PCIE/sSATA_1" and "M2_x2PCIE/sSATA_2" on the server board as shown in Figure 36.

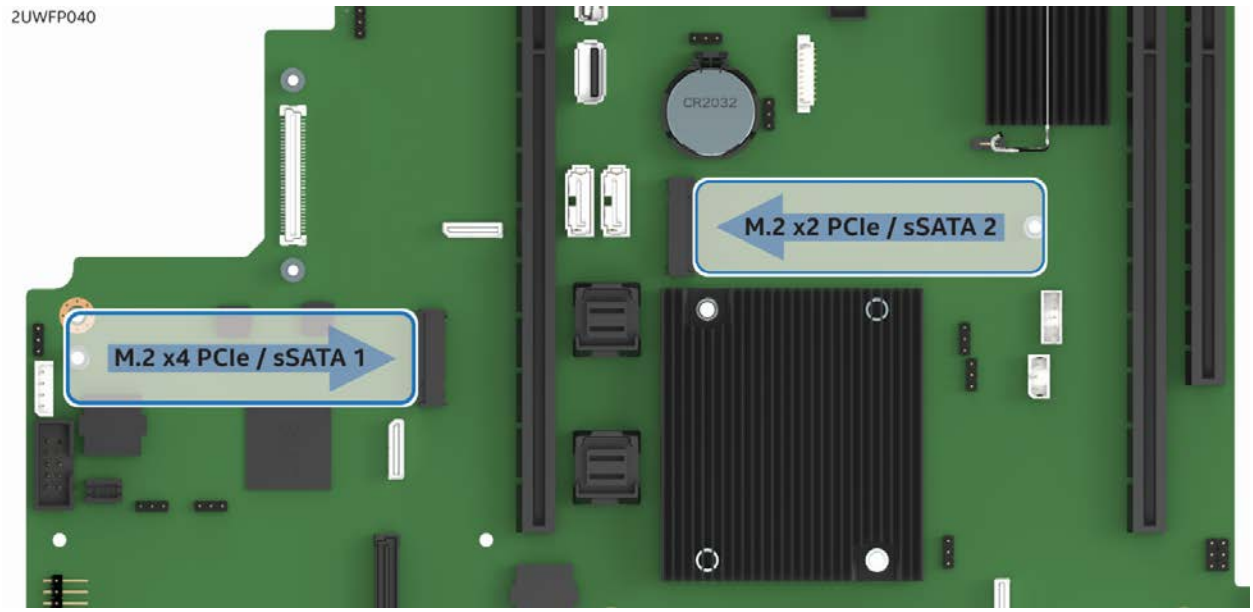


Figure 36. M.2 storage device connectors

Each M.2 connector can support PCIe or SATA modules that conform to a 2280 (80 mm) form factor.

PCIe bus lanes for each connector are routed from the Intel chipset and can be supported in single processor configurations.

The M.2 connector to the left of Riser Slot #1 is supported by PCIe x4 bus lanes and sSATA-1 from the chipset embedded sSATA controller. The M.2 connector to the right of Riser Sot #1 is supported by PCIe x2 bus lanes and sSATA-2 from the chipset embedded sSATA controller.

M.2 connector pinout definition is only made available by obtaining the board schematics directly from Intel (NDA required).

6.3.1.1 Embedded RAID Support

RAID support from embedded RAID options for server board mounted M.2 SSDs is defined as follows:

- Neither Intel ESRT2 nor Intel RSTe have RAID support for PCIe M.2 SSDs when installed to the M.2 connectors on the server board.

Note: NVMe RAID support using Intel RSTe and Intel VROC requires that the PCIe bus lanes be routed directly from the CPU. On this server board, the PCIe bus lanes routed to the on-board M.2 connectors are routed from the Intel chipset (PCH).

Note: The Intel ESRT2 option does not support PCIe devices.

- Both Intel ESRT2 and Intel RSTe provide RAID support for SATA devices (see Section 6.3.6).
- Neither embedded RAID option supports mixing of M.2 SATA SSDs and SATA hard drives within a single RAID volume.

Note: Storage devices used to create a single RAID volume created using either Intel RSTe or Intel ESRT2 cannot span across the two embedded SATA controllers nor is mixing both SATA and NVMe devices within a single RAID volume supported.

- The binary driver includes partial source files. The driver is fully open source using an MDRAID layer in Linux*.

6.3.2 Onboard PCIe* OCuLink Connectors

Depending on the model of the server board installed, the server board has two (S2600WFQ) or four (S2600WFO and S2600WFT) PCIe OCuLink connectors to provide the PCIe interface for NVMe SSDs installed to the front hot swap backplane. PCIe signals for OCuLink connectors "PCIe_SSD0" and "PCIe_SSD1" are routed directly from CPU_1 and PCIe signals for OCuLink connectors "PCIe_SSD2" and "PCIe_SSD3" are directly routed from CPU_2. See Chapter 7 for OCuLink connector pin-out definition.

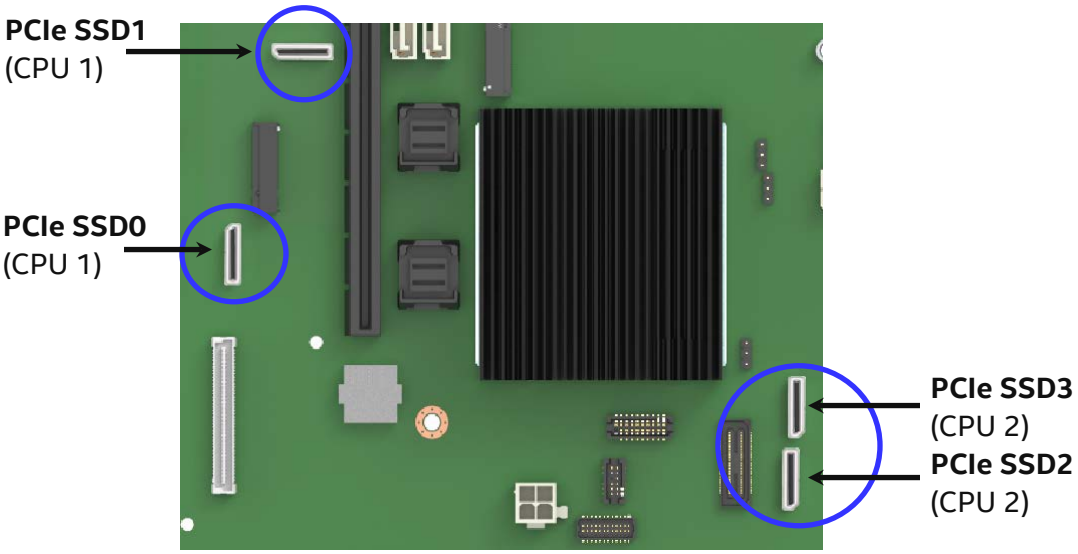


Figure 37. Onboard OCuLink connectors

6.3.3 Intel® Volume Management Device (Intel® VMD) for NVMe*

Intel® Volume Management Device (Intel® VMD) is hardware logic inside the processor root complex to help manage PCIe NVMe SSDs. It provides robust hot plus support and status LED management. This allows servicing of storage system NVMe SSD media without fear of system crashes or hangs when ejecting or inserting NVMe SSD devices on the PCIe bus.

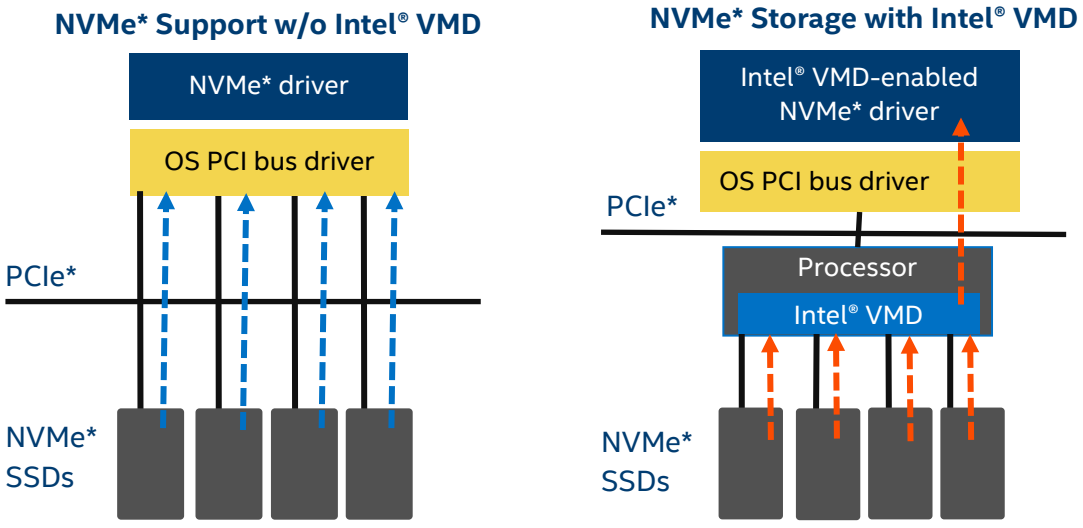


Figure 38. NVMe* storage bus event/error handling

Intel VMD handles the physical management of NVMe storage devices as a standalone function but can be enhanced when Intel VROC support options are enabled to implement RAID based storage systems.

Intel VROC includes the following features and capabilities:

- Hardware is integrated inside the processor PCIe root complex.
- Entire PCIe trees are mapped into their own address spaces (domains).
- Each domain manages x16 PCIe lanes.
- Can be enabled/disabled in BIOS setup at x4 lane granularity.
- Driver sets up/manages the domain (enumerate, event/error handling)
- May load an additional child device driver that is Intel VMD aware.
- Hot plug support - hot insert array of PCIe SSDs.
- Support for PCIe SSDs and switches only (no network interface controllers (NICs), graphics cards, etc.)
- Maximum of 128 PCIe bus numbers per domain.
- Support for MCTP over SMBus* only.
- Support for MMIO only (no port-mapped I/O).
- Does not support NTB, Quick Data Tech, Intel® Omni-Path Architecture, or SR-IOV.
- Correctable errors do not bring down the system.
- Intel VMD only manages devices on PCIe lanes routed directly from the processor. Intel VMD cannot provide device management on PCI lanes routed from the chipset (PCH)
- When Intel VMD is enabled, the BIOS does not enumerate devices that are behind Intel VMD. The Intel VMD-enabled driver is responsible for enumerating these devices and exposing them to the host.
- Intel VMD supports hot-plug PCIe SSDs connected to switch downstream ports. Intel VMD does not support hot-plug of the switch itself.

6.3.3.1 Enabling Intel® VMD support

For installed NVMe devices to utilize the Intel VMD features of the server board, Intel VMD must be enabled on the appropriate CPU PCIe root ports in BIOS setup. By default, Intel VMD support is disabled on all CPU PCIe root ports in BIOS setup.

See Table 12 to determine which specific CPU PCIe root ports are used to supply the PCIe bus lanes for onboard OCuLink connectors.

For NVMe devices attached to a riser card via a PCIe switch or plugged directly into a PCIe add-in card slot, see Table 13, Table 14, and Table 15 to determine CPU PCIe root ports supporting each add-in card slot.

In BIOS setup, the Intel VMD support menu can be found **Advanced** > **PCI Configuration** > **Volume Management Device**.

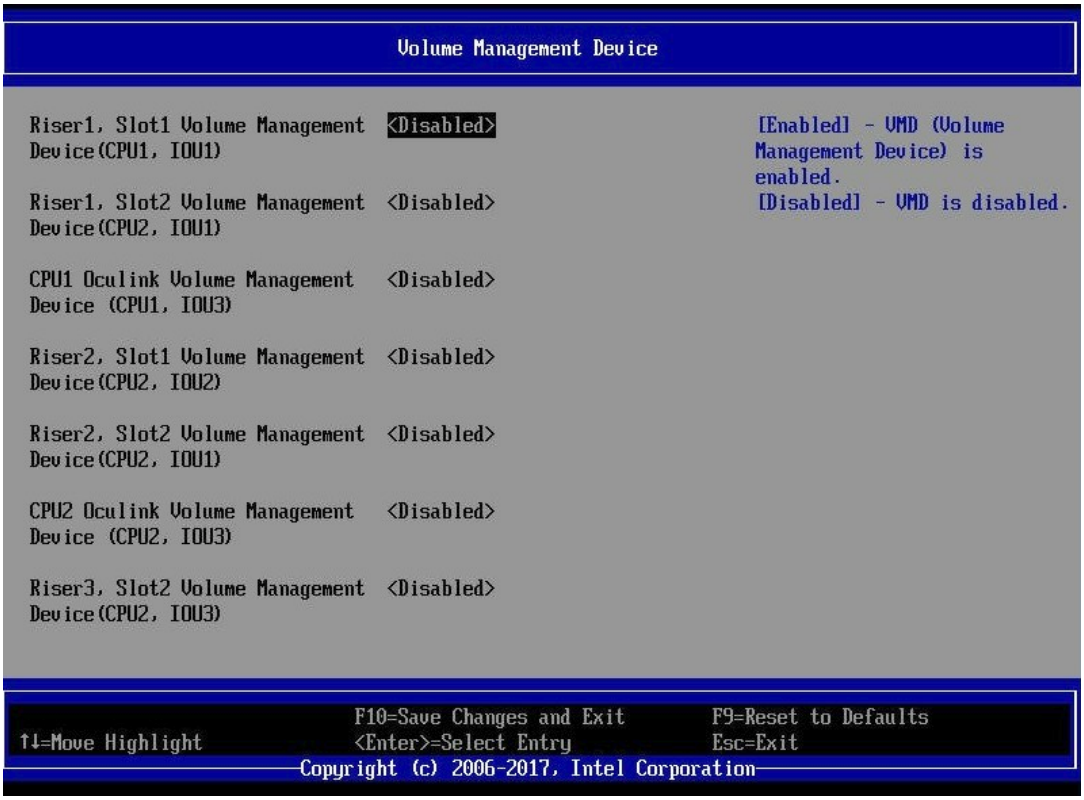


Figure 39. Intel® VMD support disabled in BIOS setup

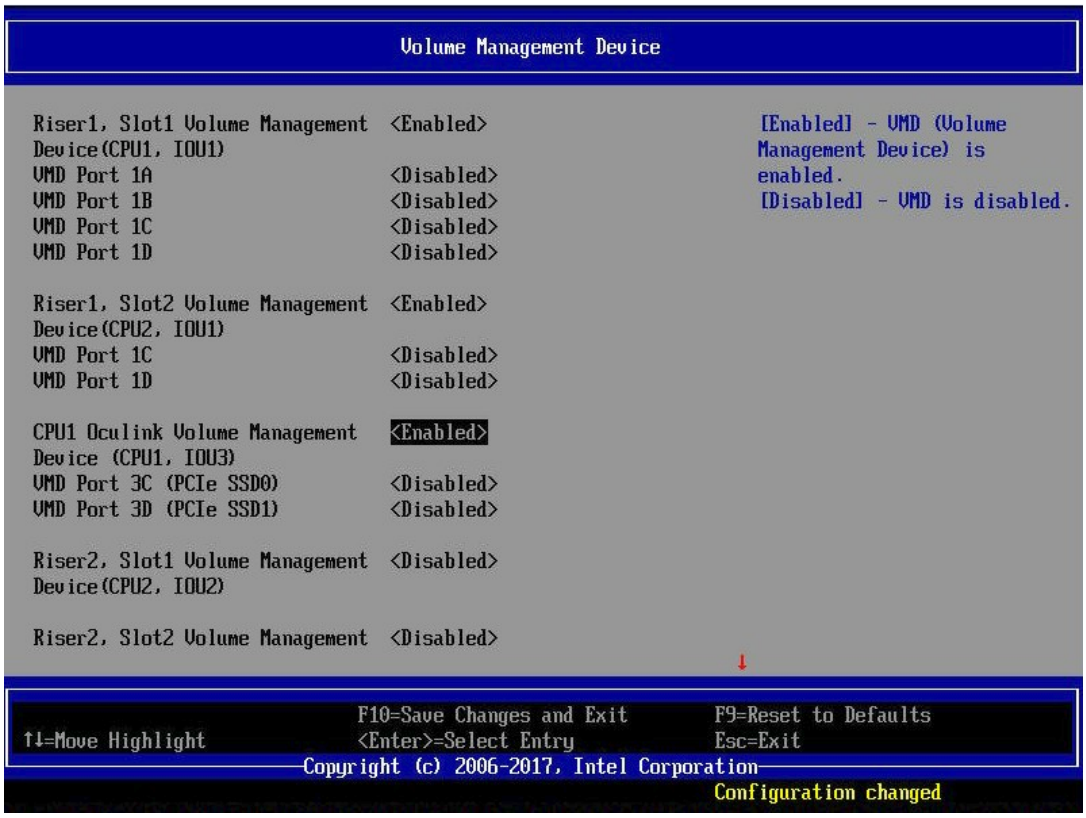


Figure 40. Intel® VMD support enabled in BIOS setup

6.3.4 Intel® Virtual RAID on Chip (Intel® VROC) For NVMe*

Intel VROC enables NVMe boot on RAID and volume management (Intel RSTe 5.0 + Intel VMD).

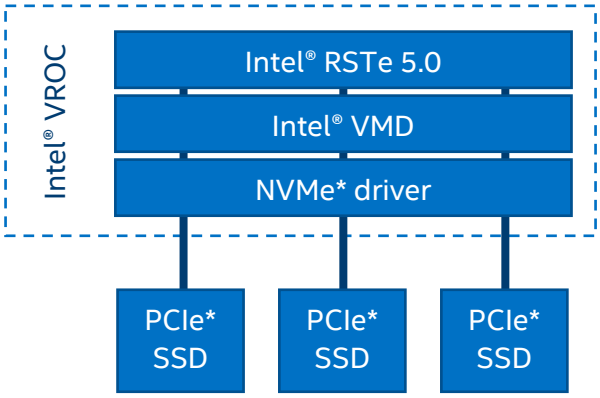


Figure 41. Intel® VROC basic architecture overview

Intel VROC supports the following:

- I/O processor with controller (ROC) and DRAM.
- No need for battery backup / RAID maintenance free backup unit.
- Protected write back cache – software and hardware that allows recovery from a double fault.
- Isolated storage devices from OS for error handling.
- Protected R5 data from OS crash.
- Boot from RAID volumes based on NVMe SSDs within a single Intel VMD domain.
- NVMe SSD hot plug and surprise removal on CPU PCIe lanes.
- LED management for CPU PCIe attached storage.
- RAID / storage management using representational state transfer (RESTful) application programming interfaces (APIs).
- Graphical user interface (GUI) for Linux.
- 4K native NVMe SSD support.

Enabling Intel VROC support requires installation of an optional upgrade key on to the server board as shown in Figure 42. Table 21 identifies available Intel VROC upgrade key options.

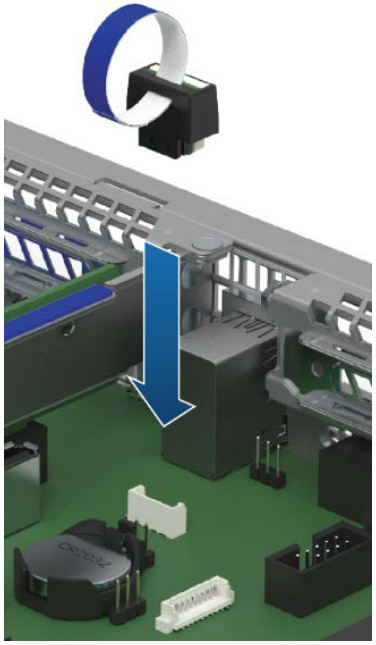


Figure 42. Intel® VROC upgrade key

Table 21. Intel® VROC upgrade key options

NVMe* RAID Major Features	Standard Intel® VROC (iPC VROCSTANMOD)	Premium Intel® VROC (iPC VROCPREMMOD)
CPU attached NVMe SSD – high perf.	√	√
Boot on RAID volume	√	√
Third party vendor SSD support	√	√
Intel® RSTe 5.0 RAID 0/1/10	√	√
Intel® RSTe 5.0 RAID 5	-	√
RAID write hole closed (RMFBU replacement)	-	√
Hot plug/ surprise removal (2.5" SSD form factor only	√	√
Enclosure LED management	√	√

Note: Intel VROC upgrade keys referenced in Table 21 are used for PCIe NVMe SSDs only. For SATA RAID support, see Section 6.3.6.

6.3.5 Onboard SATA Support

The server board utilizes two chipset embedded AHCI SATA controllers, identified as "SATA" and "sSATA", providing for up to twelve 6 Gb/sec SATA ports.

The AHCI sSATA controller provides support for up to four SATA ports on the server board:

- Two ports accessed via two white single port 7-pin connectors labeled "sSATA-4" and "sSATA-5" on the server board.
- Two ports (sSATA 1 and sSATA 2) via two M.2 SSD connectors

The AHCI SATA controller provides support for up to eight SATA ports on the server board (Intel Server Boards S2600WFT and S2600W0 only):

- Four ports from the mini-SAS HD (SFF-8643) connector labeled "SATA Ports 0-3" on the server board.
- Four ports from the mini-SAS HD (SFF-8643) connector labeled "SATA Ports 4-7" on the server board.

Note: The onboard SATA controllers are not compatible with and cannot be used with SAS expander cards.

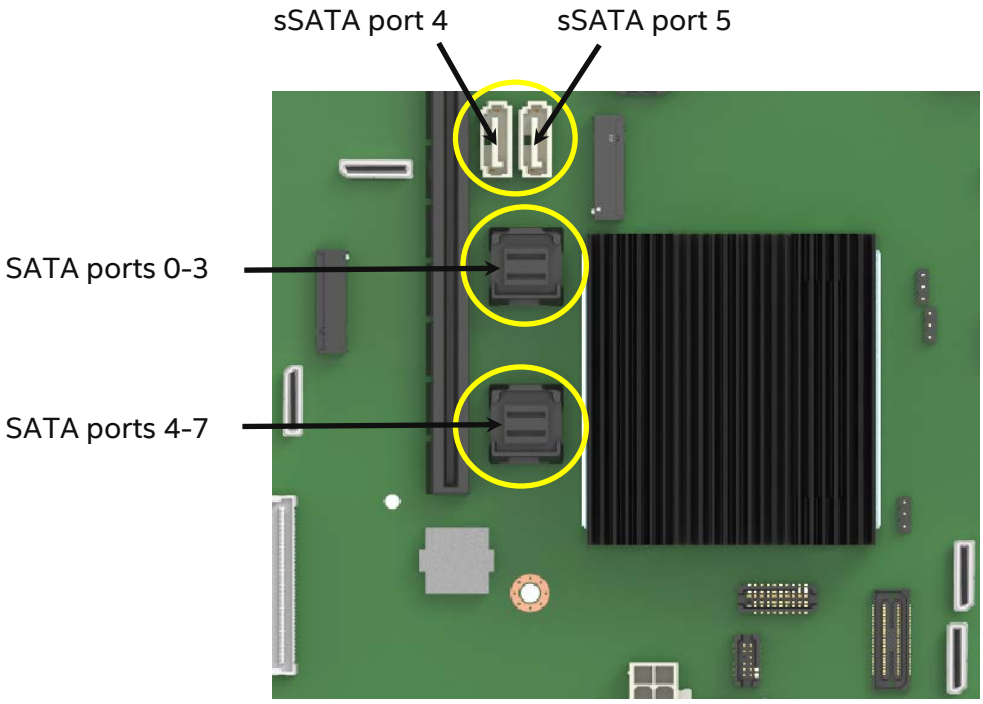


Figure 43. Onboard SATA port connector identification

Table 22. SATA and sSATA controller feature support

Feature	Description	AHCI Mode	RAID Mode Intel® RSTe	RAID Mode Intel® ESRT2
Native Command Queuing (NCQ)	Allows the device to reorder commands for more efficient data transfers	Supported	Supported	
Auto Activate for DMA	Collapses a DMA Setup then DMA Activate sequence into a DMA Setup only	Supported	Supported	
Hot Plug Support	Allows for device detection without power being applied and ability to connect and disconnect devices without prior notification to the system	Supported	Supported	
Asynchronous Signal Recovery	Provides a recovery from a loss of signal or establishing communication after hot plug	Supported	Supported	
6 Gb/s Transfer Rate	Capable of data transfers up to 6 Gb/s	Supported	Supported	Supported
ATAPI Asynchronous Notification	A mechanism for a device to send a notification to the host that the device requires attention	Supported	Supported	
Host & Link Initiated Power Management	Capability for the host controller or device to request Partial and Slumber interface power states	Supported	Supported	
Staggered Spin-Up	Enables the host the ability to spin up hard drives sequentially to prevent power load problems on boot	Supported	Supported	Supported
Command Completion Coalescing	Reduces interrupt and completion overhead by allowing a specified number of commands to complete and then generating an interrupt to process the commands	Supported	N/A	

The SATA controller and the sSATA controller can be independently enabled and disabled and configured through the BIOS setup utility under the Mass Storage Controller Configuration menu screen. The following table identifies supported setup options.

Table 23. SATA and sSATA controller BIOS setup utility options

SATA Controller	sSATA Controller	Supported
AHCI	AHCI	Yes

AHCI	Disabled	Yes
AHCI	Intel® RSTe	Yes
AHCI	Intel® ESRT2	Microsoft Windows* only
Disabled	AHCI	Yes
Disabled	Disabled	Yes
Disabled	Intel® RSTe	Yes
Disabled	Intel® ESRT2	Yes
Intel® RSTe	AHCI	Yes
Intel® RSTe	Disabled	Yes
Intel® RSTe	Intel® RSTe	Yes
Intel® RSTe	Intel® ESRT2	No
Intel® ESRT2	AHCI	Microsoft Windows only
Intel® ESRT2	Disabled	Yes
Intel® ESRT2	Intel® RSTe	No
Intel® ESRT2	Intel® ESRT2	Yes

6.3.5.1 Staggered Disk Spin-Up

Because of the high density of disk drives that can be attached to the Intel® C620 onboard AHCI SATA controller and the sSATA controller, the combined startup power demand surge for all drives at once can be much higher than the normal running power requirements and could require a much larger power supply for startup than for normal operations.

In order to mitigate this and lessen the peak power demand during system startup, both the AHCI SATA Controller and the sSATA Controller implement a Staggered Spin-Up capability for the attached drives. This means that the drives are started up separately, with a certain delay between disk drives starting.

For the onboard SATA controller, staggered spin-up is an option – **AHCI HDD Staggered Spin-Up** – in the Mass Storage Controller Configuration screen found in the BIOS setup utility.

6.3.6 Onboard SATA RAID Options

The server board includes support for two embedded SATA RAID options:

- Intel® Rapid Storage Technology enterprise (Intel® RSTe) 5.0
- Intel® Embedded Server RAID Technology 2 (Intel® ESRT2) 1.60

By default, onboard RAID options are disabled in BIOS setup. To enable onboard RAID support, access the BIOS setup utility during POST. The onboard RAID options can be found under the **sSATA Controller** or **SATA Controller** options under the following BIOS setup menu: **Advanced** > **Mass Storage Controller Configuration**.

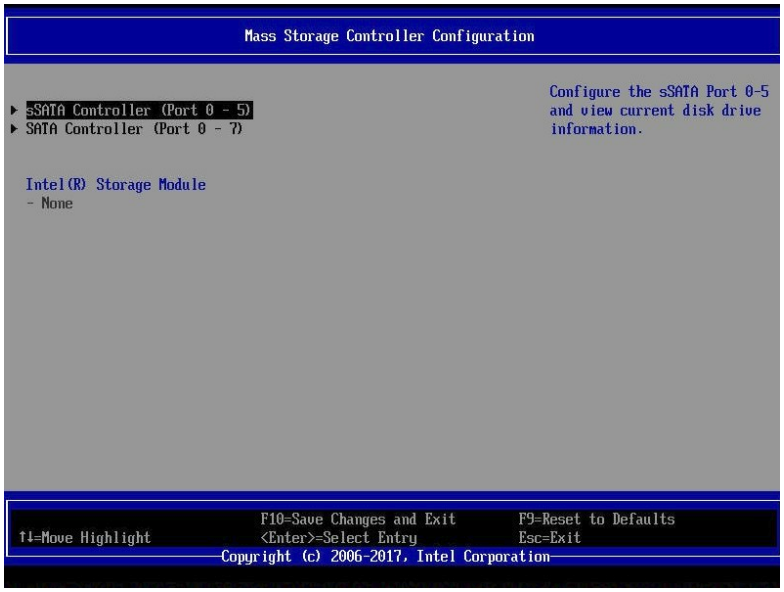


Figure 44. BIOS setup Mass Storage Controller Configuration screen

6.3.6.1 Intel® Rapid Storage Technology Enterprise (Intel® RSTe) 5.0 for SATA

Intel RSTe offers several options for RAID to meet the needs of the end user. AHCI support provides higher performance and alleviates disk bottlenecks by taking advantage of the independent DMA engines that each SATA port offers in the chipset. Supported RAID levels include 0, 1, 5, and 10.

- **RAID 0** – Uses striping to provide high data throughput, especially for large files in an environment that does not require fault tolerance.
- **RAID 1** – Uses mirroring so that data written to one disk drive simultaneously writes to another disk drive. This is good for small databases or other applications that require small capacity but complete data redundancy.
- **RAID 5** – Uses disk striping and parity data across all drives (distributed parity) to provide high data throughput, especially for small random access.
- **RAID 10** – A combination of RAID 0 and RAID 1, consists of striped data across mirrored spans. It provides high data throughput and complete data redundancy but uses a larger number of spans.

By using Intel RSTe, there is no loss of PCI resources (request/grant pair) or add-in card slot. Intel RSTe functionality requires the following:

- The embedded RAID option must be enabled in BIOS setup.
- Intel RSTe option must be selected in BIOS setup.
- Intel RSTe drivers must be loaded for the installed operating system.
- At least two SATA drives needed to support RAID levels 0 or 1.
- At least three SATA drives needed to support RAID level 5.
- At least four SATA drives needed to support RAID level 10.
- NVMe SSDs and SATA drives must not be mixed within a single RAID volume

With Intel RSTe software RAID enabled, the following features are made available:

- A boot-time, pre-operating-system environment, text-mode user interface that allows the user to manage the RAID configuration on the system. Its feature set is kept simple to keep size to a minimum, but allows the user to create and delete RAID volumes and select recovery options when problems occur. The user interface can be accessed by pressing **<CTRL-I>** during system POST.

- Boot support when using a RAID volume as a boot disk. It does this by providing Int13 services when a RAID volume needs to be accessed by MS-DOS applications (such as NT loader (NTLDR)) and by exporting the RAID volumes to the system BIOS for selection in the boot order.
- At each boot-up, a status of the RAID volumes provided to the user.

6.3.6.2 Intel® Embedded Server RAID Technology 2 (Intel® ESRT2) 1.60 for SATA

Intel ESRT2 (powered by LSI*) is a driver-based RAID solution for SATA that is compatible with previous generation Intel® server RAID solutions. Intel ESRT2 provides RAID levels 0, 1, and 10, with an optional RAID 5 capability depending on whether a RAID upgrade key is installed.

Note: The embedded Intel ESRT2 option has no RAID support for PCIe NVMe SSDs.

Intel ESRT2 is based on LSI MegaRAID software stack and utilizes the system memory and CPU.

Supported RAID levels include.

- **RAID 0** – Uses striping to provide high data throughput, especially for large files in an environment that does not require fault tolerance.
- **RAID 1** – Uses mirroring so that data written to one disk drive simultaneously writes to another disk drive. This is good for small databases or other applications that require small capacity but complete data redundancy
- **RAID 10** – A combination of RAID 0 and RAID 1, consists of striped data across mirrored spans. It provides high data throughput and complete data redundancy but uses a larger number of spans.

Optional support for RAID level 5 can be enabled with the addition of a RAID 5 upgrade key (iPN – RKSATA4R5).

- **RAID 5** – Uses disk striping and parity data across all drives (distributed parity) to provide high data throughput, especially for small random access.

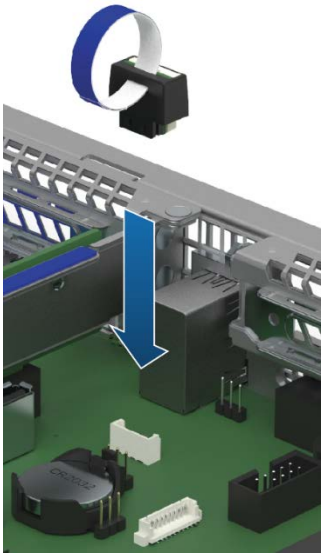


Figure 45. Intel® ESRT2 SATA RAID-5 upgrade key (iPN – RKSATA4R5)

6.4 Rear External RJ45 Connector Overview

The back edge of the server board includes several RJ45 connectors providing support for the following onboard features:

- Dedicated server management port
- Network interface connectors (S2600WFT only)
- Serial-A port (see Section 6.5)

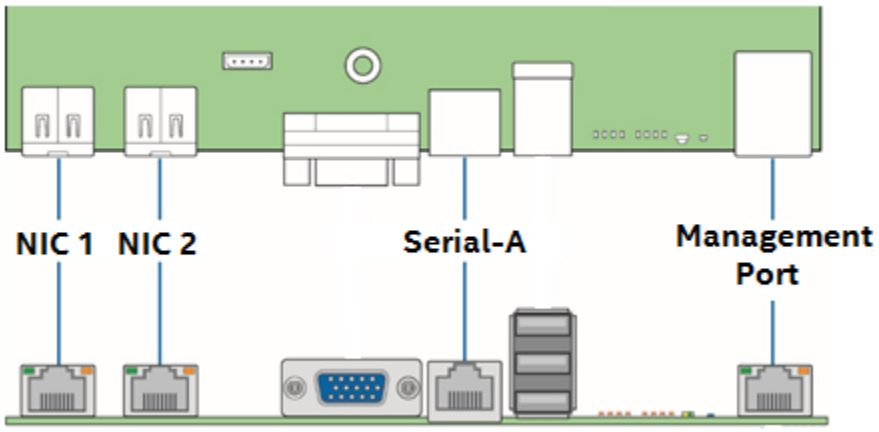


Figure 46. Rear external RJ45 connectors

RJ45 connectors used for the dedicated management port and network interface connectors include two LEDs. The LED on the left side of the connector is the link/activity LED and indicates network connection when on, and transmit/receive activity when blinking. The LED on the right side of the connector indicates link speed. Table 24 provides a full definition for the LED states.

Figure 47. RJ45 connector LEDs

Table 24. External RJ45 NIC port LED definition

LED	LED State	NIC State
Link/activity (left)	Off	LAN link not established
	Solid green	LAN link is established
	Blinking green	Transmit/receive activity
Transmit/receive (right)	Solid amber	1 Gb data rate
	Solid green	10 Gb data rate

6.4.1 RJ45 Dedicated Management Port

The server board includes a dedicated 1 GbE RJ45 management port. The management port is active with or without the Intel® Remote Management Module 4 Lite Intel® RMM4 Lite) key installed. See Chapter 8 for additional information about onboard server management support.

6.4.2 RJ45 Network Interface Connectors (Intel® Server Board S2600WFT only)

The Intel Server Board S2600WFT provides two RJ45 networking ports, “NIC #1” and “NIC #2”, in addition to the RJ45 dedicated management port. The board includes the following onboard Intel® Ethernet Controller:

- Intel® Ethernet Controller X557-AT2 10 GbE

Refer to the respective product data sheet for a complete list of supported Intel Ethernet Controller features.

6.5 Serial Port Support

The server board has support for two serial ports: Serial-A and Serial-B.

Serial A is an external RJ45 type connector located on the back edge of the server board as shown in Figure 46. The pin orientation is shown in Figure 48 and the pinout is given in Table 25.

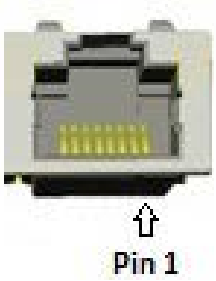


Figure 48. RJ45 Serial-A pin orientation

Table 25.Serial-A connector pinout

Signal Description	Pin#
RTS	1
DTR	2
SOUT	3
GROUND	4
RI	5
SIN	6
DCD or DSR	7
CTS	8

Note: Pin 7 of the RJ45 Serial-A connector is configurable to support either a DSR (default) signal or a DCD signal. Pin 7 signals are changed by moving the jumper on the jumper block labeled labeled “J4A2“ from pins 1–2 (default) to pins 2–3 as shown in Figure 49.

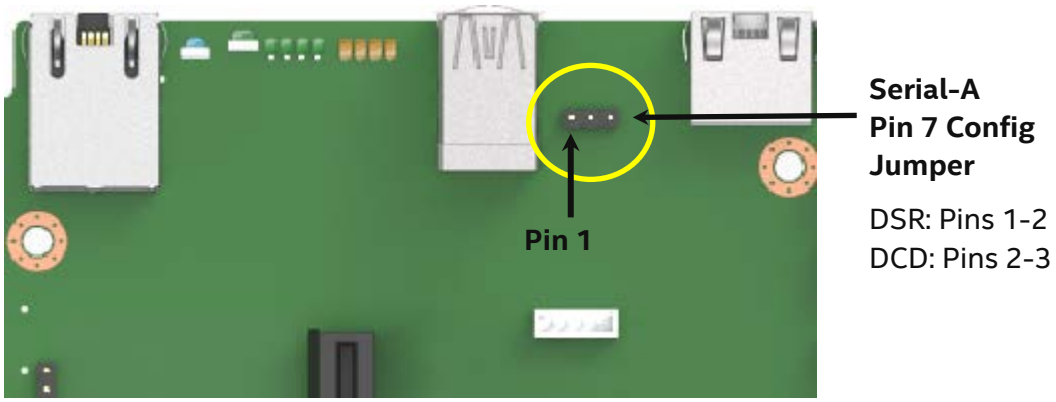


Figure 49. J4A2 Jumper block for Serial-A pin 7 configuration

Serial B is provided through an internal DH-10 header labeled “Serial_B” on the server board. The connector location is shown in Figure 50 and the pinout is given in Table 26.

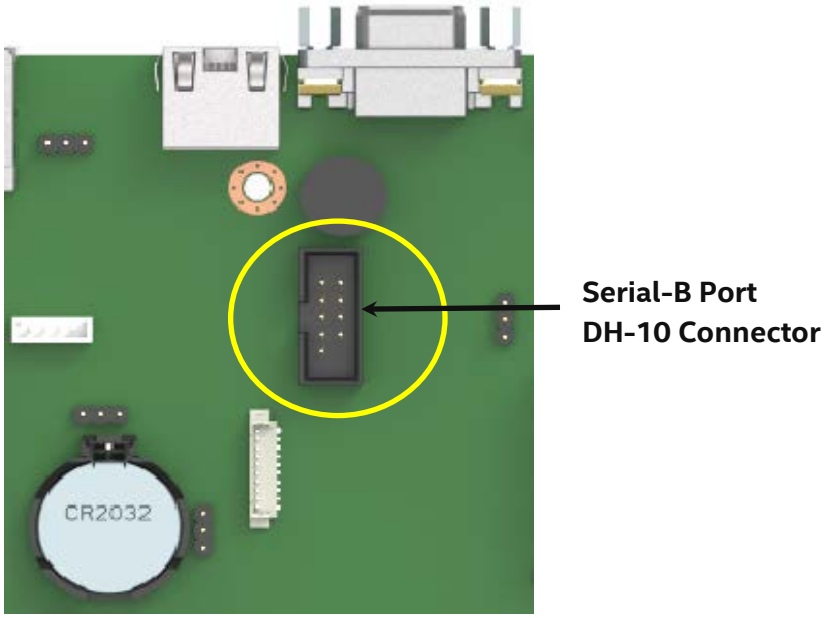


Figure 50. Serial-B connector (internal)

Table 26. Serial-B connector pinout

Signal Description	Pin#	Pin#	Signal Description
DCD	1	2	DSR
SIN	3	4	RTS
SOUT	5	6	CTS
DTR	7	8	RI
GROUND	9		KEY

6.6 USB Support

USB support is provided through several onboard internal and external connectors as described in the following sections.

6.6.1 External USB 3.0 Connector

The server board includes three (1x3 stacked) USB 3.0 ports on the back edge of the server board.

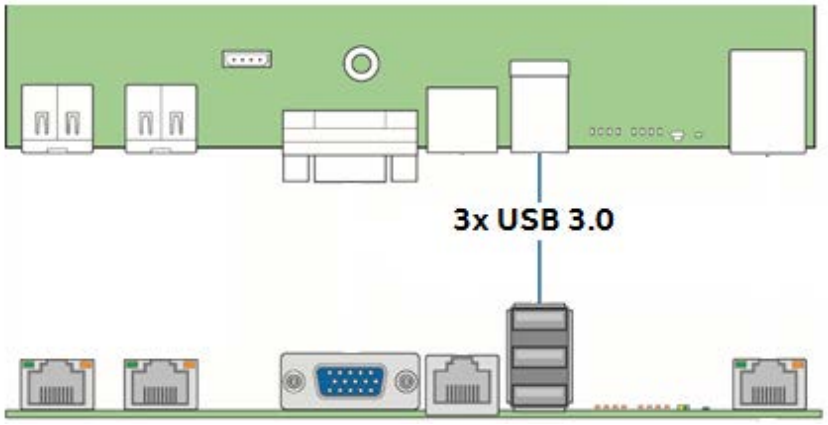


Figure 51. External USB 3.0 ports

6.6.2 Internal USB 2.0 Type-A Connector

The server board includes one internal Type-A USB 2.0 connector.

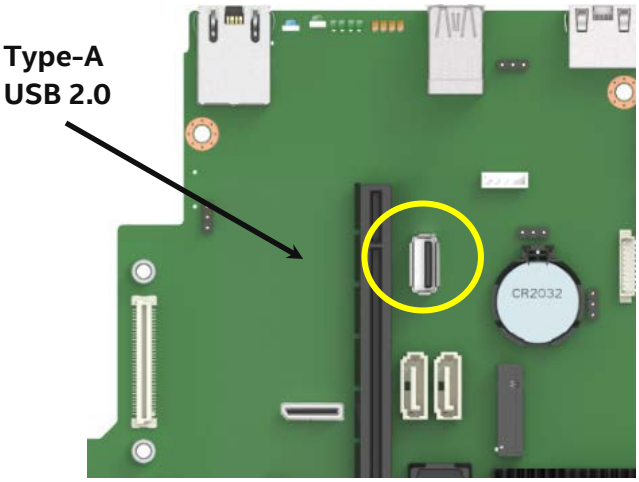


Figure 52. Internal USB 2.0 type-A connector

6.6.3 Front Panel USB 3.0 Connector

A blue 20-pin (2x10) shrouded connector on the server board (labeled “FP_USB_2.0/3.0”) provides the option of routing two USB 3.0 ports to the front of a given chassis. Table 27 provides the connector pin-out.

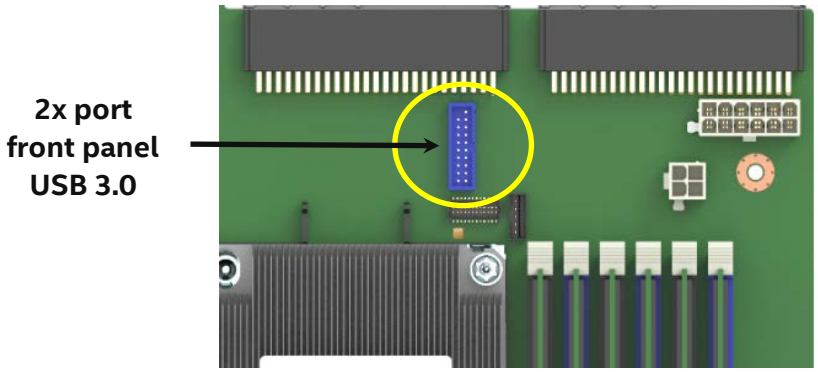


Figure 53. Front panel USB 3.0 connector

Note: The following USB ports are routed to this connector: USB 3.0 ports 1 and 2; USB 2.0 ports 11 and 13.

Table 27. Front panel USB 2.0/3.0 connector pinout ("FP_USB_2.0/ 3.0")

Signal Name	Pin#	Pin#	Signal Name
		1	P5V_USB_FP
P5V_USB_FP	19	2	USB3_04_RXN
USB3_01_RXN	18	3	USB3_04_RXP
USB3_01_RXP	17	4	GROUND
GROUND	16	5	USB3_04_TXN
USB3_01_TXN	15	6	USB3_04_TXP
USB3_01_TXP	14	7	GROUND
GROUND	13	8	USB2_13_DN
USB2_10_DN	12	9	USB2_13_DP
USB2_10_DP	11	10	USB3_ID

6.6.4 Front Panel USB 2.0 Connector

The server board includes a 10-pin connector that, when cabled, can provide up to two USB 2.0 ports to a front panel. On the server board, the connector is labeled "FP_USB_2.0_5-6" and is located on the left side, near the I/O module connector. Table 28 provides the connector pin-out.

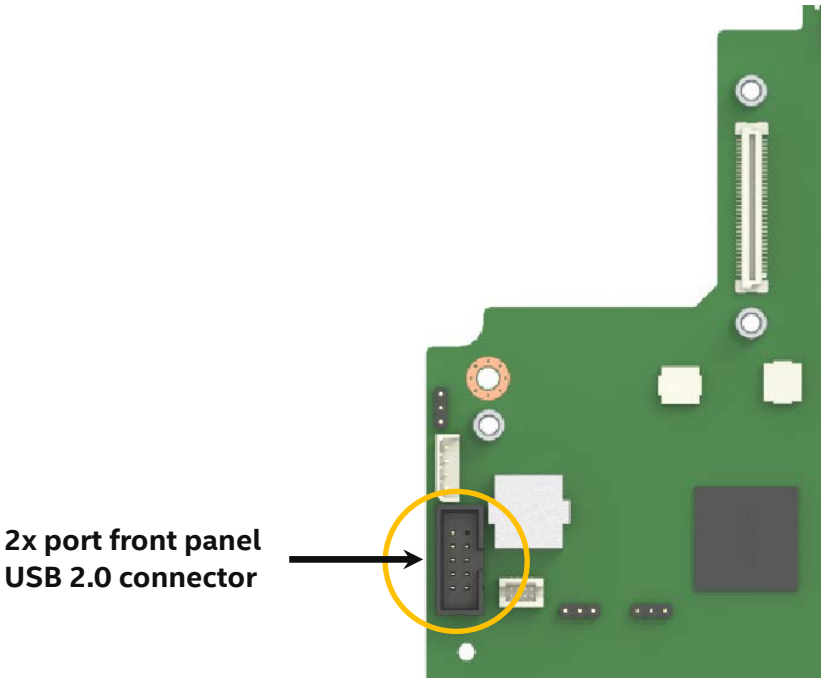


Figure 54. Front panel USB 2.0 connector

Table 28. Front panel USB 2.0 connector pinout ("FP_USB_2.0_5-6 ")

Signal Name	Pin#	Pin#	Signal Name
P5V_USB_FP	1	2	P5V_USB_FP
USB2_P11_F_DN	3	4	USB2_P13_F_DN
USB2_P11_F_DP	5	6	USB2_P13_F_DP
GROUND	7	8	GROUND
		10	TP_USB2_FP_10

6.7 Video Support

The graphics controller of the Aspeed* AST2500 BMC is a VGA-compliant controller with 2D hardware acceleration and full bus master support. With 16 MB of memory reserved, the video controller can support the resloutions specified in Table 29.

Table 29. Supported video resolutions

2D Mode	2D Video Support (Color Bit)			
Resolution	**8 bpp**	**16 bpp**	**24 bpp**	**32 bpp**
640 x 480	60, 72, 75, 85	60, 72, 75, 85	Not Supported	60, 72, 75, 85
800 x 600	60, 72, 75, 85	60, 72, 75, 85	Not Supported	60, 72, 75, 85
1024 x 768	60, 72, 75, 85	60, 72, 75, 85	Not Supported	60, 72, 75, 85
1152 x 864	75	75	75	75
1280 x 800	60	60	60	60
1280 x 1024	60	60	60	60
1440 x 900	60	60	60	60
1600 x 1200	60	60	Not Supported	Not Supported
1680 x 1050	60	60	Not Supported	Not Supported
1920 x 1080	60	60	Not Supported	Not Supported

2D Mode	2D Video Support (Color Bit)			
Resolution	**8 bpp**	**16 bpp**	**24 bpp**	**32 bpp**
1920 x 1200	60	60	Not Supported	Not Supported

6.7.1 Onboard Video Connectors

The server board includes two options to attach a monitor to the server system:

- A standard 15-pin video connector located on the back edge of the server board.

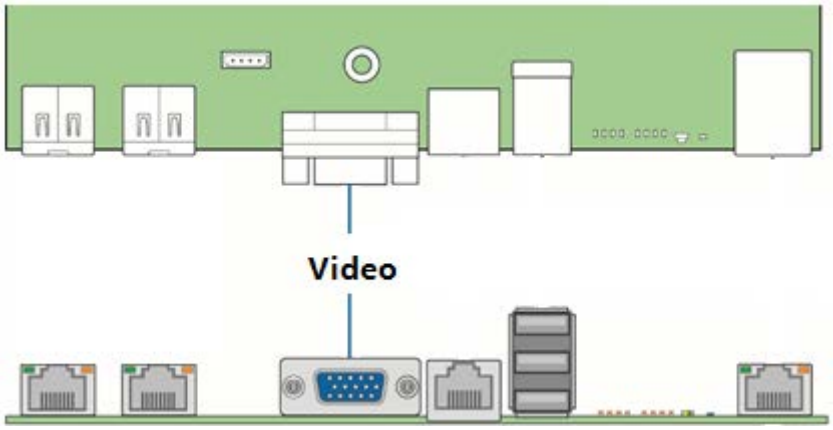


Figure 55. Rear external video connector

- On the server board near the front right edge, is A connector near the front right edge of the server board labeled “FP_VIDEO” that, when cabled, can provide video from the front of the server system. When a monitor is attached to the front of the system, the video out the back is disabled. Table 30 provides the pinout for this connector.

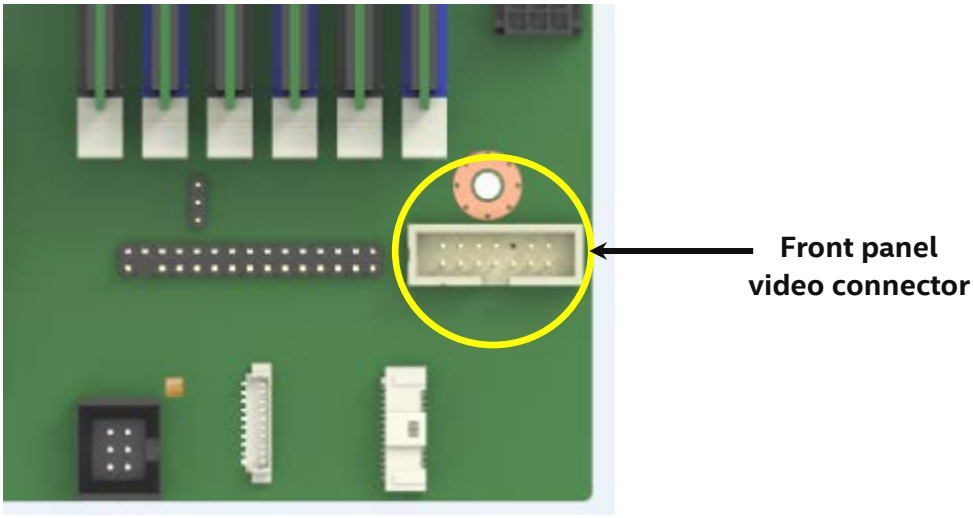


Figure 56. Front panel video connector

Table 30. Front panel video connector pinout ("FP VIDEO")

Signal Description	Pin#	Pin#	Signal Description
V_IO_FRONT_R_CONN	1	2	GROUND
V_IO_FRONT_G_CONN	3	4	GROUND
V_IO_FRONT_B_CONN	5	6	GROUND

V_BMC_GFX_FRONT_VSYN	7	8	GROUND
V_BMC_GFX_FRONT_HSYN	9		KEY
V_BMC_FRONT_DDC_SDA_CONN	11	12	V_FRONT_PRES_N
V_BMC_FRONT_DDC_SCL_CONN	13	14	P5V_VID_CONN_FNT

6.7.2 Onboard Video and Add-In Video Adapter Support

Add-in video cards can be used to either replace or complement the onboard video option of the server board. BIOS setup includes options to support the desired video operation when an add-in video card is installed.

- When both the **Onboard Video** and **Add-in Video Adapter** options are set to **Enabled**, both video displays can be active. The onboard video is still the primary console and active during BIOS POST; the add-in video adapter is only be active under an OS environment with video driver support.
- When **Onboard Video** is **Enabled** and **Add-in Video Adapter** is **Disabled**, only the onboard video is active.
- When **Onboard Video** is **Disabled** and **Add-in Video Adapter** is **Enabled**, only the add-in video adapter is active.

Configurations with add-in video cards can get more complicated with a dual CPU socket board. Some multi-socket boards have PCIe slots capable of hosting an add-in video card which are attached to the IIOs of CPU sockets other than CPU Socket 1. However, only one CPU socket can be designated as legacy VGA socket as required in POST. To provide for this, there is the PCI Configuration option **Legacy VGA Socket**. The rules for this option are:

- The **Legacy VGA Socket** option is grayed out and unavailable unless an add-in video card is installed in a PCIe slot supported by CPU 2.
- Because the onboard video is hardwired to CPU socket 1, when **Legacy VGA Socket** is set to **CPU Socket 2**, the onboard video is disabled.

6.7.3 Dual Monitor Support

The BIOS supports single and dual video when add-in video adapters are installed. Although there is no enable/disable option in BIOS setup for dual video, it works when both the **Onboard Video** and **Add-in Video Adapter** options are enabled.

In the single video mode, the onboard video controller or the add-in video adapter is detected during POST.

In dual video mode, the onboard video controller is enabled and is the primary video device while the add-in video adapter is allocated resources and is considered as the secondary video device during POST. The add-in video adapter will not be active until the operating system environment is loaded.

7. Onboard Connector/Header Pinout Definition

This section identifies the location and pinout for most onboard connectors and headers of the server board. Information for some connectors and headers are found elsewhere in the document where the feature is decribed in more detail.

Pinout definition for the following onboard connectors is only made available by obtaining the board schematics directly from Intel (NDA required).

- All riser slots
- OCP* module connector
- SAS module connector
- M.2 SSD connectors
- DIMM slots
- Processor sockets

7.1 Power Connectors

The server board includes several power connectors that are used to provide DC power to various devices.

7.1.1 Main Power

Main server board power is supplied from two slot connectors, which allow for one or two (redundant) power supplies to dock directly to the server board. Each connector is labeled as “MAIN PWR 1” or “MAIN PWR 2” on the server board as shown in Figure 57. The server board provides no option to support power supplies with cable harnesses. In a redundant power supply configuration, a failed power supply module is hot-swappable. Table 31 provides the pin-out mapping for the “MAIN PWR 1” connector and Table 32 provides the pin-out mapping for the “MAIN PWR 2” connector.

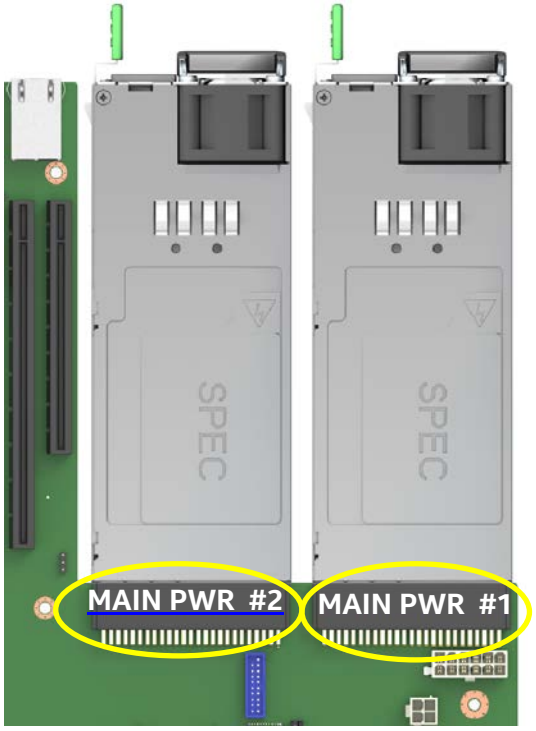


Figure 57. “MAIN PWR 1” and “MAIN PWR 2” connectors

Table 31. Main power (slot 1) connector pinout ("MAIN PWR 1")

Signal Name	Pin #	Pin#	Signal Name
GROUND	B1	A1	GROUND
GROUND	B2	A2	GROUND
GROUND	B3	A3	GROUND
GROUND	B4	A4	GROUND
GROUND	B5	A5	GROUND
GROUND	B6	A6	GROUND
GROUND	B7	A7	GROUND
GROUND	B8	A8	GROUND
GROUND	B9	A9	GROUND
P12V	B10	A10	P12V
P12V	B11	A11	P12V
P12V	B12	A12	P12V
P12V	B13	A13	P12V
P12V	B14	A14	P12V
P12V	B15	A15	P12V
P12V	B16	A16	P12V
P12V	B17	A17	P12V
P12V	B18	A18	P12V
P3V3_AUX: PD_PS1_FRU_A0	B19	A19	SMB_PMBUS_DATA_R
P3V3_AUX: PD_PS1_FRU_A1	B20	A20	SMB_PMBUS_CLK_R
P12V_STBY	B21	A21	FM_PS_EN_PSU_N
FM_PS_CR1	B22	A22	IRQ_SML1_PMBUS_ALERTR2_N
P12V_SHARE	B23	A23	ISENSE_P12V_SENSE_RTN
TP_1_B24	B24	A24	ISENSE_P12V_SENSE
FM_PS_COMPATIBILITY_BUS	B25	A25	PWRGD_PS_PWROK

Table 32. Main power (slot 2) connector pinout ("MAIN PWR 2")

Signal Name	Pin #	Pin#	Signal Name
GROUND	B1	A1	GROUND
GROUND	B2	A2	GROUND
GROUND	B3	A3	GROUND
GROUND	B4	A4	GROUND
GROUND	B5	A5	GROUND
GROUND	B6	A6	GROUND
GROUND	B7	A7	GROUND
GROUND	B8	A8	GROUND
GROUND	B9	A9	GROUND
P12V	B10	A10	P12V
P12V	B11	A11	P12V
P12V	B12	A12	P12V
P12V	B13	A13	P12V
P12V	B14	A14	P12V
P12V	B15	A15	P12V
P12V	B16	A16	P12V

Signal Name	Pin #	Pin#	Signal Name
P12V	B17	A17	P12V
P12V	B18	A18	P12V
P3V3_AUX: PU_PS2FRU_A0	B19	A19	SMB_PMBUS_DATA_R
P3V3_AUX: PD_PS2_FRU_A1	B20	A20	SMB_PMBUS_CLK_R
P12V_STBY	B21	A21	FM_PS_EN_PSU_N
FM_PS_CR1	B22	A22	IRQ_SML1_PMBUS_ALERTR3_N
P12V_SHARE	B23	A23	ISENSE_P12V_SENSE_RTN
TP_2_B24	B24	A24	ISENSE_P12V_SENSE
FM_PS_COMPATIBILITY_BUS	B25	A25	PWRGD_PS_PWROK

7.1.2 Hot Swap Backplane Power Connector

The server board includes one white 2x6-pin power connector that when cabled provides power for hot swap backplanes, as shown in Figure 58. On the server board, this connector is labeled as “HSBP PWR”.

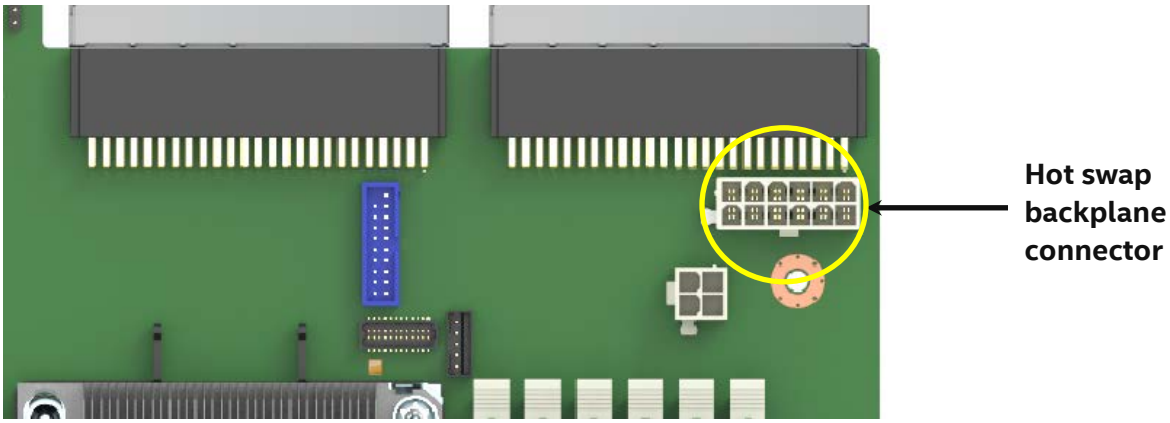


Figure 58. Hot swap backplane power connector

Table 33. Hot swap backplane power connector pinout (“HSBP PWR”)

Signal Name	Pin #	Pin #	Signal Name
GND	1	7	P12V_240VA3
GND	2	8	P12V_240VA3
GND	3	9	P12V_240VA2
GND	4	10	P12V_240VA2
GND	5	11	P12V_240VA1
GND	6	12	P12V_240VA1

7.1.3 Riser Card Supplemental 12-V Power Connectors

The server board includes two white 2x2-pin power connectors labeled “OPT_12V_PWR” that provide supplemental 12 V power-out to high power PCIe x16 add-in cards (video, GPGPU, Intel® Xeon Phi™ coprocessor) that have power requirements that exceed the 75 W maximum power supplied by the riser card slot. These connectors are identified in Figure 59. A cable from these connectors may be routed to a power-in connector on the given add-in card. Maximum power draw for each connector is 225 W, but is also limited by available power provided by the power supply and the total power draw of the given system configuration. A power budget for the complete system should be performed to determine how much supplemental power is available to support any high-power add-in cards.

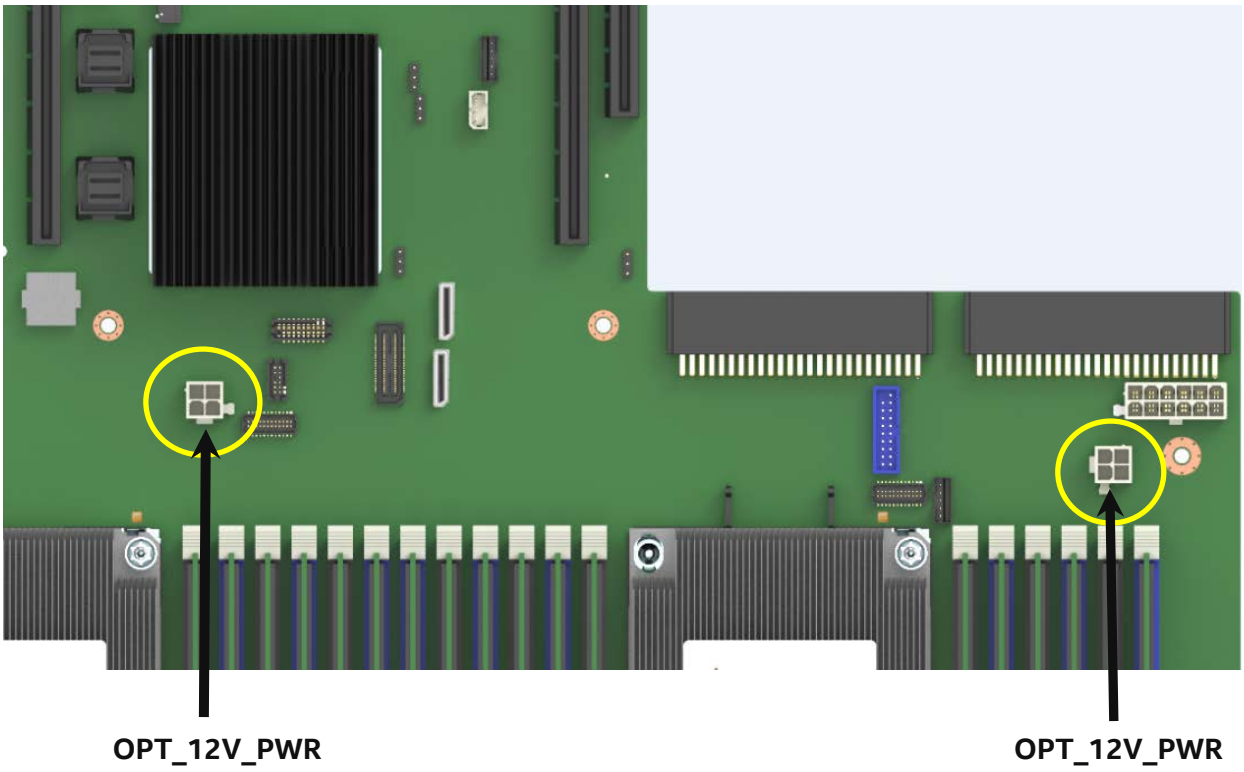


Figure 59. Riser slot auxiliary power connectors

Table 34 provides the pinout values for the 12-V power connectors.

Table 34. Riser slot auxiliary power connector pinout ("OPT_12V_PWR”)

Signal Name	Pin#	Pin#	Signal Name
P12V	3	1	GROUND
P12V	4	2	GROUND

Intel makes available a 12-V supplemental power cable that can support both 6- and 8-pin 12-V AUX power connectors found on high power add-in cards. The power cable (as shown in Figure 60) is available as a separate orderable accessory kit (iPC – AXXGPGPUCABLE).

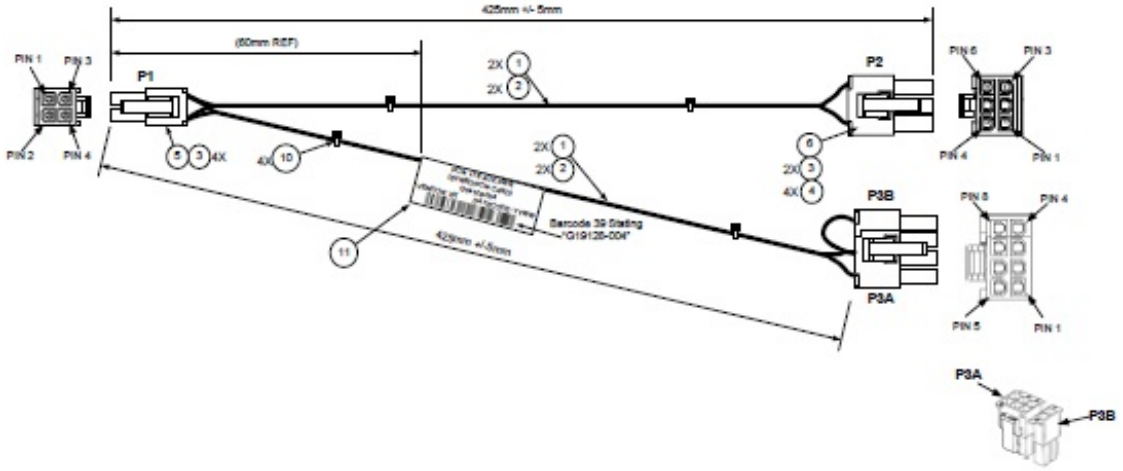


Figure 60. High power add-in card 12-V auxiliary power cable option

7.1.4 Peripheral Power Connector

The server board includes one 6-pin power connector intended to provide power for peripheral devices such as optical disk drives (ODDs) and/or solid state devices (SSDs). On the server board this connector is labeled as “Peripheral_ PWR”. Table 35 provides the pinout for this connector.

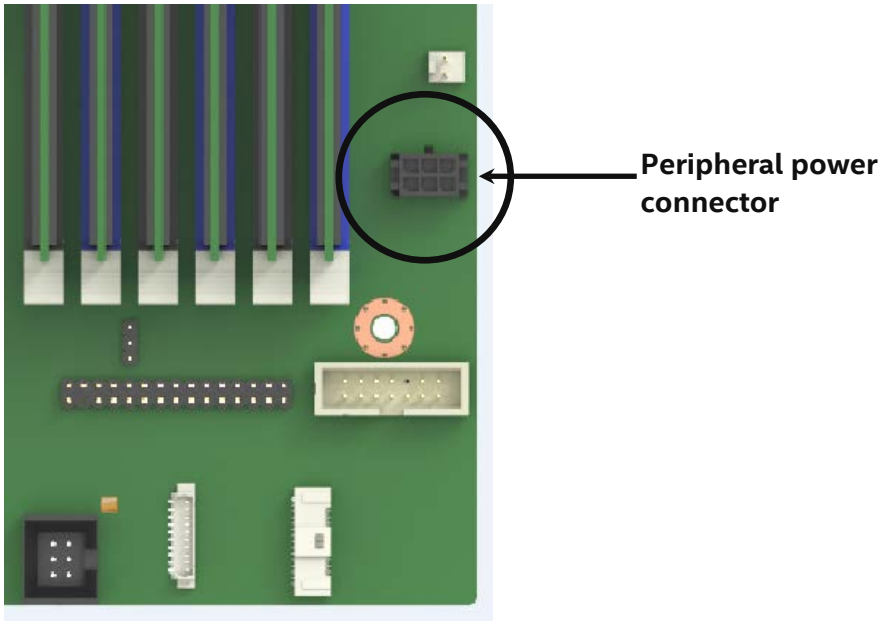


Figure 61. Peripheral power connector

Table 35. Peripheral drive power connector pinout ("Peripheral_PWR")

Signal Name	Pin#	Pin#	Signal Name
P12V	4	1	P5V
P3V3	5	2	P5V
GROUND	6	3	GROUND

7.2 Front Control Panel Headers and Connectors

The server board includes several connectors that provide various possible front panel options. This section provides a functional description and pinout for each connector.

For front panel control button and LED support, the server board includes two connector options: a 30-pin SSI compatible front panel header labeled “FRONT_PANEL”, and a custom high density 30-pin front panel connector, labeled “STORAGE _FP”.

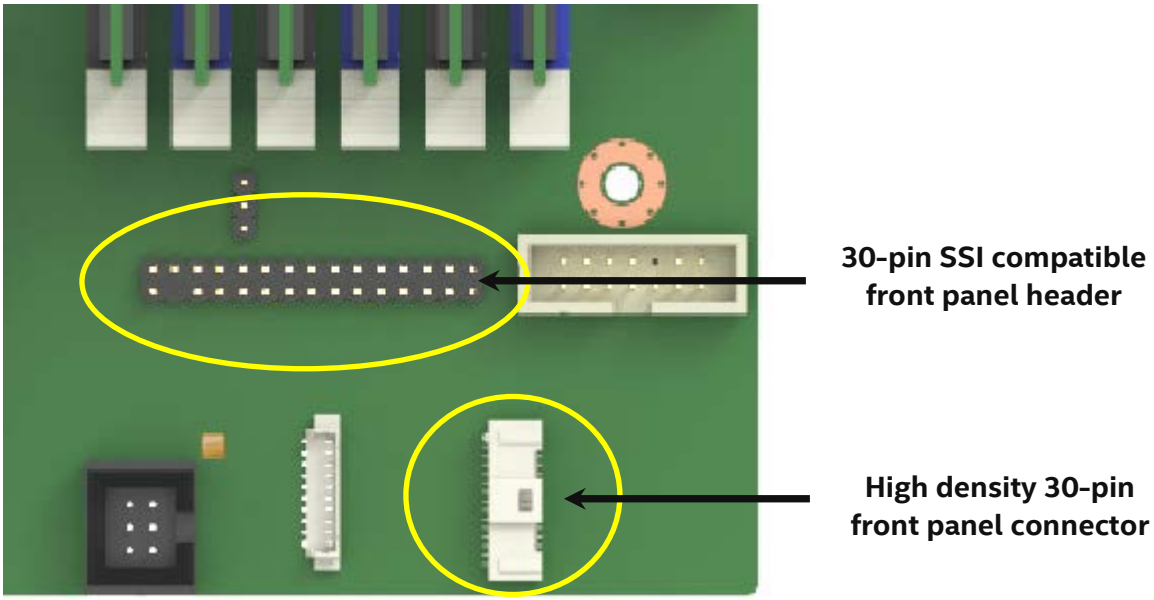


Figure 62. Front control panel connectors

Supported control buttons and LEDs are identified in Table 36.

Table 36. Front panel control button and LED support

Control Button/LED	Support
Power / Sleep Button	Yes
System ID Button	Yes
System Reset Button	Yes
NMI Button	Yes
NIC Activity LED	Yes
Storage Device Activity LED	Yes
System Status LED	Yes
System ID LED	Yes

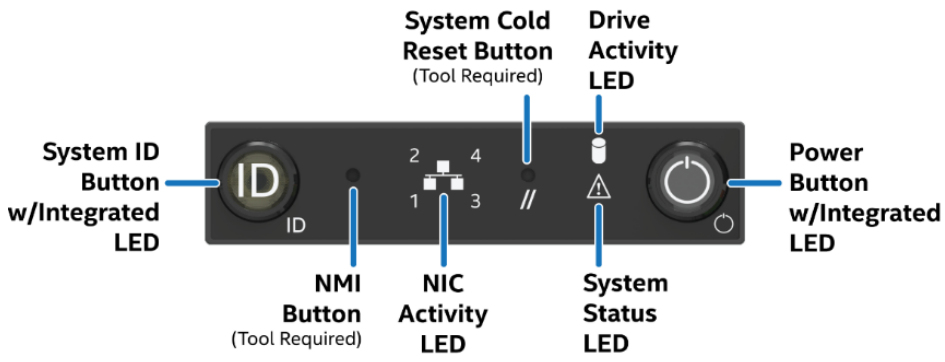


Figure 63. Example front control panel view (for reference purposes only)

The pinout for both connector types, shown in Table 37, is identical.

Table 37. 30-pin front panel connector pinouts

Signal Name	Pin#	Pin#	Signal Name
P3V3_AUX	1	2	P3V3_AUX
KEY		4	P5V_STBY
FP_PWR_LED_BUF_R_N	5	6	FP_ID_LED_BUF_R_N
P3V3	7	8	FP_LED_STATUS_GREEN_R_N
LED_HDD_ACTIVITY_R_N	9	10	FP_LED_STATUS_AMBER_R_N
FP_PWR_BTN_N	11	12	LED _NIC_LINK0_ACT_FP_N
GROUND	13	14	LED _NIC_LINK0_LNKUP_FP_N
FP_RST_BTN_R_N	15	16	SMB_SENSOR_3V3STBY_DATA_R0
GROUND	17	18	SMB_SENSOR_3V3STBY_CLK
FP_ID_BTN_R_N	19	20	FP_CHASSIS_INTRUSION
PU_FM_SIO_TEMP_SENSOR	21	22	LED_NIC_LINK1_ACT_FP_N
FP_NMI_BTN_R_N	23	24	LED_NIC_LINK1_LNKUP_FP_N
KEY			KEY
LED_NIC_LINK2_ACT_FP_N	27	28	LED_NIC_LINK3_ACT_FP_N
LED_NIC_LINK2_LNKUP_FP_N	29	30	LED_NIC_LINK3_LNKUP_FP_N

7.2.1 Front Panel LED and Control Button Features Overview

7.2.1.1 Power/Sleep Button and LED Support

Pressing the power button toggles the system power on and off. This button also functions as a sleep button if enabled by an ACPI-compliant operating system. Pressing this button sends a signal to the integrated BMC, which powers on or powers off the system. The power LED is a single color and is capable of supporting different indicator states as defined in Table 38.

Table 38. Power/sleep LED functional states

Power Mode	LED	System State	Description
Non-ACPI	Off	Power-off	System power is off and the BIOS has not initialized the chipset.
	On	Power-on	System power is on
ACPI	Off	S5	Mechanical is off and the operating system has not saved any context to the hard disk.
	On	S0	System and the operating system are up and running.

7.2.1.2 System ID Button and LED Support

Pressing the system ID button toggles both the ID LED on the front panel and the blue ID LED on the back edge of the server board. The system ID LED is used to identify the system for maintenance when installed in a rack of similar server systems. The system ID LED can also be toggled on and off remotely using the IPMI “Chassis Identify” command which causes the LED to blink for 15 seconds.

7.2.1.3 System Reset Button Support

When pressed, this button reboots and re-initializes the system.

7.2.1.4 NMI Button Support

When the NMI button is pressed, it puts the server in a halt state and causes the BMC to issue a non-maskable interrupt (NMI) for generating diagnostic traces and core dumps from the operating system. Once an NMI has been generated by the BMC, the BMC does not generate another NMI until the system has been reset or powered down.

The following actions cause the BMC to generate an NMI pulse:

- Receiving a Chassis Control command to pulse the diagnostic interrupt. This command does not cause an event to be logged in the SEL.
- Watchdog timer pre-timeout expiration with NMI/diagnostic interrupt pre-timeout action enabled.

Table 39 describes behavior regarding NMI signal generation and event logging by the BMC.

Table 39. NMI signal generation and event logging

Causal Event	NMI	
	Signal Generation	Front Panel Diag Interrupt Sensor Event Logging Support
Chassis Control command (pulse diagnostic interrupt)	X	–
Front panel diagnostic interrupt button pressed	X	X
Watchdog timer pre-timeout expiration with NMI/diagnostic interrupt action	X	X

7.2.1.5 NIC Activity LED Support

The front control panel includes an activity LED indicator for each onboard NIC. When a network link is detected, the LED lights up constantly. The LED begins to blink once network activity occurs at a rate that is consistent with the amount of network activity that is occurring.

7.2.1.6 Storage Device Activity LED Support

The storage device activity LED on the front panel indicates drive activity from the onboard storage controllers. The server board also provides a 2-pin header, labeled “HDD_Activity” on the server board, giving access to this LED for add-in controllers.

7.2.1.7 System Status LED Support

The system status LED is a bi-color (green/amber) indicator that shows the current health of the server system. The system provides two locations for this feature; one is located on the front control panel, the other is located on the back edge of the server board, viewable from the back of the system. Both LEDs are tied together and show the same state. The system status LED states are driven by the onboard platform management subsystem.

7.3 System Fan Connectors

The server board is capable of supporting up to a total of six system fans. Each system fan includes a pair of fan connectors: a 1x10 pin connector to support a dual rotor cabled fan, typically used in 1U system configurations; and a 2x3 pin connector to support a single rotor hot swap fan assembly, typically used in 2U system configurations. Concurrent use of both fan connector types for any given system fan pair is not supported.

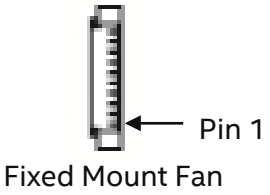


Figure 64. Dual-rotor fixed mount fan pin connector orientation

Table 40. Dual-rotor fixed mount fan connector pinout

Signal Description	Pin#
LED_FAN	10
LED_FAN_FAULT	9
SYS FAN PRSNT	8
GROUND	7
GROUND	6
FAN_TACH_#	5
P12V_FAN	4
P12V_FAN	3
FAN PWM	2
FAN_TACH_#+1	1

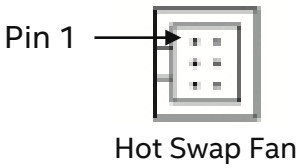


Figure 65. Hot swap fan connector pin orientation

Table 41. Hot swap fan connector pinout

Signal Name	Pin#	Pin#	Signal Name
GROUND	1	2	P12V FAN
FAN TACH	3	4	FAN PWM
SYS FAN PRSNT	5	6	LED FAN FAULT

Each connector is monitored and controlled by on-board platform management. On the server board, each system fan connector pair is labeled “SYS_FAN #”, where # is 1 through 6. Figure 66 shows the location of each system fan connector on the server board.

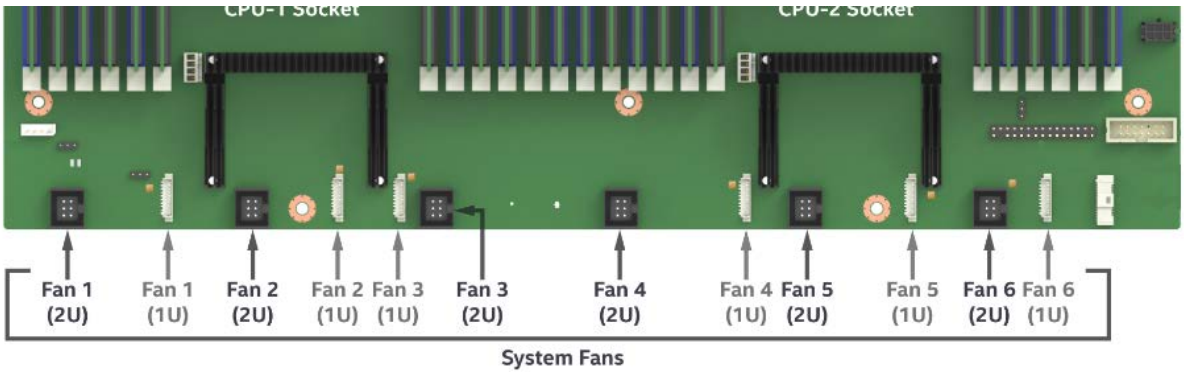


Figure 66. Fan connector locations

7.4 Management Connectors

The server board includes several management interface connectors. Table 42, Table 43, and Table 44 provide the pinout definition for each.

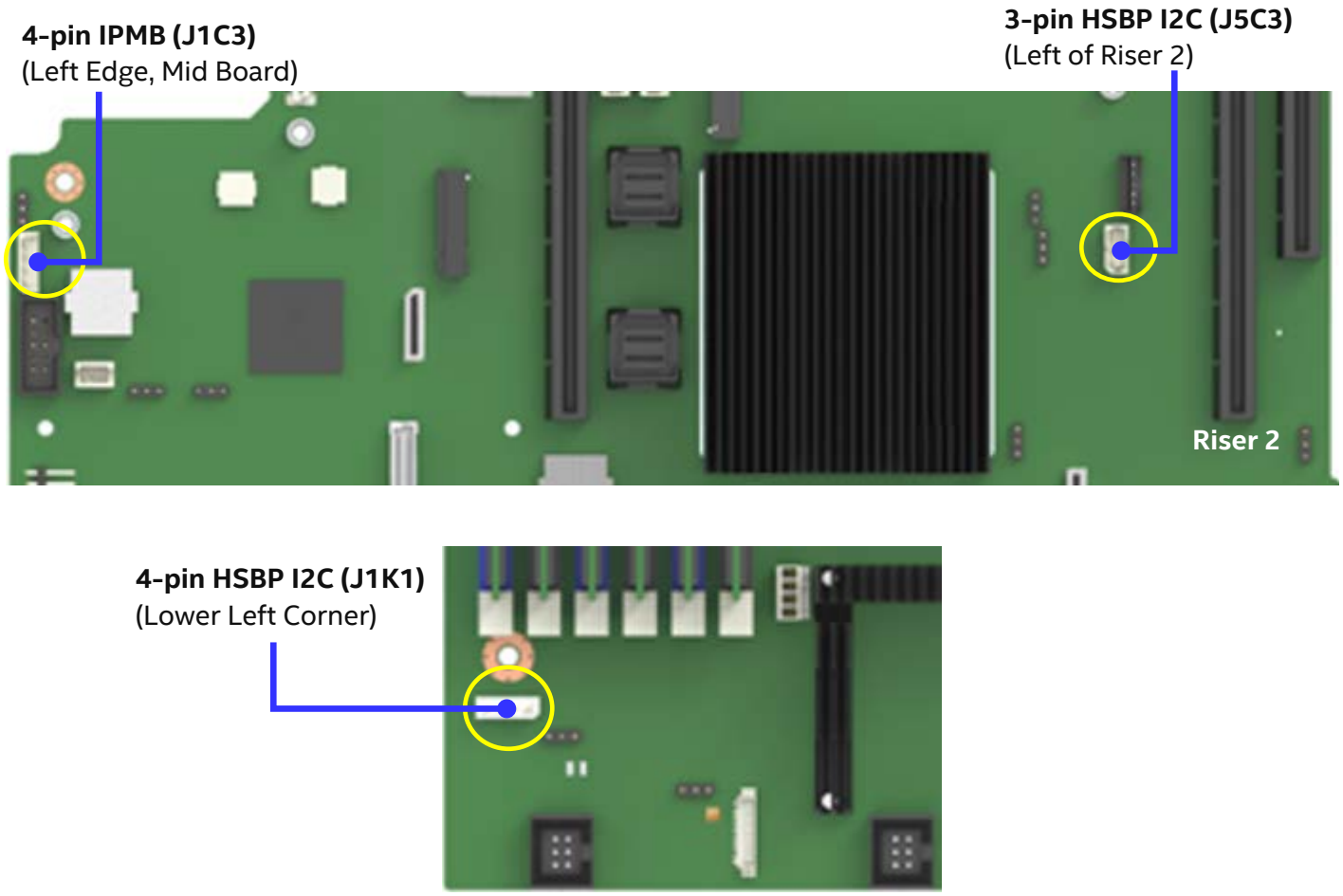


Figure 67.Hot swap backplane connector locations

Table 42. Hot swap backplane I²C connector – SMBUS 3-pin (J5C3)

Pin	Signal
1	SDA
2	Ground
3	SCL

Table 43. Hot swap backplane I²C connector – SMBUS 4-pin (J1K1)

Pin	Signal
1	SDA
2	Ground
3	SCL
4	RST_PCIE_SSD_PERST

Table 44. IPMB – SMBUS 4-pin (J1C3)

Pin	Signal
1	CMOS_SDA
2	Ground
3	CMOS_SCL
4	P5V_AUX

8. 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 Intel® Remote Management Module 4 Lite (Intel® RMM4 Lite) key.

Table 45. Intel® Remote Management Module 4 (Intel® RMM4) options

Intel Product Code (iPC)	Description	Kit Contents	Benefits
AXXRMM4LITE	Intel® Remote Management Module 4 Lite	Intel® RMM4 Lite Activation Key	Enables keyboard, video, and mouse (KVM) and media redirection

On the server board, the Intel RMM4 Lite key is installed at the location shown in Figure 68.

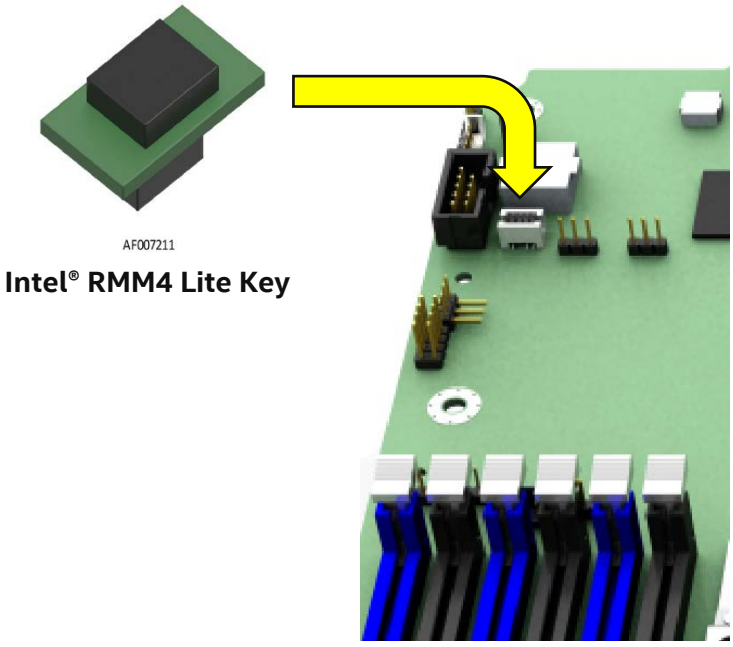


Figure 68. Intel® RMM4 Lite activation key installation

When the BMC firmware initializes, it attempts to access the Intel RMM4 Lite. If the attempt to access the Intel RMM4 Lite is successful, then the BMC activates the advanced features.

Table 46 identifies both basic and advanced server management features.

Table 46. Basic and advanced server management features overview

Feature	Basic	Advanced w/ Intel® 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

Feature	Basic	Advanced w/ Intel® RMM4 Lite Key
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

8.1 Dedicated Management Port

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

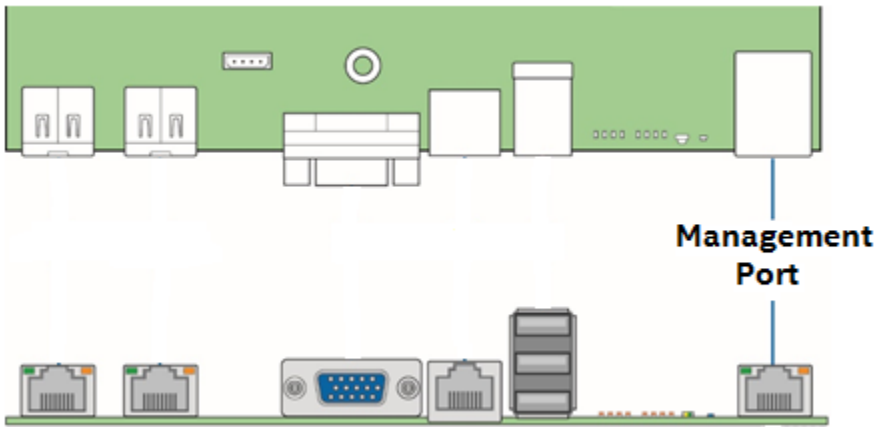


Figure 69. Dedicated managment port

8.2 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 onboard 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 supports the following client web browsers:

- Microsoft Internet Explorer*
- Mozilla Firefox*
- Google Chrome*
- Safari*

The embedded web user interface supports strong security – authentication, encryption, and firewall support – since it enables remote server configuration and control. Encryption using 128-bit SSL is supported. User authentication is based on user ID and password.

The user interface 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 is disabled and displayed in grey font in that user's display. The web interface also provides a launch point for some of the advanced features, such as keyboard, video, and mouse (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.

Additionally, the web interface can:

- Present all the basic features to the users.
- Power on, power off, and reset the server and view current power state.
- Display BIOS, BMC, ME and SDR version information
- Display overall system health.
- Display configuration of various IPMI over LAN parameters for both IPV4 and IPV6.
- Display configuration of alerts (SNMP and SMTP).
- Display system asset information for the product, board, and chassis.
- Display BMC-owned sensors (name, status, current reading, enabled thresholds), including color-code status of sensors.
- Provide ability to filter sensors based on sensor type (voltage, temperature, fan, and power supply related).
- Automatically refresh sensor data with a configurable refresh rate.
- Provide online help
- Display/clear SEL (display is in easily understandable human readable format).
- Support major industry-standard browsers (Microsoft Internet Explorer* and Mozilla Firefox*).
- Automatically time out GUI session after a user-configurable inactivity period. By default, this inactivity period is 30 minutes.
- Provide embedded platform debug feature, allowing the user to initiate a "debug dump" to a file that can be sent to Intel for debug purposes.
- Provide a virtual front panel with 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 Intel ME sensor data. Only sensors that have associated SDRs loaded are displayed.
- Save the SEL to a file.
- Force HTTPS connectivity for greater security. This is provided through a configuration option in the user interface.
- Display processor and memory information that is available over IPMI over LAN.
- Get and set Intel® Node Manager (Intel® NM) power policies
- Display the power consumed by the server.
- View and configure VLAN settings.
- Warn user that the reconfiguration of IP address causes disconnect.
- 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.
- Force into BIOS setup on a reset (server power control).
- Provide the system's Power-On Self Test (POST) sequence for the previous two boot cycles, including timestamps. The timestamps may be displayed as a time relative to the start of POST or the previous POST code.
- Provide the ability to customize the port numbers used for SMASH, http, https, KVM, secure KVM, remote media, and secure remote media.

For additional information, refer to the *Intel® Remote Management Module 4 and Integrated BMC Web Console User Guide*.

8.3 Advanced Management Feature Support

The integrated baseboard management controller has support for advanced management features which are enabled when an optional Intel RMM4 Lite is installed. The Intel RMM4 Lite 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 Lite hardware.

Key features of the Intel RMM4 Lite add-on include:

- **KVM redirection** from either the dedicated management NIC or the server board NICs used for management traffic and up to two KVM sessions. 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.
- **Media redirection** 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 to the server just like a local device, allowing system administrators or users to install software (including operating systems), copy files, update BIOS, or boot the server from this device.

8.3.1 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 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.
- Support for user definable keyboard macros.

KVM redirection feature supports the following resolutions and refresh rates:

- 640x480 at 60 Hz, 72 Hz, 75 Hz, 85 Hz
- 800x600 at 60 Hz, 72 Hz, 75 Hz, 85 Hz
- 1024x768 at 60 Hz, 72 Hz, 75 Hz, 85 Hz
- 1152x864 at 75 Hz
- 1280x800 at 60 Hz

- 1280x1024 at 60 Hz
- 1440x900 at 60 Hz
- 1600x1200 at 60 Hz

8.3.1.1 Availability

The remote KVM session is available even when the server is powered off (in stand-by mode). No restart of the remote KVM session is 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 firmware update – does require the session to be re-established.

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

8.3.1.2 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.

8.3.1.3 Usage

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

8.3.1.4 Force-enter BIOS Setup

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

8.3.2 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 to the server just like a local device, allowing system administrators or users to install software (including operating systems), copy files, update BIOS, or boot the server from this device.

The following list describes additional media redirection capabilities and features.

- The operation of remotely mounted devices is independent of the local devices on the server. Both remote and local devices are usable 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 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 either a local Floppy drive, a local USB device, or else 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. A BMC reset (for example, due to an BMC reset after BMC FW update) requires the session to be re-established
- The mounted device is visible to (and usable 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 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.

8.3.2.1 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.

8.3.3 Remote Console

The remote console is the redirected screen, keyboard, and mouse of the remote host system. To use the remote console window of the managed host system, the browser must include a Java* Runtime Environment (JRE) 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 CD-ROM media redirection, and #5123 for floppy and USB media redirection. When encryption is enabled, the protocol uses ports #7582 for KVM, #5124 for CD-ROM media redirection, and #5127 for floppy and 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 Network Address Translation (NAT) settings have to be configured accordingly.

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

8.3.4 Performance

The remote display accurately represents the local display. The feature adapts to changes in 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 does degrade performance. Enabling video compression provides the fastest response while disabling compression provides better video quality. For the best possible KVM performance, a 2 Mbps 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.

9. Light Guided Diagnostics

The server board includes several onboard LED indicators to aid troubleshooting various board level faults. Figure 70 and Figure 71 show the location for each LED.

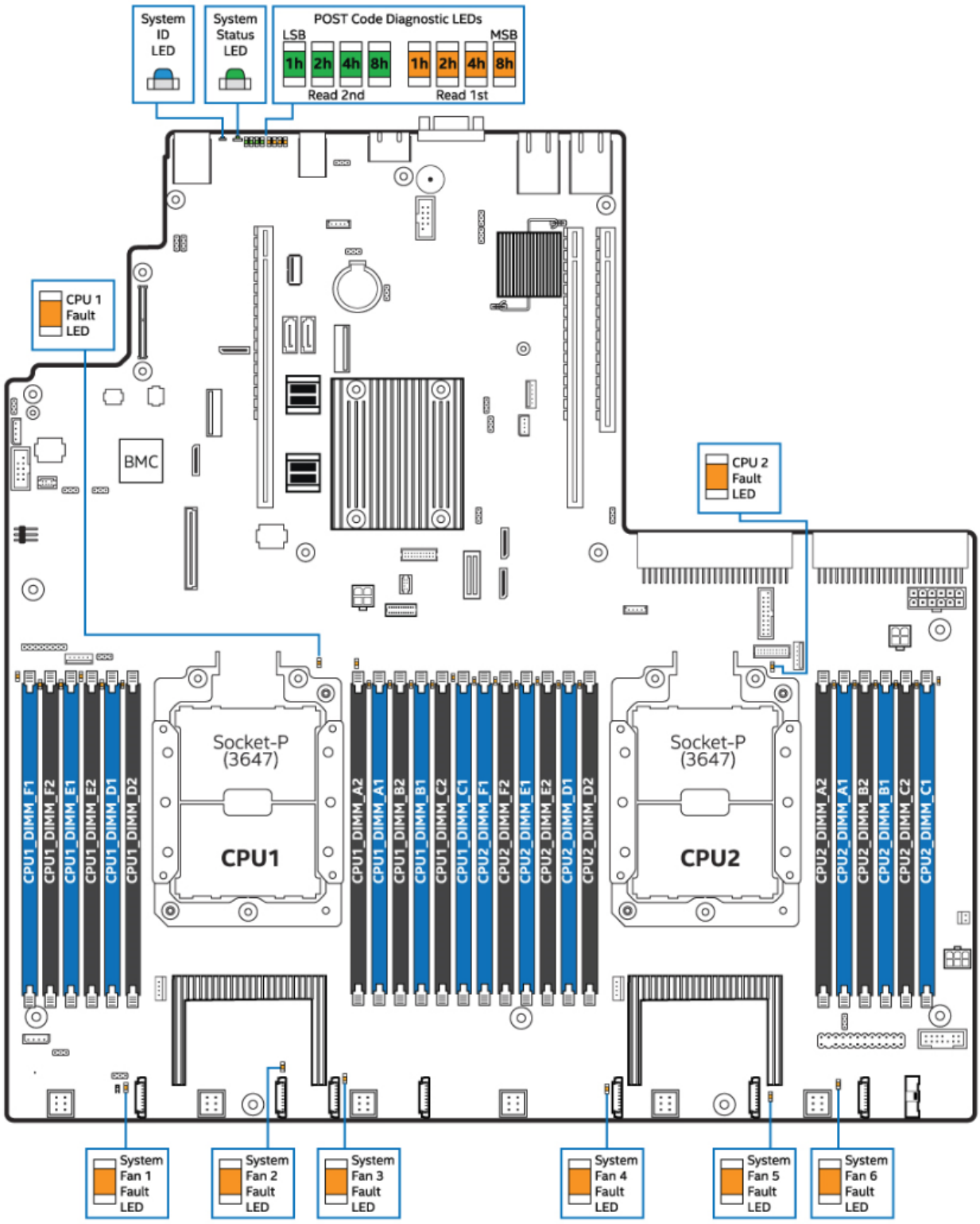


Figure 70. Onboard diagnostic and fault LED placement

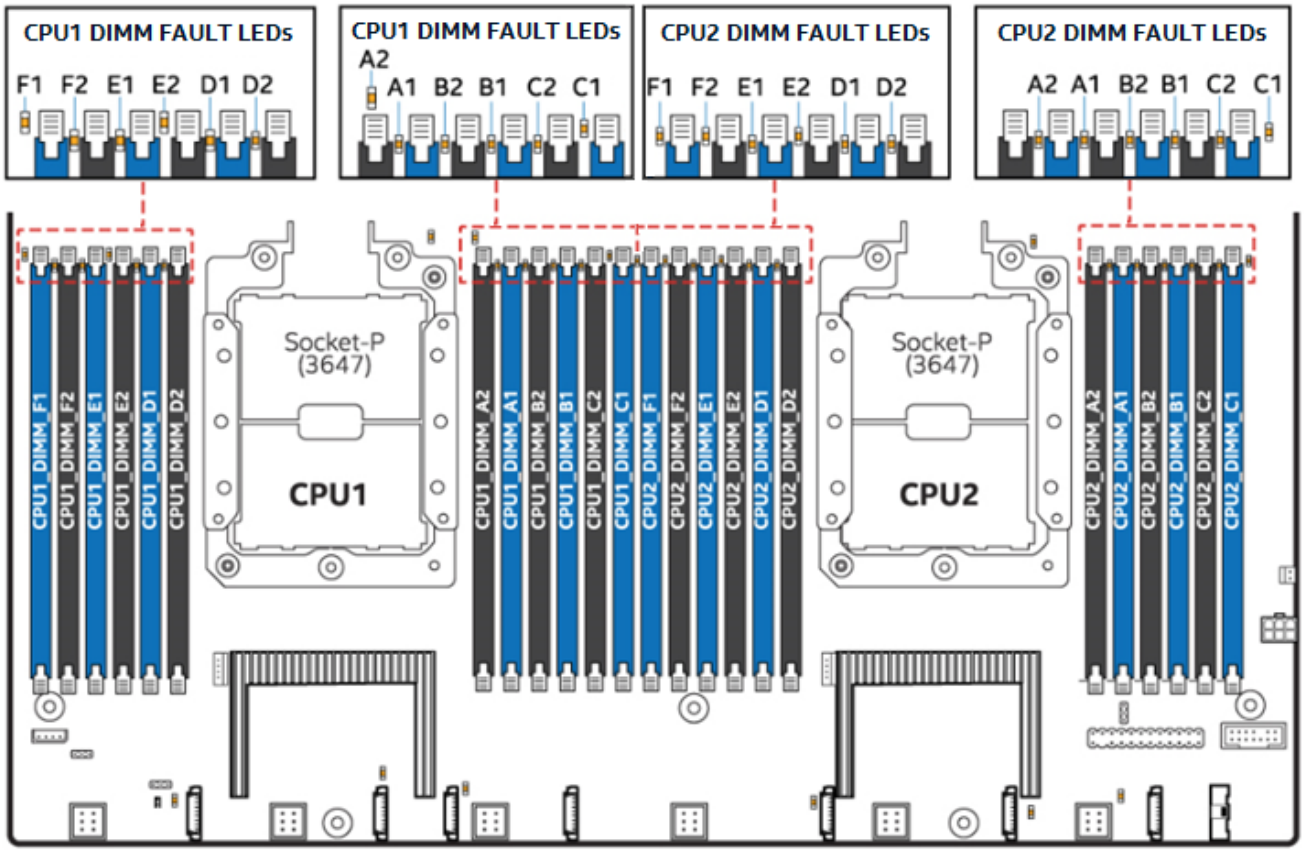


Figure 71.DIMM fault LED placement

9.1 System ID LED

The server board includes a blue system ID LED which is used to visually identify a specific server installed among many other similar servers. There are two options available for illuminating the System ID LED.

- The front panel ID LED button is pushed, which causes the LED to illuminate to a solid on state until the button is pushed again.
- An IPMI Chassis Identify command is remotely entered, which causes the LED to blink

The system ID LED on the server board is tied directly to the system ID LED on system front panel, if present.

9.2 System Status LED

The server board includes a bi-color system status LED. The system status LED on the server board is tied directly to the system status LED on the front panel (if present). This LED indicates the current health of the server. Possible LED states include solid green, blinking green, solid amber, and blinking amber.

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 blinking green to indicate that the BMC is booting. If the BMC boot process completes with no errors, the status LED changes to solid green.

Table 47 lists and describes the states of the system status LEDs.

Table 47. System status LED states

State	System Status	Description
Solid green	Ok	Indicates that the system status is 'healthy'. The system is not exhibiting any errors. AC power is present and BMC has booted and manageability functionality is up and running. 1. After a BMC reset, and in conjunction with the Chassis ID solid ON, the BMC is booting Linux*. Control has been passed from BMC uBoot to BMC Linux itself. It will be in this state for 10-20 seconds.
1 Hz blinking green	Degraded	System Degraded: 1. Redundancy loss such as power-supply or fan. Applies only if the associated platform sub-system has redundancy capabilities. 2. Fan warning or failure when the number of fully operational fans is more than minimum number needed to cool the system. 3. Non-critical threshold crossed – Temperature (including HSBP temp), voltage, input power to power supply, output current for main power rail from power supply and Processor Thermal Control (Therm Ctrl) sensors. 4. Power supply predictive failure occurred while redundant power supply configuration was present. 5. Unable to use all of the installed memory (more than 1 DIMM installed) 1. 6. Correctable Errors over a threshold and migrating to a spare DIMM (memory sparing). This indicates that the user no longer has spared DIMMs indicating a redundancy lost condition. Corresponding DIMM LED lit. 7. In mirrored configuration, when memory mirroring takes place and system loses memory redundancy. 8. Battery failure. 9. BMC executing in uBoot. (Indicated by Chassis ID blinking at 3Hz). System in degraded state (no manageability). BMC uBoot 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. 10. BMC Watchdog has reset the BMC. 11. Power Unit sensor offset for configuration error is asserted. 12. HDD HSC is off-line or degraded. 13. Hard drive fault
1 Hz blinking amber	Warning	Warning alarm – system is likely to fail: 1. Critical threshold crossed – Voltage, temperature (including HSBP temp), input power to power supply, output current for main power rail from power supply and PROCHOT (Therm Ctrl) sensors. 2. VRD Hot asserted. 3. Minimum number of fans to cool the system not present or failed 4. Power Unit Redundancy sensor – Insufficient resources offset (indicates not enough power supplies present)

9.3 BMC Boot/Reset Status LED Indicators

During the BMC boot or BMC reset process, the system status LED and System ID LED are used to indicate BMC boot process transitions and states. A BMC boot occurs when the AC power is first applied. (DC power on/off does not reset BMC.) BMC reset occurs after a BMC firmware update, on receiving a BMC cold reset command, and following a reset initiated by the BMC watchdog. Table 48 defines the LED states during the BMC boot/reset process.

Table 48. BMC boot/reset status LED indicators

BMC Boot/Reset State	System ID LED	System Status LED	Comment
BMC/video memory test failed	Solid blue	Solid amber	Non-recoverable condition. Contact an Intel representative for information on replacing this motherboard.

Both universal bootloader (u-Boot) images bad	6 Hz blinking blue	Solid amber	Non-recoverable condition. Contact an Intel representative for information on replacing this motherboard.
BMC in u-Boot	3 Hz blinking blue	1 Hz blinking green	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	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.
End of BMC boot/reset process. Normal system operation	Off	Solid green	Indicates BMC Linux* has booted and manageability functionality is up and running. Fault/status LEDs operate as per usual.

9.4 Post Code Diagnostic LEDs

A bank of eight POST code diagnostic LEDs are located on the back edge of the server next to the stacked USB connectors (see Figure 70). During the system boot process, the BIOS executes a number of platform configuration processes, each of which is assigned a specific hex POST code number. As each configuration routine is started, the BIOS displays the given POST code to the POST code diagnostic LEDs. The purpose of these LEDs is to assist in troubleshooting a system hang condition during the POST process. The diagnostic LEDs can be used to identify the last POST process to be executed. See Appendix B for a complete description of how these LEDs are read, and for a list of all supported POST codes

9.5 Fan Fault LEDs

The server board includes a fan fault LED next to each of the six system fans (see Figure 70). The LED has two states: on and off. The BMC lights a fan fault LED if the associated fan-tach sensor has a lower critical threshold event status asserted. Fan-tach sensors are manual re-arm sensors. Once the lower critical threshold is crossed, the LED remains lit until the sensor is rearmed. These sensors are rearmed at system DC power-on and system reset.

9.6 Memory Fault LEDs

The server board includes a memory fault LED for each DIMM slot (see Figure 71). When the BIOS detects a memory fault condition, it sends an IPMI OEM command (Set Fault Indication) to the BMC to instruct the BMC to turn on the associated memory slot fault LED. These LEDs are only active when the system is in the on state. The BMC does not activate or change the state of the LEDs unless instructed by the BIOS.

9.7 CPU Fault LEDs

The server board includes a CPU fault LED for each CPU socket. The CPU fault LED is lit if there is an MSID mismatch error is detected (that is, CPU power rating is incompatible with the board).

10. System Security

The server board supports a variety of system security options designed to prevent unauthorized system access or tampering of server settings. System security options supported include:

- Password protection
- Front panel lockout
- Trusted Platform Module (TPM) support
- Intel® Trusted Execution Technology (Intel® TXT)

10.1 Password Protection

The BIOS setup utility, accessed during POST, includes a Security tab where options to configure passwords, front panel lockout, and TPM settings, can be found.

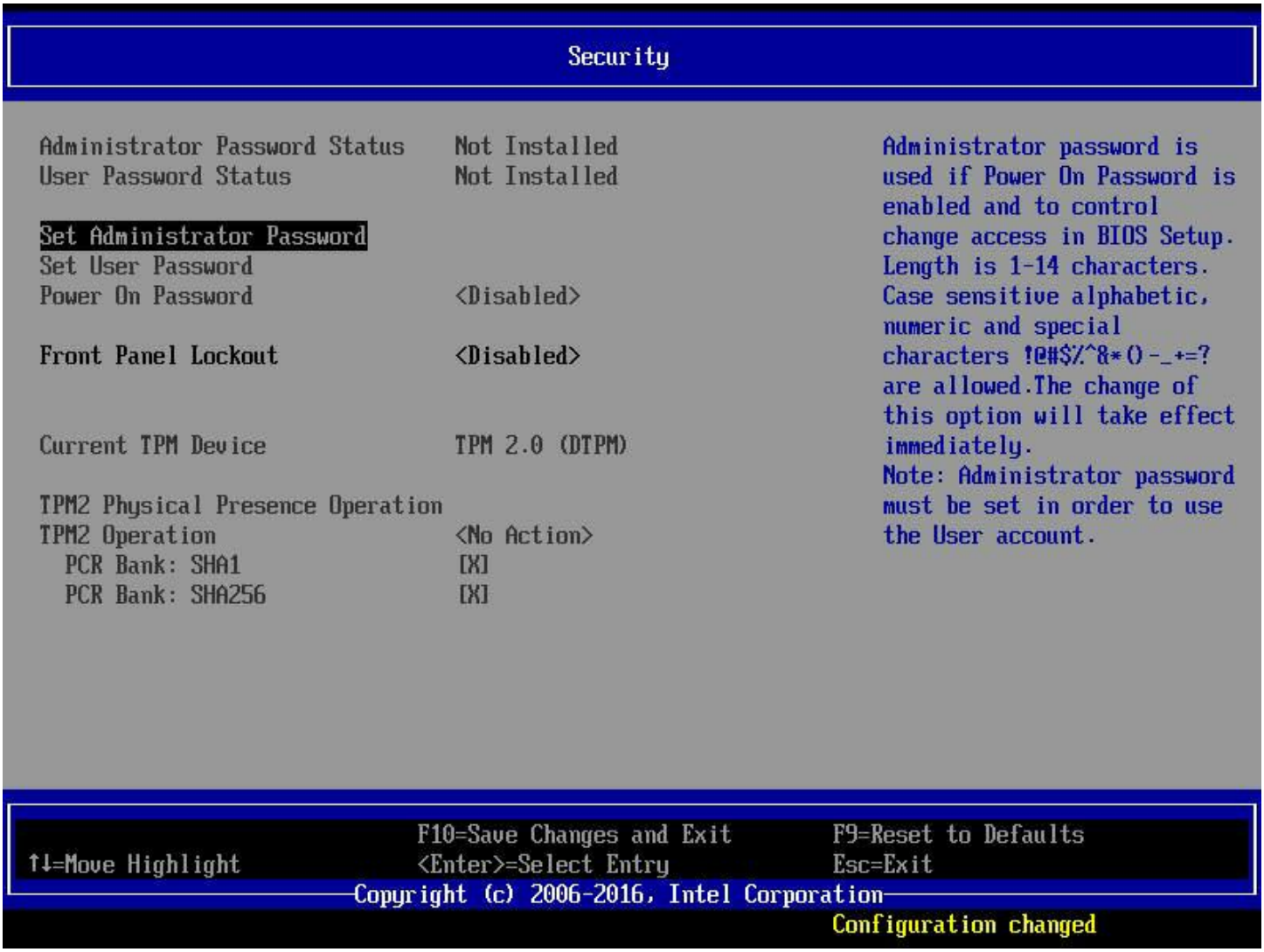


Figure 72. BIOS setup Security tab

10.1.1 Password Setup

The BIOS uses passwords to prevent unauthorized access to the server. Passwords can restrict entry to the BIOS setup utility, restrict use of the Boot Device popup menu during POST, suppress automatic USB device

re-ordering, and prevent unauthorized system power on. It is strongly recommended that an administrator password be set. A system with no administrator password set allows anyone who has access to the server to change BIOS settings.

An administrator password must be set in order to set the user password.

The maximum length of a password is 14 characters and can be made up of a combination of alphanumeric (a-z, A-Z, 0-9) characters and any of the following special characters:

```
! @ # $ % ^ & * ( ) - _ + = ?
```

Passwords are case sensitive.

The administrator and user passwords must be different from each other. An error message is displayed and a different password must be entered if there is an attempt to enter the same password for both. The use of strong passwords is encouraged, but not required. In order to meet the criteria for a strong password, the password entered must be at least eight characters in length, and must include at least one each of alphabetic, numeric, and special characters. If a weak password is entered, a warning message is displayed, and the weak password is accepted. Once set, a password can be cleared by changing it to a null string. This requires the administrator password, and must be done through BIOS setup. Clearing the administrator password also clears the user password. Passwords can also be cleared by using the password clear jumper on the server board. For more information on the password clear jumper, see Section 11.2.

Resetting the BIOS configuration settings to default values (by any method) has no effect on the administrator and user passwords.

As a security measure, if a user or administrator enters an incorrect password three times in a row during the boot sequence, the system is placed into a halt state. A system reset is required to exit out of the halt state. This feature makes it more difficult to guess or break a password.

In addition, on the next successful reboot, the Error Manager displays a Major Error code 0048, which also logs a SEL event to alert the authorized user or administrator that a password access failure has occurred.

10.1.2 System Administrator Password Rights

When the correct administrator password is entered when prompted, the user has the ability to perform the following actions:

- Access the BIOS setup utility.
- Configure all BIOS setup options in the BIOS setup utility.
- Clear both the administrator and user passwords.
- Access the Boot Menu during POST.

If the Power On Password function is enabled in BIOS setup, the BIOS halts early in POST to request a password (administrator or user) before continuing POST.

10.1.3 Authorized System User Password Rights and Restrictions

When the correct user password is entered, the user has the ability to perform the following actions:

- Access the BIOS setup utility.
- View, but not change, any BIOS setup options in the BIOS setup utility.
- Modify system time and date in the BIOS setup utility.

If the Power On Password function is enabled in BIOS setup, the BIOS halts early in POST to request a password (administrator or user) before continuing POST.

Configuring an administrator password imposes restrictions on booting the system, and configures most setup fields to read-only if the administrator password is not provided. The boot popup menu requires the

administrator password to function, and the USB reordering is suppressed as long as the administrator password is enabled. Users are restricted from booting in anything other than the boot order defined in setup by an administrator.

10.2 Front Panel Lockout

If enabled in BIOS setup from the Security screen, this option disables the following front panel features:

- The off function of the power button.
- System reset button.

If front panel lockout is enabled, system power off and reset must be controlled via a system management interface.

10.3 Trusted Platform Module (TPM) Support

The Trusted Platform Module (TPM) option is a hardware-based security device that addresses the growing concern about boot process integrity and offers better data protection. TPM protects the system startup process by ensuring it is tamper-free before releasing system control to the operating system. A TPM device provides secured storage to store data, such as security keys and passwords. In addition, a TPM device has encryption and hash functions. The server board implements TPM as per *TPM PC Client Specifications revision 1.2,* published by the Trusted Computing Group (TCG).

A TPM device is optionally installed on a high-density 14-pin connector labeled “TPM” on the server board, and is secured from external software attacks and physical theft. A pre-boot environment, such as the BIOS and operating system loader, uses the TPM to collect and store unique measurements from multiple factors within the boot process to create a system fingerprint. This unique fingerprint remains the same unless the pre-boot environment is tampered with. Therefore, it is used to compare to future measurements to verify the integrity of the boot process.

After the system BIOS completes the measurement of its boot process, it hands off control to the operating system loader and, in turn, to the operating system. If the operating system is TPM-enabled, it compares the BIOS TPM measurements to those of previous boots to make sure the system was not tampered with before continuing the operating system boot process. Once the operating system is in operation, it optionally uses TPM to provide additional system and data security (for example, Microsoft Windows 10* supports Bitlocker* drive encryption).

10.3.1 TPM Security BIOS

The BIOS TPM support conforms to the TPM PC Client Implementation Specification for Conventional BIOS the TPM Interface Specification, and the Microsoft Windows BitLocker Requirements. The role of the BIOS for TPM security includes the following:

- Measures and stores the boot process in the TPM microcontroller to allow a TPM-enabled operating system to verify system boot integrity.
- Produces extensible firmware interface (EFI) and legacy interfaces to a TPM-enabled operating system for using TPM.
- Produces Advanced Configuration and Power Interface (ACPI) TPM device and methods to allow a TPM-enabled operating system to send TPM administrative command requests to the BIOS.
- Verifies operator physical presence. Confirms and executes operating system TPM administrative command requests.
- Provides BIOS setup options to change TPM security states and to clear TPM ownership.

For additional details, refer to the *TCG PC Client Specific Implementation Specification*, the *TCG PC Client Specific Physical Presence Interface Specification*, and the *Microsoft Windows* BitLocker* Requirements* documents.

10.3.2 Physical Presence

Administrative operations to the TPM require TPM ownership or physical presence indication by the operator to confirm the execution of administrative operations. The BIOS implements the operator presence indication by verifying the setup administrator password.

A TPM administrative sequence invoked from the operating system proceeds as follows:

1. A user makes a TPM administrative request through the operating system's security software.
2. The operating system requests the BIOS to execute the TPM administrative command through TPM ACPI methods and then resets the system.
3. The BIOS verifies the physical presence and confirms the command with the operator.
4. The BIOS executes TPM administrative command, inhibits BIOS setup entry, and boots directly to the operating system which requested the TPM command.

10.3.3 TPM Security Setup Options

The BIOS TPM setup allows the operator to view the current TPM state and to carry out rudimentary TPM administrative operations. Performing TPM administrative options through the BIOS setup requires TPM physical presence verification.

Using the BIOS TPM setup, the operator can turn TPM functionality on or off and clear the TPM ownership contents. After the requested TPM BIOS setup operation is carried out, the option reverts to No Operation.

The BIOS TPM setup also displays the current state of the TPM, whether TPM is enabled or disabled and activated or deactivated. Note that while using TPM, a TPM-enabled operating system or application may change the TPM state independently of the BIOS setup. When an operating system modifies the TPM state, the BIOS Setup displays the updated TPM state.

The BIOS setup **TPM Clear** option allows the operator to clear the TPM ownership key and allows the operator to take control of the system with TPM. You use this option to clear security settings for a newly initialized system or to clear a system for which the TPM ownership security key was lost.

10.4 Intel® Trusted Execution Technology

The Intel® Xeon® processor Scalable product family supports Intel® Trusted Execution Technology (Intel® TXT), which is a robust security environment. Designed to help protect against software-based attacks, Intel TXT integrates new security features and capabilities into the processor, chipset, and other platform components. When used in conjunction with Intel® Virtualization Technology (Intel® VT), Intel TXT provides hardware-rooted trust for virtual applications.

This hardware-rooted security provides a general-purpose, safer computing environment capable of running a wide variety of operating systems and applications to increase the confidentiality and integrity of sensitive information without compromising the usability of the platform.

Intel TXT requires a computer system with Intel Virtualization Technology enabled (both VT-x and VT-d), an Intel TXT -enabled processor, chipset, and BIOS, Authenticated Code Modules, and an Intel TXT compatible measured launched environment (MLE). The MLE could consist of a virtual machine monitor, an OS, or an application. In addition, Intel TXT requires the system to include a TPM v1.2, as defined by the *Trusted Computing Group TPM PC Client Specifications, Revision 1.2*.

When available, Intel TXT can be enabled or disabled in the processor by a BIOS setup option. For general information about Intel TXT, visit http://www.intel.com/technology/security/.

11. Reset and Recovery Jumpers

The server board includes several jumper blocks which can be used to configure, protect, or recover specific features of the server board. Figure 73 identifies the location of each jumper block on the server board. Pin 1 of each jumper block can be identified by the arrowhead (▼) silkscreened on the server board next to the pin.

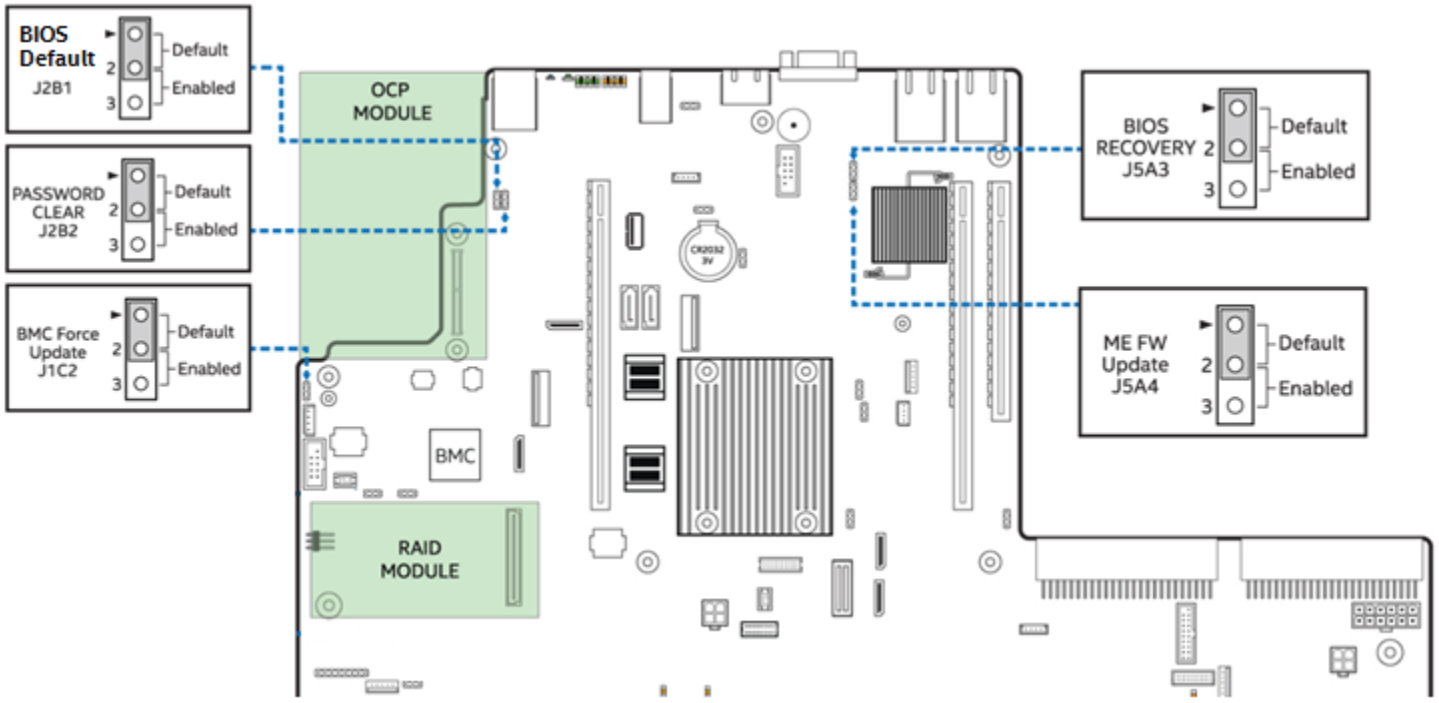


Figure 73. Reset and recovery jumper block location

The following sections describe how each jumper block is used.

11.1 BIOS Default Jumper Block

This jumper resets BIOS options, configured using the <F2> BIOS Setup Utility, back to their original default factory settings.

Note: This jumper does not reset administrator or user passwords. To reset passwords, the password clear jumper must be used.

To use the BIOS default jumper, perform the following steps:

1. Power down the server and unplug the power cord(s).
2. Remove the system top cover and move the “BIOS DFLT” jumper from pins 1-2 (normal operation) to pins 2-3 (set BIOS defaults).
3. Wait five seconds then move the jumper back to pins 1-2.
4. Re-install the system top cover.
5. Re-Install system power cords.

   Note: The system automatically powers on after AC is applied to the system.

6. During POST, press **<F2>** to access the BIOS setup utility to configure and save desired BIOS options.

After resetting BIOS options using the BIOS default jumper, the Error Manager Screen in the BIOS setup utility displays two errors:

- 0012 System RTC date/time not set
- 5220 BIOS Settings reset to default settings

Also, the system time and date may need to be reset.

11.2 Password Clear Jumper Block

This jumper causes both the user password and the administrator password to be cleared if they were set. The operator should be aware that this creates a security gap until passwords have been installed again through the BIOS setup utility. This is the only method by which the administrator and user passwords can be cleared unconditionally. Other than this jumper, passwords can only be set or cleared by changing them explicitly in BIOS setup or by similar means. No method of resetting BIOS configuration settings to default values affects either the administrator or user passwords.

To use the password clear jumper, perform the following steps:

1. Power down the server. For safety, unplug the power cord(s).
2. Remove the system top cover.
3. Move the password clear jumper from pins 1-2 (default) to pins 2-3 (password clear position).
4. Re-install the system top cover and re-attach the power cords.
5. Power up the server and press **<F2>** to access the BIOS setup utility.
6. Verify the password clear operation was successful by viewing the Error Manager screen. Two errors should be logged:
    - 5221 Passwords cleared by jumper
    - 5224 Password clear jumper is set
7. Exit the BIOS setup utility and power down the server. For safety, remove the AC power cords
8. Remove the system top cover and move the password clear jumper back to pins 1-2 (default).
9. Re-install the system top cover and reattach the AC power cords.
10. Power up the server.
11. It is strongly recommended to boot into BIOS setup immediately, navigate to the Security tab, and set the administrator and user passwords if intending to use BIOS password protection.

11.3 Intel® Management Engine (Intel® ME) Firmware Force Update Jumper Block

When the Intel ME firmware force update jumper is moved from its default position, the Intel ME is forced to operate in a reduced minimal operating capacity. This jumper should only be used if the Intel ME firmware has gotten corrupted and requires re-installation.

Note: System update files are included in the system update packages (SUP) posted to Intel's download center website at http://downloadcenter.intel.com.

To use the Intel ME firmware force update jumper, perform the following steps:

1. Turn off the system and remove the AC power cords.

    Note: If the Intel ME force update jumper is moved with AC power applied to the system, the Intel ME will not operate properly.

    ---

2. Remove the system top cover.
3. Move the "ME FRC UPD" jumper from pins 1-2 (default) to pins 2-3 (force update position).
4. Re-install the system top cover and re-attach the AC power cords.

5. Power on the system.
6. Boot to the EFI shell.
7. Change directories to the folder containing the update files.
8. Update the Intel ME firmware using the following command:

   ```
   iflash32 /u /ni  <version#>_ME.cap
   ```

9. When the update has successfully completed, power off the system.
10. Remove the AC power cords.
11. Remove the system top cover.
12. Move the “ME FRC UPD” jumper back to pins 1-2 (default).
13. Re-attach the AC power cords and power on the system.

11.4 BMC Force Update Jumper Block

The BMC force update jumper is used to put the BMC in boot recovery mode for a low-level update. It causes the BMC to abort its normal boot process and stay in the boot loader without executing any Linux* code. This jumper should only be used if the BMC firmware has become corrupted and requires re-installation.

Note: System update files are included in the SUP posted to Intel’s download center website at http://downloadcenter.intel.com.

To use the BMC force update jumper, perform the following steps:

1. Turn off the system and remove the AC power cords.

   Note: If the BMC FRC UPD jumper is moved with AC power applied to the system, the BMC will not operate properly.

   ---

2. Remove the system top cover.
3. Move the “BMC FRC UPD” jumper from pins 1 - 2 (default) to pins 2 - 3 (force update position).
4. Re-install the system top cover and re-attach the AC power cords.
5. Power on the system.
6. Boot to the EFI shell.
7. Change directories to the folder containing the update files.
8. Update the BMC firmware using the following command:

   ```
   FWPIAUPD -u -bin -ni -b -o -pia -if=usb <file name.BIN>
   ```

9. When the update has successfully completed, power off the system.
10. Remove the AC power cords.
11. Remove the system top cover.
12. Move the “BMC FRC UPD” jumper back to pins 1-2 (default).
13. Re-attach the AC power cords and power on the system.
14. Boot to the EFI shell.
15. Change directories to the folder containing the update files.
16. Re-install the board/system SDR data by running the FRUSDR utility.
17. After the SDRs have been loaded, reboot the server.

11.5 BIOS Recovery Jumper

When the BIOS recovery jumper block is moved from its default pin position (pins 1–2), the system boots using a backup BIOS image to the UEFI shell, where a standard BIOS update can be performed. See the BIOS update instructions that are included with the SUP downloaded from Intel’s download center website. This

jumper is used when the system BIOS has become corrupted and is non-functional, requiring a new BIOS image to be loaded on to the server board.

Note: The BIOS Recovery jumper is only used to re-install a BIOS image in the event the BIOS has become corrupted. This jumper is not used when the BIOS is operating normally to update the BIOS from one version to another.

Note: System update files are included in the SUP posted to Intel's download center website at http://downloadcenter.intel.com.

To use the BIOS recovery jumper, perform the following steps:

1. Turn off the system and remove the AC power cords.
2. Remove the system top cover.
3. Move the "BIOS Recovery" jumper from pins 1 – 2 (default) to pins 2 – 3 (BIOS recovery position).
4. Re-install the system top cover and re-attach the AC power cords.
5. Power on the system. The system automaticallys boot to the EFI shell.
6. Update the BIOS using the standard BIOS update instructions provided with the system update package.
7. After the BIOS update has successfully completed, power off the system. For safety, remove the AC power cords from the system.
8. Remove the system top cover.
9. Move the BIOS recovery jumper back to pins 1 – 2 (default).
10. Re-install the system top cover and re-attach the AC power cords.
11. During POST, press **<F2>** to access the BIOS setup utility to configure and save desired BIOS options.

12. Platform Management

Platform management is supported by several hardware and software components integrated on the server board that work together to:

- Control system functions – power system, ACPI, system reset control, system initialization, front panel interface, system event log.
- Monitor various board and system sensors and regulate platform thermals and performance to maintain (when possible) server functionality in the event of component failure and/or environmentally stressed conditions.
- Monitor and report system health.
- Provide an interface for Intel® Server Management software applications.

This chapter provides a high level overview of the platform management features and functionality implemented on the server board.

The *Intel® Server System BMC Firmware External Product Specification* (EPS) and the *Intel® Server System BIOS External Product Specification* (EPS) for Intel® Server Products based on the Intel® Xeon® processor E5-2600 v5 product families should be referenced for more in-depth and design level platform management information.

12.1 Management Feature Set Overview

The following sections outline features that the integrated BMC firmware can support. Support and utilization for some features is dependent on the server platform in which the server board is integrated and any additional system level components and options that may be installed.

12.1.1 IPMI 2.0 Features Overview

The baseboard management controller (BMC) supports the following IPMI 2.0 features:

- 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 to receive and process events from other platform subsystems.
- Access to system Field Replaceable Unit (FRU) devices using IPMI FRU commands.
- System Event Log (SEL) device functionality including SEL Severity Tracking and Extended SEL.
- Storage of and access to system Sensor Data Records (SDRs).
- Sensor device management and polling 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)
    - Intelligent platform management bus (IPMB) interface
    - LAN interface that supports the IPMI-over-LAN protocol (RMCP, RMCP+)
- Serial-over-LAN (SOL)
- ACPI state synchronization to state changes provided by the BIOS.
- Initialization and runtime self-tests including making results available to external entities.

See also the Intelligent Platform Management Interface Specification Second Generation v2.0.

12.1.2 Non-IPMI Features Overview

The BMC supports the following non-IPMI features.

- In-circuit BMC firmware update.

- Fault resilient booting (FRB) including FRB-2 supported by the watchdog timer functionality.
- Chassis intrusion detection (dependent on platform support).
- Fan speed control with SDR, fan redundancy monitoring, and support.
- Enhancements to fan speed control.
- Power supply redundancy monitoring and support.
- Hot-swap fan support.
- Acoustic management and support for multiple fan profiles.
- Test commands for setting and getting platform signal states.
- Diagnostic beep codes for fault conditions.
- System globally unique identifier (GUID) storage and retrieval.
- Front panel management including system status LED and chassis ID LED (turned on using a front panel button or command), secure lockout of certain front panel functionality, and button press monitoring.
- Power state retention.
- Power fault analysis.
- Intel® Light-Guided Diagnostics.
- Power unit management including support for power unit sensor and handling of power-good dropout conditions.
- DIMM temperature monitoring facilitating new sensors and improved acoustic management using closed-loop fan control algorithm taking into account DIMM temperature readings.
- Sending and responding to Address Resolution Protocols (ARPs) (supported on embedded NICs).
- Dynamic Host Configuration Protocol (DHCP) (supported on embedded NICs).
- Platform environment control interface (PECI) thermal management support.
- Email alerting.
- Support for embedded web server UI in Basic Manageability feature set.
- Enhancements to embedded web server.
    - Human-readable SEL.
    - Additional system configurability.
    - Additional system monitoring capability.
    - Enhanced online help.
- Integrated keyboard, video, and mouse (KVM).
- Enhancements to KVM redirection.
    - Support for higher resolution.
- Integrated remote media redirection.
- Lightweight Directory Access Protocol (LDAP) support.
- Intel® Intelligent Power Node Manager support.
- Embedded platform debug feature which allows capture of detailed data for later analysis.
    - Creation of password protected files accessible by Intel only.
- Provisioning and inventory enhancements.
    - Inventory data/system information export (partial SMBIOS table).
- DCMI 1.5 compliance.
- Management support for Power Management Bus (PMBus*) 1.2 compliant power supplies.
- BMC data repository (managed data region feature).
- Support for an Intel® Local Control Panel display.
- System airflow monitoring.
- Exit air temperature monitoring.
- Ethernet controller thermal monitoring.
- Global aggregate temperature margin sensor.
- Memory thermal management.
- Power supply fan sensors.

- ENERGY STAR* server support.
- Smart ride through (SmaRT) / closed-loop system throttling (CLST).
- Power supply cold redundancy.
- Power supply firmware update.
- Power supply compatibility check.
- BMC firmware reliability enhancements:
    - Redundant BMC boot blocks to avoid possibility of a corrupted boot block resulting in a scenario that prevents a user from updating the BMC.
    - BMC system management health monitoring.

12.2 Platform Management Features and Functions

12.2.1 Power Subsystem

The server board supports several power control sources that can initiate power-up or power-down activity, as detailed in Table 49.

Table 49. Power control sources

Source	External Signal Name or Internal Subsystem	Capability
Power button	Front panel power button	Turns power on or off
BMC watchdog timer	Internal BMC timer	Turns power off, or power cycle
BMC chassis control commands	Routed through command processor	Turns power on or off, or power cycle
Power state retention	Implemented by means of BMC internal logic	Turns power on when AC power returns
Chipset	Sleep S4/S5 signal (same as POWER_ON)	Turns power on or off
CPU thermal	Processor Thermtrip	Turns power off
PCH thermal	PCH Thermtrip	Turns power off
WOL (Wake On LAN)	LAN	Turns power on

12.2.2 Advanced Configuration and Power Interface (ACPI)

The server board has support for the Advanced Configuration and Power Interface (ACPI) states described in Table 50.

Table 50. ACPI power states

State	Supported	Description
S0	Yes	Working. • Front panel power LED is on (not controlled by the BMC). • Fans spin at the normal speed, as determined by sensor inputs. • Front panel buttons work normally.
S1	No	Not supported.
S2	No	Not supported.
S3	No	Supported only on workstation platforms. See appropriate platform specific Information for more information.
S4	No	Not supported.
S5	Yes	Soft off. • Front panel buttons are not locked. • Fans are stopped. • Power-up process goes through the normal boot process. • Power, reset, front panel non-maskable interrupt (NMI), and ID buttons are unlocked.

12.2.3 System Initialization

During system initialization, both the BIOS and the BMC initialize the items described in the following sections.

12.2.3.1 Processor Tcontrol Setting

Processors used with this chipset implement a feature called Tcontrol, which provides a processor-specific value that can be used to adjust the fan-control behavior to achieve optimum cooling and acoustics. The BMC reads these from the CPU through PECI Proxy mechanism provided by Intel® ME. The BMC uses these values as part of the fan-speed-control algorithm.

12.2.3.2 Fault Resilient Booting (FRB)

Fault resilient booting (FRB) is a set of BIOS and BMC algorithms and hardware support that allow a multiprocessor system to boot even if the bootstrap processor (BSP) fails. Only FRB-2 is supported using watchdog timer commands.

FRB-2 refers to the FRB algorithm that detects system failures during POST. The BIOS uses the BMC watchdog timer to back up its operation during POST. The BIOS configures the watchdog timer to indicate that the BIOS is using the timer for the FRB2 phase of the boot operation.

After the BIOS has identified and saved the BSP information, it sets the FRB-2 timer use bit and loads the watchdog timer with the new timeout interval.

If the watchdog timer expires while the watchdog use bit is set to FRB-2, the BMC (if so configured) logs a watchdog expiration event showing the FRB-2 timeout in the event data bytes. The BMC then hard resets the system, assuming the BIOS-selected reset as the watchdog timeout action.

The BIOS is responsible for disabling the FRB-2 timeout before initiating the option ROM scan and before displaying a request for a boot password. If the processor fails and causes an FRB-2 timeout, the BMC resets the system.

The BIOS gets the watchdog expiration status from the BMC. If the status shows an expired FRB-2 timer, the BIOS enters the failure in the system event log (SEL). In the OEM bytes entry in the SEL, the last POST code generated during the previous boot attempt is written. FRB-2 failure is not reflected in the processor status sensor value.

The FRB-2 failure does not affect the front panel LEDs.

12.2.3.3 Post Code Display

The BMC, upon receiving standby power, initializes internal hardware to monitor port 80h (POST code) writes. Data written to port 80h is output to the system POST LEDs. The BMC deactivates POST LEDs after POST completes. Refer to Appendix B for a complete list of supported POST code diagnostic LEDs.

12.2.4 Watchdog Timer

The BMC implements a fully IPMI 2.0 compatible watchdog timer. For details, see the *Intelligent Platform Management Interface Specification Second Generation v2.0*. The NMI/diagnostic interrupt for an IPMI 2.0 watchdog timer is associated with an NMI. A watchdog pre-timeout SMI or equivalent signal assertion is not supported.

12.2.5 System Event Log (SEL)

The BMC implements the system event log as specified in the *Intelligent Platform Management Interface Specification v2.0*. The SEL is accessible regardless of the system power state through the BMC's in-band and out-of-band interfaces.

The BMC allocates 95,231 bytes (approx. 93 KB) of non-volatile storage space to store system events. The SEL timestamps may not be in order. Up to 3,639 SEL records can be stored at a time. Because the SEL is

circular, any command that results in an overflow of the SEL beyond the allocated space will overwrite the oldest entries in the SEL, while setting the overflow flag.

12.3 Sensor Monitoring

The BMC monitors system hardware and reports system health. The information gathered from physical sensors is translated into IPMI sensors as part of the IPMI sensor model. The BMC also reports various system state changes by maintaining virtual sensors that are not specifically tied to physical hardware. This section describes general aspects of BMC sensor management as well as describing how specific sensor types are modeled. Unless otherwise specified, the term “sensor” refers to the IPMI sensor-model definition of a sensor.

- Sensor scanning
- BIOS event-only sensors
- Margin sensors
- IPMI watchdog sensor
- BMC watchdog sensor
- BMC system management health monitoring
- VR watchdog timer
- System airflow monitoring sensors - valid for Intel® server chassis only
- Fan monitoring sensors
- Thermal monitoring sensors
- Voltage monitoring sensors
- CATERR sensor
- LAN leash event monitoring
- CMOS battery monitoring
- NMI (diagnostic interrupt) sensor

12.3.1 Sensor Re-arm Behavior

12.3.1.1 Manual versus Automatic Re-arm Sensors

Sensors can be re-armed either manually or automatically. An automatic re-arm sensor re-arms (clears) the assertion event state for a threshold or offset if that threshold or offset is de-asserted after having been asserted. This allows a subsequent assertion of the threshold or an offset to generate a new event and associated side-effect. An example side-effect is boosting fans due to an upper critical threshold crossing of a temperature sensor. The event state and the input state (value) of the sensor track each other. Most sensors are of the auto-rearm type.

A manual re-arm sensor does not clear the assertion state even when the threshold or offset becomes de-asserted. In this case, the event state and the input state (value) of the sensor do not track each other. The event assertion state is "sticky". The following methods can be used to re-arm a sensor:

- Automatic re-arm – Only applies to sensors that are designated as auto re-arm.
- IPMI command – Re-arm sensor event.
- BMC internal method – The BMC may re-arm certain sensors due to a trigger condition. For example, some sensors may be re-armed due to a system reset. A BMC reset re-arms all sensors.
- System reset or DC power cycle – Re-arms all system fan sensors.

12.3.2 Thermal Monitoring

The BMC provides monitoring of component and board temperature sensing devices. This monitoring capability is instantiated in the form of IPMI analog/threshold or discrete sensors, depending on the nature of the measurement.

For analog/threshold sensors, with the exception of processor temperature sensors, critical and non-critical thresholds (upper and lower) are set through SDRs and event generation enabled for both assertion and de-assertion events.

For discrete sensors, both assertion and de-assertion event generation are enabled.

Mandatory monitoring of platform thermal sensors includes:

- Inlet temperature (physical sensor is typically on system front panel or HDD back plane),
- Board ambient thermal sensors,
- Processor temperature,
- Memory (DIMM) temperature,
- CPU voltage regulator down (VRD) hot monitoring, and
- Power supply unit (PSU) inlet temperature (only supported for PMBus*-compliant PSUs).

Additionally, the BMC firmware may create virtual sensors that are based on a combination or aggregation of multiple physical thermal sensors and the application of a mathematical formula to thermal or power sensor readings.

12.3.3 Standard Fan Management

The BMC controls and monitors the system fans. Each fan is associated with a fan speed sensor that detects fan failure and may also be associated with a fan presence sensor for hot-swap support. For redundant fan configurations, the fan failure and presence status determines the fan redundancy sensor state.

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: sleep, boost, and nominal. 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. The factors for the boost state are listed below in order of precedence, high to low. If any of these conditions apply, the fans are set to a fixed boost state speed.

- An 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 is not detected and there is not any fan boost until the 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.

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.

12.3.3.1 Hot-Swappable Fans

Hot-swappable fans, which can be removed and replaced while the system is powered on and operating, are supported. The BMC implements fan presence sensors for each hot-swappable fan.

When a fan is not present, the associated fan speed sensor is put into the reading/unavailable state, and any associated fan domains are put into the boost state. The fans may already be boosted due to a previous fan failure or fan removal.

When a removed fan is inserted, the associated fan speed sensor is re-armed. If there are no other critical conditions causing a fan boost condition, the fan speed returns to the nominal state. Power cycling or resetting the system re-arms the fan speed sensors and clears fan failure conditions. If the failure condition

is still present, the boost state returns once the sensor has re-initialized and the threshold violation is detected again.

12.3.3.2 Fan Redundancy Detection

The BMC supports redundant fan monitoring and implements a fan redundancy sensor. A fan redundancy sensor generates events when its associated set of fans transitions between redundant and non-redundant states, as determined by the number and health of the fans. The definition of fan redundancy is configuration dependent. The BMC allows redundancy to be configured on a per fan redundancy sensor basis through OEM SDR records.

A fan failure or removal of hot-swap fans up to the number of redundant fans specified in the SDR in a fan configuration is a non-critical failure and is reflected in the front panel status. A fan failure or removal that exceeds the number of redundant fans is a non-fatal, insufficient-resources condition and is reflected in the front panel status as a non-fatal error.

Redundancy is checked only when the system is in the DC-on state. Fan redundancy changes that occur when the system is DC-off or when AC is removed will not be logged until the system is turned on.

12.3.3.3 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.

12.3.3.4 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, 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 DIMMs with temperature sensors.

12.3.3.5 Thermal Sensor Input to Fan Speed Control

The BMC uses various IPMI sensors as inputs 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 the input to the 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]
- Onboard Ethernet controller temperature sensors [3, 5]
- Add-in SAS module temperature sensors [3, 5]
- PSU thermal sensor [3, 8]
- CPU VR temperature sensors [3, 6]
- DIMM VR temperature sensors [3, 6]

- BMC temperature sensor [3, 6]
- Global aggregate thermal margin sensors [7]
- Hot swap backplane temperature sensors
- Intel® OCP module temperature sensor (with option installed)
- Intel® SAS module (with option installed)
- Riser card temperature sensors (2U systems only)
- Intel® Xeon Phi™ coprocessor (2U system only with option installed)

Notes:
[1] For fan speed control in Intel chassis
[2] Temperature margin to max junction temp
[3] Absolute temperature
[4] PECI value or margin value
[5] On-die sensor
[6] Onboard sensor
[7] Virtual sensor
[8] Available only when PSU has PMBus
[9] Calculated estimate

Figure 74 shows a high-level illustration of the fan speed control structure that determines fan speed.

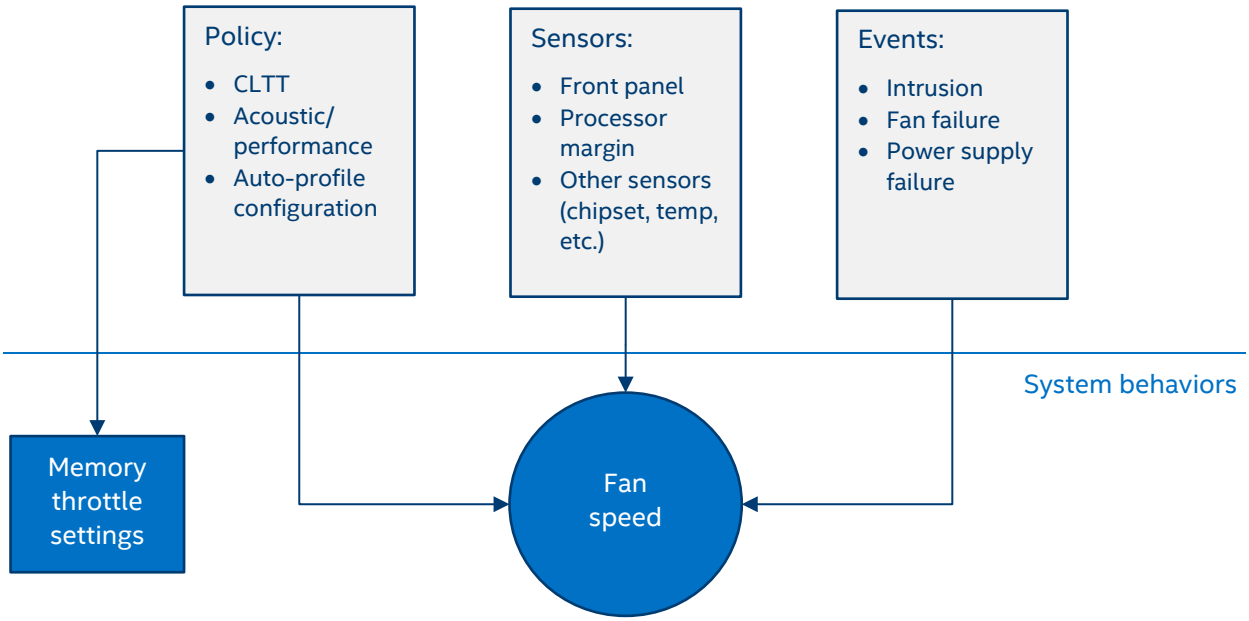


Figure 74. High-level fan speed control process

12.3.3.6 Fan Boosting Due to Fan Failures

Each fan failure is able to define a unique response from all other fan domains. An OEM SDR table defines the response of each fan domain based on a failure of any fan, including both system and power supply fans (for PMBus*-compliant power supplies only). This means that if a system has six fans, there are six different fan fail reactions.

12.3.4 Memory Thermal Management

The system memory is the most complex subsystem to manage thermally, as it requires substantial interactions between the BMC, BIOS, and the embedded memory controller hardware. This section provides an overview of this management capability from a BMC perspective.

12.3.4.1 Memory Thermal Throttling

The system supports thermal management through closed loop throttling (CLTT) only. Throttling levels are changed dynamically to cap throttling based on memory and system thermal conditions as determined by the system and DIMM power and thermal parameters. The BMC fan speed control functionality is related to the memory throttling mechanism used.

The following terminology is used for the various memory throttling options:

- **Static Closed-Loop Thermal Throttling (Static-CLTT)**: CLTT control registers are configured by the BIOS Memory Reference Code (MRC) during POST. The memory throttling is run as a closed-loop system with the DIMM temperature sensors as the control input. Otherwise, the system does not change any of the throttling control registers in the embedded memory controller during runtime.
- **Dynamic Closed-Loop Thermal Throttling (Dynamic-CLTT)**: CLTT control registers are configured by BIOS MRC during POST. The memory throttling is run as a closed-loop system with the DIMM temperature sensors as the control input. Adjustments are made to the throttling during runtime based on changes in system cooling (fan speed).

Intel® Server Systems supporting the Intel® Xeon® processor Scalable family support a type of CLTT, called a hybrid CLTT, for which the integrated memory controller estimates the DRAM temperature in between actual reads of the TSODs. Hybrid CLTT is used on all Intel Server Systems supporting the Intel Xeon processor Scalable family that have DIMMs with thermal sensors. Therefore, the terms Dynamic-CLTT and Static-CLTT are really referring to this “hybrid” mode. Note that if the IMC’s polling of the TSODs is interrupted, the temperature readings that the BMC gets from the IMC are these estimated values.

12.3.4.2 Dynamic (Hybrid) CLTT

The system supports dynamic (memory) CLTT for which the BMC firmware dynamically modifies thermal offset registers in the IMC during runtime based on changes in system cooling (fan speed). For static CLTT, a fixed offset value is applied to the TSOD reading to get the die temperature; however this is does not provide results as accurate when the offset takes into account the current airflow over the DIMM, as is done with dynamic CLTT.

To support this feature, the BMC firmware derives the air velocity for each fan domain based on the PWM value being driven for the domain. Since this relationship is dependent on the chassis configuration, a method must be used which supports this dependency (for example, through OEM SDR) that establishes a lookup table providing this relationship.

BIOS has an embedded lookup table that provides thermal offset values for each DIMM type and air velocity range (three ranges of air velocity are supported). During system boot, BIOS provides three offset values (corresponding to the three air velocity ranges) to the BMC for each enabled DIMM. Using this data the BMC firmware constructs a table that maps the offset value corresponding to a given air velocity range for each DIMM. During runtime the BMC applies an averaging algorithm to determine the target offset value corresponding to the current air velocity and then the BMC writes this new offset value into the IMC thermal offset register for the DIMM.

12.3.5 Power Management Bus (PMBus*)

The Power Management Bus (PMBus*) is an open standard protocol that is built upon the SMBus* 2.0 transport. It defines a means of communicating with power conversion and other devices using SMBus-based commands. A system must have PMBus-compliant power supplies installed in order for the BMC or Intel ME to monitor them for status and/or power metering purposes.

For more information on PMBus, see the System Management Interface Forum website, http://www.powersig.org/.

12.3.6 Component Fault LED Control

Several sets of component fault LEDs are supported on the server board (see Figure 70 and Figure 71). Some LEDs are owned by the BMC and some by the BIOS. A description of these LEDs is below and in Table 51.

- **DIMM fault LEDs** – The BMC owns the hardware control for these LEDs. The LEDs reflect the state of BIOS-owned event-only sensors. When the BIOS detects a DIMM fault condition, it sends an IPMI OEM command (Set Fault Indication) to the BMC to instruct the BMC to turn on the associated DIMM Fault LED. These LEDs are only active when the system is in the 'on' state. The BMC does not activate or change the state of the LEDs unless instructed by the BIOS.
- **HDD status LEDs** – The HSBP PSoC* of supported Intel and non-Intel chassis owns the hardware control for these LEDs and detection of the fault/status conditions that the LEDs reflect.
- **CPU fault LEDs** – The BMC owns control for these LEDs. An LED is lit if there is an MSID mismatch where the CPU power rating is incompatible with the board.

Table 51. Component fault LEDs

Component	Owner	State	Description
DIMM Fault LED	BMC	Solid amber	Memory failure – detected by BIOS
		Off	DIMM working correctly
HDD Fault LED	HSBP PSoC*	Solid amber	HDD Fault
		Blinking amber	Predictive failure, rebuild, identify
		Off	Ok (no errors)
CPU Fault LEDs	BMC	Off	Ok (no errors)
		Solid amber	MSID mismatch.

Appendix A. Integration and Usage Tips

- When adding or removing components or peripherals from the server board, power cords must be disconnected from the server. With power applied to the server, standby voltages are still present even though the server board is powered off.
- This server board supports the Intel® Xeon® processor Scalable family with a Thermal Design Power (TDP) of up to and including 205 Watts. Previous generations of the Intel® Xeon® processors are not supported. Server systems using this server board may or may not meet the TDP design limits of the server board. Validate the TDP limits of the server system before selecting a processor.
- Processors must be installed in order. CPU 1 must be populated for the server board to operate.
- The 2U 3-slot riser card and Riser Card Slots #2 and #3 on the server board can only be used in dual processor configurations.
- The riser card slots are 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.
- For the best performance, the number of DDR4 DIMMs installed should be balanced across both processor sockets and memory channels.
- On the back edge of the server board are eight diagnostic LEDs that display a sequence of amber POST codes during the boot process. If the server board hangs during POST, the LEDs display the last POST event run before the hang.
- The system status LED is set to a steady amber color for all fatal errors that are detected during processor initialization. A steady amber system status LED indicates that an unrecoverable system failure condition has occurred.
- RAID partitions created using either Intel® RSTe or Intel® ESRT2 cannot span across the two embedded SATA controllers. Only drives attached to a common SATA controller can be included in a RAID partition.

Appendix B. POST Code Diagnostic LED Decoder

As an aid in troubleshooting a system hang that occurs during a system POST process, the server board includes a bank of eight 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 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 nibbles, an upper nibble and a lower nibble. The upper nibble bits are represented by amber diagnostic LEDs and the lower nibble bits are represented by green diagnostics. 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. For each set of nibble bits, LED 0 represents the least significant bit (LSB) and LED 3 represents the most significant bit (MSB).

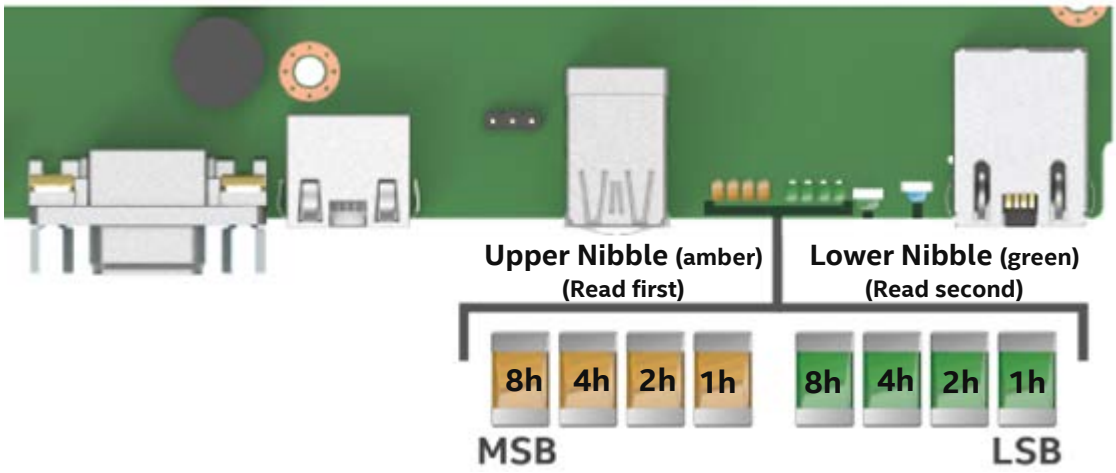


Figure 75. Onboard POST diagnostic LED location and definition

Note: Diagnostic LEDs are best read and decoded when viewing the LEDs from the back of the system.

In the following example, the BIOS sends a value of AC to the diagnostic LED decoder. The LEDs are decoded as shown in Table 52, where the upper nibble bits represented by the amber LEDs equal 1010_b or A_h and the lower nibble bits represented by the green LEDs equal 1100_b or C_h. The two are concatenated as AC_h.

Table 52. POST progress code LED example

Upper Nibble						Lower Nibble					
LED 3 (MSB)	LED 2	LED 1	LED 0 (LSB)	Binary Code	Hex Code	LED 3 (MSB)	LED 2	LED 1	LED 0 (LSB)	Binary Code	Hex Code
ON	off	ON	off	1010	A	ON	ON	off	off	1100	C

B.1. Early POST Memory Initialization MRC Diagnostic Codes

Memory initialization at the beginning of POST includes multiple functions: 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.

The MRC progress codes are displayed to the diagnostic LEDs that show the execution point in the MRC operational path at each step.

Table 53. MRC progress codes

Post Code (Hex)	Upper Nibble				Lower Nibble				Description
	8h	4h	2h	1h	8h	4h	2h	1h	
B0	1	0	1	1	0	0	0	0	Detect DIMM population
B1	1	0	1	1	0	0	0	1	Set DDR4 frequency
B2	1	0	1	1	0	0	1	0	Gather remaining SPD data
B3	1	0	1	1	0	0	1	1	Program registers on the memory controller level
B4	1	0	1	1	0	1	0	0	Evaluate RAS modes and save rank information
B5	1	0	1	1	0	1	0	1	Program registers on the channel level
B6	1	0	1	1	0	1	1	0	Perform the JEDEC defined initialization sequence
B7	1	0	1	1	0	1	1	1	Train DDR4 ranks
1	0	0	0	0	0	0	0	1	Train DDR4 ranks
2	0	0	0	0	0	0	1	0	Train DDR4 ranks – Read DQ/DQS training
3	0	0	0	0	0	0	1	1	Train DDR4 ranks – Receive enable training
4	0	0	0	0	0	1	0	0	Train DDR4 ranks – Write leveling training
5	0	0	0	0	0	1	0	1	Train DDR4 ranks – DDR channel training done
B8	1	0	1	1	1	0	0	0	Initialize CLTT/OLTT
B9	1	0	1	1	1	0	0	1	Hardware memory test and init
BA	1	0	1	1	1	0	1	0	Execute software memory init
BB	1	0	1	1	1	0	1	1	Program memory map and interleaving
BC	1	0	1	1	1	1	0	0	Program RAS configuration
BF	1	0	1	1	1	1	1	1	MRC is done

Should a major memory initialization error occur, preventing the system from booting with data integrity, a beep code is generated, the MRC displays 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. Table 54 lists all MRC fatal errors that are displayed to the diagnostic LEDs.

Note: Fatal MRC errors display POST error codes that may be the same as BIOS POST progress codes displayed later in the POST process. The fatal MRC codes can be distinguished from the BIOS POST progress codes by the accompanying memory failure beep code of three long beeps as identified in Table 57.

Table 54. MRC fatal error codes

Post Code (Hex)	Upper Nibble				Lower Nibble				Description
	8h	4h	2h	1h	8h	4h	2h	1h	
E8	1	1	1	0	1	0	0	0	No usable memory error 01h = No memory was detected from SPD read, or invalid config that causes no operable memory. 02h = Memory DIMMs on all channels of all sockets are disabled due to hardware memtest error. 03h = No memory installed. All channels are disabled.
E9	1	1	1	0	1	0	0	1	Memory is locked by Intel® TXT and is inaccessible
EA	1	1	1	0	1	0	1	0	DDR4 channel training error 01h = Error on read DQ/DQS (Data/Data Strobe) init 02h = Error on Receive Enable 03h = Error on Write Leveling 04h = Error on write DQ/DQS (Data/Data Strobe
EB	1	1	1	0	1	0	1	1	Memory test failure 01h = Software memtest failure. 02h = Hardware memtest failed.
ED	1	1	1	0	1	1	0	1	DIMM configuration population error 01h = Different DIMM types (RDIMM, LRDIMM) are detected installed in the system. 02h = Violation of DIMM population rules. 03h = The 3rd DIMM slot cannot be populated when QR DIMMs are installed. 04h = UDIMMs are not supported. 05h = Unsupported DIMM Voltage.
EF	1	1	1	0	1	1	1	1	Indicates a CLTT table structure error

B.2. BIOS POST Progress Codes

Table 55 provides a list of all POST progress codes.

Table 55. POST progress codes

Post Code (Hex)	Upper Nibble				Lower Nibble				Description
	8h	4h	2h	1h	8h	4h	2h	1h	
SEC Phase									
01	0	0	0	0	0	0	0	1	First POST code after CPU reset
02	0	0	0	0	0	0	1	0	Microcode load begin
03	0	0	0	0	0	0	1	1	CRAM initialization begin
04	0	0	0	0	0	1	0	0	PEI Cache When Disabled
05	0	0	0	0	0	1	0	1	SEC Core At Power On Begin.
06	0	0	0	0	0	1	1	0	Early CPU initialization during SEC Phase.
KTI RC (Fully leverage without platform change)									
A1	1	0	1	0	0	0	0	1	Collect info such as SBSP, boot mode, reset type, etc.
A3	1	0	1	0	0	0	1	1	Setup minimum path between SBSP and other sockets
A6	1	0	1	0	0	1	1	0	Sync up with PBSPs
A7	1	0	1	0	0	1	1	1	Topology discovery and route calculation
A8	1	0	1	0	1	0	0	0	Program final route
A9	1	0	1	0	1	0	0	1	Program final IO SAD setting
AA	1	0	1	0	1	0	1	0	Protocol layer and other uncore settings
AB	1	0	1	0	1	0	1	1	Transition links to full speed operation
AE	1	0	1	0	1	1	1	0	Coherency settings
AF	1	0	1	0	1	1	1	1	KTI initialization done
PEI Phase									
10	0	0	0	1	0	0	0	0	PEI Core
11	0	0	0	1	0	0	0	1	CPU PEIM
15	0	0	0	1	0	1	0	1	Platform Type Init
19	0	0	0	1	1	0	0	1	Platform PEIM Init
31	0	0	1	1	0	0	0	1	Memory Installed
32	0	0	1	1	0	0	1	0	CPU PEIM (CPU Init)
33	0	0	1	1	0	0	1	1	CPU PEIM (Cache Init)
34	0	0	1	1	0	1	0	0	CPU BSP Select
35	0	0	1	1	0	1	0	1	CPU AP Init
36	0	0	1	1	0	1	1	0	CPU SMM Init
4F	0	1	0	0	1	1	1	1	DXE IPL started
DXE Phase									
60	0	1	1	0	0	0	0	0	DXE Core started
62	0	1	1	0	0	0	1	0	DXE Setup Init
68	0	1	1	0	1	0	0	0	DXE PCI Host Bridge Init
69	0	1	1	0	1	0	0	1	DXE NB Init
6A	0	1	1	0	1	0	1	0	DXE NB SMM Init
70	0	1	1	1	0	0	0	0	DXE SB Init
71	0	1	1	1	0	0	0	1	DXE SB SMM Init
72	0	1	1	1	0	0	1	0	DXE SB devices Init
78	0	1	1	1	1	0	0	0	DXE ACPI Init
79	0	1	1	1	1	0	0	1	DXE CSM Init

Post Code (Hex)	Upper Nibble				Lower Nibble				Description
	8h	4h	2h	1h	8h	4h	2h	1h	
7D	0	1	1	1	1	1	0	1	DXE Removable Media Detect
7E	0	1	1	1	1	1	1	0	DXE Removable Media Detected
90	1	0	0	1	0	0	0	0	DXE BDS started
91	1	0	0	1	0	0	0	1	DXE BDS connect drivers
92	1	0	0	1	0	0	1	0	DXE PCI bus begin
93	1	0	0	1	0	0	1	1	DXE PCI Bus HPC Init
94	1	0	0	1	0	1	0	0	DXE PCI Bus enumeration
95	1	0	0	1	0	1	0	1	DXE PCI Bus resource requested
96	1	0	0	1	0	1	1	0	DXE PCI Bus assign resource
97	1	0	0	1	0	1	1	1	DXE CON_OUT connect
98	1	0	0	1	1	0	0	0	DXE CON_IN connect
99	1	0	0	1	1	0	0	1	DXE SIO Init
9A	1	0	0	1	1	0	1	0	DXE USB start
9B	1	0	0	1	1	0	1	1	DXE USB reset
9C	1	0	0	1	1	1	0	0	DXE USB detect
9D	1	0	0	1	1	1	0	1	DXE USB enable
A1	1	0	1	0	0	0	0	1	DXE IDE begin
A2	1	0	1	0	0	0	1	0	DXE IDE reset
A3	1	0	1	0	0	0	1	1	DXE IDE detect
A4	1	0	1	0	0	1	0	0	DXE IDE enable
A5	1	0	1	0	0	1	0	1	DXE SCSI begin
A6	1	0	1	0	0	1	1	0	DXE SCSI reset
A7	1	0	1	0	0	1	1	1	DXE SCSI detect
A8	1	0	1	0	1	0	0	0	DXE SCSI enable
AB	1	0	1	0	1	0	1	1	DXE SETUP start
AC	1	0	1	0	1	1	0	0	DXE SETUP input wait
AD	1	0	1	0	1	1	0	1	DXE Ready to Boot
AE	1	0	1	0	1	1	1	0	DXE Legacy Boot
AF	1	0	1	0	1	1	1	1	DXE Exit Boot Services
B0	1	0	1	1	0	0	0	0	RT Set Virtual Address Map Begin
B1	1	0	1	1	0	0	0	1	RT Set Virtual Address Map End
B2	1	0	1	1	0	0	1	0	DXE Legacy Option ROM init
B3	1	0	1	1	0	0	1	1	DXE Reset system
B4	1	0	1	1	0	1	0	0	DXE USB Hot plug
B5	1	0	1	1	0	1	0	1	DXE PCI BUS Hot plug
B8	1	0	1	1	1	0	0	0	PWRBTN Shutdown
B9	1	0	1	1	1	0	0	1	SLEEP Shutdown
C0	1	1	0	0	0	0	0	0	End of DXE
C7	1	1	0	0	0	1	1	1	DXE ACPI Enable
0	0	0	0	0	0	0	0	0	Clear POST Code

Post Code (Hex)	Upper Nibble				Lower Nibble				Description
	8h	4h	2h	1h	8h	4h	2h	1h	
S3 Resume									
E0	1	1	1	0	0	0	0	0	S3 Resume PEIM (S3 started)
E1	1	1	1	0	0	0	0	1	S3 Resume PEIM (S3 boot script)
E2	1	1	1	0	0	0	1	0	S3 Resume PEIM (S3 Video Repost)
E3	1	1	1	0	0	0	1	1	S3 Resume PEIM (S3 OS wake)
BIOS Recovery									
F0	1	1	1	1	0	0	0	0	PEIM which detected forced Recovery condition
F1	1	1	1	1	0	0	0	1	PEIM which detected User Recovery condition
F2	1	1	1	1	0	0	1	0	Recovery PEIM (Recovery started)
F3	1	1	1	1	0	0	1	1	Recovery PEIM (Capsule found)
F4	1	1	1	1	0	1	0	0	Recovery PEIM (Capsule loaded)

Appendix C. POST Code Errors

Most error conditions encountered during POST are reported using POST error codes. These codes represent specific failures, warnings, or information. 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.

Table 56 lists the supported POST error codes. Each error code is assigned an error type which determines the action the BIOS takes when the error is encountered. Error types include minor, major, and fatal. The BIOS action for each is defined as follows:

- **Minor**: An error message may be displayed to the screen or to the BIOS setup error manager and the POST error code 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**: An error message is displayed to the error manager screen and an error is logged to the SEL. If the BIOS setup option "Post Error Pause" is enabled, operator intervention is required to continue booting the system. If the BIOS setup option "POST Error Pause" is disabled, the system continues to boot.

Note: For 0048 "Password check failed", the system halts and then, after the next reset/reboot, displays the error code on the error manager screen.

- **Fatal**: If the system cannot boot, POST halts and display the following message:

  ```
  Unrecoverable fatal error found. System will not boot until the error is
     resolved
  Press <F2> to enter setup
  ```

  When the **<F2>** key on the keyboard is pressed, the error message is displayed on the error manager screen and an error is logged to the system event log (SEL) with the POST error code. The system cannot boot unless the errror is resolved. The faulty component must be replaced. The "POST Error Pause" option setting in the BIOS setup does not have any effect on this error.

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 determine which of the listed error codes are supported.

Table 56. POST error messages and handling

Error Code	Error Message	Action message	Response
0012	System RTC date/time not set		Major
0048	Password check failed	Please put right password.	Major
0140	PCI component encountered a PERR error		Major
0141	PCI resource conflict		Major
0146	PCI out of resources error	Please enable Memory Mapped I/O above 4 GB item at SETUP to use 64bit MMIO.	Major
0191	Processor core/thread count mismatch detected	Please use identical CPU type.	Fatal
0192	Processor cache size mismatch detected	Please use identical CPU type.	Fatal
0194	Processor family mismatch detected	Please use identical CPU type.	Fatal
0195	Processor Intel(R) UPI link frequencies unable to synchronize		Fatal
0196	Processor model mismatch detected	Please use identical CPU type.	Fatal
0197	Processor frequencies unable to synchronize	Please use identical CPU type.	Fatal
5220	BIOS Settings reset to default settings		Major
5221	Passwords cleared by jumper		Major
5224	Password clear jumper is Set	Recommend to remind user to install BIOS password as BIOS admin password is the master keys for several BIOS security features.	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	Baseboard Management Controller Sensor Data Record empty.	Please update right SDR.	Major
84FF	System Event Log full	Please clear SEL through EWS or SELVIEW utility.	Minor

Error Code	Error Message	Action message	Response
85FC	Memory component could not be configured in the selected RAS mode		Major
8501	Memory Population Error	Please plug DIMM at right population.	Major
8520	Memory failed test/initialization CPU1_DIMM_A1	please remove the disabled DIMM.	Major
8521	Memory failed test/initialization CPU1_DIMM_A2	please remove the disabled DIMM.	Major
8522	Memory failed test/initialization CPU1_DIMM_A3	please remove the disabled DIMM.	Major
8523	Memory failed test/initialization CPU1_DIMM_B1	please remove the disabled DIMM.	Major
8524	Memory failed test/initialization CPU1_DIMM_B2	please remove the disabled DIMM.	Major
8525	Memory failed test/initialization CPU1_DIMM_B3	please remove the disabled DIMM.	Major
8526	Memory failed test/initialization CPU1_DIMM_C1	please remove the disabled DIMM.	Major
8527	Memory failed test/initialization CPU1_DIMM_C2	please remove the disabled DIMM.	Major
8528	Memory failed test/initialization CPU1_DIMM_C3	please remove the disabled DIMM.	Major
8529	Memory failed test/initialization CPU1_DIMM_D1	please remove the disabled DIMM.	Major
852A	Memory failed test/initialization CPU1_DIMM_D2	please remove the disabled DIMM.	Major
852B	Memory failed test/initialization CPU1_DIMM_D3	please remove the disabled DIMM.	Major
852C	Memory failed test/initialization CPU1_DIMM_E1	please remove the disabled DIMM.	Major
852D	Memory failed test/initialization CPU1_DIMM_E2	please remove the disabled DIMM.	Major
852E	Memory failed test/initialization CPU1_DIMM_E3	please remove the disabled DIMM.	Major
852F	Memory failed test/initialization CPU1_DIMM_F1	please remove the disabled DIMM.	Major
8530	Memory failed test/initialization CPU1_DIMM_F2	please remove the disabled DIMM.	Major
8531	Memory failed test/initialization CPU1_DIMM_F3	please remove the disabled DIMM.	Major
8532	Memory failed test/initialization CPU1_DIMM_G1	please remove the disabled DIMM.	Major
8533	Memory failed test/initialization CPU1_DIMM_G2	please remove the disabled DIMM.	Major
8534	Memory failed test/initialization CPU1_DIMM_G3	please remove the disabled DIMM.	Major
8535	Memory failed test/initialization CPU1_DIMM_H1	please remove the disabled DIMM.	Major
8536	Memory failed test/initialization CPU1_DIMM_H2	please remove the disabled DIMM.	Major
8537	Memory failed test/initialization CPU1_DIMM_H3	please remove the disabled DIMM.	Major
8538	Memory failed test/initialization CPU2_DIMM_A1	please remove the disabled DIMM.	Major
8539	Memory failed test/initialization CPU2_DIMM_A2	please remove the disabled DIMM.	Major
853A	Memory failed test/initialization CPU2_DIMM_A3	please remove the disabled DIMM.	Major
853B	Memory failed test/initialization CPU2_DIMM_B1	please remove the disabled DIMM.	Major
853C	Memory failed test/initialization CPU2_DIMM_B2	please remove the disabled DIMM.	Major
853D	Memory failed test/initialization CPU2_DIMM_B3	please remove the disabled DIMM.	Major
853E	Memory failed test/initialization CPU2_DIMM_C1	please remove the disabled DIMM.	Major
853F (Go to 85C0)	Memory failed test/initialization CPU2_DIMM_C2	please remove the disabled DIMM.	Major
8540	Memory disabled.CPU1_DIMM_A1	please remove the disabled DIMM.	Major
8541	Memory disabled.CPU1_DIMM_A2	please remove the disabled DIMM.	Major
8542	Memory disabled.CPU1_DIMM_A3	please remove the disabled DIMM.	Major
8543	Memory disabled.CPU1_DIMM_B1	please remove the disabled DIMM.	Major

Error Code	Error Message	Action message	Response
8544	Memory disabled.CPU1_DIMM_B2	please remove the disabled DIMM.	Major
8545	Memory disabled.CPU1_DIMM_B3	please remove the disabled DIMM.	Major
8546	Memory disabled.CPU1_DIMM_C1	please remove the disabled DIMM.	Major
8547	Memory disabled.CPU1_DIMM_C2	please remove the disabled DIMM.	Major
8548	Memory disabled.CPU1_DIMM_C3	please remove the disabled DIMM.	Major
8549	Memory disabled.CPU1_DIMM_D1	please remove the disabled DIMM.	Major
854A	Memory disabled.CPU1_DIMM_D2	please remove the disabled DIMM.	Major
854B	Memory disabled.CPU1_DIMM_D3	please remove the disabled DIMM.	Major
854C	Memory disabled.CPU1_DIMM_E1	please remove the disabled DIMM.	Major
854D	Memory disabled.CPU1_DIMM_E2	please remove the disabled DIMM.	Major
854E	Memory disabled.CPU1_DIMM_E3	please remove the disabled DIMM.	Major
854F	Memory disabled.CPU1_DIMM_F1	please remove the disabled DIMM.	Major
8550	Memory disabled.CPU1_DIMM_F2	please remove the disabled DIMM.	Major
8551	Memory disabled.CPU1_DIMM_F3	please remove the disabled DIMM.	Major
8552	Memory disabled.CPU1_DIMM_G1	please remove the disabled DIMM.	Major
8553	Memory disabled.CPU1_DIMM_G2	please remove the disabled DIMM.	Major
8554	Memory disabled.CPU1_DIMM_G3	please remove the disabled DIMM.	Major
8555	Memory disabled.CPU1_DIMM_H1	please remove the disabled DIMM.	Major
8556	Memory disabled.CPU1_DIMM_H2	please remove the disabled DIMM.	Major
8557	Memory disabled.CPU1_DIMM_H3	please remove the disabled DIMM.	Major
8558	Memory disabled.CPU2_DIMM_A1	please remove the disabled DIMM.	Major
8559	Memory disabled.CPU2_DIMM_A2	please remove the disabled DIMM.	Major
855A	Memory disabled.CPU2_DIMM_A3	please remove the disabled DIMM.	Major
855B	Memory disabled.CPU2_DIMM_B1	please remove the disabled DIMM.	Major
855C	Memory disabled.CPU2_DIMM_B2	please remove the disabled DIMM.	Major
855D	Memory disabled.CPU2_DIMM_B3	please remove the disabled DIMM.	Major
855E	Memory disabled.CPU2_DIMM_C1	please remove the disabled DIMM.	Major
855F (Go to 85D0)	Memory disabled.CPU2_DIMM_C2	please remove the disabled DIMM.	Major
8560	Memory encountered a Serial Presence Detection(SPD) failure.CPU1_DIMM_A1		Major
8561	Memory encountered a Serial Presence Detection(SPD) failure.CPU1_DIMM_A2		Major
8562	Memory encountered a Serial Presence Detection(SPD) failure.CPU1_DIMM_A3		Major
8563	Memory encountered a Serial Presence Detection(SPD) failure.CPU1_DIMM_B1		Major
8564	Memory encountered a Serial Presence Detection(SPD) failure.CPU1_DIMM_B2		Major
8565	Memory encountered a Serial Presence Detection(SPD) failure.CPU1_DIMM_B3		Major

Error Code	Error Message	Action message	Response
8566	Memory encountered a Serial Presence Detection(SPD) failure.CPU1_DIMM_C1		Major
8567	Memory encountered a Serial Presence Detection (SPD) failure.CPU1_DIMM_C2		Major
8568	Memory encountered a Serial Presence Detection (SPD) failure.CPU1_DIMM_C3		Major
8569	Memory encountered a Serial Presence Detection(SPD) failure.CPU1_DIMM_D1		Major
856A	Memory encountered a Serial Presence Detection(SPD) failure.CPU1_DIMM_D2		Major
856B	Memoryencountered a Serial Presence Detection(SPD) failure.CPU1_DIMM_D3		Major
856C	Memory encountered a Serial Presence Detection(SPD) failure.CPU1_DIMM_E1		Major
856D	Memory encountered a Serial Presence Detection(SPD) failure.CPU1_DIMM_E2		Major
856E	Memory encountered a Serial Presence Detection(SPD) failure.CPU1_DIMM_E3		Major
856F	Memory encountered a Serial Presence Detection(SPD) failure.CPU1_DIMM_F1		Major
8570	Memory encountered a Serial Presence Detection(SPD) failure.CPU1_DIMM_F2		Major
8571	Memory encountered a Serial Presence Detection(SPD) failure.CPU1_DIMM_F3		Major
8572	Memory encountered a Serial Presence Detection(SPD) failure.CPU1_DIMM_G1		Major
8573	Memory encountered a Serial Presence Detection(SPD) failure.CPU1_DIMM_G2		Major
8574	Memory encountered a Serial Presence Detection(SPD) failure.CPU1_DIMM_G3		Major
8575	Memory encountered a Serial Presence Detection(SPD) failure.CPU1_DIMM_H1		Major
8576	Memory encountered a Serial Presence Detection(SPD) failure.CPU1_DIMM_H2		Major
8577	Memory encountered a Serial Presence Detection(SPD) failure.CPU1_DIMM_H3		Major
8578	Memory encountered a Serial Presence Detection(SPD) failure.CPU2_DIMM_A1		Major
8579	Memory encountered a Serial Presence Detection(SPD) failure.CPU2_DIMM_A2		Major
857A	Memory encountered a Serial Presence Detection(SPD) failure.CPU2_DIMM_A3		Major
857B	Memory encountered a Serial Presence Detection(SPD) failure.CPU2_DIMM_B1		Major
857C	Memory encountered a Serial Presence Detection(SPD) failure.CPU2_DIMM_B2		Major
857D	Memory encountered a Serial Presence Detection(SPD) failure.CPU2_DIMM_B3		Major
857E	Memory encountered a Serial Presence Detection(SPD) failure.CPU2_DIMM_C1		Major
857F (Go to 85E0)	Memory encountered a Serial Presence Detection(SPD) failure.CPU2_DIMM_C2		Major

Error Code	Error Message	Action message	Response
85C0	Memory failed test/initialization CPU2_DIMM_C3	please remove the disabled DIMM.	Major
85C1	Memory failed test/initialization CPU2_DIMM_D1	please remove the disabled DIMM.	Major
85C2	Memory failed test/initialization CPU2_DIMM_D2	please remove the disabled DIMM.	Major
85C3	Memory failed test/initialization CPU2_DIMM_D3	please remove the disabled DIMM.	Major
85C4	Memory failed test/initialization CPU2_DIMM_E1	please remove the disabled DIMM.	Major
85C5	Memory failed test/initialization CPU2_DIMM_E2	please remove the disabled DIMM.	Major
85C6	Memory failed test/initialization CPU2_DIMM_E3	please remove the disabled DIMM.	Major
85C7	Memory failed test/initialization CPU2_DIMM_F1	please remove the disabled DIMM.	Major
85C8	Memory failed test/initialization CPU2_DIMM_F2	please remove the disabled DIMM.	Major
85C9	Memory failed test/initialization CPU2_DIMM_F3	please remove the disabled DIMM.	Major
85CA	Memory failed test/initialization CPU2_DIMM_G1	please remove the disabled DIMM.	Major
85CB	Memory failed test/initialization CPU2_DIMM_G2	please remove the disabled DIMM.	Major
85CC	Memory failed test/initialization CPU2_DIMM_G3	please remove the disabled DIMM.	Major
85CD	Memory failed test/initialization CPU2_DIMM_H1	please remove the disabled DIMM.	Major
85CE	Memory failed test/initialization CPU2_DIMM_H2	please remove the disabled DIMM.	Major
85CF	Memory failed test/initialization CPU2_DIMM_H3	please remove the disabled DIMM.	Major
85D0	Memory disabled.CPU2_DIMM_C3	please remove the disabled DIMM.	Major
85D1	Memory disabled.CPU2_DIMM_D1	please remove the disabled DIMM.	Major
85D2	Memory disabled.CPU2_DIMM_D2	please remove the disabled DIMM.	Major
85D3	Memory disabled.CPU2_DIMM_D3	please remove the disabled DIMM.	Major
85D4	Memory disabled.CPU2_DIMM_E1	please remove the disabled DIMM.	Major
85D5	Memory disabled.CPU2_DIMM_E2	please remove the disabled DIMM.	Major
85D6	Memory disabled.CPU2_DIMM_E3	please remove the disabled DIMM.	Major
85D7	Memory disabled.CPU2_DIMM_F1	please remove the disabled DIMM.	Major
85D8	Memory disabled.CPU2_DIMM_F2	please remove the disabled DIMM.	Major
85D9	Memory disabled.CPU2_DIMM_F3	please remove the disabled DIMM.	Major
85DA	Memory disabled.CPU2_DIMM_G1	please remove the disabled DIMM.	Major
85DB	Memory disabled.CPU2_DIMM_G2	please remove the disabled DIMM.	Major
85DC	Memory disabled.CPU2_DIMM_G3	please remove the disabled DIMM.	Major
85DD	Memory disabled.CPU2_DIMM_H1	please remove the disabled DIMM.	Major
85DE	Memory disabled.CPU2_DIMM_H2	please remove the disabled DIMM.	Major
85DF	Memory disabled.CPU2_DIMM_H3	please remove the disabled DIMM.	Major
85E0	Memory encountered a Serial Presence Detection(SPD) failure.CPU2_DIMM_C3		Major
85E1	Memory encountered a Serial Presence Detection (SPD) failure. CPU2_DIMM_D1		Major
85E2	Memory encountered a Serial Presence Detection (SPD) failure.CPU2_DIMM_D2		Major
85E3	Memory encountered a Serial Presence Detection(SPD) failure.CPU2_DIMM_D3		Major

Error Code	Error Message	Action message	Response
85E4	Memory encountered a Serial Presence Detection(SPD) failure.CPU2_DIMM_E1		Major
85E5	Memory encountered a Serial Presence Detection(SPD) failure.CPU2_DIMM_E2		Major
85E6	Memory encountered a Serial Presence Detection(SPD) failure.CPU2_DIMM_E3		Major
85E7	Memory encountered a Serial Presence Detection (SPD) failure.CPU2_DIMM_F1		Major
85E8	Memory encountered a Serial Presence Detection(SPD) failure.CPU2_DIMM_F2		Major
85E9	Memory encountered a Serial Presence Detection(SPD) failure.CPU2_DIMM_F3		Major
85EA	Memory encountered a Serial Presence Detection(SPD) failure.CPU2_DIMM_G1		Major
85EB	Memory encountered a Serial Presence Detection(SPD) failure. CPU2_DIMM_G2		Major
85EC	Memory encountered a Serial Presence Detection(SPD) failure.CPU2_DIMM_G3		Major
85ED	Memory encountered a Serial Presence Detection(SPD) failure.CPU2_DIMM_H1		Major
85EE	Memory encountered a Serial Presence Detection(SPD) failure.CPU2_DIMM_H2		Major
85EF	Memory encountered a Serial Presence Detection(SPD) failure.CPU2_DIMM_H3		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
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.	Please disable OpRom at SETUP to save runtime memory.	Minor

C.1. POST Error Beep Codes

Table 57 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 57. POST error beep codes

Beeps	Error Message	POST Progress Code	Description
1 short	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	AE, AF	System halted because Intel® Trusted Execution Technology detected a potential violation of system security.
3 short	Memory error	Multiple	System halted because a fatal error related to the memory was detected.
3 long and 1 short	CPU mismatch error	E5, E6	System halted because a fatal error related to the CPU family/core/cache mismatch was detected.
2 short	BIOS recovery started	N/A	BIOS recovery boot has been initiated.
4 short	BIOS recovery failed	N/A	BIOS recovery has failed. This typically happens so quickly after recovery is 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 Table 58. Each digit in the code is represented by a sequence of beeps whose count is equal to the digit.

Table 58. Integrated BMC beep codes

Code	Reason for Beep	Associated Sensors
1-5-1-2	VR Watchdog Timer sensor assertion	VR Watchdog Timer
1-5-1-4	The system does not power on or unexpectedly power off and a power supply unit (PSU) is present that is an incompatible model with one or more other PSUs in the system	PS Status
1-5-2-1	No CPUs installed or first CPU socket is empty	CPU Missing Sensor
1-5-2-2	CPU CAT Error (IERR) assertion	CPU ERR2 Timeout Sensor
1-5-2-3	CPU ERR2 timeout assertion	CPU ERR2 Timeout Sensor
1-5-2-4	CPU Icc max Mismatch	CPU Icc max Mismatch Sensor
1-5-2-5	CPU population error	CPU 0 Status Sensor
1-5-4-2	Power fault: DC power is unexpectedly lost (power good dropout).	Power unit – power unit failure offset
1-5-4-4	Power control fault (power good assertion timeout).	Power unit – soft power control failure offset

Appendix D. Statement of Volatile Memory Components

This section is used to identify the volatile and non-volatile memory components of the Intel® Server Board S2600WF product family.

Table 59 provides the following data for each identified component.

- **Component Type**: Three types of components are on the server board assembly:
  - **Non-volatile**: Non-volatile memory is persistent, and is not cleared when power is removed from the system. Non-volatile memory must be erased to clear data. The exact method of clearing these areas varies by the specific component. Some areas are required for normal operation of the server, and clearing these areas may render the server board inoperable
  - **Volatile**: Volatile memory is cleared automatically when power is removed from the system.
  - **Battery powered RAM**: Battery powered RAM is similar to volatile memory, but is powered by a battery on the server board. Data in battery powered RAM is persistent until the battery is removed from the server board.
- **Size**: Size of each component in bits, Kbits, Mbits, bytes, kilobytes (KB), or megabytes (MB).
- **Board Location**: Board location is the physical location of each component corresponding to information on the server board silkscreen.
- **User Data**: The flash components on the server boards do not store user data from the operating system. No operating system level data is retained in any listed components after AC power is removed. The persistence of information written to each component is determined by its type as described in the table.

  Each component stores data specific to its function. Some components may contain passwords that provide access to that device's configuration or functionality. These passwords are specific to the device and are unique and unrelated to operating system passwords. The specific components that may contain password data are:
  - **BIOS**: The server board BIOS provides the capability to prevent unauthorized users from configuring BIOS settings when a BIOS password is set. This password is stored in BIOS flash, and is only used to set BIOS configuration access restrictions.
  - **BMC**: The server boards support an Intelligent Platform Management Interface (IPMI) 2.0 conformant baseboard management controller (BMC). The BMC provides health monitoring, alerting and remote power control capabilities for the Intel® Server Board. The BMC does not have access to operating system level data.

    The BMC supports the capability for remote software to connect over the network and perform health monitoring and power control. This access can be configured to require authentication by a password. If configured, the BMC maintains user passwords to control this access. These passwords are stored in the BMC flash.

Table 59. Volatile and non-volatile components

Component Type	Size	Board Location	User Data	Name
Non-volatile	64 MB	U3D1	No(BIOS)	BIOS Flash
Non-volatile	64 MB	U1D1	NO(FW)	BMC Flash
Non-Volatile	4 Mbit	U5M1	No	10 GB NIC EEPROM (S2600WF)
Non-volatile	N/A	U1E3	No	CPLD
Volatile	512 MB	U1D2	No	BMC firmware SDRAM
None-volatile	8 GB	U8N1	No	BMC eMMC

Note: Table 59 does not identify volatile and non-volatile memory components for devices which may be installed onto or may be used with the server board. These may include: system boards used inside a server system, processors, memory, storage devices, or add-in cards.

Appendix E. Supported Intel® Server Systems

The Intel® Server Board S2600WF product family is designed to be integrated into high density 1U and 2U rack mount servers chassis. Intel® Server Systems in this server board family include the Intel Server System R1000WF product family and the Intel Server System R2000WF product family. The sections below provide a high level overview of the features associated with each. For additional product information, refer to the Technical Product Specification, Integration and Service Guide, Product Family Configuration Guide, and other marketing material available for each of these server product families. These documents can be downloaded from the Intel website.

E.1. Intel® Server System R1000WF Product Family

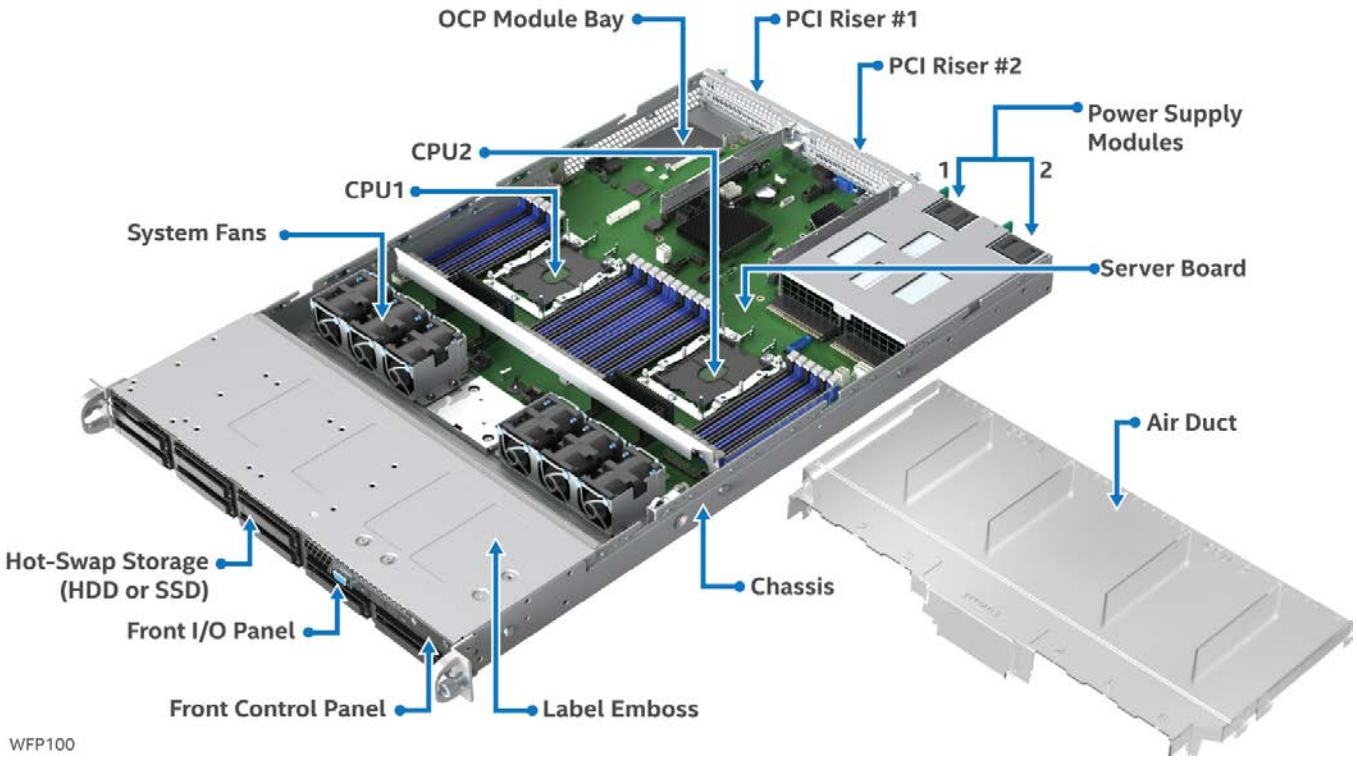


Figure 76. Intel® Server System R1000WF product family

Table 60. Intel® Server System R1000WF product family feature set

Feature	Description
Chassis Type	1U rack mount chassis
Server Board	Intel® Server Board S2600WF product family
Maximum Supported Processor Thermal Design Power (TDP)	Up to 165 Watts
External I/O Connections	• DB-15 video connectors o Front and back • RJ-45 serial port A connector on back panel • Dual RJ-45 network interface connectors (S2600WFT-based systems only) • Dedicated RJ-45 server management port on back panel • (3) – USB 3.0 connectors on back panel • (2) – USB 3.0 connectors on front panel (non-storage system configurations only)
Internal I/O Connectors/Headers	• (1) – Type-A USB 2.0 connector • (1) – DH-10 serial port B connector
System Fans	• (6) – managed 40 mm dual rotor system fans • One power supply fan for each installed power supply module
Riser Card Support	Support for two riser cards: • Riser #1 – PCIe* 3.0 x24 • Riser #2 – PCIe* 3.0 x24 With two riser cards installed, up to two possible add-in cards can be supported (one x16 PCIe* 3.0 add-in card slot per riser card): • (2) full height/half-length add-in cards via Risers #1 and #2
Power Supply Options	The server system can have up to two power supply modules installed, providing support for the following power configurations: 1+0, 1+1 redundant power, and 2+0 combined power. (2) power supply options: • AC 1100W Platinum • DC 750W Gold
Drive Support	• R1304WFxxx – 4 x 3.5” hot swap drive bays + SAS/SATA backplane • R1208WFxxx – 8 x 2.5” hot swap drive bays + SAS/SATA/NVMe* combo backplane
Supported Rack Mount Kit Accessory Options	• AXXELVRAIL – Enhanced value rack mount rail kit – 424 mm max travel length • A1UFULLRAIL – Tool-less rack mount rail kit with CMA support – 780 mm max travel length • A1USHRTRAIL – Tool-less rack mount rail kit – 780 mm max travel length (no CMA support) • AXX2POSTBRCKT – Two post fixed mount bracket kit • AXX1U2UCMA2– Cable management arm (supported with AXXFULLRAIL only)

E.2. Intel® Server System R2000WF Product Family

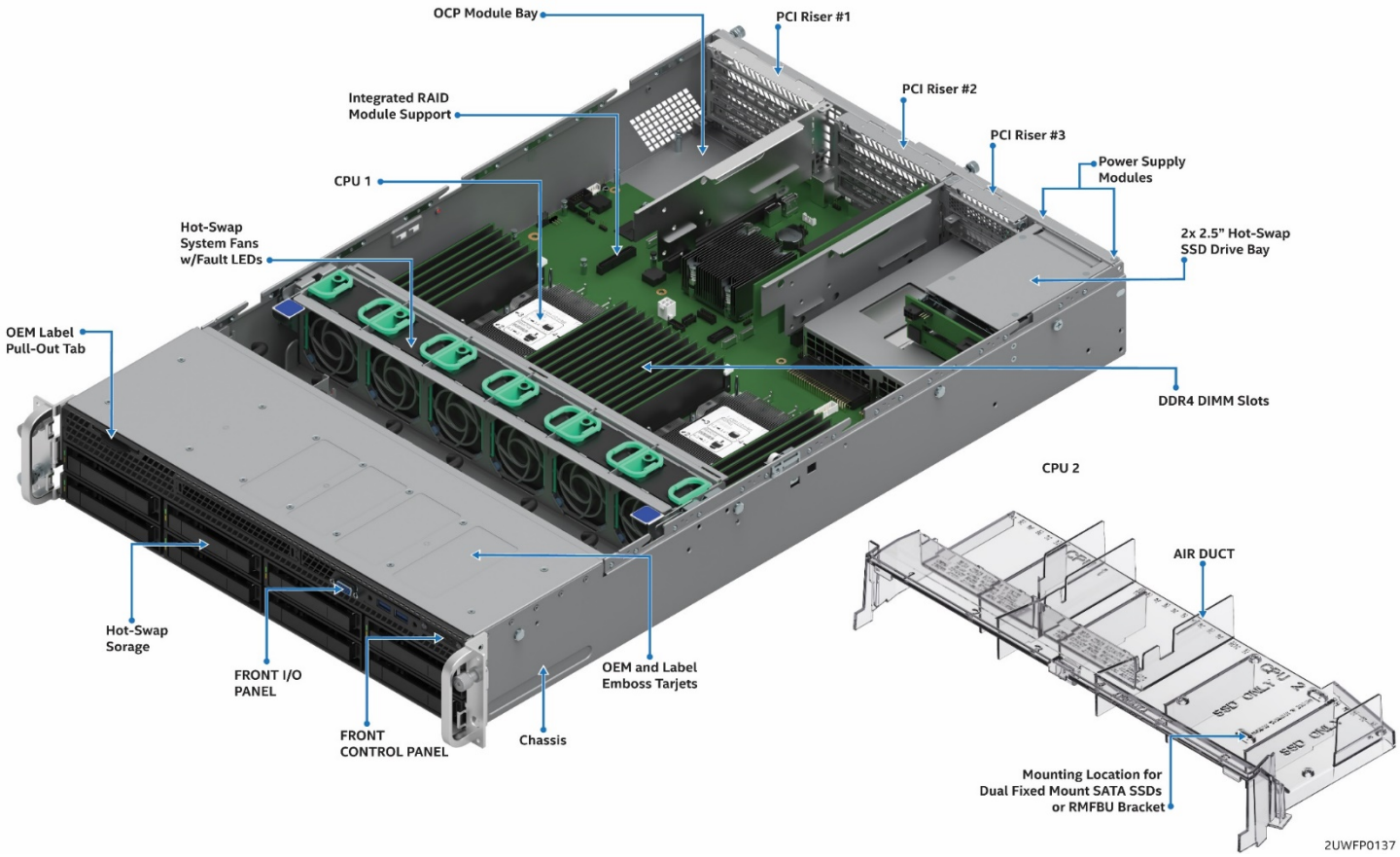


Figure 77. Intel® Server System R2000WF product family

Table 61. Intel® Server System R2000WF product family feature set

Feature	Description
Chassis Type	2U rack mount chassis
Server Board	Intel® Server Board S2600WF product family
Maximum Supported Processor Thermal Design Power (TDP)	• Up to 140 W for all Intel® system configuration options. • 165 W processors supported on Intel® Server Chassis R2208WFxxxx and R2308WFxxxx configurations only.
External I/O Connections	• DB-15 video connectors o Front and back (non-storage system configurations only) • RJ-45 serial port A connector • Dual RJ-45 network interface connectors (S2600WFT-based systems only) • Dedicated RJ-45 server management NIC • (3) – USB 3.0 connectors on back panel • (2) – USB 3.0 connectors on front panel (non-storage system configurations only) • (1) – USB 2.0 connector on rack handle (storage configurations only)
Internal I/O Connectors/Headers	• (1) – Type-A USB 2.0 connector • (1) – DH-10 serial port B connector
System Fans	• (6) – managed 60 mm hot swap capable system fans • Integrated fans included with each installed power supply module

Feature	Description
Riser Card Support	Support for three riser cards: • Riser #1 – PCIe* 3.0 x24 - up to 3 PCIe slots • Riser #2 – PCIe* 3.0 x24 - up to 3 PCIe slots • Riser #3 – PCIe* 3.0 x16 – up to 2 PCIe slots – Low profile cards only (optional) With three riser cards installed, up to eight possible add-in cards can be supported: • (4) full height/half-length + (2) full height/half-length add-in cards via Risers #1 and #2 • (2) low profile add in cards via riser #3 (option)
Power Supply Options	The server system can have up to two power supply modules installed, providing support for the following power configurations: 1+0, 1+1 redundant power, and 2+0 combined power. (3) power supply options: • AC 1100W Platinum • AC 1300W Titanium • DC 750W Gold
Drive Bay Options	Hot Swap Backplane Options: • 8 x 3.5” SAS/ SATA • 8 x 2.5” combo backplane – SAS/SATA/NVMe • 8 x 2.5” Dual Port SAS • 12 x 3.5” SAS/ SATA (supports up to 2 NVMe drives) **Note**: All available backplane options have support for SAS 3.0 (12 Gb/sec). Storage Bay Options: • 8 x 3.5” SAS/SATA hot swap drive bays • 12 x 3.5” SAS/SATA hot swap drive bays (supports up to 2 NVMe drives) • 8 x 2.5” SAS/SATA/NVMe hot swap drive bays • 16 x 2.5” SAS/SATA/NVMe hot swap drive bays • 24 x 2.5” SAS/SATA/NVMe swap drive bays • 2 x 2.5” SATA SSD Back of Chassis Hot Swap Drive Bays (accessory Option) • 2 x internal fixed mount 2.5" SSDs (all SYSTEM MODELs)
Supported Rack Mount Kit Accessory Options	• AXXELVRAIL – Enhanced value rack mount rail kit – 424 mm max travel length, 59kgs (130lbs.) max supported weight • AXXFULLRAIL – 2U premium rail with CMA support – 800 mm max travel length, 45kgs (99lbs.) max supported weight • AXXSHRTRAIL – 2U premium rail without CMA support – 788 mm max travel length, 45kgs (99lbs.) max supported weight • AXX2POSTBRCKT – Two post fixed mount bracket kit • AXXCMA2– Cable management arm (supported with AXXFULLRAIL only)

Appendix F. Glossary

Term	Definition
BMC	Baseboard Management Controller
BIOS	Basic Input/Output System
CMOS	Complementary Metal-oxide-semiconductor
CPU	Central Processing Unit
DDR4	Double Data Rate 4th edition
DIMM	Dual In-line Memory Module
DPC	DIMMs per Channel
EDS	External Design Specification
EPS	External Product Specification
FP	Front Panel
FRB	Fault Resilient Boot
FRU	Field Replaceable Unit
GPGPU	General Purpose Graphic Processing Unit
I2C	Inter-integrated Circuit bus
iPC	Intel Product Code
LED	Light Emitting Diode
LRDIMM	Load Reduced DIMM
LSB	Least Significant Bit
MSB	Most Significant Bit
NIC	Network Interface Card
NMI	Non-maskable Interrupt
OCuLink	Optical Copper Link
PCI	Peripheral Component Interconnect
PCIe*	Peripheral Component Interconnect Express*
POST	Power-on Self-Test
PSU	Power Supply Unit
RAID	Redundant Array of Independent Disks
RAM	Random Access Memory
RDIMM	Registered DIMM
ROC	RAID On Chip
SAS	Serial Attached SCSI
SATA	Serial Advanced Technology Attachment
SCA	Single Connector Attachment
SCSI	Small Computer System Interface
SDR	Sensor Data Record
SSD	Solid State Device
TPM	Trusted Platform Module
TPS	Technical Product Specification
Intel® TXT	Intel® Trusted Execution Technology for servers
VLSI	Very Large Scale Integration
VSB	Voltage Standby
Intel® VROC	Intel® Virtual RAID on CPU