Intel® Storage Server System JBOD 2000 Family

Hardware Guide

Revision 1.2

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Enterprise Platforms and Services Division

Revision History

Date	Revision Number	Modifications
December 2012	0.9	Pre-production release.
March 2013	1.0	First release.
July 2013	1.05	Removed Chapter 9 and Appendix A.
September 2013	1.1	▪ Restructured the document. ▪ Added chapter for external connection mode.
November 2013	1.2	▪ Removed JBOD2224S2SP(2.5", single port SKU) related content

Disclaimers

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1. Introduction

This Hardware Guide provides system-level information for the Intel® Storage Server System JBOD 2000 Family.

This document describes the functions and features of JBOD product that includes the chassis layout, system boards, power subsystem, cooling subsystem, storage subsystem options, and available installable options.

This document is divided into the following chapters:

- Chapter 1 – Introduction
- Chapter 2 – Product Family Overview
- Chapter 3 – System Storage and Peripheral Drive Bays Overview
- Chapter 4 – Power Subsystem
- Chapter 5 – Thermal Management
- Chapter 6 – JBOD 2000 Internal Connection Overview
- Chapter 7 – JBOD 2000 External SAS Connection Mode Overview
- Appendix A – Qualified External Mini-SAS Cable List
- Reference Documents

1.1 Server Product Use Disclaimer

It is the responsibility of the system integrator who chooses not to use Intel-developed server building blocks to consult vendor datasheets and operating parameters to determine the amount of airflow required for their specific application and environmental conditions. Intel Corporation cannot be held responsible if components fail to operate correctly when used outside any of their published operating or non-operating limits.

1.2 Product Errata

The products described in this document may contain design defects or errors known as errata which may cause the product to deviate from published specifications. Product Errata are documented in the *Intel® Storage Server System JBOD 2000 Family Monthly Specification Update* which can be downloaded from http://www.Intel.com.

2. Product Family Overview

This generation of Intel® Storage Server System JBOD 2000 Family offers a variety of options to meet the configuration requirements of high-density high-performance computing environments. The Intel® Storage Server System JBOD 2000 Family is comprised of three product offerings.

Note: The following table lists features common to the Intel® Storage Server System JBOD 2000 Family. Features that are unique to one product in the family are identified by denoting the full JBOD Product Code name.

Table 1. System Feature Set

Intel® Storage Server System JBOD 2000 Family	Description
JBOD2224S2DP	2U JBOD supports 24 x 2.5" drives, with a dual-port backplane.
JBOD2312S2SP	2U JBOD supports 12 x 3.5" drives, with a single-port backplane.

This chapter provides a high-level overview of the Intel® Storage Server System JBOD 2000 Family features and available options as supported in different JBOD SKUs. Greater detail for each major system component or feature is provided in the following chapters.

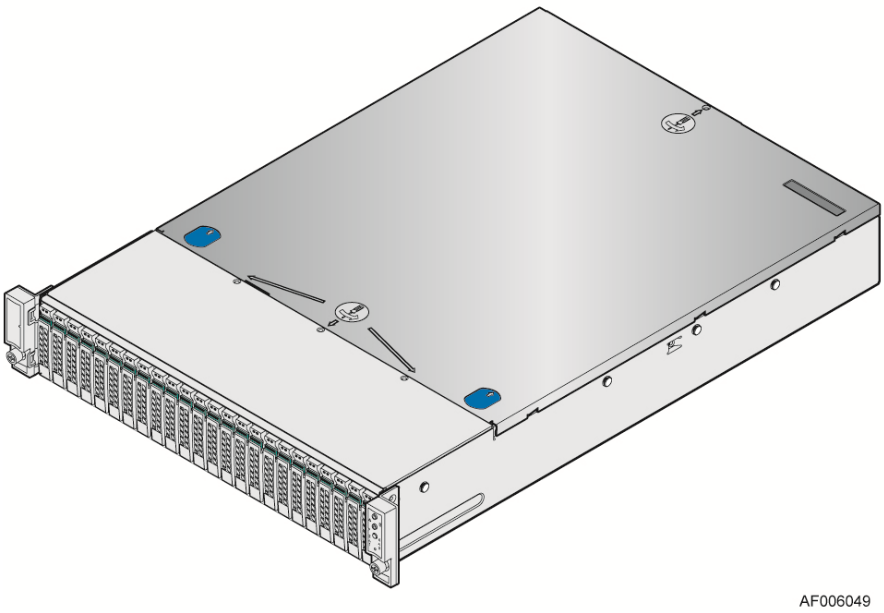

Figure 1. 24 x 2.5" Drive JBOD 2000 Product Drawing

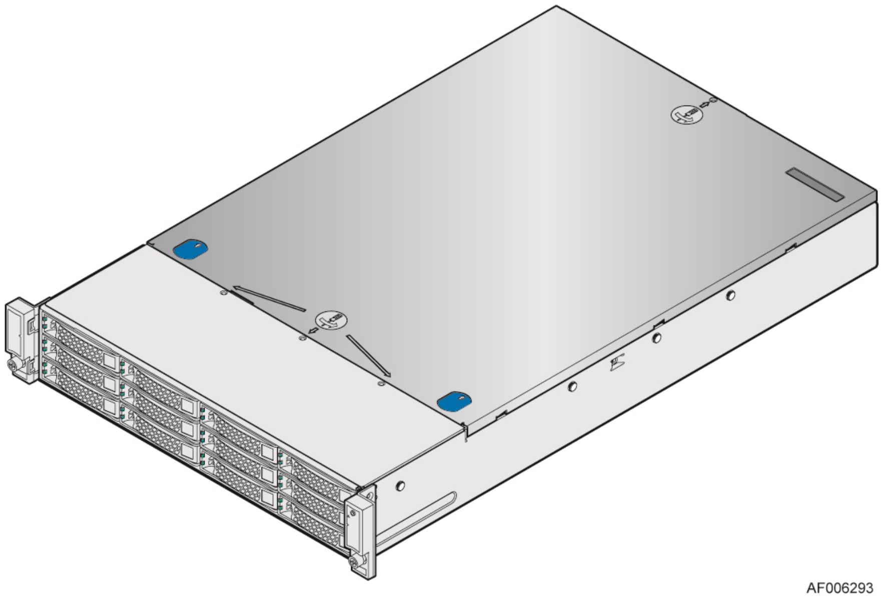

Figure 2. 12 x 3.5" Drive JBOD 2000 Product Drawing

2.1 Chassis Dimensions

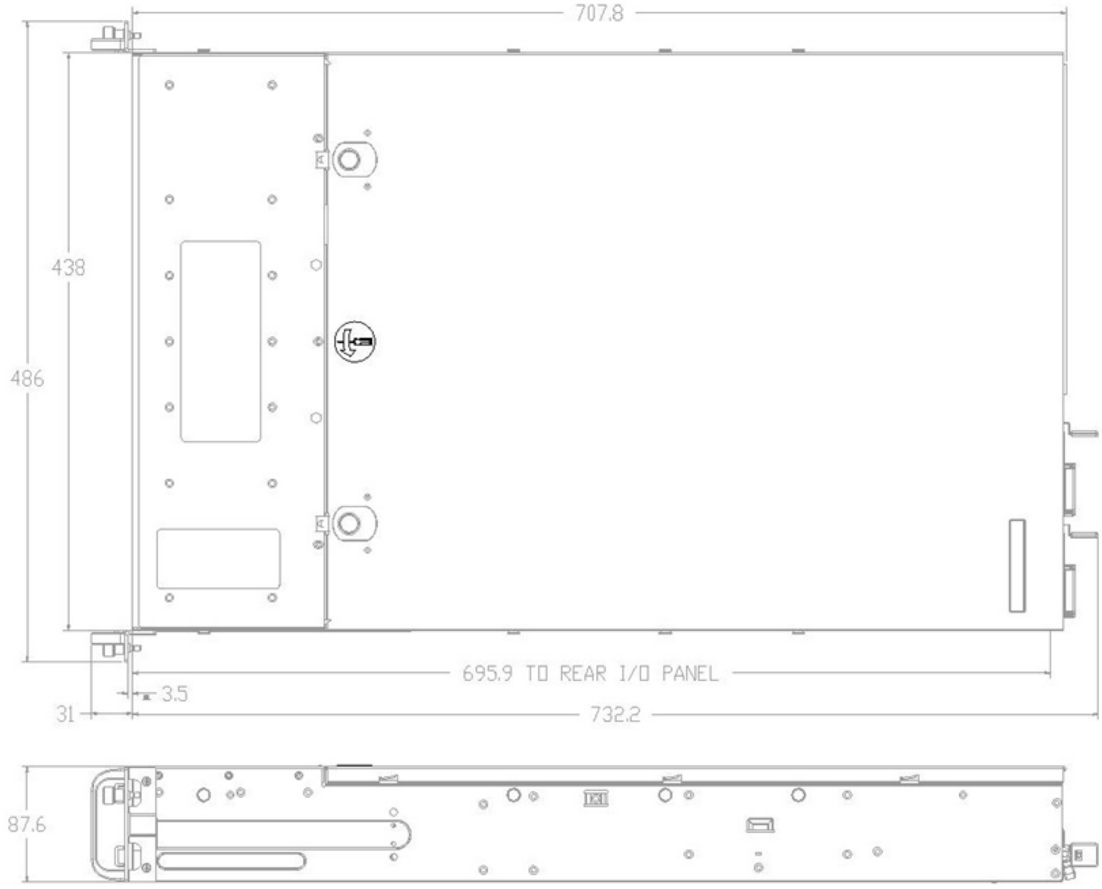

Figure 3. Chassis Dimensions

2.2 System Level Environmental Limits

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

- The system operating ambient is designed for sustained operation up to 35ºC (ASHRAE Class A2) with short-term excursion-based operation up to 45ºC (ASHRAE Class A4).
  - The system can operate up to 40ºC (ASHRAE Class A3) for up to 900 hours per year.
  - The system can operate up to 45ºC (ASHRAE Class A4) for up to 90 hours per year.
  - When operating within the extended operating temperature range, the system performance may be impacted.
  - There is no system reliability impact when operating at the extended temperature range within the approved limits.

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

Table 2. System Environmental Limits Summary

Parameter		Limits
Temperature		
	Operating	ASHRAE Class A2 – Continuous Operation. 10ºC to 35ºC [1] (50ºF to 95ºF) with the maximum rate of change not to exceed 10ºC per hour.
		ASHRAE Class A3 – Includes operation up to 40ºC for up to 900 hrs per year.
		ASHRAE Class A4 – Includes operation up to 45ºC for up to 90 hrs per year.
	Shipping	-40ºC to 70ºC (-40ºF to 158ºF)
Altitude		
	Operating	Support operation up to 3050m with ASHRAE class deratings.
Humidity		
	Shipping	50% to 90%, non-condensing with a maximum wet bulb of 28°C (at temperatures from 25°C to 35°C)
Shock		
	Operating	Half sine, 2g, 11 mSec
	Unpackaged	Trapezoidal, 25g, velocity change is based on packaged weight
	Packaged	Product Weight: ≥ 40 to < 80 Non-palletized Free Fall Height = 18 inches Palletized (single product) Free Fall Height = NA
Vibration		
	Unpackaged	5 Hz to 500 Hz 2.20 g RMS random
	Packaged	5 Hz to 500 Hz 1.09 g RMS random
AC-DC		
	Voltage	90 V AC to 132 V AC and 180 V AC to 264 V AC
	Frequency	47 Hz to 63 Hz
	Source Interrupt	No loss of data for power line drop-out of 12 mSec
	Surge Non-operating and operating	Unidirectional

Parameter		Limits
	Line to earth Only	AC Leads 2.0 kV I/O Leads 1.0 kV DC Leads 0.5 kV
ESD		
	Air Discharged	12.0 kV
	Contact Discharge	8.0 kV
Acoustics Sound Power Measured		
	Power in Watts	<300 W ≥300 W ≥600 W ≥1000 W
	Servers/Rack Mount BA	7.0 7.0 7.0 7.0

Note:

1. Intel Corporation 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 will meet the intended thermal requirements of these components. It is the responsibility of the system integrator who chooses not to use Intel developed server building blocks to consult vendor datasheets and operating parameters to determine the amount of airflow required for their specific application and environmental conditions. Intel Corporation cannot be held responsible if components fail or the server board does not operate correctly when used outside any of its published operating or non-operating limits.

***Disclaimer Note**: Intel ensures the unpackaged server board and system meet the shock requirement mentioned above through its own chassis development and system configuration. It is the responsibility of the system integrator to determine the proper shock level of the board and system if the system integrator chooses different system configuration or different chassis. 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.*

2.3 System Features and Options Overview

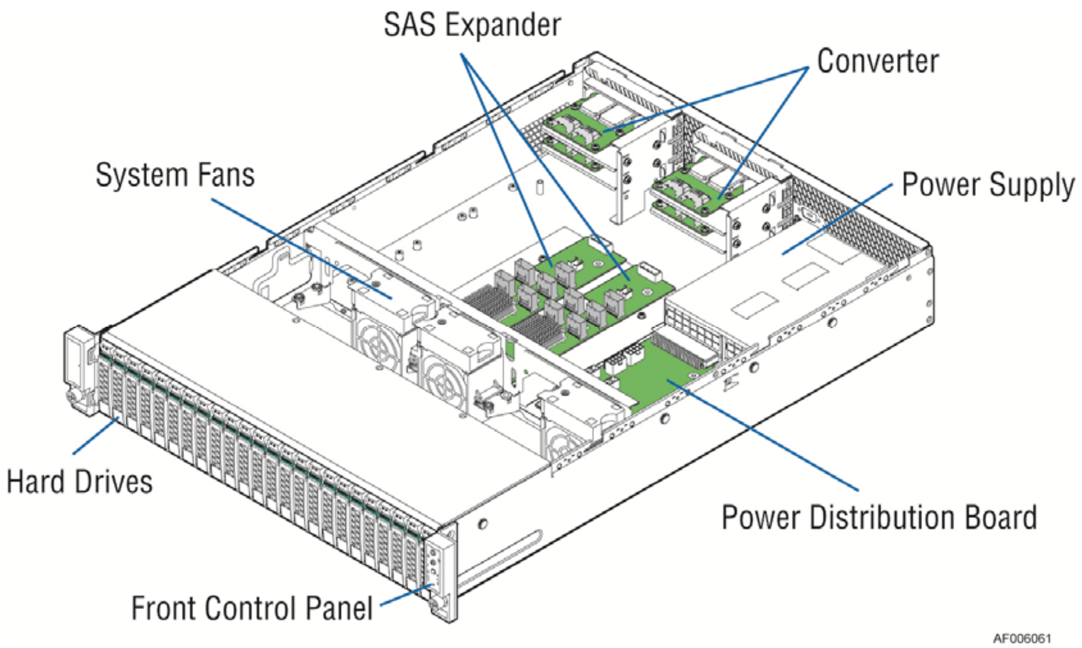

Figure 4. System Components Overview

2.3.1 Hot Swap Hard Drive Bay and Front Panel Options

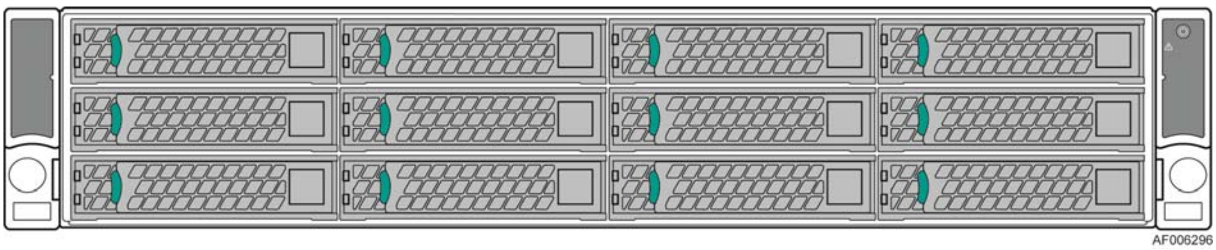

Figure 5. 12 x 3.5" Drive JBOD2000 Front View

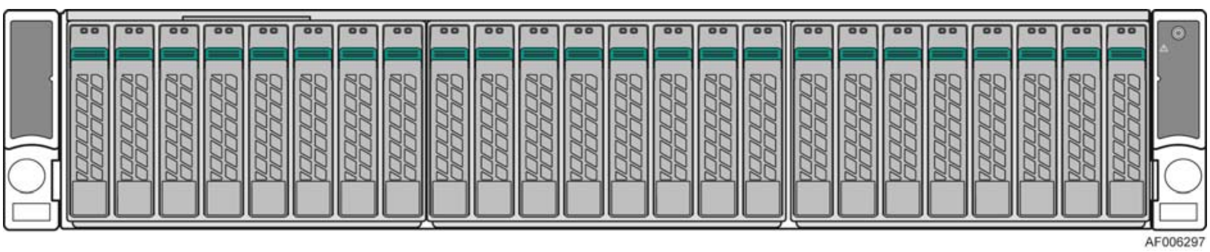

Figure 6. 24 x 2.5" Drive JBOD2000 Front View

2.3.2 Front Panel Options

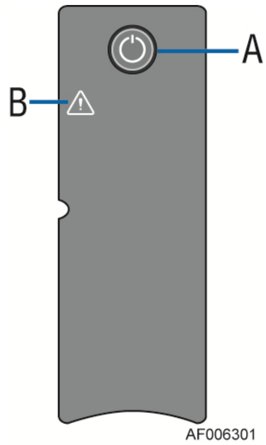

Figure 7. Front Panel Options

Label	Description
A	Power Button w/Integrated LED
B	System Status LED

The Power Button toggles the system power on and off. Pressing this button sends a signal to the integrated PDB board, which either powers on or powers off the system. The integrated LED is a single-color (Green) indicator that supports different states as defined in the following table.

Table 3. Power LED Functional States

State	Power Mode	LED	Description
Power-off	Non-ACPI	Off	System power is off.
Power-on	Non-ACPI	On	System power is on.

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, and 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 on-board platform management subsystem. The following table provides a description of each supported LED state.

Table 4. System Status LED State Definitions

Color	State	Criticality	Description
Off	System is not operating	Not ready	The system is powered off (AC and/or DC).
Green	Solid on	Ok	Indicates that the system status is “healthy”. The system is not exhibiting any errors. AC power is present and the system is either in a standby state or has been powered on.

Color	State	Criticality	Description
Amber	Solid on	SMBUS Alert Event Encountered	▪ P12V is out of its limits. ▪ P5V is out of its limits. ▪ A fan fault has been detected. ▪ An over temperature event has been detected. ▪ P3V3 is out of its limits. ▪ Remote 1 and/or Remote 2 temperature sensor is either open or shorted.

2.3.3 Back Panel Features

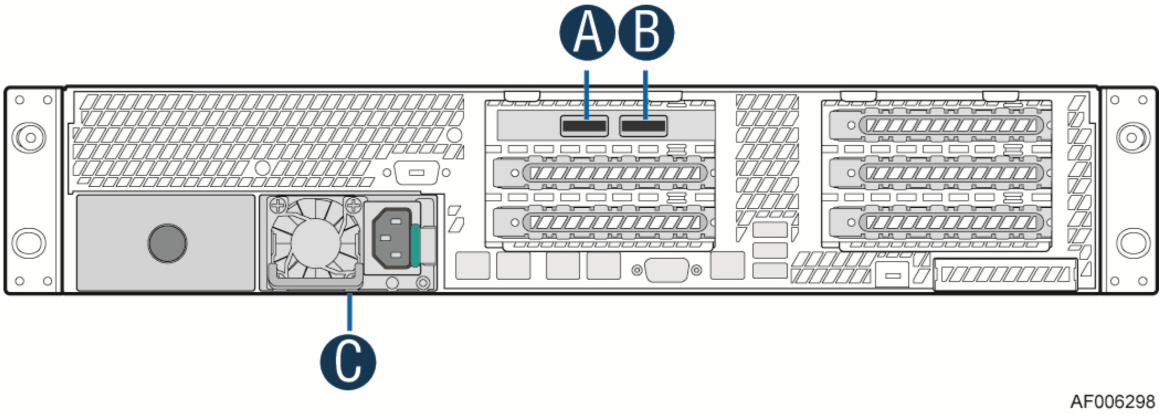

Figure 8. Single-port Backplane JBOD2000 Back View

Label	Description
A	SFF-8088 receptacle (label: A PRI)
B	SFF-8088 receptacle (label: B PRI)
C	PSU

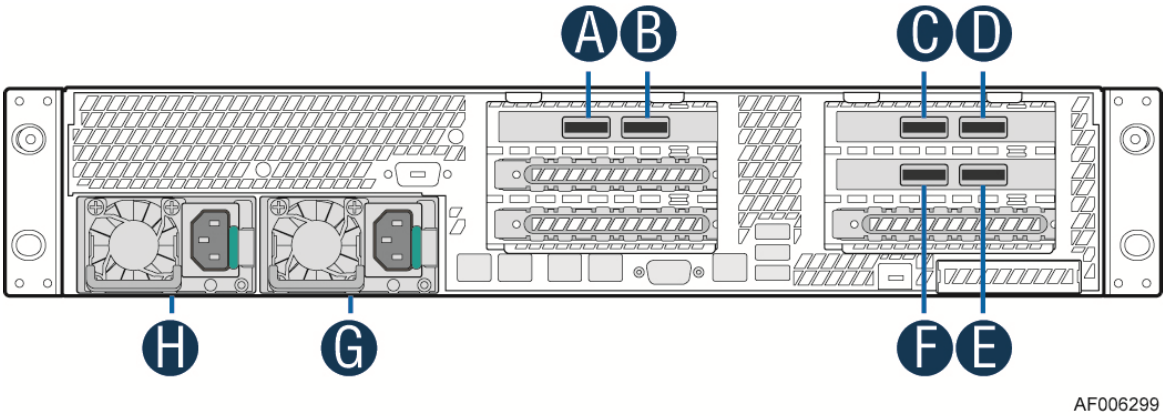

Figure 9. Dual-port Backplane JBOD2000 Back View

Label	Description
A	SFF-8088 receptacle (label: A PRI)
B	SFF-8088 receptacle (label: B PRI)
C	SFF-8088 receptacle (label: A SEC)
D	SFF-8088 receptacle (label: B SEC)
E	SFF-8088 receptacle (label: C SEC)
F	SFF-8088 receptacle (label: C PRI)
G	PSU
H	PSU

3. System Storage and Peripheral Drive Bays Overview

The Intel® Storage Server System JBOD2000 product family supports the following storage device options:

- Hot-swap 2.5" hard disk drives
- Hot-swap 3.5" hard disk drives

3.1 2.5" Hard Disk Drive Support

The server is available in 2.5" hard disk configurations of 24 drives as illustrated below.

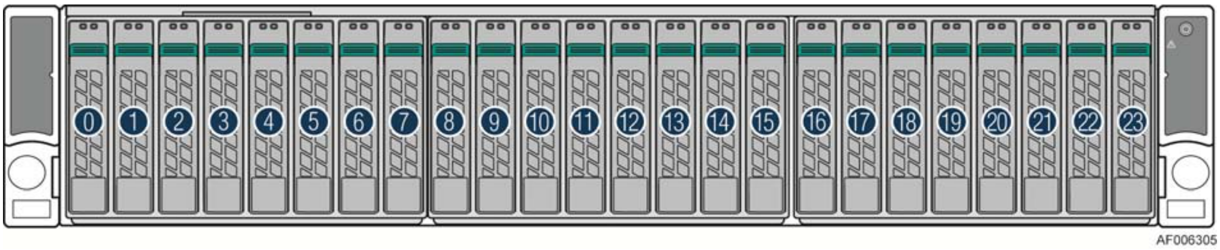

Figure 10. 2.5" Hard Drive Bay – 24-Drive Configuration

The drive bay can support either SATA or SAS hard disk drives. Mixing of drive types within a common hot-swap backplane is not supported. Systems with multiple hot-swap backplanes can support different drive type configurations as long as the drives attached to a common backplane are the same and the installed controller attached to the given backplane can support the drive type. Hard disk drive type is dependent on the type of host bus controller used, SATA only or SAS.

Each 2.5" hard disk drive is mounted to a drive tray, allowing for hot-swap extraction and insertion. Drive trays have a latching mechanism that is used to extract and insert the drives from the chassis, and lock the tray in place.

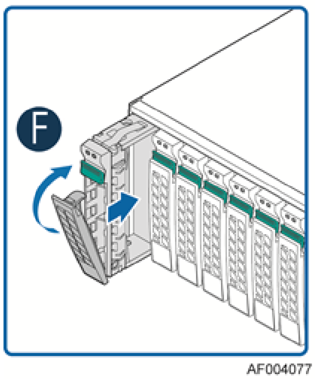

Figure 11. 2.5" Drive Tray Assembly

Light pipes integrated into the drive tray assembly direct the light emitted from Amber drive status and Green activity LEDs located next to each drive connector on the backplane, to the drive tray faceplate, making them visible from the front of the system.

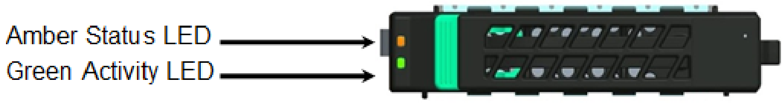

Figure 12. Status and Activity LED on 2.5" Drive Tray

Table 5. Drive Status LED States

Amber	Off	No access and no fault.
	Solid on	Hard drive fault has occurred.
	Blink	RAID rebuild in progress (1 Hz); Identify (2 Hz).

Table 6. Drive Activity LED States

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

3.1.1 2.5" Drive Hot-Swap Backplane Overview

Depending on the number of hard disk drives supported by a given system SKU, a system can be configured with one, two, or three 8-drive backplanes. Each backplane is attached to the back of the drive bay assembly.

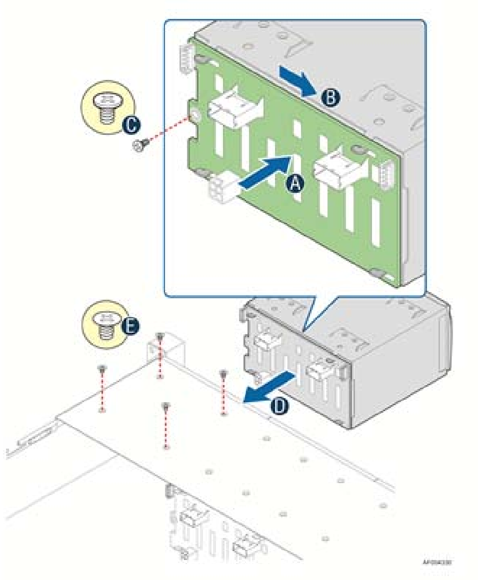

Figure 13. 2.5" Hot-Swap Backplane and Drive Bay Assembly

On the front side of each backplane are mounted eight hard disk drive interface connectors (A), each providing both power and I/O signals to the attached hard disk drives.

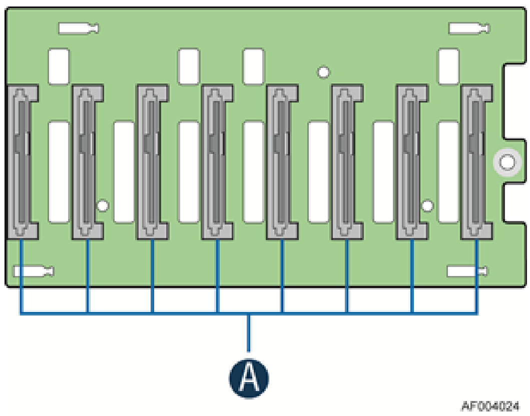

Figure 14. SFF-8482 Connector on HSBP

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

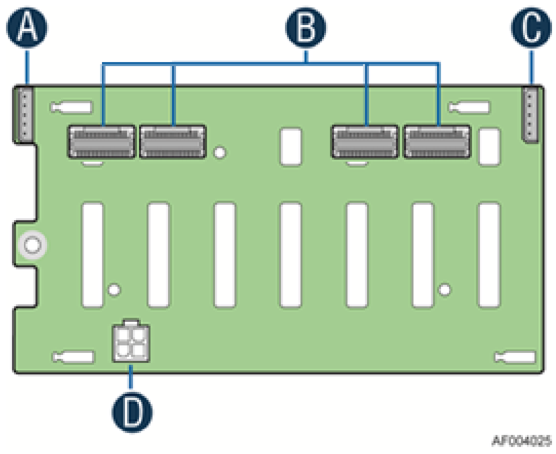

Figure 15. Components on dual port 2.5" HSBP

Label	Description
A	SMBus-Out cable connector for multi-backplane support
B	mini-SAS cable connectors
C	SMBus-In cable connector – From the server board or other backplanes
D	Power connector

A and C – SMBus Cable Connectors – The backplane includes two 1x5 cable connectors used as a management interface between the server board and the installed backplanes. In systems configured with multiple backplanes, a short jumper cable is attached between backplanes, with connector B used on the first board and connector D used on the second board, extending the SMBus to each installed backplane.

B – Multi-port Mini-SAS Cable Connectors – The backplane includes two pair of multi-port mini-SAS cable connectors. Each pair contains primary SAS port and second SAS port providing SGPIO and I/O signals for four SAS/SATA hard drives on the backplane. Cables can be routed from matching connectors on the server board, installed add-in SAS/SATA RAID cards, or optionally installed SAS expander cards for drive configurations of greater than eight hard drives.

D – Power Harness Connector – The backplane includes a 2x2 connector supplying power to the backplane. Power is routed to each installed backplane via a multi-connector power cable harness from the server board.

3.1.2 Cypress* CY8C22545 Enclosure Management Controller

The backplanes support enclosure management using a Cypress* CY8C22545 Programmable System-on-Chip (PSoC*) device. The CY8C22545 drives the hard drive activity/fault LED, hard drive present signal, and controls hard drive power-up during system power-on.

3.2 3.5" Hard Disk Drive Support

The server is available in 3.5" hard disk configurations of 12 drives as illustrated below.

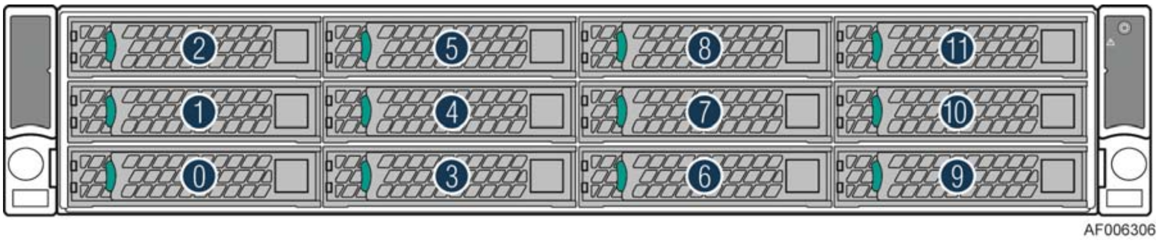

Figure 16. 3.5" Hard Drive Bay – 12-Drive Configuration

The drive bay can support either SATA or SAS hard disk drives. Mixing of drive types within the hard drive bay is not supported. Hard disk drive type is dependent on the type of host bus controller used, SATA only or SAS. Each 3.5" hard disk drive is mounted to a drive tray, allowing for hot-swap extraction and insertion. Drive trays have a latching mechanism that is used to extract and insert the drives from the chassis, and lock the tray in place.

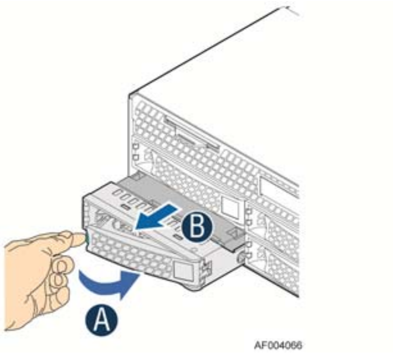

Figure 17. 3.5" Drive Tray Assembly

Light pipes integrated into the drive tray assembly direct the light emitted from Amber drive status and Green activity LEDs located next to each drive connector on the backplane, to the drive tray faceplate, making them visible from the front of the system.

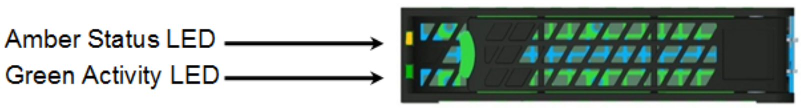

Figure 18. Status and Activity LED on 3.5" Drive Tray

Table 7. Status LED Status

Amber	Off	No access and no fault.
	Solid on	Hard drive fault has occurred.
	Blink	RAID rebuild in progress (1 Hz); Identify (2 Hz).

Table 8. Activity LED Status

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

3.2.1 3.5" Drive Hot-Swap Backplane Overview

Systems with 12-drive configurations have their own unique backplane. The backplanes mount to the back of the drive bay assembly.

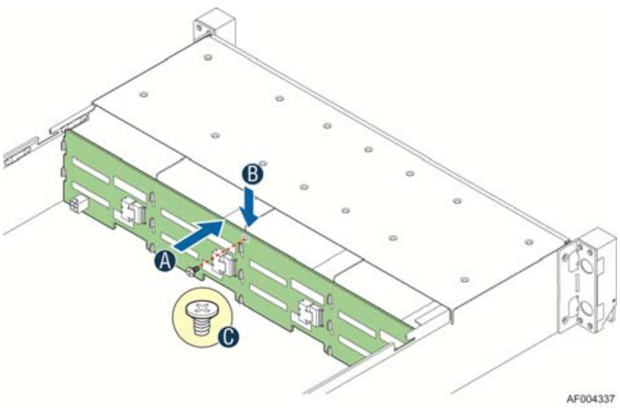

Figure 19. 3.5" Hot-Swap Backplane and Drive Bay Assembly

On the front side of each backplane are mounted 12 hard disk drive interface connectors, each providing both power and I/O signals to the attached hard disk drives.

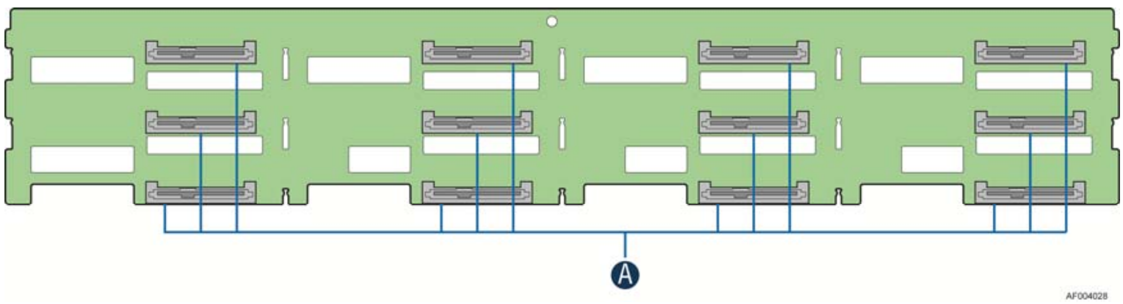

Figure 20. SFF-8482 Connector on 3.5" HSBP

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

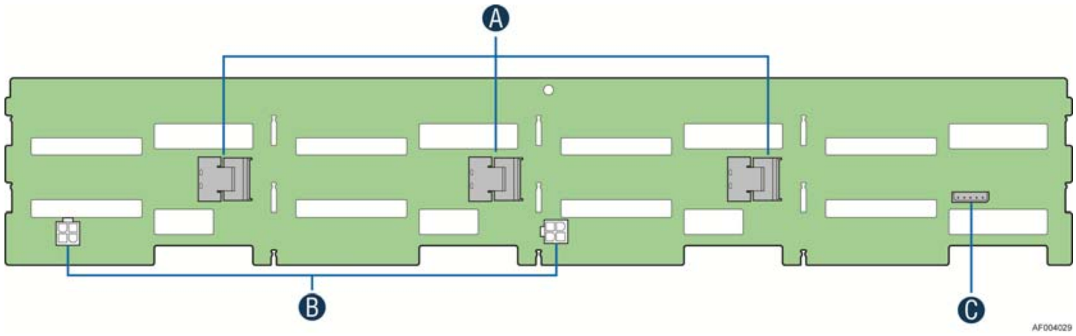

Figure 21. Components on 3.5" HSBP

Label	Description
A	4-port mini-SAS connectors
B	Power connectors
C	SMBus connector

A – 4-port Mini-SAS Connectors – The backplane includes two or three multi-port mini-SAS cable connectors, each providing SGPIO and I/O signals for four SAS/SATA hard drives on the backplane. Cables can be routed from matching connectors on the server board, add-in SAS/SATA RAID cards, or an optionally installed SAS expander card. Each mini-SAS connector includes a silk-screen identifying which drives the connector supports: Drives 0-3, Drives 4-7, and Drives 8-11.

B – Power Harness Connector – The backplane includes a 2x2 connector supplying power to the backplane. Power is routed to the backplane via a power cable harness from the server board.

C – SMBus Cable Connectors – The backplane includes a 1x5 cable connector used as a management interface to the server board.

3.2.2 Cypress* CY8C22545 Enclosure Management Controller

The backplanes support enclosure management using a Cypress* CY8C22545 Programmable System-on-Chip (PSoC*) device. The CY8C22545 drives the hard drive activity/fault LED, hard drive present signal, and controls hard drive power-up during system power-on.

4. Power Subsystem

This chapter provides a high-level overview of the power management features and specification data for the power supply options available for Intel® Storage Server System JBOD 2000 Family. Specification variations are identified for each supported power supply.

Although this system cannot be loaded high enough to hit this mode (2+0), the Intel® Storage System JBOD 2000 Family can have up to two power supply modules installed, supporting the following power supply configurations: 1+0 (single power supply), 1+1 Redundant Power, and 2+0 Combined Power (non-redundant). The 1+1 redundant power and 2+0 combined power configurations are automatically configured depending on the total power draw of the system. If the total system power draw exceeds the power capacity of a single power supply module, then power from the second power supply module will be utilized. If this occurs, power redundancy is lost. In a 2+0 power configuration, total power available maybe less than twice the rated power of the installed power supply modules due to the amount of heat produced with both supplies providing peak power. If system thermals exceed programmed limits, platform management will attempt to keep the system operational. Thermal support is open loop based on ambient temp sensor on the front panel.

The only power supply option validated for the Intel® Storage Server System JBOD 2000 Family is the 460W AC PS. The 750 W AC PS will fit and operate, but will not be validated in the JBOD or plan of record.

The power supplies are modular, allowing for tool-less insertion and extraction from a bay in the back of the chassis. When inserted, the card edge connector of the power supply mates blindly to a matching slot connector on the PDB board.

In the event of a power supply failure, redundant 1+1 power supply configurations have support for hot-swap extraction and insertion.

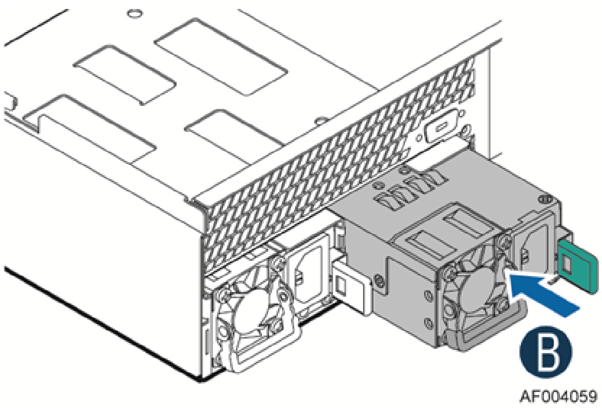

Figure 22. Power Supply Assembly

The AC input is auto-ranging and power factor corrected.

4.1 Power Distribution Board (PDB)

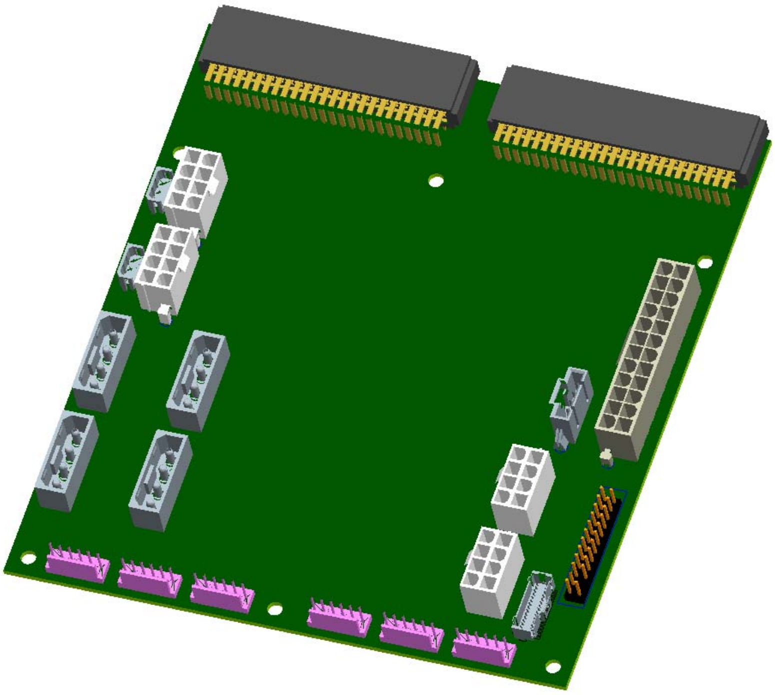

Figure 23. Power Distribution Board (PDB)

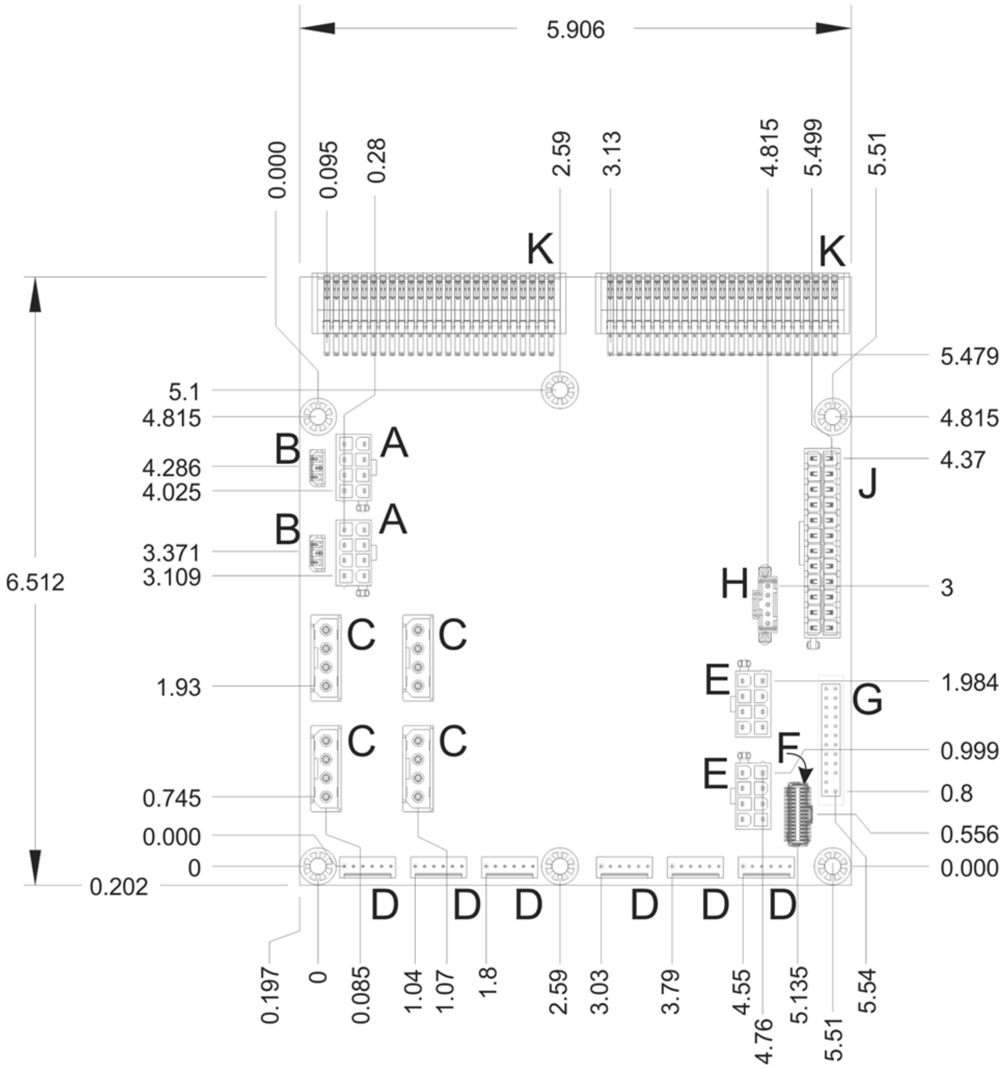

Figure 24. PDB Component Placement

Label	Description	Label	Description
A	HSBP power header	F	2x15-pin storage mini front panel header
B	Expander SES-2 header	G	2x12-pin front panel header
C	Expander power header	H	1x5 aux header
D	FAN header	J	2x12 SSI power connector
E	HSBP power header	K	power supply connector

The PDB provides power from the power supply modules to the JBOD components, and provides thermal monitoring and fan control, and includes the following features:

- The PDB connects to the power supply canister through two CRPS card edge connectors.

- Optional 2x12-pin SSI and 1x5-pin SSI power control headers (for potential future use with 4U JBOD fixed power supply).
- Power for up to two internal 36-port SAS expander cards (RES2CV360R) for the 2U JBOD with two additional connectors for future use.
- Two 2x4-pin 12V power headers and an additional two 2x4-pin 12V power headers for future use. Each cable is used to connect power to a single 12x 3.5" HSBP or up to three 8x 2.5" HSBPs.
- Support for hot-swap redundant fan speed control solutions up to three system fans and identification of fan failures at front panel fault LED indicator with communication over SES2 interface to host PC.
- SMB interface for communicating enclosure status through the expander board to the host system external host controller via SES interface. Monitoring capabilities include:
  - Fan tachs
  - 12V voltage out from PSU
  - 12V current from PSU
  - Temperature on front panel, HDDs, and on the board behind drives
  - Ambient overtemp protection: Reported to host system and fan boost only. No shutdown.
  - Degraded (PSU, FAN) state reportable to host system and on JBOD status LED

The ADT7476 thermal controller on the PDB can measure and control the speed of up to three fans. The controller provides acoustic enhancements to ensure the fans run at the lowest possible speed for the given temperature. The controller interfaces with two remote temp sensors and a local temp sensor built into the chip.

The thermal controller on the PDB is programmed using the SAS expander that comes with the Intel® Storage Server System JBOD 2000 Family. The SAS expander in the Intel® Storage System JBOD 2000 Family uses a firmware that programs the thermal controller when the system is turned on. If the SAS expander is not plugged into the PDB using the I^2C cable, the fans will run at 100% and the thermal controller will not be programmed correctly.

The cable must be connected to the I^2C port B (Port C will not program the PDB) on the expander board and then either of the I^2C connectors on the PDB before the system is turned on.

If the fan runs at 100% at room temperature, there is an issue with the SMBUS connection, the SAS expander is not getting power, or the incorrect firmware is on the expander.

When a fan fails in the Intel® Storage Server System JBOD 2000 Family, an interrupt register bit is set in the ADT7476 Thermal Controller that signals the fan fault (register shown below). The LSI expander chip on the SAS expander monitors this register, and when a fan fault bit is set in the interrupt register, this information is sent to the host system through SES. The ADT7476 controller also sends a signal out of its GPIOs to light the LED on the failed fan's hot-swap housing which makes replacing/diagnosing the failed fan much easier.

Interrupt Register 2 for ADT7476 (Bits 2, 3, and 4 used for fan faults):

Addr	R/W	Desc	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	De-fault	Lock-able
0x42	R	Interrupt Status Register 2	D2	D1	F4P	FAN3	FAN2	FAN1	OVT	12 V/VC	0x00	–

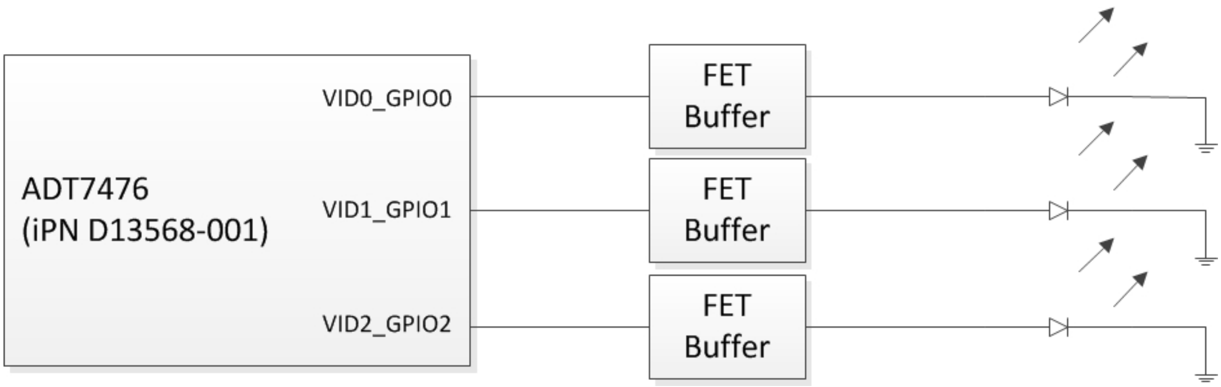

Figure 25. Fan Fault LED Block Diagram

4.2 Mechanical Overview

The physical size of the power supply enclosure is 39/40mm x 74mm x 185mm. The power supply contains a single 40mm fan. The power supply has a card edge output that interfaces with a 2x25 card edge connector in the system. The AC plugs directly into the external face of the power supply.

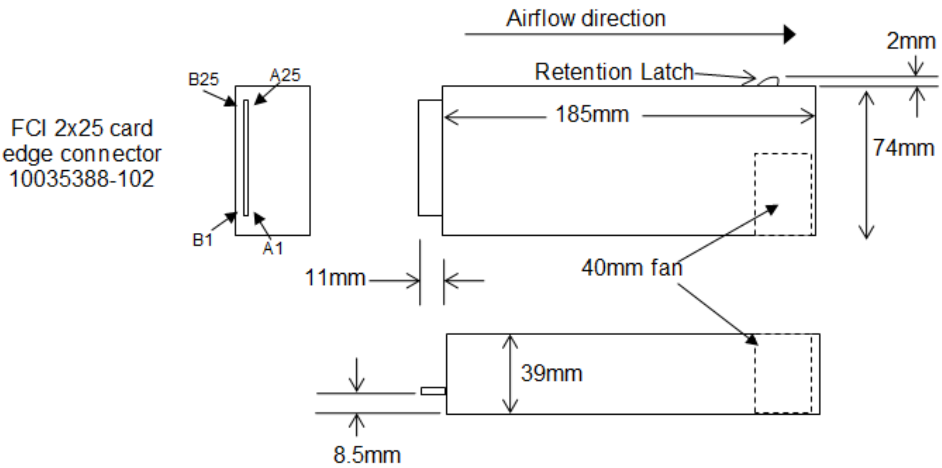

Figure 26. Power Supply Module Mechanical Drawing

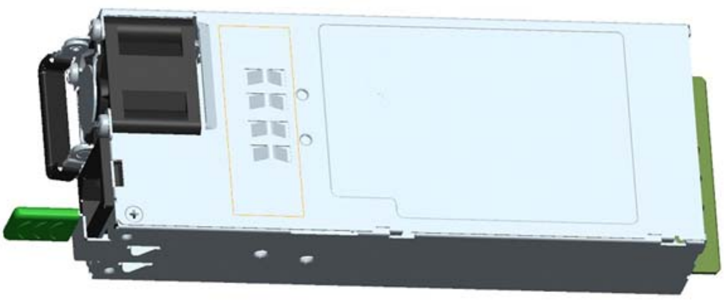

Figure 27. Power Supply Module

Figure 28. AC Power Supply – Connector View

4.3 Power Connectors

4.3.1 Power Supply Module Card Edge Connector

Each power supply module has a single 2x25 card edge output connection that plugs directly into a matching slot connector on the server board. The connector provides both power and communication signals to the server board. The following table defines the connector pin-out.

Table 9. Power Supply Module Output Power Connector Pin-out

Pin	Name	Pin	Name
A1	GND	B1	GND
A2	GND	B2	GND
A3	GND	B3	GND
A4	GND	B4	GND
A5	GND	B5	GND
A6	GND	B6	GND
A7	GND	B7	GND
A8	GND	B8	GND
A9	GND	B9	GND
A10	+12V	B10	+12V
A11	+12V	B11	+12V
A12	+12V	B12	+12V
A13	+12V	B13	+12V
A14	+12V	B14	+12V
A15	+12V	B15	+12V
A16	+12V	B16	+12V
A17	+12V	B17	+12V
A18	+12V	B18	+12V
A19	PMBus SDA	B19	A0 (SMBus address)
A20	PMBus SCL	B20	A1 (SMBus address)
A21	PSON	B21	12V stby
A22	SMBAlert#	B22	Cold Redundancy Bus
A23	Return Sense	B23	12V Load Share Bus
A24	+12V Remote Sense	B24	No Connect
A25	PWOK	B25	Compatibility Check pin*

The JBOD's PDB provides several connectors to provide power to various system options. The following sub-sections identify the location, provide the pin-out definition, and provide a brief usage description for each.

4.3.2 Hot-Swap Backplane Power Connector

The JDOB's PDB board includes four white 2x4-pin power connectors, used to provide power to the hot-swap backplanes. On the JBOD PDB, this connector is labeled as "HSBP PWR". The following table provides the pin-out for this connector.

Table 10. Hot-swap Backplane Power Connector Pin-out ("HSBP PWR")

Pin	Signal Description	Pin	Signal Description
1	Ground	5	P12V_240VA
2	Ground	6	P12V_240VA
3	Ground	7	P12V_240VA
4	Ground	8	P12V_240VA

4.4 Power Supply Module Efficiency

The following table provides the required minimum efficiency level at various loading conditions. These are provided at four different load levels: 100%, 50%, 20%, and 10%. Efficiency is tested over an AC input voltage range of 115 VAC to 220 VAC.

Table 11. 460 Watt Power Supply Efficiency (Gold)

Loading	100% of Maximum	50% of Maximum	20% of Maximum	10% of Maximum
Minimum efficiency	88%	92%	88%	80%

4.5 AC Power Cord Specification Requirements

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

Table 12. AC Power Cord Specifications

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

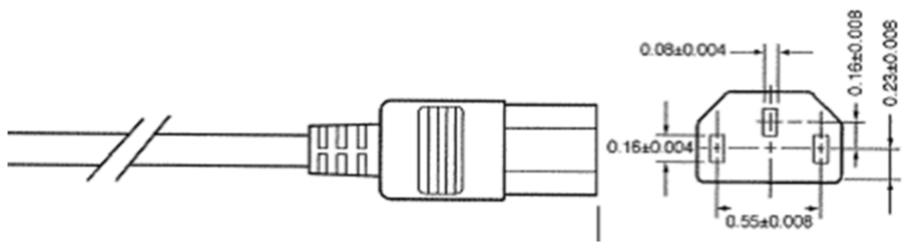

Figure 29. AC Power Cord

4.6 AC Input Specifications

4.6.1 Power Factor

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

Table 13. Power Factor

Output Power	10% Load	20% Load	50% Load	100% Load
Power factor	> 0.65	> 0.80	> 0.90	> 0.95

Tested at 230VAC, 50Hz and 60Hz and 115VAC, 60Hz

4.6.2 AC Input Voltage Specification

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

Table 14. AC Input Voltage Range

Parameter	Min	Rated	Vmax	Start-up VAC	Power-off VAC
Voltage (110)	90 Vrms	100-127 Vrms	140 Vrms	85VAC +/-4VAC	70VAC +/-5VAC
Voltage (220)	180 Vrms	200-240 Vrms	264 Vrms		
Frequency	47 Hz	50/60 Hz	63 Hz		

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

4.6.3 AC Line Isolation Requirements

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

4.6.4 AC Line Dropout/Holdup

An AC line dropout is defined to be when the AC input drops to 0VAC at any phase of the AC line for any length of time. During an AC dropout the power supply meets dynamic voltage regulation requirements. An AC line dropout of any duration does not cause tripping of control signals or protection circuits. If the AC dropout lasts longer than the holdup time, the power supply will recover and meet all turn-on requirements. The power supply meets the AC dropout requirement over rated AC voltages and frequencies. A dropout of the AC line for any duration does not cause damage to the power supply.

Table 15. AC Line Dropout/Holdup

Loading	Holdup Time
70%	12msec

4.6.4.1 AC Line 12VSB Holdup

The 12VSB output voltage stays in regulation under its full load (static or dynamic) during an AC dropout of **70ms min** (=12VSB holdup time) whether the power supply is in ON or OFF state (PSON asserted or de-asserted).

4.6.5 AC Line Fuse

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

4.6.6 AC Inrush

The AC line inrush current does not exceed **55A peak**, for up to one-quarter of the AC cycle, after which, the input current is no more than the specified maximum input current. The peak inrush current is less than the ratings of its critical components (including input fuse, bulk rectifiers, and surge limiting device).

The power supply meets the inrush requirements for any rated AC voltage, during turn-on at any phase of AC voltage, during a single cycle AC dropout condition as well as upon recovery after AC dropout of any duration, and over the specified temperature range (T_{op}).

4.6.7 AC Line Transient Specification

The AC line transient conditions are defined as sag and surge conditions. Sag conditions are also commonly referred to as “brownout”; these conditions are defined as the conditions when the AC line voltage drops below nominal voltage. Surge conditions are defined as the conditions when the AC line voltage rises above nominal voltage.

The power supply meets the requirements under the following AC line sag and surge conditions.

Table 16. AC Line Sag Transient Performance

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

Table 17. AC Line Surge Transient Performance

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

4.6.8 Susceptibility Requirements

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

Table 18. Performance Criteria

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

4.6.9 Electrostatic Discharge Susceptibility

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

4.6.10 Fast Transient/Burst

The power supply complies with the limits defined in EN 55024: 1998/A1: 2001/A2: 2003 using the IEC 61000-4-4: Second edition: 2004-07 test standard and performance criteria B defined in Annex B of CISPR 24.

4.6.11 Radiated Immunity

The power supply complies with the limits defined in EN 55024: 1998/A1: 2001/A2: 2003 using the IEC 61000-4-3: Edition 2.1: 2002-09 test standard and performance criteria A defined in Annex B of CISPR 24.

4.6.12 Surge Immunity

The power supply is tested with the system for immunity to AC unidirectional wave, 2kV line to ground and 1kV line to line, per EN 55024: 1998/A1: 2001/A2: 2003, EN 61000-4-5: Edition 1.1:2001-04.

The pass criteria include: no unsafe operation is allowed under any condition; all power supply output voltage levels to stay within proper spec levels; no change in operating state or loss of data during and after the test profile; no component damage under any condition.

The power supply complies with the limits defined in EN 55024: 1998/A1: 2001/A2: 2003 using the IEC 61000-4-5: Edition 1.1:2001-04 test standard and performance criteria B defined in Annex B of CISPR 24.

4.6.13 Power Recovery

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

4.6.14 Voltage Interruptions

The power supply complies with the limits defined in EN 55024: 1998/A1: 2001/A2: 2003 using the IEC 61000-4-11: Second Edition: 2004-03 test standard and performance criteria C defined in Annex B of CISPR 24.

4.6.15 Protection Circuits

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

4.6.16 Over Current Protection (OCP)

The power supply has a current limit to prevent the outputs from exceeding the values shown in the table below. If the current limit is exceeded, the power supply will shut down and latch off. The latch will be cleared by toggling the PSON# signal or by an AC power interruption. The power supply will not be damaged from repeated power cycling in this condition. 12VSB will be auto-recovered after removing the OCP limit.

Table 19. 460 Watt Power Supply Over Current Protection

Output Voltage	Input Voltage Range	Over Current Limit
+12V	90–264VAC	47A min; 55A max
12VSB	90–264VAC	2A min; 2.5A max

4.6.17 Over Voltage Protection (OVP)

The power supply over voltage protection is locally sensed. The power supply will shut down and latch off after an over voltage condition occurs. This latch will be cleared by toggling the PSON# signal or by an AC power interruption. The values are measured at the output of the power supply's connectors. The voltage never exceeds the maximum levels when measured at the power connectors of the power supply connector during any single point of fail. The voltage never trips any lower than the minimum levels when measured at the power connector. 12VSB will be auto-recovered after removing the OVP limit.

Table 20. Over Voltage Protection (OVP) Limits

Output Voltage	Min (V)	Max (V)
+12V	13.3	14.5
12VSB	13.3	14.5

4.6.18 Over Temperature Protection (OTP)

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

4.7 Cold Redundancy Support

Power supplies that support cold redundancy can be enabled to go into a low-power state (that is, cold redundant state) in order to provide increased power usage efficiency when system loads are such that both power supplies are not needed. When the power subsystem is in Cold Redundant mode, only the needed power supply to support the best power delivery efficiency is ON. Any additional power supplies, including the redundant power supply, are in Cold Standby state.

Each power supply has an additional signal that is dedicated to supporting Cold Redundancy, CR_BUS. This signal is a common bus between all power supplies in the system. CR_BUS is asserted when there is a fault in any power supply or the power supplies output voltage falls below the V_{fault} threshold. Asserting the CR_BUS signal causes all power supplies in Cold Standby state to power ON.

Enabling power supplies to maintain best efficiency is achieved by looking at the Load Share bus voltage and comparing it to a programmed voltage level via a PMB bus command.

Whenever there is no active power supply on the Cold Redundancy bus driving a HIGH level on the bus, all power supplies are ON no matter their defined Cold Redundant roll (active or Cold Standby). This guarantees that incorrect programming of the Cold Redundancy states of the power supply will never cause the power subsystem to shut down or become over loaded. The default state of the power subsystem is all power supplies ON. There needs to be at least one power supply in Cold Redundant Active state or Standard Redundant state to allow the Cold Standby state power supplies to go into Cold Standby state.

4.7.1 Powering on Cold Standby Supplies to Maintain Best Efficiency

Power supplies in Cold Standby state monitor the shared voltage level of the load share signal to sense when it needs to power on. Depending upon which position (1, 2, or 3) the system defines that the power supply to be in the cold standby configuration, the system will slightly change the load share threshold that the power supply will power on at.

Table 21. Example Load Share Threshold for Activating Supplies

	Enable Threshold for $V_{CR\_ON\_EN}$	Disable Threshold for $V_{CR\_ON\_DIS}$	CR_BUS De-asserted / Asserted States
Standard Redundancy	NA; Ignore dc/dc_ active# signal; power supply is always ON		OK = High Fault = Low
Cold Redundant Active	NA; Ignore dc/dc_ active# signal; power supply is always ON		OK = High Fault = Low
Cold Standby 1 (02h)	3.2V (40% of max)	3.2V x 0.5 x 0.9 = 1.44V	OK = Open Fault = Low
Cold Standby 2 (03h)	5.0V (62% of max)	5.0V x 0.67 x 0.9 = 3.01V	OK = Open Fault = Low
Cold Standby 3 (04h)	6.7V (84% of max)	6.7V x 0.75 x 0.9 = 4.52V	OK = Open Fault = Low

Notes:

Maximum load share voltage = 8.0V at 100% of rated output power
These are example load share bus thresholds; for a given power supply, these shall be customized to maintain the best efficiency curve for that specific model.

4.7.2 Powering on Cold Standby Supplies during a Fault or Over Current Condition

When an active power supply asserts its CR_BUS signal (pulling it low), all parallel power supplies in a cold standby mode will power on within 100 µsec.

4.7.3 Power Supply Turn On Function

Powering on and off the cold standby power supplies is only controlled by each PSU sensing the V_{share} bus. After a power supply turns on after crossing the enable threshold, it lowers its threshold to the disable threshold. The system defines the "position" of each power supply in the Cold Redundant operation. It will do this each time the system is powered on, a power supply fails, or a power supply is added to the system.

The system is relied upon to tell each power supply where it resides in the Cold Redundancy scheme.

4.8 Power Supply Status LED

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

Table 22. LED Indicators

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

5. Thermal Management

The Intel® Storage Server System JBOD 2000 Family is designed to operate at external ambient temperatures of between 10ºC and 35ºC with limited excursion-based operation up to 45ºC and limited performance impact. Working with integrated platform management, several features within the system are designed to move air in a front-to-back direction, through the system and over critical components to prevent them from overheating and allow the system to operate with best performance.

The installation and functionality of several JBOD components are used to maintain system thermals. They include up to three managed 60-mm system fans and one integrated 40-mm fan for each installed power supply module. Hard drive carriers can be populated with a hard drive or supplied drive blank.

5.1 Thermal Operation and Configuration Requirements

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

- The system operating ambient is designed for sustained operation up to 35ºC (ASHRAE Class A2) with short-term excursion-based operation up to 45ºC (ASHRAE Class A4).
  - The system can operate up to 40ºC (ASHRAE Class A3) for up to 900 hours per year.
  - The system can operate up to 45ºC (ASHRAE Class A4) for up to 90 hours per year.
  - System performance may be impacted when operating within the extended operating temperature range.
  - There is no long-term system reliability impact when operating at the extended temperature range within the approved limits.
- All hard drive bays must be populated. Hard drive carriers can be populated with a hard drive or supplied drive blank.
- In single power supply configurations, the second power supply bay must have the supplied filler blank installed at all times.
- The system must be configured with dual power supplies for the system to support fan redundancy.
- The system top cover must be installed at all times when the system is in operation. The only exception to this requirement is to hot replace a failed system fan, in which case the top cover can be removed for no more than three minutes at a time.

5.2 Thermal Management Overview

In order to maintain the necessary airflow within the system, all of the previously listed components and top cover need to be properly installed. For best system performance, the external ambient temperature should remain below 35ºC and all system fans should be operational. The system is designed for fan redundancy when the system is configured with two power supplies.

5.3 Thermal Sensor Input for Fan Speed Control

The power distribution board uses various sensors as inputs to fan speed control. Some of the sensors are actual physical sensors and some are virtual sensors derived from calculations.

The following thermal sensor is used as an input to fan speed control:

- Front Panel Temperature Sensor

5.4 System Fans

Three 60x38-mm fans and an embedded fan for each installed power supply, provide the primary airflow for the system. The system is designed for fan redundancy when configured with two power supply modules. If a single fan fails (system fan or power supply fan), platform management will adjust the airflow of the remaining fans and manage other platform features to maintain system thermals. Fan redundancy is lost if more than one fan is in a failed state.

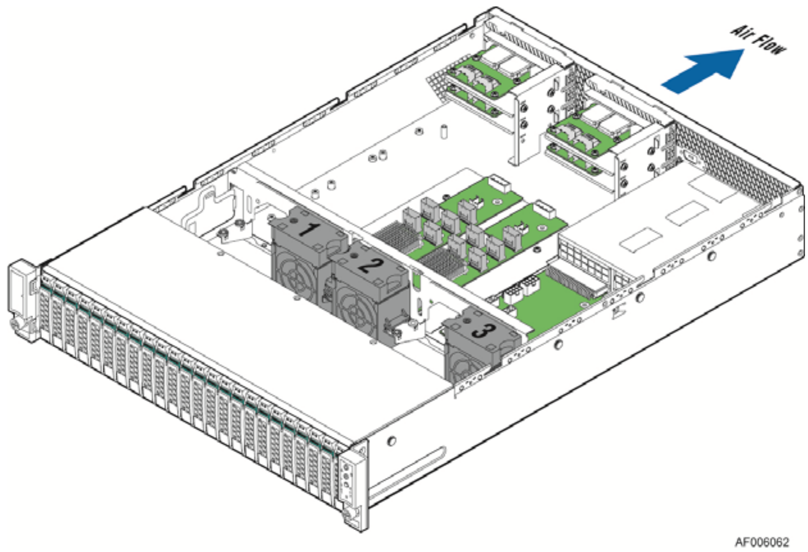

Figure 30. System Fan Identification

The system fan assembly is designed for ease of use and supports several features:

- Each fan is hot-swappable.
- Each fan is designed for tool-less insertion and extraction from the fan assembly. For instructions on installing or removing a fan module, see the *Intel® JBOD 2000 Family Service Guide*.
- Fan speed for each fan is controlled by integrated platform management controlled by the PDB board. When system thermals fluctuate high and low, the PDB firmware will increase or decrease the speeds of specific fans within the fan assembly to regulate system thermals.
- Each fan has a tachometer signal that allows the PDB to monitor its status.
- On top of each fan is an integrated fault LED, although currently this feature is not supported.

- Each fan has a 10-pin wire harness that connects to a matching connector on the PDB.

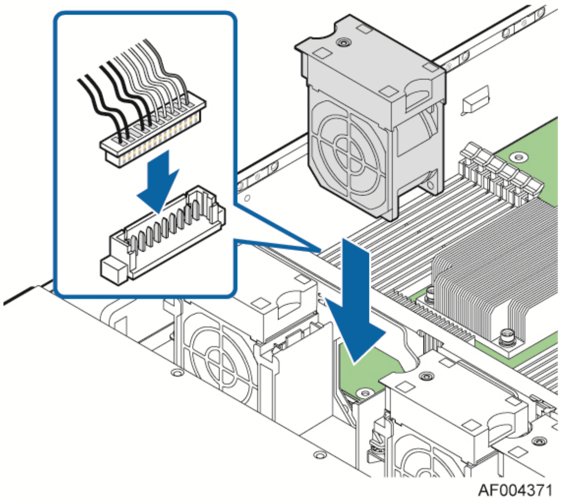

Figure 31. System Fan Assembly

Table 23. System Fan Connector Pin-out

SYS_FAN 1		SYS_FAN 2		SYS_FAN 3	
Pin#	Signal Description	Pin#	Signal Description	Pin#	Signal Description
1	FAN_TACH1_IN	1	FAN_TACH3_IN	1	FAN_TACH5_IN
2	FAN_BMC_PWM0_R_BUF	2	FAN_BMC_PWM1_R_BUF	2	FAN_BMC_PWM2_R_BUF
3	P12V_FAN	3	P12V_FAN	3	P12V_FAN
4	P12V_FAN	4	P12V_FAN	4	P12V_FAN
5	FAN_TACH0_IN	5	FAN_TACH2_IN	5	FAN_TACH4_IN
6	GROUND	6	GROUND	6	GROUND
7	GROUND	7	GROUND	7	GROUND
8	FAN_SYS0_PRSNT_N	8	FAN_SYS1_PRSNT_N	8	FAN_SYS2_PRSNT_N
9	LED_FAN_FAULT0_R	9	LED_FAN_FAULT1_R	9	LED_FAN_FAULT2_R
10	LED_FAN0	10	LED_FAN1	10	LED_FAN2

5.5 Power Supply Module Fan

Each installed power supply module includes one embedded (non-removable) 40-mm fan. It is responsible for airflow through the power supply module. If this fan fails, the power supply will continue to operate until its internal temperature reaches an upper critical limit. The power supply will be protected against over temperature conditions caused by loss of fan cooling or excessive ambient temperature. In an over temperature protection condition, the power supply module will shut down.

6. JBOD 2000 Internal Connection Overview

The Intel® Storage Server System JBOD 2000 contains the SAS expander board, power distribution board, HSBP, SAS interface board, and fans in its chassis. This chapter provides specification of the SAS expander board and SAS converter, and interconnection between those components.

6.1 Expander Board

The Intel 36-port expander is mounted vertically in the chassis and is designed on LSI's Bobcat expander technology. The expander has nine SFF8087 mini-SAS connectors that connect to either the backplane or the SAS converter boards via SFF8087 to SFF8087 cables. The dual-port backplane of the JBOD contains two 36-port expanders, while the single-port backplane contains one 36-port expander.

Features of the Intel® RAID Expander are as follows:

- SAS protocol, described in the Serial Attached SCSI (SAS) Standard, version 2.0
- Serial SCSI Protocol (SSP) to enable communication with other SAS devices
- Serial Tunneling Protocol (STP) support for SATA II through expander interfaces
- Serial Management Protocol (SMP) to share topology management information with expanders
- Supports SES for enclosure management
- Output mini-SAS connectors support sideband SGPIO as per SFF-8485 specification
- Supports both Serial Attached SCSI and Serial ATA device targets
- 6.0 Gb/s, 3.0 Gb/s, and 1.5 Gb/s data transfer rate
- SFF-8087 mini-SAS connectors
- Provides a low-latency connection to create and maintain transparent access to each connected SAS/SATA physical drive
- Staggered spin-up
- Hot-plug
- Native Command Queuing
- Allows multiple initiators to address a single target (in a fail-over configuration)

All JBOD SKUs use the 36-port SAS expander card. Single-port JBOD 2000 SKU has one 36-port SAS expander card; dual-port JBOD 2000 SKU has two 36-port expander cards.

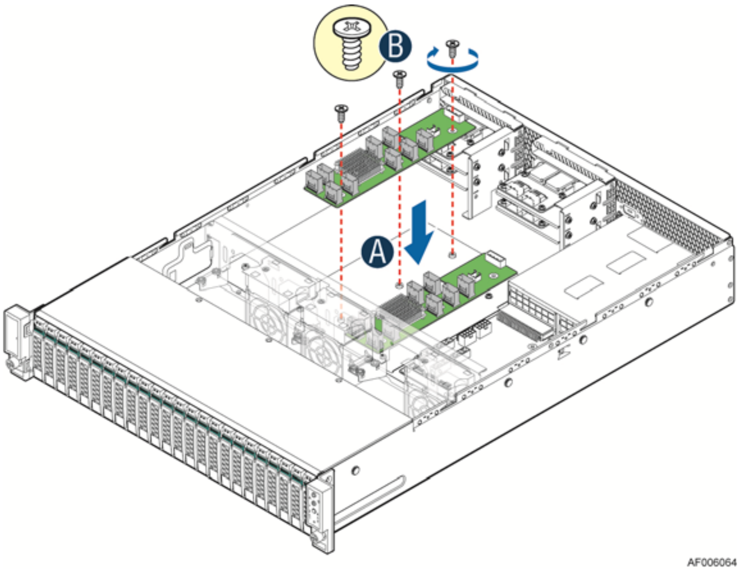

Figure 32. Internal SAS Expander Location

6.2 JBOD SAS Interface Board

The JBOD SAS interface board is an independent product – Intel® 8087-8088 Cable Connector Converter AXXSAS88CNVRT converts two internal SFF8087 x4 mini-SAS connectors to two external SFF8088 SAS x4 connectors. The 8x ports of 6Gb SAS can be supported with this adapter.

The converter includes a PCI mounting bracket that allows the converter to be mounted and retained in a rear panel PCI mounting location.

No power rails, power consumers, or temperature sensors are on the JBOD SAS interface board.

6.2.1 JBOD SAS Interface Board Port Numbering

Following is a suggestion for the JBOD SAS interface board port numbering for internal and external connections.

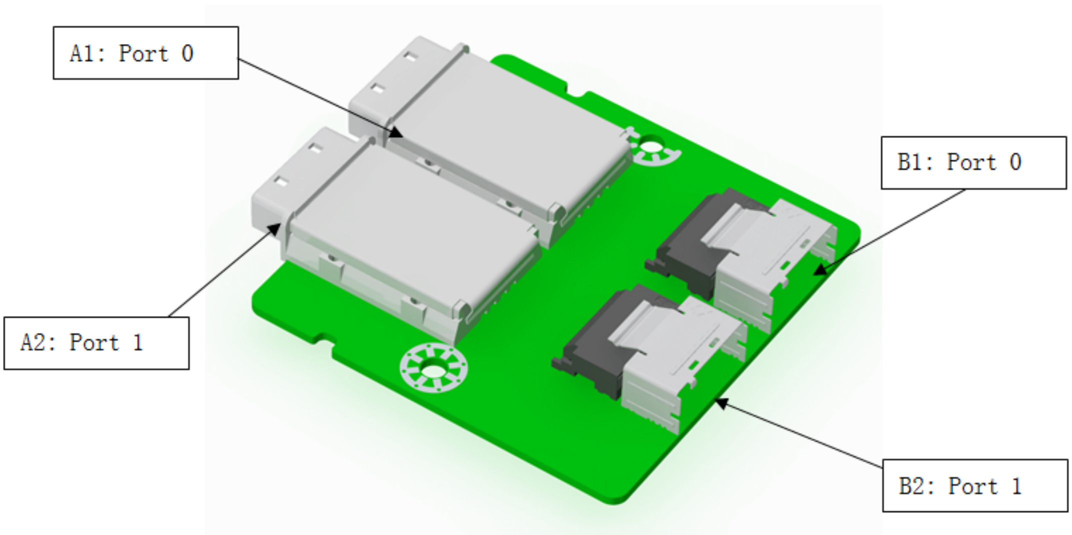

Figure 33. JBOD 2000 SAS Interface Board Port Number

Item	Description
A1	External SFF 8088 connector 0. Internally wired to B1.
A2	External SFF 8088 connector 1. Internally wired to B2.
B1	Internal SFF 8087 connector 0. Internally wired to A1
B2	Internal SFF 8087 connector 1. Internally wired to A2.

6.3 Pin-outs

See the SAS Gen2 specification for correct pin-out for the SAS internal and external connectors. The connection between the internal mini-SAS and external mini-SAS needs to be one-to-one direct connection of differential pairs with length matching on the board. The internal mini-SAS connectors should use the controller mini-SAS pin-out. The sideband signals within the internal mini-SAS connectors need to conform to the SFF-8448 specification. You do not need to do the pull-ups or pull-downs on any sideband signals (including sideband 6 and 7) when cabling externally; sidebands are only for potential debug purposes on this board.

See the following pin-out for SGPIO debug headers.

Table 24. SGPIO Headers Pin-out

Ref Des	Description
-	1x5-pin SATA SGPIO
Pin	Signal Description
1	SGPIO_CLOCK_0
2	SGPIO_LOAD_0
3	GND
4	SGPIO_DATAOUT_0
5	SGPIO_DATAIN_0

6.3.1 JBOD2312S2SP Interconnection

The Intel® Storage Server System JBOD2312S2SP has a 12x3.5" single-port HSBP, a primary SAS expander, a dual-port SAS interface board, a PDB, a PSU, and three fans in its chassis.

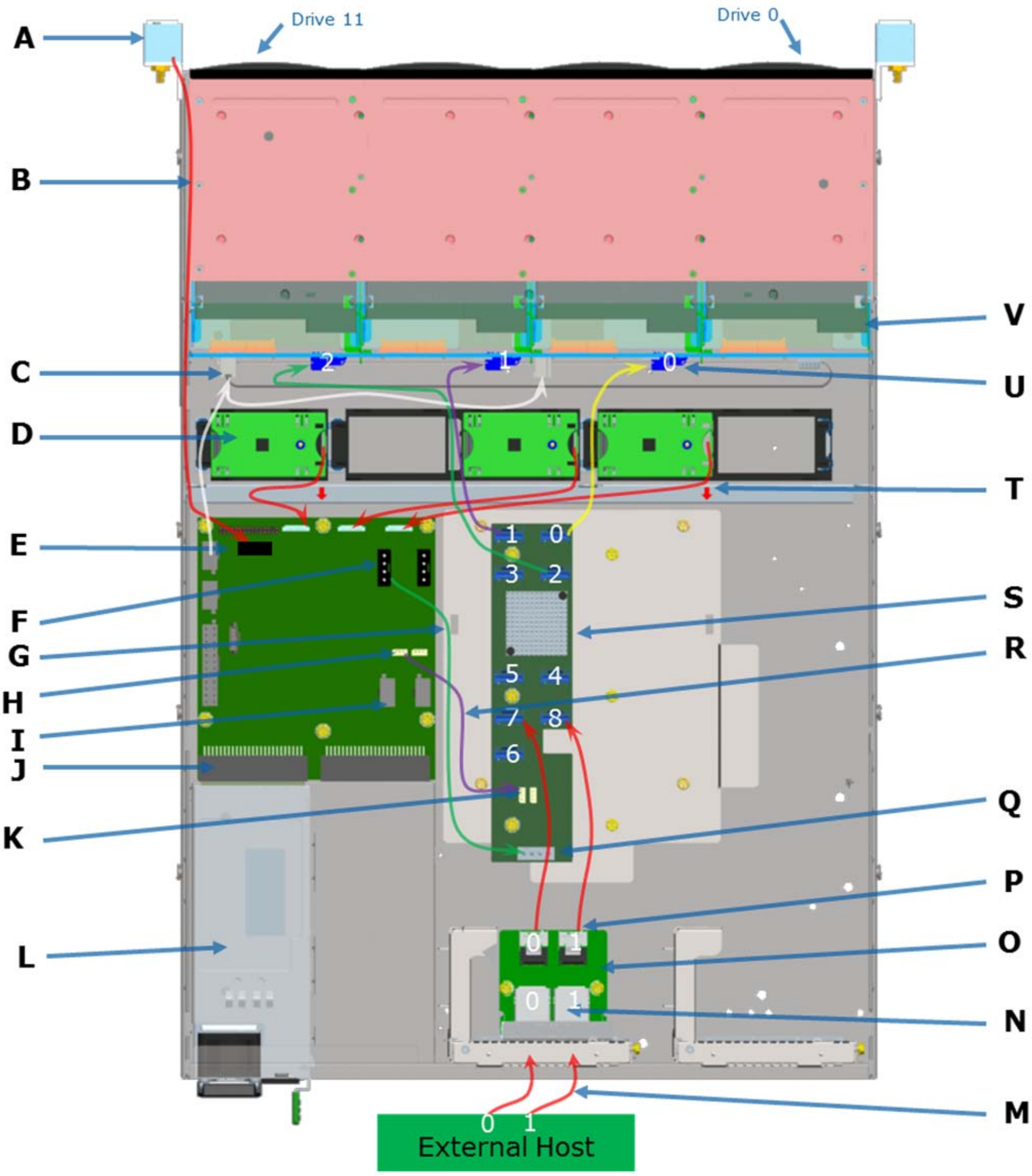

Figure 34. 12x3.5" Single-port JBOD 2000 Interconnection Diagram

Table 25. 12x3.5" Single-port JBOD 2000 Internal Components

Label	Description	Label	Description
A	Front Panel	B	Front Panel Cable
C	HSBP Power Daisy Chain Cable	D	Three 60mm System Fans
E	2x15-pin Front Panel Connector on PDB	F	1x4-pin Expander Power Connector on PDB
G	Expander Power Cable	H	SMBus Connector on PDB
I	Four 2x4-pin HSBP Power Connectors on PDB	J	2x25-pin PSU Connector on PDB
K	SMBus Connector on Expander	L	PSU
M	External mini-SAS Cable (need to order separately)	N	SFF-8088 Connector on SAS Converter 0 Port Label: A PRI 1 Port Label: B PRI
O	Primary SAS Interface Board (SFF-8087 to SFF-8088)	P	SFF-8087 Connector on SAS Converter
Q	Expander Power Connector on Expander	R	SMBus Cable
S	Primary SAS Expander	T	Fan Cable
U	Three mini-SAS Connectors on HSBP with port number	V	12x 3.5" HSBP

The following diagram is used to help identify the mini-SAS connectors found on the SAS expander cards. Take care when connecting the connectors from the SAS expander to the connectors on the backplane because each connector is pre-programmed at the factory to provide specific drive identification mapping. Improper connections may provide undesirable drive mappings. By default, the Intel® Storage Server System JBOD 2000 Family has all internal mini-SAS cables connected.

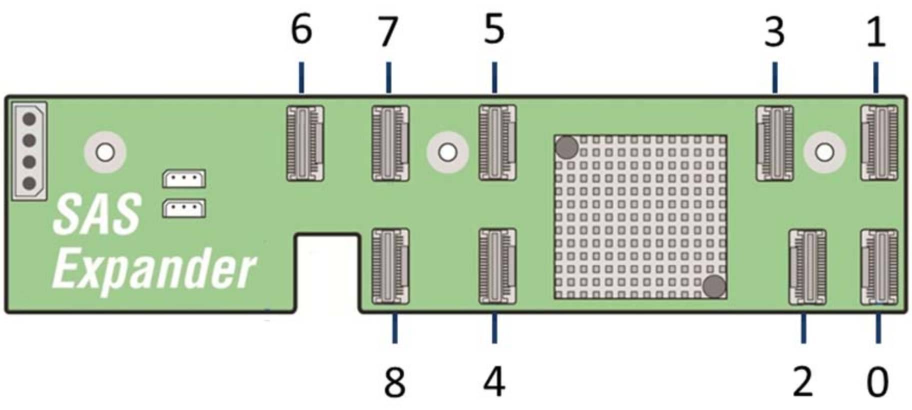

Figure 35. Primary SAS Expander

Table 26. Primary SAS Expander in 12x3.5" Single-port JBOD 2000 Connector Mapping

Primary SAS Expander Label	Interconnection
Port 0	To Backplane Port 0
Port 1	To Backplane Port 1
Port 2	To Backplane Port 2
Port 3	N/A
Port 4	N/A
Port 5	N/A
Port 6	N/A
Port 7	To Primary SAS Interface Board Internal Port 0
Port 8	To Primary SAS Interface Board Internal Port 1

6.3.2 JBOD2224S2DP Interconnection

The Intel® Storage Server System JBOD2224S2DP has three 8x2.5" dual-port HSBPs, two SAS expanders, three dual-port SAS interface boards, a PDB, two PSUs, and three fans in its chassis.

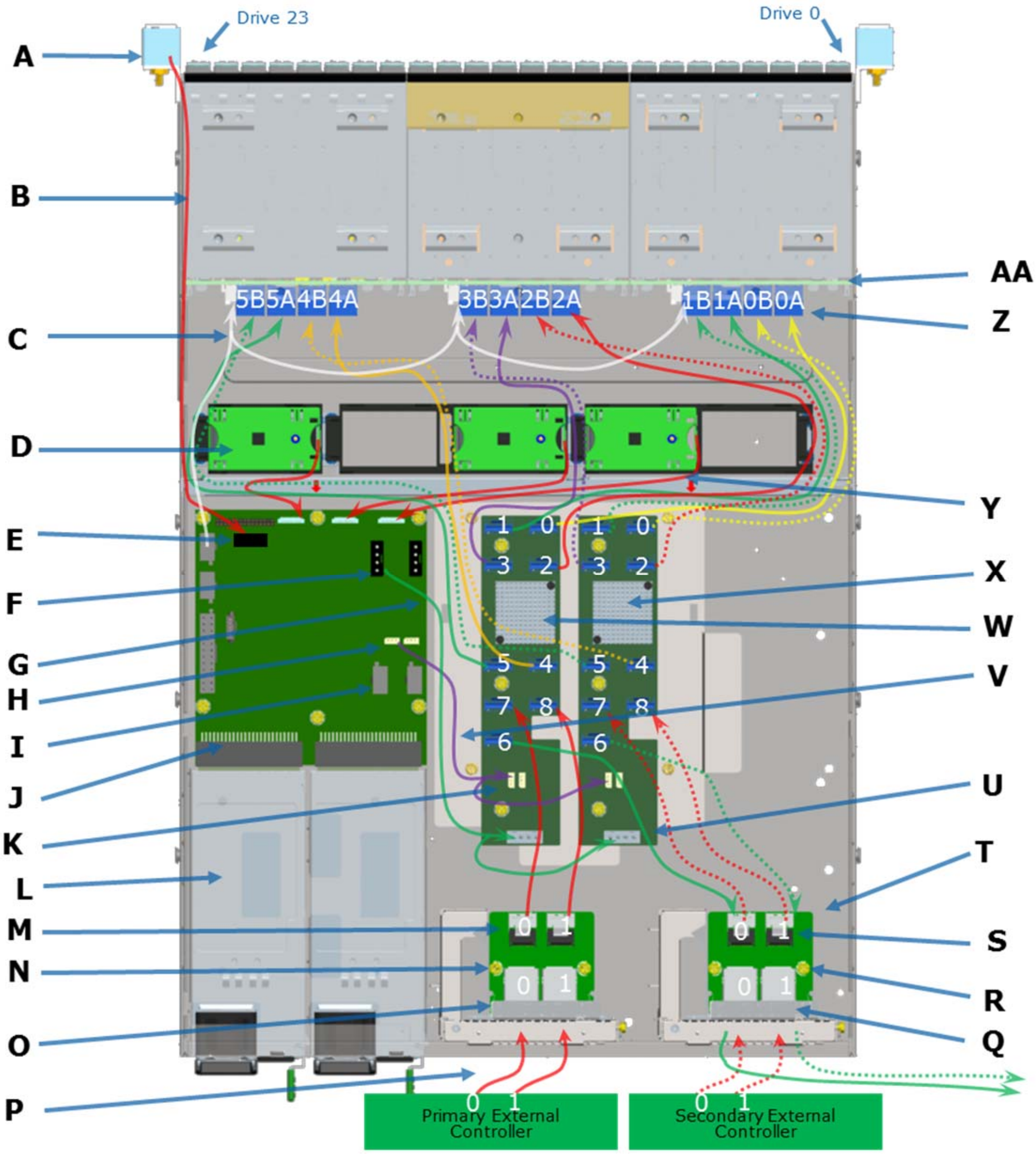

Figure 36. 2U 24x2.5" Dual-port JBOD2000 Interconnection Diagram

Table 27. 2U 24x2.5" Dual-port JBOD2000 Components

Label	Description	Label	Description
A	Front Panel	B	Front Panel Cable
C	HSBP Power Daisy Chain Cable	D	Three 60mm System Fans
E	2x15-pin Front Panel Connector on PDB	F	1x4-pin Expander Power Connector on PDB
G	Expander Power Cable	H	SMBus Connector on PDB
I	Four 2x4-pin HSBP Power Connectors on PDB	J	2x25-pin PSU Connector on PDB
K	SMBus Connector on Primary and Second Expander	L	Two PSUs
M	SFF-8087 Connector on Primary SAS Converter	N	Primary SAS Interface Board (SFF-8087 to SFF-8088)
O	SFF-8088 Connector on Primary SAS Converter Port 0 Label: A PRI Port 1 Label: B PRI	P	External mini-SAS Cable (need to order separately)
Q	SFF-8088 Connector on Second SAS Converter Port 0 Label: A SEC Port 1 Label: B SEC	R	Second SAS Interface Board (SFF-8087 to SFF-8088)
S	SFF-8087 Connector on Second SAS Converter	T	Third SAS Interface Board (SFF-8087 to SFF-8088) **Note**: It is under the second SAS converter, so it is not shown in the diagram. Its external SFF-8088 connector label is Port 0: C PRI, Port 1: C SEC.
U	Expander Power Connector on Primary and Second Expander	V	SMBus Cable
W	Primary SAS Expander	X	Second SAS Expander
Y	Fan Cable	Z	12 mini-SAS Connectors on HSBP
AA	Three 8x 2.5" Dual-port HSBPs (each HSBP has four mini-SAS connectors)		

The following diagram is used to help identify the mini-SAS connectors found on the SAS expander cards. Take care when connecting the connectors from the SAS expander to the connectors on the backplane because each connector is pre-programmed at the factory to provide specific drive identification mapping. Improper connections may provide undesirable drive mappings. By default, the Intel® Storage System JBOD 2000 Family has all internal mini-SAS cables connected.

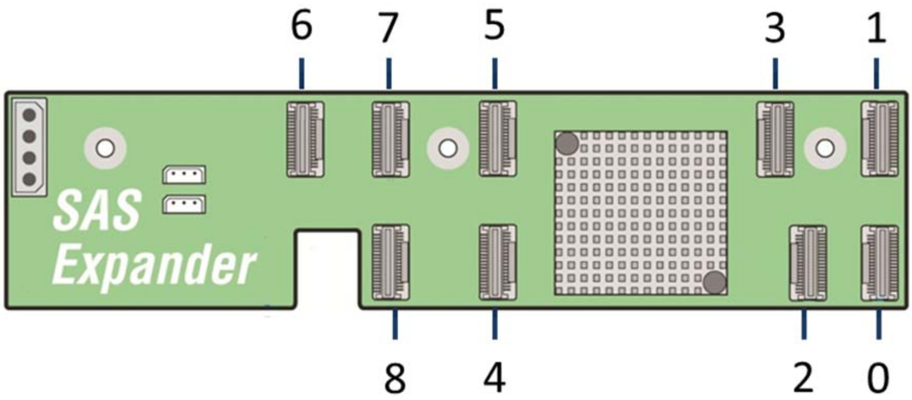

Figure 37. Primary SAS Expander

Table 28. Primary SAS Expander in 24x2.5" Dual-port JBOD 2000 Connector Mapping

Primary SAS Expander Label	Interconnection
Port 0	To Backplane Port 0A
Port 1	To Backplane Port 1A
Port 2	To Backplane Port 2A
Port 3	To Backplane Port 3A
Port 4	To Backplane Port 4A
Port 5	To Backplane Port 5A
Port 6	To Third SAS Interface Board Internal Port 0
Port 7	To Primary SAS Interface Board Internal Port 0
Port 8	To Primary SAS Interface Board Internal Port 1

Table 29. Second SAS Expander in 24x2.5" Dual-port JBOD 2000 Connector Mapping

Second SAS Expander Label	Interconnection
Port 0	To Backplane Port 0B
Port 1	To Backplane Port 1B
Port 2	To Backplane Port 2B
Port 3	To Backplane Port 3B
Port 4	To Backplane Port 4B
Port 5	To Backplane Port 5B
Port 6	To Third SAS Interface Board Internal Port 1
Port 7	To Second SAS Interface Board Internal Port 0
Port 8	To Second SAS Interface Board Internal Port 1

7. JBOD 2000 External SAS Connection Mode Overview

The Intel® Storage Server System JBOD 2000 Family supports connection to many different external SAS HBA and SAS RAID controller solutions, to achieve single JBOD connection, multiple JBODs daisy chain connection, and failover connections. This section provides an overview of the different options available.

7.1 External SAS Controller Support

Our current and future supported controllers are referenced via our JBOD 2000 Family THOL or SCT.

SAS connectivity is via the external SAS connectors (SFF8088); both native SAS HBAs and RAID HBAs are supported.

7.2 External SAS Cable

JBOD 2000 system uses SFF-8088 mini-SAS receptacle, so SFF-8088 mini-SAS cable is needed when connecting the JBOD2000 to host or cascades to other JBOD2000. The following figure is an illustration of SFF-8088 mini-SAS cable.

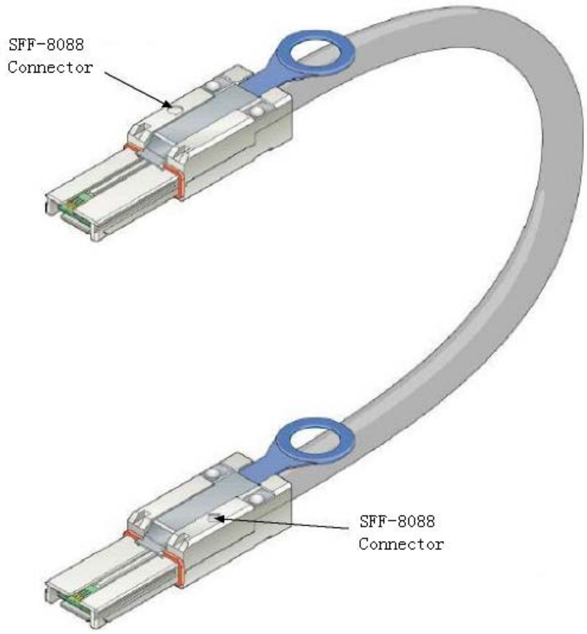

Figure 38. SFF-8088 mini-SAS Cable

According to SAS 2.0 specification, the length of mini-SAS cable has the following rules:

- The 6Gb/s SAS cables work up to 10 meters with DFE (decision feedback equalization).
- The 6Gb/s SAS cables run at less than 6 meters without DFE.
- The 3Gb/s SAS deployments are limited to cable length up to 6 meters.

The standard package of JBOD 2000 system doesn't contain the SFF-8088 mini-SAS cable (you need to order the cable from other vendors). Intel has tested some models of the mini-SAS cable (see Appendix A for the list). However, the mini-SAS cables that JBOD 2000 can support are not limited to that list; users can qualify new cables by themselves.

7.3 Hard Drive Type

JBOD 2000 can support 6Gb/s and 3Gb/s SAS hard drive and SATA hard drive. Some configurations, such as dual-domain SAS or failover cluster, need to take advantage of the dual-port SAS hard drive; SATA hard drive does not support these configurations.

Intel didn't qualify the hard drive models specially for JBOD 2000. Users can connect to JBOD 2000 to select the hard drive model by referring to the THOL of SAS HBA or RAID adapter.

7.4 JBOD Cascade

JBOD cascading is also called daisy-chaining, which means connecting multiple JBOD units to constitute deeper storage pool. How many JBOD 2000 can be cascaded depends on the property of the SAS HBA or RAID adapter that connects to JBOD 2000. However, only two layers of cascaded JBOD 2000 system have been fully validated by Intel. Only cascading the same type of JBOD 2000 is recommended, in order to avoid mixing the single-port and dual-port JBOD 2000 in a JBOD cascade group.

7.5 Single-port JBOD 2000 External Connection Mode

The Intel® Storage Server System JBOD 2000 single-port backplane SKU can support the following external connection modes.

7.5.1 Single JBOD 2000 Connection

Figure 39 shows the SAS HBA or RAID adapter connecting to one single-port JBOD 2000 with one mini-SAS cable. The single controller port incorporates four SAS lanes for a total maximum throughput of 2400MB/s with SAS 2.0 technology. In the figure, the "4\" notation indicates a 4-lane bundled path. Either A PRI or B PRI SAS port on JBOD 2000 can be connected in this scenario. SATA or SAS hard drive can be supported.

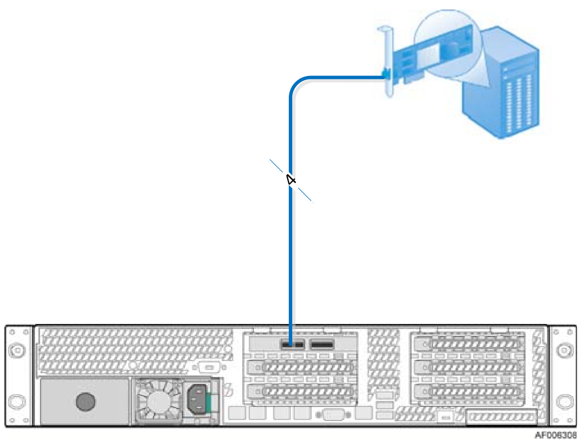

Figure 39. Single JBOD 2000 Connection

7.5.2 Two JBOD 2000 Cascade

Figure 40 shows two cascaded single-port JBOD 2000 connecting to the SAS HBA or RAID adapter with one mini-SAS cable. The function of SAS port "A PRI" and "B PRI" on JBOD 2000 are equivalent. Either "A PRI" or "B PRI" SAS port can be connected to the SAS adapter or cascaded with other JBOD2000 in this scenario. SATA or SAS hard drive can be supported.

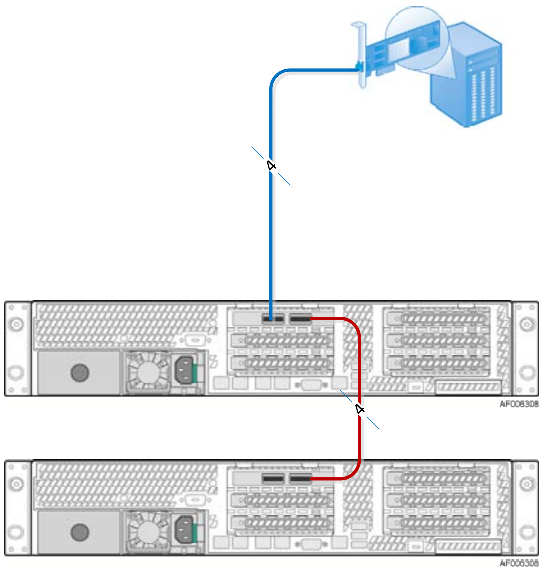

Figure 40. Two Single-port JBOD 2000 Cascade

Figure 41 shows another connection scenario in which the SAS HBA or RAID adapter has two external mini-SAS connectors. Other group of two cascaded single-port JBOD2000 can be connected to the host adapter with one mini-SAS cable. Users can get more storage space with this kind of connection mode.

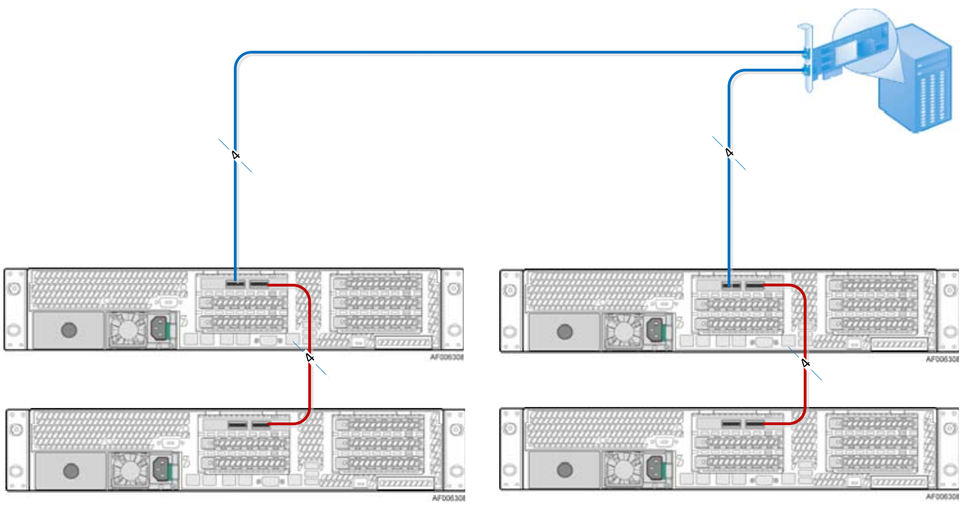

Figure 41. Two Groups of Cascaded Single-port JBOD 2000

7.5.3 Dual-path Connection

Dual-path means a host has redundant pathways to the storage device. When any part of the data pathway to a SAS domain fails, data transfer will not stop. This is one advantage of dual-path connection. Dual-path implementations cost less than dual-domain SAS implementations but do not provide the full redundancy like a dual-domain SAS solution.

Figure 42 shows the dual external mini-SAS connectors of the SAS HBA or RAID adapter connecting to JBOD 2000 with two mini-SAS cables. Each single controller port incorporates four SAS lanes for a total maximum throughput of 2400MB/s with SAS 2.0 technology. SATA or SAS hard drive can be supported. The SAS HBA or RAID adapter can handle either mini-SAS cable disconnection and maintain the data transfer between the host and JBOD 2000.

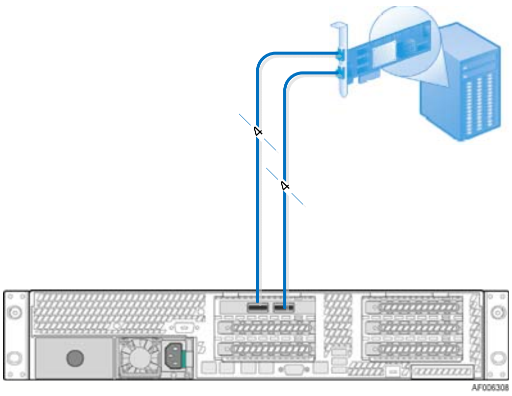

Figure 42. Dual-path Connection

7.5.4 Dual-path with Cascaded JBOD 2000

Dual-path to a single-domain provides tolerance of cable failure. Two single-port JBOD 2000 systems are cascaded with a mini-SAS cable between each "B PRI" SAS port, and a controller connects to each "A PRI" SAS port with two mini-SAS cables. Any mini-SAS cable failure will not stop the data transfer between the host and two JBOD 2000. Both SAS and SATA drives support this configuration.

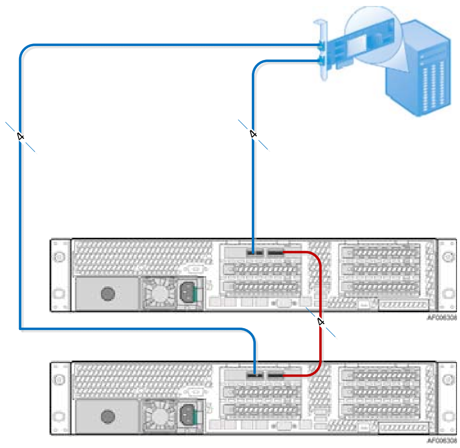

Figure 43. Dual-path with Cascaded JBOD 2000

7.6 Dual-port JBOD 2000 External Connection Mode

The Intel® Storage System JBOD 2000 dual-port SKU is compatible with the single-port JBOD 2000 connection modes in section 7.5. Besides, dual-port JBOD 2000 can support dual-domain SAS connection modes. Dual-domain SAS implementations can tolerate the failures of the SAS controller, external cable, or expander in JBOD 2000. Dual-domain SAS solutions offer higher reliability, performance, and availability. To take advantage of multiple domains, hard drives must be dual-ported and connected to pathways in both domains. The SAS drives can meet this requirement, while the SATA drives usually cannot.

7.6.1 Dual-domain SAS for Dual-port JBOD 2000

Figure 44 shows an example of a 2-connector SAS HBA or RAID adapter capable of dual-domain support. The connectors of the controller connect to “A PRI” and “A SEC” port on JBOD 2000 with two mini-SAS cables. In the figure, the “4\” notation indicates a 4-lane bundled path. This dual-domain SAS configuration can tolerate single port failure on the SAS controller, external cable failure, and failure of the expander in JBOD 2000.

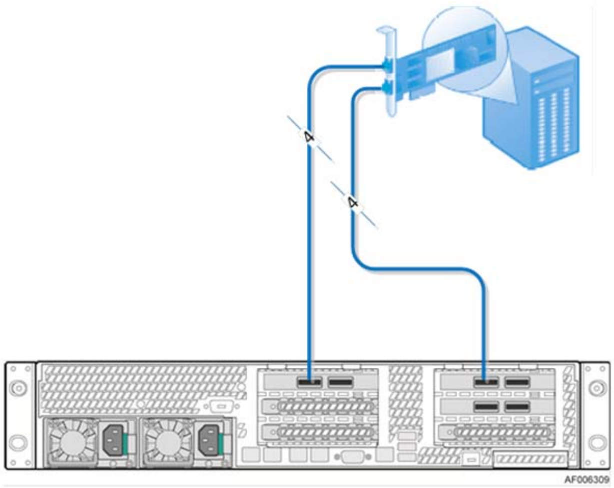

Figure 44. Dual-domain SAS for Dual-port JBOD 2000

The SAS controller in the host can be the single point of failure in the connection mode above. To avoid this, the second SAS controller can be added in the host. Figure 45 shows an example of two SAS controllers connecting to the dual-port JBOD2000. The connectors of the first controller connect to “A PRI” and “A SEC” port on JBOD 2000 with two mini-SAS cables. The connectors of the second controller connect to “B PRI” and “B SEC” port on JBOD2 000 with other two mini-SAS cables.

This kind of connection mode can tolerate SAS controller failure but usually needs additional multipath I/O (MPIO) software support, or using OS native MPIO component. MPIO is a fault-tolerance and performance enhancement technique when there is more than one physical path between the host and storage devices through the connection of the buses, controllers, switches, and bridge devices.

Note: Special FW for the SAS HBA or SAS RAID adapter may be needed for this connection mode.

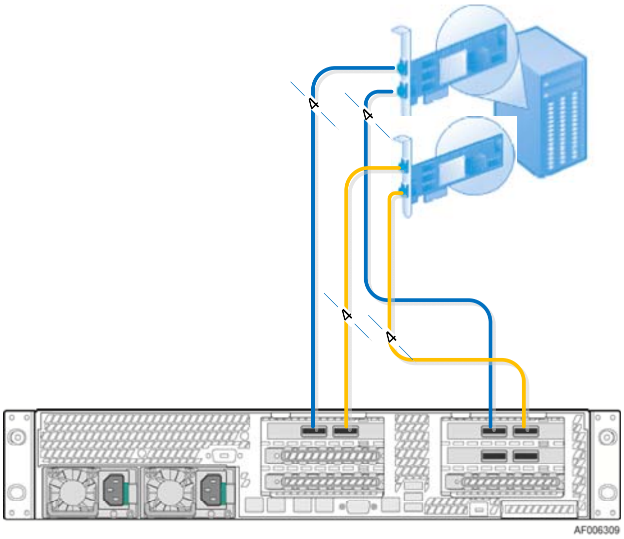

Figure 45. Two SAS Controllers Dual-domain SAS Connection

7.6.2 Dual-domain SAS for Cascaded Dual-port JBOD 2000

This dual-domain SAS architecture provides redundant pathways for two cascaded dual-port JBOD 2000 as in Figure 46. The "C PRI" ports on two JBOD 2000 are connected with one mini-SAS cable, and the "C SEC" ports are connected with another mini-SAS cable (see the red lines in Figure 46). One connector of the SAS controller is connected to "A PRI" port on one JBOD 2000, and the other connector of the controller is connected to "B SEC" on the other JBOD 2000. This connection mode provides redundancy pathways and eliminates any single point of failure.

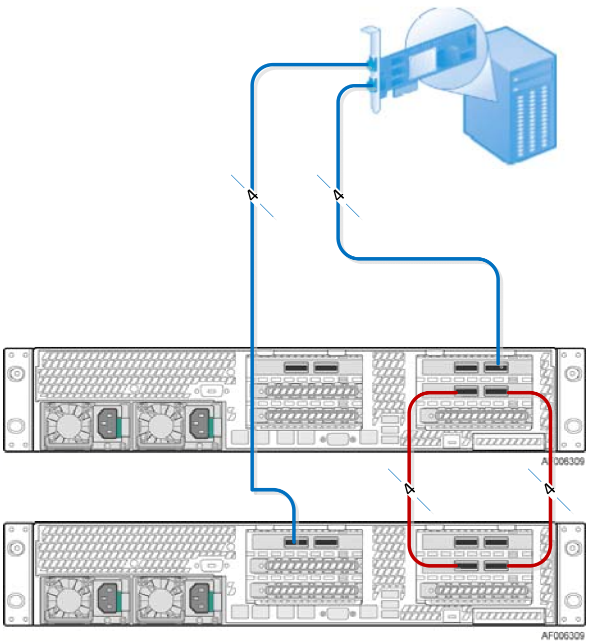

Figure 46. Dual-domain SAS for Cascaded Dual-port JBOD 2000

7.6.3 Dual-domain SAS for Two-node Cluster

This configuration is also known as a failover cluster or high-availability cluster. A failover cluster is a set of independent computers that work together to increase the availability of services and applications. If one of the nodes fails, another node begins to provide service through a process known as failover. A shared storage is needed in cluster configuration. In all clustered servers, all elements of the storage stack should be identical.

In Figure 47, the connectors of the SAS controller in the first server connect to “A PRI” and “A SEC” port on JBOD 2000 with two mini-SAS cables, and the connectors of the SAS controller in the second server connect to “B PRI” and “B SEC” port on JBOD 2000 with other two mini-SAS cables. The cluster interconnect provides redundancy in the event of HBA or cable failure. Dual-domain SAS requires active/active configurations that permit both controllers to process IO transfers. Either controller can act as a standby. To use the dual-ports for redundant pathways, all drives must be SAS drives, not SATA drives.

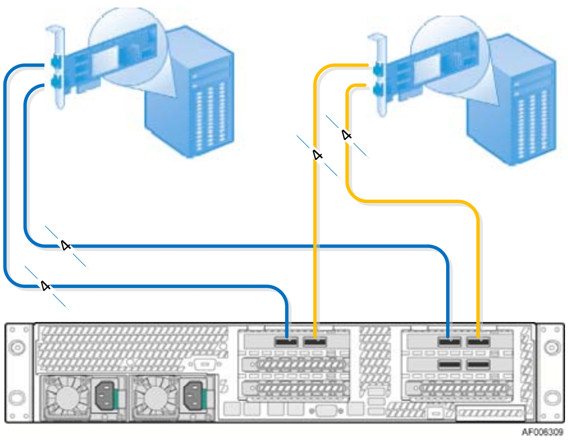

Figure 47. Dual-domain SAS for a Two-node Cluster

Figure 48 shows an example of external connection mode of two cascaded JBOD 2000 for a failover cluster. Each server connects to two JBOD, which ensures the system can tolerate the most HW failure in critical status.

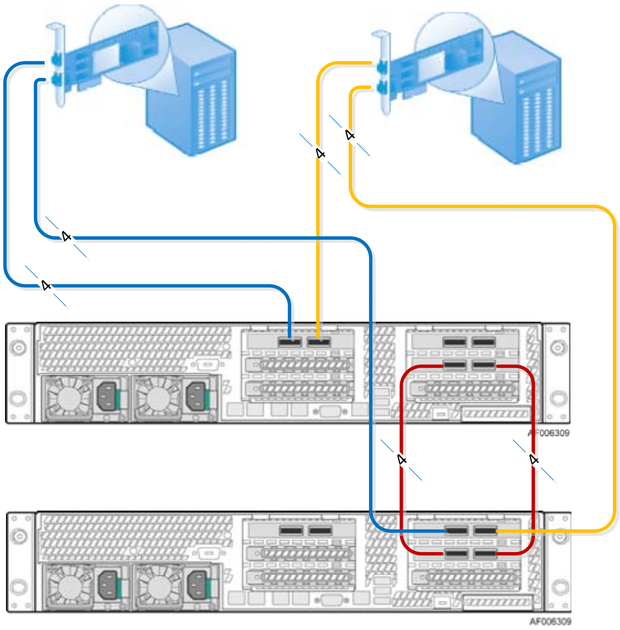

Figure 48. Cascaded JBOD 2000 for a Two-node Cluster

Note: Failover cluster usually needs special firmware and driver for SAS RAID adapter. Refer to the Intel® High Availability Storage User Guide at http://download.intel.com/support/motherboards/server/sb/g85745001_ha_installationguide.pdf

Appendix A: Qualified External Mini-SAS Cable List

Vendor	Part Number	Length	Description
Molex	745460400	0.5m	iPass* PCIe x4 Cable Assembly, 28 AWG, 0.50m Length
	745460401	1.0m	iPass* PCIe x4 Cable Assembly, 28 AWG, 1.0m Length
	745460402	2.0m	iPass* PCIe x4 Cable Assembly, 28 AWG, 2.0m Length
	745460403	3.0m	iPass* PCIe x4 Cable Assembly, 28 AWG, 3.0m Length
	745460404	4.0m	iPass* PCIe x4 Cable Assembly, 28 AWG, 4.0m Length
	745460405	5.0m	iPass* PCIe x4 Cable Assembly, 26 AWG, 5.0m Length
	745460406	6.0m	iPass* PCIe x4 Cable Assembly, 26 AWG, 6.0m Length
	745460407	7.0m	iPass* PCIe x4 Cable Assembly, 24 AWG, 7.0m Length
Amphenol	602030002		
	602030003		
	602030004		
	602030006		
	602030008		
	6020300010		

Reference Documents

Refer to the following documents for additional information:

- *Intel® Storage Server System JBOD 2000 Family Service Guide*
- *Intel® High Availability Storage User Guide*