S9200WK

Intel® Server System S9200WK

Liquid Cooled Rack Reference Design Guide

Guidelines and requirements to design rack and cabinet level solutions with the Intel® Server System S9200WK in a liquid cooled environment.

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November 2020

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Document Revision History

Date	Revision	Changes
August 2019	1.0	First release.
December 2019	1.1	• Updated chapter 6 • Added Additional references (Appendix A)
February 2020	1.2	• Updated chapter 6
		• Updated page 38, corrected calculation of CFM per System.

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1. Introduction

This reference design guide provides an overview of the architecture components, guidelines, and other requirements for designing a rack or cabinet solution with the Intel® Server System S9200WK in a liquid cooled environment.

For the purpose of this guide, the concepts of "Rack", "Cabinet", and "Cluster" are referred to in the following context:

- **Rack:** A Server system rack configured with liquid cooled 2U 4-compute module systems, Ethernet switches, high speed QSFP switches, Power Distribution Units (PDUs) and a liquid cooling manifold.

Figure 1. Rack concept

- **Cabinet:** Two racks according to the definition presented in this guide, accompanied by an Air Handler Unit (AHU) between them.

Figure 2. Cabinet concept

- **Cluster:** A group of three or more racks or cabinets according to the definition presented in this guide.

For the rack and cabinet solution described within this guide, Intel has selected Stulz* liquid cooling products. This guide includes information concerning the hardware inside the rack, the power, cooling and network infrastructure, and the physical space it occupies.

1.1 Usage disclaimer

This guide includes references to both Intel and non-Intel products but have been tested and are compatible as described. It is the responsibility of the integrator that decides against using the recommended products herein described to consult vendor datasheets and operating parameters to determine the compatibility and viability of a solution for their specific application and operating environment.

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1.2 Target audience

The information contained in this guide is intended for IT professionals with advanced knowledge of thermal, electrical and compute performance analysis for datacenter IT infrastructure deployments. The terminology used in this guide requires that the reader has experience performing this type of analysis and planning for datacenter IT infrastructure.

2. Components Overview

This chapter provides an overview of the components installed inside the reference rack and cabinet as well as the power and cooling requirements to be met when designing the reference rack and cabinet configuration.

2.1 Rack and Cabinet Configuration

The solution described within this guide is presented in two different configurations: rack and cabinet. The following is a high-level overview of the major components in both configurations:

Rack configuration:

- 24 server systems
- 4 – Power distribution units (PDU)
- 2 – Ethernet management switches
- 4 - Intel® Omni-Path edge switches
- 1 - Liquid cooling rack manifold

Cabinet configuration:

- 2 – Racks in accordance with the rack configuration
- 1 – Air handler unit (AHU)
- 1 – Rack frame for AHU

The following figures show the recommended hardware configuration when populating a rack or cabinet. **Figure 3** shows the configuration for a 48U rack with 24 chassis, Ethernet switches and Intel® Omni-Path Edge Switches, enabling an optimal configuration with the shortest cables.

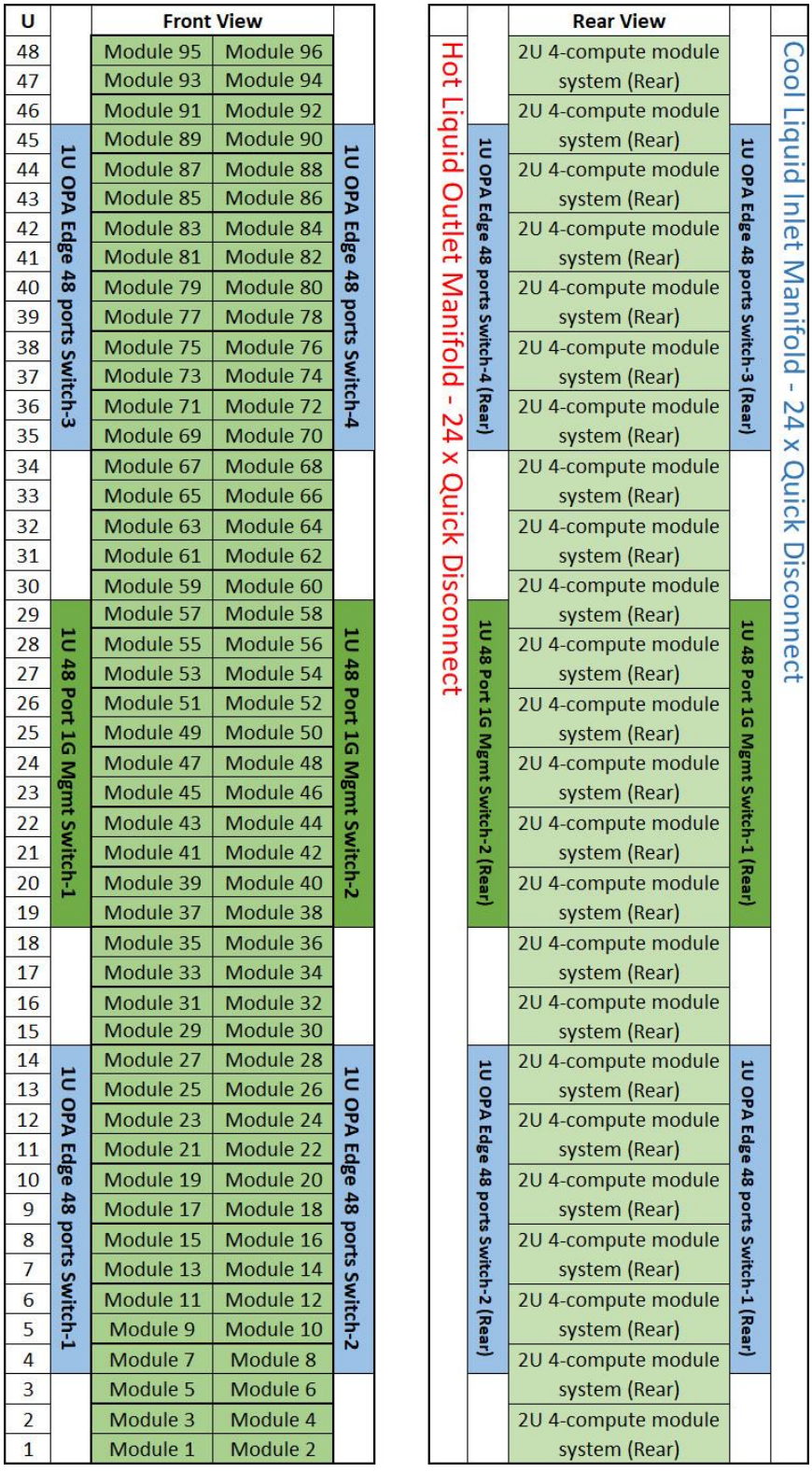


Figure 3. Reference rack layout

Figure 4 and **Figure 5** show the configuration for a cabinet comprised of 2 racks with systems and a cooling rack in between.

IT Rack - 1				Cooling Rack	IT Rack - 2			
U		Front View		Front View	U		Front View	
48		Module 95	Module 96	Air Handler (700mm Wide 1457mm Deep Empty Rack + Stulz* CyberRow) Cold Air Supply to both sides of the Compute racks	48		Module 95	Module 96
47		Module 93	Module 94		47		Module 93	Module 94
46		Module 91	Module 92		46		Module 91	Module 92
45	1U OPA Edge 48 ports Switch-3	Module 89	Module 90	1U OPA Edge 48 ports Switch-4	45	1U OPA Edge 48 ports Switch-3	Module 89	Module 90
44		Module 87	Module 88		44		Module 87	Module 88
43		Module 85	Module 86		43		Module 85	Module 86
42		Module 83	Module 84		42		Module 83	Module 84
41		Module 81	Module 82		41		Module 81	Module 82
40		Module 79	Module 80		40		Module 79	Module 80
39		Module 77	Module 78		39		Module 77	Module 78
38		Module 75	Module 76		38		Module 75	Module 76
37		Module 73	Module 74		37		Module 73	Module 74
36		Module 71	Module 72		36		Module 71	Module 72
35		Module 69	Module 70		35		Module 69	Module 70
34		Module 67	Module 68		34		Module 67	Module 68
33		Module 65	Module 66		33		Module 65	Module 66
32		Module 63	Module 64		32		Module 63	Module 64
31		Module 61	Module 62		31		Module 61	Module 62
30		Module 59	Module 60		30		Module 59	Module 60
29	1U 48 Port 1G Mgmt Switch-1	Module 57	Module 58	1U 48 Port 1G Mgmt Switch-2	29	1U 48 Port 1G Mgmt Switch-1	Module 57	Module 58
28		Module 55	Module 56		28		Module 55	Module 56
27		Module 53	Module 54		27		Module 53	Module 54
26		Module 51	Module 52		26		Module 51	Module 52
25		Module 49	Module 50		25		Module 49	Module 50
24		Module 47	Module 48		24		Module 47	Module 48
23		Module 45	Module 46		23		Module 45	Module 46
22		Module 43	Module 44		22		Module 43	Module 44
21		Module 41	Module 42		21		Module 41	Module 42
20		Module 39	Module 40		20		Module 39	Module 40
19		Module 37	Module 38		19		Module 37	Module 38
18		Module 35	Module 36		18		Module 35	Module 36
17		Module 33	Module 34		17		Module 33	Module 34
16		Module 31	Module 32		16		Module 31	Module 32
15		Module 29	Module 30		15		Module 29	Module 30
14	1U OPA Edge 48 ports Switch-1	Module 27	Module 28	1U OPA Edge 48 ports Switch-2	14	1U OPA Edge 48 ports Switch-1	Module 27	Module 28
13		Module 25	Module 26		13		Module 25	Module 26
12		Module 23	Module 24		12		Module 23	Module 24
11		Module 21	Module 22		11		Module 21	Module 22
10		Module 19	Module 20		10		Module 19	Module 20
9		Module 17	Module 18		9		Module 17	Module 18
8		Module 15	Module 16		8		Module 15	Module 16
7		Module 13	Module 14		7		Module 13	Module 14
6		Module 11	Module 12		6		Module 11	Module 12
5		Module 9	Module 10		5		Module 9	Module 10
4		Module 7	Module 8		4		Module 7	Module 8
3		Module 5	Module 6		3		Module 5	Module 6
2		Module 3	Module 4		2		Module 3	Module 4
1		Module 1	Module 2		1		Module 1	Module 2

Figure 4. Reference cabinet layout – front view

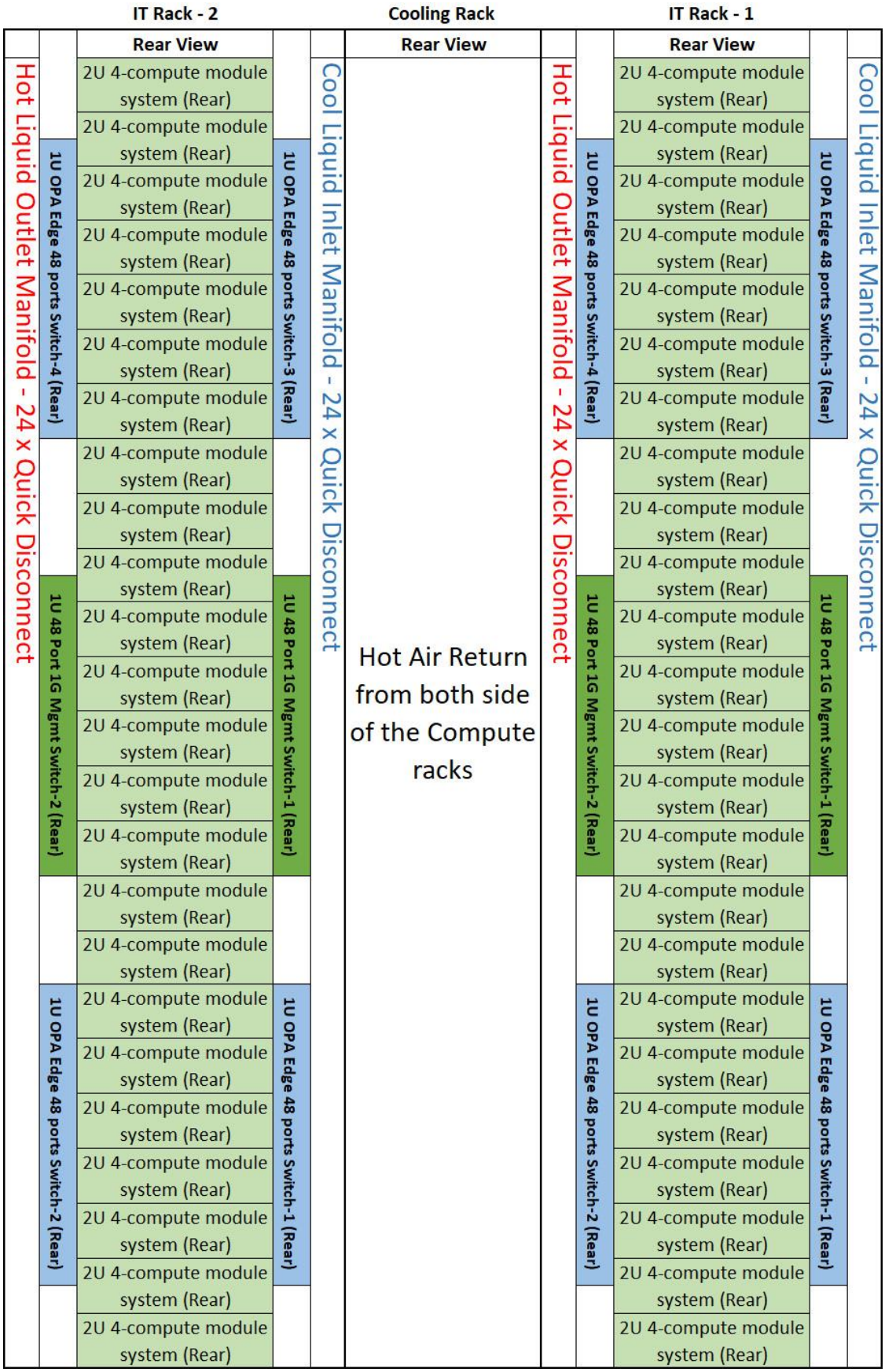


Figure 5. Reference cabinet layout – rear view

2.2 Facility Power

The following table lists the requirements for the facility in which the rack or cabinet will be installed:

Table 1. Facility power requirements

Requirement	Details
Rack input power	400VAC 3P
Power receptacles	IEC 60309 3P+N+E 63A/60A OR Terminal Block
Max input current	63 A
Single Rack power load	127 KW maximum

See Section 3.1 for details on the power budget for rack and cabinet configurations

2.3 Configuration Components

The following table lists the recommended components for each rack and cabinet configuration.

Table 2. Recommended rack and cabinet configuration components

Vendor	Item Type	Description	QTY per Rack	QTY per Cabinet
Chatsworth*	Rack Frame	48U 800mm Wide 1457mm Deep Rack - Solid Doors	1	2
Chatsworth*	Rack Frame	48U 700mm Wide 1457mm Deep Rack - Solid Doors	0	1
Stulz*	Air Handler	Cyber Row Cooling for Air in Cabinet	0	1
Intel	Server	2U, 4-compute module system	24	48
Enlogic*	EU Std certified PDU	400V 3Ph 45.36 KVA 63A 50Hz PDU	4	8
Raritan*	US Std certified PDU	400V 3Ph 55.4 KVA 80A 50Hz PDU	4	8
Cisco*	Switch - Base Unit	Catalyst 2960 1Gb Network Switch	2	4
	Fan Assembly	Switch Fan (front to back)	2	4
	PSU	Redundant PSU	4	8
Intel	100G Switch	Intel® Omni-Path Edge Switch 100 Series 48 Port 2 PSU	4	8
CoolIT*	Liquid Cooling part	Inlet Vertical Manifolds (Cold Water)	1	2
		Outlet Vertical Manifolds (Hot Water)	1	2
Intel	QSFP Cables	Intel Omni-Path 100G QSFP Cables	96	192
Amphenol*	Ethernet Cable	CAT6 Cable - Blue	100	200
Bizlink*	Power Cable	C13-C14 Power Cord	84	168
---	Power Cable	C14 - DIN Type 2508 Power Cord	1	2
King Slide*	Rail	Rack mount rail kit	24	48
Stulz*/CoolIT*	Coolant Distribution Unit (CDU)	Liquid to Liquid Cooling from Rack	0	1
Chatsworth*	Rack Frame	48U 700mm Wide 1457mm Deep Rack - Solid Doors	0	1

2.4 Server System Configuration Requirements

The rack and cabinet solutions described in this guide are built around the capabilities of the Intel® Server System S9200WK.

A liquid cooled server system configured with 1U 48C 350W compute modules is recommended for a typical HPC application. However, other configurations can be utilized based on application and workload requirements. For other SKU options, contact your local Intel representative.

The following table lists the recommended configuration for the Intel® Server System S9200WK when selected to be installed in the reference rack or cabinet.

Table 3. Intel® Server System S9200WK configuration

Description	Qty. per Node	Qty. per System
Intel Server System S9200WK		1
Consisting of:		
Intel® Server Chassis FC2000 Liquid-Cooled (2100W)		1
Intel® Compute Module S9200WK 1U Half-Width Liquid-Cooled CPU 48C 350W		4
Memory: DDR4 16GB 2R 2933 RDIMM	24	96
Storage: Intel SSD DC DCP4101 Series, M.2 PCIe Gen3 x4 512GB 22x80mm SSDPEKKA512G801	1	4
Fabric: Intel Omni-Path Host Fabric Interface Adapter 100 Series, 1 Port PCIe x16, Low Profile 100HFA016LS	1	4
2U system Rail kit		2

For more details on each configuration and other specifications, refer to the *Intel® Server System S9200WK Technical Product Specification.*

3. Electrical Specifications

This chapter provides information on power budget for the:

- Rack
- Air handling unit (AHU)
- Cooling distribution unit (CDU)
- Power distribution unit (PDU) planning and selection
- Power mapping for all equipment
- Network switch mapping

3.1 Overall Power Budget

Table 5. Cabinet power budget lists the recommended components for each rack and cabinet configuration. The total de-rated power for a rack is 159.6KVA, and the total available power in-rack is 220KW divided into 4 PDUs at 55KW each. The following tables list the estimated power budget for both the rack and cabinet. The values are based on the following assumptions:

- Node configuration: 2 x 350W CPUs, 24 X 14W DIMMs, 2 x 15W PCIE cards
- Cluster Configuration: 5 Cabinets = 10 Racks with 24 Servers each, 4 Nodes per Server, 3 end-of-row CDUs in Parallel
- Secondary Fluid: 25% Propylene Glycol Water (PG25)
- Connection Points: CBG20 QD at Rack level and SCG06 at Chassis level.
- Primary Fluid: ASHRAE W3 (32°C) Water at 360lpm per each end-of-row-based CDU.
- 3CDUs recommended for every 960 nodes (10 racks with 24 chassis each)
- 4.6lpm per chassis or 1.15lpm per compute module
- Server exit temp = 50°C.

Table 4. Rack power budget

Compute Rack		Qty. per rack	Device Power	Aggregate Power	Amps @ 240V
1	2U four node server system	24	5225W	125,400W	*21.7708333*
2	Intel Omni-Path Edge 48-port Switch	4	230W	920W	*1*
3	Cisco* 2960 Catalyst 1G Network Switch	2	125W	250W	*0.54*
	Total			**126,570W**	
	De-rated power			159,625VA	
	Available power in rack per PDU capacity	4	55,000W	220,000W	

Table 5. Cabinet power budget

L11 Cabinet (MDC - 2 x Compute IT Racks + 1 x Cooling Rack)		**Qty per cabinet**	**Device Power**	**Aggregate Power**
1	Compute Rack - 1 (24 x server systems)	2	127000W	254,000W
2	Air Handler (Cooling Rack)	1	6,100W	6,100W
	Total			**260,100W**
	De-rated power			325,125VA
Cluster level Power consumption				
1	Coolant Distribution Unit (CDU CHx750)	3	7500W	22,500W
2	L11 Cabinet	5	260,100W	1,300,500W
	Total			**1,323,000W**

	De-rated power			1,653,750VA

3.2 Power Distribution Unit (PDU) Selection

PDU selection is a crucial step in system design. When selecting a PDU, consider both the physical attributes (mechanical dimensions, mounting features, cord length, etc.) and electrical attributes (voltage type, power capacity, circuit breaker counts, etc.).

To power a single rack with 24 x 2U/4-Compute module systems, the PDU must be three-phase 400/415 V rated and have a power capacity range between 38 kVA to 46 kVA with 12 or more circuit breakers/branches. A higher power capacity, three-phase 400 V rated PDU is also acceptable.

With an estimate of the total actual power for all equipment around 127 kW in a single rack, the de-rated power budget for the rack is 159 kVA. A 20% safety margin is added into the rack level power design.

The following table lists the recommended components for each rack and cabinet configuration. **Table 2** and Table 7. US PDU recommended PDUs for the rack or cabinet configurations

3.2.1 EU Standards Compliant PDU

Table 6. EU PDU

Manufacturer	Enlogic* 3 Phase WYE
Model #	EN 1185
PDU remote management	YES (Non-Switched PDU)
Power cord length	3.0 m
Plug type & quantity	IEC309 563p6
Output receptacle/socket	36 outlets - 24 x C13, 12 x C19
Rated Input voltage	380V - 415V
Nominal Input voltage	400V
Input Frequency	50 Hz
Input Power Capacity	45.36 kVA
Input current (derated/max)	63A

3.2.2 US Standards Compliant PDU

Table 7. US PDU

Manufacturer	Raritan*
Model #	PX3-5157XU-01V2
PDU remote management	YES (Switched PDU)
Power cord length	N/A
Plug type & quantity	Terminal Block
Output receptacle/socket	48 x C13 (12A)
Rated Input voltage	380V - 415V
Nominal Input voltage	400V
Input Frequency	50/60 Hz
Input Power Capacity	52.7 kVA@380V, 57.5kVA@415V
Input current(derated/max)	80A

3.3 Power Mapping

The configuration consists of approximately 84 connections for individual power supply units for servers and switches. The power load must be distributed equally across the PDUs for the entire rack.

When the entire rack is used for a high-performance computing (HPC) application, all nodes consume approximately the same amount of power in a typically loaded configuration. The common redundant power supply units used in the Intel® Server System S9200WK operate at the higher end of their capability by splitting the load equally or accordingly when running at maximum power. Generally, if each system chassis is plugged into three different PDUs, a single PDU failure prevents all systems from running at full power. However, if two or three PSUs within the same system are plugged into one PDU and phases are balanced by evenly loading all PDUs from top to bottom, a single PDU failure affects fewer systems in the rack.

Serviceability of the server rack is improved if the chassis is plugged into power at the same unit level in the rack using the shortest possible power cable routes. The tables in this section show the recommended mapping between power supply modules and power outlets, beginning with the rack and then passing to the different PDUs. The tables are color coded for convenience.

The Intel® S9200WK Server Systems were typically configured for both the 4 PDU and 3 PDU design concepts. The configuration and measured power are shown in **Table 8** below.

Table 8. Typical Intel® Server System S9200WK Configuration

Intel® Server System S9200WK Configuration	Calculated Power Consumption (WAC)	Measured Power Consumption - typical ambient (WAC)	Measured Power Consumption - worst ambient (WAC)	+5% guard band (WAC)
CPUs- 2 x 48C DIMM- 24 x 16GB 2933MTs Fabric- 1 x OPA	4500W	4000W	4160W	4370W

Note: Deviation from the typical configuration to higher TDP configurations could result in the loss of additional server systems during PDU failures. It will require power budgeting recalculations due to the increased loading of the greater TDP configuration.

3.4 4 PDU Reference Design Power Mapping

In the 4 PDU design concept, eight Intel® S9200WK Server Platforms are connected to a single PDU. Each system power supply is connected to a different phase, e.g. PSU1 (phase 1), PSU2 (phase 2), and PSU3 (phase 3). With this distribution, the loading and phases across the PDUs are well balanced and offers the greatest redundancy and uptime during a PDU failure (refer to the 4 PDU configuration images). During a single PDU failure, it is expected that the 3 remaining operational PDUs will provide enough power to the impacted server systems to remain operational without impact to system performance.

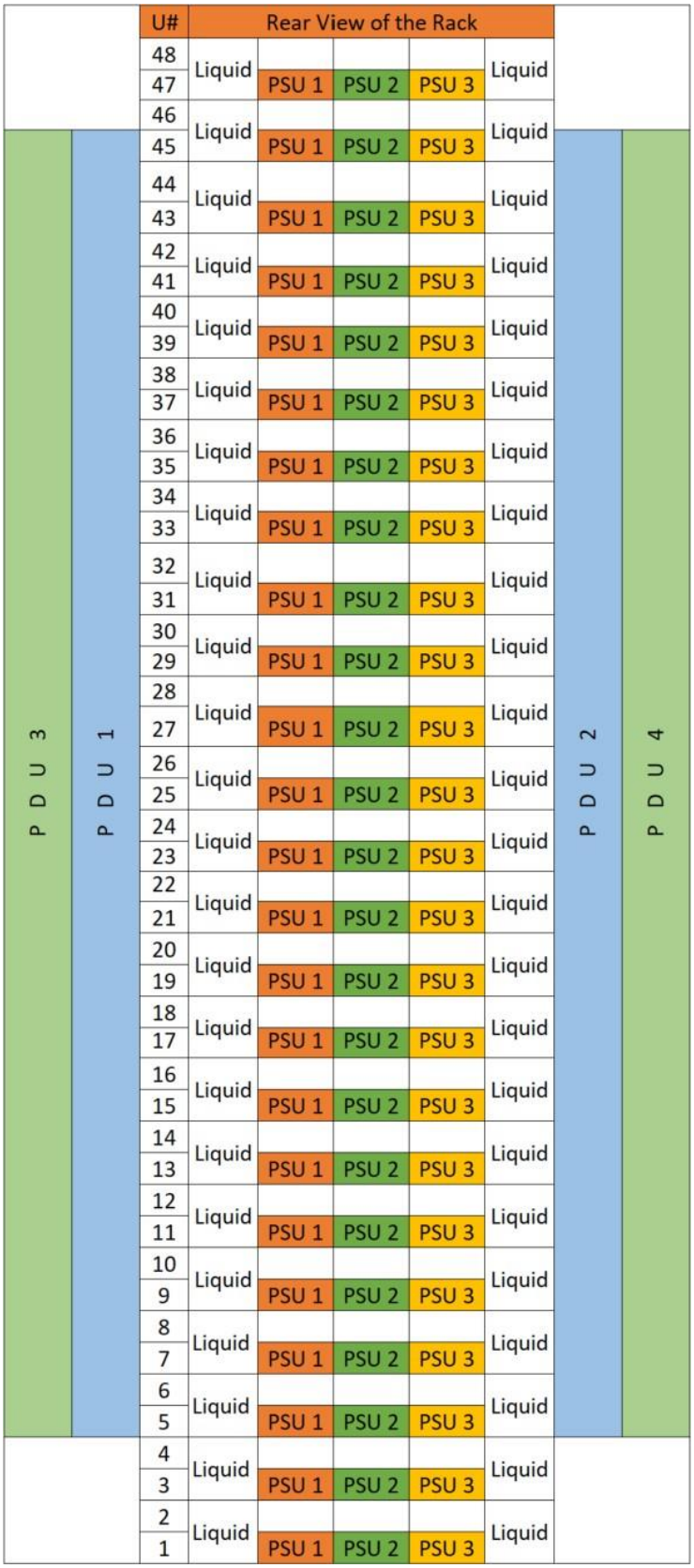
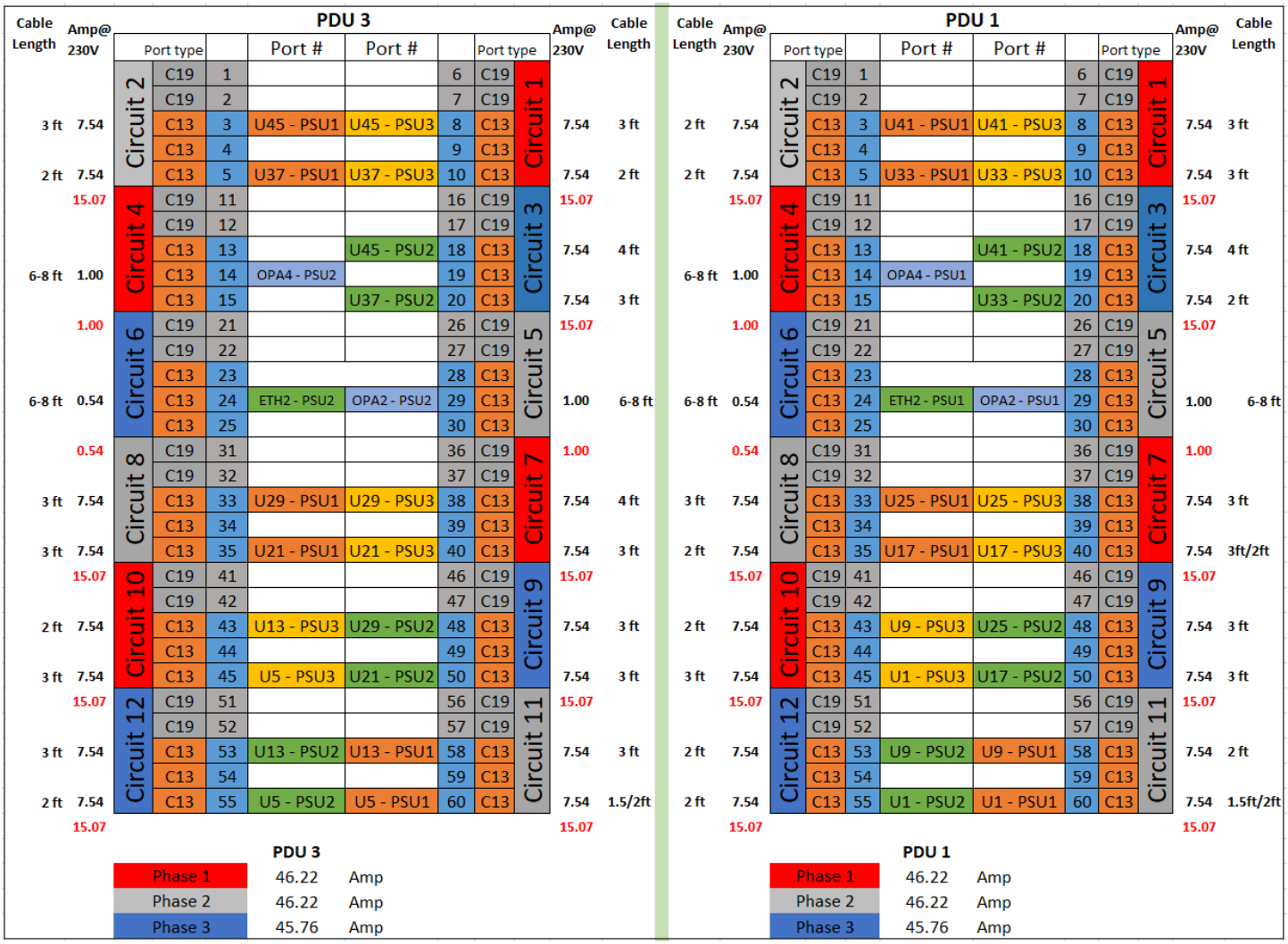


Figure 6. Power supply layout for 4 PDU design reference



PDU 3

Cable Length	Amp@ 230V	Port type		Port #	Port #		Port type	Amp@ 230V	Cable Length
		Circuit 2 C19	1			6	C19 Circuit 1		
		C19	2			7	C19		
3 ft	7.54	C13	3	U45 - PSU1	U45 - PSU3	8	C13	7.54	3 ft
		C13	4			9	C13		
2 ft	7.54	C13	5	U37 - PSU1	U37 - PSU3	10	C13	7.54	2 ft
	15.07	Circuit 4 C19	11			16	C19 Circuit 3	15.07	
		C19	12			17	C19		
		C13	13		U45 - PSU2	18	C13	7.54	4 ft
6-8 ft	1.00	C13	14	OPA4 - PSU2		19	C13		
		C13	15		U37 - PSU2	20	C13	7.54	3 ft
	1.00	Circuit 6 C19	21			26	C19 Circuit 5	15.07	
		C19	22			27	C19		
		C13	23			28	C13		
6-8 ft	0.54	C13	24	ETH2 - PSU2	OPA2 - PSU2	29	C13	1.00	6-8 ft
		C13	25			30	C13		
	0.54	Circuit 8 C19	31			36	C19 Circuit 7	1.00	
		C19	32			37	C19		
3 ft	7.54	C13	33	U29 - PSU1	U29 - PSU3	38	C13	7.54	4 ft
		C13	34			39	C13		
3 ft	7.54	C13	35	U21 - PSU1	U21 - PSU3	40	C13	7.54	3 ft
	15.07	Circuit 10 C19	41			46	C19 Circuit 9	15.07	
		C19	42			47	C19		
2 ft	7.54	C13	43	U13 - PSU3	U29 - PSU2	48	C13	7.54	3 ft
		C13	44			49	C13		
3 ft	7.54	C13	45	U5 - PSU3	U21 - PSU2	50	C13	7.54	3 ft
	15.07	Circuit 12 C19	51			56	C19 Circuit 11	15.07	
		C19	52			57	C19		
3 ft	7.54	C13	53	U13 - PSU2	U13 - PSU1	58	C13	7.54	3 ft
		C13	54			59	C13		
2 ft	7.54	C13	55	U5 - PSU2	U5 - PSU1	60	C13	7.54	1.5/2ft
	15.07							15.07	

PDU 3		
Phase 1	46.22	Amp
Phase 2	46.22	Amp
Phase 3	45.76	Amp

PDU 1

Cable Length	Amp@ 230V	Port type		Port #	Port #		Port type	Amp@ 230V	Cable Length
		Circuit 2 C19	1			6	C19 Circuit 1		
		C19	2			7	C19		
2 ft	7.54	C13	3	U41 - PSU1	U41 - PSU3	8	C13	7.54	3 ft
		C13	4			9	C13		
2 ft	7.54	C13	5	U33 - PSU1	U33 - PSU3	10	C13	7.54	3 ft
	15.07	Circuit 4 C19	11			16	C19 Circuit 3	15.07	
		C19	12			17	C19		
		C13	13		U41 - PSU2	18	C13	7.54	4 ft
6-8 ft	1.00	C13	14	OPA4 - PSU1		19	C13		
		C13	15		U33 - PSU2	20	C13	7.54	2 ft
	1.00	Circuit 6 C19	21			26	C19 Circuit 5	15.07	
		C19	22			27	C19		
		C13	23			28	C13		
6-8 ft	0.54	C13	24	ETH2 - PSU1	OPA2 - PSU1	29	C13	1.00	6-8 ft
		C13	25			30	C13		
	0.54	Circuit 8 C19	31			36	C19 Circuit 7	1.00	
		C19	32			37	C19		
3 ft	7.54	C13	33	U25 - PSU1	U25 - PSU3	38	C13	7.54	3 ft
		C13	34			39	C13		
2 ft	7.54	C13	35	U17 - PSU1	U17 - PSU3	40	C13	7.54	3ft/2ft
	15.07	Circuit 10 C19	41			46	C19 Circuit 9	15.07	
		C19	42			47	C19		
2 ft	7.54	C13	43	U9 - PSU3	U25 - PSU2	48	C13	7.54	3 ft
		C13	44			49	C13		
3 ft	7.54	C13	45	U1 - PSU3	U17 - PSU2	50	C13	7.54	3 ft
	15.07	Circuit 12 C19	51			56	C19 Circuit 11	15.07	
		C19	52			57	C19		
2 ft	7.54	C13	53	U9 - PSU2	U9 - PSU1	58	C13	7.54	2 ft
		C13	54			59	C13		
2 ft	7.54	C13	55	U1 - PSU2	U1 - PSU1	60	C13	7.54	1.5ft/2ft
	15.07							15.07	

PDU 1		
Phase 1	46.22	Amp
Phase 2	46.22	Amp
Phase 3	45.76	Amp

Figure 7. Power mapping detail for 4 PDU design reference (PDUs 1 and 3)

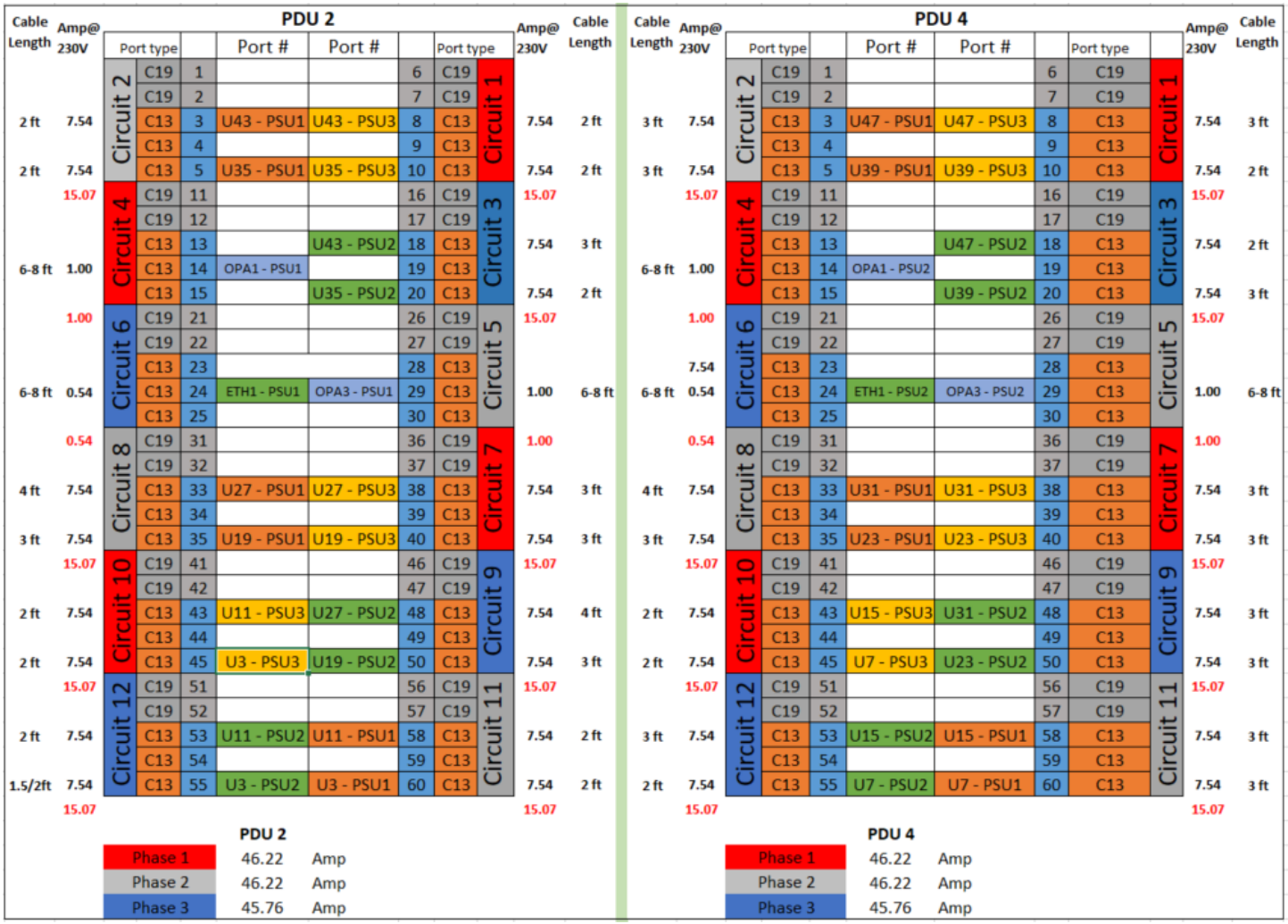


Figure 8. Power mapping detail for 4 PDU design reference (PDUs 2 and 4)

3.5 3 PDU Reference Design Power Mapping

In a 3PDU design, there is an increased risk of losing additional server systems due to the loading and mapping of the PDUs. In this design, both the Ethernet and OPA switches are connected in a redundant fashion across different PDUs. However, for this configuration the switches share power with several server systems, thereby increasing risk of losing the switches during a single PDU failure. This risk is mitigated in the 4 PDU rack design since power to the switches is separate from the server systems.

In theory, during a single PSU failure, the 2 remaining PSUs will support all system loading unless throttling triggers (e.g. OC or OT CLST) or shutdown (e.g. OCP) occurs. The increased current drawn by the remaining PSUs will increase current loading for each PDU and its associated phase. Ideally, loss of a single PSU (and single phase) will increase loading to other 2 phases, thereby reaching the input current OC trigger. Secondly, each PDU circuit breaker is set to 20A which means that as PSU loading increases, the risk for a circuit breaker trip increases as well.

Two power mappings have been considered depending on the availability of the main power lines. **Figure 10** and **Figure 11** show the power mapping when the power lines come from the top of the reference rack. **Figure 12** and **Figure 13** show the power mapping when the power lines come from the bottom of the reference rack.

U#	Rear View of the Rack				
48	Liquid				Liquid
47		PSU 1	PSU 2	PSU 3	
46	Liquid				Liquid
45		PSU 1	PSU 2	PSU 3	
44	Liquid				Liquid
43		PSU 1	PSU 2	PSU 3	
42	Liquid				Liquid
41		PSU 1	PSU 2	PSU 3	
40	Liquid				Liquid
39		PSU 1	PSU 2	PSU 3	
38	Liquid				Liquid
37		PSU 1	PSU 2	PSU 3	
36	Liquid				Liquid
35		PSU 1	PSU 2	PSU 3	
34	Liquid				Liquid
33		PSU 1	PSU 2	PSU 3	
32	Liquid				Liquid
31		PSU 1	PSU 2	PSU 3	
30	Liquid				Liquid
29		PSU 1	PSU 2	PSU 3	
28	Liquid				Liquid
27		PSU 1	PSU 2	PSU 3	
26	Liquid				Liquid
25		PSU 1	PSU 2	PSU 3	
24	Liquid				Liquid
23		PSU 1	PSU 2	PSU 3	
22	Liquid				Liquid
21		PSU 1	PSU 2	PSU 3	
20	Liquid				Liquid
19		PSU 1	PSU 2	PSU 3	
18	Liquid				Liquid
17		PSU 1	PSU 2	PSU 3	
16	Liquid				Liquid
15		PSU 1	PSU 2	PSU 3	
14	Liquid				Liquid
13		PSU 1	PSU 2	PSU 3	
12	Liquid				Liquid
11		PSU 1	PSU 2	PSU 3	
10	Liquid				Liquid
9		PSU 1	PSU 2	PSU 3	
8	Liquid				Liquid
7		PSU 1	PSU 2	PSU 3	
6	Liquid				Liquid
5		PSU 1	PSU 2	PSU 3	
4	Liquid				Liquid
3		PSU 1	PSU 2	PSU 3	
2	Liquid				Liquid
1		PSU 1	PSU 2	PSU 3	

Figure 9. Power supply layout for 3 PDU design reference rack

TOP FEED ORIENTATION

PDU3 - Top

Amp@ 230V	Port type		Port #	Port #		Port type	
	Circuit 2	C19 1			6	C19	Circuit 1
		C19 2			7	C19	
6.52		C13 3	U47 - PSU1	U47 - PSU3	8	C13	6.52
		C13 4			9	C13	
6.52		C13 5	U41 - PSU1	U41 - PSU3	10	C13	6.52
13.04	Circuit 4	C19 11			16	C19	Circuit 3 13.04
		C19 12			17	C19	
6.52		C13 13	U35 - PSU3	U47 - PSU2	18	C13	6.52
		C13 14			19	C13	
6.52		C13 15	U29 - PSU3	U41 - PSU2	20	C13	6.52
13.04	Circuit 6	C19 21			26	C19	Circuit 5 13.04
		C19 22			27	C19	
6.52		C13 23	U35 - PSU2	U35 - PSU1	28	C13	6.52
		C13 24		ETH2-PSU2	29	C13	0.54
6.52		C13 25	U29 - PSU2	U29 - PSU1	30	C13	6.52
13.04	Circuit 8	C19 31			36	C19	Circuit 7 13.58
		C19 32			37	C19	
6.52		C13 33	U23 - PSU1	U23 - PSU3	38	C13	6.52
		C13 34			39	C13	
6.52		C13 35	U17 - PSU1	U17 - PSU3	40	C13	6.52
13.04	Circuit 10	C19 41			46	C19	Circuit 9 13.04
		C19 42			47	C19	
6.52		C13 43	U11 - PSU3	U23 - PSU2	48	C13	6.52
		C13 44			49	C13	
6.52		C13 45	U5 - PSU3	U17 - PSU2	50	C13	6.52
13.04	Circuit 12	C19 51			56	C19	Circuit 11 13.04
		C19 52			57	C19	
6.52		C13 53	U11 - PSU2	U11 - PSU1	58	C13	6.52
		C13 54	OPA1-PSU2		59	C13	
6.52		C13 55	U5 - PSU2	U5 - PSU1	60	C13	6.52
13.04							13.04

PDU 3

Phase 1	52.17	Amp
Phase 2	52.71	Amp
Phase 3	52.17	Amp

PDU1 - Top

Amp@ 230V	Port type		Port #	Port #		Port type	
	Circuit 2	C19 1			6	C19	Circuit 1
		C19 2			7	C19	
6.52		C13 3	U43 - PSU1	U43 - PSU3	8	C13	6.52
		C13 4		OPA1-PSU2	9	C13	1.00
6.52		C13 5	U37 - PSU1	U37 - PSU3	10	C13	6.52
13.04	Circuit 4	C19 11			16	C19	Circuit 3 14.04
		C19 12			17	C19	
6.52		C13 13	U31 - PSU3	U43 - PSU2	18	C13	6.52
		C13 14			19	C13	
6.52		C13 15	U25 - PSU3	U37 - PSU2	20	C13	6.52
13.04	Circuit 6	C19 21			26	C19	Circuit 5 13.04
		C19 22			27	C19	
6.52		C13 23	U31 - PSU2	U31 - PSU1	28	C13	6.52
0.54		C13 24	ETH2-PSU1	ETH1-PSU2	29	C13	0.54
6.52		C13 25	U25 - PSU2	U25 - PSU1	30	C13	6.52
13.58	Circuit 8	C19 31			36	C19	Circuit 7 13.58
		C19 32			37	C19	
6.52		C13 33	U19 - PSU1	U19 - PSU3	38	C13	6.52
		C13 34			39	C13	
6.52		C13 35	U13 - PSU1	U13 - PSU3	40	C13	6.52
13.04	Circuit 10	C19 41			46	C19	Circuit 9 13.04
		C19 42			47	C19	
6.52		C13 43	U7 - PSU3	U19 - PSU2	48	C13	6.52
		C13 44		OPA2-PSU1	49	C13	1.00
6.52		C13 45	U1 - PSU3	U13 - PSU2	50	C13	6.52
13.04	Circuit 12	C19 51			56	C19	Circuit 11 14.04
		C19 52			57	C19	
6.52		C13 53	U7 - PSU2	U7 - PSU1	58	C13	6.52
		C13 54			59	C13	
6.52		C13 55	U1 - PSU2	U1 - PSU1	60	C13	6.52
13.04							13.04

PDU 1

Phase 1	53.17	Amp
Phase 2	52.71	Amp
Phase 3	53.71	Amp

Total Phase Amp per Rack

Phase 1	158.52
Phase 2	159.60
Phase 3	158.60

Figure 10. Power mapping detail (top) for 3 PDU design reference (PDUs 3 and 1)

TOP FEED ORIENTATION

PDU2 - Top

Amp@ 230V	Port type		Port #	Port #		Port type	
	C19	1			6	C19	Circuit 1
	C19	2			7	C19	
6.52	C13	3	U45 - PSU1	U45 - PSU3	8	C13	6.52
1.00	C13	4	OPA1-PSU1		9	C13	
6.52	C13	5	U39 - PSU1	U39 - PSU3	10	C13	6.52
14.04	C19	11			16	C19	Circuit 3
	C19	12			17	C19	
6.52	C13	13	U33 - PSU3	U45 - PSU2	18	C13	6.52
	C13	14			19	C13	
6.52	C13	15	U27 - PSU3	U39 - PSU2	20	C13	6.52
13.04	C19	21			26	C19	Circuit 5
	C19	22			27	C19	
6.52	C13	23	U33 - PSU2	U33 - PSU1	28	C13	6.52
0.54	C13	24	ETH1-PSU1		29	C13	
6.52	C13	25	U27 - PSU2	U27 - PSU1	30	C13	6.52
13.58	C19	31			36	C19	Circuit 7
	C19	32			37	C19	
6.52	C13	33	U21 - PSU1	U21 - PSU3	38	C13	6.52
	C13	34			39	C13	
6.52	C13	35	U15 - PSU1	U15 - PSU3	40	C13	6.52
13.04	C19	41			46	C19	Circuit 9
	C19	42			47	C19	
6.52	C13	43	U9 - PSU3	U21 - PSU2	48	C13	6.52
1.00	C13	44	OPA2-PSU2		49	C13	
6.52	C13	45	U3 - PSU3	U15 - PSU2	50	C13	6.52
14.04	C19	51			56	C19	Circuit 11
	C19	52			57	C19	
6.52	C13	53	U9 - PSU2	U9 - PSU1	58	C13	6.52
	C13	54		OPA1-PSU1	59	C13	1.00
6.52	C13	55	U3 - PSU2	U3 - PSU1	60	C13	6.52
13.04							14.04

PDU 2		
Phase 1	53.17	Amp
Phase 2	54.17	Amp
Phase 3	52.71	Amp

Figure 11. Power mapping detail (top) for 3 PDU design reference (PDU 2)

BOTTOM FEED ORIENTATION

PDU3 - Bottom

Amp@ 230V	Port type		Port #	Port #		Port type		Amp@ 230V
6.52	Circuit 11 C13	60	U47 - PSU1	U47 - PSU3	55	C13 Circuit 12		6.52
	C13	59			54	C13		
6.52	C13	58	U41 - PSU1	U41 - PSU3	53	C13		6.52
	C19	57			52	C19		
13.04	C19	56			51	C19		13.04
6.52	Circuit 9 C13	50	U35 - PSU3	U47 - PSU2	45	C13 Circuit 10		6.52
	C13	49			44	C13		
6.52	C13	48	U29 - PSU3	U41 - PSU2	43	C13		6.52
13.04	C19	47			42	C19		13.04
	C19	46			41	C19		
6.52	Circuit 7 C13	40	U35 - PSU2	U35 - PSU1	35	C13 Circuit 8		6.52
	C13	39		ETH2-PSU2	34	C13		0.54
6.52	C13	38	U29 - PSU2	U29 - PSU1	33	C13		6.52
13.04	C19	37			32	C19		13.58
	C19	36			31	C19		
6.52	Circuit 5 C13	30	U23 - PSU1	U23 - PSU3	25	C13 Circuit 6		6.52
	C13	29			24	C13		
6.52	C13	28	U17 - PSU1	U17 - PSU3	23	C13		6.52
13.04	C19	27			22	C19		13.04
	C19	26			21	C19		
6.52	Circuit 3 C13	20	U11 - PSU3	U23 - PSU2	15	C13 Circuit 4		6.52
	C13	19			14	C13		
6.52	C13	18	U5 - PSU3	U17 - PSU2	13	C13		6.52
13.04	C19	17			12	C19		13.04
	C19	16			11	C19		
6.52	Circuit 1 C13	10	U11 - PSU2	U11 - PSU1	5	C13 Circuit 2		6.52
	C13	9			4	C13		
6.52	C13	8	U5 - PSU2	U5 - PSU1	3	C13		6.52
13.04	C19	7			2	C19		13.04
	C19	6			1	C19		

PDU 3		
Phase 1	52.17	Amp
Phase 2	52.71	Amp
Phase 3	52.17	Amp

PDU1 - Bottom

Amp@ 230V	Port type		Port #	Port #		Port type		Amp@ 230V
6.52	Circuit 11 C13	60	U43 - PSU1	U43 - PSU3	55	C13 Circuit 12		6.52
	C13	59		OPA1-PSU2	54	C13		1.00
6.52	C13	58	U37 - PSU1	U37 - PSU3	53	C13		6.52
	C19	57			52	C19		
13.04	C19	56			51	C19		14.04
6.52	Circuit 9 C13	50	U31 - PSU3	U43 - PSU2	45	C13 Circuit 10		6.52
	C13	49			44	C13		
6.52	C13	48	U25 - PSU3	U37 - PSU2	43	C13		6.52
13.04	C19	47			42	C19		13.04
	C19	46			41	C19		
6.52	Circuit 7 C13	40	U31 - PSU2	U31 - PSU1	35	C13 Circuit 8		6.52
0.54	C13	39	ETH2-PSU1	ETH1-PSU2	34	C13		0.54
6.52	C13	38	U25 - PSU2	U25 - PSU1	33	C13		6.52
13.58	C19	37			32	C19		13.58
	C19	36			31	C19		
6.52	Circuit 5 C13	30	U19 - PSU1	U19 - PSU3	25	C13 Circuit 6		6.52
	C13	29			24	C13		
6.52	C13	28	U13 - PSU1	U13 - PSU3	23	C13		6.52
13.04	C19	27			22	C19		13.04
	C19	26			21	C19		
6.52	Circuit 3 C13	20	U7 - PSU3	U19 - PSU2	15	C13 Circuit 4		6.52
	C13	19		OPA2-PSU1	14	C13		1.00
6.52	C13	18	U1 - PSU3	U13 - PSU2	13	C13		6.52
13.04	C19	17			12	C19		14.04
	C19	16			11	C19		
6.52	Circuit 1 C13	10	U7 - PSU2	U7 - PSU1	5	C13 Circuit 2		6.52
	C13	9			4	C13		
6.52	C13	8	U1 - PSU2	U1 - PSU1	3	C13		6.52
13.04	C19	7			2	C19		13.04
	C19	6			1	C19		

PDU 1		
Phase 1	53.71	Amp
Phase 2	52.71	Amp
Phase 3	53.17	Amp

Total Phase Amp per Rack

Phase 1	158.60
Phase 2	158.60
Phase 3	158.52

Figure 12. Power mapping detail (bottom) for 3 PDU design reference (PDUs 3 and 1)

BOTTOM FEED ORIENTATION

PDU2 - Bottom

Amp@ 230V		Port type		Port #	Port #		Port type		
6.52	Circuit 11	C13	60	U45 - PSU1	U45 - PSU3	55	C13	Circuit 12	6.52
1.00		C13	59	OPA1-PSU1		54	C13		
6.52		C13	58	U39 - PSU1	U39 - PSU3	53	C13		6.52
		C19	57			52	C19		
14.04		C19	56			51	C19		13.04
6.52	Circuit 9	C13	50	U33 - PSU3	U45 - PSU2	45	C13	Circuit 10	6.52
		C13	49			44	C13		
6.52		C13	48	U27 - PSU3	U39 - PSU2	43	C13		6.52
13.04		C19	47			42	C19		13.04
		C19	46			41	C19		
6.52	Circuit 7	C13	40	U33 - PSU2	U33 - PSU1	35	C13	Circuit 8	6.52
0.54		C13	39	ETH1-PSU1		34	C13		
6.52		C13	38	U27 - PSU2	U27 - PSU1	33	C13		6.52
13.58		C19	37			32	C19		13.04
		C19	36			31	C19		
6.52	Circuit 5	C13	30	U21 - PSU1	U21 - PSU3	25	C13	Circuit 6	6.52
		C13	29			24	C13		
6.52		C13	28	U15 - PSU1	U15 - PSU3	23	C13		6.52
13.04		C19	27			22	C19		13.04
		C19	26			21	C19		
6.52	Circuit 3	C13	20	U9 - PSU3	U21 - PSU2	15	C13	Circuit 4	6.52
1.00		C13	19	OPA2-PSU2		14	C13		
6.52		C13	18	U3 - PSU3	U15 - PSU2	13	C13		6.52
14.04		C19	17			12	C19		13.04
		C19	16			11	C19		
6.52	Circuit 1	C13	10	U9 - PSU2	U9 - PSU1	5	C13	Circuit 2	6.52
		C13	9			4	C13		
6.52		C13	8	U3 - PSU2	U3 - PSU1	3	C13		6.52
13.04		C19	7			2	C19		13.04
		C19	6			1	C19		

PDU 2

Phase 1	52.71	Amp
Phase 2	53.17	Amp
Phase 3	53.17	Amp

Figure 13. Power mapping detail (bottom) for 3 PDU design reference (PDU 2)

4. Management Network Specifications

This chapter provides recommendations on the network mapping for the reference rack. With the cabinet being comprised of racks, the information for the reference cabinet is covered as well.

All network switches can be mounted on the side of the rack with special cutouts on the rack's EIA vertical rail. The following figures and tables show the required port mappings for six vertically mounted switches (two Ethernet switches and four Intel® OPA switches), and the cabling layout for the rack as seen from the front. The figures are listed starting from the top of the rack and are color coded for convenience.

QSFP28	CAT6	U	Front View		CAT6	QSFP28
1.0 M	6 FT	48	Compute Module 95	Compute Module 96	6 FT	1.0 M
1.0 M	6 FT	47	Compute Module 93	Compute Module 94	6 FT	1.0 M
0.5 M	6 FT	46	Compute Module 91	Compute Module 92	6 FT	0.5 M
0.5 M	6 FT	45	Compute Module 89	Compute Module 90	6 FT	0.5 M
0.5 M	6 FT	44	Compute Module 87	Compute Module 88	6 FT	0.5 M
0.5 M	6 FT	43	Compute Module 85	Compute Module 86	6 FT	0.5 M
0.5 M	6 FT	42	Compute Module 83	Compute Module 84	6 FT	0.5 M
0.5 M	6 FT	41	Compute Module 81	Compute Module 82	6 FT	0.5 M
0.5 M	6 FT	40	Compute Module 79	Compute Module 80	6 FT	0.5 M
0.5 M	6 FT	39	Compute Module 77	Compute Module 78	6 FT	0.5 M
0.5 M	6 FT	38	Compute Module 75	Compute Module 76	6 FT	0.5 M
0.5 M	6 FT	37	Compute Module 73	Compute Module 74	6 FT	0.5 M
0.5 M	3 FT	36	Compute Module 71	Compute Module 72	3 FT	0.5 M
0.5 M	3 FT	35	Compute Module 69	Compute Module 70	3 FT	0.5 M
1.0 M	3 FT	34	Compute Module 67	Compute Module 68	3 FT	1.0 M
1.0 M	3 FT	33	Compute Module 65	Compute Module 66	3 FT	1.0 M
1.0 M	3 FT	32	Compute Module 63	Compute Module 64	3 FT	1.0 M
1.0 M	3 FT	31	Compute Module 61	Compute Module 62	3 FT	1.0 M
1.0 M	3 FT	30	Compute Module 59	Compute Module 60	3 FT	1.0 M
1.0 M	3 FT	29	Compute Module 57	Compute Module 58	3 FT	1.0 M
1.0 M	3 FT	28	Compute Module 55	Compute Module 56	3 FT	1.0 M
1.0 M	3 FT	27	Compute Module 53	Compute Module 54	3 FT	1.0 M
1.0 M	3 FT	26	Compute Module 51	Compute Module 52	3 FT	1.0 M
1.0 M	3 FT	25	Compute Module 49	Compute Module 50	3 FT	1.0 M
1.0 M	3 FT	24	Compute Module 47	Compute Module 48	3 FT	1.0 M
1.0 M	3 FT	23	Compute Module 45	Compute Module 46	3 FT	1.0 M
1.0 M	3 FT	22	Compute Module 43	Compute Module 44	3 FT	1.0 M
1.0 M	3 FT	21	Compute Module 41	Compute Module 42	3 FT	1.0 M
1.0 M	3 FT	20	Compute Module 39	Compute Module 40	3 FT	1.0 M
1.0 M	3 FT	19	Compute Module 37	Compute Module 38	3 FT	1.0 M
1.0 M	3 FT	18	Compute Module 35	Compute Module 36	3 FT	1.0 M
1.0 M	3 FT	17	Compute Module 33	Compute Module 34	3 FT	1.0 M
1.0 M	6 FT	16	Compute Module 31	Compute Module 32	6 FT	1.0 M
1.0 M	6 FT	15	Compute Module 29	Compute Module 30	6 FT	1.0 M
0.5 M	6 FT	14	Compute Module 27	Compute Module 28	6 FT	0.5 M
0.5 M	6 FT	13	Compute Module 25	Compute Module 26	6 FT	0.5 M
0.5 M	6 FT	12	Compute Module 23	Compute Module 24	6 FT	0.5 M
0.5 M	6 FT	11	Compute Module 21	Compute Module 22	6 FT	0.5 M
0.5 M	6 FT	10	Compute Module 19	Compute Module 20	6 FT	0.5 M
0.5 M	6 FT	9	Compute Module 17	Compute Module 18	6 FT	0.5 M
0.5 M	6 FT	8	Compute Module 15	Compute Module 16	6 FT	0.5 M
0.5 M	6 FT	7	Compute Module 13	Compute Module 14	6 FT	0.5 M
0.5 M	6 FT	6	Compute Module 11	Compute Module 12	6 FT	0.5 M
0.5 M	6 FT	5	Compute Module 9	Compute Module 10	6 FT	0.5 M
0.5 M	6 FT	4	Compute Module 7	Compute Module 8	6 FT	0.5 M
0.5 M	6 FT	3	Compute Module 5	Compute Module 6	6 FT	0.5 M
1.0 M	6 FT	2	Compute Module 3	Compute Module 4	6 FT	1.0 M
1.0 M	6 FT	1	Compute Module 1	Compute Module 2	6 FT	1.0 M

1U OPA Edge 48 ports Switch-3 (U 45–37)
1U OPA Edge 48 ports Switch-4 (U 45–37)
1U 48 Port 1G Mgmt Switch-1 (U 29–19)
1U 48 Port 1G Mgmt Switch-2 (U 29–19)
1U OPA Edge 48 ports Switch-1 (U 14–4)
1U OPA Edge 48 ports Switch-2 (U 14–4)

Figure 14. Network Cable Length Reference Layout

Table 9. Quantity and type of cables used in the recommended configuration

Cable Type	Length	Left Side	Right Side
QSFP28 Cables	0.5 m	24	24
	1.0 m	24	24
CAT6 Ethernet cables	3 ft	20	29
	6 ft	28	28

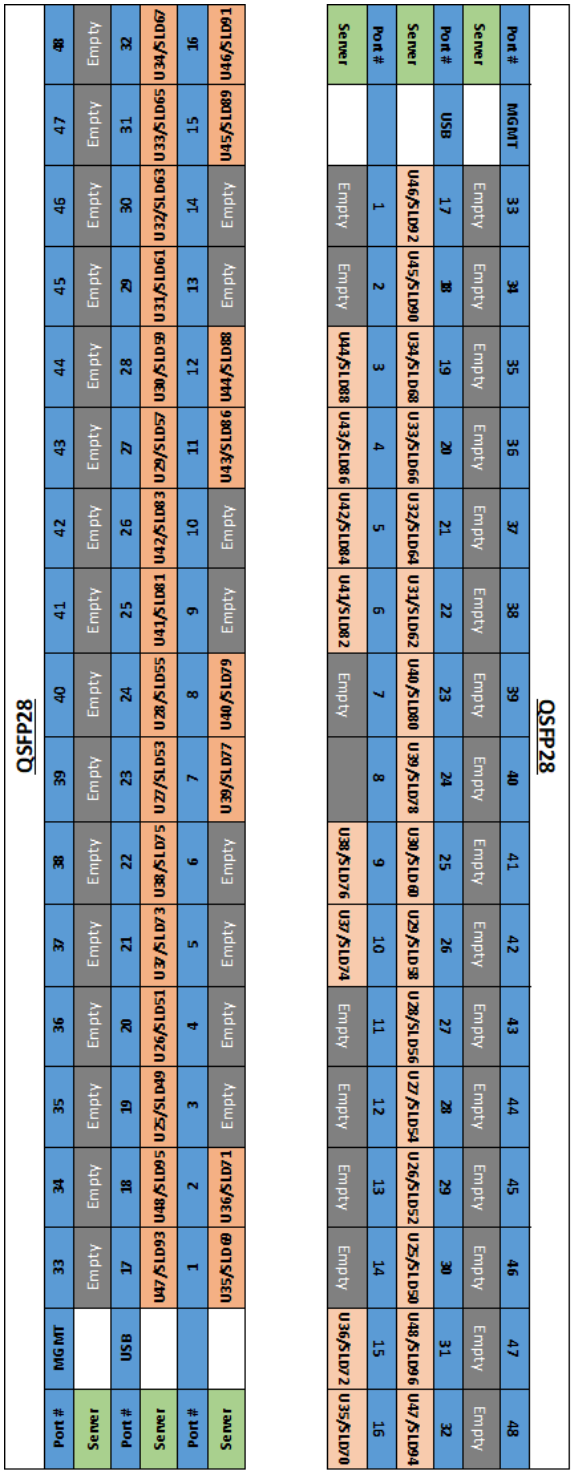


Figure 15. Port mapping reference for Intel Omni-Path switches 3 and 4

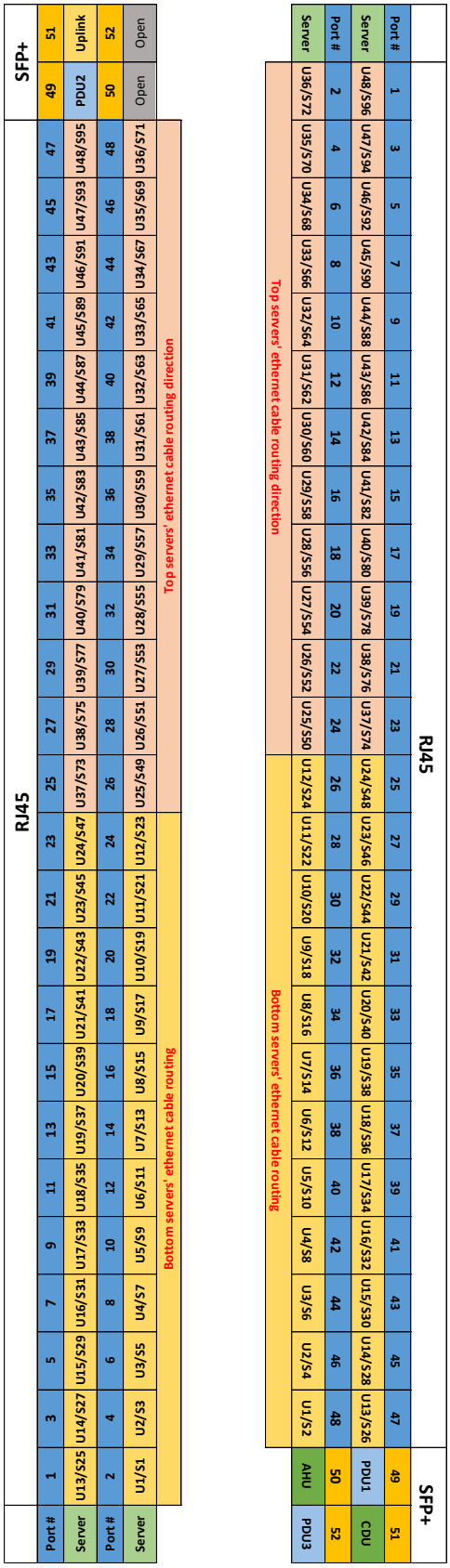


Figure 16. Port mapping reference for Ethernet switches 1 and 2

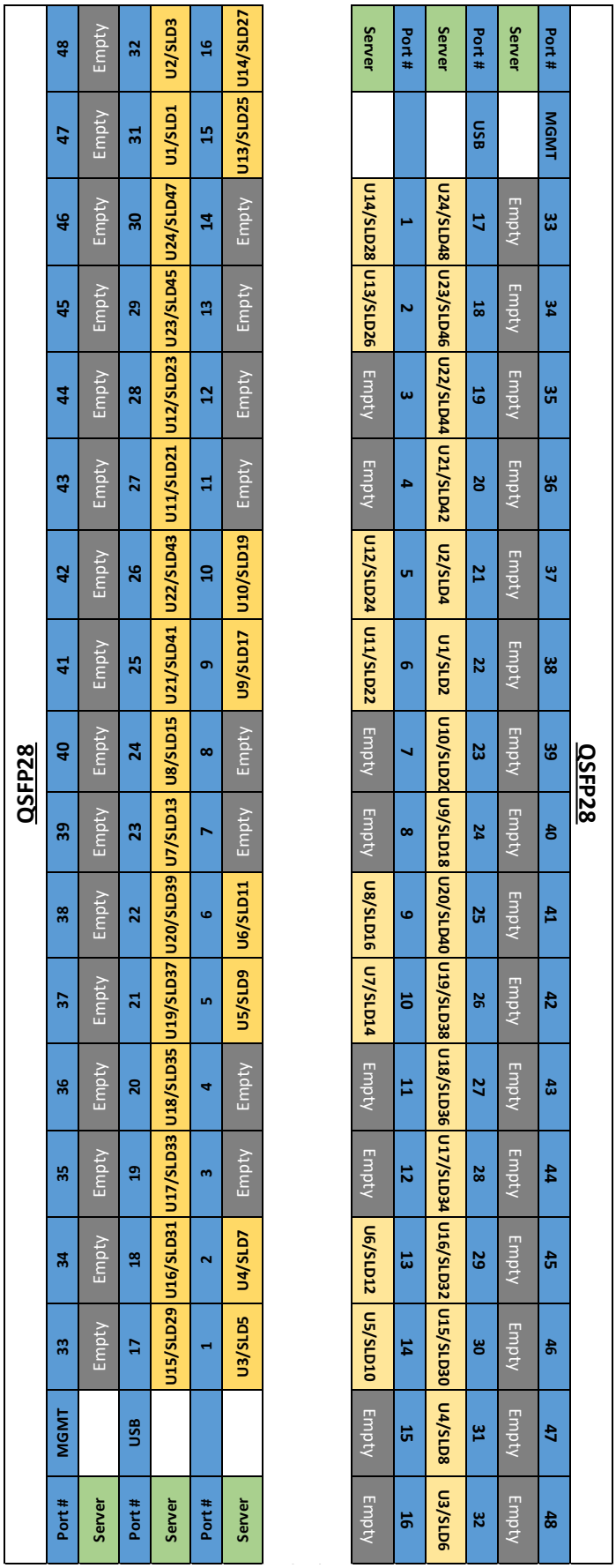


Figure 17. Port mapping reference for Intel Omni-Path switches 1 and 2

5. Mechanical Specifications

This chapter provides dimensions, weight and other mechanical specifications for some of the mentioned components used in the reference rack and cabinet configurations. Information on crating is also included.

5.1 Rack Dimensions

Dimensions for the rack described in this guide are 800mm x 1450mm x 48U.

5.2 PDU

The following tables list the mechanical specifications for the EU and US reference Power Distribution Units

Table 10. EU Compliant PDUs

Manufacturer	Enlogic* 3 Phase WYE
PDU weight	11.5 Kg
PDU dimensions (W x D x L)	59mm x 100mm x 1981mm; 2.3" x 3.9" x 78"
PDU mounting	Tool-less button

Table 11. US Compliant PDUs

Manufacturer	Raritan*
PDU weight	11.5 Kg
PDU dimensions (W x D x L)	59mm x 100mm x 1981mm; 2.3" x 3.9" x 78"
PDU mounting	Tool-less button

5.3 Management Switch

The following table lists the Management Switch's mechanical specifications

Table 12. Management Switch Spec

Manufacturer	Cisco
Model	2690
Dimensions	17.5in (W) x 16.94 in (D) x 1.75 in (H)
Weight	12.9 lbs. (5.8 Kg)

5.4 Data Switch (Fabric)

The following table lists the Data Switch's mechanical specifications

Table 13. Management Switch Spec

Manufacturer	Intel
Model	Intel® Omni-Path Edge Switch 100 Series 48
Dimensions	17.15 in x 17.3 in x 1.72 in
Weight	13.64 lb. (6.2 kg)

5.5 Liquid Cooling Manifold

The following table lists the features of the recommended liquid cooling manifold for the rack and cabinet configurations:

Table 14. Liquid cooling manifold features

Feature	Description
Ports	24 ports 90 degree SCG06 Stäubli* liquid quick disconnects on tubes affixed to barbed fittings on manifolds
Feed Orientation	Can be configured for either a top or bottom feed configuration. The bottom feed includes a Shrader* valve on top of the inlet (cold) manifold.
Leak Mitigation	Includes a solenoid on the inlet manifold (cold) and a check valve on output (hot).
Mounting	The liquid cooling manifold uses mounting plates provided by CoolIT*. The mounting plates are then affixed to both the inner side of the rack and the manifolds.

5.6 Equipment Weight Data

The following tables list the weight estimates for both the rack and cabinet:

Table 15. Rack weight estimates

#	Part name	Weight in lbs.	Qty per Rack	Total (lbs.)	Total (kg)
1	48U Rack Frame (Solid Doors)	685	1	685	311
2	Server system (2U / 4N)	116	24	2784	1263
3	OPA Edge Switch	15	2	30	14
4	Cisco 2690 Switch	13	2	26	12
5	PDU	20	4	80	36
6	Accessories - Rails, Brackets etc.	100	1	100	45
7	Cables	50	1	50	23
8	Rack manifold	50	2	100	45
	Populated compute rack		**Total**	**3855**	**1766**

Table 16. Cabinet weight estimates

#	Part name	Weight in lbs.	Qty per Rack	Total (lbs.)	Total (kg)
1	Populated compute rack	3839	2	7678	3483
2	CyberRow*	792	1	792	359
3	Empty 700mmW 1457mmD Rack	250	1	250	113
	Complete L11 Cabinet		**Total**	**8720**	**3955**

5.7 Crating

All crate materials are approved per SPEC ISTA-2B. The following steps are recommended when crating the server rack:

1. Inspect the rack caster prior to loading the rack into the crate.
2. Inspect the crates before loading the rack, noting any structural defects (per factory quality specifications).

Note: Crate includes minimum padding material to ensure a tight fit of the rack product.

3. Ensure straps are included to facilitate rack unloading. Metal straps are required for shipping.
4. Place at least 2 tilt and shock indicators inside the crate rear and side panels.
5. Place at least 1 tilt and shock indicator on external side panels.
6. Ensure pallet bolts are secured.
7. Load the rack into crate front side first.
8. Ensure crate locks are secured properly.

Note: Add accelerometers or GPS devices if required.

5.7.1 Crate Compliance Guidelines for Shipping

The crate will comply with certification requirements for overseas shipment and any certification labels required per shipping logistics will be added. Treatment and marking of the pallet must conform to the International Standards for Phytosanitary Measures, Publication no. 15 (ISPM 15) guidelines for regulating wood packaging materials in international trade.

5.8 Drawings and CAD

Drawings and CAD files may be supplied upon request and on an as needed basis. Please contact your Intel support representative for details.

6. Thermal Specifications and Requirements

This chapter provides guidelines and recommendations based on a solution configuration with an end-of-row CDU measured and cooling simulation data for cabinet configurations.

The information presented considers differences in heat produced by system memory, the power requirements presented in Chapter 3, as well as the combination of the liquid coolant flow rate with the ambient temperature. These factors directly impact the number of supported systems per rack, thus affecting the number of supported systems per cabinet.

6.1 Fluid Network Concept

The pictorial diagram below shows the basic layout and elements of the fluid system.

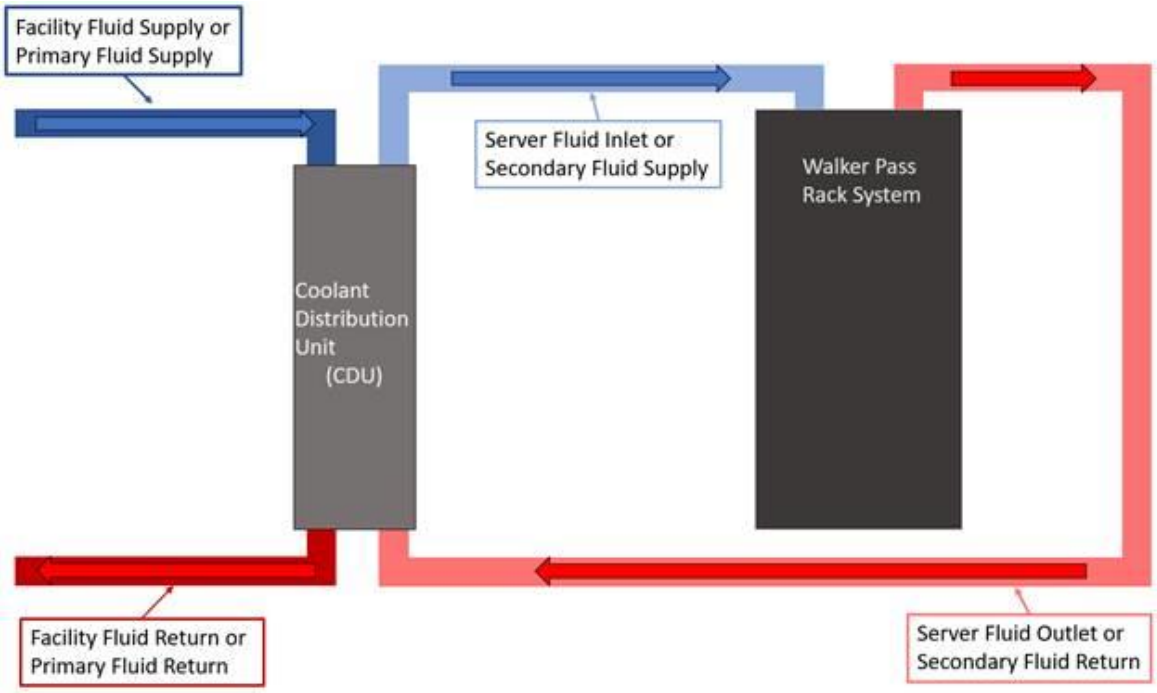


Figure 18. Rack level diagram

6.2 Boundary conditions

The operation limits of the recommended configuration for rack and cabinet are based on the following assumptions:

- 48U rack with 24, 2U form factor server systems
- Direct Liquid Cooling with a Heat Capture Rate (HCR) > 80%
- Computer Room Air Conditioning Unit (CRAC) to cool ~15 to 20% of heat for rack configurations
- Air Handler Unit (AHU) for cabinet configurations
- Fluid: 25% Propylene Glycol Water (PGW) on the secondary loop and water in the primary loop of the heat exchanger.
- Heat generated per memory DIMM: Minimum of 6W and a maximum of 14W
- Facilities flow rate for primary fluid loop: 360lpm for an end-of-row CDU.
- Server systems fluid exit temperature (Tfluid): below 65°C
- Components cooled by Passive Cooling Loop (PCL) are assumed to have 100% heat to fluid.

The chassis minimum flow rate and maximum inlet temperature numbers are shown in **Figure 19** and **Figure 21** and must not be exceeded. For example, a combination of 10°C inlet temperature and 1lpm passes but 30C and 1lpm automatically fails.

The following table lists the specific equipment used in testing the thermal requirements:

Table 17. Equipment used for simulation

Part type	Vendor	Model
Quick disconnect for the chassis	Staubli*	SCG06
Quick disconnect for the rack	Staubli*	SCG20
End-of-row heat exchanger	CoolIT*	CHX750

Caution: Configuration for maximum coolant flow rate must not exceed 4.6lpm per chassis or 1.15lpm per compute module. Coolant flow rates above this value can lead to premature wear and corrosion in the chassis plumbing and the liquid cooling loop in the compute modules.

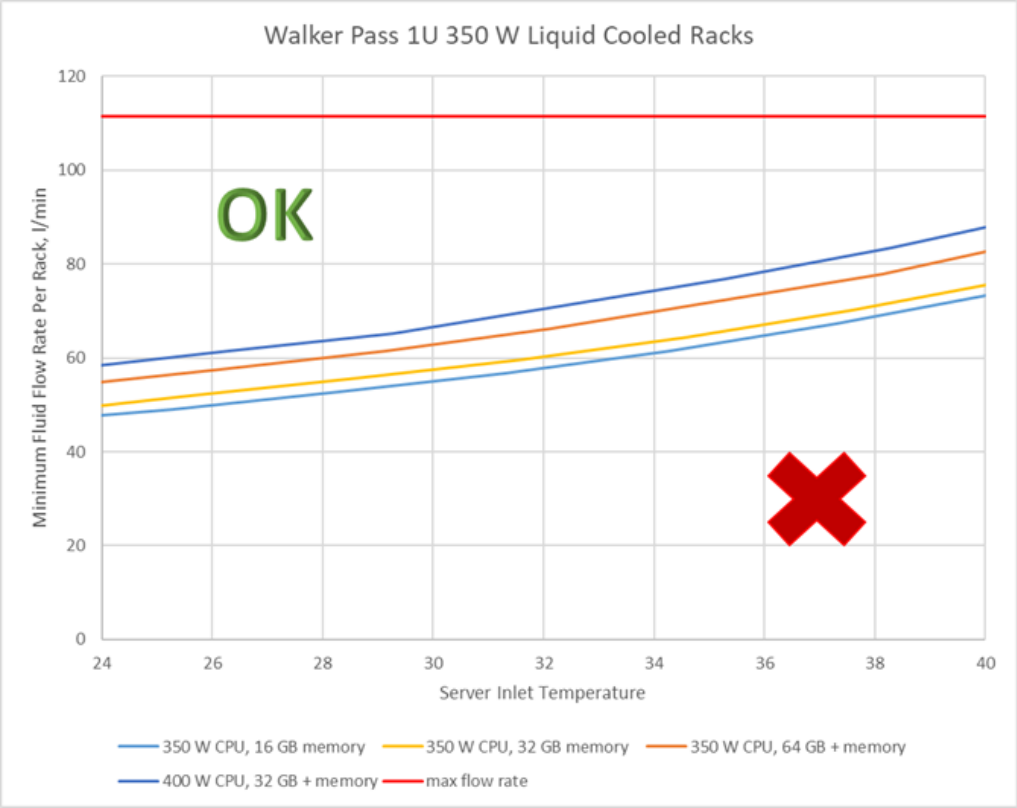


Figure 19. Minimum flow rate per rack

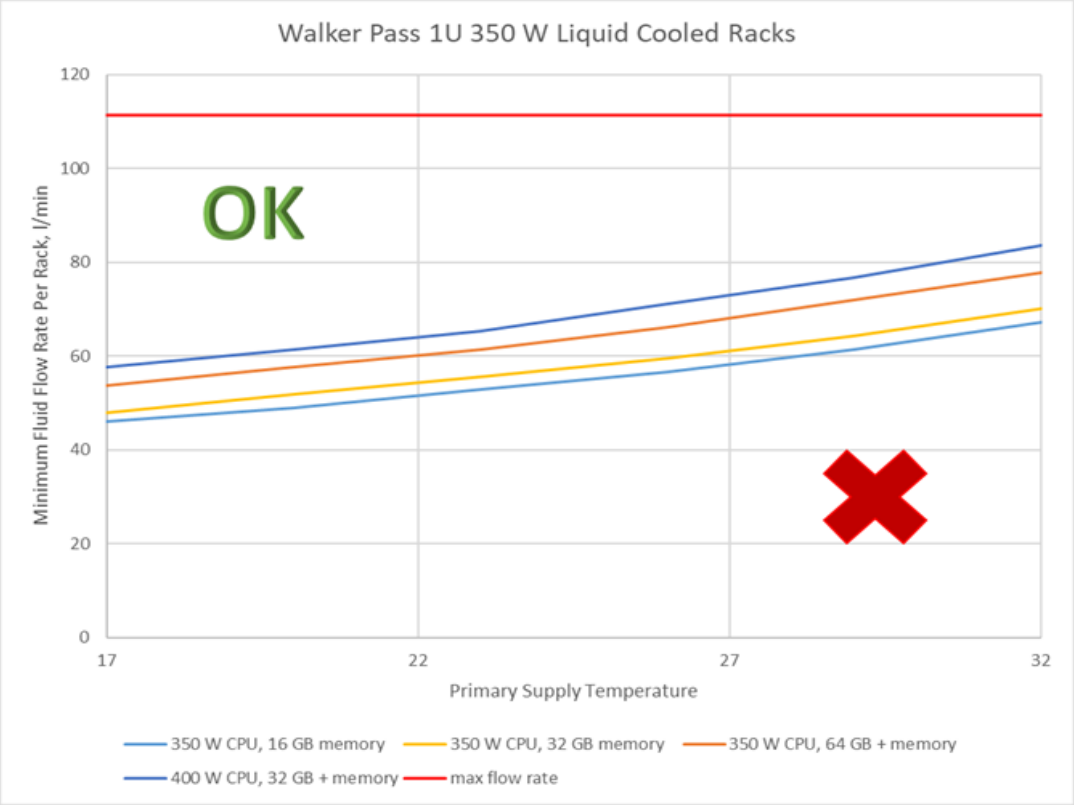


Figure 20. Minimum flow rate per rack

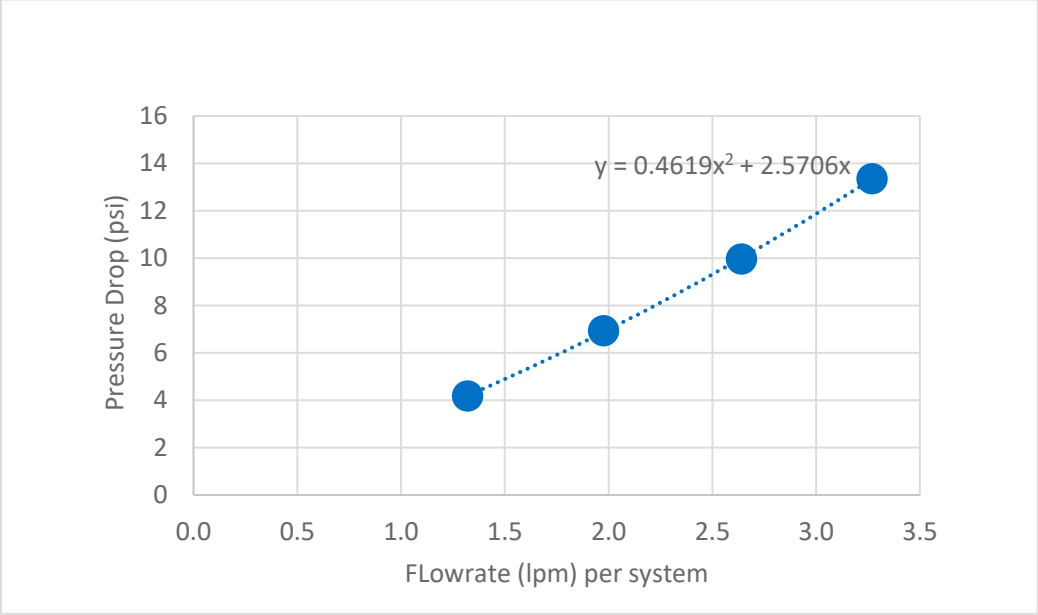


Figure 21. Pressure impedance per system

Note: Pressure drop from rack manifold quick connects are not included in Figure 21.

6.3 Thermal Requirements Based on CDU Selection (End of Row-Based)

The tables in this section show the maximum number of chassis that can be cooled using a single end-of-row CDU at different ASHRAE W conditions for facility water.

6.3.1 End-of-row CDU

When installed in an ASHRAE compliant facility, the end-of-row CDU (CoolIT* CHx750) can cool between 4 to 8 racks with 24 systems each based on DIMM thermal power and primary fluid supply temperature. The following tables list the details of the required parameters for each DIMM type's configuration. The values in the tables apply to racks with perforated or solid doors, and cabinet configurations where the AHU is on a separate fluid loop that does not affect the CDU supply temperature. The values are also based on a two pump, redundant CDU configuration, with fault tolerant fail-over in the event of a CDU failure.

Table 18. End-of-row CDU cooling for systems with 16GB DIMMs

350W CPU, 16GB DIMMs	W1 Facility Fluid (17C)	W2 Facility Fluid (27C)	W3 Facility Fluid (32C)
Number of Racks Supported	8	6	5
HX Rise (deg C)	14.1	9.4	7.3
Server Inlet Temp (deg C)	31.1	36.4	39.3
Server Flow Rate (lpm)	2.36	2.72	2.96
Rack Flow Rate (lpm)	56.6	65.3	71.0
Total System Flow Rate (lpm)	453.1	391.7	355.2
CDU Heat Load (kW)	691.6	518.7	432.3

Table 19. End-of-row CDU cooling for systems with 64GB DIMMs

350W CPU, 64GB DIMMs	W1 Facility Fluid (17C)	W2 Facility Fluid (27C)	W3 Facility Fluid (32C)
Number of Racks Supported	7	5	4
HX Rise (deg C)	14.1	8.7	6.3
Server Inlet Temp (deg C)	31.1	35.7	38.3
Server Flow Rate (lpm)	2.68	3.04	3.24
Rack Flow Rate (lpm)	64.3	73.0	77.8
Total System Flow Rate (lpm)	450.2	364.8	311.0
CDU Heat Load (kW)	737.7	526.9	421.5

6.4 Air cooling recommendations

The reference rack and cabinet configurations described assume 84% of the heat generated is captured by the liquid cooling elements. It is recommended to select an adequate air-cooling solution to capture the remaining heat. The following is a list of requirements for air cooling planning:

- Minimum system inlet temperature: 5°C
- Maximum system inlet temperature: 35°C
- Maximum system exit temperature: 55°C (from nodes into power supplies)
- Air flow rate per system:
  - Systems with 1U compute modules: 145 cfm
  - Systems with 2U compute modules: 168 cfm
- 88 cubic feet per minute (cfm) per system = 149.5m3/hr. (at 35°C ambient temperature)
- Maximum supported cfm at 100% fan speed is ~290 per chassis = 171 m3/hr.

Additional References

For additional information about the Intel® Server System S9200WK Product Family or any of its supported accessories, refer to the following resources available at http://www.intel.com/support.

Table 20. Product family reference collaterals

For this information or software	Use this document or software
For in-depth technical information about the product family	*Intel® Server System S9200WK Product Family Technical Product Specification* *Intel® Remote Management Module 4 (Intel® RMM4) and BMC Embedded Web Console User Guide* *Intel® Remote Management Module 4 Technical Product Specification* *Intel® Server System BIOS Setup Utility Guide* *Intel® Server Platform Specification Update*
For system integration and service instructions	*Intel® Server System S9200WK Product Family Setup and Service Guide*
For server configuration guidance and compatibility	Intel® Data Center Blocks Configurator (orderconfigurator.intel.com) *Intel® Server System S9200WK Product Family Configuration Guide*
For system firmware updates, onboard device drivers, and software	Download Center (https://downloadcenter.intel.com/search?keyword=S9200WK)
For system power budget guidance	Intel® Server System S9200WK Product Family Power Budget and Thermal Configuration Tool
For a complete list of supported processors, memory, add-in cards, and peripherals	Intel® Server System S9200WK Product Family support site https://www.intel.com/content/www/us/en/support/products/192334/server-products/server-systems/intel-server-system-s9200wk-family.html
Product warranty Information	Warranty Terms and Conditions (https://www.intel.com/content/www/us/en/support/services/000005886.html)
Safety and Regulatory Compliance Information	*Intel® Server System S9200WK Product Family Technical Product Specification*

Appendix A. Glossary

Term	Definition
2U	Two rack units (3.5 in.)
AHU	Air Handler Unit
Cabinet	Two racks with an Air Handler Unit
CDU	Cooling distribution unit
Chassis	Casing containing the server compute modules and fans/liquid cooling plumbing
Cluster	A group of three or more racks or cabinets
CRAC	Computer Room Air Conditioning Unit
DIMM	Dual inline memory module
HCR	Heat Capture Rate
HPC	High Performance Computing
PDU	Power Distribution Unit
PGW	Propylene Glycol Water
PSU	Power Supply Unit
Rack	A server system rack
TDP	Thermal Design Power