



OPEN

Compute Project

Open Rack V3 Power Shelf

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10/09/2020

Authors:

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Revision History

Date	Version	Change By	Comments
09/22/2020	0.5	hamidk@ tjin@	Updated spec to include FB requirements ME update.
09/28/2020	0.65	hamidk@	Updated section 4.1.1
10/09/2020	0.7	hamidk@	Removed requirement for grounding 48V return (negative) to the power shelf frame on sec 4.2

1. Scope

This document defines the technical specifications for Open Rack V3 Power Shelves used in the Open Compute Project.

2. Overview

The Open Rack Power Architecture is comprised of centralized scalable power shelf that distributes power over a common bus bar to the payload devices (IT Gear). This spec will define the power shelves that fits into the Open Rack. The power shelves shall house several rectifiers with minimum of N+1 redundancy to provide the dc power to all the payload inside the rack. Single shelf or multi-power shelves shall be used in a rack depending on the power rating of the rack and power shelf.



3. Power shelf options

The following power shelves are introduced on this Spec according to the application:

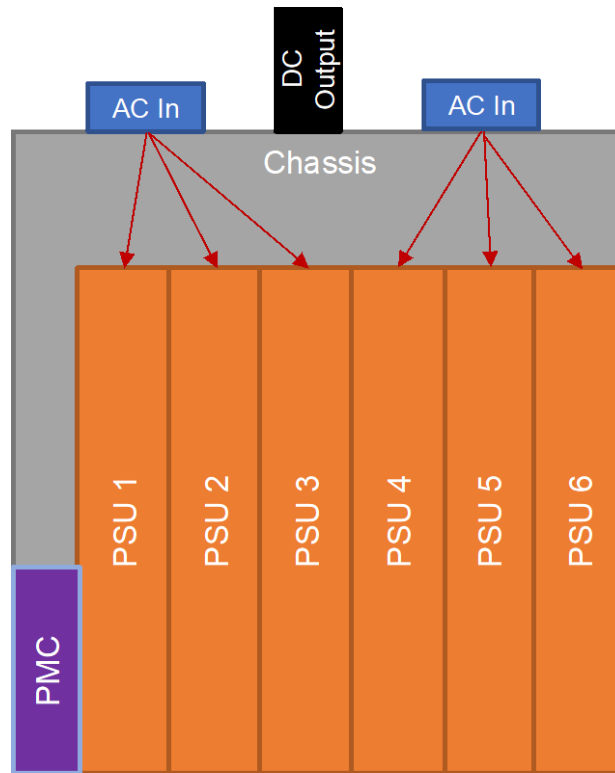
3.1. Power shelf option 1 – 6x 3kW PSU with dual cord (2x 20A NEC breaker upstream)

1 OU shelf with two AC power input.

6x 3kW rectifier slots.

Output power: 15kW with N+1 and dual cords.

Direct connect to tap-boxes/facility – no intermediate PDU.



TOP VIEW

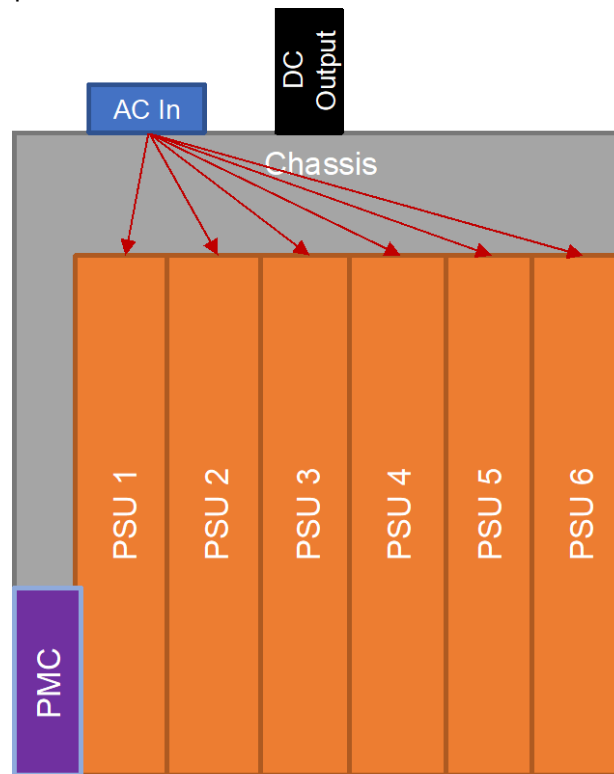
3.2. Power Shelf Option 2 – 6x 3kW PSU with Single Cord (32A IEC breaker upstream)

1U shelf with one AC power input.

6x 3kW rectifier slots.

Output power: 15kW with N+1 and single cord.

Direct connect to tap-box/facility – no intermediate PDU.



TOP VIEW

4. Electrical requirements

4.1. AC Electrical requirements

Power shelf ac input(s) are universal 7 pin connector to be configurable as:

- Star connection
- Delta Connection
- Single phase

For detail, see the ac input connector section.

- The input voltage to each phase-to-return shall be 200-277V nominal with +/- 10%.
- Frequency: 50/60 Hz
- The power module must withstand continuous exposure to 305Vac RMS input with no damage.

AC input shall have its earth ground connected to the chassis.

4.1.1. facility protection

Datacenter facility protection rating is 2x 20A NEC circuit breaker for 2-feed 1U shelf and 32A IEC for single-feed 1U shelf. Short circuit current available is 14kA for 10mS.

4.2. DC Electrical requirements

Power shelf output voltage is specified as “Narrow-range 48V system.” For details, please see OCP ORv3 rectifier spec.

Power shelf SHALL have an output voltage with ripple & noise less than 500mV peak-to-peak with a 20MHz bandwidth. This applies along the entire length of the busbar without respect to the load or physical distribution of the trays. Compliance will be verified using a 0.1mF capacitor connected locally to the oscilloscope probe tips during this measurement. Ripple and noise are defined as periodic or random signals over a frequency band of 5Hz to 20MHz measured across a steady-state resistive load. Measurements shall be made differentially using an oscilloscope with 20Mhz bandwidth limit enabled.

48V return (negative) shall be grounded to the power shelf frame.

4.3. Rectifier physical addressing

Four rectifier signal pins are used for physical addressing. There are digital signals that should have internal pull up resistors inside the rectifier. On the power shelf, these pins can be grounded (0) or left open (1) to determine rectifier location.

4.4. Monitoring & Control Interface

Each Power shelf shall include a power shelf management controller (PMC) to monitor and control various rectifier parameters. PMC is connected to rack management controller or facility level monitoring through a monitoring & control interface.

Note it is required that if PMC fails, power system shall be able to operate normally. PMC is powered from 48V bus directly.

4.5. FRU

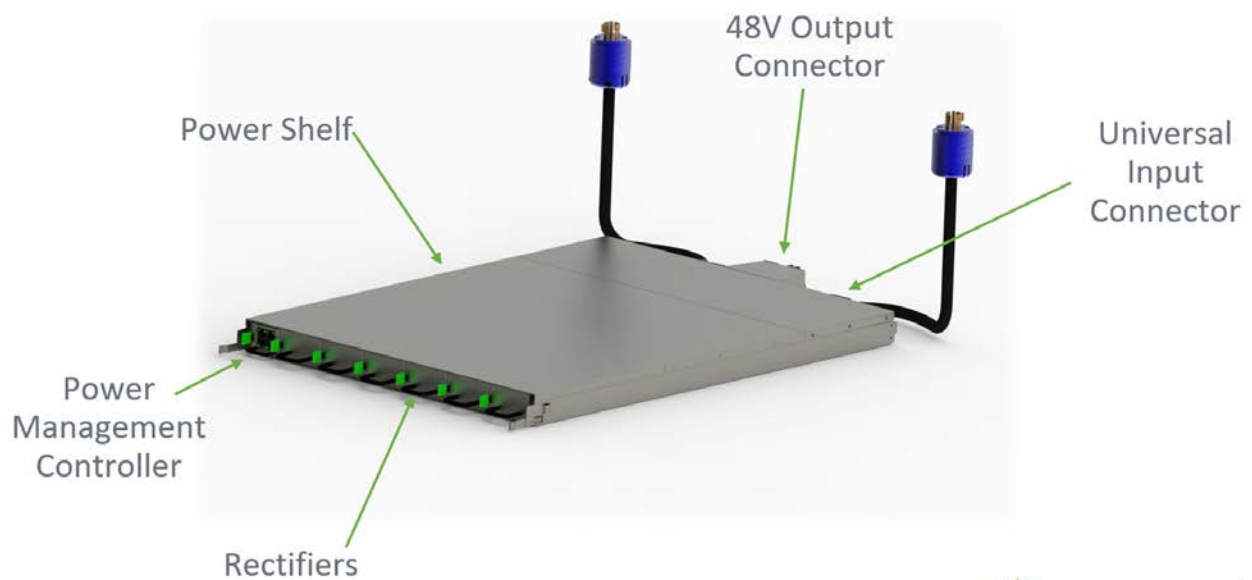
FRU data is stored in an EEPROM on the power shelf PCB. It can be accessed from an I2C line by the PMC. The FRU format should follow *IPMI Platform Management FRU Information Storage Definition 1.0, Version 1.3*. FRU shall support two-byte address and FRU content shall start from 0x0000. The FRU template is listed in Table below. The detailed FRU information should be made available prior to the build for approval.

Organization	String	Example
Board Info Area		
Language Code	19h (english)	
Board Mfg Date	[Generate build time]	
Board Mfg	Defined by vendor	
Board Product	Project Code Name	'ORv3 Shelf'
Board Serial Number	Defined by vendor	
Board Part Number	Defined by vendor	
Custom Field 1		
Custom Field 2		
Product Info Area		

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Language Code	19h (English)	
Product Manufacturer	Defined by vendor	
Product Name	Defined by vendor	
Part/Model Number	Defined by vendor	
Product Version	Defined by vendor	
Product Serial Number	Defined by vendor	
Product Asset Tag	Defined by vendor	
Product Build	EVT (or DVT, PVT)	

5. Mechanical Requirements



5.1. Power Shelf Assembly Dimensions

Power shelf options 1 and 2 are 10U tall. The overall dimensions of the 10U power shelf are 537mm x 46mm x 720mm (W X H X D). Note that the front surface of the rectifiers is recessed from the rack datum by 16mm.

5.2. ORV3 Rack Mounting Feature

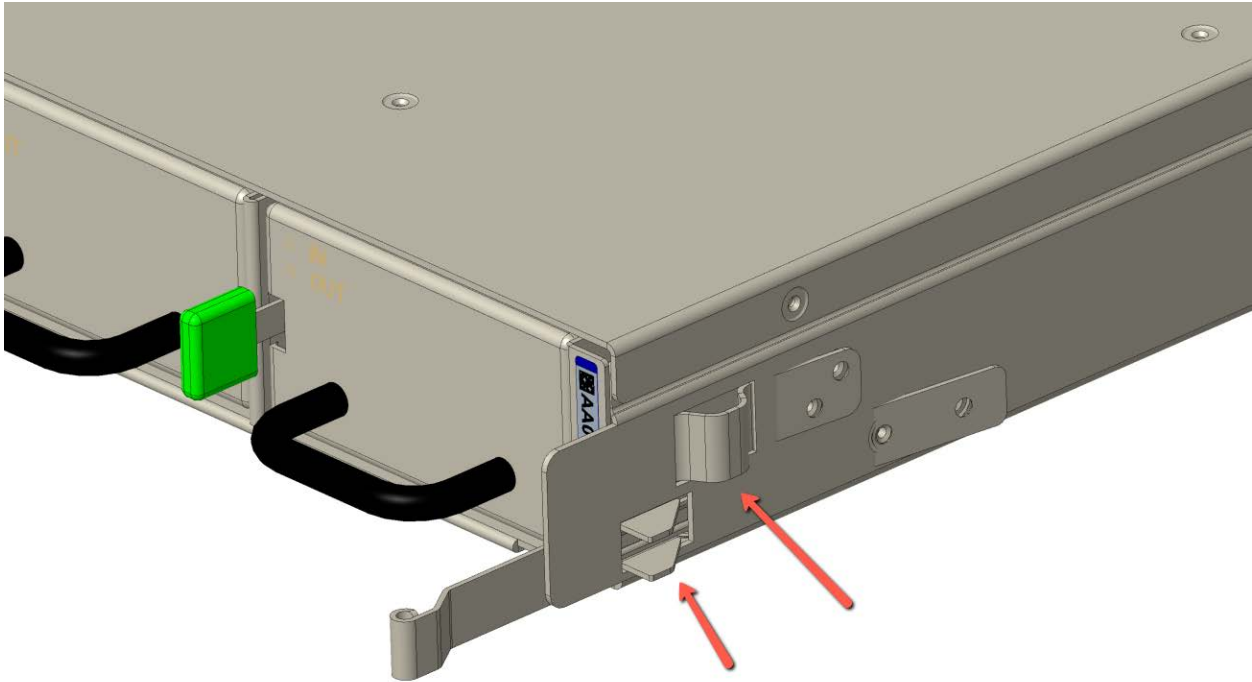


Power shelf will be front mounted to an Open Rack V3 on OU pitch rails (please refer to the Open Rack V3 specifications on more details for the design of these). The design of the 48V Output connector allows it to be placed in any location in the rack.

Rack mounting features are of particular importance in the power shelf design since they assist in constraining the power shelf in X, Y, and Z directions and promotes solid electrical contact with the 48V busbar.

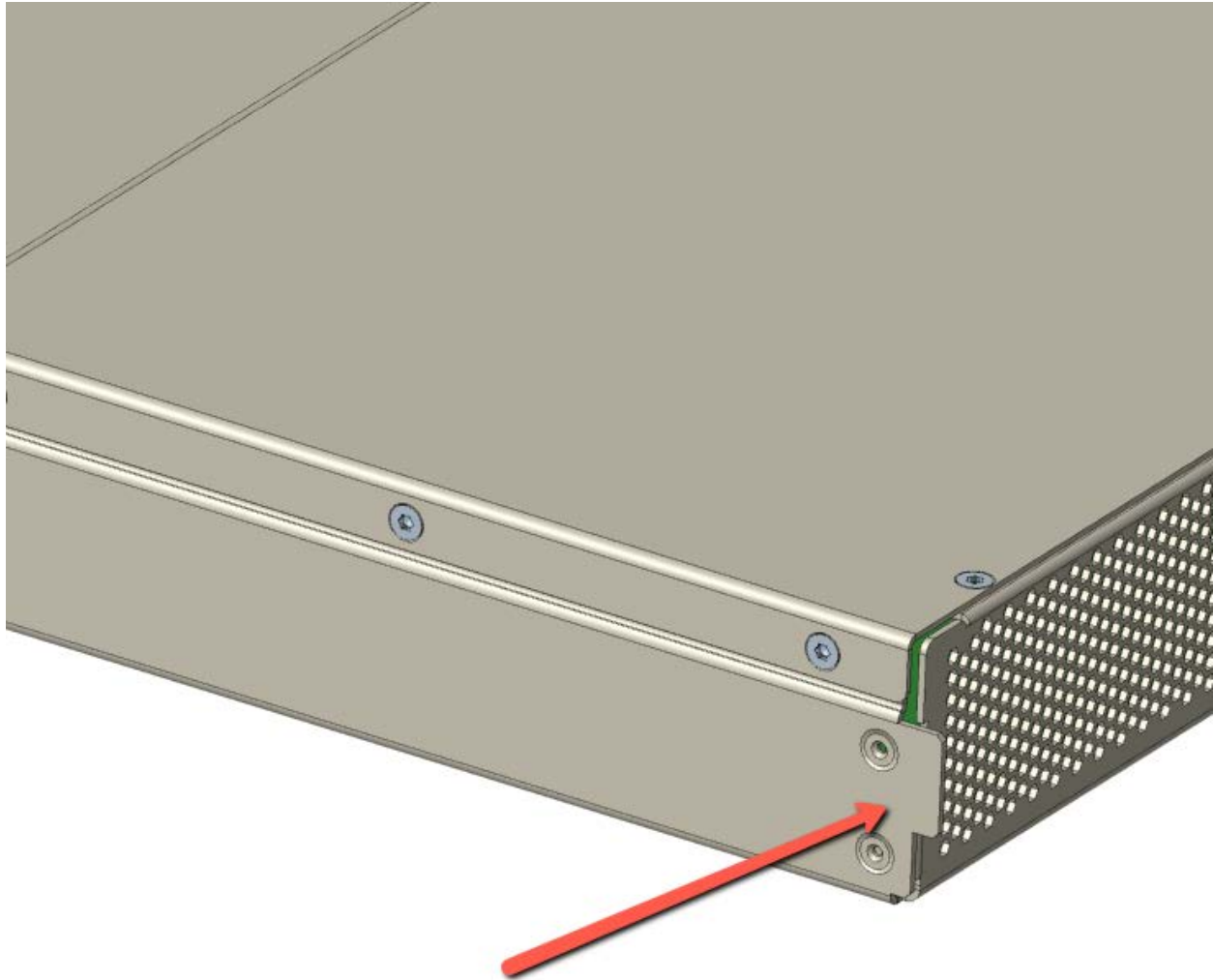
5.2.1. Front Latch & Bumper

Please refer to the mechanical CAD for the locations of the front latch and bumper. Note that these serve separate functions and should not be a single part.



5.2.2. Rear Stop

Please refer to the mechanical CAD for the geometry of the rear stop. This is required to interface properly with the ORV3 rack

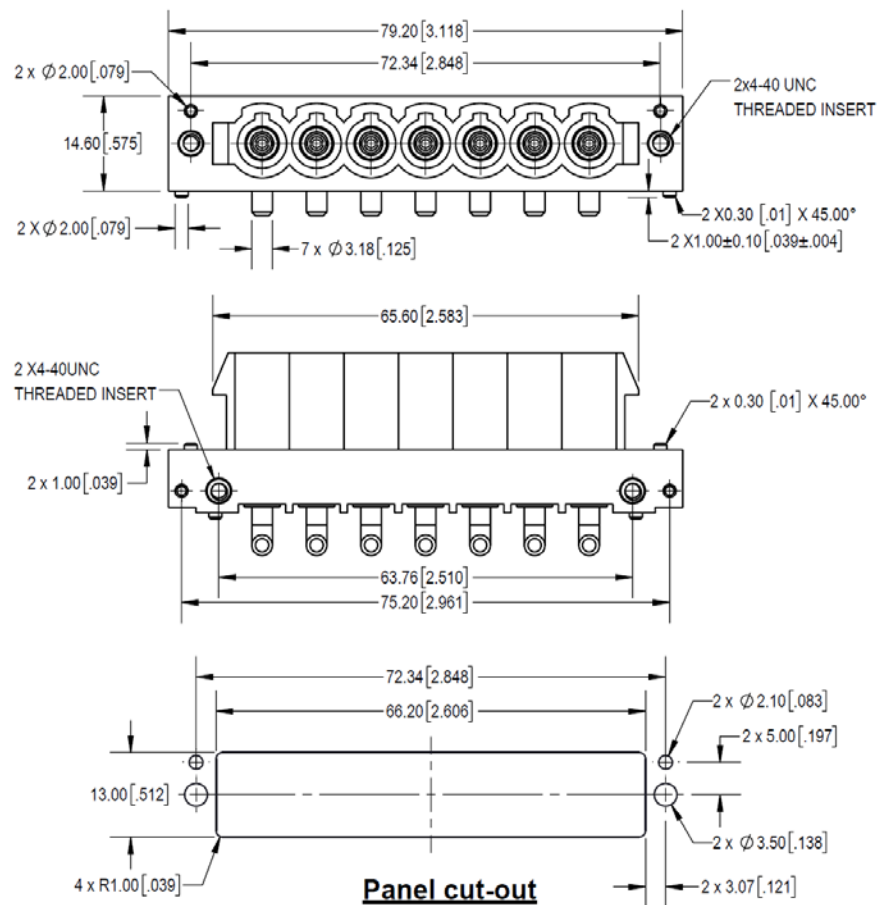


5.3. Connectors

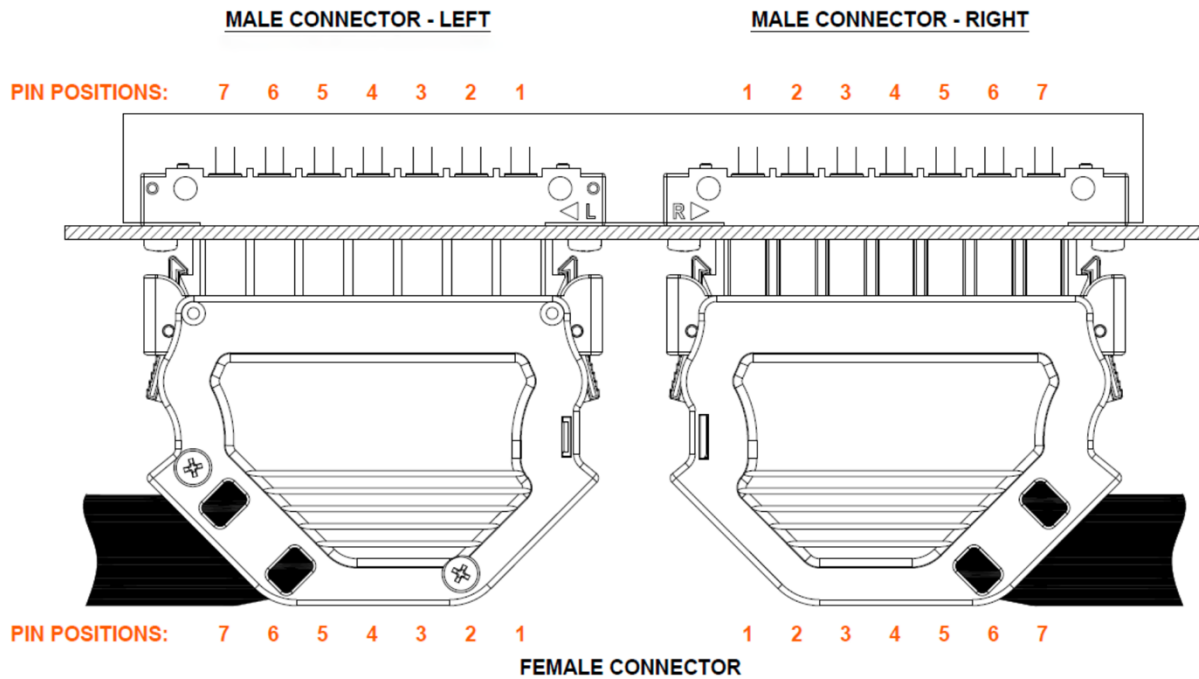
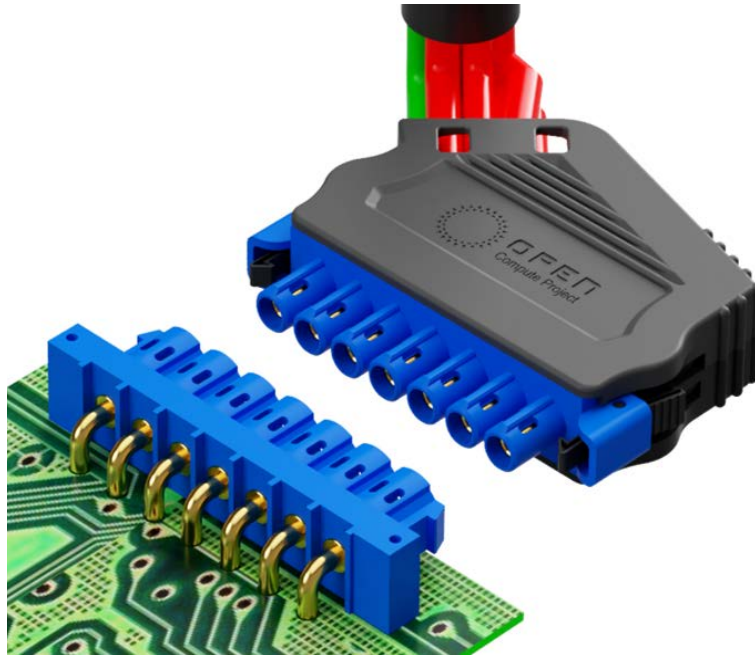
5.3.1. AC Input connector

For the 10U Shelf, please refer to the specification for the Open Rack V3 Power Shelf Universal Input Connector. This power shelf has either one or two such connectors (right only, or left and right). Please refer to the 3D drawing to identify the precise positioning of these connectors. Shown below is a drawing of the right-side male connector.

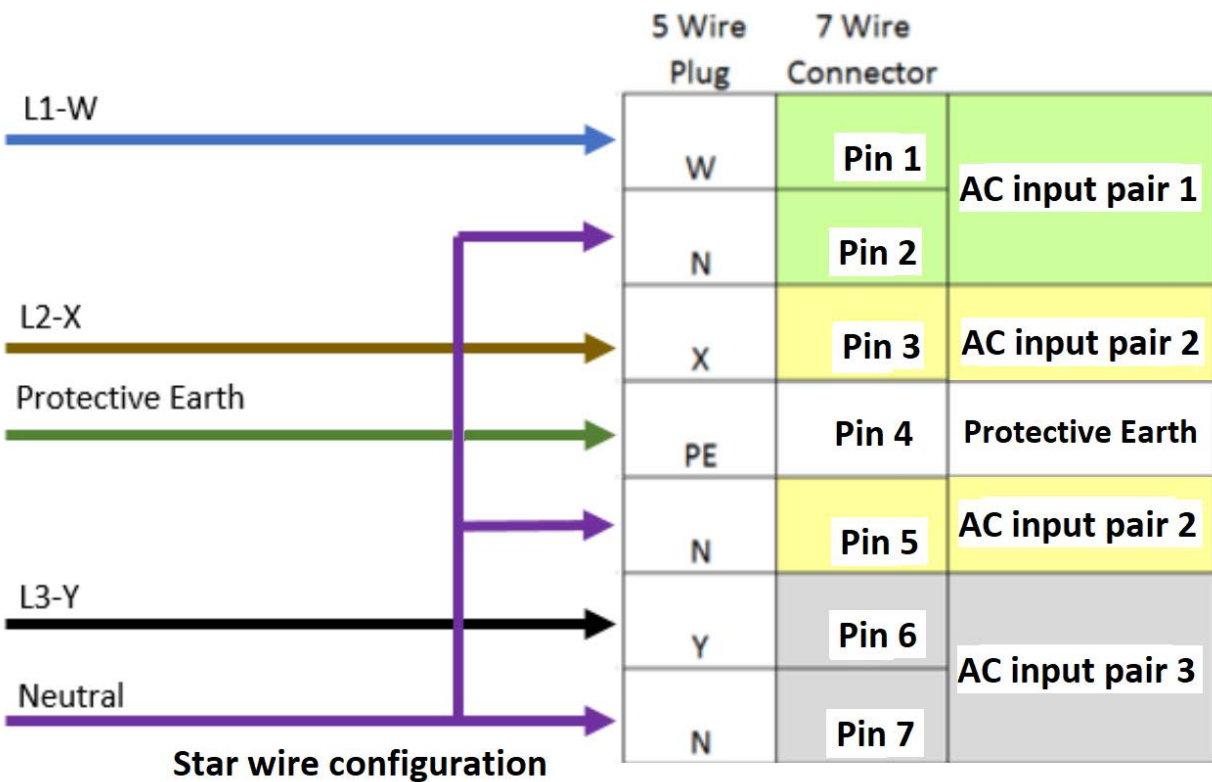
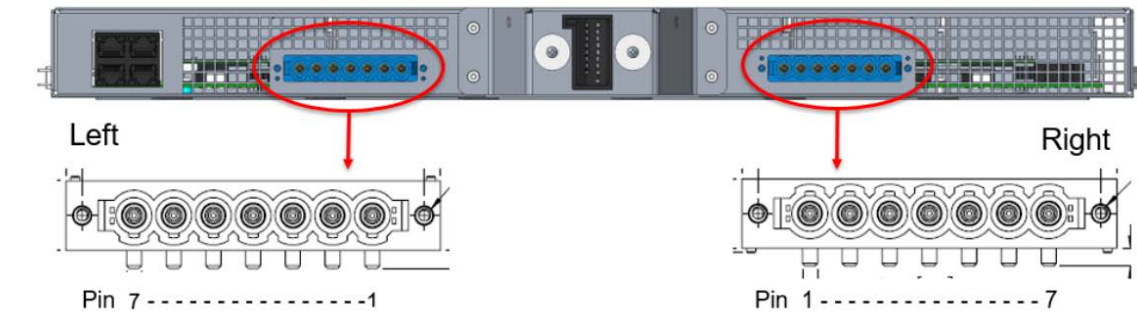
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The female mating connector brings the AC power from the data center into the shelf. It is rated for 32A and is angled outwards, such that cables may be routed along the sides of the rack. Please see Open Rack V3 specifications for more details.



The shelf input connections are for the entry of the input power to the rectifiers. It's a pluggable 7-pin connector that allows various input power configurations (star, delta, single phase.) For details, please refer to "OCP ORv3 universal input connector". Please refer to the mechanical CAD for required positioning of this connector on the rear panel.



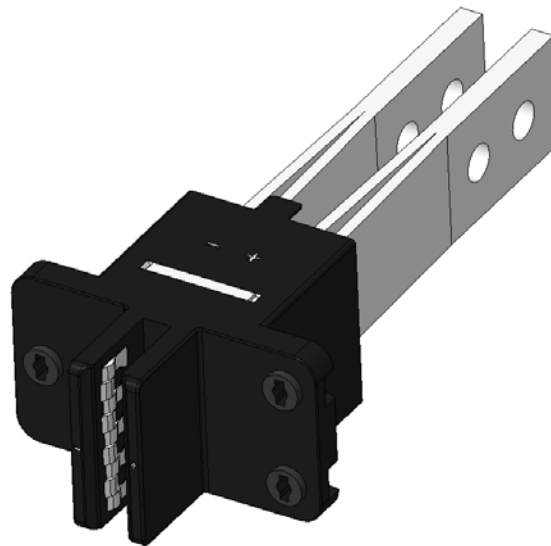
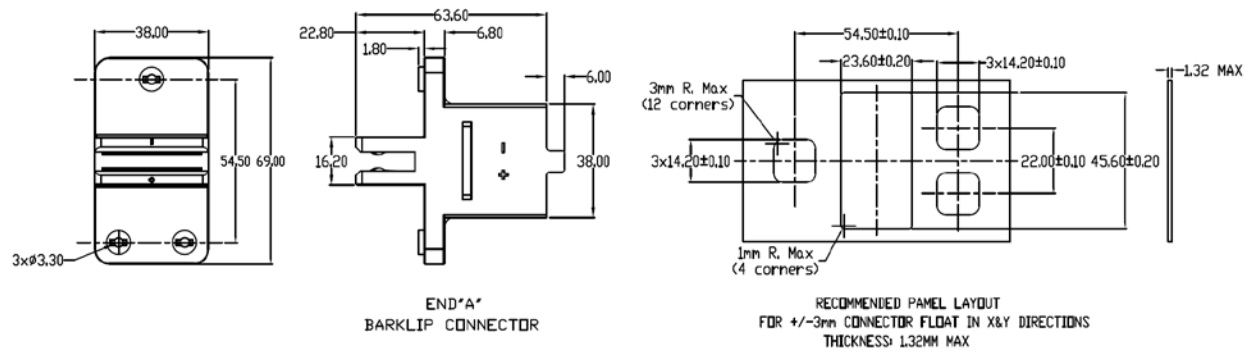
Example: 5 wire cable to 7 pin connector branching (star configuration)

5.3.2. DC Output connector

The shelf DC output floating connector blindmates to busbar bar in the rear side of the power shelf. This gives the flexibility of:

- Place power and battery shelves any desirable location on the rack.
- Can add more power and/or battery shelves as needed.

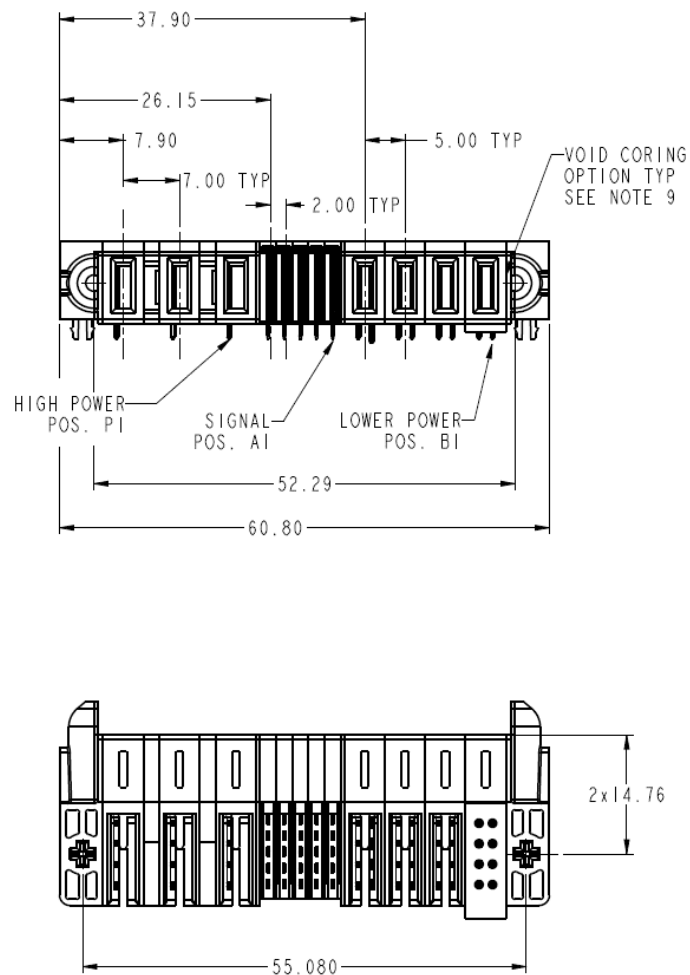
The DC Output connector shall make contact with the Open Rack V3 busbar. Please refer to the Open Rack V3 Power Shelf 48V Output Connector for more details. A drawing of the housing and recommended panel layout is shown below.



5.3.3. Power Supply Connector

The chassis side of the rear blind mate connector of the PSU shall be Amphenol 10127400-01U1520LF or equivalent. This is a R/A receptacle, PwrBlade ULTRA HD connector with 3 low power pins, 25 signal pins, and 4 high power pins. Please refer to the drawing for more details. The connector positions (in all 6 or 12 locations) within the power shelf is fixed in x, y, and z direction according to the 3D drawing. This cannot be altered due to mix-and-match requirements for the power supplies into the shelf.

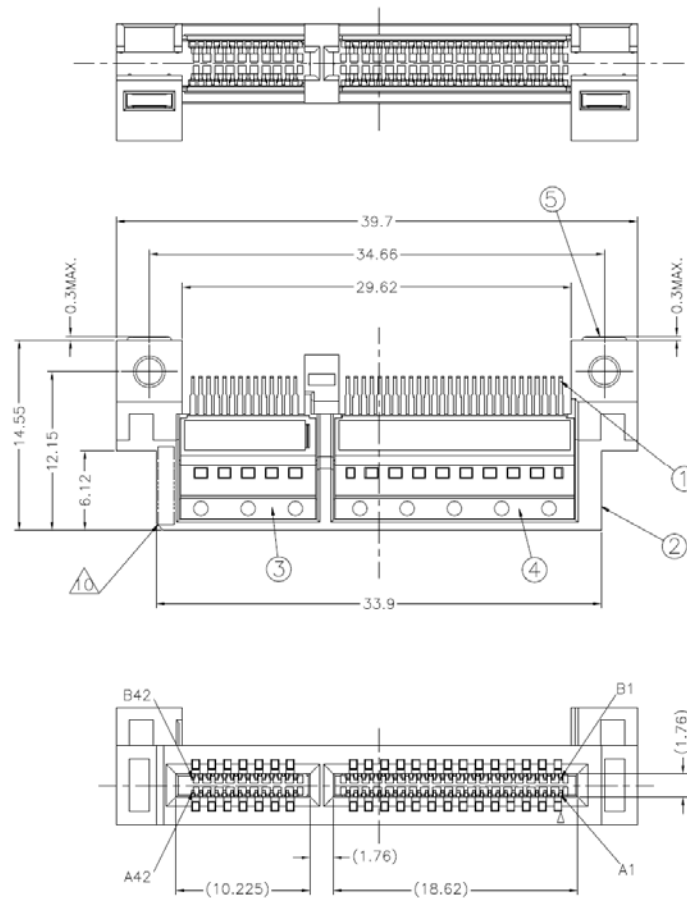
Rectifiers plug into the power shelf directly, and they shall be hot swappable while the rack is powered. Please refer to “OCP ORv3 PSU” for pinout signals.



5.3.4. PMC/PMI connector

The PMC is a blind-mate module with a 2C card edge connector. On the chassis side, the location of this connector is fixed, but the connector itself may either be PCB-mounted or a panel-mounted cable. There are no requirements on the connector interface of this blind mate connector to the rear main PCB. Please refer to the 3D drawing for the precise position.

PMC plug into the power shelf directly, and they shall be hot swappable while the rack is powered. Please refer to "OCP ORv3 PMC" for connector pinout signals.



5.4. Front Access

All 6 power supplies shall be toollessly accessible from the front, and located in the positions defined in the 3D drawing. The PMC shall also be toollessly accessible from the front and located in the position defined on the 3D drawing.

5.5. Layout

5.6. Construction

Power shelf can be welded, riveted or screwed together, consistent with meeting shock, vibration and maximum allowable deflection requirements. There shall be no sharp corners or edges. When assembled into a rack, with rectifiers installed, maximum deflection of the rectifier shelf shall be less than 1.3 mm.

5.7. Materials and Fasteners

Acceptable shelf materials include zinc plated CRS steel. Any plastic material used will meet UL 94-V0 specifications

5.8. Labeling

Labels shall be provided that identifies which DC output on the shelf is - and which is +. Also, input ac connector(s) shall be labeled accordingly. Label shall be an assembly aid to ensure cables are assembled correctly.

6. Thermal Requirements

6.1. Operational

- For operating environmental conditions, please refer to section 7.
- Airflow direction: Front-to-back
- Exhaust temperature from upstream components/assemblies: Should not exceed 60°C and should be driven by operation of upstream components (rectifier and PMC).
- Thermal margin: Reserving adequate margins on components is critical. These margins should be defined with respect to de-rated values, as appropriate. Following are the requirements.
- Component thermal margin of $\geq 7\%$ or $\geq 5^\circ\text{C}$ up to 30°C inlet/ambient and 3050m (10,000ft) above sea-level. Target whichever value is larger.
- Component thermal margin of $\geq 4\%$ or $\geq 3^\circ\text{C}$ at greater than 30°C inlet/ambient and up to 3050m (10,000ft) above sea-level. Target whichever value is larger.
- Margin to de-rated temperatures should account for associated differences in reading and measurement location. Impact to reliability should also be considered when determining required margin.

6.2. Thermal design requirements

- Sensor accuracy: For discrete and critical sensors (such as ambient temperature), an accuracy of $\pm 2^\circ\text{C}$ is required ($\leq \pm 1^\circ\text{C}$ is preferred). If a component does not have an integrated temperature sensor, and uses a proxy, need to target an accuracy $\leq \pm 5^\circ\text{C}$ ($\leq \pm 2^\circ\text{C}$ is preferred). If this component is temperature sensitive, thermal margin requirements defined above should account for sensor inaccuracy.
- Back-pressure: Shelf design should accommodate compliance requirements while ensuring reasonable impact to upstream components. Rear panel design can significantly influence the amount of back-pressure upstream components have to overcome (such as the rectifiers). In general, targeting a back-pressure of ≤ 0.15 inches of water is highly recommended (placeholder value; to be verified and updated).
- Bus-bar power or DC output connection assembly: Termination of cables within the shelf as well as the clip/connector (to the rack bus-bar) mounting at the rear panel should be designed to ensure adequate cooling for compliance requirements (temperature difference as a function of current draw).
- Surface temperature: To make the shelf safe for handling in-operation, accessible surfaces should not exceed a temperature of 70°C.

7. Environment/test requirements

- Gaseous Contamination: Severity Level G1 per ANSI/ISA 71.04-1985
- Ambient operating temperature range: -5°C to +45°C
- Operating and Storage relative humidity: 10% to 90% (non-condensing)
- Storage temperature range: -40°C to +70°C
- Transportation temperature range: -55°C to +85°C (short-term storage)
- Operating altitude with no de-ratings: 3050m (10,000 feet)
- Acoustic noise: Target sound pressure should not exceed 85dBA when fan modules are running at full speed and operating within the defined environmental envelope

7.1. Vibration & Shock

The power shelf shall meet shock and vibration test per EN 60068-2-6 and 60068-2-27 for both nonoperating and operating condition, with the specifications listed below. During operating vibration and shock tests, the power shelf shall exhibit full compliance to the specification without any electrical discontinuities.

During the non-operating tests, no damages of any kinds (included physical damages) should occur and they should not corrupt the functionalities of the PSU per the specifications.

- VIBRATION
 - Operating: 0.5g acceleration, 1.5mm amplitude, 5 to 500 Hz, 10 sweeps at 1 octave/minute per each of the three axes (one sweep is 5 to 500 to 5 Hz)
 - Non-Operating: 1g acceleration, 3mm amplitude, 5 to 500 Hz, 10 sweeps at 1 octave/minute per each of the three axes (one sweep is 5 to 500 to 5 Hz)
- SHOCK
 - Operating: 6g, half-sine 11mS, 5 shocks per each of the three axes
 - Non-Operating: 12g, half-sine 11mS, 10 shocks per each of the three axes

8. Compliance requirements

The power supply shelf shall be designed for compliance to allow worldwide deployment. Additionally, the manufacturer is fully responsible for:

- ensuring the complete compliance of the power supply shelf in the environment it is intended to function (as described by the Rack Spec)
- maintaining and updating the power supply shelf safety reports to current requirements and all new released requirements.
- all design and recertification costs required to update the power supply to meet the new requirements.
- Meeting EMC requirements
- Meeting Safety requirements

The manufacturer is responsible for obtaining the safety certifications specified below.

8.1. Safety Standards

The product is to be designed to comply with the latest edition, revision, and amendment of the following standards. The product shall be designed such that the end user could obtain the safety certifications: UL 62368-1, IEC 62368-1 and EN 62368-1; hazard-based performance standard for Audio video, IT & Communication Technology Equipment

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The manufacturer shall obtain the following safety certifications for the power supply shelf as applicable. Only requirements that absolutely rely on or are affected by the system may be left to the system level evaluation [i.e. minimize Conditions of Acceptability]. Below are common requirements for North America and Europe. For other countries, different certifications may be required:

- UL or an equivalent NRTL for the US with follow-up service (e.g. UL or CSA).
- CB Certificate and test report issued by CSA, UL, VDE, TUV or DEMKO
- CE Marking for EU

8.1.1. Component Safety requirements

Following are the safety requirements for major components:

- All Fans shall have the minimum certifications: UL and TUV or VDE.
- All current limiting devices shall have UL and TUV or VDE certifications and shall be suitable rated for the application where the device in its application complies with IEC/UL 62368-1.
- All printed wiring boards shall be rated UL94V-0 and be sourced from a UL approved printed wiring board manufacturer.
- All connectors shall be UL recognized and have a UL flame rating of UL94V-0.
- All wiring harnesses shall be sourced from a UL approved wiring harness manufacturer. SELV Cable to be rated minimum 80V, 130C.
- Product safety label must be printed on UL approved label stock and printer ribbon. Alternatively, labels can be purchased from a UL approved label manufacturer.
- The product must be marked with the correct regulatory markings to support the certifications that are specified in this document.

8.2. EMC Requirements

The power shelf shall meet the following requirements in the latest edition of standards when operating under typical load conditions and with all ports fully loaded;

The Power supply integrated into the shelf is called the component power supply. Manufacturer shall provide the proof of compliance for the component power supply that are required for spare parts shipment. The component power supply shall not contribute any noncompliant conditions to the end-use product.

If at any time it is found that a supplier's component power supply causes the end-use product to fail emissions and/or immunity testing, the supplier will be instructed to investigate and resolve the problem. The power shelf shall have minimum 6dB margin from the Class A limit for the radiated and conducted emissions. Depending on the system manufacturer's design goals and business needs, more margin may be required when it is integrated into the final end system.

The following EMC Standards (the latest version) are applicable to the product.

- FCC /ICES-003
- CISPR 32/EN55032
- CISPR 35/EN55035 - Immunity
- EN61000-3-2 - Harmonics
- EN61000-3-3 - Voltage Flicker
- VCCI
- KN 32 and KN35

Each individual basic standard for immunity test has the following minimum passing requirement. Higher level of passing criteria may be applied depending on the system manufacturer's design goals and business needs.

- EN61000-4-2 Electrostatic Discharge Immunity
 - Contact discharge: >4kV
 - Air discharge: >8kV

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- EN61000-4-3 Radiated Immunity
 - > 3V/m
- EN61000-4-4 Electrical Fast Transient Immunity
 - AC Power Line: >1kV
 - Signal Line: >0.5kV
- EN61000-4-5 Surge
 - AC Power Line: >1kV (Line-to-line), >2kV (Line-to-earth)
 - Signal Port: >1kV
- EN61000-4-6 Immunity to Conducted Disturbances
 - DC Power Line: > 3Vrms
- EN61000-4-8 Power Frequency Magnetic Field Immunity, when applicable
 - > 1A/m
- EN61000-4-11 Voltage dip and sag

8.3. Environmental Compliance

The power shelf (including all components inside) shall comply with the following minimum environmental requirement and manufacturer shall provide full material disclosure, Declaration of Conformity and technical documentations to demonstrate compliance. The system manufacture may have additional requirements depending on its design goals and business needs.

- RoHS Directive (2011/65/EU and 2015/863/EU); aims to reduce the environmental impact of EEE by restricting the use of certain substances during manufacture
- REACH Regulation (EC) No 1907/2006; registration with the European Chemicals Agency (ECHA), evaluation, authorization and restriction of chemicals.
- Halogen Free: IEC 61249-2-21, Definition of Halogen Free, 900ppm for Br or Cl, or 1500ppm combined
- US SEC conflict mineral regulation to source mineral materials from socially responsible countries, if applicable
- Waste Electrical and Electronic Equipment (“WEEE”) Directive (2012/19/EU) if applicable; aims to reduce the environmental impact of EEE by restricting the use of certain substances during manufacture

8.4. Documentation

The manufacturer shall provide reproducible copies of all pertinent documentation relating to the following:

- Product Information
- Bill of Materials
- Schematics
- functional test report
- Final Compliance Approval
- NRTL certificate and report, Conditions of Acceptability and test report plus User documentation that explains safe installation and operating procedures.
- CB Certificate and report, including schematics
- Manufacturer’s Declaration of Conformity to EN 62368-1, EN55032, EN55035 and ROHS
- FCC Part 15 Class A and CISPR32 Class A test data
- Declaration of Conformity to EN 61000-3-2 Class A and test report including waveforms and harmonic output levels.
- Other applicable certificates required by the system manufacturer.