3.0kW Cost-Effective PSU (Nanyang)

Product Specification

Version 1.5

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1 Scope

This document defines the technical specifications for Open Rack V3 rectifier used in the Open Compute Project (OCP).

2 Overview

This spec will define the single phase 50.0V (48.0V) power rectifiers that fits into the 48V power shelf. The rectifier is intended for use in a power shelf that is part of the rack, for supplying DC power to system loads. Several rectifiers with minimum of N+1 redundancy shall be included in the power shelf.

3 Electrical Requirements

Requirements brief summary is given below:

- 3kW output power
- Input rated voltage 200V to 277Vac with +/- 10%
- Output voltage 50.0V fixed on normal operation
- Peak efficiency > 97.5% at Vin of 208~277VAC, measured with fans
- Active power factor correction (meets EN/IEC 61000-3-2 and EN 60555-2 requirements)
- DC Output overvoltage and overcurrent protection
- AC Input overvoltage and undervoltage protection
- Over-temperature warning and protection
- Active current sharing on top of droop
- Hot insertion/removal (hot plug)
- Front to back air cooling
- Internally controlled variable-speed fan
- Ability to field FW upgrade (with bootloader)
- All field replaceable components shall be Tool-less front side removal

3.1 AC Input Voltage and Frequency

The rectifier shall be capable of supplying full rated output power over single phase input voltage range of 180 – 305V, and frequency of 47 – 63 Hz. Table 1 specifies the AC input voltage and frequency requirements for continuous operation.

Parameter	Typical	Min	Max	Power rating (W)
AC Input Voltage	208, 230, 240Vac or 277Vac	180Vac	305Vac	Nominal Power
Frequency	60Hz	47Hz	63Hz	Nominal Power

Table 1: AC Input Voltage & Frequency Requirements

In addition, rectifier shall meet ITIC compliant requirements as below:

- 140V for 500mS
- 160V for 10S

- 0V for 20mS

After the above time, the rectifier shall derate power from 3.0kW @180V to 1.5kW @ 100V linearly and shut off at 85V.

3.2 Start-up Sequence

The rectifier shall be able to start up under rated nominal power at the min AC input voltage (180 VAC) as specified in Table 1 above. With AC present, within specified parameters, the rectifier must always remain operational. The start-up sequence shall be designed such that the rectifiers are able to meet the overall system start-up time and inrush current requirements specified below.

3.3 Start - up / Turn on Time - Cold Start

The output voltage of the rectifier shall be monotonic during turn on and turn off, there shall not have any reverse voltage during turn off. The ramp time shall be software settable.

3.4 Start - up / Turn on Time - AC Failure / Recovery

The rectifier shall recover automatically after an AC power failure. The start-up time requirement shall be same as that of a cold start specified in section above.

3.5 Input Overvoltage and Under Voltage Protection

The maximum ac input voltage will never be above 345V for one ac cycle. The rectifier shall contain protection circuitry such that application of an input voltage below the minimum specified in Table 1 shall not cause any damage to the rectifier. The rectifier shall shut down if the input voltage is over the maximum input voltage.

3.6 Input Over-Current Protection

The rectifier shall incorporate primary fusing on both phase and return lines for input over-current protection to meet product safety requirements. Fuses shall be selected to prevent nuisance trips. Fuse may be internal to unit and need not be user serviceable. AC inrush current shall not cause the fuse to blow under any conditions. No rectifier operating condition shall cause the fuse to blow unless a component in the rectifier has failed. This includes DC output overload and short-circuit conditions.

3.7 AC Inrush Current

Maximum AC inrush current from cold power-on shall be limited to no greater than the maximum peak input current at any AC operating voltage and a temperature of 25C. This specified inrush current shall not include the X-Capacitors charging.

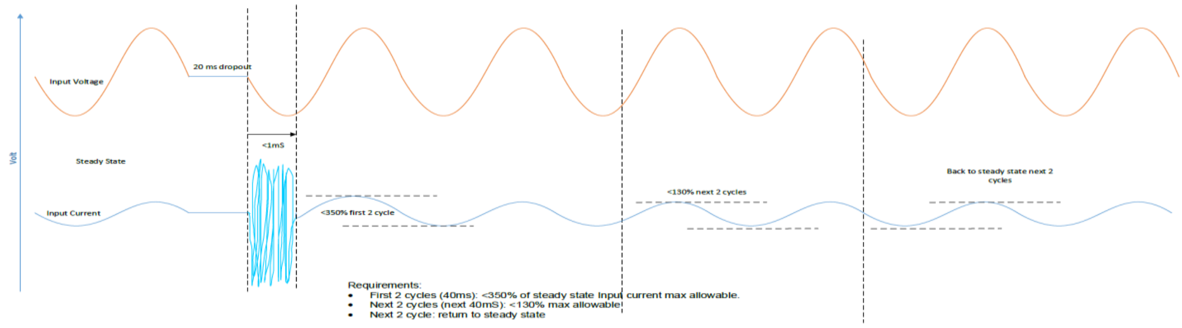


Figure 1: AC Inrush Current

3.8 Efficiency

The efficiency of the rectifiers when measured at an AC input voltage of 208V~277V and with the cooling fans connected (with input and output voltage measured at corresponding connectors, at 25C ambient and after 30 minutes running at full load) shall meet the requirements outlined in Table 2 below.

Load Range (%)	Peak Efficiency (%)	Min Efficiency (%)
30% to 100% of full load	> 97.5% @230, 240, 277V > 96.5% @208V	> 96.5% @230, 240, 277V > 95.5% @208V
10% to 30% of full load	-	94% @208V~277V

Table 2: Efficiency Requirements

3.9 Power Factor

The rectifier shall incorporate an active power factor correction circuit such that the power factor exceeds 0.97 from 30% to 100% loads and when measured at AC input voltage of 208~277V. For loads less than 30% and down to 10% the power factor shall not be less than 0.85.

3.10 Total Harmonic Current Distortion (THD)

The total harmonic current distortion of each rectifier shall not exceed 5% with load higher than 50%.

Output load (% of max output load per module)	Maximum ITHD (%)
5-15	20
15-30	10
30-100	5

Table 3: Total Harmonic Current Distortion (THD)

3.11 DC Output voltage

The DC output voltage of the rectifier shall be fixed at 50.0V while in normal operation. The rectifier shall supply rated power for the entire range of DC output voltage of 48.0V to 50.0V.

3.12 DC Output set point voltage accuracy

The rectifier set point voltage accuracy at 50% load shall be +/- 0.25% or 0.125V.

3.13 DC Output droop voltage

The rectifier droop voltage (0%-100%) shall be 1.00% or 0.50V. The droop voltage can be programmed to 1%-5%.

3.14 DC Output Voltage Ripple & Noise

The DC output voltage ripple and noise shall not exceed 500mV peak to peak. 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.

3.15 Dynamic Response

DC output transient response shall be measured by applying a minimum load of 10% to 50% and 50% to 100% load transient repeated at a rate of 20Hz. The slew-rate of the load transitions shall be at least 1A/µs. Under these testing conditions, the DC output voltage shall not vary by more than 1V for undershoot and overshoot.

Output	Delta step load	Frequency	Transient load rate	Capacitance test load
+50.0V	60% of maximum rated load 1%-61% and 40% to 100%	20 – 5000 Hz	0.25 – 1 A/us	3500uF +/-5%

Table 4: Dynamic Response

3.16 Overshoot at Turn-on/Turn-off

The output voltage overshoot upon the application or removal of AC input voltage, under the specified input voltage defined before, shall not exceed 1V.

3.17 Hold-up Time

The rectifier shall have a hold up time of minimum of 20ms after loss of AC input voltage at 100% load. During the hold-up time period, the dc voltage is allowed to drop by 2.0V.

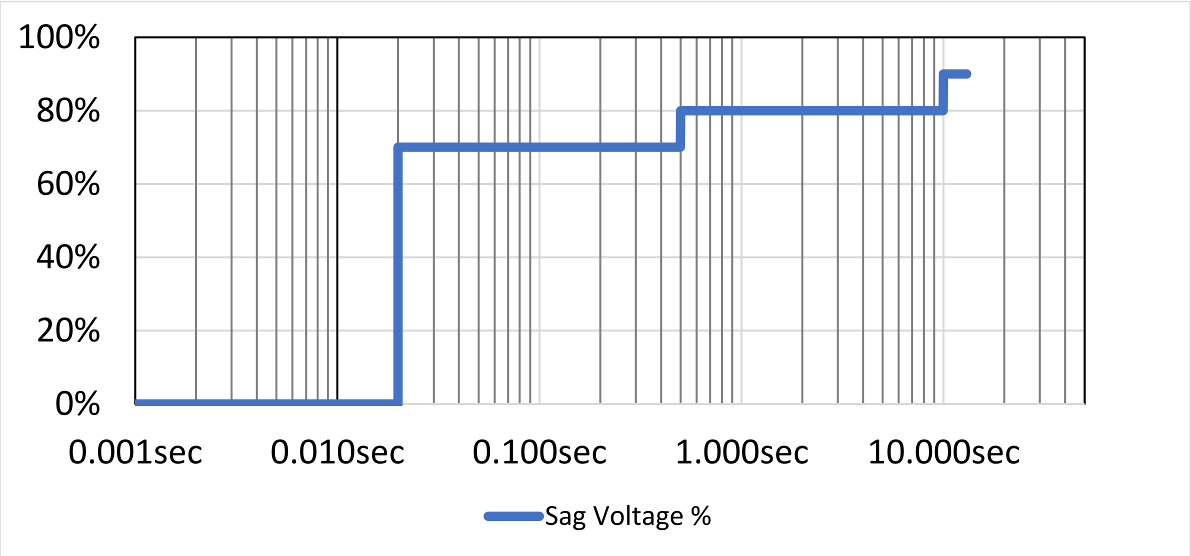


Figure 2: Data Center Recovery Worst Case Under Voltage %

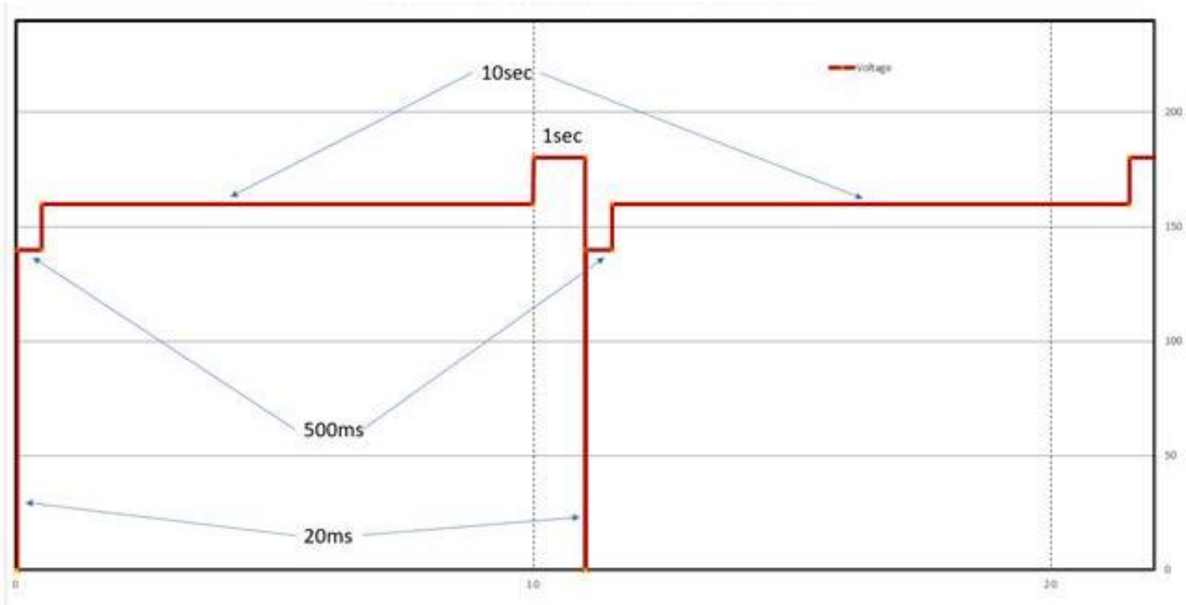


Figure 3: Back to back transfer minimum voltage

3.18 Over - Voltage Protection (OVP)

The rectifier shall shut down for DC output voltage exceeding 52.0V. The reacting time shall not exceed 200ms. For DC output voltage shall never exceed 54.0V.

3.19 Constant power operation

The rectifier shall go to constant current operation mode in case of over-power. As a result, the dc output voltage starts to drop. The rectifier shuts off if its output voltage is lower than 42.0V for 200mS. If the rectifier voltage is lower than 10.0V (short circuit condition), the rectifier shuts off immediately. No component shall damage.

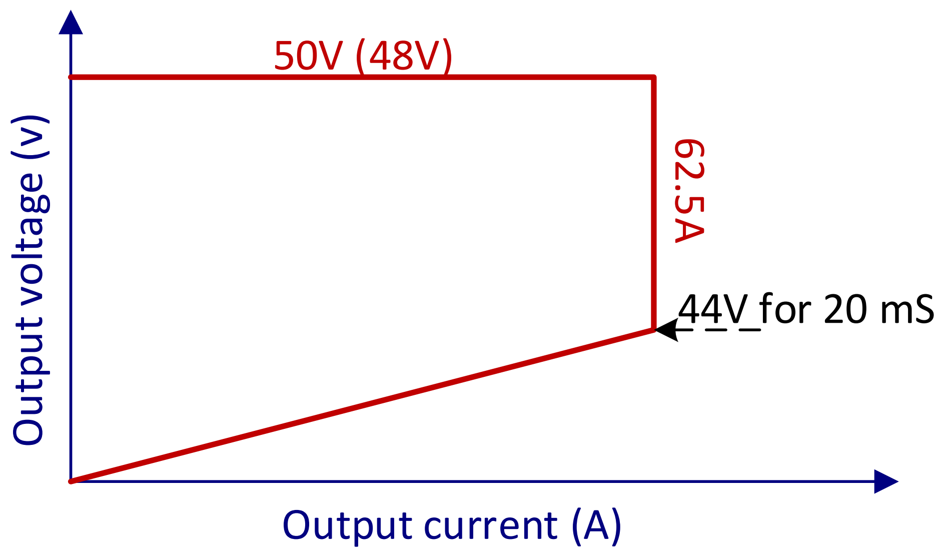


Figure 4: Constant power operation

3.20 Output Short-circuit and Overload Protection (OCP)

The protection shall be implemented with a hiccup mode. it tries to restart 5 times (2 second off, 200mSecond on) and then locks out.

3.21 Over Temperature Protection

The rectifier shall employ over temperature protection for both ambient over temperature and internal thermal temperature to protect the rectifier. The rectifier shall shut down under over temperature condition, and recover after certain period after the over temperature condition is removed.

3.22 Reverse Polarity Protection

The rectifier shall employ reverse polarity protection to protect the rectifier and attached load in the case of accidental mis-wiring. The protection shall be implemented with a short circuit hiccup mode. In this mode, if the rectifier voltage is below 10.0VDC, it tries to restart 3 times and then locks out.

3.23 Active Current Sharing Accuracy through analog bus.

The rectifiers shall have a dedicated analog bus for active current sharing. With the maximum number of rectifiers connected in the system, the current sharing accuracy shall be +/- 3% or better under load > 90% and +/- 5% or better under load > 50%.

This active current sharing shall be disabled by software.

3.24 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) on left open (1) to determine rectifier location as below:

Rectifier location 1-1 (row-column): 0001

Rectifier location 1-2: 0010

Rectifier location 1-3: 0011

.

Rectifier location 2-1: 0111

.

and so on.

3.25 Battery testing

Rectifier output voltage is nominally 50V and regulated battery is 48V. When battery testing is requested through FW, rectifiers shall change their output voltage to 48V, so the batteries increase their voltage to 50V and get tested. There shall be a time out for this mode.

4 Communication

The rectifiers shall communicate to SMC through single PMBus. Please refer to SMC Spec for details.

The software interface shall be operational when the AC is present or when the DC output bus is powered up by other power sources.

- Fault conditions
  - Last power failure event

- Rectifier failure

- Read:
  - Voltage in
  - Current in
  - Voltage out
  - Current out
  - Temperatures
  - Fan speeds
  - Power out
  - Power in
  - Position
  - Serial Number
  - Manufacturer part number
  - Hardware revision
  - Firmware revision
- Write:
  - Set output voltage setpoint (with timeout)
  - Set output current limit (with timeout)
  - Clear faults
  - Set turn-on ramp time (adjustable from 5 to 15 seconds, default is 9 seconds)
  - Set the time delay before resuming (adjustable from 2 to 5 seconds default is 2 seconds)
- Upgrades:
  - Upgrade firmware image(s)

4.1 Firmware Upgrade

The interface shall allow the user to re-flash firmware on the device. Firmware upgrade shall result in no power interruption on the shelf level (the unit being upgrade can go offline.) Upgrades can be done 1 rectifier at a time.

4.2 Output Voltage / Current Control

The interface shall allow the user to control output voltage and current in a single instruction on a single or all rectifiers. Valid voltage ranges are 50V or 48V. Valid max output current ranges are 0A to 62.5A. The rectifier shall hold up the specified voltage or max current. Note rectifier overcurrent limit shall override this in the case of a fault. Output changes shall take less than 100ms to take effect. The interface shall allow the user to specify a timeout in seconds.

4.3 DC Voltage Status

The interface shall provide the current output voltage with no more than 250ms latency, no less than 0.02 volt precision and 2% accuracy.

4.4 DC Current Status

The interface shall provide the current output current with no more than 250ms latency, no less than 0.1 ampere precision, and 2% accuracy.

4.5 DC Energy Status

The interface shall provide the total energy delivered since interface initialization with precision no less than 1 milliwatt-hour, 3% accuracy and capacity no less than 2^64 milliwatt-hours.

4.6 Last Power Failure Fault Conditions

The interface shall record and make available the total number of seconds since the last power failure event defined by one of the following conditions:

- Output voltage below 40V.
- Output voltage above 60V.
- Output current above over current protection level
- Fan failure
- Temperature > 55C

4.7 Rectifier Failure

The interface shall export any condition in which a single rectifier needs servicing.

4.8 Identification

The interface shall export its hardware and firmware version identification as well as a serial number uniquely identifiable to the device itself.

4.9 Position

The interface shall export the position of each rectifier and ID of the shelf that it is in.

5 Environment

5.1 Temperature

- Operational: 0C to +55C
- Non-operational: -40C to +85C

5.2 Humidity

- Operational: 10-90% RH non-condensing
- Non-operational: 5-93% RH non-condensing

5.3 Altitude

- Operational: 0 to 3000m
- Non-operational: 0 to 12000m

5.4 Acoustic Noise

- <= 55 dBA at maximum operation point

5.5 Vibration

5.5.1 Operational

Equipment must satisfy .17G vertical z-axis: .12G horizontal x- and y- axes swept from 5-500-5 Hz, 5 sweeps in all, at 1 octave/min. Reference spec (IEC 60068-2-6 Test Fc). Equipment shall be running diagnostic test while sweep is going on.

5.5.2 Non-Operational

Packaged unit must satisfy ASTM D 4169 Level 2 Schedule E using 60min Truck then 120 min Air Power Spectrum

Unpackaged unit, attached to a shaker using product's mounting points, must survive 3 hours random vibration per the following PSD Break Points.

Frequency	G^2/Hz
1	.00004
4	.00675
8	.00759
15	.0273
17.5	.0102
26	.148
34	.000355
122	.000006
Grms = .92	

Table 5: Vibration Spectrum

5.6 Shock

5.6.1 Operational

Equipment must satisfy 10 +/- shocks, 3.5G, 11 msec half-sine, in the x-y- and z- axes. Ref spec (IEC 60068-2-27 Test Ea). Equipment shall be running diagnostic test during shock events.

5.6.2 Non-Operational

Packaged unit must satisfy ASTM D4169 Schedule A Level 2, 6 impacts, before and after shipping vibe with the last impact at twice the height on the most typical surface to be dropped on.

Unpackaged unit, attached to a test machine using product's mounting points, must survive 3 +/- Shocks, 7.5 G, 19 msec half sine, in the vertical axis only

6 Thermal

6.1 Airflow Openings

The rectifier shall provide an intake from the front side and exhaust to the rear side to allow front to back device cooling.

6.2 Fan

Mounting of the fan must meet any vibration and acoustic criteria and will not violate any physical constraints outlined. The fan shall be included within the power supply enclosure.

6.3 Fan Failure

If a fan fails, the rectifier must indicate the failure with a signal that will be reported via SW as well as an LED indicator on the front panel. The rectifier shall not need to shut down because of a failed fan and only shut down if there is a fault, ie. over-temperature fault.

6.4 Temperature Sensors

The temperature sensors shall be chosen to meet the monitoring requirements and the accuracy for the sensing is within a +/- 2.0C tolerance. Exhaust and inlet temperature sensors are required in the unit.

6.5 Rectifier Thermal Monitoring

Each rectifier shall provide the following parameters via the defined communication protocol. The following thermal parameters must be available for each rectifier and labeled accordingly:

- Inlet temperature
- Exhaust temperature
- Average fan rpm (if >1 fan used in the rectifiers) percent is acceptable as long as full speed rpm is provided at some point.
- Fan fail signals

6.6 Rectifier Exhaust Temperature

Maximum rectifier exhaust temp shall be 70C at back pressure between 0 and 0.05 inch H2O. While rectifier is plugged in, the rectifier fan(s) shall not get turned off even at low/idle load (due to potential high back pressure.) The rectifier design shall be able to handle back pressure up to 0.05 inch H2O.

7 Mechanical

Please see appendix 1 for Mechanical dimensions of the rectifier.

7.1 Physical Dimensions

The sheet metal material shall be steel, pre-plated hot-dip zinc coated, with 1mm of thickness. See Section _____ for details on the finish and resistance against corrosion.

The rectifier dimensions are: 40.0mm tall, 73.5mm wide, and 520.0mm deep (nominal dimensions). Each of these dimensions may have a tolerance of +/- 0.5mm.

The PSU mechanical chassis is composed by a base and a cover assembled using flathead screws: no rivets are allowed (the PSU may be opened by using a screwdriver).

7.2 Chassis Interface

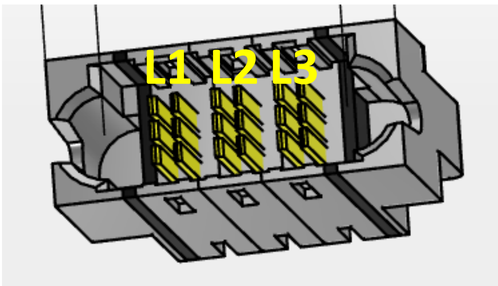
The handle of the rectifier may not protrude from the front surface of the rectifier by more than 16mm. The latch shall be located on the left side of the rectifier and interface with a rectangular hole in the chassis wall (please refer to the 3D drawing for latch location on the rectifier). A mechanical latch should be used to securely fasten the PSU within the PowerShelf. All touch points, including the latch should be colored green (Pantone 375C). The latches shall have a backstop to prevent damage to the latch during actuation and should only lock into place when a good electrical contact is made on the rear blind mate connectors. A sturdy handle should be implemented which makes removal and insertion of the PSU as smooth as possible. Both the latch and handle should be implemented in a way such that it does not obscure any LEDs or silkscreens. Please note that the PSU will be heavy and the handle should be sturdy enough to carry the entire weight of the PSU. This scheme will allow a quick installation of the Power Supply in the tray, and without the need of using a screwdriver. The front face where the handle is attached should have perforated holes to allow airflow for the fan(s). Furthermore a 'keying' feature should be used such that the PSU cannot be installed upside down.

7.3 Connectors

7.3.1 Input

The AC connector (top) is a FCI PwrBladeUltra 3HP(7.62mm pitch), press fit or solder tail acceptable.

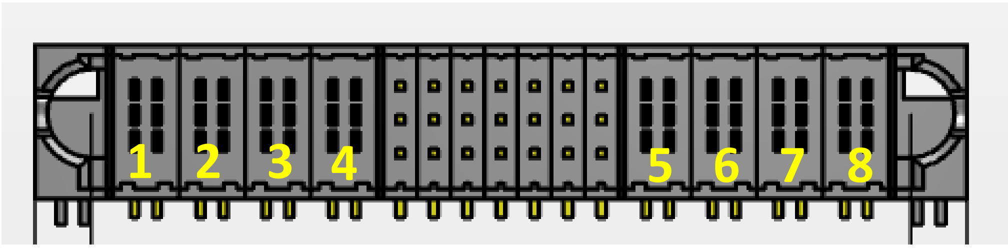
FCI PN: 10106116-3000003



7.3.2 Output

The output DC / signals (bottom) connector is a FCI PwrBladeUltra 4HP(5.0mm pitch) + 21S + 4HP(5.0mm pitch), press fit or solder tail acceptable.

FCI PN: 10127397-03h1410



7.3.3 Pin Assignment

PIN	NAME	DESCRIPTION	Length
Input Pins			
L1	LINE	AC Line	NORMAL
L2	NEUTRAL	AC Neutral	NORMAL
L3	P.E.	Protective Earth	LONG
Signal Pins			
A1	PSON	Power Supply On (Input)	NORMAL
B1	PSKILL	Power Supply Kill (Input)	SHORT
C1	ACOK	AC OK Signal	NORMAL
A2	PGOOD	Power Good Signal	NORMAL
B2	PRESENT	Power Supply Present	NORMAL
C2	SGND	Signal Ground	LONG
A3	SGND	Signal Ground	LONG
B3	SGND	Signal Ground	LONG
C3	SCL	I2C Clock Signal Line	NORMAL
A4	SDA	I2C Data Signal Line	NORMAL
B4	SMB_ALERT	SMB Alert Signal Output	NORMAL
C4	ISHARE	+V1 Current Share Bus	NORMAL
A5	CANH	CAN High Signal	NORMAL
B5	CANL	CAN Low Signal	NORMAL
C5	+V1_SENSE	Main Output Positive Sense	NORMAL
A6	+V1_SENSE_R	Main Output Negative Sense	NORMAL
B6	PS_A3	I2C Device address bit (most significant)	NORMAL
C6	PS_A2	I2C Device address bit	NORMAL
A7	PS_A1	I2C Device address bit	NORMAL
B7	PS_A0	I2C Device address bit (least significant)	NORMAL
C7	SGND	Signal Ground	LONG

PIN	NAME	DESCRIPTION	Length
Output Pins			
1,2,3,4	+V1	Main Output (+12.5V/+50.0V)	NORMAL
5,6,7,8	COM	Main Output Ground	NORMAL

Table 6: Pin Assignment

7.3.4 Pinout Facing PSU Connector

LINE	NEUTRAL	PE
L1	L2	L3

+	+	+	+	C	ACOK	SGND	SCL	ISHARE	+V1_SEN	PS_A2	SGND	C	C	C	C	C
V	V	V	V	B	PSKILL	PRESENT	SGND	SMB_ALE	CANL	PS_A3	PS_A0	B	O	O	O	O
1	1	1	1	A	PSON	PGOOD	SGND	SDA	CANH	+V1_S_R	PS_A1	A	M	M	M	M
1	2	3	4		1	2	3	4	5	6	7		5	6	7	8

7.3.5 Pin Description

- LINE, NEUTRAL
  Primary side AC input. Maximum current: 20A
- P.E.
  Primary safety ground connection to chassis and internal PCB. Must be bonded to chassis.
- PSON (input)
  The PSON signal is required to remotely turn on/off the power supply. PSON is an active low signal that turns on +V1 power rail. When this signal is not pulled low by the system, or left open, the output turns off. This signal is pulled to a standby voltage by a pull-up resistor internal to the power supply.

Signal	Accepts an open collector/drain input from the system. Internally pulled-up.	
PSON = LO	ON	
PSON = HI or OPEN	OFF	
	Min	Max
Logic level lo (PSU on)	0V	1.63V
Logic level hi (PSU off)	1.90V	3.46V
Source current, Vpson = LOW		4mA

Table 7: PSON

- PSKILL (input)
  This signal is to be on a short pin on the connector and wired to ground on the system side. It should be pulled up with resistor within the PSU. If the PSU is pulled hot from the system this is the first connection to break, transitioning to a logic high and signaling the PSU to immediately stop sourcing current. This prevents arcing at the power pins when they break contact during the extraction.
- ACOK
  Input AC source voltage present and within operational limits.
- PGOOD
  PGOOD is a power good signal and will be pulled HIGH by the power supply to indicate that +V1 output is within the regulation limits of the power supply. When any output voltage falls below regulation limits or when AC power has been removed for a time sufficiently long so that power supply operation is no longer guaranteed, PGOOD will be de-asserted to a LOW state.

Signal		
PGOOD = HI	Power GOOD	
PGOOD = LO	Power Not GOOD	
	Min	Max
Logic level lo, Isink=400uA	0V	0.4V
Logic level hi, Isource= 200uA	2.4V	3.46V
Sink current, PGOOD = lo	400uA	
Source current, PGOOD = hi	200uA	

Table 8: PGOOD

- PRESENT (output)
  This signal is pulled low in the PSU by a 100-ohm resistor, signaling to the system that a PSU is present.
- SGND
  Common return for all signals.
- SCL
  SMBUS / I2C clock interface. A resistor of 1.5K to 10K is pulled up to 3.3V on the system side. A minimum of 100 kHz I2C rate is required.
  Signal amplitude, Rise/Fall time, Undershoot/Overshoot shall fulfill the requirements defined in I2C standards.
- SDA
  SMBUS / I2C data interface. A resistor of 1.5K to 10K is pulled up to 3.3V on the system side.
  Signal amplitude, Rise/Fall time, Undershoot/Overshoot shall fulfill the requirements defined in I2C standards.
- SMB_ALERT
  This signal indicates that the power supply is experiencing a problem that the user should investigate. This should be asserted due to Critical events or Warning events. The signal should activate in the case of critical component temperature reached a warning threshold, general failure, over-current, over-voltage, under-voltage, failed fan. This signal may also indicate the power supply is reaching its end of life or is operating in an environment exceeding the specified limits. A resistor of 1.5K to 10K is pulled up to 3.3V on the system.

Signal	Open collector output. Pull up required on system side.	
SMB_Alert = HI	OK	
SMB_Alert = LO	Power Alert to System	
	Min	Max
Logic level lo, Isink = 400uA	0V	0.4V
Logic level hi, Isource = 200uA	2.4V	3.46V
Sink current, SMB_Alert = lo	400uA	
Source current, SMB_Alert = hi	200uA	

Table 9:SMB_Alert

- ISHARE (analog bus)
  This share signal from all PSUs wired in parallel are to be connected to a common node in the system. This is a bi-directional analog signal that is used to maintain balanced current between the active power supplies in the system.

Load	Min	Typ	Max	Units	Tolerance
0%	0	0	0.5	Volts	
4%	0.21	0.28	0.35	Volts	+/-25%

25%	1.64	1.75	1.86	Volts	+/-6%
50%	3.36	3.5	3.64	Volts	+/-4%
100%	6.72	7	7.28	Volts	+/-4%

Table 10: ISHARE

- CANH, CANL
  CAN signals that are either driven to a "dominant" state with CANH > CANL, or not driven and pulled by passive resistors to a "recessive" state with CANH ≤ CANL.
- +V1_SENSE, +V1_SENSE_R
  +V1 sense. Compensates the voltage drops caused by resistive losses to the load.
- PS_A3, PS_A2, PS_A1_ PS_A0
  I2C bits to allow addressing of slave devices operating on the PMBus (Power Management Bus) protocol.
- +V1
  Main output power rail. Must be fully isolated from main and all other signals.
- COM
  Return path for +V1 output rail. Must be fully isolated from main and all other signals.

8 Reliability and Quality

8.1 Derating Design

A comprehensive stress analysis and derating design shall be performed for the rectifier. The stress analysis shall include electrical, thermal, and mechanical stresses with actual measurements. The components in the rectifier design shall be properly derated and to meet the derating guideline as specified in IPC-9592B “Requirements for Power Conversion Devices for the Computer and Telecommunication Industries”, Appendix A or supplier’s own derating guideline.

8.2 Reliability Prediction

A reliability prediction shall be performed for the rectifier using Telcordia SR-332 Issue 2 Method I, Case I (Part Count). The rectifier shall have a minimum MTBF= 1,000,000 hrs at 30C, 100% load per IPC-9592B without fan.

8.3 Design Failure Mode and Effect Analysis (DFMEA)

A comprehensive DFMEA shall be performed for the rectifier. The DFMEA report shall include a list of critical components, risk areas, and corrective actions taken.

8.4 High Accelerated Life Test (HALT)

A comprehensive HALT shall be performed on the rectifiers. The HALT equipment, testing procedure, sample size, testing report and documentation, and root cause analysis and corrective action requirements shall follow the requirements as specified in IPC-9592B, Section 5.2.3 and Appendix D.

8.5 Burn-In (BI) and Ongoing Reliability Testing (ORT)

Either 100% burn-in or 100% HASS (Highly Accelerated Stress Screening) test shall be performed at the beginning of the rectifier mass production. Either BI or HASS could be chosen based on supplier’s capability and preference.

The detailed requirements for BI and HASS test durations, duration reduction plan, and test profile shall follow the requirements as specified in IPC-9592B, Appendix E for Category 1 PCD products.

After meeting the acceptable failure rate criteria as listed in Table E-1 of IPC-9592B Appendix E, the 100% BI or HASS could be reduced to sampling BI or HASA.

Ongoing Reliability Testing (ORT) shall be performed on the rectifiers when BI or HASS test is reduced from 100% to sampling and when BI or HASS is eliminated after at least one (1) year. The detailed ORT plan and requirements shall follow the requirements as specified in IPC-9592B, Appendix E, Section E.2.3.

8.6 Manufacturing Quality

It is required to meet the quality process requirements as specified in IPC-9592B, Section 6 ("Quality Process"), which include PFMEA, statistical process control (SPC), corrective action process, yield control, materials traceability, product change notice (PCN), qualification of change, etc.

9 Compliance requirements

The power supply unit 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.

9.1 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

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

9.1.1 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.

9.2 EMC Requirements

The power supply 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
- EN61000-4-3 Radiated Immunity
  -
- 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

9.3 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 CI, 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

9.4 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.