True Three Phase 380 – 480 Vac to 48Vdc Power Shelf

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Scope

This document defines the technical specifications for:

- A true 3 phase 380 – 480 Vac to 48Vdc Power Shelf used in Open Compute Project Open Rack Standard V2.0

- The shelf is 2 open rack units high

- Is fed with a single 50A AC cord whip

- Delivers power using bus bar clips onto the 48V bus located in the shallow depth (660mm) cabinet as defined in Open Rack Standard V2.0

Benefits

1. Simple AC wiring in the data center. AC distribution wiring includes three phase conductors and one safety ground. No neutral is required.

2. AC phases are intrinsically balanced. Each 3-phase power converter processes all 3 phases, so provisioning to match need, and unit failures do not change the phase balance on the AC power feed into the facility. There should be no billing anomalies.

3. Simple powering of an Open Rack or cabinet. A single 50A whip can power an entire cabinet – depending on data center rack thermal capability.

4. Power can be flexibly located vertically in the rack. A dedicated position for power, driven by the need for bus bar studs, where power is introduced, is not required. The 2-rack unit shelf can be placed as needed in the rack to support logical partitioning of the data processing equipment.

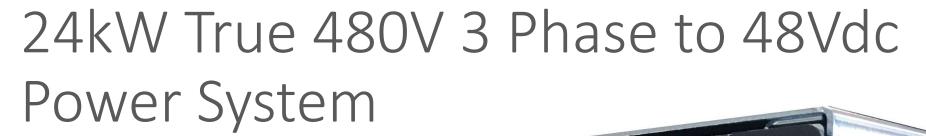5. Easy integration into Enterprise/Building management systems using Ethernet protocols (SNMP and MODBUS).

Submission Basis: OCP Inspired

Open Web Foundation Contributor License Agreement ("OWF CLA 1.0") ("Contribution License") by:
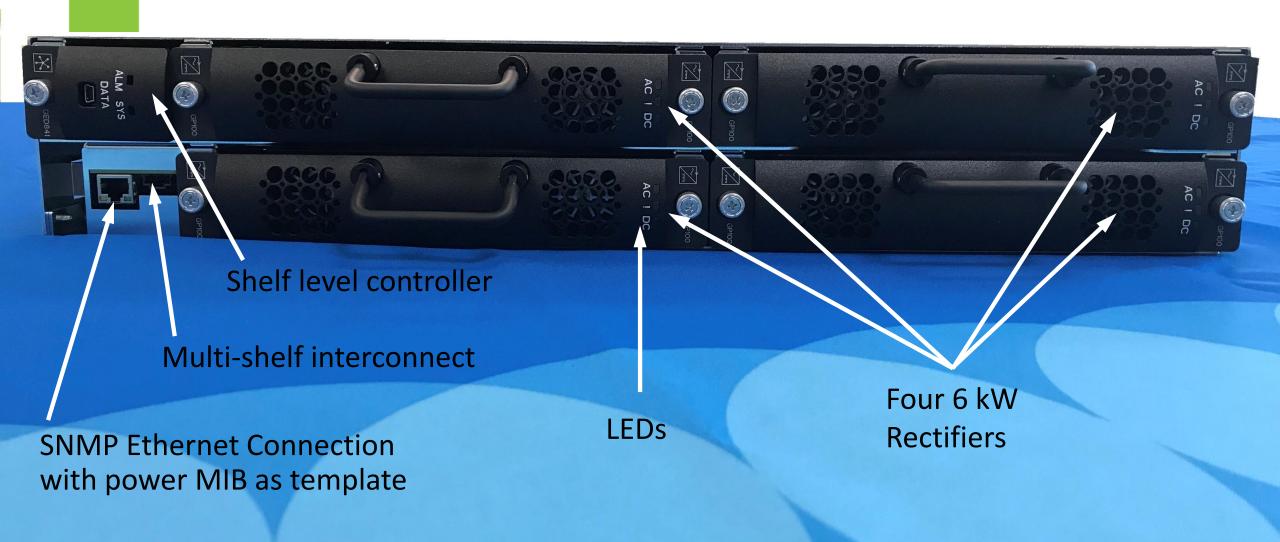
General Electric

24kW True 480V 3 Phase to 48Vdc Power System

One 50A Whip Feed - 500A Plug-in DC Bus Bar Connections - Fits in Shallow 48V OCP V2 Rack

Front View

Shelf level controller

Multi-shelf interconnect

SNMP Ethernet Connection
with power MIB as template

LEDs

Four 6 kW
Rectifiers
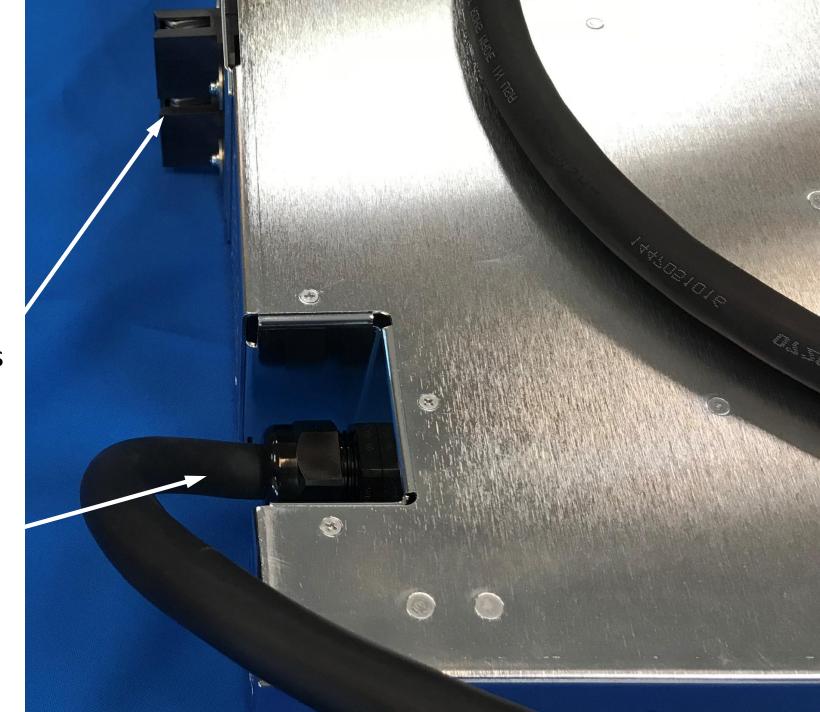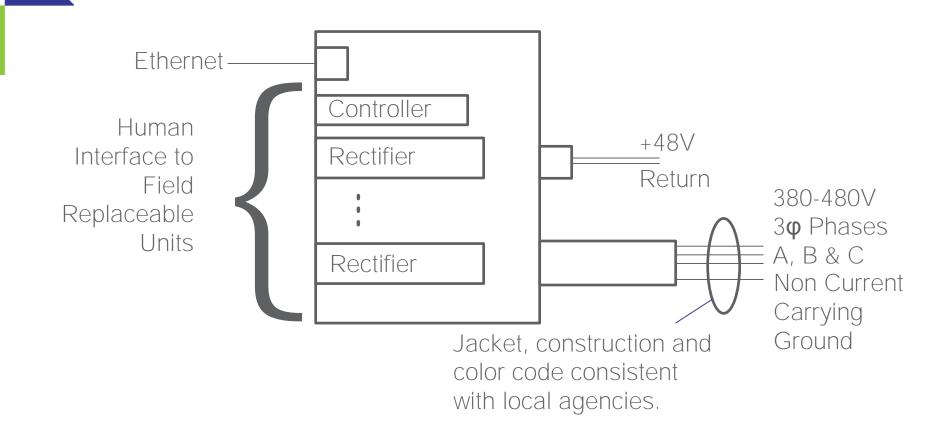
Back View

DC Output consistent with
OCP V2 Rack Standard 48V bus

2 Meter long strain relieved 480
VAC cord, blunt cut or twist lock
connector

Block Diagram

Ethernet

Controller

Rectifier

Human Interface to Field Replaceable Units

Rectifier

+48V
Return

380-480V
3φ Phases
A, B & C
Non Current
Carrying
Ground

Jacket, construction and color code consistent with local agencies.

OCP Tenets

- Efficiency
- Scale
- Openness
- Impact

Efficiency

- AC Distribution efficiency – 1.8% improved due to 480V, 0.3% improvement 3 phase vs 1 phase

- Rectifier Efficiency – Almost as High as single phase

- DC Distribution efficiency – 48V vs 12V – lower losses due to current reduction (1/4) – copper losses, connector losses (current dependent)

Efficiency – AC Distribution Losses

- Typical AC installations engineered to trade copper cost against losses
  - 3% Voltage drop in the ac loop
  - Cost of Utility power has changed since this trade off was established

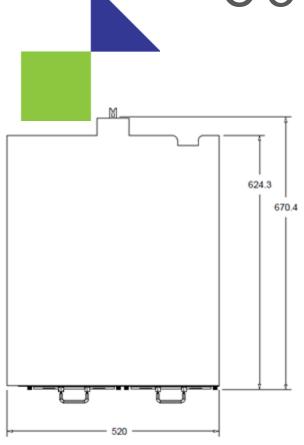208 vs. 480 Vac and 3-Phase vs. 1-Phase   176A, 53V @ efficiency of 80% Load

Rectifier					AC Distribution		Total Loss	
Rectifier	Vac	Phases	Efficiency (80% Load)	Rectifier Loss	AC Dist Loss (3-Phase)		Total Loss	Efficiency Rect & AC Dist
595LTA	480	3	93.2%	634.3	354.2	3.8%	988.5	90.4%
595LTB	208	3	91.0%	839.5	522.3	5.6%	1361.8	87.3%
NE050AC48	208	1	92.0%	746.2	545.9	5.9%	1292.1	87.8%

3-Phase dist voltage drop taken as 1.5% per line. Line currents are phase currents * sqrt(3).
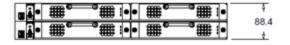
- 480V Rectifiers Better than 208V Rectifiers - efficiency
- 3 Phase Rectifiers better than 1 phase rectifiers (ac distribution losses)
- Power Factor corrected rectifiers draw lower RMS current, reducing losses

Compatibility

- The true three phase power shelf is 2 OpenU tall (96mm).

- The depth is 625mm, except where the floating (+/-2mm) busbar interface is defined. A 2 meter long four conductor power cord (3 phases and safety ground) pigtail is provided in the right rear corner. For UL Listed North American applications at 480Vac, the cord shall be terminated with a UL/CSA listed 3-Pole, 4-Wire Grounding twist lock connector (such as Hubble CS8165C or Leviton CS8165C). For 380V applications the cord will match standards for host country and be provided blunt cut at 2 meters for termination on site. The strain relief for this pigtail shall accommodate the 616mm depth and allow for a 90-degree bend, up or down, in 100mm.

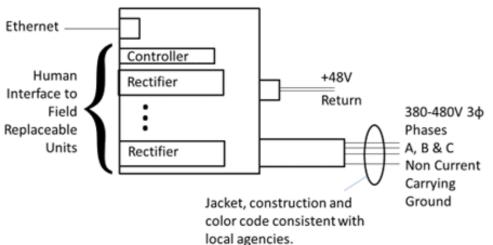- The width and fastenings are to fit in the Open Rack V2.0.

Compatibility

Cold Aisle View

Block Diagram

Ethernet

Human Interface to Field Replaceable Units

Controller

Rectifier

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•
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Rectifier

+48V
Return

380-480V 3φ
Phases
A, B & C
Non Current
Carrying
Ground

Jacket, construction and color code consistent with local agencies.

Shelf level controller

Multi-shelf interconnect

SNMP Ethernet Connection with power MIB as template

LEDs

Four 6 kW Rectifiers

Compatibility

DC Output Parameters

- Consistent with Open Rack Standard V2.0

Thermal Design Requirements

- Consistent with Open Rack Standard V2.0

I/O System

- Ethernet, consistent with OCP Hardware Management Project

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Scale

- Power can be flexibly located vertically in the rack.

- A dedicated position for power, driven by the need for bus bar studs, where power is introduced, is not required.

- The 2-rack unit shelf can be placed as needed in the rack to support logical partitioning of the data processing equipment and scaling of power requirements.

Openness

Contributions

1. Hardware and management spec for 380-480 3φ AC to 48Vdc shelf.

2. 3D CAD for the external envelope (in STEP format).

3. In the future a compliant product.

Openness

An Open Power Management Interface consistent with the OCP Hardware Management project.

Protocols supported by the power shelf controller include SNMP or a RESTful API consistent with the Redfish system.

The data available to the management system can be broken into the following sets:

1. System data,
2. System control,
3. Rectifier data, and
4. Alarms.

The following tables describe each of these categories.

Openness – System Data

System Data	
Voltage	Network Domain Name
Current	DNS Server Address
Ambient Temperature	Ethernet Address
High Ambient Temperature	DHCP mode
Low Ambient Temperature	Working Ethernet Address
System Alarm State	Network Subnet Mask
Product Code	Energy Management Mode
Serial Number	Efficiency Target
System Date	Efficiency Turn On Threshold
System Time	Voltage Set Point
System Description	
Software Versions (boot, controller, web pages)	Total Installed Rectifier Capacity
	Total On-line rectifier capacity

Openness – System Control

System Control	
Rectifier Restart	Emergency Power Off
Uninstall Missing Equipment	

Openness – Rectifier Data

Rectifier Data	
Product Code	AC Voltage
Serial Number	AC Current
Description	DC Voltage
Capacity (Amps)	DC Current
Rectifier Current Limit	State
Software Version	Temperature

Openness – Alarms

Alarms		
Rectifier Fail	Redundancy Loss	Clock Changed
AC Fail	Loadshare Fail	Configuration Changed
High DC Voltage	Rectifier Shutdown	Processor Halt
Low DC Voltage	Incompatible Rectifier	Self Test Failed
Rectifier Fan Fail	Manual Off	Passwords At Default
Rectifier ORing Fault		History Cleared
		Excessive Login Attempts
		External Password Changed
		Controller Memory Backup Fail

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Impact

1. Efficient Brownfield Applications of OCP Elements

2. Larger Community

3. Extend the 48V User Base/Market

4. Simplicity

Impact

Orderable Part Numbers:

1600145397A   J2014001L701 - GP100 OCP 4 POS 480V POWER SHELF
1600092582A   GED841E_0I6R_USB_S Controller
1600092584A   GP100HR3R48TEZEC Rectifier