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Compute Project

## Open Rack AC and DC gPDUs Hardware v0.3

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## 1 Scope

This specification defines the technical requirements for Open Compute Project AC and DC power distribution units, known as gPDUs. The "g" stands for the code name "Gemini," since the AC and DC PDUs share the same form factor and are symmetrically installed to the rear frame side of the OCP Open Rack.

The AC gPDU is powered from the AC line (480V US, 380V EU) RMS WYE three-phase 5-wires, with output distributed over three AC single-phase dangle cables Line-to-Neutral (277V US, 220V EU). The DC gPDU is powered by 48V DC nominal, from a battery backup source. The gPDUs are used for online AC power distribution and offline DC power distribution in the Open Rack, and work in conjunction with the OCP 4.2KW 12V redundant power shelf.

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## 3 Overview

When data center design and hardware design move in concert, they can improve efficiency and reduce power consumption. To this end, the Open Compute Project is a set of technologies that reduces energy consumption and cost, increases reliability and choice in the marketplace, and simplifies operations and maintenance. One key objective is openness—the project is starting with the opening of the specifications and mechanical designs for the major components of a data center, and the efficiency results achieved at facilities using Open Compute technologies.

Two components of this project are AC and DC gPDUs. The AC gPDU accepts as input voltage a 3-phase WYE wiring 277/480Vac RMS nominal voltage for US deployment, and a 3-phase RST wiring 220/380 Vac RMS nominal voltage for EU deployment (4 wires + Ground), and provides a total of three output dangle cables. Each output dangle cable is 277Vac nominal single-phase (16A) for the US model, or 220Vac nominal single-phase (30A) for the EU model, terminated to an AC plug that connects to the rear panel of the Open Rack power shelf v1.0 for online power functions. Six AC outlets distributed in two banks of three make the 277V/220V available on the gPDU faceplate for other uses. Each pair of outlets is protected by a 10A fuse, while the maximum continuous current on those outlets is 8A maximum for the individual socket or for the pair. Line(s) and Neutral terminations are electrically isolated vs. ground chassis (1500Vac RMS).

The DC gPDU accepts as input voltage a 48Vdc nominal. The same model is used for both US and EU deployments, which provides a total of three output dangle cables. Each output dangle cable is rated 48Vdc nominal (120A) and is terminated to a DC plug that connects to the rear panel of the Open Rack power shelf for offline backup power functions. The DC gPDU includes two more inputs at 48Vdc, routed to two pairs of DC outlets installed on the gPDU faceplate, with each pair composed of one Tyco and one Anderson Power connector. These outlets, rated 15A at 48V each, are used to power IT switches and any IT devices that need stable online backup power during AC outages. The 48Vdc nominal voltage is provided by the OCP Battery Cabinet for DC UPS equivalent functions.

No other fuses or any other components, such as capacitors or surge devices, are used in both the AC and DC gPDUs.

All PCBs, if used, are FR4 base material type, with 2mm of thickness, with a minimum 2 oz. in two copper layers (minimum 140 microns thick). Positive and negative terminations are electrically isolated vs. ground chassis (1500Vac RMS).

### 3.1 Accessibility

The gPDUs must be installed in an Open Rack deployed in a restricted (controlled) area with service accessibility exclusively permitted to authorized personnel only. Only certified and trained personnel can access the gPDUs and their interconnections.

## 3.2 License

As of April 7, 2011, the following persons or entities have made this Specification available under the Open Web Foundation Final Specification Agreement (OWFa 1.0), which is available at

<http://www.openwebfoundation.org/legal/the-owf-1-0-agreements/owfa-1-0>

Facebook, Inc.

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## 4 Compliance Requirements

The gPDUs comply with the safety standards listed below as stand-alone units, and are certified and labeled accordingly.

### 4.1 Safety Certifications, Applicable Documents

The gPDUs are UL Recognized (Underwriters Laboratories, Inc.), and are in accordance with UL/CSA 60950-1 (a standard for safety of IT equipment):

- CAN/CSA-C22.2 No. 60950-1-03 (a standard for safety of IT equipment)
- EN60950-1:2006/IEC60950-1 (a standard for safety of IT equipment)
- CE Mark, CB Report and Certificate
- UL94V-0 material flammability rating, with an oxygen index of at least 28%

### 4.2 Environmental Engineering Standards

- ETS 300 019-2-3, Class 3.2 (Operation)
- ETS 300 019-2-2, Class 2.3 (Transportation)
- ETS 300 019-2-1, Class 1.2 (Storage)

### 4.3 AC Mains Leakage Current for AC gPDUs

Leakage current from each Line-to-Ground and from the Neutral-to-Ground, does not exceed 0.1mA RMS at 60Hz, and 480Vac/277Vac.

### 4.4 RoHS Compliance

The gPDUs are RoHS-6 compliant (BOM and Manufacturing Process).

## 4.5 Cables

All the AC and DC cables are UL and CSA certified. Insulators are flame retardant and halogen free. The DC PVC cables also meet VW-1 (UL 1581).

All AC cables are rated 600Vac RMS.

All DC cables are rated min 300Vac RMS, and are "medium strand count" type.

## 5 AC gPDU Input

### 5.1 US Model

The input voltage is 3-phase WYE wiring, 277/480Vac RMS nominal, 50 ~ 60 Hz. The nominal maximum continuous input current per phase is 16 Amps RMS, at 50°C of ambient temperature. The AC gPDU supports 20 Amps RMS continuous per phase at 50°C of ambient temperature.

The input connector is a NEMA L22-20P plug, with an AWG 10 five-conductor power cord, rated 600Vac RMS, retained at the top of the gPDU by a suitable cable gland for a proper mechanical assembly. The power cord length is 2 meters. The cable is a suitable industrial-grade sheathed power cord, UL listed, black color, with the external look of a single large cable.

### 5.2 EU Model

The input voltage is 3-phase RST wiring, 220/380Vac RMS nominal, 50 ~ 60 Hz. The nominal maximum continuous input current per phase is 30 Amps RMS at 50°C of ambient temperature.

The input connector is an IEC 309 5 pole 32A plug (Mennekes Type 4, Bals 204-TLS or equivalent), with an AWG 10 five-conductor power cord rated 600Vac RMS, retained at the top of the gPDU by a suitable cable gland for a proper mechanical assembly. The power cord length is 2 meters. The cable is a suitable industrial-grade sheathed power cord, UL listed, black color, with the external look of a single large cable.

### 5.3 Grounding Scheme

The ground wire, available at the input AC plug inside the gPDU, is directly connected to the sheet metal chassis near the cable inlet. The ground is then brought to all the outputs (either dongles or outlets) with dedicated cables connected directly to the chassis using threaded studs and nuts that are internal to the AC gPDU. The same scheme applies to the DC gPDU, where the ground is also taken from the chassis. In this case, a further cable is used externally to electrically secure the connection of the DC gPDU chassis to the Open Rack chassis.

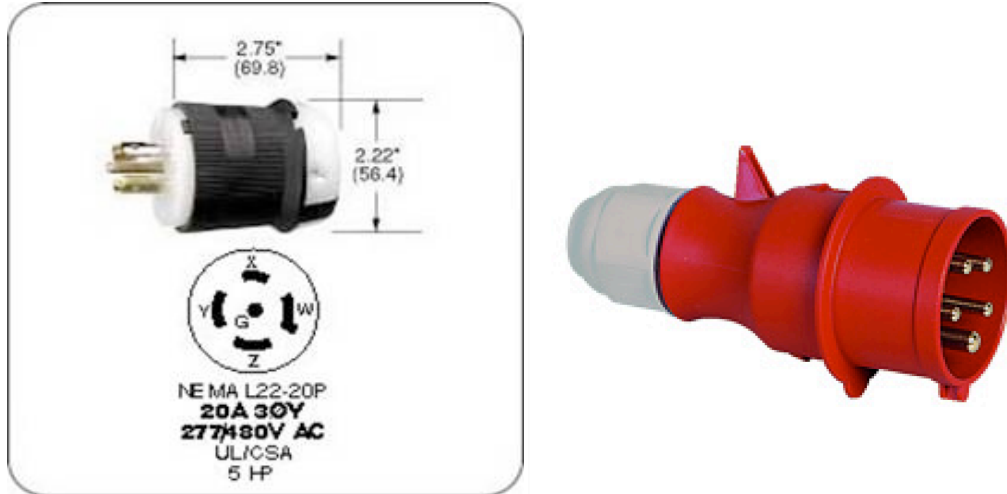


Figure 1 AC Plugs: NEMA L22-20P 20A plug (US plug, left) and IEC 9 32A plug (EU plug, right)

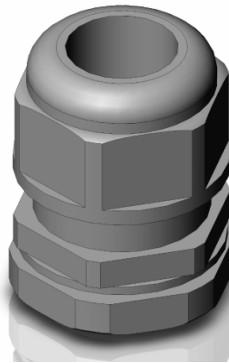


Figure 2 Example Cable Gland for Retaining All AC Cables to AC gPDU Housing

## 6 AC gPDUs Outputs

The 5-wires of a three-phase system are normally named as follows:

- Line1 (L1) is denominated X (US) and R (EU)
- Line2 (L2) is denominated Y (US) and S (EU)
- Line3 (L3) is denominated Z (US) and T (EU)
- The neutral is denominated W (US) and N (EU)
- The ground is denominated G or GND (it is connected to the gPDU chassis)

The three output dongle cables as well as the sequence of (3 + 3) AC outlets, from top to bottom, are connected and denominated as follows:

X (L1), Y (L2), Z (L3) for US

or:

R (L1), S (L2), T (L3) for EU

### 6.1 Output Dongle Cables

- AWG 10, 600V, UL 2586, #10 3C, sheathed black
- Each dongle cable for a US AC gPDU is rated 16A (300V or 600V)
- Each dongle cable for an EU AC gPDU is rated 30A (300V or 600V)

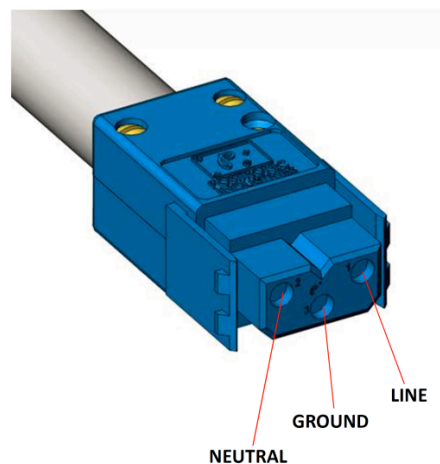
- Total length of each dongle cable is 370mm, including the Positronic connector housing
- The dongle cables are retained to the gPDU using cable glands

## 6.2 AC Connector Plug

The dongle cables are terminated by the AC connector plug. Part information is as follows:

- The Positronic housing part number is PLB3W3F0000/AA (one for each dongle cable)
- The Positronic female terminal part number is FC610N2/AA (three for each Positronic housing)

The AC dongle cable must be custom molded to the Positronic connector housing.



**Figure 3 Positronic Connector with Positronic Strain-Relief Installed on the Housing and Cables (Note: A custom molding is required in place of the strain relief.)**

## 6.3 AC Fuse

The AC fuse for the 6 AC outlets can be from either of these vendors:

- Littelfuse, P/N: 0LGR010.V (10A, 300V)
- Bussmann, P/N: GLR-10 (10A, 300V)

One fuse powers each pair of paralleled AC outlets. The fuse(s) are connected in series to the line(s).

## 6.4 AC Fuse Holder

The panel mount for the AC fuse holder can be from either of these vendors, but must come from the same vendor as the AC fuse:

- Littelfuse, P/N: 0LHR0000T (10A, 300V)
- Bussmann, P/N: HLR-2A (10A, 300V)

## 6.5 AC Outlets

There are three pairs of outlets, and each pair is paralleled and connected to one line and neutral through a fuse. The fuse is in series to the Line.

The US AC gPDU outlet has these characteristics:



- 277V nominal
- There are (3 + 3) outlets in each AC gPDU
- Each pair of paralleled AC outlets is rated 8A maximum (total, for the individual socket or for the pair)
- Outlet part number is Rong-Feng RF-203P-HP-1.2 (or equivalent)

The EU AC gPDU outlet has these characteristics:

- 220V nominal
- There are (3 + 3) outlets in each AC gPDU
- Each pair of paralleled AC outlets is rated 8A maximum (total, for the individual socket or for the pair)
- Outlet part number is Rong-Feng SS-130-PC-4.8 (or equivalent)

## 7 DC gPDU Inputs

### 7.1 Main 48Vdc Input

The main 48Vdc input for the gPDU comprises one cable pair with these characteristics:

- AWG 0 cable pair, UL 1015, 1 meter long, enclosed in black shrink tube
- Cables are retained at top of the gPDU by a built-in system that includes grommets; same system is also used for the remaining cables that exit the gPDU
- Connector is Anderson Power SB175; polarity is stamped on the connector body
- Current rating is 175A continuous, or 350A for 90 seconds

### 7.2 Ground Cable

A small cable, terminated on both sides with ring terminals, is shipped together with the DC gPDU already installed on top of the housing with a screw and spring washer. The other ring terminal is installed in the Open Rack frame after the gPDU is installed in the rack.

The cable is AWG 14, UL 1015, green color, 170mm in length. The two rings crimped on both sides are from KST, part number RVL2-5 (or equivalent). See also Figure 7 for the mechanical drawing of the DC gPDU.

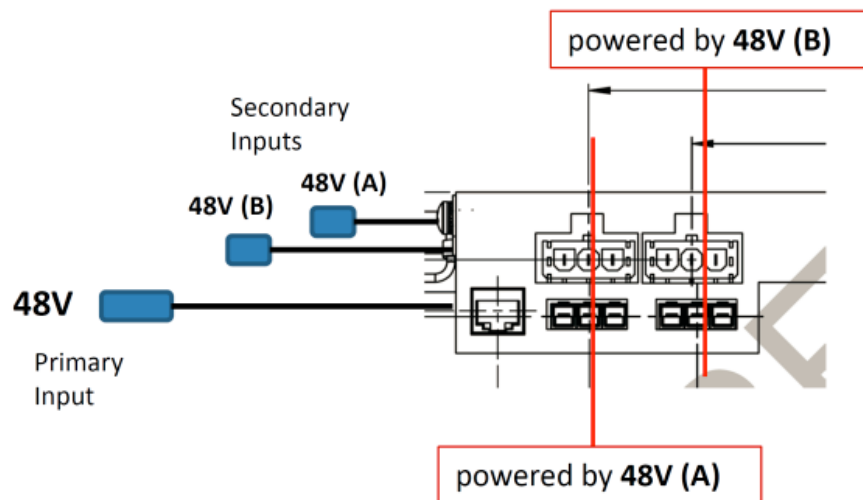


Figure 4 DC gPDU Inputs

### 7.3 Auxiliary 48Vdc Inputs

There are two auxiliary 48Vdc inputs in the gPDU, each comprises one cable pair with these characteristics:

- AWG 16, UL 2586, 0.5 meter long, cable pairs are individually enclosed in black shrink tube
- Cables are retained at the top of the gPDU by a built-in system and grommets; grommets are also installed where the cables exit the gPDU
- Connector is Anderson Power PP15 type, P/N 115170S1 (custom duplex connector)
- Current rating is 15A continuous each

These two inputs power two pairs of DC outlets installed on the top of the DC gPDU. See Figure 4.

### 7.4 48Vdc Outlet Outputs

The output outlets are labeled with a silkscreen, and powered by the auxiliary inputs A and B. Each outlet is rated 15A continuous. Polarity of the DC gPDU, from top to bottom, is +48V, RTN, GND chassis ground.

The outlets used come from the following manufacturers:

- Molex, part number 43160-3103
- Anderson Power PP15 type, part number 114961G1 (custom triplet)

The connector outlets pair at the top is composed of one Anderson Power and one Molex, electrically in parallel, and connected to input A.

The second outlet pair (just underneath the first) is identical but connected to input B.

For all four connectors, the middle pin receptacle is connected to the chassis ground of the DC gPDU. For the same connector, the top to bottom sequence is as follows: Positive, Negative, Ground.

Figure 4 shows the DC inputs connected to these DC sockets. Basically, these sockets can be conveniently used to power TOR switches or any other DC powered IT device in the Open Rack that needs uninterruptible power when an AC outage occurs. One OCP battery cabinet normally powers 6 Open Racks, so for 6 DC gPDUs, the maximum power allocated for all the DC sockets is 2.4KW, which corresponds to ~ 400W total for each DC gPDU output socket. This is the available DC online backup power for the TOR switches and other DC-powered devices. This power can be increased by giving up some more power for battery charging; see the OCP Battery Cabinet Hardware v1.0 specification at [www.opencompute.org/projects/battery-cabinet/](http://www.opencompute.org/projects/battery-cabinet/).

Refer to Figure 6 for detailed dimensions.

### 7.5 RJ45 Ports

There are (3 + 1) additional RJ45 sockets (board-mounted) installed in the DC gPDU front panel, as shown in the schematic in Figure 5 below.

- Three input RJ45 sockets are located along the DC gPDU enclosure faceplate, near the corresponding DC output dongles. They are connected to the three power shelves installed in the Open Rack.
- One output RJ45 socket is located at the top of the PDU enclosure faceplate, near the DC outlets. This RJ45 will be connected to a digital monitoring device positioned on

top of the Open Rack. This box monitors the status of health of the three power shelves, or the loss of power redundancy.

The RJ45 socket reference component is from Sun-Jun, part number 9688-8811-SE-A (or equivalent).

### 7.5.1 Schematic of the RJ45 Connections

J1 connects to the digital monitoring device while J2, J3, and J4 connect individually to each power shelf. The wiring on J2, J3, and J4 is identical — only pin 7 and 8 are used — because each power shelf only uses pin 7 and 8 to transfer the FAIL signal.

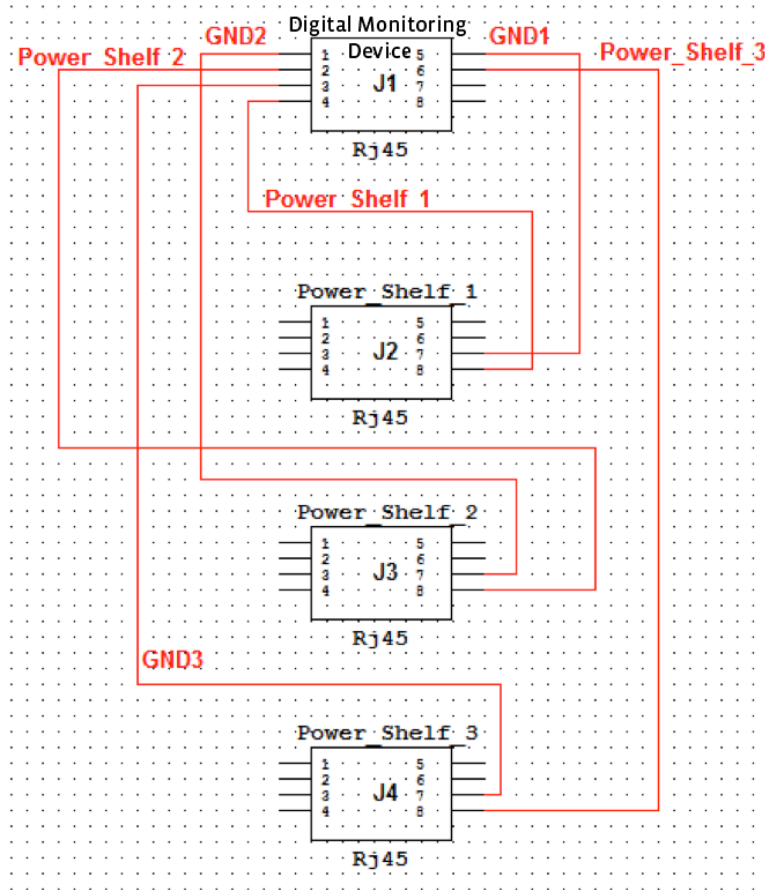


Figure 5 DC gPDU RJ45 Wiring Schematic

## 7.6 DC Dongle Cable Size and Type

The dongle cable size is AWG 4, UL10070, black color. There are three cable pairs of output dongles, and each pair is enclosed in black shrink tube. The dongle cables are retained to the DC gPDU housing and grommets are also used. The three dongle outputs are paralleled inside the gPDU and connected to the  $\pm 48V$  lines from the main 48Vdc input; copper bus bars are used inside the DC gPDU for this purpose. The bars are 3mm x 25mm, not plated but individually enclosed in a shrink tube.

The three dongle cable pairs are individually terminated to an Anderson Power SB120 connector.

Each dongle cable current rating is 120A continuous. Its total length is 360mm, including the connector housing.

## 8 Mechanical Requirements

- The sheet metal chassis material is steel, pre-plated hot-dip zinc-coated fine texture, JIS G3302 SGCC (Z20 to Z22), with 1.2mm of thickness. The Z parameter defines the coating thickness: Z20 is for 40µm of thickness, and Z22 is for 43µm. The Japanese standard is JIS G3302, while the US standard is ASTM A653.
- Detailed AC and DC gPDUs mechanical drawings are available in conjunction with this specification. They show all the dimensions, construction details, label information, silkscreen, connectors and dongles locations, and so forth.
- The gPDUs are not painted. The silkscreen is painted black directly on metal surface.
- The mechanical design prevents sharp edges and metal oxidation in the critical points of the sheet metal, for example in the cut and bend portions. No bare edges are left unprotected; touch-up plating to the edges is applied as needed to avoid corrosion.

### 8.1 Disallowed Components

- The chassis design does not promote the growth and propagation of zinc and tin whiskers.
- Metal base materials with electro-zinc plating or poor conductivity plating are not allowed.
- Aluminum material is not allowed for the enclosure.
- The chassis enclosure, as well as the whole gPDU, meets the contamination requirements of section 11 of the ANSI specification.
- The gPDU chassis is not classified as a "fire enclosure" chassis.
- Extracts of the complete mechanical drawings are included in Figure 6 and Figure 7.

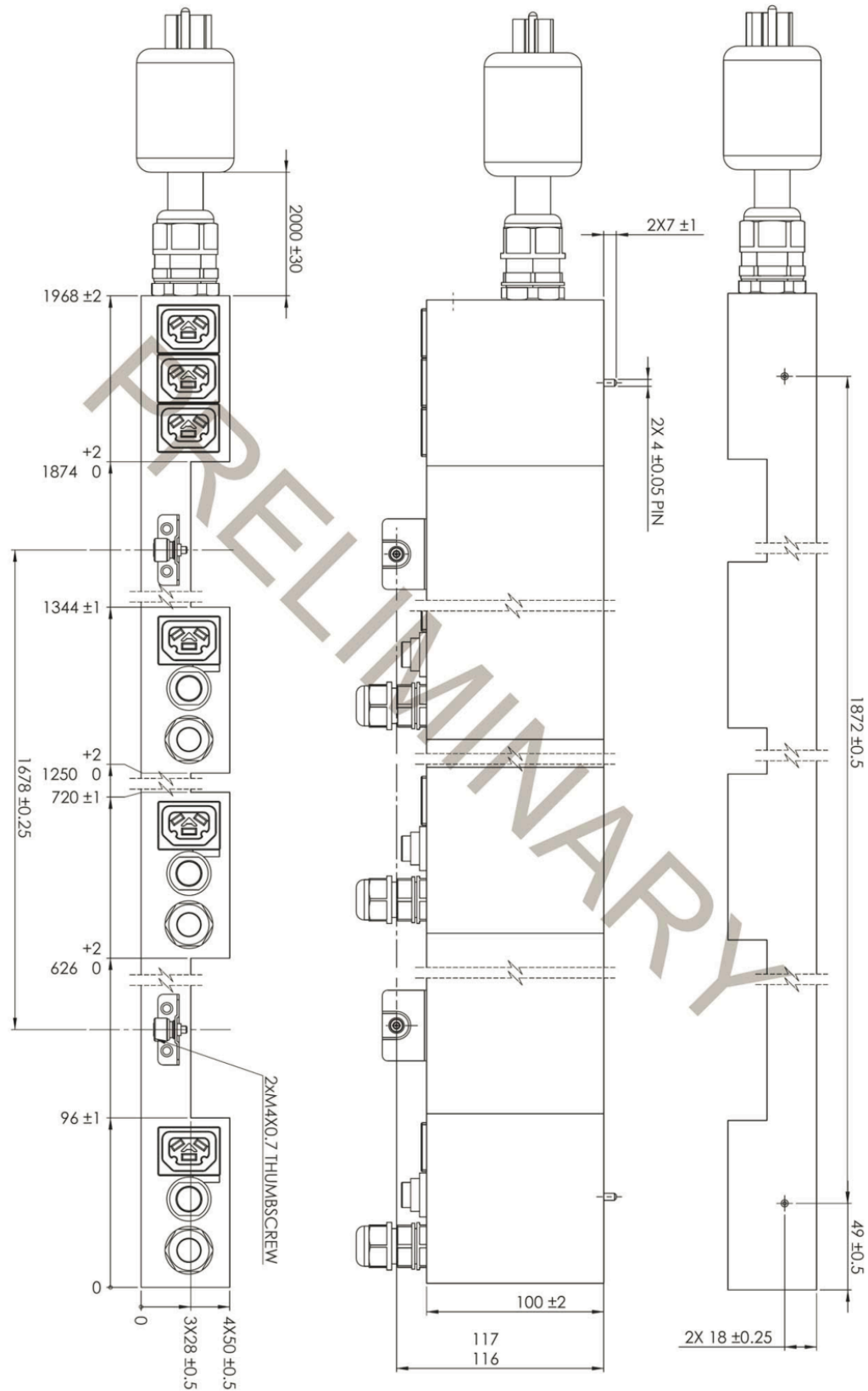


Figure 6 AC gPDU

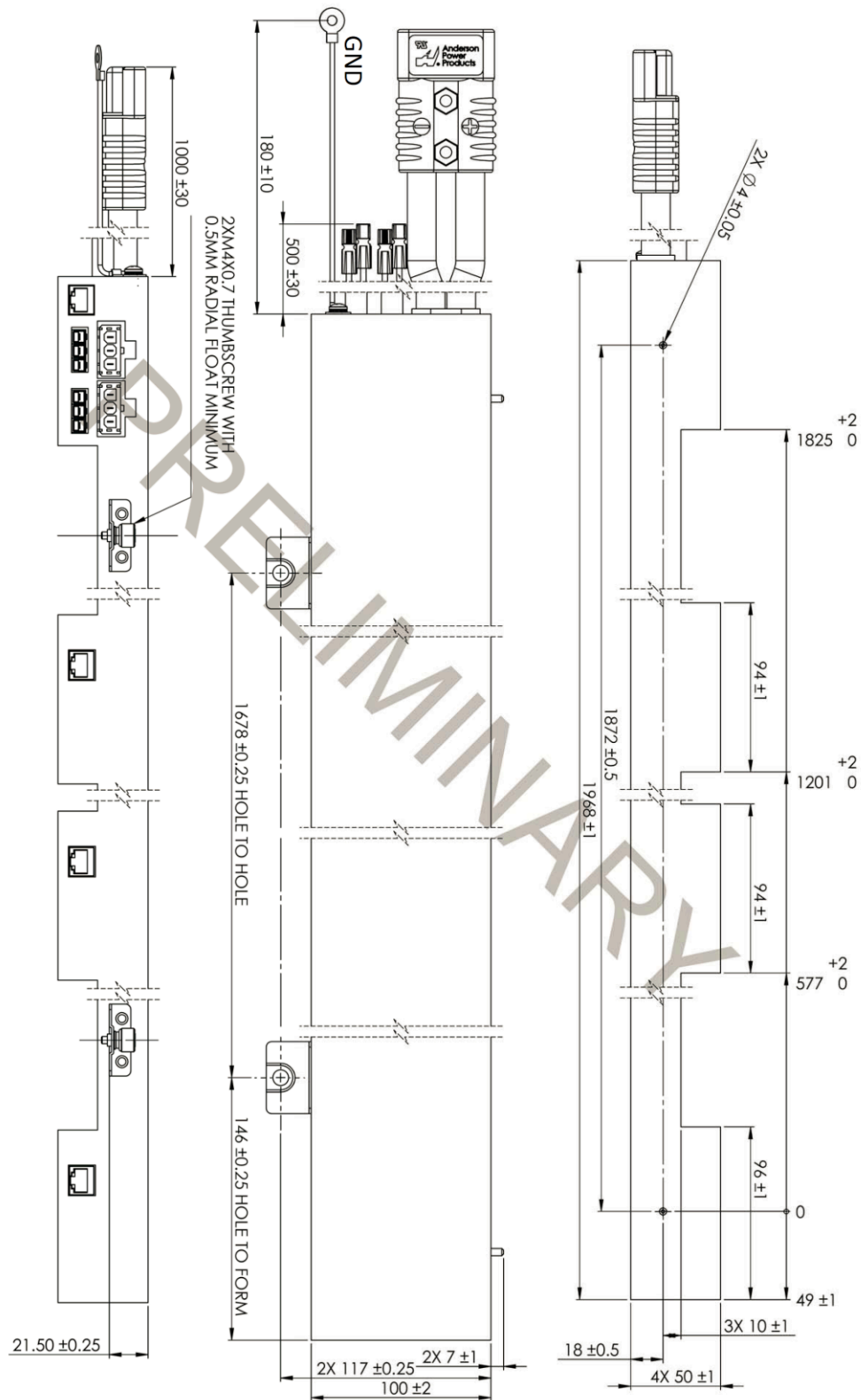


Figure 7 DC gPDU

## 9 Isolation Requirements

Isolation between input and outputs (both phases and neutral, or positive and negative) and chassis ground is 1500Vac RMS minimum (AC gPDU and DC gPDU).

## 10 Environmental Requirements

- Gaseous contamination: severity level G1 per ANSI/ISA 71.04-1985
- Ambient operating temperature range: -5°C to +50°C
- Operating and storage relative humidity: 5% to 95% (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 deratings: 3000m (10,000 feet)

### 10.1 Vibration and Shock

The gPDUs meet shock and vibration tests per IEC78-2(\*) & IEC721-3(\*) Standard & Levels, with the specifications listed below.

	Operating	Non-Operating
<b>Vibration</b>	0.5g acceleration, 1.5mm amplitude, 5 to 500 Hz, 10 sweeps at 1 octave / minute for each of the three axes (one sweep is 5 to 500 to 5 Hz)	1g acceleration, 3mm amplitude, 5 to 500 Hz, 10 sweeps at 1 octave / minute for each of the three axes (one sweep is 5 to 500 to 5 Hz)
<b>Shock</b>	6g, half-sine 11mS, 5 shocks for each of the three axes	12g, half-sine 11mS, 10 shocks for each of the three axes

Figure 8 Vibration and Shock Requirements