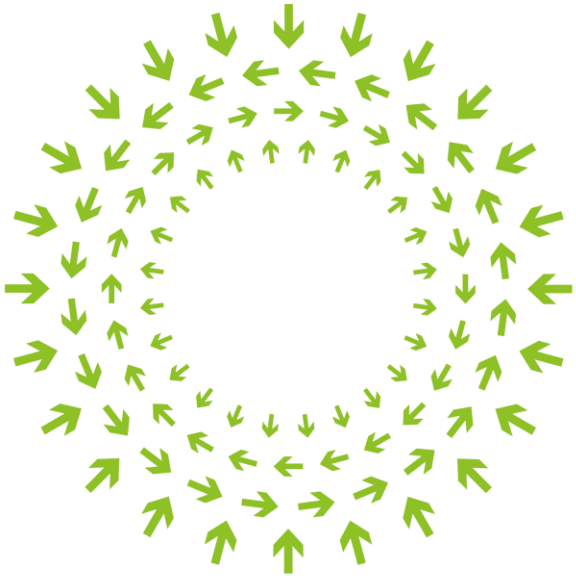


OPEN

Compute Project

277Vac US Power Distribution Unit for V2 Open Rack

Author: Samir Kala, Power Engineer, Facebook

Author: Steve Mills, Mechanical Engineer, Facebook

Scope

This specification defines the technical requirements for a custom AC power strip, used for AC power distribution in a data center. At system level this device shall be installed in an IT chassis and will work in conjunction with Facebook's V2 Open Rack design.

Contents

Overview

The AC power box is designed to accept an input voltage of 3-phase WYE wiring 277/480V_{AC} RMS voltage (4 wires + ground). This box PDU will have two inputs and two outputs. Each inputs 5 wires will pass through a surge protection circuit inside the sheet metal PDU housing via appropriate strain reliefs and then be terminated via a Positronic connector with a custom over molding. There will be no fuses in this power strip.

License

1. Electrical

1.1 Basic functional schematic

This AC power box has two L22-20P inputs that pass its 5-wires through a surge protection circuit and then terminates at the output Positronic connector. Each of the output cables will be directly connected to the appropriate pin on the female Positronic connector as shown below in Section 3.3.2.

1.2 Input

1.2.1 Input Rating

Input voltage is a 3-phase WYE wiring, 277/480VAC RMS, 50-60Hz. The nominal max continuous input current per phase is 16A (20A de-rated 80%) RMS at 45°C ambient temperature.

1.2.2 Input Connection

The input plug should be a certified custom molded NEMA L22-20P plug type with UL2586 AWG#12 five conductor power cord. The plug must enter the power strip by a suitable strain relief for a proper mechanical assembly. There shall be two different lengths of the power cords in the AC box PDU. Both cords shall have an input length of 1500mm from the L22-20P plug to the base of the sheet metal box. The cord should be a suitable industrial-grade power cable, Underwriter Laboratories (UL) recognized and Conformité Européenne (CE) certified, with the five conductors enclosed in a further insulating layer so that it resembles a single cable when viewed externally.

Figure 1: **NEMA L22-20**

Per electrical standards, the 5-wires of a 3-Phase WYE system are denoted as following:

- Line 1 is denoted as ‘X’ (black)
- Line 2 is denoted as ‘Y’ (red)
- Line 3 is denoted as ‘Z’ (blue)
- The neutral wire is denoted as ‘W’ (white)
- The ground wire is denoted as ‘G’ (green)

1.2.3 Surge Protection

The surge protection circuit shall meet 2kV differential mode and 4kV common mode. Each of the three input lines (L1, L2, L3) should be connected to the neutral line (N) via a varistor (at least 20mm diameter) with a protection device (thermal fuse). No input fuses are needed on the lines. Each of the three lines should be connected to ground with a varistor. After the varistor all three lines can be connected together

and then connected to ground via a 2.7kV gas tube. Each of the six varistors shall have a protection fuse in series (either built inside the varistor or a thermal fuse installed on the body of the varistor and shrink tubed together – reference fuse Japan Anzen Dengu Co 'N4F' 1A 250V 127C). Each of the three lines shall also have a 32A inductor, with 1µH. The inductor shall have a wire diameter greater or equal to 3mm and shall be placed horizontally flat on the printed circuit board (PCB) for greater mechanical stability. A 4W, 100ohm resistor shall be placed in parallel with each of the inductors. These resistors will need to withstand a very high voltage for a few microseconds. All these components shall be placed on a PCB board that has a maximum current density of 3A per square mm, and is entirely conformal coated. There will be two identical surge protection circuits used for each of the inputs, therefore two surge protection circuits in the box PDU. All the components used for surge protection shall be submitted for evaluation and quality assessment. The five AC input wires (L1, L2, L3, N, G) shall be securely connected to the surge protection PCB via terminal block input and the five output wires from the surge protection circuit (L1', L2', L3', N, G) shall also be securely connected via a terminal block.

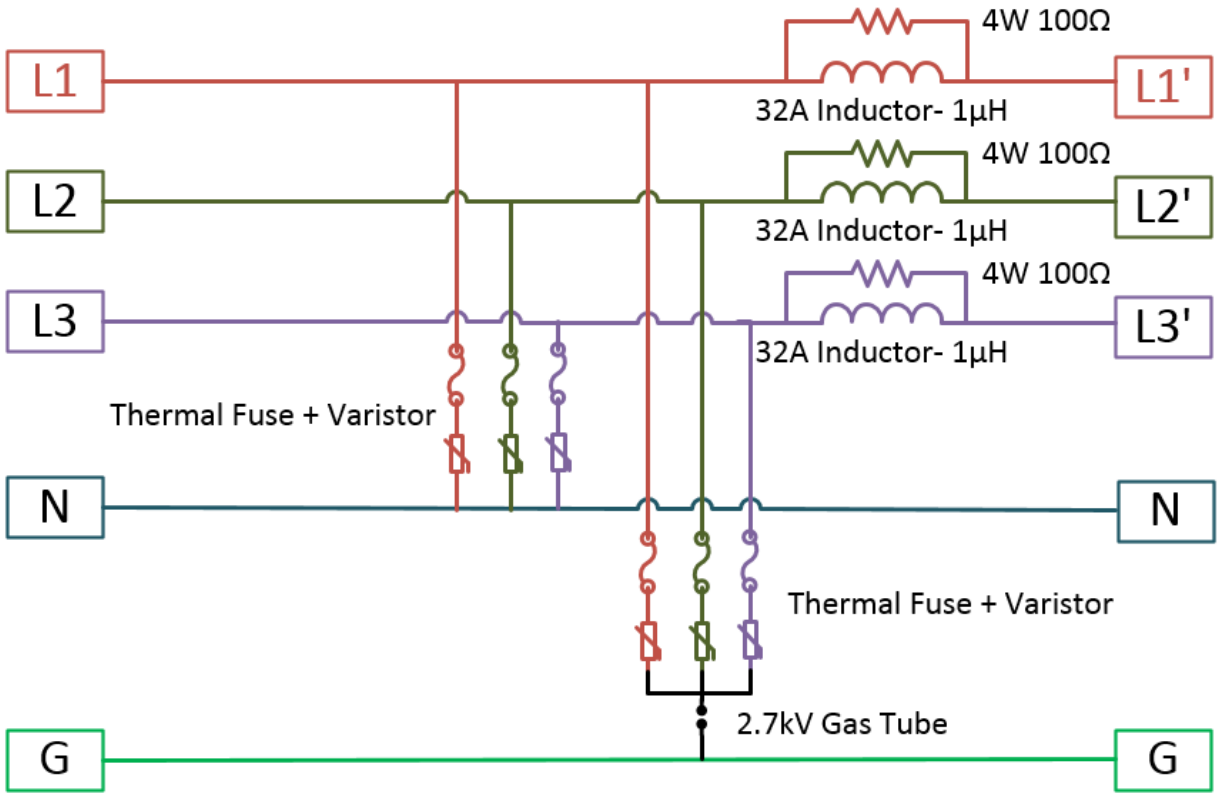


Figure 2: **Surge protection circuit schematic**

1.3 Output

1.3.1 Output Rating

The AWG#12 5-wires from the output of the surge protection circuit from the terminal block shall be

terminated with a Positronic SP5YYE1F0091/AA with custom molding around the connector. The total length of the output cords shall be 1080mm and 2020mm respectively from the PDU box via a suitable strain relief, to the end of the Positronic connector. The max output rating for the cable is 16A at 277Vac.

1.3.2 Output Polarity

The output polarity of the Positronic connector should be as follows.

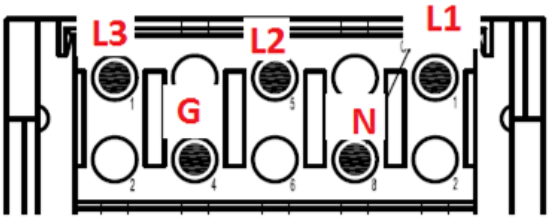


Figure 3: **Female Positronic SP5YYE1F0091/AA (looking at the female connector head on)**

2 4. Mechanical

2.1 Dimensions

The power strip shall be sized as per the mechanical drawing at the end of this specification.

2.2 Mounting Interfaces

The AC PDU box should be mounted using five tabs and locked in with the two latches both on the top surface of the PDU, which allows for tool-less installation. The latches should be of a green color, preferably Pantone 375C. Refer to the mechanical drawing at the end of this specification.

2.3 Finish

The power strip sheet metal plate should be made of hot-dip zinc coated, JIS G3302 SGOC to avoid the creation of zinc whiskers. The Japanese standard is JIS G3302 while the US standard is ASTM A653. The exterior chassis surface shall be powder coated RAL 9005 (Jet Black). More information can be found on the mechanical drawing notes at the end of this specification.

2.4 Silkscreen

The PDU box shall follow the silkscreen markings shown on the mechanical drawing at the end of this specification. The drawing designates the shelves to which the input plug will provide power.

3 Regulatory Compliance Approvals

3.1 Agency Approval

The power strip shall be UL recognized and in accordance with UL/CSA 60950-1 safety standard, as well as CE certified and restriction of hazardous substances (RoHS) compliant. There are no fuses in this V2 AC PDU therefore the PDU cannot be safety certified as a stand-alone. The PDU certification will rely on the breaker powering it therefore the certification shall be done in conjunction with the breaker (bundle breaker

+ PDU).

3.2 Production Line Test

3.2.1 High Potential Test

Full production, 100%, of the power strips shall comply with the minimum high-potential test described below. The test shall be applied between the AC input side (the three phase lines) and the earth GND (NEMA L22-20P ground terminal).

Parameter	Setting
Voltage	1500Vac RMS or 2121Vdc (minimum)
Trip current sensitivity	10mA RMS (maximum)
Voltage ramp time	500V/S (minimum)
Dwell time	1 Second (minimum)
Breakdown arc detection	10μS (maximum)

3.2.2 Ground Bond Test

Full production, 100% of the power strips shall comply with the minimum ground bond test as described below. The test shall be applied between the accessible sheet metal chassis and the AC input plug ground terminal (NEMA L22-20P ground terminal).

Parameter	Setting
Current	30A RMS (minimum)
Voltage	2.5Vac RMS (minimum)
Trip Resistance Sensitivity	0.1Ω (maximum)

3.2.3 Voltage Polarity Test

One hundred percent of the power strips should be verified for correct polarity see Section 3.3.2.

3.2.4 PDU Pull Test

As per UL65090 (Section 3.2.6) the AC/DC power cord should be subjected to a steady pull value as shown in the table below, applied in the most unfavorable direction (preferably 45 degree angle in four directions from normal exit plane of the cable for an angled pull), each time for a duration of one second.

Mass (M) of the equipment Kg	Pull N
M≤1	30
1<Mll	60
M>4	100

During the tests, the power supply cord shall not be damaged. This is checked by visual inspection and by an electric strength test between the power cord conductors and accessible conductive parts, at the test voltage appropriate for reinforced insulation. After the tests, the power supply cord shall not have been longitudinally displaced by more than 2 mm nor shall there be appreciable strain at the connections, and clearances and creepage distances shall not be significantly reduced.

3.2.5 PDU Insertion Test

Adding to the pull test specified above, the PDU connector (sampled as per AQL) to the power shelf should be subject to a maximum of 25 cycles of repeated insertion and removal.

During the tests, the connector pins shall not be damaged. This is checked by visual inspection of the connector pins. After the test, there shall not be any visible damage to the pins.

4 Environmental

4.1 Temperature

4.1.1 Operating Ambient Temperature

The ambient operating temperature range should be from -5°C to +45°C.

4.1.2 Storage

The storage temperature range should be from -40°C to 70°C.

4.1.3 Transit

The transportation temperature range should be from -55 °C to 85 °C (short term storage, 72 hours).

4.2 Humidity

4.2.1 Operating

Operating relative humidity, 10% to 90% (non-condensing).

4.2.2 Non-operating

5% to 95% relative humidity, 38.7°C maximum wet bulb temperature with no cosmetic damage.

4.3 Altitude

4.3.1 Operating

The operating altitude with no de-rating should be from 0 to 10,000 feet (0 to 3,000 meters), altitude change rate between testing conditions to be at least 2,000 ft/min.

4.3.2 Non-operating

0 to 49,000 feet (0 to 15,000 meters), altitude change rate between testing conditions to be at least 2,000 ft/min.

4.4 Vibration and Shock

The power strip should meet shock and vibration test per IEC78-2 (*) & IEC721-3- (*) standards and levels with the specifications listed below. During operating vibration and shock tests, the devices shall exhibit full compliance to the specification without any electrical discontinuities. During non-operating tests, no damages of any kind, including physical damages, should occur or hinder the functionalities of the devices per the subsections below.

4.4.1 Vibration Operating

Sinusoidal vibration: 0.25G zero to peak. Frequency is 10Hz to 500Hz, 0.25 oct/min in each of three mutually perpendicular axes. Three sweeps from 10Hz to 500Hz to 10Hz in each axis shall be tested.

4.4.2 Vibration Non-operating

Sinusoidal vibration: 0.75G zero-to-peak, 10Hz to 500Hz, 0.5 oct/min. The test shall be one sweep from 10Hz to 500Hz in each of the three mutually perpendicular axes.

4.4.3 Shock Operating

Half sine wave shock: 5G, 11ms duration, and three half sine wave shocks in each direction of three mutually perpendicular axes.

4.4.4 Shock Non-operating

Half sine wave shock: 140G, 2ms duration, half sine wave shock in each direction of three mutually perpendicular axes. There shall be one shock input in each direction of three mutually perpendicular axes for a total of six shock inputs.

5 Reliability, Quality, Miscellaneous

5.1 Specification Compliance, Quality, FA, Warranty

- The vendor is responsible that the power strip meets both stand-alone unit and system-level specifications. The vendor is also responsible for assuring that the power strip shipped in production will conform to this specification, with no deviations.
- A specification compliance matrix must be submitted to the vendor for each power strip revision.
- The vendor is responsible for exceeding the production quality standards achieved on the pilot run build, without fluctuations.
- Failure analysis on defective units shall be provided with a corrective action plan, within two weeks after the RMAed units are received at the customer's facility.
- The vendor shall warrant the power strip for defects & workmanship for a period of two years from the date of shipment, when device is operated within specifications. The warranty is fully transferable to any end user. A standard 'VOID' Warranty Sticker shall be applied.

5.2 Mass Production: First Article Samples

Prior to final project release and mass production, the vendor will submit a few production pilot run samples, including the following documentation:

- All the pertinent development docs, production docs, and reports, necessary to release the product for mass production.
- The pilot samples shall be built in the allocated facility for mass production, and using hard-tooled chassis and parts (where applicable).
- A full specification compliance matrix, full test report, and production line final test 'PASS' tickets.
- Samples that passed the burn-in process planned for production (if any).
    - Samples must be shipped using a shipping box that is approved for production.
- A mechanical FAI report shall be submitted that shows compliance with all of the notes and dimensions in the mechanical drawing shown in Section 8 below.
- The units are certified, and the safety label is applied[1]

5.3 Quality Control, Process, Burn-In

- Incoming Quality: < 0.1% rejections
- Cpk values will exceed 1.33 (Pilot Build and Production)

5.4 Packaging

The Power Strip shall be shipped using a custom package. The quality of the packing assembly must ensure that the power strip will not be damaged during transportation. The power strips will arrive in optimum condition and be suitable for immediate use.

A shipping box shock test shall be proposed by the vendor and submitted to the recipient for audit and approval.

5.5 Documentation

The Vendor shall provide the following documentation (prototypes may not include portion of these documents) if applicable:

- Schematics, component placement, board layout (PDF format)
- Build of materials list, including an approved vendor list (AVL)
- Mechanical drawings (PDF format. Native 3D files and/or DXFs) will be provided to perform collaborative work on the design, for seamless device integration at the system-level chassis.
- High potential test, ground bond test, isolation, surge test, thermal test

NOTE: The vendor shall propose a qualification test plan and a reliability test plan.

[1] A 'Pending Certification' sticker may be allowed until the certification process in complete.

5.6 Change Authorization, Revision Control

Once the project is released to mass production, no design changes, AVL changes, manufacturing process or materials changes are allowed without prior written authorization.

An AVL is a list of all the components listed in the BOM. Any change requests must be submitted with proper documentation showing the details of the changes, and reason for the changes, including changes affecting form, fit, function, safety, or serviceability of the product. Major changes in the product (or in the manufacturing process) will require re-qualification and/or re-certification to the product. Thus, a new set of first-article samples may be required to complete the engineering change order (ECO) process.

Any modifications after approval would phase-in during production without causing any delays or shifting the current production schedule. Enough ECO advance notice shall be given to all appropriate entities in the supply chain in such occurrences.

All changes must go through a formal ECO process, starting from the pilot run and onward, and the revision (shown in the Safety Label) will increment accordingly.

5.7 Revision Control

Copies of all ECOs affecting the product will be provided for sign off.

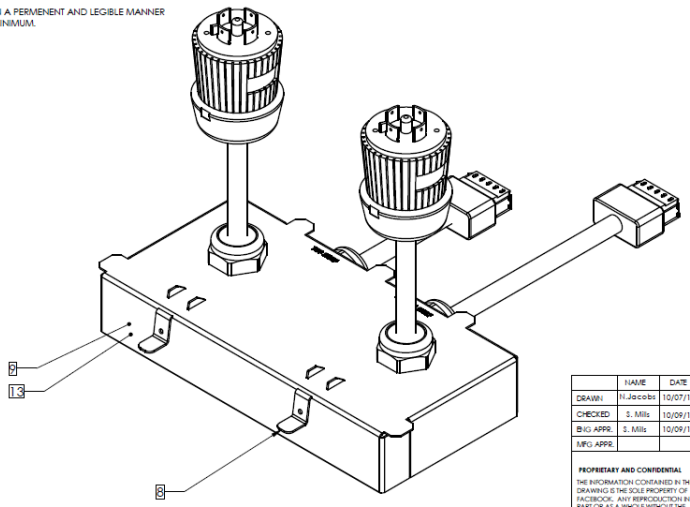
6 Mechanical Drawing

Please review the mechanical drawings for the AC PDU.

NOTES

1. INTERPRET DIMENSIONS PER ASME Y14.5M-2009.
2. ALL DIMENSIONS ARE MM.
3. ALL MATERIALS AND MANUFACTURING METHODS USED MUST BE UL RECOGNIZED AND COMPLY WITH ROHS 2002/95/EC.
4. ALL DIMENSIONS SHOWN SHALL BE CONSIDERED CRITICAL TO FUNCTION AND CHECKED DURING FIRST ARTICLE INSPECTION.
5. COMPONENT SHALL BE CLEAN AND FREE FROM FOREIGN MATERIAL, DIRT,OIL,GREASE,OR OTHER CONTAMINANTS ARE NOT ALLOWED.
3. ALL COMPONENTS SHALL BE UL 94V-0 RECOGNIZED AND 2002/95/EC ROHS COMPLIANT.
6. CASE MATERIAL SHALL RESIST THE CREATION OF ZINC WHISKERS, SUCH AS ASTM A653 AND JIS G3302 SGOC. ELECTOGALVINIZED PLATING IS NOT ALLOWED.
5. ALL DIMENSIONS ARE CONSIDERED CRITICAL TO FUNCTION DIMENSIONS AND SHALL BE INCLUDED IN PART QUALIFICATION.
6. TOLERANCES UNLESS OTHERWISE SPECIFIED ARE:
   - HOLE TO HOLE: 0.13MM/.005IN
   - HOLE TO FOLD: 0.25MM/.01IN
   - EDGE TO FOLD: 0.25MM/.01IN
   - FOLD TO FOLD: 0.40MM/.016IN
   - HOLE TO EDGE: 0.25MM/.01IN
   - HOLE DIAMETER: 0.08/.003IN
   - ANGLES: 0.5
7. CONNECTORS ORIENTED AS SHOWN.
8. LATCH COLOR PANTONE 375C GREEN. LATCHES MUST HAVE A BACKSTOP TO PREVENT DAMAGE TO LATCH DURING ACTUATION.
9. AREA RESERVED FOR ASSET TAG LOCATION SHOULD BE SOLID AND SMOOTH APPROXIMATELY WHERE SHOWN.
10. ALL EDGES SHALL BE CONDITIONED FOR HANDLING WITH A BURR NO GREATER THAN 10% OF MATERIAL THICKNESS AND SHALL CONFORM TO UL SAFETY SPECIFICATION 1439.
11. NO BARE EDGES MAY BE LEFT UNPROTECTED. NEITHER ELECTROPLATED ZINC NOR POOR CONDUCTIVITY PLATINGS ARE ALLOWED. PDU SHOULD PASS RUST GRADE 6 PER ASTM D610-01 AFTER 48 HOURS OF SALT SPRAY PER ASTMB117-07.
12. THE POWER STRIP IN THE WHOLE, AND SO ALSO THE CHASSIS ENCLOSURE, SHALL MEET CERTAIN CONTAMINATION REQUIREMENTS "GASEOUS CONTAMINATION: SERVERITY LEVEL G1 PER ANSI/ISA 71.04-1985".
13. MARK P/N WITH P/N DASH AND REVISON LEVEL AS SPECIFIED ON PURCHASE ORDER (BOM) APPROXIMATELY WHERE SHOWN.
14. ALL WIRE COLOR TO COMPLY WITH NATIONAL ELECTRIC CODE AND ALL CONNECTORS MUST BE UL RECOGIZED.
15. OPERATIONAL TEMPERATURE 7-45C.
16. EXTERIOR CHASSIS SURFACE TO BE POWDER COATED RAL 9005 "JET BLACK".
17. INPUT CONNECTORS FOR THE TOP AND BOTTOM SHELF SHALL BE MARKED IN A PERMENENT AND LEGIBLE MANNER APPROXIAMTELY WHERE SHOWN WITH A HIGH CONTRAST FONT 8MM TALL MINIMUM.

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED
	1	INITIAL RELEASE		SM
	2	SHT 2 ZN C2 AND C4 UPDATE TOL: SHT 2 ZN B5 UPDATE TOL: SHT 2 ZN D7 ADD MARKING TO THE BOTTOM OF THE CHASSIS.	19 NOV 14	SM



	NAME	DATE
DRAWN	N.Jacobs	10/07/14
CHECKED	S. Mills	10/09/14
ENG APPR.	S. Mills	10/09/14
MFG APPR.		

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TITLE: PDU, AC, 277V, 20A, 3P, DUAL I/O, NA, V2

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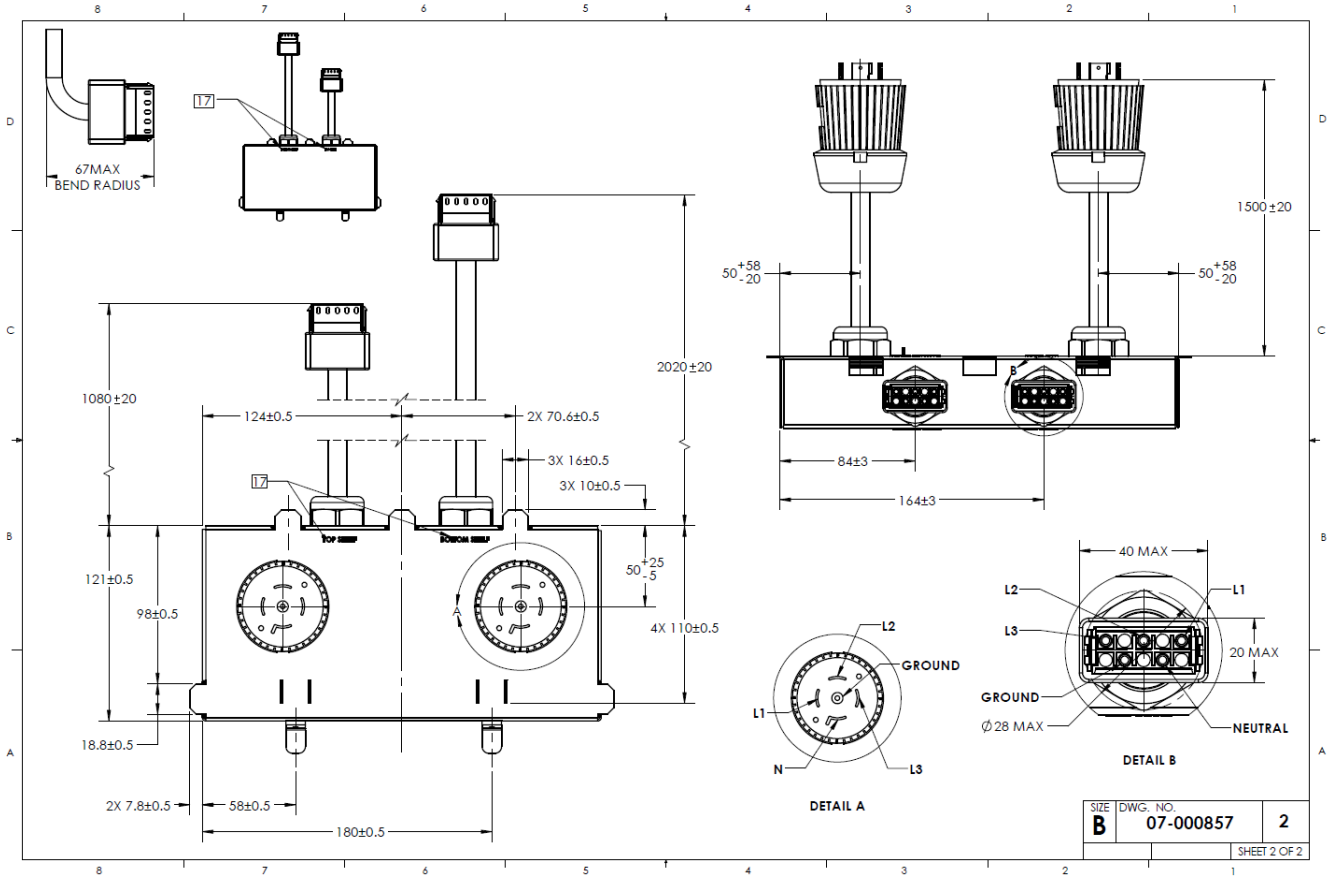
SHEET 1 OF 2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84±3
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98±0.5
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2X 7.8±0.5
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L1
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NEUTRAL
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DWG. NO. 07-000857
2
SHEET 2 OF 2