



PowerDirect Power Monitoring Module (PMM)

User Manual

Specification Number: 1PMM1S0

Model Number: PMM1S0

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Admonishments Used in this Document



DANGER! Warns of a hazard the reader **will** be exposed to that will **likely** result in death or serious injury if not avoided. (ANSI, OSHA)



WARNING! Warns of a potential hazard the reader **may** be exposed to that **could** result in death or serious injury if not avoided. This admonition is not used for situations that pose a risk only to equipment, software, data, or service. (ANSI)



CAUTION! Warns of a potential hazard the reader **may** be exposed to that **could** result in minor or moderate injury if not avoided. (ANSI, OSHA) This admonition is not used for situations that pose a risk only to equipment, data, or service, even if such use appears to be permitted in some of the applicable standards. (OSHA)



ALERT! Alerts the reader to an action that **must be avoided** in order to protect equipment, software, data, or service. (ISO)



ALERT! Alerts the reader to an action that **must be performed** in order to prevent equipment damage, software corruption, data loss, or service interruption. (ISO)



FIRE SAFETY! Informs the reader of fire safety information, reminders, precautions, or policies, or of the locations of fire-fighting and fire-safety equipment. (ISO)



SAFETY! Informs the reader of general safety information, reminders, precautions, or policies not related to a particular source of hazard or to fire safety. (ISO, ANSI, OSHA)

Important Safety Instructions

Safety Admonishments Definitions

Definitions of the safety admonishments used in this document are listed under “Admonishments Used in this Document” on page iv.

General Safety



DANGER! YOU MUST FOLLOW APPROVED SAFETY PROCEDURES.

Performing the following procedures may expose you to hazards. These procedures should be performed by qualified technicians familiar with the hazards associated with this type of equipment. These hazards may include shock, energy, and/or burns. To avoid these hazards:

- a) The tasks should be performed in the order indicated.
- b) Remove watches, rings, and other metal objects.
- c) Prior to contacting any uninsulated surface or termination, use a voltmeter to verify that no voltage or the expected voltage is present. Check for voltage with both DC voltmeters prior to making contact.
- d) Wear eye protection.
- e) Use certified and well maintained insulated tools. Use double insulated tools appropriately rated for the work to be performed.

Personal Protective Equipment (PPE)



DANGER! ARC FLASH AND SHOCK HAZARD.

Appropriate PPE and tools required when working on this equipment. An appropriate flash protection boundary analysis should be done to determine the “hazard/risk” category, and to select proper PPE.



Only authorized and properly trained personnel should be allowed to install, inspect, operate, or maintain the equipment.

Do not work on LIVE parts. If required to work or operate live parts, obtain appropriate Energized Work Permits as required by the local authority, per NFPA 70E “Standard for Electrical Safety in the Workplace”.

Handling Equipment Containing Static Sensitive Components



ALERT! Installation or removal of equipment containing static sensitive components requires careful handling. Before handling any equipment containing static sensitive components, read and follow the instructions contained on the Static Warning Page.

Static Warning



This equipment contains static sensitive components. The warnings listed below must be observed to prevent damage to these components. Disregarding any of these warnings may result in personal injury or damage to the equipment.

1. Strictly adhere to the procedures provided in this document.
2. Before touching any equipment containing static sensitive components, discharge all static electricity from yourself by wearing a wrist strap grounded through a one megohm resistor. Some wrist straps have a built-in one megohm resistor; no external resistor is necessary. Read and follow wrist strap manufacturer's instructions outlining use of a specific wrist strap.
3. Do not touch traces or components on equipment containing static sensitive components. Handle equipment containing static sensitive components only by the edges that do not have connector pads.
4. After removing equipment containing static sensitive components, place the equipment only on static dissipative surfaces such as conductive foam or ESD bag. Do not use ordinary Styrofoam or ordinary plastic.
5. Store and ship equipment containing static sensitive components only in static shielding containers.
6. If necessary to repair equipment containing static sensitive components, wear an appropriately grounded wrist strap, work on a conductive surface, use a grounded soldering iron, and use grounded test equipment.

1 Introduction

1.1 Overview

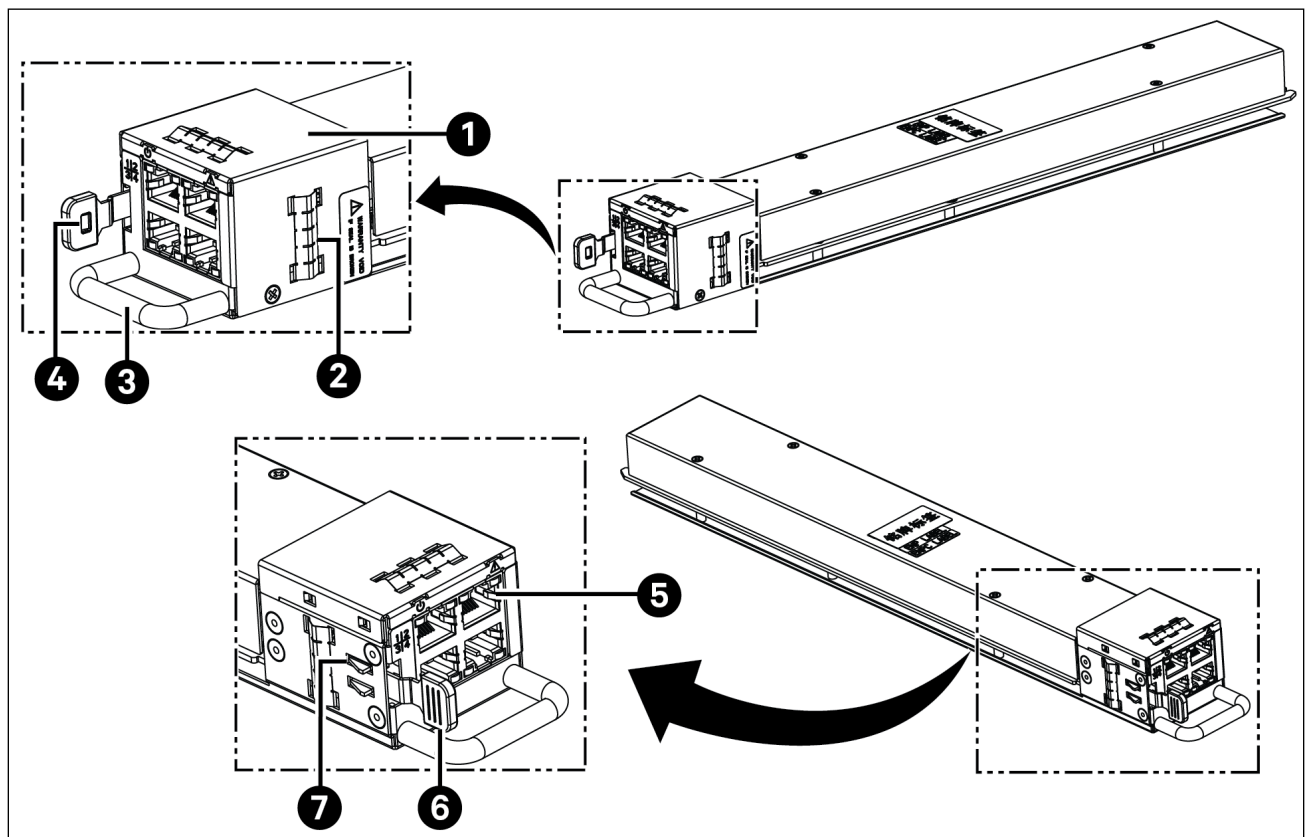
These instructions describe the complete functionality of an Open Rack V3 Power Monitoring Module (PMM) used in the Open Compute Project.

The PMM is a power monitoring module, which collects PSU/BBUs signals and report the collected data to an external management unit as a Modbus server. PMM sits on Open Rack V3 Power and Battery Shelves. It is connected to the PSUs or BBUs in the shelf through the system back board and connected to the centralized system or cascaded expansion shelf through the front RJ45 connectors.

The key features are as following:

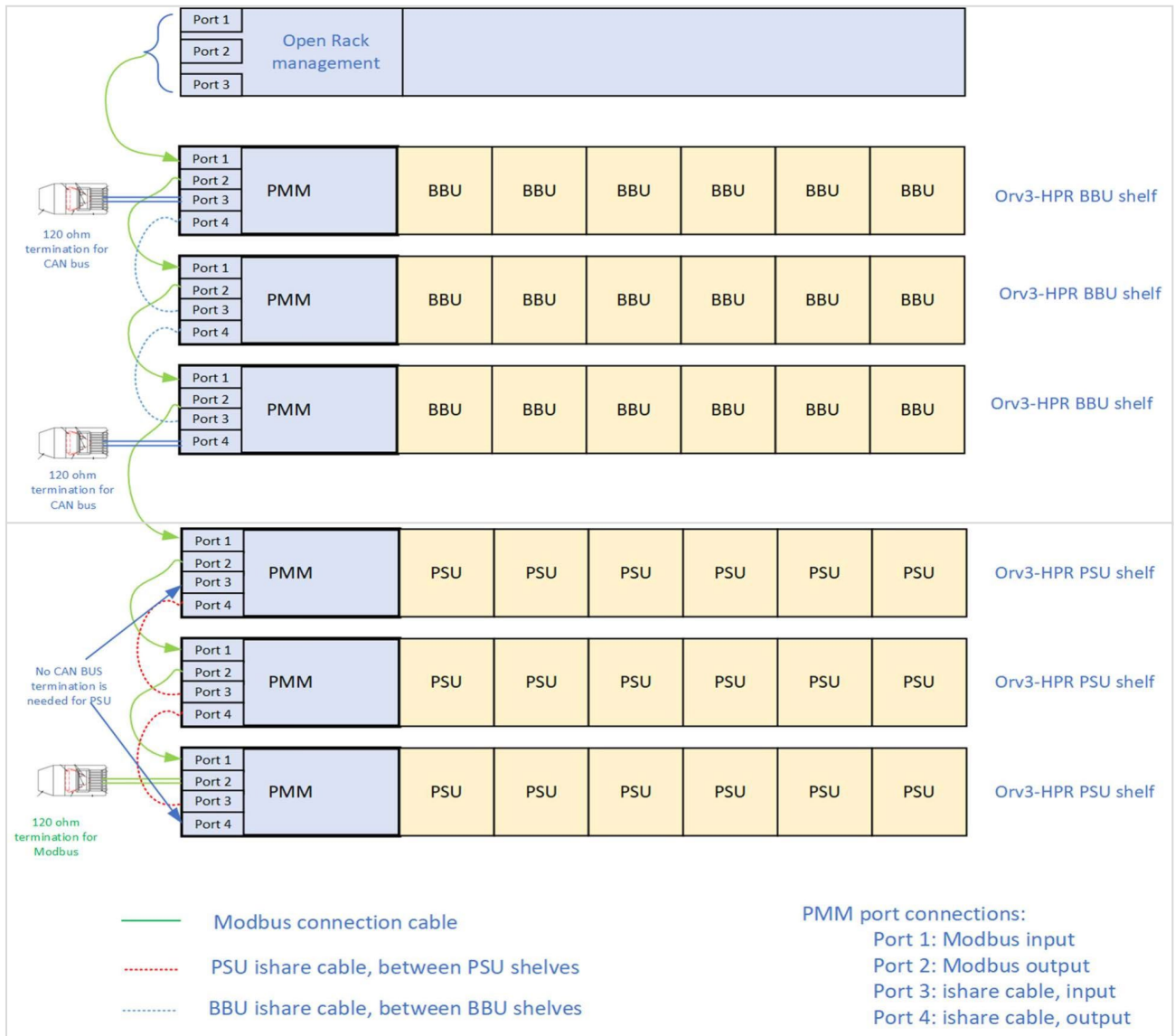
- RS485 Modbus is used as the communication interface between the rack management device and the PMM module, and the PMM acts as a Modbus server.
- PMM supports multi-shelves daisy-chain Modbus connections and mixed connections of PSU and BBU racks on the daisy chain.
- The PMM automatically assigns and shares unique Modbus addresses and CAN bus addresses for PMMs/racks and BBUs on the same daisy chain.
- The PMM communicates with the PSU/BBU modules in the rack via RS485 Modbus through the PMM PCB edge connector.
- The PMM comes with a microcontroller unit (MCU) that collects and consolidates time-critical PSU or BBU parameters from all modules within the rack in short time intervals (500ms to 1s) and shares the information with rack management devices as required.
- PMM provides rack-level health information, such as chassis manufacturing information, PMM manufacturing information, Modbus communication status (CRC, timeout, etc.), and available rectifier list.
- PMM supports online fail-safe firmware upgrade for both the PMM itself and the modules in the shelf. During the PMM firmware upgrade process, any power supply at the rack level cannot be interrupted.
- Supports PMM hot-swappable.
- Each shelf must have one PMM.

Figure 1.1 PMM Module Structure



Item	Description
1	Shell
2	EMI Gaskets
3	Handle
4	Latch
5	RJ45 Connector
6	Spring Latch Handle
7	Securing Latch

Figure 1.2 Power Shelf Overview



1.2 Electric Specifications

1.2.1 4x RJ45 Connectors

In the front of the PMM, there is a single 4x RJ45 connector. This is a modular jack connector in a 2x2 configuration of RJ45s with two LEDs. Looking from the front, top left RJ45 is #1, top right is #2, bottom left is #3, bottom right is #4. RJ45 #1&2:

RJ45 Port #1 and Port #2 include electrical connections for Modbus communications, address pins, and alarm signals. The dual-port design allows for daisy-chain Modbus connections with multiple PSU shelves, BBU shelves, and RPU on the same daisy chain.

RJ45 #3 and #4 include signals for internal rack control. Connections between different types of racks are not allowed. Pin 6 on #3 and #4 is used to monitor if the daisy chain cable is installed or missing.

Communication with rack monitor via Modbus .RJ45 #3&4: Intended for inter shelf control and multiple shelf parallel operation.

Figure 1.3 RJ45 Connectors

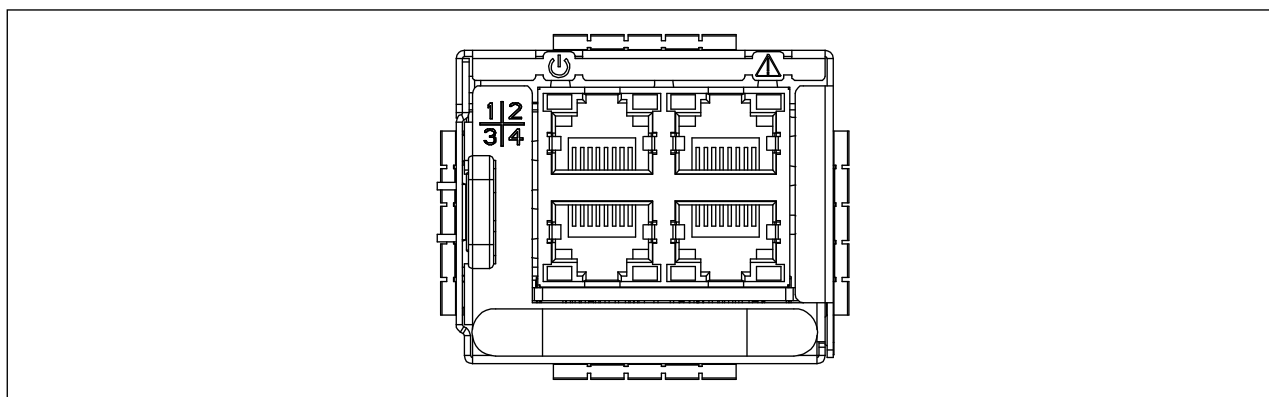


Table 1.1 RJ45 Pin Definition

RJ45 #1			RJ45 #2		
Pin	Wire Color	Function	Pin	Wire Color	Function
1	White/Orange	GND	1	White/Orange	GND
2	Orange	PLS	2	Orange	PLS
3	White/Green	CLS	3	White/Green	CLS
4	Blue	RS485A	4	Blue	RS485A
5	White/Blue	RS485B	5	White/Blue	RS485B
6	Green	RS485_Addr2	6	Green	RS485_Addr2
7	White/Brown	RS485_Addr1	7	White/Brown	RS485_Addr1
8	Brown	RS485_Addr0	8	Brown	RS485_Addr0
RJ45 #3			RJ45 #4		
Pin	Wire Color	Function	Pin	Wire Color	Function
1	White/Orange	ISHARE	1	White/Orange	ISHARE
2	Orange	GND	2	Orange	GND
3	White/Green	SYNC_START_L	3	White/Green	SYNC_START_L
4	Blue	CAN_H	4	Blue	CAN_H_OUT
5	White/Blue	CAN_L	5	White/Blue	CAN_L_OUT
6	Green	SYNC_STOP_L	6	Green	SYNC_STOP_L
7	White/Brown	SOH_L	7	White/Brown	SOH_L
8	Brown	Missing Daisy Chain Cable	8	Brown	GND

1.2.2 Edge Connector

There are many signals on the edge connector. Yellow signals currently have no use case and connection on the PMM and are reserved for future expansion. All other signals are routed in the power/battery shelf backplane.

All other signals are routed in the power/BBU shelf backplanes.

Figure 1.4 Edge Connector



Table 1.2 Edge Connector Pin Definition

Pin #	Signal Name	I/O	Description	Connection on PMM (NC=Not connected)
A1	ADDR_ID_0	I	Shelf ID: 000 Power Shelf(1U) 001 Battery Shelf	
B1	ADDR_ID_1	I		
A2	ADDR_ID_2	I		
B2	GND	I	Ground	
A3	ALERT_0_N	I	PSU/BBU Alert	
B3	ALERT_1_N	I	PSU/BBU Alert	
A4	ALERT_2_N	I	PSU/BBU Alert	
B4	ALERT_3_N	I	PSU/BBU Alert	
A5	ALERT_4_N	I	PSU/BBU Alert	
B5	ALERT_5_N	I	PSU/BBU Alert	
A6	ALERT_6_N	I	PSU/BBU Alert	NC
B6	ALERT_7_N	I	PSU/BBU Alert	NC
A7	ALERT_8_N	I	PSU/BBU Alert	NC
B7	ALERT_9_N	I	PSU/BBU Alert	NC
A8	ALERT_10_N	I	PSU/BBU Alert	NC
B8	ALERT_11_N	I	PSU/BBU Alert	NC
A9	GND	I	Ground	
B9	RESET_0	O	PSU/BBU Reset	NC
A10	RESET_1	O	PSU/BBU Reset	NC
B10	RESET_2	O	PSU/BBU Reset	NC
A11	RESET_3	O	PSU/BBU Reset	NC
B11	RESET_4	O	PSU/BBU Reset	NC
A12	RESET_5	O	PSU/BBU Reset	NC
B12	RESET_6	O	PSU/BBU Reset	NC
A13	RESET_7	O	PSU/BBU Reset	NC
B13	RESET_8	O	PSU/BBU Reset	NC
A14	RESET_9	O	PSU/BBU Reset	NC
B14	RESET_10	O	PSU/BBU Reset	NC
A15	RESET_11	O	PSU/BBU Reset	NC
B15	GND	I	Ground	
A16	PLS	I	PSU/BBU Power Loss Siren	
B16	BKP	I	PSU/BBU BKP, removed from module	NC
A17	Shelf_Addr0	O	PSU/BBU Shelf Modbus address	
B17	Shelf_Addr1	O	PSU/BBU Shelf Modbus address	
A18	Shelf_Addr2	O	PSU/BBU Shelf Modbus address	
B18	RS485A_Int	I/O	Shared PSU/BBU Modbus (to PSU/BBU Modules)	
A19	RS485B_Int	I/O	Shared PSU/BBU Modbus (to PSU/BBU Modules)	



Pin #	Signal Name	I/O	Description	Connection on PMM (NC=Not connected)
B19	I2C_SDA_0	I/O	PSU/BBU #0 PMBUS	NC
A20	I2C_CLK_0	I/O	PSU/BBU #0 PMBUS	NC
B20	I2C_SDA_1	I/O	PSU/BBU #1 PMBUS	NC
A21	I2C_CLK_1	I/O	PSU/BBU #1 PMBUS	NC
B21	I2C_SDA_2	I/O	PSU/BBU #2 PMBUS	NC
A22	I2C_CLK_2	I/O	PSU/BBU #2 PMBUS	NC
B22	I2C_SDA_3	I/O	PSU/BBU #3 PMBUS	NC
A23	I2C_CLK_3	I/O	PSU/BBU #3 PMBUS	NC
B23	I2C_SDA_4	I/O	PSU/BBU #4 PMBUS	NC
A24	I2C_CLK_4	I/O	PSU/BBU #4 PMBUS	NC
B24	I2C_SDA_5	I/O	PSU/BBU #5 PMBUS	NC
A25	I2C_CLK_5	I/O	PSU/BBU #5 PMBUS	NC
B25	I2C_SDA_shelf	I/O	I2C for Shelf Temp and FRU	
A26	I2C_CLK_shelf	O	I2C for Shelf Temp and FRU	
B26	Shelf_Addr3	I/O	Add one bit to the PSU/BBU Shelf address, connect to BBU slot address A3.	
A27	GPIO3	I/O	PRESENT_L for lot 1, pull high through 4.7kohm	
B27	GPIO4	I/O	PRESENT_L for lot 2, pull high through 4.7kohm	
A28	GPIO5	I/O	PRESENT_L for lot 3, pull high through 4.7kohm	
B28	GPIO6	I/O	PRESENT_L for lot 4, pull high through 4.7kohm	
A29	GPIO7	I/O	PRESENT_L for lot 5, pull high through 4.7kohm	
B29	GPIO8	I/O	PRESENT_L for lot 6, pull high through 4.7kohm	
A30	CAN_H	I/O	/	
B30	CAN_L	I/O	/	
A31	SYNC_STOP_L	I/O	/	
B31	GND	O	Ground	
A32	ISHARE	A	PSU/BBU Current Sharing	
B32	SYNC_START_L	I/O	PSU/BBU Sync Start	
A33	SOH_L	O	BBU SOH_L	
B33	P3V3_Shelf	O	3.3V for Shelf I2C	
A34	GND	O	Ground	
B34	ADC0	A	/	NC
A35	ADC1	A	/	NC
B35	ADC2	A	/	NC
A36	ADC3	A	/	NC
B36	ADC4	A	/	NC
A37	(ADC5) CAN_H_OUT	A	CAN bus loop back from far end module via 0 ohm resistor	NC
B37	(ADC6) CAN_L_OUT	A	CAN bus loop back from far end module 0 ohm resistor	
A38	Shelf_EEPROM _WP(ADC7)	A	Shelf EEPROM write protection control	
B38	Power_KILL	I	Power Kill, short pin Connected to 3.3V via 1kOhm resistor DNI; connect to GND via 10 Ohm on shelf	
A39	RSVD	-	Reserved	
B39	RSVD	-	Reserved	
A40	P48V_RTN(GND)	I	Ground	
B40	P48V_RTN(GND)	I	Ground	
A41	NC (clearance)	-	No Connect	
B41	NC (clearance)	-	No Connect	
A42	P48V_IN	I	48V Power In	

Pin #	Signal Name	I/O	Description	Connection on PMM (NC=Not connected)
B42	P48V_IN	I	48V Power In	

1.2.3 Indicator Light

There are two LED indicator lights. Refer to Table 1.3 for details.

Table 1.3 Indicator Light Definition

States	Blue LED	Amber LED	Meaning
			
1	Off	Off	No power to PMM or PMM Power Failure
2	Solid on	Off	PMM operation normal
3	Solid on	x	PMM ready (not including wiring checking)
4	Blinking	x	PMM FW upgrade
5	Blinking or solid on	Blink (0.25s/0.25s)	ISHARE cable not detected (Not apply to the first shelf) (priority 3, see note)
6	Solid on	Blink (0.5s/0.5s)	No valid PMM Modbus address. (Serial link doesn't receive valid data and A2=0) (priority 2)
7	Solid on	Solid on	PMM in unknow shelf type (priority 1)
8	Off	Solid on	PMM permanent failure (but power is ok to drive the LED) (priority 0, highest) ** (phase in before PVT)



NOTE! When there are two or more failures happening at the same time, use the LED to indicate the failure with the highest priority. Priority 0 represents the highest priority.

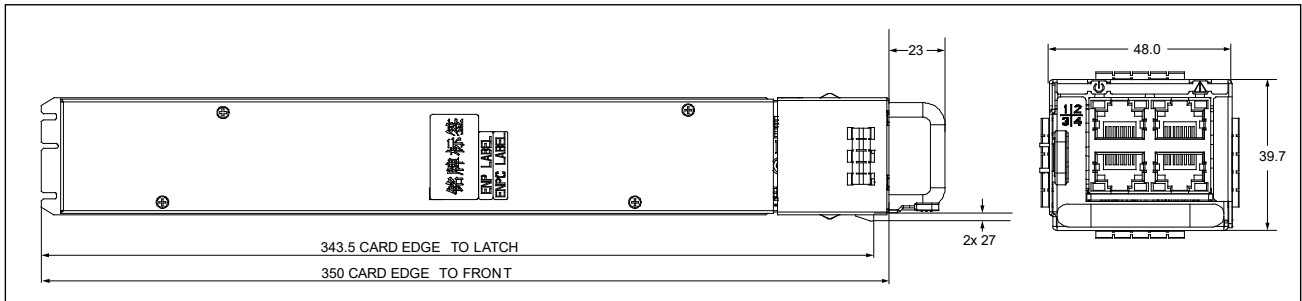
2 Mechanical Specifications

2.1 Dimensions

Dimensions:

- a) Millimeters: 48 (Height) X 39.7 (Width) X 350 (Depth)
- b) Inches: 1.89 (Height) X 1.56 (Width) X 13.78 (Depth)

Figure 2.1 PMM Dimensions



2.2 Construction

The PMM base can be welded, riveted, or screwed together, consistent with meeting shock and vibration requirements. There are no sharp corners or edges.

The sheet metal material is pre-plated hot-dip zinc coated, with 0.8 mm to 1.0 mm of thickness.

2.3 Latch and Handle

A latch and handle are required for PMM removal and installation. The latch is attached in the location shown on the mechanical drawing, to interface with the cutout in the chassis. The latch design may vary, but the finger interface of the latch is Pantone 375C (Green).

The handle is to be designed so it does not interfere with the removal and insertion of cables into the RJ45 connectors. Handle touch points are Pantone 375C (Green).

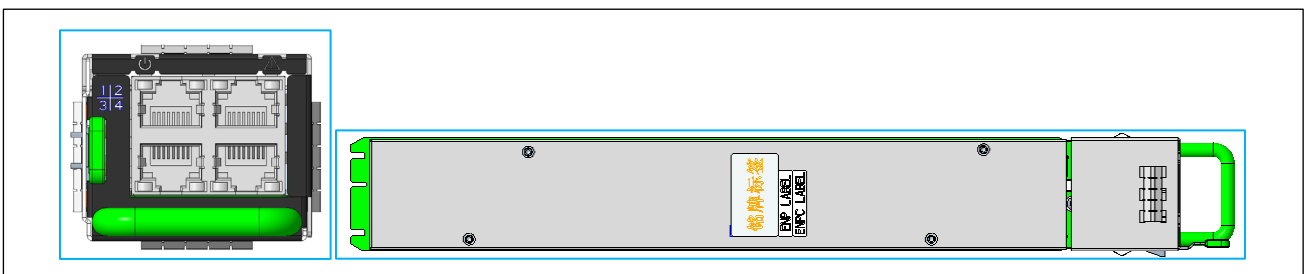
2.4 EMI Gaskets

EMI gaskets are placed on the left and right and/or top and bottom sides of the PMM. The main purpose of the gaskets is for PMM module to shelf grounding and secondary purpose is for EMI containment. Gaskets are placed towards the front of the PMM so they make full contact with the walls of the shelf.

2.5 Labeling and Markings

Markings are placed on the front of the PMM module to indicate RJ45 connector positions. Preferred method is silk screening / pad printing. Product Label is at the bottom of the casing, printed in orange background.

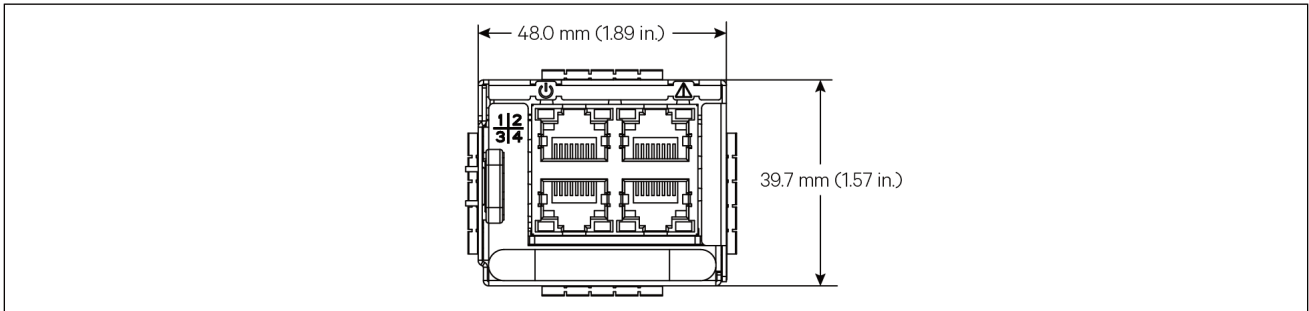
Figure 2.2 PMM Labeling and Markings



2.6 RJ45 Connector Dimensions

In the front of the PMM, there is a single 4x RJ45 connector. This is a modular jack connector in a 2x2 configuration of RJ45s with LEDs. The dimensions of the RJ45 connectors are as following:

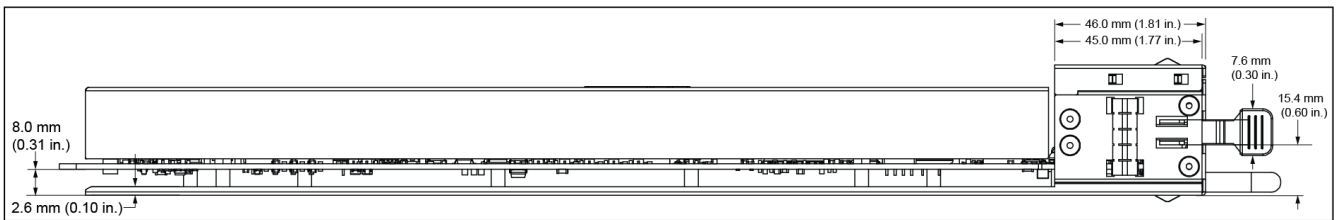
Figure 2.3 RJ45 Connector Dimensions



2.7 Blind Mate Connector Dimensions

In the front of the PMM, there is a single 4x RJ45 connector. This is a modular jack connector in a 2x2 configuration of RJ45s with LEDs. The dimensions of the RJ45 connectors are as following:

Figure 2.4 Blind Mate Connector Dimensions



3 Compliance Specifications

3.1 Altitude

Altitude: 3050 m (10000 ft) at full power (power limited for heights above 3050 m).

3.2 Pollution

Pollution Level II: Only non-conductive contaminants.

3.3 High Voltage Category

High Voltage Category: II.

4 Thermal Specifications

4.1 Power Input/Output

Power Input:

Voltage: 36 VDC to 60 VDC

Current: < 0.5 A

Power Output:

Voltage: 3 VDC to 3.6 VDC

Current: < 0.1 A

4.2 Temperature and Humidity

Operating Temperature and Humidity Range: -5 °C to +45 °C (+23 °F to +113 °F); 10% to 90% RH, (non-condensing)

Storage Temperature and Humidity Range: -40 °C to +70 °C (-40 °F to +158 °F); 10% to 90% RH, (non-condensing)

Transporting Temperature and Humidity Range: -40 °C to +70 °C (-40 °F to +158 °F); 10% to 90% RH, (non-condensing)

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