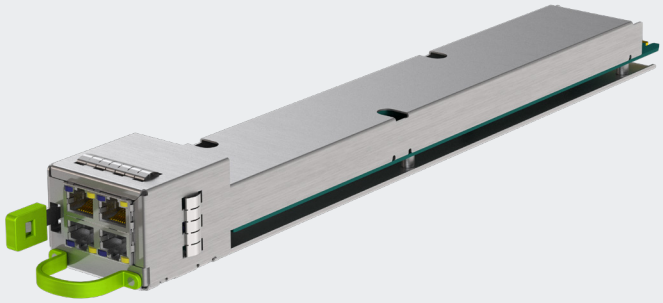
ARTESYN
OPEN Rack V3 HPR PMM

ORv3 Power Monitoring Module



Advanced Energy's Artesyn™ PMM is a shelf power monitor module (card) for the ORv3 HPR power shelf. The PMM card sits on ORv3 power shelves. Each shelf must have one PMM on the shelf. The PMM design supports MODBUS daisy chain connection to allow multiple shelves on the single MODBUS daisy chain by automatically allocating each PSU shelf a unique MODBUS address and CAN Bus address if applicable.

PMM card in shelf

AT A GLANCE

Typical Application

Open Compute Project

Input Connector

Edge Connector

Output Connector

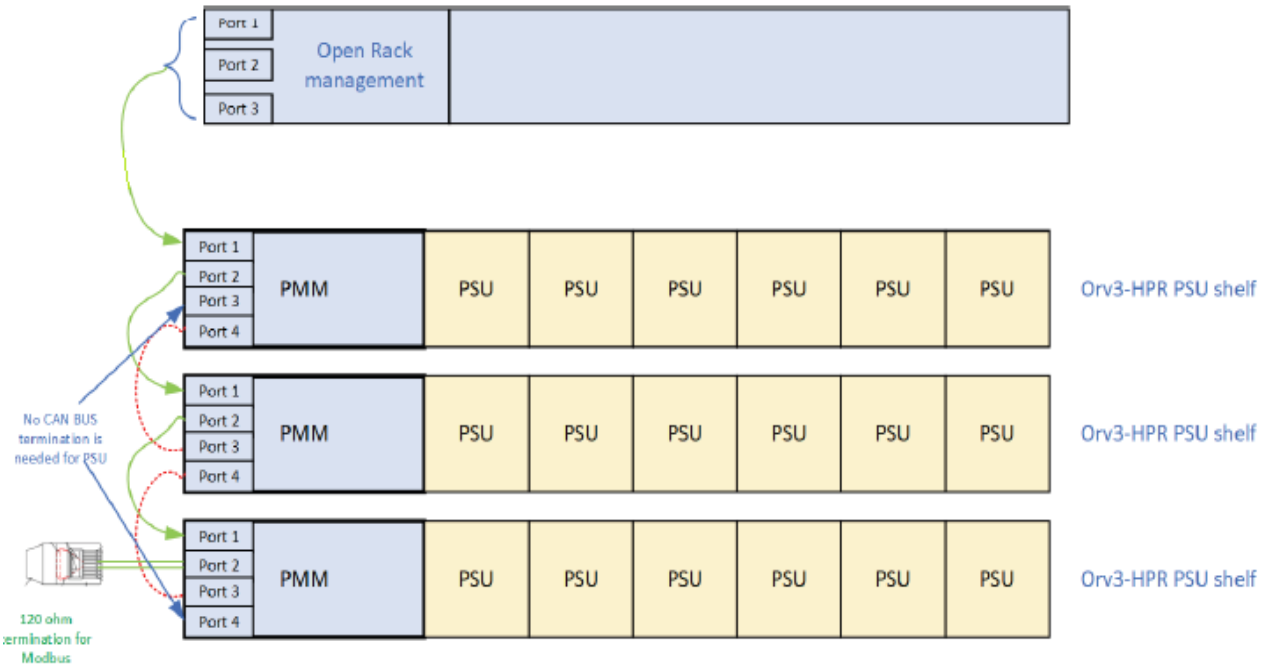
4 x RJ45 Connector

Communication Protocol

MODBUS

OVERVIEW

The figure below shows a typical Modbus daisy chain connections and inter shelf control daisy chain connections on a ORv3-HPR rack with three PSU shelves, and one rack management device.



Modbus connection cable

PSU ishare cable, between PSU shelves

PMM port connections:

Port 1: Modbus input
Port 2: Modbus output
Port 3: ishare cable, input
Port 4: ishare cable, output

ELECTRICAL SPECIFICATIONS

Power Monitoring Module (PMM) Key Features

1. ORv3 HPR continues using the RS485 Modbus as the communication interface between the rack management device and the PMM card through an 8-pin Ethernet cable. The PMM acts as a Modbus slave.
2. The PMM supports multi-shelf daisy chain Modbus connection.
3. The PMM automatically allocates and shares unique Modbus addresses and CAN bus addresses for the PMMs/Shelves on the same daisy chain.
4. The PMM also communicates with PSU modules in the shelf via RS485 Modbus, through the PMM PCB edge card connector. Since the module uses the same communication interface as in ORv3, the changes on the PSU module register map and their firmware are minimized.
5. The PMM, with a microcontroller unit (MCU) included in the design, collects, and consolidates the timing critical PSU parameters from all the modules within the shelf within short time interval (~500 ms to 1 s) and share the information with the rack management device upon request.
6. The PMM collects all data from the modules within the shelf periodically (~10 s) and provides Modbus read service to the rack management device.
7. The PMM provides the capability for the rack management device to indirectly access (read and write) the individual register on any module, with the sacrifice of read and write latency. The write access request from rack management is limited to configuration only. Usually, there is no need for the rack management device to read individual registers on the module.
8. The PMM supports online fail-safe FW upgrade for both the PMM itself and the modules in the shelf. The firmware upgrade for PMM will NOT cause any power interruption at rack level.
9. The PMM supports hot swap of the PMM without affecting the key functionality of PSU shelves. Hot swap of the PMM will NOT cause any power interruption at rack level.

The PSU module is able to operate on its own without any power interruption during the following scenarios:

- Firmware update and reboot
- Failed the FW upgrade and recovered to the previous FW version
- Reseat of the PMM card
- Hot swap, replace and power up the PMM

...

It is OK for the rack management device to temporarily lose the communication to the shelves during the above scenarios.

ELECTRICAL SPECIFICATIONS

4 x RJ45 Connectors

The PMM contains four RJ45 connectors located on the bulkhead of the assembly. The pinouts of the four connectors are shown below. The RJ45 location is defined in the mechanical section.

Looking from the front, top left RJ45 is #1, top right is #2, bottom left is #3, bottom right is #4.

RJ45 port #1 and port #2 includes the electrical connections for the Modbus communication, address pins and alert signals. Two-port design allows daisy chain Modbus connection with multiple PSU shelves, and RPU on the same daisy chain.

Pin #1-7 and Pin #2-7 are used as the UART for serial communication between two PMMs. Specifically, the PMM will receive the data with pin #1-7 from the previous PMM and send data with pin #2-7 to the next PMM on the daisy chain. Besides using as the UART, the Pin #1-8, #1-7, #1-6 are monitored by MCU to obtain the Modbus port address <pin6/7/8> from the rack management device.

RJ45 #1			RJ45 #2		
Pin	**Wire Color**	**Function**	**Pin**	**Wire Color**	**Function**
1	White/Orange	GND	1	White/Orange	GND
2	Orange	-	2	Orange	PLS
3	White/Green	-	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 and #4 includes the signals for inter shelf control. Connections between the different types of shelves are NOT allowed.

Pin 6 on #3 and #4 are used to monitor whether the daisy chain cable is installed or missing.

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

ELECTRICAL SPECIFICATIONS

PMM RS485 Modbus Interface

The RS485 Modbus is the only data communication interface between the rack management device and the PMMs on the power shelves. For simplicity, we will call the interface the PMM Modbus hereafter. The Modbus differential pair signals are connected to Pin4, 5 of port #1 and port #2, and the MCU.

The Modbus design follows Modbus standard specifications (<as in ORv3), but runs at a higher baud rate.

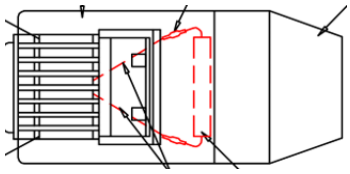
There is another Modbus interface between the PMM and PSU modules. We will call it the module Modbus hereafter.

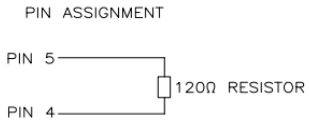
Modbus Termination

Unlike the ORv3 which was designed to support up to two PSU shelves on a single Modbus daisy chain, the ORv3 HPR will support more than 3 shelves on the same Modbus port. As of today, there is a discussion to have 8 PSU shelves on the same Modbus daisy chain. In this case, the load to the Modbus driver is too heavy if each shelf includes a 120 ohm termination resistor.

To solve the problem, ORv3 HPR will use external Modbus termination. One RJ45 termination plug is needed on the last open Modbus port (The port #2 on the last PMM, either on PSU shelf or RPU).

Below is the termination plug drawing for reference. There is a 120 ohm resistor between pin 4 and pin 5. All those pins are floating. (Reference PN: Amphenol Canada Corp. P-RJP-1MF-0001)





PMM Modbus and CAN Bus Address Allocation

Inter PMM/Shelf Communication

Both Modbus and CAN bus communication require a unique address for each node on the daisy chain. Since all PMMs are manufactured the same, having the PMM with different pre-defined addresses is very hard to manage. The PMM design must be able to automatically allocate a unique PMM Modbus address or CAN bus address.

The MCU on the PMM can help to assign the PMM Modbus address if the MCU has the knowledge of the allocated Modbus addresses on the previous nodes. To solve the issue, a serial data communication is proposed to send the address information from one PMM to the next PMM on the daisy chain.

Serial data communication from one PMM to the next PMM on the daisy chain, this design is to use pin 7 on port #1 (or write as pin #1-7) to receive the data from the previous Modbus node (PMM) and use pin #2-7 to transmit the data to the next Modbus node (PMM).

Since the rack management device doesn't support this feature, the first PMM on the daisy won't be able to receive any serial data from pin #1-7. Lucky that the pin #1-6 is currently set to 1 (high) by the rack management device, the PMM can utilize the pin #1-6 to judge if the current PMM is the first PMM on the daisy chain.

All PMMs set the pin #2-6 to 0 (low) to indicate the availability of serial data communication to the next PMM.

The current view of the communication speed is ~9600 baud rate, one direction only.

Module Modbus Address Allocation

To simplify the on-shelf module Modbus communication, it is suggested to use the fixed Modbus address for all modules on the shelf based on the module's slot location. For example, use the 0b'100000zzz for modules on the shelf, where zzz is the slot address of the module. It can apply to PSU.

PMM Modbus Address and CAN Bus Address Allocation

The PMM Modbus address of all the PMMs/shelves on the same daisy chain must be unique to avoid address conflict.

With the serial communication capability described earlier, each PMM card can assign itself a Modbus address based on the information it receives from the previous shelf. The new information can be sent to the next shelf again. By doing so, all the PMMs on the daisy generate its own Modbus address one by one in the order of the locations on the daisy chain.

Please refer to PMM SW/communication specs for details of Modbus address and CAN bus allocation.

ELECTRICAL SPECIFICATIONS

Edge Connector

There are several signals on the edge connector. The following signals have no use-case currently, for future expansions marked with NC (Not Connected on PMM) - A6, B6, A7, B7, A8, B8, B9, A10, B10, A11, B11, A12, B12, A13, B13, A14, B14, A15, B16, B19, A20, B20, A21, B21, A22, B22, A23, B23, A24, B24, A25, B34, A35, B35, A36, B36, A39, B39.

All other signals are routed in the power shelf backplanes.

Pin #	Signal Name	I/O	Description	
A1	ADDR_ID_0	I	Shelf ID: 000 1U power shelf	-
B1	ADDR_ID_1	I		
A2	ADDR_ID_2	I		
B2	GND	I	Ground	-
A3	ALERT_0_N	I	PSU alert	-
B3	ALERT_1_N	I	PSU alert	-
A4	ALERT_2_N	I	PSU alert	-
B4	ALERT_3_N	I	PSU alert	-
A5	ALERT_4_N	I	PSU alert	-
B5	ALERT_5_N	I	PSU alert	-
A6	ALERT_6_N	I	PSU alert	NC
B6	ALERT_7_N	I	PSU alert	NC
A7	ALERT_8_N	I	PSU alert	NC
B7	ALERT_9_N	I	PSU alert	NC
A8	ALERT_10_N	I	PSU alert	NC
B8	ALERT_11_N	I	PSU alert	NC
A9	GND	I	Ground	-
B9	RESET_0	O	PSU reset	NC
A10	RESET_1	O	PSU reset	NC
B10	RESET_2	O	PSU reset	NC
A11	RESET_3	O	PSU reset	NC
B11	RESET_4	O	PSU reset	NC
A12	RESET_5	O	PSU reset	NC
B12	RESET_6	O	PSU reset	NC
A13	RESET_7	O	PSU reset	NC
B13	RESET_8	O	PSU reset	NC
A14	RESET_9	O	PSU reset	NC
B14	RESET_10	O	PSU reset	NC
A15	RESET_11	O	PSU reset	NC
B15	GND	I	Ground	-
A16	PLS	I	PSU power loss siren	-
B16	BKP	I	PSU BKP	NC
A17	Shelf_Addr0	O	PSU MODBUS address	-
B17	Shelf_Addr1	O	PSU MODBUS address	-
A18	Shelf_Addr2	O	PSU MODBUS address	-
B18	RS485A_Int	I/O	Shared PSU MODBUS	-

Pin #	Signal Name	I/O	Description	
A19	RS485B_Int	I/O	Shared PSU MODBUS	-
B19	I2C_SDA_0	I/O	PSU #0 PMBUS	NC
A20	I2C_CLK_0	I/O	PSU #0 PMBUS	NC
B20	I2C_SDA_1	I/O	PSU #1 PMBUS	NC
A21	I2C_CLK_1	I/O	PSU #1 PMBUS	NC
B21	I2C_SDA_2	I/O	PSU #2 PMBUS	NC
A22	I2C_CLK_2	I/O	PSU #2 PMBUS	NC
B22	I2C_SDA_3	I/O	PSU #3 PMBUS	NC
A23	I2C_CLK_3	I/O	PSU #3 PMBUS	NC
B23	I2C_SDA_4	I/O	PSU #4 PMBUS	NC
A24	I2C_CLK_4	I/O	PSU #4 PMBUS	NC
B24	I2C_SDA_5	I/O	PSU #5 PMBUS	NC
A25	I2C_CLK_5	I/O	PSU #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 shelf address	-
A27	GPIO3	I/O	PRESENT_L for slot 1, pull high through 4.7k ohm	-
B27	GPIO4	I/O	PRESENT_L for slot 2, pull high through 4.7k ohm	-
A28	GPIO5	I/O	PRESENT_L for slot 3, pull high through 4.7k ohm	-
B28	GPIO6	I/O	PRESENT_L for slot 4, pull high through 4.7k ohm	-
A29	GPIO7	I/O	PRESENT_L for slot 5, pull high through 4.7k ohm	-
B29	GPIO8	I/O	PRESENT_L for slot 6, pull high through 4.7k ohm	-
A30	CAN_H	I/O		-
B30	CAN_L	I/O		-
A31	SYNC_STOP_L	I/O		-
B31	GND	O	Ground	-
A32	ISHARE	A	PSU current sharing	-
B32	SYNC_START_L	I/O	PSU sync start	-
A33	SOH_L	O	-	-
B33	P3V3_shelf	O	3.3 V for shelf I2C	-
A34	GND	O	Ground	-

ELECTRICAL SPECIFICATIONS

Edge Connector

Pin #	Signal Name	I/O	Description	
B34	ADC0	A		NC
A35	ADC1	A		NC
B35	ADC2	A		NC
A36	ADC3	A		NC
B36	ADC4	A		NC
A37	CAN_H_OUT (ADC5)	A	CAN bus loop back from far end module via 0 ohm resistor	-
B37	CAN_L_OUT (ADC6)	A	CAN bus loop back from far end module via 0 ohm resistor	-
A38	Shelf_EEPROM_WP (ADC7)	A	Shelf EEPROM write protection	-
B38	Power_KILL	I	Power Kill, short pin. Connect to 3.3 V via 1k ohm 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	-
B42	P48V_IN	I	48V power in	-

Power Supplies

The shelf provides 48 V power to the PMM card through the edge connector. A Power kill short pin signal is also available on the PMM.

The PMM converts the 48 V power input to the power rails needed for the MCU and other components. The PMM also provides 3.3 V across the connector to the power shelf to power up the shelf manufacturing EEPROM.

One critical requirement for PMM power design is to avoid the arcing or damage during the PMM plug in and out when the shelf is powered up. The Power_Kill signal on the edge connector helps serve the purpose.

I2C for Shelf Manufacturing EEPROM

The PMM is able to read the shelf manufacturing data from the shelf EEPROM (address 0x50) through the I2C bus. The EEPROM is write-protected by default and can be enabled from the MCU if needed.

The same I2C bus can also be used to access the manufacturing EEPROM on the PMM itself. This EEPROM can be replaced by MCU interval flash but suggests keeping the option available on the PCB layout.

Power Loss Siren Signal

The power loss siren signals from all modules on the shelf are wire ORed together and connected to pin 2 on #1 and #2 directly through the edge connector (no connecting to MCU).

The power loss siren signals from all shelves on the same Modbus daisy chain are wire ORed through the daisy chain.

The power loss signal is monitored by the rack management device on the ORv3 HPR rack.

ELECTRICAL SPECIFICATIONS

Signals for Inter Shelf Control

The following signals are critical to the PSU module's operation when there are multiple shelves on the same 48 V power bus. The signals connects directly to the #3 and #4 on the front panel through the edge connector (Not through the MCU!).

- ISHARE
- Sync_start_L
- CAN bus + & CAN bus –
- SOH_L
- Sync_stop_L

Modbus for Module Communication

The RS485 Modbus is used for data communication between the PMM and modules. This Modbus interface is called module Modbus hereafter.

Since the Modbus was used in ORv3 for module communication, using the Modbus for ORv3 HPR module communication can significantly reduce the module firmware changes. The module Modbus will operate at baud rate of 115200, with one termination resistor near the RS485 transceiver on PMM.

The module Modbus design follows the standard Modbus specifications.

PMM Manufacturing EEPROM

PMM manufacturing information such as FBPN, vendor PN, Hardware and FW version etc are stored in the non-volatile memory, either in the MCU flash or EEPROM on the PMM. The contents should NOT be changed during the FW upgrade, unless the change is on purpose during the manufacturing process.

The information is available for inquiry from the Modbus. The exact Modbus register map is defined in the register map.

Micro Controller Unit

The Micro Controller Unit (MCU) is the most important component on the PMM card. It will help the PMM to implement the following key tasks:

- Collects and consolidates the status of modules within the shelf by monitoring some hardware signals.
- Collects manufacturing information about the shelf and the PMM itself through I2C etc.
- Prepare the module and shelf data for inquiry from the rack management device.
- Provide response to request from rack management device (as Modbus slave).
- Allocate shelf address based on inputs from RJ45 port #1 (Pin status or serial communication).
- Share the shelf address to the next PMM/shelf through RJ45 port #2 (serial communication).
- Manage the module FW upgrade. Provide FW upgrade service to the rack management device.
- The MCU is able to keep and report the age of the cached data.

The selected MCU has enough processing power, memory, accessories and spare I/Os to support future growth without changing the MCU.

A couple of latched I/Os is needed to keep some critical I/Os unchanged during the FW upgrade or MCU reboot.

Communication with Rack Management Device

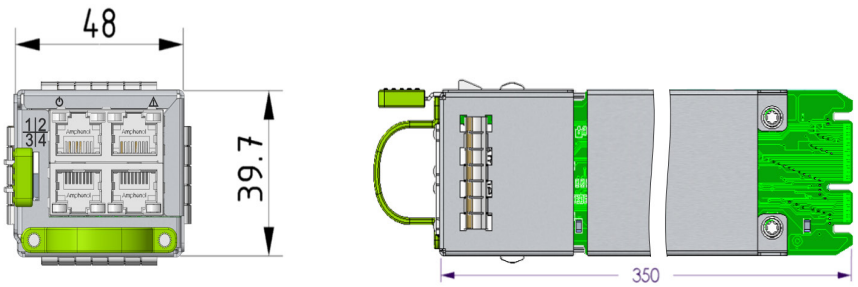
The PMM, as a Modbus slave, provides Modbus service to the rack management device through the Modbus cable. The Modbus communication follows the standard Modbus specifications, including the register map definition and related Modbus functions.

Please refer to PMM SW/communication specs and register maps for details of communication between Rack management device, PMM and Modules.

MECHANICAL SPECIFICATIONS

PMM Physical Dimensions

The PMM is 39.7 mm x 48 mm x 350 mm [Width x Height x Depth].



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 to 1.0 mm of thickness.

Latch and Handle Requirements

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 must be 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 to be Pantone 375C (Green).

EMI Gaskets

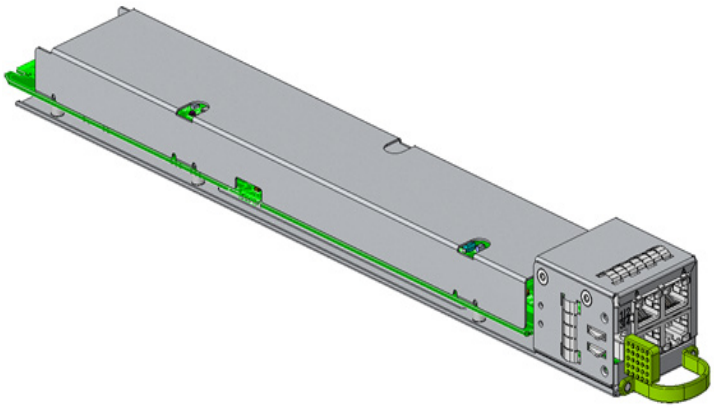
EMI gaskets are to be placed on the left & right and/or top & bottom sides of the PMM. The main purpose of the gaskets is for PMM to shelf grounding and secondary purpose is for EMI containment. Gaskets are to be placed towards the front of the PMM so they make full contact with the walls of the shelf.

Labeling and Markings

Markings are placed on the front of the PMM to indicate RJ45 connector positions. Preferred method is silk screening / pad printing.

Cover

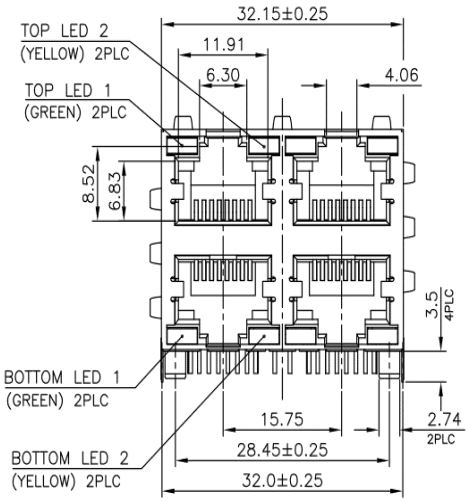
The assembly has a sheet metal cover to protect board components from damage. The cover is held down by screws to the board and shall not interfere with any shelf features that are required for installation of the PMM.



MECHANICAL SPECIFICATIONS

RJ45 Connector

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 MPN is TE 2041376-3, Amphenol RJSAE-4DN-0003HF or equivalent. Note that this connector comes with spring fingers. These must contact the PMM chassis in order to provide sufficient EMI sealing.



LED on Front Panel

Due to the limited size of the PMM front panel, the PMM will use LEDs on the RJ45 ports as its indicators. Blue LEDs (#1 and #2 in the drawing below) on the RJ45 ports will be controlled at the same time as a single Blue LED. Amber LEDs (#3 and #4 in the drawing below) on the RJ45 ports will be controlled at the same time as a single amber LED. A silk screen is placed above the RJ45 connector as shown below (concept drawing only).

States	Blue LED	Amber LED	Description
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 (0.25 s/0.25 s)	ISHARE cable not detected (Not apply to the first shelf) (priority 3, see note)
6	Solid on	Blink (0.5 s/0.5 s)	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)

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.

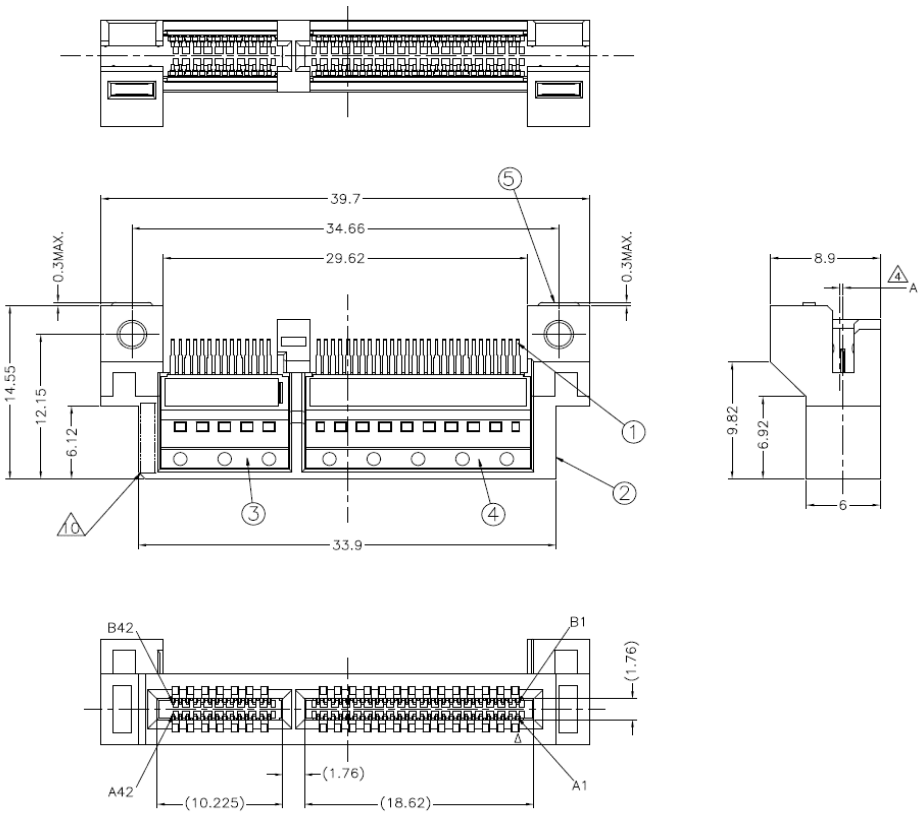
MECHANICAL SPECIFICATIONS

Blind Mate Connector

The PCB (card edge) of the PMM blind mates into a 2C connector on the shelf side. The location of this connector is fixed, but the connector itself may either be mounted on a PCB or a panel-mounted cable. There are no specific requirements for the interface of this blind mate connector to the main shelf PCB. Please refer to the ORv3 Power Shelf specification for more details on this.

Approved connectors are:

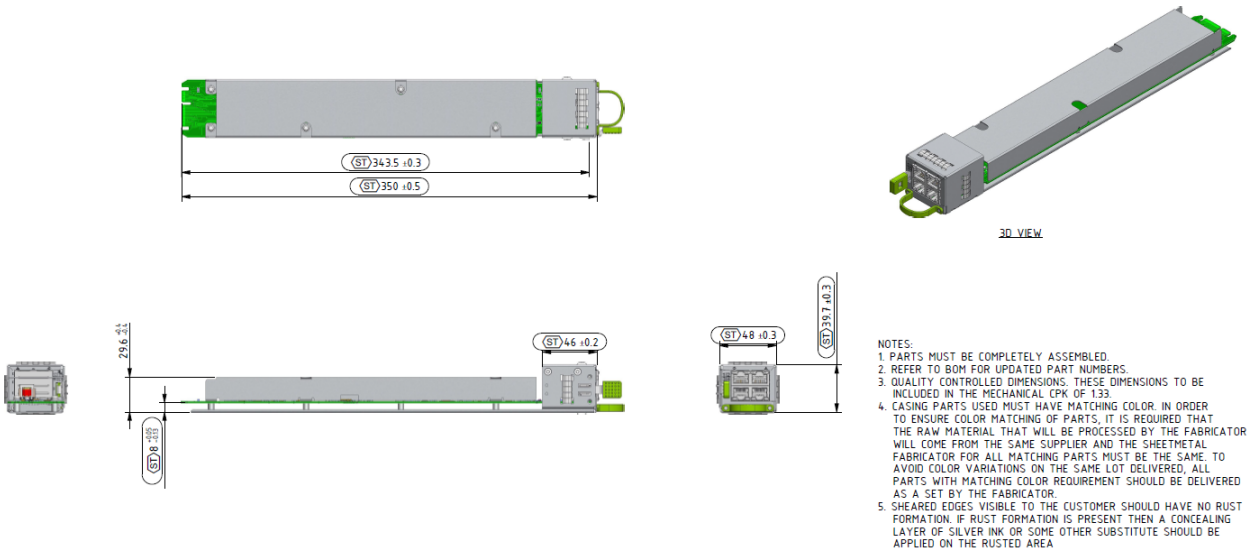
- TE Sliver 2340326-01
- Amphenol Mini Cool Edge ME1008413401101
- Molex Edgeline Sliver 2086104157



MECHANICAL SPECIFICATIONS

Mechanical Drawings

All dimensions are in mm.



ORDERING INFORMATION

Model	Description
700-043397-0100	Standard ORV3 HPR Power Monitoring Module

ENVIRONMENTAL SPECIFICATIONS

Safety Standards

Power Monitoring Module (PMM) is tested together in the OCP ORv3 HPR power shelf and comply with all safety requirements specified in OCP Open Rack V3 HPR Power shelf.

Any component or signal that controls charging and discharging battery is evaluated under single fault condition per UL62368-1 Annex M.

EMC Requirements

Power Monitoring Module (PMM) is tested together in the OCP power shelf and comply with all EMC requirements specified in OCP Open Rack V3 Power shelf document when PMM board runs in a normal operation mode.

Environmental Compliance

Manufacturer of PMM provides full material disclosure, and technical documentations to demonstrate compliance to environmental compliance requirements such as ROHS, REACH, WEEE etc, depending on the end user's goals and business need.

Documentation

The Power Monitoring Module (PMM) is covered under all documents specified in OCP Open Rack V3 Power shelf document.

Operating Temperature

Power Monitoring Module (PMM) will operate within stated specifications at cold aisle (inlet) temperature from -5°C to 45°C.

Altitude

Power Monitoring Module (PMM) will operate within specifications at altitudes up to 3,050 m (10,000 ft) above sea level.

Humidty

Power Monitoring Module(PMM) will operate within specifications when subjected to a relative humidity from 10% to 90% non-condensing.

Vibration and Shock (non-packaged)

The PMM meets vibration and shock test per EN 60068-2-6 and 60068-2-27 respectively and is to be performed at system shelf level (i.e. power shelf installed with PSUs and PMM).

Package Vibration, Drop and Compression

PMM in their package meet the following requirements:

Package Vibration	1.146 G_{rms}, 2-200-2 Hz, all three axes, Random Vibe	ISTA 3E 06-06
Package Drop	8-inch drop	ISTA 3E 06-06
Package Compression	Maximum compression loading on a bulk pack	ASTM D 642-94

Operational Thermal Requirements

Reserving adequate margins on components is critical. These margins should be defined with respect to de-rated values, as appropriate.

Component thermal margin of ≥7% or ≥5°C up to 30°C inlet/ambient and 3,050 m (10,000 ft) above sea-level. Target whichever value is larger.
Component thermal margin of ≥4% or ≥3°C at greater than 30°C inlet/ambient and up to 3,050 m (10,000 ft) above sea-level. Target whichever value is larger.
Margin to de-rated temperatures should account for associated differences in reading and measurement location. Impact to reliability should also be considered when determining required margin.

MODBUS COMMUNICATION INTERFACE SPECIFICATION

Serial Configuration

Parameter	Settings
Data Rate	19200 to 115200, 115200 (default)
Data Bits	8
Parity	Even
Stop Bits	1

Device Addressing

PSU Shelf	PMM Address	PSU Address
1	0x01	0x10 - 0x1F
2	0x02	0x20 - 0x2F
3	0x03	0x30 - 0x3F
4	0x04	0x40 - 0x4F
5	0x05	0x50 - 0x5F
6	0x06	0x60 - 0x6F
7	0x07	0x70 - 0x7F
8	0x08	0x80 - 0x8F
9	0x09	0x90 - 0x9F
10	0x0A	0xA0 - 0xAF
11	0x0B	0xB0 - 0xBF
12	0x0C	0xC0 - 0xCF
13	0x0D	0xD0 - 0xDF
14	0x0E	0xE0 - 0xEF

CRC Checking

The PSU includes an error-checking field that is based on a Cyclical Redundancy Checking (CRC) method performed on the message contents. Details are found in “Modbus over serial line” v1.02 document section 2.5.1.2 CRC Checking.

Error Handling

The PSU will report Modbus error codes if the request command is invalid.

Error Code	Description
01	Illegal Function
02	Illegal Data Address
03	Illegal Data Value

Response Timeouts

The PMM should respond to Modbus request within 1 sec, unless the configuration demands the request to be dropped.
By default, the PMM will drop any request for the following situations:

- Requested Virtual Address is out of range.
- Requested Virtual Address should be on this shelf, but is not PRESENT.
- Requested Virtual Address is PRESENT but does not respond.
- In Cached mode, cached data is too stale.

The PSU should respond to Modbus request within 1 s.

MODBUS COMMUNICATION INTERFACE SPECIFICATION

Operation Modes for PMM

There're two operating modes with respect to how a system communicates (monitor, configure, reprogram) with the PMM: Passthrough mode and Cached mode.

Passthrough Mode:
Passthrough mode is the default operating mode of the PMM. In this mode, All modbus requests to any of the virtual addresses of any attached module on the rack get converted to their target shelf's internal modbus address, and the commands are passed through directly. The PMM has no involvement other than translating a given virtual address in its shelf to the target internal address.

Cached mode:
In Cached mode, the PMM caches the modbus database of each connected module on the shelf for quick access. Modbus requests to attached modules instead are accepted and responded to at the PMM itself using the cached database values for read requests. Any non-read requests are handled as passthrough.

Operation Modes for PSU

There're two operating modes with respect to how a system communicates (monitor, configure, reprogram) with the PSU: MAP mode and ISP mode.

MAP Mode:
The MAP (Main Application Program) mode is the normal operating mode of the PSU. In this mode, readable parameters are available.

ISP mode:
In ISP (In-System Programming) mode, the firmware can be updated through the Modbus interface. MAP mode functions are inhibited in ISP mode with the exception of some Modbus commands related to the ISP operation. Only the MAP firmware will be affected by any firmware update in ISP mode. All data (except those that should change along with a firmware update, e.g. FW version) and configuration registered in the non-volatile memory will not be altered in ISP mode. In case of a problem during firmware update (e.g. loss of power, communication error, corrupted MAP firmware, etc.) the product will remain or boot up in ISP mode to be able to reinitiate and complete the firmware update process. After a successful firmware update the PSU shall operate normally again.

PMM Status Registers

Module Present:

0x57	Bit	Name	Description
High Byte	7:0	-	-
Low Byte	7:6	-	-
	5	Present_L_6	Module 6 is present
	4	Present_L_5	Module 5 is present
	3	Present_L_4	Module 4 is present
	2	Present_L_3	Module 3 is present
	1	Present_L_2	Module 2 is present
	0	Present_L_1	Module 1 is present

Module Alert:

0x58	Bit	Name	Description
High Byte	7:0	-	-
Low Byte	7:6	-	-
	5	Alert_L_6	Module 6 alert
	4	Alert_L_5	Module 5 alert
	3	Alert_L_4	Module 4 alert
	2	Alert_L_3	Module 3 alert
	1	Alert_L_2	Module 2 alert
	0	Alert_L_1	Module 1 alert

MODBUS COMMUNICATION INTERFACE SPECIFICATION

General Alarm Status:

0x59	Bit	Name	Description
High Byte	7:5	-	-
	4	Ishare Cable Not Detected	Refer to 0x56
	3:1	-	-
	0	Module Alerts	Refer to 0x58
Low Byte	7	-	-
	6	Serial Link Fault	Refer to 0x5D bit 0
	5	PMM Communication Error	-
	4	Module Communication Error	Refer to 0x5D bits 1-6
	3	Communication	A bit is set in communication alarm register (0x40)
	2	Shelf EEPROM Modbus Table Fault	Modbus table CRC error
	1	Shelf EEPROM Fault	Refer to 0x5D bit 8
	0	Missing Modules	Compare modules planned with modules present

Module Planned:

0x5A	Bit	Name	Description
High Byte	7:0	-	-
Low Byte	7:6	-	-
	5	Module 6 planned	-
	4	Module 5 planned	-
	3	Module 4 planned	-
	2	Module 3 planned	-
	1	Module 2 planned	-
	0	Module 1 planned	-

PMM LED Status:

0x5C	Bit	Name	Description
High Byte	7:0	-	-
Low Byte	7:6	-	-
	5:4	Amber LED Status	00: Off 01: On 10: Blinking at 1 Hz 11: Blinking at 2 Hz
	3:2	-	-
	1:0	Blue LED Status	00: Off 01: On 10: Blinking at 1 Hz

MODBUS COMMUNICATION INTERFACE SPECIFICATION

Comunications Alarm Status:

0x5D	Bit	Name	Description
High Byte	7:1	-	-
	0	Shelf EEPROM Fault	I2C Comms fail with EEPROM
Low Byte	7	-	-
	6	Module 6 Modbus Fault	-
	5	Module 5 Modbus Fault	-
	4	Module 4 Modbus Fault	-
	3	Module 3 Modbus Fault	-
	2	Module 2 Modbus Fault	-
	1	Module 1 Modbus Fault	-
	0	RX Serial Input Failure	No message from previous PMM

Digital Outputs Test:

0x7C	Bit	Name	Description
High Byte	7	Test mode enable	1 = test mode
	6:4	-	-
	3	Shelf EEPROM WP	-
	2	-	-
	1	Led Blue	1 = On
	0	Led Amber	1 = On
Low Byte	7	Internal Shelf Addr Int 3	-
	6	Internal Shelf Addr Int 2	-
	5	Internal Shelf Addr Int 1	-
	4	Internal Shelf Addr Int 0	-
	3	-	-
	2	RJ45 Port2 Addr 2	-
	1	RJ45 Port2 Addr 1	-
	0	RJ45 Port2 Addr 0	-

IN-SYSTEM FIRMWARE UPDATE

Firmware Update Registers

Unlock Firmware Update Mode:

The Unlock Firmware Update Mode (Modbus Register 0300h) is used as a key to allow entering Boot Mode.

Value	Description
0x55AA	Key to allow boot mode

Enter Boot Mode:

The Enter Boot Mode (Modbus Register 0301h) is used to switch to boot mode.

Value	Description
0xAA55	Enter to boot mode

Firmware Update Status

The Firmware Update Status (Modbus Register 0302h) provides the firmware update status.

Value	Description
0x0000	Normal operating status
0x0001	Entered boot mode status
0x0006	FW pack is correct
0x0018	Wait status
0x0055	FW update failed
0x00AA	FW update success

Firmware Verify

The Firmware Verify (Modbus Register 0303h) is used for firmware verify.

Value	Description
0x55AA	Verify Firmware

Exit Boot Mode

The Exit Boot Mode (Modbus Register 0304h) is used to execute or abort the Firmware update.

Value	Description
0x55AA	Exit boot mode

Firmware Packet

The Firmware packet (Modbus Register 0310h to 032Fh) is used to write 64-byte packet of data to the current flash address.

IN-SYSTEM FIRMWARE UPDATE

Parsing the Firmware Image

The firmware is in BIN format. It contains all the data that are needed in the update process.
Data starts from the address **0000h** and data are sent in 68-byte groups.
Suppose that the BIN file contains:

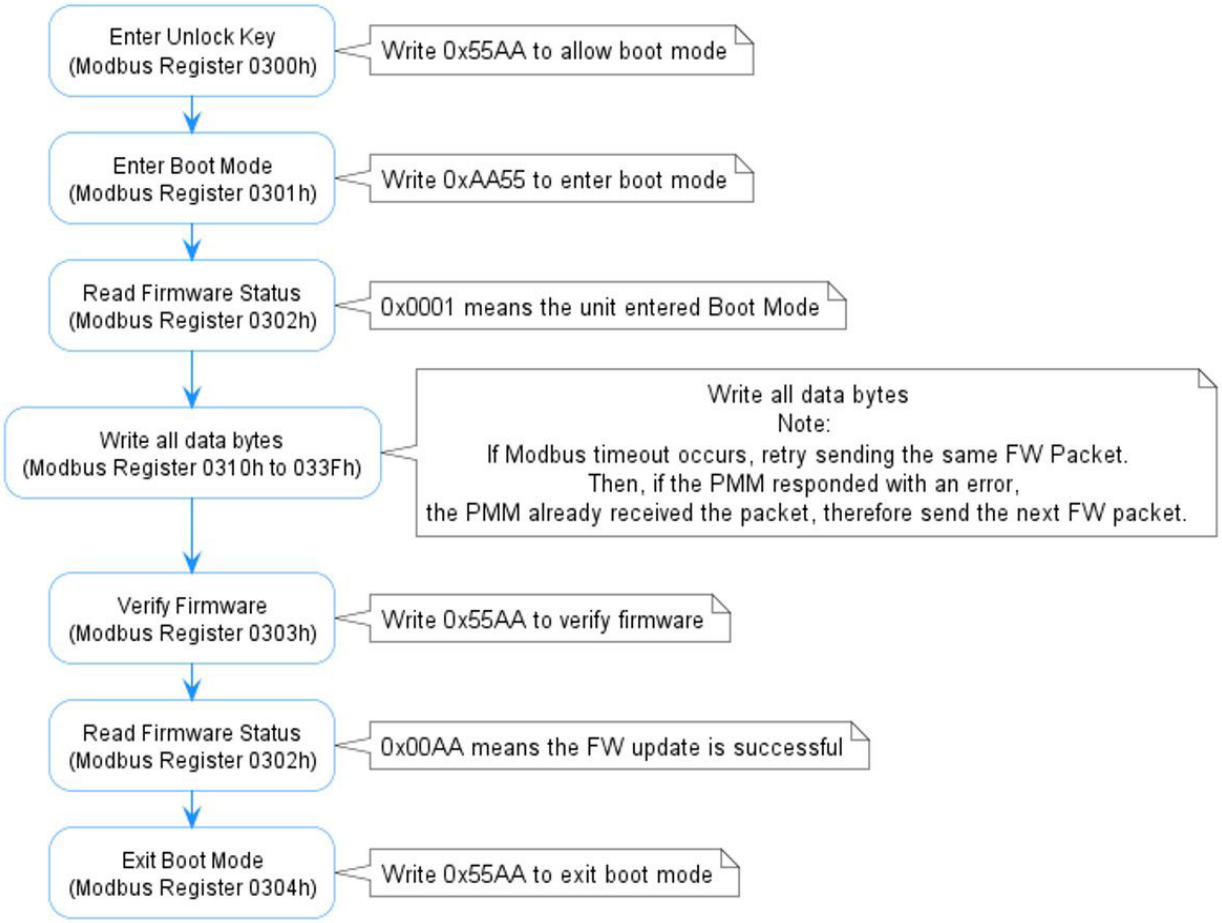
Offset (h)	00	01	02	03	04	05	06	07	08	09	0A	. . .	42	43
00000000	00	00	00	40	5B	0B	66	D1	FF	FF	00	. . .	FF	FF
00000044	00	00	00	40	FF	FF	FF	FF	FF	FF	FF	. . .	FF	FF
00000088	00	00	00	40	FF	FF	FF	FF	FF	FF	FF	. . .	FF	FF
000000CC	00	00	40	40	FF	FF	FF	FF	FF	FF	FF	. . .	FF	FF
00000110	00	00	00	40	FF	FF	FF	FF	FF	FF	FF	. . .	FF	FF
00000154	00	00	00	40	FF	FF	FF	FF	FF	FF	FF	. . .	FF	FF
00000198	00	00	00	40	FF	FF	FF	FF	FF	FF	FF	. . .	FF	FF
000001DC	00	00	00	40	FF	FF	FF	FF	FF	FF	FF	. . .	FF	FF
.														
.														
.														

For each 68-byte group, the data block can be divided as follows:

Response Code	Description	Description	Description
00h	1 byte	Block type	Always set to 0x00 for PMM
01h to 02h	2 bytes	Block number	Increments by 1 after every block
03h	1 byte	Block data size	0x40 – which means 64 bytes of data
04h to 43h	64 bytes	FW data	FW data loaded into DSP

IN-SYSTEM FIRMWARE UPDATE

Firmware Update Process



In any case that the firmware update process fails (e.g. due to loss of power, communication error, etc.) the PMM will remain operation using the current FW image.

Expected FW update completion time is approx. 10 secs.

ABOUT ADVANCED ENERGY

Advanced Energy (AE) has devoted more than four decades to perfecting power for its global customers. AE designs and manufactures highly engineered, precision power conversion, measurement and control solutions for mission-critical applications and processes.

Our products enable customer innovation in complex applications for a wide range of industries including semiconductor equipment, industrial, manufacturing, telecommunications, data center computing, and medical. With deep applications know-how and responsive service and support across the globe, we build collaborative partnerships to meet rapid technological developments, propel growth for our customers, and innovate the future of power.

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