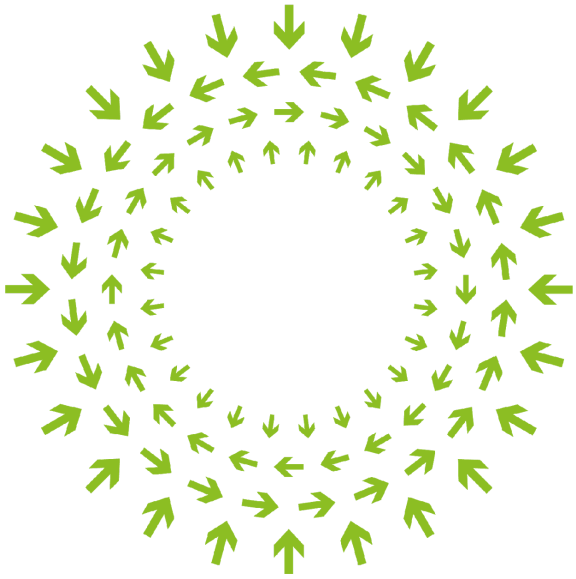

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Open Rack V3 Modbus Communication Specification

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Table of Contents

Revision history

Date	Revision	History	Author
09/26/2020	0.1	First draft for PSU V3 Basic to V2/G2 Spec Version 1.9 (6/26/2020)	Delta
11/09/2020	0.2	Updated addressing and data rate	Hamid and David S.
23/02/2021	0.3	3.1 Addressing: correction of Addressing 6.0 black box: added PF & iTHD basic to G2 5.10 Timestamp added basic to G2 5.10 Fan RPM Override: added reset condition of 0x122 in Section 5.12 PSU V3 Modbus Register map new MFR Register 0xDA added	Delta
15/03/2021	0.4	# Section 5.12 changed Register format of PSU_Output Voltage from N=11 to 10 # Section 3.3 added Big-Endian Byte order	Delta/Hamid & David S.
6/17/2021	0.5	Changed PSU address to 00 (b7 b6) to be different from V2. Added address 11 for special devices	Hamid
7/30/2021	0.6	Moved register maps to appendix	Hamid
9/2/2021	0.7	Change PSU address to 11 and special device address to 00.	Hamid

1.0 Introduction

This manual describes the communication protocol to be used with Rack Monitor and Power Shelf V3.

2.0 Data Link Layer

2.1 Standard and protocol

Open Rack V3 utilizes the RS485 standard for communication between the power supplies residing in a 'Power Shelf' and a 'Rack Monitor'.

MODBUS is the serial communication protocol to be used with this standard.

All aspects of the MODBUS protocol are to follow the MODBUS Organization specifications and implementation guides, namely the reference documents below:

[1]: MODBUS Serial Line Protocol and Implementation Guide V1.02
[2]: MODBUS Protocol Specification (MODBUS APPLICATION PROTOCOL SPECIFICATIONV1.1b)

There will be exceptions granted if hardware does not allow for use of required transmission. However, the transmission across products and vendors must remain as stated in this document.

The protocol is a half-duplex Master/Slave. The Rack Monitor is always the master and has complete, unidirectional control over the slaves. Power supplies and other devices are considered slaves in this arrangement.

Unicast protocol mode is to be implemented. This means that the master always addresses one node only at a given time. Broadcast mode is not allowed in this communication scheme. There is only one master in the system. Slaves do not initiate communication to the master or other slaves.

2.2 MODBUS Transaction state diagram

Figure 1 outlines the transaction state diagram between the Master (Rackmon) and slaves along with exception to be thrown where appropriate.

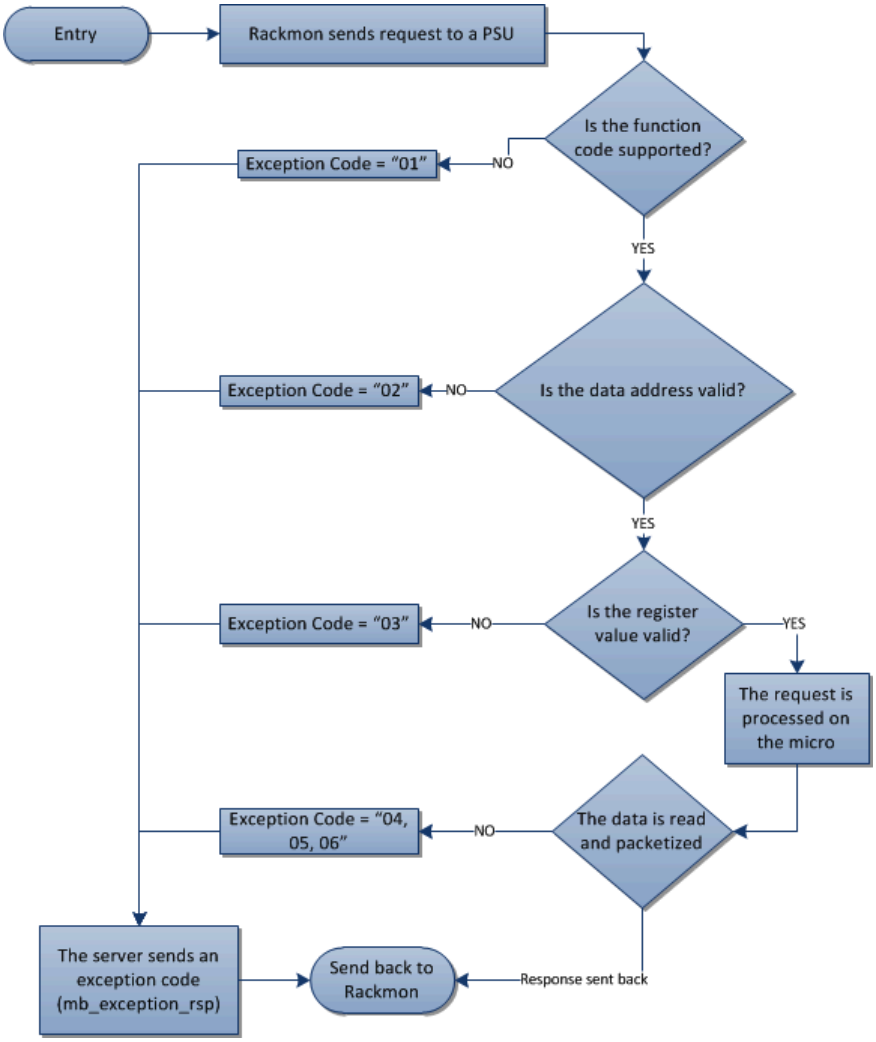

Figure 1 Transaction State diagram

3.0 Hardware Interface

Up to three racks can be connected to one system monitor. In each rack, there can be at most one power shelves; each power shelf can house three Power Supplies and three Battery Backup Units. All slaves have their own unique address.

To accommodate such addressing, without allowing broadcast mode, the following structure is to be used to give each power supply a unique address.

3.1 Addressing

Each power supply will have an address in the following format:

Table 1 Power Supply address format

Fixed	Fixed	Rack_ADD2	Rack_ADD1	Rack_ADD0	PSU_ADD 2	PSU_ADD 1	PSU_ADD 0
b7	b6	b5	b4	b3	b2	b1	b0
1	1	X2	X1	X0	Z2	Z1	Z0

PSU_ADDx: hardwired at the shelf

Rack_ADD1, Rack_ADD0: Hardwired at TOR

Rack_ADD2: Hardwired at PMI (pin 6) for daisy-chain purposes.

Each BBU will have an address in the following format:

Table 2 BBU address format

Fixed	Fixed	Rack_ADD2	Rack_ADD1	Rack_ADD0	BBU_ADD 2	BBU_ADD 1	BBU_ADD 0
b7	b6	b5	b4	b3	b2	b1	b0
0	1	X2	X1	X0	Z2	Z1	Z0

BBU_ADDx: hardwired at the shelf

Rack_ADD1, Rack_ADD0: Hardwired at TOR

Rack_ADD2: Hardwired at PMI (pin 6) for daisy-chain purposes.

Special devices (like RPU, etc)

Table 3 special device address format

Fixed	Fixed	Rack_ADD2	Rack_ADD1	Rack_ADD0	BBU_ADD 2	BBU_ADD 1	BBU_ADD 0
b7	b6	b5	b4	b3	b2	b1	b0
0	0	X2	X1	X0	Z2	Z1	Z0

** don't use address 0x00, which is reserved for broadcasting.

3.2 Message Frame

The message frame follows a standard MODBUS RTU frame format:

Table 6 Message Frame

Start	Address	Function	Data	CRC	End
≥3.5 Bytes	1 Byte	1 Byte	0-32 Bytes	2 Bytes	≥3.5 Bytes

Table 7 Message Frame

Parameter	Description
Bit Rate (Default)	Supports 19.2k ~ 115.2k b/s
Bits per Byte	1 Start Bit
	8 Data Bits (LSB sent first)
	1 Parity Bit (Even)
	1 Stop Bit
Address	Slave Address
Function	Refer to Table 8
Data	Read request: 4 bytes
	Write request 1-32 bytes
	Read/Write request is determined by the number of Bytes received
CRC	Refer to reference 1, section 2.5.1.2
Start/End	At least 3.5 Bytes
Reply Timeout	1sec

3.3 MODBUS Functions

A subset of the standard MODBUS functions will be used. All functions that are not defined will return an exception code.

Table 8 Function Table

Function Name	Type	Comments	Code	Notes
Read Holding register	R	Read register	0x03	Required
Read input register	R	Read register	0x04	Required
Write Single Register	W	Write register	0x06	Required but will fail on all read only registers
Write multiple register	W	Write multiple registers	0x10	Optional but will fail if not properly implemented
Read File Record	R	May be used by vendor for Firmware update, etc.	0x14	Optional but will fail if not properly implemented

Write File Record	W	May be used by vendor for Firmware update, etc.	0x15	Optional but will fail if not properly implemented
Bit masked Write register	W	Write only unmasked bits in a register	0x16	Optional but will fail if not properly implemented
R/W multiple	R/W	Read a register and write many registers at once	0x17	Optional but will fail if not properly implemented
Encapsulated Transport	NA	May be used by vendor for Firmware update, etc.	0x2B	Optional but will fail if not properly implemented
Vendor defined functions	N/A	May be used by vendor for Firmware update, etc.	0x41 to 0x48, 0x64-0x6E	Optional but will fail if not properly implemented

All PSU Data are define as in Modbus Spec ***Modbus_Application_Protocol_V1_1b3*** with Big-Endian Byte order

3.4 Read Holding Register

The (0x03) function code is to be implemented per state diagram below; extracted from [2]MODBUS protocol Specification V1.1b, Section 6.3

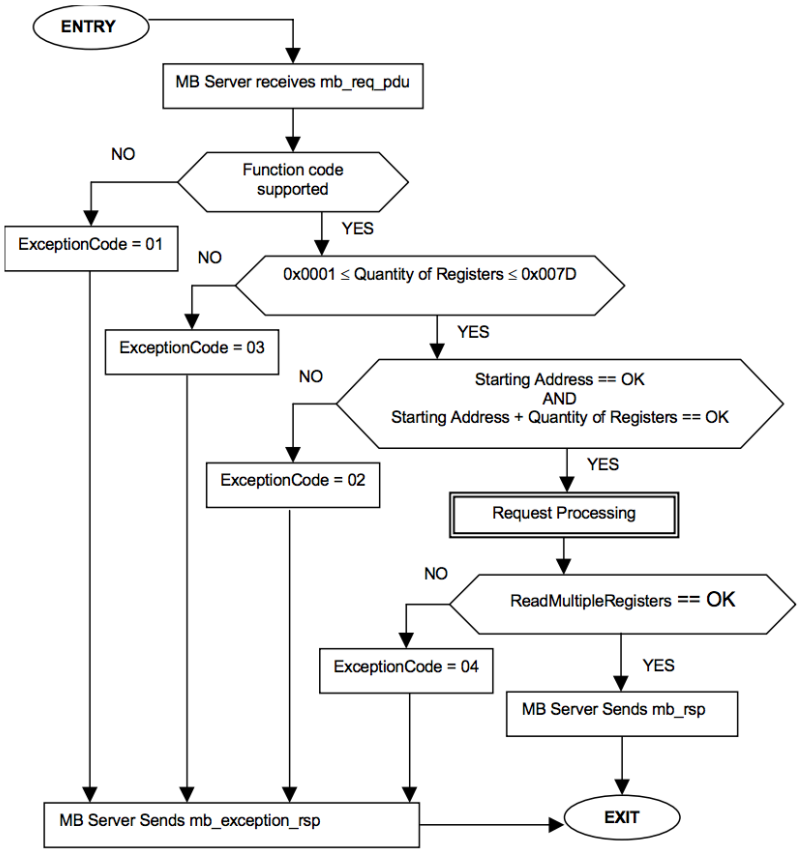

Figure 4 Read holding Register state diagram

3.5 Register Mapping

The two types of registers holding and input will be mapped to the same memory space. A read of a holding register at address X will return the same result as a read of an input register at address X. Writes will only be allowed to writable registers. All attempts to write to read-only registers will result in a normal exception (Section 7, [2] MODBUS Protocol Specification V1.1b)

3.6 Two Wire MODBUS implementation

This serial communication is implemented on a two-wire interface in accordance with EIA/TIA-485. In this two-wire implementation only one Master-Slave (driver) pair can transmit.

In addition to the two transmit wires. A reference ground will be available on pin 1.

System is used locally within a rack, the wire length is under 2.5meters.

120Ω Termination resistor shall be added on the shelf and its position is farthest from shelf output RJ45 connector.

The Master and Slaves will utilize RJ45 connectors and twisted Cat-5 cable to accommodate the two-wire system. Other extra pins on the cable and connector will be used for addressing purposes.

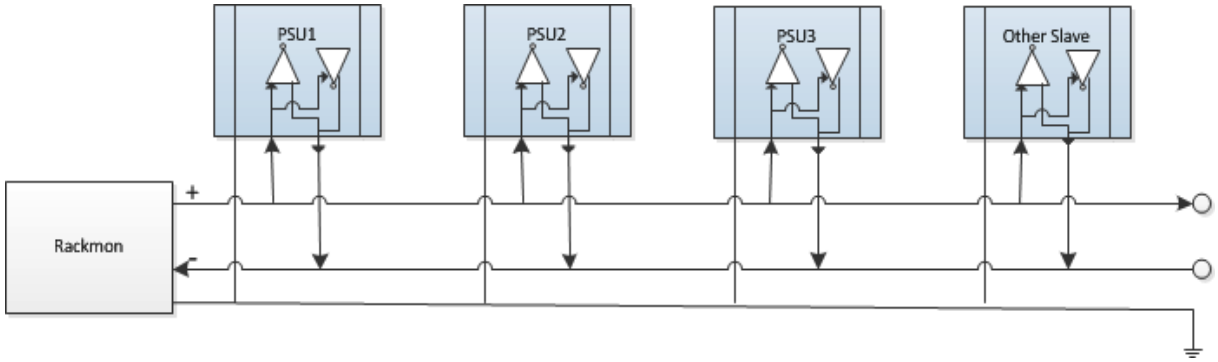

Figure 5 Two wire implementation (TBD)

The pin out is as follows, using the TIA-568-B wire coloring:

Table 9 RJ45 Connector pin-out

Pin	Wire color	Function
1	White/Orange	GND
2	Orange	PLS

3	White/Green	BKP
4	Blue	RS485A
5	White/Blue	RS485B
6	Green	RS485_Addr2
7	White/Brown	RS485_Addr1
8	Brown	RS485_Addr0

4.0 PSU V3 communication block diagram

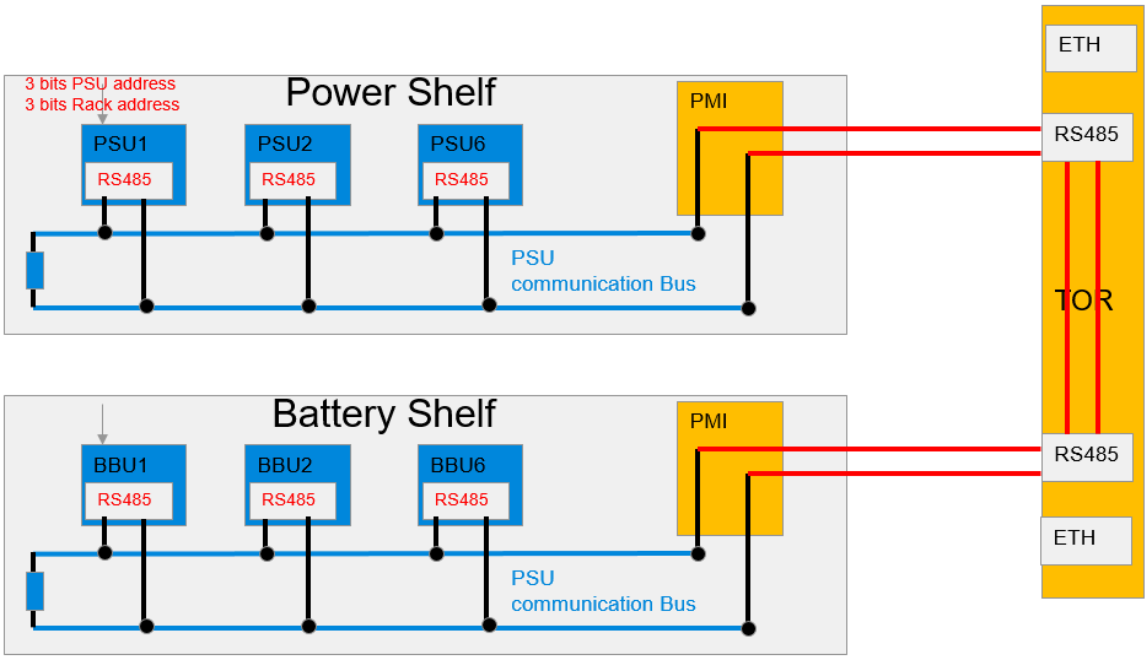

Figure: 1

In V3 design, the following key features are added.

1. PSU power monitoring registers. See details in PSU/BBU register maps.
2. PSU/BBU black box through Modbus. See details PSU/BBU register maps.
3. System controlling knobs:

   Variable Modbus baud rate

5.0 Special Notes

5.1 Variable Modbus Baud Rate

The PSU/BBU shall respond accordingly within 1 second after Rach Monitor successfully writing to corresponding registers.

Starting procedure:

Rack Monitor writes the baud rate speed configuration number (1:19200; 2:38400; 3:57600; 4:115200) to the related register.

If Rack Monitor doesn't receive a positive response or no communication response after 10 minutes from any PSUs or BBUs, next communication will be using the default baud rate.

Finishing procedure:

PSU or BBU will reply to acknowledge the change and next communication will use the new baud rate speed.

PSU or BBU will go back to the default baud rate when there is no valid MODBUS communication after 10 minutes timeout.

Note:

1. The baud rate shall be changed in normal operation mode only and bootloader will follow the same baud rate speed which is set in normal operation mode.
2. No valid MODBUS communication timeout is 10 minutes.

5.2 Unix Timestamp

Use case:

Rack Monitor to provide PSU/BBU Blackbox wall clock time stamp.

Procedure:

Rack Monitor punches wall clock Unix time to PSU/BBU every two minutes.

5.3 2's compliment encoding

$Y = X/2\text{^}N$

$277volts = 17728/2\text{^}6$

Where Y is the real world measurement expressed in an integer. 277Volts displayed to the user by the application run on the Master device.

X is the decimal representation of the binary number held in the register. 17728 in binary is 0100010101000000. The leftmost bit is the most significant and is 0 therefor it is a positive number.

N is the sign magnitude. This is specified in the table above (N=6 for Input Voltage AC).

Appendix A: PSU Modbus register map

See attached.

Appendix B: BBU Modbus register map

See attached.