InfraStruXure Manager v4.x Addendum: Building Management System Integration

Introduction

This addendum provides information about the integration of the APC® InfraStruXure Manager™ Appliance with a Building Management System (BMS). The BMS connects to the InfraStruXure Manager RS-485 serial interface, and the Modbus Remote Terminal Unit (RTU) protocol is used for the InfraStruXure Manager-to-BMS communication. Below are the RS-485 cable pin-outs and the serial port settings required for this InfraStruXure Manager-to-BMS communication.

RS-485 Port Connector.

The following table identifies the active pins for a 9-pin, female (DB9-F) connector used for the connection to the BMS and InfraStruXure Manager RS-485 ports.

InfraStruXure Manager DB9 F-Pin	RS-485 Signal
1	Not Used
2	Not Used
3	RxD/TxD+
4	Ground
5	Not Used
6	Ground
7	Not Used
8	RxD/TxD-
9	Not Used
Shell	Chassis Ground

Modbus RTU Protocol Specifications.

BMS systems generally transmit data at a baud rate of 19200 or 9600, either of which the InfraStruXure Manager server can be configured to use for its RS-485 port communication. In addition, the following communication settings must also be configured for the communication and data transmission between the InfraStruXure Manager server and the BMS:

8 data bits
1 stop bit
Even Parity

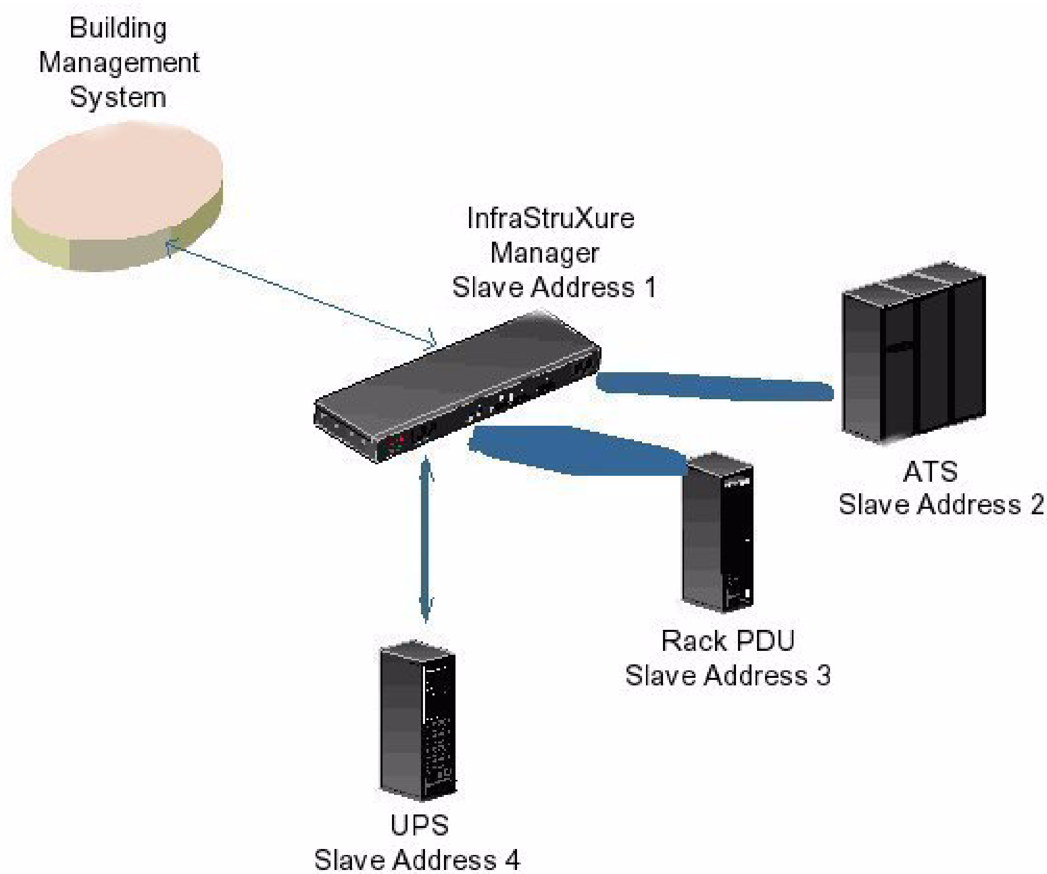
Note: Any data transmission errors could be a result of incorrect communication settings.

BMS-to-Monitored Devices Communication Path

When BMS support is enabled at an InfraStruXure Manager server, that server can assign up to 247 slave addresses: 2-through-247 can be assigned to devices the InfraStruXure Manager server monitors, slave address 1 is always assigned to the InfraStruXure Manager server itself. Each slave address serves as a unique identifier for its assigned device's individual data points. The InfraStruXure Manager server then acts as a gateway between the BMS and the slave address devices.

- The InfraStruXure Manager RS-485 port connects to the BMS.
- The InfraStruXure Manager server connects to the devices that have been assigned slave addresses, and provides data points to the BMS as described in the "InfraStruXure Manager Data Point Communication" section.

This allows for one connection between the BMS and InfraStruXure Manager server, instead of multiple connections to each device. This BMS-to-InfraStruXure Manager communication uses Modbus, as described in the "Modbus Function Code 04 (Read Input Registers)" section, to allow the BMS to request data from any slave address device as if connected directly to that device.



InfraStruXure Manager Data Point Communication

Modbus queries and replies, as described in the "Modbus Function Code 04 (Read Input Registers)" section, are used for the communication between the BMS and the InfraStruXure Manager server.

1. The BMS sends a Modbus query for data point information from a device. The query identifies the unique address assigned to the device, and the register addresses that identify the data points that the BMS is requesting. These addresses, known as BMS slave addresses, are different from the IP addresses used by the InfraStruXure Manager server to communicate with the supported devices.

2. The BMS query is routed to an internal Modbus component. This component determines how the InfraStruXure Manager server will access the requested data points from the addressed device:

   a. Internally: For most of the devices it monitors, the InfraStruXure Manager server can access the requested data points from an internal component that is specific to the addressed device. The InfraStruXure Manager server constantly polls the devices it monitors for status and other information and stores the polled data in device-specific data caches, one data cache for each monitored device. The Modbus component can use M11 OIDs to access the data points requested by a BMS query from the data cache for an addressed device.

   b. SNMP pass-through: As APC devices are updated to support BMS integration, the InfraStruXure Manager server can use SNMP to get the data point information from those devices. The Modbus query is wrapped in an SNMP GET that is sent to the device; the device sends back the requested data to the InfraStruXure Manager server.

3. Once the Modbus component has retrieved the requested data points from that addressed device, the InfraStruXure Manager server uses a Modbus response to send the data points to the BMS.

This addendum focuses on the data points that the InfraStruXure Manager server can provide directly from the data caches at its device-specific components. The internally-supported devices, and their data points are described in the "InfraStruXure Manager Device Data Points" section.

Note: As APC devices are updated to support BMS integration, a Microsoft® Excel (*.xls) file with the data points that can be accessed from that device will be available from APC. This file will be listed under **InfraStruXure Manager** on the APC Web site download page (**www.apc.com/tools/download/**)

Modbus Function Code 04 (Read Input Registers)

The InfraStruXure Manager server currently supports using Modbus Function Code 04 (Read Input Registers) only for the BMS integration. For this support, the communication between a BMS and the slave address devices that connect to the InfraStruXure Manager server involves Read Input Registers, Queries, and Responses.

The following passage from the Modbus Technical Spec Chapter 2, Data and Control Functions details the Read Input Register, Query, and Response functions:

Read Input Registers.

Reads the binary contents of input registers (3X references) in the slave. Broadcast is not supported. The maximum parameters supported by various controller models are listed below.

Query.

The query message specifies the starting register and quantity of registers to be read. Registers are addressed starting at zero- registers 1 ... 16 are addressed as 0 ... 15.

The following is an example of a request to read register 30009 at slave device 17:

Field Name	**Example (Hexidecimal)**
Slave Address	11
Function	04
Starting Address High	00
Starting Address Low	08
Number of Points High	00
Number of Points Low	01
Error Check (LRC or CRC)	--

Response.

The register data in the response message is packed as two bytes per register, with the binary contents right-justified within each byte. For each register, the first byte contains the high-order bits, and the second byte, the low-order bits. The response is returned when the data is completely assembled.

The following is an example of a response to the query above:

Field Name	**Example (Hexidecimal)**
Slave Address	11
Function	04
Byte Count	02
Data High (Register 30009)	00
Data Low (Register 30009)	0A
Error Check (LRC or CRC)	--

Note The contents of register 30009 are shown as the two-byte values of 00 0A hexidecimal, or 10 decimal.

InfraStruXure Manager Device Data Points

The following sections describe the data points the InfraStruXure Manager server can provide from internal, device-specific data caches in response to BMS Modbus queries, as described in the "InfraStruXure Manager Data Point Communication" section.

- "InfraStruXure Manager Device Data"
- "Environmental Monitor Unit Device Data"
- "Automatic Transfer Switch (ATS) Device Data"
- "Metered and Switched Rack Power Distribution Unit (Rack PDU) Device Data"
- "InfraStruXure Power Distribution Unit (InfraStruXure PDU) Device Data"
- "Symmetra UPS Device Data"

Note: The data points are Input Register addresses. Each device type has different levels of information available through Modbus.

Floating point numbers.

Modbus registers contain 16 bits of data. Because Modbus registers do not handle floating point numbers, any floating point number is converted to an integer by multiplying it by 10, 100 or 1000 (depending on the number of decimal places) to preserve precision. Thus in the description of some of the valid responses described in this application note, a note will indicate that the response must be divided by 10, 100, or 1000 to yield the correct results.

How the tables are formatted.

Each table contains the following columns:

- Register Address – the address of the Input Register at which the data resides. Included in parenthesis is the hexidecimal representation of that address which would appear in a Modbus packet. The hexidecimal representation is zero-based, as described in "Modbus Function Code 04 (Read Input Registers)" in the "Query" section.
- Description – a brief description of what the data at this address represents
- Units – the units, if any, of the data at this address
- Valid Responses – values which may be returned and their meanings

Registers common to all device types.

The register address 30001 (0x00) is always the Device Type. This allows the BMS to determine the layout of the rest of the register table so that it can send appropriate requests.

InfraStruXure Manager Device Data

The InfraStruXure Manager data points provide a quick high-level view of the system as a whole. The overall status of each device monitored by the InfraStruXure Manager server can be obtained, as well as the status of the InfraStruXure Manager server itself.

The InfraStruXure Manager server's status is equal to the most severe status of all its monitored devices. This allows for a tiered form of querying from the BMS.

- If InfraStruXure Manager server's status is Informational, all its monitored devices are also in an Informational state, and no further querying needs to be done (unless desired).
- If InfraStruXure Manager server's status is Warning or Critical, each offending device can be found by scanning InfraStruXure Manager server's data points. That device can then be queried directly to find the source of the problem.

Register Address	Description	Units	Valid Responses
30001 (0x00)	Device Type	NA	01 = InfraStruXure Manager server
30002 through 30248 (0x01 through 0xF7)	Device Status of each device monitored by the InfraStruXure Manager server (including the InfraStruXure Manager server itself) 0x01 = Device status of device at slave address 01 0x02 = Device status of device at slave address 02 0x03 = Device status of device at slave address 03 etc.	NA	If the register relates to the InfraStruXure Manager: server 00 = No Device Present 01 = Unknown Status 02 = Informational 03 = Warning 04 = Critical If the register relates to another device: 00 = Unknown / No Device Present 02 = Informational 04 = Warning 08 = Critical

Environmental Monitor Unit Device Data

The Environmental Monitor Unit data points provide information about the temperature and humidity at up to two probes, and the overall device status.

Register Address	Description	Units	Valid Responses
30001 (0x00)	Device Type	NA	09 = Environmental Monitor Unit
30002 (0x01)	Device Status	NA	00 = Unknown 02 = Informational 04 = Warning 08 = Critical
30003 (0x02)	Probe 1 Temperature	Degrees Celsius	0 – 6000 Response must be divided by 100 to yield 0.00 – 60.00
30004 (0x03)	Probe 2 Temperature	Degrees Celsius	0 – 6000 Response must be divided by 100 to yield 0.00 – 60.00
30005 (0x04)	Probe 1 Humidity	Percent	0 – 9500 Response must be divided by 100 to yield 0.00 – 95.00
30006 (0x05)	Probe 2 Humidity	Percent	0 – 9500 Response must be divided by 100 to yield 0.00 – 95.00

Automatic Transfer Switch (ATS) Device Data

The ATS data points provide information about the overall device status.

Register Address	Description	Units	Valid Responses
30001 (0x00)	Device Type	NA	06 = Automatic Transfer Switch (Redundant Switch)
30002 (0x01)	Device Status	NA	00 = Unknown 02 = Informational 04 = Warning 08 = Critical

Metered and Switched Rack Power Distribution Unit (Rack PDU) Device Data

The Metered and Switched Rack PDU data points provide information about the overall device status.

Register Address	Description	Units	Valid Responses
30001 (0x00)	Device Type	NA	0C = Legacy Metered Rack PDU OE = 3rd Generation Metered or Switched Rack PDU
30002 (0x01)	Device Status	NA	00 = Unknown 02 = Informational 04 = Warning 08 = Critical

InfraStruXure Power Distribution Unit (InfraStruXure PDU) Device Data

The InfraStruXure PDU data points provide information about many aspects of this device, from high-level (Device Status) to mid-level (Circuit Panel Input OverVoltage L1) to low-level (Circuit Panel Input Voltage L1). The data points were set up to allow for a tiered form of querying from the BMS, with the state data points grouped together (30003 – 30029), followed by more detailed data points.

- If the InfraStruXure PDU Device Status is Informational, all values are within their user-defined thresholds or normal range, and no further querying needs to be done (unless desired).
- If the InfraStruXure PDU Device Status is Warning or Critical, the state data points can all be gathered in one request to determine the cause of the problem. Data pertaining to portions of the device that may vary from model to model (i.e., Breakers) are at the end of the table, as these data points use register addresses that are dynamically allocated. This keeps the addressing scheme of the remainder of the table intact.

Register Address	Description	Units	Valid Responses
30001 (0x00)	Device Type	NA	0D = Power Distribution Unit
30002 (0x01)	Device Status	NA	00 = Unknown 02 = Informational 04 = Warning 08 = Critical

30003 (0x02)	Communication State If communications are not established with the device the responses of the remainder of the data points are deemed stale and should not be considered accurate until communications are established again.	NA	00 = No Comm Established 01 = Agent Comm. Established 02 = Device Comm. Established
30004 (0x03)	Transformer Input: Undervoltage L1 Transformer input's low voltage threshold exceeded on phase 1	NA	00 = Unknown State 01 = True State 02 = False State
30005 (0x04)	Transformer Input: Overvoltage L1 Transformer input's high voltage threshold exceeded on phase 1	NA	00 = Unknown State 01 = True State 02 = False State
30006 (0x05)	Transformer Input: Undervoltage L2 Transformer input's low voltage threshold exceeded on phase 2	NA	00 = Unknown State 01 = True State 02 = False State
30007 (0x06)	Transformer Input: Overvoltage L2 Transformer input's high voltage threshold exceeded on phase 2	NA	00 = Unknown State 01 = True State 02 = False State
30008 (0x07)	Transformer Input: Undervoltage L3 Transformer input's low voltage threshold exceeded on phase 3	NA	00 = Unknown State 01 = True State 02 = False State
30009 (0x08)	Transformer Input: Overvoltage L3 Transformer input's high voltage threshold exceeded on phase 3	NA	00 = Unknown State 01 = True State 02 = False State
30010 (0x09)	Transformer Input: Over Temp Transformer input's high temperature threshold exceeded state	NA	00 = Unknown State 01 = True State 02 = False State
30011 (0x0A)	Ground Monitoring Point: Ground OverCurrent	NA	00 = Unknown State 01 = True State 02 = False State
30012 (0x0B)	Circuit Panel Input: UnderVoltage L1 Circuit panel input's low voltage threshold exceeded on phase 1	NA	00 = Unknown State 01 = True State 02 = False State
30013 (0x0C)	Circuit Panel Input: OverVoltage L1 Circuit panel input's high voltage threshold exceeded on phase 1	NA	00 = Unknown State 01 = True State 02 = False State

30014 (0x0D)	Circuit Panel Input: UnderVoltage L2 Circuit panel input's low voltage threshold exceeded on phase 2	NA	00 = Unknown State 01 = True State 02 = False State
30015 (0x0E)	Circuit Panel Input: OverVoltage L2 Circuit panel input's high voltage threshold exceeded on phase 2	NA	00 = Unknown State 01 = True State 02 = False State
30016 (0x0F)	Circuit Panel Input: UnderVoltage L3 Circuit panel input's low voltage threshold exceeded on phase 3	NA	00 = Unknown State 01 = True State 02 = False State
30017 (0x10)	Circuit Panel Input: OverVoltage L3 Circuit panel input's high voltage threshold exceeded on phase 3	NA	00 = Unknown State 01 = True State 02 = False State
30018 (0x11)	Circuit Panel Input: OverCurrent L1 Circuit panel input's high current threshold exceeded on phase 1	NA	00 = Unknown State 01 = True State 02 = False State
30019 (0x12)	Circuit Panel Input: OverCurrent L2 Circuit panel input's high current threshold exceeded on phase 2	NA	00 = Unknown State 01 = True State 02 = False State
30020 (0x13)	Circuit Panel Input: OverCurrent L3 Circuit panel input's high current threshold exceeded on phase 3	NA	00 = Unknown State 01 = True State 02 = False State
30021 (0x14)	Circuit Panel Input: UnderCurrent L1 Circuit panel input's low current threshold exceeded on phase 1	NA	00 = Unknown State 01 = True State 02 = False State
30022 (0x15)	Circuit Panel Input: UnderCurrent L2 Circuit panel input's low current threshold exceeded on phase 2	NA	00 = Unknown State 01 = True State 02 = False State
30023 (0x16)	Circuit Panel Input: UnderCurrent L3 Circuit panel input's low current threshold exceeded on phase 3	NA	00 = Unknown State 01 = True State 02 = False State
30024 (0x17)	Circuit Panel Input: Frequency Out Of Range Circuit panel input's frequency is outside normal range	NA	00 = Unknown State 01 = True State 02 = False State

30025 (0x18)	Circuit Panel Input: Neutral Overcurrent	NA	00 = Unknown State 01 = True State 02 = False State
30026 (0x19)	UPS Input: Voltage Lost L1 (UPS Input Fuse Problem) The UPS input voltage on phase 1 has dropped to 0	NA	00 = Unknown State 01 = True State 02 = False State
30027 (0x1A)	UPS Input: Voltage Lost L2 (UPS Input Fuse Problem) The UPS input voltage on phase 2 has dropped to 0	NA	00 = Unknown State 01 = True State 02 = False State
30028 (0x1B)	UPS Input: Voltage Lost L3 (UPS Input Fuse Problem) The UPS input voltage on phase 3 has dropped to 0	NA	00 = Unknown State 01 = True State 02 = False State
30029 (0x1C)	PowerFlow Bypass: Status	NA	00 = Unknown 01 = UPS Operation Mode 02 = System Off Mode 03 = On Battery Mode 04 = Maintenance Bypass Mode 05 = Atypical Bypass Mode 06 = No Panel Feed Mode 07 = Forced Bypass Mode 08 = Panel Feed Mode
30030 (0x1D)	Service Type	NA	00 = Delta 01 = WYE
30031 (0x1E)	Utility Input: Voltage Voltage coming in from the power utility	Volts	120 – 600
30032 (0x1F)	Load Tie Present	NA	00 = Not Present 01 = Present
30033 (0x20)	Load Test Present	NA	00 = Not Present 01 = Present
30034 (0x21)	Main Input: Position	NA	00 = Closed 01 = Open
30035 (0x22)	Main Input: Rating	Amps	00 = 20 01 = 30 02 = 40 03 = 50 04 = 60 05 = None
30036 (0x23)	Bypass: Position Q1	NA	00 = Closed 01 = Open

30037 (0x24)	Bypass: Position Q2	NA	00 = Closed 01 = Open
30038 (0x25)	Bypass: Position Q3	NA	00 = Closed 01 = Open
30039 (0x26)	Bypass: Rating Q2	Amps	80 – 400
30040 (0x27)	Bypass: Rating Q3	Amps	80 – 400
30041 (0x28)	Load Paralleling Position	NA	00 = Closed 01 = Open
30042 (0x29)	Power Flow: Panel Rating	Amps	0 – 65535
30043 (0x2A)	Power Flow: EPO Mode	NA	00 = Disarmed 01 = Armed
30044 (0x2B)	Transformer Input: Voltage L1L2 Transformer input's voltage between phases 1 and 2	Volts	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30045 (0x2C)	Transformer Input: Voltage L2L3 Transformer input's voltage between phases 2 and 3	Volts	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30046 (0x2D)	Transformer Input: Voltage L3L1 Transformer input's voltage between phases 3 and 1	Volts	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30047 (0x2E)	Transformer Input: Voltage L1N Transformer input's voltage between phases 1 and Neutral	Volts	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30048 (0x2F)	Transformer Input: Voltage L2N Transformer input's voltage between phases 2 and Neutral	Volts	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30049 (0x30)	Transformer Input: Voltage L3N Transformer input's voltage between phases 3 and Neutral	Volts	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30050 (0x31)	Transformer Input: Frequency	Hz	0 – 999 Response must be divided by 10 to yield 0.0 – 99.9
30051 (0x32)	Transformer Input: Under Voltage Threshold	Percent	0 – 30
30052 (0x33)	Transformer Input: Over Voltage Threshold	Percent	0 – 30

30053 (0x34)	Circuit Panel Input: Current L1 Circuit panel input's phase 1 current	Amps	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30054 (0x35)	Circuit Panel Input: Current L2 Circuit panel input's phase 2 current	Amps	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30055 (0x36)	Circuit Panel Input: Current L3 Circuit panel input's phase 3 current	Amps	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30056 (0x37)	Circuit Panel Input: Current Neutral Circuit panel input's neutral current	Amps	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30057 (0x38)	Circuit Panel Input: Power L1 Circuit panel input's phase 1 power	Watts	0 – 65535
30058 (0x39)	Circuit Panel Input: Power L2 Circuit panel input's phase 2 power	Watts	0 – 65535
30059 (0x3A)	Circuit Panel Input: Power L3 Circuit panel input's phase 3 power	Watts	0 – 65535
30060 (0x3B)	Circuit Panel Input: Total Power Circuit panel input's total power	Watts	0 – 65535
30061 (0x3C)	Circuit Panel Input: Volt Amps L1 Circuit panel input's phase 1 volt amps	VoltAmps	0 – 65535
30062 (0x3D)	Circuit Panel Input: Volt Amps L2 Circuit panel input's phase 2 volt amps	VoltAmps	0 – 65535
30063 (0x3E)	Circuit Panel Input: Volt Amps L3 Circuit panel input's phase 3 volt amps	VoltAmps	0 – 65535
30064 (0x3F)	Circuit Panel Input: Total Volt Amps Circuit panel input's total volt amps	VoltAmps	0 – 65535
30065 (0x40)	Circuit Panel Input: Power Factor L1 Circuit panel input's phase 1 power factor	NA	0 – 100 Response must be divided by 100 to yield 0 or 1
30066 (0x41)	Circuit Panel Input: Power Factor L2 Circuit panel input's phase 2 power factor	NA	0 – 100 Response must be divided by 100 to yield 0 or 1
30067 (0x42)	Circuit Panel Input: Power Factor L3 Circuit panel input's phase 3 power factor	NA	0 – 100 Response must be divided by 100 to yield 0 or 1

30068 (0x43)	Circuit Panel Input: Total Power Factor Circuit panel input’s total power factor	NA	0 – 100 Response must be divided by 100 to yield 0 or 1
30069 (0x44)	Circuit Panel Input: Voltage L1L2 Circuit panel input’s voltage between phases 1 and 2	Volts	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30070 (0x45)	Circuit Panel Input: Voltage L2L3 Circuit panel input’s voltage between phases 2 and 3	Volts	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30071 (0x46)	Circuit Panel Input: Voltage L3L1 Circuit panel input’s voltage between phases 3 and 1	Volts	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30072 (0x47)	Circuit Panel Input: Voltage L1N Circuit panel input’s voltage between phases 1 and neutral	Volts	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30073 (0x48)	Circuit Panel Input: Voltage L2N Circuit panel input’s voltage between phases 2 and neutral	Volts	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30074 (0x49)	Circuit Panel Input: Voltage L3N Circuit panel input’s voltage between phases 3 and neutral	Volts	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30075 (0x4A)	Circuit Panel Input: Frequency	Hz	0 – 999 Response must be divided by 10 to yield 0.0 – 99.9
30076 (0x4B)	Circuit Panel Input: Under Voltage Threshold	Percent	0 – 30
30077 (0x4C)	Circuit Panel Input: Over Voltage Threshold	Percent	0 – 30
30078 (0x4D)	Circuit Panel Input: Under Current Threshold Phase	Percent	0 – 100
30079 (0x4E)	Circuit Panel Input: Over Current Threshold Phase	Percent	0 – 100
30080 (0x4F)	Circuit Panel Input: Over Current Threshold Neutral	Percent	0 – 100

30081 (0x50)	Circuit Panel Input: Frequency Threshold	Hz	00 = 0.2 01 = 0.5 02 = 1.0 03 = 2.0 04 = 3.0 05 = 4.0 06 = 5.0 07 = 9.0
30082 (0x51)	Ground Monitoring Point: Ground Current	Amps	0 – 50 Response must be divided by 10 to yield 0.0 – 5.0
30083 (0x52)	Ground Monitoring Point: Ground Current Threshold	Amps	1 – 50 Response must be divided by 10 to yield 1.0 – 5.0
30084 (0x53)	Load Tie Point: Voltage L1L2 Load tie point's voltage between phases 1 and 2	Volts	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30085 (0x54)	Load Tie Point: Voltage L2L3 Load tie point's voltage between phases 2 and 3	Volts	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30086 (0x55)	Load Tie Point: Voltage L3L1 Load tie point's voltage between phases 3 and 1	Volts	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30087 (0x56)	Load Tie Point: Voltage L1N Load tie point's voltage between phases 1 and neutral	Volts	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30088 (0x57)	Load Tie Point: Voltage L2N Load tie point's voltage between phases 2 and neutral	Volts	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30089 (0x58)	Load Tie Point: Voltage L3N Load tie point's voltage between phases 3 and neutral	Volts	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30090 (0x59)	Contact Count	NA	0 - 4
30091 (0x5A)	Breaker Count	NA	0 - 84
30092 (0x5B)	Bypass Input Open	NA	00 = Unknown State 01 = True State 02 = False State

30093 (0x5C)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30094 (0x5D)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30095 (0x5E)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30096 (0x5F)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30097 (0x60)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30098 (0x61)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30099 (0x62)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30100 (0x63)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30101 (0x64)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30102 (0x65)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30103 (0x66)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30104 (0x67)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30105 (0x68)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30106 (0x69)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30107 (0x6A)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30108 (0x6B)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30109 (0x6C)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30110 (0x6D)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30111 (0x6E)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30112 (0x6F)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30113 (0x70)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED

30114 (0x71)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30115 (0x72)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30116 (0x73)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30117 (0x74)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30118 (0x75)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30119 (0x76)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30120 (0x77)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
30121 (0x78)	RESERVED FOR FUTURE EXPANSION	NA	RESERVED
Starting with the Contact data points, the register addresses are generated dynamically, rather than hard-coded, based on the number of contacts. Contacts are 0 indexed for purposes of register addressing (the first contact number is 0, the second contact is 1, etc.). If there are no contacts, the Contact data points are skipped, and the Breaker data points, identified further on in this table, would start at register address 30122. If there are two contacts, the address of the Contact data points would be as follows: 30122 = Contact 1 State 30123 = Contact 1 Alarm State 30124 = Contact 1 Configuration 30125 = Contact 2 State 30126 = Contact 2 Alarm State 30127 = Contact 2 Configuration The total number of contacts can be found above (Contact Count).			
30122 (0x79) + (contact number X 3)	Contact: State Indicates if the contact is in an Active or Inactive state. Depending on the Contact Configuration (below), Active may be open or closed.	NA	00 = Active 01 = Inactive
30123 (0x7A) + (contact number X 3)	Contact: Alarm State	NA	00 = No Alarm 64 = Contact Abnormal

InfraStruXure

POWER RACK AIR

<table>
<tr><td>30124
(0x7B)
+
(contact
number X
3)</td><td>Contact: Configuration

This allows the user to determine if the contact’s active state is open or closed.</td><td>NA</td><td>00 = Active State is Closed
01 = Active State is Open</td></tr>
<tr><td colspan="4">Starting with 30122, the first register address that the Contact data points can use, the register addresses are generated dynamically, rather than hard-coded, based on the number of contacts. For example, the Breaker data points would start at register address 30122, for no contacts, or at 30128, following the six data points (three each) used for two contacts.

Breakers are 0 indexed for purposes of register addressing (the first breaker number is 0, the second breaker is 1, etc.). As was the case with the Contact data points, it there are no breakers, the next six data points would be skipped. If there are two breakers, the address of the Breaker data points would start immediately following the last Contact data point, or at 30122 for no contacts. For the following example, there are two contacts and two breakers:

30128 = Breaker 1 Alarm State
30129 = Breaker 1 Rating
30130 = Breaker 1 Tie Indicator
30131 = Breaker 1 Under Current Threshold
30132 = Breaker 1 Over Current Threshold
30133 = Breaker 1 Current
30134 = Breaker 2 Alarm State
30135 = Breaker 2 Rating
30136 = Breaker 2 Tie Indicator
30137 = Breaker 2 Under Current Threshold
30138 = Breaker 2 Over Current Threshold
30139 = Breaker 2 Current

The total number of breakers can be found above (Breaker Count).</td></tr>
<tr><td>30122
(0x79)
+
(Contact
Count X 3)
+
(breaker
number X
6)</td><td>Breaker: Alarm State</td><td>NA</td><td>00 = No Alarms
01 = Undercurrent
02 = Overcurrent
03 = Alarm Conflict</td></tr>
<tr><td>30123
(0x7A)
+
(Contact
Count X 3)
+
(breaker
number X
6)</td><td>Breaker: Rating</td><td>Amps</td><td>0 – 60</td></tr>
</table>

30124 (0x7B) + (Contact Count X 3) + (breaker number X 6)	Breaker: Tie Indicator	NA	00 = No Tie Present 01 = Tie Present
30125 (0x7C) + (Contact Count X 3) + (breaker number X 6)	Breaker: Under Current Threshold	Amps	0 – 256
30126 (0x7D) + (Contact Count X 3) + (breaker number X 6)	Breaker: Over Current Threshold	Amps	0 – 256
30127 (0x7E) + (Contact Count X 3) + (breaker number X 6)	Breaker: Current	Amps	0 – 65535 40kVA Unit: Response must be divided by 100 to yield 0.00 – 655.35 80kVA Unit: the bytes returned are swapped (i.e. returned bytes 12 34 should be swapped to read 34 12). Division of amps to get correct decimal placement is done AFTER the swapping of bytes. Response must be divided by 10 to yield 0.0 – 6553.5

Symmetra UPS Device Data

The Symmetra UPS data points provide information about many aspects of this device, from high-level (Device Status) to mid-level (Output Voltage Threshold Exceeded) to low-level (Output Voltage). The data points were set up to allow for a tiered form of querying from the BMS, with the state data points grouped together (30003 – 30069), followed by more detailed data points.

- If the Symmetra UPS Device Status is Informational, all values are within their user-defined thresholds or normal range, and no further querying needs to be done (unless desired).
- If the Symmetra UPS Device Status is Warning or Critical, the state data points can all be gathered in one request to determine the cause of the problem. Data pertaining to portions of the device that may vary from model to model (i.e., Output Phases) are at the end of the table, as these data points use register addresses that are dynamically allocated. This keeps the addressing scheme of the remainder of the table intact.

Register Address	Description	Units	Valid Responses
30001 (0x00)	Device Type	NA	08 = Symmetra
30002 (0x01)	Device Status	NA	00 = Unknown 02 = Informational 04 = Warning 08 = Critical
30003 (0x02)	Communication State If communications are not established with the device the responses of the remainder of the data points are deemed stale and should not be considered accurate until communications are established again.	NA	00 = No Comm Established 01 = Agent Comm. Established 02 = Device Comm. Established
30004 (0x03)	Power Failure (On Battery State)	NA	00 = Unknown State 01 = True State 02 = False State
30005 (0x04)	Runtime Violation	NA	00 = Unknown State 01 = True State 02 = False State
30006 (0x05)	Discharged Battery	NA	00 = Unknown State 01 = True State 02 = False State
30007 (0x06)	Low Battery	NA	00 = Unknown State 01 = True State 02 = False State

30008 (0x07)	Battery Voltage High	NA	00 = Unknown State 01 = True State 02 = False State
30009 (0x08)	Battery Failure	NA	00 = Unknown State 01 = True State 02 = False State
30010 (0x09)	Battery Charger Failure	NA	00 = Unknown State 01 = True State 02 = False State
30011 (0x0A)	No Batteries Found	NA	00 = Unknown State 01 = True State 02 = False State
30012 (0x0B)	Battery Temperature High	NA	00 = Unknown State 01 = True State 02 = False State
30013 (0x0C)	Output Voltage Out Of Range	NA	00 = Unknown State 01 = True State 02 = False State
30014 (0x0D)	Load (kVA) Alarm	NA	00 = Unknown State 01 = True State 02 = False State
30015 (0x0E)	Overloaded	NA	00 = Unknown State 01 = True State 02 = False State
30016 (0x0F)	Timed Sleep Mode	NA	00 = Unknown State 01 = True State 02 = False State
30017 (0x10)	UPS Off	NA	00 = Unknown State 01 = True State 02 = False State
30018 (0x11)	Self Test Result	NA	00 = Unknown 01 = Passed 02 = Failed
30019 (0x12)	Base Module Fan Failure	NA	00 = Unknown State 01 = True State 02 = False State
30020 (0x13)	System Level Fan Failure	NA	00 = Unknown State 01 = True State 02 = False State
30021 (0x14)	Power Module Failure	NA	00 = Unknown State 01 = True State 02 = False State
30022 (0x15)	No Working Power Modules	NA	00 = Unknown State 01 = True State 02 = False State

30023 (0x16)	In Forced Bypass	NA	00 = Unknown State 01 = True State 02 = False State
30024 (0x17)	Software Bypass	NA	00 = Unknown State 01 = True State 02 = False State
30025 (0x18)	Hardware Failure Bypass	NA	00 = Unknown State 01 = True State 02 = False State
30026 (0x19)	Overloaded Bypass	NA	00 = Unknown State 01 = True State 02 = False State
30027 (0x1A)	UPS Switch Bypass	NA	00 = Unknown State 01 = True State 02 = False State
30028 (0x1B)	Shutdown from Bypass	NA	00 = Unknown State 01 = True State 02 = False State
30029 (0x1C)	Base Module Bypass Power Supply Failure	NA	00 = Unknown State 01 = True State 02 = False State
30030 (0x1D)	Bypass Not In Range	NA	00 = Unknown State 01 = True State 02 = False State
30031 (0x1E)	Stuck In Bypass Mode	NA	00 = Unknown State 01 = True State 02 = False State
30032 (0x1F)	Stuck in On-Line Mode	NA	00 = Unknown State 01 = True State 02 = False State
30033 (0x20)	Maintenance Bypass Failure	NA	00 = Unknown State 01 = True State 02 = False State
30034 (0x21)	Backfeed Relay Open	NA	00 = Unknown State 01 = True State 02 = False State
30035 (0x22)	System Start Up Configuration Failure	NA	00 = Unknown State 01 = True State 02 = False State
30036 (0x23)	External DC Disconnect Switch Open	NA	00 = Unknown State 01 = True State 02 = False State
30037 (0x24)	Input Circuit Breaker Open	NA	00 = Unknown State 01 = True State 02 = False State

30038 (0x25)	Not Synchronized Fault	NA	00 = Unknown State 01 = True State 02 = False State
30039 (0x26)	Site Wiring Fault	NA	00 = Unknown State 01 = True State 02 = False State
30040 (0x27)	Internal Communications Failure	NA	00 = Unknown State 01 = True State 02 = False State
30041 (0x28)	Redundant Intelligence Module In Control	NA	00 = Unknown State 01 = True State 02 = False State
30042 (0x29)	Redundant Intelligence Module Presence	NA	00 = Unknown 01 = Inserted 02 = Removed
30043 (0x2A)	Redundant Intelligence Module Failed	NA	00 = Unknown State 01 = True State 02 = False State
30044 (0x2B)	Main Intelligence Module Presence	NA	00 = Unknown 01 = Inserted 02 = Removed
30045 (0x2C)	Main Intelligence Module Failed	NA	00 = Unknown State 01 = True State 02 = False State
30046 (0x2D)	Extended Run Frame Fault	NA	00 = Unknown State 01 = True State 02 = False State
30047 (0x2E)	Redundancy Lost	NA	00 = Unknown State 01 = True State 02 = False State
30048 (0x2F)	Redundancy Alarm (Below Threshold)	NA	00 = Unknown State 01 = True State 02 = False State
30049 (0x30)	InputDisconnectQ001 Status	NA	00 = Unknown 01 = Open 02 = Closed
30050 (0x31)	OutputDisconnectQ002 Status	NA	00 = Unknown 01 = Open 02 = Closed
30051 (0x32)	BypassQ003 Status	NA	00 = Unknown 01 = Open 02 = Closed
30052 (0x33)	External Switch Gear Communication Card Presence	NA	00 = Unknown 01 = Inserted 02 = Removed

30053 (0x34)	External Switch Gear Communication Card Failure	NA	00 = Unknown State 01 = True State 02 = False State
30054 (0x35)	Isolation Transformer Temperature High	NA	00 = Unknown State 01 = True State 02 = False State
30055 (0x36)	Internal DC Disconnect Switch Open	NA	00 = Unknown State 01 = True State 02 = False State
30056 (0x37)	Static Bypass Switch Module Presence	NA	00 = Unknown 01 = Inserted 02 = Removed
30057 (0x38)	Static Bypass Switch Module Failure	NA	00 = Unknown State 01 = True State 02 = False State
30058 (0x39)	System ID Card Presence	NA	00 = Unknown 01 = Inserted 02 = Removed
30059 (0x3A)	System ID Card Failure	NA	00 = Unknown State 01 = True State 02 = False State
30060 (0x3B)	System Power Supply Card Failure	NA	00 = Unknown State 01 = True State 02 = False State
30061 (0x3C)	Battery Monitor Card Failure	NA	00 = Unknown State 01 = True State 02 = False State
30062 (0x3D)	Battery Monitor Card Presence	NA	00 = Unknown 01 = Inserted 02 = Removed
30063 (0x3E)	XR Communication Card Presence	NA	00 = Unknown 01 = Inserted 02 = Removed
30064 (0x3F)	XR Communication Card Failure	NA	00 = Unknown State 01 = True State 02 = False State
30065 (0x40)	RESERVED	NA	RESERVED
30066 (0x41)	Output Percent Load State	NA	N/A
30067 (0x42)	Shutting Down	NA	00 = False (Shutdown Not In Progress) 01 = True (Shutdown Is In Progress)

30068 (0x43)	Runtime Calibrating	NA	00 = Unknown State 01 = Runtime Calibration in Progress 02 = Runtime Calibration Complete 03 = Runtime Calibration Canceled
30069 (0x44)	Diagnostic State	NA	00 = Unknown State 01 = Self Test in Progress 02 = Self Test Complete 03 = Self Test Passed 04 = Self Test Failed
30070 (0x45)	Number Of Batteries	NA	1 - 99
30071 (0x46)	Number Of Bad Batteries	NA	1 - 99
30072 (0x47)	Low Runtime Threshold	Minutes	0 – 999
30073 (0x48)	Runtime Remaining	Minutes	0 – 9999
30074 (0x49)	Battery Capacity	Percent	0 – 1000 Response must be divided by 10 to yield 0.0 – 100.0
30075 (0x4A)	Internal Battery Temp	Degrees Celsius	0 – 1000 Response must be divided by 10 to yield 0.0 – 100.0
30076 (0x4B)	Nominal Battery Voltage	Volts	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30077 (0x4C)	Actual Battery Bus Voltage	Volts	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
30078 (0x4D)	Battery Current	Amps	0 – 99999 Response must be divided by 10 to yield 0.0 – 9999.9
30079 (0x4E)	Minimum Return Capacity	Percent	00 10 25 90
30080 (0x4F)	Low Battery Runtime	Minutes	02 05 07 10
30081 (0x50)	RESERVED	NA	RESERVED

30082 (0x51)	Input Line Fail Cause	NA	00 = No Transfers Have Occurred 01 = Detection of low utility voltage 02 = Detection of high utility voltage 03 = Unacceptable utility voltage rate of change 04 = Detection of a line voltage notch or spike 05 = Due to software command or UPS's test control
30083 (0x52)	Number Input Phases	NA	3
30084 (0x53)	Number Of Inputs	NA	2
30085 (0x54)	Input Frequency	Hz	0 – 9999 Response must be divided by 100 to yield 0.00 – 99.99
30086 (0x55)	Number Of Outputs	NA	1
30087 (0x56)	Number Output Phases	NA	3
30088 (0x57)	RESERVED	NA	RESERVED
30089 (0x58)	Output Frequency	Hz	0 – 9999 Response must be divided by 100 to yield 0.00 – 99.99
30090 (0x59)	Power Module Count	NA	0 - 5
30091 (0x5A)	Current Redundancy (Fault Tolerance Level)	NA	0 - 4
30092 (0x5B)	Current Load Capability	kVA	0 – 999 Response must be divided by 10 to yield 0.0 – 99.9
30093 (0x5C)	System Power Supply Count	NA	0 - 2
30094 (0x5D)	RESERVED	NA	RESERVED

<table>
<tr><td colspan="4">Starting with 30099, the first register address that Phase 2 of Input 1 can use, the register addresses are generated dynamically, rather than hard-coded, based on the number of inputs and input phases. For example, the Output data points would start at register address 30122 for a single input with one phase, or at 30128 for a single input with 3 phases.

The two possible inputs (main and bypass) are 0 indexed for purposes of register addressing (the first input is 0 and the second input is 1). For each input there is an Input Type and Reserved data point, and at least Input Voltage and Input Current data points for one phases.

For the following example, there is one input with three phases:

30095 = Input 1 Type
30096 = RESERVED
30097 = Input 1 Phase 1 Voltage
30098 = Input 1 Phase 1 Current
30099 = Input 1 Phase 2 Voltage
30100 = Input 1 Phase 2 Current
30101 = Input 1 Phase 3 Voltage
30102 = Input 1 Phase 3 Current

The next set of data points (Output) would start at 30103. For 1 input with a single phase the Output data points would start at 30099.</td></tr>
<tr><td></td><td>Input Type</td><td>NA</td><td>01 = Unknown
02 = Main
03 = Bypass</td></tr>
<tr><td></td><td>RESERVED</td><td>NA</td><td>RESERVED</td></tr>
<tr><td></td><td>Input Voltage</td><td>Volts</td><td>0 – 9999
Response must be divided by 10 to yield 0.0 – 999.9</td></tr>
<tr><td></td><td>Input Current</td><td>Amps</td><td>0 – 9999
Response must be divided by 100 to yield 0.00 – 99.99</td></tr>
</table>

The Output data point addresses are dynamically generated based on the number of Inputs and input phases. For example, the Output data points would start at 30103 for a single, 3-phase input, or at 30099 for a single, 1-phase input.

Outputs are 0 indexed for purposes of register addressing (the first output is 0, the second output is 1, etc.). For each output phase there is an Output Voltage, Output Current, Output Max Current, Output Load, Output Percent Load and Output Percent Power.

For the following example, there is a single, 3-phase output, and the starting data point address is 30103 because the UPS has a single, 3-phase input:

30103 = Output 1 Phase 1 Output Voltage
30104 = Output 1 Phase 1 Output Current
30105 = Output 1 Phase 1 Output Max Current
30106 = Output 1 Phase 1 Output Load
30107 = Output 1 Phase 1 Output Percent Load
30108 = Output 1 Phase 1 Output Percent Power
30109 = Output 1 Phase 2 Output Voltage
30110 = Output 1 Phase 2 Output Current
30111 = Output 1 Phase 2 Output Max Current
30112 = Output 1 Phase 2 Output Load
30113 = Output 1 Phase 2 Output Percent Load
30114 = Output 1 Phase 2 Output Percent Power
30115 = Output 1 Phase 3 Output Voltage
30116 = Output 1 Phase 3 Output Current
30117 = Output 1 Phase 3 Output Max Current
30118 = Output 1 Phase 3 Output Load
30119 = Output 1 Phase 3 Output Percent Load
30120 = Output 1 Phase 3 Output Percent Power

The next set of data points (Power Modules) would start at 30120. For 1 single-phase output, the Power Modules data points would start at 30109.

	Output Voltage	Volts	0 – 9999 Response must be divided by 10 to yield 0.0 – 999.9
	Output Current	Amps	0 – 999 Response must be divided by 10 to yield 0.0 – 99.9
	Output Max Current	Amps	0 – 999 Response must be divided by 10 to yield 0.0 – 99.9
	Output Load	VoltAmps	0 - 9999 Response must be divided by 10 to yield 0.0 – 999.9
	Output Percent Load	Percent	0 – 100
	Output Percent Power	Percent	0 – 100

<table>
<tr><td colspan="4">The Power Module data point addresses are dynamically generated based on the number of Inputs and input phases, and Outputs and output phases. For example, the Power Module data points would start at 30129 for a UPS that has dual, 3-phase inputs, and a single, 1-phase output, or at 30121 for a UPS with a single, 3-phase input and a single, 3-phase output.

Power Modules are 0 indexed for purposes of register addressing (the first module is 0, the second module is 1, etc.). For each Power Module, there is single, Power Module Status State data point.

For the following example, there are four modules, and the starting data point address is 30121 because the UPS has a single, 3-phase input and a single, 3-phase output:

30121 = Power Module 1 Status State
30122 = Power Module 2 Status State
30123 = Power Module 3 Status State
30124 = Power Module 4 Status State</td></tr>
<tr><td></td><td>Power Module Status State</td><td>NA</td><td>00 = Off & OK
01 = On & OK
02 = Off & failed
03 = On & failed
04 = MIM Unable to communicate w/ this module
05 = RIM: unable to communicate w/ this module
06 = MIM unable to communicate w/ RIM (MIM in control)
07 = RIM unable to communicate w/ MIM (RIM in control)</td></tr>
</table>