SATEC

Phasor Measurement Unit

PMU PRO

Modbus Communications Protocol

Reference Guide

BG0650 Rev. A3

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REVISION HISTORY

A1	Mar 2024	Initial release
A2	Aug 2024	Added IEEE C37.118.2 channel names and second client-server TCP/UDP and spontaneous UDP data streams.
A3	Sep 2024	Added address settings for the second IEC 60870-5 Ethernet interface.

Table of Contents

1 General

This document specifies a subset of the Modbus communications protocol used to transfer data between a master computer station and the PMU. The document provides the complete information necessary to develop third-party communications software capable of communication with the PMU. Refer to the PMU Installation and Operation Manual for more information on communication connections and configuring communication parameters in your device.

2 Modbus Protocol Implementation

For detailed information on the Modbus protocol, message framing and error checking, refer to the Modbus Protocol Reference Guide. It can be downloaded from the Modbus-IDA Website at http://www.modbus.org/. The following paragraphs outline some issues concerning the implementation of the Modbus protocol in the PMU.

2.1 Transmission Modes

The PMU can be set up to communicate on a serial Modbus network using either RTU, or ASCII serial transmission mode, and via the Internet using Modbus/TCP mode. Refer to the PMU Installation and Operation Manual for information on selecting the transmission mode in your device.

2.2 Serial Modbus Connections

The PMU has one 485 and one IR port, which can operate in Modbus RTU or Modbus ASCII mode.

The port baud rate and data format are configurable via the device Serial Ports setup (see the PMU Installation and Operation Manual for details).

2.3 TCP/IP Modbus Connections

The PMU has two Ethernet ports with the ability to support up to 8 simultaneous TCP connections each. Both ports provide Modbus/TCP servers on TCP port 502.

The PMU uses keepalive probes to detect dead connections and prevent resource leaks. If the connection is idle longer than configured, the device sends a keepalive request to check if the connection is alive. If no reply is received after 5 successive keepalive retransmissions, the connection is considered dead and will be closed. The idle time before sending a probe to test for an inactive session is configurable through the device Network Setup (see the PMU Installation and Operation Manual) and can be set from 1 to 60 seconds. The default value is 20 seconds.

The client connection idle timeout can be used to terminate a connection if it has been inactive for too long. It can be configured from 30 to 300 seconds, or set to 0 to inactivate it. The default value is 120 seconds. If the idle timeout is enabled, then the master station should periodically send probe requests to the device to maintain some kind of activity on the connection socket if it wants to keep the connection open.

2.4 Device Addressing

The address field contains a user assigned address of the device (1-247) on a Modbus network. Broadcast mode using address 0 is not supported. The device address can be configured via the Serial Ports setup (see the PMU Installation and Operation Manual).

When communicating via the Internet, the address field is not checked and is returned in the response message header.

2.5 Function Field

The Modbus functions implemented in the PMU are listed in Table 2-1. Function 04 can be used in the same context as function 03. The maximum number of registers that can be read or written in one request with functions 03, 04 and 16 is limited to 120 in Modbus RTU mode and 60 in Modbus ASCII mode. Addressing more registers than allowed will be responded with the exception code 02 “Illegal data address”.

Table 2-1 Modbus Function Codes

Code (decimal)	Meaning in Modbus	Action
03	Read holding registers	Read multiple registers
04	Read input registers	Read multiple registers

Code (decimal)	Meaning in Modbus	Action
06	Preset single register	Write single register
16	Preset multiple registers	Write multiple registers
22	Mask write	Set or clear individual bits
08[1]	Loop-back test	Communications test

[1] The PMU supports only diagnostic code 0 - return query data.

2.6 Exception Responses

The device sends an exception response when an error is detected in the received message. To indicate that the response is notification of an error, the high order bit of the function code is set to 1.

Implemented exception response codes:

- **01** - Illegal function
- **02** - Illegal data address
- **03** - Illegal data value
- **04** - Device failure
- **06** - Device is busy

When the character framing, parity, or redundancy check detects a communication error, processing of the masters request is terminated. The device will not act on or respond to the message.

2.7 Modbus Register Addresses

The PMU Modbus registers are numbered in the range of 0 to 65535. From the Modbus applications, the PMU Modbus registers can be accessed by simulating holding registers of the Modicon 584, 884 or 984 Programmable Controller, using a 5-digit "4XXXX" or 6-digit "4XXXXX" addressing scheme. To map the PMU register address to the range of the Modbus holding registers, add a value of 40001 to the PMU register address. When a register address exceeds 9999, use a 6-digit addressing scheme by adding 400001 to the PMU register address.

2.8 Data Formats

The PMU uses four data formats to exchange data between a master station and the device: 16-bit short integer, 32-bit long integer, 32-bit single precision floating point and 32-bit modulo-10000 formats.

Binary values and counters are always transmitted in 32-bit registers.

32-bit analog registers and counters can be read either in long integer or in single precision floating point format. The register type can be selected in the device separately for analog registers and binary counters via Modbus register 246. See Section 6.3 on how to configure the 32-bit register type in your device.

Analog registers 256 through 308 and 4320 through 10751 contain scaled 16-bit values.

2.8.1 16-bit Scaled Integer Format

16-bit scaled data is transmitted in a single 16-bit Modbus register as unsigned (UINT16) integer numbers using the linear conversion to accommodate large-scale and fractional numbers to a 16-bit register format. The linear conversion uses two scales to read the raw data from the device and convert it into engineering units: the device original engineering scale and the Modbus conversion scale.

When transmitting measured data, the device scales it to the range of Modbus Low and High conversion scales. To reconstruct data in the original engineering units, perform the reverse conversion using the following formula:

$$Engineering\_Units = \frac{Raw\_Data \times (ENG\_HI - ENG\_LO)}{RAW\_HI - RAW\_LO} + ENG\_LO$$

where:

ENG_LO and ENG_HI	-	reading low and high scales in engineering units
RAW_LO and RAW_HI	-	raw data low and high scales (by default, 0 and 9999)
Raw_Data	-	raw input data in the range of RAW_LO to RAW_HI
Engineering_Units	-	true value in engineering units

Modbus conversion scales can be configured via registers 240 and 241. The default Modbus conversion scale is 0 for the low scale and 9999 for the high scale. See Section 6.2 on how to change the conversion scale in your device.

Engineering scales are indicated in the Modbus map for each scaled 16-bit register (see Sections 3.2 and 3.3). See Chapter 4, Data Scales and Units, for information on data scales and measurement units that depend on the device's input scales, such as volts, amps and powers.

Conversion Examples

1. Voltage readings

a) Assume device settings (direct wiring): PT ratio = 1, voltage scale = 144V, conversion scale = 0-9999.

Voltage engineering scales (see Chapter 4):

HI_ENG = Vmax = 144.0 × PT ratio = 144.0 × 1 = 144.0V
LO_ENG = 0V

If the raw data reading is 4790 then the voltage reading in engineering units will be as follows:

Volts reading = 4790 × (144.0 - 0)/(9999 - 0) + 0 = 68.9V

b) Assume device settings (wiring via PT): PT ratio = 13,800V : 120V = 115, voltage scale = 144V, conversion scale = 0-9999.

Voltage engineering scales (see Chapter 4):

HI_ENG = Vmax = 144.0 × PT ratio = 144 × 115 = 16,560V
LO_ENG = 0V

If the raw data reading is 4790 then the voltage reading in engineering units will be as follows:

Volts reading = 4790 × (16560 - 0)/(9999 - 0) + 0 = 7,933V

2. Current readings

Assume device settings: CT ratio = 200A : 5A = 40, current scale = 10A, conversion scale = 0-9999.

Current engineering scales (see Chapter 4):

HI_ENG = Imax = CT ratio × 10 = 40 × 10 = 400.00A
LO_ENG = 0A

If the raw data reading is 2500 then the current reading in engineering units will be as follows:

Amps reading = 2500 × (400.00 - 0)/(9999 - 0) + 0 = 100.00A

3. Power readings

Assume device settings (wiring via PT): PT ratio = 13,800V : 120V = 115, voltage scale = 144V, CT ratio = 200A : 5A = 40, current scale = 10A, conversion scale = 0-9999.

Active power engineering scales (rounded to whole kW, see Chapter 4):

HI_ENG = Pmax = Vmax × Imax × 2 = (144 × 115) × (40 × 10) × 2/1000 = 13248 kW
LO_ENG = -Pmax = -13248 kW

If the raw data reading is 5500 then the power reading in engineering units will be as follows:

Power reading = 5500 × (13248 - (-13248))/(9999 - 0) + (-13248) = 1326 kW

If the raw data reading is 4500 then the power reading in engineering units will be as follows:

Power reading = 4500 × (13248 - (-13248))/(9999 - 0) + (-13248) = -1324 kW

4. Power Factor readings

Power factor engineering scales (see Chapter 4):

HI_ENG = 1.000.
LO_ENG = -1.000.

If the raw data reading is 8900 then the power factor in engineering units will be as follows:

Power factor reading = 8900 × (1.000 - (-1.000))/(9999 - 0) + (-1.000) = 0.78

2.8.2 32-bit Long Integer Format

32-bit long integer data is transmitted in two adjacent 16-bit Modbus registers as unsigned (UINT32) or signed (INT32) whole numbers. The first register contains the low-order word (lower 16 bits) and the second register contains the high order word (higher 16 bits). The low-order word always starts at an even Modbus address. The value range for unsigned data is 0 to 4,294,967,295; for signed data the range is -2,147,483,648 to 2,147,483,647.

If your Modbus driver does not support a 32-bit long integer format, you can read the two 16-bit registers separately, and then convert them into a 32-bit value as follows (using C notation):

32-bit value = (signed short)high_order_register × 65536L + (unsigned short)low_order_register

Examples

1. Unsigned 32-bit Values

If you read unsigned Voltage V1 of 69,000V from registers 13952-13953, then the register readings will be as follows:

(13952) = 3464
(13953) = 1

The 32-bit value is (1 x 65536 + 3464) = 69000V.

2. Signed 32-bit Values

If you read signed kW of -789kW from registers 14336-14337, then the register readings will be:

(14336) = 64747 (unsigned)
(14337) = 65535 (unsigned) or -1(signed value).

To take the high order register as a signed value, compare it with 32767. If the value is less or equal to 32767, use it as is. If it is greater than 32767, then this is a negative number in a two's complement code (like in our example) - just subtract it from 65536 to get the original negative value.

The 32-bit reading is (-1 x 65536 + 64747) = -789kW.

Fractional 32-bit data is transmitted using decimal scaling to pass fractional numbers in integer format. Fractional numbers are pre-multiplied by 10 to the power N, where N is the number of digits in the fractional part. For example, the frequency reading of 50.01 Hz is transmitted as 5001, having been pre-multiplied by 100.

Whenever a data register contains a fractional number, the register measurement unit is given with a multiplier ×0.1, ×0.01 or ×0.001, showing the weight of the least significant decimal digit. To get an actual fractional number with specified precision, multiply the register value by the given multiplier. To write a fractional number into the register, divide the number by the given multiplier.

2.8.3 32-bit Floating Point Format

32-bit analog registers and binary counters can be read in IEEE single precision floating point format in two adjacent 16-bit Modbus registers, the low order register first. The low-order register always starts at an even Modbus address.

See Section 6.3 on how to configure the 32-bit register format in your device.

2.9 User Assignable Registers

The PMU provides 120 user assignable registers in the address range of 0 to 119. You can re-map any register available in the device to any assignable register so that Modbus registers that reside at different locations may be simply accessed using a single request by re-mapping them to adjacent addresses.

The actual addresses of the assignable registers, which are accessed via addresses 0 through 119, are specified in the register map (registers 120 through 239), where register 120 contains the actual address of the register accessed via register 0, register 121 contains the actual address of the register accessed via register 1, and so on. The assignable registers and the map registers themselves may not be re-mapped.

Initially these registers are reserved and none of them points to an actual register address. To build your own register map, write to map registers 120 to 239 the actual addresses you want to read from or write to via the assignable area (registers 0 to 119). 32-bit long registers should always be aligned at even addresses. For example, to read registers 4672 (1-second V1 voltage, scaled short integer) and 14336-14337 (total kW, long integer) via registers 0-2, do the following:

- write 14336 to register 120
- write 14337 to register 121
- write 4672 to register 122

Reading from registers 0-2 will return the kW reading in registers 0 (low 16 bits) and 1 (high 16 bits), and the voltage reading in register 2.

2.10 Password Protection

The PMU has a password protection option allowing you to protect your setups, cumulative registers and logs from being changed or cleared through communications. You can disable or enable password protection through communications or via PAS. For details, refer to the PMU Installation and Operation Manual.

The password must be written to the device authorization register (44378-44379) before another write request is issued. If the correct password is not supplied while password protection is enabled, the device will respond to all write requests with the exception code 01 (illegal operation).

After making changes, it is recommended to write a zero in the device authorization register to activate password protection.

2.11 Data Recording and File Transfers

2.11.1 Log File Organization

Historical files are stored in flash memory. Memory space is allocated for each file statically when you set up your files and will not change unless you re-organize files.

Data records in a file are arranged in the order of their recording. Each record has a unique 16-bit sequence number that is incremented modulo 65536 with each new record. The sequence number can be used to point to a particular record in the file, or to check the sequence of records when uploading files from the device.

Each file has a write position pointer that indicates the place where the next record will be recorded, and a read position pointer that indicates the place from where the current record will be read. Both pointers show sequence numbers of the records they point to rather than record offsets in the file.

After acknowledging a record you have read, the read pointer automatically advances to the next record in the file. When the read pointer gets to the record to which the file write pointer points, the end-of-file (EOF) flag is set. It is automatically cleared when a new record is added to the file, or when you explicitly move the read pointer to any record within a file.

If a file has a wrap-around attribute (circular file), the most recent records can overwrite the oldest records. When this happens at the current read position, the read pointer automatically advances forward in order to point to the oldest record in the file.

The PMU keeps a separate read pointer for each communication port so that access to the same file through a different port will not affect current active sessions for other ports.

Data Log Files

Data log files can store up to 16 measured parameters per a record. Any data measured by the device can be stored in the log file. The number of parameters that each record will hold and the list of parameters you want to be recorded in the file can be selected through the Data log setup registers for a particular file.

Recording data to data log files can be triggered through the setpoints, either on a time basis, or upon any event detected by the setpoints.

2.11.2 File Transfers

File transfer protocol provides both data transfer and information services. File transfer is performed through two blocks of registers: a 32-word master request block and a 1792-word read-only file response block. After a master application has written the request into the file request block, the requested data is available for a read through the file response block registers. File transfer functions allow changing the file or section position in order to point to the desired record.

The information service uses separate 8-word file info request and 200-word file info response blocks. The extended file information is available including current file pointers' positions, file contents, the number of records in the file, allocated file size, time of file creation, time of the last file update and reset, and more.

Common File Transfer

Log files can be read either in a sequence record-by-record, or in a random order. Each Read-File request fills the file response block with the data of the record pointed to by the file (or section) read pointer. If you want to begin reading a file from a particular record, which sequence number is known, you can change the pointer position by issuing the Set-File-Position request with the desired sequence number. If you want to read a file from the beginning, send the Reset-File-Position request that moves the pointer to the oldest file record. If you do not change the file position, then you will continue reading the file from the record following the one you have read the last time you accessed the file.

You need not explicitly move the file position to the following record if you want to continue reading a file in sequence after you have uploaded the current record. Instead, issue an acknowledgment request that automatically advances the file pointer to the next record, and then read the record data through the file response block.

The file response block can contain more than one record. The number of records available in the block and the file record size in words are always reported in the block heading. There are no special rules on how to read records from the file transfer block. You can read a single record or all records together, or begin reading from the last record and end with the first record. However, you should remember: 1) after an acknowledgment, the file position moves to the record following the last one you have accessed in the file transfer block; and 2) data in the file transfer block does not change until you either issue an acknowledgment, or explicitly change the file position by the Set-File-Position or Reset-File-Position requests.

The file transfer is completed after you have read the last record of the file. Before storing a file record to your database, always check bit 9 in the record status word, which contains the end-of-file (EOF) flag. This bit set to 1 indicates that the file read pointer does not point to any record within the file, and you should not store any record that has this bit set. The EOF flag is set only after you have acknowledged the last record of the file, so that testing for end-of-file requires one extra read. If you wish to stop the transfer just after storing the last file record, acknowledge the record

and check bit 0 in the record status word. Bit 0 is set to 1 only once when you read the last record of the file.

The following gives a summary of steps you should do to read an ordinal log file:

1. If you want to begin reading a file from a particular record or from the first record, use either the Set-File-Position request with the desired record sequence number, or the Reset-File-Position request. Preset a section number and channel ID to zero.
2. Write the Read-File request with a section number and channel ID set to zero.
3. Read the record data from the file response block.
4. Write an acknowledgment for the file. You need not fill all the request fields: only the file function is required. The file pointer will be moved to the next file record.

Repeat steps 3-4 until all the file records are read.

2.12 TCP Notification Client

The TCP notification client can establish connections with a remote Modbus/TCP server and send notification messages either on events, or periodically on a time basis.

Notification messages are sent via a block of 24 Modbus registers using write function 16. The following table shows the message exchange structure.

Register Offset	Description	Type	Comment
+0-1	Device serial number	UINT32	
+2-4	Device MAC address	CHAR6	
+5	Device address	UINT16	1 for Ethernet
+6-7	Device IP address	UINT32	Network byte order
+8	Event type	UINT16	See F22 in Section 5
+9	Event sequence number	UINT16	
+10-11	Start event timestamp, seconds	UINT32	Local time since Jan 1, 1970
+12-13	Start event timestamp, seconds fraction, in microseconds	UINT32	
+14-15	End event timestamp, seconds	UINT32	Local time since Jan 1, 1970
+16-17	End event timestamp, seconds fraction, in microseconds	UINT32	
+18	Not used	UINT16	Written as 0
+19	Critical trigger ID	UINT16	See Table below
+20-21	Critical trigger value	UINT32	See Table below
+22-23	Reserved	UINT32	Written as 0

The reported trigger type and value depend on the event source and are described in the following table.

Event Source	Trigger Type	Trigger Value
Setpoint events	Critical setpoint trigger caused setpoint operation or release (see F12 in Section 5)	Trigger entering or return value

After receiving a write acknowledgement from a server, a TCP connection is still open for 10 seconds to give the server an opportunity to access device registers through an open socket. It may help you access the device from outside your local network when the server is located on another network. The notification client will respond to all server requests as if it were a regular incoming connection.

In case a client connection is not used for following data transfers, it is recommended for the server to close the connection immediately after sending a write acknowledgement; otherwise there will be a 10-second delay before the next notification may be sent.

If there is no activity on the connection socket, it will be closed in 10 seconds. In the event a connection attempt was unsuccessful, the notification client retries two more times before announcing a connection failure.

The server’s IP address, port number and starting Modbus register address are programmable in the device. To configure and enable the notification client in your device via PAS, select Communication Setup in the Meter Setup menu, and click on the TCP Notification Client Setup tab.

Client connections are triggered via programmable setpoints. To send event notifications to a server, configure a setpoint to respond to desired triggers or to periodic time events and add the "Send notification" action to the end of the setpoint actions list.

Setpoint operation events triggered by regular analog and digital triggers are reported twice - when the event starts and when it ends, except of the pulsed events and time triggers that will be reported once. In the start notification message, the event end timestamp is zeroed, and the critical trigger value indicates its entering value, while the second notification message gives both the event start and end time and shows the trigger return value.

3 Modbus Register Map

3.1 Modbus Setup Registers

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
Modbus Assignable Registers							
0-119							
+0		Register 0 contents	0-65535		UINT16	R/W	
+1		Register 1 contents	0-65535		UINT16	R/W	
		...					
+119		Register 119 contents	0-65535		UINT16	R/W	
Assignable Registers Map							
120-239							
+0		Register 0 address	0-65535		UINT16	R/W	
+1		Register 1 address	0-65535		UINT16	R/W	
+119		Register 119 address	0-65535		UINT16	R/W	
Modbus Conversion Scales							
240		Low raw scale	0-32768		UINT16	R/W	Default 0
241		High raw scale	1023-65535		UINT16	R/W	Default 9999
Device Conversion Scales							
242		Voltage scale, secondary volts	60-600	1V	UINT16	R/W	Default 144V
243		Current scale, secondary amps	10-200	×0.1A	UINT16	R/W	Default 2×CT secondary
244-245		Reserved			UINT16	R	
32-bit Register Format							
246		32-bit register format	Bits 0-1 - analog values: 0 = 32-bit integer 1 = 32-bit floating point Bits 2-3 - binary counters: 0 = 32-bit integer 1 = 32-bit floating point		UINT16	R/W	Default: 32-bit integer analog values 32-bit integer binary counters

3.2 16-bit Scaled Analog Values - Basic Register Set

Address	Point ID	Description[2]	Low and High Scales[1]	Units[1]	Type	R/W	Notes
256-308		**Average Values**					
+0	0x1100	V1 voltage	0-Vmax	U1	UINT16	R	
+1	0x1101	V2 voltage	0-Vmax	U1	UINT16	R	
+2	0x1102	V3 voltage	0-Vmax	U1	UINT16	R	
+3	0x1103	I1 current	0-Imax	U2	UINT16	R	
+4	0x1104	I2 current	0-Imax	U2	UINT16	R	
+5	0x1105	I3 current	0-Imax	U2	UINT16	R	
+6	0x1106	kW L1	-Pmax-Pmax	U3	INT16	R	
+7	0x1107	kW L2	-Pmax-Pmax	U3	INT16	R	
+8	0x1108	kW L3	-Pmax-Pmax	U3	INT16	R	
+9	0x1109	kvar L1	-Pmax-Pmax	U3	INT16	R	
+10	0x110A	kvar L2	-Pmax-Pmax	U3	INT16	R	
+11	0x110B	kvar L3	-Pmax-Pmax	U3	INT16	R	
+12	0x110C	kVA L1	-Pmax-Pmax	U3	UINT16	R	
+13	0x110D	kVA L2	-Pmax-Pmax	U3	UINT16	R	
+14	0x110E	kVA L3	-Pmax-Pmax	U3	UINT16	R	
+15	0x110F	Power factor L1	-1.000-1.000	0.001	INT16	R	
+16	0x1110	Power factor L2	-1.000-1.000	0.001	INT16	R	
+17	0x1111	Power factor L3	-1.000-1.000	0.001	INT16	R	
+18	0x1403	Total PF	-1.000-1.000	0.001	INT16	R	
+19	0x1400	Total kW	-Pmax-Pmax	U3	INT16	R	
+20	0x1401	Total kvar	-Pmax-Pmax	U3	INT16	R	
+21	0x1402	Total kVA	-Pmax-Pmax	U3	UINT16	R	
+22	0x1501	In current	0-Imax	U2	UINT16	R	
+23	0x1502	Frequency	45.00-65.00	0.01Hz	UINT16	R	
+24-52		Not used	0		UINT16	R	

NOTES:

1 For volts, amps and power scales refer to Chapter 4 ”Data Scales and Units”.

2 All AC measurements are one-second average fundamental frequency values updated at the UTC second rollover.

3.3 16-bit Scaled Analog Values

Address	Point ID	Description[2]	Low and High Scales[1]	Units[1]	Type	R/W	Notes
4352-4405		**RT Phase Values**					
+0	0x0C00	V1 voltage	0-Vmax	U1	UINT16	R	
+1	0x0C01	V2 voltage	0-Vmax	U1	UINT16	R	
+2	0x0C02	V3 voltage	0-Vmax	U1	UINT16	R	
+3	0x0C03	I1 current	0-Imax	U2	UINT16	R	
+4	0x0C04	I2 current	0-Imax	U2	UINT16	R	
+5	0x0C05	I3 current	0-Imax	U2	UINT16	R	
+6	0x0C06	kW L1	-Pmax-Pmax	U3	INT16	R	
+7	0x0C07	kW L2	-Pmax-Pmax	U3	INT16	R	
+8	0x0C08	kW L3	-Pmax-Pmax	U3	INT16	R	
+9	0x0C09	kvar L1	-Pmax-Pmax	U3	INT16	R	
+10	0x0C0A	kvar L2	-Pmax-Pmax	U3	INT16	R	
+11	0x0C0B	kvar L3	-Pmax-Pmax	U3	INT16	R	
+12	0x0C0C	kVA L1	0-Pmax	U3	UINT16	R	
+13	0x0C0D	kVA L2	0-Pmax	U3	UINT16	R	
+14	0x0C0E	kVA L3	0-Pmax	U3	UINT16	R	
+15	0x0C0F	Power factor L1	-1.000-1.000	0.001	INT16	R	
+16	0x0C10	Power factor L2	-1.000-1.000	0.001	INT16	R	
+17	0x0C11	Power factor L3	-1.000-1.000	0.001	INT16	R	
+18-29		Not used	0		UINT16	R	
+30	0x0C1E	V12 voltage	0-Vmax	U1	UINT16	R	
+31	0x0C1F	V23 voltage	0-Vmax	U1	UINT16	R	
+32	0x0C20	V31 voltage	0-Vmax	U1	UINT16	R	
4512-4527		**Average Analog Inputs**					
+0	0x0E80	Analog input AI1	AI1min-AI1max		UINT16	R	
+1-15		Reserved	0		UINT16	R	
4544-4557		**RT Total Values**					
+0	0x0F00	Total kW	-Pmax-Pmax	U3	INT16	R	
+1	0x0F01	Total kvar	-Pmax-Pmax	U3	INT16	R	
+2	0x0F02	Total kVA	0-Pmax	U3	UINT16	R	
+3	0x0F03	Total PF	-1.000-1.000	0.001	INT16	R	
4608-4616		**RT Auxiliary Values**					
+0	0x1000	Not used	0		UINT16	R	
+1	0x1001	In current	0-Imax	U2	UINT16	R	
+2	0x1002	Frequency	0-100.00	0.01Hz	UINT16	R	
+3	0x1003	Voltage unbalance	0-300.0	0.1%	UINT16	R	
+4	0x1004	Current unbalance	0-300.0	0.1%	UINT16	R	
+5	0x1005	Not used			UINT16	R	
+6	0x1006	Not used	0		UINT16	R	
+7	0x1007	Not used	0		UINT16	R	

Address	Point ID	Description[2]	Low and High Scales[1]	Units[1]	Type	R/W	Notes
+8	0x1008	Frequency (3 decimals)	0-100.000	0.001Hz	UINT16	R	
4640-4663		**RT Phasor Values**					
+0	0x1080	V1 voltage magnitude	0-Vmax	U1	UINT16	R	
+1	0x1081	V2 voltage magnitude	0-Vmax	U1	UINT16	R	
+2	0x1082	V3 voltage magnitude	0-Vmax	U1	UINT16	R	
+3	0x1083	Not used	0	U1	UINT16	R	
+4	0x1084	I1 current magnitude	0-Imax	U2	UINT16	R	
+5	0x1085	I2 current magnitude	0-Imax	U2	UINT16	R	
+6	0x1086	I3 current magnitude	0-Imax	U2	UINT16	R	
+7	0x1087	Not used	0	U2	UINT16	R	
+8	0x1088	V1 voltage angle	-180.0-180.0	0.1º	INT16	R	
+9	0x1089	V2 voltage angle	-180.0-180.0	0.1º	INT16	R	
+10	0x108A	V3 voltage angle	-180.0-180.0	0.1º	INT16	R	
+11	0x108B	Not used	0	0.1º	INT16	R	
+12	0x108C	I1 current angle	-180.0-180.0	0.1º	INT16	R	
+13	0x108D	I2 current angle	-180.0-180.0	0.1º	INT16	R	
+14	0x108E	I3 current angle	-180.0-180.0	0.1º	INT16	R	
+15	0x108F	Not used	0	0.1º	INT16	R	
4672-4710		**Average Phase Values**					
+0	0x1100	V1 voltage	0-Vmax	U1	UINT16	R	
+1	0x1101	V2 voltage	0-Vmax	U1	UINT16	R	
+2	0x1102	V3 voltage	0-Vmax	U1	UINT16	R	
+3	0x1103	I1 current	0-Imax	U2	UINT16	R	
+4	0x1104	I2 current	0-Imax	U2	UINT16	R	
+5	0x1105	I3 current	0-Imax	U2	UINT16	R	
+6	0x1106	kW L1	-Pmax-Pmax	U3	INT16	R	
+7	0x1107	kW L2	-Pmax-Pmax	U3	INT16	R	
+8	0x1108	kW L3	-Pmax-Pmax	U3	INT16	R	
+9	0x1109	kvar L1	-Pmax-Pmax	U3	INT16	R	
+10	0x110A	kvar L2	-Pmax-Pmax	U3	INT16	R	
+11	0x110B	kvar L3	-Pmax-Pmax	U3	INT16	R	
+12	0x110C	kVA L1	0-Pmax	U3	UINT16	R	
+13	0x110D	kVA L2	0-Pmax	U3	UINT16	R	
+14	0x110E	kVA L3	0-Pmax	U3	UINT16	R	
+15	0x110F	Power factor L1	-1.000-1.000	0.001	INT16	R	
+16	0x1110	Power factor L2	-1.000-1.000	0.001	INT16	R	
+17	0x1111	Power factor L3	-1.000-1.000	0.001	INT16	R	
+18-29		Not used	0		UINT16	R	
+30	0x111E	V12 voltage	0-Vmax	U1	UINT16	R	
+31	0x111F	V23 voltage	0-Vmax	U1	UINT16	R	
+32	0x1120	V31 voltage	0-Vmax	U1	UINT16	R	
4864-4877		**Average Total Values**					
+0	0x1400	Total kW	-Pmax-Pmax	U3	INT16	R	

Address	Point ID	Description[2]	Low and High Scales[1]	Units[1]	Type	R/W	Notes
+1	0x1401	Total kvar	-Pmax-Pmax	U3	INT16	R	
+2	0x1402	Total kVA	0-Pmax	U3	UINT16	R	
+3	0x1403	Total PF	-1.000-1.000	0.001	INT16	R	
4928-4944		**Average Auxiliary Values**					
+0	0x1500	Not used	0		UINT16	R	
+1	0x1501	In current	0-Imax	U2	UINT16	R	
+2	0x1502	Frequency	0-100.00	0.01Hz	UINT16	R	
+3	0x1503	Voltage unbalance	0-300.0	0.1%	UINT16	R	
+4	0x1504	Current unbalance	0-300.0	0.1%	UINT16	R	
+5	0x1505	Not used	0		UINT16	R	
+6	0x1506	Not used	0		UINT16	R	
+7	0x1507	Not used	0		UINT16	R	
+8	0x1508	Not used	0		UINT16	R	
+9	0x1509	Internal temperature	-200.0 to 200.0	0.1ºC	UINT16	R	
+10	0x150A	Frequency (3 decimals)	0-100.000	0.001Hz	UINT16	R	
+11	0x150B	Lithium battery voltage	0-100.000	0.001V	UINT16	R	
5152-5167		**RT Symmetrical Components**					
+0	0x1880	Positive sequence voltage	0-Vmax	U1	UINT16	R	
+1	0x1881	Negative sequence voltage	0-Vmax	U1	UINT16	R	
+2	0x1882	Zero sequence voltage	0-Vmax	U1	UINT16	R	
+3	0x1883	Negative sequence voltage unbalance	0-300.0	0.1%	UINT16	R	
+4	0x1884	Zero sequence voltage unbalance	0-300.0	0.1%	UINT16	R	
+5	0x1885	Positive sequence current	0-Imax	U2	UINT16	R	
+6	0x1886	Negative sequence current	0-Imax	U2	UINT16	R	
+7	0x1887	Zero sequence current	0-Imax	U2	UINT16	R	
+8	0x1888	Negative sequence current unbalance	0-300.0	0.1%	UINT16	R	
+9	0x1889	Zero sequence current unbalance	0-300.0	0.1%	UINT16	R	
+10	0x188A	Zero sequence voltage, V0seq (alias)	0-Vmax	U1	UINT16	R	
+11	0x188B	Positive sequence voltage, V1seq (alias)	0-Vmax	U1	UINT16	R	
+12	0x188C	Negative sequence voltage, V2seq (alias)	0-Vmax	U1	UINT16	R	
+13	0x188D	Zero sequence voltage, V0seq (alias)	0-Imax	U2	UINT16	R	
+14	0x188E	Positive sequence voltage, V1seq (alias)	0-Imax	U2	UINT16	R	
+15	0x188F	Negative sequence voltage, V2seq (alias)	0-Imax	U2	UINT16	R	
6208-6225		**RT Fundamental Phase Values (alias)**					
+0	0x2900	V1 voltage	0-Vmax	U1	UINT16	R	
+1	0x2901	V2 voltage	0-Vmax	U1	UINT16	R	
+2	0x2902	V3 voltage	0-Vmax	U1	UINT16	R	
+3	0x2903	I1 current	0-Imax	U4	UINT16	R	
+4	0x2904	I2 current	0-Imax	U4	UINT16	R	
+5	0x2905	I3 current	0-Imax	U4	UINT16	R	
+6	0x2906	kW L1	-Pmax-Pmax	U3	INT16	R	
+7	0x2907	kW L2	-Pmax-Pmax	U3	INT16	R	
+8	0x2908	kW L3	-Pmax-Pmax	U3	INT16	R	

Address	Point ID	Description[2]	Low and High Scales[1]	Units[1]	Type	R/W	Notes
+9	0x2909	kvar L1	-Pmax-Pmax	U3	INT16	R	
+10	0x290A	kvar L2	-Pmax-Pmax	U3	INT16	R	
+11	0x290B	kvar L3	-Pmax-Pmax	U3	INT16	R	
+12	0x290C	kVA L1	0-Pmax	U3	UINT16	R	
+13	0x290D	kVA L2	0-Pmax	U3	UINT16	R	
+14	0x290E	kVA L3	0-Pmax	U3	UINT16	R	
+15	0x290F	Displacement power factor L1	-1.000-1.000	0.001	INT16	R	
+16	0x2910	Displacement power factor L2	-1.000-1.000	0.001	INT16	R	
+17	0x2911	Displacement power factor L3	-1.000-1.000	0.001	INT16	R	
6272-6275		**RT Fundamental Total Values (alias)**					
+0	0x2A00	Total fundamental kW	-Pmax-Pmax	U3	INT16	R	
+1	0x2A01	Total fundamental kvar	-Pmax-Pmax	U3	INT16	R	
+2	0x2A02	Total fundamental kVA	0-Pmax	U3	UINT16	R	
+3	0x2A03	Total displacement PF	-1.000-1.000	0.001	INT16	R	
7360-7375		**RT Analog Inputs**					
+0	0x3B00	Analog input AI1	AI1min-AI1max		UINT16	R	
+1-15		Reserved			UINT16	R	
7392-7407		**RT Raw Analog Inputs**					
+0	0x3B80	Analog input AI1	0-65535		UINT16	R	
+1-15		Reserved			UINT16	R	

NOTES:

1 For volts, amps, power and frequency scales and units, refer to Section 4 "Data Scales and Units".

2 All AC measurements are fundamental frequency values. Real-time (RT) measurements are synchronized with the PMU frame rate. All average measurements are one-second average values updated at the UTC second rollover.

3.4 32-bit Binary and Analog Values

Address	Point ID	Description[2]	Options/Range[1]	Units[1]	Type	R/W	Notes
11776-11777	0x0000	**None**	0		UINT32	R	
		Setpoint Status	0x00000000 - 0xFFFFFFF				
11840-11841		Setpoints 1-32 (alias)	0x00000000 - 0xFFFFFFF		UINT32	R	
27648-27649		Setpoints 1-32	0x00000000 - 0xFFFFFFF		UINT32	R	
	0x0080	Setpoint #1	0/1			TRG	
	0x0081	Setpoint #2	0/1			TRG	
		...					
	0x009F	Setpoint #32	0/1			TRG	
		Event Flags					
12160-12161		Event flags 1-32	0x00000000 - 0xFFFFFFF		UINT32	R	
	0x0300	Event flag #1	0/1			TRG	
	0x0301	Event flag #2	0/1			TRG	
		...					
	0x031F	Event flag #32	0/1			TRG	
		Periodic Timers					
	0x0500	Timer #1	0/1			TRG	
	0x0501	Timer #2	0/1			TRG	
		...					
	0x050F	Timer #16	0/1			TRG	
		Digital Inputs					3
12544-12545		Digital inputs DI1–DI25	0x00000000 - 0x01FFFFF		UINT32	R	
	0x0600	Digital input DI1	0/1			TRG	
	0x0601	Digital input DI2	0/1			TRG	
		...					
	0x0618	Digital input DI25	0/1			TRG	
		Pulse Inputs					4
	0x0700	Digital input DI1	0/1			TRG	
	0x0701	Digital input DI2	0/1			TRG	
		...					
	0x0718	Digital input DI25	0/1			TRG	
		Relay Outputs					
12800-12801		Relay outputs RO1–RO13	0x00000000 - 0x00001FFF		UINT32	R	
	0x0800	Relay output RO1	0/1			TRG	
	0x0801	Relay output RO2	0/1			TRG	
		...					
	0x080C	Relay output RO13	0/1			TRG	
13056-13119		**Counters**					
+0,1	0x0A00	Counter #1	0 - 999,999,999		UINT32	R/W	
+2,3	0x0A01	Counter #2	0 - 999,999,999		UINT32	R/W	
		...					

Address	Point ID	Description[2]	Options/Range[1]	Units[1]	Type	R/W	Notes
+62,63	0x0A1F	Counter #32	0 - 999,999,999		UINT32	R/W	
13184-13207		**Time/Date**					
+0,1	0x0B00	Packed date	YYMMDD		UINT32	TRG,R	
+2,3	0x0B01	Packed time	hhmmss		UINT32	TRG,R	
+4,5	0x0B02	Day of week	1-7, 1 = Sun, 7 = Sat		UINT32	TRG,R	
+6,7	0x0B03	Year	0-99		UINT32	TRG,R	
+8,9	0x0B04	Month	1-12		UINT32	TRG,R	
+10,11	0x0B05	Day of month	1-31		UINT32	TRG,R	
+12,13	0x0B06	Hours	0-23		UINT32	TRG,R	
+14,15	0x0B07	Minutes	0-59		UINT32	TRG,R	
+16,17	0x0B08	Seconds	0-59		UINT32	TRG,R	
+18,19	0x0B09	Minute interval	1-5,10,15,20,30,60 (triggers)		UINT32	TRG,R	Indicates present minutes
+20,21	0x0B0A	Timestamp, seconds	F1	sec	UINT32	R	
+22,23	0x0B0B	Timestamp, fraction of second	0-999999	µsec	UINT32	R	
13312-13419		**RT Phase Values**					
+0,1	0x0C00	V1 voltage	0-Vmax	U1	UINT32	R	
+2,3	0x0C01	V2 voltage	0-Vmax	U1	UINT32	R	
+4,5	0x0C02	V3 voltage	0-Vmax	U1	UINT32	R	
+6,7	0x0C03	I1 current	0-Imax	U2	UINT32	R	
+8,9	0x0C04	I2 current	0-Imax	U2	UINT32	R	
+10,11	0x0C05	I3 current	0-Imax	U2	UINT32	R	
+12,13	0x0C06	kW L1	-Pmax-Pmax	U3	INT32	R	
+14,15	0x0C07	kW L2	-Pmax-Pmax	U3	INT32	R	
+16,17	0x0C08	kW L3	-Pmax-Pmax	U3	INT32	R	
+18,19	0x0C09	kvar L1	-Pmax-Pmax	U3	INT32	R	
+20,21	0x0C0A	kvar L2	-Pmax-Pmax	U3	INT32	R	
+22,23	0x0C0B	kvar L3	-Pmax-Pmax	U3	INT32	R	
+24,25	0x0C0C	kVA L1	0-Pmax	U3	UINT32	R	
+26,27	0x0C0D	kVA L2	0-Pmax	U3	UINT32	R	
+28,29	0x0C0E	kVA L3	0-Pmax	U3	UINT32	R	
+30,31	0x0C0F	Power factor L1	-1000-1000	×0.001	INT32	R	
+32,33	0x0C10	Power factor L2	-1000-1000	×0.001	INT32	R	
+34,35	0x0C11	Power factor L3	-1000-1000	×0.001	INT32	R	
+36-59		Not used	0		UINT32	R	
+60,61	0x0C1E	V12 voltage	0-Vmax	U1	UINT32	R	
+62,63	0x0C1F	V23 voltage	0-Vmax	U1	UINT32	R	
+64,65	0x0C20	V31 voltage	0-Vmax	U1	UINT32	R	
13632-13663		**Average Analog Inputs**					
+0,1	0x0E80	Analog input AI1	AI1min-AI1max		INT32	R	
+2-31		Reserved			INT32	R	
13696-13723		**RT Total Values**					
+0,1	0x0F00	Total kW	-Pmax-Pmax	U3	INT32	R	
+2,3	0x0F01	Total kvar	-Pmax-Pmax	U3	INT32	R	

Address	Point ID	Description[2]	Options/Range[1]	Units[1]	Type	R/W	Notes
+4,5	0x0F02	Total kVA	0-Pmax	U3	UINT32	R	
+6,7	0x0F03	Total PF	-1000-1000	×0.001	INT32	R	
13824-13841		**RT Auxiliary Values**					
+0,1	0x1000	I4 current	0-Imax	U2	UINT32	R	
+2,3	0x1001	In current	0-Imax	U2	UINT32	R	
+4,5	0x1002	Frequency	0-10000	×0.01Hz	UINT32	R	
+6,7	0x1003	Voltage unbalance	0-3000	×0.1%	UINT32	R	
+8,9	0x1004	Current unbalance	0-3000	×0.1%	UINT32	R	
+10,11	0x1005	Not used	0		UINT32	R	
+12,13	0x1006	Not used	0	U4	UINT32	R	
+14,15	0x1007	Not used	0	U2	UINT32	R	
+16,17	0x1008	Frequency (3 decimals)	0-100000	×0.001Hz	UINT32	R	
13888-13935		**RT Phasor Values**					
+0,1	0x1080	V1 voltage magnitude	0-Vmax	U1	UINT32	R	
+2,3	0x1081	V2 voltage magnitude	0-Vmax	U1	UINT32	R	
+4,5	0x1082	V3 voltage magnitude	0-Vmax	U1	UINT32	R	
+6,7	0x1083	Not used	0	U1	UINT32	R	
+8,9	0x1084	I1 current magnitude	0-Imax	U2	UINT32	R	
+10,11	0x1085	I2 current magnitude	0-Imax	U2	UINT32	R	
+12,13	0x1086	I3 current magnitude	0-Imax	U2	UINT32	R	
+14,15	0x1087	Not used	0	U2	UINT32	R	
+16,17	0x1088	V1 voltage angle	-1800-1800	×0.1º	INT32	R	
+18,19	0x1089	V2 voltage angle	-1800-1800	×0.1º	INT32	R	
+20,21	0x108A	V3 voltage angle	-1800-1800	×0.1º	INT32	R	
+22,23	0x108B	Not used	0	×0.1º	INT32	R	
+24,25	0x108C	I1 current angle	-1800-1800	×0.1º	INT32	R	
+26,27	0x108D	I2 current angle	-1800-1800	×0.1º	INT32	R	
+28,29	0x108E	I3 current angle	-1800-1800	×0.1º	INT32	R	
+30,31	0x108F	Not used	0	×0.1º	INT32	R	
13952-14029		**Average Phase Values**					
+0,1	0x1100	V1 voltage	0-Vmax	U1	UINT32	R	
+2,3	0x1101	V2 voltage	0-Vmax	U1	UINT32	R	
+4,5	0x1102	V3 voltage	0-Vmax	U1	UINT32	R	
+6,7	0x1103	I1 current	0-Imax	U2	UINT32	R	
+8,9	0x1104	I2 current	0-Imax	U2	UINT32	R	
+10,11	0x1105	I3 current	0-Imax	U2	UINT32	R	
+12,13	0x1106	kW L1	-Pmax-Pmax	U3	INT32	R	
+14,15	0x1107	kW L2	-Pmax-Pmax	U3	INT32	R	
+16,17	0x1108	kW L3	-Pmax-Pmax	U3	INT32	R	
+18,19	0x1109	kvar L1	-Pmax-Pmax	U3	INT32	R	
+20,21	0x110A	kvar L2	-Pmax-Pmax	U3	INT32	R	
+22,23	0x110B	kvar L3	-Pmax-Pmax	U3	INT32	R	
+24,25	0x110C	kVA L1	0-Pmax	U3	UINT32	R	

Address	Point ID	Description[2]	Options/Range[1]	Units[1]	Type	R/W	Notes
+26,27	0x110D	kVA L2	0-Pmax	U3	UINT32	R	
+28,29	0x110E	kVA L3	0-Pmax	U3	UINT32	R	
+30,31	0x110F	Power factor L1	-1000-1000	×0.001	INT32	R	
+32,33	0x1110	Power factor L2	-1000-1000	×0.001	INT32	R	
+34,35	0x1111	Power factor L3	-1000-1000	×0.001	INT32	R	
+36-59	0x1112	Not used	0	×0.1%	UINT32	R	
+60,61	0x111E	V12 voltage	0-Vmax	U1	UINT32	R	
+62,63	0x111F	V23 voltage	0-Vmax	U1	UINT32	R	
+64,65	0x1120	V31 voltage	0-Vmax	U1	UINT32	R	
14336-14363		**Average Total Values**					
+0,1	0x1400	Total kW	-Pmax-Pmax	U3	INT32	R	
+2,3	0x1401	Total kvar	-Pmax-Pmax	U3	INT32	R	
+4,5	0x1402	Total kVA	0-Pmax	U3	UINT32	R	
+6,7	0x1403	Total PF	-1000-1000	×0.001	INT32	R	
14464-14487		**Average Auxiliary Values**					
+0,1	0x1500	Not used	0	U2	UINT32	R	
+2,3	0x1501	In current	0-Imax	U2	UINT32	R	
+4,5	0x1502	Frequency	0-10000	×0.01Hz	UINT32	R	
+6,7	0x1503	Voltage unbalance	0-3000	×0.1%	UINT32	R	
+8,9	0x1504	Current unbalance	0-3000	×0.1%	UINT32	R	
+10,11	0x1505	Not used	0		UINT32	R	
+12,13	0x1506	Not used	0		UINT32	R	
+14,15	0x1507	Not used	0		UINT32	R	
+16,17	0x1508	Not used	0		UINT32	R	
+18,19	0x1509	Internal temperature	-2000 to 2000	×0.1ºC	INT32	R	
+20,21	0x150A	Frequency (3 decimals)	0-100000	×0.001Hz	UINT32	R	
+22,23	0x150B	Lithium battery voltage	0-100000	×0.001V	UINT32	R	
14912-14943		**RT Symmetrical Components**					
+0,1	0x1880	Positive sequence voltage	0-Vmax	U1	UINT32	R	
+2,3	0x1881	Negative sequence voltage	0-Vmax	U1	UINT32	R	
+4,5	0x1882	Zero sequence voltage	0-Vmax	U1	UINT32	R	
+6,7	0x1883	Negative sequence voltage unbalance	0-3000	×0.1%	UINT32	R	
+8,9	0x1884	Zero sequence voltage unbalance	0-3000	×0.1%	UINT32	R	
+10,11	0x1885	Positive sequence current	0-Imax	U2	UINT32	R	
+12,13	0x1886	Negative sequence current	0-Imax	U2	UINT32	R	
+14,15	0x1887	Zero sequence current	0-Imax	U2	UINT32	R	
+16,17	0x1888	Negative sequence current unbalance	0-3000	×0.1%	UINT32	R	
+18,19	0x1889	Zero sequence current unbalance	0-3000	×0.1%	UINT32	R	
+20,21	0x188A	Zero sequence voltage, V0seq (alias)	0-Vmax	U1	UINT32	R	
+22,23	0x188B	Positive sequence voltage, V1seq (alias)	0-Vmax	U1	UINT32	R	
+24,25	0x188C	Negative sequence voltage, V2seq (alias)	0-Vmax	U1	UINT32	R	
+26,27	0x188D	Zero sequence current, I0seq (alias)	0-Imax	U2	UINT32	R	
+28,29	0x188E	Positive sequence current, I1seq (alias)	0-Imax	U2	UINT32	R	

Address	Point ID	Description[2]	Options/Range[1]	Units[1]	Type	R/W	Notes
+30,31	0x188F	Negative sequence current, I2seq (alias)	0-Imax	U2	UINT32	R	
17024-17059		**RT Fundamental Phase Values (alias)**					
+0,1	0x2900	V1 voltage	0-Vmax	U1	UINT32	R	
+2,3	0x2901	V2 voltage	0-Vmax	U1	UINT32	R	
+4,5	0x2902	V3 voltage	0-Vmax	U1	UINT32	R	
+6,7	0x2903	I1 current	0-Imax	U4	UINT32	R	
+8,9	0x2904	I2 current	0-Imax	U4	UINT32	R	
+10,11	0x2905	I3 current	0-Imax	U4	UINT32	R	
+12,13	0x2906	kW L1	-Pmax-Pmax	U3	INT32	R	
+14,15	0x2907	kW L2	-Pmax-Pmax	U3	INT32	R	
+16,17	0x2908	kW L3	-Pmax-Pmax	U3	INT32	R	
+18,19	0x2909	kvar L1	-Pmax-Pmax	U3	INT32	R	
+20,21	0x290A	kvar L2	-Pmax-Pmax	U3	INT32	R	
+22,23	0x290B	kvar L3	-Pmax-Pmax	U3	INT32	R	
+24,25	0x290C	kVA L1	0-Pmax	U3	UINT32	R	
+26,27	0x290D	kVA L2	0-Pmax	U3	UINT32	R	
+28,29	0x290E	kVA L3	0-Pmax	U3	UINT32	R	
+30,31	0x290F	Displacement power factor L1	-1000-1000	×0.001	INT32	R	
+32,33	0x2910	Displacement power factor L2	-1000-1000	×0.001	INT32	R	
+34,35	0x2911	Displacement power factor L3	-1000-1000	×0.001	INT32	R	
17152-17159		**RT Fundamental Total Values (alias)**					
+0,1	0x2A00	Total fundamental kW	-Pmax-Pmax	U3	INT32	R	
+2,3	0x2A01	Total fundamental kvar	-Pmax-Pmax	U3	INT32	R	
+4,5	0x2A02	Total fundamental kVA	0-Pmax	U3	UINT32	R	
+6,7	0x2A03	Total displacement PF	-1000-1000	×0.001	INT32	R	
19328-19359		**RT Analog Inputs**					
+0,1	0x3B00	Analog input AI1	AI1min-AI1max		INT32	R	
+2-31	0x3B01	Reserved			INT32	R	
19392-19423		**RT Raw Analog Inputs**					
+0,1	0x3B80	Analog input AI1	0-65535		UINT32	R	
+2-31	0x3B81	Reserved			UINT32	R	
29824-29919		**Synchrophasor**					
+0,1	0x8D00	Frame number	0-239		UINT32	R	
+2,3	0x8D01	Frame timestamp, UTC seconds since 1/1/1970	F1	sec	UINT32	R	
+4,5	0x8D02	Frame timestamp, fraction of second	0-999999	µsec	UINT32	R	
+6,7	0x8D03	Time quality, bitmap	F39		UINT32	R	
+8,9	0x8D04	Data source/stream ID number	1-65534		UINT32	R	
+10,11	0x8D05	Frame status, bitmap	F40		UINT32	R	
+12,13	0x8D06	Frequency deviation from nominal or actual frequency, Hz	-32767 to 32767, or 0 to 100000	×0.001 Hz	UINT32	R	
+14,15	0x8D07	Rate of change of frequency (ROCOF), Hz/s	-32767 to 32767	×0.01 Hz/s	UINT32	R	
+16,17	0x8D08	V1 phasor magnitude	0-Vmax	U1	UINT32	R	
+18,19	0x8D09	V1 phasor angle	-179999 to 180000	×0.001 deg	UINT32	R	

Address	Point ID	Description[2]	Options/Range[1]	Units[1]	Type	R/W	Notes
+20,21	0x8D0A	V2 phasor magnitude	0-Vmax	U1	UINT32	R	
+22,23	0x8D0B	V2 phasor angle	-179999 to 180000	×0.001 deg	UINT32	R	
+24,25	0x8D0C	V3 phasor magnitude	0-Vmax	U1	UINT32	R	
+26,27	0x8D0D	V3 phasor angle	-179999 to 180000	×0.001 deg	UINT32	R	
+28,29	0x8D0E	I1 phasor magnitude	0-Imax	U2	UINT32	R	
+30,31	0x8D0F	I1 phasor angle	-179999 to 180000	×0.001 deg	UINT32	R	
+32,33	0x8D10	I2 phasor magnitude	0-Imax	U2	UINT32	R	
+34,35	0x8D11	I2 phasor angle	-179999 to 180000	×0.001 deg	UINT32	R	
+36,37	0x8D12	I3 phasor magnitude	0-Imax	U2	UINT32	R	
+38,39	0x8D13	I3 phasor angle	-179999 to 180000	×0.001 deg	UINT32	R	
+40,41	0x8D14	V1 phasor, Re	0-Vmax	V	FLOAT32	R	
+42,43	0x8D15	V1 phasor, Im	0-Vmax	V	FLOAT32	R	
+44,45	0x8D16	V2 phasor, Re	0-Vmax	V	FLOAT32	R	
+46,47	0x8D17	V2 phasor, Im	0-Vmax	V	FLOAT32	R	
+48,49	0x8D18	V3 phasor, Re	0-Vmax	V	FLOAT32	R	
+50,51	0x8D19	V3 phasor, Im	0-Vmax	V	FLOAT32	R	
+52,53	0x8D1A	I1 phasor, Re	0-Imax	A	FLOAT32	R	
+54,55	0x8D1B	I1 phasor, Im	0-Imax	A	FLOAT32	R	
+56,57	0x8D1C	I2 phasor, Re	0-Imax	A	FLOAT32	R	
+58,59	0x8D1D	I2 phasor, Im	0-Imax	A	FLOAT32	R	
+60,61	0x8D1E	I3 phasor, Re	0-Imax	A	FLOAT32	R	
+62,63	0x8D1F	I3 phasor, Im	0-Imax	A	FLOAT32	R	
+64,65	0x8D20	V1seq positive sequence voltage phasor magnitude	0-Vmax	U1	UINT32	R	
+66,67	0x8D21	V1seq positive sequence voltage phasor angle	-179999 to 180000	×0.001 deg	UINT32	R	
+68,69	0x8D22	I1seq positive sequence current phasor magnitude	0-Imax	U2	UINT32	R	
+70,71	0x8D23	I1seq positive sequence current phasor angle	-179999 to 180000	×0.001 deg	UINT32	R	
+72,73	0x8D24	V1seq positive sequence voltage phasor, Re	0-Vmax	V	FLOAT32	R	
+74,75	0x8D25	V1seq positive sequence voltage phasor, Im	0-Vmax	V	FLOAT32	R	
+76,77	0x8D26	I1seq positive sequence current phasor, Re	0-Imax	A	FLOAT32	R	
+78,79	0x8D27	I1seq positive sequence current phasor, Im	0-Imax	A	FLOAT32	R	
+80,81	0x8D20	V2seq negative sequence voltage phasor magnitude	0-Vmax	U1	UINT32	R	
+82,83	0x8D21	V2seq negative sequence voltage phasor angle	-179999 to 180000	×0.001 deg	UINT32	R	
+84,85	0x8D22	I2seq negative sequence current phasor magnitude	0-Imax	U2	UINT32	R	
+86,87	0x8D23	I2seq negative sequence current phasor angle	-179999 to 180000	×0.001 deg	UINT32	R	
+88,89	0x8D24	V2seq negative sequence voltage phasor, Re	0-Vmax	V	FLOAT32	R	
+90,91	0x8D25	V2seq negative sequence voltage phasor, Im	0-Vmax	V	FLOAT32	R	
+92,93	0x8D26	I2seq negative sequence current phasor, Re	0-Imax	A	FLOAT32	R	
+94,95	0x8D27	I2seq negative sequence current phasor, Im	0-Imax	A	FLOAT32	R	

NOTES:

[1] For volts, amps, power and frequency scales and units, refer to Section 4 ”Data Scales and Units”.

[2] All AC measurements are fundamental frequency values. Real-time (RT) measurements are synchronized with the PMU frame rate. All average measurements are one-second average values updated at the UTC second rollover.

[3] Digital input registers indicate the state of the level-sensitive digital inputs in a 32-bit packed format beginning from the nearest lower point number divisible by 32. For example, registers 12544-12545 and 12548-12549 report the same 32-bit value that shows the state of digital inputs DI1:DI32. Bits that reference non-existent points will contain zeros.

[4] Pulse input registers indicate the transition status of the edge sensitive digital inputs. A bit value is set to '1' if a pulse edge (either rising, falling, or any of them depending on the input polarity setting) has been detected on the input. Pulse inputs cannot be directly read but can be tested through the setpoints and/or linked to the pulse counters.

3.5 Device Control and Status Registers

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
Event Flags Registers (bitmap)							
44032-44033		Event flags 1-32 set register (0 = no effect, 1 = set)	0x00000000 - 0xFFFFFFF		UINT32	W	Read as 0
44034-44035		Event flags 1-32 clear register (0=clear,1 = no effect)	0x00000000 - 0xFFFFFFF		UINT32	W	Read as 0
44036-44037		Event flags 1-32 status (0 = cleared, 1 = set)	0x00000000 - 0xFFFFFFF		UINT32	R	
Remote Relay Control Registers (bitmap)							
44046-44047		Force relay operate register: 0 = no effect, 1 = operate	0x00000000 - 0x00001FFF		UINT32	W	Read as 0
44050-44051		Force relay release register: 0 = no effect, 1 = release	0x00000000 - 0x00001FFF		UINT32	W	Read as 0
44054-44055		Locally latched relays status: 0 = unlatched, 1 = locally latched	0x00000000 - 0x00001FFF		UINT32	R	
44058-44059		Remote latched relays status: 0 = unlatched, 1 = remote latched	0x00000000 - 0x00001FFF		UINT32	R	
44062-44063		Direct relay control disable status: 0 = direct control enabled, 1 = direct control disabled	0x00000000 - 0x00001FFF		UINT32	R	Direct control is disabled if a relay is under local automation control
44066-44067		Relay status: 0 = open, 1 = closed	0x00000000 - 0x00001FFF		UINT32	R	
44070-44071		Latch relays mode: 0 = unlatched mode, 1 = latched mode	0x00000000 - 0x00001FFF		UINT32	R	
44074-44075		Pulse relays mode: 0 = not pulse mode, 1 = pulse mode	0x00000000 - 0x00001FFF		UINT32	R	
44078-44079		KYZ relays mode: 0 = not KYZ mode, 1 = KYZ mode	0x00000000 - 0x00001FFF		UINT32	R	
44082-44083		Relay polarity mode: 0 = normal mode, 1 = inverting mode	0x00000000 - 0x00001FFF		UINT32	R	
Reset/Clear Registers							
44106		Clear counters	0 = clear all counters, 1-32 = clear counter #1-32		UINT16	W	
44107		Clear Min/Max log	0		UINT16	W	
44108		Clear operation/event counters	6 = clear communication counters		UINT16	W	
Device Mode Control Registers							
44135		Controller/setpoints operation	0 = disabled, 1 = enabled		UINT16		
Memory Status Registers							
44262-44263		Memory size, bytes			UINT32	R	
44264-44265		Free memory, bytes			UINT32	R	
44266-44277		Reserved			UINT32	R	
Log Notification Registers (bitmap)							
44278-44279		Files 0-8 (0 = no new logs, 1 = new record logged)	0x00000000 - 0x000001FF		UINT32	R	
Setpoint Status Registers (bitmap)							
44294-44295		Setpoints 1-32 status (0 = released, 1 = operated)	0x00000000 - 0xFFFFFFFF		UINT32	R	
44298-44309		Reserved			UINT32	R	

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
Setpoint Alarm Latch Registers (bitmap)							
44310-44311		Setpoints 1-32 alarm status. When read: 0 = no setpoint operations logged, 1 = setpoint has been operated at least once since the last alarm bit reset. When written: 0 = clear setpoint alarm bit, 1 = no effect.	0x00000000 - 0xFFFFFFFF		UINT32	R/W	
44314-44325		Reserved					
Device Diagnostics Register (bitmap)							
44326-44327		Device self-diagnostics flags. When read: 0 = no faults logged, 1 = a fault bit has been set at least once since the last reset. When written: 0 = clear a fault bit, 1 = no effect.	F23		UINT32	R/W	
Port Identification							
44342		Connection port number	0 = COM1 RS-485 port, 6 = USB/Modbus port, 7… = TCP port		UINT16	R	
44343		Serial port interface (COM1)	2 = RS-485		UINT16	R	
Network Identification							
44346-44367							
+0,1		Network 1 IP address			UINT32	R	Network byte order
+2,3		Network 1 subnet mask			UINT32	R	Network byte order
+4,5		Network 1 default gateway			UINT32	R	Network byte order
+6-21		Not used			UINT32	R	
+22,23		Network 2 IP address			UINT32	R	Network byte order
+24,25		Network 2 subnet mask			UINT32	R	Network byte order
+26,27		Network 2 default gateway			UINT32	R	Network byte order
Device Authorization Register							
44378-44379		When write: 8-digit password. When read: 0 = access permitted, -1 = authorization required.	0-99999999 (write) 0/-1 (read)		INT32	R/W	
Communication Status							
44394		Not used	0		UINT16	R	
44395		Not used	0		UINT16	R	
44396		RSTP status	Bit 0=1: RSTP is running Bits 1-3: network1 RSTP status Bits 4-6: network1 RSTP role Bits 7-9: network2 RSTP status Bits 10-12: network2 RSTP role RSTP port status 0=disabled 1=broken 2=blocking 3=listening 4=learning		UINT16	R	

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
			5=forwarding RSTP port role: 0=disabled 1=root 2=designated 3=alternate 4=backup else unknown				
Communication Counters							
44410		Successful eXpertPower client connections	0-65534		UINT16	R	
44411		Failed eXpertPower client connections	0-65534		UINT16	R	
44412		Successful TCP notification client connections	0-65534		UINT16	R	
44413		Failed TCP notification client connections	0-65534		UINT16	R	
Factory Diagnostic Registers							
45952-46079		Factory diagnostic registers			UINT32	R	

3.6 Device Setup Registers

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
Device Identification							
46080-46111							
+0,1		Device serial number	1-99999999		UINT32	R	
+2,3		Device model ID	23000		UINT32	R	
+4-11		Device model name	"PMU"		CHAR16	R	Null-terminated string
+12-13		Device options (bitmap)			UINT32	R	
+14-17		Not used			UINT16	R	
+18		CPU board hardware revision	Bits 0:3 - CPU board revision Bits 4:7 - CPU version X, Y, Z, V Bits 8:15 - LCD ID		UINT16	R	
+19		Analog board hardware revision	Bit 4 - 0=no onboard IO Bit 5 - 0=no Ethernet Bit 7 - 0= no anti-aliasing filter Bits 8:11 - analog board revision Bits 12:15 - CT type		UINT16	R	
+20		Device firmware version number	4801-4899		UINT16	R	Two higher decimal digits = major version number, two lower decimal digits = minor version number
+21		Device firmware build number	1-99		UINT16	R	
+22-23		Not used			UINT16	R	
+24		Device bootloader version number	101-999		UINT16	R	Two higher decimal digits = major version number, two lower decimal digits = minor version number
+25		Device bootloader build number	1-99		UINT16	R	
+26		Not used			UINT16	R	
+27		Device firmware sub-build number	0-99		UINT16	R	
+28-29		Reserved			UINT16	R	
+30		Device firmware checksum			UINT16	R	
+31		Device bootloader checksum			UINT16	R	
Factory Device Settings							
46112-46207							
+0		V1-V3 input range	120, 480	V	UINT16	R	
+1		V1-V3 input overload	120	%	UINT16	R	
+2-3		Not used			UINT16	R	
+4		I1-I3 input range	1, 5	A	UINT16	R	
+5		I1-I3 input overload	200	%	UINT16	R	
+6-63		Not used			UINT16	R	
+64		Ethernet 1 MAC address 0-1	0x0500		UINT16	R	
+65		Ethernet 1 MAC address 2-3	0x00F0		UINT16	R	
+66		Ethernet 1 MAC address 4-5	0x0000-0xFFFF		UINT16	R	
+67		Ethernet 2 MAC address 0-1	0x0500		UINT16	R	

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
+68		Ethernet 2 MAC address 2-3	0x00F0		UINT16	R	
+69		Ethernet 2 MAC address 4-5	0x0000-0xFFFF		UINT16	R	
+67-95		Reserved			UINT16	R	
Basic Setup							
46208-46270							
+0		Reserved	1		UINT16	R	
+1		PT ratio (primary to secondary ratio)	10-65000	×0.1	UINT16	R/W	
+2		PT secondary (line-to-line voltage)	500-7000	×0.1	UINT16	R/W	
+3-4		Reserved	65535	×0.1	UINT16	R	
+5		CT primary current	1-30000	A	UINT16	R/W	
+6-16		Reserved	65535		UINT16	R	
+17		Nominal line frequency	50, 60	Hz	UINT16	R/W	
+18		Phase order	0=ABC, 1=CBA		UINT16	R/W	
+19-22		Reserved	65535		UINT16	R	
+23		Data rate, frames/s	1,2,3,4,5,6,10,12,15,20,25,30,50, 60,100,120,200,240		UINT16	R/W	
+24-59		Reserved	65535		UINT16	R	
+60		L1 current direction	0=regular, 1=reverse		UINT16	R/W	
+61		L2 current direction	0=regular, 1=reverse		UINT16	R/W	
+62		L3 current direction	0=regular, 1=reverse		UINT16	R/W	
Local Settings							
46400-46415							
+0		Time zone offset from UTC, min	0-+/-720		INT16	R/W	
+1		Daylight saving time (DST)	0=disabled 1=enabled		UINT16	R/W	
+2		DST start month	1-12		UINT16	R/W	
+3		DST start week of the month	1-4 = 1st, 2nd, 3rd and 4th week, 5=the last week of the month		UINT16	R/W	
+4		DST start weekday	1-7 (1=Sun, 7=Sat)		UINT16	R/W	
+5		DST end month	1–12		UINT16	R/W	
+6		DST end week of the month	1-4 = 1st, 2nd, 3rd and 4th week, 5=last week of the month		UINT16	R/W	
+7		DST end weekday	1-7 (1=Sun, 7=Sat)		UINT16	R/W	
+8		Clock synchronization source	0 = IRIG-B, 0x7FFD = 1588 PTP		UINT16	R/W	
+9		Not used			UINT16	R/W	
+10		DST start hour	1-6		UINT16	R/W	
+11		DST end hour	1-6		UINT16	R/W	
+12-15		Reserved			UINT16	R/W	
Clock Setup and Status							
46416-46447							
+0,1		Local time, in seconds, since Jan 1, 1970	F1	sec	UINT32	R/W	
+2,3		Fraction of second, µsec	0-999999	µsec	UINT32	R/W	
+4		Fraction of second, milliseconds	0-999	ms	UINT16	R/W	

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
+5		Seconds	0-59		UINT16	R/W	
+6		Minutes	0-59		UINT16	R/W	
+7		Hour	0-23		UINT16	R/W	
+8		Day of month	1-31		UINT16	R/W	
+9		Month	1-12		UINT16	R/W	
+10		Year (calendar year minus 2000)	0-99		UINT16	R/W	
+11		Weekday	1-7 (1=Sun, 7=Sat)		UINT16	R	
+12		Daylight savings time status	0=standard time, 1=daylight savings time is active		UINT16	R	
+13		IRIG-B/PTP status	0=testing, 1=no signal, 2=time unlocked, 3=time locked		UINT16	R	
+14-31		Reserved			UINT16		
Communication Port Setup							
46448-46463							
+0		Communication protocol	0 = Modbus RTU, 1 = Modbus ASCII, 2 = DNP3.0, 7=IEC 60870-5		UINT16	R/W	
+1		Interface	2 = RS-485		UINT16	R/W	
+2		Device address	Modbus: 1-247 DNP3.0: 0–65532 IEC 60870-5: 1-254 (1 octet), 1-65532 (2 octets)		UINT16	R/W	
+3		Baud rate	4 = 2400 bps, 5 = 4800 bps, 6 = 9600 bps, 7 = 19200 bps, 8 = 38400 bps, 9 = 57600 bps, 10 = 115200 bps		UINT16	R/W	
+4		Data format	0 = 7 bits/even parity, 1 = 8 bits/no parity, 2 = 8 bits/even parity		UINT16	R/W	
+5		Reserved	65535		UINT16	R	
+6		Reserved	65535		UINT16	R	
+7		Minimum delay before sending data	0-1000 (default = 5)	ms	UINT16	R/W	
+8		Inter-character timeout	1-1000 (default = 4)	ms	UINT16	R/W	Added to standard 4-character time
+9-15		Reserved	65535		UINT16	R	
Network Setup							
46576-46607		**Network 1**					
+0,1		Device IP address	0x01000000-0xFFFFFFFF		UINT32	R/W	Network byte order
+2,3		Network subnet mask	0x00000001-0xFFFFFFFF		UINT32	R/W	Network byte order
+4,5		Network default gateway	0x00000000-0xFFFFFFFF		UINT32	R/W	Network byte order
+6,7		DHCP	0=disable, 1=enable		UINT32	R/W	
+8,9		TCP service port (not used)	502		UINT32	R/W	
+10,11		Primary DNS IP address (not used)			UINT32	R/W	
+12,13		Secondary DNS IP address (not used)			UINT32	R/W	
+14,15		Client connection idle timeout, s	0=disable, 30-300 s	s	UINT32	R/W	

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
+16,17		Application protocol address (not used)			UINT32	R/W	
+18,19		Switch mode	0=daisy chain, 1=separated		UINT32	R/W	
+20,21		TCP keepalive time	0=disable, 1-60 s	s	UINT32	R/W	
+22-31		Reserved				R	
46608-46639		**Network 2**					
+0,1		Device IP address	0x01000000-0xFFFFFFFF		UINT32	R/W	Network byte order
+2,3		Network subnet mask	0x00000001-0xFFFFFFFF		UINT32	R/W	Network byte order
+4,5		Network default gateway	0x00000000-0xFFFFFFFF		UINT32	R/W	Network byte order
+6,7		DHCP	0=disable, 1=enable		UINT32	R/W	
+8,9		TCP service port (not used)	502		UINT32	R/W	
+10,11		Primary DNS IP address (not used)			UINT32	R/W	
+12,13		Secondary DNS IP address (not used)			UINT32	R/W	
+14,15		Client connection idle timeout, s	0=disable, 30-300 s	s	UINT32	R/W	
+16,17		Application protocol address (not used)			UINT32	R/W	
+18,19		Switch mode (not used)			UINT32	R/W	
+20,21		TCP keepalive time	0=disable, 1-60 s	s	UINT32	R/W	
+22-31		Reserved				R	
Password Setup							
46704-46711							
+0,1		Communications password Level 1 (8 digits)	0-99999999		UINT32	R/W	Read as 0
+2		Password protection enabled	0 = disabled, 1 = enabled		UINT16	R/W	
+3		Reserved			UINT16	R/W	
+4,5		Communication password Level 2 (8 digits)	0-99999999		UINT32	R/W	Read as 0
+6,7		Communication password Level 3 (8 digits)	0-99999999		UINT32	R/W	Read as 0
46712-46719		Reserved					
Expert Power Service Setup							
46768-46783							
+0,1		Expert Power server IP Address	0x01000000-0xFFFFFFFF		UINT32	R/W	Default = 20.157.123.32
+2,3		Expert Power server TCP service port	0-65535		UINT32	R/W	Default = 5001
+4,5		Expert Power client enabled	0=client disabled, 1=client enabled		UINT32	R/W	
+6,7		Time to next session	1-99999	min	UINT32	R/W	
+8,9		Time to next session	1-99999	min	UINT32	R	Same as previous
+10,11		Connection network	0=Ethernet		UINT32	R/W	
+12-15		Reserved					
TCP Notification Client Setup							
46896-46991							
+0,1		Client enabled	0=disabled, 1=enabled		UINT32	R/W	
+2,3		Server address	0x01000000-0xFFFFFFFF		UINT32	R/W	
+4,5		Server port	0-65535		UINT32	R/W	
+6,7		Message exchange address	0-65535		UINT32	R/W	
+8,9		Connection network	0=Ethernet		UINT32	R/W	
+10-15		Reserved					

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
Transformer Correction Setup							
47072-47099							
+0		Ratio correction factor	900-1100	×0.001	UINT16	R/W	
+1		Phase angle error	-6000 to 6000	min	INT16	R/W	
+2,3		Reserved			INT16	R/W	
47072-47075		**V1 transformer correction**					
47076-47079		**V2 transformer correction**					
47080-47083		**V3 transformer correction**					
47084-47087		**Not used**					
47088-47091		**I1 transformer correction**					
47092-47095		**I2 transformer correction**					
47096-47099		**I3 transformer correction**					
Display Setup							
48664-48695							
+0		Brightness	20-100	%	UINT16	R/W	
+1		Backlight time	0 = continuous, 1-10	min	UINT16	R/W	
+2		Language	0=English, 1=Russian, 3=Spanish, 4=Chinese		UINT16	R/W	
+3		Volts resolution	1-3		UINT16	R/W	
+4		Current resolution	1-2		UINT16	R/W	
+5		Power resolution	1-3		UINT16	R/W	
+6-7		Not used			UINT16	R/W	
+8		Auto-return	0=disabled, 1-5, 10, 15, 20, 25, 30	min	UINT16	R/W	
+9-15		Not used			UINT16	R/W	
+12-16		Custom name/ID	Null-terminated ASCII string		UINT16	R/W	Up to 9 characters
+17-31		Reserved			UINT16	R/W	
RSTP Setup							
48696-48725							
+0		RSTP enabled	0=disabled, 1=enabled		UINT16	R/W	
+1		RSTP bridge priority	0–61440, in steps of 4096		UINT16	R/W	Default 32768
+2		RSTP Hello time	1-10	seconds	UINT16	R/W	Default 2
+3		RSTP forward delay	4-30	seconds	UINT16	R/W	Default 15
+4		RSTP TX hold count	1-10	BPDU	UINT16	R/W	Default 6
+5-9		Reserved			UINT16	R/W	
+10,11		RSTP network1 port path cost	0-240, in steps of 16		UINT32	R/W	Default 128
+12		RSTP network1 port priority	1-200,000,000		UINT16	R/W	Default 200,000 (for 100Mb/s Ethernet connection)
+13,19		Reserved			UINT16	R/W	
+20,21		RSTP network2 port path cost	0-240, in steps of 16		UINT32	R/W	Default 128
+22		RSTP network2 port priority	1-200,000,000		UINT16	R/W	Default 200,000 (for 100Mb/s Ethernet connection)
+23,29		Reserved			UINT16	R/W	

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
IEC 61850 License Setup							
46762-46767							
+0,1		License code, first word			UINT32	R/W	
+2,3		License code, second word			UINT32	R/W	
+4,5		Current license type	0=no valid license -1=permanent license		UINT32	R	
IEC 61850 Dataset Setup							
49210-49278							
+0		Read: current dataset number Write: number of dataset members	1-16/1-64		UINT16	R/W	Write a dataset number before reading dataset registers
+1		Activate	Write: 1=activate		UINT16	R/W	Write 1 to store and activate setup
+2-34		Dataset reference (without IED name)			CHAR66	R/W	
+35		Dataset member number	0-63		UINT16	R/W	Write a dataset member number before reading following registers
+36-68		Dataset member reference (without IED name)			CHAR66	R/W	
IEC 61850 Dataset List							
49280-49332							
		Command registers					Write 1-2 registers for a command
+0		Write: read command Read:	0xE0E0=read dataset list		UINT16	W	Write a command before reading setup registers
+1		Write: no action Read: number of configured datasets			UINT16	R	
+2-18		Not used			UINT16	R	
+19		Dataset number			UINT16	R	
+20-52		Dataset reference (without IED name)			CHAR66	R	Reading register #52 advances to the next dataset in the list
IEC 61850 Report Deadbands							
49396-49444							See F27 for measured value indices
+0		Measured value 1 deadband	1-50000	×0.001%	UINT16	R/W	
…		…	1-50000	×0.001%	UINT16	R/W	
+48		Measured value 49 deadband	1-50000	×0.001%	UINT16	R/W	
49445-49459		Reserved	65535		UINT16	R	
IEC 60870-5 Options Setup							
49460-49495		**Network 1**					
59318-59353		**Network 2**					
+0		Maximum length of variable frame, octets	32-255		UINT16	R/W	
+1		Link address length, octets	1-2		UINT16	R/W	
+2		Cause of transmission length, octets	1-2		UINT16	R/W	
+3		Length of common address of ASDU, octets	1-2		UINT16	R/W	
+4		Length of information object address, octets	1-3		UINT16	R/W	
+5		Select-before-operate timeout, s	0-30		UINT16	R/W	
+6		Short pulse duration, ms	100-3000	ms	UINT16	R/W	
+7		Long pulse duration, ms	100-3000	ms	UINT16	R/W	

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
+8,9		Time synchronization period, s	1-86400, 0=not active	s	UINT32	R/W	
+10		Local counter freeze period, min	1-60, 0=not active	min	UINT16	R/W	
+11		Cyclic data transmission period, ms	100-30000, 0=not active	ms	UINT16	R/W	
+12,13		IP address 1 for spontaneous/cyclic transmission	0-0xFFFFFE, 0=not active		UINT32	R/W	
+14,15		IP address 2 for spontaneous/cyclic transmission	0-0xFFFFFE, 0=not active		UINT32	R/W	
+16,17		Not used	0		UINT32	R/W	
+18		Not used	0		UINT16	R/W	
+19		Respond with class 1 data to class 2 requests	0=disabled, 1=enabled		UINT16	R/W	
+20		Single point start mapped address	1-4095		UINT16	R/W	
+21		Single point default static object type	F30		UINT16	R/W	
+22		Single point default event object type	F31		UINT16	R/W	
+23		Double point start mapped address	1-4095		UINT16	R/W	
+24		Double point default static object type	F32		UINT16	R/W	
+25		Double point default event object type	F33		UINT16	R/W	
+26		Measured value start mapped address	1-4095		UINT16	R/W	
+27		Measured value default static object type	F34		UINT16	R/W	
+28		Measured value default event object type	F35		UINT16	R/W	
+29		Integrated totals start mapped address	1-4095		UINT16	R/W	
+30		Integrated totals default static object type	F36		UINT16	R/W	
+31		Integrated totals default event object type	F37		UINT16	R/W	
+32		Voltage units	0=V, 1=kV		UINT16	R/W	
+33		Current units	0=A, 1=kA		UINT16	R/W	
+34		Power units	0=kW, 1=MW		UINT16	R/W	
+35		Redundancy mode	1, 2		UINT16	R/W	
IEC 60870-5 Class 2 Data and Counters Setup							
49524-49619		**Network 1**					
59382-59477		**Network 2**					
+0		Information object type and flags	Bits 0:7 – static object type identification (F30, F32, F34, F36), Bit 8=1 – freeze with reset, Bit 9=1 – local freeze, Bit 10=1 – cyclic data transmission, Bit 11=1 – general interrogation, Bits 12:15 – interrogation group = 0-15 (0=no group assigned)				
+1		Start information object address	1-65535		UINT16	R/W	
+2		Number of elements in the range	1-128		UINT16	R/W	
+0-2		**Object address range #1**					
+3-5		**Object address range #2**					
…		**…**					
+93-95		**Object address range #32**					

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
IEC 60870-5 Assignable Point Map and Events Setup							
49716-49971		**Network 1**			UINT16	R/W	
59574-59829		**Network 2**			UINT16	R/W	
+0		Point ID	See Section 3.4		UINT16	R/W	
+1		Information object type and flags	Bits 0:7 – static object type identification (F3, F5, F7), Bits 8:9 – relation (0=delta, 1= more than, 2 = less than) Bit 10=1 – class 1 assignment		UINT16	R/W	
+2,3		Deadband/threshold	See Section 3.4 for the point range and resolution		INT32	R/W	
+0-3		**Mapped static/event point #1**					
+4-7		**Mapped static/event point #2**					
…		**…**					
+252-255		**Mapped static/event point #64**					
DNP Options Setup							
51158-51183							
+0		Default Binary Input Static object variation	F24 (default 0)		UINT16	R/W	
+1		Binary Input Change object variation	F24 (default 1)		UINT16	R/W	
+2		Default Binary Counter object variation	F24 (default 3)		UINT16	R/W	
+3		Frozen Binary Counter object variation	F24 (default 4)		UINT16	R/W	
+4		Reserved			UINT16	R/W	
+5		Binary Counter Change Event object variation	F24 (default 2)		UINT16	R/W	
+6		Default Analog Input object variation	F24 (default 3)		UINT16	R/W	
+7		Reserved			UINT16	R/W	
+8		Reserved			UINT16	R/W	
+9		Analog Input Change Event object variation	F24 (default 2)		UINT16	R/W	
+10		Re-mapping static point indices for event objects	0=disabled (default), 1=enabled		UINT16	R/W	
+11		16-bit BC scaling	0=×1 (default), 1=×10, 2=×100, 3=×1000		UINT16	R/W	
+12		16-bit AI scaling	0=disabled, 1=enabled		UINT16	R/W	
+13		Number of Analog Input change event points	0 to 43 (default 43)		UINT16	R/W	
+14		Number of Binary Input change event points	0 to 32 (default 21)		UINT16	R/W	
+15		Number of Binary Counter change event points	0 to 16 (default 0)		UINT16	R/W	
+16		Select/Operate Timeout	2 to 30 seconds (default 10 sec)		UINT16	R/W	
+17		Multi-fragment Interval	50 to 500 ms (default 50 ms)		UINT16	R/W	
+18-21		Reserved	Read as 65535		UINT16	R/W	
+22,23		Time Sync Period	1 to 86400 seconds (default 86400 sec), 0=disable time requests		UINT32	R/W	
+24		Voltage scale, secondary volts	60 to 600	V	UINT16	R/W	
+25		Current scale, secondary amps	10 to 200	×0.1A	UINT16	R/W	

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
51184-51189		Reserved					
DNP Events Setup							
51190-51445							
+0,1		Threshold/Deadband	See Section 3.5 for point value limits.		INT32	R/W	A hysteresis for the point return threshold is 0.05Hz for frequency and 2% of the operating threshold for other points
+2		DNP point index	DNP point index for the selected object		UINT16	R/W	
+3		Event scan control field (bitmap)	Bits 0-1 - DNP Object: 0=none, 1=AI, 2=BI, 3=BC Bit 2 – Object change event scan: 0= disabled, 1=enabled Bits 5-6 - DNP event poll class: 0=Class 1, 1=Class 2, 2=Class 3 Bit 7 – unused Bits 8-9 – Threshold/Deadband relation: 0=Delta, 1=more than (over threshold), 2=less than (under threshold)		UINT16	R/W	
51190-51193		**DNP Event #1**					
51194-51197		**DNP Event #2**					
		…					
51442-51445		**DNP Event #64**					
51446-51573		Reserved					
DNP Class 0 Point Assignment							
51702-51797							
+0		DNP object and variation	F25		UINT16	R/W	
+1		Start point index in a range			UINT16	R/W	
+2		Number of the points in a range	0-128		UINT16	R/W	
51702-51704		**DNP Class 0 Points Range 1**					
51705-51707		**DNP Class 0 Points Range 2**					
		…					
51795-51797		**DNP Class 0 Points Range 32**					
51798-51893		Reserved					
File Setup							
52598-52687							
+0		File type	0		UINT16	R/W	
+1		File attributes (bitmap)	F3		UINT16	R/W	
+2		Number of records in the file	0-65535, 0 = delete file		UINT16	R/W	
+3		Number of sections/channels in the file	0 = non-partitioned file		UINT16	R/W	
+4		Number of parameters per section record	1-16		UINT16	R/W	
+5		Not used	0		UINT16	R/W	

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
+6		Section record size, bytes (for info only)			UINT16	R	
+7		File record size, bytes (for info only)			UINT16	R	
+8,9		Allocated file size, bytes (for info only)			UINT32	R	
52598-52607		**Event Log Setup**					
52608-52617		**Data Log #1 Setup**					
52618-52627		**Data Log #2 Setup**					
52628-52637		**Data Log #3 Setup**					
52638-52647		**Data Log #4 Setup**					
52648-52657		**Data Log #5 Setup**					
52658-52667		**Data Log #6 Setup**					
52668-52677		**Data Log #7 Setup**					
52678-52687		**Data Log #8 Setup**					
Data Log Setup							
54006-54261							
+0		Data log parameter #1 ID	0x0000-0xFFFF		UINT16	R/W	
+1		Data log parameter #2 ID	0x0000-0xFFFF		UINT16	R/W	
+2		Data log parameter #3 ID	0x0000-0xFFFF		UINT16	R/W	
+3		Data log parameter #4 ID	0x0000-0xFFFF		UINT16	R/W	
+4		Data log parameter #5 ID	0x0000-0xFFFF		UINT16	R/W	
+5		Data log parameter #6 ID	0x0000-0xFFFF		UINT16	R/W	
+6		Data log parameter #7 ID	0x0000-0xFFFF		UINT16	R/W	
+7		Data log parameter #8 ID	0x0000-0xFFFF		UINT16	R/W	
+8		Data log parameter #9 ID	0x0000-0xFFFF		UINT16	R/W	
+9		Data log parameter #10 ID	0x0000-0xFFFF		UINT16	R/W	
+10		Data log parameter #11 ID	0x0000-0xFFFF		UINT16	R/W	
+11		Data log parameter #12 ID	0x0000-0xFFFF		UINT16	R/W	
+12		Data log parameter #13 ID	0x0000-0xFFFF		UINT16	R/W	
+13		Data log parameter #14 ID	0x0000-0xFFFF		UINT16	R/W	
+14		Data log parameter #15 ID	0x0000-0xFFFF		UINT16	R/W	
+15		Data log parameter #16 ID	0x0000-0xFFFF		UINT16	R/W	
+16-31		Reserved			UINT16	R/W	
54006-54037		**Data log #1 Setup**					
54038-54069		**Data log #2 Setup**					
54070-54101		**Data log #3 Setup**					
54102-54133		**Data log #4 Setup**					
54134-54165		**Data log #5 Setup**					
54166-54197		**Data log #6 Setup**					
54198-54229		**Data log #7 Setup**					
54230-54261		**Data log #8 Setup**					
Control Setpoints Setup							
57184-59103							
+0		Condition #1: Trigger parameter ID	F12		UINT16	R/W	
+1		Condition #2: Trigger parameter ID	F12		UINT16	R/W	

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
+2		Condition #3: Trigger parameter ID	F12		UINT16	R/W	
+3		Condition #4: Trigger parameter ID	F12		UINT16	R/W	
+4		Condition #1: Logical operator	0 = OR, 1 = AND		UINT16	R/W	
+5		Condition #2: Logical operator	0 = OR, 1 = AND		UINT16	R/W	
+6		Condition #3: Logical operator	0 = OR, 1 = AND		UINT16	R/W	
+7		Condition #4: Logical operator	0 = OR, 1 = AND		UINT16	R/W	
+8		Condition #1: Relational operator	F13		UINT16	R/W	
+9		Condition #2: Relational operator	F13		UINT16	R/W	
+10		Condition #3: Relational operator	F13		UINT16	R/W	
+11		Condition #4: Relational operator	F13		UINT16	R/W	
+12,13		Condition #1: Operate limit			INT32	R/W	
+14,15		Condition #2: Operate limit			INT32	R/W	
+16,17		Condition #3: Operate limit			INT32	R/W	
+18,19		Condition #4: Operate limit			INT32	R/W	
+20,21		Condition #1: Release limit			INT32	R/W	
+22,23		Condition #2: Release limit			INT32	R/W	
+24,25		Condition #3: Release limit			INT32	R/W	
+26,27		Condition #4: Release limit			INT32	R/W	
+28		Action #1: Action ID	F14		UINT16	R/W	
+29		Action #2: Action ID	F14		UINT16	R/W	
+30		Action #3: Action ID	F14		UINT16	R/W	
+31		Action #4: Action ID	F14		UINT16	R/W	
+32,33		Action #1: Parameter value			INT32	R/W	
+34,35		Action #2: Parameter value			INT32	R/W	
+36,37		Action #3: Parameter value			INT32	R/W	
+38,39		Action #4: Parameter value			INT32	R/W	
+40,41		Operate delay	0-10000000	0.001 s	UINT32	R/W	
+42,43		Release delay	0-10000000	0.001 s	UINT32	R/W	
+44-59		Not used			UINT16	R/W	
57184-57243		**Setpoint #1**					
57244-57303		**Setpoint #2**					
		...					
59044-59103		**Setpoint #32**					
Control Setpoints Setup (alias)							
59104-59177							
+0		Setpoint number	0-31		UINT16	R/W	Write a setpoint number first before reading following registers
+1		Variation	8		UINT16	R/W	
+2		Condition #1: Trigger parameter ID	F12		UINT16	R/W	
+3		Condition #2: Trigger parameter ID	F12		UINT16	R/W	
+4		Condition #3: Trigger parameter ID	F12		UINT16	R/W	
+5		Condition #4: Trigger parameter ID	F12		UINT16	R/W	
+6		Condition #5: Trigger parameter ID	F12		UINT16	R/W	

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
+7		Condition #6: Trigger parameter ID	F12		UINT16	R/W	
+8		Condition #7: Trigger parameter ID	F12		UINT16	R/W	
+9		Condition #8: Trigger parameter ID	F12		UINT16	R/W	
+10		Condition #1: Logical operator	0 = OR, 1 = AND		UINT16	R/W	
+11		Condition #2: Logical operator	0 = OR, 1 = AND		UINT16	R/W	
+12		Condition #3: Logical operator	0 = OR, 1 = AND		UINT16	R/W	
+13		Condition #4: Logical operator	0 = OR, 1 = AND		UINT16	R/W	
+14		Condition #5: Logical operator	0 = OR, 1 = AND		UINT16	R/W	
+15		Condition #6: Logical operator	0 = OR, 1 = AND		UINT16	R/W	
+16		Condition #7: Logical operator	0 = OR, 1 = AND		UINT16	R/W	
+17		Condition #8: Logical operator	0 = OR, 1 = AND		UINT16	R/W	
+18		Condition #1: Relational operator	F13		UINT16	R/W	
+19		Condition #2: Relational operator	F13		UINT16	R/W	
+20		Condition #3: Relational operator	F13		UINT16	R/W	
+21		Condition #4: Relational operator	F13		UINT16	R/W	
+22		Condition #5: Relational operator	F13		UINT16	R/W	
+23		Condition #6: Relational operator	F13		UINT16	R/W	
+24		Condition #7: Relational operator	F13		UINT16	R/W	
+25		Condition #8: Relational operator	F13		UINT16	R/W	
+26,27		Condition #1: Operate limit			INT32	R/W	
+28,29		Condition #2: Operate limit			INT32	R/W	
+30,31		Condition #3: Operate limit			INT32	R/W	
+32,33		Condition #4: Operate limit			INT32	R/W	
+34,35		Condition #5: Operate limit			INT32	R/W	
+36,37		Condition #6: Operate limit			INT32	R/W	
+38,39		Condition #7: Operate limit			INT32	R/W	
+40,41		Condition #8: Operate limit			INT32	R/W	
+42,43		Condition #1: Release limit			INT32	R/W	
+44,45		Condition #2: Release limit			INT32	R/W	
+46,47		Condition #3: Release limit			INT32	R/W	
+48,49		Condition #4: Release limit			INT32	R/W	
+50,51		Condition #5: Release limit			INT32	R/W	
+52,53		Condition #6: Release limit			INT32	R/W	
+54,55		Condition #7: Release limit			INT32	R/W	
+56,57		Condition #8: Release limit			INT32	R/W	
+58		Action #1: Action ID	F14		UINT16	R/W	
+59		Action #2: Action ID	F14		UINT16	R/W	
+60		Action #3: Action ID	F14		UINT16	R/W	
+61		Action #4: Action ID	F14		UINT16	R/W	
+62,63		Action #1: Parameter value			INT32	R/W	
+64,65		Action #2: Parameter value			INT32	R/W	
+66,67		Action #3: Parameter value			INT32	R/W	
+68,69		Action #4: Parameter value			INT32	R/W	

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
+70,71		Operate delay	0-10000000	0.001 s	UINT32	R/W	
+72,73		Release delay	0-10000000	0.001 s	UINT32	R/W	
59178-59253		Reserved	0		INT16	R/W	
Periodic Timers Setup							
61024-61087							
+0,1		Time interval (positive in seconds, negative in cycles)	-100000000 -100000000	0.001 s/c	UINT32	R/W	
61024-61025		**Timer #1 Setup**		0.001 s/c	UINT32	R/W	
61026-61027		**Timer #2 Setup**		0.001 s/c	UINT32	R/W	
		…					
61040-61041		**Timer #9 Setup**		0.001s/c	UINT32	R/W	
61042-61043		**Timer #10 Setup** (factory preset)	-500 (half-cycle)	0.001cyc	UINT32	R	
61044-61045		**Timer #11 Setup** (factory preset)	-1000 (one cycle)	0.001cyc	UINT32	R	
61046-61047		**Timer #12 Setup** (factory preset)	200 (200 ms = 10/12 cycles)	0.001 s	UINT32	R	
61048-61049		**Timer #13 Setup** (factory preset)	3000 (3 sec = 150/180 cycles)	0.001 s	UINT32	R	
61050-61051		**Timer #14 Setup** (factory preset)	10000 (10 sec)	0.001 s	UINT32	R	
61052-61053		**Timer #15 Setup** (factory preset)	600000 (10 min)	0.001 s	UINT32	R	
61054-61055		**Timer #16 Setup** (factory preset)	7200000 (2 hours)	0.001 s	UINT32	R	
61056-61087		Reserved					
Counter Source Setup							
61472-61727							
+0		Pulse source ID	F16		UINT16	R/W	
+1		Target counter number	0-31		UINT16	R/W	
+2,3		Multiplier	+/-1-10000		INT32	R/W	
61472-61475		**Counter Source #1**					
61476-61479		**Counter Source #2**					
		…					
61724-61727		**Counter Source #32**					
Digital Inputs Setup							
61728-61827							
+0		Pulse mode	0 = pulse, 1 = KYZ		UINT16	R/W	
+1		Polarity	Bit 0 – pulse polarity: 0=normal, 1=inverting Bit 1 – input polarity: 0=normal, 1=inverting		UINT16	R/W	
+2		De-bounce time, ms	1-1000		UINT16	R/W	Note 3
+3		Flags	Not used		UINT16	R/W	
61728-61731		**DI1 Setup**					
61732-61735		**DI2 Setup**					
		…					
61824-61827		**DI25 Setup**					
Relay Outputs Setup							
61984-62061							

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
+0		Operation Mode	0=unlatched, 1=latched, 2=pulse, 3=KYZ		UINT16	R/W	
+1		Flags	Bit 0 – polarity: 0=normal, 1=inverting Bit 1 - retentive mode: 0=disabled, 1=enabled		UINT16	R/W	
+2		Pulse width, ms	1-3000		UINT16	R/W	
+3		Pulse source ID	Not used		UINT16	R/W	
+4,5		Pulse units	Not used		UINT32	R/W	
61984-61989		**RO1 Setup**					
61990-61995		**RO2 Setup**					
		…					
62056-62061		**RO13 Setup**					
Analog Inputs Setup							
62368-62559							
+0		Input parameter ID	0 = input not assigned		UINT16	R/W	
+1		Not used	0		UINT16	R/W	
+2,3		Zero scale value (0/4 mA)	Up to 9 digits including decimal places (±)		INT32	R/W	
+4,5		Full scale value (1/20 mA)	Up to 9 digits including decimal places (±)		INT32	R/W	For ±1 mA and 1 mA inputs, set full scale for 2 mA
62368-62373		**AI1 Setup**					
62374-62559		Reserved					
Common Data Exchange							
47480-47603							
+0		Setup array type	17=IEEE C37.118.2 setup 18=IEC 61850 IED setup 19=IEC 61850 RCB setup 20=IEC 61850 GOOSE publisher setup 22=IEC 61850 SV publisher setup 23=IEEE C37.118.2 channel names		UINT16	R/W	Write the array type and offset before reading/writing following registers
+1		Setup array offset, words	0-578		UINT16	R/W	
+2		Block length, words	0-120		UINT16	R/W	Read as 0
+3		Last block	0=no, 1=yes		UINT16	R/W	Read as 0
+4-123		Setup data [0…119]			UINT16	R/W	
IEC 61850 IED Setup							
[+0-32]		IED name			CHAR66	R/W	
[+33]		IEC 61850 edition	1=Ed2		UINT16	R/W	
[+34-50]		Subnet name			CHAR34	R/W	Default = "W01"
[+51-58]		Access point name			CHAR16	R/W	Default = "S1"
[+59-91]		Location			CHAR66	R/W	
[+92]		Client connection idle timeout	0=disabled, 1-10 min	min	UINT16	R/W	
[+93]		TCP keepalive time	1-60 s	s	UINT16	R/W	Default = 20 s

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
[+94]		Maximum instances/clients per RCB	0=non-indexed, 1, 2, 4		UINT16	R/W	
[+95]		Voltage units	0=V, 1=kV		UINT16	R/W	
[+96]		Current units	0=A, 1=kA		UINT16	R/W	
[+97]		Power units	0=kW, 1=MW		UINT16	R/W	
[+98-109]		Not used	0		UINT16	R/W	
[+110,111]		IED IP address			UINT32	R	Network byte order
[+112,113]		IED subnet mask			UINT32	R	Network byte order
[+114,115]		IED default gateway			UINT32	R	Network byte order
[+116-118]		IED MAC address			CHAR6	R	
IEC 61850 RCB Setup							
[+0]		RCB number	0-7: MET1/URep01-URep08 8-15: MET1/BRep01-BRep08		UINT16	R/W	Write an RCB number first before reading following registers
[+1]		Not used			UINT16	R/W	
[+2-66]		RCB reference (LDInst/RCBName)			CHAR130	R/W	
[+67-131]		RptID			CHAR130	R/W	
[+132]		RptEna	0=no, 1=yes		UINT16	R	
[+133-197]		Dataset reference (without IED name)			CHAR130	R/W	
[+198,199]		ConfRev			UINT32	R/W	
[+200,201]		OptFlds			UINT32	R/W	
[+202,203]		BufTm			UINT32	R/W	
[+204]		SqNum			UINT16	RW	
[+206]		TrgOps			UINT16	R/W	
[+208,209]		IntgPd			UINT32	R/W	
[+210]		Resv	0=no, 1=yes		UINT16	R	
[+211]		RCB type	1=BRCB, 2=URCB		UINT16	R	
[+212]		Max RCB instances	0=non-indexed, 1, 2, 4		UINT16	R	
IEC 61850 GOOSE Publisher Setup							
[+0]		Publisher number	0		UINT16	R/W	Write a publisher number first before reading following registers
[+1]		Not used			UINT16	R/W	
[+2-66]		Goose control block reference (without IED name)	"CTRL/LLN0GOGoCBPub1"		CHAR130	R	
[+67]		Publisher enabled	0 = disabled, 1 = enabled		UINT16	R/W	
[+68-132]		GOOSE ID	"MET1/LLN0GOGoCBPub1"		CHAR130	R/W	
[+133-197]		Dataset reference (without IED name)	"MET1/LLN0$DSetGOOSE1"		CHAR130	R/W	
[+198,199]		Configuration revision	1		UINT32	R/W	Default = 1
[+200]		Needs commissioning	0=no, 1=yes		UINT16	R	Default = 0
[+201-203]		Destination MAC address (multicast)	01:0C:CD:01:00:00 to 01:0C:CD:01:01:FF		CHAR6	R/W	Default = 01:0C:CD:01:01:FF
[+204]		Destination VLAN priority	4		UINT16	R	Default = 4
[+205]		Destination VLAN ID	0		UINT16	R	Default = 0
[+206]		Destination application ID	0-0xFFFF		UINT16	R/W	Default = 0x3001
[+207]		Maximum retransmission interval	500-60000	ms	UINT16	R/W	Default = 5000

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
IEC 61850 SV Publisher Setup							Access via common data exchange
[+0]		SV publisher number	0		UINT16	R/W	Write before r/w other registers
[+1-33]		SV control block name	"MsvCBPub1"		CHAR66	R	Null-terminated string
[+34-66]		SV control block reference (without IED name)	"PMU/LLN0MSMsvCBPub1"		CHAR130	R	Null-terminated string
[+99]		SV transmission enabled	0 = disabled, 1 = enabled		UINT16	R/W	
[+100-164]		SV ID			CHAR130	R/W	Null-terminated string
[+165-229]		Dataset reference (without IED name)	"PMU/LLN0$DSetSV1"		CHAR130	R/W	Null-terminated string
[+230,231]		Configuration revision	1-4294967295		UINT32	R/W	
[+232]		Sample rate, samples/s	1-240		UINT16	R/W	
[+233]		Optional fields (included in multicast SV message)	Bit 7=0: reserved=0 (R) Bit 6=1: RefrTm included (R/W) Bit 5=1: SmpSynch included=1 (R) Bit 4=1: SmpRate included (R/W) Bit 3=1: DatSet included (R/W) Bit 2=1: security included=0 (R) Bit 1=1: timestamp included (R/W) Bit 0=0: reserved=0 (R)		UINT16	R/W	Default = [01110000]
[+234]		Sample mode	1=samples per second		UINT16	R	
[+235-237]		Destination MAC address (multicast)	01:0C:CD:04:00:00 to 01:0C:CD:04:01:FF		CHAR6	R/W	Default = 01:0C:CD:04:01:FF
[+238]		Destination VLAN priority	0-7		UINT16	R/W	Default = 4
[+239]		Destination VLAN ID	0x000-0xFFF		UINT16	R/W	Default = 0
[+240]		Destination application ID	0x4000-0x4FFF		UINT16	R/W	Default = 0x4000
[+241]		Number of ASDU in one APDU	1		UINT16	R	
IEEE C37.118.2 Setup							Access via common data exchange
[+0-9]		Station name			CHAR20	R/W	Up to 16 ASCII characters
[+10]		Client-server TCP/UDP data stream 1 ID	1-65534		UINT16	R/W	Default=7000
[+11]		Phasor coordinate format	0=rectangular, 1=polar		UINT16	R/W	
[+12]		Phasor/frequency data format	0=16-bit integer, 1=32-bit IEEE floating point, 2=32-bit IEEE floating point with actual frequency		UINT16	R/W	
[+13]		PMU reporting rate, frames/s	1,2,3,4,5,6,10,12,15,20,25,30,50, 60,100,120,200,240		UINT16	R/W	Submultiple/multiple of the nominal frequency
[+14]		Global PMU ID	Not used		CHAR16	R/W	16 bytes/32 HEX characters
[+22,23]		PMU latitude	-90.00000-90.00000	deg	FLOAT32	R/W	
[+24,25]		PMU longitude	-180.00000-180.00000	deg	FLOAT32	R/W	
[+26,27]		PMU elevation	Unspecified	m	FLOAT32	R/W	
[+28]		Configuration change count	0-65535		UINT16	R/W	
[+29]		Local UDP port	1024-49151		UINT16	R/W	Default=4713
[+30]		Local TCP port	1024-49151		UINT16	R/W	Default=4712
[+31]		Stop UDP data streams	0=no, 1=yes		UINT16	R/W	
[+32]		Enable spontaneous UDP data stream 1	0=disable, 1=enable		UINT16	R/W	
[+33]		Spontaneous UDP stream 1 destination UDP port	1024-49151		UINT16	R/W	Default=4713
[+34,35]		Spontaneous UDP stream 1 destination IP address	0x01000001-0xFFFFFFFF		UINT32	R/W	Default=225.100.100.1

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
[+36]		Performance/service class	0=P class, 1=M class		UINT16	R/W	
[+37]		Analog data format	0=16-bit integer, 1=32-bit IEEE floating point		UINT16	R/W	
[+38]		Analog data	Bit 0=1: P,Q,S,PF Bit 1=1: P Bit 2=1: Q Bit 3=1: S Bit 4=1: PF		UINT16	R/W	
[+39]		Digital data words	0=none, 1=16DI, 2=32DI		UINT16	R/W	
[+40]		Time synchronization	0=IRIG-B, 1=IEEE 1588 PTPv2		UINT16	R/W	
[+41]		Phasor type	Phasor components (phasor type+1): Bit 0=1: phases Va,Vb,Vc,Ia,Ib,Ic Bit 1=1: positive sequence V1, I1 Bit 2=1: negative sequence V2, I2		UINT16	R/W	
[+42]		Spontaneous CFG frames	0=no, 1=CFG-2, 2=CFG-3		UINT16	R/W	
[+43]		Client-server TCP/UDP stream 1 data rate	Submultiple of the reporting rate		UINT16	R/W	
[+44]		Enable spontaneous UDP data stream 2	0=disable, 1=enable		UINT16	R/W	
[+45]		Spontaneous UDP stream 2 destination UDP port	1024-49151		UINT16	R/W	Default=4713
[+46,47]		Spontaneous UDP stream 2 destination IP address	0x01000001-0xFFFFFFFF		UINT32	R/W	Default=225.100.100.2
[+48]		Spontaneous UDP data stream 1 ID	1-65534		UINT16	R/W	Default=7002
[+49]		Spontaneous UDP stream 1 data rate	Submultiple of the reporting rate		UINT16	R/W	
[+50]		Spontaneous UDP data stream 2 ID	1-65534		UINT16	R/W	Default=7003
[+51]		Spontaneous UDP stream 2 data rate	Submultiple of the reporting rate		UINT16	R/W	
[+52]		Client-server TCP/UDP data stream 2 ID	1-65534		UINT16	R/W	Default=7001
[+53]		Client-server TCP/UDP stream 2 data rate	Submultiple of the reporting rate		UINT16	R/W	
IEEE C37.118.2 Channel Names Setup							Access via common data exchange
[+0-9]		VA name			CHAR16	R/W	Up to 16 ASCII characters
[+10-19]		VB name			CHAR16	R/W	
[+20-29]		VC name			CHAR16	R/W	
[+30-39]		IA name			CHAR16	R/W	
[+40-49]		IB name			CHAR16	R/W	
[+50-59]		IC name			CHAR16	R/W	
[+60-69]		V1 name			CHAR16	R/W	
[+70-79]		I1 name			CHAR16	R/W	
[+80-89]		V2 name			CHAR16	R/W	
[+90-99]		I2 name			CHAR16	R/W	
[+100-319]		Reserved			CHAR16	R/W	
[+320-329]		P name			CHAR16	R/W	
[+330-339]		Q name			CHAR16	R/W	
[+340-349]		S name			CHAR16	R/W	
[+350-359]		PF name			CHAR16	R/W	
[+360-479]		Reserved			CHAR16	R/W	
[+480-489]		DI1 name			CHAR16	R/W	

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
[+490-499]		DI2 name			CHAR16	R/W	
…		…					
[+790-799]		DI32 name			CHAR16	R/W	

3.7 Expansion I/O Slots Configuration

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
Expansion I/O Slots Configuration Info							
63008-63071							
+0		I/O type	Bitmap		UINT16	R	Note 2
+1		Number of I/Os on the slot	0-8		UINT16	R	
+2		First I/O number on the slot	0-24		UINT16	R	Note 1
+3		Last I/O number on the slot	0-24		UINT16	R	Note 1
63008-63011		**I/O Slot #1 Configuration**					
63012-63015		**I/O Slot #2 Configuration**					
63016-63019		**I/O Slot #3 Configuration**					
63020-63023		**I/O Slot #4 Configuration**					
63024-63067		Reserved					
On-board I/O Configuration Info							
63068-63071		**On-board AI Configuration Info**					
+0		On-board AI type (programmable)	Bitmap		UINT16	R/W	Note 2
+1		Number of on-board AI's	1		UINT16	R	
+2		First I/O number on the slot	0		UINT16	R	Note 1
+3		Last I/O number on the slot	0		UINT16	R	Note 1
Expansion I/O Modules Type Info							
63072-63119							
+0		Number of I/O modules of this type	0-3		UINT16	R	
+1		Total number of I/O's of this type	0-24		UINT16	R	
+2		Not used			UINT16	R	
+3		Not used	0		UINT16	R	
63072-63075		**DI Module Type Info**					
63076-63079		**RO Module Type Info**					
63080-63083		**AI Module Type Info**					
63084-63087		**AO Module Type Info**					
63088-63119		Reserved					

NOTES:

1. I/O numbers of expansion I/O modules are automatically assigned in the order of connection. The connection order is counted for each I/O module type separately.
If the I/O module position is changed but its order in the chain of the modules of the same type is preserved, then all I/Os on the module will retain their I/O numbers. On the dual AI/AO module, both AI and AO will have same logical I/O range.

2. The type of a module in the corresponding slot position, number of I/Os on the module and their I/O numbers can be read through the Expansion I/O Slots Configuration Info registers. I/O module type register contains bit-mapped information on the module type and its options in bits D7:D0 as shown in the Table below.

3. The same debounce time is used for each group of two adjacent digital inputs. Changing the debounce time for any input in a group will automatically set the same time for the paired input.

I/O Module Type

Module	Option	D7	D6	D5	D4	D3	D2	D1	D0
8DI		0	0	0	0	1	0	0	0
4DO		0	0	0	1	1	0	0	0
On-board AI	±1 mA	0	0	1	0	0	0	0	0
On-board AI	0-20 mA	0	0	1	0	0	0	0	1
On-board AI	4-20 mA	0	0	1	0	0	0	1	0
On-board AI	0-1 mA	0	0	1	0	0	0	1	1
Empty slot		1	1	1	1	1	1	1	1

3.8 File Transfer Blocks

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
File Transfer Control Blocks							
63120-63151		**File Request Block**					
+0		File function	1 = ACK - acknowledgement 3 = set file position 5 = reset file position 7 = find 11 = read file 127 = erase file		UINT16	R/W	1 - clears the file transfer block 3 - changes the file position 5 - sets the file position at the first (oldest) record 7 - finds a record matching an event or/and time (see Note 3) 11 - opens the file for reading from the present file position
+1		File ID	F2		UINT16	R/W	
+2		Section number (functions 3, 5, 11)	0		UINT16	R/W	
+3		Section channel ID (functions 3, 5, 11)	0		UINT16	R/W	
+4		Record sequence number (functions 3, 11)	0-65535		UINT16	R/W	The record sequence number with function 11 does not change the file position (see Note 2).
+5		Request variation (function 11)	0, 4		UINT16	R/W	See file response headings
+6		Find key: Event type	F22		UINT16	R/W	Note 2
+7		Find key: Event number	1 - 65535		UINT16	R/W	Note 2
+8, 9		Find key: Start time, seconds since 1/1/1970	F1	sec	UINT32	R/W	Note 2
+10,11		Find key: Start time, fraction of second in µsec	0-999999	µsec	UINT32	R/W	Note 2
+12,13		Find key: End time, seconds since 1/1/1970	F1	sec	UINT32	R/W	Note 2
+14,15		Find key: End time, fraction of second in µsec	0-999999	µsec	UINT32	R/W	Note 2
+16-31		Reserved			UINT16	R/W	
63152-64943		**File Response Block**					
		Data transfer area [0 – 1791]			UINT16	R	
64944-64951		**File Info Request Block**					
+0		File function	9 = read file info		UINT16	R/W	
+1		File ID	F2		UINT16	R/W	
+2		Section number	0		UINT16	R/W	
+3		Section channel ID	0		UINT16	R/W	
+4		Not used	0		UINT16	R/W	
+5		Request variation	0, 1, 2		UINT16	R/W	
+6-7		Reserved			UINT16	R/W	
64952-65151		**File Info Response Block**					
		Data transfer area [0 - 199]			UINT16	R	

NOTES:

1. The record sequence number with function 11 (Read-File) does not change the file position and is used only as a reference to track the order of records. The file transfer block will continue to hold the same data until it is acknowledged, or until the file position is explicitly moved to another record. The file position is automatically moved to the next record after acknowledgment.

2. Function 7 (Find) puts into the file request block the sequence number of the first record in the file that matches the event or/and the time. Any one of the find keys can be omitted by setting it to 0. If one or a number of find keys are omitted, the device will use the remaining keys to locate the matching record. If the record could not be found, the device responds to the write request with the exception code 3 (illegal data). The status of the operation can be read through the file status word in the file info block.

File Response Blocks

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
File Info Response Block (Variation 0 – File info)							
64952-64959		**Block Heading**					
+0		File function	9		UINT16	R	
+1		File ID	F2		UINT16	R	
+2		Section number	0		UINT16	R	
+3		Section channel ID	0		UINT16	R	
+4		Number of records in the block	1		UINT16	R	
+5		Record size, words	36		UINT16	R	
+6		Request variation	0		UINT16	R	
+7		Reserved	0		UINT16	R	
64960-64997		**File Info**					
+0		File type	0		UINT16	R	
+1		File attributes	F3		UINT16	R	
+2		File (section) status	F4		UNT16	R	
+3		Number of sections in the file	0		UINT16	R	
+4,5		File channel mask (channels 1-32), bitmap	0		UINT32	R	
+6,7		File channel mask (channels 33-64), bitmap	0		UINT32	R	
+8		Number of records in the file	0-65535		UINT16	R	
+9		Number of records until the end of the file	0-65535		UINT16	R	
+10		Current record (read position) sequence number	0-65535		UINT16	R	
+11		Current write position sequence number	0-65535		UINT16	R	
+12		First (oldest) record sequence number	0-65535		UINT16	R	
+13		Last (newest) record sequence number	0-65535		UINT16	R	
+14,15		Last record time, seconds since 1/1/1970	F1	sec	UINT32	R	
+16,17		Last record time, fraction of second	0-999999	µsec	UINT32	R	
+18,19		First record time, seconds since 1/1/1970	F1	sec	UINT32	R	
+20,21		First record time, fraction of second	0-999999	µsec	UINT32	R	
+22,23		Creation time, seconds since 1/1/1970	F1	sec	UINT32	R	
+24,25		Creation time, fraction of second	0-999999	µsec	UINT32	R	
+26,27		Reset time, seconds since 1/1/1970	F1	sec	UINT32	R	
+28,29		Reset time, fraction of second	0-999999	µsec	UINT32	R	
+30		Maximum number of records	0-65535		UINT16	R	
+31		Number of parameters per data section record	0-16		UINT16	R	
+32		Section record size, bytes		Byte	UINT16	R	
+33		File record size, bytes		Byte	UINT16	R	
+34,35		Allocated file size, bytes		Byte	UINT32	R	

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
File Info Response Block (Variation 1 – Current record info)							
64952-64959		**Block Heading**					
+0		File function	9		UINT16	R	
+1		File ID	F2		UINT16	R	
+2		Section number	0		UINT16	R	
+3		Section channel ID	0		UINT16	R	
+4		Number of records in the block	1		UINT16	R	
+5		Record size, words	8		UINT16	R	
+6		Request variation	1		UINT16	R	
+7		Reserved	0		UINT16	R	
64960-64997		**File Info**					
+0		File (section) status	F4		UNT16	R	
+1		Number of records in the file	0-65535		UINT16	R	
+2		Number of records until the end of the file	0-65535		UINT16	R	
+3		Current record (read position) sequence number	0-65535		UINT16	R	
+4,5		Current record time, seconds since 1/1/1970	F1	sec	UINT32	R	
+6,7		Current record time, fraction of second	0-999999	µsec	UINT32	R	
File Info Response Block (Variation 2 – Data log record structure)							
64952-64959		**Block Heading**					
+0		File function	9		UINT16	R	
+1		File ID	1-8		UINT16	R	
+2		Section number	0		UINT16	R	
+3		Section channel ID	0		UINT16	R	
+4		Number of records in the block	1		UINT16	R	
+5		Record size, words	2 + Number of parameters		UINT16	R	
+6		Request variation	2		UINT16	R	
+7		Reserved	0		UINT16	R	
64960-65151		**File Info**					
+0		Not used	0		UINT16	R	
+1		Number of fields in a data record	1-16		UINT16	R	
+2		Field 1 parameter ID	0-0xFFFF		UINT16	R	
+3		Field 2 parameter ID	0-0xFFFF		UINT16	R	
…		…					
Event Log Response Block							
63152-63159		**Block Heading**					
+0		Last file function	1, 3, 5, 11		UINT16	R	
+1		File ID	0		UINT16	R	
+2		Section number	0		UINT16	R	
+3		Section channel ID	0		UINT16	R	
+4		Number of records in the block	1-32		UINT16	R	
+5		Record size, words	12		UINT16	R	
+6		Request variation	0		UINT16	R	
+7		Reserved	0		UINT16	R	

Address	Point ID	Description	Options/Range	Units	Type	R/W	Notes
63160-63543		**Event Log Records**					
+0		Record status	F5		INT16	R	
+1		Record sequence number	0-65535		UINT16	R	
+2, 3		Trigger time, seconds since 1/1/1970	F1	sec	UINT32	R	
+4, 5		Trigger time, fraction of second in µsec	0-999999	µsec	UINT32	R	
+6		Event number	1-65535		UINT16	R	
+7		Event point/source ID	F19		UINT16	R	
+8		Event effect	F20		UINT16	R	
+9		Reserved	0		UINT16	R	
+10,11		Value triggered			INT32	R	
63160-63171		**Record #1**					
		…					
63532-63543		**Record #32**					
Data Log Response Block							
63152-63159		**Block Heading**					
+0		Last file function	1, 3, 5, 11		UINT16	R	
+1		File ID	1-8 (F2)		UINT16	R	
+2		Section number	0		UINT16	R	
+3		Section channel ID	0		UINT16	R	
+4		Number of records in the block	1-32		UINT16	R	
+5		Record size, words	8 + 2×Number of parameters		UINT16	R	
+6		Request variation	0		UINT16	R	
+7		Reserved	0		UINT16	R	
63160-64439		**Data Log Records**					
+0		Record status	F5		INT16	R	
+1		Record sequence number	0-65535		UINT16	R	
+2,3		Record time, seconds since 1/1/1970	F1	sec	UINT32	R	
+4,5		Record time, fraction of second in µsec	0-999999	µsec	UINT32	R	
+6		Trigger event type	F22		INT16	R	
+7		Trigger event number	1-65535		UINT16	R	
+8,9		Log value #1			INT32	R	
+10,11		Log value #2			INT32	R	
…		…				R	
63160-…		**Record #1** (variable length)					
		…					
		Record #32 (variable length)					

4 Data Scales and Units

Code	Condition	Value/Range	Notes
Data Scales			
Vmax		Voltage Scale × PT Ratio, V	2
Imax		Current Scale × CT Ratio, A,	1, 3
Pmax	PT Ratio = 1	Vmax × Imax × 2, W	4
	PT Ratio > 1	(Vmax × Imax × 2)/1000, kW	4
AImin AImax	+/-1mA	AImin = -AI full scale (at -2 mA) AImax = AI full scale (at +2 mA)	5
	0-20mA	AImin = AI zero scale AImax = AI full scale	5
	4-20mA	AImin = AI zero scale AImax = AI full scale	5
	0-1mA	AImin = AI zero scale AImax = AI full scale (at 2 mA))	5
Data Units			
U1	PT Ratio = 1	0.1V	
	PT Ratio > 1	1V	
U2		0.01A	
U3	PT Ratio = 1	1W/Var/VA	
	PT Ratio > 1	1kW/kvar/kVA	
	V4 PT Ratio > 1	1V	

1 CT Ratio = CT primary current/CT secondary current

2 The Voltage Scale is configurable via the Modbus Setup registers (see Section 3.1) or via the Basic Setup in PAS. The default value is 144V.

3 The Current Scale is configurable via the Modbus Setup registers (see Section 3.1) or via the Basic Setup in PAS. The default value is 2×CT secondary current.

4 Pmax is rounded to whole kilowatts. When PT=1.0, Pmax is limited to 9,999,000 watts and is truncated to this value if greater.

5 AI zero and full scales are engineering scales configurable via the Analog Input Setup in PAS (see the PMU Installation and Operation Manual).

5 Data Formats

Format Code	Value	Description	Notes
Timestamp			
F1		Local time in a UNIX-style format. Represents the number of seconds since midnight (00:00:00), January 1, 1970. The time is valid after January 1, 2000.	
File ID			
F2	0	Event log	
	1-8	Data log #1-#8	
File Attributes			
F3	Bit 0 = 0	Non-wrap file (stop when full)	
	Bit 0 = 1	Wrap-around (circular) file	
File Status Word (bitmap)			
F4	Bit 0 = 1	The last record of the file is being read	
	Bit 8 = 1	File is empty	
	Bit 9 = 1	Reading after EOF	
	Bit 10 = 1	Corrupted record (CRC error)	
	Bit 11 = 1	No file section found for the requested channel	
	Bit 12 = 1	Reading after the end of a data block	
	Bit 13 = 1	File is not accessible	
	Bit 14 = 1	Record not found	
	Bit 15 = 1	Generic read error (with one of the bits 8-14)	
File Record Status Word (bitmap)			
F5	Bit 0 = 1	The last record of the file is being read	
	Bit 8 = 1	File is empty	
	Bit 9 = 1	Reading after EOF	
	Bit 10 = 1	Corrupted record (CRC error)	
	Bit 11 = 1	No file section found for the requested channel	
	Bit 12 = 1	Reading after the end of a data block	
	Bit 13 = 1	File is not accessible	
	Bit 14 = 1	Record not found	
	Bit 15 = 1	Generic read error (with one of the bits 8-14)	
Setpoint Trigger Parameters ID			
F12	0x0000-0xFFFF	Any data point ID	See Section 3.4
Setpoint Relational Operator			
F13	0 = NONE	No relation (used with pulsed events)	
	1 = GREATER OR EQUAL	Analog value or counter is over the operate limit	
	2 = LESS OR EQUAL	Analog value or counter is under the operate limit	
	3 = EQUAL	Analog value or counter is equal to the operate limit	
	4 = NOT EQUAL	Analog value or counter is not equal to the operate limit	
	5 = ON	Binary status is 1/ON	
	6 = OFF	Binary status is 0/OFF	
	7 = NEW	New Min/Max value logged for the point	
	8 = Delta	The absolute value of the difference between the last reported value and the current value exceeds the specified threshold	
	12 = Delta+	Incremental delta - the positive difference between the current value and the last reported value exceeds the specified threshold	
	13 = Delta-	Decremental delta - the positive difference between the last reported value and the current value exceeds the specified threshold	
	14 = rDelta	Relative delta - the absolute value of the difference between the last tested value and the current value exceeds the specified threshold	
	15 = rDelta+	Incremental relative delta - the positive difference between the current value and the last tested value exceeds the specified threshold	
	16 = rDelta-	Decremental relative delta - the positive difference between the last tested value and the current value exceeds the specified threshold	
Setpoint Action ID			
F14	0x0000	No action	
	0x2000-0x201F	Set user event flag #1-#32	
	0x2100-0x211F	Clear user event flag #1-#32	

Format Code	Value	Description	Notes
	0x3000-0x300C	Operate relay RO1-RO13	
	0x3100-0x310C	Release latched relay RO1-RO13	
	0x4000-0x401F	Increment counter #1-#32	
	0x4100-0x411F	Decrement counter #1-#32	
	0x4200-0x421F	Clear counter #1-#32	
	0x5100	Send event notification	
	0x5300	Remote control	
	0x6400	Clear all counters	
	0x7000	Event log on setpoint operated	
	0x7001	Event log on setpoint released	
	0x7002	Event log on any setpoint transition	
	0x7100-0x7107	Data log 1-8	
Counter Source ID			
F16	0x0000	None	
	0x0700-0x0718	Pulse input DI1-DI25	
Event Source/Point ID			
F19		**Setpoint Operation Events**	
	0x0000-0x59FF	Trigger parameter ID	
	0x6400-0xFFFF	Trigger parameter ID	
		Setpoint Action Events	
	0x5A00-0x5A1F	Setpoint #1-#32	
		Communications Events	
	0x5B00-0x5BFF	Data/Function point ID (low byte, see F21)	
		Self-Check Diagnostics Events	
	0x5D00-0x5DFF	Data/Function point ID (low byte, see F21)	
		Self-Update Events	
	0x5E08	RTC DST/Standard time update	1
		Run-time Error	
	0x6014	Library error	
	0x6015	RTOS Kernel error	
	0x6016	Task error	
		Control Events	
	0x6103	Remote control (Value: 0=OFF, 1=ON)	
		Hardware Diagnostics Events	
	0x6201	Permanent fault	
	0x6202	RAM/Data error	
	0x6203	CPU watchdog reset	
	0x6204	DSP/Sampling fault	
	0x6205	CPU exception	
	0x6206	Reserved	
	0x6207	Software watchdog reset	
	0x620D	Low battery	
	0x620E	Expanded memory fault (Event effect = File ID + 1)	
	0x620F	CPU EEPROM fault	
	0x6210	AC board EEPROM fault	
	0x6211	I/O board EEPROM fault	
		External Events	
	0x6300	Power down	
	0x6308	Power up	
	0x6309	External reset	
	0x6318	IRIG-B/PTP signal lost	
	0x6319	IRIG-B/PTP time unlocked	
	0x631A	IRIG-B/PTP time locked	
Event Effect ID			
F20		**Communications/Self-check/Self-update Events**	
	0x0000	None	
	0x6400	All counters cleared	
	0x6401-0x641F	Counter cleared (low byte = counter ID)	
	0x6A00-0x6A08	Log file cleared (low byte = File ID)	
	0x6B06	Communication counters cleared	
	0xF100-0xF11F	Setpoint cleared (low byte = setpoint ID)	
	0xF200	Setup/Data cleared	
	0xF300	Setup reset (set by default)	
	0xF400	Setup changed	
	0xF500	RTC set	1
	0xF600	Device function/option enabled	
	0xF700	Device function/option disabled	

Format Code	Value	Description	Notes
	0xF800	Device function restarted	
	0xF900	Device function stopped	
	0xFA00	Operation succeeded	
	0xFB00	No change detected	
	0xFC00	Operation failed	
	0xFD00	Calibrated	
		Setpoint Operation Events	
	0xE100-0xE11F	Setpoint operated (low byte = setpoint ID)	
	0xE200-0xE21F	Setpoint released (low byte = setpoint ID)	
		Setpoint Action Events	
	See F14	Setpoint action ID	
Data/Function Point ID			
F21		**Data Location**	
	0x03	Data memory	
	0x04	Factory setup	
	0x05	Access/Password setup	
	0x06	Basic setup	
	0x07	Communications setup	
	0x08	Real-time clock	
	0x09	Digital inputs setup	
	0x0A	Pulse counters setup	
	0x0E	Timers setup	
	0x10	Event/alarm setpoints	
	0x12	User assignable register map	
	0x13	Reserved	
	0x14	Data log setup	
	0x15	File/Memory setup	
	0x1D	RO Setup	
	0x1C	User selectable options	
	0x1F	DNP 3.0 class 0 map	
	0x20	DNP 3.0 options setup	
	0x21	DNP 3.0 events setup	
	0x22	DNP 3.0 event setpoints	
	0x23	Calibration registers	
	0x24	Date/Time Setup	
	0x25	Net setup	
	0x26	AI setup	
	0x2A	Device mode control	
	0x2B-0x2C	Reserved	
	0x2D	Transformer correction setup	
	0x2E	IEC 61850 setup	
	0x2F	Reserved	
	0x30	IEC 60870 setup	
	0x33	IEEE C37.118.2 setup	
	0x34	PMU setup	
		Device Mode/Operation	
	0x40	General device operations	
	0x42	Setpoints mode	
	0x4C	Firmware download	2
	0x4F	Password tampering attempt	
		Device Diagnostics	
	0x80	Device diagnostics	
	0x81	Critical error	
Event Type ID			
F22		**Setpoint Events**	
	0x0000	SP: Generic setpoint event	
	0x0001-0x0020	SP1-SP32: Setpoint #1-#32 event	
		DI Events	
	0x0300	DI: Generic DI event	
	0x0301-0x0319	DI1-DI25: DI1-DI25 event	
		RO Events	
	0x0400	RO: Generic RO event	
	0x0401-0x040D	RO1-RO13: RO1-RO13 event	
Device Diagnostics (bitmap)			
F23	Bit 0 = 1	Critical error	
	Bit 1 = 1	Permanent fault (critical error)	
	Bit 2 = 1	RAM/Data error	

Format Code	Value	Description	Notes
	Bit 3 = 1	CPU watchdog reset	
	Bit 4 = 1	DSP/Sampling fault	
	Bit 5 = 1	CPU exception	
	Bit 6	Reserved	
	Bit 7 = 1	Software watchdog reset	
	Bit 8 = 1	Power down	
	Bit 9 = 1	Device reset	
	Bit 10 = 1	Configuration reset	
	Bit 11 = 1	RTC fault (critical error)	
	Bit 12 = 1	Configuration fault (critical error)	
	Bit 13	Reserved	
	Bit 14 = 1	Expanded memory fault	
	Bit 15 = 1	CPU EEPROM fault	
	Bit 16 = 1	AC board EEPROM fault	
	Bit 17 = 1	I/O board EEPROM fault	
	Bit 18	Reserved	
	Bit 19	Reserved	
	Bit 20 = 1	C Library error	
	Bit 21 = 1	RTOS Kernel error	
	Bit 22 = 1	Task error	
	Bit 23	Reserved	
	Bit 24 = 1	IRIG-B/PTP signal lost	
	Bit 25 = 1	IRIG-B/PTP time unlocked	
DNP Object Types			
F24		**Binary Input Static Object**	
	0	Single-Bit Binary Input	
	1	Binary Input With Status	
		Binary Input Change Event Object	
	0	Binary Input Change Without Time	
	1	Binary Input Change With Time	
		Binary Counter	
	0	32-bit Binary Counter	
	1	32-bit Binary Counter Without Flag	
	2	16-bit Binary Counter	
	3	16-bit Binary Counter Without Flag	
		Binary Counter Change Event	
	0	32-bit Counter Change Event Without Time	
	1	32-bit Counter Change Event With Time	
	2	16-bit Counter Change Event Without Time	
	3	16-bit Counter Change Event With Time	
		Analog Input	
	0	32-bit Analog Input	
	1	32-bit Analog Input Without Flag	
	2	16-bit Analog Input	
	3	16-bit Analog Input Without Flag	
		Analog Input Change Event	
	0	32-bit Analog Change Event Without Time	
	1	32-bit Analog Change Event With Time	
	2	16-bit Analog Change Event Without Time	
	3	16-bit Analog Change Event With Time	
DNP Class 0 Objects			
F25	0x1E01	Analog Input 30:01	
	0x1E02	Analog Input 30:02	
	0x1E03	Analog Input 30:03	
	0x1E04	Analog Input 30:04	
	0x2801	Analog Output 40:01	
	0x2802	Analog Output 40:02	
	0x0101	Binary Input 01:01	
	0x0102	Binary Input 01:02	
	0x1401	Binary Counter 20:01	
	0x1402	Binary Counter 20:02	
	0x1405	Binary Counter 20:05	
	0x1406	Binary Counter 20:06	
IEC 61850 Measured Value Indices			
F27	0	Phase voltage	
	1	Not used	
	2	Not used	

Format Code	Value	Description	Notes
	3	Phase currents	
	4	Neutral current	
	5	Not used	
	6	Not used	
	7	Not used	
	8	Not used	
	9	Voltage sequence	
	10	Current sequence	
	11	Not used	
	12	Voltage unbalance	
	13	Current unbalance	
	14	Active power	
	15	Reactive power	
	16	Active power import/export	
	17	Reactive power import/export	
	18	Apparent power	
	19	Not used	
	20	Not used	
	21	Not used	
	22	Power factor	
	23	Not used	
	24	Frequency	
	25	Not used	
	26	Not used	
	27	Not used	
	28	Not used	
	29	Not used	
	30	Not used	
	31	Not used	
	32	Not used	
	33	Analog input #1	
Single Point Info Static Type			
F30	1	M_SP_NA_1	
	2	M_SP_TA_1 (CP24Time2a)	
	30	M_SP_TB_1 (CP56Time2a)	
Single Point Info Event Type			
F31	2	M_SP_TA_1 (CP24Time2a)	
	30	M_SP_TB_1 (CP56Time2a)	
Double Point Info Static Type			
F32	3	M_DP_NA_1	
	4	M_DP_TA_1 (CP24Time2a)	
	31	M_DP_TB_1 (CP56Time2a)	
Double Point Info Event Type			
F33	4	M_DP_TA_1 (CP24Time2a)	
	31	M_DP_TB_1 (CP56Time2a)	
Measured Value Static Type			
F34	9	M_ME_NA_1	
	10	M_ME_NB_1	
	11	M_ME_NC_1	
	12	M_ME_TA_1 (CP24Time2a)	
	13	M_ME_TB_1 (CP24Time2a)	
	14	M_ME_TC_1 (CP24Time2a)	
	34	M_ME_TD_1 (CP56Time2a)	
	35	M_ME_TE_1 (CP56Time2a)	
	36	M_ME_TF_1 (CP56Time2a)	
Measured Value Event Type			
F35	12	M_ME_TA_1 (CP24Time2a)	
	13	M_ME_TB_1 (CP24Time2a)	
	14	M_ME_TC_1 (CP24Time2a)	
	34	M_ME_TD_1 (CP56Time2a)	
	35	M_ME_TE_1 (CP56Time2a)	
	36	M_ME_TF_1 (CP56Time2a)	
Integrated Totals Static Type			
F36	15	M_IT_NA_1	
	16	M_IT_TA_1 (CP24Time2a)	
	37	M_IT_TB_1 (CP56Time2a)	

Format Code	Value	Description	Notes
Integrated Totals Event Type			
F37	16	M_IT_TA_1 (CP24Time2a)	
	37	M_IT_TB_1 (CP56Time2a)	
PMU Time Quality (bitmap)			
F39	Bits 0:3	0xF = clock failure, time not reliable 0xB = time within 10 s 0xA = time within 1 s 0x9 = time within 100 ms 0x8 = time within 10 ms 0x7 = time within 1 ms 0x6 = time within 100 µs 0x5 = time within 10 µs 0x4 = time within 1 µs 0x3 = time within 100 ns 0x2 = time within 10 ns 0x1 = time within 1 ns 0x0 = locked to UTC traceable source	
	Bit 4	Leap second pending	
	Bit 5	Leap second occurred	
	Bit 6	Leap second direction, 0 = add, 1=delete	
PMU Frame Status (bitmap)			
F40	Bits 0:3	Trigger reason	
	Bits 4:5	Unlocked time: 0 = sync locked or unlocked time < 10 s (best quality) 1 = unlocked time < 100 s 2 = unlocked time <= 1000 s 3 = unlocked time > 1000 s	
	Bits 6:8	PMU time quality: 1 = maximum time error < 100 ns 2 = maximum time error < 1 µs 3 = maximum time error < 10 µs 4 = maximum time error < 100 µs 5 = maximum time error < 1 ms 6 = maximum time error < 10 ms 7 = maximum time error > 10 ms or time error unknown	
	Bit 9	1 = data modified by post processing, 0 = otherwise	
	Bit 10	Configuration change, set to 1 for 1 min to advise configuration will change, and cleared to 0 when change effected	
	Bit 11	1 = PMU trigger detected, 0 = no trigger	
	Bit 12	Data sorting, 0 = by timestamp, 1 = by arrival	
	Bit 13	0 = PMU in sync with a UTC traceable time source	
	Bits 14:15	Data error: 0 = good measurement data 1 = PMU error (no information about data) 2 = PMU in test mode or absent data tags inserted (do not use values) 3 = PMU error (do not use values)	

NOTES:

[1] The event value field indicates the present device time in the F1 format.

[2] The event value field indicates the firmware version number in the following order: byte 0 = major number, byte 1 = minor number, byte 2 = build number.

6 Configuring Modbus

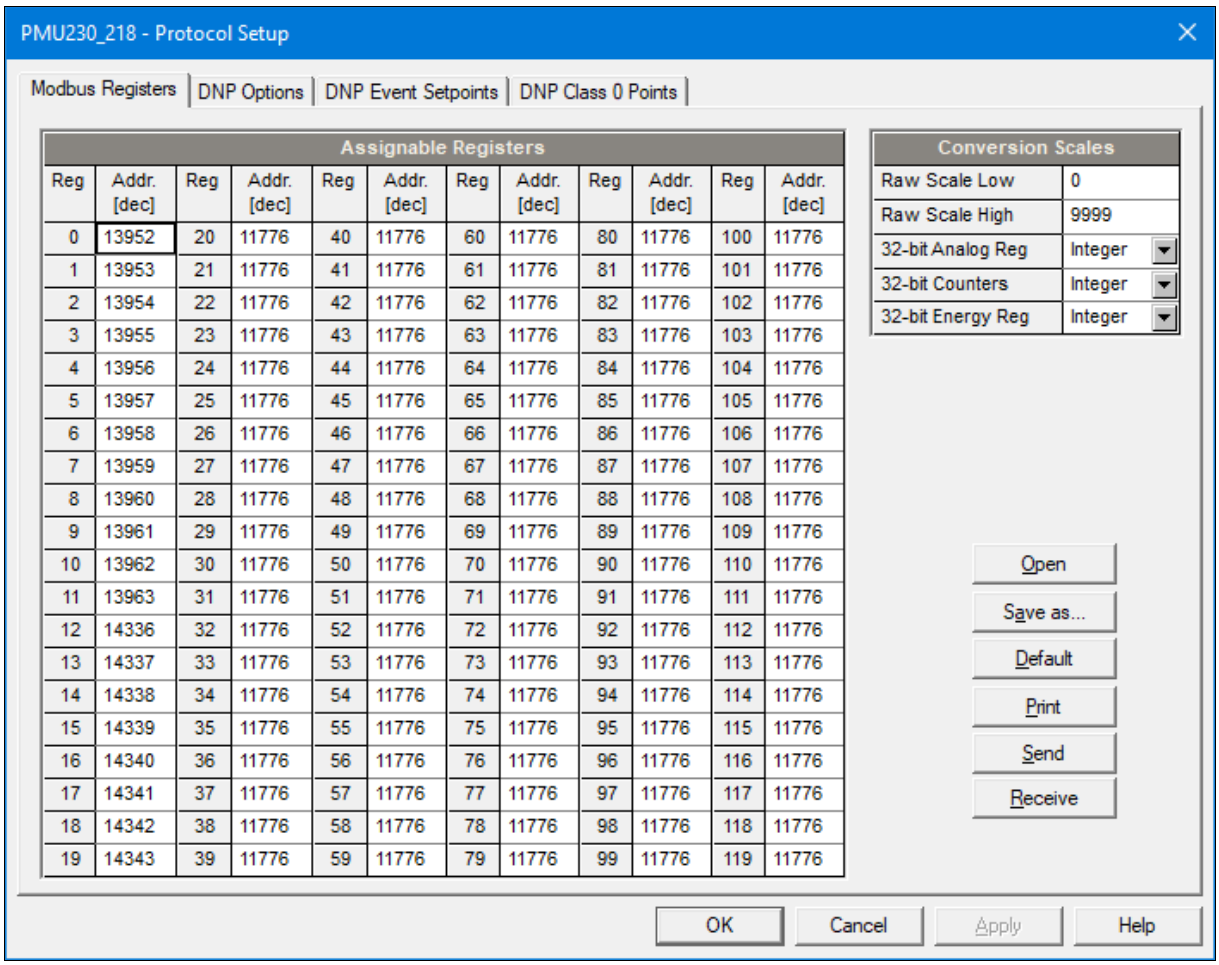
6.1 Configuring Assignable Registers

The PMU provides 120 user assignable registers in the address range of 0 to 119. You can re-map any register available in the device to any assignable register so that Modbus registers that reside at different locations may be simply accessed using a single request by re-mapping them to adjacent addresses.

Initially these registers are reserved and none of them points to an actual data register.

To build your own Modbus register map:

1. From the Meter Setup menu select Protocol Setup and click on the Modbus Registers tab.
2. Click on the Default button to cause the assignable registers to reference the actual default device register 11776 (0 through 119 are not allowable register addresses for re-mapping).



3. Type in the actual addresses you want to read from or write to via the assignable registers. Refer to the Section 3 for a list of the available registers. Note that 32-bit Modbus registers should always start at an even register address.
4. Click Send to download your setup to the device.

6.2 Configuring the 16-bit Conversion Scale

16-bit analog registers are normally read with scaling to the default range of 0 to 9999.

To change the default conversion scale:

1. Select Protocol Setup from the Meter Setup menu, and click on the Modbus Registers tab.
2. Select the desired 16-bit low and high conversion scales in the Conversion Scales pane. The allowable range is 0 to 65535.
3. Click Send to download your setup to the device.

6.3 Selecting 32-bit Register Format

32-bit Modbus analog registers and binary counters can be read in either integer or IEEE single precision floating point format. Both are factory set to 32-bit integer format.

To change the registers format:

1. Select Protocol Setup from the Meter Setup menu, and click on the Modbus Registers tab.
2. Select the desired 32-bit register format in the Conversion Scales pane.
3. Click Send to download your setup to the device.