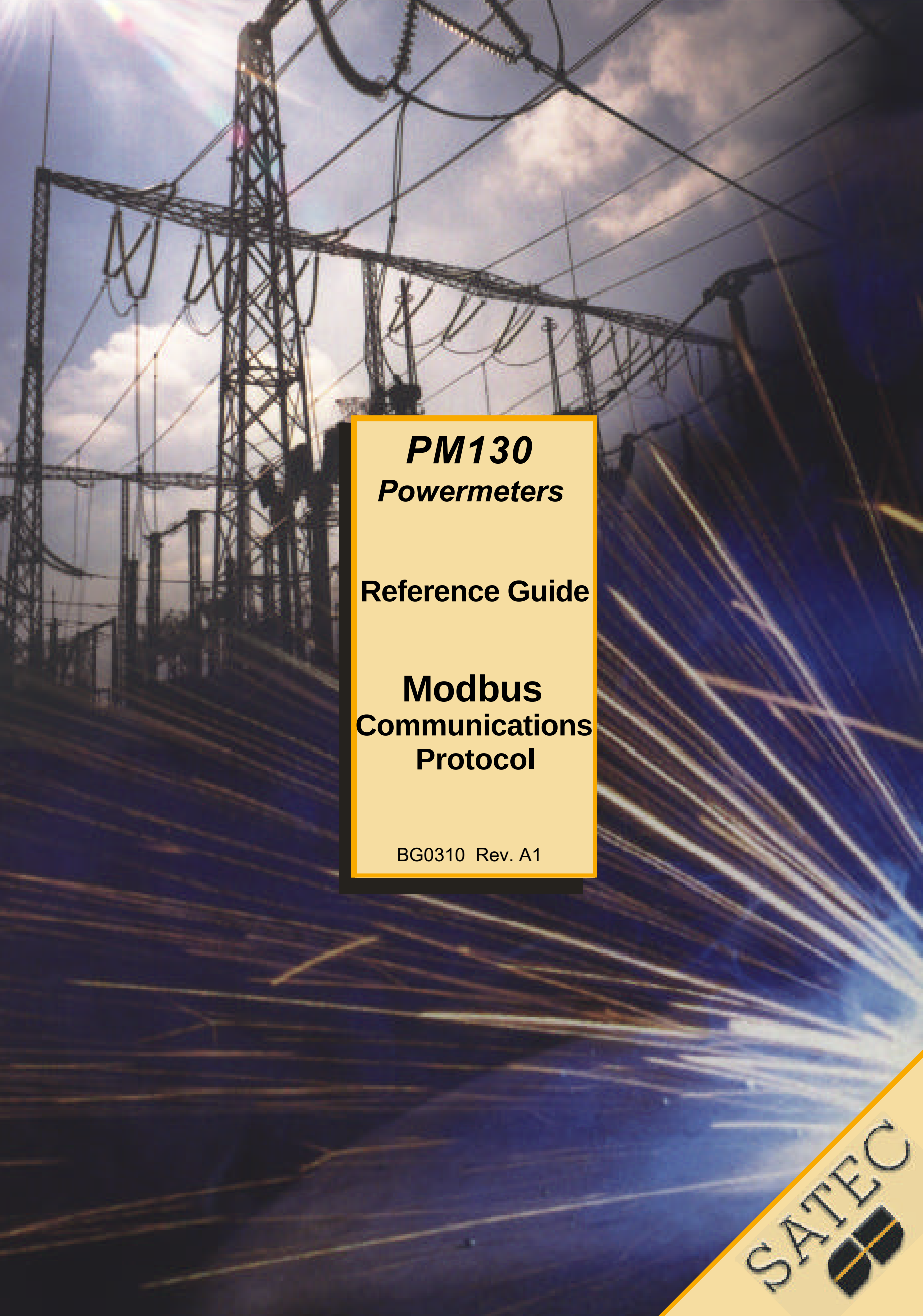

PM130
Powermeters

Reference Guide

Modbus
Communications Protocol

BG0310 Rev. A1

SATEC

SERIES PM130 POWERMETERS

COMMUNICATIONS

Modbus Communications Protocol

REFERENCE GUIDE

Every effort has been made to ensure that the material herein is complete and accurate. However, the manufacturer is not responsible for any mistakes in printing or faulty instructions contained in this book. Notification of any errors or misprints will be received with appreciation.

For further information regarding a particular installation, operation or maintenance of equipment, contact the manufacturer or your local representative or distributor.

BG0310 Rev.A1

Table of Contents

1 GENERAL

This document specifies a subset of the Modbus serial communications protocol used to transfer data between a master computer station and the PM130. The document provides the complete information necessary to develop a third-party communications software capable of communication with the Series PM130 Powermeters. Additional information concerning communications operation, configuring the communications parameters, and communications connections is found in "Series PM130 Powermeters, Installation and Operation Manual".

IMPORTANT

In 3-wire connection schemes, the unbalanced current and phase readings for power factor, active power, and reactive power will be zeros, because they have no meaning. Only the total three-phase power values can be used.
Most of the instrument advanced features are configured using multiple setup parameters that can be accessed in some contiguous registers. When writing the setup registers, it is recommended to write all the registers at once using a single request, or to clear (zero) the setup before writing into separate registers.

Specification changes

The following indicates specification changes which apply to PM130 instruments with firmware version 3.54 or later:
Added 32-bit long integer format for extended data registers (see Sections 4.2 and 5.8).

2 MODBUS FRAMING

2.1 Transmission Mode

The protocol uses the Modbus Remote Terminal Unit (RTU) transmission mode. In RTU mode, data is sent in 8-bit binary characters. The 8 bit even parity or 8 bit no parity data format must be selected when configuring the instrument communications. The data format is shown in the following table.

Table 2-1 RTU Data Format

Field	No. of bits
Start bit	1
Data bits ①	8
Parity (optional)	1
Stop bit	1

① Least significant bit first

2.2 The RTU Frame Format

Frame synchronization is maintained in RTU transmission mode by simulating a synchronization message. The receiving device monitors the elapsed time between receptions of characters. If three and one-half character times elapse without a new character or completion of the frame, then the device flushes the frame and assumes that the next byte received will be an address. The frame format is defined below.
The maximum query and response message length is 256 bytes including check characters.

RTU Message Frame Format

T1 T2 T3	Address	Function	Data	CRC Check	T1 T2 T3
	8 bits	8 bits	N * 8 bits	16 bits	

2.3 Address Field

The address field contains a user assigned address (1-247) of the instrument that is to receive a message. Address 0 is used in broadcast mode to transmit to all instruments (broadcast mode is available only for functions 06 and 16). In this case all instruments receive the message and take action on the request, but do not issue a response. In the PM130, the broadcast mode is supported only for register addresses 287-294 and 301-302 (reset energies and maximum demands), 3404-3415 (reset/clear registers), and 4352-4358 (real-time clock registers).

2.4 Function Field

The function field contains a function code that tells the instrument what action to perform. Function codes used in the protocol are shown below in Table 2-2.

Table 2-2 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
08	Loop-back test	Communications test

NOTE Broadcast mode available only for functions code 06 and 16.

2.5 Data Field

The data field contains information needed by the instrument to perform a specific function, or data collected by the instrument in response to a query.

IMPORTANT Fields composed of two bytes are sent in the order high byte first, low byte second.

2.6 Error Check Field

The error check field contains the Cyclical Redundancy Check (CRC) word. The start of the message is ignored in calculating the CRC. The CRC-16 error check sequence is implemented as described in the following paragraphs.

The message (data bits only, disregarding start/stop and optional parity bits) is considered one continuous binary number whose most significant bit (MSB) is transmitted first. The message is pre-multiplied by x^{16} (shifted left 16 bits), and then divided by $x^{16} + x^{15} + x^2 + 1$ expressed as a binary number (11000000000000101). The integer quotient digits are ignored and the 16-bit remainder (initialized to all ones at the start to avoid the case of all zeros being an accepted message) is appended to the message (MSB first) as the two CRC check bytes. The resulting message including CRC, when divided by the same polynomial ($x^{16} + x^{15} + x^2 + 1$) at the receiver will give a zero remainder if no errors have occurred. (The receiving unit recalculates the CRC and compares it to the transmitted CRC). All arithmetic is performed modulo two (no carries).

The device used to serialize the data for transmission will send the conventional LSB or right-most bit of each character first. In generating the CRC, the first bit transmitted is defined as the MSB of the dividend. For convenience, and since there are no carries used in the arithmetic, let's assume while computing the CRC that the MSB is on the right. To be consistent, the bit order of the generating polynomial must be reversed. The MSB of the polynomial is dropped since it affects only the quotient and not the remainder. This yields 1010 0000 0000 0001 (Hex A001). Note that this reversal of the bit order will have no effect whatever on the interpretation or bit order of characters external to the CRC calculations.

The step by step procedure to form the CRC-16 check bytes is as follows:

1. Load a 16-bit register with all 1's.
2. Exclusive OR the first 8-bit byte with the low order byte of the 16-bit register, putting the result in the 16-bit register.
3. Shift the 16-bit register one bit to the right.

4a. If the bit shifted out to the right (flag) is one, exclusive OR the generating polynomial 1010 000 000 0001 with the 16-bit register.

4b. If the bit shifted out to the right is zero, return to step 3.

5. Repeat steps 3 and 4 until 8 shifts have been performed.
6. Exclusive OR the next 8-bit byte with the 16-bit register.
7. Repeat step 3 through 6 until all bytes of the message have been exclusive ORed with the 16-bit register and shifted 8 times.
8. When the 16-bit CRC is transmitted in the message, the low order byte will be transmitted first, followed by the high order byte.

For detailed information about CRC calculation, refer to the Modbus Protocol Reference Guide.

3 MODBUS MESSAGE FORMATS

3.1 Function 03 - Read Multiple Registers

This command allows the user to obtain contents of up to 125 contiguous registers from a single data table.
Request

Instrument Address	Function (03)	Starting Address	Word Count	Error Check
1 byte	1 byte	2 bytes	2 bytes	2 bytes

Starting Address Address of the first register to be read
Word Count The number of contiguous words to be read

Response

Instrument Address	Function (03)	Byte Count	Data Word 1	...	Data Word N	Error Check
1 byte	1 byte	1 byte	2 bytes	...	2 bytes	2 bytes

The byte count field contains quantity of bytes to be returned.

3.2 Function 04 - Read Multiple Registers

This command allows the user to obtain contents of up to 125 contiguous registers from a single data table. It can be used instead of function 03.
Request

Instrument Address	Function (04)	Starting Address	Word Count	Error Check
1 byte	1 byte	2 bytes	2 bytes	2 bytes

Starting Address Address of the first register to be read
Word Count The number of contiguous words to be read

Response

Instrument Address	Function (04)	Byte Count	Data Word 1	...	Data Word N	Error Check
1 byte	1 byte	1 byte	2 bytes	...	2 bytes	2 bytes

The byte count field contains quantity of bytes to be returned.

3.3 Function 06 - Write Single Register

This command allows the user to write the contents of a data register in any data table where a register can be written.
Request

Instrument Address	Function (06)	Starting Address	Data Word	Error check
1 byte	1 byte	2 bytes	2 bytes	2 bytes

Starting Address Address of the register to be written
Data Value Data to be written to the register

Response

The normal response is the retransmission of the write request.

3.4 Function 16 - Write Multiple Registers

This request allows the user to write the contents of multiple contiguous registers to a single data table where registers can be written.

Request

Instrument Address	Function (16)	Starting Address	Word Count	Byte Count
1 byte	1 byte	2 bytes	2 bytes	1 byte

Data Word 1	...	...	...	Data Word N	Error Check
2 bytes	...	...	...	2 bytes	2 bytes

Starting Address Address of the first register to be written
Word Count The number of contiguous words to be written
Byte Count The number of bytes to be written

Response

Instrument Address	Function (16)	Starting Address	Word Count	Error Check
1 byte	1 byte	2 bytes	1 word	2 bytes

3.5 Function 08 - Loop-back Communications Test

The purpose of this request is to check the communications link between the specified instrument and PC.

Request

Instrument Address	Function (08)	Diagnostic Code (0)	Data	Error Check
1 byte	1 byte	2 bytes	2 bytes	2 bytes

Diagnostic Code Designates action to be taken in Loop-back test. The protocol supports only Diagnostic Code 0 - return query data.

Data Query data. The data passed in this field will be returned to the master through the instrument. The entire message returned will be identical to the message transmitted by the master, field-per-field.

Response

Instrument Address	Function (08)	Diagnostic Code (0)	Data	Error Check
1 byte	1 byte	2 bytes	2 bytes	2 bytes

The normal response is the re-transmission of a test message.

3.6 Exception Responses

The instrument sends an exception response when errors are 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.

Exception Response

Instrument Address	Function (high order bit is set to 1)	Exception Code	Error Check
1 byte	1 byte	1 byte	2 byte

Exception response codes:
01 - Illegal function
02 - Illegal data address
03 - Illegal data value
06 - Busy, rejected message. The message was received without errors, but the instrument is being programmed from the keypad (only for requests accessing setup registers).

NOTE When the character framing, parity, or redundancy check detects a communication error, processing of the master's request stops. The instrument will not act on or respond to the message.

4 PROTOCOL IMPLEMENTATION

4.1 Modbus Register Addresses

The PM130 Modbus registers are referred to by using addresses in the range of 0 to 65535. From within the Modbus applications, the PM130 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 PM130 register address to the range of the Modbus holding registers, add a value of 40001 to the PM130 register address. When a register address exceeds 9999, use a 6-digit addressing scheme by adding 400001 to the PM130 register address.

4.2 Data Formats

The PM130 uses three data formats to pass data between a master application and the instrument: a 16-bit integer format, a 32-bit modulo 10000 format, and a 32-bit long integer format.

4.2.1 16-bit Integer Format

A 16-bit data is transmitted in a single 16-bit Modbus register as unsigned or signed integer (whole) numbers without conversion or using pre-scaling to accommodate large-scale and fractional numbers to a 16-bit register format. Scaling can be made using either the LIN3 linear conversion, or decimal pre-scaling to pass fractional numbers in integer format.

Non-scaled data
The data will be presented exactly as retrieved by the communications program from the instrument. The value range for unsigned data is 0 to 65535; for signed data the range is -32768 to 32767.

LIN3 (Linear) Scaling
This conversion maps the raw data received by the communications program in the range of 0 - 9999 onto the user-defined LO scale/HI scale range. The conversion is carried out according to the formula:

$$Y = (X / 9999) \times (HI - LO) + LO$$

where:

Y	-	the true value in engineering units
X	-	the raw input data in the range of 0 - 9999
LO, HI	-	the data low and high scales in engineering units

When data conversion is necessary, the HI and LO scales, and data conversion method are indicated for the corresponding registers.

EXAMPLE
Suppose you have read a value of 5000 from register 256 that contains a voltage reading (see *Table 5-1*). If your instrument has the 144V input option, and you use potential transformers with the ratings of 22,000V : 110V = 200, then the voltage high scale is HI = 144×200 = 28,800, and in accordance with the above formula, the voltage reading in engineering units will be as follows:

$$5000 \times (28800 - 0)/9999 + 0 = 14401V$$

When a value is written to the instrument, the conversion is carried out in reverse to produce the written value in the range of 0 - 9999:

$$X = 9999 \times (Y - LO) / (HI - LO)$$

Decimal Scaling

Decimal pre-scaling can be used to accommodate fractional numbers to an integer register format. Fractional numbers pre-multiplied by 10 in 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 an actual register resolution (the weight of the least significant decimal digit). To get an actual fractional number with specified precision, scale the register value with the given multiplier. To write a fractional number into the register, divide the number by the given multiplier.

4.2.2 32-bit Modulo 10000 Format

The short energy registers 287-294, and 301-302 are transmitted in two contiguous 16-bit registers in modulo 10000 format. The first (low order) register contains the value mod 10000, and the second (high order) register contains the value/10000. To get the true energy reading, the high order register value should be multiplied by 10,000 and added to the low order register.

4.2.3 32-bit Long Integer Format

In a 32-bit long integer format, data is transmitted in two adjacent 16-bit Modbus registers as unsigned or signed long integer (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) of the 32-bit long number. 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.

A 32-bit data can be transmitted without conversion as is, or by using decimal pre-scaling to transform fractional numbers to an integer format as described above (see Decimal Scaling in Section 4.2.1).

4.3 User Assignable Registers

The PM130 contains the 120 user assignable registers in the address range of 0 to 119 (see Table 4-1), any of which you can map to either register address accessible in the instrument. Registers that reside in different locations may be accessed by a single request by re-mapping them to adjacent addresses in the user assignable registers area.

The actual addresses of the assignable registers which are accessed via addresses 0 to 119 are specified in the user assignable register map (see Table 4-2). This map occupies addresses from 120 to 239, where map register 120 should contain the actual address of the register accessed via assignable register 0, register 121 should contain the actual address of the register accessed via assignable register 1, and so on. Note that the assignable register addresses and the map register addresses may not be re-mapped.

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 (0 to 119). Note that long word registers should always be aligned at even addresses. For example, if you want to read registers 7136 (real-time voltage of phase A, word) and 7576/7577 (kWh import, long word) via registers 0-2, then do the following:

- write 7576 to register 120
- write 7577 to register 121
- write 7136 to register 122

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

Table 4-1 User Assignable Registers

Register contents	Address	Size, byte	Direction	Range
User definable data 0	0	①	①	①
User definable data 1	1	①	①	①
User definable data 2	2	①	①	①
...	...	...	...	...
User definable data 119	119	①	①	①

① - depends on the mapped register

Table 4-2 User Assignable Register Map

Register contents	Address	Size, byte	Direction	Range
Register address for user data 0	120	2	R/W	240 to 9999
Register address for user data 1	121	2	R/W	240 to 9999
Register address for user data 2	122	2	R/W	240 to 9999
...	...	...	...	...
Register address for user data 119	239	2	R/W	240 to 9999

5 POWERMETER REGISTERS DESCRIPTION

5.1 Basic Data Registers

Table 5-1 Basic Data Registers

Parameter	Address	Size, byte	Direction	Unit	Scale ①		Conversion
					Low	High	
Voltage L1/L12 ⑤	256	2	R	V	0	Vmax	LIN3
Voltage L2/L23 ⑤	257	2	R	V	0	Vmax	LIN3
Voltage L3/L31 ⑤	258	2	R	V	0	Vmax	LIN3
Current L1	259	2	R	A	0	Imax	LIN3
Current L2	260	2	R	A	0	Imax	LIN3
Current L3	261	2	R	A	0	Imax	LIN3
kW L1 (P)	262	2	R	kW	-Pmax	Pmax	LIN3
kW L2 (P)	263	2	R	kW	-Pmax	Pmax	LIN3
kW L3 (P)	264	2	R	kW	-Pmax	Pmax	LIN3
kvar L1 (P)	265	2	R	kvar	-Pmax	Pmax	LIN3
kvar L2 (P)	266	2	R	kvar	-Pmax	Pmax	LIN3
kvar L3 (P)	267	2	R	kvar	-Pmax	Pmax	LIN3
kVA L1 (P)	268	2	R	kVA	-Pmax	Pmax	LIN3
kVA L2 (P)	269	2	R	kVA	-Pmax	Pmax	LIN3
kVA L3 (P)	270	2	R	kVA	-Pmax	Pmax	LIN3
Power factor L1 (P)	271	2	R	0.001	-1.000	1.000	LIN3
Power factor L2 (P)	272	2	R	0.001	-1.000	1.000	LIN3
Power factor L3 (P)	273	2	R	0.001	-1.000	1.000	LIN3
Total power factor (P)	274	2	R	0.001	-1.000	1.000	LIN3
Total kW (P)	275	2	R	kW	-Pmax	Pmax	LIN3
Total kvar (P)	276	2	R	kvar	-Pmax	Pmax	LIN3
Total kVA (P)	277	2	R	kVA	-Pmax	Pmax	LIN3
Neutral current	278	2	R	A	0	Imax	LIN3
Frequency	279	2	R	0.01 Hz	45.00	65.00	LIN3
Maximum sliding window kW demand ④ (E)	280	2	R/W	kW	-Pmax	Pmax	LIN3
Accumulated kW demand (E)	281	2	R/W	kW	-Pmax	Pmax	LIN3
Maximum sliding window kVA demand ④ (E)	282	2	R/W	kVA	-Pmax	Pmax	LIN3
Accumulated kVA demand (E)	283	2	R/W	kVA	-Pmax	Pmax	LIN3
Max. ampere demand L1	284	2	R/W	A	0	Imax	LIN3
Max. ampere demand L2	285	2	R/W	A	0	Imax	LIN3
Max. ampere demand L3	286	2	R/W	A	0	Imax	LIN3
kWh import (low) (E)	287	2	R/W	kWh	0	9999	NONE
kWh import (high) (E)	288	2	R/W	kWh $x10^4$	0	9999	$x10^4$
kWh export (low) (E)	289	2	R/W	kWh	0	9999	NONE
kWh export (high) (E)	290	2	R/W	kWh $x10^4$	0	9999	$x10^4$
+kvarh net (low) ② (E)	291	2	R/W	kvarh	0	9999	NONE
+kvarh net (high) ② (E)	292	2	R/W	kvarh $x10^4$	0	9999	$x10^4$

Parameter	Add-ress	Size, byte	Direc-tion	Unit	Scale ① Low	High	Con-version
-kvarh net (low) ③ (E)	293	2	R/W	kvarh	0	9999	NONE
-kvarh net (high) ③ (E)	294	2	R/W	kvarh x10^4	0	999	x10^4
Reserved	295	2	R				
Reserved	296	2	R				
Reserved	297	2	R				
Reserved	298	2	R				
Reserved	299	2	R				
Reserved	300	2	R				
kVAh (low) (E)	301	2	R/W	kVAh	0	9999	NONE
kVAh (high) (E)	302	2	R/W	kVAh x10^4	0	9999	x10^4
Present sliding window kW demand ④ (E)	303	2	R	kW	-Pmax	Pmax	LIN3
Present sliding window kVA demand ④ (E)	304	2	R	kVA	-Pmax	Pmax	LIN3
PF at maximum siding window kVA demand (E)	305	2	R	0.001	-1.000	1.000	LIN3
Reserved	306	2	R				
Reserved	307	2	R				
Reserved	308	2	R				

① The parameter limits are as follows:
Vmax (690 V input option) = 828V @ PT Ratio = 1
Vmax (690 V input option) = 144 × PT Ratio [V] @ PT Ratio > 1
Vmax (120 V input option) =144 × PT Ratio [V]
Imax (50% over-range) = 1.5 × CT primary current [A]
Pmax = (Imax × Vmax × 3)/1000 [kW] if wiring mode is 4LN3 or 3LN3
Pmax = (Imax × Vmax × 2)/1000 [kW] if wiring mode is 4LL3, 3OP2, 3DIR2, 3OP3 or 3LL3
② Positive readings of kvarh net
③ Negative readings of kvarh net
④ To get block interval demand readings, specify the number of demand periods equal to 1 (see Table 5-2)
⑤ When the 4LN3 or 3LN3 wiring mode is selected, the voltages will be line-to-neutral; for any other wiring mode, they will be line-to-line voltages.
(P) available in the PM130P and PM130E
(E) available in the PM130E

NOTE Writing a zero to one of registers 280-286 causes reset of all maximum demands. Writing a zero to one of registers 287-294 and 301-302 causes reset of all accumulated energies.

5.2 Basic Setup

Table 5-2 Basic Setup Registers

Parameter	Add-ress	Size, byte	Direc-tion	Range
Wiring mode ①	2304	2	R/W	0 = 3OP2, 1 = 4LN3, 2 = 3DIR2, 3 = 4LL3, 4 = 3OP3, 5 = 3LN3, 6 = 3LL3
PT ratio	2305	2	R/W	10 to 65000 × 0.1
CT primary current	2306	2	R/W	1 to 50000 A

Parameter	Add-ress	Size, byte	Direc-tion	Range
Power demand period (E)	2307	2	R/W	1,2,5,10,15,20,30,60 min, 255 = external synchronization ②
Volt/ampere demand period	2308	2	R/W	0 to 1800 sec
Averaging buffer size	2309	2	R/W	8, 16, 32
Reset enable/disable	2310	2	R/W	0 = disable, 1 = enable
Reserved	2311	2	R	Read as 65535
The number of demand periods (E)	2312	2	R/W	1 to 15
Reserved	2313	2	R	Read as 65535
Reserved	2314	2	R	Read as 65535
Nominal frequency	2315	2	R/W	50, 60 Hz
Reserved	2316	2	R	Read as 65535

① The wiring mode options are as follows:
3OP2 - 3-wire open delta using 2 CTs (2 element)
4LN3 - 4-wire WYE using 3 PTs (3 element), line to neutral voltage readings
3DIR2 - 3-wire direct connection using 2 CTs (2 element)
4LL3 - 4-wire WYE using 3 PTs (3 element), line to line voltage readings
3OP3 - 3-wire open delta using 3 CTs (2 1/2 element)
3LN3 - 4-wire WYE using 2 PTs (2 1/2 element), line to neutral voltage readings
3LL3 - 4-wire WYE using 2 PTs (2 1/2 element), line to line voltage readings
② Synchronization of power demand interval can be made through communications using the Synchronize power demand interval command (see Table 5-5)
(E) available in the PM130E

5.3 User Selectable Options Setup

Table 5-3 User Selectable Options Registers

Parameter	Add-ress	Size, byte	Direc-tion	Range
Power calculation mode (P)	2376	2	R/W	0 = using reactive power, 1 = using non-active power
Energy roll value (E) ①	2377	2	R/W	0 = 1×10^4 1 = 1×10^5 2 = 1×10^6 3 = 1×10^7 4 = 1×10^8
Phase energy calculation mode (E)	2378	2	R/W	0 = disable, 1 = enable

(P) available in the PM130P and PM130E (read as 65535 in the PM130)
(E) available in the PM130E (read as 65535 in the PM130 and PM130P)
① For short energy registers (see Table 5-1), the maximum roll value will be 1×10^8 for positive readings and 1×10^7 for negative readings.

5.4 Communications Setup

Table 5-4 Communications Setup Registers

Parameter	Address	Size, byte	Direction	Range
Reserved	2344	2	R	Read as 65535
Interface	2345	2	R/W	2 = RS-485 (not changeable)
Address	2346	2	R/W	1 to 247
Baud rate	2347	2	R/W	0 = 110 bps 1 = 300 bps 2 = 600 bps 3 = 1200 bps 4 = 2400 bps 5 = 4800 bps 6 = 9600 bps 7 = 19200 bps
Data format	2348	2	R/W	1 = 8 bits/no parity 2 = 8 bits/even parity

When changing the instrument address, baud rate or data format, the new communications parameters will take effect 100 ms after the instrument responds to the master's request.

5.5 Reset/Synchronization Registers

Table 5-5 Reset/Synchronization Registers

Register function	Address	Size byte	Direction	Reset value
Clear total energy registers (E)	3404	2	W	0
Clear total maximum demand registers	3405	2	W	0 = all maximum demands 1 = power demands (E) 2 = volt/ampere demands
Reserved	3406-3407	2		
Clear event/time counters (E)	3408	2	W	0 = all counters 1-4 = counter #1 - #4
Clear Min/Max log	3409	2	W	0
Reserved	3410-3419	2		
Synchronize power demand interval (E) ①	3420	2	W	0

① 1) If the power demand period is set to External Synchronization (see Table 5-2), writing a zero to this location will simulate an external synchronization pulse denoting the start of the next demand interval. The synchronization requests should not follow in intervals of less than 30 seconds, or the request will be rejected.

2) If the power demand period is specified in minutes, writing a zero to this location provides synchronization of the instrument's internal timer with the time of reception of the master's request. If the time expired from the beginning of the current demand interval is more than 30 seconds, the new demand interval starts immediately, otherwise synchronization is delayed until the next demand interval.

(E) - available in the PM130E

5.6 Instrument Status

Table 5-6 Instrument Status Registers

Parameter	Address	Size, byte	Direc-tion	Unit	Range
Instrument reset register ①	2560	2	R/W		0 (when read) 65535 (when written) = reset the instrument
Reserved	2561	2	R		Read as 0
Relay status	2562	2	R		see Table 5-7
Reserved	2563	2	R		Read as 0
Reserved	2564	2	R		
Firmware version number	2565	2	R		0-65535
Instrument options 1	2566	2	R		see Table 5-8
Instrument options 2	2567	2	R		see Table 5-8

① Writing a value of 65535 into register 2560 will cause the instrument to perform a warm restart.

Table 5-7 Relay Status

Bit number	Description
0-6	Not used (permanently set to 1)
7	Relay status
8-15	Not used (permanently set to 0)

Bit meaning: 0 = relay operated, 1 = relay released

Table 5-8 Instrument Options

Options register	Bit	Description
Options1	0	120V option
	1	690V option
	2-4	Reserved
	5	150% current over-range
	6-8	Reserved
	9	Relays option
	10-15	Reserved
Options 2	0-2	Number of relays - 1
	3-15	Reserved

5.7 Extended Status

Table 5-9 Extended Status Registers

Register description	Address	Size, byte	Direction	Value range
Relay status	3452	2	R	see Table 5-10
Reserved	3453-3454	2 2	R	Read as 0
Setpoints status	3455	2	R	see Table 5-11
Log status	3456	2	R	see Table 5-12
Reserved	3457-3473	2	R	Read as 0
Setpoint alarm status	3474	2	R/W	see Table 5-13
Self-check alarm status	3475	2	R/W	see Table 5-14

Table 5-10 Relay Status

Bit	Description
0	Relay status
1-15	Not used (permanently set to 0)

Bit meaning: 0 = relay released, 1 = relay operated

Table 5-11 Setpoints Status

Bit	Description
0	Setpoint # 1 status
1	Setpoint # 2 status
2	Setpoint # 3 status
3	Setpoint # 4 status
4	Setpoint # 5 status
5	Setpoint # 6 status
6	Setpoint # 7 status
7	Setpoint # 8 status
8	Setpoint # 9 status
9	Setpoint # 10 status
10	Setpoint # 11 status
11	Setpoint # 12 status
12	Setpoint # 13 status
13	Setpoint # 14 status
14	Setpoint # 15 status
15	Setpoint # 16 status

Bit meaning: 0 = setpoint is released, 1 = setpoint is operated

Table 5-12 Log Status

Bit	Description
0	Reserved
1	New Min/Max Log
2-15	Not used (permanently set to 0)

Bit meaning: 0 = no new logs, 1 = new log recorded (the new log flag is reset when the user reads the first log record after the flag has been set)

Table 5-13 Setpoint Alarm Status

Bit	Description
0	Alarm #1
1	Alarm #2
2	Alarm #3
3	Alarm #4
4	Alarm #5
5	Alarm #6
6	Alarm #7
7	Alarm #8
8	Alarm #9
9	Alarm #10
10	Alarm #11
11	Alarm #12
12	Alarm #13
13	Alarm #14
14	Alarm #15
15	Alarm #16

Bit meaning: 1 = setpoint has been operated

The setpoint alarm register stores the status of the operated setpoints by setting the appropriate bits to 1. The alarm status bits can be reset all together by writing zero to the setpoint alarm register. It is possible to reset each alarm status bit separately by writing back the contents of the alarm register with a corresponding alarm bit set to 0.

Table 5-14 Self-check Alarm Status

Bit	Description
0	Reserved
1	ROM error
2	RAM error
3	Watchdog timer reset
4	Sampling failure
5	Out of control trap
6	Reserved
7	Timing failure
8	Loss of power (power up)
9	External reset (warm restart)
10	Configuration corrupted
11-15	Reserved

The self-check alarm register indicates possible problems with the instrument hardware or setup configuration. The hardware problems are indicated by the appropriate bits which are set whenever the instrument fails self-test diagnostics or in the event of loss of power. The setup configuration problems are indicated by the dedicated bit which is set when either configuration register is corrupted. In this event, the instrument will use the default configuration. The configuration corrupt bit may also be set as a result of the legal changes in the setup configuration since the instrument might implicitly change or clear other setups if they are affected by the changes made.

Hardware fault bits can be reset by writing zero to the self-check alarm register. The configuration corrupt status bit is also reset automatically when you change setup either via the front panel or through communications.

5.8 Extended Data Registers

The following table lists all registers containing the data measured by the instrument. Notice that these registers are arranged into groups which are not located at adjacent addresses. You can re-map these registers into adjacent addresses to access multiple data from different data groups by using a single request. Refer to Section 2.9 for information on the user assignable registers.

Along with the register address, the table shows for each data item its data identifier (ID). This is a one word containing a data group ID in the high byte and the parameter offset in a group in the low byte. Data IDs are used to specify input or output parameters whenever a data parameter specification is needed, for example, when selecting analog output parameters or reading Min/Max log records.

Table 5-16 Extended Data Registers

Parameter	16-bit Register		32-bit	Data	Dir.	Unit②	Range/Scale①	
	Reg.	Conv.	Register	ID			Low	High
None								
None	6656		11776-11777	0	R		0	0
Relays								
Relay status (see Table 5-10)	6976		12800-12801	2048	R		0	3
Event/time counters								
Counter #1	7056 7057		13056-13057	2560	R/W		0	99999
Counter #2	7058 7059		13058-13059	2561	R/W		0	99999
Counter #3	7060 7061		13060-13061	2562	R/W		0	99999
Counter #4	7062 7063		13062-13063	2563	R/W		0	99999
Real-time values per phase (power values - P)								
Voltage L1/L12 ⑤	7136	LIN3	13312-13313	3072	R	V	0	Vmax
Voltage L2/L23 ⑤	7137	LIN3	13314-13315	3073	R	V	0	Vmax
Voltage L3/L31 ⑤	7138	LIN3	13316-13317	3074	R	V	0	Vmax
Current L1	7139	LIN3	13318-13319	3075	R	A	0	Imax
Current L2	7140	LIN3	13320-13321	3076	R	A	0	Imax
Current L3	7141	LIN3	13322-13323	3077	R	A	0	Imax
kW L1	7142	LIN3	13324-13325	3078	R	kW	-Pmax	Pmax
kW L2	7143	LIN3	13326-13327	3079	R	kW	-Pmax	Pmax
kW L3	7144	LIN3	13328-13329	3080	R	kW	-Pmax	Pmax
kvar L1	7145	LIN3	13330-13331	3081	R	kvar	-Pmax	Pmax
kvar L2	7146	LIN3	13332-13333	3082	R	kvar	-Pmax	Pmax
kvar L3	7147	LIN3	13334-13335	3083	R	kvar	-Pmax	Pmax
kVA L1	7148	LIN3	13336-13337	3084	R	kVA	0	Pmax
kVA L2	7149	LIN3	13338-13339	3085	R	kVA	0	Pmax
kVA L3	7150	LIN3	13340-13341	3086	R	kVA	0	Pmax
Power factor L1	7151	LIN3	13342-13343	3087	R	0.001	-1.000	1.000
Power factor L2	7152	LIN3	13344-13345	3088	R	0.001	-1.000	1.000
Power factor L3	7153	LIN3	13346-13347	3089	R	0.001	-1.000	1.000
Reserved	7154		13348-13349	3090	R		0	0
Reserved	7155		13350-13351	3091	R		0	0
Reserved	7156		13352-13353	3092	R		0	0
Reserved	7157		13354-13355	3093	R		0	0
Reserved	7158		13356-13357	3094	R		0	0
Reserved	7159		13358-13359	3095	R		0	0
Reserved	7160		13360-13361	3096	R		0	0
Reserved	7161		13362-13363	3097	R		0	0
Reserved	7162		13364-13365	3098	R		0	0
Reserved	7163		13366-13367	3099	R		0	0
Reserved	7164		13368-13369	3100	R		0	0
Reserved	7165		13370-13371	3101	R		0	0
Voltage L12	7166	LIN3	13372-13373	3102	R	V	0	Vmax
Voltage L23	7167	LIN3	13374-13375	3103	R	V	0	Vmax
Voltage L31	7168	LIN3	13376-13377	3104	R	V	0	Vmax
Real-time total values (P)								
Total kW	7256	LIN3	13696-13697	3840	R	kW	-Pmax	Pmax
Total kvar	7257	LIN3	13698-13699	3841	R	kvar	-Pmax	Pmax
Total kVA	7258	LIN3	13700-13701	3842	R	kVA	0	Pmax

Parameter	16-bit Register		32-bit	Data	Dir.	Unit②	Range/Scale①	
	Reg.	Conv.	Register	ID			Low	High
Total PF	7259	LIN3	13702-13703	3843	R	0.001	-1.000	1.000
Reserved	7260		13704-13705	3844	R		0	
Reserved	7261		13706-13707	3845	R		0	
Real-time auxiliary values								
Reserved	7296		13824-13825	4096	R		0	0
Neutral current	7297	LIN3	13826-13827	4097	R	A	0	Imax
Frequency ②	7298	LIN3	13828-13829	4098	R	0.01Hz	0	100.00
Voltage unbalance (P)	7299	LIN3	13830-13831	4099	R	1%	0	300
Current unbalance (P)	7300	LIN3	13832-13833	4100	R	1%	0	300
Average values per phase (power values - P)								
Voltage L1/L12 ⑤	7336	LIN3	13952-13953	4352	R	V	0	Vmax
Voltage L2/L23 ⑤	7337	LIN3	13954-13955	4353	R	V	0	Vmax
Voltage L3/L31 ⑤	7338	LIN3	13956-13957	4354	R	V	0	Vmax
Current L1	7339	LIN3	13958-13959	4355	R	A	0	Imax
Current L2	7340	LIN3	13960-13961	4356	R	A	0	Imax
Current L3	7341	LIN3	13962-13963	4357	R	A	0	Imax
kW L1	7342	LIN3	13964-13965	4358	R	kW	-Pmax	Pmax
kW L2	7343	LIN3	13966-13967	4359	R	kW	-Pmax	Pmax
kW L3	7344	LIN3	13968-13969	4360	R	kW	-Pmax	Pmax
kvar L1	7345	LIN3	13970-13971	4361	R	kvar	-Pmax	Pmax
kvar L2	7346	LIN3	13972-13973	4362	R	kvar	-Pmax	Pmax
kvar L3	7347	LIN3	13974-13975	4363	R	kvar	-Pmax	Pmax
kVA L1	7348	LIN3	13976-13977	4364	R	kVA	0	Pmax
kVA L2	7349	LIN3	13978-13979	4365	R	kVA	0	Pmax
kVA L3	7350	LIN3	13980-13981	4366	R	kVA	0	Pmax
Power factor L1	7351	LIN3	13982-13983	4367	R	0.001	-1.000	1.000
Power factor L2	7352	LIN3	13984-13985	4368	R	0.001	-1.000	1.000
Power factor L3	7353	LIN3	13986-13987	4369	R	0.001	-1.000	1.000
Reserved	7354		13988-13989	4370	R		0	0
Reserved	7355		13990-13991	4371	R		0	0
Reserved	7356		13992-13993	4372	R		0	0
Reserved	7357		13994-13995	4373	R		0	0
Reserved	7358		13996-13997	4374	R		0	0
Reserved	7359		13998-13999	4375	R		0	0
Reserved	7360		14000-14001	4376	R		0	0
Reserved	7361		14002-14003	4377	R		0	0
Reserved	7362		14004-14005	4378	R		0	0
Reserved	7363		14006-14007	4379	R		0	0
Reserved	7364		14008-14009	4380	R		0	0
Reserved	7365		14010-14011	4381	R		0	0
Voltage L12	7366	LIN3	14012-14013	4382	R	V	0	Vmax
Voltage L23	7367	LIN3	14014-14015	4383	R	V	0	Vmax
Voltage L31	7368	LIN3	14016-14017	4384	R	V	0	Vmax
Average total values (P)								
Total kW	7456	LIN3	14336-14337	5120	R	kW	-Pmax	Pmax
Total kvar	7457	LIN3	14338-14339	5121	R	kvar	-Pmax	Pmax
Total kVA	7458	LIN3	14340-14341	5122	R	kVA	0	Pmax
Total PF	7459	LIN3	14342-14343	5123	R	0.001	-1.000	1.000
Reserved	7460		14344-14345	5124	R		0	0
Reserved	7461		14346-14347	5125	R		0	0
Average auxiliary values								
Reserved	7496		14464-14465	5376	R		0	0
Neutral current	7497	LIN3	14466-14467	5377	R	A	0	Imax
Frequency ②	7498	LIN3	14468-14469	5378	R	0.01Hz	0	100.00

Parameter	16-bit Register		32-bit	Data	Dir.	Unit②	Range/Scale①	
	Reg.	Conv.	Register	ID			Low	High
Voltage unbalance (P)	7499	LIN3	14470-14471	5379	R	1%	0	300
Current unbalance (P)	7500	LIN3	14472-14473	5380	R	1%	0	300
Present demands								
Volt demand L1/L12 (P) ⑤	7536	LIN3	14592-14593	5632	R	V	0	Vmax
Volt demand L2/L23 (P) ⑤	7537	LIN3	14594-14595	5633	R	V	0	Vmax
Volt demand L3/L31 (P) ⑤	7538	LIN3	14596-14597	5634	R	V	0	Vmax
Ampere demand L1	7539	LIN3	14598-14599	5635	R	A	0	Imax
Ampere demand L2	7540	LIN3	14600-14601	5636	R	A	0	Imax
Ampere demand L3	7541	LIN3	14602-14603	5637	R	A	0	Imax
Block kW demand (E)	7542	LIN3	14604-14605	5638	R	kW	0	Pmax
Reserved	7543		14606-14607	5639	R		0	0
Block kVA demand (E)	7544	LIN3	14608-14609	5640	R	kVA	0	Pmax
Sliding window kW demand (E)	7545	LIN3	14610-14611	5641	R	kW	0	Pmax
Reserved	7546		14612-14613	5642	R		0	0
Sliding window kVA demand (E)	7547	LIN3	14614-14615	5643	R	kVA	0	Pmax
Reserved	7548		14616-14617	5644	R		0	0
Reserved	7549		14618-14619	5645	R		0	0
Reserved	7550		14620-14621	5646	R		0	0
Accumulated kW demand (import) (E)	7551	LIN3	14622-14623	5647	R	kW	0	Pmax
Reserved	7552		14624-14625	5648	R		0	0
Accumulated kVA demand	7553	LIN3	14626-14627	5649	R	kVA	0	Pmax
Predicted sliding window kW demand	7554	LIN3	14628-14629	5650	R	kW	0	Pmax
Reserved	7555		14630-14631	5651	R		0	0
Predicted sliding window kVA demand (E)	7556	LIN3	14632-14633	5652	R	kVA	0	Pmax
PF at maximum sliding window kVA demand (E)	7557	LIN3	14634-14635	5653	R	0.001	-1.000	1.000
Total energies (E)								
kWh import	7576 7577		14720-14721	5888	R	kWh	0	10^8-1
kWh export ④	7578 7579		14722-14723	5889	R	kWh	0	10^8-1
Reserved	7580 7581		14724-14725	5890	R		0	0
Reserved	7582 7583		14726-14727	5891	R		0	0
kvarh import	7584 7585		14728-14729	5892	R	kvarh	0	10^8-1
kvarh export ④	7586 7587		14730-14731	5893	R	kvarh	0	10^8-1
Reserved	7588 7589		14732-14733	5894	R		0	0
Reserved	7590 7591		14734-14735	5895	R		0	0
kVAh total	7592 7593		14736-14737	5896	R	kVAh	0	10^8-1
Phase energies (E)								
kWh import L1	7616 7617		14848-14849	6144	R	kWh	0	10^8-1

Parameter	16-bit Register		32-bit	Data	Dir.	Unit②	Range/Scale①	
	Reg.	Conv.	Register	ID			Low	High
kWh import L2	7618 7619		14850-14851	6145	R	kWh	0	10^8-1
kWh import L3	7620 7621		14852-14853	6146	R	kWh	0	10^8-1
kvarh import L1	7622 7623		14854-14855	6147	R	kvarh	0	10^8-1
kvarh import L2	7624 7625		14856-14857	6148	R	kvarh	0	10^8-1
kvarh import L3	7626 7627		14858-14859	6149	R	kvarh	0	10^8-1
kVAh total L1	7628 7629		14860-14861	6150	R	kVAh	0	10^8-1
kVAh total L2	7630 7631		14862-14863	6151	R	kVAh	0	10^8-1
kVAh total L3	7632 7633		14864-14865	6152	R	kVAh	0	10^8-1
Reserved								
Reserved	8296 ... 8313		17024-17025 ... 17058-17059	10496 ... 10513	R		0	0
Reserved								
Reserved	8336 ... 8339		17152-17153 ... 17158-17159	10752 ... 10755	R		0	0
Minimum real-time values per phase (M)								
Voltage L1/L12 ⑤	8416	LIN3	17408-17409	11264	R	V	0	Vmax
Voltage L2/L23 ⑤	8417	LIN3	17410-17411	11265	R	V	0	Vmax
Voltage L3/L31 ⑤	8418	LIN3	17412-17413	11266	R	V	0	Vmax
Current L1 (P)	8419	LIN3	17414-17415	11267	R	A	0	Imax
Current L2 (P)	8420	LIN3	17416-17417	11268	R	A	0	Imax
Current L3 (P)	8421	LIN3	17418-17419	11269	R	A	0	Imax
Minimum real-time total values (M) (P)								
Total kW	8456	LIN3	17536-17537	11520	R	kW	-Pmax	Pmax
Total kvar	8457	LIN3	17538-17539	11521	R	kvar	-Pmax	Pmax
Total kVA	8458	LIN3	17540-17541	11522	R	kVA	0	Pmax
Total PF ③	8459	LIN3	17542-17543	11523	R	0.001	0	1.000
Minimum real-time auxiliary values (M)								
Reserved	8496		17664-17665	11776	R		0	0
Neutral current (P)	8497	LIN3	17666-17667	11777	R	A	0	Imax
Frequency (P) ②	8498	LIN3	17668-17669	11778	R	0.01Hz	0	100.00
Minimum demands (M) - Reserved								
Reserved	8536 ... 8547		17792-17793 ... 18814-18815	12032 ... 12043	R		0	0
Maximum real-time values per phase (M)								
Voltage L1/L12 ⑤	8736	LIN3	18432-18433	13312	R	V	0	Vmax
Voltage L2/L23 ⑤	8737	LIN3	18434-18435	13313	R	V	0	Vmax
Voltage L3/L31 ⑤	8738	LIN3	18436-18437	13314	R	V	0	Vmax
Current L1 (P)	8739	LIN3	18438-18439	13315	R	A	0	Imax
Current L2 (P)	8740	LIN3	18440-18441	13316	R	A	0	Imax
Current L3 (P)	8741	LIN3	18442-18443	13317	R	A	0	Imax
Maximum real-time total values (M) (P)								
Total kW	8776	LIN3	18560-18561	13568	R	kW	-Pmax	Pmax

Parameter	16-bit Register		32-bit Register	Data ID	Dir.	Unit②	Range/Scale①	
	Reg.	Conv.					Low	High
Total kvar	8777	LIN3	18562-18563	13569	R	kvar	-Pmax	Pmax
Total kVA	8778	LIN3	18564-18565	13570	R	kVA	0	Pmax
Total PF ③	8779	LIN3	18566-18567	13571	R	0.001	0	1.000
Maximum real-time auxiliary values (M)								
Reserved	8816		18688-18689	13824	R		0	
Neutral current (P)	8817	LIN3	18680-18681	13825	R	A	0	Imax
Frequency (P) ②	8818	LIN3	18682-18683	13826	R	0.01Hz	0	100.00
Maximum demands (M)								
Max. volt demand L1/L12 (P) ⑤	8856	LIN3	18816-18817	14080	R	V	0	Vmax
Max. volt demand L2/L23 (P) ⑤	8857	LIN3	18818-18819	14081	R	V	0	Vmax
Max. volt demand L3/L31 (P) ⑤	8858	LIN3	18820-18821	14082	R	V	0	Vmax
Max. ampere demand L1	8859	LIN3	18822-18823	14083	R	A	0	Imax
Max. ampere demand L2	8860	LIN3	18824-18825	14084	R	A	0	Imax
Max. ampere demand L3	8861	LIN3	18826-18827	14085	R	A	0	Imax
Reserved	8862		18828-18829	14086	R		0	0
Reserved	8863		18830-18831	14087	R		0	0
Reserved	8864		18832-18833	14088	R		0	0
Max. sliding window kW demand (E)	8865	LIN3	18834-18835	14089	R	kW	0	Pmax
Reserved	8866		18836-18837	14090	R		0	0
Max. sliding window kVA demand (E)	8867	LIN3	18838-18839	14091	R	kVA	0	Pmax

① For the parameter limits, see note ① to Table 5-1
② The actual frequency range is 45.00 - 65.00 Hz
③ Absolute min/max value (lag or lead)
④ The exported energy registers are read as positive unsigned long (32-bit) integers
⑤ When the 4LN3 or 3LN3 wiring mode is selected, the voltages will be line-to-neutral; for any other wiring mode, they will be line-to-line voltages.
(M) These parameters are logged to the Min/Max log
(P) available in the PM130P and PM130E (E) available in the PM130E

5.9 Alarm/Event Setpoints

Table 5-16 Setpoint Registers

Setpoint	Setup registers (see Table 5-17)
Setpoint #1	2576-2583
Setpoint #2	2584-2591
Setpoint #3	2592-2599
Setpoint #4	2600-2607
Setpoint #5	2608-2615
Setpoint #6	2616-2623
Setpoint #7	2624-2631
Setpoint #8	2632-2639
Setpoint #9	2640-2647
Setpoint #10	2648-2655
Setpoint #11	2656-2663
Setpoint #12	2664-2671
Setpoint #13	2672-2679
Setpoint #14	2680-2687
Setpoint #15	2688-2695
Setpoint #16	2696-2703

Table 5-17 Setpoint Setup Registers

Parameter	Offset	Size, byte	Direction	Range
Trigger parameter ID	+0	2	R/W	see Table 5-18
Action	+1	2	R/W	see Table 5-19
Operate delay	+2	2	R/W	0-9999 (× 0.1 sec)
Release delay	+3	2	R/W	0-9999 (× 0.1 sec)
Operate limit	+4 +5	4	R/W	see Table 5-18
Release limit	+6 +7	4	R/W	see Table 5-18

The setpoint is disabled when its trigger parameter is set to NONE. To disable the setpoint, write zero into this register.
When writing the setpoint registers (except the event when the setpoint is to be disabled), it is recommended to write all the setpoint registers using a single request, or disable the setpoint before writing into separate registers. Each value being written is checked for compatibility with the other setpoint parameters; if the new value does not conform to these, the request will be rejected.
Operate and release limits for the trigger parameters and their conversion scales are indicated in Table 5-18. Each limit value occupies two contiguous registers, the first of which (low word) contains the limit value, and the second (high word) is reserved for long parameters. This register is always read as zero. When written, its value is ignored.
Limits indicated in Table 5-18 by a N/A mark are read as zeros. When writing, they can be omitted or should be written as zeros.
When a setpoint action is directed to a relay allocated to output energy pulses, an attempt to re-allocate it for a setpoint will result in a negative response.

Table 5-18 Setpoint Trigger Parameters

Trigger parameter	Trigger ID	Size, byte	Unit	**Limit/scale ①**		Con-version
				Low	High	
None						
None	0	2		N/A	N/A	NONE
Phase reversal						
Positive phase rotation reversal	35073	2		N/A	N/A	NONE
Negative phase rotation reversal	35074	2		N/A	N/A	NONE
High/low real-time values on any phase						
High voltage ④	3584	2	V	0	Vmax	LIN3
Low voltage ④	36096	2	V	0	Vmax	LIN3
High current	3585	2	A	0	Imax	LIN3
Low current	36097	2	A	0	Imax	LIN3
Reserved	3591	2				
Reserved	3592	2				
Reserved	3593	2				
Reserved	3594	2				
High/low real-time auxiliary values						
High frequency ③	4098	2	0.01Hz	0	100.00	LIN3
Low frequency ③	36866	2	0.01Hz	0	100.00	LIN3
High/low average values per phase						
High current L1	4355	2	A	0	Imax	LIN3
High current L2	4356	2	A	0	Imax	LIN3
High current L3	4357	2	A	0	Imax	LIN3
Low current L1	37123	2	A	0	Imax	LIN3
Low current L2	37124	2	A	0	Imax	LIN3

Trigger parameter	Trigger ID	Size, byte	Unit	Limit/scale ①		Con-version
				Low	High	
Low current L3	37125	2	A	0	Imax	LIN3
High/low average values on any phase						
High voltage ④	4864	2	V	0	Vmax	LIN3
Low voltage ④	37376	2	V	0	Vmax	LIN3
High current	4865	2	V	0	Vmax	LIN3
Low current	37377	2	V	0	Vmax	LIN3
High/low average total values (P)						
High total kW import	5126	2	kW	-Pmax	Pmax	LIN3
High total kW export	5127	2	kW	-Pmax	Pmax	LIN3
High total kvar import	5128	2	kvar	-Pmax	Pmax	LIN3
High total kvar export	5129	2	kvar	-Pmax	Pmax	LIN3
High total kVA	5122	2	kVA	0	Pmax	LIN3
Low total PF Lag	37892	2	0.001	0	1.000	LIN3
Low total PF Lead	37893	2	0.001	0	1.000	LIN3
High/low average auxiliary values						
High neutral current	5377	2	A	0	Imax	LIN3
High frequency ③	5378	2	0.01Hz	0	100.00	LIN3
Low frequency ③	38146	2	0.01Hz	0	100.00	LIN3
High present demands						
High volt demand L1/L12 (P) ④	5632	2	V	0	Vmax	LIN3
High volt demand L2/L23 (P) ④	5633	2	V	0	Vmax	LIN3
High volt demand L3/L31 (P) ④	5634	2	V	0	Vmax	LIN3
High ampere demand L1	5635	2	A	0	Imax	LIN3
High ampere demand L2	5636	2	A	0	Imax	LIN3
High ampere demand L3	5637	2	A	0	Imax	LIN3
High block kW demand (E)	5638	2	kW	0	Pmax	LIN3
High block kVA demand (E)	5640	2	kVA	0	Pmax	LIN3
High sliding window kW demand (E)	5641	2	kW	0	Pmax	LIN3
High sliding window kVA demand (E)	5643	2	kVA	0	Pmax	LIN3
High accumulated kW demand (E)	5647	2	kW	0	Pmax	LIN3
High accumulated kVA demand (E)	5649	2	kVA	0	Pmax	LIN3
High predicted kW demand (E)	5650	2	kW	0	Pmax	LIN3
High predicted kVA demand (E)	5652	2	kVA	0	Pmax	LIN3

① For parameter limits, see Note ① to Table 5-1
② The setpoint is operated when the actual phase sequence does not match the indicated phase rotation
③ The actual frequency range is 45.00 - 65.00 Hz
④ When the 4LN3 or 3LN3 wiring mode is selected, the voltages will be line-to-neutral; for any other wiring mode, they will be line-to-line voltages.
(P) available in the PM130P and PM130E
(E) available in the PM130E

Table 5-19 Setpoint Actions

Action	ID
No action	0
Operate relay	12288
Increment counter #1	16384
Increment counter #2	16385
Increment counter #3	16386

Action	ID
Increment counter #4	16387
Count operating time using counter #1 ①	17408
Count operating time using counter #2 ①	17409
Count operating time using counter #3 ①	17410
Count operating time using counter #4 ①	17411

① This action converts a common event counter to the time counter which measures time at 0.1 hour resolution while the setpoint is in the operated state. Each time counter has a non-volatile shadow counter which counts time at 1 second resolution before the corresponding time counter is incremented.

5.10 Pulsing Setpoints

Table 5-20 Pulsing Registers

Setup registers (see Table 5-21)
2892-2893

Table 5-21 Pulsing Setup Registers

Parameter	Offset	Size, byte	Direction	Range
Output parameter ID	+0	2	R/W	see Table 5-22
Number of unit-hours per pulse	+1	2	R/W	1-9999

Table 5-22 Pulsing Output Parameters

Pulsing parameter	ID
None	0
kWh import	1
kWh export	2
kvarh import	4
kvarh export	5
kvarh total (absolute)	6
kVAh total	7

5.11 Relay Operation Control

These registers allow the user to manually override a relay operation that is normally operated via alarm setpoints.

A relay allocated as a pulsing relay may not be manually operated or released. When a relay is allocated for pulsing, it automatically reverts to normal operation.

Table 5-23 Relay Operation Control Registers

Parameter	Address	Size, byte	Direction	Range
Relay control status	3244	2	R/W	see Table 5-24

Table 5-24 Relay Operation Status

Operation status	Value
Normal operation	0
Force operate	1
Force release	2

5.12 Min/Max Log

The Min/Max log registers are supported only for compatibility with other models of instruments. Because the Min/Max log is not time stamped in the PM130, reading these registers returns you only values of the Min/Max log parameters which you can read directly via extended data registers (see Table 5-15).

Table 5-25 Min/Max Log Windows Registers

Min/Max log window	Registers (see Table 5-26)
Min/Max log window #1	4174-4181
Min/Max log window #2	4182-4189
Min/Max log window #3	4190-4197
Min/Max log window #4	4198-4205
Min/Max log window #5	4206-4213
Min/Max log window #6	4214-4221
Min/Max log window #7	4222-4229
Min/Max log window #8	4230-4237
Min/Max log window #9	4238-4245
Min/Max log window #10	4246-4253
Min/Max log window #11	4254-4261
Min/Max log window #12	4262-4269

Table 5-26 Min/Max Log Window Registers

Parameter	Offset	Size, byte	Direction	Range
Second	+0	2	R	0
Minute	+1	2	R	0
Hour	+2	2	R	0
Day	+3	2	R	0
Month	+4	2	R	0
Year	+5	2	R	0
Parameter value ①	+6 +7	4	R	see Table 5-15

① The Min/Max parameter value can be read in one or two registers depending on the value type. For the value length and conversion scales, refer to Table 5-15. The time stamp is not available in the PM130 and is read as zeros.

Table 5-27 Min/Max Log Mapping Register

Parameter	Address	Size, byte	Direction	Range
Min/Max log start parameter ID for window #1	4172	2	R/W	see Table 5-15

From 1 to 12 adjacent Min/Max log records can be read at a time via the Min/Max log windows. The starting window #1 can be mapped to any Min/Max log parameter listed in Table 5-15 by writing the parameter ID to the Min/Max log mapping register. This must be written before reading the Min/Max log windows. Note that through Min/Max log windows, you can read only adjacent parameters within the same Min/Max log data group. Reading parameters outside of the selected Min/Max log data group will return zero.