SERIES PM130P/E/EH POWERMETERS

COMMUNICATIONS

DNP V3.0 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.

REVISION HISTORY

Rev.A2 (F/W Version 3.54 or later)

1. Added Select Before Operate.
2. Implemented Relay Pulse On, Pulse Off.
3. Added Scaling Analog Input Objects.

Rev.A3 (F/W Version 3.56 or later)

1. Added the Broken Delta wiring configuration.
2. Added DNP Class 0 points setup.
3. Removed DNP Class 0 group setup.
4. DNP Scaling is ON by default.
5. The communication protocol is changeable through communications.

Rev.A4 (F/W Version 3.58.1 or later)

1. Added the firmware build number (Table 4-4).
2. Added three-phase average voltage and current points.

Rev.A5

1. Changed frequency scale (Table 4-1).

BG0374 Rev. A5

July 2007

Table of Contents

1 GENERAL

This document specifies a subset of the DNP V3.0 serial communications protocol used to transfer data between a master computer station and the Series PM130 Powermeters. The document provides all necessary information for developing a third-party communications software capable of communicating with the PM130.

Additional information concerning communications operation, configuration of communications parameters, and communications connections is found in the Series PM130 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.

Designations used in the guide:

E - available in the meters with the E and EH suffixes

EH - available in the meters with the EH suffix

2 DNP PROTOCOL

2.1 Introduction

DNP V3.00 (Distributed Network Protocol) is an open standard designed by Harris Control Division. DNP defines a command-response method of communicating digital information between a master and a slave device. Detailed information regarding DNP V3.00 is available in the “Basic 4 Document Set” which can obtained from the DNP User Group.

2.2 PM130 Deviation from Standard

The PM130 does not support unsolicited requests or hardware collision avoidance.

The data link layer differs from the Basic 4 specifications because of the master-slave relationship between devices. When the Powermeter receives a request, no further requests can be sent until after the Powermeter makes the appropriate response.

2.3 DNP Request/Response Overview

The PM130 DNP implementation supports a wide variety of messages. The most common method to extract information from the Powermeter is to issue a Read Class-0 request.

There is an option for assigning objects to be polled via Class 0 requests. When this option is used, the Class 0 response includes all static object points specified by the Class 0 Point Assignment Setup Registers (see Table 4-21). By default, the following points are specified by the Class 0 Point Assignment setup: 32 first Analog Input points from Table 4-1, 3 Analog Output first 3 points from Table 4-2, and 1 Binary Input points represented Relay Status (see Table 4-9).

The PM130, like most devices, retrieves regular analog and binary data from the instrument by executing a directed (non-broadcast) Read of the configured Class 0 object (object 60, variation 1, qualifier 6).

A Binary-Output-Status object that indicates the current state of a control digital point (relay) uses *remote forced data* as well as *local forced data* bits. The value of a *state* bit indicates the current state of the digital output point.

The PM130 executes the parameter clear function and demands resets using the Direct-Operate (or SBO/Operate or Direct-Operate-No-Acknowledge) command to specified points of the Control-Relay-Output-Block object.

Issuing the Direct-Operate (or SBO/Operate or Direct-Operate-No-Acknowledge) command to points 0 through 13 of the Analog-Output-Block object can change the setup parameters. The DNP functions Write, Cold-Restart and Delay Measurement are also supported by the PM130. Refer to *Appendix A* for specific requests and responses. *Appendix B* contains the standard DNP Device Profile Document.

The Powermeter attempts to respond with the same object variation and qualifier as those in the request. Exceptions to this rule include changing variation 0 to a specific variation and changing qualifier code 6 to 1.

If the Powermeter receives an invalid request, it sets the internal indication to the error code. The following internal indication bits are supported:

Octet Position	Bit Position	Description
0	0	Set when a request is received with a broadcast destination address. Cleared after next response.
0	7	Device restart - set when the instrument powers up or after executing Cold Restart. Cleared by writing zero to object 80.
0	5	Set when the instrument is in the Local state (is being programmed via the front panel). Cleared when the instrument is in the Remote state.
1	5	Set when the current configuration in the instrument is corrupted. May also be set as a result of the legal changes in the setup configuration whenever another setup is affected by the changes made. Cleared when either setup is reloaded.

3 DNP Interface

3.1 General

This section describes a LEVEL 1 DNP V3.00 communication protocol implemented between a master station and a slave Powermeter. A DNP device (RTU, Computer, etc.) has an address in the range of 0 to 65535, and it is this address that allows a master to selectively request data from any other device. DNP uses the address 65535 for broadcast function. A broadcast request never generates a DNP response.

The DNP implementation in the PM130 conforms to all Harris IED implementation guidelines. All data items that are available from the Powermeter can be obtained via the DNP Read Class 0 command. Individual items can also be read using the Read Analog-Input, Read Counter, Read Analog Output Status or Read Binary Input commands.

Some registers can be reset to zero by issuing the Direct-Operate (or SBO/Operate or Direct-Operate-No-Acknowledge) command to specified points of the Control-Relay-Output-Block object. The reset request to reset the Energy, Demands, Counters and Min/Max values must use a code operation Pulse On. Latch-On / Latch-Off operation codes are used to control the digital software/hardware points.

The setpoint parameters can be changed by issuing the Direct-Operate (or SBO/Operate or Direct-Operate-No-Acknowledge) command using the Analog-Output-Block object.

3.2 DNP Address

The instrument on a DNP link must have a unique address. The PM130 allows one of 256 addresses to be selected. The selectable addresses have a range of 0-255.

3.3 Transaction Timing

To allow the master to switch the communication link, it is guaranteed that the Powermeter minimum response time be at least 3.5 character time (depending on the baud rate) and at least 5 ms. Table 3-1 shows the actual response time measured at 9600 bps.

Table 3-1 Response Time

Number of Parameters	Typical response time, ms	Maximum response time, ms
1	10	12
5	15	16
10	21	22
43 (Object 30:3)	45	62

Note that Direct-Operate (or SBO/Operate or Direct-Operate-No-Acknowledge) requests for reset/clear registers and setpoint changing are immediately confirmed.

3.4 Object Format

The PM130 uses two objects, which correspond to instrument measurements. These are Counter (object 20, variations 5 and 6) and Analog-Input (object 30, variations 1, 2, 3 and 4).

The Single-Bit Binary-Input (object 1, variation 1) and Binary-Output-Status (object 10, variation 2) are used to represent the state of digital input/output points (software or hardware). The Control-Relay-Output-Block (object 12, variation 1) is used to control digital points.

The PM130 supports a response when a value is requested as a variation 0 and will respond as if the requested variation was for a 32 bit Counter or 32/16 bit Analog-Input or 16 bit Analog-Output-Status.

3.5 Scaling Analog Input Objects

With the Analog-Input objects, either variation 1 through 4 can be used. Variations specified in the tables in Section 4 show those that should be used to read a full-range value without a possible over-range error when no scaling is used to accommodate the value to the requested object size.

When over-range occurs, a positive value is reported as 32767 and a negative value as -32768, with the over-range bit being set to 1 in the flag octet if a variation 2 is requested. To avoid over-range errors when a variation 2 or 4 is required, a liner scaling may be used (see Section 4.6, DNP Options Setup) to scale 32-bit analog readings to 16-bit Analog Input objects. By default, scaling is disabled.

When scaling is enabled, either analog input requested with a variation 2 or 4 will be scaled to the range of -32768 to 32767 for bi-directional parameters (such as power and power factor), and to the range of 0 to 32767 for single-ended positive parameters (voltage, current, frequency, etc.). To get a true reading, the reverse conversion should be done using the following formula:

$$Y = ((X – DNP\_LO) \times (HI - LO)) /(DNP\_HI – DNP\_LO) + LO$$

where:

Y	-	the true reading in engineering units
X	-	the raw input data in the range of DNP_LO – DNP_HI
LO, HI	-	the data low and high scales in engineering units (specified for each Analog-Input point, Section 4)
DNP_LO	-	DNP low conversion scale: DNP_LO = -32768 for a point with a negative LO scale, DNP_LO = 0 for a point with a zero or positive LO scale
DNP_HI	-	DNP high conversion scale: DNP_HI = 32767

EXAMPLE

Suppose you have read a value of 201 for point 3 that contains a current reading (see *Table 4-1*). If your instrument has CT primary current 5000 A, then the current high scale is HI = 1.5×5000 = 7500, and in accordance with the above formula, the current reading in engineering units will be as follows:

$$(201 - 0) \times (7500 - 0)/(32767 - 0) + 0 = 46A$$

4 PM130 Registers

4.1 Basic Data Registers

These registers are used to retrieve a predefined set of the data measured by the Powermeter. All electrical parameters are averaged values over the specified number of real-time measurements.

Table 4-1 Input Data Parameters

Object/Var. [4]	Parameter	Object/Point	Unit	Value range [1]
30:3	Voltage L1/L12 [3]	AI:0	V	0 to Vmax
30:3	Voltage L2/L23 [3]	AI:1	V	0 to Vmax
30:3	Voltage L3/L31 [3]	AI:2	V	0 to Vmax
30:3	Current L1	AI:3	A	0 to Imax
30:3	Current L2	AI:4	A	0 to Imax
30:3	Current L3	AI:5	A	0 to Imax
30:3	kW L1	AI:6	kW	-Pmax to Pmax
30:3	kW L2	AI:7	kW	-Pmax to Pmax
30:3	kW L3	AI:8	kW	-Pmax to Pmax
30:3	kvar L1	AI:9	kvar	-Pmax to Pmax
30:3	kvar L2	AI:10	kvar	-Pmax to Pmax
30:3	kvar L3	AI:11	kvar	-Pmax to Pmax
30:3	kVA L1	AI:12	kVA	0 to Pmax
30:3	kVA L2	AI:13	kVA	0 to Pmax
30:3	kVA L3	AI:14	kVA	0 to Pmax
30:4	Power factor L1	AI:15	0.001	-999 to 1000
30:4	Power factor L2	AI:16	0.001	-999 to 1000
30:4	Power factor L3	AI:17	0.001	-999 to 1000
30:4	Total power factor	AI:18	0.001	-999 to 1000
30:3	Total kW	AI:19	kW	-Pmax to Pmax
30:3	Total kvar	AI:20	kvar	-Pmax to Pmax
30:3	Total kVA	AI:21	kVA	0 to Pmax
30:3	Neutral (unbalanced) current	AI:22	A	0 to Imax
30:4	Frequency	AI:23	0.01Hz	0 to 10000
30:3	Maximum sliding window kW demand [2] [E]	AI:24	kW	0 to Pmax
30:3	Accumulated kW demand [E]	AI:25	kW	0 to Pmax
30:3	Maximum sliding window kVA demand [2] [E]	AI:26	kVA	0 to Pmax
30:3	Accumulated kVA demand [E]	AI:27	kVA	0 to Pmax
30:3	Maximum ampere demand L1	AI:28	A	0 to Imax
30:3	Maximum ampere demand L2	AI:29	A	0 to Imax
30:3	Maximum ampere demand L3	AI:30	A	0 to Imax
30:3	Present sliding window kW demand [E]	AI:31	kW	0 to Pmax
30:3	Present sliding window kVA demand [E]	AI:32	kVA	0 to Pmax
30:4	PF at maximum kVA sliding window demand [E]	AI:33	0.001	0 to 1000
30:4	Voltage THD L1/L12 [5] [EH]	AI:34	0.1%	0 to 9999
30:4	Voltage THD L2/L23 [5] [EH]	AI:35	0.1%	0 to 9999
30:4	Voltage THD L3 [5] [EH]	AI:36	0.1%	0 to 9999
30:4	Current THD L1 [EH]	AI:37	0.1%	0 to 9999
30:4	Current THD L2 [EH]	AI:38	0.1%	0 to 9999
30:4	Current THD L3 [EH]	AI:39	0.1%	0 to 9999
30:4	Current TDD L1 [EH]	AI:40	0.1%	0 to 1000
30:4	Current TDD L2 [EH]	AI:41	0.1%	0 to 1000
30:4	Current TDD L3 [EH]	AI:42	0.1%	0 to 1000
20:5	kWh import [E]	BC:0	kWh	0 to 99,999,999
20:5	kWh export [E]	BC:1	kWh	0 to 99,999,999

Object/Var. [4]	Parameter	Object/Point	Unit	Value range [1]
20:5	kvarh net [E]	BC:2	kvarh	-99,999,999 to 99,999,999
20:5	kVAh [E]	BC:3	kVAh	0 to 99,999,999
20:5	kvarh import [6] [E]	BC:4	kvarh	0 to 99,999,999
20:5	kvarh export [6] [E]	BC:5	kvarh	0 to 99,999,999

AI indicates Analog-Input point, BC – binary counter point. First 32 AI points assigned to Class 0 by default.

[1] The parameter limits are as follows:

Vmax (690 V input option) = 828 V @ 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 (x150% over-range) = 1.5 * CT primary current [A]
Pmax = (Imax * Vmax * 3)/1000 [kW] if wiring mode is 4LN3, 3LN3 or 3BLN3
Pmax = (Imax * Vmax * 2)/1000 [kW] if wiring mode is 4LL3, 3OP2, 3DIR2, 3OP3, 3LL3 or 3BLL3

[2] To get block interval demand readings, specify the number of demand periods equal to 1 (see Table 4-2)

[3] When the 4LN3, 3LN3 or 3BLN3 wiring mode is selected, the voltages will be line-to-neutral; for any other wiring mode, they will be line-to-line voltages.

[4] Variations specified in the table show those that should be used to read a full-range value without a possible over-range error when no scaling is used to accommodate the value to the requested object size (see Section 3.5).

[5] In the 4LN3, 4LL3, 3LN3, 3LL3, 3BLN3, 3BLL3 and 3DIR2 wiring modes, the harmonic voltages will represent line-to-neutral voltages; in the 3OP2 and 3OP3 wiring modes, they will comprise L12 and L23 line-to-line voltages.

[6] Available starting with F/W Version 3.57 or later.

4.2 Basic Setup Registers

These registers are used to access the basic setup parameters. In the event that the modulus field is not equal to 1, the value received from the Powermeter must be multiplied by the modulus. When written, such a number should be divided by the modulus. The first 3 points of the following basic setup registers (Object 40, Variation 2) are assigned to Class 0 by default.

Table 4-2 Basic Setup Registers

Object/Var.	Parameter	Object/Point	Range
40:2 (read) 41:2 (write)	Wiring mode [1]	AO:0	0 = 3OP2, 1 = 4LN3,2 = 3DIR2, 3 = 4LL3, 4 = 3OP3, 5 = 3LN3, 6 = 3LL3, 8 = 3BLN3, 9 = 3BLL3
40:1 (read) 41:1 (write)	PT ratio	AO:1	10 to 65000 × 0.1
40:1 (read) 41:1 (write)	CT primary current	AO:2	1 to 50000 A
40:2 (read) 41:2 (write)	Power demand period [E]	AO:3	1,2,5,10,15,20,30,60 min 255 = external synchronization [2]
40:2 (read) 41:2 (write)	Volt/ampere demand period	AO:4	0 to 1800 sec
40:2 (read) 41:2 (write)	Averaging buffer size	AO:5	8, 16, 32
40:2 (read) 41:2 (write)	Reset enable/disable	AO:6	0 = disable, 1 = enable
40:1 (read)	Reserved	AO:7	Read as 65535
40:2 (read) 41:2 (write)	The number of demand periods [E]	AO:8	1 – 15
40:1 (read)	Reserved	AO:9	Read as 65535
40:1 (read)	Reserved	AO:10	Read as 65535
40:2 (read) 41:2 (write)	Nominal frequency	AO:11	50, 60
40:2 (read) 41:2 (write)	Maximum demand load current	AO:12	0 to 50000 A (0 = CT primary current)

AO indicates Analog-Output-Status (Read) and Analog-Output-Block (Write) points.

[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
3BLN3 - 3-wire Broken Delta (2 1/2 element), line to neutral voltage readings
3BLL3 - 3-wire Broken Delta (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 4-7).

4.3 User Selectable Options Setup

Table 4-3 User Selectable Options Registers

Object/Var.	Parameter	Object/Point	Range
40:2 (read) 41:2 (write)	Power calculation mode	AO:92	0 = using reactive power, 1 = using non-active power
40:2 (read) 41:2 (write)	Energy roll value [1] [E]	AO:93	0 = 1×10^4 1 = 1×10^5 2 = 1×10^6 3 = 1×10^7 4 = 1×10^8
40:2 (read) 41:2 (write)	Phase energy calculation mode [E]	AO:94	0 = disable, 1 = enable

[1] For short energy readings (see Table 4-1), the maximum roll value will be 1×10^8 for positive and negative readings.

4.4 Firmware Version and Device Options

The registers shown in Table 4-4 are used to retrieve the firmware version number and instrument options.

Table 4-4 Firmware & Instrument Options Registers

Object/Var.	Parameter	Object/Point	R/W	Range
30:4	Firmware build number [1]	AI:1023	R	0-65535
30:4	Firmware version number	AI:1024	Read	0-65535
30:3	Instrument option 1	AI:1025	Read	see Table 4-5
30:3	Instrument option 2	AI:1026	Read	see Table 4-5

AI indicates Analog-Input points.

[1] Available starting with F/W Version 3.58.1 or later.

Table 4-5 Instrument Options

Options register	Bit number	Description
Options 1 (AI:1025)	0 1 2-4 5 6-8 9 10-15	120V option 690V option Reserved 150% current over-range Reserved Relays option Reserved
Options 2 (AI:1026)	0-2 3-15	Number of relays - 1 Reserved

4.5 Communications Setup

These registers are used to access the communications setup parameters.

Table 4-6 Communications Setup Registers

Object / Var.	Parameter	Object / Point	Range
40:1 (read)	Protocol	AO:64	0 = ASCII 1 = Modbus RTU 2 = DNP3.0
40:2 (read) 41:2 (write)	Interface	AO:65	2 = RS-485 (not changeable)
40:2 (read) 41:2 (write)	Address	AO:66	0 to 255
40:2 (read) 41:2 (write)	Baudrate	AO:67	0 = 110 bps 1 = 300 bps 2 = 600 bps 3 = 1200 bps 4 = 2400 bps 5 = 4800 bps 6 = 9600 bps 7 = 19200 bps
40:2 (read) 41:2 (write)	Data format	AO:68	1 = 8 bits/no parity 2 = 8 bits/even parity

AO indicates Analog-Output points.

NOTE

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.

4.6 DNP Options Setup

These registers are used to access the DNP Options Setup parameters.

Table 4-7 DNP Options Setup Registers

Object / Var.	Parameter	Object / Point	Range
40:1 (read)	Reserved	AO:32-37	Read as 65535
40:1 (read) 41:1 (write)	Analog Input variation	AO:38	0 - obj:30 var:1, 1- obj:30 var:3, 2 - obj:30 var:2, 3- obj:30 var:4
40:1 (read)	Reserved	AO:39-43	Read as 65535
40:1 (read) 41:2 (write)	DNP Scaling	AO:44	0 – scaling OFF, 1 - scaling ON
40:1 (read)	Reserved	AO:45-47	Read as 65535
40:2 (read) 41:2 (write)	Select/Operate Timeout	AO:48	2 to 30 seconds
40:2 (read)	Reserved	AO:49-52	Read as 65535
40:2(read) 41:2 (write)	Time Synch Period	AO:53	1 to 84600 seconds

AO indicates Analog-Output points.

The Analog Input variation defines the default variation of the Analog Input object that is selected when no specific variation is requested for the Analog Input object by a master station, particularly with the Analog Input object requests using Qualifier code 06 (variation 0). By default it is set to the 16-bit Analog Input object without flag (object 30, variation 4).

The DNP Scaling is used to control the scaling mechanism. The scaling is turned ON if this parameter is set to 1. By default this parameter is set to 1 and scaling is ON. Choosing 32-bit Analog Input objects(object 30, variation 1, 3) disables this parameter.

The Select Before Operate command causes the PM130 to start a timer. The Operate command must be received correctly before the value specified by the Select / Operate Timeout parameter expires.

4.7 Resetting Energy, Demands, Counters and Min/Max log

The energy value can be reset to zero by issuing the Direct-Operate (or SBO/Operate or Direct-Operate-No-Acknowledge) command using the Control-Relay-Output-Block object to point 0. The request must use the operation Pulse-On. Issuing the same parameters and Direct-Operate (or SBO/Operate or Direct-Operate-No-Acknowledge) command to points 1-3 can reset the maximum demands.

Table 4-8 Reset/Clear Registers

Object / Var.	Register function	Object / Point	R / W	Description
10:2 12:1	Clear total energy registers [E]	BO:0 CROB:0	Read Write	Return zero PULSE ON
10:2 12:1	Clear total maximum demand registers (all demands)	BO:1 CROB:1	Read Write	Return zero PULSE ON
10:2 12:1	Clear power demands [E]	BO:2 CROB:2	Read Write	Return zero PULSE ON
10:2 12:1	Clear volt/ampere demands	BO:3 CROB:3	Read Write	Return zero PULSE ON
10:2 12:1	Reserved	BO:4-11 CROB:4-11	Read Write	Return zero
10:2 12:1	Clear pulse counters (all counters)	BO:12 CROB:12	Read Write	Return zero PULSE ON
10:2 12:1	Clear pulse counter #1	BO:13 CROB:13	Read Write	Return zero PULSE ON
10:2 12:1	Clear pulse counter #2	BO:14 CROB:14	Read Write	Return zero PULSE ON
10:2 12:1	Clear pulse counter #3	BO:15 CROB:15	Read Write	Return zero PULSE ON
10:2 12:1	Clear pulse counters #4	BO:16 CROB:16	Read Write	Return zero PULSE ON
10:2 12:1	Reserved	BO:17-20 CROB:17-20	Read Write	Return zero
10:2 12:1	Clear Min/Max log	BO:21 CROB:21	Read Write	Return zero PULSE ON
10:2 12:1	Reserved	BO:22-39 CROB:22-39	Read Write	Return zero
10:2 12:1	Synchronize power demand interval [1] [E]	BO:40 CROB:40	Read Write	Return zero PULSE ON

BO indicates Binary Output Status. CROB indicates Control-Relay-Output-Block point.

[1] 1) If the power demand period is set to External Synchronization (see Table 4-2), 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.

The following restriction should be noticed when using object 12 to control the listed points.

- The *Count* byte is ignored. The *Control Code* byte is checked for the following:
  - *Pulse On* (1) is valid for all points;
  - All other codes are invalid and will be rejected.
- The *On Time* and *Off Time* fields are ignored.
- The status byte in the response will reflect the success or failure of the control operation:
  - *Request Accepted* (0) will be returned if the command was accepted;
  - *Request not Accepted due to Formatting Errors* (3) will be returned if the *Control Code* byte was incorrectly formatted or if an invalid code was present in the command;
  - *Control Operation not Supported for this Point* (4) will be returned if the Control Point was out of control (for instance, reset is disabled via Basic Setup).

Issuing the same parameters and Direct-Operate (or SBO/Operate or Direct-Operate-No-Acknowledge) command to point 12-16 can clear the Pulse Counters.

Issuing the same parameters and Direct-Operate (or SBO/Operate or Direct-Operate-No-Acknowledge) command to point 21 can reset the Min/Max log.

4.8 Status Registers

These registers are used to retrieve the status of digital input/output points (hardware or software) from the instrument.

Table 4-9 Status Registers (Read)

Object/Var.	Description	Object/Point	Bit meaning
01:1	Relay status	BI:0	0 = relay released, 1 = relay operated
01:1	Reserved	BI:1-15	Not used (permanently set to 0)
01:1	Reserved	BI:16-31	Not used (permanently set to 0)
01:1	Setpoints #1 - #16	BI:32-47	Setpoint status: 0 - is released; 1 - is operated

BI indicates Single-Bit Binary-Input points (Read).

4.9 Alarm Status Registers

These registers are used to retrieve the status alarm parameters from the instrument.

NOTE

The PM130 provides two alarm registers: the first is the setpoint alarm register, and the second is the self-check alarm register.

The setpoint alarm points store the status of the operated alarm setpoints by setting the appropriate bits to 1. The alarm status points can be reset by issuing the Direct-Operate (or SBO/Operate or Direct-Operate-No-Acknowledge) command using the Control-Relay-Output-Block (object 12, variation 1) to points 48 to 63. Only the Latch-Off operation code is accepted. It is possible to reset each alarm status point separately by writing 0 to a corresponding alarm point.

The self-check alarm points indicate possible problems with the instrument hardware or setup configuration. Hardware problems are indicated by the appropriate points which are set whenever the instrument fails self-test diagnostics or in the event of loss of power. The dedicated binary point indicates setup configuration problems and 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.

Issuing the Direct-Operate (or SBO/Operate or Direct-Operate-No-Acknowledge) command using the Control-Relay-Output-Block object (with the code operation Latch-Off) to points from range 64 to 75 can reset hardware fault points. The configuration corrupt status point is also reset automatically when you change setup either via the front panel or through communications.

Table 4-10 Alarm Status Registers

Object/Var.	Description	Object/Point	Bit meaning
	Setpoint Alarm Register		1 = setpoint has been operated 0 = setpoint hasn't been operated
10:2(read) 12:1(write)	Alarm #1 -#16	B0:48-63 CROB:48-63	
	Self-check Alarm Register		1 = alarm has been asserted 0 = alarm hasn't been asserted
10:2(read) 12:1(write)	Reserved	B0:64 CROB:64	Not defined
10:2(read) 12:1(write)	ROM error	B0:65 CROB:65	
10:2(read) 12:1(write)	RAM error	B0:66 CROB:66	
10:2(read)	Watchdog timer reset	B0:67	

Object / Var.	Description	Object / Point	Bit meaning
12:1(write)		CROB:67	
10:2(read) 12:1(write)	Sampling failure	B0:68 CROB:68	
10:2(read) 12:1(write)	Out of control trap	B0 :69 CROB:69	
10:2(read) 12:1(write)	Reserved	BI :70 CROB:70	Not defined
10:2(read) 12:1(write)	Timing failure	B0 :71 CROB:71	
10:2(read) 12:1(write)	Loss of power (power up)	B0:72 CROB:72	
10:2(read) 12:1(write)	External reset (Cold Restart) [1]	B0:73 CROB:73	
10:2(read) 12:1(write)	Configuration corrupted [1]	B0:74 CROB:74	
10:2(read) 12:1(write)	Reserved	75-79 75-79	Not defined

BO indicates Binary-Output -Status (Read) or Control-Relay-Output Block (Write) points.

[1] These self-check alarms are doubled with the corresponding internal indication bits.

The following restrictions should be noted when using object 12 to control the listed points:

- The *Count* byte is ignored.
- The *Control Code* byte is checked:
  - *Latch Off* is valid for all points;
  - All other codes are invalid and will be rejected.
- The *On Time* and *Off Time* fields are ignored.
- The status byte in the response will reflect the success or failure of the control operation:
  - *Request Accepted* (0) will be return if the command was accepted;
  - *Request not Accepted due to Formatting Errors* (3) will be returned if the *Control Code* byte was incorrectly formatted or if an invalid Code was present in the command.

4.10 Extended Data Registers

These registers are used to retrieve any data measured by the instrument. A list of the extended data parameters, their points and value ranges are shown in Table 4-11.

Table 4-11 Extended Data Registers

Object / Var. [7]	Parameter	Object / Point	Unit	Value range [1]
30:4	None	AI:32768		0
Relay status				
01:1	Relay status	BI:34816		0/1
01:1	Reserved	BI:34817- BI:34831		0/0
Event / time counters				
20:5	Counter #1	BC:35328		0 to 99999
20:5	Counter #2	BC:35329		0 to 99999
20:5	Counter #3	BC:35330		0 to 99999
20:5	Counter #4	BC:35331		0 to 99999
Real-time values per phase (power values - P)				
30:3	Voltage L1/L12 [4]	AI:35840	V	0 to Vmax
30:3	Voltage L2/L23 [4]	AI:35841	V	0 to Vmax
30:3	Voltage L3/L31 [4]	AI:35842	V	0 to Vmax
30:3	Current L1	AI:35843	A	0 to Imax
30:3	Current L2	AI:35844	A	0 to Imax
30:3	Current L3	AI:35845	A	0 to Imax
30:3	kW L1	AI:35846	kW	-Pmax to Pmax
30:3	kW L2	AI:35847	kW	-Pmax to Pmax

Object / Var. [7]	Parameter	Object / Point	Unit	Value range [1]
30:3	kW L3	AI:35848	kW	-Pmax to Pmax
30:3	kvar L1	AI:35849	kvar	-Pmax to Pmax
30:3	kvar L2	AI:35850	kvar	-Pmax to Pmax
30:3	kvar L3	AI:35851	kvar	-Pmax to Pmax
30:3	kVA L1	AI:35852	kVA	0 to Pmax
30:3	kVA L2	AI:35853	kVA	0 to Pmax
30:3	kVA L3	AI:35854	kVA	0 to Pmax
30:4	Power factor L1	AI:35855	0.001	-999 to 1000
30:4	Power factor L2	AI:35856	0.001	-999 to 1000
30:4	Power factor L3	AI:35857	0.001	-999 to 1000
30:4	Voltage THD L1/L12 [5] [EH]	AI:35858	0.1%	0 to 9999
30:4	Voltage THD L2/L23 [5] [EH]	AI:35859	0.1%	0 to 9999
30:4	Voltage THD L3 [5] [EH]	AI:35860	0.1%	0 to 9999
30:4	Current THD L1 [EH]	AI:35861	0.1%	0 to 9999
30:4	Current THD L2 [EH]	AI:35862	0.1%	0 to 9999
30:4	Current THD L3 [EH]	AI:35863	0.1%	0 to 9999
30:4	K-Factor L1 [EH]	AI:35864	0.1	10 to 9999
30:4	K-Factor L2 [EH]	AI:35865	0.1	10 to 9999
30:4	K-Factor L3 [EH]	AI:35866	0.1	10 to 9999
30:4	Current TDD L1 [EH]	AI:35867	0.1%	0 to 1000
30:4	Current TDD L2 [EH]	AI:35868	0.1%	0 to 1000
30:4	Current TDD L3 [EH]	AI:35869	0.1%	0 to 1000
30:3	Voltage L12	AI:35870	V	0 to Vmax
30:3	Voltage L23	AI:35871	V	0 to Vmax
30:3	Voltage L31	AI:35872	V	0 to Vmax
Real-time total values				
30:3	Total kW	AI:36608	kW	-Pmax to Pmax
30:3	Total kvar	AI:36609	kvar	-Pmax to Pmax
30:3	Total kVA	AI:36610	kVA	0 to Pmax
30:4	Total PF	AI:36611	0.001	-999 to 1000
30:4	Total PF lag [8]	AI:36612	0.001	0 to 1000
30:4	Total PF lead [8]	AI:36613	0.001	0 to 1000
30:3	Total kW import [8]	AI:36614	kW	0 to Pmax
30:3	Total kW export [8]	AI:36615	kW	0 to Pmax
30:3	Total kvar import [8]	AI:36616	kvar	0 to Pmax
30:3	Total kvar export [8]	AI:36617	kvar	0 to Pmax
30:3	3-phase average voltage [4, 8]	AI:36618	V	0 to Vmax
30:3	3-phase average L-L voltage [8]	AI:36619	V	0 to Vmax
30:3	3-phase average current [8]	AI:36620	A	0 to Imax
Real-time auxiliary values				
30:4	Reserved	AI:36864		0
30:3	Neutral current	AI:36865	A	0 to Imax
30:4	Frequency	AI:36866	0.01 Hz	0 to 10000 [3]
30:3	Voltage unbalance	AI:36867	%	0 to 300
30:4	Current unbalance	AI:36868	%	0 to 300
Phasors [6]				
30:3	Voltage L1/L12	AI:36992	V	0 to Vmax
30:3	Voltage L2/L23	AI:36993	V	0 to Vmax
30:3	Voltage L3/L31	AI:36994	V	0 to Vmax
30:3	Reserved	AI:36995	V	0 to Vmax
30:3	Current L1	AI:36996	A	0 to Imax
30:3	Current L2	AI:36997	A	0 to Imax
30:3	Current L3	AI:36998	A	0 to Imax
30:3	Reserved	AI:36999	A	0 to Imax
30:4	V1/V12 Voltage angle	AI:37000	0.1°	-180.0 to 180.0
30:4	V2/V23 Voltage angle	AI:37001	0.1°	-180.0 to 180.0
30:4	V3/V31 Voltage angle	AI:37002	0.1°	-180.0 to 180.0
30:4	Reserved	AI:37003		-180.0 to 180.0
30:4	I1 Current angle	AI:37004	0.1°	-180.0 to 180.0
30:4	I2 Current angle	AI:37005	0.1°	-180.0 to 180.0
30:4	I3 Current angle	AI:37006	0.1°	-180.0 to 180.0
30:4	Reserved	AI:37007		-180.0 to 180.0

Object / Var. [7]	Parameter	Object / Point	Unit	Value range [1]
Average values per phase (power values - P)				
30:3	Voltage L1/L12 [4]	AI:37120	V	0 to Vmax
30:3	Voltage L2/L23 [4]	AI:37121	V	0 to Vmax
30:3	Voltage L3/L31 [4]	AI:37122	V	0 to Vmax
30:3	Current L1	AI:37123	A	0 to Imax
30:3	Current L2	AI:37124	A	0 to Imax
30:3	Current L3	AI:37125	A	0 to Imax
30:3	kW L1	AI:37126	kW	-Pmax to Pmax
30:3	kW L2	AI:37127	kW	-Pmax to Pmax
30:3	kW L3	AI:37128	kW	-Pmax to Pmax
30:3	kvar L1	AI:37129	kvar	-Pmax to Pmax
30:3	kvar L2	AI:37130	kvar	-Pmax to Pmax
30:3	kvar L3	AI:37131	kvar	-Pmax to Pmax
30:3	kVA L1	AI:37132	kVA	0 to Pmax
30:3	kVA L2	AI:37133	kVA	0 to Pmax
30:3	kVA L3	AI:37134	kVA	0 to Pmax
30:4	Power factor L1	AI:37135	0.001	-999 to 1000
30:4	Power factor L2	AI:37136	0.001	-999 to 1000
30:4	Power factor L3	AI:37137	0.001	-999 to 1000
30:4	Voltage THD L1/L12 [5] [EH]	AI:37138	0.1%	0 to 9999
30:4	Voltage THD L2/L23 [5] [EH]	AI:37139	0.1%	0 to 9999
30:4	Voltage THD L3 [5] [EH]	AI:37140	0.1%	0 to 9999
30:4	Current THD L1 [EH]	AI:37141	0.1%	0 to 9999
30:4	Current THD L2 [EH]	AI:37142	0.1%	0 to 9999
30:4	Current THD L3 [EH]	AI:37143	0.1%	0 to 9999
30:4	K-Factor L1 [EH]	AI:37144	0.1	10 to 9999
30:4	K-Factor L2 [EH]	AI:37145	0.1	10 to 9999
30:4	K-Factor L3 [EH]	AI:37146	0.1	10 to 9999
30:4	Current TDD L1 [EH]	AI:37147	0.1%	0 to 1000
30:4	Current TDD L2 [EH]	AI:37148	0.1%	0 to 1000
30:4	Current TDD L3 [EH]	AI:37149	0.1%	0 to 1000
30:4	Voltage L12	AI:37150	V	0 to Vmax
30:4	Voltage L23	AI:37151	V	0 to Vmax
30:4	Voltage L31	AI:37152	V	0 to Vmax
Average total values				
30:3	Total kW	AI:37888	kW	-Pmax to Pmax
30:3	Total kvar	AI:37889	kvar	-Pmax to Pmax
30:3	Total kVA	AI:37890	kVA	0 to Pmax
30:4	Total PF	AI:37891	0.001	-999 to 1000
30:4	Total PF lag [8]	AI:37892	0.001	0 to 1000
30:4	Total PF lead [8]	AI:37893	0.001	0 to 1000
30:3	Total kW import [8]	AI:37894	kW	0 to Pmax
30:3	Total kW export [8]	AI:37895	kW	0 to Pmax
30:3	Total kvar import [8]	AI:37896	kvar	0 to Pmax
30:3	Total kvar export [8]	AI:37897	kvar	0 to Pmax
30:3	3-phase average voltage [4, 8]	AI:37898	V	0 to Vmax
30:3	3-phase average L-L voltage [8]	AI:37899	V	0 to Vmax
30:3	3-phase average current [8]	AI:37900	A	0 to Imax
Average auxiliary values				
30:4	Reserved	AI:38144		0
30:3	Neutral current	AI:38145	A	0 to Imax
30:4	Frequency	AI:38146	0.01 Hz	0 to 10000 [3]
30:4	Voltage unbalance	AI:38147	%	0 to 300
30:4	Current unbalance	AI:38148	%	0 to 300
Present demands				
30:3	Volt demand L1/L2 [4]	AI:38400		0 to Vmax
30:3	Volt demand L2/L3 [4]	AI:38401		0 to Vmax
30:3	Volt demand L3/L1 [4]	AI:38402		0 to Vmax
30:3	Ampere demand L1	AI:38403	A	0 to Imax
30:3	Ampere demand L2	AI:38404	A	0 to Imax
30:3	Ampere demand L3	AI:38405	A	0 to Imax

Object / Var. [7]	Parameter	Object / Point	Unit	Value range [1]
30:3	Block kW demand [E]	AI:38406	kW	0 to Pmax
30:4	Reserved	AI:38407		0
30:3	Block kVA demand [E]	AI:38408	kVA	0 to Pmax
30:3	Sliding window kW demand [E]	AI:38409	kW	0 to Pmax
30:4	Reserved	AI:38410		0
30:3	Sliding window kVA demand [E]	AI:38411	kVA	0 to Pmax
30:4	Reserved	AI:38412		0
30:4	Reserved	AI:38413		0
30:4	Reserved	AI:38414		0
30:3	Accumulated kW demand [E]	AI:38415	kW	0 to Pmax
30:4	Reserved	AI:38416		0
30:3	Accumulated kVA demand [E]	AI:38417	kVA	0 to Pmax
30:3	Predicted sliding window kW demand [E]	AI:38418	kW	0 to Pmax
30:4	Reserved	AI:38419		
30:3	Predicted sliding window kVA demand [E]	AI:38420	kVA	0 to Pmax
30:3	PF at maximum kVA sliding window [E]	AI:38421	0.001	0 to 1000
Total energies [E]				
20:5	kWh import	BC:38656	kWh	0 to 10^8 -1
20:5	kWh export	BC:38657	kWh	0 to 10^8 -1
20:5	Reserved	BC:38658		0
20:5	Reserved	BC:38659		0
20:5	kvarh import	BC:38660	kvarh	0 to 10^8 -1
20:5	kvarh export	BC:38661	kvarh	0 to 10^8 -1
20:5	Reserved	BC:38662		0
20:5	Reserved	BC:38663		0
20:5	kVAh total	BC:38664	kVAh	0 to 10^8 -1
Phase energies [E]				
20:5	kWh import L1	BC:38912	kWh	0 to 10^8 -1
20:5	kWh import L2	BC:38913	kWh	0 to 10^8 -1
20:5	kWh import L3	BC:38914	kWh	0 to 10^8 -1
20:5	kvarh import L1	BC:38915	kvarh	0 to 10^8 -1
20:5	kvarh import L2	BC:38916	kvarh	0 to 10^8 -1
20:5	kvarh import L3	BC:38917	kvarh	0 to 10^8 -1
20:5	kVAh total L1	BC:38918	kVAh	0 to 10^8 -1
20:5	kVAh total L2	BC:38919	kVAh	0 to 10^8 -1
20:5	kVAh total L3	BC:38920	kVAh	0 to 10^8 -1
Fundamental (H01) real-time values per phase [EH]				
30:3	Voltage L1/L12 [5]	AI:43264	V	0 to Vmax
30:3	Voltage L2/L23 [5]	AI:43265	V	0 to Vmax
30:3	Voltage L3 [5]	AI:43266	V	0 to Vmax
30:3	Current L1	AI:43267	A	0 to Imax
30:3	Current L2	AI:43268	A	0 to Imax
30:3	Current L3	AI:43269	A	0 to Imax
30:3	kW L1	AI:43270	kW	-Pmax to Pmax
30:3	kW L2	AI:43271	kW	-Pmax to Pmax
30:3	kW L3	AI:43272	kW	-Pmax to Pmax
30:3	kvar L1	AI:43273	kvar	-Pmax to Pmax
30:3	kvar L2	AI:43274	kvar	-Pmax to Pmax
30:3	kvar L3	AI:43275	kvar	-Pmax to Pmax
30:3	kVA L1	AI:43276	kVA	0 to Pmax
30:3	kVA L2	AI:43277	kVA	0 to Pmax
30:3	kVA L3	AI:43278	kVA	0 to Pmax
30:4	Power factor L1	AI:43279	0.001	-999 to 1000
30:4	Power factor L2	AI:43280	0.001	-999 to 1000
30:4	Power factor L3	AI:43281	0.001	-999 to 1000
Fundamental (H01) real-time total values [EH]				
30:3	Total kW	AI:43520	kW	-Pmax to Pmax
30:3	Total kvar	AI:43521	kvar	-Pmax to Pmax

Object/Var. [7]	Parameter	Object/ Point	Unit	Value range [1]
30:3	Total kVA	AI:43522	kVA	0 to Pmax
30:4	Total PF	AI:43523	0.001	-999 to 1000
Minimum real-time values per phase (M)				
30:3	Voltage L1/L12 [4]	AI:44032	V	0 to Vmax
30:3	Voltage L2/L23 [4]	AI:44033	V	0 to Vmax
30:3	Voltage L3/L31[4]	AI:44034	V	0 to Vmax
30:3	Current L1	AI:44035	A	0 to Imax
30:3	Current L2	AI:44036	A	0 to Imax
30:3	Current L3	AI:44037	A	0 to Imax
Minimum real-time total values (M)				
30:3	Total kW	AI:44288	kW	-Pmax to Pmax
30:3	Total kvar	AI:44289	kvar	-Pmax to Pmax
30:3	Total kVA	AI:44290	kVA	0 to Pmax
30:3	Total PF [2]	AI:44291	0.001	0 to 1000
Minimum real-time auxiliary values (M)				
30:4	Reserved	AI:44544		0
30:3	Neutral current	AI:44545	A	0 to Imax
30:4	Frequency	AI:44546	0.01 Hz	0 to 10000 [3]
Minimum demands (M) – Reserved				
30:4	Reserved	AI:44800-		0
		AI:44811		0
Maximum real-time values per phase (M)				
30:3	Voltage L1/L12 [4]	AI:46080	V	0 to Vmax
30:3	Voltage L2/L23 [4]	AI:46081	V	0 to Vmax
30:3	Voltage L3/L31 [4]	AI:46082	V	0 to Vmax
30:3	Current L1	AI:46083	A	0 to Imax
30:3	Current L2	AI:46084	A	0 to Imax
30:3	Current L3	AI:46085	A	0 to Imax
Maximum real-time total values (M)				
30:3	Total kW	AI:46336	kW	-Pmax to Pmax
30:3	Total kvar	AI:46337	kvar	-Pmax to Pmax
30:3	Total kVA	AI:46338	kVA	0 to Pmax
30:3	Total PF [2]	AI:46339	0.001	0 to 1000
Maximum real-time auxiliary values (M)				
30:4	Reserved	AI:46592		0
30:3	Neutral current	AI:46593	A	0 to Imax
30:4	Frequency	AI:46594	0.01 Hz	0 to 10000 [3]
Maximum demands (M)				
30:3	Max. volt demand L1/L12 [4]	AI:46848	V	0 to Vmax
30:3	Max. volt demand L2/L23 [4]	AI:46849	V	0 to Vmax
30:3	Max. volt demand L3/L31 [4]	AI:46850	V	0 to Vmax
30:3	Max. ampere demand L1	AI:46851	A	0 to Imax
30:3	Max. ampere demand L2	AI:46852	A	0 to Imax
30:3	Max. ampere demand L3	AI:46853	A	0 to Imax
30:3	Reserved	AI:46854		0
30:3	Reserved	AI:46855		0
30:3	Reserved	AI:46856		0
30:3	Maximum sliding window kW demand	AI:46857	kW	0 to Pmax
30:3	Reserved	AI:46858		0
30:3	Maximum sliding window kVA demand	AI:46859	kVA	0 to Pmax

1 For the parameter limits, see Note1 to Table 4-1.

2 Absolute min/max value (lag or lead)

3 The actual frequency range is 45.00 - 65.00 Hz

4 When the 4LN3 , 3LN3 or 3BLN3 wiring mode is selected, the voltages will be line-to-neutral; for any other wiring mode, they will be line-to-line voltages.

5 In the 4LN3, 4LL3, 3LN3, 3LL3, 3BLN3, 3BLL3 and 3DIR2 wiring modes, the harmonic voltages will represent line-to-neutral voltages; in the 3OP2 and 3OP3 wiring modes, they will comprise L12 and L23 line-to-line voltages.

[6] Available in Version 3.55 and later. Phase angles are referenced to Voltage V1 in 4-wire (4LN3, 4LL3, 3LN3 and 3LL3 wiring modes), and to Voltage V12 in 3-wire connections (3DIR2, 3OP2 and 3OP3 wiring modes).

[7] Variations specified in the table show those that should be used to read a full-range value without a possible over-range error when no scaling is used to accommodate the value to the requested object size (see Section 3.5).

[8] Available in Version 3.58.01 and later.

(M) These parameters are logged to the Min/Max log

4.11 Alarm/Event Setpoints Registers

These registers allow obtaining or changing the setup of the sixteen alarm setpoints.

Table 4-12 Alarm/Event Setpoints

Setpoint #	Points
Setpoint #1	512-517
Setpoint #2	518-523
Setpoint #3	524-529
Setpoint #4	530-535
Setpoint #5	536-541
Setpoint #6	542-547
Setpoint #7	548-553
Setpoint #8	554-559
Setpoint #9	560-565
Setpoint #10	566-571
Setpoint #11	572-577
Setpoint #12	578-583
Setpoint #13	584-589
Setpoint #14	590-595
Setpoint #15	596-601
Setpoint #16	602-607

Table 4-13 Setpoint Registers

Setpoint	Object/Var.	Register contents	Object/Point	Range/Scale
#1	40:1(read) 41:1(write)	Trigger parameter ID	AO:512	see Table 4-14
	40:1(read) 41:1(write)	Action	AO:513	see Table 4-15
	40:2(read) 41:2(write)	Operate delay	AO:514	0-9999 (× 0.1 sec)
	40:2(read) 41:2(write)	Release delay	AO:515	0-9999 (× 0.1 sec)
	40:1(read) 41:1(write)	Operate limit	AO:516	see Table 4-14
	40:1(read) 41:1(write)	Release limit	AO:517	see Table 4-14
#16	40:1(read) 41:1(write)	Trigger parameter ID	AO:602	see Table 4-14
	40:2(read) 41:2(write)	Action	AO:603	see Table 4-15
	40:2(read) 41:2(write)	Operate delay	AO:604	0-9999 (× 0.1 sec)
	40:2(read) 41:2(write)	Release delay	AO:605	0-9999 (× 0.1 sec)
	40:1(read) 41:1(write)	Operate limit	AO:606	see Table 4-14
	40:1(read) 41:1(write)	Release limit	AO:607	see Table 4-14

NOTES

1. The setpoint is disabled when its trigger parameter is set to NONE. To disable the setpoint, write zero into this register.
2. 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, and if the new value does not conform to those, the request will be rejected.

3. Operate and release limits for the trigger parameters and their conversion scales are indicated in Table 4-14. 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.
4. Limits indicated in Table 4-14 by a N/A mark are read as zeros and are not checked when written. Write them as zeros.
5. 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 4-14 Setpoint Trigger Parameters

Trigger parameter	Trigger ID		Limits	
	Hex	Dec	Unit	Range [1]
None				
None	0000	0		0
Phase reversal				
Positive phase rotation reversal [2]	8901	35073		N/A
Negative phase rotation reversal [2]	8902	35074		N/A
High/low real-time values on any phase				
High voltage [4]	0E00	3584	V	0 to Vmax
Low voltage [4]	8D00	36096	V	0 to Vmax
High current	0E01	3585	A	0 to Imax
Low current	8D01	36097	A	0 to Imax
High voltage THD [5] [EH]	0E07	3591	0.1%	0 to 9999
High current THD [EH]	0E08	3592	0.1%	0 to 9999
High K-Factor [EH]	0E09	3593	0.1	10 to 9999
High current TDD [EH]	0E0A	3594	0.1%	0 to 1000
High/low real-time auxiliary values				
High frequency	1002	4098	0.01 Hz	0 to 10000 [3]
Low frequency	9002	36866	0.01 Hz	0 to 10000 [3]
High/low average values per phase				
High current L1	1103	4355	A	0 to Imax
High current L2	1104	4356	A	0 to Imax
High current L3	1105	4357	A	0 to Imax
Low current L1	9103	37123	A	0 to Imax
Low current L2	9104	37124	A	0 to Imax
Low current L3	9105	37125	A	0 to Imax
High/low average values on any phase				
High voltage [4]	1300	4864	V	0 to Vmax
Low voltage [4]	9200	37376	V	0 to Vmax
High current	1301	4865	V	0 to Vmax
Low current	9201	37377	V	0 to Vmax
High/low average total values				
High total kW import	1406	5126	kW	0 to Pmax
High total kW export	1407	5127	kW	0 to Pmax
High total kvar import	1408	5128	kvar	0 to Pmax
High total kvar export	1409	5129	kvar	0 to Pmax
High total kVA	1402	5122	kVA	0 to Pmax
Low total PF lag	9404	37892	0.001	0 to 1000
Low total PF lead	9405	37893	0.001	0 to 1000
High/low average auxiliary values				
High neutral current	1501	5377	A	0 to Imax
High frequency	1502	5378	0.01 Hz	0 to 10000 [3]
Low frequency	9502	38146	0.01 Hz	0 to 10000 [3]
High present demands				
High volt demand L1/L12 [4]	1600	5632	V	0 to Vmax
High volt demand L2/L23 [4]	1601	5633	V	0 to Vmax
High volt demand L3/L31 [4]	1602	5634	V	0 to Vmax
High ampere demand L1	1603	5635	A	0 to Imax
High ampere demand L2	1604	5636	A	0 to Imax
High ampere demand L3	1605	5637	A	0 to Imax

Trigger parameter	Trigger ID		Limits	
	Hex	Dec	Unit	Range [1]
High block kW demand [E]	1606	5638	kW	0 to Pmax
High block kVA demand [E]	1608	5640	kVA	0 to Pmax
High sliding window kW demand [E]	1609	5641	kW	0 to Pmax
High sliding window kVA demand [E]	160B	5643	kVA	0 to Pmax
High accumulated kW demand [E]	160F	5647	kW	0 to Pmax
High accumulated kVA demand [E]	1611	5649	kVA	0 to Pmax
High predicted kW demand [E]	1612	5650	kW	0 to Pmax
High predicted kVA demand [E]	1614	5652	kVA	0 to Pmax

[1] For the parameter limits, see Note[1] to Table 4-1.

[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 , 3LN3 or 3BLN3 wiring mode is selected, the voltages will be line-to-neutral; for any other wiring mode, they will be line-to-line voltages.

[5] In the 4LN3, 4LL3, 3LN3, 3LL3, 3BLN3, 3BLL3 and 3DIR2 wiring modes, the harmonic voltages will represent line-to-neutral voltages; in the 3OP2 and 3OP3 wiring modes, they will comprise L12 and L23 line-to-line voltages.

Table 4-15 Setpoint Actions

Description	Action ID	
	Hex	Dec
No action	0x0000	0
Operate relay	0x3000	12288
Increment counter #1	0x4000	16384
Increment counter #2	0x4001	16385
Increment counter #3	0x4002	16386
Increment counter #4	0x4003	16387
Count operating time using counter #1 [1]	0x4400	17408
Count operating time using counter #2 [1]	0x4401	17409
Count operating time using counter #3 [1]	0x4402	17410
Count operating time using counter #4 [1]	0x4403	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.

4.12 Pulsing Setpoints Registers

These registers are used to obtain or change the setup of the pulsing output for either of two relays.

NOTE

Allocating a relay as a pulsing relay will unconditionally disable all setpoints associated with this relay. If a relay was manually operated or released, it will automatically revert to normal operation.

Table 4-16 Pulsing Setpoints

Relay	Registers
Relay	768-769

Table 4-17 Pulsing Setpoint Registers

Object/Var.	Register contents	Object/Point	Range
40:2(read) 41:2(write)	Output parameter ID	AO:768	See Table 4-18
40:2(read) 41:2(write)	Number of unit-hours per pulse	AO:769	1-9999 for energy pulsing, otherwise write 0.

Table 4-18 Pulsing Output Parameters

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

4.13 Relay Operation Control

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

NOTE

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 4-19 Relay Operation Control Registers

Object / Var.	Register contents	Object / Point	State Range
10:2(read) 12:1(write)	Relay Force operate/Force release/Normal	BO:80 CROB:80	0/1 = state OFF/ON

The following restrictions should be noted when using object 12 to control the listed points:

- The *Count* byte is ignored.
- The *Control Code* byte is checked:
  - Pulse On , Pulse Off, Latch On, Latch Off are valid for all points;
  - All others *Codes* are invalid and wil be rejected;
  - The *Clear* sub-field is valid;
  - The others sub-fields are ignored.
- The *On Time* specifies in ms the amount of time the digital point is to be turned on. The *On Time* minimal value is 500 ms and the actual value may differ from the specified value by up to 50 ms.
- The *Off Time* specifies in ms the amount of time the digital point is to be turned off. The *Off Time* minimal value is 500 ms and the actual value may differ from the specified value by up to 50 ms.
- The *Status* byte in the response will reflect the success or failure of the control operation:
  - *Request Accepted* (0) will be return if the command was accepted;
  - *Request not Accepted due to Formatting Errors* (3) will be returned if the *Control Code* byte was incorrectly formatted or an invalid Code was present in the command;
  - *Control Operation not Supported for this Point* (4) will be returned if the Control Point was out of control (for instance, a relay is allocated for pulsing via Basic Setup).

To manually operate the relay, use the Direct-Operate (or SBO/Operate or Direct-Operate-No-Acknowledge) command to point 80 of the Control-Relay-Output-Block object with the *Control Code* value *Latch On*. To manually release the relay, use the Direct-Operate (or SBO/Operate or Direct-Operate-No-Acknowledge) command to point 80 of the Control-Relay-Output-Block object with the *Control Code* value *Latch Off*. To revert relay to normal operation, use the Direct-Operate (or SBO/Operate or Direct-Operate-No-Acknowledge) command to the point 80 of the Control-Relay-Output-Block object with the *Control Code* value *Nul Operation* and *Clear* sub-field set to 1.

4.14 Class 0 Point Assignment

These registers allow the user to change the assignments of the DNP points for the Class 0 polling response.

Table 4-20 Class 0 Assignment Register Groups

Groups	Points
Group #1	1152-1154
Group #2	1155-1157
...	...
Group #32	1245-1247

Table 4-21 Class 0 Point Assignment Setup Registers

Group	Object / Var.	Register Contents	Object / Point	Range / Scale
#1	40:1(read) 41:1(write)	DNP Object and Variation	AO:1152	See Table 4-22
	40:1(read) 41:1(write)	DNP Point number	AO:1153	0 - 65535
	40:1(read) 41:1(write)	Number of the DNP points	AO:1154	≥1 if Point number is correct
...		...	...	...
#32	40:1(read) 41:1(write)	DNP Object and Variation	AO:1245	See Table 4-22
	40:1(read) 41:1(write)	DNP Point number	AO:1246	0 - 65535
	40:1(read) 41:1(write)	Number of the DNP points	AO:1247	≥1 if Point number is correct

Table 4-22 DNP Read Objects to Assign to Class 0

No.	Object & Variation	Code	
		Hexadecimal	Decimal [1]
1	Analog Input 30:01	0x1E01	7681
2	Analog Input 30:02	0x1E02	7682
3	Analog Input 30:03	0x1E03	7683
4	Analog Input 30:04	0x1E04	7684
5	Analog Output 40:01	0x2801	10241
6	Analog Output 40:02	0x2802	10242
7	Binary Input 01:01	0x0101	257
8	Binary Ouput Status 10:02	0x1002	4098
9	Binary Counter 20:05	0x1405	5125
10	Binary Counter 20:06	0x1406	5126

[1] The decimal value calculated as follows: Object * 256 + Variation. For instance, Analog Input object 30, variation 03: 30 * 256 + 3 = 7683.

Appendix A DNP Application Messages

The Powermeter is a DNP IED responding to external DNP Master requests. *Table A-1* describes the Series PM130 application level responses to external requests, including object variations, functions, codes and qualifiers supported by the instrument. The object and formats are detailed in the DNP Basic 4 Documentation Set.

Table A-1 Application Responses

OBJECT			REQUEST		RESPONSE	
Obj	**Var**	**Description**	**Func. Code**	**Qual. Code**	**Func. Code**	**Qual. Code**
01	0	Single Bit Binary Input	1	B	129	01
01	1	Single Bit Binary Input	1	A	129	C
10	0	Binary Output	1	B	129	01
10	2	Binary Output Status	1	A	129	C
12	1	Control Relay Output Block	3,4,5	A	129	C
12	1	Control Relay Output Block	6	A	None	N/A
20	0	Counter (responds like 20:5)	1	B	129	01
20	5	32-bit Binary Counter without flag	1	A	129	C
20	6	16-bit Binary Counter without flag	1	A	129	C
30	0	Analog Input (responds like 30:3)	1	B	129	01
30	1	32-bit Analog Input	1	A	129	C
30	2	16-bit Analog Input	1	A	129	C
30	3	32-bit Analog Input without flag	1	A	129	C
30	4	16-bit Analog Input without flag	1	A	129	C
40	0	Analog Output Status(responds like 40:1)	1	B	129	01
40	1	32-bit Analog Output Status	1	A	129	C
40	2	16-bit Analog Output Status	1	A	129	C
41	1	32-bit Analog Output Block	3,4,5	A	129	C
41	2	16-bit Analog Output Block	3,4,5	A	129	C
41	1	32-bit Analog Output Block	6	A	None	N/A
41	2	16-bit Analog Output Block	6	A	None	N/A
60	1	Class 0	1	B	129	01
60	2	Class 1	1	06,07,08	129	N/R
60	3	Class 2	1	06,07,08	129	N/R
60	4	Class 3	1	06,07,08	129	N/R
80	1	Internal indication [1]	2	D	129	N/A
N/A	N/A	Cold Restart [2] (respond obj. 52:2)	13	N/A	129	07
N/A	N/A	Delay Measurement (respond obj. 52:2)	23	N/A	129	07

[1] For this object, the qualifier code must specify an index 7 only.

[2] Respond with a time object 50 variation 2 indicating time till the instrument availability

Qualifier Hex Codes for each category:

A - 00,01,03,04,07,17,27,08,18,28

B - 06 only

C - Qualifier echo

D - 00,01,03,04,17,27,18,28

N/A - Not Available

N/R - Null Response.

Appendix B DNP Device Profile

DNP V3.00

DEVICE PROFILE DOCUMENT

This document must be accompanied by a table having the following headings:

Object Group | Request Function Codes | Response Function Codes

Object Variation | Request Qualifiers | Response Qualifiers

Object Name (optional)

Vendor Name: SATEC Ltd.

Device Name: Powermeter Series PM130

Highest DNP Level Supported:	Device Function:
For Requests L1	☐ Master ■ Slave
For Responses L1	

Instrument supports READ of each object using either all points (Qualifier = 6) or specific points using qualifier defined in Basic 4 Documentation Set: 00, 01, 03, 04, 07, 17, 27, 08, 18, 28. Control Relay Block requires specific parameters described in this manual. Treats range field of qualifier 07 and 08 to mean point range [0...N-1].

Maximum Data Link Frame Size (octets):	Maximum Application Fragment Size (octets):
Transmitted 292	Transmitted 2048
Received 292	Received 249

Maximum Data Link Re-tries:	Maximum Application Layer Re-tries:
■ None	■ None
☐ Fixed at_____	☐ Configurable, range ____ to _____
☐ Configurable, range ___ to_____	(Fixed is not permitted)

Requires Data Link Layer Confirmation:

■ Never

☐ Always

☐ Sometimes If 'Sometimes', when? _____

☐ Configurable If 'Configurable', how? _____

Requires Application Layer Confirmation:

■ Never

☐ Always (not recommended)

☐ When reporting Event Data (Slave devices only)

☐ When sending multi-fragment responses (Slave devices only)

☐ Sometimes If 'Sometimes', when? _____

☐ Configurable If 'Configurable', how? _____

Timeouts while waiting for:

Data Link Confirm ■ None ☐ Fixed at _____ ☐ Variable ☐ Configurable

Complete Appl. Fragment ■ None ☐ Fixed at _____ ☐ Variable ☐ Configurable

Application Confirm ■ None ☐ Fixed at _____ ☐ Variable ☐ Configurable

Complete Appl. Response ■ None ☐ Fixed at _____ ☐ Variable ☐ Configurable

Others _____

Attach explanation if 'Variable' or 'Configurable' was checked for any timeout

Sends/Executes Control Operations:

WRITE Binary Outputs	■ Never	☐ Always	☐ Sometimes	☐ Configurable
SELECT/OPERATE	☐ Never	■ Always	☐ Sometimes	☐ Configurable
DIRECT OPERATE	☐ Never	■ Always	☐ Sometimes	☐ Configurable
DIRECT OPERATE - NO ACK	☐ Never	■ Always	☐ Sometimes	☐ Configurable
Count > 1	■ Never	☐ Always	☐ Sometimes	☐ Configurable
Pulse On	☐ Never	☐ Always	■ Sometimes①④	☐ Configurable
Pulse Off	☐ Never	☐ Always	■ Sometimes④	☐ Configurable
Latch On	☐ Never	☐ Always	■ Sometimes②	☐ Configurable
Latch Off	☐ Never	☐ Always	■ Sometimes③	☐ Configurable
Queue	■ Never	☐ Always	☐ Sometimes	☐ Configurable
Clear Queue	☐ Never	☐ Always	■ Sometimes④	☐ Configurable

- Select timeout period is configurable : 2s to 30s

① used to activate the *Reset* function associated with points 0 to 21
② ③ used to configure Class 0 object assignment (points 96 to 119)
② ③ ④ used to control Relays associated with point 80
③ used to reset the setpoint alarm and self-check alarm registers associated with points 48 to 74

Reports Binary Input Change Events when no specific variation requested: ■ Never ☐ Only time-tagged ☐ Only non-time-tagged ☐ Configurable to send both, one or the other (attach explanation)	Reports time-tagged Binary Input Change Events when no specific variation requested: ■ Never ☐ Binary Input Change With Time ☐ Binary Input Change With Relative Time ☐ Configurable (attach explanation)
Sends Unsolicited Responses: ■ Never ☐ Configurable (attach explanation) ☐ Only certain objects ☐ Sometimes (attach explanation) ☐ ENABLE/DISABLE UNSOLICITED Function codes supported	Sends Static Data in Unsolicited Responses: ■ Never ☐ When Device Restarts ☐ When Status Flags Change No other options are permitted.

Default Counter Object/Variation: ☐ No Counters Reported ☐ Configurable (attach explanation) ■ Default Object 20 Default Variation 5 ☐ Point-by-point list attached	Counters Roll Over at: ☐ No Counters Reported ☐ Configurable (attach explanation) ☐ 16 Bits ☐ 32 Bits ■ Other Value Counters -99999999 to 99999999 (point 2) 0 to 9999999((points 0,1,3) ☐ Point-by-point list attached
Sends Multi-Fragment Responses: ■ Yes ☐ No	

NOTES