SERIES PM172 POWERMETERS
COMMUNICATIONS

DNP3-2000 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.

Rev.A7 (F/W Version 4.88.8 or later):

1. Added DNP 16-bit BC scaling option.

Rev.A6 (F/W Version 4.88.3 or later):

2. Added DNP Binary Output Object 10 Variation 01 (packed bit read).
3. Added DNP points BC:4, BC:5 for kvarh imp/exp energy counters.

Rev.A5 (F/W Version 4.88.2 or later):

1. Added the Broken Delta wiring configuration.
2. Communication protocol is changeable through communications.
3. DNP event setpoints are configurable for High and Low thresholds and Delta triggers.
4. Removed DNP Class 0 group assignments.
5. The battery status is reported in the device self-check register.

Rev.A4 (F/W Version 4.86 or later):

1. Added DNP Class 0 point assignments.
2. Separated the DNP Class 0 assignment and DNP Events setup.
3. Control Relay Output Block point #100 allows assigning Relay status Points to the Class 0 polling.
4. The Frozen Counter points have the same numbers as the corresponding Binary Counters.

BG0273 Rev. A7

Table of Contents

1 GENERAL

This document specifies a subset of the DNP3-1999 serial communications protocol used to transfer data between a master computer station and the Series PM172 Powermeters. The document provides all necessary information for developing third-party communications software capable of communicating with the PM172.

Additional information concerning communications operation, configuration of communications parameters, and communications connections is found in the Series PM172 Installation and Operation Manual.

IMPORTANT

1. The voltage parameters throughout the protocol can represent line-to-neutral or line-to-line voltages depending on the wiring mode selected in the instrument. 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. In 4LN3, 4LL3, 3LN3, 3LL3, 3BLN3 and 3BLL3 wiring modes, harmonic voltages will represent line-to-neutral voltages. In a 3-wire direct connection, harmonic voltages will represent line-to-neutral voltages as they appear on the instrument's input transformers. In a 3-wire open delta connection, harmonic voltages will comprise L12 and L23 line-to-line voltages.
2. In 3-wire connection schemes, the unbalanced current and phase readings for power factor, active power, and reactive power will be zero, because they have no meaning. Only the total three-phase power values can be used.
3. Most of the instrument’s advanced features are configured using multiple setup parameters that can be accessed in 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. Each written value is checked for compatibility with the other setup parameters, and if the new value does not conform to them, the request will be rejected.

2 DNP PROTOCOL

Introduction

DNP3-2000 (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 slave device. Detailed information regarding DNP3-2000is available in the “Basic 4 Document Set” which can be obtained from the DNP User Group. This document describes a LEVEL 2 DNP3-2000 communication protocol implemented between a master station and a slave PM172 instrument.

PM172 Deviation from Standard

The PM172 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.

DNP Implementation

Overview

The PM172, like most devices, retrieves regular analog and binary data from the instrument by executing directed (non-broadcast) Read requests.

Binary-Output-Status objects and Analog-Output-Status objects are sent with flags that always indicate ONLINE.

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 PM172 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 appropriative points 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 PM172. 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 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	4	Time-synchronization required from the master. Cleared when master sets the time.
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.

Class 0 Response

The PM172 DNP implementation supports a wide variety of messages. The most common method to extract DNP static object information 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 3-

30). By default, the following points are specified by the Class 0 Point Assignment setup: 32 first Analog Input points from Table 3-1, 3 Analog Output first 3 points from Table 3-2, 2 Binary Input points represented Status Inputs and 2 Binary Input points represented Relay Status (see Table 3-13).

Object Point Mapping and Event Objects

The PM172 has a special mapping mechanism allowing you to map either static object point onto predefined point range. A total of 32 points are available for mapping. DNP static objects can be accessed directly by using the dedicated object point number. DNP event objects can be generated and accessed only through a mapping mechanism.

You can map any of the 32 mapping points to either Analog Input, Binary Input or Binary Counter object point. By default those are factory mapped to the first 32 points of the Analog Input object: 32 points from the Basic Data Registers (see Table 3-1). To re-map these, you must define the required number of points for each allowable DNP object in the DNP Options Setup (see Table 3-8), and then configure each point individually to be polled as an event source, via the DNP Event Setpoints Setup (see Table 3-9). For any mapped static object point, you can enable a corresponding event object point. Note that any changes made to the DNP Options Setup cause a reset of the DNP Event Options Setup points to their defaults.

All event options are disabled by default. Since a mapped static point is configured to create DNP Event objects, events are generated for this point as its value or state changes. Two different scan time rates are used for polling events:

- 200 ms for Binary Counter and Analog Input points;
- 50 ms for Binary Input points.

The memory consumption for keeping events depends on the event objects variation (DNP object size). The maximum buffer size (MBS) per DNP Event Object/ Event Class is 256 byte. The maximum number of events that the instrument can hold can be calculated as follows:

Maximum Events Number = MBS / (DNP Event Object Size + 1)

For example, the instrument can hold up to 21 measures of the 32-bit Analog Change Event With Time Object: (256 / 12) or up to 32 measures of the 8-bit Binary Change Event With Time Object: (256 / 8).

To suppress mapping, explicitly set all registers that specify the number of the Analog Input, Binary Input and/or Binary Counter objects to 0. In this case PM172 supports Static Operation Polling only.

DNP Address

The instrument on a DNP link must have a unique address. The PM172 allows one of 256 addresses to be selected. The selectable addresses have a range of 0-255. DNP uses the address 65535 for broadcast function. Note that a broadcast request never generates a DNP response.

Transaction Timing

To allow the master to switch the communication link, the Powermeter minimum response time must be at least 3.5 character time (depending on the baud rate) and at least 5 ms. Table 2-1 shows the actual response time measured at 9600 bps.

Table 2-1 Response Time

No. 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.

Scaling 16-bit Analog Inputs

With the Analog-Input objects, any of variations 1 through 4 can be used. Variations specified in the tables in Section 3 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 3, 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 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 reports a current reading (see Table 3-1). If your instrument has CT primary current 5000 A, then the current high scale is HI = 2.0×5000 = 10000, and the current reading in engineering units will be as follows:

$$(201 - 0) \times (10000 - 0)/(32767 - 0) + 0 = 61.34A$$

Scaling 16-bit Binary Counters

Binary counters are stored in the device in 32-bit integer format. Using 16-bit Binary Counter objects can cause over-range errors if the counter value exceeds 32767. Scaling binary counters (see DNP Options setup in Section 3.9) allows changing a binary counter unit from 1 to 1000 in powers of 10 to accommodate a 32-bit counter value to 16-bit object format. If the scaling unit is greater than 1, the counter value is reported being divided by the scaling unit. To get the actual value, multiply the counter reading by the selected scaling unit.

3 PM172 Registers

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 3-1 Basic Data

Object:Var [5]	Parameter	Object:Point	Unit [2]	Value range [1]
30:3	Voltage L1/L12 [4]	AI:0	V	0 to Vmax
30:3	Voltage L2/L23 [4]	AI:1	V	0 to Vmax
30:3	Voltage L3/L31 [4]	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 [4] (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 [4] (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 [3] (E)	AI:31	kW	0 to Pmax
30:3	Present sliding window kVA demand [3] (E)	AI:32	kVA	0 to Pmax
30:4	PF import at maximum kVA sliding window demand (E)	AI:33		0 to 1000
30:4	Voltage THD L1/L12	AI:34	%	0 to 9999
30:4	Voltage THD L2/L23	AI:35	%	0 to 9999
30:4	Voltage THD L3	AI:36	%	0 to 9999
30:4	Current THD L1	AI:37	%	0 to 9999
30:4	Current THD L2	AI:38	%	0 to 9999
30:4	Current THD L3	AI:39	%	0 to 9999
30:4	Current TDD L1	AI:40	%	0 to 1000
30:4	Current TDD L2	AI:41	%	0 to 1000
30:4	Current TDD L3	AI:42	%	0 to 1000
20:5	kWh import (E)	BC:0	kWh	0 to 999,999,999
20:5	kWh export (E)	BC:1	kWh	0 to 999,999,999
20:5	kvarh net (E)	BC:2	kvarh	-999,999,999 to 999,999,999
20:5	kVAh (E)	BC:3	kVAh	0 to 999,999,999

Object:Var [5]	Parameter	Object:Point	Unit [2]	Value range [1]
20:5	kvarh import (E) [6]	BC:4	kvarh	0 to 999,999,999
20:5	kvarh export (E) [6]	BC:5	kvarh	0 to 999,999,999

AI indicates Analog-Input point, BC - Binary Counter point.

[1] The parameter limits are as follows:

Imax (200% over-range) = 2 × CT primary current [A]

Direct wiring (PT Ratio = 1):

Vmax (690 V input option) = 828.0 V
Vmax (120 V input option) = 144.0 V
Pmax = (Imax × Vmax × 3) [kW x 0.001] if wiring mode is 4LN3, 3LN3 or 3BLN3
Pmax = (Imax × Vmax × 2) [kW x 0.001] if wiring mode is 4LL3, 3OP2, 3DIR2, 3OP3, 3LL3 or 3BLL3

Wiring via PTs (PT Ratio > 1):

Vmax (690 V input option) = 144 × PT Ratio [V]
Vmax (120 V input option) = 144 × PT Ratio [V]
Pmax = (Imax × Vmax × 3)/1000 [MW x 0.001] if wiring mode is 4LN3. 3LN3 or 3BLN3
Pmax = (Imax × Vmax × 2)/1000 [MW x 0.001] if wiring mode is 4LL3, 3OP2, 3DIR2, 3OP3, 3LL3 or 3BLL3

[2] When using direct wiring (PT Ratio = 1), voltages are transmitted in 0.1 V units, currents in 0.01 A units, and powers in 0.001 kW/kvar/kVA units. For wiring via PT (PT Ratio > 1), voltages are transmitted in 1V units, currents in 0.01 A units, and powers in 1 kW/kvar/kVA units.

[3] To get block interval demand readings, set the number of demand periods equal to 1 (see Table 3-4).

[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.

[5] 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, Scaling Analog Input Objects).

[6] Available starting with F/W Version 4.88.3 or later.

E Available in the PM172E

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.

Table 3-2 Basic Setup Registers

Object: Variation	Parameter	Object: Point	Range	Comment
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 5000 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	
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 Hz	
40:2 (read) 41:2 (write)	Maximum demand load current	AO:12	0 to 10000 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

E Available in the PM172E

User Selectable Options Setup

Table 3-3 User Selectable Options Registers

Object: Variation	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 (E)	AO:93	0 = 1×10^4 1 = 1×10^5 2 = 1×10^6 3 = 1×10^7 4 = 1×10^8 5 = 1×10^9
40:2 (read) 41:2 (write)	Phase energy calculation mode (E)	AO:94	0 = disabled, 1 = enabled
40:2 (read) 41:2 (write)	Analog output option	AO:95	0 = none, 1 = 0-20 mA, 2 = 4-20 mA, 3 = 0-1 mA 4 = ±1 mA
40:2 (read) 41:2 (write)	Analog expander output [1]	AO:96	0 = none, 1 = 0-20 mA, 2 = 4-20 mA, 3 = 0-1 mA 4 = ±1 mA

1 Do not enable the analog expander output if the analog expander is not connected to the instrument, otherwise the computer communications will become garbled.

E - Available in the PM172E (in the PM172P read as 65535)

Firmware Version and Device Options

The registers shown in Table 3-4 are used to retrieve the firmware version number and instrument options.

Table 3-4 Firmware and Instrument Options Registers

Object: Variation	Parameter	Object: Point	Read/ Write	Range
30:4	Firmware build number [1]	AI:1023	Read	0-65535
30:4	Firmware version number	AI:1024	Read	0-65535
30:3	Instrument option 1	AI:1025	Read	See Table 3-5
30:3	Instrument option 2	AI:1026	Read	See Table 3-5
30:4	Active serial port number	AI:1027	Read	0 = COM1, 1 = COM2

AI indicates Analog-Input points. Scaling mechanism is not supported for these registers.

1 Available starting with F/W Version 4.88.2 or later.

Table 3-5 Instrument Options

Point	Bit number	Description
Options 1 (AI:1025)	0 1	120V option 690V option

Point	Bit number	Description
	2-3	Reserved
	4	100% current over-range
	5	Reserved
	6	Analog output 0/4-20 mA
	7	Analog output 0-1 mA
	8	Analog output ±1 mA
	9	Relays option
	10	Digital inputs option
	11-13	Reserved
	14	Analog expander output ±1 mA
	15	Reserved
Options 2 (AI:1026)	0-2	Number of relays – 1
	3-6	Number of digital inputs – 1
	7-8	Number of analog outputs –1
	9-15	Reserved

Communications Setup

These registers are used to access the communications setup parameters.

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.

Table 3-6 Communications Setup Registers

Comm. Port	Object: Variation	Parameter	Object: Point	Range
Port #1	40:1 (read)	Protocol	AO:64	0 = ASCII 1 = Modbus RTU 2 = DNP3.0
	40:2 (read) 41:2 (write)	Interface	AO:65	0 = RS-232, 1 = RS-422, 2 = RS-485
	40:2 (read) 41:2 (write)	Address	AO:66	0 to 255
	40:2 (read) 41:2 (write)	Baud rate	AO:67	0 = 110 bps 4 = 2400 bps 1 = 300 bps 5 = 4800 bps 2 = 600 bps 6 = 9600 bps 3 = 1200 bps 7 = 19200 bps
	40:2 (read) 41:2 (write)	Data format	AO:68	1 = 8 bits/no parity 2 = 8 bits/even parity
	40:2 (read) 41:2 (write)	Incoming flow control (handshaking)	AO:69	0 = no handshaking 1 = software handshaking (XON/XOFF protocol) 2 = hardware handshaking (CTS protocol)
	40:2 (read) 41:2 (write)	Outgoing flow control (RTS/DTR)	AO:70	0 = RTS signal not used 1 = RTS permanently asserted (DTR mode) 2 = RTS asserted during the transmission
Port #2	40:1 (read)	Protocol	AO:80	0 = ASCII 1 = Modbus RTU 2 = DNP3.0
	40:2 (read) 41:2 (write)	Interface	AO:81	1 = RS-422, 2 = RS-485
	40:2 (read) 41:2 (write)	Address	AO:82	0 to 255
	40:2 (read) 41:2 (write)	Baud rate	AO:83	0 = 110 bps 4 = 2400 bps 1 = 300 bps 5 = 4800 bps 2 = 600 bps 6 = 9600 bps 3 = 1200 bps 7 = 19200 bps
	40:2 (read) 41:2 (write)	Data format	AO:84	1 = 8 bits/no parity 2 = 8 bits/even parity
	40:1 (read)	Reserved	AO:85	Read as 65535

AO indicates Analog-Output points.

DNP Options Setup

This section describes the general DNP setup registers related to DNP timing and events processing. The following static objects generate the corresponding DNP change events:

Table 3-7 DNP Static, Frozen and Event Objects

Static Object		Change Object	
Name	**Obj:Var**	**Name**	**Obj:Var**
Single-Bit Binary Input	01:1	Binary Input Change Without Time	02:1
Binary Input With Status	01:2	Binary Input Change With Time	02:2
32-bit:		32-bit:	
Binary Counter	20:1	Counter Change Event Without Time	22:1
Binary Counter Without Flag	20:5	Counter Change Event With Time	22:5
16-bit:		16-bit	
Binary Counter	20:2	Counter Change Event Without Time	22:2
Binary Counter Without Flag	20:6	Counter Change Event With Time	22:6
32-bit:			
Frozen Counter	21:1		
Frozen Counter Without Flag	21:9		
Frozen Counter With Time of Freeze	21:5		
16-bit:			
Frozen Counter	21:2		
Frozen Counter Without Flag	21:10		
Frozen Counter With Time of Freeze	21:6		
32-bit:		32-bit:	
Analog Input	30:1	Analog Change Event Without Time	32:1
Analog Input Without Flag	30:3	Analog Change Event With Time	32:3
16-bit:		16-bit:	
Analog Input	30:2	Analog Change Event Without Time	32:2
Analog Input Without Flag	30:4	Analog Change Event With Time	32:4

The following registers are used to access the DNP Options Setup parameters. The value range of points 32 to 41 reflects the elements number of the corresponding DNP object/variation list described above. For instance, the default value for the frozen Binary Counter is the Frozen Counter Without Flag Obj21:Var10.

Table 3-8 DNP Options Setup Registers

Object: Variation	Parameter	Object: Point	Range
40:2 (read) 41:2 (write)	Binary Input Static Object	AO:32	0 to 1, 0 by default
40:2 (read) 41:2 (write)	Binary Input Change Object	AO:33	0 to 1, 1 by default
40:2 (read) 41:2 (write)	Binary Counter Object	AO:34	0 to 3, 3 by default
40:2 (read) 41:2 (write)	Frozen Binary Counter Object	AO:35	0 to 5, 4 by default
40:2 (read) 41:2 (write)	Reserved	AO:36	
40:2 (read) 41:2 (write)	Binary Counter Change Event Object	AO:37	0 to 3, 2 by default
40:2 (read) 41:2 (write)	Analog Input Object	AO:38	0 to 3, 3 by default
40:2 (read) 41:2 (write)	Reserved	AO:39	
40:2 (read) 41:2 (write)	Reserved	AO:40	
40:2 (read) 41:2 (write)	Analog Input Change Event Object	AO:41	0 to 3, 2 by default
40:1 (read) 41:2 (write)	Re-mapping static point indices for event objects	AO:42	0 – disabled (default) 1 – enabled
40:1 (read) 41:2 (write)	16-bit Binary Counter Scaling [2]	AO:43	0=×1 (default), 1=×10, 2=×100, 3=×1000
40:1 (read) 41:2 (write)	16-bit Analog Input Scaling	AO:44	0 – disabled 1 – enabled (default)
40:2 (read) 41:2 (write)	Number of the Analog Input points to generate events [1]	AO:45	0 to 32 (default 32)
40:2 (read) 41:2 (write)	Number of the Binary Input points to generate events [1]	AO:46	0 to 32(default 0)

Object: Variation	Parameter	Object: Point	Range
40:2 (read) 41:2 (write)	Number of the Binary Counter points to generate events [1]	AO:47	0 to 32 (default 0)
40:2 (read) 41:2 (write)	Select/Operate Timeout	AO:48	2 to 30 seconds (the default 10 seconds)
40:2 (read) 41:2 (write)	Multi Fragment Interval	AO:49	50 to 500 ms (the default 50 ms)
40:2 (read)	Reserved	AO:50-52	Read as 65535
40:2 (read) 41:2 (write)	Time Synch Period (E)	AO:53	1 to 86400 seconds (the default 86400 sec)

AO indicates Analog-Output points.

E Available in the PM172E

1 The total number of points for generating events may not exceed 32. If the total number of the points is set to 0, the report-by-exception mode is not supported.

2 Available with F/W version 4.88.8 or later.

The Analog Input object variation sets the default variation for the Analog Input objects, which will be used if no specific variation is requested by a master station with the qualifier code 06 (variation 0). By default, it is set to the 16-bit Analog Input object without flag (object 30, variation 4).

The Analog Input Scaling is used to control the scaling of the 16-bit analog input points. By default, the scaling is ON. Choosing 32-bit objects (object 30, variations 1, 3) for analog input points disables this setting.

The meter supports up to 32 Analog Input, Binary Input and Binary Counter points that can generate events. By default, 32 Analog Input points 0 through 31 are configured for generating events. To re-map the current setting, write desired values into Analog Output points 45-47.

The Select Before Operate command causes the PM172 to start a timer. The Operate command must be sent before the timeout defined by the Select/Operate Timeout expires.

The meter requests time synchs when the time specified by the Time Synch Period parameter has elapsed. The bit 4 of the first octet in the internal indication word will be set. The master synchronizes the time by writing the Time and Date object to the meter.

DNP Event Definition Registers

These registers are used to define the DNP Event Setup parameters.

Table 3-9 DNP Event Definition Registers

DNP Map Group	Object:Var	Register Contents	Object:Point	Range/Scale
#0	40:2(read) 41:2(write)	DNP point number	AO:896	Any actual DNP point number of the selected object [1]
	40:1(read) 41:1(write)	Dead band	AO:897	-2147483848 to 2147483647 (not used for BI change events)
	40:2(read) 41:2(write)	Event option control field	AO:898	See Table 3-10
	.....	.....	.....	.....
#31	40:2(read) 41:2(write)	DNP point number	AO:989	Any actual DNP point number of the selected object [1]
	40:2(read) 41:2(write)	Dead band	AO:990	-2147483848 to 2147483647 (not used for BI change events)
	40:2(read) 41:2(write)	Event option control field	AO:991	See Table 3-10

1 Selected object: Analog Input (AI), Binary Input (BI) or Binary Counter (BC)

Table 3-10 DNP Event Control Field

Bits	Name	Range
0-1	DNP object	0 = none, 1 = AI change event, 2= BI change event, 3= BC change event
2	Object change event scan	0 = disabled, 1 = enabled
3-4	Not used	
5-6	DNP event poll class	0 = Class 1, 1 = Class 2, 2 = Class 3
7	Event log on an event [1,2]	0 = disabled, 1 = enabled
8-9	Threshold/Deadband relation	0 = Delta, 1 = More than (over threshold) [1], 3 = Less than (under threshold) [1]
10-15	Not used	

1 Available starting with F/W Version 4.88.2 or later.

2 The source of the DNP events recorded to the device Event log is identified as the general Setpoint #17.

Either an operating threshold, or deadband should be specified to generate events for numeric (AI and BC) objects, using one of the three allowable relations:

1. Delta – a new event is generated when the absolute value of the difference between the last reported value of the point and its current value exceeds the specified deadband value.
2. More than (Over) - a new event is generated when the point value rises over the specified threshold, and then when the point value returns below the threshold taking into consideration a predefined hysteresis.
3. Less than (Under) - a new event is generated when the point value drops below the specified threshold, and then when the point value returns above the threshold taking into consideration a predefined hysteresis.

A hysteresis for the point return threshold is 0.05 Hz for frequency and 2% of the operating threshold for all other points.

The scan time for binary input change events is 50 ms with a timestamp precision at +/-10 ms. The scan time for analog input and binary counter change events is 200 ms.

Freeze Requests on Binary Counter Objects

Acceptable object variation and qualifier combinations included in the device response are specified in Table 3-7. The Immediate Freeze, Immediate Freeze-No Acknowledgement, Freeze and Clear, Freeze and Clear-No Acknowledgement DNP commands can be applied to all Binary Counters objects supported by the PM172. These registers are used to access the Frozen Binary Counters.

Table 3-11 Frozen Binary Counters

Object:Var (See Table 3-7)	Parameter	Object: Point	Unit	Value range
Total energies (E)				
21:var	kWh import	FBC:0	kWh	0 to 999,999,999
21:var	kWh export	FBC:1	kWh	0 to 999,999,999
21:var	kvarh net	FBC:2	kvarh	-999,999,999 to 999,999,999
21:var	kVAh	FBC:3	kVAh	0 to 999,999,999
21:var	kvarh import [1]	FBC:4	kvarh	0 to 999,999,999
21:var	kvarh export [1]	FBC:5	kvarh	0 to 999,999,999
Pulse counters (E)				
21:var	Pulse counter #1	FBC:35328	n/a	0 to 999999
21:var	Pulse counter #2	FBC:35329	n/a	0 to 999999
21:var	Pulse counter #3	FBC:35330	n/a	0 to 999999
21:var	Pulse counter #4	FBC:35331	n/a	0 to 999999
Total energies(E)(Extended Registers)				
21:var	kWh import	FBC:38656	kWh	0 to 999,999,999
21:var	kWh export	FBC:38657	kWh	0 to 999,999,999
21:var	Reserved	FBC:38658		0
21:var	Reserved	FBC:38659		0
21:var	kvarh import	FBC:38660	kvarh	0 to 999,999,999
21:var	kvarh export	FBC:38661	kvarh	0 to 999,999,999
21:var	Reserved	FBC:38662		0
21:var	Reserved	FBC:38663		0
21:var	kVAh total	FBC:38664	kVAh	0 to 999,999,999
Phase energies (E)				
21:var	kWh import L1	FBC:38912	kWh	0 to 999,999,999
21:var	kWh import L2	FBC:38913	kWh	0 to 999,999,999
21:var	kWh import L3	FBC:38914	kWh	0 to 999,999,999

Object:Var (See Table 3-7)	Parameter	Object: Point	Unit	Value range
21:var	kvarh import L1	FBC:38915	kvarh	0 to 999,999,999
21:var	kvarh import L2	FBC:38916	kvarh	0 to 999,999,999
21:var	kvarh import L3	FBC:38917	kvarh	0 to 999,999,999
21:var	kVAh total L1	FBC:38918	kVAh	0 to 999,999,999
21:var	kVAh total L2	FBC:38919	kVAh	0 to 999,999,999
21:var	kVAh total L3	FBC:38920	kVAh	0 to 999,999,999

[1] Available with F/W Version 4.88.3 or later.

FBC indicates Frozen-Binary-Counter points.

Warning

Any attempt to issue a freeze and clear (or freeze and clear - No acknowledgement) to object 20 variation 0 using function code 0x09 (or 0x10) and the data qualifier 0x06 causes all counters specified in this manual to be reset to zero.

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 3-12 Reset/Clear Registers

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

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

E Available in the PM172E

The following restriction should be noted 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.

Status Registers

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

Table 3-13 Status Registers (*Read*)

Object/ Var.	Description	Object/ Point	Bit meaning
01:1 01:1	Relay #1 status Relay #2 status	BI:0 BI:1	Relay status: 0 = released, 1 = operated
01:1 01:1	Status input #1 Status input #2	BI:16 BI:17	Contact: 0 = open, 1 = closed
01:1	Battery status	BI:48	0 = low, 1 = normal

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

Alarm Status Registers

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

NOTE

The PM172 provides the self-check alarm register.

The self-check alarm points indicate possible problems with the instrument hardware or setup configuration. The 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 the setup configuration problems, 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.

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 3-14 Alarm Status Registers

Object/ Var.	Description	Object/ Point	Bit meaning
	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	Reading returns 0
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) 12:1(write)	Watchdog timer reset	B0:67 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	Reading returns 0

Object/ Var.	Description	Object/ Point	Bit meaning
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)	Time synchronization required [1]	B0:75 CROB:75	
10:2(read) 12:1(write)	Low battery [2]	B0:76 CROB:76	
10:2(read) 12:1(write)	Reserved	77-79 77-79	Reading returns 0

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.
2 Available with F/W version 4.88.2 or later.

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.

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 3-15.

Table 3-15 Extended Data Registers

Obj:Var [6]	Parameter	Object:Point	Unit [2]	Value/Range [1]	Comment
30:4	None	AI:32768	n/a	0	
Status inputs					
01:1	Status input #1	BI:34304	n/a	0/1	
01:1	Status input #2	BI:34305	n/a	0/1	
Relay status					
01:1	Relay #1 status	BI:34816	n/a	0/1	
01:1	Relay #2 status	BI:34817	n/a	0/1	
Pulse counters (E)					
20:5	Pulse counter #1	BC:35328	n/a	0 to 999999	
20:5	Pulse counter #2	BC:35329	n/a	0 to 999999	
20:5	Pulse counter #3	BC:35330	n/a	0 to 999999	
20:5	Pulse counter #4	BC:35331	n/a	0 to 999999	
Real-time values per phase					
30:3	Voltage L1/L12 [5]	AI:35840	0.1V/1V	0 to Vmax	
30:3	Voltage L2/L23 [5]	AI:35841	0.1V/1V	0 to Vmax	
30:3	Voltage L3/L31 [5]	AI:35842	0.1V/1V	0 to Vmax	
30:3	Current L1	AI:35843	0.01A/1A	0 to Imax	
30:3	Current L2	AI:35844	0.01A/1A	0 to Imax	
30:3	Current L3	AI:35845	0.01A/1A	0 to Imax	
30:3	kW L1	AI:35846	0.001kW/1kW	-Pmax to Pmax	
30:3	kW L2	AI:35847	0.001kW/1kW	-Pmax to Pmax	

Obj:Var [6]	Parameter	Object:Point	Unit [2]	Value/Range [1]	Comment
30:3	kW L3	AI:35848	0.001kW/1kW	-Pmax to Pmax	
30:3	kvar L1	AI:35849	0.001kvar/1kvar	-Pmax to Pmax	
30:3	kvar L2	AI:35850	0.001kvar/1kvar	-Pmax to Pmax	
30:3	kvar L3	AI:35851	0.001kvar/1kvar	-Pmax to Pmax	
30:3	kVA L1	AI:35852	0.001kVA/1kVA	0 to Pmax	
30:3	kVA L2	AI:35853	0.001kVA/1kVA	0 to Pmax	
30:3	kVA L3	AI:35854	0.001kVA/1kVA	0 to Pmax	
30:4	Power factor L1	AI:35855	0.001	-999 to 1000	× 0.001
30:4	Power factor L2	AI:35856	0.001	-999 to 1000	× 0.001
30:4	Power factor L3	AI:35857	0.001	-999 to 1000	× 0.001
30:4	Voltage THD L1/L12	AI:35858	0.1%	0 to 9999	×0.1
30:4	Voltage THD L2/L23	AI:35859	0.1%	0 to 9999	×0.1
30:4	Voltage THD L3	AI:35860	0.1%	0 to 9999	×0.1
30:4	Current THD L1	AI:35861	0.1%	0 to 9999	×0.1
30:4	Current THD L2	AI:35862	0.1%	0 to 9999	×0.1
30:4	Current THD L3	AI:35863	0.1%	0 to 9999	×0.1
30:4	K-Factor L1	AI:35864	0.1	10 to 9999	×0.1
30:4	K-Factor L2	AI:35865	0.1	10 to 9999	×0.1
30:4	K-Factor L3	AI:35866	0.1	10 to 9999	×0.1
30:4	Current TDD L1	AI:35867	0.1%	0 to 1000	×0.1
30:4	Current TDD L2	AI:35868	0.1%	0 to 1000	×0.1
30:4	Current TDD L3	AI:35869	0.1%	0 to 1000	×0.1
30:3	Voltage L12	AI:35870	0.1V/1V	0 to Vmax	
30:3	Voltage L23	AI:35871	0.1V/1V	0 to Vmax	
30:3	Voltage L31	AI:35872	0.1V/1V	0 to Vmax	
Real-time total values					
30:3	Total kW	AI:36608	0.001kW/1kW	-Pmax to Pmax	
30:3	Total kvar	AI:36609	0.001kvar/1kvar	-Pmax to Pmax	
30:3	Total kVA	AI:36610	0.001kVA/1kVA	0 to Pmax	
30:4	Total PF	AI:36611	0.001	-999 to 1000	×0.001
30:4	Reserved	AI:36612	n/a	0	
30:4	Reserved	AI:36613	n/a	0	
Real-time auxiliary values					
30:4	Reserved	AI:36864		0	
30:3	Neutral current	AI:36865	0.01A	0 to Imax	
30:4	Frequency [3]	AI:36866	0.01Hz	0 to 10000	×0.01
30:4	Voltage unbalance	AI:36867	1%	0 to 300	
30:4	Current unbalance	AI:36868	1%	0 to 300	×0.01
Average values per phase					
30:3	Voltage L1/L12 [5]	AI:37120	0.1V/1V	0 to Vmax	
30:3	Voltage L2/L23 [5]	AI:37121	0.1V/1V	0 to Vmax	
30:3	Voltage L3/L31 [5]	AI:37122	0.1V/1V	0 to Vmax	
30:3	Current L1	AI:37123	0.01A/1A	0 to Imax	
30:3	Current L2	AI:37124	0.01A/1A	0 to Imax	
30:3	Current L3	AI:37125	0.01A/1A	0 to Imax	
30:3	kW L1	AI:37126	0.001kW/1kW	-Pmax to Pmax	
30:3	kW L2	AI:37127	0.001kW/1kW	-Pmax to Pmax	
30:3	kW L3	AI:37128	0.001kW/1kW	-Pmax to Pmax	
30:3	kvar L1	AI:37129	0.001kvar/1kvar	-Pmax to Pmax	
30:3	kvar L2	AI:37130	0.001kvar/1kvar	-Pmax to Pmax	
30:3	kvar L3	AI:37131	0.001kvar/1kvar	-Pmax to Pmax	
30:3	kVA L1	AI:37132	0.001kVA/1kVA	0 to Pmax	
30:3	kVA L2	AI:37133	0.001kVA/1kVA	0 to Pmax	
30:3	kVA L3	AI:37134	0.001kVA/1kVA	0 to Pmax	
30:4	Power factor L1	AI:37135	0.001	-999 to 1000	×0.001
30:4	Power factor L2	AI:37136	0.001	-999 to 1000	×0.001
30:4	Power factor L3	AI:37137	0.001	-999 to 1000	×0.001
30:4	Voltage THD L1/L12	AI:37138	0.1%	0 to 9999	×0.1
30:4	Voltage THD L2/L23	AI:37139	0.1%	0 to 9999	×0.1
30:4	Voltage THD L3	AI:37140	0.1%	0 to 9999	×0.1
30:4	Current THD L1	AI:37141	0.1%	0 to 9999	×0.1
30:4	Current THD L2	AI:37142	0.1%	0 to 9999	×0.1

Obj:Var [6]	Parameter	Object:Point	Unit [2]	Value/Range [1]	Comment
30:4	Current THD L3	AI:37143	0.1%	0 to 9999	×0.1
30:4	K-Factor L1	AI:37144	0.1	10 to 9999	×0.1
30:4	K-Factor L2	AI:37145	0.1	10 to 9999	×0.1
30:4	K-Factor L3	AI:37146	0.1	10 to 9999	×0.1
30:4	Current TDD L1	AI:37147	0.1%	0 to 1000	×0.1
30:4	Current TDD L2	AI:37148	0.1%	0 to 1000	×0.1
30:4	Current TDD L3	AI:37149	0.1%	0 to 1000	×0.1
30:3	Voltage L12	AI:37150	0.1V/1V	0 to Vmax	
30:3	Voltage L23	AI:37151	0.1V/1V	0 to Vmax	
30:3	Voltage L31	AI:37152	0.1V/1V	0 to Vmax	
Average total values					
30:3	Total kW	AI:37888	0.001kW/1kW	-Pmax to Pmax	
30:3	Total kvar	AI:37889	0.001kvar/1kvar	-Pmax to Pmax	
30:3	Total kVA	AI:37890	0.001kVA/1kVA	0 to Pmax	
30:4	Total PF	AI:37891	0.001	-999 to 1000	×0.001
30:4	Reserved	AI:37892		0	
30:4	Reserved	AI:37893		0	
Average auxiliary values					
30:4	Reserved	AI:38144		0	
30:3	Neutral current	AI:38145	0.01A	0 to Imax	
30:4	Frequency [3]	AI:38146	0.01Hz	0 to 10000	×0.01
30:4	Voltage unbalance	AI:38147	1%	0 to 300	
30:4	Current unbalance	AI:38148	1%	0 to 300	×0.01
Present demands					
30:3	Volt demand L1/L12 [5]	AI:38400	0.1V/1V	0 to Vmax	
30:3	Volt demand L2/L23 [5]	AI:38401	0.1V/1V	0 to Vmax	
30:3	Volt demand L3/L31 [5]	AI:38402	0.1V/1V	0 to Vmax	
30:3	Ampere Demand L1	AI:38403	0.01A	0 to Imax	
30:3	Ampere Demand L2	AI:38404	0.01A	0 to Imax	
30:3	Ampere Demand L3	AI:38405	0.01A	0 to Imax	
30:3	Block kW import demand (E)	AI:38406	0.001kW/1kW	0 to Pmax	
30:3	Block kvar import demand (E)	AI:38407	0.001kvar/1kvar	0 to Pmax	
30:3	Block kVA demand (E)	AI:38408	0.001kVA/1kVA	0 to Pmax	
30:3	Sliding window kW import demand (E)	AI:38409	0.001kW/1kW	0 to Pmax	
30:3	Sliding window kvar import demand (E)	AI:38410	0.001kvar/1kar	0 to Pmax	
30:3	Sliding window kVA demand (E)	AI:38411	0.001kVA/1kVA	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 import demand (E)	AI:38415	0.001kW/1kW	0 to Pmax	
30:3	Accumulated kvar import demand (E)	AI:38416	0.001kvar/1kvar	0 to Pmax	
30:3	Accumulated kVA demand (E)	AI:38417	0.001kVA/1kVA	0 to Pmax	
30:3	Predicted sliding window kW import demand (E)	AI:38418	0.001kW/1kW	0 to Pmax	
30:3	Predicted sliding window kvar import demand (E)	AI:38419	0.001kvar/1kvar	0 to Pmax	
30:3	Predicted sliding window kVA demand (E)	AI:38420	0.001kVA/1kVA	0 to Pmax	
30:4	PF (import) at maximum sliding window kVA demand (E)	AI:38421	0.001	0 to 1000	× 0.001
30:3	Block kW export demand (E)	AI:38422	0.001kW/1kW	0 to Pmax	
30:3	Block kvar export demand (E)	AI:38423	0.001kvar/1kvar	0 to Pmax	
30:3	Sliding window kW export demand (E)	AI:38424	0.001kW/1kW	0 to Pmax	
30:3	Sliding window kvar export demand (E)	AI:38425	0.001kvar/1kvar	0 to Pmax	
30:3	Accumulated kW export demand (E)	AI:38426	0.001kW/1kW	0 to Pmax	

Obj:Var [6]	Parameter	Object:Point	Unit [2]	Value/Range [1]	Comment
30:3	Accumulated kvar export demand (E)	AI:38427	0.001kvar/1kvar	0 to Pmax	
30:3	Predicted sliding window kW export demand (E)	AI:38428	0.001kW/1kW	0 to Pmax	
30:3	Predicted sliding window kvar export demand (E)	AI:38429	0.001kvar/1kvar	0 to Pmax	
Total energies(E)					
20:5	kWh import	BC:38656	kWh	0 to 999,999,999	
20:5	kWh export	BC:38657	kWh	0 to 999,999,999	
20:5	Reserved	BC:38658		0	
20:5	Reserved	BC:38659		0	
20:5	kvarh import	BC:38660	kvarh	0 to 999,999,999	
20:5	kvarh export	BC:38661	kvarh	0 to 999,999,999	
20:5	Reserved	BC:38662		0	
20:5	Reserved	BC:38663		0	
20:5	kVAh total	BC:38664	kVAh	0 to 999,999,999	
Phase energies(E)					
20:5	kWh import L1	BC:38912	kWh	0 to 999,999,999	
20:5	kWh import L2	BC:38913	kWh	0 to 999,999,999	
20:5	kWh import L3	BC:38914	kWh	0 to 999,999,999	
20:5	kvarh import (inductive) L1	BC:38915	kvarh	0 to 999,999,999	
20:5	kvarh import (inductive) L2	BC:38916	kvarh	0 to 999,999,999	
20:5	kvarh import (inductive) L3	BC:38917	kvarh	0 to 999,999,999	
20:5	kVAh total L1	BC:38918	kVAh	0 to 999,999,999	
20:5	kVAh total L2	BC:38919	kVAh	0 to 999,999,999	
20:5	kVAh total L3	BC:38920	kVAh	0 to 999,999,999	
Fundamental (H01) real-time values per phase					
30:3	Voltage L1/L12	AI:43264	0.1V/1 V	0 to Vmax	
30:3	Voltage L2/L23	AI: 43265	0.1V/1 V	0 to Vmax	
30:3	Voltage L3/L31	AI: 43266	0.1V/1 V	0 to Vmax	
30:3	Current L1	AI: 43267	0.01A/1A	0 to Imax	
30:3	Current L2	AI: 43268	0.01A/1A	0 to Imax	
30:3	Current L3	AI: 43269	0.01A/1A	0 to Imax	
30:3	kW L1	AI: 43270	0.001kW/1kW	-Pmax to Pmax	
30:3	kW L2	AI: 43271	0.001kW/1kW	-Pmax to Pmax	
30:3	kW L3	AI: 43272	0.001kW/1kW	-Pmax to Pmax	
30:3	kvar L1	AI: 43273	0.001kvar/1kvar	-Pmax to Pmax	
30:3	kvar L2	AI: 43274	0.001kvar/1kvar	-Pmax to Pmax	
30:3	kvar L3	AI: 43275	0.001kvar/1kvar	-Pmax to Pmax	
30:3	kVA L1	AI: 43276	0.001kVA/1kVA	0 to Pmax	
30:3	kVA L2	AI: 43277	0.001kVA/1kVA	0 to Pmax	
30:3	kVA L3	AI: 43278	0.001kVA/1kVA	0 to Pmax	
30:4	Power factor L1	AI: 43279	0.001	-999 to 1000	×0.001
30:4	Power factor L2	AI: 43280	0.001	-999 to 1000	×0.001
30:4	Power factor L3	AI: 43281	0.001	-999 to 1000	×0.001
Fundamental (H01) real-time total values					
30:3	Total kW	AI:43520	0.001kW/1kW	-Pmax to Pmax	
30:3	Total kvar	AI: 43521	0.001kvar/1kvar	-Pmax to Pmax	
30:3	Total kVA	AI: 43522	0.001kVA/1kVA	0 to Pmax	
30:4	Total PF	AI: 43523	0.001	-999 to 1000	×0.001
Minimum real-time values per phase (M)					
30:3	Voltage L1/L12 [5]	AI:44032	0.1V/1V	0 to Vmax	
30:3	Voltage L2/L23 [5]	AI:44033	0.1V/1V	0 to Vmax	
30:3	Voltage L3/L31 [5]	AI:44034	0.1V/1V	0 to Vmax	
30:3	Current L1	AI:44035	0.01A	0 to Imax	
30:3	Current L2	AI:44036	0.01A	0 to Imax	
30:3	Current L3	AI:44037	0.01A	0 to Imax	
Minimum real-time total values (M)					
30:3	Total kW	AI:44288	0.001kW/1kW	-Pmax to Pmax	
30:3	Total kvar	AI:44289	0.001kvar/1kvar	-Pmax to Pmax	
30:3	Total kVA	AI:44290	0.001kVA/1kVA	0 to Pmax	
30:4	Total PF [4]	AI:44291	0.001	-999 to 1000	×0.001

Obj:Var [6]	Parameter	Object:Point	Unit [2]	Value/Range [1]	Comment
Minimum real-time auxiliary values (M)					
30:4	Reserved	AI:44544		0	
30:3	Neutral current	AI:44545	0.01A	0 to Imax	
30:4	Frequency [3]	AI:44546	0.01Hz	0 to 10000	×0.01
Minimum demands (M)					
30:4	Reserved	AI:44800-AI:44816		0	
Maximum real-time values per phase (M)					
30:3	Voltage L1/L12 [5]	AI:46080	0.1V/1V	0 to Vmax	
30:3	Voltage L2/L23 [5]	AI:46081	0.1V/1V	0 to Vmax	
30:3	Voltage L3/L31 [5]	AI:46082	0.1V/1V	0 to Vmax	
30:3	Current L1	AI:46083	0.01A	0 to Imax	
30:3	Current L2	AI:46084	0.01A	0 to Imax	
30:3	Current L3	AI:46085	0.01A	0 to Imax	
Maximum real-time total values (M)					
30:3	Total kW	AI:46336	0.001kW/1kW	-Pmax to Pmax	
30:3	Total kvar	AI:46337	0.001kvar/1kvar	-Pmax to Pmax	
30:3	Total kVA	AI:46338	0.001kVA/1kVA	0 to Pmax	
30:4	Total PF [4]	AI:46339	0.001	-999 to 1000	×0.001
Maximum real-time auxiliary values (M)					
30:4	Reserved	AI:46592		0	
30:3	Neutral current	AI:46593	0.01A	0 to Imax	
30:4	Frequency [3]	AI:46594	0.01Hz	0 to 10000	×0.01
Maximum demands (M)					
30:3	Max. volt demand L1/L12 [5]	AI:46848	0.1V/1V	0 to Vmax	
30:3	Max. volt demand L2/L23 [5]	AI:46849	0.1V/1V	0 to Vmax	
30:3	Max. volt demand L3/L31 [5]	AI:46850	0.1V/1V	0 to Vmax	
30:3	Max. ampere demand L1	AI:46851	0.01A	0 to Imax	
30:3	Max. ampere demand L2	AI:46852	0.01A	0 to Imax	
30:3	Max. ampere demand L3	AI:46853	0.01A	0 to Imax	
30:4	Reserved	AI:46854		0	
30:4	Reserved	AI:46855		0	
30:4	Reserved	AI:46856		0	
30:3	Max. sliding window kW import demand (E)	AI:46857	0.001kW/1kW	0 to Pmax	
30:3	Max. sliding window kvar import demand (E)	AI:46858	0.001kvar/1kvar	0 to Pmax	
30:3	Max. sliding window kVA demand (E)	AI:46859	0.001kVA/1kVA	0 to Pmax	
30:4	Reserved	AI:46860		0	
30:4	Reserved	AI:46861		0	
30:4	Reserved	AI:46862		0	
30:3	Max. sliding window kW export demand (E)	AI:46863	0.001kW/1kW	0 to Pmax	
30:3	Max. sliding window kvar export demand (E)	AI:46864	0.001kvar/1kvar	0 to Pmax	

1 For the parameter limits, see Note [1] to Table 3-1.

2 When using direct wiring (PT Ratio = 1), voltages are transmitted in 0.1V units, currents in 0.01A units, and powers in 0.001 kW/kvar/kVA units. For wiring via PT (PT Ratio > 1), voltages are transmitted in 1V units, currents in 0.01A units, and powers in 1 kW/kvar/kVA units.

3 The actual frequency range is 45.00 - 65.00 Hz.

4 Absolute min/max value (lag or lead).

5 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.

6 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, *Scaling Analog Input Objects*).

M These parameters are logged to the Min/Max log.

E Available in the PM172E

Analog Output Setup

These registers are used to obtain or change the allocation of the internal multiplexed analog output channels. For the output parameters that can be selected see Table 3-18.

Table 3-16 Analog Output Allocation Registers

Channel	Points
Channel #1	192-194
Channel #2	195-197

Table 3-17 Analog Channel Allocation Registers

Channel	Object:Var	Register contents	Object:Point	Range/scale
#1	40:2(read) 41:2(write)	Output parameter ID	AO:192	See Table 3-18
	40:1(read) 41:1(write)	Zero scale (0/4 mA)	AO:193	
	40:1(read) 41:1(write)	Full scale (20/1 mA)	AO:194	
#2	40:2(read) 41:2(write)	Output parameter ID	AO:195	See Table 3-18
	40:1(read) 41:1(write)	Zero scale (0/4 mA)	AO:196	
	40:1(read) 41:1(write)	Full scale (20/1 mA)	AO:197	

NOTES

1. Except for the signed power factor (see Note 3 to Table 3-18), the output scale is linear within the value range. The scale range will be inverted if the full scale specified is less than the zero scale.

2. For bi-directional analog output (±1 mA), the zero scale corresponds to the center of the scale range (0 mA) and the direction of current matches the sign of the output parameter. For signed (bi-directional) values, such as powers and signed power factor, the scale is always symmetrical with regard to 0 mA, and the full scale corresponds to +1 mA output for positive readings and to -1 mA output for negative readings. For these, the zero scale (0 mA output) is permanently set in the instrument to zero for all parameters except of signed power factor for which it is set to 1.000. In the write request, the zero scale is ignored. No error will occur when you attempt to change it. Unsigned parameters are output within the current range 0 to +1 mA and can be scaled using both zero and full scales as in the event of single-ended analog output.

Table 3-18 Analog Output Parameters

Parameter	ID	Unit [2]	Scale range [1]	Modulus
None	0	n/a	0	
Real-time values per phase				
Voltage L1/L12 [5]	3072	0.1V/1V	0 to Vmax	
Voltage L2/L23 [5]	3073	0.1V/1V	0 to Vmax	
Voltage L3/L31 [5]	3074	0.1V/1V	0 to Vmax	
Current L1	3075	0.01A	0 to Imax	
Current L2	3076	0.01A	0 to Imax	
Current L3	3077	0.01A	0 to Imax	
Real-time total values				
Total kW	3840	0.001kW/1kW	-Pmax to Pmax	
Total kvar	3841	0.001kvar/1kvar	-Pmax to Pmax	
Total kVA	3842	0.001kVA/1kVA	0 to Pmax	
Total PF④	3843	0.001	-999 to 1000	×0.001
Total PF lag	3844	0.001	-999 to 1000	×0.001
Total PF lead	3845	0.001	-999 to 1000	×0.001
Real-time auxiliary values				
Frequency [3]	4098	0.01Hz	0 to 10000	×0.01
Average values per phase				
Voltage L1/L12 [5]	4352	0.1V/1V	0 to Vmax	
Voltage L2/L23 [5]	4353	0.1V/1V	0 to Vmax	
Voltage L3/L31 [5]	4354	0.1V/1V	0 to Vmax	

Parameter	ID	Unit [2]	Scale range [1]	Modulus
Current L1	4355	0.01A	0 to Imax	
Current L2	4356	0.01A	0 to Imax	
Current L3	4357	0.01A	0 to Imax	
Average total values				
Total kW	5120	0.001kW/1kW	-Pmax to Pmax	
Total kvar	5121	0.001kvar/1kvar	-Pmax to Pmax	
Total kVA	5122	0.001kVA/1kVA	0 to Pmax	
Total PF [4]	5123	0.001	-999 to 1000	×0.001
Total PF lag	5124	0.001	-999 to 1000	×0.001
Total PF lead	5125	0.001	-999 to 1000	×0.001
Average auxiliary values				
Neutral current	5377	0.01A	0 to Imax	
Frequency [3]	5378	0.01Hz	0 to 10000	×0.01
Present demands				
Accumulated kW import demand (E)	5647	0.001kW/1kW	0 to Pmax	
Accumulated kvar import demand (E)	5648	0.001kvar/1kvar	0 to Pmax	
Accumulated kVA demand (E)	5649	0.001kVA/1kVA	0 to Pmax	
Accumulated kW export demand (E)	5658	0.001kW/1kW	0 to Pmax	
Accumulated kvar export demand (E)	5659	0.001kvar/1kvar	0 to Pmax	

1 For the parameter limits, see Note [1] to Table 4.1.

2 When using direct wiring (PT Ratio = 1), voltages are transmitted in 0.1V units, currents in 0.01A units, and powers in 0.001 kW/kvar/kVA units. For wiring via PTs (PT Ratio > 1), voltages are transmitted in 1V units, currents in 0.01A units, and powers in 1 kW/kvar/kVA units.

3 The actual frequency range is 45.00 to 65.00 Hz

4 The output scale for signed (bi-directional) power factor is symmetrical with regard to ±1.000 and is linear from -0 to -1.000, and from 1.000 to +0 (note that -1.000 ≡ +1.000). Negative power factor is output as [-1.000 minus measured value], and non-negative power factor is output as [+1.000 minus measured value]. To define the entire range for power factor from -0 to +0, the scales would be specified as -0/0. Because a negative zero may not be transmitted, the value of -0.001 is used to specify the scale of -0, and both +0.001 and 0.000 are used to specify the scale of +0. To define the range of -0 to 0, you must send -1/1 or -1/0 (considering the modulus of ×0.001).

5 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.

E Available in the PM172E

Analog Expander Channels Allocation Registers

These registers are used to obtain or change the allocation of the analog expander channels. For the output parameters that can be selected see Table 3-18.

Table 3-19 Analog Expander Allocation Registers

Channel	Points	Channel	Points
Channel #1	256-258	Channel #9	280-282
Channel #2	259-261	Channel #10	283-285
Channel #3	262-264	Channel #11	286-288
Channel #4	265-267	Channel #12	289-291
Channel #5	268-270	Channel #13	292-294
Channel #6	271-273	Channel #14	295-297
Channel #7	274-276	Channel #15	298-300
Channel #8	277-279	Channel #16	301-303

Table 3-20 Analog Expander Channel Allocation Registers

Channel	Object:Var	Register contents	Object:Point	Range/Scale
#1	40:2(read) 41:2(write)	Output parameter ID	AO:256	See Table 3-18
	40:1(read) 41:1(write)	Zero scale (0/4 mA)	AO:257	
	40:1(read) 41:1(write)	Full scale (20 mA)	AO:258	
	. . .			

Channel	Object:Var	Register contents	Object:Point	Range/Scale
#16	40:2(read) 41:2(write)	Output parameter ID	AO:301	See Table 3-18
	40:1(read) 41:1(write)	Zero scale (0/4 mA)	AO:302	
	40:1(read) 41:1(write)	Full scale (20 mA)	AO:303	

NOTE

Settings you made for analog expander outputs will not be in effect until the analog expander output is globally enabled. To activate the analog expander output, set the analog expander option to the enabled state in the user selectable options setup (see Table 3-3).

Digital Inputs Allocation Registers

These registers are used to obtain or change the allocation of the instrument digital inputs.

Table 3-21 Digital Inputs Allocation Registers (E)

Object:Var	Register contents	Object:Point	Range
40:2(read) 41:2(write)	Status inputs allocation [1]	AO:130	See Table 3-22
40:2(read) 41:2(write)	Pulse inputs allocation	AO:131	See Table 3-22
40:2(read) 41:2(write)	Not used [1]	AO:132	Reads as 0
40:2(read) 41:2(write)	External synchronization pulse allocation	AO:133	See Table 3-22

[1] Writing to these locations is ignored. No error will occur.

E Available in the PM172E

NOTES

1. All digital inputs that are not allocated as pulse inputs will be automatically configured as status inputs.
2. A digital input allocated for the external synchronization pulse will be automatically configured as a pulse input.

Table 3-22 Digital Inputs Allocation Mask

Bit number	Description
0	Digital input # 1 allocation status
1	Digital input # 2 allocation status
2-15	N/A (read as 0)

Bit meaning: 0 = input not allocated, 1 = input allocated to the group

Pulsing Setpoints Registers

These registers are used to obtain or change the setup of the pulsing output for any 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 3-23 Pulsing Setpoints (E)

Relay	Registers
Relay #1	768-769
Relay #2	770-771

E Available in the PM172E

Table 3-24 Pulsing Setpoint Registers

Object:Var	Register contents	Object:Point	Range
40:2(read) 41:2(write)	Output parameter ID	AO:768	See Table 3-25
40:2(read) 41:2(write)	Number of unit-hours per pulse	AO:769	1-9999 for energy pulsing, otherwise write 0.
40:2(read) 41:2(write)	Output parameter ID	AO:770	See Table 3-25
40:2(read) 41:2(write)	Number of unit-hours per pulse	AO:771	1-9999 for energy pulsing, otherwise write 0.

Table 3-25 Pulsing Output Parameters

Pulsing parameter	Identifier
None	0
KWh import	1
KWh export	2
Kvarh import (inductive)	4
Kvarh export (capacitive)	5
Kvarh total (absolute)	6
KVAh	7

Relay Operation Control

These points allow the user to manually override relay operation 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 3-26 Relay Operation Control Registers

Object:Var	Register Contents	Object:Point	State Range
10:2(read) 12:1(write)	Relay #1 Force operate/Force release/Normal	BO:80 CROB:80	0/1 = state OFF/ON
10:2(read) 12:1(write)	Relay #2 Force operate/Force release/Normal	BO:81 CROB:81	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, and Latch Off are valid for all points
  - All others Codes are invalid and will 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 minimal value of the On Time 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 minimal value of the Off Time 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.

To manually operate relay #1, 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 relay #1, 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 control relay #2, use point 81. To revert relay #1 or #2 to normal operation, use the Direct-Operate (or SBO/Operate or Direct-Operate-No-

Acknowledge) command to the correspondent point of the Control-Relay-Output-Block object with the Control Code value Null Operation and Clear sub-field set to 1.

Pulse Counter Setup

Table 3-27 Pulse Counter Register (available in the PM172E)

Counter	Setup registers (see Table 3-28)
Counter #1	832-833
Counter #2	834-835
Counter #3	836-837
Counter #4	838-839

Table 3-28 Pulse Counter Setup Registers

Object:Var	Register contents	Object:Point	Range
40:2(read) 41:2(write)	Associated digital input ID	AO:832	See Table 3-29
40:2(read) 41:2(write)	Scale factor (number of units per input pulse)	AO:833	1-9999
…	…	…	…
40:2(read) 41:2(write)	Associated digital input ID	AO:838	See Table 3-29
40:2(read) 41:2(write)	Scale factor (number of units per input pulse)	AO:839	1-9999

Table 3-29 Pulsing Output Parameters

Discrete input	Identifier
Not allocated	0
Digital input #1	1
Digital input #2	2

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Class 0 Point Assignment

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

Table 3-30 Class 0 Assignment Register Groups

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

Table 3-31 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 3-32
	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
#2	40:1(read) 41:1(write)	DNP Object and Variation	AO:1155	See Table 3-32
	40:1(read) 41:1(write)	DNP Point number	AO:1156	0 - 65535
	40:1(read) 41:1(write)	Number of the DNP points	AO:1157	≥1 if point number is correct
…		…	…	…
#32	40:1(read) 41:1(write)	DNP Object and Variation	AO:1245	See Table 3-32
	40:1(read) 41:1(write)	DNP Point number	AO:1246	0 - 65535

Group	Object:Var	Register Contents	Object: Point	Range/scale
	40:1(read) 41:1(write)	Number of the DNP points	AO:1247	≥1 if point number is correct

Table 3-32 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 Input 01:02	0x0102	258
9	Binary Output 10:01 [2]	0x0A01	2561
10	Binary Output Status 10:02	0x1002	4098
11	Binary Counter 20:01	0x1401	5121
12	Binary Counter 20:02	0x1402	5122
13	Binary Counter 20:05	0x1405	5125
14	Binary Counter 20:06	0x1406	5126
15	Frozen Counter 21:01	0x1501	5377
16	Frozen Counter 21:02	0x1502	5378
17	Frozen Counter 21:05	0x1505	5381
18	Frozen Counter 21:06	0x1506	5382
19	Frozen Counter 21:09	0x1509	5385
20	Frozen Counter 21:10	0x150A	5386

1 The decimal value is calculated as Object × 256 + Variation.

2 Available starting with F/W Version 4.88.3 or later.

Example: Analog Input object 30, variation 03 is calculated as 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 PM172 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**	**Function Code**	**Qualifier Code**	**Function Code**	**Qualifier Code**
01	0	Single Bit Binary Input	1	B	129	01
01	1	Single Bit Binary Input	1	A	129	C
01	2	Binary Input with Status	1	A	129	C
02	0	Binary Input Change	1	06	129	17,28
02	1	Binary Input Change without Time	1	07,08	129	17,28
02	2	Binary Input Change with Time	1	07,08	129	17,28
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	Binary Counter	1, 7,9, 8,10	B B B	129 129 129	01 N/R N/A
20	1	32-bit Binary Counter	1	A	129	C
20	2	16-bit Binary Counter	1	A	129	C
20	5	32-bit Binary Counter without flag	1	A	129	C
20	6	16-bit Binary Counter without flag	1	A	129	C
21	0	Frozen Counter	1	B	129	01
21	1	32-bit Frozen Counter				
21	2	16-bit Frozen Counter				
21	5	32-bit Frozen Counter with time of freeze				
21	6	16-bit Frozen Counter with time of freeze				
21	9	32-bit Frozen Counter without flag				
21	10	16-bit Frozen Counter without flag				
22	0	Counter Change Event	1	06	129	17
22	1	32-bit Counter Change Event without Time	1	07,08	129	17
22	2	16-bit Counter Change Event without Time	1	07,08	129	17
22	5	32-bit Counter Change Event with Time	1	07,08	129	17
22	6	16-bit Counter Change Event with Time	1	07,08	129	17
30	0	Analog Input (respond 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
32	0	Analog Change Event	1	06	129	17
32	1	32-bit Analog Change Event without Time	1	07,08	129	17
32	2	16-bit Analog Change Event without Time	1	07,08	129	17
32	3	32-bit Analog Change Event with Time	1	07,08	129	17
32	4	16-bit Analog Change Event with Time	1	07,08	129	17
40	0	Analog Output Status (respond 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
50	1	Time and Date [1]	1,2	A	129	C
60	1	Class 0	1	B	129	01
60	2	Class 1	1	06,07,08	129	17

Object			Request		Response	
Obj	**Var**	**Description**	**Function Code**	**Qualifier Code**	**Function Code**	**Qualifier Code**
60	3	Class 2	1	06,07,08	129	17
60	4	Class 3	1	06,07,08	129	17
80	1	Internal indication [2]	2	D	129	
N/A	N/A	Cold Restart [3] (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 quantity specified in the request must be exactly 1or an index of 0, as there is only one instance of this object defined in the instrument.

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

[3] Respond with time object 50 variation 2 indicating time until 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

<table>
<tr><td colspan="2">DNP3-2000
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)</td></tr>
<tr><td colspan="2">Vendor Name: SATEC Ltd.</td></tr>
<tr><td colspan="2">Device Name: Powermeter Series PM172</td></tr>
<tr><td>Highest DNP Level Supported:
For Requests L2
For Responses L2</td><td>Device Function:
☐ Master ■ Slave</td></tr>
<tr><td colspan="2">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].</td></tr>
<tr><td>Maximum Data Link Frame Size (octets):
Transmitted 292
Received 292</td><td>Maximum Application Fragment Size (octets):
Transmitted 2048
Received 249</td></tr>
<tr><td>Maximum Data Link Re-tries:
■ None
☐ Fixed at_____
☐ Configurable, range ___ to_____</td><td>Maximum Application Layer Re-tries:
■ None
☐ Configurable, range ____ to _____
(Fixed is not permitted)</td></tr>
</table>

Device Profile Document (continued)

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 _5 sec__ ☐ Variable ☐ Configurable

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

Others

Timeouts between fragments of the multi-fragment responses. Configurable:

50-500 ms (50 ms by default).

_____

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

Device Profile Document (continued)

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 ④ used to control Relays associated with points 80 to 81

③ used to reset the self-check alarm registers associated with points 64 to 75

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)

Device Profile Document (continued)

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 -999999999 to 99999999 (point 2) 0 to 9999999 (points 0,1,3) ☐ Point-by-point list attached
Sends Multi-Fragment Responses: ■ Yes ☐ No	