



# **Power Quality and Revenue Meter EM720/EM720T**

## **DNP3 Communications Protocol**

### **Reference Guide**

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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.

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# 1 General

This document specifies a subset of the DNP3 communications protocol used to transfer data between a master computer station and the EM720. The document provides the complete information necessary to develop third-party communications software capable of communication with the Series EM720 instruments. Refer to the EM720 Operation Manual for more information on communications operation, configuring the communications parameters, and communications connections.

## **IMPORTANT**

1. 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 will be shown.
2. Most of the advanced features are configured using multiple setup parameters that can be accessed in a number of 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.

## 2 DNP 3.0 Protocol Implementation

DNP3 (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 is available in the "Basic 4 Document Set" which can be obtained from the DNP User Group.

### 2.1 Deviations from Standard

The EM720 implements Level 2 of the DNP3 communication protocol. The device 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 device receives a request, no further requests can be sent until after the device makes the appropriate response.

### 2.2 DNP Implementation

The EM720, like most devices, allows retrieving regular analog and binary data from the device 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 EM720 executes the parameter clear function and demands resets using the Direct-Operate, SBO/Operate or Direct-Operate-No-Acknowledge command to specified points of the Control-Relay-Output-Block object.

Issuing the Direct-Operate, SBO/Operate or Direct-Operate-No-Acknowledge command to appropriate points of the Analog-Output-Block object can change the setup parameters. The device also supports the DNP functions Write, Cold-Restart and Delay Measurement.

Refer to Appendix A for specific requests and responses. Appendix B contains the standard DNP Device Profile Document.

The device 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 device 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 device 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 device is in the Local state. Cleared when the device in the Remote state.   |
| 1              | 5            | Set when the current configuration in the device 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 by writing zero to points 64-75 using object 12. |

## 2.2.1 Class 0 Response

The EM720 DNP implementation supports a wide variety of messages. The most common method of getting static object information from the meter via DNP is to issue a read Class 0 request.

The EM720 allows you to configure the Class 0 response by assigning ranges of points to be polled via Class 0 requests (see Section 3.9, DNP Protocol setup).

## 2.2.2 Event Objects

The EM720 allows you to assign any static object point to a predefined object change event point for Class 1, Class 2 or Class 3 event polling. A total of 64 change event points are available. You can assign any of the Analog Input, Binary Input or Binary Counter static points to the corresponding change event point through the DNP Event setup (see Section 3.9). You can also link any point to Class 1, Class 2 or Class 3 object polling.

By default, a change event point index is the same as for the corresponding static object point. The EM720 gives you an option to re-map a static point index for the corresponding event point starting with index 0, separately for each object type - Analog Input, Binary Input or Binary Counter change events. For example, if the re-mapping option is active and you first assign static point AI:23 (1-sec frequency) to an event Class 1 point, the corresponding Analog Input change event point will be identified as point 0 in the Class 1 poll response.

Each point assigned to an event class can be separately enabled or disabled for scanning. Each point can also be linked to the common device Event log so that each change would be recorded to the Event log under common Setpoint #17.

The conditions for Analog Input change events can be specified by either an operating threshold, or a deadband, using one of the following three relations:

- 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;
- 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;
- 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.

For Binary Counter and Binary Input change events, a Delta relation is only applicable.

The number of event points for each object type (Analog Input, Binary Input or Binary Counter) is limited through the DNP Options setup (see Section 3.9). Every time you change the number of points for any of the objects, the device clears all event buffers and links the default set of static points to each event object type.

The scan time rates for polling events of different types are as follows:

- 1 cycle for Binary Input points
- 200 ms for Binary Counter and Analog Input points

The memory consumption for keeping events depends on the event objects variation, or DNP object size. For each event object type and event class, the device uses a separate buffer. The maximum buffer size per DNP event object/event class is 512 bytes. The maximum number of events per class that the device can hold can be calculated as follows:

$$\text{Maximum number of events} = 512 / (\text{DNP Event Object Size} + 1)$$

For example, the device can hold up to  $512/12=40$  measures of the 32-bit Analog change event with Time objects, or up to  $512/8=64$  measures of the 8-bit Binary change event with Time objects.

To disable change event objects, set to 0 all registers that define the number of the Analog Input, Binary Input and Binary Counter objects to generate events. In this case, the device will support only static objects.

### 2.2.3 Device Address

Each device on a DNP link must have a unique address. The EM720 allows a device address in the range of 0 to 65532 to be selected. The DNP master can use addresses 65533 to 65535 for broadcast requests. A broadcast request never generates a DNP response.

### 2.2.4 Transaction Timing

The EM720 response time to master requests is indicated in Table 2-1.

**Table 2-1 Response Time**

| Baud Rate, bps | Response Time, ms |     |         |
|----------------|-------------------|-----|---------|
|                | Min               | Max | Typical |
| 9600           | 13                | 15  | 13      |
| 19200          | 11                | 12  | 11      |
| 57600          | 9                 | 10  | 9       |
| 115200         | 9                 | 10  | 9       |

The Direct-Operate, SBO/Operate or Direct-Operate-No-Acknowledge requests for reset/clear registers and changing setpoints are immediately confirmed.

### 2.2.5 Scaling 16-bit Analog Inputs

Any of the variations 1 through 4 can be used with the Analog Input objects. Variations specified in Sections 3.1 and 3.5 show those that can 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 in the flag octet being set to 1 if a variation 2 is requested. To avoid over-range errors when a variation 2 or 4 is required, a linear scaling may be used to scale 32-bit analog readings to 16-bit Analog Input objects (see Section 3.9, DNP Options setup). Scaling is enabled in the device by default.

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:

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

where:

- Y - True reading in engineering units
- X - Raw input data in the range of DNP\_LO – DNP\_HI
- LO, HI - Data low and high scales in engineering units (for device data scales, see 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

If you have read a value of 201 for point AI:3 that shows the I1 current (see Section 3.1) and the CT primary current is 200A (the high current scale is 2x200 = 400A), then the current reading in engineering units is as follows:

$$(201 - 0) \times (400 - 0) / (32767 - 0) + 0 = 2.45\text{A}$$

## 2.2.6 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.

## 2.3 Password Protection

The EM720 has a password protection option allowing you to protect your setups, cumulative registers and logs from being changed or cleared through communications. You can disable or enable password protection through communications or via the front display. For details, refer to your instrument Installation and Operation Manual.

When password protection is enabled, the user password you set in your instrument should be written into the device authorization register (point AO:192) before another write request is issued. If the correct password is not supplied while password protection is enabled, the instrument will respond to all write requests with the exception response "Control operation not supported for this point". It is recommended to clear the password register after you have completed your changes in order to activate password protection.

## 3 DNP Point Map

### 3.1 Analog Inputs - Basic Set

| Object : Var. | Object : Point | Description                                   | Options/Range <sup>2</sup> | Units <sup>2</sup> | Type   | R/W | Notes                    |
|---------------|----------------|---|----------------------------|--------------------|--------|-----|--------------------------|
| 30:3          | AI:0           | V1/V12 Voltage                                | 0-Vmax                     | U1                 | UINT32 | R   | <sup>1</sup>             |
| 30:3          | AI:1           | V2/V23 Voltage                                | 0-Vmax                     | U1                 | UINT32 | R   | <sup>1</sup>             |
| 30:3          | AI:2           | V3/V31 Voltage                                | 0-Vmax                     | U1                 | UINT32 | R   | <sup>1</sup>             |
| 30:3          | AI:3           | I1 Current                                    | 0-Imax                     | U2                 | UINT32 | R   |                          |
| 30:3          | AI:4           | I2 Current                                    | 0-Imax                     | U2                 | UINT32 | R   |                          |
| 30:3          | AI:5           | I3 Current                                    | 0-Imax                     | U2                 | UINT32 | R   |                          |
| 30:3          | AI:6           | kW L1   | -Pmax-Pmax                 | U3                 | INT32  | R   |                          |
| 30:3          | AI:7           | kW L2   | -Pmax-Pmax                 | U3                 | INT32  | R   |                          |
| 30:3          | AI:8           | kW L3   | -Pmax-Pmax                 | U3                 | INT32  | R   |                          |
| 30:3          | AI:9           | kvar L1                                       | -Pmax-Pmax                 | U3                 | INT32  | R   |                          |
| 30:3          | AI:10          | kvar L2                                       | -Pmax-Pmax                 | U3                 | INT32  | R   |                          |
| 30:3          | AI:11          | kvar L3                                       | -Pmax-Pmax                 | U3                 | INT32  | R   |                          |
| 30:3          | AI:12          | kVA L1  | 0-Pmax                     | U3                 | UINT32 | R   |                          |
| 30:3          | AI:13          | kVA L2  | 0-Pmax                     | U3                 | UINT32 | R   |                          |
| 30:3          | AI:14          | kVA L3  | 0-Pmax                     | U3                 | UINT32 | R   |                          |
| 30:4          | AI:15          | Power factor L1                               | -1000-1000                 | ×0.001             | INT16  | R   |                          |
| 30:4          | AI:16          | Power factor L2                               | -1000-1000                 | ×0.001             | INT16  | R   |                          |
| 30:4          | AI:17          | Power factor L3                               | -1000-1000                 | ×0.001             | INT16  | R   |                          |
| 30:4          | AI:18          | Total PF                                      | -1000-1000                 | ×0.001             | INT16  | R   |                          |
| 30:3          | AI:19          | Total kW                                      | -Pmax-Pmax                 | U3                 | INT32  | R   |                          |
| 30:3          | AI:20          | Total kvar                                    | -Pmax-Pmax                 | U3                 | INT32  | R   |                          |
| 30:3          | AI:21          | Total kVA                                     | 0-Pmax                     | U3                 | UINT32 | R   |                          |
| 30:3          | AI:22          | In (neutral) Current                          | 0-Imax                     | U2                 | UINT32 | R   |                          |
| 30:4          | AI:23          | Frequency                                     | 0-Fmax                     | ×0.01Hz            | UINT16 | R   |                          |
| 30:3          | AI:24          | Maximum kW import sliding window demand       | 0-Pmax                     | U3                 | UINT32 | R   |                          |
| 30:3          | AI:25          | kW import accumulated demand                  | 0-Pmax                     | U3                 | UINT32 | R   |                          |
| 30:3          | AI:26          | Maximum kVA sliding window demand             | 0-Pmax                     | U3                 | UINT32 | R   |                          |
| 30:3          | AI:27          | kVA accumulated demand                        | 0-Pmax                     | U3                 | UINT32 | R   |                          |
| 30:3          | AI:28          | I1 Maximum ampere demand                      | 0-Imax                     | U2                 | UINT32 | R   |                          |
| 30:3          | AI:29          | I2 Maximum ampere demand                      | 0-Imax                     | U2                 | UINT32 | R   |                          |
| 30:3          | AI:30          | I3 Maximum ampere demand                      | 0-Imax                     | U2                 | UINT32 | R   |                          |
| 30:3          | AI:31          | Present kW import sliding window demand       | 0-Pmax                     | U3                 | UINT32 | R   |                          |
| 30:3          | AI:32          | Present kVA sliding window demand             | 0-Pmax                     | U3                 | UINT32 | R   |                          |
| 30:4          | AI:33          | PF (import) at Max. kVA sliding window demand | 0-1000                     | ×0.001             | UINT16 | R   |                          |
| 30:4          | AI:34          | V1/V12 Voltage THD                            | 0-9999                     | ×0.1%              | UINT16 | R   | <sup>1</sup> 3-sec value |
| 30:4          | AI:35          | V2/V23 Voltage THD                            | 0-9999                     | ×0.1%              | UINT16 | R   | <sup>1</sup> 3-sec value |
| 30:4          | AI:36          | V3/V31 Voltage THD                            | 0-9999                     | ×0.1%              | UINT16 | R   | <sup>1</sup> 3-sec value |

| Object : Var. | Object : Point | Description    | Options/Range <sup>2</sup> | Units <sup>2</sup> | Type   | R/W | Notes       |
|---------------|----------------|----------------|----------------------------|--------------------|--------|-----|-------------|
| 30:4          | AI:37          | I1 Current THD | 0-9999                     | ×0.1%              | UINT16 | R   | 3-sec value |
| 30:4          | AI:38          | I2 Current THD | 0-9999                     | ×0.1%              | UINT16 | R   | 3-sec value |
| 30:4          | AI:39          | I3 Current THD | 0-9999                     | ×0.1%              | UINT16 | R   | 3-sec value |
| 30:4          | AI:40          | I1 Current TDD | 0-1000                     | ×0.1%              | UINT16 | R   | 3-sec value |
| 30:4          | AI:41          | I2 Current TDD | 0-1000                     | ×0.1%              | UINT16 | R   | 3-sec value |
| 30:4          | AI:42          | I3 Current TDD | 0-1000                     | ×0.1%              | UINT16 | R   | 3-sec value |

**NOTES:**

<sup>1</sup> 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.

<sup>2</sup> All analog input points except of harmonics are 1-second average values. For volts, amps and power scales and units, refer to Section 4 "Data Scales and Units". For analog input scaling formulas and examples, see Section 2.2.5, "Scaling Analog Input Objects".

### 3.2 Binary Inputs - Basic Set

| Object : Var. | Object : Point | Description     | Range | Units | Type | R/W | Notes |
|---------------|----------------|-----------------|-------|-------|------|-----|-------|
| 01:1          | BI:0           | Relay #1 status | 0-1   |       |      | R   |       |
| 01:1          | BI:1           | Relay #2 status | 0-1   |       |      | R   |       |
| 01:1          | BI:2           | Relay #3 status | 0-1   |       |      | R   |       |
| 01:1          | BI:3           | Relay #4 status | 0-1   |       |      | R   |       |
| 01:1          | BI:16          | Status input #1 | 0-1   |       |      | R   |       |
| 01:1          | BI:17          | Status input #2 | 0-1   |       |      | R   |       |
| 01:1          | BI:18          | Status input #3 | 0-1   |       |      | R   |       |
| 01:1          | BI:19          | Status input #4 | 0-1   |       |      | R   |       |
| 01:1          | BI:20          | Status input #5 | 0-1   |       |      | R   |       |
| 01:1          | BI:21          | Status input #6 | 0-1   |       |      | R   |       |
| 01:1          | BI:22          | Status input #7 | 0-1   |       |      | R   |       |
| 01:1          | BI:23          | Status input #8 | 0-1   |       |      | R   |       |
| 01:1          | BI:48          | Battery status  | 0-1   |       |      | R   |       |

### 3.3 Binary Counters - Basic Set

| Object : Var. | Object : Point | Description  | Range           | Units | Type   | R/W | Notes |
|---------------|----------------|--------------|-----------------|-------|--------|-----|-------|
| 20:5          | BC:0           | kWh import   | 0-1,000,000,000 | kWh   | UINT32 | R   |       |
| 20:5          | BC:1           | kWh export   | 0-1,000,000,000 | kWh   | UINT32 | R   |       |
| 20:5          | BC:2           | kvarh net    | 0-1,000,000,000 | kvarh | UINT32 | R   |       |
| 20:5          | BC:3           | kVAh         | 0-1,000,000,000 | kVAh  | UINT32 | R   |       |
| 20:5          | BC:4           | kvarh import | 0-1,000,000,000 | kvarh | UINT32 | R   |       |
| 20:5          | BC:5           | kvarh export | 0-1,000,000,000 | kvarh | UINT32 | R   |       |

### 3.4 Frozen Binary Counters

| Object : Var. <sup>1</sup>           | Object : Point | Description  | Range           | Units   | Type   | R/W | Notes |
|--------------------------------------|----------------|--------------|-----------------|---------|--------|-----|-------|
| <b>Total Energies – Basic Set</b>    |                |              |                 |         |        |     |       |
| 21:var                               | FBC:0          | kWh import   | 0-1,000,000,000 | kWh     | UINT32 | R   |       |
| 21:var                               | FBC:1          | kWh export   | 0-1,000,000,000 | kWh     | UINT32 | R   |       |
| 21:var                               | FBC:2          | kvarh net    | 0-1,000,000,000 | kvarh   | UINT32 | R   |       |
| 21:var                               | FBC:3          | kVAh         | 0-1,000,000,000 | kVAh    | UINT32 | R   |       |
| 21:var                               | FBC:4          | kvarh import | 0-1,000,000,000 | kvarh   | UINT32 | R   |       |
| 21:var                               | FBC:5          | kvarh export | 0-1,000,000,000 | kvarh   | UINT32 | R   |       |
| <b>Counters – Extended Set</b>       |                |              |                 |         |        |     |       |
| 21:var                               | FBC:35328      | Counter #1   | 0-1,000,000,000 |         | UINT32 | R   |       |
| 21:var                               | FBC:35329      | Counter #2   | 0-1,000,000,000 |         | UINT32 | R   |       |
| 21:var                               | FBC:35330      | Counter #3   | 0-1,000,000,000 |         | UINT32 | R   |       |
| 21:var                               | FBC:35331      | Counter #4   | 0-1,000,000,000 |         | UINT32 | R   |       |
| 21:var                               | FBC:35332      | Counter #5   | 0-1,000,000,000 |         | UINT32 | R   |       |
| 21:var                               | FBC:35333      | Counter #6   | 0-1,000,000,000 |         | UINT32 | R   |       |
| 21:var                               | FBC:35334      | Counter #7   | 0-1,000,000,000 |         | UINT32 | R   |       |
| 21:var                               | FBC:35335      | Counter #8   | 0-1,000,000,000 |         | UINT32 | R   |       |
| <b>Total Energies - Extended Set</b> |                |              |                 |         |        |     |       |
| 21:var                               | FBC:38656      | kWh import   | 0-1,000,000,000 | 1 kWh   | UINT32 | R   |       |
| 21:var                               | FBC:38657      | kWh export   | 0-1,000,000,000 | 1 kWh   | UINT32 | R   |       |
| 21:var                               | FBC:38658      | Not used     |                 |         | UINT32 | R   |       |
| 21:var                               | FBC:38659      | Not used     |                 |         | UINT32 | R   |       |
| 21:var                               | FBC:38660      | kvarh import | 0-1,000,000,000 | 1 kvarh | UINT32 | R   |       |
| 21:var                               | FBC:38661      | kvarh export | 0-1,000,000,000 | 1 kvarh | UINT32 | R   |       |
| 21:var                               | FBC:38662      | Not used     |                 |         | UINT32 | R   |       |
| 21:var                               | FBC:38663      | Not used     |                 |         | UINT32 | R   |       |
| 21:var                               | FBC:38664      | kVAh total   | 0-1,000,000,000 | 1 kVAh  | UINT32 | R   |       |

**NOTE**

<sup>1</sup> For object variation, see DNP Options setup (see Section 3.9).

### 3.5 Analog Inputs, Binary Inputs and Counters – Extended Set

| Object : Var. | Object : Point | Description                 | Options/Range <sup>3</sup> | Units <sup>3</sup> | Type   | R/W | Notes        |
|---------------|----------------|-----------------------------|----------------------------|--------------------|--------|-----|--------------|
| 30:4          | AI:32768       | None                        | 0                          |                    | UINT16 | R   |              |
|               |                | <b>Digital Inputs</b>       |                            |                    |        | R   |              |
| 01:1          | BI:34304       | DI1                         | 0-1                        |                    |        | R   |              |
| 01:1          | BI:34305       | DI2                         | 0-1                        |                    |        | R   |              |
| 01:1          | BI:34306       | DI3                         | 0-1                        |                    |        | R   |              |
| 01:1          | BI:34307       | DI4                         | 0-1                        |                    |        | R   |              |
| 01:1          | BI:34308       | DI5                         | 0-1                        |                    |        | R   |              |
| 01:1          | BI:34309       | DI6                         | 0-1                        |                    |        | R   |              |
| 01:1          | BI:34310       | DI7                         | 0-1                        |                    |        | R   |              |
| 01:1          | BI:34311       | DI8                         | 0-1                        |                    |        | R   |              |
|               |                | <b>Relay Outputs</b>        |                            |                    |        | R   |              |
| 01:1          | BI:34816       | Relay #1                    | 0-1                        |                    |        | R   |              |
| 01:1          | BI:34817       | Relay #2                    | 0-1                        |                    |        | R   |              |
| 01:1          | BI:34818       | Relay #3                    | 0-1                        |                    |        | R   |              |
| 01:1          | BI:34819       | Relay #4                    | 0-1                        |                    |        | R   |              |
|               |                | <b>Counters</b>             |                            |                    |        |     |              |
| 20:5          | BC:35328       | Counter #1                  | 0-1,000,000,000            |                    | UINT32 | R   |              |
| 20:5          | BC:35329       | Counter #2                  | 0-1,000,000,000            |                    | UINT32 | R   |              |
| 20:5          | BC:35330       | Counter #3                  | 0-1,000,000,000            |                    | UINT32 | R   |              |
| 20:5          | BC:35331       | Counter #4                  | 0-1,000,000,000            |                    | UINT32 | R   |              |
| 20:5          | BC:35332       | Counter #5                  | 0-1,000,000,000            |                    | UINT32 | R   |              |
| 20:5          | BC:35333       | Counter #6                  | 0-1,000,000,000            |                    | UINT32 | R   |              |
| 20:5          | BC:35334       | Counter #7                  | 0-1,000,000,000            |                    | UINT32 | R   |              |
| 20:5          | BC:35335       | Counter #8                  | 0-1,000,000,000            |                    | UINT32 | R   |              |
|               |                | <b>1-Cycle Phase Values</b> |                            |                    |        |     |              |
| 30:3          | AI:35840       | V1/V12 Voltage              | 0-Vmax                     | U1                 | UINT32 | R   | <sup>1</sup> |
| 30:3          | AI:35841       | V2/V23 Voltage              | 0-Vmax                     | U1                 | UINT32 | R   | <sup>1</sup> |
| 30:3          | AI:35842       | V3/V31 Voltage              | 0-Vmax                     | U1                 | UINT32 | R   | <sup>1</sup> |
| 30:3          | AI:35843       | I1 Current                  | 0-Imax                     | U2                 | UINT32 | R   |              |
| 30:3          | AI:35844       | I2 Current                  | 0-Imax                     | U2                 | UINT32 | R   |              |
| 30:3          | AI:35845       | I3 Current                  | 0-Imax                     | U2                 | UINT32 | R   |              |
| 30:3          | AI:35846       | kW L1                       | -Pmax-Pmax                 | U3                 | INT32  | R   |              |
| 30:3          | AI:35847       | kW L2                       | -Pmax-Pmax                 | U3                 | INT32  | R   |              |
| 30:3          | AI:35848       | kW L3                       | -Pmax-Pmax                 | U3                 | INT32  | R   |              |
| 30:3          | AI:35849       | kvar L1                     | -Pmax-Pmax                 | U3                 | INT32  | R   |              |
| 30:3          | AI:35850       | kvar L2                     | -Pmax-Pmax                 | U3                 | INT32  | R   |              |
| 30:3          | AI:35851       | kvar L3                     | -Pmax-Pmax                 | U3                 | INT32  | R   |              |
| 30:3          | AI:35852       | kVA L1                      | 0-Pmax                     | U3                 | UINT32 | R   |              |
| 30:3          | AI:35853       | kVA L2                      | 0-Pmax                     | U3                 | UINT32 | R   |              |

| Object : Var. | Object : Point | Description                     | Options/Range <sup>3</sup> | Units <sup>3</sup> | Type   | R/W | Notes                      |
|---------------|----------------|---------------------------------|----------------------------|--------------------|--------|-----|----------------------------|
| 30:3          | AI:35854       | kVA L3                          | 0-Pmax                     | U3                 | UINT32 | R   |                            |
| 30:4          | AI:35855       | Power factor L1                 | -1000-1000                 | ×0.001             | INT16  | R   |                            |
| 30:4          | AI:35856       | Power factor L2                 | -1000-1000                 | ×0.001             | INT16  | R   |                            |
| 30:4          | AI:35857       | Power factor L3                 | -1000-1000                 | ×0.001             | INT16  | R   |                            |
| 30:4          | AI:35858       | V1/V12 Voltage THD              | 0-9999                     | ×0.1%              | UINT16 | R   | <sup>2</sup> 0.2-sec value |
| 30:4          | AI:35859       | V2/V23 Voltage THD              | 0-9999                     | ×0.1%              | UINT16 | R   | <sup>2</sup> 0.2-sec value |
| 30:4          | AI:35860       | V3/V31 Voltage THD              | 0-9999                     | ×0.1%              | UINT16 | R   | <sup>2</sup> 0.2-sec value |
| 30:4          | AI:35861       | I1 Current THD                  | 0-9999                     | ×0.1%              | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:35862       | I2 Current THD                  | 0-9999                     | ×0.1%              | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:35863       | I3 Current THD                  | 0-9999                     | ×0.1%              | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:35864       | I1 K-Factor                     | 10-9999                    | ×0.1               | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:35865       | I2 K-Factor                     | 10-9999                    | ×0.1               | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:35866       | I3 K-Factor                     | 10-9999                    | ×0.1               | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:35867       | I1 Current TDD                  | 0-1000                     | ×0.1%              | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:35868       | I2 Current TDD                  | 0-1000                     | ×0.1%              | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:35869       | I3 Current TDD                  | 0-1000                     | ×0.1%              | UINT16 | R   | 0.2-sec value              |
| 30:3          | AI:35870       | V12 Voltage                     | 0-Vmax                     | U1                 | UINT32 | R   |                            |
| 30:3          | AI:35871       | V23 Voltage                     | 0-Vmax                     | U1                 | UINT32 | R   |                            |
| 30:3          | AI:35872       | V31 Voltage                     | 0-Vmax                     | U1                 | UINT32 | R   |                            |
|               |                | <b>1-Cycle Total Values</b>     |                            |                    |        |     |                            |
| 30:3          | AI:36608       | Total kW                        | -Pmax-Pmax                 | U3                 | INT32  | R   |                            |
| 30:3          | AI:36609       | Total kvar                      | -Pmax-Pmax                 | U3                 | INT32  | R   |                            |
| 30:3          | AI:36610       | Total kVA                       | 0-Pmax                     | U3                 | UINT32 | R   |                            |
| 30:4          | AI:36611       | Total PF                        | -1000-1000                 | ×0.001             | INT16  | R   |                            |
| 30:4          | AI:36612       | Total PF lag                    | 0-1000                     | ×0.001             | UINT16 | R   |                            |
| 30:4          | AI:36613       | Total PF lead                   | 0-1000                     | ×0.001             | UINT16 | R   |                            |
| 30:3          | AI:36614       | Total kW import                 | 0-Pmax                     | U3                 | UINT32 | R   |                            |
| 30:3          | AI:36615       | Total kW export                 | 0-Pmax                     | U3                 | UINT32 | R   |                            |
| 30:3          | AI:36616       | Total kvar import               | 0-Pmax                     | U3                 | UINT32 | R   |                            |
| 30:3          | AI:36617       | Total kvar export               | 0-Pmax                     | U3                 | UINT32 | R   |                            |
| 30:3          | AI:36618       | 3-phase average L-N/L-L voltage | 0-Vmax                     | U1                 | UINT32 | R   | <sup>1</sup>               |
| 30:3          | AI:36619       | 3-phase average L-L voltage     | 0-Vmax                     | U1                 | UINT32 | R   |                            |
| 30:3          | AI:36620       | 3-phase average current         | 0-Imax                     | U2                 | UINT32 | R   |                            |
|               |                | <b>1-Cycle Auxiliary Values</b> |                            |                    |        |     |                            |
| 30:3          | AI:36864       | I4 Current                      | 0-I4max                    | U2                 | UINT32 | R   |                            |
| 30:3          | AI:36865       | In (neutral) Current            | 0-Imax                     | U2                 | UINT32 | R   |                            |
| 30:4          | AI:36866       | Frequency                       | 0-Fmax                     | ×0.01Hz            | UINT16 | R   |                            |
| 30:4          | AI:36867       | Voltage unbalance               | 0-3000                     | ×0.1%              | UINT16 | R   |                            |
| 30:4          | AI:36868       | Current unbalance               | 0-3000                     | ×0.1%              | UINT16 | R   |                            |
|               |                | <b>1-Second Phase Values</b>    |                            |                    |        |     |                            |
| 30:3          | AI:37120       | V1/V12 Voltage                  | 0-Vmax                     | U1                 | UINT32 | R   | <sup>1</sup>               |
| 30:3          | AI:37121       | V2/V23 Voltage                  | 0-Vmax                     | U1                 | UINT32 | R   | <sup>1</sup>               |
| 30:3          | AI:37122       | V3/V31 Voltage                  | 0-Vmax                     | U1                 | UINT32 | R   | <sup>1</sup>               |

| Object : Var. | Object : Point | Description                     | Options/Range <sup>3</sup> | Units <sup>3</sup> | Type   | R/W | Notes                    |
|---------------|----------------|---------------------------------|----------------------------|--------------------|--------|-----|--------------------------|
| 30:3          | AI:37123       | I1 Current                      | 0-Imax                     | U2                 | UINT32 | R   |                          |
| 30:3          | AI:37124       | I2 Current                      | 0-Imax                     | U2                 | UINT32 | R   |                          |
| 30:3          | AI:37125       | I3 Current                      | 0-Imax                     | U2                 | UINT32 | R   |                          |
| 30:3          | AI:37126       | kW L1                           | -Pmax-Pmax                 | U3                 | INT32  | R   |                          |
| 30:3          | AI:37127       | kW L2                           | -Pmax-Pmax                 | U3                 | INT32  | R   |                          |
| 30:3          | AI:37128       | kW L3                           | -Pmax-Pmax                 | U3                 | INT32  | R   |                          |
| 30:3          | AI:37129       | kvar L1                         | -Pmax-Pmax                 | U3                 | INT32  | R   |                          |
| 30:3          | AI:37130       | kvar L2                         | -Pmax-Pmax                 | U3                 | INT32  | R   |                          |
| 30:3          | AI:37131       | kvar L3                         | -Pmax-Pmax                 | U3                 | INT32  | R   |                          |
| 30:3          | AI:37132       | kVA L1                          | 0-Pmax                     | U3                 | UINT32 | R   |                          |
| 30:3          | AI:37133       | kVA L2                          | 0-Pmax                     | U3                 | UINT32 | R   |                          |
| 30:3          | AI:37134       | kVA L3                          | 0-Pmax                     | U3                 | UINT32 | R   |                          |
| 30:4          | AI:37135       | Power factor L1                 | -1000-1000                 | ×0.001             | INT16  | R   |                          |
| 30:4          | AI:37136       | Power factor L2                 | -1000-1000                 | ×0.001             | INT16  | R   |                          |
| 30:4          | AI:37137       | Power factor L3                 | -1000-1000                 | ×0.001             | INT16  | R   |                          |
| 30:4          | AI:37138       | V1/V12 Voltage THD              | 0-9999                     | ×0.1%              | UINT16 | R   | <sup>2</sup> 3-sec value |
| 30:4          | AI:37139       | V2/V23 Voltage THD              | 0-9999                     | ×0.1%              | UINT16 | R   | <sup>2</sup> 3-sec value |
| 30:4          | AI:37140       | V3/V31 Voltage THD              | 0-9999                     | ×0.1%              | UINT16 | R   | <sup>2</sup> 3-sec value |
| 30:4          | AI:37141       | I1 Current THD                  | 0-9999                     | ×0.1%              | UINT16 | R   | 3-sec value              |
| 30:4          | AI:37142       | I2 Current THD                  | 0-9999                     | ×0.1%              | UINT16 | R   | 3-sec value              |
| 30:4          | AI:37143       | I3 Current THD                  | 0-9999                     | ×0.1%              | UINT16 | R   | 3-sec value              |
| 30:4          | AI:37144       | I1 K-Factor                     | 10-9999                    | ×0.1               | UINT16 | R   | 3-sec value              |
| 30:4          | AI:37145       | I2 K-Factor                     | 10-9999                    | ×0.1               | UINT16 | R   | 3-sec value              |
| 30:4          | AI:37146       | I3 K-Factor                     | 10-9999                    | ×0.1               | UINT16 | R   | 3-sec value              |
| 30:4          | AI:37147       | I1 Current TDD                  | 0-1000                     | ×0.1%              | UINT16 | R   | 3-sec value              |
| 30:4          | AI:37148       | I2 Current TDD                  | 0-1000                     | ×0.1%              | UINT16 | R   | 3-sec value              |
| 30:4          | AI:37149       | I3 Current TDD                  | 0-1000                     | ×0.1%              | UINT16 | R   | 3-sec value              |
| 30:3          | AI:37150       | V12 Voltage                     | 0-Vmax                     | U1                 | UINT32 | R   |                          |
| 30:3          | AI:37151       | V23 Voltage                     | 0-Vmax                     | U1                 | UINT32 | R   |                          |
| 30:3          | AI:37152       | V31 Voltage                     | 0-Vmax                     | U1                 | UINT32 | R   |                          |
|               |                | <b>1-Second Total Values</b>    |                            |                    |        |     |                          |
| 30:3          | AI:37888       | Total kW                        | -Pmax-Pmax                 | U3                 | INT32  | R   |                          |
| 30:3          | AI:37889       | Total kvar                      | -Pmax-Pmax                 | U3                 | INT32  | R   |                          |
| 30:3          | AI:37890       | Total kVA                       | 0-Pmax                     | U3                 | UINT32 | R   |                          |
| 30:4          | AI:37891       | Total PF                        | -1000-1000                 | ×0.001             | INT16  | R   |                          |
| 30:4          | AI:37892       | Total PF lag                    | 0-1000                     | ×0.001             | UINT16 | R   |                          |
| 30:4          | AI:37893       | Total PF lead                   | 0-1000                     | ×0.001             | UINT16 | R   |                          |
| 30:3          | AI:37894       | Total kW import                 | 0-Pmax                     | U3                 | UINT32 | R   |                          |
| 30:3          | AI:37895       | Total kW export                 | 0-Pmax                     | U3                 | UINT32 | R   |                          |
| 30:3          | AI:37896       | Total kvar import               | 0-Pmax                     | U3                 | UINT32 | R   |                          |
| 30:3          | AI:37897       | Total kvar export               | 0-Pmax                     | U3                 | UINT32 | R   |                          |
| 30:3          | AI:37898       | 3-phase average L-N/L-L voltage | 0-Vmax                     | U1                 | UINT32 | R   | <sup>1</sup>             |
| 30:3          | AI:37899       | 3-phase average L-L voltage     | 0-Vmax                     | U1                 | UINT32 | R   |                          |

| Object : Var. | Object : Point | Description                                   | Options/Range <sup>3</sup> | Units <sup>3</sup> | Type   | R/W | Notes |
|---------------|----------------|---|----------------------------|--------------------|--------|-----|-------|
| 30:3          | AI:37900       | 3-phase average current                       | 0-Imax                     | U2                 | UINT32 | R   |       |
|               |                | <b>1-Second Auxiliary Values</b>              |                            |                    |        |     |       |
| 30:3          | AI:38144       | I4 Current                                    | 0-I4max                    | U2                 | UINT32 | R   |       |
| 30:3          | AI:38145       | In (neutral) Current                          | 0-Imax                     | U2                 | UINT32 | R   |       |
| 30:4          | AI:38146       | Frequency                                     | 0-Fmax                     | ×0.01Hz            | UINT16 | R   |       |
| 30:4          | AI:38147       | Voltage unbalance                             | 0-3000                     | ×0.1%              | UINT16 | R   |       |
| 30:4          | AI:38148       | Current unbalance                             | 0-3000                     | ×0.1%              | UINT16 | R   |       |
|               |                | <b>Present Volt, Ampere and Power Demands</b> |                            |                    |        |     |       |
| 30:3          | AI:38400       | V1/V12 Volt demand                            | 0-Vmax                     | U1                 | UINT32 | R   | 2     |
| 30:3          | AI:38401       | V2/V23 Volt demand                            | 0-Vmax                     | U1                 | UINT32 | R   | 2     |
| 30:3          | AI:38402       | V3/V31 Volt demand                            | 0-Vmax                     | U1                 | UINT32 | R   | 2     |
| 30:3          | AI:38403       | I1 Ampere demand                              | 0-Imax                     | U2                 | UINT32 | R   |       |
| 30:3          | AI:38404       | I2 Ampere demand                              | 0-Imax                     | U2                 | UINT32 | R   |       |
| 30:3          | AI:38405       | I3 Ampere demand                              | 0-Imax                     | U2                 | UINT32 | R   |       |
| 30:3          | AI:38406       | kW import block demand                        | 0-Pmax                     | U3                 | UINT32 | R   |       |
| 30:3          | AI:38407       | kvar import block demand                      | 0-Pmax                     | U3                 | UINT32 | R   |       |
| 30:3          | AI:38408       | kVA block demand                              | 0-Pmax                     | U3                 | UINT32 | R   |       |
| 30:3          | AI:38409       | kW import sliding window demand               | 0-Pmax                     | U3                 | UINT32 | R   |       |
| 30:3          | AI:38410       | kvar import sliding window demand             | 0-Pmax                     | U3                 | UINT32 | R   |       |
| 30:3          | AI:38411       | kVA sliding window demand                     | 0-Pmax                     | U3                 | UINT32 | R   |       |
| 30:3          | AI:38412       | Not used                                      |                            |                    | UINT32 | R   |       |
| 30:3          | AI:38413       | Not used                                      |                            |                    | UINT32 | R   |       |
| 30:3          | AI:38414       | Not used                                      |                            |                    | UINT32 | R   |       |
| 30:3          | AI:38415       | kW import accumulated demand                  | 0-Pmax                     | U3                 | UINT32 | R   |       |
| 30:3          | AI:38416       | kvar import accumulated demand                | 0-Pmax                     | U3                 | UINT32 | R   |       |
| 30:3          | AI:38417       | kVA accumulated demand                        | 0-Pmax                     | U3                 | UINT32 | R   |       |
| 30:3          | AI:38418       | kW import predicted sliding window demand     | 0-Pmax                     | U3                 | UINT32 | R   |       |
| 30:3          | AI:38419       | kvar import predicted sliding window demand   | 0-Pmax                     | U3                 | UINT32 | R   |       |
| 30:3          | AI:38420       | kVA predicted sliding window demand           | 0-Pmax                     | U3                 | UINT32 | R   |       |
| 30:4          | AI:38421       | PF (import) at Max. kVA sliding window demand | 0-1000                     | ×0.001             | UINT16 | R   |       |
| 30:3          | AI:38422       | kW export block demand                        | 0-Pmax                     | U3                 | UINT32 | R   |       |
| 30:3          | AI:38423       | kvar export block demand                      | 0-Pmax                     | U3                 | UINT32 | R   |       |
| 30:3          | AI:38424       | kW export sliding window demand               | 0-Pmax                     | U3                 | UINT32 | R   |       |
| 30:3          | AI:38425       | kvar export sliding window demand             | 0-Pmax                     | U3                 | UINT32 | R   |       |
| 30:3          | AI:38426       | kW export accumulated demand                  | 0-Pmax                     | U3                 | UINT32 | R   |       |
| 30:3          | AI:38427       | kvar export accumulated demand                | 0-Pmax                     | U3                 | UINT32 | R   |       |
| 30:3          | AI:38428       | kW export predicted sliding window demand     | 0-Pmax                     | U3                 | UINT32 | R   |       |
| 30:3          | AI:38429       | kvar export predicted sliding window demand   | 0-Pmax                     | U3                 | UINT32 | R   |       |
|               |                | <b>Total Energies</b>                         |                            |                    |        |     |       |
| 20:5          | BC:38656       | kWh import                                    | 0-1,000,000,000            | 1 kWh              | UINT32 | R   |       |
| 20:5          | BC:38657       | kWh export                                    | 0-1,000,000,000            | 1 kWh              | UINT32 | R   |       |
| 20:5          | BC:38658       | Not used                                      |                            |                    | UINT32 | R   |       |
| 20:5          | BC:38659       | Not used                                      |                            |                    | UINT32 | R   |       |

| Object : Var. | Object : Point | Description                       | Options/Range <sup>3</sup> | Units <sup>3</sup> | Type   | R/W | Notes          |
|---------------|----------------|-----------------------------------|----------------------------|--------------------|--------|-----|----------------|
| 20:5          | BC:38660       | kvarh import                      | 0-1,000,000,000            | 1 kvarh            | UINT32 | R   |                |
| 20:5          | BC:38661       | kvarh export                      | 0-1,000,000,000            | 1 kvarh            | UINT32 | R   |                |
| 20:5          | BC:38662       | Not used                          |                            |                    | UINT32 | R   |                |
| 20:5          | BC:38663       | Not used                          |                            |                    | UINT32 | R   |                |
| 20:5          | BC:38664       | kVAh total                        | 0-1,000,000,000            | 1 kVAh             | UINT32 | R   |                |
|               |                | <b>V1/V12 Harmonic Distortion</b> |                            |                    |        |     | 2              |
| 30:4          | AI:39168       | H01 Harmonic distortion           | 0-100.00                   | 0.01%              | UINT16 | R   |                |
| 30:4          | AI:39169       | H02 Harmonic distortion           | 0-100.00                   | 0.01%              | UINT16 | R   |                |
| 30:4          |                | ...                               |                            |                    |        |     |                |
| 30:4          | AI:39217       | H50 Harmonic distortion           | 0-100.00                   | 0.01%              | UINT16 | R   |                |
|               |                | <b>V2/V23 Harmonic Distortion</b> |                            |                    |        |     | 2              |
| 30:4          | AI:39424       | H01 Harmonic distortion           | 0-100.00                   | 0.01%              | UINT16 | R   |                |
| 30:4          | AI:39425       | H02 Harmonic distortion           | 0-100.00                   | 0.01%              | UINT16 | R   |                |
| 30:4          |                | ...                               |                            |                    |        |     |                |
| 30:4          | AI:39473       | H50 Harmonic distortion           | 0-100.00                   | 0.01%              | UINT16 | R   |                |
|               |                | <b>V3/V31 Harmonic Distortion</b> |                            |                    |        |     | 2              |
| 30:4          | AI:39680       | H01 Harmonic distortion           | 0-100.00                   | 0.01%              | UINT16 | R   |                |
| 30:4          | AI:39681       | H02 Harmonic distortion           | 0-100.00                   | 0.01%              | UINT16 | R   |                |
| 30:4          |                | ...                               |                            |                    |        |     |                |
| 30:4          | AI:39729       | H50 Harmonic distortion           | 0-100.00                   | 0.01%              | UINT16 | R   |                |
|               |                | <b>I1 Harmonic Distortion</b>     |                            |                    |        |     |                |
| 30:4          | AI:39936       | H01 Harmonic distortion           | 0-100.00                   | 0.01%              | UINT16 | R   |                |
| 30:4          | AI:39937       | H02 Harmonic distortion           | 0-100.00                   | 0.01%              | UINT16 | R   |                |
| 30:4          |                | ...                               |                            |                    |        |     |                |
| 30:4          | AI:39985       | H50 Harmonic distortion           | 0-100.00                   | 0.01%              | UINT16 | R   |                |
|               |                | <b>I2 Harmonic Distortion</b>     |                            |                    |        |     |                |
| 30:4          | AI:40192       | H01 Harmonic distortion           | 0-100.00                   | 0.01%              | UINT16 | R   |                |
| 30:4          | AI:40193       | H02 Harmonic distortion           | 0-100.00                   | 0.01%              | UINT16 | R   |                |
| 30:4          |                | ...                               |                            |                    |        |     |                |
| 30:4          | AI:40241       | H50 Harmonic distortion           | 0-100.00                   | 0.01%              | UINT16 | R   |                |
|               |                | <b>I3 Harmonic Distortion</b>     |                            |                    |        |     |                |
| 30:4          | AI:40448       | H01 Harmonic distortion           | 0-100.00                   | 0.01%              | UINT16 | R   |                |
| 30:4          | AI:40449       | H02 Harmonic distortion           | 0-100.00                   | 0.01%              | UINT16 | R   |                |
| 30:4          |                | ...                               |                            |                    |        |     |                |
| 30:4          | AI:40497       | H50 Harmonic distortion           | 0-100.00                   | 0.01%              | UINT16 | R   |                |
|               |                | <b>Fundamental Phase Values</b>   |                            |                    |        |     | 0.2-sec values |
| 30:3          | AI:43264       | V1/V12 Voltage                    | 0-Vmax                     | U1                 | UINT32 | R   | 2              |
| 30:3          | AI:43265       | V2/V23 Voltage                    | 0-Vmax                     | U1                 | UINT32 | R   | 2              |
| 30:3          | AI:43266       | V3/V31 Voltage                    | 0-Vmax                     | U1                 | UINT32 | R   | 2              |
| 30:3          | AI:43267       | I1 Current                        | 0-Imax                     | U2                 | UINT32 | R   |                |
| 30:3          | AI:43268       | I2 Current                        | 0-Imax                     | U2                 | UINT32 | R   |                |

| Object : Var. | Object : Point        | Description                         | Options/Range <sup>3</sup> | Units <sup>3</sup> | Type   | R/W | Notes                      |
|---------------|-----------------------|-------------------------------------|----------------------------|--------------------|--------|-----|----------------------------|
| 30:3          | AI:43269              | I3 Current                          | 0-Imax                     | U2                 | UINT32 | R   |                            |
| 30:3          | AI:43270              | kW L1                               | -Pmax-Pmax                 | U3                 | INT32  | R   |                            |
| 30:3          | AI:43271              | kW L2                               | -Pmax-Pmax                 | U3                 | INT32  | R   |                            |
| 30:3          | AI:43272              | kW L3                               | -Pmax-Pmax                 | U3                 | INT32  | R   |                            |
| 30:3          | AI:43273              | kvar L1                             | -Pmax-Pmax                 | U3                 | INT32  | R   |                            |
| 30:3          | AI:43274              | kvar L2                             | -Pmax-Pmax                 | U3                 | INT32  | R   |                            |
| 30:3          | AI:43275              | kvar L3                             | -Pmax-Pmax                 | U3                 | INT32  | R   |                            |
| 30:3          | AI:43276              | kVA L1                              | 0-Pmax                     | U3                 | UINT32 | R   |                            |
| 30:3          | AI:43277              | kVA L2                              | 0-Pmax                     | U3                 | UINT32 | R   |                            |
| 30:3          | AI:43278              | kVA L3                              | 0-Pmax                     | U3                 | UINT32 | R   |                            |
| 30:4          | AI:43279              | Power factor L1                     | -1000-1000                 | ×0.001             | INT16  | R   |                            |
| 30:4          | AI:43280              | Power factor L2                     | -1000-1000                 | ×0.001             | INT16  | R   |                            |
| 30:4          | AI:43281              | Power factor L3                     | -1000-1000                 | ×0.001             | INT16  | R   |                            |
|               |                       | <b>Fundamental Total Values</b>     |                            |                    |        |     | 0.2-sec values             |
| 30:3          | AI:43520              | Total fundamental kW                | -Pmax-Pmax                 | U3                 | INT32  | R   |                            |
| 30:3          | AI:43521              | Total fundamental kvar              | -Pmax-Pmax                 | U3                 | INT32  | R   |                            |
| 30:3          | AI:43522              | Total fundamental kVA               | 0-Pmax                     | U3                 | UINT32 | R   |                            |
| 30:4          | AI:43523              | Total fundamental PF                | -1000-1000                 | ×0.001             | INT16  | R   |                            |
|               |                       | <b>Minimum 1-Cycle Phase Values</b> |                            |                    |        |     |                            |
| 30:3          | AI:44032              | V1/V12 Voltage                      | 0-Vmax                     | U1                 | UINT32 | R   | <sup>2</sup>               |
| 30:3          | AI:44033              | V2/V23 Voltage                      | 0-Vmax                     | U1                 | UINT32 | R   | <sup>2</sup>               |
| 30:3          | AI:44034              | V3/V31 Voltage                      | 0-Vmax                     | U1                 | UINT32 | R   | <sup>2</sup>               |
| 30:3          | AI:44035              | I1 Current                          | 0-Imax                     | U2                 | UINT32 | R   |                            |
| 30:3          | AI:44036              | I2 Current                          | 0-Imax                     | U2                 | UINT32 | R   |                            |
| 30:3          | AI:44037              | I3 Current                          | 0-Imax                     | U2                 | UINT32 | R   |                            |
| 30:3          | AI:44038-<br>AI:44049 | Not used                            | 0                          |                    | INT32  | R   |                            |
| 30:4          | AI:44050              | V1/V12 Voltage THD                  | 0-9999                     | ×0.1%              | UINT16 | R   | <sup>2</sup> 0.2-sec value |
| 30:4          | AI:44051              | V2/V23 Voltage THD                  | 0-9999                     | ×0.1%              | UINT16 | R   | <sup>2</sup> 0.2-sec value |
| 30:4          | AI:44052              | V3/V31 Voltage THD                  | 0-9999                     | ×0.1%              | UINT16 | R   | <sup>2</sup> 0.2-sec value |
| 30:4          | AI:44053              | I1 Current THD                      | 0-9999                     | ×0.1%              | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:44054              | I2 Current THD                      | 0-9999                     | ×0.1%              | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:44055              | I3 Current THD                      | 0-9999                     | ×0.1%              | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:44056              | I1 K-Factor                         | 10-9999                    | ×0.1               | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:44057              | I2 K-Factor                         | 10-9999                    | ×0.1               | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:44058              | I3 K-Factor                         | 10-9999                    | ×0.1               | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:44059              | I1 Current TDD                      | 0-1000                     | ×0.1%              | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:44060              | I2 Current TDD                      | 0-1000                     | ×0.1%              | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:44061              | I3 Current TDD                      | 0-1000                     | ×0.1%              | UINT16 | R   | 0.2-sec value              |
|               |                       | <b>Minimum 1-Cycle Total Values</b> |                            |                    |        |     |                            |
| 30:3          | AI:44288              | Total kW                            | -Pmax-Pmax                 | U3                 | INT32  | R   |                            |
| 30:3          | AI:44289              | Total kvar                          | -Pmax-Pmax                 | U3                 | INT32  | R   |                            |
| 30:3          | AI:44290              | Total kVA                           | 0-Pmax                     | U3                 | UINT32 | R   |                            |

| Object : Var. | Object : Point        | Description                             | Options/Range <sup>3</sup> | Units <sup>3</sup> | Type   | R/W | Notes                      |
|---------------|-----------------------|---|----------------------------|--------------------|--------|-----|----------------------------|
| 30:4          | AI:44291              | Total PF                                | 0-1000                     | ×0.001             | UINT16 | R   | Absolute value             |
|               |                       | <b>Minimum 1-Cycle Auxiliary Values</b> |                            |                    |        |     |                            |
| 30:3          | AI:44544              | I4 Current                              | 0-I4max                    | U2                 | UINT32 | R   |                            |
| 30:3          | AI:44545              | In Current                              | 0-Imax                     | U2                 | UINT32 | R   |                            |
| 30:4          | AI:44546              | Frequency                               | 0-Fmax                     | ×0.01Hz            | UINT16 | R   |                            |
|               |                       | <b>Maximum 1-Cycle Phase Values</b>     |                            |                    |        |     |                            |
| 30:3          | AI:46080              | V1/V12 Voltage                          | 0-Vmax                     | U1                 | UINT32 | R   | <sup>2</sup>               |
| 30:3          | AI:46081              | V2/V23 Voltage                          | 0-Vmax                     | U1                 | UINT32 | R   | <sup>2</sup>               |
| 30:3          | AI:46082              | V3/V31 Voltage                          | 0-Vmax                     | U1                 | UINT32 | R   | <sup>2</sup>               |
| 30:3          | AI:46083              | I1 Current                              | 0-Imax                     | U2                 | UINT32 | R   |                            |
| 30:3          | AI:46084              | I2 Current                              | 0-Imax                     | U2                 | UINT32 | R   |                            |
| 30:3          | AI:46085              | I3 Current                              | 0-Imax                     | U2                 | UINT32 | R   |                            |
| 30:3          | AI:46086-<br>AI:46097 | Not used                                | 0                          |                    | INT32  | R   |                            |
| 30:4          | AI:46098              | V1/V12 Voltage THD                      | 0-9999                     | ×0.1%              | UINT16 | R   | <sup>2</sup> 0.2-sec value |
| 30:4          | AI:46099              | V2/V23 Voltage THD                      | 0-9999                     | ×0.1%              | UINT16 | R   | <sup>2</sup> 0.2-sec value |
| 30:4          | AI:46100              | V3/V31 Voltage THD                      | 0-9999                     | ×0.1%              | UINT16 | R   | <sup>2</sup> 0.2-sec value |
| 30:4          | AI:46101              | I1 Current THD                          | 0-9999                     | ×0.1%              | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:46102              | I2 Current THD                          | 0-9999                     | ×0.1%              | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:46103              | I3 Current THD                          | 0-9999                     | ×0.1%              | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:46104              | I1 K-Factor                             | 10-9999                    | ×0.1               | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:46105              | I2 K-Factor                             | 10-9999                    | ×0.1               | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:46106              | I3 K-Factor                             | 10-9999                    | ×0.1               | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:46107              | I1 Current TDD                          | 0-1000                     | ×0.1%              | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:46108              | I2 Current TDD                          | 0-1000                     | ×0.1%              | UINT16 | R   | 0.2-sec value              |
| 30:4          | AI:46109              | I3 Current TDD                          | 0-1000                     | ×0.1%              | UINT16 | R   | 0.2-sec value              |
|               |                       | <b>Maximum 1-Cycle Total Values</b>     |                            |                    |        |     |                            |
| 30:3          | AI:46336              | Total kW                                | -Pmax-Pmax                 | U3                 | INT32  | R   |                            |
| 30:3          | AI:46337              | Total kvar                              | -Pmax-Pmax                 | U3                 | INT32  | R   |                            |
| 30:3          | AI:46338              | Total kVA                               | 0-Pmax                     | U3                 | UINT32 | R   |                            |
| 30:4          | AI:46339              | Total PF                                | 0-1000                     | ×0.001             | UINT16 | R   | Absolute value             |
|               |                       | <b>Maximum 1-Cycle Auxiliary Values</b> |                            |                    |        |     |                            |
| 30:3          | AI:46592              | I4 Current                              | 0-I4max                    | U2                 | UINT32 | R   |                            |
| 30:3          | AI:46593              | In Current                              | 0-Imax                     | U2                 | UINT32 | R   |                            |
| 30:4          | AI:46594              | Frequency                               | 0-Fmax                     | ×0.01Hz            | UINT16 | R   |                            |
|               |                       | <b>Maximum Demands</b>                  |                            |                    |        |     |                            |
| 30:3          | AI:46848              | V1/V12 Maximum volt demand              | 0-Vmax                     | U1                 | UINT32 | R   | <sup>2</sup>               |
| 30:3          | AI:46849              | V2/V23 Maximum volt demand              | 0-Vmax                     | U1                 | UINT32 | R   | <sup>2</sup>               |
| 30:3          | AI:46850              | V3/V31 Maximum volt demand              | 0-Vmax                     | U1                 | UINT32 | R   | <sup>2</sup>               |
| 30:3          | AI:46851              | I1 Maximum ampere demand                | 0-Imax                     | U2                 | UINT32 | R   |                            |
| 30:3          | AI:46852              | I2 Maximum ampere demand                | 0-Imax                     | U2                 | UINT32 | R   |                            |
| 30:3          | AI:46853              | I3 Maximum ampere demand                | 0-Imax                     | U2                 | UINT32 | R   |                            |
| 30:3          | AI:46854              | Not used                                |                            |                    | UINT32 | R   |                            |

| Object : Var. | Object : Point | Description                               | Options/Range <sup>3</sup> | Units <sup>3</sup> | Type   | R/W | Notes |
|---------------|----------------|---|----------------------------|--------------------|--------|-----|-------|
| 30:3          | AI:46855       | Not used                                  |                            |                    | UINT32 | R   |       |
| 30:3          | AI:46856       | Not used                                  |                            |                    | UINT32 | R   |       |
| 30:3          | AI:46857       | Maximum kW import sliding window demand   | 0-Pmax                     | U3                 | UINT32 | R   |       |
| 30:3          | AI:46858       | Maximum kvar import sliding window demand | 0-Pmax                     | U3                 | UINT32 | R   |       |
| 30:3          | AI:46859       | Maximum kVA sliding window demand         | 0-Pmax                     | U3                 | UINT32 | R   |       |
| 30:3          | AI:46860       | Not used                                  |                            |                    | UINT32 | R   |       |
| 30:3          | AI:46861       | Not used                                  |                            |                    | UINT32 | R   |       |
| 30:3          | AI:46862       | Not used                                  |                            |                    | UINT32 | R   |       |
| 30:3          | AI:46863       | Maximum kW export sliding window demand   | 0-Pmax                     | U3                 | UINT32 | R   |       |
| 30:3          | AI:46864       | Maximum kvar export sliding window demand | 0-Pmax                     | U3                 | UINT32 | R   |       |

**NOTES:**

- <sup>1</sup> When the 4LN3, 4LL3, 3LN3 or 3LL3 wiring mode is selected, the voltages will be line-to-neutral; for any other wiring mode, they will be line-to-line.
- <sup>2</sup> 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.
- <sup>3</sup> For volts, amps, power and frequency scales and units refer to Section 4 "Data Scales and Units". For analog input scaling formulas and examples, see Section 2.2.5, " Scaling Analog Input Objects".

### 3.6 Factory Device Settings and Identification

| Object:Var.                    | Object:Point  | Description                                   | Options/Range            | Units | Type   | R/W | Notes   |
|--------------------------------|---------------|---|--------------------------|-------|--------|-----|---|
| <b>Device Identification</b>   |               |   |                          |       |        |     |   |
| 30:3                           | AI:256        | Device serial number                          | 0-999999                 |       | UINT32 | R   |   |
| 30:4                           | AI:257        | Device model ID                               | 72000                    |       | UINT16 | R   |   |
| 30:4                           | AI:258-AI:261 | Device model name                             | "EM720"                  |       | UINT32 | R   | Null-terminated string. Each four characters are packed into a 32-bit word.                       |
| 30:3                           | AI:262-AI:265 | Reserved                                      |                          |       | UINT32 | R   |   |
| 30:4                           | AI:266        | Device firmware version number                | 2600-2699                |       | UINT16 | R   | Two higher decimal digits = major version number, two lower decimal digits = minor version number |
| 30:4                           | AI:267        | Device firmware build number                  | 1-99                     |       | UINT16 | R   |   |
| 30:4                           | AI:268        | Transient coprocessor firmware version number | 2700-2799                |       | UINT16 | R   |   |
| 30:4                           | AI:269        | Transient coprocessor firmware build number   | 1-99                     |       | UINT16 | R   |   |
| 30:4                           | AI:270        | Boot loader version number                    |                          |       | UINT16 | R   | Two higher decimal digits = major version number, two lower decimal digits = minor version number |
| 30:4                           | AI:271        | Boot loader build number                      | 1-99                     |       | UINT16 | R   |   |
| 30:3                           | AI:272-AI:274 | Reserved                                      |                          |       | UINT32 | R   |   |
| <b>Factory Device Settings</b> |               |   |                          |       |        |     |   |
| 30:4                           | AI:275        | V1-V4 input range                             | 480, 120 (option U)      | V     | UINT16 | R   |   |
| 30:4                           | AI:276        | V1-V4 input overload                          | 120                      | %     | UINT16 | R   |   |
| 30:3                           | AI:277-AI:278 | Reserved                                      |                          |       | UINT32 | R   |   |
| 30:4                           | AI:279        | I1-I4 input range                             | 1, 5                     | A     | UINT16 | R   |   |
| 30:4                           | AI:280        | I1-I4 input overload                          | 200                      | %     | UINT16 | R   |   |
| 30:4                           | AI:281-AI:288 | Reserved                                      |                          |       | UINT16 | R   |   |
| <b>Port Identification</b>     |               |   |                          |       |        |     |   |
| 30:4                           | AI:320        | Current serial port number                    | 0=COM1, 1=COM2, 2 = COM3 |       | UINT16 | R   |   |

### 3.7 Device Control

| Object : Var.                        | Object : Point       | Description   | Options/Range                    | Units | Type | R/W    | Notes                                 |
|--------------------------------------|----------------------|---|----------------------------------|-------|------|--------|---------------------------------------|
| <b>Device Authorization Register</b> |                      |   |                                  |       |      |        |                                       |
| 40:1(read)<br>41:1(write)            | AO:192               | When write: 8-digit password. When read:<br>0 = access permitted, -1 = authorization<br>required. | 0/-1 (Read)<br>0-99999999(Write) |       |      | R/W    |                                       |
| <b>Device Reset/Clear</b>            |                      |   |                                  |       |      |        |                                       |
| 10:2(read)<br>12:1(write)            | BO:0<br>CROB:0       | Clear total energy registers  | 0/1 = state OFF/ON               |       |      | R<br>W | Returns zero<br>PULSE ON <sup>1</sup> |
| 10:2(read)<br>12:1(write)            | BO:1<br>CROB:1       | Clear total maximum demand registers (all<br>demands)   | 0/1 = state OFF/ON               |       |      | R<br>W | Returns zero<br>PULSE ON <sup>1</sup> |
| 10:2(read)<br>12:1(write)            | BO:2<br>CROB:2       | Clear power demands   | 0/1 = state OFF/ON               |       |      | R<br>W | Returns zero<br>PULSE ON <sup>1</sup> |
| 10:2(read)<br>12:1(write)            | BO:3<br>CROB:3       | Clear volt/ampere/harmonic demands  | 0/1 = state OFF/ON               |       |      | R<br>W | Returns zero<br>PULSE ON <sup>1</sup> |
| 10:2(read)<br>12:1(write)            | BO:4-11<br>CROB:4-11 | Reserved  | 0/1 = state OFF/ON               |       |      | R<br>W | Returns zero<br>PULSE ON <sup>1</sup> |
| 10:2(read)<br>12:1(write)            | BO:12<br>CROB:12     | Clear pulse counters (all counters)   | 0/1 = state OFF/ON               |       |      | R<br>W | Returns zero<br>PULSE ON <sup>1</sup> |
| 10:2(read)<br>12:1(write)            | BO:13<br>CROB:13     | Clear pulse counter#1   | 0/1 = state OFF/ON               |       |      | R<br>W | Returns zero<br>PULSE ON <sup>1</sup> |
| 10:2(read)<br>12:1(write)            | BO:14<br>CROB:14     | Clear pulse counter#2   | 0/1 = state OFF/ON               |       |      | R<br>W | Returns zero<br>PULSE ON <sup>1</sup> |
| 10:2(read)<br>12:1(write)            | BO:15<br>CROB:15     | Clear pulse counter#3   | 0/1 = state OFF/ON               |       |      | R<br>W | Returns zero<br>PULSE ON <sup>1</sup> |
| 10:2(read)<br>12:1(write)            | BO:16<br>CROB:16     | Clear pulse counter#4   | 0/1 = state OFF/ON               |       |      | R<br>W | Returns zero<br>PULSE ON <sup>1</sup> |
| 10:2(read)<br>12:1(write)            | BO:17<br>CROB:17     | Clear pulse counter#5   | 0/1 = state OFF/ON               |       |      | R<br>W | Returns zero<br>PULSE ON <sup>1</sup> |
| 10:2(read)<br>12:1(write)            | BO:18<br>CROB:18     | Clear pulse counter#6   | 0/1 = state OFF/ON               |       |      | R<br>W | Returns zero<br>PULSE ON <sup>1</sup> |
| 10:2(read)<br>12:1(write)            | BO:19<br>CROB:19     | Clear pulse counter#7   | 0/1 = state OFF/ON               |       |      | R<br>W | Returns zero<br>PULSE ON <sup>1</sup> |
| 10:2(read)<br>12:1(write)            | BO:20<br>CROB:20     | Clear pulse counter#8   | 0/1 = state OFF/ON               |       |      | R<br>W | Returns zero<br>PULSE ON <sup>1</sup> |
| 10:2(read)<br>12:1(write)            | BO:21<br>CROB:21     | Clear Min/Max log   | 0/1 = state OFF/ON               |       |      | R<br>W | Returns zero<br>PULSE ON <sup>1</sup> |
| <b>Remote Relay Control</b>          |                      |   |                                  |       |      |        |                                       |
| 10:2(read)<br>12:1(write)            | BO:80<br>CROB:80     | Relay #1 Force operate/Force release/Normal   | 0/1 = state OFF/ON               |       |      | R/W    | 4                                     |
| 10:2(read)<br>12:1(write)            | BO:81<br>CROB:81     | Relay #2 Force operate/Force release /Normal  | 0/1 = state OFF/ON               |       |      | R/W    | 4                                     |
| 10:2(read)                           | BO:82                | Relay #3 Force operate/Force release /Normal  | 0/1 = state OFF/ON               |       |      | R/W    | 4                                     |

| Object : Var.             | Object : Point | Description                                  | Options/Range      | Units | Type | R/W | Notes |
|---------------------------|----------------|--|--------------------|-------|------|-----|-------|
| 12:1(write)               | CROB:82        |  |                    |       |      |     |       |
| 10:2(read)                | BO:83          | Relay #4 Force operate/Force release /Normal | 0/1 = state OFF/ON |       |      | R/W | 4     |
| 12:1(write)               | CROB:83        |  |                    |       |      |     |       |
| <b>Device Diagnostics</b> |                |  |                    |       |      |     |       |
| 10:2(read)                | BO:128         | Reserved                                     | 0/1 = state OFF/ON |       |      | R/W | 2     |
| 12:1(write)               | CROB:128       |  |                    |       |      |     |       |
| 10:2(read)                | BO:129         | Permanent fault                              | 0/1 = state OFF/ON |       |      | R/W | 2     |
| 12:1(write)               | CROB:129       |  |                    |       |      |     |       |
| 10:2(read)                | BO:130         | RAM/Data error                               | 0/1 = state OFF/ON |       |      | R/W | 2     |
| 12:1(write)               | CROB:130       |  |                    |       |      |     |       |
| 10:2(read)                | BO:131         | CPU watchdog reset                           | 0/1 = state OFF/ON |       |      | R/W | 2     |
| 12:1(write)               | CROB:131       |  |                    |       |      |     |       |
| 10:2(read)                | BO:132         | Sampling fault                               | 0/1 = state OFF/ON |       |      | R/W | 2     |
| 12:1(write)               | CROB:132       |  |                    |       |      |     |       |
| 10:2(read)                | BO:133         | CPU exception                                | 0/1 = state OFF/ON |       |      | R/W | 2     |
| 12:1(write)               | CROB:133       |  |                    |       |      |     |       |
| 10:2(read)                | BO:134         | Reserved                                     | 0/1 = state OFF/ON |       |      | R/W | 2     |
| 12:1(write)               | CROB:134       |  |                    |       |      |     |       |
| 10:2(read)                | BO:135         | Software watchdog reset                      | 0/1 = state OFF/ON |       |      | R/W | 2     |
| 12:1(write)               | CROB:135       |  |                    |       |      |     |       |
| 10:2(read)                | BO:136         | Power down                                   | 0/1 = state OFF/ON |       |      | R/W | 2     |
| 12:1(write)               | CROB:136       |  |                    |       |      |     |       |
| 10:2(read)                | BO:137         | Device reset                                 | 0/1 = state OFF/ON |       |      | R/W | 2     |
| 12:1(write)               | CROB:137       |  |                    |       |      |     |       |
| 10:2(read)                | BO:138         | Configuration reset                          | 0/1 = state OFF/ON |       |      | R/W | 2     |
| 12:1(write)               | CROB:138       |  |                    |       |      |     |       |
| 10:2(read)                | BO:139         | RTC fault                                    | 0/1 = state OFF/ON |       |      | R/W | 2     |
| 12:1(write)               | CROB:139       |  |                    |       |      |     |       |
| 10:2(read)                | BO:140         | Configuration fault                          | 0/1 = state OFF/ON |       |      | R/W | 2     |
| 12:1(write)               | CROB:140       |  |                    |       |      |     |       |
| 10:2(read)                | BO:141         | Reserved                                     | 0/1 = state OFF/ON |       |      | R/W | 2     |
| 12:1(write)               | CROB:141       |  |                    |       |      |     |       |
| 10:2(read)                | BO:142         | Expanded/Data FLASH memory fault             | 0/1 = state OFF/ON |       |      | R/W | 2     |
| 12:1(write)               | CROB:142       |  |                    |       |      |     |       |
| 10:2(read)                | BO:143         | CPU EEPROM fault                             | 0/1 = state OFF/ON |       |      | R/W | 2     |
| 12:1(write)               | CROB:143       |  |                    |       |      |     |       |
| 10:2(read)                | BO:144         | Reserved                                     | 0/1 = state OFF/ON |       |      | R/W | 2     |
| 12:1(write)               | CROB:144       |  |                    |       |      |     |       |
| 10:2(read)                | BO:145         | I/O board EEPROM fault                       | 0/1 = state OFF/ON |       |      | R/W | 2     |
| 12:1(write)               | CROB:145       |  |                    |       |      |     |       |
| 10:2(read)                | BO:146         | Transient coprocessor fault                  | 0/1 = state OFF/ON |       |      | R/W | 2     |
| 12:1(write)               | CROB:146       |  |                    |       |      |     |       |
| 10:2(read)                | BO:147         | Reserved                                     | 0/1 = state OFF/ON |       |      | R/W | 2     |
| 12:1(write)               | CROB:147       |  |                    |       |      |     |       |

| Object : Var.             | Object : Point     | Description           | Options/Range      | Units | Type | R/W | Notes        |
|---------------------------|--------------------|-----------------------|--------------------|-------|------|-----|--------------|
| 10:2(read)<br>12:1(write) | BO:148<br>CROB:148 | C Library error       | 0/1 = state OFF/ON |       |      | R/W | <sup>2</sup> |
| 10:2(read)<br>12:1(write) | BO:149<br>CROB:149 | RTOS Kernel error     | 0/1 = state OFF/ON |       |      | R/W | <sup>2</sup> |
| 10:2(read)<br>12:1(write) | BO:150<br>CROB:150 | Task error            | 0/1 = state OFF/ON |       |      | R/W | <sup>2</sup> |
| 10:2(read)<br>12:1(write) | BO:151<br>CROB:151 | Reserved              | 0/1 = state OFF/ON |       |      | R/W | <sup>2</sup> |
| 10:2(read)<br>12:1(write) | BO:152<br>CROB:152 | IRIG-B signal lost    | 0/1 = state OFF/ON |       |      | R/W | <sup>2</sup> |
| 10:2(read)<br>12:1(write) | BO:153<br>CROB:153 | IRIG-B time unlocked  | 0/1 = state OFF/ON |       |      | R/W | <sup>2</sup> |
| 10:2(read)<br>12:1(write) | BO:154<br>CROB:154 | Reserved              | 0/1 = state OFF/ON |       |      | R/W | <sup>2</sup> |
| 10:2(read)<br>12:1(write) | BO:155<br>CROB:155 | Magnetic interference | 0/1 = state OFF/ON |       |      | R/W | <sup>2</sup> |
| 10:2(read)<br>12:1(write) | BO:156<br>CROB:156 | Reserved              | 0/1 = state OFF/ON |       |      | R/W | <sup>2</sup> |
| 10:2(read)<br>12:1(write) | BO:157<br>CROB:157 | Motion/tilt sensor    | 0/1 = state OFF/ON |       |      | R/W | <sup>2</sup> |
| 10:2(read)<br>12:1(write) | BO:158<br>CROB:158 | Circuit fault         | 0/1 = state OFF/ON |       |      | R/W | <sup>2</sup> |
| 10:2(read)<br>12:1(write) | BO:159<br>CROB:159 | Reserved              | 0/1 = state OFF/ON |       |      | R/W | <sup>2</sup> |

**NOTES:**

<sup>1</sup> 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:
  - Pulse On (1) is valid for all points; 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) is 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) is returned if the Control Point was out of control.

<sup>2</sup> The alarm indication points indicate possible problems with the device 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, SBO/Operate or Direct-Operate-No-Acknowledge command using the Control-Relay-Output-Block object (with the code operation Latch-Off) to points 64-75 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.

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; 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) is returned if the command was accepted;
  - Request not Accepted due to Formatting Errors (3) is returned if the Control Code byte was incorrectly formatted or if an invalid Code was present in the command.

<sup>3</sup> These self-check alarms are doubled with the corresponding internal indication bits.

<sup>4</sup> To manually operate a relay, use the Direct-Operate, SBO/Operate or Direct-Operate-No-Acknowledge command to point 80 or 81 of the Control-Relay-Output-Block object with the Control Code value Latch On. To manually release Relay #1, use the Direct-Operate, SBO/Operate or Direct-Operate-No-Acknowledge command to point 80 or 81 of the Control-Relay-Output-Block object with the Control Code value Latch Off.

To operate a relay in pulse mode with the Pulse On or Pulse Off control code, put the relay in pulse mode and select a required pulse polarity via the Relay Outputs setup (use the supplemental PAS software to change the relay properties). The actual pulse width will be taken from the On Time/Off Time fields of the Control-Relay-Output-Block object.

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 (Pulse On/Close) and Latch Off (Pulse On/Trip) are valid for all points; other codes are invalid and will be rejected;
  - Clear sub-field is valid; other 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 10 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 10 ms.
- ♦ The Status byte in the response reflects 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.

### 3.8 Device Setup

| Object:Var.                 | Object:Point | Description                                  | Options/Range                   | Units | Type   | R/W | Notes  |
|-----------------------------|--------------|--|---------------------------------|-------|--------|-----|--|
| <b>Basic Setup</b>          |              |  |                                 |       |        |     |  |
| 40:2 (read)<br>41:2 (write) | AO:0         | Wiring mode                                  | F1                              |       | UINT16 | R/W |  |
| 40:1 (read)<br>41:1 (write) | AO:1         | PT ratio (primary to secondary ratio)        | 10-65000                        | ×0.1  | UINT16 | R/W |  |
| 40:2 (read)<br>41:2 (write) | AO:2         | PT secondary (line-to-line) voltage          | 10-480                          | V     | UINT16 | R/W |  |
| 40:2 (read)<br>41:2 (write) | AO:3-4       | Reserved                                     |                                 |       | UINT16 | R   | Read as 65535  |
| 40:2 (read)<br>41:2 (write) | AO:5         | CT primary current                           | 1-20000                         | A     | UINT16 | R/W |  |
| 40:2 (read)<br>41:2 (write) | AO:6         | Reserved                                     |                                 |       | UINT16 | R   | Read as 65535  |
| 40:2 (read)<br>41:2 (write) | AO:7         | I4 CT primary current                        | 1-20000                         | A     | UINT16 | R/W |  |
| 40:1 (read)                 | AO:8-16      | Reserved                                     |                                 |       | UINT16 | R   | Read as 65535  |
| 40:2 (read)<br>41:2 (write) | AO:17        | Nominal line frequency                       | 50, 60                          | Hz    | UINT16 | R/W |  |
| 40:2 (read)                 | AO:18-23     | Reserved                                     |                                 |       | UINT16 | R   | Read as 65535  |
| 40:2 (read)<br>41:2 (write) | AO:24        | I maximum demand load current                | 0-20000                         | A     | UINT16 | R/W |  |
| 40:2 (read)<br>41:2 (write) | AO:25        | I4 maximum demand load current               | 0-20000                         | A     | UINT16 | R/W |  |
| 40:2 (read)                 | AO:26-31     | Reserved                                     |                                 |       | UINT16 | R   | Read as 65535  |
| <b>Demand Setup</b>         |              |  |                                 |       |        |     |  |
| 40:2 (read)<br>41:2 (write) | AO:32        | Power demand period (block interval)         | 1, 2, 3, 5, 10, 15, 30, 60      | min   | UINT16 | R/W |  |
| 40:2 (read)<br>41:2 (write) | AO:33        | Number of demand periods in a sliding window | 1-15                            |       | UINT16 | R/W |  |
| 40:2 (read)<br>41:2 (write) | AO:34        | Demand synchronization source input          | 0 = device clock, 1-8 = DI1-DI8 |       | UINT16 | R/W | A DI input is considered a pulse or KYZ input. The pulse edge restarts the power demand accumulation interval. |
| 40:2 (read)                 | AO:35-39     | Reserved                                     |                                 |       | UINT16 | R/W | Read as 65535  |
| 40:2 (read)<br>41:2 (write) | AO:40        | Volt demand period                           | 0-9000                          | sec   | UINT16 | R/W |  |
| 40:2 (read)<br>41:2 (write) | AO:41        | Ampere demand period                         | 0-9000                          | sec   | UINT16 | R/W |  |
| 40:2 (read)<br>41:2 (write) | AO:42        | Harmonic demand period                       | 0-9000                          | sec   | UINT16 | R/W |  |
| 40:2 (read)                 | AO:43-47     | Reserved                                     |                                 |       | UINT16 | R/W | Read as 65535  |

| Object:Var.                      | Object:Point | Description  | Options/Range  | Units   | Type   | R/W | Notes                             |
|----------------------------------|--------------|--|--|---------|--------|-----|-----------------------------------|
| <b>Device Options Setup</b>      |              |  |  |         |        |     |                                   |
| 40:2 (read)<br>41:2 (write)      | AO:48        | Power calculation mode   | 0 = using reactive power:<br>$S = f(P,Q)$ ,<br>1 = using non-active power:<br>$Q=f(S,P)$                             |         | UINT16 | R/W |                                   |
| 40:2 (read)<br>41:2 (write)      | AO:49        | Energy roll value  | 2 = 100,000.0 kWh<br>3 = 1,000,000.0 kWh<br>4 = 10,000,000.0 kWh<br>5 = 100,000,000.0 kWh (default)                  |         | UINT16 | R/W |                                   |
| 40:2 (read)<br>41:2 (write)      | AO:50        | Reserved   |  |         | UINT16 | R/W | Read as 65535                     |
| 40:2 (read)<br>41:2 (write)      | AO:51        | End of billing (TOU/Billing maximum demand reset) mode, bitmap       | Bit 0 = 1 – automatic/monthly mode allowed<br>Bit 1 = 1 - COM mode allowed<br>Bit 2 = 1 - manual mode allowed        |         | UINT16 | R/W |                                   |
| 40:2 (read)                      | AO:52-55     | Reserved   |  |         | UINT16 | R/W | Read as 65535                     |
| 40:2 (read)<br>41:2 (write)      | AO:56        | Energy LED test mode   | 0 = disabled, 1 = enabled  |         | UINT16 | R/W |                                   |
| 40:2 (read)<br>41:2 (write)      | AO:57        | Energy LED pulse rate, Wh/impulse, varh/impulse (in secondary units) | 1 - 40   | ×0.01Wh | UINT16 | R/W |                                   |
| 40:2 (read)                      | AO:50-55     | Reserved   |  |         | UINT16 | R/W | Read as 65535                     |
| <b>Communication Ports Setup</b> |              |  |  |         |        |     |                                   |
| <b>COM1 Setup</b>                |              |  |  |         |        |     |                                   |
| 40:2 (read)<br>41:2 (write)      | AO:112       | Communication protocol   | 0 = Modbus RTU, 1 = Modbus ASCII, 2 = DNP3.0, 6 = IEC 62056-21, 7 = IEC 61850  |         | UINT16 | R/W |                                   |
| 40:2 (read)<br>41:2 (write)      | AO:113       | Interface  | 0 = RS-232, 1 = RS-422, 2 = RS-485, 3 = Infrared, 8 = GSM/GPRS   |         | UINT16 | R/W |                                   |
| 40:2 (read)<br>41:2 (write)      | AO:114       | Device address   | Modbus: 1-247<br>DNP3.0: 0-65532   |         | UINT16 | R/W |                                   |
| 40:2 (read)<br>41:2 (write)      | AO:115       | Baud rate  | 3 = 1200 bps, 4 = 2400 bps, 5 = 4800 bps, 6 = 9600 bps, 7 = 19200 bps, 8 = 38400 bps, 9 = 57600 bps, 10 = 115200 bps |         | UINT16 | R/W |                                   |
| 40:2 (read)<br>41:2 (write)      | AO:116       | Data format  | 0 = 7 bits/even parity,<br>1 = 8 bits/no parity,<br>2 = 8 bits/even parity   |         | UINT16 | R/W |                                   |
| 40:2 (read)<br>41:2 (write)      | AO:117       | CTS mode   | 0 = not used, 1 = wait for CTS before sending data   |         | UINT16 | R/W | N/A for COM1-COM3 (read as 65535) |
| 40:2 (read)<br>41:2 (write)      | AO:118       | RTS mode   | 0 = not used,<br>1 = RTS is asserted during the transmission   |         | UINT16 | R/W | N/A for COM1-COM3 (read as 65535) |
| 40:2 (read)                      | AO:119       | Minimum delay before sending data                                    | 0-1000 (default = 5)   | ms      | UINT16 | R/W |                                   |

| Object:Var.                 | Object:Point | Description                                    | Options/Range                          | Units | Type   | R/W | Notes         |
|-----------------------------|--------------|--|--|-------|--------|-----|---------------|
| 41:2 (write)                |              |  |  |       |        |     |               |
| 40:2 (read)<br>41:2 (write) | AO:120       | Inter-character time-out                       | 0-1000 (default = four-character time) | ms    | UINT16 | R/W |               |
| 40:2 (read)<br>41:2 (write) | AO:121       | Port direction                                 | 0 = slave (default), 1 = master        |       | UINT16 | R/W |               |
| 40:2 (read)<br>41:2 (write) | AO:122       | Receive timeout (for a master port only)       | 500-30000                              | ms    | UINT16 | R/W |               |
| 40:2 (read)<br>41:2 (write) | AO:123-127   | Reserved                                       |  |       | UINT16 | R   | Read as 65535 |
|                             |              | <b>COM2 Setup</b>                              |  |       |        |     |               |
|                             | AO:128-143   | Point descriptions and ranges as for port COM1 |  |       |        | R/W |               |
|                             |              | <b>COM3 Setup</b>                              |  |       |        |     |               |
|                             | AO:144-159   | Point descriptions and ranges as for port COM1 |  |       |        | R/W |               |

### 3.9 DNP Protocol Setup

| Object:Var.                 | Object:Point | Description   | Options/Range  | Units         | Type   | R/W | Notes |
|-----------------------------|--------------|---|--|---------------|--------|-----|-------|
| <b>DNP Options Setup</b>    |              |   |  |               |        |     |       |
| 40:2 (read)<br>41:2 (write) | AO:64        | Default Binary Input Static object variation                | F3 (default=0)   |               | UINT16 | R/W | 1     |
| 40:2 (read)<br>41:2 (write) | AO:65        | Default Binary Input Change object variation                | F3 (default=1)   |               | UINT16 | R/W | 1     |
| 40:2 (read)<br>41:2 (write) | AO:66        | Default Binary Counter object variation                     | F3 (default=3)   |               | UINT16 | R/W | 1     |
| 40:2 (read)<br>41:2 (write) | AO:67        | Default Frozen Binary Counter object variation              | F3 (default=4)   |               | UINT16 | R/W | 1     |
| 40:2 (read)                 | AO:68        | Reserved  | Read as 65535  |               | UINT32 | R   |       |
| 40:2 (read)<br>41:2 (write) | AO:69        | Default Binary Counter Change Event object variation        | F3 (default=2)   |               | UINT16 | R/W | 1     |
| 40:2 (read)<br>41:2 (write) | AO:70        | Default Analog Input object variation                       | F3 (default=3)   |               | UINT16 | R/W | 1     |
| 40:2 (read)                 | AO:71        | Reserved  | Read as 65535  |               | UINT32 | R/W |       |
| 40:2 (read)                 | AO:72        | Reserved  | Read as 65535  |               | UINT32 | R/W |       |
| 40:2 (read)<br>41:2 (write) | AO:73        | Default Analog Input Change Event object variation          | F3 (default=2)   |               | UINT16 | R/W | 1     |
| 40:2 (read)<br>41:2 (write) | AO:74        | Re-mapping static point indices for event objects           | 0=disabled (default), 1=enabled  |               | UINT16 | R/W |       |
| 40:1 (read)<br>41:2 (write) | AO:75        | 16-bit BC scaling   | 0= $\times 1$ (default), 1= $\times 10$ , 2= $\times 100$ , 3= $\times 1000$ |               | UINT16 | R/W | 6     |
| 40:1 (read)<br>41:2 (write) | AO:76        | 16-bit AI scaling   | 0=disabled, 1=enabled (default)  |               | UINT16 | R/W | 3     |
| 40:2 (read)<br>41:2 (write) | AO:77        | Number of points allocated for Analog Input change events   | 0 to 64 (default=32)   |               | UINT16 | R/W | 2     |
| 40:2 (read)<br>41:2 (write) | AO:78        | Number of points allocated for Binary Input change events   | 0 to 64 (default=0)  |               | UINT16 | R/W | 2     |
| 40:2 (read)<br>41:2 (write) | AO:79        | Number of points allocated for Binary Counter change events | 0 to 64 (default=0)  |               | UINT16 | R/W | 2     |
| 40:2 (read)<br>41:2 (write) | AO:80        | Select/Operate Timeout                                      | 2 to 30 (default=10 sec)   | sec           | UINT16 | R/W | 4     |
| 40:2 (read)<br>41:2 (write) | AO:81        | Multi Fragment Interval                                     | 50 to 500 (default=50 ms)  | ms            | UINT16 | R/W |       |
| 40:1 (read)                 | AO:82-AO:84  | Reserved  | Read as 65535  |               | UINT32 | R   |       |
| 40:2 (read)<br>41:2 (write) | AO:85        | Time Sync Period  | 1 to 86400 (default=86400 sec)<br>0 = disable time requests                  | sec           | UINT32 | R/W | 5     |
| 40:2 (read)<br>41:2 (write) | AO:86        | Voltage scale, volts secondary                              | 60 to 828V (default=144V)  | V             | UINT16 | R/W |       |
| 40:2 (read)<br>41:2 (write) | AO:87        | Current scale, amps secondary                               | 100  | $\times 0.1A$ | UINT16 | R/W |       |

| Object:Var.                          | Object:Point    | Description                       | Options/Range  | Units | Type   | R/W | Notes   |
|--------------------------------------|-----------------|-----------------------------------|--|-------|--------|-----|---|
| <b>DNP Events Setup</b>              |                 |                                   |  |       |        |     |   |
| 40:1(read)<br>41:1(write)            |                 | Threshold/Deadband                |  |       | UINT32 | R/W | A hysteresis for the point return threshold is 0.05Hz for frequency and 2% of the operating threshold for other points      |
| 40:1(read)<br>41:1(write)            |                 | DNP point number                  | DNP point number available for the selected object   |       | UINT32 | R/W |   |
| 40:2(read)<br>41:2(write)            |                 | Event scan control field (bitmap) | Bits 0-1 - DNP Object:<br>0=none, 1=AI, 2=BI, 3=BC<br>Bit 2 - Object change event scan:<br>0= event disabled, 1=enabled<br>Bits 5-6 - DNP event poll class:<br>0=Class 1, 1=Class 2, 2=Class 3<br>Bit 7 - Event log on an event:<br>0=disabled, 1=enabled<br>Bits 8-9 - Threshold/Deadband relation:<br>0=Delta, 1=more than (over threshold), 2=less than (under threshold) |       | UINT16 | R/W | If Event log is enabled, the source of a DNP event will be recorded to the device Event log file as a general Setpoint #17. |
|                                      | AO:896-AO:898   | <b>DNP Event #1</b>               |  |       |        |     |   |
|                                      | AO:899-AO:901   | <b>DNP Event #2</b>               |  |       |        |     |   |
|                                      |                 | ...                               |  |       |        |     |   |
|                                      | AO:1085-AO:1087 | <b>DNP Event #64</b>              |  |       |        |     |   |
| <b>DNP Class 0 Point Assignments</b> |                 |                                   |  |       |        |     |   |
| 40:1(read)<br>41:1(write)            |                 | DNP object and variation          | F4   |       | UINT32 | R/W |   |
| 40:1(read)<br>41:1(write)            |                 | Start point number                | Start point number for the selected object   |       | UINT32 | R/W |   |
| 40:2(read)<br>41:2(write)            |                 | Number of points in a range       | 0-128  |       | UINT16 | R/W |   |
|                                      | AO:1152-AO:1154 | <b>DNP Class 0 Point Range 1</b>  |  |       |        |     |   |
|                                      | AO:1155-AO:1157 | <b>DNP Class 0 Point Range 2</b>  |  |       |        |     |   |
|                                      |                 | ...                               |  |       |        |     |   |
|                                      | AO:1245-AO:1247 | <b>DNP Class 0 Point Range 32</b> |  |       |        |     |   |

**NOTES:**

- 1 The default variation indicates the variation that is used for requests with qualifier code 06 (variation 0) when no specific variation is requested by a master station.
- 2 The sum of all points allocated for change event objects should not exceed 64. If no points are allocated for change events, the report-by-exception mode is not supported.
- 3 Scaling 16-bit AI objects (see Section 2.2.5) lets accommodate 32-bit analog input readings to 16-bit object format. Scaling is enabled by default. It is not applied to 32-bit AI objects (object 30, variations 1 and 3).
- 4 The Select Before Operate command causes the device to start a timer. The following Operate command must be sent before the value specified by the Select/Operate Timeout expires.

- <sup>5</sup> The device requests time synchronization by bit 4 in the first octet of the internal indication word being set when the time specified by the Time Sync Period elapses. The master should synchronize the time in the device by writing the Time and Date object. The meter does not request time synchronization if the Time Sync Period is set to 0.
- <sup>6</sup> Scaling 16-bit Binary Counters (see Section 2.2.6) allows changing a counter unit in powers of 10 to accommodate a 32-bit counter value to 16-bit BC object format.

## 4 Data Scales and Units

| Code                                   | Condition    | Value   | Range                      | Notes |
|--|--------------|---|----------------------------|-------|
| <b>Data Scales</b>                     |              |   |                            |       |
| Vmax                                   |              | Voltage scale × PT Ratio, V   |                            | 2     |
| I <sub>max</sub>                       |              | Current Scale × CT Ratio <sup>1</sup> , A                                       |                            | 3     |
| I <sub>4max</sub>                      |              | Current Scale × I <sub>4</sub> CT Ratio <sup>1</sup> , A                        |                            | 3     |
| Pmax                                   |              | Vmax × I <sub>max</sub> × 2, W  |                            | 4     |
| Fmax                                   |              | 100 Hz  |                            |       |
| Al <sub>min</sub><br>Al <sub>max</sub> | +/-1mA       | Al <sub>min</sub> = -AI full scale × 2<br>Al <sub>max</sub> = AI full scale × 2 |                            |       |
|  | 0-20mA       | Al <sub>min</sub> = AI zero scale<br>Al <sub>max</sub> = AI full scale          |                            |       |
|  | 4-20mA       | Al <sub>min</sub> = AI zero scale<br>Al <sub>max</sub> = AI full scale          |                            |       |
|  | 0-1mA        | Al <sub>min</sub> = AI zero scale<br>Al <sub>max</sub> = AI full scale          |                            |       |
| <b>Data Units</b>                      |              |   |                            |       |
| U1                                     | PT Ratio = 1 | 0.1 V   |                            |       |
|  | PT Ratio > 1 | 1 V   |                            |       |
| U2                                     |              | 0.01 A  | 0 to 2×CT primary current  |       |
| U3                                     | PT Ratio = 1 | 1 W/Var/VA  |                            |       |
|  | PT Ratio > 1 | 1 kW/kvar/kVA   |                            |       |
| U4                                     |              | 0.01 A  | 0 to 10×CT primary current |       |

<sup>1</sup> CT Ratio = CT primary current/CT secondary current

<sup>2</sup> The default Voltage scale is 144V (120V +20%). You can change it via the Device Data Scale setup (see Section 3.1) or via the Device Options setup in PAS.

<sup>3</sup> The default Current scale is 2 × CT secondary current (2 × 1A or 2 × 5A depending on the order).

<sup>4</sup> Pmax is rounded to whole kilowatts. With PT=1.0, if Pmax is greater than 9,999,000 W, it is truncated to 9,999,000 W.

## 5 Data Formats

| Format Code                  | Value                                    | Description   | Notes |
|------------------------------|--|---|-------|
| <b>Wiring Mode</b>           |  |   |       |
| F1                           | 0  | 3OP2 - 3-wire open delta using 2 CTs (2 element)                                |       |
|                              | 1  | 4LN3 - 4-wire WYE using 3 PTs (3 element), line-to-neutral voltage readings     |       |
|                              | 2  | 3DIR2 - 3-wire direct connection using 2 CTs (2 element)                        |       |
|                              | 3  | 4LL3 - 4-wire WYE using 3 PTs (3 element), line-to-line voltage readings        |       |
|                              | 4  | 3OP3 - 3-wire open delta using 3 CTs (2 1/2 element)                            |       |
|                              | 5  | 3LN3 - 4-wire WYE using 2 PTs (2 1/2 element), line-to-neutral voltage readings |       |
|                              | 6  | 3LL3 - 4-wire WYE using 2 PTs (2 1/2 element), line-to-line voltage readings    |       |
| <b>DNP Object Variations</b> |  |   |       |
| F3                           | <b>Static Binary Input Objects</b>       |   |       |
|                              | 0  | Single-Bit Binary Input   |       |
|                              | 1  | Binary Input With Status  |       |
|                              | <b>Binary Input Change Event Objects</b> |   |       |
|                              | 0  | Binary Input Change Without Time  |       |
|                              | 1  | Binary Input Change With Time   |       |
|                              | <b>Static Binary Counters</b>            |   |       |
|                              | 0  | 32-bit Binary Counter   |       |
|                              | 1  | 32-bit Binary Counter Without Flag  |       |
|                              | 2  | 16-bit Binary Counter   |       |
|                              | 3  | 16-bit Binary Counter Without Flag  |       |
|                              | <b>Binary Counter Change Events</b>      |   |       |
|                              | 0  | 32-bit Counter Change Event Without Time  |       |
|                              | 1  | 32-bit Counter Change Event With Time   |       |
|                              | 2  | 16-bit Counter Change Event Without Time  |       |
|                              | 3  | 16-bit Counter Change Event With Time   |       |
|                              | <b>Frozen Binary Counters</b>            |   |       |
|                              | 0  | 32-bit Frozen Counter   |       |
|                              | 1  | 32-bit Frozen Counter Without Flag  |       |
|                              | 2  | 32-bit Frozen Counter With Time of Freeze                                       |       |
|                              | 3  | 16-bit Frozen Counter   |       |
|                              | 4  | 16-bit Frozen Counter Without Flag  |       |
|                              | 5  | 16-bit Frozen Counter With Time of Freeze                                       |       |
|                              | <b>Static Analog Input Objects</b>       |   |       |
|                              | 0  | 32-bit Analog Input   |       |
|                              | 1  | 32-bit Analog Input Without Flag  |       |
|                              | 2  | 16-bit Analog Input   |       |
|                              | 3  | 16-bit Analog Input Without Flag  |       |
|                              | <b>Analog Input Change Events</b>        |   |       |
|                              | 0  | 32-bit Analog Change Event Without Time   |       |
|                              | 1  | 32-bit Analog Change Event With Time  |       |
|                              | 2  | 16-bit Analog Change Event Without Time   |       |
| 3                            | 16-bit Analog Change Event With Time     |   |       |
| <b>DNP Class 0 Objects</b>   |  |   |       |
| F4                           | 0x1E01                                   | Analog Input 30:01  |       |
|                              | 0x1E02                                   | Analog Input 30:02  |       |
|                              | 0x1E03                                   | Analog Input 30:03  |       |
|                              | 0x1E04                                   | Analog Input 30:04  |       |
|                              | 0x2801                                   | Analog Output 40:01   |       |
|                              | 0x2802                                   | Analog Output 40:02   |       |
|                              | 0x0101                                   | Binary Input 01:01  |       |
|                              | 0x0102                                   | Binary Input 01:02  |       |
|                              | 0x1401                                   | Binary Counter 20:01  |       |
|                              | 0x0A01                                   | Binary Output 10:01   |       |
|                              | 0x0A01                                   | Binary Output Status 10:02  |       |
|                              | 0x1402                                   | Binary Counter 20:02  |       |
|                              | 0x1405                                   | Binary Counter 20:05  |       |
|                              | 0x1406                                   | Binary Counter 20:06  |       |
|                              | 0x1501                                   | Frozen Counter 21:01  |       |
|                              | 0x1502                                   | Frozen Counter 21:02  |       |

| <b>Format Code</b> | <b>Value</b> | <b>Description</b>   | <b>Notes</b> |
|--------------------|--------------|----------------------|--------------|
|                    | 0x1505       | Frozen Counter 21:05 |              |
|                    | 0x1506       | Frozen Counter 21:06 |              |
|                    | 0x1509       | Frozen Counter 21:09 |              |
|                    | 0x150A       | Frozen Counter 21:10 |              |

# APPENDIX A DNP Application Messages

The device is a DNP IED responding to external DNP Master requests. Table A-1 describes the EM720 application level responses to external requests, including object variations, functions, codes and qualifiers supported by the device. The object and formats are detailed in the DNP Basic 4 Documentation Set.

**Table A-1 Application Responses**

| Object |           | Description                               | Request            |                | Response          |                  |
|--------|-----------|---|--------------------|----------------|-------------------|------------------|
| Object | Variation |   | 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     | 1         | Binary Output                             | 1                  | A              | 129               | C                |
| 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,<br>7,9,<br>8,10 | B<br>B<br>B    | 129<br>129<br>129 | 01<br>N/R<br>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 <sup>1</sup>                | 1,2                | A              | 129               | C                |
| 60     | 1         | Class 0                                   | 1                  | B              | 129               | 01               |
| 60     | 2         | Class 1                                   | 1                  | 06,07,08       | 129               | 17               |
| 60     | 3         | Class 2                                   | 1                  | 06,07,08       | 129               | 17               |
| 60     | 4         | Class 3                                   | 1                  | 06,07,08       | 129               | 17               |
| 80     | 1         | Internal indication <sup>2</sup>          | 2                  | D              | 129               |                  |

| Object |           |   | Request       |                | Response      |                |
|--------|-----------|---|---------------|----------------|---------------|----------------|
| Object | Variation | Description                                   | Function Code | Qualifier Code | Function Code | Qualifier Code |
| N/A    | N/A       | Cold Restart <sup>3</sup> (respond Obj. 52:2) | 13            | N/A            | 129           | 07             |
| N/A    | N/A       | Delay Measurement (respond Obj. 52:2)         | 23            | N/A            | 129           | 07             |

<sup>1</sup> For this object, the quantity specified in the request must be exactly 1 or an index of 0, as there is only one instance of this object defined in the device.

<sup>2</sup> For this object, the qualifier code must specify an index 7 only.

<sup>3</sup> Respond with time object 50 variation 2 indicating time until device 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

|   |  |
|---|--|
| <b>DNP3</b><br><b>DEVICE PROFILE DOCUMENT</b><br>This document must be accompanied by a table having the following headings:<br>Object Group                      Request Function Codes              Response Function Codes<br>Object Variation                      Request Qualifiers                      Response Qualifiers<br>Object Name (optional)  |  |
| Vendor Name: SATEC Ltd.   |  |
| Device Name: Powermeter Series EM720  |  |
| Highest DNP Level Supported:<br>For Requests    L2<br>For Responses    L2   | Device Function:<br><input type="checkbox"/> Master <input checked="" type="checkbox"/> Slave  |
| Device 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):<br>Transmitted    292<br>Received        292   | Maximum Application Fragment Size (octets):<br>Transmitted    2048<br>Received        249  |
| Maximum Data Link Retries:<br><input checked="" type="checkbox"/> None<br><input type="checkbox"/> Fixed at _____<br><input type="checkbox"/> Configurable, range ____ to _____   | Maximum Application Layer Retries:<br><input checked="" type="checkbox"/> None<br><input type="checkbox"/> Configurable, range ____ to _____<br>(Fixed is not permitted) |
| Requires Data Link Layer Confirmation:<br><input checked="" type="checkbox"/> Never<br><input type="checkbox"/> Always<br><input type="checkbox"/> Sometimes    If 'Sometimes', when? _____<br><input type="checkbox"/> Configurable    If 'Configurable', how? _____   |  |
| Requires Application Layer Confirmation:<br><input type="checkbox"/> Never<br><input type="checkbox"/> Always (not recommended)<br><input checked="" type="checkbox"/> When reporting Event Data (Slave devices only)<br><input type="checkbox"/> When sending multi-fragment responses (Slave devices only)<br><input type="checkbox"/> Sometimes    If 'Sometimes', when? _____<br><input type="checkbox"/> Configurable    If 'Configurable', how? _____ |  |

Device Profile Document (continued)

|  |   |
|--|---|
| <p>Timeouts while waiting for:</p> <p>Data Link Confirm    <input checked="" type="checkbox"/> None   <input type="checkbox"/> Fixed at _____   <input type="checkbox"/> Variable   <input type="checkbox"/> Configurable</p> <p>Complete Appl. Fragment    <input checked="" type="checkbox"/> None   <input type="checkbox"/> Fixed at _____   <input type="checkbox"/> Variable   <input type="checkbox"/> Configurable</p> <p>Application Confirm   <input type="checkbox"/> None   <input checked="" type="checkbox"/> Fixed at <u>5 sec</u>   <input type="checkbox"/> Variable   <input type="checkbox"/> Configurable</p> <p>Complete Appl. Response    <input checked="" type="checkbox"/> None   <input type="checkbox"/> Fixed at _____   <input type="checkbox"/> Variable   <input type="checkbox"/> Configurable</p> <p>Others</p> <p>Timeouts between fragments of the multi-fragment responses. Configurable:<br/>50-500 ms (50 ms by default).</p> <hr/> <p>Attach explanation if 'Variable' or 'Configurable' was checked for any timeout</p>  |   |
| <p>Sends/Executes Control Operations:</p> <p>WRITE Binary Outputs   <input checked="" type="checkbox"/> Never   <input type="checkbox"/> Always   <input type="checkbox"/> Sometimes   <input type="checkbox"/> Configurable</p> <p>SELECT/OPERATE    <input type="checkbox"/> Never   <input checked="" type="checkbox"/> Always   <input type="checkbox"/> Sometimes   <input type="checkbox"/> Configurable</p> <p>DIRECT OPERATE    <input type="checkbox"/> Never   <input checked="" type="checkbox"/> Always   <input type="checkbox"/> Sometimes   <input type="checkbox"/> Configurable</p> <p>DIRECT OPERATE -</p> <p>NO ACK                <input type="checkbox"/> Never   <input checked="" type="checkbox"/> Always   <input type="checkbox"/> Sometimes   <input type="checkbox"/> Configurable</p> <p>Count &gt; 1            <input checked="" type="checkbox"/> Never   <input type="checkbox"/> Always   <input type="checkbox"/> Sometimes   <input type="checkbox"/> Configurable</p> <p>Pulse On              <input type="checkbox"/> Never   <input type="checkbox"/> Always   <input checked="" type="checkbox"/> Sometimes<sup>1,4</sup>   <input type="checkbox"/> Configurable</p> <p>Pulse Off             <input checked="" type="checkbox"/> Never   <input type="checkbox"/> Always   <input type="checkbox"/> Sometimes<sup>4</sup>   <input type="checkbox"/> Configurable</p> <p>Latch On              <input type="checkbox"/> Never   <input type="checkbox"/> Always   <input checked="" type="checkbox"/> Sometimes<sup>2</sup>   <input type="checkbox"/> Configurable</p> <p>Latch Off             <input type="checkbox"/> Never   <input type="checkbox"/> Always   <input checked="" type="checkbox"/> Sometimes<sup>3</sup>   <input type="checkbox"/> Configurable</p> <p>Queue                 <input checked="" type="checkbox"/> Never   <input type="checkbox"/> Always   <input type="checkbox"/> Sometimes   <input type="checkbox"/> Configurable</p> <p>Clear Queue         <input type="checkbox"/> Never   <input type="checkbox"/> Always   <input checked="" type="checkbox"/> Sometimes<sup>4</sup>   <input type="checkbox"/> Configurable</p> <p>◆ <b>Select timeout period is configurable: 2s to 30s</b></p> <p>1    used to activate the <i>Reset</i> function associated with points 0 to 21</p> <p>2, 3, 4 used to control Relays associated with points 80 to 81</p> <p>3    used to reset the self-check alarm registers associated with points 64 to 75</p> |   |
| <p>Reports Binary Input Change Events when no specific variation requested:</p> <p><input type="checkbox"/> Never</p> <p><input type="checkbox"/> Only time-tagged</p> <p><input type="checkbox"/> Only non-time-tagged</p> <p><input checked="" type="checkbox"/> Configurable to send both, one or the other (attach explanation)</p> <p>Configurable to send one or the other.</p>  | <p>Reports time-tagged Binary Input Change Events when no specific variation requested:</p> <p><input type="checkbox"/> Never</p> <p><input checked="" type="checkbox"/> Binary Input Change With Time</p> <p><input type="checkbox"/> Binary Input Change With Relative Time</p> <p><input type="checkbox"/> Configurable (attach explanation)</p> |

Device Profile Document (continued)

|  |   |
|--|---|
| <p>Sends Unsolicited Responses:</p> <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Never</li> <li><input type="checkbox"/> Configurable (attach explanation)</li> <li><input type="checkbox"/> Only certain objects</li> <li><input type="checkbox"/> Sometimes (attach explanation)</li> <li><input type="checkbox"/> ENABLE/DISABLE UNSOLICITED</li> </ul> <p>Function codes supported</p> | <p>Sends Static Data in Unsolicited Responses:</p> <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Never</li> <li><input type="checkbox"/> When Device Restarts</li> <li><input type="checkbox"/> When Status Flags Change</li> </ul> <p>No other options are permitted.</p>   |
| <p>Default Counter Object/Variation:</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> No Counters Reported</li> <li><input type="checkbox"/> Configurable (attach explanation)</li> <li><input checked="" type="checkbox"/> Default Object      20</li> <li>    Default Variation    5</li> <li><input type="checkbox"/> Point-by-point list attached</li> </ul>                                      | <p>Counters Roll Over at:</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> No Counters Reported</li> <li><input type="checkbox"/> Configurable (attach explanation)</li> <li><input type="checkbox"/> 16 Bits</li> <li><input type="checkbox"/> 32 Bits</li> <li><input checked="" type="checkbox"/> Other Value Counters <ul style="list-style-type: none"> <li>-999999999 to 999999999 (point 2)</li> <li>0 to 99999999 (points 0,1,3)</li> </ul> </li> <li><input type="checkbox"/> Point-by-point list attached</li> </ul> |
| <p>Sends Multi-Fragment Responses:    <input type="checkbox"/> Yes    <input checked="" type="checkbox"/> No</p>   |   |