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COMMUNICATIONS GUIDE

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1 Modbus Overview

1.1 Modbus Protocol

The GE Multilin PQMII implements a subset of the AEG Modicon Modbus RTU serial communication standard. Many popular programmable controllers support this protocol directly with a suitable interface card allowing direct connection of the PQMII. Although the Modbus protocol is hardware independent, the PQMII interface uses 2-wire RS485 and 9-pin RS232 interfaces. Modbus is a single-master multiple-slave protocol suitable for a multi-drop configuration provided by RS485 hardware. In this configuration, up to 32 slaves can be daisy-chained together on a single communication channel.

The PQMII is always a Modbus slave; it cannot be programmed as a Modbus master. Computers or PLCs are commonly programmed as masters. The Modbus protocol exists in two versions: Remote Terminal Unit (RTU, binary) and ASCII. Only the RTU version is supported by the PQMII. Monitoring, programming and control functions are possible using read and write register commands.

1.2 Electrical Interface

The electrical interface is 2-wire RS485 and 9-pin RS232. In a 2-wire RS485 link, data flow is bi-directional and half duplex. That is, data is never transmitted and received at the same time. RS485 lines should be connected in a daisy-chain configuration (avoid star connections) with a terminating network installed at each end of the link, i.e. at the master end and the slave farthest from the master. The terminating network should consist of a 120 Ω resistor in series with a 1 nF ceramic capacitor when used with Belden 9841 RS485 wire. The value of the terminating resistors should be equal to the characteristic impedance of the line. This is approximately 120 Ω for standard #22 AWG twisted-pair wire. Shielded wire should always be used to minimize noise. Polarity is important in RS485
communications: each ‘+’ terminal of every device must be connected together for the system to operate. See PQMII Instruction Manual section 2.2.11: RS485 Serial Ports for details on serial port wiring.

1.3 Data Frame Format and Data Rate

One data frame of an asynchronous transmission to or from a PQMII consists of 1 start bit, 8 data bits, and 1 stop bit, resulting in a 10-bit data frame. This is important for high-speed modem transmission, since 11-bit data frames are not supported by Hayes modems at bit rates greater than 300 bps. The Modbus protocol can be implemented at any standard communication speed. The PQMII supports operation at 1200, 2400, 4800, 9600, and 19200 baud.

1.4 Data Packet Format

A complete request/response sequence consists of the following bytes (transmitted as separate data frames):

**Master Request Transmission:**
- SLAVE ADDRESS: 1 byte
- FUNCTION CODE: 1 byte
- DATA: variable number of bytes depending on the Function Code
- CRC: 2 bytes

**Slave Response Transmission:**
- SLAVE ADDRESS: 1 byte
- FUNCTION CODE: 1 byte
- DATA: variable number of bytes depending on FUNCTION CODE
- CRC: 2 bytes

The **Slave Address** is the first byte of every transmission. It represents the user-assigned address of the slave device assigned to receive the message sent by the master. Each slave device must be assigned a unique address so only it responds to a transmission that starts with its address. In a master request transmission, the Slave Address represents the address to which the request is being sent. In a slave response transmission the Slave Address represents the address sending the response.

A master transmission with a Slave Address of 0 indicates a broadcast command. **Broadcast commands can be used only to store setpoints or perform commands.**

The **Function Code** is the second byte of every transmission. Modbus defines function codes of 1 to 127. The PQMII implements some of these functions. See 2.1 Supported Modbus Functions for details of the supported function codes. In a master request transmission the Function Code tells the slave what action to perform. In a slave response transmission if the Function Code sent from the slave is the same as the Function Code sent from the master then the slave performed the function as requested. If the high order bit of the Function Code sent from the slave is a 1 (i.e. if the Function Code is > 127) then the slave did not perform the function as requested and is sending an error or exception response.
The **Data** is a variable number of bytes depending on the Function Code. This may be Actual Values, Setpoints, or addresses sent by the master to the slave or by the slave to the master. See 2.1 **Supported Modbus Functions** for a description of the supported functions and the data required for each.

The **CRC** is a two byte error checking code. See the following section for details.

### 1.5 Error Checking

The RTU version of Modbus includes a 2-byte CRC-16 (16-bit cyclic redundancy check) with every transmission. The CRC-16 algorithm essentially treats the entire data stream (data bits only; start, stop and parity are ignored) as one continuous binary number. This number is first shifted left 16 bits and then divided by a characteristic polynomial (11000000000000101B). The 16-bit remainder is appended to the end of the transmission, MSByte first. The resulting message including CRC, when divided by the same polynomial at the receiver, results in a zero remainder if no transmission errors have occurred.

If a PQMII Modbus slave device receives a transmission in which an error is indicated by the CRC-16 calculation, the slave device will not respond to the transmission. A CRC-16 error indicates that one or more bytes of the transmission were received incorrectly and thus the entire transmission should be ignored in order to avoid the PQMII performing any incorrect operation.

The CRC-16 calculation is an industry standard method used for error detection. An algorithm is included here to assist programmers in situations where no standard CRC-16 calculation routines are available.

### 1.6 CRC-16 Algorithm

Once the following algorithm is complete, the working register “A” will contain the CRC value to be transmitted. Note that this algorithm requires the characteristic polynomial to be reverse bit ordered. The MSbit of the characteristic polynomial is dropped since it does not affect the value of the remainder. The following symbols are used in the algorithm:

- `-->`: data transfer;
- `A`: 16-bit working register;
- `AL`: low order byte of `A`;
- `AH`: high order byte of `A`;
- `CRC`: 16-bit CRC-16 value;
- `i` and `j`: loop counters;
- `{+}`: logical exclusive-OR operator;
- `Di`: i-th data byte (`i = 0` to `N – 1`);
- `G`: 16-bit characteristic polynomial = 101000000000001 with MSbit dropped and bit order reversed;
- `shr(x)`: shift right (the LSbit of the low order byte of `x` shifts into a carry flag, a ‘0’ is shifted into the MSbit of the high order byte of `x`, all other bits shift right one location)

The algorithm is shown below:

1. **FFFF hex --> A**
2. 0 --> i
3. 0 --> j
4. Di (+) AL --> AL
5. j + 1 --> j
6. shr(A)
7. is there a carry? No: go to 8; Yes: G (+) A --> A
8. is j = 8? No: go to 5; Yes: go to 9.
9. i + 1 --> i
10. is i = N? No: go to 3; Yes: go to 11.
11. A --> CRC

1.7 Timing

Data packet synchronization is maintained by timing constraints. The receiving device must measure the time between the reception of characters. If three and one half character times elapse without a new character or completion of the packet, then the communication link must be reset (i.e. all slaves start listening for a new transmission from the master). Thus at 9600 baud a delay of greater than $3.5 \times \frac{1}{9600} \times 10 = 3.65$ ms will cause the communication link to be reset.

1.8 Reading Long Integers from the Memory Map

1.8.1 Description

The PQMII memory map contains data formatted as a long integer type, or 32 bits. Because the Modbus protocol maximum register size is 16 bits, the PQMII stores long integers in 2 consecutive register locations, 2 high order bytes, and 2 low order bytes. The data can be retrieved by the following logic:

```
READ THE HIGH ORDER REGISTER AND STORE THIS VALUE INTO "A"

READ THE LOW ORDER REGISTER AND STORE THIS VALUE INTO "B"

DATA VALUE = (A x 2^32) + B

IS THE MOST SIGNIFICANT BIT OF THE HIGH ORDER REGISTER SET?
  i.e. is HIGH ORDER REGISTER > 32767?

YES

DATA VALUE = DATA VALUE

NO

(DATA VALUE = DATA VALUE – 2^32)
OR
APPLY 2's COMPLEMENT TO DATA VALUE; THE SIGN IS IMPLIED TO BE NEGATIVE
```

1.8.2 Example

Reading a positive 3 Phase Real Power actual value from the PQMII:

<table>
<thead>
<tr>
<th>Register</th>
<th>Actual Value</th>
<th>Description</th>
<th>Units &amp; Scale</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>02F0</td>
<td>004Fh</td>
<td>3 Phase Real Power (high)</td>
<td>0.01 x kW</td>
<td>F4</td>
</tr>
</tbody>
</table>
Following the method described above, we have:

\[
\text{DATA VALUE} = (004F \times 2^{16}) + 35D1 \quad \text{hexadecimal}
\]
\[
= 5177344 + 13777 \quad \text{converted to decimal}
\]
\[
= 5191121 \quad \text{decimal}
\]

The most significant bit of the High Order register is not set, therefore the Data Value is as calculated. Applying the Units and Scale parameters to the Data Value, we multiply the Data Value by 0.01 kW. Therefore the resultant value of 3 Phase Real Power as read from the memory map is 51911.21 kW.

Reading a negative 3 Phase Real Power actual value from the PQMII:

Following the method described above:

\[
\text{DATA VALUE} = (FF3A \times 2^{16}) + EA7B \quad \text{hexadecimal}
\]
\[
= (65338 \times 2^{16}) + 60027 \quad \text{converted to decimal}
\]
\[
= 4282051195 \quad \text{decimal}
\]

The most significant bit of the High Order register is set, therefore the Data Value is:

\[
\text{DATA VALUE} = \text{DATA VALUE} - 2^{32} = 4282051195 - 4294967296 = -12916101
\]

Multiply the Data Value by 0.01 kW according to the Units and Scale parameter. The resultant 3 Phase Real Power value read from the memory map is –129161.01 kW.
2 Modbus Functions

2.1 Supported Modbus Functions

The following functions are supported by the PQMII:

- 03h: Read Setpoints and Actual Values
- 04h: Read Setpoints and Actual Values
- 05h: Execute Operation
- 06h: Store Single Setpoint
- 07h: Read Device Status
- 08h: Loopback Test
- 10h: Store Multiple Setpoints

2.2 Read Setpoints/Actual Values (Function Codes 03/04h)

Modbus implementation: Read Input and Holding Registers
PQMII Implementation: Read Setpoints and Actual Values

For the PQMII Modbus implementation, these commands are used to read any setpoint ('holding registers') or actual value ('input registers'). Holding and input registers are 16-bit (two byte) values with the high-order byte transmitted first. Thus, all setpoints and actual values are sent as two bytes. A maximum of 125 registers can be read in one transmission. Function codes 03 and 04 are configured to read setpoints or actual values interchangeably since some PLCs do not support both of them.

The slave response to function codes 03/04 is the slave address, function code, number of data bytes to follow, the data, and the CRC. Each data item is sent as a 2 byte number with the high order byte first.

Message Format and Example for Modbus Function Code 03/04h:

Request slave 17 to respond with 3 registers starting at address 006B. For this example the register data in these addresses is:

| Address: | 006B | 006C | 006D |
| Data: | 022B | 0000 | 0064 |

The master/slave packet format is shown below:

<table>
<thead>
<tr>
<th>Master Transmission</th>
<th>Bytes</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slave Address</td>
<td>1</td>
<td>11</td>
<td>message for slave 17</td>
</tr>
<tr>
<td>Function Code</td>
<td>1</td>
<td>03</td>
<td>read registers</td>
</tr>
<tr>
<td>Data Starting Address</td>
<td>2</td>
<td>00 6B</td>
<td>data starting at 006B</td>
</tr>
<tr>
<td>Number Of Setpoints</td>
<td>2</td>
<td>00 03</td>
<td>3 registers = 6 bytes total</td>
</tr>
<tr>
<td>CRC</td>
<td>2</td>
<td>9D 8D</td>
<td>CRC error code</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Slave Response</th>
<th>Bytes</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slave Address</td>
<td>1</td>
<td>11</td>
<td>message from slave 17</td>
</tr>
</tbody>
</table>
2.3 Execute Operation (Function Code 05h)

**Modbus Implementation:** Force Single Coil  
**PQMI Implementation:** Execute Operation

This function code allows the master to request a PQMII to perform specific command operations. The command numbers listed in the Commands area of the memory map correspond to operation codes for function code 05.

The operation commands can also be initiated by writing to the Commands area of the memory map using function code 16. 2.9 Performing Commands (Function Code 10h) for complete details.

**Message Format and Example for Modbus Function Code 05h:**

Reset PQMII (operation code 1).

<table>
<thead>
<tr>
<th>Master Transmission</th>
<th>Bytes</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slave Address</td>
<td>1</td>
<td>11</td>
<td>message for slave 17</td>
</tr>
<tr>
<td>Function Code</td>
<td>1</td>
<td>05</td>
<td>execute operation</td>
</tr>
<tr>
<td>Operation Code</td>
<td>2</td>
<td>00 01</td>
<td>Reset command (operation code 1)</td>
</tr>
<tr>
<td>Code Value</td>
<td>2</td>
<td>FF 00</td>
<td>perform function</td>
</tr>
<tr>
<td>CRC</td>
<td>2</td>
<td>DF 6A</td>
<td>CRC error code</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Slave Response</th>
<th>Bytes</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slave Address</td>
<td>1</td>
<td>11</td>
<td>message from slave 17</td>
</tr>
<tr>
<td>Function Code</td>
<td>1</td>
<td>05</td>
<td>execute operation</td>
</tr>
<tr>
<td>Operation Code</td>
<td>2</td>
<td>00 01</td>
<td>operation code 1</td>
</tr>
<tr>
<td>Code Value</td>
<td>2</td>
<td>FF 00</td>
<td>perform function</td>
</tr>
<tr>
<td>CRC</td>
<td>2</td>
<td>DF 6A</td>
<td>CRC error code</td>
</tr>
</tbody>
</table>

2.4 Broadcast Command (Function Code 05h)

**Modbus Implementation:** Force Single Coil  
**PQMI Implementation:** Execute Operation

This function code allows the master to request all PQMIs on a particular communications link to Clear All Demand Data. The PQMII will recognize a packet as being a broadcast command if the Slave Address is transmitted as 0. Below is an example of the Broadcast Command to Clear All Demand Data.

**Message Format and Example for Modbus Function Code 05h:**

<table>
<thead>
<tr>
<th>Slave Response</th>
<th>Bytes</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slave Address</td>
<td>1</td>
<td>11</td>
<td>message for slave 17</td>
</tr>
<tr>
<td>Function Code</td>
<td>1</td>
<td>05</td>
<td>execute operation</td>
</tr>
<tr>
<td>Operation Code</td>
<td>2</td>
<td>00 01</td>
<td>operation code 1</td>
</tr>
<tr>
<td>Code Value</td>
<td>2</td>
<td>FF 00</td>
<td>perform function</td>
</tr>
<tr>
<td>CRC</td>
<td>2</td>
<td>DF 6A</td>
<td>CRC error code</td>
</tr>
</tbody>
</table>
Clear All Demand Data on all PQMIIs (operation code 34).

<table>
<thead>
<tr>
<th>Master Transmission</th>
<th>Bytes</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slave Address</td>
<td>1</td>
<td>00</td>
<td>broadcast command (address = 0)</td>
</tr>
<tr>
<td>Function Code</td>
<td>1</td>
<td>05</td>
<td>execute operation</td>
</tr>
<tr>
<td>Operation Code</td>
<td>2</td>
<td>00 22</td>
<td>clear all demand data (op. code 34)</td>
</tr>
<tr>
<td>Code Value</td>
<td>2</td>
<td>FF 00</td>
<td>perform function</td>
</tr>
<tr>
<td>CRC</td>
<td>2</td>
<td>2D E1</td>
<td>CRC error code</td>
</tr>
</tbody>
</table>

Slave Response Bytes Example Description

Slave does not respond back to the master.

2.5 Store Single Setpoint (Function Code 06h)

**Modbus Implementation:** Preset Single Register
**PQMII Implementation:** Store Single Setpoint

This command allows the master to store a single setpoint into the memory of a PQMII. The slave response to this function code is to echo the entire master transmission.

**Message Format and Example for Modbus Function Code 06h:**

Request slave 17 to store the value 01E4 in setpoint address 1020. After the transmission in this example is complete, setpoint address 1020 will contain the value 01E4.

<table>
<thead>
<tr>
<th>Master Transmission</th>
<th>Bytes</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slave Address</td>
<td>1</td>
<td>11</td>
<td>message for slave 17</td>
</tr>
<tr>
<td>Function Code</td>
<td>1</td>
<td>06</td>
<td>store single setpoint</td>
</tr>
<tr>
<td>Data Starting Address</td>
<td>2</td>
<td>10 20</td>
<td>setpoint address 1020</td>
</tr>
<tr>
<td>Data</td>
<td>2</td>
<td>01 E4</td>
<td>data for setpoint address 1020</td>
</tr>
<tr>
<td>CRC</td>
<td>2</td>
<td>8E 47</td>
<td>CRC error code</td>
</tr>
</tbody>
</table>

Slave Response Bytes Example Description

<table>
<thead>
<tr>
<th>Slave Response</th>
<th>Bytes</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slave Address</td>
<td>1</td>
<td>11</td>
<td>message from slave 17</td>
</tr>
<tr>
<td>Function Code</td>
<td>1</td>
<td>06</td>
<td>store single setpoint</td>
</tr>
<tr>
<td>Data Starting Address</td>
<td>2</td>
<td>10 20</td>
<td>setpoint address 1020</td>
</tr>
<tr>
<td>Data</td>
<td>2</td>
<td>01 E4</td>
<td>data stored in setpoint address 1020</td>
</tr>
<tr>
<td>CRC</td>
<td>2</td>
<td>8E 47</td>
<td>CRC error code</td>
</tr>
</tbody>
</table>

2.6 Read Device Status (Function Code 07h)

**Modbus Implementation:** Read Exception Status
**PQMII Implementation:** Read Device Status

This is a function used to quickly read the status of a selected device. A short message length allows for rapid reading of status. The status byte returned will have individual bits set to 1 or 0 depending on the status of the slave device.

PQMII General Device Status Byte:

<table>
<thead>
<tr>
<th>Bit Position</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>B0 (LSBit)</td>
<td>Alarm Condition = 1</td>
</tr>
</tbody>
</table>
2.7 Loopback Test (Function Code 08h)

**Modbus Implementation:** Loopback Test  
**PQMII Implementation:** Loopback Test  

This function is used to test the integrity of the communication link. The PQMII will echo the request.

**Message Format and Example for Modbus Function Code 08h:**

Loopback test from slave 17.

<table>
<thead>
<tr>
<th>Master Transmission</th>
<th>Bytes</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slave Address</td>
<td>1</td>
<td>11</td>
<td>message for slave 17</td>
</tr>
<tr>
<td>Function Code</td>
<td>1</td>
<td>08</td>
<td>loopback test</td>
</tr>
<tr>
<td>Diagnostic code</td>
<td>2</td>
<td>00 00</td>
<td>must be 00 00</td>
</tr>
<tr>
<td>Data</td>
<td>2</td>
<td>00 00</td>
<td>must be 00 00</td>
</tr>
<tr>
<td>CRC</td>
<td>2</td>
<td>E0 0B</td>
<td>CRC error code</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Slave Response</th>
<th>Bytes</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slave Address</td>
<td>1</td>
<td>11</td>
<td>message from slave 17</td>
</tr>
<tr>
<td>Function Code</td>
<td>1</td>
<td>08</td>
<td>loopback test</td>
</tr>
<tr>
<td>Diagnostic Code</td>
<td>2</td>
<td>00 00</td>
<td>must be 00 00</td>
</tr>
<tr>
<td>Data</td>
<td>2</td>
<td>00 00</td>
<td>must be 00 00</td>
</tr>
<tr>
<td>CRC</td>
<td>2</td>
<td>E0 0B</td>
<td>CRC error code</td>
</tr>
</tbody>
</table>

**Bit Position** | **Description**

| B1 | Self test failure = 1 |
| B2 | Alarm relay energized = 1 |
| B3 | Aux 1 relay energized = 1 |
| B4 | Aux 2 relay energized = 1 |
| B5 | Aux 3 relay energized = 1 |
| B6 | Not used |
| B7 (MSBit) | Not used |
2.8 Store Multiple Setpoints (Function Code 10h)

**Modbus Implementation:** Preset Multiple Registers  
**PQMII Implementation:** Store Multiple Setpoints

This function code allows multiple setpoints to be stored into the PQMII memory. Modbus ‘registers’ are 16-bit (2-byte) values transmitted high order byte first. Thus all PQMII setpoints are sent as two bytes. The maximum number of setpoints that can be stored in one transmission is dependent on the slave device. Modbus allows up to a maximum of 60 holding registers to be stored. The PQMII allows 60 registers to be stored in one transmission. The PQMII response to this function is to echo the slave address, function code, starting address, the number of setpoints stored, and the CRC.

**Message Format and Example for function code 10h:**

Request slave 17 to store the value 01F4 to setpoint address 1028 and the value 2710 to setpoint address 1029.

<table>
<thead>
<tr>
<th>Master Transmission</th>
<th>Bytes</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slave Address</td>
<td>1</td>
<td>11</td>
<td>message for slave 17</td>
</tr>
<tr>
<td>Function Code</td>
<td>1</td>
<td>10</td>
<td>store multiple setpoints</td>
</tr>
<tr>
<td>Data Starting Address</td>
<td>2</td>
<td>10 28</td>
<td>setpoint address 1028</td>
</tr>
<tr>
<td>Number of Setpoints</td>
<td>2</td>
<td>00 02</td>
<td>2 setpoints = 4 bytes total</td>
</tr>
<tr>
<td>Byte Count</td>
<td>1</td>
<td>04</td>
<td>4 bytes of data</td>
</tr>
<tr>
<td>Data 1</td>
<td>2</td>
<td>01 F4</td>
<td>data for setpoint address 1028</td>
</tr>
<tr>
<td>Data 2</td>
<td>2</td>
<td>27 10</td>
<td>data for setpoint address 1029</td>
</tr>
<tr>
<td>CRC</td>
<td>2</td>
<td>33 23</td>
<td>CRC error code</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Slave Response</th>
<th>Bytes</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slave Address</td>
<td>1</td>
<td>11</td>
<td>message from slave 17</td>
</tr>
<tr>
<td>Function Code</td>
<td>1</td>
<td>10</td>
<td>store multiple setpoints</td>
</tr>
<tr>
<td>Data Starting Address</td>
<td>2</td>
<td>10 28</td>
<td>setpoint address 1028</td>
</tr>
<tr>
<td>Number of Setpoints</td>
<td>2</td>
<td>00 02</td>
<td>2 setpoints</td>
</tr>
<tr>
<td>CRC</td>
<td>2</td>
<td>C7 90</td>
<td>CRC error code</td>
</tr>
</tbody>
</table>

2.9 Performing Commands (Function Code 10h)

Some PLCs may not support command execution using function code 05 but do support storing multiple setpoints with function code 10h. To perform this operation using function code 10h, a certain sequence of commands must be written to the PQMII. The sequence consists of: command function register, command operation register and command data (if required). The command function register must be written with the value of 05, indicating an execute operation. The command operation register must then be written with a valid command operation number from the list of commands shown in the memory map. The command data registers must be written with valid data if the command operation requires data. The selected command will be executed immediately upon receipt of a valid transmission.

**Message Format and Example for Function Code 10h:**
Perform a reset on PQMII (operation code 1).

<table>
<thead>
<tr>
<th>Master Transmission</th>
<th>Bytes</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slave Address</td>
<td>1</td>
<td>11</td>
<td>message for slave 17</td>
</tr>
<tr>
<td>Function Code</td>
<td>1</td>
<td>10</td>
<td>store multiple setpoints</td>
</tr>
<tr>
<td>Data Starting Address</td>
<td>2</td>
<td>00 80</td>
<td>setpoint address 0080</td>
</tr>
<tr>
<td>Number of Setpoints</td>
<td>2</td>
<td>00 02</td>
<td>2 setpoints = 4 bytes total</td>
</tr>
<tr>
<td>Byte Count</td>
<td>1</td>
<td>04</td>
<td>4 bytes of data</td>
</tr>
<tr>
<td>Data 1</td>
<td>2</td>
<td>00 05</td>
<td>data for setpoint address 0080</td>
</tr>
<tr>
<td>Data 2</td>
<td>2</td>
<td>00 01</td>
<td>data for setpoint address 0081</td>
</tr>
<tr>
<td>CRC</td>
<td>2</td>
<td>B0 D6</td>
<td>CRC error code</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Slave Response</th>
<th>Bytes</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slave Address</td>
<td>1</td>
<td>11</td>
<td>message from slave 17</td>
</tr>
<tr>
<td>Function Code</td>
<td>1</td>
<td>10</td>
<td>store multiple setpoints</td>
</tr>
<tr>
<td>Data Starting Address</td>
<td>2</td>
<td>00 80</td>
<td>setpoint address 0080</td>
</tr>
<tr>
<td>Number of Setpoints</td>
<td>2</td>
<td>00 02</td>
<td>2 setpoints</td>
</tr>
<tr>
<td>CRC</td>
<td>2</td>
<td>46 7A</td>
<td>CRC error code</td>
</tr>
</tbody>
</table>

### 2.10 Broadcast Command (Function Code 10h)

In applications where multiple devices are daisy-chained, it may be necessary to synchronize device clocks (date and/or time) through one command. The broadcast command allows such synchronization. The PQMII recognizes a packet as being a broadcast command if the Slave Address is transmitted as 0.

**Message Format and Example for Function Code 10h:**

Send broadcast command to store 1:27:10.015 pm, October 29, 1997.

<table>
<thead>
<tr>
<th>Master Transmission</th>
<th>Bytes</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slave Address</td>
<td>1</td>
<td>00</td>
<td>broadcast command (address = 0)</td>
</tr>
<tr>
<td>Function Code</td>
<td>1</td>
<td>10</td>
<td>store multiple setpoints</td>
</tr>
<tr>
<td>Data Starting Address</td>
<td>2</td>
<td>00 F0</td>
<td>setpoint address 00F0</td>
</tr>
<tr>
<td>Number of Setpoints</td>
<td>2</td>
<td>00 04</td>
<td>4 setpoints = 8 bytes total</td>
</tr>
<tr>
<td>Byte Count</td>
<td>1</td>
<td>08</td>
<td>8 bytes of data</td>
</tr>
<tr>
<td>Data 1</td>
<td>2</td>
<td>0D 1B</td>
<td>hours (24-hour format), minutes</td>
</tr>
<tr>
<td>Data 2</td>
<td>2</td>
<td>27 1F</td>
<td>milliseconds</td>
</tr>
<tr>
<td>Data 3</td>
<td>2</td>
<td>0A 1D</td>
<td>month, day</td>
</tr>
<tr>
<td>Data 4</td>
<td>2</td>
<td>07 CD</td>
<td>year (four digits, i.e. 1997)</td>
</tr>
<tr>
<td>CRC</td>
<td>2</td>
<td>9D 8D</td>
<td>CRC error code</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Slave Response</th>
<th>Bytes</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slave does not respond back to the master.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The PQMII allows the date and time to be stored separately. In other word, a broadcast command can be sent to store just date or time.
### 2.11 Error Responses

When a PQMII detects an error other than a CRC error, a response will be sent to the master. The MSbit of the Function Code byte will be set to 1 (i.e. the function code sent from the slave will be equal to the function code sent from the master plus 128). The following byte will be an exception code indicating the type of error that occurred.

Transmissions received from the master with CRC errors are ignored by the PQMII.

The slave response to an error (other than CRC error) will be:

- Slave Address: 1 byte
- Function Code: 1 byte (with MSbit set to 1)
- Exception Code: 1 byte
- CRC: 2 bytes

The PQMII implements the following exception response codes.

- **01 - Illegal Function**: The function code transmitted is not one of the functions supported by the PQMII.
- **02 - Illegal Data Address**: The address referenced in the data field transmitted by the master is not an allowable address for the PQMII.
- **03 - Illegal Data Value**: The value referenced in the data field transmitted by the master is not within range for the selected data address.
3 Modbus Memory Map

3.1 Memory Map Information

The data stored in the PQMII are grouped by setpoints and actual values. Setpoints can be read and written by a master computer; actual values are read-only. All setpoints and actual values are stored as two-byte values; that is, each register address is the address of a two-byte value. In the Modbus memory map, addresses are shown in hexadecimal notation; data values (setpoint ranges, increments, factory values) are in decimal notation.

3.2 User-definable Memory Map

The PQMII contains a user-definable area in the memory map. This area allows remapping of the addresses of all actual values and setpoints registers. The user-definable area has two sections:

- A Register Index area (memory map addresses 0180h to 01F7h) that contains 120 actual values or setpoints register addresses.
- A Register area (memory map addresses 0100h to 017Fh) that contains the data at the addresses in the Register Index.

Register data that is separated in the rest of the memory map may be remapped to adjacent register addresses in the user-definable registers area. This is accomplished by writing to register addresses in the user-definable register index area. This allows for improved throughput of data and can eliminate the need for multiple read command sequences.

For example, if the values of Phase A Current (register address 0240h) and Phase A Power Factor (register address 02FDh) are required to be read from a PQMII, their addresses may be remapped as follows:

1. Write 0240h to address 0180h (User-Definable Register Index 0000) using Modbus function code 06h or 10h.
2. Write 02FDh to address 0181h (User-Definable Register Index 0001) using Modbus function code 06h or 10h.

A read (function code 03h or 04h) of registers 0100h (User-Definable Register 0000) and 0101h (User-Definable Register 0001) will return the Phase A Current and Phase A Power Factor.
### 3.3 PQMII Memory Map

The PQMII memory map is shown in the following table.

#### Table 1: PQMII Memory Map (Sheet 1 of 43)

<table>
<thead>
<tr>
<th>GROUP</th>
<th>ADDR (HEX)</th>
<th>DESCRIPTION</th>
<th>RANGE</th>
<th>STEP VALUE</th>
<th>UNITS and SCALE</th>
<th>FORMAT</th>
<th>FACTORY DEFAULT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product Information (Input Registers) Addresses: 0000 to 007F</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PRODUCT ID</strong></td>
<td>0000</td>
<td>Product Device Code</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>F1</td>
<td>F3</td>
</tr>
<tr>
<td>0001</td>
<td>Hardware Version Code</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>F5</td>
<td>current version</td>
<td></td>
</tr>
<tr>
<td>0002</td>
<td>Main Software Version Code</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>F1</td>
<td>current version</td>
<td></td>
</tr>
<tr>
<td>0003</td>
<td>Modification File Number 1</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>F1</td>
<td>mod. file number 1</td>
<td></td>
</tr>
<tr>
<td>0004</td>
<td>Boot Software Version Code</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>F1</td>
<td>current version</td>
<td></td>
</tr>
<tr>
<td>0005</td>
<td>Reserved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0006</td>
<td>Product options</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>F100</td>
<td>from order code</td>
<td></td>
</tr>
<tr>
<td>0007</td>
<td>Modification File Number 2</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>F1</td>
<td>mod. file number 2</td>
<td></td>
</tr>
<tr>
<td>0008</td>
<td>Modification File Number 3</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>F1</td>
<td>mod. file number 3</td>
<td></td>
</tr>
<tr>
<td>0009</td>
<td>Modification File Number 4</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>F1</td>
<td>mod. file number 4</td>
<td></td>
</tr>
<tr>
<td>000A</td>
<td>Modification File Number 5</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>F1</td>
<td>mod. file number 5</td>
<td></td>
</tr>
<tr>
<td>000B</td>
<td>CPU Speed</td>
<td>0 to 1</td>
<td>1</td>
<td>---</td>
<td>F45</td>
<td>16 MHz</td>
<td></td>
</tr>
<tr>
<td>to</td>
<td>↓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>001F</td>
<td>Reserved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0020</td>
<td>Serial Number Character 1 and 2</td>
<td>---</td>
<td>---</td>
<td>ASCII</td>
<td>F10</td>
<td>1st, 2nd char.</td>
<td></td>
</tr>
<tr>
<td>0021</td>
<td>Serial Number Character 3 and 4</td>
<td>---</td>
<td>---</td>
<td>ASCII</td>
<td>F10</td>
<td>3rd, 4th char.</td>
<td></td>
</tr>
<tr>
<td>0022</td>
<td>Serial Number Character 5 and 6</td>
<td>---</td>
<td>---</td>
<td>ASCII</td>
<td>F10</td>
<td>5th, 6th char.</td>
<td></td>
</tr>
<tr>
<td>0023</td>
<td>Serial Number Character 7 and 8</td>
<td>---</td>
<td>---</td>
<td>ASCII</td>
<td>F10</td>
<td>7th, 8th char.</td>
<td></td>
</tr>
<tr>
<td>0024</td>
<td>Reserved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to</td>
<td>↓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0030</td>
<td>Manufacture Month/Day</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>F24</td>
<td>manf. month/day</td>
<td></td>
</tr>
<tr>
<td>0031</td>
<td>Manufacture Year</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>F25</td>
<td>manufacture year</td>
<td></td>
</tr>
<tr>
<td>0032</td>
<td>Calibration Month/Day</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>F24</td>
<td>cal. month/day</td>
<td></td>
</tr>
<tr>
<td>0033</td>
<td>Calibration Year</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>F25</td>
<td>calibration year</td>
<td></td>
</tr>
<tr>
<td>0034</td>
<td>Reserved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0035</td>
<td>Reserved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to</td>
<td>↓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>007F</td>
<td>Reserved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Commands (Holding Registers) Addresses: 0080 to 00EF</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>COMMANDS</strong></td>
<td>0080</td>
<td>Command Function Code</td>
<td>5</td>
<td>---</td>
<td>---</td>
<td>F1</td>
<td>3</td>
</tr>
<tr>
<td>0081</td>
<td>Command Operation Code</td>
<td>0 to 35</td>
<td>1</td>
<td>---</td>
<td>F7</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>0082</td>
<td>Command Data 1</td>
<td>0 to 65535</td>
<td>1</td>
<td>---</td>
<td>*</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>0083</td>
<td>Command Data 2</td>
<td>0 to 65535</td>
<td>1</td>
<td>---</td>
<td>F31</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>0084</td>
<td>Command Data 3</td>
<td>0 to 65535</td>
<td>1</td>
<td>---</td>
<td>F8</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>0085</td>
<td>Command Data 4</td>
<td>0 to 65535</td>
<td>1</td>
<td>---</td>
<td>F8</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>0086</td>
<td>Command Data 5</td>
<td>0 to 65535</td>
<td>1</td>
<td>---</td>
<td>F8</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>0087</td>
<td>Command Data 6</td>
<td>0 to 65535</td>
<td>1</td>
<td>---</td>
<td>F8</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- *Data type depends on the Command Operation Code.*
- **Any valid Actual Values or Setpoints address.**
- ***Maximum Setpoint value represents "OFF".*
- ****Minimum Setpoint value represents "OFF".*
- *****Maximum Setpoint value represents "UNLIMITED".
### Table 1: PQMII Memory Map (Sheet 2 of 43)

<table>
<thead>
<tr>
<th>GROUP</th>
<th>ADDR (HEX)</th>
<th>DESCRIPTION</th>
<th>RANGE</th>
<th>STEP VALUE</th>
<th>UNITS and SCALE</th>
<th>FORMAT</th>
<th>FACTORY DEFAULT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0088</td>
<td>Command Data 7</td>
<td>0 to 65535</td>
<td>1</td>
<td>---</td>
<td>FB</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>0089</td>
<td>Command Data 8</td>
<td>0 to 65535</td>
<td>1</td>
<td>---</td>
<td>FB</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>008A</td>
<td>Command Data 9</td>
<td>0 to 65535</td>
<td>1</td>
<td>---</td>
<td>FB</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>008B</td>
<td>Command Data 10</td>
<td>0 to 65535</td>
<td>1</td>
<td>---</td>
<td>FB</td>
<td>D</td>
</tr>
<tr>
<td>COMMANDS continued</td>
<td>008C</td>
<td>Command Data 11</td>
<td>0 to 65535</td>
<td>1</td>
<td>---</td>
<td>FB</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>008D</td>
<td>Reserved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>008E</td>
<td>Reserved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>008F</td>
<td>Reserved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0090</td>
<td>Time Hours/Minutes</td>
<td>0 to 65535</td>
<td>1</td>
<td>hr/min</td>
<td>F22</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>0091</td>
<td>Time Seconds</td>
<td>0 to 59999</td>
<td>1</td>
<td>ns</td>
<td>F23</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>0092</td>
<td>Date Month/Day</td>
<td>0 to 65535</td>
<td>1</td>
<td>---</td>
<td>F24</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>0093</td>
<td>Date Year</td>
<td>0 to 2037</td>
<td>1</td>
<td>---</td>
<td>F25</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>0094</td>
<td>Reserved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0095</td>
<td>Reserved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USER DEFINABLE REGISTERS</td>
<td>0100</td>
<td>User Definable Data 0000</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>0101</td>
<td>User Definable Data 0001</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>0102</td>
<td>User Definable Data 0002</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>0103</td>
<td>User Definable Data 0003</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
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**Notes:**
- *Data type depends on the Command Operation Code.*
- **Any valid Actual Values or Setpoints address.**
- ***Maximum Setpoint value represents "OFF".***
- ****Minimum Setpoint value represents "OFF".****
- *****Maximum Setpoint value represents "UNLIMITED".
### Table 1: PQMII Memory Map (Sheet 3 of 43)

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**Notes:**

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**COMM–16**

**PQMI POWER QUALITY METER – INSTRUCTION MANUAL**
### Table 1: PQMII Memory Map (Sheet 4 of 43)

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Notes:
- *Data type depends on the Command Operation Code.
- **Any valid Actual Values or Setpoints address.
- ***Maximum Setpoint value represents “OFF”.
- ****Minimum Setpoint value represents “OFF”.
- *****Maximum Setpoint value represents “UNLIMITED”.

### Table 1: PQMII Memory Map (Sheet 5 of 43)

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**COMM–18**

PQMI POWER QUALITY METER – INSTRUCTION MANUAL
### Table 1: PQMII Memory Map (Sheet 6 of 43)

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**Notes:**
* Data type depends on the Command Operation Code.
** Any valid Actual Values or Setpoints address.
*** Maximum Setpoint value represents “OFF”.
**** Minimum Setpoint value represents “OFF”.
***** Maximum Setpoint value represents “UNLIMITED”.

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**Table 1: PQMII Memory Map (Sheet 6 of 43)**

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**Notes:**
- *Data type depends on the Command Operation Code.
- **Any valid Actual Values or Setpoints address.
- ***Maximum Setpoint value represents "OFF".
- ****Minimum Setpoint value represents "OFF".
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**Notes:**
- *Data type depends on the Command Operation Code.
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- ****Minimum Setpoint value represents “OFF”.
- *****Maximum Setpoint value represents “UNLIMITED”.

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PQMII POWER QUALITY METER – INSTRUCTION MANUAL

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COMM–24 PQMII POWER QUALITY METER – INSTRUCTION MANUAL
Table 1: PQMII Memory Map (Sheet 12 of 43)

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PQMII POWER QUALITY METER – INSTRUCTION MANUAL

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**Notes:**
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**** Minimum Setpoint value represents “OFF”.
***** Maximum Setpoint value represents “UNLIMITED”.

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PQMII POWER QUALITY METER – INSTRUCTION MANUAL

COMM-27
### Table 1: PQMII Memory Map (Sheet 15 of 43)

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Notes:  
* Data type depends on the Command Operation Code.  
** Any valid Actual Values or Setpoints address.  
*** Maximum Setpoint value represents “OFF”.  
**** Minimum Setpoint value represents “OFF”.  
***** Maximum Setpoint value represents “UNLIMITED”.
### Table 1: PQMII Memory Map (Sheet 18 of 43)

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**Notes:**
* Data type depends on the Command Operation Code.
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**** Minimum Setpoint value represents "OFF".
***** Maximum Setpoint value represents "UNLIMITED".
## Table 1: PQMII Memory Map (Sheet 20 of 43)

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### Table 1: PQMII Memory Map (Sheet 21 of 43)

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**Notes:**
- *Data type depends on the Command Operation Code.
- **Any valid Actual Values or Setpoints address.
- ***Maximum Setpoint value represents “OFF”.
- ****Minimum Setpoint value represents “OFF”.
- *****Maximum Setpoint value represents “UNLIMITED”.

**COMM–34**

**PQMII POWER QUALITY METER – INSTRUCTION MANUAL**
Table 1: PQMII Memory Map (Sheet 22 of 43)

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Notes:
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PQMIPOWER QUALITY METER – INSTRUCTION MANUAL  COMM-35
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**Notes:**
- *Data type depends on the Command Operation Code.
- **Any valid Actual Values or Setpoints address.
- *** Maximum Setpoint value represents "OFF".
- **** Minimum Setpoint value represents "OFF".
- ***** Maximum Setpoint value represents "UNLIMITED".
### Table 1: PQMII Memory Map (Sheet 24 of 43)

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- *Data type depends on the Command Operation Code.
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### Table 1: PQMII Memory Map (Sheet 25 of 43)

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<td>Log 2 Pointer to 1st Item of 1st Rec. (high)</td>
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<td>Log 2 Block Number of Next Record to Write</td>
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<td>Log 2 Register No. of Next Record to Write</td>
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<td>Log 2 Pointer of 1st Item of Record after Last (high)</td>
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<td>Total Number of Events Since Last Clear</td>
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<td>EVENT RECORD</td>
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<td>Event Record Last Cleared Date - Month/Day</td>
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**Notes:**

* Data type depends on the Command Operation Code.
** Any valid Actual Values or Setpoints address.
*** Maximum Setpoint value represents “OFF”.
**** Minimum Setpoint value represents “OFF”.
***** Maximum Setpoint value represents “UNLIMITED”.

---

**COMM–38 PQMII POWER QUALITY METER – INSTRUCTION MANUAL**

**CHAPTER COMM: COMMUNICATIONS GUIDE**

**DATA LOGGER LOG 1 HEADER**

---

**DATA LOGGER LOG 2 HEADER**

---

**EVENT RECORD**

---

---
### Table 1: PQMII Memory Map (Sheet 26 of 43)

<table>
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<tr>
<th>GROUP</th>
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<th>STEP VALUE</th>
<th>UNITS and SCALE</th>
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### Notes:
* Data type depends on the Command Operation Code.
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<th>UNITS and SCALE</th>
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### Table 1: PQMII Memory Map (Sheet 28 of 43)

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| Notes: | * Data type depends on the Command Operation Code.  
** Any valid Actual Values or Setpoints address.  
*** Maximum Setpoint value represents “OFF”.  
**** Minimum Setpoint value represents “OFF”.  
***** Maximum Setpoint value represents “UNLIMITED”. |
### Table 1: PQMII Memory Map (Sheet 29 of 43)

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**Notes:**
- *Data type depends on the Command Operation Code.
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- **** Minimum Setpoint value represents "OFF".
- ***** Maximum Setpoint value represents "UNLIMITED".
Table 1: PQMII Memory Map (Sheet 30 of 43)

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Notes: *Data type depends on the Command Operation Code.  
**Any valid Actual Values or Setpoints addresses.  
***Maximum Setpoint value represents "OFF".  
****Minimum Setpoint value represents "OFF".  
*****Maximum Setpoint value represents "UNLIMITED".
### Table 1: PQMII Memory Map (Sheet 31 of 43)

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**Notes:**
- *Data type depends on the Command Operation Code.*
- **Any valid Actual Values or Setpoints address.**
- ***Maximum Setpoint value represents “OFF”.***
- ****Minimum Setpoint value represents “OFF”.***
- *****Maximum Setpoint value represents “UNLIMITED”.***
## Table 1: PQMII Memory Map (Sheet 32 of 43)

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**Notes:**
* Data type depends on the Command Operation Code.
** Any valid Actual Values or Setpoints address.
*** Maximum Setpoint value represents “OFF”.
**** Minimum Setpoint value represents “OFF”.
***** Maximum Setpoint value represents “UNLIMITED”. 
### Table 1: PQMII Memory Map (Sheet 33 of 43)

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**** Minimum Setpoint value represents "OFF".
***** Maximum Setpoint value represents "UNLIMITED".
### Table 1: PQMII Memory Map (Sheet 34 of 43)

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**Notes:**
* Data type depends on the Command Operation Code.
** Any valid Actual Values or Setpoints address.
*** Maximum Setpoint value represents “OFF”.
**** Minimum Setpoint value represents “OFF”.
***** Maximum Setpoint value represents “UNLIMITED”.

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PQMII POWER QUALITY METER – INSTRUCTION MANUAL

COMM-47
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Notes:  
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---

Table 1: PQMII Memory Map (Sheet 35 of 43)
Table 1: PQMII Memory Map (Sheet 36 of 43)

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Notes: * Data type depends on the Command Operation Code.  ** Any valid Actual Values or Setpoints address.  *** Maximum Setpoint value represents “OFF”.  **** Minimum Setpoint value represents “OFF”.  ***** Maximum Setpoint value represents “UNLIMITED”.
### Table 1: PQMII Memory Map (Sheet 37 of 43)

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**Notes:**
* Data type depends on the Command Operation Code.
** Any valid Actual Values or Setpoints address.
*** Maximum Setpoint value represents "OFF".
**** Minimum Setpoint value represents "OFF".
***** Maximum Setpoint value represents "UNLIMITED".
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**Notes:**
* Data type depends on the Command Operation Code.
** Any valid Actual Values or Setpoints address.
*** Maximum Setpoint value represents "OFF".
**** Minimum Setpoint value represents "OFF".
***** Maximum Setpoint value represents "UNLIMITED".
Table 1: PQMII Memory Map (Sheet 39 of 43)

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Notes:
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Table 1: PQMII Memory Map (Sheet 40 of 43)

Notes: *Data type depends on the Command Operation Code. **Any valid Actual Values or Setpoints address. ***Maximum Setpoint value represents "OFF". ****Minimum Setpoint value represents "OFF". *****Maximum Setpoint value represents "UNLIMITED".
### Table 1: PQMII Memory Map (Sheet 41 of 43)

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Notes:  
*Data type depends on the Command Operation Code.  
**Any valid Actual Values or Setpoints address.  
***Maximum Setpoint value represents "OFF".  
****Minimum Setpoint value represents "OFF".  
*****Maximum Setpoint value represents "UNLIMITED".
### Table 1: PQMII Memory Map (Sheet 42 of 43)

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<td></td>
<td>12DD</td>
<td>Switch Input B Trigger</td>
<td>0 to 2</td>
<td>1</td>
<td>--</td>
<td>F39</td>
<td>0 = OFF</td>
</tr>
<tr>
<td></td>
<td>12DE</td>
<td>Switch Input C Trigger</td>
<td>0 to 2</td>
<td>1</td>
<td>--</td>
<td>F39</td>
<td>0 = OFF</td>
</tr>
<tr>
<td></td>
<td>12DF</td>
<td>Switch Input D Trigger</td>
<td>0 to 2</td>
<td>1</td>
<td>--</td>
<td>F39</td>
<td>0 = OFF</td>
</tr>
<tr>
<td></td>
<td>12E0</td>
<td>Trace Memory Trigger Delay</td>
<td>0 to 30</td>
<td>1</td>
<td>cycles</td>
<td>F1</td>
<td>4 Cycles</td>
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<tr>
<td></td>
<td>12E1</td>
<td>Trace Memory Waveform Selection</td>
<td>0 to 6</td>
<td>1</td>
<td>--</td>
<td>F40</td>
<td>0 = ia</td>
</tr>
<tr>
<td></td>
<td>12E2</td>
<td>Trace Memory Trigger Delay Relay</td>
<td>0 to 4</td>
<td>1</td>
<td>--</td>
<td>F29</td>
<td>0 = OFF</td>
</tr>
<tr>
<td></td>
<td>12E3</td>
<td>Reserved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12EF</td>
<td>Reserved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PRODUCT OPTIONS</strong></td>
<td>12F0</td>
<td>Product Options Upgrade</td>
<td>1 to 23</td>
<td>1</td>
<td>--</td>
<td>F116</td>
<td>2=PQMII</td>
</tr>
<tr>
<td></td>
<td>12F1</td>
<td>Product Modifications Upgrade MOD1</td>
<td>2 to 999</td>
<td>1</td>
<td>--</td>
<td>F1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>12F2</td>
<td>Product Modifications Upgrade MOD2</td>
<td>2 to 999</td>
<td>1</td>
<td>--</td>
<td>F1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>12F3</td>
<td>Product Modifications Upgrade MOD3</td>
<td>2 to 999</td>
<td>1</td>
<td>--</td>
<td>F1</td>
<td>0</td>
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<tr>
<td></td>
<td>12F4</td>
<td>Product Modifications Upgrade MOD4</td>
<td>2 to 999</td>
<td>1</td>
<td>--</td>
<td>F1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>12F5</td>
<td>Product Modifications Upgrade MOD5</td>
<td>2 to 999</td>
<td>1</td>
<td>--</td>
<td>F1</td>
<td>0</td>
</tr>
</tbody>
</table>

**Notes:**
* Data type depends on the Command Operation Code.
** Any valid Actual Values or Setpoints address.
*** Maximum Setpoint value represents "OFF".
**** Minimum Setpoint value represents "OFF".
***** Maximum Setpoint value represents "UNLIMITED".
### Table 1: PQMII Memory Map (Sheet 43 of 43)

<table>
<thead>
<tr>
<th>GROUP</th>
<th>ADDR (HEX)</th>
<th>DESCRIPTION</th>
<th>RANGE</th>
<th>STEP VALUE</th>
<th>UNITS and SCALE</th>
<th>FORMAT</th>
<th>FACTORY DEFAULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRODUCT OPTIONS</td>
<td>12F6</td>
<td>Passcode Input 1</td>
<td>32 to 127</td>
<td>1</td>
<td>---</td>
<td>F10</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>12F7</td>
<td>Passcode Input 2</td>
<td>32 to 127</td>
<td>1</td>
<td>---</td>
<td>F10</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>12F8</td>
<td>Passcode Input 3</td>
<td>32 to 127</td>
<td>1</td>
<td>---</td>
<td>F10</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>12F9</td>
<td>Passcode Input 4</td>
<td>32 to 127</td>
<td>1</td>
<td>---</td>
<td>F10</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>12FA</td>
<td>Passcode Input 5</td>
<td>32 to 127</td>
<td>1</td>
<td>---</td>
<td>F10</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>12FB</td>
<td>Passcode Input 6</td>
<td>32 to 127</td>
<td>1</td>
<td>---</td>
<td>F10</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>12FC</td>
<td>Passcode Input 7</td>
<td>32 to 127</td>
<td>1</td>
<td>---</td>
<td>F10</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>12FD</td>
<td>Passcode Input 8</td>
<td>32 to 127</td>
<td>1</td>
<td>---</td>
<td>F10</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>12FE</td>
<td>Passcode Input 9</td>
<td>32 to 127</td>
<td>1</td>
<td>---</td>
<td>F10</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>12FF</td>
<td>Passcode Input 10</td>
<td>32 to 127</td>
<td>1</td>
<td>---</td>
<td>F10</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>1300</td>
<td>Reserved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOLTAGE DISTURBANCE</td>
<td>131F</td>
<td>Reserved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RECORDER</td>
<td>1320</td>
<td>Record Selector</td>
<td>0 to 65535</td>
<td>1</td>
<td>---</td>
<td>F1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>1321</td>
<td>Sag Level % Nominal</td>
<td>20 to 100</td>
<td>1</td>
<td>%</td>
<td>F1***</td>
<td>OFF</td>
</tr>
<tr>
<td></td>
<td>1322</td>
<td>Swell Level % Nominal</td>
<td>101 to 151</td>
<td>1</td>
<td>%</td>
<td>F1***</td>
<td>OFF</td>
</tr>
<tr>
<td></td>
<td>1323</td>
<td>Reserved</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- *Data type depends on the Command Operation Code.*
- **Any valid Actual Values or Setpoints address.**
- ***Maximum Setpoint value represents "OFF".*
- ****Minimum Setpoint value represents "OFF".*
- *****Maximum Setpoint value represents "UNLIMITED".*
### 3.4 Memory Map Data Formats

#### Table 2: Data Formats (Sheet 1 of 18)

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Bitmask</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>Unsigned Integer - Numerical Data</td>
<td>FFFF</td>
</tr>
<tr>
<td>F2</td>
<td>Signed Integer - Numerical Data</td>
<td>FFFF</td>
</tr>
<tr>
<td>F3</td>
<td>Unsigned Long Integer - Numerical Data</td>
<td>FFFFFFFF</td>
</tr>
<tr>
<td>F4</td>
<td>Signed Long Integer - Numerical Data</td>
<td>FFFFFFFF</td>
</tr>
<tr>
<td>F5</td>
<td>Hardware Version Code</td>
<td>FFFF</td>
</tr>
<tr>
<td>F6</td>
<td>Unsigned Integer - Current Key Press</td>
<td>FFFF</td>
</tr>
<tr>
<td>F7</td>
<td>Unsigned Integer - Command</td>
<td>FFFF</td>
</tr>
</tbody>
</table>

- **F1**: FFFF
- **F2**: FFFF
- **F3**: FFFFFFFF
- **F4**: FFFFFFFF
- **F5**: FFFF
- **F6**: 0000 = no key, FE01 = Enter, FE02 = Menu, FE04 = Message Right, FE08 = Value Up, FD01 = Reset, FD02 = Message Left, FD04 = Message Up, FD08 = Value Down, FB01 = Escape, FB02 = Message Down
- **F7**: 1 = Reset, 2 = Alarm Relay On, 3 = Alarm Relay Off, 4 = Auxiliary Relay 1 On, 5 = Auxiliary Relay 1 Off, 6 = Auxiliary Relay 2 On, 7 = Auxiliary Relay 2 Off, 8 = Auxiliary Relay 3 On, 9 = Auxiliary Relay 3 Off, 10 = Set Clock Time

- **1 = A**
- **2 = B**
- **↓**
- **26 = Z**
### Table 2: Data Formats (Sheet 2 of 18)

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Bitmask</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Set Clock Date</td>
<td>---</td>
</tr>
<tr>
<td>12</td>
<td>Display 40 char. Flash Msg for 5 s</td>
<td>---</td>
</tr>
<tr>
<td>13</td>
<td>Simulate Keypress</td>
<td>---</td>
</tr>
<tr>
<td>14</td>
<td>Clear Energy Values</td>
<td>---</td>
</tr>
<tr>
<td>15</td>
<td>Clear Max. Demand Values</td>
<td>---</td>
</tr>
<tr>
<td>16</td>
<td>Clear Min./Max. Current Values</td>
<td>---</td>
</tr>
<tr>
<td>17</td>
<td>Clear Min./Max. Voltage Values</td>
<td>---</td>
</tr>
<tr>
<td>18</td>
<td>Clear Min./Max. Power Values</td>
<td>---</td>
</tr>
<tr>
<td>19</td>
<td>Clear Max. THD Values</td>
<td>---</td>
</tr>
<tr>
<td>20</td>
<td>Clear Switch Input Pulse Count</td>
<td>---</td>
</tr>
<tr>
<td>21</td>
<td>High Speed Sampling Trigger</td>
<td>---</td>
</tr>
<tr>
<td>22</td>
<td>Upload Mode Entry 2</td>
<td>---</td>
</tr>
<tr>
<td>23</td>
<td>Upload Mode Entry 1</td>
<td>---</td>
</tr>
<tr>
<td>24</td>
<td>Factory Setpoints Reload 2</td>
<td>---</td>
</tr>
<tr>
<td>25</td>
<td>Factory Setpoints Reload 1</td>
<td>---</td>
</tr>
<tr>
<td>26</td>
<td>Test Relays and LEDs</td>
<td>---</td>
</tr>
<tr>
<td>27</td>
<td>Waveform Capture Trigger</td>
<td>---</td>
</tr>
<tr>
<td>28</td>
<td>Start Data Log(s)</td>
<td>---</td>
</tr>
<tr>
<td>29</td>
<td>Stop Data Log(s)</td>
<td>---</td>
</tr>
<tr>
<td>30</td>
<td>Resize Data Logs (valid only if both logs are stopped)</td>
<td>---</td>
</tr>
<tr>
<td>31</td>
<td>Clear Event Record</td>
<td>---</td>
</tr>
<tr>
<td>32</td>
<td>Trigger Trace Memory</td>
<td>---</td>
</tr>
<tr>
<td>33</td>
<td>Re-arm Trace Mem.</td>
<td>---</td>
</tr>
<tr>
<td>34</td>
<td>Clear All Demand</td>
<td>---</td>
</tr>
<tr>
<td>35</td>
<td>Clear Min./Max. Freq</td>
<td>---</td>
</tr>
<tr>
<td>40</td>
<td>Clear Voltage Disturbance Recorder</td>
<td>---</td>
</tr>
</tbody>
</table>

| F8   | Unsigned Integer - Keypress Simulation         | FFFF    |
| 49   | ‘1’ = Menu                                     | ---     |
| 50   | ‘2’ = Escape                                   | ---     |
| 51   | ‘3’ = Reset                                    | ---     |
| 52   | ‘4’ = Enter                                    | ---     |
| 53   | ‘5’ = Message Up                               | ---     |
| 54   | ‘6’ = Message Down                             | ---     |
| 55   | ‘7’ = Message Left                             | ---     |
Table 2: Data Formats (Sheet 3 of 18)

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Bitmask</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>56 = '8' = Message Right</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>57 = '9' = Value Up</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>97 = '0' = Value Down</td>
<td>--</td>
</tr>
<tr>
<td>F9</td>
<td><strong>Unsigned Integer - Relay/LED Test Data</strong></td>
<td>FFFF</td>
</tr>
<tr>
<td></td>
<td>Alarm Relay</td>
<td>0001</td>
</tr>
<tr>
<td></td>
<td>Auxiliary Relay 1</td>
<td>0002</td>
</tr>
<tr>
<td></td>
<td>Auxiliary Relay 2</td>
<td>0004</td>
</tr>
<tr>
<td></td>
<td>Auxiliary Relay 3</td>
<td>0008</td>
</tr>
<tr>
<td></td>
<td>'Alarm' LED</td>
<td>0010</td>
</tr>
<tr>
<td></td>
<td>'Program' LED</td>
<td>0020</td>
</tr>
<tr>
<td></td>
<td>'Simulation' LED</td>
<td>0040</td>
</tr>
<tr>
<td></td>
<td>'Self Test' LED</td>
<td>0080</td>
</tr>
<tr>
<td></td>
<td>'Alarm' Relay LED</td>
<td>0100</td>
</tr>
<tr>
<td></td>
<td>'Aux 1' Relay LED</td>
<td>0200</td>
</tr>
<tr>
<td></td>
<td>'Aux 2' Relay LED</td>
<td>0400</td>
</tr>
<tr>
<td></td>
<td>'Aux 3' Relay LED</td>
<td>0800</td>
</tr>
<tr>
<td>F10</td>
<td><strong>Two ASCII Characters</strong></td>
<td>FFFF</td>
</tr>
<tr>
<td></td>
<td>32-127 = ASCII Character</td>
<td>FFF0</td>
</tr>
<tr>
<td></td>
<td>32-127 = ASCII Character</td>
<td>FF7F</td>
</tr>
<tr>
<td>F11</td>
<td><strong>Unsigned Integer - Enable/Disable</strong></td>
<td>FFFF</td>
</tr>
<tr>
<td></td>
<td>0 = Disable/OFF</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>1 = Enable/ON</td>
<td>--</td>
</tr>
<tr>
<td>F12</td>
<td><strong>Unsigned Integer - Modbus Baud Rate</strong></td>
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<tr>
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<td>0 = 1200</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>1 = 2400</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>2 = 4800</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>3 = 9600</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>4 = 19200</td>
<td>--</td>
</tr>
<tr>
<td>F13</td>
<td><strong>Unsigned Integer - Parity Type</strong></td>
<td>FFFF</td>
</tr>
<tr>
<td></td>
<td>0 = None</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>1 = Even</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>2 = Odd</td>
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</tr>
<tr>
<td>F14</td>
<td><strong>UNSIGNED INTEGER - ANALOG OUTPUT TYPE</strong></td>
<td>FFFF</td>
</tr>
<tr>
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<td>0 = Not Used</td>
<td>--</td>
</tr>
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</table>
Table 2: Data Formats (Sheet 4 of 18)

<table>
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<th>Code</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Phase A Current</td>
<td>--</td>
</tr>
<tr>
<td>2</td>
<td>Phase B Current</td>
<td>--</td>
</tr>
<tr>
<td>3</td>
<td>Phase C Current</td>
<td>--</td>
</tr>
<tr>
<td>4</td>
<td>Neutral Current</td>
<td>--</td>
</tr>
<tr>
<td>5</td>
<td>Avg Phase Current</td>
<td>--</td>
</tr>
<tr>
<td>6</td>
<td>Current Unbalance</td>
<td>--</td>
</tr>
<tr>
<td>7</td>
<td>Voltage Van</td>
<td>--</td>
</tr>
<tr>
<td>8</td>
<td>Voltage Vbn</td>
<td>--</td>
</tr>
<tr>
<td>9</td>
<td>Voltage Vcn</td>
<td>--</td>
</tr>
<tr>
<td>10</td>
<td>Voltage Vab</td>
<td>--</td>
</tr>
<tr>
<td>11</td>
<td>Voltage Vbc</td>
<td>--</td>
</tr>
<tr>
<td>12</td>
<td>Voltage Vca</td>
<td>--</td>
</tr>
<tr>
<td>13</td>
<td>Avg Phase Voltage</td>
<td>--</td>
</tr>
<tr>
<td>14</td>
<td>Average Line Voltage</td>
<td>--</td>
</tr>
<tr>
<td>15</td>
<td>Voltage Unbalance</td>
<td>--</td>
</tr>
<tr>
<td>16</td>
<td>Frequency</td>
<td>--</td>
</tr>
<tr>
<td>17</td>
<td>3Φ Power Factor</td>
<td>--</td>
</tr>
<tr>
<td>18</td>
<td>3Φ Real Power [kW]</td>
<td>--</td>
</tr>
<tr>
<td>19</td>
<td>3Φ Reactive Pwr [kvar]</td>
<td>--</td>
</tr>
<tr>
<td>20</td>
<td>3Φ Apparent Pwr [kVA]</td>
<td>--</td>
</tr>
<tr>
<td>21</td>
<td>3Φ Real Power [MW]</td>
<td>--</td>
</tr>
<tr>
<td>22</td>
<td>3Φ Reactive Power [Mvar]</td>
<td>--</td>
</tr>
<tr>
<td>23</td>
<td>3Φ Apparent Pwr [MVA]</td>
<td>--</td>
</tr>
<tr>
<td>24</td>
<td>Ph A Power Factor</td>
<td>--</td>
</tr>
<tr>
<td>25</td>
<td>Phase A Real Power</td>
<td>--</td>
</tr>
<tr>
<td>26</td>
<td>Ph A Reactive Power</td>
<td>--</td>
</tr>
<tr>
<td>27</td>
<td>Ph A Apparent Power</td>
<td>--</td>
</tr>
<tr>
<td>28</td>
<td>Ph B Power Factor</td>
<td>--</td>
</tr>
<tr>
<td>29</td>
<td>Phase B Real Power</td>
<td>--</td>
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<tr>
<td>30</td>
<td>Ph B Reactive Power</td>
<td>--</td>
</tr>
<tr>
<td>31</td>
<td>Ph B Apparent Power</td>
<td>--</td>
</tr>
<tr>
<td>32</td>
<td>Ph C Power Factor</td>
<td>--</td>
</tr>
<tr>
<td>33</td>
<td>Phase C Real Power</td>
<td>--</td>
</tr>
<tr>
<td>34</td>
<td>Ph C Reactive Power</td>
<td>--</td>
</tr>
</tbody>
</table>
### Table 2: Data Formats (Sheet 5 of 18)

<table>
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<th>Code</th>
<th>Description</th>
<th>Bitmask</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>Ph C Apparent Power</td>
<td>--</td>
</tr>
<tr>
<td>36</td>
<td>3Φ Positive Real Energy Used</td>
<td>--</td>
</tr>
<tr>
<td>37</td>
<td>3Φ Positive Reactive Energy Used</td>
<td>--</td>
</tr>
<tr>
<td>38</td>
<td>3Φ Negative Real Energy Used</td>
<td>--</td>
</tr>
<tr>
<td>39</td>
<td>3Φ Negative Reactive Energy Used</td>
<td>--</td>
</tr>
<tr>
<td>40</td>
<td>3Φ Apparent Energy Used</td>
<td>--</td>
</tr>
<tr>
<td>41</td>
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<td>3 Wire Delta / 2 VTs</td>
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<td>3 Wire Direct</td>
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<tr>
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<td>4 = Auxiliary Relay 3</td>
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<tr>
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<td>5 = Pulse Input 1</td>
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<tr>
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<tr>
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<td>8 = Select Main/Alt Analog Output</td>
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</tr>
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<td>9 = Select Main/Alt Analog Input</td>
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<td>11 = Pulse Input 3</td>
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<td>12 = Pulse Input 4</td>
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<td>13 = Clear Energy</td>
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<td>14 = Clear Demand</td>
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<td>F22</td>
<td>Time Hours/minutes</td>
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<td>Hours: 0 = 12 am, 1 = 1 am,..., 23 = 11 pm</td>
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### Table 2: Data Formats (Sheet 7 of 18)

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<td>Seconds: 0 = 0.000s,..., 59999 = 59.999s</td>
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<td>F24</td>
<td>Date Month/day</td>
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<td>Month: 1=January,..., 12=December</td>
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<tr>
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<td>Day: 1 to 31 in steps of 1</td>
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<tr>
<td>F25</td>
<td>Unsigned Integer - Date Year</td>
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<td>Year: 1995, 1996,...</td>
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<td>Unsigned Integer: Harmonic Spectrum Parameter</td>
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<td>0 = None</td>
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<tr>
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<td>1 = Phase A Current</td>
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</tr>
<tr>
<td></td>
<td>2 = Phase B Current</td>
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</tr>
<tr>
<td></td>
<td>3 = Phase C Current</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>4 = Neutral Current</td>
<td>--</td>
</tr>
<tr>
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<td>5 = Voltage Vax</td>
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</tr>
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<td>6 = Voltage Vbx</td>
<td>--</td>
</tr>
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<td>7 = Voltage Vcx</td>
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<td>Unsigned Integer - Switch Activation</td>
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<td>0 = Open</td>
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<td>1 = Closed</td>
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<td>0 = Thermal Exponential</td>
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<td>1 = Block Interval</td>
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<td>2 = Rolling Interval</td>
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<td>2 = Auxiliary Relay 1</td>
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<td>3 = Auxiliary Relay 2</td>
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<td>1 = Any Two</td>
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### Table 2: Data Formats (Sheet 8 of 18)

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<td>1 = Yes</td>
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<td>0 = Run to Fill</td>
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<td>1 = Circulate</td>
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<td>1 = Log 1</td>
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</tr>
<tr>
<td></td>
<td>2 = Log 2</td>
<td>--</td>
</tr>
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<td>4 = Reset</td>
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<td>8 = Switch C Alarm</td>
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<td>9 = Switch D Alarm</td>
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<td>11 = COM2 Fail Alarm</td>
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<tr>
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<td>12 = Self Test Alarm</td>
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Table 2: Data Formats (Sheet 9 of 18)

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# Table 2: Data Formats (Sheet 10 of 18)

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<td>Switch D Alarm Clear</td>
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</tr>
<tr>
<td>53</td>
<td>COM1 Fail Alarm Clear</td>
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</tr>
<tr>
<td>54</td>
<td>COM2 Fail Alarm Clear</td>
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<tr>
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<td>Self Test Alarm Clear</td>
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<td>Clock Not Set Alarm Clear</td>
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<td>Parameters Not Set Alarm Clear</td>
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<td>U/V Alarm Clear</td>
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<td>Current Unbalance Alarm Clear</td>
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<td>PF Lead 2 Alarm Clear</td>
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<td>PF Log 2 Alarm Clear</td>
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</tr>
<tr>
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<td>kVA Demand Alarm Clear</td>
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<td>81</td>
<td>Phase A Current Demand Alarm Clear</td>
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<tr>
<td>82</td>
<td>Phase B Current Demand Alarm Clear</td>
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### Table 2: Data Formats (Sheet 11 of 18)

<table>
<thead>
<tr>
<th>Code</th>
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<tr>
<td>83</td>
<td>Phase C Current Demand Alarm Clear</td>
<td></td>
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<tr>
<td>84</td>
<td>Neutral Current Demand Alarm Clear</td>
<td></td>
</tr>
<tr>
<td>85</td>
<td>Pulse In 1 Alarm Clr</td>
<td></td>
</tr>
<tr>
<td>86</td>
<td>I THD Alarm Clear</td>
<td></td>
</tr>
<tr>
<td>87</td>
<td>V THD Alarm Clear</td>
<td></td>
</tr>
<tr>
<td>88</td>
<td>Analog Input Main Alarm Clear</td>
<td></td>
</tr>
<tr>
<td>89</td>
<td>Analog Input Alternate Alarm Clear</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>Data Log 1 Alarm Clr</td>
<td></td>
</tr>
<tr>
<td>91</td>
<td>Data Log 2 Alarm Clr</td>
<td></td>
</tr>
<tr>
<td>92</td>
<td>Pulse Input 2 Alarm</td>
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</tr>
<tr>
<td>93</td>
<td>Pulse Input 3 Alarm</td>
<td></td>
</tr>
<tr>
<td>94</td>
<td>Pulse Input 4 Alarm</td>
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<tr>
<td>95</td>
<td>Pulse Count Total Alarm</td>
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<tr>
<td>96</td>
<td>Pulse In 2 Alarm Clr</td>
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<tr>
<td>97</td>
<td>Pulse In 3 Alarm Clr</td>
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<tr>
<td>98</td>
<td>Pulse In 4 Alarm Clr</td>
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<tr>
<td>99</td>
<td>Pulse Input Total Alarm Clear</td>
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<tr>
<td>100</td>
<td>Time Alarm</td>
<td></td>
</tr>
<tr>
<td>101</td>
<td>Time Alarm Clear</td>
<td></td>
</tr>
<tr>
<td>102</td>
<td>Trace Memory Trig</td>
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**F37 Trace Memory Usage**

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<tbody>
<tr>
<td>0</td>
<td>1 x 36 cycles</td>
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</tr>
<tr>
<td>1</td>
<td>2 x 18 cycles</td>
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<tr>
<td>2</td>
<td>3 x 12 cycles</td>
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**F38 Trace Memory Trigger Mode**

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<th>Code</th>
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<tbody>
<tr>
<td>0</td>
<td>One Shot</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Retrigger</td>
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**F39 Trace Memory Switch Input Trigger**

<table>
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<tbody>
<tr>
<td>0</td>
<td>Off</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Open-to-closed</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Closed-to-open</td>
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**F40 Trace Memory Waveform Selection**

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<tr>
<td>0</td>
<td>ia</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>ib</td>
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Table 2: Data Formats (Sheet 12 of 18)

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<tr>
<td>2</td>
<td>Ic</td>
<td>--</td>
</tr>
<tr>
<td>3</td>
<td>In</td>
<td>--</td>
</tr>
<tr>
<td>4</td>
<td>Va</td>
<td>--</td>
</tr>
<tr>
<td>5</td>
<td>Vb</td>
<td>--</td>
</tr>
<tr>
<td>6</td>
<td>Vc</td>
<td>--</td>
</tr>
<tr>
<td>F41</td>
<td>Trace Memory Triggers</td>
<td>FFFF</td>
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<tr>
<td>0</td>
<td>Trace Memory Not Triggered</td>
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</tr>
<tr>
<td>1</td>
<td>Ia Overcurrent</td>
<td>--</td>
</tr>
<tr>
<td>2</td>
<td>Ib Overcurrent</td>
<td>--</td>
</tr>
<tr>
<td>3</td>
<td>Ic Overcurrent</td>
<td>--</td>
</tr>
<tr>
<td>4</td>
<td>In Overcurrent</td>
<td>--</td>
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<tr>
<td>5</td>
<td>Va Overvoltage</td>
<td>--</td>
</tr>
<tr>
<td>6</td>
<td>Vb Overvoltage</td>
<td>--</td>
</tr>
<tr>
<td>7</td>
<td>Vc Overvoltage</td>
<td>--</td>
</tr>
<tr>
<td>8</td>
<td>Va Undervoltage</td>
<td>--</td>
</tr>
<tr>
<td>9</td>
<td>Vb Undervoltage</td>
<td>--</td>
</tr>
<tr>
<td>10</td>
<td>Vc Undervoltage</td>
<td>--</td>
</tr>
<tr>
<td>11</td>
<td>Switch Input A</td>
<td>--</td>
</tr>
<tr>
<td>12</td>
<td>Switch Input B</td>
<td>--</td>
</tr>
<tr>
<td>13</td>
<td>Switch Input C</td>
<td>--</td>
</tr>
<tr>
<td>14</td>
<td>Switch Input D</td>
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</tr>
<tr>
<td>15</td>
<td>Serial Comms.</td>
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<tr>
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<td>Pulse Input Totalization</td>
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<tr>
<td>0</td>
<td>1+2</td>
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</tr>
<tr>
<td>1</td>
<td>1+3</td>
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</tr>
<tr>
<td>2</td>
<td>1+4</td>
<td>--</td>
</tr>
<tr>
<td>3</td>
<td>2+3</td>
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</tr>
<tr>
<td>4</td>
<td>2+4</td>
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</tr>
<tr>
<td>5</td>
<td>3+4</td>
<td>--</td>
</tr>
<tr>
<td>6</td>
<td>1+2+3</td>
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<tr>
<td>7</td>
<td>1+3+4</td>
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<td>1+2+3+4</td>
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<td>1+2+4</td>
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### Table 2: Data Formats (Sheet 13 of 18)

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<tr>
<td>F44</td>
<td>Phase CT Wiring</td>
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<tr>
<td></td>
<td>0 = Phase A, B and C</td>
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</tr>
<tr>
<td></td>
<td>1 = Phase A and B only</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>2 = Phase A and C only</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>3 = Phase A only</td>
<td>--</td>
</tr>
<tr>
<td>F45</td>
<td>CPU Speed</td>
<td>FFFF</td>
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<tr>
<td></td>
<td>0 = 16 MHz</td>
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</tr>
<tr>
<td></td>
<td>1 = 25 MHz</td>
<td>--</td>
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<tr>
<td>F47</td>
<td>DNP Port</td>
<td>FFFF</td>
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<td></td>
<td>0 = None</td>
<td>--</td>
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<tr>
<td></td>
<td>1 = RS232</td>
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</tr>
<tr>
<td></td>
<td>2 = COM1</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td>3 = COM2</td>
<td>--</td>
</tr>
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<td>PQMII Options</td>
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<td>PQMII (Display Version)</td>
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<td>T1 (0-1mA Transducer)</td>
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<td></td>
<td>C (Control) Option</td>
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<td></td>
<td>A (Power Analysis) Option</td>
<td>0010</td>
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<tr>
<td>F101</td>
<td>Switch Input Status (0 = Open, 1 = Closed)</td>
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<tr>
<td></td>
<td>Switch A</td>
<td>0100</td>
</tr>
<tr>
<td></td>
<td>Switch B</td>
<td>0200</td>
</tr>
<tr>
<td></td>
<td>Switch C</td>
<td>0400</td>
</tr>
<tr>
<td></td>
<td>Switch D</td>
<td>0800</td>
</tr>
<tr>
<td>F102</td>
<td>LED Status Flags: (0=Inactive, 1=Active)</td>
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<tr>
<td></td>
<td>Aux 1 Relay</td>
<td>0001</td>
</tr>
<tr>
<td></td>
<td>Aux 2 Relay</td>
<td>0002</td>
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<tr>
<td></td>
<td>Aux 3 Relay</td>
<td>0004</td>
</tr>
<tr>
<td></td>
<td>Alarm</td>
<td>0008</td>
</tr>
<tr>
<td></td>
<td>Program</td>
<td>0010</td>
</tr>
<tr>
<td></td>
<td>Simulation</td>
<td>0020</td>
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<td>Alarm Relay</td>
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## Table 2: Data Formats (Sheet 14 of 18)

<table>
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<tbody>
<tr>
<td>F103</td>
<td><strong>LED Attribute Flags</strong> (0 = Flashing, 1 = Solid; Active)</td>
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</tr>
<tr>
<td></td>
<td>Aux 1 Relay</td>
<td>0001</td>
</tr>
<tr>
<td></td>
<td>Aux 2 Relay</td>
<td>0002</td>
</tr>
<tr>
<td></td>
<td>Aux 3 Relay</td>
<td>0004</td>
</tr>
<tr>
<td></td>
<td>Alarm</td>
<td>0008</td>
</tr>
<tr>
<td></td>
<td>Program</td>
<td>0010</td>
</tr>
<tr>
<td></td>
<td>Simulation</td>
<td>0020</td>
</tr>
<tr>
<td></td>
<td>Alarm Relay</td>
<td>0040</td>
</tr>
<tr>
<td></td>
<td>Self Test</td>
<td>0080</td>
</tr>
<tr>
<td>F104</td>
<td><strong>Output Relay Flag</strong> (0=de-energized, 1=energized)</td>
<td>FFFF</td>
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<tr>
<td></td>
<td>Alarm Relay</td>
<td>0001</td>
</tr>
<tr>
<td></td>
<td>Auxiliary Relay 1</td>
<td>0002</td>
</tr>
<tr>
<td></td>
<td>Auxiliary Relay 2</td>
<td>0004</td>
</tr>
<tr>
<td></td>
<td>Auxiliary Relay 3</td>
<td>0008</td>
</tr>
<tr>
<td>F105</td>
<td><strong>Alarm Status Flags 1</strong></td>
<td>FFFF</td>
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<tr>
<td></td>
<td>Phase Undercurrent Alarm</td>
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<tr>
<td></td>
<td>Phase Overcurrent Alarm</td>
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<td></td>
<td>Neutral Overcurrent Alarm</td>
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<td>Undervoltage Alarm</td>
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<td>Overvoltage Alarm</td>
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<td>Current Unbalance Alarm</td>
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<td>Voltage Unbalance Alarm</td>
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<td>Voltage Phase Reversal</td>
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<td>PF Lead Alarm 1</td>
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<td>PF Lead Alarm 2</td>
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<td>Power Factor Lag Alarm 1</td>
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<tr>
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<td>Power Factor Lag Alarm 2</td>
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<td>Positive Real Power Alarm</td>
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<tr>
<td></td>
<td>Neg Real Power Alarm</td>
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<td>Pos Reactive Power Alarm</td>
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<td>Neg Reactive Power Alarm</td>
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### Table 2: Data Formats (Sheet 15 of 18)

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<td>Clock Not Set Alarm</td>
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<td>Parameters Not Set Alarm</td>
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<td>Pulse Input 1 Alarm</td>
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<td>Current THD Alarm</td>
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<td>Voltage THD Alarm</td>
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</tr>
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<td>Analog Input Main Alarm</td>
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<tr>
<td></td>
<td>Analog Input Alt Alarm</td>
<td>0040</td>
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<td></td>
<td>Data Log 1</td>
<td>0080</td>
</tr>
<tr>
<td></td>
<td>Data Log 2</td>
<td>0100</td>
</tr>
<tr>
<td></td>
<td>Negative Real Power Demand Alarm</td>
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<tr>
<td></td>
<td>Negative Reactive Power Demand Alarm</td>
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<tr>
<td></td>
<td>Pulse Input 2 Alarm</td>
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</tr>
<tr>
<td></td>
<td>Pulse Input 3 Alarm</td>
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</tr>
<tr>
<td></td>
<td>Pulse Input 4 Alarm</td>
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<td>Totalized Pulse In Alarm</td>
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<td>Time Alarm</td>
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</table>

| F108  | Internal Fault Error Code       | FFFF    |
|       | ADC Ref Out of Range            | 0001    |
### Table 2: Data Formats (Sheet 16 of 18)

<table>
<thead>
<tr>
<th>Code</th>
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<tr>
<td>Reserved</td>
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<td>Switch Input Circuit Fault</td>
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<tr>
<td>Reserved</td>
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<tr>
<td>F109</td>
<td>General Status</td>
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<tr>
<td>Alarm Present</td>
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</tr>
<tr>
<td>Clock Not Set</td>
<td>0002</td>
<td></td>
</tr>
<tr>
<td>Clock Drifting</td>
<td>0004</td>
<td></td>
</tr>
<tr>
<td>Data Log 1 Running</td>
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<td></td>
</tr>
<tr>
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Table 2: Data Formats (Sheet 17 of 18)

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<td>Log 1</td>
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<tr>
<td></td>
<td>Log 2</td>
<td>0002</td>
</tr>
<tr>
<td>F111</td>
<td>Event Record Switches And Relay Status</td>
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<td>Alarm Relay</td>
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</tr>
<tr>
<td></td>
<td>Auxiliary Relay 1</td>
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</tr>
<tr>
<td></td>
<td>Auxiliary Relay 2</td>
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</tr>
<tr>
<td></td>
<td>Auxiliary Relay 3</td>
<td>0008</td>
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<tr>
<td>F112</td>
<td>Event Recorder Event Enable Flags 4</td>
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<td>Power Off</td>
<td>0002</td>
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<td>Alarm / Control Reset</td>
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<td>Setpoint Access Enable</td>
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<td>F113</td>
<td>Trace Memory Triggered Flag Status</td>
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<td></td>
<td>0 = Trace Memory Not Triggered</td>
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<tr>
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<td>1 = Trace Memory Triggered</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>2 to 16 = Not Used</td>
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<td>F114</td>
<td>Power Alarms Level Base Units</td>
<td>FFFF</td>
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<td>0 = kW/kVAR</td>
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<tr>
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<td>1 = MW/MVAR</td>
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</tr>
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<td>2 to 16 = Not Used</td>
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<td>Phase Overcurrent Activation</td>
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<td>0 = Average</td>
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<tr>
<td></td>
<td>1 = Maximum</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>2 to 16 = Not Used</td>
<td>---</td>
</tr>
<tr>
<td>F116</td>
<td>Product Options Upgrade</td>
<td>FFFF</td>
</tr>
<tr>
<td></td>
<td>1=PQMII</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>3=PQMII-T20</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>5=PQMII-T1</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>7=PQMII-C</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>9=PQMII-T20-C</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>11=PQMII-T1-C</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>13=PQMII-A</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>15=PQMII-T20-A</td>
<td>---</td>
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</table>
3.5 Analog Output Parameter Range

<table>
<thead>
<tr>
<th>No.</th>
<th>Analog Out Parameter</th>
<th>Range</th>
<th>Step</th>
<th>Units/scale</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Not Used</td>
<td>0</td>
<td>0</td>
<td>---</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>Phase A Current</td>
<td>0 to 150</td>
<td>1</td>
<td>%</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Phase B Current</td>
<td>0 to 150</td>
<td>1</td>
<td>%</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>Phase C Current</td>
<td>0 to 150</td>
<td>1</td>
<td>%</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>Neutral Current</td>
<td>0 to 150</td>
<td>1</td>
<td>%</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>Average Phase Current</td>
<td>0 to 150</td>
<td>1</td>
<td>%</td>
<td>0</td>
</tr>
</tbody>
</table>

* Since values of –0 and +0 both exist for power factor, the value stored in the PQMII serial register is the opposite of the value shown on the display. For example: if a range of 0.23 lead (–0.23) to 0.35 lag (+0.35) is required, –77 (–100 + 23) and +65 (100 – 35) must be sent.
Table 3: Analog Output Parameter Range for Serial Ports (Sheet 2 of 3)

<table>
<thead>
<tr>
<th>No.</th>
<th>Analog Out Parameter</th>
<th>Range</th>
<th>Step</th>
<th>Units/scale</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Current Unbalance</td>
<td>0 to 1000</td>
<td>1</td>
<td>0.1 x%</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>Voltage Van</td>
<td>0 to 200</td>
<td>1</td>
<td>%</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>Voltage Vbn</td>
<td>0 to 200</td>
<td>1</td>
<td>%</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>Voltage Vcn</td>
<td>0 to 200</td>
<td>1</td>
<td>%</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>Voltage Vab</td>
<td>0 to 200</td>
<td>1</td>
<td>%</td>
<td>0</td>
</tr>
<tr>
<td>11</td>
<td>Voltage Vbc</td>
<td>0 to 200</td>
<td>1</td>
<td>%</td>
<td>0</td>
</tr>
<tr>
<td>12</td>
<td>Voltage Vca</td>
<td>0 to 200</td>
<td>1</td>
<td>%</td>
<td>0</td>
</tr>
<tr>
<td>13</td>
<td>Average Phase Voltage</td>
<td>0 to 200</td>
<td>1</td>
<td>%</td>
<td>0</td>
</tr>
<tr>
<td>14</td>
<td>Average Line Voltage</td>
<td>0 to 200</td>
<td>1</td>
<td>%</td>
<td>0</td>
</tr>
<tr>
<td>15</td>
<td>Voltage Unbalance</td>
<td>0 to 1000</td>
<td>1</td>
<td>0.1 x%</td>
<td>0</td>
</tr>
<tr>
<td>16</td>
<td>Frequency</td>
<td>0 to 7500</td>
<td>1</td>
<td>0.01 x Hz</td>
<td>0</td>
</tr>
<tr>
<td>17</td>
<td>*3 Phase PF</td>
<td>-99 to +99</td>
<td>1</td>
<td>0.01 x PF</td>
<td>0</td>
</tr>
<tr>
<td>18</td>
<td>3 Phase kW</td>
<td>-32500 to +32500</td>
<td>1</td>
<td>kW</td>
<td>0</td>
</tr>
<tr>
<td>19</td>
<td>3 Phase kvar</td>
<td>-32500 to +32500</td>
<td>1</td>
<td>kvar</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>3 Phase kVA</td>
<td>0 to 65400</td>
<td>1</td>
<td>kVA</td>
<td>0</td>
</tr>
<tr>
<td>21</td>
<td>3 Phase MW</td>
<td>-32500 to +32500</td>
<td>1</td>
<td>0.1 x MW</td>
<td>0</td>
</tr>
<tr>
<td>22</td>
<td>3 Phase Mvar</td>
<td>-32500 to +32500</td>
<td>1</td>
<td>0.1 x Mvar</td>
<td>0</td>
</tr>
<tr>
<td>23</td>
<td>3 Phase MVA</td>
<td>0 to 65400</td>
<td>1</td>
<td>0.1 x MVA</td>
<td>0</td>
</tr>
<tr>
<td>24</td>
<td>*Phase A PF</td>
<td>-99 to +99</td>
<td>1</td>
<td>0.01 x PF</td>
<td>0</td>
</tr>
<tr>
<td>25</td>
<td>Phase A kW</td>
<td>-32500 to +32500</td>
<td>1</td>
<td>kW</td>
<td>0</td>
</tr>
<tr>
<td>26</td>
<td>Phase A kvar</td>
<td>-32500 to +32500</td>
<td>1</td>
<td>kvar</td>
<td>0</td>
</tr>
<tr>
<td>27</td>
<td>Phase A kVA</td>
<td>0 to 65400</td>
<td>1</td>
<td>kVA</td>
<td>0</td>
</tr>
<tr>
<td>28</td>
<td>*Phase B PF</td>
<td>-99 to +99</td>
<td>1</td>
<td>0.01 x PF</td>
<td>0</td>
</tr>
<tr>
<td>29</td>
<td>Phase B kW</td>
<td>-32500 to +32500</td>
<td>1</td>
<td>kW</td>
<td>0</td>
</tr>
<tr>
<td>30</td>
<td>Phase B kvar</td>
<td>-32500 to +32500</td>
<td>1</td>
<td>kvar</td>
<td>0</td>
</tr>
<tr>
<td>31</td>
<td>Phase B kVA</td>
<td>0 to 65400</td>
<td>1</td>
<td>kVA</td>
<td>0</td>
</tr>
<tr>
<td>32</td>
<td>*Phase C PF</td>
<td>-99 to +99</td>
<td>1</td>
<td>0.01 x PF</td>
<td>0</td>
</tr>
<tr>
<td>33</td>
<td>Phase C kW</td>
<td>-32500 to +32500</td>
<td>1</td>
<td>kW</td>
<td>0</td>
</tr>
<tr>
<td>34</td>
<td>Phase C kvar</td>
<td>-32500 to +32500</td>
<td>1</td>
<td>kvar</td>
<td>0</td>
</tr>
</tbody>
</table>

* Since values of –0 and +0 both exist for power factor, the value stored in the PQMII serial register is the opposite of the value shown on the display. For example: if a range of 0.23 lead (–0.23) to 0.35 lag (+0.35) is required, –77 (–100 + 23) and +65 (100 – 35) must be sent.
### Table 3: Analog Output Parameter Range for Serial Ports (Sheet 3 of 3)

<table>
<thead>
<tr>
<th>No.</th>
<th>Analog Out Parameter</th>
<th>Range</th>
<th>Step</th>
<th>Units/scale</th>
<th>Default</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>Phase C kVA</td>
<td>0 to 65400</td>
<td>1</td>
<td>kVA</td>
<td>0</td>
</tr>
<tr>
<td>36</td>
<td>3 Phase +kWh Used</td>
<td>0 to 65400</td>
<td>1</td>
<td>kWh</td>
<td>0</td>
</tr>
<tr>
<td>37</td>
<td>3 Phase +kvarh Used</td>
<td>0 to 65400</td>
<td>1</td>
<td>kvarh</td>
<td>0</td>
</tr>
<tr>
<td>38</td>
<td>3 Phase -kWh Used</td>
<td>0 to 65400</td>
<td>1</td>
<td>kWh</td>
<td>0</td>
</tr>
<tr>
<td>39</td>
<td>3 Phase -kvarh Used</td>
<td>0 to 65400</td>
<td>1</td>
<td>kvarh</td>
<td>0</td>
</tr>
<tr>
<td>40</td>
<td>3 Phase kVAh Used</td>
<td>0 to 65400</td>
<td>1</td>
<td>kVAh</td>
<td>0</td>
</tr>
<tr>
<td>41</td>
<td>Phase A Current Demand</td>
<td>0 to 7500</td>
<td>1</td>
<td>A</td>
<td>0</td>
</tr>
<tr>
<td>42</td>
<td>Phase B Current Demand</td>
<td>0 to 7500</td>
<td>1</td>
<td>A</td>
<td>0</td>
</tr>
<tr>
<td>43</td>
<td>Phase C Current Demand</td>
<td>0 to 7500</td>
<td>1</td>
<td>A</td>
<td>0</td>
</tr>
<tr>
<td>44</td>
<td>Neutral Current Demand</td>
<td>0 to 7500</td>
<td>1</td>
<td>A</td>
<td>0</td>
</tr>
<tr>
<td>45</td>
<td>3 Phase kW Demand</td>
<td>-32500 to +32500</td>
<td>1</td>
<td>kW</td>
<td>0</td>
</tr>
<tr>
<td>46</td>
<td>3 Phase kvar Demand</td>
<td>-32500 to +32500</td>
<td>1</td>
<td>kvar</td>
<td>0</td>
</tr>
<tr>
<td>47</td>
<td>3 Phase kVA Demand</td>
<td>0 to 65400</td>
<td>1</td>
<td>kVA</td>
<td>0</td>
</tr>
<tr>
<td>48</td>
<td>3 Phase Current THD</td>
<td>0 to 1000</td>
<td>1</td>
<td>0.1 × %</td>
<td>0</td>
</tr>
<tr>
<td>49</td>
<td>Three Phase Voltage THD</td>
<td>0 to 1000</td>
<td>1</td>
<td>0.1 × %</td>
<td>0</td>
</tr>
<tr>
<td>50</td>
<td>Phase A Current THD</td>
<td>0 to 1000</td>
<td>1</td>
<td>0.1 × %</td>
<td>0</td>
</tr>
<tr>
<td>51</td>
<td>Phase B Current THD</td>
<td>0 to 1000</td>
<td>1</td>
<td>0.1 × %</td>
<td>0</td>
</tr>
<tr>
<td>52</td>
<td>Phase C Current THD</td>
<td>0 to 1000</td>
<td>1</td>
<td>0.1 × %</td>
<td>0</td>
</tr>
<tr>
<td>53</td>
<td>Voltage Van THD</td>
<td>0 to 1000</td>
<td>1</td>
<td>0.1 × %</td>
<td>0</td>
</tr>
<tr>
<td>54</td>
<td>Voltage Vbn THD</td>
<td>0 to 1000</td>
<td>1</td>
<td>0.1 × %</td>
<td>0</td>
</tr>
<tr>
<td>55</td>
<td>Voltage Vcn THD</td>
<td>0 to 1000</td>
<td>1</td>
<td>0.1 × %</td>
<td>0</td>
</tr>
<tr>
<td>56</td>
<td>Voltage Vab THD</td>
<td>0 to 1000</td>
<td>1</td>
<td>0.1 × %</td>
<td>0</td>
</tr>
<tr>
<td>57</td>
<td>Voltage Vbc THD</td>
<td>0 to 1000</td>
<td>1</td>
<td>0.1 × %</td>
<td>0</td>
</tr>
<tr>
<td>58</td>
<td>Neutral Current THD</td>
<td>0 to 1000</td>
<td>1</td>
<td>0.1 × %</td>
<td>0</td>
</tr>
<tr>
<td>59</td>
<td>Serial Control</td>
<td>-32500 to +32500</td>
<td>1</td>
<td>---</td>
<td>0</td>
</tr>
</tbody>
</table>

* Since values of −0 and +0 both exist for power factor, the value stored in the PQMI serial register is the opposite of the value shown on the display. For example: if a range of 0.23 lead (−0.23) to 0.35 lag (+0.35) is required, −77 (−100 + 23) and +65 (100 − 35) must be sent.
# DNP 3.0 Communications

## 4.1 DNP 3.0 Device Profile Document

The communications port configured as a DNP slave port must support the full set of features listed in the Level 2 DNP V3.00 Implementation (DNP-L2) described in Chapter 2 of the subset definitions. See the DNP protocol website at [http://www.dnp.org](http://www.dnp.org) for details.

<table>
<thead>
<tr>
<th>DNP 3.0: DEVICE PROFILE DOCUMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vendor Name: General Electric Multilin Inc.</td>
</tr>
<tr>
<td>Device Name: PQMII Power Quality Meter</td>
</tr>
<tr>
<td>Highest DNP Level Supported:</td>
</tr>
<tr>
<td>For Requests: Level 2</td>
</tr>
<tr>
<td>For Responses: Level 2</td>
</tr>
<tr>
<td>Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table):</td>
</tr>
<tr>
<td>Maximum Data Link Frame Size (octets):</td>
</tr>
<tr>
<td>Transmitted: 249</td>
</tr>
<tr>
<td>Received: 292</td>
</tr>
<tr>
<td>Maximum Data Link Re-tries:</td>
</tr>
<tr>
<td>[ ] None</td>
</tr>
<tr>
<td>[ ] Fixed</td>
</tr>
<tr>
<td>[ ] Configurable</td>
</tr>
<tr>
<td>Requires Data Link Layer Confirmation:</td>
</tr>
<tr>
<td>[ ] Never</td>
</tr>
<tr>
<td>[ ] Always</td>
</tr>
<tr>
<td>[ ] Sometimes</td>
</tr>
<tr>
<td>[ ] Configurable</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Timeouts while waiting for:</td>
</tr>
<tr>
<td>Data Link Confirm</td>
</tr>
<tr>
<td>Complete Appl. Fragment</td>
</tr>
<tr>
<td>Application Confirm</td>
</tr>
<tr>
<td>(fixed value is 5000 milliseconds)</td>
</tr>
<tr>
<td>Complete Appl. Response</td>
</tr>
<tr>
<td>Others: [ ] None</td>
</tr>
</tbody>
</table>
### Implementation Table

The following table lists all objects recognized and returned by the PQMII. Additional information provided on the following pages includes lists of the default variations and defined point numbers returned for each object.

#### Implementation Table Notes:

1. For this object, the quantity specified in the request must be exactly 1 as there is only one instance of this object defined in the relay.
2. All static input data known to the relay is returned in response to a request for Class 0. This includes all objects of type 1 (Binary Input) and type 30 (Analog Input).
3. The point tables for Binary Input and Analog Input objects contain a field which defines which event class the corresponding static data has been assigned to.

4. For this object, the qualifier code must specify an index of 7 only.

5. Warm Restart (function code 14) is supported although it is not required by the DNP level 2 specification.

6. Object 1 Variation 1 always indicates On Line for all points.

### Table 4: DNP Implementation Table

<table>
<thead>
<tr>
<th>Obj</th>
<th>Var</th>
<th>Description</th>
<th>Func Codes</th>
<th>Qual Codes (Hex)</th>
<th>Func Codes</th>
<th>Qual Codes (Hex)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>Binary Input - All Variations</td>
<td>06</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>Binary Input</td>
<td>00, 01, 06</td>
<td>129</td>
<td>00, 01</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>Binary Input With Status (Note 6)</td>
<td>00, 01, 06</td>
<td>129</td>
<td>00, 01</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>Binary Input Change - All Variations</td>
<td>06, 07, 08</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>Binary Input Change Without Time</td>
<td>06, 07, 08</td>
<td>129</td>
<td>17, 28</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Binary Input Change With Time</td>
<td>06, 07, 08</td>
<td>129</td>
<td>17, 28</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>Binary Output - All Variations</td>
<td>06</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>Binary Output Status</td>
<td>00, 01, 06</td>
<td>129</td>
<td>00, 01</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>1</td>
<td>Control Relay Output Block</td>
<td>3, 4, 5, 6</td>
<td>17, 28</td>
<td>129</td>
<td>17, 28</td>
</tr>
<tr>
<td>20</td>
<td>0</td>
<td>Binary Counter - All Variations</td>
<td>06, 07, 08</td>
<td>129</td>
<td>00, 01</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>5</td>
<td>32-Bit Binary Counter Without Flag</td>
<td>06, 07, 08</td>
<td>129</td>
<td>00, 01</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>6</td>
<td>16-Bit Binary Counter Without Flag</td>
<td>06, 07, 08</td>
<td>129</td>
<td>00, 01</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>0</td>
<td>Analog Input - All Variations</td>
<td>06</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>1</td>
<td>32-Bit Analog Input With Flag</td>
<td>00, 01, 06</td>
<td>129</td>
<td>00, 01</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>2</td>
<td>16-Bit Analog Input With Flag</td>
<td>00, 01, 06</td>
<td>129</td>
<td>00, 01</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>3</td>
<td>32-Bit Analog Input Without Flag</td>
<td>00, 01, 06</td>
<td>129</td>
<td>00, 01</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>4</td>
<td>16-Bit Analog Input Without Flag</td>
<td>00, 01, 06</td>
<td>129</td>
<td>00, 01</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>0</td>
<td>Analog Input Change - All Variations</td>
<td>06, 07, 08</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>1</td>
<td>32-Bit Analog Input Change without Time</td>
<td>06, 07, 08</td>
<td>129</td>
<td>17, 28</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>2</td>
<td>16-Bit Analog Input Change without Time</td>
<td>06, 07, 08</td>
<td>129</td>
<td>17, 28</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>3</td>
<td>32-Bit Analog Input Change with Time</td>
<td>06, 07, 08</td>
<td>129</td>
<td>17, 28</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>4</td>
<td>16-Bit Analog Input Change with Time</td>
<td>06, 07, 08</td>
<td>129</td>
<td>17, 28</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>1</td>
<td>Time and Date</td>
<td>07 (Note 1)</td>
<td>129</td>
<td>07</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>1</td>
<td>Class 0 Data (Note 2)</td>
<td>06</td>
<td>129</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>2</td>
<td>Class 1 Data (Note 3)</td>
<td>06, 07, 08</td>
<td>129</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>3</td>
<td>Class 2 Data (Note 3)</td>
<td>06, 07, 08</td>
<td>129</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>4</td>
<td>Class 3 Data (Note 3)</td>
<td>06, 07, 08</td>
<td>129</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>1</td>
<td>Internal Indications</td>
<td>00 (Note 4)</td>
<td>129</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1, 2, 3, 4, 5, 6: see the IMPLEMENTATION TABLE NOTES above.
### 4.3 Default Variations

The following table specifies the default variation for all objects returned by the relay. These are the variations that will be returned for the object in a response when no specific variation is specified in a request.

#### Table 5: Default Variations

<table>
<thead>
<tr>
<th>Object</th>
<th>Description</th>
<th>Default Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Binary Input - Single Bit</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Binary Input Change With Time</td>
<td>2</td>
</tr>
<tr>
<td>10</td>
<td>Binary Output Status</td>
<td>2</td>
</tr>
<tr>
<td>12</td>
<td>Control Relay Output Block</td>
<td>1</td>
</tr>
<tr>
<td>20</td>
<td>32-Bit Binary Counter Without Flag</td>
<td>5</td>
</tr>
<tr>
<td>30</td>
<td>16-Bit Analog Input Without Flag</td>
<td>2</td>
</tr>
<tr>
<td>32</td>
<td>16-Bit Analog Input Change Without Time</td>
<td>2</td>
</tr>
</tbody>
</table>

### 4.4 Internal Indication Bits

The following internal indication bits are supported:

#### Table 6: Internal Indication Bits

<table>
<thead>
<tr>
<th>Character Position</th>
<th>Bit Position</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>7</td>
<td>Device Restart: set when PQMII powers up, cleared by writing zero to object 80</td>
</tr>
<tr>
<td>0</td>
<td>4</td>
<td>Need Time -- set whenever the PQMII has a “CLOCK NOT SET” alarm, cleared by setting the clock</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>Class 1: indicates that class 1 events are available</td>
</tr>
<tr>
<td>0</td>
<td>2</td>
<td>Class 2: indicates that class 2 events are available</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
<td>Class 3: indicates that class 2 events are available</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>Buffer Overflow: generally indicates that the host has not picked up the event data often enough</td>
</tr>
</tbody>
</table>
5 DNP Point Lists

5.1 Binary Input / Binary Input Change

The DNP point list for Binary Input / Binary Input Change Point List (objects 01 and 02, respectively), is shown below.

This point is also reflected in the corresponding internal indication (IIN) bit in each response header.

Table 7: Binary Input / Binary Input Change Points (Sheet 1 of 4)

<table>
<thead>
<tr>
<th>Index</th>
<th>Description</th>
<th>Event Class Assigned To</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Alarm condition(s) active</td>
<td>Class 1</td>
</tr>
<tr>
<td>1</td>
<td>Clock not set *</td>
<td>Class 1</td>
</tr>
<tr>
<td>2</td>
<td>Clock drifting</td>
<td>Class 1</td>
</tr>
<tr>
<td>3</td>
<td>Internal error: ADC reference out of range</td>
<td>Class 1</td>
</tr>
<tr>
<td>4</td>
<td>Reserved</td>
<td>---</td>
</tr>
<tr>
<td>5</td>
<td>Internal error: switch input circuit fault</td>
<td>Class 1</td>
</tr>
<tr>
<td>6</td>
<td>PQMII (display) option installed **</td>
<td>Class 1</td>
</tr>
<tr>
<td>7</td>
<td>T20 (4-20 mA transducer) option installed **</td>
<td>Class 1</td>
</tr>
<tr>
<td>8</td>
<td>T1 (0-1 mA transducer) option installed **</td>
<td>Class 1</td>
</tr>
<tr>
<td>9</td>
<td>C (control) option installed **</td>
<td>Class 1</td>
</tr>
<tr>
<td>10</td>
<td>A (power analysis) option installed **</td>
<td>Class 1</td>
</tr>
<tr>
<td>11</td>
<td>Switch A closed</td>
<td>Class 1</td>
</tr>
<tr>
<td>12</td>
<td>Switch B closed</td>
<td>Class 1</td>
</tr>
<tr>
<td>13</td>
<td>Switch C closed</td>
<td>Class 1</td>
</tr>
<tr>
<td>14</td>
<td>Switch D closed</td>
<td>Class 1</td>
</tr>
<tr>
<td>15</td>
<td>Alarm relay energized</td>
<td>Class 1</td>
</tr>
<tr>
<td>16</td>
<td>Auxiliary relay 1 energized</td>
<td>Class 1</td>
</tr>
<tr>
<td>17</td>
<td>Auxiliary relay 2 energized</td>
<td>Class 1</td>
</tr>
<tr>
<td>18</td>
<td>Auxiliary relay 3 energized</td>
<td>Class 1</td>
</tr>
<tr>
<td>19</td>
<td>Aux 1 relay LED active</td>
<td>Class 1</td>
</tr>
<tr>
<td>20</td>
<td>Aux 2 relay LED active</td>
<td>Class 1</td>
</tr>
</tbody>
</table>

* This point is also reflected in the corresponding internal indication (IIN) bit in each response header.
** This point is not reflected in a Binary Input Change.
### Table 7: Binary Input / Binary Input Change Points (Sheet 2 of 4)

<table>
<thead>
<tr>
<th>Index</th>
<th>Description</th>
<th>Event Class Assigned To</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>Aux 3 relay LED active</td>
<td>Class 1</td>
</tr>
<tr>
<td>22</td>
<td>Alarm LED active</td>
<td>Class 1</td>
</tr>
<tr>
<td>23</td>
<td>Program LED active</td>
<td>Class 1</td>
</tr>
<tr>
<td>24</td>
<td>Simulation LED active</td>
<td>Class 1</td>
</tr>
<tr>
<td>25</td>
<td>Alarm relay LED active</td>
<td>Class 1</td>
</tr>
<tr>
<td>26</td>
<td>Self test LED active</td>
<td>Class 1</td>
</tr>
<tr>
<td>27</td>
<td>Reserved</td>
<td>---</td>
</tr>
<tr>
<td>28</td>
<td>Reserved</td>
<td>---</td>
</tr>
<tr>
<td>29</td>
<td>Reserved</td>
<td>---</td>
</tr>
<tr>
<td>30</td>
<td>Reserved</td>
<td>---</td>
</tr>
<tr>
<td>31</td>
<td>Reserved</td>
<td>---</td>
</tr>
<tr>
<td>32</td>
<td>Reserved</td>
<td>---</td>
</tr>
<tr>
<td>33</td>
<td>Reserved</td>
<td>---</td>
</tr>
<tr>
<td>34</td>
<td>Reserved</td>
<td>---</td>
</tr>
<tr>
<td>35</td>
<td>Alarm active: phase undercurrent</td>
<td>Class 1</td>
</tr>
<tr>
<td>36</td>
<td>Alarm active: phase overcurrent</td>
<td>Class 1</td>
</tr>
<tr>
<td>37</td>
<td>Alarm active: neutral overcurrent</td>
<td>Class 1</td>
</tr>
<tr>
<td>38</td>
<td>Alarm active: undervoltage</td>
<td>Class 1</td>
</tr>
<tr>
<td>39</td>
<td>Alarm active: overvoltage</td>
<td>Class 1</td>
</tr>
<tr>
<td>40</td>
<td>Alarm active: current unbalance</td>
<td>Class 1</td>
</tr>
<tr>
<td>41</td>
<td>Alarm active: voltage unbalance</td>
<td>Class 1</td>
</tr>
<tr>
<td>42</td>
<td>Alarm active: voltage phase reversal</td>
<td>Class 1</td>
</tr>
<tr>
<td>43</td>
<td>Alarm active: power factor lead alarm 1</td>
<td>Class 1</td>
</tr>
<tr>
<td>44</td>
<td>Alarm active: power factor lead alarm 2</td>
<td>Class 1</td>
</tr>
<tr>
<td>45</td>
<td>Alarm active: power factor lag alarm 1</td>
<td>Class 1</td>
</tr>
<tr>
<td>46</td>
<td>Alarm active: power factor lag alarm 2</td>
<td>Class 1</td>
</tr>
<tr>
<td>47</td>
<td>Alarm active: positive real power</td>
<td>Class 1</td>
</tr>
<tr>
<td>48</td>
<td>Alarm active: negative real power</td>
<td>Class 1</td>
</tr>
<tr>
<td>49</td>
<td>Alarm active: positive reactive power</td>
<td>Class 1</td>
</tr>
</tbody>
</table>

* This point is also reflected in the corresponding internal indication (IIN) bit in each response header.
** This point is not reflected in a Binary Input Change.
Table 7: Binary Input / Binary Input Change Points (Sheet 3 of 4)

<table>
<thead>
<tr>
<th>Index</th>
<th>Description</th>
<th>Event Class Assigned To</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>Alarm active: negative reactive power</td>
<td>Class 1</td>
</tr>
<tr>
<td>51</td>
<td>Alarm active: underfrequency</td>
<td>Class 1</td>
</tr>
<tr>
<td>52</td>
<td>Alarm active: overfrequency</td>
<td>Class 1</td>
</tr>
<tr>
<td>53</td>
<td>Alarm active: real power demand</td>
<td>Class 1</td>
</tr>
<tr>
<td>54</td>
<td>Alarm active: reactive power demand</td>
<td>Class 1</td>
</tr>
<tr>
<td>55</td>
<td>Alarm active: apparent power demand</td>
<td>Class 1</td>
</tr>
<tr>
<td>56</td>
<td>Alarm active: phase A current demand</td>
<td>Class 1</td>
</tr>
<tr>
<td>57</td>
<td>Alarm active: phase B current demand</td>
<td>Class 1</td>
</tr>
<tr>
<td>58</td>
<td>Alarm active: phase C current demand</td>
<td>Class 1</td>
</tr>
<tr>
<td>59</td>
<td>Alarm active: Neutral demand</td>
<td>Class 1</td>
</tr>
<tr>
<td>60</td>
<td>Alarm active: switch A</td>
<td>Class 1</td>
</tr>
<tr>
<td>61</td>
<td>Alarm active: switch B</td>
<td>Class 1</td>
</tr>
<tr>
<td>62</td>
<td>Alarm active: switch C</td>
<td>Class 1</td>
</tr>
<tr>
<td>63</td>
<td>Alarm active: switch D</td>
<td>Class 1</td>
</tr>
<tr>
<td>64</td>
<td>Alarm active: internal fault</td>
<td>Class 1</td>
</tr>
<tr>
<td>65</td>
<td>Alarm active: serial COM1 failure</td>
<td>Class 1</td>
</tr>
<tr>
<td>66</td>
<td>Alarm active: serial COM2 failure</td>
<td>Class 1</td>
</tr>
<tr>
<td>67</td>
<td>Alarm active: clock not set</td>
<td>Class 1</td>
</tr>
<tr>
<td>68</td>
<td>Alarm active: parameters not set</td>
<td>Class 1</td>
</tr>
<tr>
<td>69</td>
<td>Alarm active: Pulse input 1</td>
<td>Class 1</td>
</tr>
<tr>
<td>70</td>
<td>Alarm active: current THD</td>
<td>Class 1</td>
</tr>
<tr>
<td>71</td>
<td>Alarm active: voltage THD</td>
<td>Class 1</td>
</tr>
<tr>
<td>72</td>
<td>Alarm active: analog input main</td>
<td>Class 1</td>
</tr>
<tr>
<td>73</td>
<td>Alarm active: analog input alt</td>
<td>Class 1</td>
</tr>
<tr>
<td>74</td>
<td>Alarm active: data log 1</td>
<td>Class 1</td>
</tr>
<tr>
<td>75</td>
<td>Alarm active: data log 2</td>
<td>Class 1</td>
</tr>
<tr>
<td>76</td>
<td>Alarm active: Negative real demand</td>
<td>Class 1</td>
</tr>
<tr>
<td>77</td>
<td>Alarm active: Negative reactive demand</td>
<td>Class 1</td>
</tr>
<tr>
<td>78</td>
<td>Alarm active: Pulse input 2</td>
<td>Class 1</td>
</tr>
</tbody>
</table>

* This point is also reflected in the corresponding internal indication (IINI) bit in each response header.
** This point is not reflected in a Binary Input Change.
5.2 Binary Output / Control Relay Output

The DNP point list for Binary Outputs / Control Relay Outputs (objects 10 and 12, respectively) is shown below:

<table>
<thead>
<tr>
<th>Index</th>
<th>Description</th>
<th>Event Class Assigned To</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Reset</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Alarm relay on</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Alarm relay off</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Auxiliary relay 1 on</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Auxiliary relay 1 off</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Auxiliary relay 2 on</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Auxiliary relay 2 off</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Auxiliary relay 3 on</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Auxiliary relay 3 off</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Display 40 character flash message for 5 seconds (the display message must be set up using Modbus)</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Clear energy values</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Clear max. demand values</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Clear min./max current values</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Clear min./max voltage values</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Clear min./max power values</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Clear max. THD values</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Clear switch input pulse count</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Clear event record</td>
<td></td>
</tr>
</tbody>
</table>

* This point is also reflected in the corresponding internal indication (IIN) bit in each response header.
** This point is not reflected in a Binary Input Change.
Index points 0 and 9 through 27 are not reflected in the Binary Output.

The following restrictions should be observed when using object 12 to control the points listed in the following table:

1. The **Count** field is checked first. If it is zero, the command will be accepted but no action will be taken. If this field is non-zero, the command will be executed exactly once regardless of its value.

2. The **Control Code** field of object 12 is then inspected:
   - A NUL Code will cause the command to be accepted without any action being taken.
   - A Code of “Pulse On” (1) is valid for all points. This is used to activate the function (e.g., Reset) associated with the point.
   - All other Codes are invalid and will be rejected.
   - The Queue, Clear, and Trip/Close sub-fields are ignored.

3. The **On Time** and **Off Time** fields are ignored. A “Pulse On” Code takes effect immediately when received. Thus, the timing is irrelevant.

4. The **Status** field in the response will reflect the success or failure of the control attempt thus:
   - A Status of “Request Accepted” (0) will be returned if the command was accepted.
   - A Status of “Request not Accepted due to Formatting Errors” (3) will be returned if the Control Code field was incorrectly formatted or an invalid Code was present in the command.
   - A Status of “Control Operation not Supported for this Point” (4) will be returned in response to a “Latch On” or “Latch Off” command.

### Table 8: Binary Output / Control Relay Output Points

<table>
<thead>
<tr>
<th>Index</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Simulate “MENU” keypress</td>
</tr>
<tr>
<td>19</td>
<td>Simulate “ESCAPE” keypress</td>
</tr>
<tr>
<td>20</td>
<td>Simulate “RESET” keypress</td>
</tr>
<tr>
<td>21</td>
<td>Simulate “ENTER” keypress</td>
</tr>
<tr>
<td>22</td>
<td>Simulate “MESSAGE UP” keypress</td>
</tr>
<tr>
<td>23</td>
<td>Simulate “MESSAGE DOWN” keypress</td>
</tr>
<tr>
<td>24</td>
<td>Simulate “MESSAGE LEFT” keypress</td>
</tr>
<tr>
<td>25</td>
<td>Simulate “MESSAGE RIGHT” keypress</td>
</tr>
<tr>
<td>26</td>
<td>Simulate “VALUE UP” keypress</td>
</tr>
<tr>
<td>27</td>
<td>Simulate “VALUE DOWN” keypress</td>
</tr>
</tbody>
</table>
5. An operate of the Reset, alarm relay on/off or Aux Relay 1-3 on/off points may fail (even if the command is accepted) due to other inputs or conditions (e.g., alarm conditions) existing at the time. To verify the success or failure of an operate of these points it is necessary that the associated Binary Input(s) be examined after the control attempt is performed.

6. When using object 10 to read the status of a Binary Output, a read will always return zero.

5.3 Analog Input/Output Change

In the following point list for Analog Input/Output Change, the entry in the “Format” column indicates that the format of the associated data point can be determined by looking up the entry in Table 2: Data Formats. For example, an “F1” format is described in that table as a (16-bit) unsigned value without any decimal places. Therefore, the value read should be interpreted in this manner.

<table>
<thead>
<tr>
<th>Point</th>
<th>Modbus Reg</th>
<th>Description</th>
<th>Unit / Value</th>
<th>Deadband</th>
<th>Format Code</th>
<th>Event Class Assigned To</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1050</td>
<td>Phase CT Primary setpoint</td>
<td>amps 1 unit</td>
<td>F1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1052</td>
<td>Neutral CT Primary setpoint</td>
<td>amps 1 unit</td>
<td>F1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1054</td>
<td>VT Ratio setpoint</td>
<td>0.1 x ratio 1 unit</td>
<td>F1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1055</td>
<td>VT Nominal Secondary Volts setpoint</td>
<td>volts 1 unit</td>
<td>F1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>-</td>
<td>VT Nominal Ph-to-Ph Voltage</td>
<td>32-bit volts 1 unit</td>
<td>F3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>-</td>
<td>VT Nominal Phase-to-Neutral Voltage</td>
<td>32-bit volts 1 unit</td>
<td>F3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>-</td>
<td>Nominal Single-Phase VA</td>
<td>32-bit VA 1 unit</td>
<td>F3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>-</td>
<td>Nominal Three-Phase VA</td>
<td>32-bit VA 1 unit</td>
<td>F3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>0240</td>
<td>Phase A Current</td>
<td>1000ths of nominal A 20 units</td>
<td>F1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>0241</td>
<td>Phase B Current</td>
<td>1000ths of nominal</td>
<td>20 units</td>
<td>F1</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>0242</td>
<td>Phase C Current</td>
<td>1000ths of nominal</td>
<td>20 units</td>
<td>F1</td>
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footnote reference are located at the end of the table
Table 9: Point List for Analog Input/Output Change (Sheet 2 of 6)

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Footnote reference are located at the end of the table.
### Table 9: Point List for Analog Input/Output Change (Sheet 3 of 6)

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Footnote reference are located at the end of the table.
Table 9: Point List for Analog Input/Output Change (Sheet 4 of 6)

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<td>0323</td>
<td>Phase A Reactive Power Maximum</td>
<td>1000ths of nominal</td>
<td>1 unit</td>
<td>F4</td>
<td>3</td>
</tr>
<tr>
<td>104</td>
<td>0325</td>
<td>Phase A Apparent Power Maximum</td>
<td>1000ths of nominal</td>
<td>1 unit</td>
<td>F3</td>
<td>3</td>
</tr>
<tr>
<td>105</td>
<td>0327</td>
<td>Phase A Power Factor Maximum</td>
<td>%</td>
<td>1 unit</td>
<td>F2</td>
<td>3</td>
</tr>
<tr>
<td>106</td>
<td>0328</td>
<td>Phase B Real Power Minimum</td>
<td>1000ths of nominal</td>
<td>1 unit</td>
<td>F4</td>
<td>3</td>
</tr>
<tr>
<td>107</td>
<td>032A</td>
<td>Phase B Reactive Power Minimum</td>
<td>1000ths of nominal</td>
<td>1 unit</td>
<td>F4</td>
<td>3</td>
</tr>
<tr>
<td>108</td>
<td>032C</td>
<td>Phase B Apparent Power Minimum</td>
<td>1000ths of nominal</td>
<td>1 unit</td>
<td>F3</td>
<td>3</td>
</tr>
</tbody>
</table>

Footnote reference are located at the end of the table.
## Table 9: Point List for Analog Input/Output Change (Sheet 5 of 6)

<table>
<thead>
<tr>
<th>Point</th>
<th>Modbus Reg</th>
<th>Description</th>
<th>Unit / Value</th>
<th>Deadband</th>
<th>Format Code</th>
<th>Event Class Assigned To</th>
</tr>
</thead>
<tbody>
<tr>
<td>109</td>
<td>032E</td>
<td>Phase B Power Factor Minimum %</td>
<td>%</td>
<td>1 unit F2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>032F</td>
<td>Phase B Real Power Maximum 1000ths of nominal</td>
<td>1000ths of nominal</td>
<td>1 unit F4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>111</td>
<td>0331</td>
<td>Phase B Reactive Power Maximum</td>
<td>1000ths of nominal</td>
<td>1 unit F4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>112</td>
<td>0333</td>
<td>Phase B Apparent Power Maximum</td>
<td>1000ths of nominal</td>
<td>1 unit F3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>113</td>
<td>0335</td>
<td>Phase B Power Factor Maximum %</td>
<td>%</td>
<td>1 unit F2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>114</td>
<td>0336</td>
<td>Phase C Real Power Minimum 1000ths of nominal</td>
<td>1000ths of nominal</td>
<td>1 unit F4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>115</td>
<td>0338</td>
<td>Phase C Reactive Power Minimum</td>
<td>1000ths of nominal</td>
<td>1 unit F4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>116</td>
<td>033A</td>
<td>Phase C Apparent Power - Minimum</td>
<td>1000ths of nominal</td>
<td>1 unit F3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>117</td>
<td>033C</td>
<td>Phase C Power Factor Minimum %</td>
<td>%</td>
<td>1 unit F2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>118</td>
<td>033D</td>
<td>Phase C Real Power Maximum 1000ths of nominal</td>
<td>1000ths of nominal</td>
<td>1 unit F4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>119</td>
<td>033F</td>
<td>Phase C Reactive Power Maximum</td>
<td>1000ths of nominal</td>
<td>1 unit F4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>120</td>
<td>0341</td>
<td>Phase C Apparent Power Maximum</td>
<td>1000ths of nominal</td>
<td>1 unit F3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>121</td>
<td>0343</td>
<td>Phase C Power Factor Maximum %</td>
<td>%</td>
<td>1 unit F2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>122</td>
<td>040A</td>
<td>Phase A Current Demand Maximum 1000ths of nominal</td>
<td>1000ths of nominal</td>
<td>1 unit F1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>123</td>
<td>040B</td>
<td>Phase B Current Demand Maximum 1000ths of nominal</td>
<td>1000ths of nominal</td>
<td>1 unit F1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>124</td>
<td>040C</td>
<td>Phase C Current Demand Maximum 1000ths of nominal</td>
<td>1000ths of nominal</td>
<td>1 unit F1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>125</td>
<td>040D</td>
<td>Neutral Current Demand Maximum</td>
<td>1000ths of nominal</td>
<td>1 unit F1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>126</td>
<td>040E</td>
<td>3 Phase Real Power Dmd Max</td>
<td>1000ths of nominal</td>
<td>1 unit F4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>127</td>
<td>0410</td>
<td>3 Phase React Power Dmd Max</td>
<td>1000ths of nominal</td>
<td>1 unit F4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>128</td>
<td>0412</td>
<td>3 Phase Apparent Power Dmd Max</td>
<td>1000ths of nominal</td>
<td>1 unit F3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>129</td>
<td>0441</td>
<td>Frequency Minimum 0.01 x Hz</td>
<td>0.01 Hz</td>
<td>.01 Hz</td>
<td>F1</td>
<td>3</td>
</tr>
<tr>
<td>130</td>
<td>0442</td>
<td>Frequency Maximum 0.01 x Hz</td>
<td>0.01 Hz</td>
<td>.01 Hz</td>
<td>F1</td>
<td>3</td>
</tr>
<tr>
<td>131</td>
<td>0482</td>
<td>Phase A Current THD - Maximum 0.1 x %</td>
<td>0.1 x %</td>
<td>1 unit F1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>132</td>
<td>0483</td>
<td>Phase B Current THD - Maximum 0.1 x %</td>
<td>0.1 x %</td>
<td>1 unit F1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>133</td>
<td>0484</td>
<td>Phase C Current THD - Maximum 0.1 x %</td>
<td>0.1 x %</td>
<td>1 unit F1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>134</td>
<td>0485</td>
<td>Neutral Current THD - Maximum 0.1 x %</td>
<td>0.1 x %</td>
<td>1 unit F1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>135</td>
<td>0486</td>
<td>Voltage Van THD - Maximum 0.1 x %</td>
<td>0.1 x %</td>
<td>1 unit F1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>136</td>
<td>0487</td>
<td>Voltage Vbn THD - Maximum 0.1 x %</td>
<td>0.1 x %</td>
<td>1 unit F1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>137</td>
<td>0488</td>
<td>Voltage Vcn THD - Maximum 0.1 x %</td>
<td>0.1 x %</td>
<td>1 unit F1</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

*footnote reference are located at the end of the table*
1. This point is used to reconstruct current values from the 1,000ths per-unit quantities given in the other points. Multiply the particular point by this one, and divide by 1000 to get amps. For example, given a CT primary setpoint value of 3000 and an actual phase A current reading from the DUT of 1077 A, the reconstructed phase A current is:

\[ I_a(\text{reconstructed}) = \frac{I_a \times \text{Point 8}}{1000} = \frac{3000 \times 359}{1000} = 1077 \text{ A} \]

2. The VT Ratio setpoint is always reported, but is not used if a direct (i.e., without VTs) voltage wiring scheme is configured. In this case the VT Ratio setpoint is ignored, and a ratio of 1.0:1 is used in the PQMII.

3. This point is used to reconstruct voltage values from the 1,000ths per-unit quantities given in the other points. Multiply the particular point by this one, and divide by 1000 to get volts. Since some SCADA systems do not read 32 bit values, you can also multiply the VT ratio and nominal secondary (both of which are 16 bit) in the master in cases where the nominal primary may exceed 32767 volts. For example, given a VT ratio of 300:1, a VT nominal secondary volts setting of 115 V, and an actual phase-neutral voltage reading from the DUT of 19919 V, we have:

\[ V_a(\text{reconstructed}) = \frac{V_a \times \text{Point 14}}{1000} = \frac{577 \times 34500}{1000} = 19.91 \text{ kV} \]

\[ V_{bn}(\text{reconstructed}) = \frac{V_{bn} \times \text{Point 18}}{1000} = \frac{577 \times 59756}{1000} = 34.50 \text{ kV} \]
4. This point is used to reconstruct power values from the 1,000ths per-unit quantities given in the other points. Multiply the particular point by this one, and divide by 100 to get VA, kW or kvar.

5. The maximum value for Nominal Single-Phase VA and Nominal Three-Phase VA is 983010000 VA. When this value is over-range, it will indicate “1”; in this case, the DNP power values become the actual value and no formula is used.

6. In Modbus, the current keypress is reported with format code F6. In order to fit the value into a sixteen-bit signed value, F8 is used in DNP, with ASCII zero (48 decimal) returned when no key is pressed.

7. This point is not used for reconstructing any voltage values. The difference between phase-to-phase and phase-to-neutral values is accounted for in the actual voltage points themselves. The VT nominal phase-to-neutral voltage (point 5) is used to reconstruct all voltage values.

5.4 Counters

The DNP point list for Binary Counters (object 20) is shown below:

<table>
<thead>
<tr>
<th>Point Num</th>
<th>Modbus Register</th>
<th>Description</th>
<th>Unit</th>
<th>Format code</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0450</td>
<td>Pulse Input 1</td>
<td>-</td>
<td>F3</td>
</tr>
<tr>
<td>1</td>
<td>0452</td>
<td>Pulse Input 2</td>
<td>-</td>
<td>F3</td>
</tr>
<tr>
<td>2</td>
<td>0454</td>
<td>Pulse Input 3</td>
<td>-</td>
<td>F3</td>
</tr>
<tr>
<td>3</td>
<td>0456</td>
<td>Pulse Input 4</td>
<td>-</td>
<td>F3</td>
</tr>
<tr>
<td>4</td>
<td>0460</td>
<td>Totalized Pulse Input</td>
<td>-</td>
<td>F3</td>
</tr>
<tr>
<td>5</td>
<td>03D0</td>
<td>3 Phase Positive Real Energy Used</td>
<td>kWh</td>
<td>F3</td>
</tr>
<tr>
<td>6</td>
<td>03D2</td>
<td>3 Phase Negative Real Energy Used</td>
<td>kWh</td>
<td>F3</td>
</tr>
<tr>
<td>7</td>
<td>03D4</td>
<td>3 Phase Positive React. Energy Used</td>
<td>kvarh</td>
<td>F3</td>
</tr>
<tr>
<td>8</td>
<td>03D6</td>
<td>3 Phase Negative React. Energy Used</td>
<td>kvarh</td>
<td>F3</td>
</tr>
<tr>
<td>9</td>
<td>03D8</td>
<td>3 Phase Apparent Energy Used</td>
<td>kVArh</td>
<td>F3</td>
</tr>
<tr>
<td>10</td>
<td>03DA</td>
<td>3 Phase Energy Used in Last 24 h</td>
<td>kWh</td>
<td>F3</td>
</tr>
<tr>
<td>11</td>
<td>03DC</td>
<td>3 Phase Energy Cost Since Reset</td>
<td>cents</td>
<td>F3</td>
</tr>
<tr>
<td>12</td>
<td>03DE</td>
<td>3 Phase Energy Cost Per Day</td>
<td>cents</td>
<td>F3</td>
</tr>
</tbody>
</table>

Only counter points 0 to 4 can be cleared using function codes 9 and 10, and doing so disturbs the totals presented on the display and via Modbus communications. In general, the binary output points which clear data should be used if it is necessary to clear any of these counters.