

PXM 4/6/8K DNP3

PXM 4/6/8K DNP3 Ethernet Communications User Manual



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1. Introduction

This document contains the Power Xpert® Meter (PXM Meter) 4000/6000/8000 Series device Distributed Network Protocol (DNP) 3 ethernet communication Level-2 device profile along with a detailed explanation of the web utility to configure DNP3 parameters of the PXM Meter.

Note: The PXM 4/6/8K supports DNP3 ethernet communication. DNP3 serial communication is not supported.

2. DNP3 Protocol Primer

Acknowledgment: Base materials used in Section 2 of this manual were provided by and used with the permission of the DNP Users Group www.dnp.org.

This is a primer for Users who want a quick understanding of DNP3 without having to comb through the tedious details of a complex specification. The writing style is meant to be informal and personal.¹

Let us start with what it is. Protocols define the rules by which devices talk with each other, and DNP3 is a protocol for transmission of data from point A to point B using serial and IP communications. It has been used primarily by utilities such as the electric and water companies, but it functions well for other areas.

A typical electric company may have a common operations center that monitors all of the equipment at each of its substations. In the operations center, a powerful computer stores all of the incoming data and displays the system for the human operators. Substations have many devices that need monitoring (Are circuit breakers opened or closed?), current sensors (How many amperes are flowing?) and voltage transducers (What is the line potential?). That only scratches the surface. A utility is interested in monitoring many parameters, too numerous to discuss here. The operations personnel often need to switch sections of the power grid into or out of service. Computers are situated in substations to collect the data for transmission to the master station in the operations center. The substation computers are also called upon to energize or de-energize the breakers and voltage regulators.

DNP3 uses the term **outstation** to denote remote computers as are found in the field. The term **master** is used for the computers in the control centers.

DNP3 provides the rules for remotely located computers and master station computers to communicate data and control commands. DNP3 is a non-proprietary protocol that is available to anyone by visiting the web site www.dnp.org. Only a nominal fee is charged for documentation, but otherwise it is available worldwide with no restrictions. This means a utility can purchase master station and outstation computing equipment from any manufacturer and be assured that they will reliably talk to each other. Vendors compete based upon their computing equipment's features,

costs and quality factors instead of who has the best protocol. Utilities are not bound to one manufacturer after the initial sale.

What do the computers talk about? Outstation computers gather data for transmission to the master.

- Binary input data that is useful to monitor two-state devices. For example, a circuit breaker is closed or tripped; a pipeline pressure alarm shows normal or excessive.
- Analog input data that conveys voltages, currents, power, reservoir water levels, and temperatures.
- Count input data that reports energy in kilowatt hours or fluid volume.
- Files that contain configuration data.

The master station issues control commands that take the form of:

- Close or trip a circuit breaker, start or stop a motor, and open or close a valve; and/or
- Analog output values to set a regulated pressure or a desired voltage level.

Other things the computers talk to each other about are synchronizing the time and date, sending historical or logged data, waveform data, and on and on.

2.1 Why DNP3?

DNP3 was designed to optimize the transmission of data acquisition information and control commands from one computer to another. It is not a general purpose protocol like those found on the Internet for transmitting email, hypertext documents, SQL queries, multimedia, and huge files. It is intended for Supervisory Control and Data Acquisition (SCADA) applications.

¹ Readers should not assume this document contains formal rules, which are only provided by the DNP3 Specification volumes.

2. DNP3 Protocol Primer

2.1.1 Master and Outstation Databases

Figure 1 shows the master-outstation relationship and gives a simplistic view of the databases and software processes involved. The master is on the left side of **Figure 1**, and the outstation is on the right side.

A series of square blocks at the top of the outstation depict data stored in its database and output devices. The various data types are conceptually organized as arrays. An array of binary input values represents states of physical or logical Boolean devices. Values in the analog input array represent input quantities that the outstation measured or computed. An array of counters represents count values, such as kilowatt hours, that are ever increasing (until they reach a maximum and then roll over to zero and start counting again). Control outputs are organized into an array representing physical or logical on-off, raise-lower, and trip-close points. Lastly, the array of analog outputs represents physical or logical analog quantities such as those used for set points.

The elements of the arrays are labeled 0 through N - 1 where N is the number of blocks shown for the respective data type. In DNP3 terminology, the element numbers are called the point indexes. Indexes are zero-based in DNP3, that is, the lowest element is always identified as zero. Indexes are zero-based in DNP3, that is, the lowest element is always identified as zero.

Notice that the DNP3 master also has a similar database for the input data types (binary, analog and counter.) The master uses values in its database for the specific purposes of displaying system states, closed-loop control, alarm notification, billing, and much, much more. An objective of the master is to keep its database updated. It accomplishes this by sending requests to the outstation asking it to return the values in the outstation's database. This is termed polling. The outstation responds to the master's request by transmitting the contents of its database. Arrows are drawn at the bottom of **Figure 1** showing the direction of the requests (toward the outstation) and the direction of the responses (toward the master). Later, we will discuss systems whereby the outstations transmit responses without being asked.

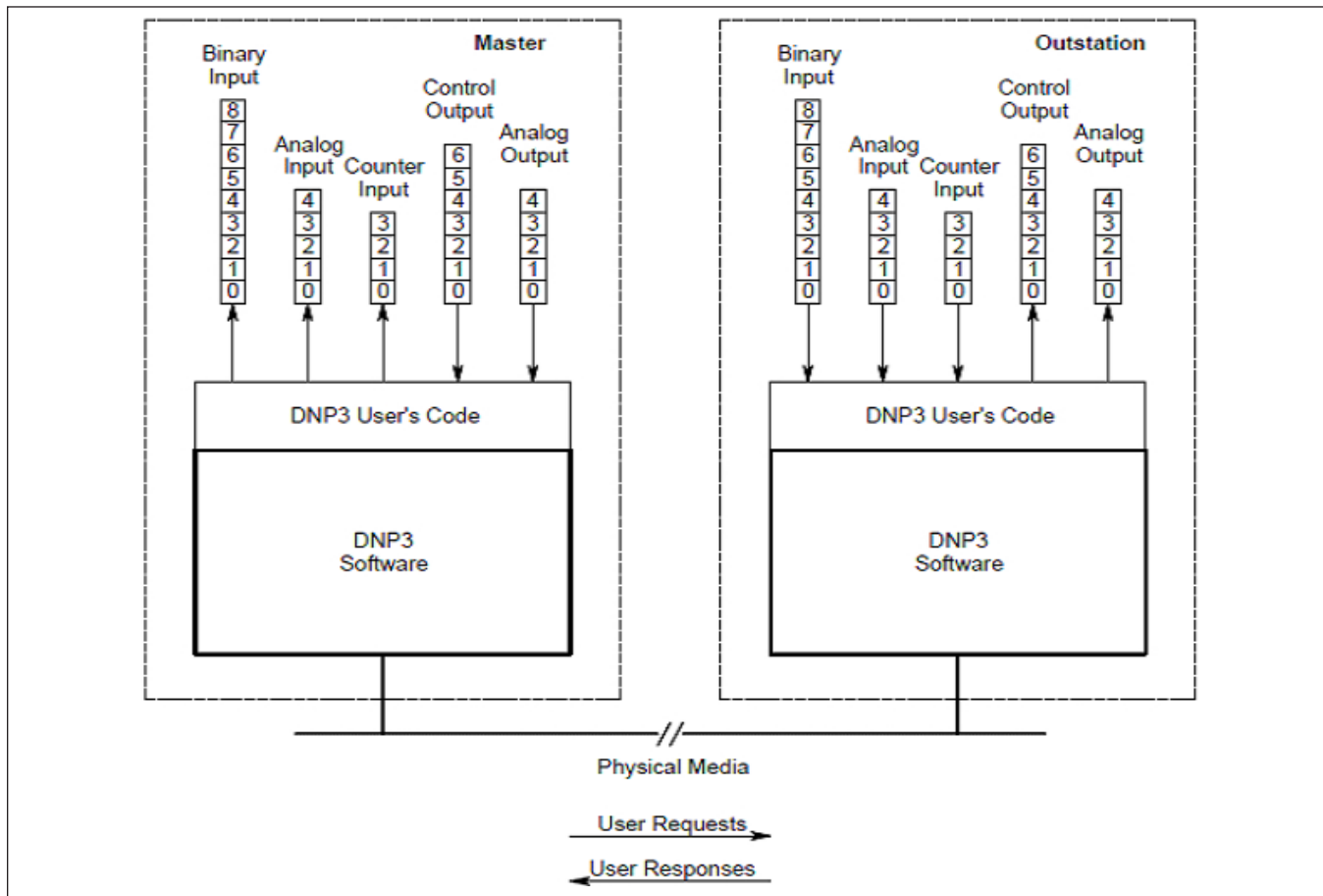


Figure 1. Master and Outstation Relationship.

2.1.2 Layering

The master and the outstation shown in **Figure 1** each have two software layers. The top layer is the DNP3 user layer. In the master, it is the software that interacts with the database and initiates the requests for the outstation's data. In the outstation, it is the software that fetches the requested data from the outstation's database for responding to master requests. It is interesting to note that if no physical separation of the master and outstation existed, eliminating the DNP3 might be possible by connecting these two upper layers together. However, since physical, or possibly logical separation of the master and outstation exists, DNP3 software is placed at a lower level. The DNP3 User's code uses the DNP3 software for transmission of requests or responses to the matching DNP3 User's code at the other end. More will be said about data types and software layers later, but first we want to examine a few typical system architectures where DNP3 is used.

2.1.3 System Architecture

Figure 2 shows common system architectures in use today. At the top is a simple one-on-one system having one master station and one outstation. The physical connection between the two is typically a dedicated or dial-up telephone line.

The second type of system is known as a multi-drop design. One master station communicates with multiple outstation devices. Conversations are typically between the master and one outstation at a time. The master requests data from the first outstation, then moves onto the next outstation for its data, and continually interrogates each outstation in a round robin order. The communication media is a multi-dropped telephone line, fiber optic cable, or radio. Each outstation can hear messages from the master and is only permitted to respond to messages addressed to it. Outstations may or may not be able to hear each other.

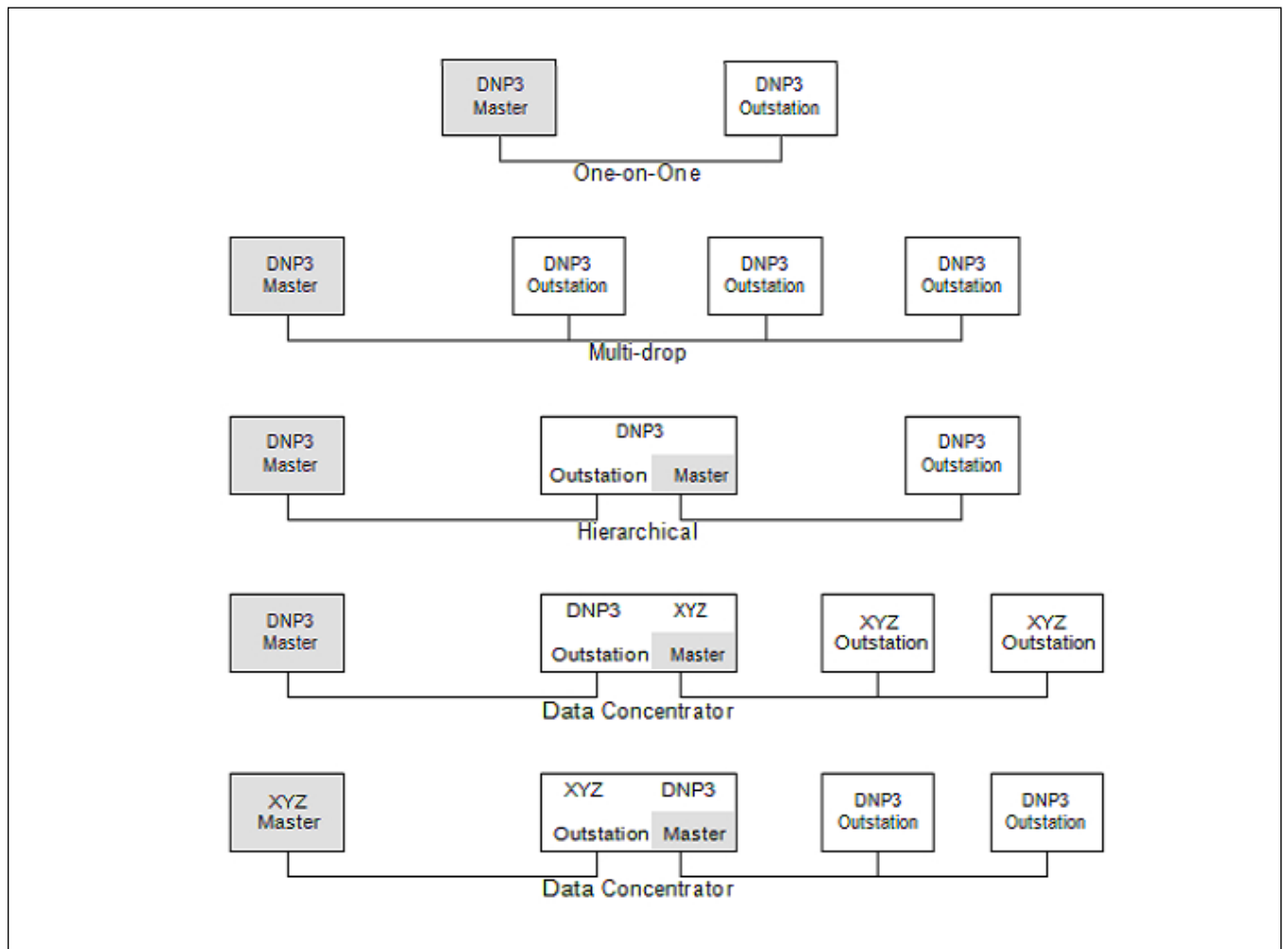


Figure 2. Common System Architectures.

2. DNP3 Protocol Primer

In some multi-drop forms, communications are peer-to-peer. A station may operate as a master for gathering information or sending commands to the outstation in another station. And then, it may change roles to become an outstation to another station.

The middle row in **Figure 2** shows a hierarchical type system where the device in the middle is an outstation to the master at the left and is a master with respect to the outstation on the right. The middle device is often termed a sub-master.

Both lines at the bottom of **Figure 2** show data concentrator applications and protocol converters. A device may gather data from multiple outstations on the right side of the figure and store this data in its database where it is retrievable by a master station on the left side of the figure. This design is often seen in substations where the data concentrator collects information from local intelligent devices for transmission to the master station.

2.1.4 TCP/IP

Many vendors offer products that operate using TCP/IP to transport DNP3 messages in lieu of the media discussed above. Link layer frames, which we have not talked about yet, are embedded into TCP/IP packets. This approach has enabled DNP3 to take advantage of Internet technology and permitted economical data collection and control between widely separated devices.

2.1.5 More On Layering

Communication circuits between the devices are often imperfect. They are susceptible to noise and signal distortion. DNP3 software is layered to provide reliable data transmission and to affect an organized approach to the transmission of data and commands. **Figure 3** shows the layering that was not shown in **Figure 1**.

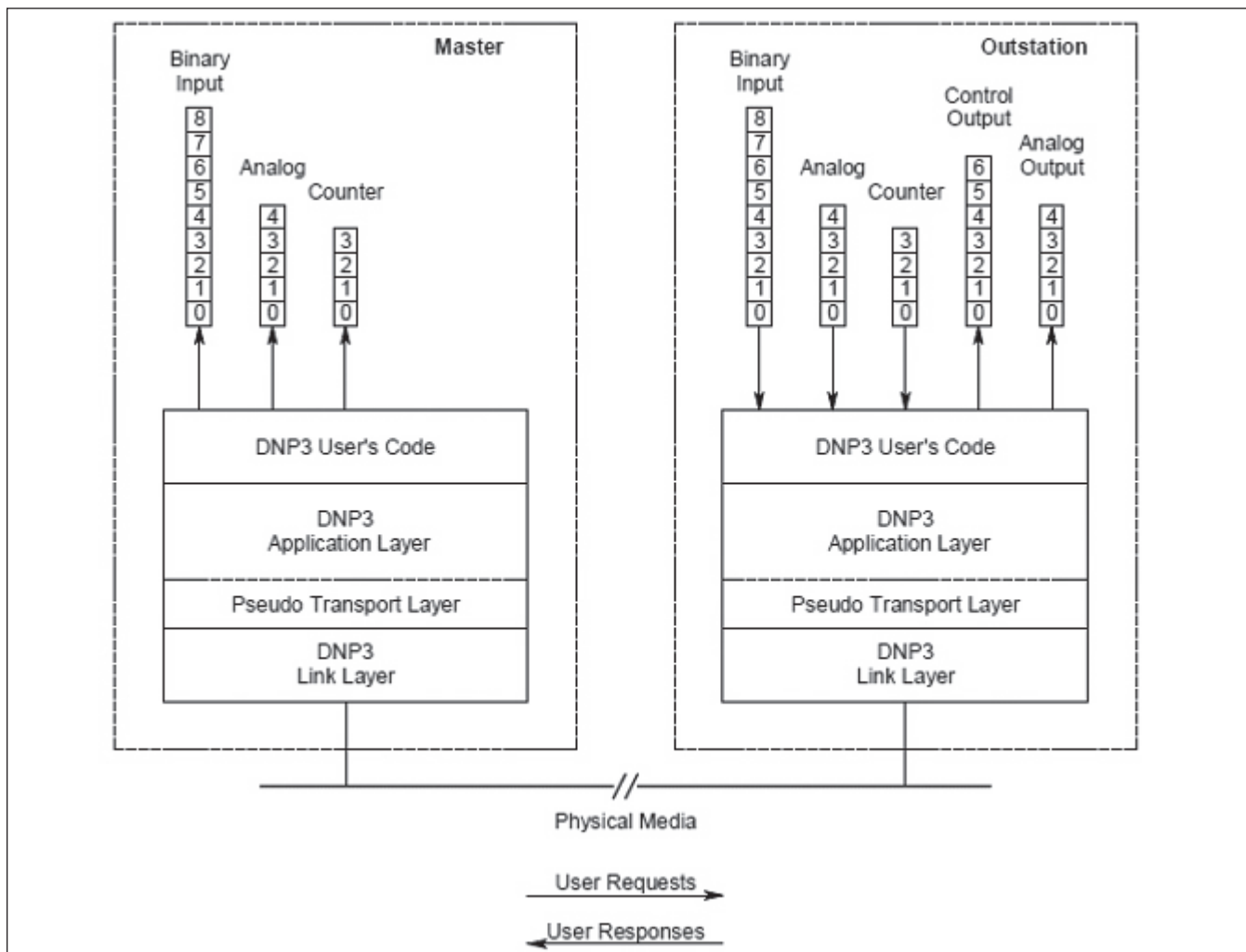


Figure 3. Master and Outstation Relationship – Layering.

2.2 Link Layer Responsibility

The link layer has the responsibility of making the physical link reliable. It does this by providing error detection and duplicate frame detection. The link layer sends and receives packets, which in DNP3 terminology are called frames. Sometimes transmission of more than one frame is necessary to transport all of the information from one device to another.

A DNP3 frame consists of a header and data section. The header specifies the frame size, contains data link control information and identifies the DNP3 source and destination device addresses. The data section is commonly called the payload and contains data passed down from the layers above.

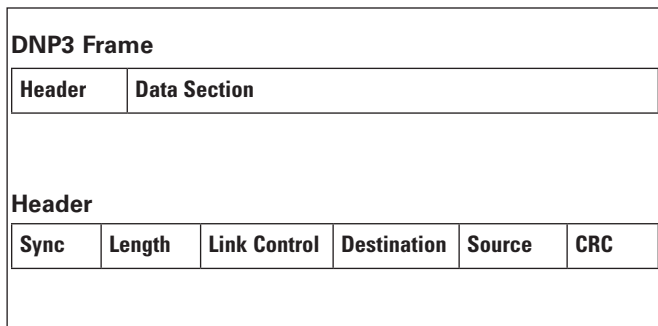


Figure 4. DNP3 Header and Data Sections.

Every frame begins with two sync bytes that help the receiver determine where the frame begins. The length specifies the number of octets in the remainder of the frame, not including CRC check octets. The link control octet is used for the sending and receiving link layers to coordinate their activities.

2.2.1 Addressing

The destination address specifies which DNP3 device should process the data, and the source address identifies which DNP3 device sent the message. Having both destination and source addresses satisfies at least one requirement for peer-to-peer communications because the receiver knows where to direct its responses. 65,520 individual addresses are available. Every DNP3 device must have a unique address within the collection of devices sending and receiving messages to and from each other. Three destination addresses are reserved by DNP3 to denote an all-call message; that is, the frame should be processed by all receiving DNP3 devices. One address is a universal address, the details of which are not given here, and twelve addresses are reserved for special needs in the future.

2.2.2 CRC Checks

The data payload in the link frame contains a pair of CRC octets for every 16 data octets. This provides a high degree of assurance that communication errors can be detected. The maximum number of octets in the data payload is 250, not including CRC octets. (The maximum length link layer frame is 292 octets if all the CRC and header octets are counted.)

2.2.3 Link Layer Confirmation

One often hears the term “link layer confirmation” when DNP3 is discussed. A feature of DNP3’s link layer is the ability for the transmitter of the frame to request the receiver to confirm that the frame arrived. Using this feature is optional, and it is often not employed because there are other methods for confirming receipt of data. It provides an extra degree of assurance of reliable communications. If a confirmation is not received, the link layer may retry the transmission. Some disadvantages to using link layer confirmation are the extra time required for confirmation messages and waiting for multiple timeouts when retries are configured.

2.2.4 Transport Layer

The transport layer has the responsibility of breaking long application layer messages into smaller packets sized for the link layer to transmit, and, when receiving, to reassemble frames into longer application layer messages. In DNP3 the transport layer is incorporated into the application layer. The transport layer requires only a single octet overhead to do its job. Therefore, since the link layer can handle only 250 data octets, and one of those is used for the transport function, each link layer frame can hold as many as 249 application layer octets.

2.2.5 Application Layer Fragments

Application layer messages are broken into fragments. Maximum fragment size is determined by the size of the receiving device’s buffer. The normal range is 2048 to 4096 bytes. A message that is larger than one fragment requires multiple fragments. Fragmenting messages is the responsibility of the application layer.

Note that an application layer fragment of size 2,048 must be broken into 9 frames by the transport layer, and a fragment size of 4,096 needs 17 frames. Interestingly, it has been learned by experience that communications are sometimes more successful for systems operating in high noise environments if the fragment size is significantly reduced.

2. DNP3 Protocol Primer

2.3 Static and Event Data

The application layer works together with the transport and link layers to enable reliable communications. It provides standardized functions and data formatting with which the user layer above can interact. Before functions, data groups, and variations can be discussed, the terms static, events, and classes need to be covered.

In DNP3, the term **static** is used with data and refers to the present value. Thus static binary input data refers to the present On or Off state of a bi-state device. Static analog input data contains the value of an analog at the instant it is transmitted. One possibility DNP3 allows is requesting some or all of the static data in an outstation device.

DNP3 **events** are associated with something significant happening. Examples are state changes, values exceeding some threshold, snapshots of varying data, transient data, and newly available information. An event occurs when a binary input changes from an On to an Off state or when an analog value changes by more than its configured dead-band limit. DNP3 provides the ability to report events with and without time stamps so that, if desired, the master will have the information to generate a time sequence report.

The master's user layer can direct DNP3 to request events. Usually, a master is updated more rapidly if it spends most of its time polling for events from the outstation and only occasionally asks for static data as an integrity measure. The reason updates are faster is because the number of events generated between outstation interrogations is small and, therefore, less data must be returned to the master.

DNP3 goes a step further by classifying events into three classes. When DNP3 was conceived, class 1 events were considered as having higher priority than class 2 events, and class 2 were higher than class 3 events. While that scheme can be still be configured, some DNP3 Users have developed other strategies more favorable to their operation for assigning events into the classes. The user layer can request the application layer to poll for class 1, 2, or 3 events or any combination of them.

2.3.1 Variations

DNP3 has provisions for representing data in different formats. Examination of analog data formats is helpful to understand the flexibility of DNP3. Static, present value, analog data can be represented by variation numbers as follows:

1. A 32-bit integer value with flag;
2. A 16-bit integer value with flag;
3. A 32-bit integer value;
4. A 16-bit integer value;
5. A 32-bit floating point value with flag; and
6. A 64-bit floating point value with flag.

Note: The flag referred to is a single octet with bit fields indicating whether the source is on-line, the data source restarted, communications are lost with a downstream source, the data is forced and the value is over range.

Not all DNP3 devices can transmit or interpret all six variations. Later, DNP3 levels are discussed, but for now, suffice it to say that DNP3 devices must be able to transmit the simplest variations so that any receiver can interpret the contents.

Event analog data can be represented by these variations:

1. A 32-bit integer value with flag;
2. A 16-bit integer value with flag;
3. A 32-bit integer value with flag and event time;
4. A 16-bit integer value with flag and event time;
5. A 32-bit floating point value with flag;
6. A 64-bit floating point value with flag;
7. A 32-bit floating point value with flag and event time; and
8. A 64-bit floating point value with flag and event time.

The flag has the same bit fields as for the static variations.

2.3.2 Group

It appears by looking at the above variations that variation 1 and 2 analog events cannot be differentiated from variation 1 and 2 static analog values. DNP3 solves this predicament by assigning group numbers. Static analog values are assigned as group 30, and event analog values are assigned as group 32. Static analog values, group 30, can be formatted in one of 6 variations, and event analog values, group 32, can be formatted in one of 8 variations.

When a DNP3 outstation transmits a message containing response data, the message identifies the group number and variation of every value within the message. Group and variation numbers are also assigned for counters, binary inputs, controls and analog outputs. In fact, all valid data types and formats in DNP3 are identified by group and variation numbers. Defining the allowable groups and variations helps DNP3 assure interoperability between devices. DNP3's basic documentation contains a library of valid groups and their variations.

2.3.3 Objects

When data from an index is transmitted across the wire, the sender must suitably encode the information to enable a receiving device to parse and properly interpret this data. The bits and bytes for each index appearing in the message are called an **object**. That is, objects in the message are the encoded representation of the data from a point, or other structure, and the object format depends upon which group and variation number are chosen.

2.3.4 Reading Data

The master's user layer formulates its request for data from the outstation by telling the application layer what function to perform, such as reading, and by specifying the data types it wants from the outstation. The request can specify how many objects it wants or it can specify specific objects or a range of objects from index number X through index number Y. The application layer then passes the request down through the transport layer to the link layer that, in turn, sends the message to the outstation. The link layer at the outstation checks the frames for errors and passes them up to the transport layer where the complete message is assembled in the outstation's application layer. The application layer then tells its user layer which groups and variations were requested.

Responses work similarly, in that the outstation's user layer fetches the desired data and presents it to the application layer that, in turn, uses the group and variation numbers to format user layer data into objects. Data is then passed downward, across the communication channel and upward to the master's application layer. Here the data objects are then presented to the master's user layer.

2.3.5 Other Functions

Reading data was briefly described in Section 2.3.4, but DNP3 software is designed to handle other functions. For one, the master can set the time in the outstation. The master can transmit freeze accumulator requests, and it can transmit requests for control operations and setting of analog output values using select-before-operate or direct-operate sequences.

2.4 Unsolicited Responses

One area that has not been covered yet is transmission of unsolicited messages. This is a mode of operating where the outstation spontaneously transmits a response without having received a specific request for the data. Not all outstations have this capability. This mode is useful when the system has many outstations and the master requires notification as soon as possible after a change occurs. Rather than waiting for a master station polling cycle to get around to it, the outstation simply transmits the change.

Before configuring a system for unsolicited messages, a few basics need to be considered. First, spontaneous transmissions should generally occur infrequently, otherwise, too much contention can occur, and controlling media access via master station polling would be better. The second basic issue is that the outstation should have some way of knowing whether it can transmit without stepping on another outstation's message. DNP3 leaves specification of algorithms to the system implementer.

2.5 Implementation Levels

One last area of discussion involves implementation levels. The DNP3 organization recognizes that supporting every feature of DNP3 is not necessary for every device. Some devices are limited in memory and speed and do not need specific features, while other devices must have the more advanced features to accomplish their task. DNP3 organizes complexity into three levels. At the lowest level, level 1, only very basic functions must be provided and all others are optional. Level 2 handles more functions, groups, and variations, and level 3 is even more sophisticated. Within each level, only certain combinations of request formats and response formats are required. This was done to limit software code in masters and outstations while still assuring interoperability.

2.6 Summary

It should be apparent by now that DNP3 is a protocol that fits well into the data acquisition world. It transports data as generic values, it has a rich set of functions, and it was designed to work in a wide area communications network. The standardized approach of groups and variations, and link, transport and application layers, plus public availability makes DNP3 a protocol to be regarded.

3. DNP Device Profile

3. DNP Device Profile

<p>DNP V3.0 DEVICE PROFILE DOCUMENT This document must be accompanied by a table having the following headings:</p> <table border="0"> <tr> <td>Object Group Request</td> <td>Function Codes</td> <td>Response Function Codes</td> </tr> <tr> <td>Object Variation</td> <td>Request Qualifiers</td> <td>Response Qualifiers</td> </tr> <tr> <td>Object Name (optional)</td> <td></td> <td></td> </tr> </table>		Object Group Request	Function Codes	Response Function Codes	Object Variation	Request Qualifiers	Response Qualifiers	Object Name (optional)		
Object Group Request	Function Codes	Response Function Codes								
Object Variation	Request Qualifiers	Response Qualifiers								
Object Name (optional)										
Vendor Name: Eaton										
Device Name: Power Expert Meter 4k/6k/8k										
Highest DNP Level Supported: For Requests : Level 2 For Responses : Level 2	Device Function: <input type="checkbox"/> Master <input checked="" type="checkbox"/> Slave									
<p>Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported. For static (non-change-event) object requests, request qualifier codes 07 and 08 (limited quantity), and 17 and 28 (index) are supported. 16-bit and 32-bit Analog Change Events with Time are supported. Floating Point Analog Output Status and Output Block Objects 40 are supported. The read function code for Object 50 (Time and Date), variation 1, is supported.</p>										
Maximum Data Link Frame Size (octets): ➤ Transmitted: 292 ➤ Received : 292	Maximum Application Fragment Size (octets): ➤ Transmitted: Configurable up-to 2048 ➤ Received : 2048									
Maximum Data Link Re-tries: <input type="checkbox"/> None <input type="checkbox"/> Fixed at _____ <input checked="" type="checkbox"/> Configurable from 0 to 15	Maximum Application Layer Re-tries: <input checked="" type="checkbox"/> None <input type="checkbox"/> Configurable									

Requires Data Link Layer Confirmation:

- Never
- Always
- Sometimes
- Configurable as:**
 - **When reporting Event Data.**
 - **When sending multi-fragment responses.**

Requires Application Layer Confirmation:

- Never
- Always
- When reporting Event Data
- When sending multi-fragment responses
- Sometimes
- Configurable as: “Only when reporting Event Data” or “When reporting event data and multi fragment messages”.**

Timeouts while waiting for:

- Data Link Confirm : None Fixed at ____ Variable **Configurable.**
- Complete Appl. Fragment : **None** Fixed at ____ Variable Configurable.
- Application Confirm : None **Fixed at 10 Sec** Variable Configurable.
- Complete Appl. Response : **None** Fixed at ____ Variable Configurable.

Others:

- Transmission Delay, configurable
- Select/Operate Arm Timeout, configurable 0 sec to 30 sec
- Need Time Interval, configurable 1 sec to 86400 sec (1 day)
- Data Link Confirm Timeout, configurable 0.1 sec to 30 sec
- Binary Change Event Scan Period, fixed at 1 sec
- Analog Change Event Scan Period, fixed at 1 sec
- Counter Change Event Scan Period, fixed at 1 sec
- Frozen Counter Change Event Scan Period, fixed at 1 sec

3. DNP Device Profile

<p>Sends/Executes Control Operations:</p> <table border="0"> <tr> <td>➤ WRITE Binary Outputs :</td> <td><input checked="" type="checkbox"/> Never</td> <td><input type="checkbox"/> Always</td> <td><input type="checkbox"/> Sometimes</td> <td><input type="checkbox"/> Configurable</td> </tr> <tr> <td>➤ SELECT/OPERATE :</td> <td><input type="checkbox"/> Never</td> <td><input checked="" type="checkbox"/> Always</td> <td><input type="checkbox"/> Sometimes</td> <td><input type="checkbox"/> Configurable</td> </tr> <tr> <td>➤ DIRECT OPERATE :</td> <td><input type="checkbox"/> Never</td> <td><input checked="" type="checkbox"/> Always</td> <td><input type="checkbox"/> Sometimes</td> <td><input type="checkbox"/> Configurable</td> </tr> <tr> <td>➤ DIRECT OPERATE-NACK :</td> <td><input type="checkbox"/> Never</td> <td><input checked="" type="checkbox"/> Always</td> <td><input type="checkbox"/> Sometimes</td> <td><input type="checkbox"/> Configurable</td> </tr> <tr> <td>➤ Count > 1 :</td> <td><input checked="" type="checkbox"/> Never</td> <td><input type="checkbox"/> Always</td> <td><input type="checkbox"/> Sometimes</td> <td><input type="checkbox"/> Configurable</td> </tr> <tr> <td>➤ Pulse On :</td> <td><input checked="" type="checkbox"/> Never</td> <td><input type="checkbox"/> Always</td> <td><input type="checkbox"/> Sometimes</td> <td><input type="checkbox"/> Configurable</td> </tr> <tr> <td>➤ Pulse Off :</td> <td><input checked="" type="checkbox"/> Never</td> <td><input type="checkbox"/> Always</td> <td><input type="checkbox"/> Sometimes</td> <td><input type="checkbox"/> Configurable</td> </tr> <tr> <td>➤ Latch On :</td> <td><input type="checkbox"/> Never</td> <td><input checked="" type="checkbox"/> Always</td> <td><input type="checkbox"/> Sometimes</td> <td><input type="checkbox"/> Configurable</td> </tr> <tr> <td>➤ Latch Off :</td> <td><input type="checkbox"/> Never</td> <td><input checked="" type="checkbox"/> Always</td> <td><input type="checkbox"/> Sometimes</td> <td><input type="checkbox"/> Configurable</td> </tr> <tr> <td>➤ Queue :</td> <td><input checked="" type="checkbox"/> Never</td> <td><input type="checkbox"/> Always</td> <td><input type="checkbox"/> Sometimes</td> <td><input type="checkbox"/> Configurable</td> </tr> <tr> <td>➤ Clear Queue :</td> <td><input checked="" type="checkbox"/> Never</td> <td><input type="checkbox"/> Always</td> <td><input type="checkbox"/> Sometimes</td> <td><input type="checkbox"/> Configurable</td> </tr> </table>		➤ WRITE Binary Outputs :	<input checked="" type="checkbox"/> Never	<input type="checkbox"/> Always	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable	➤ SELECT/OPERATE :	<input type="checkbox"/> Never	<input checked="" type="checkbox"/> Always	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable	➤ DIRECT OPERATE :	<input type="checkbox"/> Never	<input checked="" type="checkbox"/> Always	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable	➤ DIRECT OPERATE-NACK :	<input type="checkbox"/> Never	<input checked="" type="checkbox"/> Always	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable	➤ Count > 1 :	<input checked="" type="checkbox"/> Never	<input type="checkbox"/> Always	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable	➤ Pulse On :	<input checked="" type="checkbox"/> Never	<input type="checkbox"/> Always	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable	➤ Pulse Off :	<input checked="" type="checkbox"/> Never	<input type="checkbox"/> Always	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable	➤ Latch On :	<input type="checkbox"/> Never	<input checked="" type="checkbox"/> Always	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable	➤ Latch Off :	<input type="checkbox"/> Never	<input checked="" type="checkbox"/> Always	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable	➤ Queue :	<input checked="" type="checkbox"/> Never	<input type="checkbox"/> Always	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable	➤ Clear Queue :	<input checked="" type="checkbox"/> Never	<input type="checkbox"/> Always	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable
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➤ Latch On :	<input type="checkbox"/> Never	<input checked="" type="checkbox"/> Always	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable																																																				
➤ Latch Off :	<input type="checkbox"/> Never	<input checked="" type="checkbox"/> Always	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable																																																				
➤ Queue :	<input checked="" type="checkbox"/> Never	<input type="checkbox"/> Always	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable																																																				
➤ Clear Queue :	<input checked="" type="checkbox"/> Never	<input type="checkbox"/> Always	<input type="checkbox"/> Sometimes	<input type="checkbox"/> Configurable																																																				
<p>Reports Binary Input Change Events when no specific variation requested:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Never <input type="checkbox"/> Only time-tagged <input type="checkbox"/> Only non-time-tagged <input checked="" type="checkbox"/> Configurable to send both, one or the other 	<p>Reports time-tagged Binary Input Change Events when no specific variation requested:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Never <input type="checkbox"/> Binary Input Change With Time <input type="checkbox"/> Binary Input Change With Relative Time <input checked="" type="checkbox"/> Configurable to Binary Input Change With Time and Binary Input Change With Relative Time 																																																							
<p>Sends Unsolicited Responses:</p> <ul style="list-style-type: none"> <input checked="" type="checkbox"/> Never <input type="checkbox"/> Configurable <input type="checkbox"/> Only certain objects <input type="checkbox"/> Sometimes <input type="checkbox"/> ENABLE/DISABLE UNSOLICITED 	<p>Sends Static Data in Unsolicited Responses:</p> <ul style="list-style-type: none"> <input checked="" type="checkbox"/> Never <input type="checkbox"/> When Device Restarts <input type="checkbox"/> When Status Flags Change <p>No other options are permitted.</p>																																																							

<p>Default Counter Object/Variation:</p> <p><input type="checkbox"/> No Counters Reported</p> <p><input checked="" type="checkbox"/> Configurable</p> <p><input type="checkbox"/> Default</p> <ul style="list-style-type: none"> ▪ Object ▪ Variation <p><input type="checkbox"/> Point-by-point list attached</p>	<p>Counters Roll Over at:</p> <p><input type="checkbox"/> No Counters Reported</p> <p><input type="checkbox"/> Configurable</p> <p><input checked="" type="checkbox"/> 16 Bits</p> <p><input checked="" type="checkbox"/> 32 Bits</p> <p><input type="checkbox"/> Other Value: _____</p> <p><input type="checkbox"/> Point-by-point list attached</p>
<p>Sends Multi-Fragment Responses:</p> <p><input type="checkbox"/> Yes</p> <p><input type="checkbox"/> No</p> <p><input checked="" type="checkbox"/> Configurable as: "Always" or "When reporting Event Data"</p>	
<p>Sequential File Transfer Support:</p> <p>Append File Mode : <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> <p>Custom Status Code Strings : <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> <p>Permissions Field : <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> <p>File Events Assigned to Class : <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> <p>File Events Send Immediately: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> <p>Multiple Blocks in a Fragment: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> <p>Max Number of Files Open : 0</p>	

4. Implementation Table

4. Implementation Table

The following table identifies which object variations, function codes, and qualifiers the PXM 4/6/8 K meter supports in both request messages and in response messages.

For static (non-change-event) objects, requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01. Requests sent with qualifiers 17 or 28 will be responded with qualifiers 17 or 28. For change-event objects, qualifiers 17 or 28 are always responded.

Table 1. Object Variations, Function Codes, and Qualifiers.

Object Number	Variation Number	Object Description	REQUEST Master May Issue Outstation Must Parse		RESPONSE Master Must Parse Outstation May Issue	
			Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
1	0	Binary Input – Any Variation	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)		
1	1 (default – see note 1)	Binary Input	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index – see note 2)
1	2	Binary Input with Status	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index – see note 2)
2	0	Binary Input Change – Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
2	1	Binary Input Change without Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
2	2	Binary Input Change with Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
10	0	Binary Output – Any Variation	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)		
10	1	Binary Output	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index – see note 1)
10	2 (default – see note 1)	Binary Output Status	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index – see note 2)
12	1	Control Relay Output Block	3 (select) 4 (operate) 5 (direct op) 6 (dir. op, noack)	17, 28 (index)	129 (response)	echo of request
20	0	Binary Counter – Any Variation	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)		
			7 (freeze) 8 (freeze no ack)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty)		

4. Implementation Table

Object			REQUEST Master May Issue Outstation Must Parse	RESPONSE Master Must Parse Outstation May Issue		
Object Number	Variation Number	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
20	1	32-Bit Binary Counter (with Flag)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index –see note 2)
20	2	16-Bit Binary Counter (with Flag)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index –see note 2)
20	5	32-Bit Binary Counter without Flag	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index –see note 2)
20	6	16-Bit Binary Counter without Flag	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index –see note 2)
21	0	Frozen Counter – Any Variation	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)		
21	1	32-Bit Frozen Counter (with Flag)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index –see note 2)
21	2	16-Bit Frozen Counter (with Flag)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index –see note 2)
21	5	32-Bit Frozen Counter with Time Of Freeze	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop) 17, 28 (index –see note 1)
21	6	16-Bit Frozen Counter with Time Of Freeze	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop) 17, 28 (index –see note 1)
21	9 (default – see note 1)	32-Bit Frozen Counter without Flag	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop) 17, 28 (index –see note 2)
21	10	16-Bit Frozen Counter without Flag	1 (read)	00, 01 (start-stop) 06 (no range, or all)	129 (response)	00, 01 (start-stop) 17, 28 (index –see note 2)
22	0	Counter Change Event – Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
22	1 (default – see note 1)	32-Bit Counter Change Event without Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
22	2	16-Bit Counter Change Event without Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
22	5	32-Bit Counter Change Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
22	6	16-Bit Counter Change Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)

4. Implementation Table

Object			REQUEST Master May Issue Outstation Must Parse	RESPONSE Master Must Parse Outstation May Issue		
Object Number	Variation Number	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
23	0	Frozen Counter Event (Variation 0 is used to request default variation)	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
23	1 (default – see note 1)	32-Bit Frozen Counter Event	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
23	2	16-Bit Frozen Counter Event	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
23	5	32-Bit Frozen Counter Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
23	6	16-Bit Frozen Counter Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
30	0	Analog Input - Any Variation	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)		
30	1	32-Bit Analog Input	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index –see note 2)
30	2	16-Bit Analog Input	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index –see note 2)
30	3 (default – see note 1)	32-Bit Analog Input without Flag	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index –see note 2)
30	4	16-Bit Analog Input without Flag	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index –see note 2)
30	5	short floating point	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index –see note 2)
32	0	Analog Change Event – Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
32	1 (default – see note 1)	32-Bit Analog Change Event without Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
32	2	16-Bit Analog Change Event without Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
32	3	32-Bit Analog Change Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
32	4	16-Bit Analog Change Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
32	5	short floating point Analog Change Event without Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
32	7	short floating point Analog Change Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)

4. Implementation Table

Object			REQUEST Master May Issue Outstation Must Parse	RESPONSE Master Must Parse Outstation May Issue		
Object Number	Variation Number	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
34	0	Analog Input Dead band (Variation 0 is used to request default variation)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)		
34	1	16 bit Analog Input Dead band	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index –see note 2)
			2 (write)	00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)		
34	2 (default – see note 1)	32 bit Analog Input Deadband	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index –see note 2)
			2 (write)	00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)		
40	0	Analog Output Status	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)		
40	1	32-Bit Analog Output Status	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index –see note 2)
40	2 (default – see note 1)	16-Bit Analog Output Status	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index –see note 2)
40	3	short floating point Analog Output Status	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index –see note 2)
50	0	Time and Date				
50	1 (default – see note 1)	Time and Date	1 (read)	07, (limited qty = 1)	129 (response)	07 (limited qty = 1)
			2 (write)	07, (limited qty = 1)		
60	1	Class 0 Data	1 (read)	06 (no range, or all)		
60	2	Class 1 Data	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
60	3	Class 2 Data	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
60	4	Class 3 Data	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
80	1	Internal Indications	1 (read)	00, 01 (start-stop)	129 (response)	00, 01 (start-stop)

Note 1: A default variation refers to the variation responded when variation 0 is requested and/or in class 0, 1, 2, or 3 scans. Default variations are configurable; however, default settings for the configuration parameters are indicated in the table above.

Note 2: For static (non-change-event) objects, qualifiers 17 or 28 are only responded when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01. (For change-event objects, qualifiers 17 or 28 are always responded.)

Note 3: Writes of Internal Indications are only supported for index 4 or 7 (Need Time IIN1-4 or Restart IIN1-7)

5. DNP3 Ethernet Communication Setup Configuration Utility

5. DNP3 Ethernet Communication Setup Configuration Utility

It is necessary to configure DNP parameters and DNP database to match specific requirements/needs of an application. A simple, easy to use web based interface is provided to configure DNP parameters and database as per user requirement. Installer can get connected to meter by entering IP address of meter in a web browser. No separate software installation is required to configure DNP3 stack. Below sections explain each steps of DNP3 configuration in detail.

DNP3 configuration setup is located at Setup -> Meter Setup & commissioning -> Communication -> Ethernet / LAN Setup -> DNP3 Setup.

DNP3 setup is divided in subpages as per category explained below.

The screenshot displays the 'DNP3 Node Identification' configuration page. The left sidebar shows a tree view of setup categories, with 'DNP3 Setup' expanded and 'DNP3 Node Identification' selected. The main content area displays the following configuration details:

DNP Master Address:	3
PXM Meter Address :	4
User Assigned ID/Code :	Meter 61
TCP/IP Port :	20000

Figure 5. DNP3 Setup Page.

5.1 DNP3 Node Identification

When this page is selected, existing / default parameters are loaded from meter to JAVA GUI as in **Figure 6**.

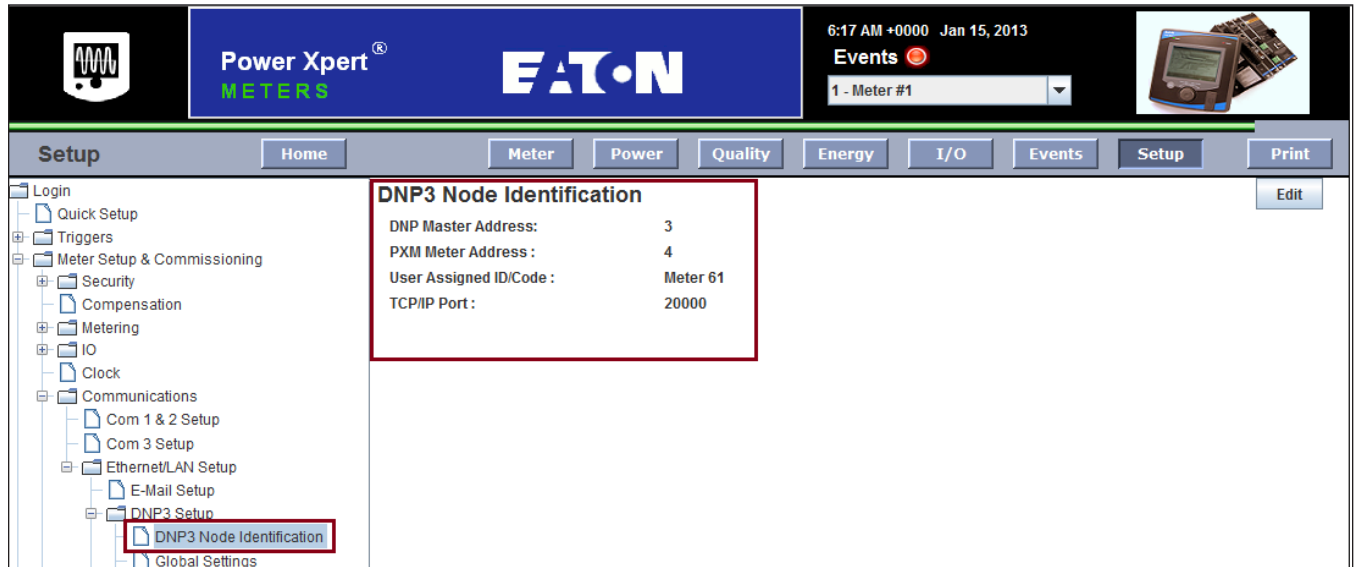


Figure 6. DNP3 Node Identification Page.

If the User wishes to change parameters' then the User first needs to press "Edit" option and "Authenticate" self to avoid unauthorized access. After Authentication, the parameters shall be editable as shown in **Figure 7**.

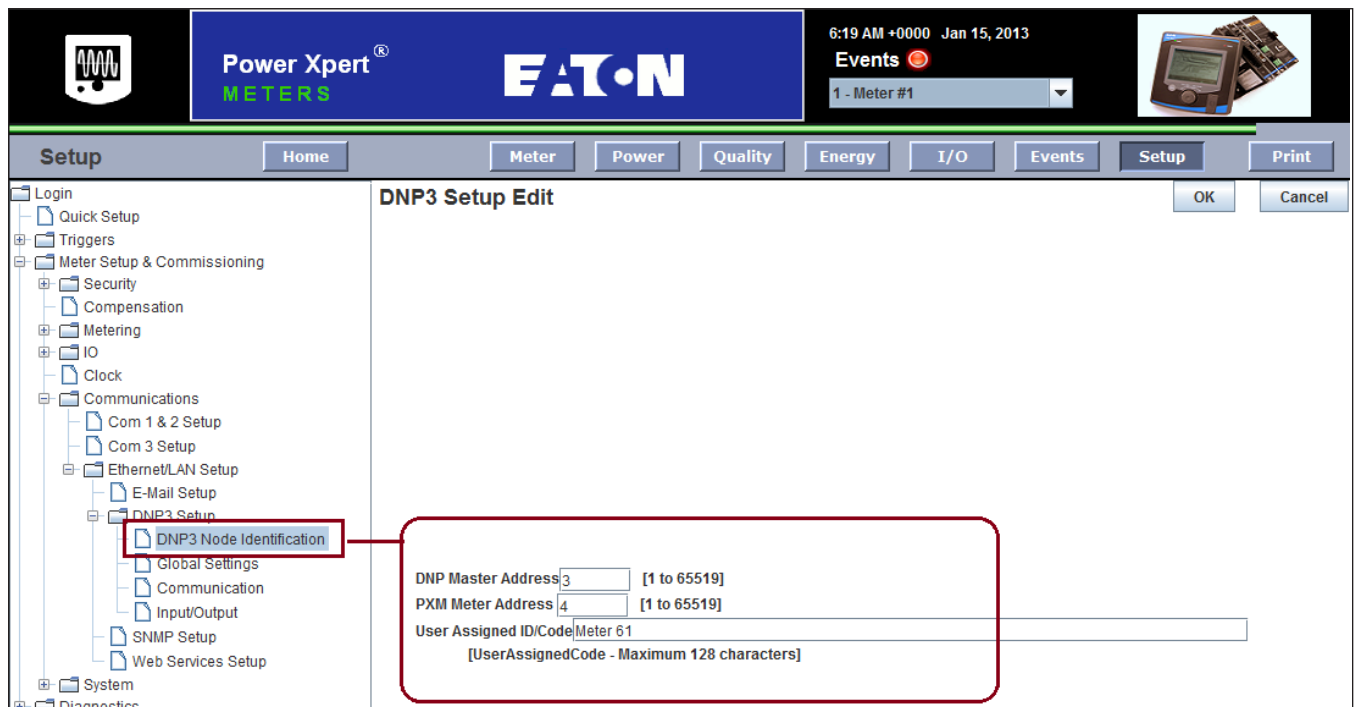


Figure 7. DNP3 Setup Edit Page.

5. DNP3 Ethernet Communication Setup Configuration Utility

The User can set three parameters:

1. DNP Master Address

It is the address of DNP master with which the PXM meter shall exchange DNP3 data. This address shall be validated by PXM meter and responses shall be sent ONLY if a request is sent by the DNP master with this address. This address shall be used in DNP3 source field in DNP frames from master to slave.

2. PXM Meter Address

This is the DNP3 address with which the DNP3 master device shall identify the specific PXM meter in the DNP network. This address shall be used in the DNP3 destination field in DNP frames from master to slave. The PXM meter shall match the destination address in the received frame and the User assigned PXM meter address. If a match is found, then the frame shall be processed further.

3. User Assigned ID/Code

The User can assign a name to the PXM meter for identification. This helps in easy identification of the PXM meter location by the user instead of remembering the meter by the DNP3 address.

Note: PXM DNP3 implementation uses port 20,000 for its communication. This port is not configurable and is fixed. To communicate with PXM meter over TCP/IP DNP, the master must use 20,000 as port number.

5.2 Global Settings

When this page is selected, the User can configure the following parameters.

1. DNP Select Operation Timeout

This parameter is used for Select-Before-Operate (SBO) operation on digital outputs (relays). If the SBO mode is used by the master to operate meter's digital outputs, then "DNP Select operation timeout" parameter is used. In this particular operation, the DNP3 master first sends a select request for particular digital output. When this request is received, the PXM meter starts a timer for duration specified by "DNP Select operation timeout" parameter. If the operate command is received from DNP3 master before this timer elapses, then that digital output is operated as per the master request.

If this timer expires before the operate request is received, then the operate request is rejected by PXM meter.

Select Before Operate:	
DNP Select Operation Timeout	5 Seconds [1 to 6500]
Define Variation Settings:	
DNP Default Object 1 Variation	1 [1,2]
DNP Default Object 2 Variation	2 [1,2,3]
DNP Default Object 10 Variation	2 [1,2]
DNP Default Object 20 Variation	5 [1,2,5,6]
DNP Default Object 21 Variation	9 [1,2,5,6,9,10]
DNP Default Object 22 Variation	1 [1,2,5,6]
DNP Default Object 23 Variation	1 [1,2,5,6]
DNP Default Object 30 Variation	5 [1,2,3,4,5]
DNP Default Object 32 Variation	1 [1,2,3,4,5,7]
DNP Default Object 34 Variation	2 [1,2,3]
DNP Default Object 40 Variation	2 [1,2,3]

Figure 8. DNP3 Global Settings Setup Edit Page.

Note: It is necessary that the digital I/O card is installed in the PXM meter to use this option. SBO operation is supported only on relays R1, R2, and R3 and these relays should be selected in the DNP input output section as explained later in this document.

2. DNP Default Object X Variation (X =1, 2, 10, 20, 21, 22, 23, 30, 32, 34, 40)

The DNP3 master may send requests to get the DNP3 slave data (PXM data) objects with variation 0. In this case, the meter can send responses with the default variation. It is possible to configure object wise default variation for the PXM meter on web page. The User can select the default variation from the drop down list given against each object.

5.3 Communication

The User can set the DNP3 stack communication related parameter in this web page. There are layer wise sections for easy parameter settings.

The screenshot displays the 'DNP3 Communication Setup Edit' web page. The navigation tree on the left includes categories like Login, Triggers, Meter Setup & Commissioning, Security, Compensation, Metering, IO, Clock, Communications, Com 1 & 2 Setup, Com 3 Setup, Ethernet/LAN Setup, E-Mail Setup, DNP3 Setup, DNP3 Node Identification, Global Settings, Communication (highlighted), Input/Output, SNMP Setup, Web Services Setup, System, and Diagnostics. The main content area is titled 'DNP3 Communication Setup Edit' and contains three distinct configuration sections:

- DNP Application Layer:**
 - Application Layer Multiple Fragment Confirmation
 - Application Layer Multiple Fragment Response Allowed
 - Application Layer Maximum Fragment Length Tx: [50 to 2048]
- DNP Data Link Layer:**
 - Link Layer Confirmation: (dropdown)
 - Link Layer Retries: [0 to 15]
 - Link Layer Time Out: mS [10 to 60000]
 - Link Layer Confirmation Time Out: mS [100 to 30000]
- DNP Time Sync:**
 - Time Synchronization Type: (dropdown)
 - Time Synchronization Interval: Seconds [1 to 86400]

Figure 9. Communication Related Parameters Page.

5. DNP3 Ethernet Communication Setup Configuration Utility

5.3.1 DNP Application Layer

In this section, the User can set the parameters related to DNP Application Layer that follow.

1. Application Layer Multiple Layer Confirmation

If the checkbox is selected, it means that a confirmation message is expected from DNP master in response to an application layer frame sent by PXM meter. For example, assume that the application frame from the PXM meter to DNP master consists of events data which are stored in PXM meter buffer. If this option is selected and if the PXM meter does not receive an application layer confirmation from the DNP master, then the PXM meter shall not delete currently stored events from its buffer.

If the checkbox is not selected, then it means that a confirmation message is not expected from the DNP master in response of an application layer frame sent by the PXM meter.

2. Application Layer Multiple Fragment Responses Allowed

This parameter indicates whether the PXM meter is allowed to send multiple application fragments in response to the request from the DNP master. It is possible that data which needs to be sent to the DNP master may not fit into a single application fragment. In such case, if this option is selected then the PXM meter shall send multiple application frames to send complete data. Otherwise, if this option is cleared (i.e. unchecked) then the PXM meter shall send only single application frame to the DNP master. In this case, it is up to the DNP master to send multiple requests to make sure that all expected data is fetched from the PXM meter stopped.

3. Application Layer Multiple Fragment Length

This parameter indicates the maximum length of an application frame which the PXM meter shall transmit. It is possible in certain cases that the buffer reserved in the DNP master for reception of data is less than what the PXM meter can transmit. To match the reception requirement of a DNP master, this parameter is configurable in the PXM meter. The range provided is from 50 to 2,048 bytes.

5.3.2 DNP Data Link Layer

In this section, the User can set the parameters related to the DNP Data Link layer that follows.

1. DNP Link Layer Confirmation

For this parameter, the User can select three options as shown below.

- Never

The PXM meter shall never expect or wait for a confirmation message from the DNP master in response to the data link layer frame sent to the master.

- Sometimes

The PXM meter shall expect or wait for a confirmation message from the DNP master in response to the data link layer frame sent to the master in certain cases only.

If the data link frame contains events or related data, then the PXM meter shall expect a data link confirmation from the DNP master. If the data link frame contains static information, then the PXM meter shall not expect a data link confirmation from the DNP master.

Choosing this option may add overhead at the DNP master. Therefore, it needs to be selected carefully.

- Always

The PXM meter shall always expect or wait for a confirmation message from the DNP master in response to a data link layer frame sent to the master.

2. Link Layer Retries

This parameter indicates how many times the PXM meter shall attempt to retransmit the DNP link frame in case of failure of DNP link layer confirmation from the DNP master. Range of this parameter is from 0 to 15.

It is obvious that if the link layer confirmation parameter is set to the option "Never", then the link layer retries parameter does not hold any significance since the PXM meter shall never attempt retransmission of link frame.

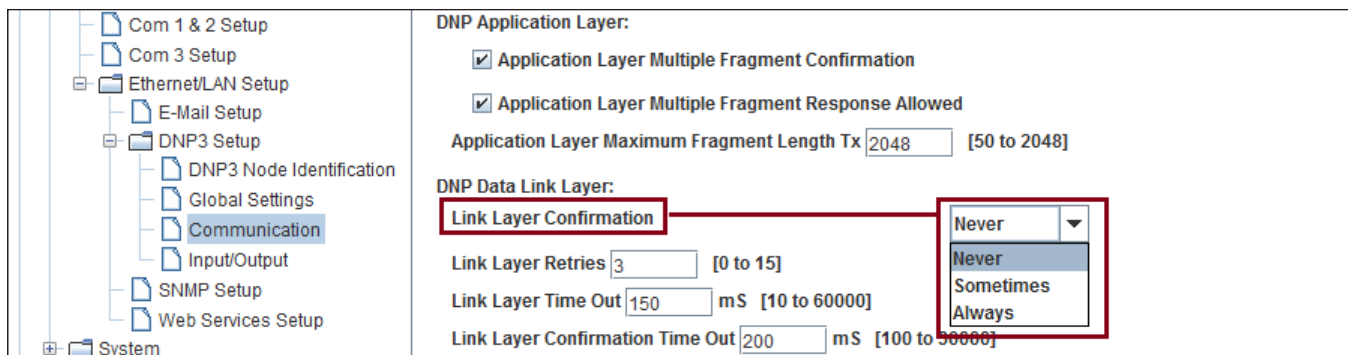


Figure 10. Link Layer Confirmation Choices.

5. DNP3 Ethernet Communication Setup Configuration Utility

3. Link Layer Confirmation Time Out

It is the time duration between two successive DNP link layer frames in case of link layer retries from the PXM meter. The range for this parameter is 100 mS to 30,000 mS.

It is the time duration for which the PXM meter will wait before attempting retransmission of the link layer frame if the link layer confirmation message is not received from the DNP master.

4. Link Layer Time Out

It is the maximum amount of time to wait for a complete frame after receiving valid frame sync characters. The range for this parameter is 10 mS to 60,000 mS.

- Interval

The PXM meter will periodically set the time sync flag to request time synchronization to match the time/date of the master.

When the time sync flag is set by the PXM meter, it is up to the DNP master to achieve time synchronization by sending a time write request to the PXM meter. When time sync is successful, the PXM meter shall clear the time sync flag in it IIN bytes and shall restart a timer. Duration of the timer will be decided by the "Interval" parameter. Once this timer elapses, the PXM meter will again set the time sync flag in it IIN bytes. This will indicate to the DNP master that the PXM meter is requesting time sync and it will repeat the procedure as explained above.

This frequent time synchronization makes sure that time in the DNP master and PXM meter is same.

5.3.3 DNP Time Sync

It may be required to synchronize the DNP master and the PXM meter real time clock (RTC). This parameter is configurable and has options as explained below.

1. Time Synchronization Type

- None

There will be no time synchronization between the DNP master and PXM meter. The PXM meter shall never set the time sync flag in IIN bytes.

2. Time Synchronization Interval

It is amount of time in seconds the PXM meter will wait before setting a time sync flag after the successful clearing of time sync flag.

The screenshot shows the configuration utility interface. On the left, a tree view shows 'DNP3 Setup' expanded to 'Communication'. The main area displays the following settings:

- Application Layer Maximum Fragment Length Tx: 2048 [50 to 2048]
- DNP Data Link Layer:
 - Link Layer Confirmation: Never
 - Link Layer Retries: 3 [0 to 15]
 - Link Layer Time Out: 150 mS [10 to 60000]
 - Link Layer Confirmation Time Out: 200 mS [100 to 30000]
- DNP Time Sync:
 - Time Synchronization Type: Interval (selected)
 - Time Synchronization Interval: 70 Seconds [1 to 86400]

Figure 11. Time Synchronization Type Page

5. DNP3 Ethernet Communication Setup Configuration Utility

5.4 DNP3 Input/Output Setup

As explained in Section 2, it is necessary to create a DNP slave database in PXM meter so that data can be exchanged with the DNP master. Organization of this database may vary from application to application depending on needs of the situation. Therefore, it is up to installer to correctly configure this database to get appropriate results. Appendix A provides a list of PXM meter parameters / variables which can be added to the PXM DNP slave database. Using the DNP Input/Output web page, the User can select and configure the required meter parameters for the specific requirement. List in Appendix A has been prepared by keeping reference to the MODBUS address and length. For the encoding of these parameters, the User should refer to the MODBUS section.

DNP3 database configuration can be done with the User interface provided on DNP3 Setup -> DNP3 Input/Output web page. The DNP3 database is arranged in tabs as explained in the following

Figure 12 shows simple steps to prepare the DNP slave database in the PXM meter.

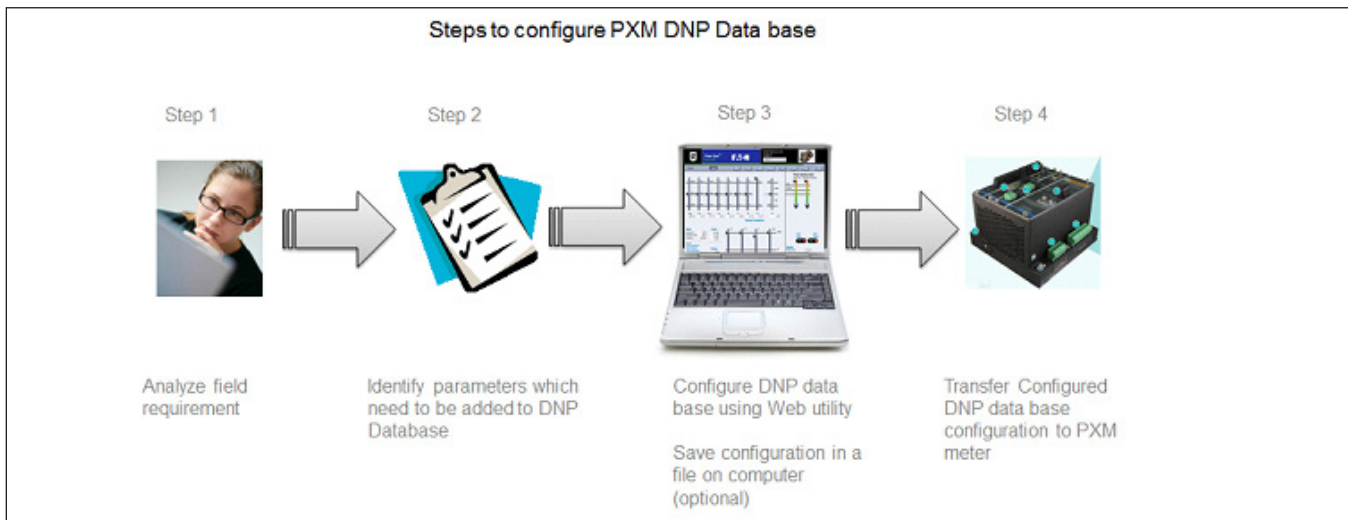


Figure 12. Steps to Prepare the DNP Slave Database in the PXM Meter.

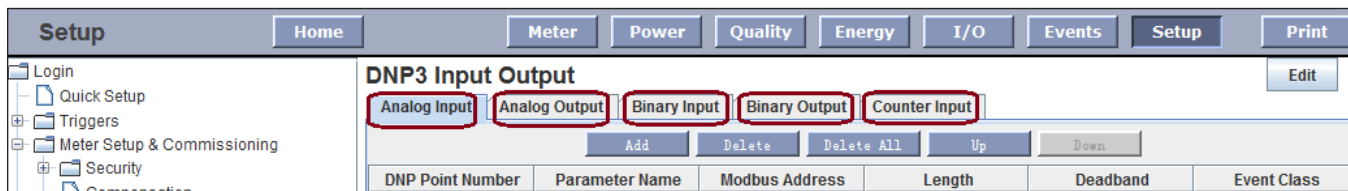


Figure 13. DNP3 Input/Output Page.

5. DNP3 Ethernet Communication Setup Configuration Utility

1. Analog Input: (DNP Object 30, 32)

Static analog inputs are configured under Object 30 whereas analog change events are configured under Object 32.

2. Analog Output: (DNP Object 40)

Analog output status is configured under Object 40. Please note that current DNP3 implementation in PXM meter allows only the read operation on analog outputs.

3. Binary Input: (DNP Object 1, 2)

Static digital inputs are configured under Object 1 whereas digital input change events are configured under Object 2.

4. Binary Output: (DNP Object 10, 12)

Digital output status is configured under Object 10 whereas CROB operations are configured under Object 12.

5. Binary Counter: (DNP Object 20, 21, 22, 23)

Static binary counters are configured under Group 20, counter change events are configured under Object 21, frozen counters are configured under Object 22, and frozen counter events are configured under Object 23.

The User has options to Load & Save DNP3 database configuration from the meter or a file. Each of these options can be accessed using the buttons provided on lower part of DNP Input Output page.

Note: Unless the User authenticates him/herself by valid User name and password, these buttons will not be operational. The User needs to press the Edit button and enter credentials to access these options.

1. Load Config

The User can load a pre-configured DNP database configuration from a file into the User interface to save efforts. This file must be generated using the web interface and must be present on the computer where the web utility is being executed.

Upon pressing this button, the User will be prompted to select a configuration file. The User needs to select an appropriate configuration file for loading into web interface.

DNP Point Number	Parameter Name	Modbus Address	Length	Deadband	Event Class
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Figure 14. Load & Save Buttons on the DNP Input/Output Page.

5. DNP3 Ethernet Communication Setup Configuration Utility

DNP Point Number	Parameter Name	Modbus Address	Length	Deadband	Event Class
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Figure 15. Configuration File Selected to Load.

All configuration data available in the file will be loaded into the web interface and displayed for the User for further operations. File data shall be loaded automatically into the individual tabs as per category. For example, if a file has analog data (Object 30, 32), then it will be loaded into the Analog Input tab and if the file has binary counter data (Object 20, 21, 22, 23) then it will be loaded into the Binary Counter tab of the web interface.

2. Save Config

When the User completes configuration of the DNP3 database, the User may wish to save the configuration into a file on computer for future use and reference. By using “Save Config” option on the web interface, the User can save it on computer. The User will be prompted to select a location and provide a file name for the configuration file.

3. Get From Meter

If the meter is already configured with a DNP database, then the User may transfer an existing DNP database configuration into the web interface by using the “Get From Meter” option. This option is particularly useful when the User wants to modify an existing configuration.

4. Save To Meter

When the User completes the configuration of the DNP database on the web interface, the User must transfer this configuration into the PXM meter. By using the “Save To Meter” option, this operation is achieved.

Note: Unless the meter reboots after using the “Save to Meter” option, the newly configured database will not be effective. After using this option, the web interface will prompt the User if the PXM meter needs to be rebooted or not. The User may choose to reboot or must reboot meter manually later so that the modified DNP database becomes effective.

5.5 Procedure to Create the DNP3 Database Configuration

Appendix A provides a list of meter parameters which can be added to the DNP database. The User needs to select parameters from the list and add them to the DNP3 database. For easy selection, the meter parameters are arranged as per DNP object groups in the Input Output web page.

The procedure for selecting and adding parameters to the DNP3 database is same for all objects. Each tab is assigned to particular DNP3 objects. Each tab has buttons and there functionality is explained in the following.

1. Add
Adds a new parameter to the DNP3 database. When the User selects this option, the new pop-up window allows the User to select the new meter parameter and set the properties of parameter. For example, add a binary counter when the User selects the Add option below the pop-up window.
2. Delete All
Deletes all parameters present in the selection list on a particular tab. For example, if the Delete All button is pressed on the binary counter tab, then all parameters (i.e. binary counters) in the selection list are deleted.

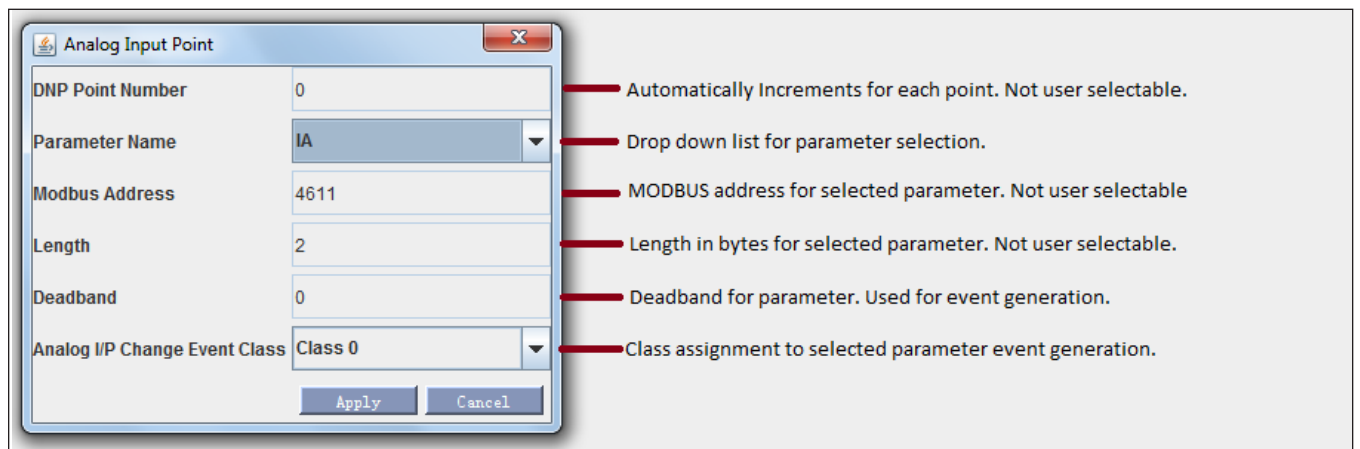


Figure 16. Adding a New Parameter to the DNP3 Database.

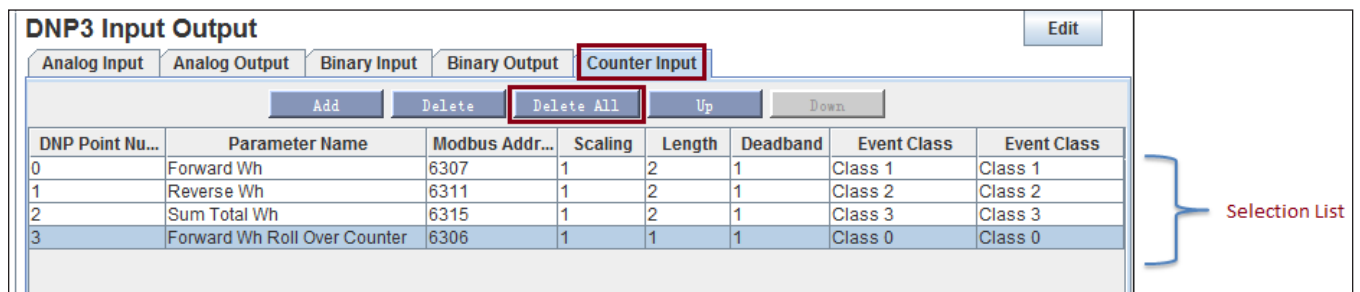


Figure 17. Binary Counter Button.

5. DNP3 Ethernet Communication Setup Configuration Utility

3. Delete

Deletes selected parameters in the selection list on particular a tab. For example, if the Delete button is pressed on Binary Counter tab, then a particular selected parameter (i.e. binary counter) in the selection list is deleted.

4. Up

Moves a particular parameter to a higher DNP index than its existing position. When the list is populated and it is required to change the order (i.e. DNP index) of a particular point to fulfill a field requirement, then using the UP button will achieved this goal.

5. Down

Move a particular parameter to a lower DNP index than its existing position. When the list is populated and it is required to change the order (i.e. DNP index) of a particular point to fulfill a field requirement, then using the DOWN button will achieved this goal.

The following is an example of UP and Down button movement of a binary counter.

5.5.1 Editing an Existing Parameter

If the User wishes to edit an existing parameter, then the User needs to “double” click the required parameter so that Edit pop up window will appear. The Edit window will be loaded with existing data. The User then can modify the parameter configuration and then press the “Apply” button so that particular parameter will be modified. If the User clicks “Cancel”, then the modifications will be discarded and will not be applied to the meter parameter. The User must use the “Save to Meter” option so that the modified parameters are transferred to the meter.

DNP Point Nu...	Parameter Name	Modbus Addr...	Scaling	Length	Deadband	Event Class	Event Class
0	Forward Wh	6307	1	2	1	Class 1	Class 1
1	Reverse Wh	6311	1	2	1	Class 2	Class 2
2	Sum Total Wh	6315	1	2	1	Class 3	Class 3
3	Forward Wh Roll Over Counter	6306	1	1	1	Class 0	Class 0

Figure 18. Delete Button.

DNP Point Nu...	Parameter Name	Modbus Addr...	Scaling	Length	Deadband	Event Class	Event Class
0	Forward Wh	6307	1	2	1	Class 1	Class 1
1	Reverse Wh	6311	1	2	1	Class 2	Class 2
2	Sum Total Wh	6315	1	2	1	Class 3	Class 3
3	Forward Wh Roll Over Counter	6306	1	1	1	Class 0	Class 0
4	Received/Lagging VArh	6323	1	2	0	Class 0	Class 0
5	Sum Total Wh Roll Over Counter	6314	1	1	0	Class 0	Class 0

Figure 19. UP and DOWN Button Function.

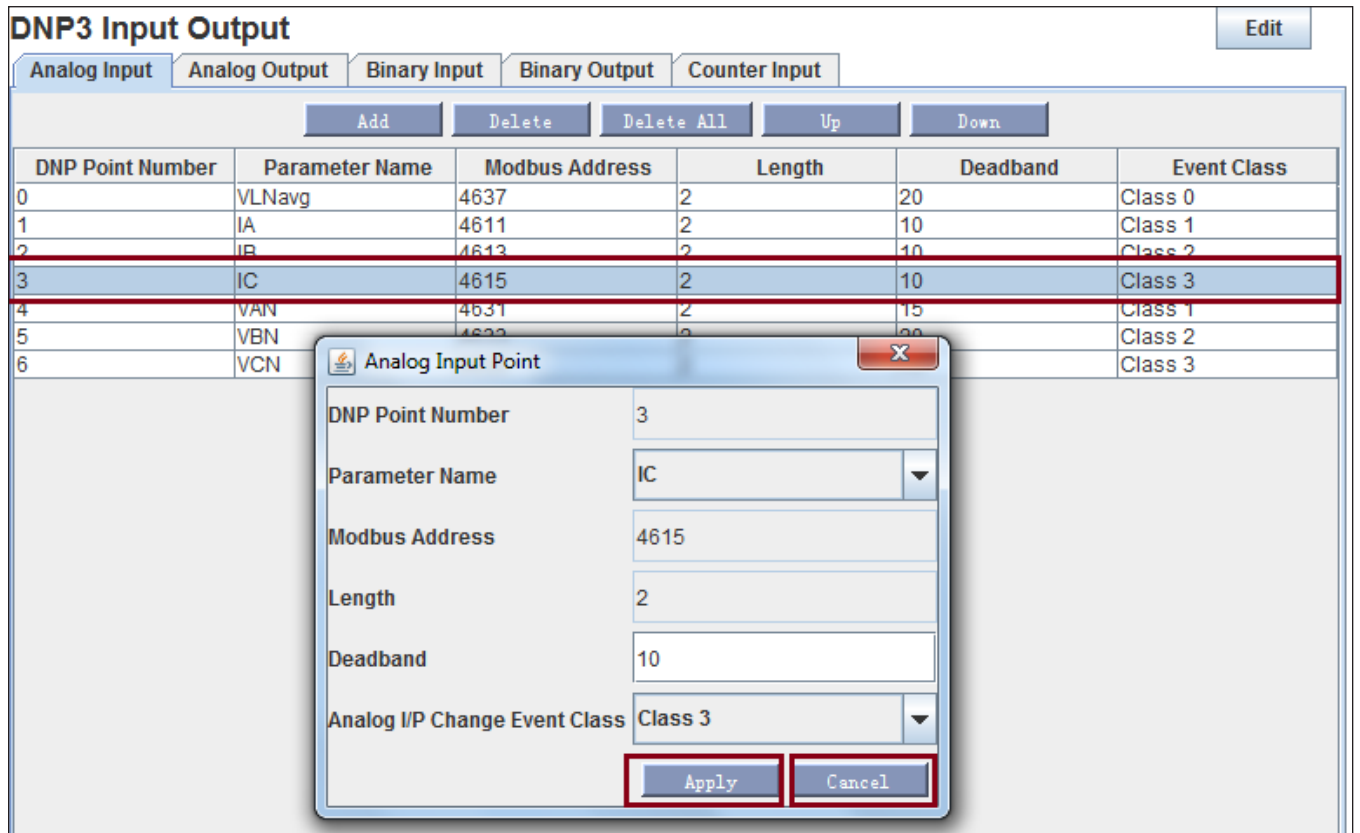


Figure 20. Applying the Modified Parameter(s).

5.6 Assigning a Dead Band

PXM DNP implementation uses a fixed dead banding method for event detection. If a static value of a meter parameter changes beyond the assigned dead band limit, then the event is triggered and stored in the internal event buffer. Dead band value indicates the number of counts used for event comparison.

For analog inputs, if a reference value goes above OR below the dead band limit, then an event is triggered. For example, if IA is assigned with a dead band value of 10 and reference value of IA is 500 Amps, then an event will be triggered in the case of the static value of IA is less than 490 Amps or greater than 510 Amps. When this particular event is triggered, the value of IA which caused the event becomes reference for next event comparison.

For binary counters, if the difference/delta between reference value and current value is greater than the dead band, then an event is triggered. This is because the counter value cannot decrement. When an event is triggered, the value which caused the event becomes reference for the next event comparison.

For binary inputs, state stage causes an event generation, therefore it is not required to assign a dead band to the binary inputs.

Below are limits for different types of event storages in the PXM meter.

- Analog input change events 500
- Binary input change events 250
- Binary counter input change events 250
- Frozen binary counter change events 250

Note: If the User selects an event class as 0, then the dead band cannot be programmed. Similarly, if the User assigns class 1, 2, or 3, then the dead band value cannot be zero.

Appendix A Points List

#	Parameter Name	Eng. Unit	DNP3 Category	Size
1	Floating-Point Word Order Setting	Encoded	Analog Output	16 Bit
2	Fixed-Point Word Order Setting	Encoded	Analog Output	16 Bit
3	Product ID	0	Analog Input	32 Bit
4	Primary/Secondary Status	Encoded	Analog Input	16 Bit
5	Cause Of Status	Encoded	Analog Input	16 Bit
6	IA	Amps	Analog Input	32 Bit
7	IB	Amps	Analog Input	32 Bit
8	IC	Amps	Analog Input	32 Bit
9	IG	Amps	Analog Input	32 Bit
10	IN	Amps	Analog Input	32 Bit
11	Iavg	Amps	Analog Input	32 Bit
12	VAB	Volts	Analog Input	32 Bit
13	VBC	Volts	Analog Input	32 Bit
14	VCA	Volts	Analog Input	32 Bit
15	VLLavg	Volts	Analog Input	32 Bit
16	VAN	Volts	Analog Input	32 Bit
17	VBN	Volts	Analog Input	32 Bit
18	VCN	Volts	Analog Input	32 Bit
19	VLNavg	Volts	Analog Input	32 Bit
20	VNG	Volts	Analog Input	32 Bit
21	Real Power (Watts)	Watts	Analog Input	32 Bit
22	Reactive Power (VAr)	VAr	Analog Input	32 Bit
23	Apparent Power (VA)	VA	Analog Input	32 Bit
24	PFd [Displacement Power Factor]	0	Analog Input	32 Bit
25	PFa [Apparent/True Power Factor]	0	Analog Input	32 Bit
26	Frequency	Hz	Analog Input	32 Bit
27	K-factor	0	Analog Input	32 Bit
28	Transformer Harmonic Derating Factor (sqrt2/CrestFactor)	0	Analog Input	32 Bit
29	Phase A Watts	Watts	Analog Input	32 Bit
30	Phase B Watts	Watts	Analog Input	32 Bit
31	Phase C Watts	Watts	Analog Input	32 Bit
32	Phase A VAr	Var	Analog Input	32 Bit
33	Phase B VAr	Var	Analog Input	32 Bit
34	Phase C VAr	Var	Analog Input	32 Bit
35	Phase A VA	VA	Analog Input	32 Bit
36	Phase B VA	VA	Analog Input	32 Bit
37	Phase C VA	VA	Analog Input	32 Bit
38	Phase A PFd [Displacement Power Factor]	0	Analog Input	32 Bit
39	Phase B PFd	0	Analog Input	32 Bit

#	Parameter Name	Eng. Unit	DNP3 Category	Size
40	Phase C PFd	0	Analog Input	32 Bit
41	Phase A PFa [Apparent/True Power Factor]	0	Analog Input	32 Bit
42	Phase B PFa	0	Analog Input	32 Bit
43	Phase C PFa	0	Analog Input	32 Bit
44	Source1 VAB (AUX)	Volts	Analog Input	32 Bit
45	Source1 VBC (AUX)	Volts	Analog Input	32 Bit
46	Source1 VCA (AUX)	Volts	Analog Input	32 Bit
47	Phase A Direct (V)	Volts	Analog Input	32 Bit
48	Phase A Quadrature (V)	Volts	Analog Input	32 Bit
49	Phase B Direct (V)	Volts	Analog Input	32 Bit
50	Phase B Quadrature (V)	Volts	Analog Input	32 Bit
51	Phase C Direct (V)	Volts	Analog Input	32 Bit
52	Phase C Quadrature (V)	Volts	Analog Input	32 Bit
53	Positive Sequence Direct (V)	Volts	Analog Input	32 Bit
54	Positive Sequence Quadrature (V)	Volts	Analog Input	32 Bit
55	Forward Wh	kWh	Counter	32 Bit
56	Forward Wh Roll Over Counter	kWh	Counter	16 Bit
57	Reverse Wh	kWh	Counter	32 Bit
58	Reverse Wh Roll Over Counter	kWh	Counter	16 Bit
59	Sum Total Wh	kWh	Counter	32 Bit
60	Sum Total Wh Roll Over Counter	kWh	Counter	16 Bit
61	Delivered/Leading VARh	kvarh	Counter	32 Bit
62	Delivered/Leading VARh Roll Over Counter	kvarh	Counter	16 Bit
63	Received/Lagging VARh	kvarh	Counter	32 Bit
64	Received/Lagging VARh Roll Over Counter	kvarh	Counter	16 Bit
65	Net VARh	kvarh	Counter	32 Bit
66	Net VARh Roll Over Counter	kvarh	Counter	16 Bit
67	VAh	kVAh	Counter	32 Bit
68	Vah Roll Over Counter	kVAh	Counter	16 Bit
69	Event Count	EventCount	Counter	32 Bit
70	Nines Of Availability/Performance	Percentage	Analog Input	32 Bit
71	System Frequency	Hertz	Analog Input	32 Bit
72	Ig 200 [200ms rms current]	Amps	Analog Input	32 Bit
73	In 200	Amps	Analog Input	32 Bit
74	Ia 200	Amps	Analog Input	32 Bit
75	Ib 200	Amps	Analog Input	32 Bit
76	Ic 200	Amps	Analog Input	32 Bit
77	Iavg 200	Amps	Analog Input	32 Bit
78	VInavg 200 [200ms rms voltage]	Volts	Analog Input	32 Bit
79	Vng 200	Volts	Analog Input	32 Bit
80	VlIavgAUX 200	Volts	Analog Input	32 Bit

Appendix A Points List

#	Parameter Name	Eng. Unit	DNP3 Category	Size
81	VabAUX 200	Volts	Analog Input	32 Bit
82	VbcAUX 200	Volts	Analog Input	32 Bit
83	VcaAUX 200	Volts	Analog Input	32 Bit
84	Van 200	Volts	Analog Input	32 Bit
85	Vab 200	Volts	Analog Input	32 Bit
86	Vbn 200	Volts	Analog Input	32 Bit
87	Vbc 200	Volts	Analog Input	32 Bit
88	Vcn 200	Volts	Analog Input	32 Bit
89	Vca 200	Volts	Analog Input	32 Bit
90	Vllavg 200	Volts	Analog Input	32 Bit
91	Phase A Apparent/True Power Factor	0	Analog Input	32 Bit
92	Phase B Apparent/True Power Factor	0	Analog Input	32 Bit
93	Phase C Apparent/True Power Factor	0	Analog Input	32 Bit
94	System Apparent/True Power Factor	0	Analog Input	32 Bit
95	Real Forward Energy Rate A	kWh	Counter	32 Bit
96	Real Forward Energy Rate A Roll Over Counter	kWh	Counter	16 Bit
97	Real Forward Energy RTP	kWh	Counter	32 Bit
98	Real Forward Energy RTP Roll Over Counter	kWh	Counter	16 Bit
99	Total Real Forward Energy	kWh	Counter	32 Bit
100	Total Real Forward Energy Roll Over Counter	kWh	Counter	16 Bit
101	Real Reverse Energy Rate A	kWh	Counter	32 Bit
102	Real Reverse Energy Rate A Roll Over Counter	kWh	Counter	16 Bit
103	Real Reverse Energy RTP	kWh	Counter	32 Bit
104	Real Reverse Energy RTP Roll Over Counter	kWh	Counter	16 Bit
105	Total Real Reverse Energy	kWh	Counter	32 Bit
106	Total Real Reverse Energy Roll Over Counter	kWh	Counter	16 Bit
107	Real Net Energy Rate A	kWh	Counter	32 Bit
108	Real Net Energy Rate A Roll Over Counter	kWh	Counter	16 Bit
109	Real Net Energy RTP	kWh	Counter	32 Bit
110	Real Net Energy RTP Roll Over Counter	kWh	Counter	16 Bit
111	Total Real Net Energy	kWh	Counter	32 Bit
112	Total Real Net Energy Roll Over Counter	kWh	Counter	16 Bit
113	Real Total Energy Rate A	kWh	Counter	32 Bit
114	Real Total Energy Rate A Roll Over Counter	kWh	Counter	16 Bit
115	Real Total Energy RTP	kWh	Counter	32 Bit
116	Real Total Energy RTP Roll Over Counter	kWh	Counter	16 Bit
117	Total Real Total Energy	kWh	Counter	32 Bit
118	Total Real Total Energy Roll Over Counter	kWh	Counter	16 Bit
119	Apparent Energy (kVAh) Rate A	kVAh	Counter	32 Bit
120	Apparent Energy (kVAh) Rate A Roll Over Counter	kVAh	Counter	16 Bit
121	Apparent Energy (kVAh) RTP	kVAh	Counter	32 Bit

#	Parameter Name	Eng. Unit	DNP3 Category	Size
122	Apparent Energy (kVAh) RTP Roll Over Counter	kVAh	Counter	16 Bit
123	Total Apparent Energy	kVAh	Counter	32 Bit
124	Total Apparent Energy Roll Over Counter	kVAh	Counter	16 Bit
125	Reactive Delivered Energy Rate A	kvarh	Counter	32 Bit
126	Reactive Delivered Energy Rate A Roll Over Counter	kvarh	Counter	16 Bit
127	Reactive Delivered Energy RTP	kvarh	Counter	32 Bit
128	Reactive Delivered Energy RTP Roll Over Counter	kvarh	Counter	16 Bit
129	Total Reactive Delivered Energy	kvarh	Counter	32 Bit
130	Total Reactive Delivered Energy Roll Over Counter	kvarh	Counter	16 Bit
131	Reactive Received Energy Rate A	kvarh	Counter	32 Bit
132	Reactive Received Energy Rate A Roll Over Counter	kvarh	Counter	16 Bit
133	Reactive Received Energy RTP	kvarh	Counter	32 Bit
134	Reactive Received Energy RTP Roll Over Counter	kvarh	Counter	16 Bit
135	Total Reactive Received Energy	kvarh	Counter	32 Bit
136	Total Reactive Received Energy Roll Over Counter	kvarh	Counter	16 Bit
137	Reactive Net Energy Rate A	kvarh	Counter	32 Bit
138	Reactive Net Energy Rate A Roll Over Counter	kvarh	Counter	16 Bit
139	Reactive Net Energy RTP	kvarh	Counter	32 Bit
140	Reactive Net Energy RTP Roll Over Counter	kvarh	Counter	16 Bit
141	Total Reactive Net Energy	kvarh	Counter	32 Bit
142	Total Reactive Net Energy Roll Over Counter	kvarh	Counter	16 Bit
143	Reactive Total Energy Rate A	kvarh	Counter	32 Bit
144	Reactive Total Energy Rate A Roll Over Counter	kvarh	Counter	16 Bit
145	Reactive Total Energy RTP	kvarh	Counter	32 Bit
146	Reactive Total Energy RTP Roll Over Counter	kvarh	Counter	16 Bit
147	Total Reactive Total Energy	kvarh	Counter	32 Bit
148	Total Reactive Total Energy Roll Over Counter	kvarh	Counter	16 Bit
149	Crest Factor Phase A	0	Analog Input	32 Bit
150	Crest Factor Phase B	0	Analog Input	32 Bit
151	Crest Factor Phase C	0	Analog Input	32 Bit
152	Crest Factor System Maximum	0	Analog Input	32 Bit
153	ITIC Factor Phase A	0	Analog Input	32 Bit
154	ITIC Factor Phase B	0	Analog Input	32 Bit
155	ITIC Factor Phase C	0	Analog Input	32 Bit
156	ITIC Factor System Minimum	0	Analog Input	32 Bit
157	Flicker Perceptibility Phase AN	0	Analog Input	32 Bit
158	Flicker Perceptibility Phase AB	0	Analog Input	32 Bit
159	Flicker Perceptibility Phase BN	0	Analog Input	32 Bit
160	Flicker Perceptibility Phase BC	0	Analog Input	32 Bit
161	Flicker Perceptibility Phase CN	0	Analog Input	32 Bit
162	Flicker Perceptibility Phase CA	0	Analog Input	32 Bit

Appendix A Points List

#	Parameter Name	Eng. Unit	DNP3 Category	Size
163	Short Term Flicker Perceptibility Phase AN	0	Analog Input	32 Bit
164	Short Term Flicker Perceptibility Phase AB	0	Analog Input	32 Bit
165	Short Term Flicker Perceptibility Phase BN	0	Analog Input	32 Bit
166	Short Term Flicker Perceptibility Phase BC	0	Analog Input	32 Bit
167	Short Term Flicker Perceptibility Phase CN	0	Analog Input	32 Bit
168	Short Term Flicker Perceptibility Phase CA	0	Analog Input	32 Bit
169	K-Factor Phase A	0	Analog Input	32 Bit
170	K-Factor Phase B	0	Analog Input	32 Bit
171	K-Factor Phase C	0	Analog Input	32 Bit
172	K-Factor System Maximum	0	Analog Input	32 Bit
173	Even Harmonic Distortion Magnitude Neutral Current	0	Analog Input	32 Bit
174	Even Harmonic Distortion Magnitude AUX VAB	Volts	Analog Input	32 Bit
175	Even Harmonic Distortion Magnitude AUX VBC	Volts	Analog Input	32 Bit
176	Even Harmonic Distortion Magnitude AUX VCA	Volts	Analog Input	32 Bit
177	Even Harmonic Distortion Magnitude Phase A Current	Amps	Analog Input	32 Bit
178	Even Harmonic Distortion Magnitude VAB	Volts	Analog Input	32 Bit
179	Even Harmonic Distortion Magnitude VAN	Volts	Analog Input	32 Bit
180	Even Harmonic Distortion Magnitude Phase B Current	Amps	Analog Input	32 Bit
181	Even Harmonic Distortion Magnitude VBC	Volts	Analog Input	32 Bit
182	Even Harmonic Distortion Magnitude VBN	Volts	Analog Input	32 Bit
183	Even Harmonic Distortion Magnitude Phase C Current	Amps	Analog Input	32 Bit
184	Even Harmonic Distortion Magnitude VCA	Volts	Analog Input	32 Bit
185	Even Harmonic Distortion Magnitude VCN	Volts	Analog Input	32 Bit
186	Odd Harmonic Distortion Magnitude Neutral Current	Ampere	Analog Input	32 Bit
187	Odd Harmonic Distortion Magnitude AUX VAB	Volts	Analog Input	32 Bit
188	Odd Harmonic Distortion Magnitude AUX VBC	Volts	Analog Input	32 Bit
189	Odd Harmonic Distortion Magnitude AUX VCA	Volts	Analog Input	32 Bit
190	Odd Harmonic Distortion Magnitude Phase A Current	Amps	Analog Input	32 Bit
191	Odd Harmonic Distortion Magnitude VAB	Volts	Analog Input	32 Bit
192	Odd Harmonic Distortion Magnitude VAN	Volts	Analog Input	32 Bit
193	Odd Harmonic Distortion Magnitude Phase B Current	Amps	Analog Input	32 Bit
194	Odd Harmonic Distortion Magnitude VBC	Volts	Analog Input	32 Bit
195	Odd Harmonic Distortion Magnitude VBN	Volts	Analog Input	32 Bit
196	Odd Harmonic Distortion Magnitude Phase C Current	Amps	Analog Input	32 Bit
197	Odd Harmonic Distortion Magnitude VCA	Volts	Analog Input	32 Bit
198	Odd Harmonic Distortion Magnitude VCN	Volts	Analog Input	32 Bit
199	Interharmonic Distortion Magnitude Neutral Current	Ampere	Analog Input	32 Bit
200	Interharmonic Distortion Magnitude AUX VAB	Volts	Analog Input	32 Bit
201	Interharmonic Distortion Magnitude AUX VBC	Volts	Analog Input	32 Bit
202	Interharmonic Distortion Magnitude AUX VCA	Volts	Analog Input	32 Bit
203	Interharmonic Distortion Magnitude Phase A Current	Amps	Analog Input	32 Bit

#	Parameter Name	Eng. Unit	DNP3 Category	Size
204	Interharmonic Distortion Magnitude VAB	Volts	Analog Input	32 Bit
205	Interharmonic Distortion Magnitude VAN	Volts	Analog Input	32 Bit
206	Interharmonic Distortion Magnitude Phase B Current	Amps	Analog Input	32 Bit
207	Interharmonic Distortion Magnitude VBC	Volts	Analog Input	32 Bit
208	Interharmonic Distortion Magnitude VBN	Volts	Analog Input	32 Bit
209	Interharmonic Distortion Magnitude Phase C Current	Amps	Analog Input	32 Bit
210	Interharmonic Distortion Magnitude VCA	Volts	Analog Input	32 Bit
211	Interharmonic Distortion Magnitude VCN	Volts	Analog Input	32 Bit
212	Total Harmonic Distortion Magnitude Neutral Current	Amps	Analog Input	32 Bit
213	Total Harmonic Distortion Magnitude AUX VAB	Volts	Analog Input	32 Bit
214	Total Harmonic Distortion Magnitude AUX VBC	Volts	Analog Input	32 Bit
215	Total Harmonic Distortion Magnitude AUX VCA	Volts	Analog Input	32 Bit
216	Total Harmonic Distortion Magnitude Phase A Current	Amps	Analog Input	32 Bit
217	Total Harmonic Distortion Magnitude VAB	Volts	Analog Input	32 Bit
218	Total Harmonic Distortion Magnitude VAN	Volts	Analog Input	32 Bit
219	Total Harmonic Distortion Magnitude Phase B Current	Amps	Analog Input	32 Bit
220	Total Harmonic Distortion Magnitude VBC	Volts	Analog Input	32 Bit
221	Total Harmonic Distortion Magnitude VBN	Volts	Analog Input	32 Bit
222	Total Harmonic Distortion Magnitude Phase C Current	Amps	Analog Input	32 Bit
223	Total Harmonic Distortion Magnitude VCA	Volts	Analog Input	32 Bit
224	Total Harmonic Distortion Magnitude VCN	Volts	Analog Input	32 Bit
225	Displacement Power Factor DPFa	0	Analog Input	32 Bit
226	Displacement Power Factor DPFb	0	Analog Input	32 Bit
227	Displacement Power Factor DPFc	0	Analog Input	32 Bit
228	Displacement Power Factor DPFsyst	0	Analog Input	32 Bit
229	Apparent Power Sa	kVA	Analog Input	32 Bit
230	Apparent Power Sb	kVA	Analog Input	32 Bit
231	Apparent Power Sc	kVA	Analog Input	32 Bit
232	Apparent Power Stotal	kVA	Analog Input	32 Bit
233	Reactive Power Qa	kvar	Analog Input	32 Bit
234	Reactive Power Qb	kvar	Analog Input	32 Bit
235	Reactive Power Qc	kvar	Analog Input	32 Bit
236	Reactive Power Qsys	kvar	Analog Input	32 Bit
237	Real Power Pa	kW	Analog Input	32 Bit
238	Real Power Pb	kW	Analog Input	32 Bit
239	Real Power Pc	kW	Analog Input	32 Bit
240	Real Power Ptotal	kW	Analog Input	32 Bit
241	Phase Angle IN	Degrees	Analog Input	32 Bit
242	Phase Angle IA	Degrees	Analog Input	32 Bit
243	Phase Angle IB	Degrees	Analog Input	32 Bit
244	Phase Angle IC	Degrees	Analog Input	32 Bit

Appendix A Points List

#	Parameter Name	Eng. Unit	DNP3 Category	Size
245	Phase Angle VAN	Degrees	Analog Input	32 Bit
246	Phase Angle VBN	Degrees	Analog Input	32 Bit
247	Phase Angle VCN	Degrees	Analog Input	32 Bit
248	Phase Angle VAB	Degrees	Analog Input	32 Bit
249	Phase Angle VBC	Degrees	Analog Input	32 Bit
250	Phase Angle VCA	Degrees	Analog Input	32 Bit
251	Current Phasor Ig Direct	Amps	Analog Input	32 Bit
252	Current Phasor Ig Quadrature	Amps	Analog Input	32 Bit
253	Current Phasor In Direct	Amps	Analog Input	32 Bit
254	Current Phasor In Quadrature	Amps	Analog Input	32 Bit
255	Current Phasor Ia Direct	Amps	Analog Input	32 Bit
256	Current Phasor Ia Quadrature	Amps	Analog Input	32 Bit
257	Current Phasor Ib Direct	Amps	Analog Input	32 Bit
258	Current Phasor Ib Quadrature	Amps	Analog Input	32 Bit
259	Current Phasor Ic Direct	Amps	Analog Input	32 Bit
260	Current Phasor Ic Quadrature	Amps	Analog Input	32 Bit
261	Voltage Phasor VAN Direct	Volts	Analog Input	32 Bit
262	Voltage Phasor VAN Quadrature	Volts	Analog Input	32 Bit
263	Voltage Phasor VBN Direct	Volts	Analog Input	32 Bit
264	Voltage Phasor VBN Quadrature	Volts	Analog Input	32 Bit
265	Voltage Phasor VCN Direct	Volts	Analog Input	32 Bit
266	Voltage Phasor VCN Quadrature	Volts	Analog Input	32 Bit
267	Voltage Phasor VAB Direct	Volts	Analog Input	32 Bit
268	Voltage Phasor VAB Quadrature	Volts	Analog Input	32 Bit
269	Voltage Phasor VBC Direct	Volts	Analog Input	32 Bit
270	Voltage Phasor VBC Quadrature	Volts	Analog Input	32 Bit
271	Voltage Phasor VCA Direct	Volts	Analog Input	32 Bit
272	Voltage Phasor VCA Quadrature	Volts	Analog Input	32 Bit
273	Symmetric Component Pos Seq I Direct	Amps	Analog Input	32 Bit
274	Symmetric Component Pos Seq I Quadrature	Amps	Analog Input	32 Bit
275	Symmetric Component Neg Seq I Direct	Amps	Analog Input	32 Bit
276	Symmetric Component Neg Seq I Quadrature	Amps	Analog Input	32 Bit
277	Symmetric Component Zero Seq I Direct	Amps	Analog Input	32 Bit
278	Symmetric Component Zero Seq I Quadrature	Amps	Analog Input	32 Bit
279	Symmetric AUX Component Pos Seq Vxmr Direct	Volts	Analog Input	32 Bit
280	Symmetric AUX Component Pos Seq Vxmr Quadrature	Volts	Analog Input	32 Bit
281	Symmetric AUX Component Neg Seq Vxmr Direct	Volts	Analog Input	32 Bit
282	Symmetric AUX Component Neg Seq Vxmr Quadrature	Volts	Analog Input	32 Bit
283	Symmetric AUX Component Zero Seq Vxmr Direct	Volts	Analog Input	32 Bit
284	Symmetric AUX Component Zero Seq Vxmr Quadrature	Volts	Analog Input	32 Bit
285	Symmetric Component Pos Seq V Direct	Volts	Analog Input	32 Bit

#	Parameter Name	Eng. Unit	DNP3 Category	Size
286	Symmetric Component Pos Seq V Quadrature	Volts	Analog Input	32 Bit
287	Symmetric Component Neg Seq V Direct	Volts	Analog Input	32 Bit
288	Symmetric Component Neg Seq V Quadrature	Volts	Analog Input	32 Bit
289	Symmetric Component Zero Seq V Direct	Volts	Analog Input	32 Bit
290	Symmetric Component Zero Seq V Quadrature	Volts	Analog Input	32 Bit
291	Last Month Demand Current Peak Dmd Rate A	Amps	Analog Input	32 Bit
292	Last Month Demand Current Peak Dmd Rate RTP	Amps	Analog Input	32 Bit
293	Last Month Fwd Real Demand Power Peak Dmd Rate A	Watts	Analog Input	32 Bit
294	Last Month Fwd Real Demand Power Peak Dmd Rate RTP	Watts	Analog Input	32 Bit
295	Last Month Rev Real Demand Power Peak Dmd Rate A	Watts	Analog Input	32 Bit
296	Last Month Rev Real Demand Power Peak Dmd Rate RTP	Watts	Analog Input	32 Bit
297	Last Month Net Real Demand Power Peak Dmd Rate A	Watts	Analog Input	32 Bit
298	Last Month Net Real Demand Power Peak Dmd Rate RTP	Watts	Analog Input	32 Bit
299	Last Month Sum Real Demand Power Peak Dmd Rate A	Watts	Analog Input	32 Bit
300	Last Month Sum Real Demand Power Peak Dmd Rate RTP	Watts	Analog Input	32 Bit
301	Last Month Delivered Reactive Demand Power Peak Dmd Rate A	var	Analog Input	32 Bit
302	Last Month Delivered Reactive Demand Power Peak Dmd Rate RTP	var	Analog Input	32 Bit
303	Last Month Received Reactive Demand Power Peak Dmd Rate A	var	Analog Input	32 Bit
304	Last Month Received Reactive Demand Power Peak Dmd Rate RTP	var	Analog Input	32 Bit
305	Last Month Net Reactive Demand Power Peak Dmd Rate A	var	Analog Input	32 Bit
306	Last Month Net Reactive Demand Power Peak Dmd Rate RTP	var	Analog Input	32 Bit
307	Last Month Sum Reactive Demand Power Peak Dmd Rate A	var	Analog Input	32 Bit
308	Last Month Sum Reactive Demand Power Peak Dmd Rate RTP	var	Analog Input	32 Bit
309	Last Month Apparent Demand Power Peak Dmd Rate A	VA	Analog Input	32 Bit
310	Last Month Apparent Demand Power Peak Dmd Rate RTP	VA	Analog Input	32 Bit
311	Last Peak Demand Current Peak Dmd Rate A	Amps	Analog Input	32 Bit
312	Last Peak Demand Current Peak Dmd Rate RTP	Amps	Analog Input	32 Bit
313	Last Peak Fwd Real Demand Power Peak Dmd Rate A	Watts	Analog Input	32 Bit
314	Last Peak Fwd Real Demand Power Peak Dmd Rate RTP	Watts	Analog Input	32 Bit
315	Last Peak Rev Real Demand Power Peak Dmd Rate A	Watts	Analog Input	32 Bit
316	Last Peak Rev Real Demand Power Peak Dmd Rate RTP	Watts	Analog Input	32 Bit
317	Demand P Rev Rate A	Watts	Analog Input	32 Bit
318	Demand P Rev Rate RTP	Watts	Analog Input	32 Bit
319	Last Peak Net Real Demand Power Peak Dmd Rate A	Watts	Analog Input	32 Bit
320	Last Peak Net Real Demand Power Peak Dmd Rate RTP	Watts	Analog Input	32 Bit
321	Demand P Net Rate A	Watts	Analog Input	32 Bit
322	Demand P Net Rate RTP	Watts	Analog Input	32 Bit
323	Last Peak Sum Real Demand Power Peak Dmd Rate A	Watts	Analog Input	32 Bit
324	Last Peak Sum Real Demand Power Peak Dmd Rate RTP	Watts	Analog Input	32 Bit
325	Demand P Sum Rate A	Watts	Analog Input	32 Bit
326	Demand P Sum Rate RTP	Watts	Analog Input	32 Bit

Appendix A Points List

#	Parameter Name	Eng. Unit	DNP3 Category	Size
327	Last Peak Delivered Reactive Demand Power Peak Dmd Rate A	var	Analog Input	32 Bit
328	Last Peak Delivered Reactive Demand Power Peak Dmd Rate RTP	var	Analog Input	32 Bit
329	Demand Q Rev Rate A	Vars	Analog Input	32 Bit
330	Demand Q Rev Rate RTP	Vars	Analog Input	32 Bit
331	Last Peak Received Reactive Demand Power Peak Dmd Rate A	var	Analog Input	32 Bit
332	Last Peak Received Reactive Demand Power Peak Dmd Rate RTP	var	Analog Input	32 Bit
333	Demand Q Fwd Rate A	Vars	Analog Input	32 Bit
334	Demand Q Fwd Rate RTP	Vars	Analog Input	32 Bit
335	Last Peak Net Reactive Demand Power Peak Dmd Rate A	var	Analog Input	32 Bit
336	Last Peak Net Reactive Demand Power Peak Dmd Rate RTP	var	Analog Input	32 Bit
337	Demand Q Net Rate A	Vars	Analog Input	32 Bit
338	Demand Q Net Rate RTP	Vars	Analog Input	32 Bit
339	Last Peak Sum Reactive Demand Power Peak Dmd Rate A	var	Analog Input	32 Bit
340	Last Peak Sum Reactive Demand Power Peak Dmd Rate RTP	var	Analog Input	32 Bit
341	Demand Q Sum Rate A	Vars	Analog Input	32 Bit
342	Demand Q Sum Rate RTP	Vars	Analog Input	32 Bit
343	Last Peak Apparent Demand Power Peak Dmd Rate A	VA	Analog Input	32 Bit
344	Last Peak Apparent Demand Power Peak Dmd Rate RTP	VA	Analog Input	32 Bit
345	Demand S Rate A	VA	Analog Input	32 Bit
346	Demand S Rate RTP	VA	Analog Input	32 Bit
347	Last Reset Demand Current Peak Dmd Rate A	Amps	Analog Input	32 Bit
348	Last Reset Demand Current Peak Dmd Rate RTP	Amps	Analog Input	32 Bit
349	Last Reset Fwd Real Demand Power Peak Dmd Rate A	Watts	Analog Input	32 Bit
350	Last Reset Fwd Real Demand Power Peak Dmd Rate RTP	Watts	Analog Input	32 Bit
351	Last Reset Fwd Real Power Accum Rate A	kWh	Counter	32 Bit
352	Last Reset Fwd Real Power Accum Rate A Roll Over Counter	kWh	Counter	16 Bit
353	Last Reset Fwd Real Power Accum Rate RTP	kWh	Counter	32 Bit
354	Last Reset Fwd Real Power Accum Rate RTP Roll Over Counter	kWh	Counter	16 Bit
355	Last Reset Rev Real Peak Dmd Rate A	Watts	Analog Input	32 Bit
356	Last Reset Rev Real Peak Dmd Rate RTP	Watts	Analog Input	32 Bit
357	Last Reset Rev Real Power Accum Rate A	kWh	Counter	32 Bit
358	Last Reset Rev Real Power Accum Rate A Roll Over Counter	kWh	Counter	16 Bit
359	Last Reset Rev Real Power Accum Rate RTP	kWh	Counter	32 Bit
360	Last Reset Rev Real Power Accum Rate RTP Roll Over Counter	kWh	Counter	16 Bit
361	Last Reset Net Real Demand Power Peak Dmd Rate A	Watts	Analog Input	32 Bit
362	Last Reset Net Real Demand Power Peak Dmd Rate RTP	Watts	Analog Input	32 Bit
363	Last Reset Net Real Power Accum Rate A	kWh	Counter	32 Bit
364	Last Reset Net Real Power Accum Rate A Roll Over Counter	kWh	Counter	16 Bit
365	Last Reset Net Real Power Accum Rate RTP	kWh	Counter	32 Bit
366	Last Reset Net Real Power Accum Rate RTP Roll Over Counter	kWh	Counter	16 Bit
367	Last Reset Sum Real Demand Power Peak Dmd Rate A	Watts	Analog Input	32 Bit

#	Parameter Name	Eng. Unit	DNP3 Category	Size
368	Last Reset Sum Real Demand Power Peak Dmd Rate RTP	Watts	Analog Input	32 Bit
369	Last Reset Sum Real Power Accum Rate A	kWh	Counter	32 Bit
370	Last Reset Sum Real Power Accum Rate A Roll Over Counter	kWh	Counter	16 Bit
371	Last Reset Sum Real Power Accum Rate RTP	kWh	Counter	32 Bit
372	Last Reset Sum Real Power Accum Rate RTP Roll Over Counter	kWh	Counter	16 Bit
373	Last Reset Delivered Reactive Demand Power Peak Dmd Rate A	var	Analog Input	32 Bit
374	Last Reset Delivered Reactive Demand Power Peak Dmd Rate RTP	var	Analog Input	32 Bit
375	Last Reset Delivered Reactive Power Accum Rate A	kvarh	Counter	32 Bit
376	Last Reset Delivered Reactive Power Accum Rate A Roll Over Counter	kvarh	Counter	16 Bit
377	Last Reset Delivered Reactive Power Accum Rate RTP	kvarh	Counter	32 Bit
378	Last Reset Delivered Reactive Power Accum Rate RTP Roll Over Counter	kvarh	Counter	16 Bit
379	Last Reset Received Reactive Demand Power Peak Dmd Rate A	var	Analog Input	32 Bit
380	Last Reset Received Reactive Demand Power Peak Dmd Rate RTP	var	Analog Input	32 Bit
381	Last Reset Received Reactive Power Accum Rate A	kvarh	Counter	32 Bit
382	Last Reset Received Reactive Power Accum Rate A Roll Over Counter	kvarh	Counter	16 Bit
383	Last Reset Received Reactive Power Accum Rate RTP	kvarh	Counter	32 Bit
384	Last Reset Received Reactive Power Accum Rate RTP Roll Over Counter	kvarh	Counter	16 Bit
385	Last Reset Net Reactive Demand Power Peak Dmd Rate A	var	Analog Input	32 Bit
386	Last Reset Net Reactive Demand Power Peak Dmd Rate RTP	var	Analog Input	32 Bit
387	Last Reset Net Reactive Power Accum Rate A	kvarh	Counter	32 Bit
388	Last Reset Net Reactive Power Accum Rate A Roll Over Counter	kvarh	Counter	16 Bit
389	Last Reset Net Reactive Power Accum Rate RTP	kvarh	Counter	32 Bit
390	Last Reset Net Reactive Power Accum Rate RTP Roll Over Counter	kvarh	Counter	16 Bit
391	Last Reset Sum Reactive Demand Power Peak Dmd Rate A	var	Analog Input	32 Bit
392	Last Reset Sum Reactive Demand Power Peak Dmd Rate RTP	var	Analog Input	32 Bit
393	Last Reset Sum Reactive Power Accum Rate A	kvarh	Counter	32 Bit
394	Last Reset Sum Reactive Power Accum Rate A Roll Over Counter	kvarh	Counter	16 Bit
395	Last Reset Sum Reactive Power Accum Rate RTP	kvarh	Counter	32 Bit
396	Last Reset Sum Reactive Power Accum Rate RTP Counter	kvarh	Counter	32 Bit
397	Last Reset Apparent Demand Power Peak Dmd Rate A	VA	Analog Input	32 Bit
398	Last Reset Apparent Demand Power Peak Dmd Rate RTP	VA	Analog Input	32 Bit
399	Last Reset Apparent Demand Power Accum Rate A	kVAh	Counter	32 Bit
400	Last Reset Apparent Demand Power Accum Rate A Roll Over Counter	kVAh	Counter	16 Bit
401	Last Reset Apparent Demand Power Accum Rate Tot	kVAh	Counter	32 Bit
402	Last Reset Apparent Demand Power Accum Rate Tot Roll Over Counter	kVAh	Counter	16 Bit
403	Last Reset Apparent Demand Power Accum Rate RTP	kVAh	Counter	32 Bit
404	Last Reset Apparent Demand Power Accum Rate RTP Roll Over Counter	kVAh	Counter	16 Bit
405	Sag/Swell Count Sag Level 1	0	Counter	16 Bit
406	Sag/Swell Count Sag Level 2	0	Counter	16 Bit
407	Sag/Swell Count Sag Level 4	0	Counter	16 Bit
408	Sag/Swell Count Sag Level 8	0	Counter	16 Bit

Appendix A Points List

#	Parameter Name	Eng. Unit	DNP3 Category	Size
409	Sag/Swell Count Swell Level 1	0	Counter	16 Bit
410	Sag/Swell Count Swell Level 2	0	Counter	16 Bit
411	Sag/Swell Count Swell Level 4	0	Counter	16 Bit
412	Sag/Swell Count Swell Level 8	0	Counter	16 Bit
413	Current Month Demand Iavg 200 Rate A Peak	Ampere	Analog Input	32 Bit
414	Current Month Demand Iavg 200 Rate RTP Peak	Ampere	Analog Input	32 Bit
415	Current Month Demand P Fwd Rate A Peak	Watts	Analog Input	32 Bit
416	Current Month Demand P Fwd Rate RTP Peak	Watts	Analog Input	32 Bit
417	Current Month Demand P Rev Rate A Peak	Watts	Analog Input	32 Bit
418	Current Month Demand P Rev Rate RTP Peak	Watts	Analog Input	32 Bit
419	Current Month Demand P Net Rate A Peak	Watts	Analog Input	32 Bit
420	Current Month Demand P Net Rate RTP Peak	Watts	Analog Input	32 Bit
421	Current Month Demand P Sum Rate A Peak	Watts	Analog Input	32 Bit
422	Current Month Demand P Sum Rate RTP Peak	Watts	Analog Input	32 Bit
423	Current Month Demand Q Rev Rate A Peak	Vars	Analog Input	32 Bit
424	Current Month Demand Q Rev Rate RTP Peak	Vars	Analog Input	32 Bit
425	Current Month Demand Q Fwd Rate A Peak	Vars	Analog Input	32 Bit
426	Current Month Demand Q Fwd Rate RTP Peak	Vars	Analog Input	32 Bit
427	Current Month Demand Q Net Rate A Peak	Vars	Analog Input	32 Bit
428	Current Month Demand Q Net Rate RTP Peak	Vars	Analog Input	32 Bit
429	Current Month Demand Q Sum Rate A Peak	Vars	Analog Input	32 Bit
430	Current Month Demand Q Sum Rate RTP Peak	Vars	Analog Input	32 Bit
431	Current Month Demand S Rate A Peak	VA	Analog Input	32 Bit
432	Current Month Demand S Rate RTP Peak	VA	Analog Input	32 Bit
433	PQ Index latest 10 min	0	Analog Input	32 Bit
434	PQ Index latest 24 hour	0	Analog Input	32 Bit
435	PQ Index Mean PQ	0	Analog Input	32 Bit
436	PQ Index Sag Level	0	Analog Input	32 Bit
437	PQ Index Swell Level	0	Analog Input	32 Bit
438	PQ Index DvDt Count	0	Analog Input	32 Bit
439	PQ Index THD Iavg	0	Analog Input	32 Bit
440	PQ Index THD Vavg	0	Analog Input	32 Bit
441	PQ Index Pst	0	Analog Input	32 Bit
442	PQ Index Sag Score	0	Analog Input	32 Bit
443	PQ Index Swell Score	0	Analog Input	32 Bit
444	PQ Index DvDt Score	0	Analog Input	32 Bit
445	PQ Index THD Iavg Score	0	Analog Input	32 Bit
446	PQ Index THD Vavg Score	0	Analog Input	32 Bit
447	PQ Index Pst Score	0	Analog Input	32 Bit
448	Discrete Input 1 Status	0	Digital Input	16 Bit
449	Discrete Input 2 Status	0	Digital Input	16 Bit

#	Parameter Name	Eng. Unit	DNP3 Category	Size
450	Discrete Input 3 Status	0	Digital Input	16 Bit
451	Discrete Input 4 Status	0	Digital Input	16 Bit
452	Discrete Input 5 Status	0	Digital Input	16 Bit
453	Discrete Input 6 Status	0	Digital Input	16 Bit
454	Discrete Input 7 Status	0	Digital Input	16 Bit
455	Discrete Input 8 Status	0	Digital Input	16 Bit
456	Form C Relay 1 Status	0	Digital Output	16 Bit
457	Form C Relay 2 Status	0	Digital Output	16 Bit
458	Form C Relay 3 Status	0	Digital Output	16 Bit
459	Discrete Input 1 Count	0	Counter	16 Bit
460	Discrete Input 2 Count	0	Counter	16 Bit
461	Discrete Input 3 Count	0	Counter	16 Bit
462	Discrete Input 4 Count	0	Counter	16 Bit
463	Discrete Input 5 Count	0	Counter	16 Bit
464	Discrete Input 6 Count	0	Counter	16 Bit
465	Discrete Input 7 Count	0	Counter	16 Bit
466	Discrete Input 8 Count	0	Counter	16 Bit
467	Solid State Relay 1 Count	0	Counter	16 Bit
468	Solid State Relay 2 Count	0	Counter	16 Bit
469	Form C Relay 1 Count	0	Counter	16 Bit
470	Form C Relay 2 Count	0	Counter	16 Bit
471	Form C Relay 3 Count	0	Counter	16 Bit

Notes

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