

M6xx

Measurement Centre and Transducer

DNP3 Manual

M6xx

Measurement Centre and Transducer

Publication Reference: M6xxD/EN/M/B

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CERTIFICATION

Alstom Grid certifies that the calibration of the products is based on measurements using equipment whose calibration is traceable to the United States National Institute of Standards Technology (NIST).

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M6xx Manual Set

M65x User Manual

M6xx Modbus Protocol Manual

M6xx DNP3 Protocol Manual

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SAFETY SECTION

Please refer to the M65x or M66x User Manual for information regarding safety, installation, commissioning and decommissioning.

1.0 DNP INTERFACE

1.1 Description

The DNP network is a "MASTER" to "SLAVE" network; that is to say, one node asks a question and a second node answers. A NODE is a DNP device (RTU, Computer, M65x, M66x, etc.) that is connected to the network. Each DNP NODE has an ADDRESS in the range of 0 to 65519, and it is this address that allows a MASTER to selectively request data from any other device. DNP uses the address range 65533-65536 for broadcast functions. Broadcast requests never generate DNP responses.

The DNP implementation in the M6xx conforms to DNP3 specifications as defined by DNP.org (derived from the Harris IED (Intelligent Electronics Devices) implementation guidelines). Data obtained by the **DNP READ CLASS 0** command is configurable. Individual items can also be read using **READ BINARY OUTPUT STATUS** or **READ ANALOGUE INPUT** or **READ COUNTER** or **READ ANALOGUE OUTPUT STATUS** or **READ BINARY INPUT** or **READ FROZEN COUNTER** commands.

The Energy values can be reset to zero by issuing the **DIRECT OPERATE**, **DIRECT OPERATE NO ACKNOWLEDGE**, or **SELECT BEFORE OPERATE** by using the *CONTROL RELAY OUTPUT BLOCK* object.

The Demand values can be reset by issuing the same **DIRECT OPERATE**, **DIRECT OPERATE NO ACKNOWLEDGE**, or **SELECT BEFORE OPERATE** command to the other points of this object.

M6xx **ANALOGUE OUTPUTS** have two read/write values: Tag and Tag1. They can be changed by issuing **DIRECT OPERATE**, **DIRECT OPERATE NO ACKNOWLEDGE**, or **SELECT BEFORE OPERATE** by using the *ANALOGUE OUTPUT BLOCK* object. Due to the limited number of FLASH write cycles, they SHOULD NOT be written continuously.

Four legacy values are also presented. They are CT Scale Factor Normalized Ratio and Divisor, and VT Scale Factor Normalized Ratio and Divisor. They are derived from the PT scale and CT scale configured through the browser interface.

The **SELECT BEFORE OPERATE** arm timeout value is configurable from zero to 64 seconds.

1.2 DNP Address

The serial port in the M65x can be set up to be RS-232 or RS-485, and support baud rates from 9600 to 115200. Configuring the Serial Ports can be accomplished by using the display buttons or via a standard web browser while setting the address is done via a web browser only.

Each DNP instrument responds to a single destination address in the range 0-65519. Each instrument on a DNP link must have a unique address. M6xx meters will allow any of the 65520 addresses to be selected. DNP instruments also use a BROADCAST address range of 65533-65535. Requests sent to a BROADCAST address cause the instrument to execute the function but not generate a response.

1.3 Transaction Timing

M6xx meters complete a set of calculations approximately every 100ms. Incoming messages are parsed every 50ms.

1.4 Object Format

M6xx meters report all static measurements via the use of three static objects. These objects include COUNTER (object 20, variations 1, 2, 5 and 6), ANALOGUE INPUT (object 30, variations 1, 2, 3 and 4) and BINARY INPUT (object 2, variations 1 and 2). These objects are read only and cannot be modified by DNP MASTER devices.

ANALOGUE OUTPUT STATUS (object 40, variation 2) can read CT and VT configuration information and two tag registers. ANALOGUE OUTPUT BLOCK (object 41, variation 2) can be used to write the Tag/Tag1 register through DNP. Due to the limited number of FLASH write cycles, Tag/Tag1 SHOULD

NOT be written continuously. Pseudo output points (such as demand and energy resets) are reported using the BINARY OUTPUT STATUS (object 10, variation 2).

M6xx meters are capable of reporting ANALOGUE CHANGE EVENTS (object 32, variations 1 through 4). Any ANALOGUE INPUT can be configured to report as a CLASS-1, CLASS-2, or CLASS-3 ANALOGUE CHANGE EVENT. Point, Class, Analogue Deadband Values and Object Variation are all selectable by use of the Ethernet service port and web browser. The default Object Variations are selectable by Object (not by point). All ANALOGUE CHANGE EVENTS can be configured to report with or without time.

M6xx meters support frozen counter events (object 21, variations 1, 2, 5 and 6 which are 16 or 32-bit with or without time).

M6xx meters support one BINARY INPUT (object 1, variations 1 and 2) and one BINARY INPUT CHANGE event (object 2, variations 1, 2, and 3). The single binary input is derived from the OR of the bits from the Health status word.

The DNP3 protocol allows each device to determine the best method of data transfer. The M6xx meters support this by selecting the most appropriate response variation when either the requested variation is 0 or a CLASS-0 read is requested. Both COUNTER and ANALOGUE INPUT objects allow optional flags to be used. If a value is requested as variation 0, the M6xx meter responds as selected with the default variation selected through the browser.

When reading objects, the Health Check point (object 30, point 0) should always be read and checked before interpreting data, since some failure modes will cause erroneous data to be presented (See Section 1.8). The majority of the points are represented in Normalized 2's complement format. For conversion of the point data into engineering units, please refer to Section 1.6. Appendix A provides the Legacy or Bitronics Legacy Fixed (BiLF) point set used in the M6xx.

NOTE: Unless otherwise specified, all points are READ ONLY.

1.4.1 DNP3 Calculation-Type Codes

The DNP3 Type codes for Optimal Resolution that are applicable to the point assignments in the appendix tables are highlighted within the following Calculation Type table:

Type	Description
T1	Unsigned 16-Bit Integer
T2	Signed 16-Bit Integer - 2's Complement - Saturation 10
	Float Value = (Integer Value) / 32768 * Scale * 10)
	Example: 5.0 A stored as 16384 when Amp Scale = 1:1
T3	Signed 16-Bit Integer - 2's Complement - Saturation 15
	Float Value = (Integer Value) / 32768 * Scale * 15)
	Example: 150 A stored as 16384 when Amp Scale = 20:1
T4	Signed 16-Bit Integer - 2's Complement - Saturation 150
	Float Value = (Integer Value) / 32768 * Scale * 150)
	Example: 119.998 V stored as 26214 when Volt Scale = 1:1
T5	Signed 16-Bit Integer - 2's Complement - Saturation 1500
	Float Value = (Integer Value) / 32768 * Scale * 1500)
	Example: -750.0 W stored as -16384 when Volt Scale = 1:1, Amp Scale 1:1
T6	Signed 16-Bit Integer - 2's Complement - Saturation 4500
	Float Value = (Integer Value) / 32768 * Scale * 4500)
	Example: -90.0 kW stored as -8192 when Volt Scale = 20:1, Amp Scale 4:1
T7	Signed 16-Bit Integer - 2's Complement - 3 Decimal Places
	Example: -12.345 stored as -12345
T8	Signed 16-Bit Integer - 2's Complement - 2 Decimal Places
	Example: 123.45 stored as 12345
T9	Signed 16-Bit Integer - 2's Complement - 1 Decimal Place
	Example: -1234.5 stored as -12345
T10	Unsigned 16-Bit Integer - Normalized Ratio
	ratio = (Normalized Ratio / Ratio Divisor)
	Example : 1.234, 12.34, 123.4, and 1234 are all stored as 1234
T11	Unsigned 16-Bit Integer - Ratio Divisor
	ratio = (Normalized Ratio / Ratio Divisor); valid Ratio Divisors are 1,10,100,1000
	Example: X.XXX stored as 1000, XX.XX stored as 100, XXX.X stored as 10
T12	Signed 16-Bit - 2's Complement - Saturation 2
	Gain Value = Integer Value /16384)
	Example: -0.250 stored as -4096
T13	Unsigned 16-Bit Integer - 12 Bit Offset Binary - Saturation 10
	Float Value =(Integer Value - 2047) / (2048)) * Scale * 10

Type	Description
	Example: 5.0 A stored as 3071 when Amp Scale 1:1
T14	Unsigned 16-Bit Integer - 12 Bit Offset Binary - Saturation 150
	Float Value = (Integer Value - 2047) / (2048) * Scale * 150
	Example: 119.97 V stored as 3685 when Volt Scale 1:1
T15	Unsigned 16-Bit Integer - 12 Bit Offset Binary - Saturation 1000
	Float Value = (Integer Value - 2047) / (2048) * Scale * 1000
	Example: -500 W stored as 1023 when Volt Scale = 1:1, Amp Scale = 1:1
T16	Unsigned 16-Bit Integer - 12 Bit Offset Binary - Saturation 3000
	Float Value = (Integer Value - 2047) / (2048) * Scale * 3000
	Example: 349.10 kW stored as 3040 when Volt Scale = 6:1, Amp Scale = 40:1
T17	Unsigned 16-Bit Integer - 12 Bit Offset Binary - Saturation 15
	Float Value = (Integer Value - 2047) / (2048) * Scale * 15
	Example: 11.79 A stored as 2369 when Amp Scale 5:1
T18	Unsigned 16-Bit Integer - 12 Bit Offset Binary -1 Decimal Place
	Float Value = (Integer Value - 2047) / (10))
	Example: 121.4 degrees stored as 3261
T19	Unsigned 16-Bit Integer - 12 Bit Offset Binary -3 Decimal Place
	Float Value = (Integer Value - 2047) / (1000))
	Example: 0.978 Power Factor stored as 3025
T20	Unsigned 16-Bit Integer - Bit Control/Status
	0' - stored as zero; '1' - stored as 65536
T21	Unsigned 16-Bit Integer - 3 Decimal Places
	Example: 54.321 stored as 54321
T22	Bit
	Example: 1-bit is set, 0-bit is clear
T23	Signed 16-Bit Integer – 2's complement – Saturation 300
	Float Value = ((Integer Value)/32768) * Scale * 300)
	Example: 207.846 V stored as 22702 when Volt Scale = 1:1
T24	Signed 16-Bit Integer – 2's Complement – 3 Decimal Places, offset by 60
	Float Value = (Integer Value)/1000) + 60.0)
	Example: 60.005Hz stored as 5

1.5 Configuration

1.5.1 Setting CT and VT Ratios

M6xx meters are capable of internally storing and recalling CT and VT ratios. The CT and VT ratios are configured through the Web interface or front panel, and are stored in non-volatile memory on the CT/VT section of the power supply board. Each ratio is stored in two points, one for the Normalized Ratio and the other for the Ratio Divisor. Allowable constants for the normalized ratios are 1000 to 9999. The Ratio Divisors may be 1, 10, 100, or 1000 only. The number stored will be the high side rating of the CT Ratio or VT Ratio. Both a 500:5 ratio CT and a 100:1 CT will have a value of 100 stored. For example, to calculate a CT and VT ratio for Phase A from the data stored in the M6xx meters, use the following equation:

$$Phase\ A\ CT_{RATIO} = \frac{Phase\ A\ CT\ Value\ (AO : 21)}{Phase\ A\ CT\ Ratio\ Divisor\ (AO : 22)}$$

$$Phase\ A\ VT_{RATIO} = \frac{Phase\ A\ VT\ Value\ (AO : 05)}{Phase\ A\ VT\ Ratio\ Divisor\ (AO : 06)}$$

M6xx meters calculate all measured quantities in secondary units (except energy). The CT and VT ratio information is used to calculate the primary values.

In the event of a CT/VT Ratio Checksum Failure, the value in the Normalized CT Ratio and Normalized VT Ratio points default to 1000, and the value in the CT Ratio Divisor and VT Ratio Divisor default to 1000. This results in a 1:1 CT Ratio and 1:1 VT Ratio.

1.5.2 Resetting Energy and Demands

The Energy and Demand registers can be reset by issuing a *CONTROL RELAY OUTPUT BLOCK* to the appropriate BINARY OUTPUT.

Reset Functions
Reset Energy
Reset Demand Amps
Reset Demand Volts
Reset Demand Power

1.5.3 Tag Registers

The M6xx meters provide a "TAG" BINARY OUTPUT for user identification purposes. DNP sessions have an additional tag register ("Tag Register 1"). An *ANALOGUE OUTPUT BLOCK* can be issued to either point to write a number from 0 to 65,535 in a tag register. Tag registers are also writeable through the web interface.

1.6 Converting Data to Engineering Units

As mentioned in Section 1.5, the majority of the data is stored in a normalized 2's complement format. When displaying these values at another location, it may be desirable to convert this format into engineering units. This conversion is readily accomplished using the following simple scaling equations:

BASIC EQUATION FOR NORMALIZED ANALOGUE INPUTS:

$$\text{Engineering Units} = \frac{\text{Value}}{32768} \times \text{Default Full Scale}_{\text{SECONDARY}} \times \frac{\text{Normalized Scale Factor}}{\text{Scale Factor Divisor}}$$

The **Value** referred to in the equations would be the value stored in the point that you wished to convert to engineering units. For example if you wanted to convert Phase A Amperes into engineering units, Value would be the value in ANALOGUE-INPUT point.

ENERGY is stored as 32-BIT values in static COUNTER points. Energy values are in units of PRIMARY kWh or kVARh.

FREQUENCY is stored as a single binary value that is the actual frequency times 100.

POWER FACTOR is stored as the value times 1000. Negative power factors indicate that the VARs are positive. The sign of the Power Factor is the inversion of the Exclusive-OR of the Watts and VARs (i.e. if either or both of the Watts or VARs are negative, then the Power Factor will be negative).

3 and 2 ½ ELEMENT EQUATIONS (5Amp CTs):

$$AMPERES_{(Inst, Fund, Demand, Max)} = \frac{Value}{32768} \times 10^* \times CT_{RATIO}$$

$$AMPERES_N_{(Inst, Fund, Demand, Max)} = \frac{Value}{32768} \times 15^* \times CT_{RATIO}$$

$$VOLTS_{L-N (Inst, Fund, Demand, Min, Max)} = \frac{Value}{32768} \times 150 \times PT_{RATIO}$$

$$VOLTS_{L-L (Inst, Demand, Min, Max)} (SCALED) = \frac{Value}{32768} \times 150 \times PT_{RATIO} \times \sqrt{3}$$

$$WATTS (VARs) (VAs)_{TOTAL (Inst, Demand, Min, Max)} = \frac{Value}{32768} \times 4500^* \times PT_{RATIO} \times CT_{RATIO}$$

$$WATTS (VARs) (VAs)_{PER PHASE (Inst)} = \frac{Value}{32768} \times 1500^* \times PT_{RATIO} \times CT_{RATIO}$$

$$FREQUENCY = \frac{Value}{100}$$

$$POWER FACTOR_{(True, Displacement)} = \frac{Value}{1000}$$

$$kWh (kVARh) = Value$$

$$THD, TDD_{(Amps, Volts, Inst, Demand, Max)} = \frac{Value}{10}$$

$$K - Factor = \frac{Value}{100}$$

* For One Amp CT Option, divide this value by 5

2 ELEMENT EQUATIONS (5Amp CTs) :

$$AMPERES_{(Inst, Fund, Demand, Max)} = \frac{Value}{32768} \times 10^* \times CT_{RATIO}$$

$$VOLTS_{L-L(Inst, Demand, Min, Max)} = \frac{Value}{32768} \times 150 \times PT_{RATIO}$$

$$WATTS (VARs)(VAs)_{TOTAL(Inst, Demand, Min, Max)} = \frac{Value}{32768} \times 3000^* \times PT_{RATIO} \times CT_{RATIO}$$

$$FREQUENCY = \frac{Value}{100}$$

$$POWER FACTOR_{(True, Displacement)} = \frac{Value}{1000}$$

$$kWh (kVARh) = Value$$

$$THD, TDD_{(Amps, Volts, Inst, Demand, Max)} = \frac{Value}{10}$$

$$K - Factor = \frac{Value}{100}$$

* For One Amp CT Option, divide this value by 5

The above equations provide answers in fundamental units (VOLTS, AMPS, WATTS, VARs, VAs and Hz). If the user desires other units such as KILOVOLTS, KILOWATTS or KILOVARs, the answers given by the equations should be divided by 1,000. If the user desires MEGAWATTS or MEGAVARS, the answers given by the equations should be divided by 1,000,000. Energy values are in units of kWh or kVARh.

1.7 Primary Units

An option exists to choose Primary Units instead of the pre-existing scaling mode, 'Optimal Resolution' adding the concept of 'scaling modes' to M6xx. The pre-existing scaling mode is called 'Optimal Resolution' on the basis that resolution of the protocols are optimized based on secondary full scale and therefore independent of CT and VT settings. The 'Primary Units' mode creates protocol values that include CT and VT settings, which requires the user to choose a scaling factor (in multiples of 10). The scaling factor must be selected such that it achieves the desired resolution and does not cause an overflow in the protocol value. The Scaling mode selection and the scaling factors are maintained separately for both Modbus and DNP and are configured on the Settings/Protocol webpage. Below is a screen shot and explanation of the Primary Units mode:

Scaling	<input type="radio"/>	Optimal Resolution
	<input checked="" type="radio"/>	Primary Units
Amps per count		0.100 ▾
Volts per count		1.000 ▾
Watts per count		10.00 ▾

There are three new configurable parameters:

- Amps per count – APC
- Volts per count – VPC
- Watts per count - WPC

There are three new calculation types:

- Currents - B16_2S_PRIMARY_I
 $Measurement = ProtocolValue * APC$
- Voltages - B16_2S_PRIMARY_V
 $Measurement = ProtocolValue * VPC$
- Powers - B16_2S_PRIMARY_P
 $Measurement = ProtocolValue * WPC$

When Primary Unit mode is selected, appropriate calculation types are substituted per the following table. This substitution occurs across all pre-defined and user configured register sets. Note, other calculation types are unaffected as they represent their values (such as Frequency, Power factor) in primary units even in Optimal Resolution mode. Also, since the 12-bit calculation types are not included in the substitution this means that the Modbus BiLF12 register set is not affected.

Modbus Manual	DNP Manual	Optimal Resolution Calculation Type	Replaced by Calculation Type	Note
T2	T2	B16_2S_10_M10	B16_2S_PRIMARY_I	
T3	T3	B16_2S_15_M15	B16_2S_PRIMARY_I	
T4	T4	B16_2S_150_M150	B16_2S_PRIMARY_V	
T23	T23	B16_2S_300_M300	B16_2S_PRIMARY_V	
na	na	B16_2S_600_M600	B16_2S_MULT_10	Power supply voltage
T5	T5	B16_2S_1500_M1500	B16_2S_PRIMARY_P	
T6	T6	B16_2S_4500_M4500	B16_2S_PRIMARY_P	

1.8 Data Sets and Data Types

The M6xx meters are shipped with a pre-defined set of data points and data types. These fixed points do not change. The List of Available Measurements may be found in the M65x or M66x User Manual. The Ethernet port and web browser are required to create the configurable points list. See section 1.11 for more detail.

For users who wish to use M6xx meters on systems configured for other Bitronics products, a Legacy point list may be selected. This Legacy list cannot be modified, and will cause the M6xx to emulate the response of a Bitronics MultiComm or PowerPlex unit.

1.8.1 Configuring the Class-0 Response

The Class-0 request is a very short request to “give all essential data”. Since the M6xx is capable of providing a significant amount of data, provisions have been made to tailor the response to this request. A web browser interfacing to the Ethernet service port is required to change the Class-0 response. The Legacy Class-0 response can also be configured.

When selecting a Legacy points list, the user will be prompted to enter a BiLF Class0 mask. The following table shows what bits must be set to get the legacy class0 response. In Legacy mode, a zero BiLF Class0 mask returns a fairly small collection of points. As each bit is set, more points are added to the response.

BiLF Class0 Bitmask		
Configuration Bit	Description	Objects
Always included in Class0 scan.	Resets	CLASS0 RESPONSE CONFIGURATION
	Health, Volts, Amps, Watts, VARs, Frequency	
	Configuration Settings	
Bit 0	Energy & Heartbeat (Counter Objects)	BO:0-3
Bit 1	Instantaneous VA & PF	AI:0-20
Bit 2	RMS Demands	AO:4, 6
Bit 3	Maintenance Information	CT:0,1,2,3,4
Bit 14	Include all data in Class0 poll	AI:21 - AI:28
		AI:29 - AI:54
		AI:55 - AI:58
		AO:0-3, 10 – 14
		Include all data in Class0 poll

1.8.2 Configuring Class-1, Class-2 and Class-3 Events

ANALOGUE INPUT points can be monitored for ANALOGUE CHANGE EVENTS by assigning the point to CLASS-1, CLASS-2, or CLASS-3.

ANALOGUE INPUT events are logged when a change in the input exceeds the DEADBAND associated with the point. DEADBANDs can be adjusted through the browser.

FROZEN COUNTERS can be assigned to CLASS-1, 2, or 3.

FROZEN COUNTER events are logged and enabled when a running counter is frozen.

BINARY INPUT events are logged and enabled whenever an enabled binary input changes state.

1.9 Health Check

The M6xx meters have several self-tests built in to ensure that the instrument is performing accurately. The results of these self-tests are available in the Health Check register (AO:00), which is a simple 16-bit binary value. Each bit represents the results of a particular self-test, with "0" indicating the test was passed, and "1" indicating the test was failed. If Health status failures occur, the meter may have experienced an operational failure. The table below provides a reference of error codes. Contact the factory for further instructions.

A logical OR of the individual health check bits is available as a Binary input, with "0" indicating that all tests have passed, and "1" indicating that at least one test failed.

Health Check Error Codes	
Bit	Description
0	Checksum error on analogue output (either 0-1mA or 4-20mA) calibration constants
2	Checksum error on gain calibration of inputs
4	Checksum error on phase calibration of inputs
12	Indicates firmware download in progress and measurements are offline
15	Protocol configuration error

1.10 Heartbeat State Counter

M6xx meters provide a Heartbeat State Counter Register that allows the user to determine the time between successive polls. This counter will increment by the number of milliseconds that have elapsed since the last time the data was updated. Another use of this register is as a visual indicator that the data is changing; it allows users of certain MMIs to identify disruption in the polling of the instrument. The Heartbeat State Counter is a full 32-bit counter that rolls over at 4,294,967,295 (4,294,967 seconds). The counter starts at zero on power-up, and is NOT stored in non-volatile memory.

1.11 Meter ID Register

M6xx meters provide a "Meter Type ID" register for model identification purposes (AI:55) which returns a value of 600 (BiLF12 Modbus, BiLF DNP), 601 (BiLF16 Modbus), or 602 (TUC DNP/Modbus).

1.12 Custom Points Lists

A custom points list can be defined for each DNP session. Select the session from the Session dropdown box and click the "Edit Points List" button to begin editing the selected session's points list.



Home Data Resets **Settings** Contact

[Settings](#) / Protocol

Protocol Configuration


Protocol Modbus DNP3

DNP3 Protocol Scaling
Scaling Optimal Resolution Primary Units

Amps per count
Volts per count
Watts per count

DNP Session
Session
Type
IED (Source)
Master (Destination)
Tag Register
Master IP Address
IED Listen Port

The DNP Points List Configuration summary page is displayed by object. Select the DNP object you would like to edit from the "DNP Type" dropdown box. The properties of the selected object appear in separate columns in the summary list.



Home Data Resets **Settings** Contact [printer friendly](#)

[Settings](#) / Protocol

DNP Points List Configuration

DNP Type
Analog Inputs

DNP Point Measurement	Calc Type	Class				Deadband
		0	1	2	3	
000 Health	B16_LOC_HEALTH_LO	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Miscellaneous
001 RMS Amps A	B16_2S_10_M10	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Phase Current
002 RMS Amps B	B16_2S_10_M10	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Phase Current
003 RMS Amps C	B16_2S_10_M10	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Phase Current
004 RMS Volts A	B16_2S_150_M150	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Voltages
005 RMS Volts B	B16_2S_150_M150	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Voltages
006 RMS Volts C	B16_2S_150_M150	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Voltages
007 RMS Watts Total	B16_2S_4500_M4500	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Power Actual
008 RMS VARs Total	B16_2S_4500_M4500	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Power Reactive
009 RMS Watts A	B16_2S_1500_M1500	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Power Actual
010 RMS Watts B	B16_2S_1500_M1500	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Power Actual
011 RMS Watts C	B16_2S_1500_M1500	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Power Actual
012 RMS VARs A	B16_2S_1500_M1500	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Power Reactive
013 RMS VARs B	B16_2S_1500_M1500	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Power Reactive

[Edit List](#)

[Cancel](#) [Apply](#)

Click on the "Edit List" button to modify the list.

DNP Points List Configuration

DNP Type
Analog Inputs

Available	Selected
Health	000 Health
RMS Amps A	001 RMS Amps A
RMS Amps B	002 RMS Amps B
RMS Amps C	003 RMS Amps C
RMS Volts A	004 RMS Volts A
RMS Volts B	005 RMS Volts B
RMS Volts C	006 RMS Volts C
RMS Watts Total	007 RMS Watts Total
RMS VARs Total	008 RMS VARs Total
RMS Watts A	009 RMS Watts A
RMS Watts B	010 RMS Watts B
RMS Watts C	011 RMS Watts C
RMS VARs A	012 RMS VARs A
RMS VARs B	013 RMS VARs B
RMS VARs C	014 RMS VARs C

[Select All](#) [>>](#) [<<](#)

[Reserved >>](#) [Clear](#) [Use BiLF List](#)

Note: Settings are saved to IED upon clicking the "Apply" button on next page.

[Cancel](#) [Next >](#)

All available measurements and data are displayed in the “Available” list in the left-hand pane. The present points list configuration is shown in the “Selected” list in the right-hand pane. Measurement and data items can be added to and removed from the “Selected” list using the buttons on the page:

- Select All** – Highlights all measurement/data items in “Available” list
- >>** – Places highlighted measurement/data items from “Available” list into the “Selected” list.
- Reserved >** – Places a “Reserved” placeholder item in the “Selected” list.
- <<** – Removes highlighted items from the “Selected” list.
- ^** – Shifts highlighted items in the “Selected” list up by one point position.
- v** – Shifts highlighted items in the “Selected” list down by one point position.
- Clea** – Clears the “Selected” list for selected DNP Type.
- Use BiLF List** – Replaces the entire “Selected” list with the standard BiLF points list. A “Class 0 Enable” can be entered to programmatically configure Class 0 for all items in the list (see BiLF Class0 Bitmask table in section 1.7.1 above).

NOTES

- ❖ Multiple items can be selected at once using the shift or control keys.
- ❖ Any item that appears in the “Selected” list appears gray in the “Available” list.
- ❖ The same data item can be used in multiple different points.
- ❖ Items added to the “Selected” list will be placed *above* the first highlighted item.
- ❖ If no items are highlighted in the “Selected” list, items are added to the end of the list.

2.0 DNP PROTOCOL

2.1 Introduction

DNP3 (Distributed Network Protocol) is an open standard that was designed by Harris Controls Division and then placed in the public domain. DNP defines a command/response method of communicating digital information between a master and slave device. The electrical connection between devices is known as a bus. In DNP, two types of devices attach to the bus: one master and one or more slave devices. A master device issues commands to slaves. A slave device, such as an M6xx meter, issues responses to master commands that are addressed to them. Each bus must contain exactly one master and may contain as many slaves as the electrical standards permit. DNP over TCP creates one logical "bus" per connection providing a TCP tunnel for DNP data.

All devices on a bus must operate according to the same electrical standards (i.e. all must be RS-232C or all must be RS-485). RS-232C standards specify that only two devices may be connected to a bus (i.e. only one slave is allowed). RS-485 specifications allow up to 32 devices (31 slaves) on a bus.

Detailed information regarding DNP3 is available in a document titled "Basic 8 Document Set" which can be obtained from the DNP Users Group. The remainder of this chapter provides a brief overview of the protocol as implemented in the M6xx meters.

2.2 Overall Protocol Structure

DNP is a 3-layer protocol based upon the standard IEC 870-5 (Telecontrol Equipment and Systems - Transmission Protocols). The three layers comprise the Enhanced Performance Architecture (EPA) and is a subset of the more familiar ISO-OSI 7-layer protocol. The three layers are the physical, data link, and application layers. The physical layer is responsible for transmission of raw 8-bit bytes (octets) across the network medium. The data link layer is responsible for reliably maintaining connectivity between devices. The application layer defines standardized messages that flow between devices. DNP further defines an extra layer known as the transport layer that allows long messages to be broken down into smaller pieces.

2.3 DNP Request/Response Overview

The M6xx DNP implementation supports a wide variety of messages. The most general method to extract information from an M6xx meter is to issue a **READ CLASS-0** request. DNP devices respond with the points configured to be returned in the Class-0 response. See Section 1.7.1 for more details on Class-0 configuration. This allows the MASTER to quickly retrieve important data from the instrument and determine whether the output points are online (i.e. whether energy/demand resets or ratio setup requests can be honored). An M6xx meter also allows READs of individual objects specifying all points (variation 6) or individual points (other variations). M6xx meters execute the energy clear function and demand resets using the **DIRECT OPERATE**, **DIRECT OPERATE NO ACKNOWLEDGE**, or **SELECT BEFORE OPERATE** functions to the *CONTROL RELAY OUTPUT BLOCK* object points. Tag registers writes are made via **DIRECT OPERATE**, **DIRECT OPERATE NO ACKNOWLEDGE**, or **SELECT BEFORE OPERATE** to the *ANALOGUE OUTPUT BLOCK* object points. Configuration setups are also made via the **DIRECT OPERATE**, **DIRECT OPERATE NO ACKNOWLEDGE**, or **SELECT BEFORE OPERATE** object. The DNP function code WRITE is also supported by the M6xx meters.

An M6xx meter will attempt to respond with the same object variation and qualifier as in the request. Exceptions to this rule include class scans, read all points (var 6), and events. These responses use the default variations configured for each session through the web browser.

3.0 DNP3 OVER ETHERNET (TCP)

If the M6xx meter has the Ethernet SCADA protocols option, then it will respond to DNP3 commands via TCP. The M6xx meters can support either DNP3 or Modbus, and HTML protocols over the Ethernet link. The table below lists the default port assignments for all Ethernet based protocols supported by the M6xx meters.

Protocol	Port Number
DNP3	20000 (TCP, UDP)
Modbus	502 (TCP)
HTML	80 (TCP)

3.1 DNP/IP

The DNP/IP (DNP Over TCP/IP) interface allows up to 3 DNP Masters to communicate with the M6xx. Each remote IP Master may communicate with the M6xx meter via TCP. If multiple Masters share an IP address, each Master must connect to a unique IED Listen port

For each protocol session, the Master IP address and the IED Listen Port number may be specified. The current Settings for each session can be viewed or changed from the web browser. Use the Settings tab to navigate to the Protocol Configuration page. A radio button selects the protocol. If the Master IP address is set to 0.0.0.0 a Master connection will be accepted from any IP address. The default IED listen port number for DNP3 is 20000 (see table above).

After establishment of a TCP connection from a DNP Client, the M6xx meters can verify contact by periodically sending REQUEST LINK STATUS messages. This period is configured using each DNP Session's "Link Status Period" parameter (default is 300 seconds).

See appendix B for DNP configuration parameters.

4.0 DNP3 EVENTS OVERVIEW

DNP3 provides for a method of reporting data only when it may be of interest to the application. This can significantly reduce the network bandwidth required by eliminating the redundant polling of data and only polling data when it changes enough to be considered relevant, generating an event.

Events are pre-assigned to one of three CLASSES, (CLASS-1, CLASS-2, or CLASS-3). When an event occurs, the data point and OBJECT type are placed in a buffer and the event's specific CLASS BIT (BIT1, BIT2, or BIT3 of the first IIN octet) is set in the IED's Internal Indications (IIN) field. DNP3 master devices monitor the IIN bits and will issue a specific CLASS-1, CLASS-2, or CLASS-3 poll when the respective CLASS IIN bit is set. The IED will respond to the specific CLASS poll with all data buffered for the CLASS requested and then clear the associated CLASS IIN bit.

M6xx supports 3 types of DNP events:

- 1.) Analogue Input Events, which are triggered when a change in the corresponding Analogue Inputs exceed the Analogue Input group deadband. The deadband group values are set in the session's advanced section.
- 2.) Frozen Counter Events, which are triggered by any freeze of an enabled running counter.
- 3.) Binary Input Events, which are triggered by any change of an enabled binary input point.

Each of the three DNP sessions has storage for 200 Analogue Input Events, 100 Frozen Counter Events and 20 Binary Input events.

Events can be reported in two modes: thru master polling and Unsolicited Responses. A session can be configured to generate an Unsolicited Response when event timing and count criteria have been satisfied. A connection (serial or TCP/IP socket) must exist for Unsolicited Responses to be reported. Connection continuity can be monitored using Link Status Period described in 3.1.

4.1 ANALOGUE CHANGE EVENTS

ANALOGUE CHANGE events occur when an ANALOGUE INPUT that is assigned to CLASS-1, CLASS-2, or CLASS-3 changes by more than its configured DEADBAND value since the last event. Once the ANALOGUE INPUT's value changes by more than the configured DEADBAND, the specific ANALOGUE INPUT point number and the new value are placed in the ANALOGUE CHANGE EVENT BUFFER as an ANALOGUE CHANGE EVENT. The M6xx meters can be configured to report The ANALOGUE CHANGE EVENT Data Object in one of two Variations, either 16-BIT ANALOGUE CHANGE EVENT WITHOUT TIME (object 32, variation 2) or 16-BIT ANALOGUE CHANGE EVENT WITH TIME (object 32, variation 4). All ANALOGUE CHANGE EVENTS will be reported with the same configured VARIATION. The default ANALOGUE CHANGE EVENT variation (with or without time) can be set using a web browser. The browser is also used to set the DEADBAND value for each configured ANALOGUE CHANGE EVENT.

4.2 FROZEN COUNTER EVENTS

M6xx meters support the DNP3 FROZEN COUNTER Object. Each DNP3 BINARY COUNTER (OBJECT 20) Point configured will automatically have an associated FROZEN COUNTER (OBJECT 21) Point configured. The BINARY COUNTER and its associated FROZEN COUNTER will have the same point number (FROZEN COUNTER Point '0' will contain the value frozen from BINARY COUNTER Point '0').

M6xx meters will support the IMMEDIATE FREEZE (FC-07), IMMEDIATE FREEZE – NO ACKNOWLEDGEMENT (FC-08), FREEZE AND CLEAR (FC-09), and FREEZE AND CLEAR – NO ACKNOWLEDGEMENT (FC-10) Function Codes. Freeze commands and FROZEN COUNTERS can use any of the same QUALIFIERS and VARIATIONS as the BINARY COUNTERS.

Each DNP3 master communication session will have its own unique set of FROZEN COUNTERS. Once a DNP3 master initiates communication with the M6xx meter, a communications session is established. This communication session allocates a dedicated set of FROZEN COUNTERS specifically for the new DNP3 master. When the DNP3 master issues a FREEZE or FREEZE AND CLEAR command, only the FROZEN COUNTERS allocated for that DNP3 master are frozen (and cleared depending on the command). This allows multiple masters to maintain their own FROZEN COUNTERS and prevents one DNP3 master from inadvertently clearing another DNP3 master's counter(s).

All FROZEN COUNTERS are volatile. As previously mentioned, the FROZEN COUNTERS are initialized to zero at start up. Any FROZEN COUNTERS that are part of a re-started communication session are initialised to zero as well. Any values frozen but not read prior to the M6xx meter restarting or that were not read prior to the communication session closing are lost. BINARY COUNTERS are also resynchronized with the energy measurement values at system start up and session start up.

4.3 BINARY INPUT CHANGE EVENTS

BINARY INPUT CHANGE events can be generated by the M6xx BINARY INPUT. This input is the OR of the individual HEALTH STATUS bits defined in 1.9 Health Check.

APPENDIX A: BITRONICS LEGACY DNP3 POINT ASSIGNMENTS

Bitronics Legacy DNP3 Point Assignments											
DNP Point	Contents	Data	Scale	Ind	Values/Dependencies	Type	Min	Max	Step	Class	0
AI:00	Health 0	T1			Bit-0	Non zero = Error	Data	0-Norm	1-Fail	1	Always
					Bit-1	Non zero = Error					
					Bit-2	Non zero = Error					
					Bit-3	Non zero = Error					
					Bit-4	Non zero = Error					
					Bit-5	Non zero = Error					
					Bit-6	Non zero = Error					
					Bit-7	Non zero = Error					
					Bit-8	Non zero = Error					
					Bit-9	Non zero = Error					
					Bit-10	Non zero = Error					
					Bit-11	Non zero = Error					
					Bit-12	Non zero = Error					
					Bit-13	Non zero = Error					
					Bit-14	Non zero = Error					
Bit-15	Non zero = Error										
AI:01	Amps A	T2	Amp Scale			Data	0	32767	$((1/32768) * 10 * \text{Amp Scale}) A$	Always	
AI:02	Amps B	T2	Amp Scale			Data	0	32767	$((1/32768) * 10 * \text{Amp Scale}) A$	Always	
AI:03	Amps C	T2	Amp Scale			Data	0	32767	$((1/32768) * 10 * \text{Amp Scale}) A$	Always	
AI:04	Volts A	T4	Volt Scale			Data	0	32767	$((1/32768) * 150 * \text{Volt Scale}) V$	Always	
AI:05	Volts B	T4	Volt Scale			Data	0	32767	$((1/32768) * 150 * \text{Volt Scale}) V$	Always	
AI:06	Volts C	T4	Volt Scale			Data	0	32767	$((1/32768) * 150 * \text{Volt Scale}) V$	Always	
AI:07	Watts Total	T6	Amp Scale * Volt Scale			Data	-32768	32767	$((1/32768) * 4500 * \text{Amp Scale} * \text{Volt Scale}) W$	Always	
AI:08	VARs Total	T6	Amp Scale * Volt Scale			Data	-32768	32767	$((1/32768) * 4500 * \text{Amp Scale} * \text{Volt Scale}) \text{ vars}$	Always	
AI:09	Watts A	T5	Amp Scale * Volt Scale			Data	-32768	32767	$((1/32768) * 1500 * \text{Amp Scale} * \text{Volt Scale}) W$	Always	
AI:10	Watts B	T5	Amp Scale * Volt Scale			Data	-32768	32767	$((1/32768) * 1500 * \text{Amp Scale} * \text{Volt Scale}) W$	Always	

Bitronics Legacy DNP3 Point Assignments											
	DNP Point	Contents	Data	Scale	Ind	Values/Dependencies	Type	Min	Max	Step	Class 0
	AI:11	Watts C	T5	Amp Scale * Volt Scale			Data	-32768	32767	$((1/32768) * 1500 * \text{Amp Scale} * \text{Volt Scale}) W$	Always
	AI:12	VARs A	T5	Amp Scale * Volt Scale			Data	-32768	32767	$((1/32768) * 1500 * \text{Amp Scale} * \text{Volt Scale}) \text{ vars}$	Always
	AI:13	VARs B	T5	Amp Scale * Volt Scale			Data	-32768	32767	$((1/32768) * 1500 * \text{Amp Scale} * \text{Volt Scale}) \text{ vars}$	Always
	AI:14	VARs C	T5	Amp Scale * Volt Scale			Data	-32768	32767	$((1/32768) * 1500 * \text{Amp Scale} * \text{Volt Scale}) \text{ vars}$	Always
	AO:00	CT Value	T10				Data	1000	9999	1	3
	AO:01	CT Ratio Divisor	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	3
	AO:02	PT Value	T10				Data	1000	9999	1	3
	AO:03	VT Ratio Divisor	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)	3
	AI:19	Amps Residual	T3	Amp Scale			Data	0	32767	$((1/32768) * 15 * \text{Amp Scale}) A$	Always
	CT:0	Watt-Hrs Normal (High Word)	T1				Data	0	65536	65536 KiloWattHours	0
	CT:1	Watt-Hrs Reverse (High Word)	T1				Data	0	65536	65536 KiloWattHours	0
	CT:2	VAR-Hrs Lag (High Word)	T1				Data	0	65536	65536 KiloVarHours	0
	CT:3	VAR-Hrs Lead (High Word)	T1				Data	0	65536	65536 KiloVarHours	0
	AI:20	System Frequency	T8				Data	2000	8000	0.01 Hz	Always
	AI:64	Reserved	T4	Volt Scale			Data	0	32767	$((1/32768) * 150 * \text{Volt Scale}) V$	Never
	AI:71	Reserved	T9				Data	-1800	1800	0.1 Degrees	Never
	AI:70	Reserved	T8				Data	2000	8000	0.001 Hz	Never
	CT:4	Heart Beat	T1				Data	0	4,294,967,295	1 msec	0
	AI:21	VAs A	T5	Amp Scale * Volt Scale			Data	0	32767	$((1/32768) * 1500 * \text{Amp Scale} * \text{Volt Scale}) VAs$	1
	AI:22	VAs B	T5	Amp Scale * Volt Scale			Data	0	32767	$((1/32768) * 1500 * \text{Amp Scale} * \text{Volt Scale}) VAs$	1
	AI:23	VAs C	T5	Amp Scale * Volt Scale			Data	0	32767	$((1/32768) * 1500 * \text{Amp Scale} * \text{Volt Scale}) VAs$	1
	AI:24	VAs Tot. Geom	T6	Amp Scale * Volt Scale			Data	0	32767	$((1/32768) * 4500 * \text{Amp Scale} * \text{Volt Scale}) VAs$	1

Bitronics Legacy DNP3 Point Assignments											
DNP Point	Contents	Data	Scale	Ind	Values/Dependencies	Type	Min	Max	Step	Class	0
AI:25	Power Factor A	T7				Data	-1000	1000	0.001		1
AI:26	Power Factor B	T7				Data	-1000	1000	0.001		1
AI:27	Power Factor C	T7				Data	-1000	1000	0.001		1
AI:28	Power Factor Tot. Geom	T7				Data	-1000	1000	0.001		1
AI:15	Amp Scale Factor	T10				Setting	1000	9999	1		Always
AI:16	Amp Scale Factor Divisor	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)		Always
AI:17	Volt Scale Factor	T10				Setting	1000	9999	1		Always
AI:18	Volt Scale Factor Divisor	T11				Setting	1	1000	Multiply by 10 (valid values are 1,10,100,1000)		Always
AI:29	Demand Amps A	T2	Amp Scale			Data	0	32767	$((1/32768) * 10 * \text{Amp Scale})$	A	2
AI:30	Demand Amps B	T2	Amp Scale			Data	0	32767	$((1/32768) * 10 * \text{Amp Scale})$	A	2
AI:31	Demand Amps C	T2	Amp Scale			Data	0	32767	$((1/32768) * 10 * \text{Amp Scale})$	A	2
AI:32	Demand (Max) Amps A	T2	Amp Scale			Data	0	32767	$((1/32768) * 10 * \text{Amp Scale})$	A	2
AI:33	Demand (Max) Amps B	T2	Amp Scale			Data	0	32767	$((1/32768) * 10 * \text{Amp Scale})$	A	2
AI:34	Demand (Max) Amps C	T2	Amp Scale			Data	0	32767	$((1/32768) * 10 * \text{Amp Scale})$	A	2
AI:35	Demand Amps Residual	T3	Amp Scale			Data	0	32767	$((1/32768) * 15 * \text{Amp Scale})$	A	2
AI:36	Demand (Max) Amps Residual	T3	Amp Scale			Data	0	32767	$((1/32768) * 15 * \text{Amp Scale})$	A	2
AI:37	Demand Volts A	T4	Volt Scale			Data	0	32767	$((1/32768) * 150 * \text{Volt Scale})$	V	2
AI:38	Demand Volts B	T4	Volt Scale			Data	0	32767	$((1/32768) * 150 * \text{Volt Scale})$	V	2
AI:39	Demand Volts C	T4	Volt Scale			Data	0	32767	$((1/32768) * 150 * \text{Volt Scale})$	V	2
AI:40	Demand (Max) Volts A	T4	Volt Scale			Data	0	32767	$((1/32768) * 150 * \text{Volt Scale})$	V	2
AI:41	Demand (Max) Volts B	T4	Volt Scale			Data	0	32767	$((1/32768) * 150 * \text{Volt Scale})$	V	2
AI:42	Demand (Max) Volts C	T4	Volt Scale			Data	0	32767	$((1/32768) * 150 * \text{Volt Scale})$	V	2
AI:43	Demand (Min) Volts A	T4	Volt Scale			Data	0	32767	$((1/32768) * 150 * \text{Volt Scale})$	V	2
AI:44	Demand (Min) Volts B	T4	Volt Scale			Data	0	32767	$((1/32768) * 150 * \text{Volt Scale})$	V	2
AI:45	Demand (Min) Volts C	T4	Volt Scale			Data	0	32767	$((1/32768) * 150 * \text{Volt Scale})$	V	2
AI:46	Demand Watts Total	T6	Amp Scale * Volt Scale			Data	-32768	32767	$((1/32768) * 4500 * \text{Amp Scale} * \text{Volt Scale})$	W	2
AI:47	Demand (Max) Watts Total	T6	Amp Scale * Volt Scale			Data	-32768	32767	$((1/32768) * 4500 * \text{Amp Scale} * \text{Volt Scale})$	W	2

Bitronics Legacy DNP3 Point Assignments											
	DNP Point	Contents	Data	Scale	Ind	Values/Dependencies	Type	Min	Max	Step	Class 0
	AI:48	Demand (Min) Watts Total	T6	Amp Scale * Volt Scale			Data	-32768	32767	$((1/32768) * 4500 * \text{Amp Scale} * \text{Volt Scale}) W$	2
	AI:49	Demand VARs Total	T6	Amp Scale * Volt Scale			Data	-32768	32767	$((1/32768) * 4500 * \text{Amp Scale} * \text{Volt Scale}) \text{ vars}$	2
	AI:50	Demand (Max) VARs Total	T6	Amp Scale * Volt Scale			Data	-32768	32767	$((1/32768) * 4500 * \text{Amp Scale} * \text{Volt Scale}) \text{ vars}$	2
	AI:51	Demand (Min) VARs Total	T6	Amp Scale * Volt Scale			Data	-32768	32767	$((1/32768) * 4500 * \text{Amp Scale} * \text{Volt Scale}) \text{ vars}$	2
	AI:52	Demand VAs Total	T6	Amp Scale * Volt Scale			Data	0	32767	$((1/32768) * 4500 * \text{Amp Scale} * \text{Volt Scale}) VAs$	2
	AI:53	Demand (Max) VAs Total	T6	Amp Scale * Volt Scale			Data	0	32767	$((1/32768) * 4500 * \text{Amp Scale} * \text{Volt Scale}) VAs$	2
	AI:54	Demand (Min) VAs Total	T6	Amp Scale * Volt Scale			Data	0	32767	$((1/32768) * 4500 * \text{Amp Scale} * \text{Volt Scale}) VAs$	2
	AI:55	Meter Type	T1		600	Legacy points list	Data	600	602	0	3
	AI:56	Protocol Version	T21				Data	0	65536	0.001	3
	AI:57	Factory Version Software	T21				Data	0	65536	0.001	3
	AI:58	Reserved	T21				Data	0	65536	0.001	3
	AI:59	Volts N-G	T4	Volt Scale			Data	0	32767	$((1/32768) * 150 * \text{Volt Scale}) V$	Never
	AI:60	Volts A-B	T23	Volt Scale			Data	0	32767	$((1/32768) * 300 * \text{Volt Scale}) V$	Never
	AI:61	Volts B-C	T23	Volt Scale			Data	0	32767	$((1/32768) * 300 * \text{Volt Scale}) V$	Never
	AI:62	Volts C-A	T23	Volt Scale			Data	0	32767	$((1/32768) * 300 * \text{Volt Scale}) V$	Never
	AI:63	System Frequency (1mHz)	T24				Data	-32768	32767	0.001Hz	Never
	AI:65	Reserved	T4	Volt Scale			Data	0	32767	$((1/32768) * 150 * \text{Volt Scale}) V$	Never
	AI:66	Reserved	T4	Volt Scale			Data	0	32767	$((1/32768) * 150 * \text{Volt Scale}) V$	Never
	AI:67	Reserved	T4	Volt Scale			Data	0	32767	$((1/32768) * 150 * \text{Volt Scale}) V$	Never
	AI:68	Reserved	T4	Volt Scale			Data	0	32767	$((1/32768) * 150 * \text{Volt Scale}) V$	Never
	AI:69	Reserved	T4	Volt Scale			Data	0	32767	$((1/32768) * 150 * \text{Volt Scale}) V$	Never
	AO:04	BiLF Class 0 Mask	T1				Setting	0	65536	1	Always
	AO:06	Tag Register	T1				Setting	0	65536	1	Always
	BO:00	Reset Energy	T22		0	Normal	Setting	0	1	1	Always
1					Reset Energy Counters						

Bitronics Legacy DNP3 Point Assignments											
DNP Point	Contents	Data	Scale	Ind	Values/Dependencies	Type	Min	Max	Step	Class	0
BO:01	Reset Demand Amps	T22		0	Normal	Setting	0	1	1		Always
				1	Reset Amp Demands						
BO:02	Reset Demand Volts	T22		0	Normal	Setting	0	1	1		Always
				1	Reset Volt Demands						
BO:03	Reset Demand Power	T22		0	Normal	Setting	0	1	1		Always
				1	Reset Power Demands						
AI:72	Demand Volts AB	T23	Volt Scale			Data	0	32767	((1/32768) * 300 * Volt Scale) V		Never
AI:73	Demand Volts BC	T23	Volt Scale			Data	0	32767	((1/32768) * 300 * Volt Scale) V		Never
AI:74	Demand Volts CA	T23	Volt Scale			Data	0	32767	((1/32768) * 300 * Volt Scale) V		Never
AI:75	Demand (Max) Volts AB	T23	Volt Scale			Data	0	32767	((1/32768) * 300 * Volt Scale) V		Never
AI:76	Demand (Max) Volts BC	T23	Volt Scale			Data	0	32767	((1/32768) * 300 * Volt Scale) V		Never
AI:77	Demand (Max) Volts CA	T23	Volt Scale			Data	0	32767	((1/32768) * 300 * Volt Scale) V		Never
AI:78	Demand (Min) Volts AB	T23	Volt Scale			Data	0	32767	((1/32768) * 300 * Volt Scale) V		Never
AI:79	Demand (Min) Volts BC	T23	Volt Scale			Data	0	32767	((1/32768) * 300 * Volt Scale) V		Never
AI:80	Demand (Min) Volts CA	T23	Volt Scale			Data	0	32767	((1/32768) * 300 * Volt Scale) V		Never
AI:81	Volts Aux	T4				Data	0	32767	((1/32768) * 600) V		Never
AI:82	Watt-Hours Net (Signed)	T1				Data	0	65536	65536 KiloWattHours		Never
AI:83	VA-Hours	T1				Data	0	65536	65536 KiloVAHours		Never
AI:84	Max Average Watts A	T6	Amp Scale * Volt Scale			Data	-32768	32767	((1/32768) * 1500 * Amp Scale * Volt Scale) W		Never

Bitronics Legacy DNP3 Point Assignments											
DNP Point	Contents	Data	Scale	Ind	Values/Dependencies	Type	Min	Max	Step	Class	0
AI:85	Max Average Watts B	T6	Amp Scale * Volt Scale			Data	-32768	32767	((1/32768) * 1500 * Amp Scale * Volt Scale) W	Never	
AI:86	Max Average Watts C	T6	Amp Scale * Volt Scale			Data	-32768	32767	((1/32768) * 1500 * Amp Scale * Volt Scale) W	Never	
AI:87	Max Average VARs A	T6	Amp Scale * Volt Scale			Data	-32768	32767	((1/32768) * 1500 * Amp Scale * Volt Scale) VARs	Never	
AI:88	Max Average VARs B	T6	Amp Scale * Volt Scale			Data	-32768	32767	((1/32768) * 1500 * Amp Scale * Volt Scale) VARs	Never	
AI:89	Max Average VARs C	T6	Amp Scale * Volt Scale			Data	-32768	32767	((1/32768) * 1500 * Amp Scale * Volt Scale) VARs	Never	
AI:90	Max Average VAs A	T6	Amp Scale * Volt Scale			Data	0	32767	((1/32768) * 1500 * Amp Scale * Volt Scale) VAs	Never	
AI:91	Max Average VAs B	T6	Amp Scale * Volt Scale			Data	0	32767	((1/32768) * 1500 * Amp Scale * Volt Scale) VAs	Never	
AI:92	Max Average VAs C	T6	Amp Scale * Volt Scale			Data	0	32767	((1/32768) * 1500 * Amp Scale * Volt Scale) VAs	Never	
AI:93	Average Watts A	T5	Amp Scale * Volt Scale			Data	-32768	32767	((1/32768) * 1500 * Amp Scale * Volt Scale) W	Never	
AI:94	Average Watts B	T5	Amp Scale * Volt Scale			Data	-32768	32767	((1/32768) * 1500 * Amp Scale * Volt Scale) W	Never	
AI:95	Average Watts C	T5	Amp Scale * Volt Scale			Data	-32768	32767	((1/32768) * 1500 * Amp Scale * Volt Scale) W	Never	
AI:96	Average VARs A	T5	Amp Scale * Volt Scale			Data	-32768	32767	((1/32768) * 1500 * Amp Scale * Volt Scale) VARs	Never	
AI:97	Average VARs A	T5	Amp Scale * Volt Scale			Data	-32768	32767	((1/32768) * 1500 * Amp Scale * Volt Scale) VARs	Never	
AI:98	Average VARs A	T5	Amp Scale * Volt Scale			Data	-32768	32767	((1/32768) * 1500 * Amp Scale * Volt Scale) VARs	Never	
AI:99	Average VAs A	T6	Amp Scale * Volt Scale			Data	0	32767	((1/32768) * 1500 * Amp Scale * Volt Scale) VAs	Never	
AI:100	Average VAs B	T6	Amp Scale * Volt Scale			Data	0	32767	((1/32768) * 1500 * Amp Scale * Volt Scale) VAs	Never	
AI:101	Average VAs C	T6	Amp Scale * Volt Scale			Data	0	32767	((1/32768) * 1500 * Amp Scale * Volt Scale) VAs	Never	

Bitronics Legacy DNP3 Point Assignments											
	DNP Point	Contents	Data	Scale	Ind	Values/Dependencies	Type	Min	Max	Step	Class 0
	AI:102	Min Average Watts A	T6	Amp Scale * Volt Scale			Data	-32768	32767	$((1/32768) * 1500 * \text{Amp Scale} * \text{Volt Scale}) W$	Never
	AI:103	Min Average Watts B	T6	Amp Scale * Volt Scale			Data	-32768	32767	$((1/32768) * 1500 * \text{Amp Scale} * \text{Volt Scale}) W$	Never
	AI:104	Min Average Watts C	T6	Amp Scale * Volt Scale			Data	-32768	32767	$((1/32768) * 1500 * \text{Amp Scale} * \text{Volt Scale}) W$	Never
	AI:105	Min Average VARs A	T6	Amp Scale * Volt Scale			Data	-32768	32767	$((1/32768) * 1500 * \text{Amp Scale} * \text{Volt Scale}) \text{VARs}$	Never
	AI:106	Min Average VARs B	T6	Amp Scale * Volt Scale			Data	-32768	32767	$((1/32768) * 1500 * \text{Amp Scale} * \text{Volt Scale}) \text{VARs}$	Never
	AI:107	Min Average VARs C	T6	Amp Scale * Volt Scale			Data	-32768	32767	$((1/32768) * 1500 * \text{Amp Scale} * \text{Volt Scale}) \text{VARs}$	Never
	AI:108	Min Average VAs A	T6	Amp Scale * Volt Scale			Data	0	32767	$((1/32768) * 1500 * \text{Amp Scale} * \text{Volt Scale}) \text{VAs}$	Never
	AI:109	Min Average VAs B	T6	Amp Scale * Volt Scale			Data	0	32767	$((1/32768) * 1500 * \text{Amp Scale} * \text{Volt Scale}) \text{VAs}$	Never
	AI:110	Min Average VAs C	T6	Amp Scale * Volt Scale			Data	0	32767	$((1/32768) * 1500 * \text{Amp Scale} * \text{Volt Scale}) \text{VAs}$	Never

When connected to 2 Element (DELTA or 3-wire) systems, the Per-Element quantities may have no direct physical meaning.

APPENDIX B: DNP3 CONFIGURATION PARAMETERS

Configuration Parameter	Description	Default or Options
DNP Session		
Session	The number of the session you are configuring	Option of 1, 2, or 3
Type	The session type	Option Serial, TCP, or UDP
IED (Source)	The source address for the selected session	Default is 1
Master (Destination)	The destination address for the selected session. If Validate Source Address (see below) is selected, this will be the address to compare the master's source address to. If Validate Source Address is not selected, this address will be used as the address to send unsolicited responses. All other responses will be sent to the source address received from the master.	Default is 0
Tag Register	Location of the tag register	0 to 65535
Tag Register 1	Secondary tag register	0 to 65535
Link Status Period (Seconds)	How often to send link status requests if no DNP3 frames have been received on this session. In DNP3 IP Networking spec this is called keep-alive interval.	Default is 300 seconds
Validate Source Address	Specify whether or not to validate source address in received frames. DNP3 frames contain both a source address field and a destination address field. If the box is not checked, DNP3 does not validate the source address and frames whose destination address matches a configured slave session will be accepted. Setting this to TRUE (checking the box) requires both source and destination addresses to match a local slave session before the frame is accepted.	Default is box unchecked (disabled). Checking the box enables the function.
Enable Self Address	Specify whether or not to enable self address functionality on this slave device as specified by DNP Technical Bulletin 2003-003 Self-Address Reservation. Slave will respond to address 0xffc as though it received a request for its configured address. It will respond with its own address so the master can automatically discover the slave address	Default is false (box not checked), checking the box enables this function.
Delete Oldest Event	Selects whether or not the oldest event is deleted when a session's event buffer overflows (setting BUFFER OVERFLOW IIN)	Default is box unchecked, checking the box enables this function.
Allow Resets	Selects whether resets are allowed	Default is box checked. Unchecking the box disables the function.

Configuration Parameter	Description	Default or Options
Allow Time Set	Selects whether time set is allowed	Default is box checked. Unchecking the box disables the function.
Set Needtime IIN	Specifies whether this device will set the Need Time IIN bit in response to this session at startup and after the clock valid period has elapsed. If this bit is set the slave will request time synchronization from the master by setting the Need Time IIN bit in responses. Typically this parameter should be true for one session for each slave device. Set this parameter to FALSE (box unchecked) if report by exception is not supported or there is no reason this device needs to be synchronized from the master.	Default is box checked. Unchecking the box disables the function.
Deadbands		
Phase Current	In Optimal Resolution mode, deadbands are in percents with a minimum value of .01%. In Primary Units mode, deadbands are in per count integers.	1.00%
Neutral Current	In Optimal Resolution mode, deadbands are in percents with a minimum value of .01%. In Primary Units mode, deadbands are in per count integers.	.10%
Voltages	In Optimal Resolution mode, deadbands are in percents with a minimum value of .01%. In Primary Units mode, deadbands are in per count integers.	1.00%
Power Reactive	In Optimal Resolution mode, deadbands are in percents with a minimum value of .01%. In Primary Units mode, deadbands are in per count integers.	1.00%
Power Actual	In Optimal Resolution mode, deadbands are in percents with a minimum value of .01%. In Primary Units mode, deadbands are in per count integers.	1.00%
Frequency	In Optimal Resolution mode, deadbands are in percents with a minimum value of .01%. In Primary Units mode, deadbands are in per count integers.	1.00%
Miscellaneous	In Optimal Resolution mode, deadbands are in percents with a minimum value of .01%. In Primary Units mode, deadbands are in per count integers.	1.00%
Timeouts		
Needtime (minutes)	Specifies how long (in minutes) the local clock will remain valid after receiving a time synchronization.	Default is 30 minutes.
Application Confirm (ms)	Application confirm timeout specifies how long the slave DNP device will wait for an application layer confirmation from the master. This, in combination with unsolicited Retry Timeout or unsolicited Offline Timeout, will determine how frequently an unsolicited response will be resent.	Default is 10 seconds
Select (ms)	Select Timeout specifies the maximum amount of time that a select will remain valid before the corresponding operate is received. If an operate request is received after this period has elapsed, the operate request will fail.	Default is 5 seconds

Configuration Parameter	Description	Default or Options
Unsolicited Response		
UR Enable	Determines whether unsolicited responses are allowed. If unsolicited Response Enable is FALSE, no unsolicited responses will be generated and requests to enable or disable unsolicited responses will fail.	Default is box unchecked, checking the box enables this function.
Enable Initial Null	Determines whether unsolicited null responses will be sent when session comes online. Specs say send initial unsolicited null response on restart. Previous versions of SCL would also send unsolicited null response when a session came back online. Add this configuration to allow user to maintain that behaviour by setting this to TRUE if desired.	Default is box unchecked, checking the box enables this function.
Class1 Count	When unsolicited response is enabled, the maximum number of events that are stored before an unsolicited response is generated.	Default is 5, maximum is 255.
Class1 Timeout (ms)	When unsolicited response is enabled, the maximum amount of time (in ms) after an event before an unsolicited response is generated.	Default is 5000 ms
Class2 Count	When unsolicited response is enabled, the maximum number of events that are stored before an unsolicited response is generated.	Default is 5, maximum is 255.
Class2 Timeout (ms)	When unsolicited response is enabled, the maximum amount of time (in ms) after an event before an unsolicited response is generated.	Default is 5000 ms
Class3 Count	When unsolicited response is enabled, the maximum number of events that are stored before an unsolicited response is generated.	Default is 5, maximum is 255.
Class3 Timeout (ms)	When unsolicited response is enabled, the maximum amount of time (in ms) after an event before an unsolicited response is generated.	Default is 5000 ms
Max Retries	The maximum number of unsolicited retries before changing to the 'Offline Timeout' period described below. This parameter allows you to specify up to 65535 retries. If you want an infinite number of retries set Offline Timeout to the same value as Retry Timeout.	Default is 3
Retry Timeout (ms)	Specifies the time, in milliseconds, to delay after an unsolicited confirm timeout before retrying the unsolicited response.	Default is 5000 ms
Offline Timeout (seconds)	Specifies the time, in seconds, to delay after an unsolicited timeout before retrying the unsolicited response after the Max Retries listed above have been attempted. To disable retries after Max Retries set this value to the maximum value of 65535.	Default is 30 seconds
Default Variations	Specifies the variation that will be used for unsolicited responses and in response to a read requesting variation 0.	

Configuration Parameter	Description	Default or Options
Binary Input		With flags
Binary Input Event		With absolute time
Binary Output		Output status with flags
Counter		32-bit without flag
Frozen Counter		32-bit without flag
Counter Event		32-bit with flag
Frozen Counter Event		32-bit with flag
Analogue Input		16-bit without flag
Analogue Input Event		16-bit without time
Analogue Output Status		16-bit with flag
Transmit/Receive		
Receive Fragment Size	Maximum receive fragment size.	Default is 2048 (max)
Transmit Fragment Size	Maximum transmit fragment size.	Default is 2048 (max)
Receive Frame Size	Receive link layer frame size. This includes room for link header and CRCs	Default is 292 (max)
Transmit Frame Size	Transmit link layer frame size. This includes room for link header and CRCs	Default is 292 (max)
Receive Frame Timeout (ms)	Maximum amount of time (ms) to wait for a complete frame after receiving valid frame sync characters	Default is 15,000 milliseconds
First Character Timeout (ms)	Minimum time, in milliseconds, after receiving a character before we will attempt to transmit a character on this channel. This is generally useful when using a modem or some other communication device that requires a minimum time between receive and transmit.	Default is 0 milliseconds
Link Confirm Mode	When should we ask for link layer confirmations? The options are: NEVER (not for any frame) SOMETIMES (multi-frame fragments) ALWAYS (for all frames)	Default is Never
Link Confirm Timeout (ms)	Maximum amount of time (ms) to wait for a link level confirm if requested. Even if the Link Confirm Mode is set to NEVER this will still be used for Link Test Frame and Request Link Status if they are sent.	Default is 2000 ms
Link Retries	Maximum number of link layer retries if link layer confirm times out.	Default is 3

Configuration Parameter	Description	Default or Options
Link Offline Poll Period (ms)	Specifies how often (ms) a session that is offline will attempt to re-establish communication. This includes attempting to open/reopen a channel and/or issuing request status messages as appropriate for the current configuration.	Default is 10,000 ms
TCP/IP and UDP		
Master IP Address	The IP address to accept TCP connection from. May be *.*.* (0.0.0.0) indicating accept connection from any client.	Default listing is 0.0.0.0
IED Listen Port	On server and Dual End Point Device the port to listen on	Default value of 20000
IP Connect Timeout (ms)	Number of milliseconds to wait for TCP connect to succeed or fail	Default is 1000 ms
UDP Broadcast Address	Destination IP address for UDP broadcast requests. This is only used by a DNP Master when TCP and UDP are supported. If UDP ONLY is configured, IP Address will be used as destination for all requests.	Default listing is 0.0.0.0
UDP Local Port	Local port for sending and receiving UDP datagrams on. If this is set to NONE(0), UDP will not be enabled.	Default value of 20000
UDP Destination Port	If TCP and UDP are configured, this is not used. If UDP ONLY is configured this specifies the destination UDP/IP port to send responses to.	Default value is 2
UDP Initial Unsolicited Port	If UDP ONLY is configured this specifies the destination UDP/IP port to send the initial Unsolicited Null response to. After receiving a UDP request from master, UDP Destination Port (which may indicate the use of src port) will be used for all responses.	Default value of 20000
UDP Validate Address	Whether or not to validate source address of received UDP datagram.	Default value is box unchecked

APPENDIX C: DNP3 DEVICE PROFILE

DNP V3	
DEVICE PROFILE DOCUMENT	
Vendor Name: Alstom Grid	
Device Name: M65x and M66x	
Highest DNP Level Supported:	Device Function:
For Requests: Level 2 For Responses: Level 2	<input type="checkbox"/> Master <input checked="" type="checkbox"/> Slave
Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported:	
<p>For static (non-change-event) object requests, request qualifier codes 00 and 01 (start-stop), 07 and 08 (limited quantity), and 17 and 28 (index) are supported in addition to request qualifier code 06 (no range). Static object requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01. Static object requests sent with qualifiers 17 or 28 will be responded with qualifiers 17 or 28. For change-event object requests, qualifiers 17 or 28 are always responded.</p> <p>16-bit Analogue Change Events may be requested. Binary Change Events may be requested. Frozen Counter Events may be requested. The read function code for Object 50 (Time and Date), variation 1, is supported.</p>	
Maximum Data Link Frame Size (octets):	Maximum Application Fragment Size (octets):
Transmitted: 292 Received 292	Transmitted: 2048 Received 2048
Maximum Data Link Re-tries:	Maximum Application Layer Re-tries:
<input type="checkbox"/> None <input type="checkbox"/> Fixed <input checked="" type="checkbox"/> Configurable from 0 to 255	<input checked="" type="checkbox"/> None <input type="checkbox"/> Configurable
Requires Data Link Layer Confirmation:	
<input type="checkbox"/> Never <input type="checkbox"/> Always <input type="checkbox"/> Sometimes <input checked="" type="checkbox"/> Configurable as: Never, Only for multi-frame messages, or Always	
Requires Application Layer Confirmation:	
<input type="checkbox"/> Never <input type="checkbox"/> Always <input type="checkbox"/> When reporting Event Data (Slave devices only) <input type="checkbox"/> When sending multi-fragment responses (Slave devices only) <input type="checkbox"/> Sometimes <input checked="" type="checkbox"/> Configurable as: "Only when reporting event data", or "When reporting event data or multi-fragment messages."	
Timeouts while waiting for:	
Data Link Confirm: <input type="checkbox"/> None <input type="checkbox"/> Fixed at _ <input type="checkbox"/> Variable <input checked="" type="checkbox"/> Configurable	
Complete Appl. Fragment: <input checked="" type="checkbox"/> None <input type="checkbox"/> Fixed at _ <input type="checkbox"/> Variable <input type="checkbox"/> Configurable	
Application Confirm: <input type="checkbox"/> None <input type="checkbox"/> Fixed at _ <input type="checkbox"/> Variable <input checked="" type="checkbox"/> Configurable	
Complete Appl. Response: <input checked="" type="checkbox"/> None <input type="checkbox"/> Fixed at _ <input type="checkbox"/> Variable <input type="checkbox"/> Configurable	
Others: Transmission Delay, configurable. Arm Select Timeout, configurable.	

DNP V3

DEVICE PROFILE DOCUMENT

Sends/Executes Control Operations:

- | | | | | |
|-----------------------|--|---|------------------------------------|---------------------------------------|
| WRITE Binary Outputs | <input type="checkbox"/> Never | <input checked="" 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-NO ACK | <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 type="checkbox"/> Never | <input checked="" type="checkbox"/> Always | <input type="checkbox"/> Sometimes | <input type="checkbox"/> Configurable |
| Pulse Off | <input type="checkbox"/> Never | <input checked="" type="checkbox"/> Always | <input type="checkbox"/> Sometimes | <input type="checkbox"/> Configurable |
| Latch On | <input checked="" type="checkbox"/> Never | <input type="checkbox"/> Always | <input type="checkbox"/> Sometimes | <input type="checkbox"/> Configurable |
| Latch Off | <input checked="" type="checkbox"/> Never | <input 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 |

Attach explanation if 'Sometimes' or 'Configurable' was checked for any operation.

Reports Binary Input Change Events when no specific variation requested:

- Never**
- Only time-tagged
- Only non-time-tagged
- Configurable**

Reports time-tagged Binary Input Change Events when no specific variation requested:

- Never**
- Binary Input Change With Time
- Binary Input Change With Relative Time
- Configurable**

Sends Unsolicited Responses:

- Never
- Configurable
- Only certain objects
- Sometimes (attach explanation)
- ENABLE/DISABLE UNSOLICITED**
Function codes supported

Sends Static Data in Unsolicited Responses:

- Never**
- When Device Restarts
- When Status Flags Change

No other options are permitted.

Default Counter Object/Variation:

- No Counters Reported
- Configurable
- Default Object: 20**
Default Variation: 5
- Point-by-point list attached

Counters Roll Over at:

- No Counters Reported
- Configurable (attach explanation)
- 16 Bits
- 32 Bits**
- Other Value: _____
- Point-by-point list attached

Sends Multi-Fragment Responses:

- Yes**
- No

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