Bitronics

MultiComm

DNP3 Protocol Option Manual

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-S113 (Formerly DOS11.3)	RS-232C DNP3 Protocol
-S123 (Formerly DOS12.3)	RS-485 DNP3 Protocol

Firmware Version 4.20 and Later
Includes Information on CI1 Option (1 Amp Inputs)

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DNP Communication Firmware	Description
1.00	Original MultiComm Modbus Communication Firmware. Used with Version 3.00 MultiComm Meter Firmware
1.10	Added VAs, PF, and Network Writeable CT/PT Ratios. Used with Version 3.30 MultiComm Meter Firmware.
1.20	Added Demand Option. New Analog Inputs and Demand Reset points
1.21	Added RS-485 support to Version 1.20
2.00	Added support for RTH (harmonic) functions. Added Tag Register. Added network screen setup. Added configuration register to limit Class 0 Response and to allow Data Link Confirms. Added transport layer to allow multi-fragment response. Changed COLD/WARM RESTART. Added NAK (w/o DFC) response if instrument is UN-RESET.
2.10	Added MultiComm RT (instantaneous models)

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1.0 DESCRIPTION

1.1 Introduction

The -S113 and -S123 DNP3 protocol option for the MULTICOMM family of instruments is designed to allow operation of these instruments on DNP3 instrument networks. The DNP3 protocol is a widely supported open interconnect originally designed by GE-Harris Controls (formerly Westronics, Inc). The -S113 option provides point-to-point communication using RS-232C as the physical link. The -S123 option provides multi-drop access to networks using RS-485 as the physical link. For the sake of brevity, the term DNP will mean the DNP3 protocol throughout this document.

1.2 Features

- ***** Rugged Bitronics design
- ***** Dedicated communications processor: fast response for maximum instrument polling rates
- ***** User selectable instrument address with pushbutton front panel display
- ***** Data link activity indicator
- ***** Supports read via both class and specific objects
- ***** Supports energy and demand resets with or without acknowledge
- ***** Supports remote setting of CT and PT scaling factors
- ***** "Anti-jabber" hardware on RS-485 transmitter isolates instrument during fault
- ***** DNP compliance verified by GE-Harris for GE-Harris D20 RTU, and by ACS for the ACS 7500 Series RTU

1.3 Specifications

Resolution:

Amperes:	0.007% of 5* A nominal
Volts:	0.004% of 120V nominal
Frequency:	0.01 Hz
Per Phase Watts/VARs/VAs:	0.009% of 500* W nominal
Total Watts/VARs/Vas:	0.009% of 1000* W nominal (2 Element)
	0.009% of 1500* W nominal (2½ or 3 Element)
Power Factor:	0.001
K Factor:	0.01
TDD, THD:	0.1%

* - When CI1 Option (1Amp Input) is installed, divide this value by 5

1.3 Specifications, (Cont'd)

Accuracy:	Same as base meter (0.25% Class per ANSI Std 460-1988)

DNP3

Compliance Level:	Exceeds IED Application Layer Level 1 (L1)
Connector:	4-pin Terminal Block for shielded twisted pair
Communication:	9600 Baud, 8 Data, 1 Stop, No Parity, Half Duplex
Interface:	2 wire RS-485 Option -S123, or 3 wire RS-232C Option -S113
Distance:	4,000 ft (1,200m) RS-485, 50 ft RS-232C

Functions Codes:

Read	- All objects (by class)
Read	- Specific values (Analog Inputs, Counters, Binary and Analog Output Status)
Write	- Internal Indication object
Direct Op	- Control Relay and Analog Output Block (also Direct Operate-No Acknowledge)
Cold Restart	- Instrument re-initialization
Warm Restart	- DNP communication processor restart

DNP Objects:

Bin Output Sts	- Energy reset and demand reset status
Control Relay	- Energy and demand reset operation
Counter	- Energy measurements
Analog Input	- Non-energy measurements
Analog Output	- Remote CT/PT ratio setup
Time	- Cold and warm restarts
Class	- Read all instrument data
Internal Ind.	- DNP administrative functions

DNP Addresses:	0-255 (other ranges available, consult Bitronics representative)
Response Time:	Response begins 10-30 msec after valid command received for Class-0 Response limited to approximately 70 Data Objects Response begins 50-70 msec after valid command received for Class-0 Response for all Data Objects (approximately 322)
Anti-Jabber:	RS-485 line de-activates within 0.2 seconds of instrument fault

EEPROM Memory Endurance:

Writeable Registers: 1,000,000 minimum changes per register (Register Writes)

2.0 PRINCIPLES OF OPERATION

2.1 Modular construction

The Bitronics MultiComm instrument option is composed of three major modules. The DNP network connects to the output connector board which in turn is driven by the interface transceiver which is controlled by the DNP interface processor.

2.2 Output Connector Board

The DNP network connection is made via the 4 pin terminal block connector on the back of the instrument. An EARTH GROUND input is provided and is connected to the SHIELD terminal through 200 ohms. Both the SHIELD GROUND and the EARTH GROUND input are connected to the MultiComm Processor Board via a 100 ohm resistor. For proper operation of the RS-485 and RS-232C interfaces, the SHIELD GROUND connection must be utilized. If ground potentials under 14 volts can be guaranteed, the EARTH GROUND connection MAY be used but is not required. Refer to Figure 2 for the input circuit and connection diagrams.

2.3 Interface Transceiver

The communications channel transceiver is located on the analog processing board. This transceiver provides the drive to transmit and receive messages on the DNP cable. This circuit is an RS-232C transceiver IC for the -S113 option. The -S123 option uses a two-wire RS-485 transceiver IC for this function. The transceiver is connected to the Output Connector Board via the Power Supply Board and a three wire cable to the rear terminal block.

2.4 MultiComm Processor Board

The MultiComm Processor Board contains an Intel 80C51FA microcontroller and its associated circuitry. This processor handles all the message reception, error detecting, message transaction and other network overhead required by the DNP network, as well as communicating with the HOST processor. The HOST processor handles all other functions of the instrument. Approximately every 0.6 seconds (150msec on “B” models), the MultiComm processor receives a copy of all the data calculated by the HOST processor. The HOST and MultiComm processors communicate via transaction messages that are sent through the DUAL-PORT RAM.

The MultiComm processor processes all the DNP messages. When the MultiComm processor receives a DNP message, it checks if the DNP destination address of the message is either the address of this instrument or the broadcast address. The instrument address is set via two 16-position rotary switches SW3 and SW4, which are also located on this board (See section 5.1 for instructions on setting the instrument address). If the DNP destination address matches this instrument, the MultiComm processor generates a response. If the function code is READ, the MultiComm processor generates the response from its copy of the meter data. If the message is a properly formatted DIRECT OPERATE or DIRECT OPERATE-NO ACKNOWLEDGE (energy/demand reset or CT/PT ratio setup), the MultiComm processor generates a response and sends a transaction to the HOST processor. Note that both read and write requests are immediately satisfied using information located on the MultiComm board.

The MultiComm processing board also controls the state of the RS-485 transmitter in instruments equipped with the -S123 option. Since RS-485 uses a party-line arrangement, the failure of any instrument to return the transmitter to the passive state after transmission can cause the entire link to malfunction. The MultiComm processing board incorporates hardware which will remove the instrument from the party line if certain timing constraints are not met by the microcontroller. This "anti-jabber" system ensures that a malfunctioning instrument will not cause the communication bus to "lock-up".

Status of the DNP network at this node is indicated by the Diagnostic LED which is located in the upper left hand corner of the MultiComm processor board. This Diagnostic LED is visible through the faceplate, and can been seen in the upper left hand corner of the upper display. Section 3.8 describes the operation of the Diagnostic LED.

The CT/PT switch and the select pushbutton are also mounted on the MultiComm Processor Board, however both these switches are read by the HOST processor. A second pushbutton switch is mounted on the faceplate, and connected to the MultiComm Processor board via a pair of wires and a connector. This switch is connected in parallel with the select switch mounted on the MultiComm Processor board, and is used to stop and start the scrolling of the front display (refer to the base MultiComm instrument manual for details).

3.0 DNP INTERFACE

3.1 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, MultiComm Instrument, etc.) which is connected to the network. Each DNP NODE has an ADDRESS in the range of 0 to 65535, and it is this address that allows a MASTER to selectively request data from any other device. DNP uses the address 65535 for broadcast functions. Broadcast requests NEVER generate DNP responses.

The DNP implementation in the MultiComm Instrument conforms to all the GE-Harris IED (Intelligent Electronics Devices) implementation guidelines. All data items that are available from the instrument can be obtained via the DNP READ CLASS-0 command. Individual items can also be read using READ BINARY-OUTPUT-STATUS or READ ANALOG-INPUT or READ COUNTER or READ ANALOG-OUTPUT-STATUS commands.

The Energy values can be RESET to ZERO by issuing the DIRECT-OPERATE (or DIRECT- OPERATE-NO-ACKNOWLEDGE) using the CONTROL-RELAY-OUTPUT-BLOCK object to point 0. The request must use the parameters to PULSE-ON for ON 1 millisecond and OFF 0 milliseconds. The Registers will be reset within 0.6 seconds, however it takes the meter 6 seconds to clear the energy data stored in the EEPROM. The USER must ensure that the power is not interrupted to the meter for this 6 second period after this command is issued.

The Demand values can be RESET by issuing the same DIRECT-OPERATE (or DIRECT-OPERATE-NO ACKNOWLEDGE) command to other points of this object. Point 1, point 2, point 3 and point 4 are used to RESET the Amp Demands, Volt Demands, Power Demands and Harmonic Demands (respectively). The Demand Registers will be RESET within 0.6 seconds, however it takes the meter up to 10 seconds to reset t he demand data stored in EEPROM. The USER must ensure that the power is not interrupted to the meter for this 10 second period after this command is issued. Refer to Appendix E (point list) for more information.

The CT and PT scale factors can be changed by issuing DIRECT-OPERATE (or DIRECT- OPERATE-NO-ACKNOWLEDGE) using the ANALOG-OUTPUT-BLOCK object. Note that when these scale factors are written, all demand values are reset to zero. Due to the limited number of EEPROM write cycles, scale factors **SHOULD NOT** be written continuously. Refer to Section 3.5 for more information on setting CT and PT ratios.

The TDD Denominators can be changed by issuing DIRECT-OPERATE (or DIRECT-OPERATE-NO-ACKNOWLEDGE) using the ANALOG-OUTPUT-BLOCK object. Due to the limited number of EEPROM write cycles, TDD Denominators **SHOULD NOT** be written continuously. Refer to Section 3 for more information on setting CT and PT ratios.

3.2 DNP Address

Each DNP instrument responds to a single destination address in the range 0-65534. Each instrument on a DNP link must have a unique address. MultiComm instruments allow one of 256 addresses to be selected. Unless otherwise specified at time of order, the selectable addresses are in the range of 0-255. See section 5.1 for instructions on setting the address. DNP instruments also use a GLOBAL address of 65535. Requests sent to the GLOBAL address cause the instrument to execute the function but not to respond.

3.3 Transaction Timing

The instrument completes a set of calculations approximately every 0.6seconds (150msec on “B” models). At the completion of the calculation the HOST processor services any pending transactions (reset energy requests) and updates the DATA in the MultiComm Processor. Since the MultiComm Processor maintains a copy of the data, a response for 70 data objects will begin 10-30 milliseconds after receipt of a request from a DNP MASTER device (response time for requests of all 322 Data Objects will be 50-70 milliseconds). DIRECT-OPERATE (or DIRECT-OPERATE-NO-ACKNOWLEDGE) requests (reset energy/demand and ratio setup) are immediately confirmed but the actual operation will not occur for up to 600 milliseconds. An additional 6 seconds is required for the HOST processor to write to its EEPROM.

3.4 Object Format

The instrument uses two objects which correspond to the measurements the instrument is making. These are the COUNTER (object 20, variations 1,2,5 and 6) and ANALOG-INPUT (object 30, variations 1,2,3 and 4). In addition, it returns to the DNP MASTER device two status objects which indicate whether the instrument is ready to accept energy/demand resets or ratio setup commands. The objects are the BINARY-OUTPUT-STATUS (object 10, variation 2) and ANALOG-OUTPUT-STATUS (object 40, variation 2).

The DNP protocol allows each device to determine the best method of data transfer. MultiComm instruments 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 ANALOG-INPUT objects allow optional flags to be used. If a value is requested as variation 0, MultiComm instruments respond as if the requested variation was for a 32 bit COUNTER or 16 bit ANALOG-INPUT or 16 bit ANALOG-OUTPUT-STATUS. If the internal flags indicate other than ONLINE, a flagged response of the requested size is returned, otherwise the unflagged response is sent. Appendix C details the conditions which set flags. CLASS-0 reads are treated as a request for all known points in variation 0.

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 3.7). The majority of the points are represented in **NORMALIZED 2'S COMPLEMENT** format, for conversion of the register data into **ENGINEERING UNITS**, please refer to Section 3.6. For specifics concerning the correct command and its implementation, users are directed to the User's manual for the specific device that will request the data. Listed on the following pages are the register assignments for the instrument. The "COMMON REGISTER ASSIGNMENTS" pertain to both demand and non-demand instruments. The registers on the "DEMAND REGISTER ASSIGNMENTS" list are only in instruments with demand measurements. Unless otherwise specified, all registers are READ-ONLY.

3.4.1 INSTANTANEOUS Data Registers for 2 ½ or 3 Element Models

Quantity	Object: Point	Representation
Health Check	AI:0	Refer to Section 3.7
Amperes Phase A	AI:1	
Amperes Phase B	AI:2	0 = 0Amps; 32767 = 10.0[*] Amps
Amperes Phase C	AI:3	
Volts Phase A-N	AI:4	
Volts Phase B-N	AI:5	0 = 0Volts; 32767 = 150.0Volts
Volts Phase C-N	AI:6	
Watts Total 3 Phase	AI:7	-32768 = -4500[*] Watts; 0 = 0Watts; +32767 = +4500[*] Watts
VARs Total 3 Phase	AI:8	-32768 = -4500[*] VARS; 0 = 0VARS; +32767 = +4500[*] VARs
Watts Phase A	AI:9	-32768 = -1500[*] Watts; 0 = 0Watts;
Watts Phase B	AI:10	+32767 = +1500[*] Watts
Watts Phase C	AI:11	
VARs Phase A	AI:12	-32768 = -1500[*] VARs; 0 = 0VARS;
VARs Phase B	AI:13	+32767 = +1500[*] VARs
VARs Phase C	AI:14	
CT Value	AI:15	Actual CT or PT ratio is: Value / Divisor
CT Divisor	AI:16	For example the CT ratio 5:5 has the
PT Value	AI:17	Value=5000 and Divisor=1000.
PT Divisor	AI:18	Ratios are expressed CT:5 (CT:1 for units with CI1 option), and PT:1
Neutral (Residual) Current	AI:19	0 = 0Amps; 32767 = 15.0[*] Amps
Frequency	AI:20	0 = <45.00Hz; 4500 = 45.00Hz 7500 = 75.00Hz; 9999 = >75.00Hz
VAs Phase A	AI:21	
VAs Phase B	AI:22	0 = 0VAs; +32767 = +1500[*] VAs
VAs Phase C	AI:23	
VAs Total	AI:24	0 = 0VAs; +32767 = +4500[*] VAs

[*] - When CI1 Option (1Amp Input) is installed, divide this value by 5

3.4.1 INSTANTANEOUS Data Registers for 2 ½ or 3 Element Models, Cont'd

Quantity	Object: Point	Representation
Power Factor Phase A	AI:25	| -1000 = -1.000 (lag)
Power Factor Phase B	AI:26	| 0 = 0; +1000 = +1.000 (lead);
Power Factor Phase C	AI:27	| +1999 = Signal too low
Power Factor Total	AI:28	|
Meter Type Identifier	AI:55	See **Table 4**
Communications Firmware Revision	AI:56|	
Host Firmware Rev.	AI:57	| Packed BCD XX.XX
Host Micro Firmware Rev.	AI:58	|
+ kWatthour	CT:0	0 = 0kWh; 99999999 = 99,999,999 kWh
- kWatthour	CT:1	0 = 0kWh; 99999999 = -99,999,999 kWh
+ kVARhour	CT:2	0 = 0kVARh;99999999 = 99,999,999 kVARh
- kVARhour	CT:3	0 = 0kVARh; 99999999= -99,999,999 kVARh
Heartbeat State Counter	CT:4	See Section 3.9
Energy RESET	BO:0	Read via obj 10-2, write via 12-1, see **Table 1**, section 3.5.2
CT Value	AO:0 |	These are the writable versions of the Analog
CT Divisor	AO:1 |	input points AI:15 through AI:18. They are
PT Value	AO:2 |	read via object 40-2 and written via object
41-		
PT Divisor	AO:3 |	2. Reads return same values as the Analog Inputs.
Configuration Setup Reg 1	AO:4	Read/Write - See **Table 3**, section 3.5.5
Configuration Setup Reg 2	AO:5	Always returns 0 - Future expansion
User Writeable Tag Reg	AO:6	Read/Write - 0 to 32,767
TDD Denominators	AO:7-9 |	Read/Write, MTWIEx always returns 0
Display Screen Setup Reg 1	AO:10|	
Display Screen Setup Reg 2	AO:11|	
Display Screen Setup Reg 3	AO:12|	Read/Write - See **Table 2**, section 3.5.4
Display Screen Setup Reg 4	AO:13|	
Display Screen Setup Reg 5	AO:14|	

AI indicates Analog-Input point, **CT** Counter point, **BO** Binary-Output, and **AO** Analog-Output

3.4.2 DEMAND Data Registers for 2 ½ or 3 Element Models

Quantity	Object: Point	Representation
Present Demand Amps φA	AI:29	
Present Demand Amps φB	AI:30	0[1] = 0Amps; 32767 = 10.0[*] Amps
Present Demand Amps φC	AI:31	
Max Demand Amps φA	AI:32	
Max Demand Amps φB	AI:33	0[1] = 0Amps; 32767 = 10.0[*] Amps
Max Demand Amps φC	AI:34	
Present Dem. Amps Neutral	AI:35	0[1] = 0Amps; 32767 = 15.0[*] Amps
Max Demand Amps Neutral	AI:36	0[1] = 0Amps; 32767 = 15.0[*] Amps
Present Demand Volts φA	AI:37	
Present Demand Volts φB	AI:38	0[1] = 0Volts; 32767 = 150.0Volts
Present Demand Volts φC	AI:39	
Max Demand Volts φA	AI:40	
Max Demand Volts φB	AI:41	0[1] = 0Volts; 32767 = 150.0Volts
Max Demand Volts φC	AI:42	
Min Demand Volts φA	AI:43	
Min Demand Volts φB	AI:44	0[1] = 0Volts; 32767 = 150.0Volts
Min Demand Volts φC	AI:45	
Present Dem. Watts Total	AI:46	+32767 = +4500[*] Watts
Max Demand Watts Total	AI:47	0[1] = 0Watts;
Min Demand Watts Total	AI:48	-32768 = -4500[*] Watts
Present Dem. VARs Total	AI:49	+32767 = +4500[*] VARs
Max Demand VARs Total	AI:50	0[1] = 0VARs
Min Demand VARs Total	AI:51	-32768 = -4500[*] VARs
Present Dem. VAs Total	AI:52	+32767 = +4500[*] VAs
Max Demand VAs Total	AI:53	0[1] = 0VAs
Min Demand VAs Total	AI:54	-32768 = -4500[*] VAs
Amp Demand RESET	BO:1	Read via obj 10-2, write via 12-1,
Volt Demand RESET	BO:2	see **Table 1**, section 3.5.2
Power/VA Demand RESET	BO:3	

AI indicates Analog-Input, **BO** Binary-Output

[*] - When CI1 Option (1Amp Input) is installed, divide this value by 5

[1] - IE models always return the value 0

3.4.3 RTH SUMMARY Data Registers for 2 ½ or 3 Element Models

Quantity	Object: Point	Representation
Fundamental Amps φA	AI:59	|
Fundamental Amps φB	AI:60	| 0 = 0Amps; 32767 = 10.0* Amps
Fundamental Amps φC	AI:61	|
Fundamental Amps Neutral	AI:62	0 = 0Amps; 32767 = 15.0* Amps
Fundamental Volts φA	AI:63	|
Fundamental Volts φB	AI:64	| 0 = 0Volts; 32767 = 150.0Volts
Fundamental Volts φC	AI:65	|
TDD[1] Amps φA	AI:66	|
TDD[1] Amps φB	AI:67	| 0 = 0.0%; 9999 = 999.9%
TDD[1] Amps φC	AI:68	| Set to 0 on low signal
TDD[1] Odd Amps φA	AI:69	|
TDD[1] Odd Amps φB	AI:70	| 0 = 0.0%; 9999 = 999.9%
TDD[1] Odd Amps φC	AI:71	| Set to 0 on low signal
TDD[1] Even Amps φA	AI:72	|
TDD[1] Even Amps φB	AI:73	| 0 = 0.0%; 9999 = 999.9%
TDD[1] Even Amps φC	AI:74	| Set to 0 on low signal
THD Volts φA	AI:75	|
THD Volts φB	AI:76	| 0 = 0.0%; 9999 = 999.9%
THD Volts φC	AI:77	| Set to 0 on low signal
THD Odd Volts φA	AI:78	|
THD Odd Volts φB	AI:79	| 0 = 0.0%; 9999 = 999.9%
THD Odd Volts φC	AI:80	| Set to 0 on low signal
THD Even Volts φA	AI:81	|
THD Even Volts φB	AI:82	| 0 = 0.0%; 9999 = 999.9%
THD Even Volts φC	AI:83	| Set to 0 on low signal
K-Factor Amps φA	AI:84	|
K-Factor Amps φB	AI:85	| 100 = 1.00; 32767 = 327.67
K-Factor Amps φC	AI:86	| Set to 100 on low signal

[1] If TDD Denominator is set to 0 (0Amps) the TDD calculation will use Fundamental Amps as the Denominator, which will result in all Current Distortions being expressed as THD.

* - When CI1 Option (1Amp Input) is installed, divide this value by 5

3.4.3 RTH SUMMARY Data Registers for 2 ½ or 3 Element Models (Cont'd)

Quantity	Object: Point	Representation
Displacement PF φA	AI:87	-1000 = -1.000; 0 = 0; 1000 = +1.000
Displacement PF φB	AI:88	1999 = Amps or Volts too low
Displacement PF φC	AI:89	(-) lagging; (+) leading
Displacement PF Total	AI:90	-1000 = -1.000; 0 = 0; 1000 = +1.000 1999 = Amps or Volts too low (-) lagging; (+) leading
Present Demand Fund. Amps N	AI:91	0 = 0Amps; 32767 = 15.0* Amps
Max Demand Fund. Amps N	AI:92	0 = 0Amps; 32767 = 15.0* Amps
Present Demand TDD[1] Amps φA	AI:93	
Present Demand TDD[1] Amps φB	AI:94	0 = 0.0%; 9999 = 999.9%
Present Demand TDD[1] Amps φC	AI:95	
Max Demand TDD[1] Amps φA	AI:96	
Max Demand TDD[1] Amps φB	AI:97	0 = 0.0%; 9999 = 999.9%
Max Demand TDD[1] Amps φC	AI:98	
Present Demand THD Volts φA	AI:99	
Present Demand THD Volts φB	AI:100	0 = 0.0%; 9999 = 999.9%
Present Demand THD Volts φC	AI:101	
Max Demand THD Volts φA	AI:102	
Max Demand THD Volts φB	AI:103	0 = 0.0%; 9999 = 999.9%
Max Demand THD Volts φC	AI:104	
Amp Demand RESET	BO:1	
Volt Demand RESET	BO:2	Read via obj 10-2, write via 12-1,
Power/VA Demand RESET	BO:3	see **Table 1**, section 3.5.2
Harmonic Demand RESET	BO:4	
TDD Denominator Amps φA	AO:7	Read/Write 0[1] = 0Amps; 32,767 =
TDD Denominator Amps φB	AO:8	10.0* Amps Secondary. If reg = 0,
TDD Denominator Amps φC	AO:9	then Fund Amps will be used (THD)
		Factory Default = 5* Amps Secondary

AI indicates Analog-Input point, **CT** Counter point, **BO** Binary-Output, and **AO** Analog-Output

[1] If TDD Denominator is set to 0 (0Amps) the TDD calculation will use Fundamental Amps as the Denominator, which will result in all Current Distortions being expressed as THD. IE models always return the value 0.

* - When CI1 Option (1Amp Input) is installed, divide this value by 5

3.4.4 RTH INDIVIDUAL Data Registers for 2 ½ or 3 Element Models

Quantity	Object: Point	Representation
φA Amps Distortion Denominator	AI:105	0 = 0Amps; 32767 = 10.0[*] Amps =AO:7 if TDD, =AI:59 if THD
φA Amps Demand Distortion[1] - I_1	AI:106	
φA Amps Demand Distortion[1] - I_2	AI:107	
:	:	0 = 0.0%; 9999 = 999.9%
:	:	Set to 0 on low signal
φA Amps Demand Distortion[1] - I_{30}	AI:135	
φA Amps Demand Distortion[1] - I_{31}	AI:136	
φB Amps Distortion Denominator	AI:137	0 = 0Amps; 32767 = 10.0[*] Amps =AO:7 if TDD, =AI:60 if THD
φB Amps Demand Distortion[1] - I_1	AI:138	
φB Amps Demand Distortion[1] - I_2	AI:139	
:	:	0 = 0.0%; 9999 = 999.9%
:	:	Set to 0 on low signal
φB Amps Demand Distortion[1] - I_{30}	AI:167	
φB Amps Demand Distortion[1] - I_{31}	AI:168	
φC Amps Distortion Denominator	AI:169	0 = 0Amps; 32767 = 10.0[*] Amps =AO:7 if TDD, =AI:61 if THD
φC Amps Demand Distortion[1] - I_1	AI:170	
φC Amps Demand Distortion[1] - I_2	AI:171	
:	:	0 = 0.0%; 9999 = 999.9%
:	:	Set to 0 on low signal
φC Amps Demand Distortion[1] - I_{30}	AI:199	
φC Amps Demand Distortion[1] - I_{31}	AI:200	

[1] If TDD Denominator is set to 0 (0Amps) the TDD calculation will use Fundamental Amps as the Denominator, which will result in all Current Distortions being expressed as THD.

[*] - When CI1 Option (1Amp Input) is installed, divide this value by 5

3.4.4 RTH INDIVIDUAL Data Registers for 2 ½ or 3 Element Models (Cont'd)

Quantity	Object: Point	Representation
φA Volts Distortion Denominator	AI:201	| 0 = 0Volts; 32767 = 150.0Volts | =AI:63
φA Volts Harm. Distortion - V_1	AI:202|	
φA Volts Harm. Distortion - V_2	AI:203|	
:	:	| 0 = 0.0%; 9999 = 999.9%
:	:	| Set to 0 on low signal
φA Volts Harm. Distortion - V_{30}	AI:231|	
φA Volts Harm. Distortion - V_{31}	AI:232|	
φB Volts Distortion Denominator	AI:233	| 0 = 0Volts; 32767 = 150.0Volts | =AI:64
φB Volts Harm. Distortion - V_1	AI:234|	
φB Volts Harm. Distortion - V_2	AI:235|	
:	:	| 0 = 0.0%; 9999 = 999.9%
:	:	| Set to 0 on low signal
φB Volts Harm. Distortion - V_{30}	AI:263|	
φB Volts Harm. Distortion - V_{31}	AI:264|	
φC Volts Distortion Denominator	AI:265	| 0 = 0Volts; 32767 = 150.0Volts | =AI:65
φC Volts Harm. Distortion - V_1	AI:266|	
φC Volts Harm. Distortion - V_2	AI:267|	
:	:	| 0 = 0.0%; 9999 = 999.9%
:	:	| Set to 0 on low signal
φC Volts Harm. Distortion - V_{30}	AI:295|	
φC Volts Harm. Distortion - V_{31}	AI:296|	

AI indicates Analog-Input point, **CT** Counter point, **BO** Binary-Output, and **AO** Analog-Output

3.4.5 INSTANTANEOUS Data Registers for 2 Element Models

Quantity	Object: Point	Representation
Health Check	AI:0	Refer to Section 3.7
Amperes Phase A	AI:1	
Amperes Phase B	AI:2	0 = 0Amps; 32767 = 10.0* Amps
Amperes Phase C	AI:3	
Volts Phase A-B	AI:4	
Volts Phase B-C	AI:5	0 = 0Volts; 32767 = 150.0Volts
Volts Phase C-A	AI:6	
Watts Total 3 Phase	AI:7	-32768 = -3000* Watts; 0 = 0Watts; +32767 = +3000* Watts
VARs Total 3 Phase	AI:8	-32768 = -3000* VARS; 0 = 0VARS; +32767 = +3000* VARs
Unused	AI:9	
Unused	AI:10	Always 0
Unused	AI:11	
Unused	AI:12	
Unused	AI:13	Always 0
Unused	AI:14	
CT Value	AI:15	Actual CT or PT ratio is: Value / Divisor
CT Divisor	AI:16	For example the CT ratio 5:5 has the
PT Value	AI:17	Value=5000 and Divisor=1000.
PT Divisor	AI:18	Ratios are expressed CT:5 (CT:1 for units with CI1 option), and PT:1
Unused	AI:19	Always 0
Frequency	AI:20	0 = <45.00Hz; 4500 = 45.00Hz 7500 = 75.00Hz; 9999 = >75.00Hz
Unused	AI:21	
Unused	AI:22	Always 0
Unused	AI:23	
VAs Total	AI:24	0 = 0VAs; +32767 = +3000* VAs

* - When CI1 Option (1Amp Input) is installed, divide this value by 5

3.4.5 INSTANTANEOUS Data Registers for 2 Element Models (Cont'd)

Quantity	Object: Point	Representation
Unused	AI:25	Always 0
Unused	AI:26	Always 0
Unused	AI:27	Always 0
Power Factor Total	AI:28	-1000 = -1.000 (lag); 0 = 0; +1000 = +1.000 (lead); +1999 = Signal too low
Meter Type Identifier	AI:55	See **Table 4**
Communications Firmware Revision	AI:56	Packed BCD XX.XX
Host Firmware Rev.	AI:57	Packed BCD XX.XX
Host Micro Firmware Rev.	AI:58	Packed BCD XX.XX
+ kWatthour	CT:0	0 = 0kWh; 99999999 = 99,999,999 kWh
- kWatthour	CT:1	0 = 0kWh; 99999999 = -99,999,999 kWh
+ kVARhour	CT:2	0 = 0kVARh;99999999 = 99,999,999 kVARh
- kVARhour	CT:3	0 = 0kVARh; 99999999= -99,999,999 kVARh
Heartbeat State Counter	CT:4	See Section 3.9
Energy RESET	BO:0	Read via obj 10-2, write via 12-1, see **Table 1**, section 3.5.2
CT Value	AO:0	These are the writable versions of the Analog input points A:15 through A:18. They are read via object 40-2 and written via object 41-2. Reads return same values as the Analog Inputs.
CT Divisor	AO:1	
PT Value	AO:2	
PT Divisor	AO:3	
Configuration Setup Reg 1	AO:4	Read/Write - See **Table 3**, section 3.5.5
Configuration Setup Reg 2	AO:5	Always returns 0 - Future expansion
User Writeable Tag Reg	AO:6	Read/Write - 0 to 32,767
TDD Denominators	AO:7-9	Read/Write, MTWIEx always returns 0
Display Screen Setup Reg 1	AO:10	Read/Write - See **Table 2**, section 3.5.4
Display Screen Setup Reg 2	AO:11	
Display Screen Setup Reg 3	AO:12	
Display Screen Setup Reg 4	AO:13	
Display Screen Setup Reg 5	AO:14	

AI indicates Analog-Input point, **CT** Counter point, **BO** Binary-Output, and **AO** Analog-Output

3.4.6 DEMAND Data Registers for 2 Element Models

Quantity	Object: Point	Representation
Present Demand Amps φA	AI:29	0^1 = 0Amps; 32767 = 10.0* Amps
Present Demand Amps φB	AI:30	
Present Demand Amps φC	AI:31	
Max Demand Amps φA	AI:32	0^1 = 0Amps; 32767 = 10.0* Amps
Max Demand Amps φB	AI:33	
Max Demand Amps φC	AI:34	
Unused	AI:35	Always 0
Unused	AI:36	Always 0
Present Dem. Volts φA-B	AI:37	0^1 = 0Volts; 32767 = 150.0Volts
Present Dem. Volts φB-C	AI:38	
Present Dem. Volts φC-A	AI:39	
Max Demand Volts φA-B	AI:40	0^1 = 0Volts; 32767 = 150.0Volts
Max Demand Volts φB-C	AI:41	
Max Demand Volts φC-A	AI:42	
Min Demand Volts φA-B	AI:43	0^1 = 0Volts; 32767 = 150.0Volts
Min Demand Volts φB-C	AI:44	
Min Demand Volts φC-A	AI:45	
Present Dem. Watts Total	AI:46	+32767 = +3000* Watts
Max Demand Watts Total	AI:47	0^1 = 0Watts;
Min Demand Watts Total	AI:48	-32768 = -3000* Watts
Present Dem. VARs Total	AI:49	+32767 = +3000* VARs
Max Demand VARs Total	AI:50	0^1 = 0VARs
Min Demand VARs Total	AI:51	-32768 = -3000* VARs
Present Demand VAs Total	AI:52	+32767 = +3000* VAs
Max Demand VAs Total	AI:53	0^1 = 0VAs
Min Demand VAs Total	AI:54	-32768 = -3000* VAs
Amp Demand RESET	BO:1	Read via obj 10-2, write via 12-1, see **Table 1**, section 3.5.2
Volt Demand RESET	BO:2	
Power/VA Demand RESET	BO:3	

AI indicates Analog-Input point, **BO** Binary-Output

* - When CI1 Option (1Amp Input) is installed, divide this value by 5

[1] - MTWINx models always return the value 0

3.4.7 RTH SUMMARY Data Registers for 2 Element Models

Quantity	Object: Point	Representation
Fundamental Amps φA	AI:59	|
Fundamental Amps φB	AI:60	| 0 = 0Amps; 32767 = 10.0* Amps
Fundamental Amps φC	AI:61	|
Unused	AI:62	Always 0
Fundamental Volts φA-B	AI:63	|
Fundamental Volts φB-C	AI:64	| 0 = 0Volts; 32767 = 150.0Volts
Fundamental Volts φC-A	AI:65	|
TDD[1] Amps φA	AI:66	|
TDD[1] Amps φB	AI:67	| 0 = 0.0%; 9999 = 999.9%
TDD[1] Amps φC	AI:68	| Set to 0 on low signal
TDD[1] Odd Amps φA	AI:69	|
TDD[1] Odd Amps φB	AI:70	| 0 = 0.0%; 9999 = 999.9%
TDD[1] Odd Amps φC	AI:71	| Set to 0 on low signal
TDD[1] Even Amps φA	AI:72	|
TDD[1] Even Amps φB	AI:73	| 0 = 0.0%; 9999 = 999.9%
TDD[1] Even Amps φC	AI:74	| Set to 0 on low signal
THD Volts φA-B	AI:75	|
THD Volts φB-C	AI:76	| 0 = 0.0%; 9999 = 999.9%
THD Volts φC-A	AI:77	| Set to 0 on low signal
THD Odd Volts φA-B	AI:78	|
THD Odd Volts φB-C	AI:79	| 0 = 0.0%; 9999 = 999.9%
THD Odd Volts φC-A	AI:80	| Set to 0 on low signal
THD Even Volts φA-B	AI:81	|
THD Even Volts φB-C	AI:82	| 0 = 0.0%; 9999 = 999.9%
THD Even Volts φC-A	AI:83	| Set to 0 on low signal
K-Factor Amps φA	AI:84	|
K-Factor Amps φB	AI:85	| 100 = 1.00; 32767 = 327.67
K-Factor Amps φC	AI:86	| Set to 100 on low signal

[1] If TDD Denominator is set to 0 (0Amps) the TDD calculation will use Fundamental Amps as the Denominator, which will result in all Current Distortions being expressed as THD.

* - When CI1 Option (1Amp Input) is installed, divide this value by 5

3.4.7 RTH SUMMARY Data Registers for 2 Element Models (Cont'd)

Quantity	Object: Point	Representation
Unused	AI:87	Always 0
Unused	AI:88	Always 0
Unused	AI:89	Always 0
Displacement PF Total	AI:90	-1000 = -1.000; 0 = 0; 1000 = 1.000 1999 = Amps or Volts too low (-) lagging; (+) leading
Unused	AI:91	Always 0
Unused	AI:92	Always 0
Present Demand TDD[1] Amps φA	AI:93	0 = 0.0%; 9999 = 999.9%
Present Demand TDD[1] Amps φB	AI:94	0 = 0.0%; 9999 = 999.9%
Present Demand TDD[1] Amps φC	AI:95	0 = 0.0%; 9999 = 999.9%
Max Demand TDD[1] Amps φA	AI:96	0 = 0.0%; 9999 = 999.9%
Max Demand TDD[1] Amps φB	AI:97	0 = 0.0%; 9999 = 999.9%
Max Demand TDD[1] Amps φC	AI:98	0 = 0.0%; 9999 = 999.9%
Present Demand THD Volts φA-B	AI:99	0 = 0.0%; 9999 = 999.9%
Present Demand THD Volts φB-C	AI:100	0 = 0.0%; 9999 = 999.9%
Present Demand THD Volts φC-A	AI:101	0 = 0.0%; 9999 = 999.9%
Max Demand THD Volts φA-B	AI:102	0 = 0.0%; 9999 = 999.9%
Max Demand THD Volts φB-C	AI:103	0 = 0.0%; 9999 = 999.9%
Max Demand THD Volts φC-A	AI:104	0 = 0.0%; 9999 = 999.9%
Amp Demand RESET	BO:1	Read via obj 10-2, write via 12-1, see **Table 1**, section 3.5.2.
Volt Demand RESET	BO:2	Read via obj 10-2, write via 12-1, see **Table 1**, section 3.5.2.
Power/VA Demand RESET	BO:3	Read via obj 10-2, write via 12-1, see **Table 1**, section 3.5.2.
Harmonic Demand RESET	BO:4	Read via obj 10-2, write via 12-1, see **Table 1**, section 3.5.2.
TDD Denominator Amps φA	AO:7	Read/Write 0[1] = 0Amps; 32,767 = 10.0* Amps Secondary. If reg = 0, then Fund Amps will be used (THD) Factory Default = 5* Amps Secondary
TDD Denominator Amps φB	AO:8	Read/Write 0[1] = 0Amps; 32,767 = 10.0* Amps Secondary. If reg = 0, then Fund Amps will be used (THD) Factory Default = 5* Amps Secondary
TDD Denominator Amps φC	AO:9	Read/Write 0[1] = 0Amps; 32,767 = 10.0* Amps Secondary. If reg = 0, then Fund Amps will be used (THD) Factory Default = 5* Amps Secondary

AI indicates Analog-Input point, **CT** Counter point, **BO** Binary-Output, and **AO** Analog-Output

[1] If TDD Denominator is set to 0 (0Amps) the TDD calculation will use Fundamental Amps as the Denominator, which will result in all Current Distortions being expressed as THD. IE models always return the value 0.

* - When CI1 Option (1Amp Input) is installed, divide this value by 5

3.4.8 RTH INDIVIDUAL Data Registers for 2 Element Models

Quantity	Object: Point	Representation
φA Amps Distortion Denominator	AI:105	0 = 0Amps; 32767 = 10.0* Amps
		=AO:7 if TDD, =AI:59 if THD
φA Amps Demand Distortion[1] - I_1	AI:106	
φA Amps Demand Distortion[1] - I_2	AI:107	
:	:	0 = 0.0%; 9999 = 999.9%
:	:	Set to 0 on low signal
φA Amps Demand Distortion[1] - I_{30}	AI:135	
φA Amps Demand Distortion[1] - I_{31}	AI:136	
φB Amps Distortion Denominator	AI:137	0 = 0Amps; 32767 = 10.0* Amps
		=AO:7 if TDD, =AI:60 if THD
φB Amps Demand Distortion[1] - I_1	AI:138	
φB Amps Demand Distortion[1] - I_2	AI:139	
:	:	0 = 0.0%; 9999 = 999.9%
:	:	Set to 0 on low signal
φB Amps Demand Distortion[1] - I_{30}	AI:167	
φB Amps Demand Distortion[1] - I_{31}	AI:168	
φC Amps Distortion Denominator	AI:169	0 = 0Amps; 32767 = 10.0* Amps
		=AO:7 if TDD, =AI:61 if THD
φC Amps Demand Distortion[1] - I_1	AI:170	
φC Amps Demand Distortion[1] - I_2	AI:171	
:	:	0 = 0.0%; 9999 = 999.9%
:	:	Set to 0 on low signal
φC Amps Demand Distortion[1] - I_{30}	AI:199	
φC Amps Demand Distortion[1] - I_{31}	AI:200	

[1] If TDD Denominator is set to 0 (0Amps) the TDD calculation will use Fundamental Amps as the Denominator, which will result in all Current Distortions being expressed as THD.

* - When CI1 Option (1Amp Input) is installed, divide this value by 5

3.4.8 RTH INDIVIDUAL Data Registers for 2 Element Models (Cont'd)

Quantity	Object: Point	Representation
φA-B Volts Distortion Denominator	AI:201	0 = 0Volts; 32767 = 150.0Volts =AI:63
φA-B Volts Harm. Distortion - V_1	AI:202	0 = 0.0%; 9999 = 999.9% Set to 0 on low signal
φA-B Volts Harm. Distortion - V_2	AI:203	
:	:	
:	:	
φA-B Volts Harm. Distortion - V_{30}	AI:231	
φA-B Volts Harm. Distortion - V_{31}	AI:232	
φB-C Volts Distortion Denominator	AI:233	0 = 0Volts; 32767 = 150.0Volts =AI:64
φB-C Volts Harm. Distortion - V_1	AI:234	0 = 0.0%; 9999 = 999.9% Set to 0 on low signal
φB-C Volts Harm. Distortion - V_2	AI:235	
:	:	
:	:	
φB-C Volts Harm. Distortion - V_{30}	AI:263	
φB-C Volts Harm. Distortion - V_{31}	AI:264	
φC-A Volts Distortion Denominator	AI:265	0 = 0Volts; 32767 = 150.0Volts =AI:65
φC-A Volts Harm. Distortion - V_1	AI:266	0 = 0.0%; 9999 = 999.9% Set to 0 on low signal
φC-A Volts Harm. Distortion - V_2	AI:267	
:	:	
:	:	
φC-A Volts Harm. Distortion - V_{30}	AI:295	
φC-A Volts Harm. Distortion - V_{31}	AI:296	

AI indicates Analog-Input point, **CT** Counter point, **BO** Binary-Output, and **AO** Analog-Output

3.5 Configuration

3.5.1 Setting CT and PT Ratios

The MultiComm meter is capable of internally storing and recalling CT and PT ratios. The only output quantities that are scaled by these ratios are the Energy counters, points CT:0 through CT:3 (Refer to Section 3.4 for point assignments). The CT and PT ratios are written to Analog Output Points AO:0 through AO:3 through the DNP communication port, and are stored in non-volatile memory on the CT/PT Board. Each ratio is stored in two Analog Output Points, one for the normalized format ratio, and the other for the divisor. Allowable values for CT ratios are 500 to 9999, and 1000 to 9999 for PT ratios. The divisors may be 1, 10, 100, or 1000 only. The number stored will be the high side rating of the CT. A 500:5 ratio CT will have a value of 500 stored, while a 100:1 CT will have a value of 100 stored. For example, to calculate a CT ratio from the data stored in the MultiComm meter, use the following equation:

$$CT_{RATIO} = \frac{CT\ Value\,(AI:15)}{CT\ Divisor\,(AI:16)\ x\ CT\ Secondary}$$

$$PT_{RATIO} = \frac{PT\ Value\,(AI:17)}{PT\ Divisor\,(AI:18)}$$

CT/PT RATIO EQUATIONS:
The CT and PT ratios values may be used with the equations in Section 3.6 to derive primary unit quantities from the MultiComm. For example, the equation for amperes becomes:

$$AMPEREs = \frac{Value}{32768}\ x\ Full\ Scale\ Value\ x\ CT\ Ratio$$

The values stored in points AO:0 through AO:3 are duplicated in Analog Input Points AI:15 through AI:18 respectively. Points AI:15 through AI:18 are READ ONLY and cannot be written to. Some RTUs (such as the GE-Harris D20) require that the AO status point be reported in the Class 0 poll in order to write to it. In Bitronics RT/RTH instruments, AO:0 to AO:3 are normally deactivated in the Class 0 poll response. It may therefore be necessary to reconfigure the instrument if one wishes to set the CT or PT ratios over the network. Refer to Section 3.5.5 of this manual, and the documentation of your particular RTU for details. In the event of a CT/PT Ratio Checksum Failure, the value in the CT Ratio and PT Ratio registers default to 65535 (FFFF Hex), and the value in the CT Ratio Divisor and PT Ratio Divisor default to 0001. See Section 3.7 for more details.

WARNING - THE RATIO NON-VOLATILE MEMORY STORAGE HAS A 1,000,000 CYCLE ENDURANCE (RATIOS CAN BE CHANGED 1,000,000 TIMES). ONLY WRITE TO RATIO REGISTERS WHEN THE RATIOS NEED TO BE CHANGED.

3.5.2 Resetting Energy and Demands

The Energy values can be RESET to ZERO by issuing the DIRECT-OPERATE (or DIRECT- OPERATE-NO-ACKNOWLEDGE) using the CONTROL-RELAY-OUTPUT-BLOCK object to point 0. The request must use the parameters to PULSE-ON for ON 1 millisecond and OFF 0 milliseconds. The Registers will be reset within 0.6 seconds, however it takes the meter 6 seconds to clear the energy data stored in the EEPROM. The USER must ensure that the power is not interrupted to the meter for this 6 second period after this command is issued.

The Demand values can be RESET by issuing the same DIRECT-OPERATE (or DIRECT-OPERATE-NO ACKNOWLEDGE) command to other points of this object. Point 1, point 2, point 3 and point 4 are used to RESET the Amp Demands, Volt Demands, Power Demands and Harmonic Demands (respectively). The Demand Registers will be RESET within 0.6 seconds, however it takes the meter up to 10 seconds to reset t he demand data stored in EEPROM. The USER must ensure that the power is not interrupted to the meter for this 10 second period after this command is issued. Refer to Table 1 and Appendix E for more information.

Binary Output Index	Description	Objects Affected
BO:0	Reset (ZERO) Energy	Counters CT:0,1,2,3
BO:1	Reset AMP Demands	Analog Inputs AI:29-36, AI:91,92
BO:2	Reset Volt Demands	Analog Inputs AI:37-45
BO:3	Reset Power Demands	Analog Inputs AI:46-54
BO:4	Reset Harmonic Demands	Analog Inputs AI:93-104

3.5.3 TDD Writeable Denominators

The MultiComm instrument is capable of internally storing and recalling Current Values that are used as Denominators in determining the Total Demand Distortion (TDD) (Refer to Section 3.4 for point assignments). The denominator values are stored for each phase, and are written through the DNP communication port to Analog Output Points AO:7 through AO:9 which correspond to Phase A, Phase B, and Phase C respectively. These denominators affect all Current Harmonic Measurements (Refer to Section 3.4 for register assignments). The Denominators are stored in non-volatile memory on the Analog Board. The value that needs to be stored follows the same equation that is used with the other measurements. For a 5A secondary CT, the equation for amperes becomes:

$$AMPEREs = \frac{Value}{32768} \; x \; 10 \; x \; \frac{CT\ Value}{CT\ \ Ratio\ Divisor\ x\ 5}$$

where Value is the Binary Value that should be stored in the denominator register, and

Amperes is the actual value of primary current that the user intends for the TDD calculations. The factory default value is 16384 that corresponds to 5 Amps Secondary (1 Amp for CI1 option). If the value stored in the denominator register are set to Zero amps (Value = 0), then the Harmonic Distortion calculations will use the Fundamental Magnitude of the current, which will result in the Distortion Values to be in the form of THD instead of TDD. The values stored in registers AO:7, AO:8 and AO:9 are duplicated in registers AI:105, AI:137 and AI:169 respectively if the value are non-zero (TDD). If registers AO:7,AO:8 and /or AO:9 are set to zero (THD) then the registers AI:105, AI:137 and AI:169 will contain the Magnitude of the Fundamental.

WARNING - THE DENOMINATOR NON-VOLATILE MEMORY STORAGE HAS A 1,000,000 CYCLE ENDURANCE (DENOMINATORS CAN BE CHANGED 1,000,000 TIMES). ONLY WRITE TO THE DENOMINATOR REGISTERS WHEN THE DENOMINATORS NEED TO BE CHANGED.

3.5.4 Display Configuration Registers

In addition to configuring the display using the internal switches, MultiComm "B" instruments allow the user to configure the front panel display via the network port. This is accomplished utilizing five Display Configuration Registers, which are shown in Table 2. These registers are 16 bits wide, and are programmed in a binary fashion. The lower 8 bits of the first register (Analog Output AO:10) contain status information. Bit 7 (D) is set (bit = 1) if the display has not been configured. If this bit is set, the display will be configured to the factory default setting, which is to show all available screens, and front panel resets enabled. Scrolling of the display screens is controlled by AO:10 bit 6 (S). If this bit is set (bit=1), then the display is in the scrolling mode. The lower 6 bits of AO:10 are the present screen number if the display has been stopped (scrolling off). If the display is scrolling, then these 6 bits will be zero. The remaining bits of AO:10, bits 8 through 15, are screen enable bits, with each bit corresponding to a specific screen number. Setting the appropriate bit (bit=1) enables the in screen indicated in the table. Descriptions of the actual screen number indicated in Table 3 are presented in the appropriate MultiComm Instrument Manual. Bit 8 (screen 0) is the "Front Panel Reset Enable" screen, which does not get displayed, but when enabled allows the user to reset Demand Values from the front panel push button. Analog Outputs AO:11 through AO:14 contain the rest of the screen enables as indicated in Table 3. The upper 8 bits of register AO:14 are not used. The table also lists the decimal value of each bit position, as an aid in determining the decimal value to place in each register. For example, if a user wanted to enable screens 8, 9, 10 and 20, the user would write the value 4103 decimal (1 + 2 + 4 + 4096 = 4103) to AO:11. This is equivalent to writing 0001 0000 0000 0111 Binary or 1007 Hexadecimal to AO:11. The Display Configuration is stored in non-volatile memory (EEPROM) and it will be correct after a power outage.

WARNING - THE DISPLAY CONFIGURATION NON-VOLATILE MEMORY STORAGE HAS A 1,000,000 CYCLE ENDURANCE (DISPLAY CONFIG-URATION CAN BE CHANGED 1,000,000 TIMES). ONLY WRITE TO THE DISPLAY CONFIGURATION REGISTERS WHEN THE CONFIGURATION NEEDS TO BE CHANGED.

Bit Position																
	15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Decimal Value **Analog Output**	32768	16384	8192	4096	2048	1024	512	256	128	64	32	16	8	4	2	1
AO:10	7	6	5	4	3	2	1	0	D	S	Screen Number if Stopped, Else 0					
AO:11	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8
AO:12	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24
AO:13	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40
AO:14	Unused								63	62	61	60	59	58	57	56

3.5.5 Communication Configuration Registers

MultiComm “B” instruments provide READ/WRITE Configuration Registers that allow the user to configure various parameters within the instrument. These Configuration Registers are currently defined as shown in Table 3. Bits AO:4.0-9 allow the user to configure the “Class 0" response, **these bits only affect the Class 0 poll**, all other DNP requests will return all objects.. Setting a particular bit causes the indicated objects to be sent during a Class 0 poll. Further details can be found in Appendix E. The factory default configuration for RTH instruments (MTWDExxx) is 07h, and for RT instruments (MTWIExxx) it is 03h. This configuration setting causes the “B” MultiComm instrument to return the same objects as the previous “Alpha Series” MultiComm instruments, with two exceptions. The difference is in AO:0-3, the RT/RTH has these outputs turned off, and AO:4-6 are sent back instead. AO:4&5 must be sent back to allow certain RTUs to alter the configuration registers. Since this would have caused an increase in the polling time over the “Alpha Series”, the CT/PT AO:0-3 were turned off. The positive effect of this change is that the poll time is actually faster than the equivalent “Alpha Series”. A down side is that with certain RTUs (such as the GE-Harris D20), the CT/PT ratios cannot be written by the RTU until AO:0-3 are turned back on by setting configuration bit AO:4.3 to a one. This will only be necessary if the user is trying to alter the CT or PT ratio via the RTU. This is only a problem with certain RTUs, and the user should consult their RTU manual for specifics. If the configuration AO:4 and AO:5 are set to 00, the instrument will still return AI:0-20, AO:4-6 and BO:0-4. Setting AO:4.14 causes Data Link Confirms to be sent. The Configuration registers are stored in non-volatile memory (EEPROM).

WARNING - THE COMMUNICATION CONFIGURATION NON-VOLATILE MEMORY STORAGE HAS A 1,000,000 CYCLE ENDURANCE (CONFIG CAN BE CHANGED 1,000,000 TIMES). ONLY WRITE TO THE COMMUNICATION

CONFIGURATION REGISTERS WHEN THE CONFIGURATION NEEDS TO BE CHANGED.

Configuration Bit	Description		Objects	Bytes
AO:4.0	Energy & Heartbeat (Counter Objects)	CLASS 0 RESPONSE CONFIGURATION	CT:0,1,2,3,4	25
AO:4.1	Instantaneous VA & PF		AI:21 - AI:28	16
AO:4.2	RMS Demands		AI:29 - AI:54	52
AO:4.3	Maintenance Information		AI:55 - AI:58 AO:0-3, 10 - 14	35
AO:4.4	Instantaneous Total Distortions		AI:59 - AI:90 AO:7-9	64
AO:4.5	Distortion Demands		AI:91 - AI:104 AO:7-9	28
AO:4.6	Current Individual Harmonics 1 thru 15		AI:105 - AI:120 AI:137 - AI:152 AI:169 - AI:184 AO:7-9	96
AO:4.7	Current Individual Harmonics 16 thru 31		AI:121 - AI:136 AI:153 - AI:168 AI:185 - AI:200 AO:7-9	96
AO:4.8	Voltage Individual Harmonics 1 thru 15		AI:201 - AI:216 AI:233 - AI:248 AI:265 - AI:280 AO:7-9	96
AO:4.9	Voltage Individual Harmonics 16 thru 31		AI:217 - AI:232 AI:249 - AI:264 AI:281 - AI:296 AO:7-9	96
AO:4.10	Spare			N/A
AO:4.11	Spare			N/A
AO:4.12	Spare			N/A
AO:4.13	Spare			N/A
AO:4.14	Send with Data Link Confirms			N/A
AO:4.15	Sign Bit (Not Used)			N/A
AO:5.0-15	Spare			N/A

3.5.6 Tag Register

MultiComm “B” instruments provide a “TAG” register for user identification purposes (AO:6). This register is READ/WRITE register that allows the user to write a number from 1 to 32,767 in the tag register. The Instrument will write this value in non-volatile memory EEPROM, so that the value will be available after any power outage. Any attempts to write values above 32,767 will return an illegal value error. Units will be set to 0 from the factory.

WARNING - THE TAG REGISTER NON-VOLATILE MEMORY STORAGE HAS A 1,000,000 CYCLE ENDURANCE (THE TAG REGISTER CAN BE CHANGED 1,000,000 TIMES). ONLY WRITE TO THE TAG REGISTER WHEN THE TAG NEEDS TO BE CHANGED.

3.5.7 Meter ID Register

MultiComm “B” instruments provide an “ID” register for model identification purposes (AI:55). This register is preprogrammed at the factory, refer to table 4.

Model	ID	Model	ID
MTWIE1B	201	MTWDE1B	301
MTWIE2B	202	MTWDE2B	302
MTWIE3B	203	MTWDE3B	303
MTWIE4B	204	MTWDE4B	304
MTWIE5B	205	MTWDE5B	305
MTWIE6B	206	MTWDE6B	306
MTWIEC1B - VI3	207	MTWDEC1B - VI3	307
MTWIEC2B - VI2	208	MTWDEC2B - VI2	308
MTWIEC2B - VI4	209	MTWDEC2B - VI4	309
MTWIEC4B - VI3	210	MTWDEC4B - VI3	310
MTWIEC5B - VI2	211	MTWDEC5B - VI2	311
MTWIEC5B - VI4	212	MTWDEC5B - VI4	312

3.6 Converting Data to Engineering Units

As was mentioned in the previous section, 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 ANALOG INPUTS:

$$Engineering\ Units = \frac{Value}{32768}\ x\ Full\ Scale_{SECONDARY}\ x\ Ratio$$

The CT and PT ratios are the **NAMEPLATE** ratings of the instrument transformers. The PT ratio in these equations is the same as the PT ratio stored in the instrument since convention is to specify the PT ratio as a ratio to 1. For 5Amp CTs, the CT ratio in these equations is not the same as the ratio stored in the meter, but rather the number stored in the meter divided by 5. This is due to the fact that 5Amp CT ratios are normally specified as a ratio to 5. For 1Amp Cts, the CT ratio is the same as that stored in the instrument. Refer to Section 3.5.1 for more information on the CT/PT Ratios. For example a 500:5 CT and a 4:1 PT would have the following ratios:

$$CT_{RATIO} = 500:5 = \frac{500}{5} = 100 \qquad PT_{RATIO} = 4:1 = \frac{4}{1} = 4$$

The **Value** referred to in the equations would be the value stored in the register 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 ANALOG-INPUT point 1.

The **ENERGY Registers** are 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.

THD and **TDD** are stored as a single binary value that is the actual THD or TDD times 10.

K FACTOR is stored as a single binary value that is the actual K Factor times 100.

3 and 2 ½ ELEMENT EQUATIONS:

$$AMPEREs_{(Inst,Fund,Demand,\mathrm{Max})} = \frac{Value}{32768} \; x \; 10^{*} \; x \; CT_{RATIO}$$

$$AMPEREs_{N\,(Inst,Fund,Demand,\mathrm{Max})} = \frac{Value}{32768} \; x \; 15^{*} \; x \; CT_{RATIO}$$

$$VOLTs_{L\text{-}N\,(Inst,Fund,Demand,\mathrm{Min},\mathrm{Max})} = \frac{Value}{32768} \; x \; 150 \; x \; PT_{RATIO}$$

$$VOLTs_{L\text{-}L\,(Inst,Demand,\mathrm{Min},\mathrm{Max})}(SCALED) = \frac{Value}{32768} \; x \; 150 \; x \; PT_{RATIO} \; x \; \sqrt{3}$$

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

$$WATTs\,(VARs)(VAs\,)_{PER\ PHASE\,(Inst)} = \frac{Value}{32768} \; x \; 1500^{*} \; x \; PT_{RATIO} \; x \; CT_{RATIO}$$

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

$$POWER\ FACTOR_{(True,Displacement)} = \frac{Value}{1000} \; (\,-\,Lag, +\,Lead)$$

$$kWh\,(kVARh) = Value$$

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

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

$$*\ For\ CI1\ Option,\ divide\ this\ value\ by\ 5$$

2 ELEMENT EQUATIONS:

$$AMPEREs_{(Inst, Fund, Demand, \max)} = \frac{Value}{32768} \, x \, 10^{*} \, x \, CT_{RATIO}$$

$$VOLTs_{L\text{-}L\,(Inst, Demand, \min, \max)} = \frac{Value}{32768} \, x \, 150 \, x \, PT_{RATIO}$$

$$WATTs\,(VARs)\,(VAs)_{TOTAL\,(Inst, Demand, \min, \max)} = \frac{Value}{32768} \, x \, 3000^{*} \, x \, PT_{RATIO} \, x \, CT_{RATIO}$$

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

$$POWER\ FACTOR_{(True, Displacement)} = \frac{Value}{1000} (-Lag, +Lead)$$

$$kWh\,(kVARh) = Value$$

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

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

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

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.

3.7 Health Check

The health check word is used to indicate possible problems with any data value. A health check value of zero indicates proper operation. Non-zero values indicate errors in either the instrument or values being measured. The following information is contained in the Health Check value (bit 0 is the low order bit and the description indicates the meaning when the bit is set). **The Health Check Value should always be read and checked before interpreting data, since some failure modes will cause erroneous data to be presented.** Please consult Table I in the MultiComm Users Manual for a full description of the failures. Some of these bits are also reflected in the flags of ANALOG-INPUT points. Refer to Appendix C for more information.

BIT Code	DESCRIPTION	Self Test Fault	Display
0	CT/PT Ratio Checksum Failure [1]	2	---1
1	CT/PT Board Calibration Checksum Failure [2]	3	---2
2	Analog Board Calibration Checksum Failure [2]	4	---3
3	Input Over-Range (Clipping) [3]	6	---4
4	Program Memory (EPROM) Failure [4]	7	---5
5	A/D Self-Test Error [4]	8	---6
6	External Memory (XRAM) Failure [4]	9	---7
7	Host-MultiComm Interface Crash	10	---8
8	Phase Calibration Checksum Failure [5]	N/A	N/A
9	Energy Storage Checksum Failure [6]	11	---9
10	Demand Storage Parity Error [7]	12	--10
11	Configuration Parity Error	13	--11
12	Future Expansion - will read 0		
13	Future Expansion - will read 0		
14	Future Expansion - will read 0		
15	Will Always Read 0		

---

[1] - All measurements except energy are accurate, CT & PT ratio may be corrupted, no display on instrument. All energies calculated after the failure will be in secondary units (CT Ratio = 5:5 and PT Ratio = 1:1).

[2] - Accuracy of measurements reduced to +/-3% or better.

[3] - Accuracy of measurements reduced - dependent on amount of signal overrange.

[4] - Data may be corrupted and is unreliable.

[5] - Accuracy of WATT/VAR/Power Factor/Energy measurements reduced to +/-0.5% or better.

[6] - Stored Energy Data may be corrupted and may be unreliable.

[7] - Minimum and Maximum Demand Data may be corrupted. Present Demands unaffected.

3.8 Diagnostic LED

The Diagnostic LED is an indicator that shows the communications activity on the DNP port of the instrument. The Diagnostic LED is a red indicator that is located in the upper left corner of the top display. Because the LED is actually on the board below the Display Board, the Diagnostic LED has a limited viewing angle. The Diagnostic LED will flash every time the MultiComm processor transmits a message. If the LED does not flash when a message requiring a response is sent to it from a MASTER, check the network for the following problems:

* Cable open or short circuit

* Defective termination

* Incorrect DNP address

* Incorrect polarity of cable connections

3.9 Heartbeat State Counter

MultiComm "B" instruments provide a Heartbeat State Counter Register that allows the user to determine when the data is updated within the instrument. This counter will increment by the number of internal 10 millisecond states that have elapsed since the last time the data was updated. Users can use a change in this value as an indication of the instant that the data has been updated in the MultiComm processor. On sequential polls, users can also use the difference in this counter to determine the time that has elapsed between poles. A third use of this register is as a visual indicator that the data is changing, which allows users of certain MMIs to identify disruption in the polling of the instrument. The Heartbeat State Counter is a full 32bit counter that rolls over at 2^{32} (715827.88 minutes or 497.1 days). The counter starts at zero on power-up, and is NOT stored in non-volatile memory.

4.0 DNP PROTOCOL

4.1 Introduction

DNP3 (Distributed Network Protocol) is an open standard which was designed by GE-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, master and slave devices. A master device issues commands to slaves. A slave device, such as a MULTICOMM instrument, issues responses to master commands which are addressed to them. Each bus must contain exactly one master and may contain as many slaves as the electrical standards permit.

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 4 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 MultiComm instruments.

4.2 Overall Protocol Structure

DNP is a 3-layer protocol based upon the standard IEC 870-5 (Telecontrol Equipment and Systems - Transmission Protocols). The 3 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 two devices. The application layer defines standardized messages which flow between devices. DNP further defines an extra layer known as the transport layer which allows very long messages to be broken down into smaller pieces.

4.3 MultiComm Deviations from Standard

The Basic 4 Document set is imprecise in certain areas. In order to ensure compatibility with the GE-Harris D20 RTU and the ACS 7500 Series RTU, the MultiComm DNP protocol differs from the Basic 4 specification.

The MultiComm physical layer is either 3-wire RS-232C (RX-TX-COM) or 2-wire RS-485 (A-B). Neither of these is described in the basic 4 set although the RS-232C and RS-485 versions have been tested with the GE-Harris D20 RTU and the ACS 7500 Series RTU. Since both RS-232C and 2-wire RS-485 allow only a single master station, MultiComm instruments do not support unsolicited responses nor hardware collision avoidance.

The data link layer differs from the Basic 4 specifications because of the master-slave relationship between devices. When MultiComm instruments receive a request, no further requests can be sent until after the MultiComm instrument makes the appropriate response. This implies that the MultiComm data buffer is full during the interval between the request and response and that the DFC indicator should be set in each acknowledgment response. Setting this indicator, however, would cause needless network traffic. Therefore, MultiComm instruments respond with the DFC bit CLEAR unless a second request is received before the first is processed. In this case, the data link layer response would indicate a NACK with the DFC indicator set.

The application layer of the DNP protocol leaves many details open to interpretation. Most devices retrieve data from the Multifunction instrument by executing a directed (non-broadcast) READ of all CLASS-0 objects (object 60, variation 1, qualifier 6). As was mentioned in Section 3.5.5, MultiComm "B" instruments respond with the digital output status for all points (including any demand reset points), and a configurable number of 16-BIT ANALOG-INPUT values, 32-BIT COUNTER values, and 16-bit ANALOG-OUTPUT-STATUS values for the 4 CT/PT ratio values. The ANALOG-INPUT and COUNTER values are sent with flags unless the flags would indicate just ONLINE, in which case the flags are suppressed. Requests for all CLASS objects (object 60, variation 0) are treated as CLASS-0. READ of CLASS-1 or CLASS-2 or CLASS-3 objects return NO objects. CLASS READs with other variations or qualifier fields other than 6 return errors. MultiComm instruments recognize ALL VALID qualifier fields except qualifier code 11 (the Free-Format Qualifier).

4.4 DNP Request/Response Overview

The MultiComm DNP implementation supports a wide variety of messages. The most general method to extract information from a MultiComm instrument is to issue a READ CLASS-0 request. DNP devices respond with the value of all input points and the status of all output points. This allows the MASTER to retrieve all readings from the instrument and determine whether the output points are ONLINE (ie: whether energy/demand resets or ratio setup requests can be honored). MultiComm instruments also allow READs of individual objects specifying all points (variation 6) or individual points (other variations). MultiComms execute the energy clear function and demand resets using the DIRECT-OPERATE (or DIRECT-OPERATE-NO-ACKNOWLEDGE) functions to the CONTROL-RELAY-OUTPUT-BLOCK object points 0 through 4. CT/PT ratio setups are made via the DIRECT-OPERATE (or DIRECT-OPERATE-NO-ACKNOWLEDGE) TO THE ANALOG-OUTPUT-BLOCK object points 0 through 3 (point 0 corresponds with ANALOG-INPUT point 15, CT value). TDD Denominator, Configuration and Screen Configuration setups are also made via the DIRECT-OPERATE (or DIRECT-OPERATE-NO-ACKNOWLEDGE) TO THE ANALOG-OUTPUT-BLOCK object. The DNP function codes WRITE, COLD-RESTART, and WARM-RESTART are also supported by MultiComm instruments. Refer to Appendix A for specific requests and responses. Appendix E contains the standard DNP Device Profile Document which includes the optional point list section.

MultiComm instruments attempt to respond with the same object variation and qualifier as in the request. Exceptions to this rule include changing variation 0 to a specific variation, changing non-flag/flag requests to flagged/non-flagged responses, and changing qualifier code 6 to 0 or 6 to 1.

If the MultiComm instrument receives an invalid request, it outputs the request up to the point of error and sets the internal indication to the error code. This is done as a debugging aid.

5.0 INSTALLATION

5.1 Setting DNP Address

The MultiComm Instrument provides for direct connection to a DNP Network. As was mentioned in Section 3.2, each device on a given network must have a different ADDRESS. A pair of address selector switches (SW3 & SW4) are located on the MultiComm Processor Board, and they are accessible through holes in the Display Board. These switches allow address selection in the range of 0-255 (unless otherwise specified at the time or instrument order). When the meter is powered, the ADDRESS can be easily checked by pressing the front mounted SELECT button down and scrolling through the available screens (refer to the MultiComm Users Manual for more details on the screens). After all the screens have been viewed, a marker screen (CT/ID/PT shown below) will be displayed for 1.2 seconds.

5000	CT Ratio	(5000:5 shown)(5000:1 with CI1 option)
12	ID Address	(12 shown)
1000	PT Ratio	(1000:1 shown)
CT·ID·PT		

This screen serves two purposes - to indicate to the user that all enabled screens have been viewed and to provide the CT/ID/PT information. The DNP Address is on the middle display. This provides the user with a simple method verifying the address without having to remove the faceplate of the instrument.

If the address needs to be changed, the following procedure should be followed:

1. With the MultiComm meter under power, remove the four screws holding the front panel to the meter. Carefully move the front panel away from the instrument to expose the front panel select switch, and disconnect the connector from the display board. Remove the faceplate and gasket.

2. Flip the small toggle switch on the left of the meter UP for CT set (DOWN for PT set). The top display will show the present CT setting, the middle display will show the instrument address and the bottom display will show the present PT setting. The Alphanumeric display will indicate which ratio is being set. **Be careful not to push the Select button at this time or the CT\PT ratio will be altered.** If the CT and/or PT ratio are accidently changed, refer to the MultiComm Users Manual for instructions on setting the CT/PT ratio.

3. The ADDRESS selector switches are SW3 & SW4, and are located on the right hand side of the Display Board, just below the SELECT pushbutton. The

switches have 16 positions (0-9,A-F). The switch can be rotated with a small flat blade screwdriver, or a small phillips screwdriver. Using the table on the next two pages, find the desired DNP address and dial the switches SW4 and SW3 to the corresponding hexadecimal values. **The NEW address will take effect immediately**, and the center display will change as the switches are rotated.

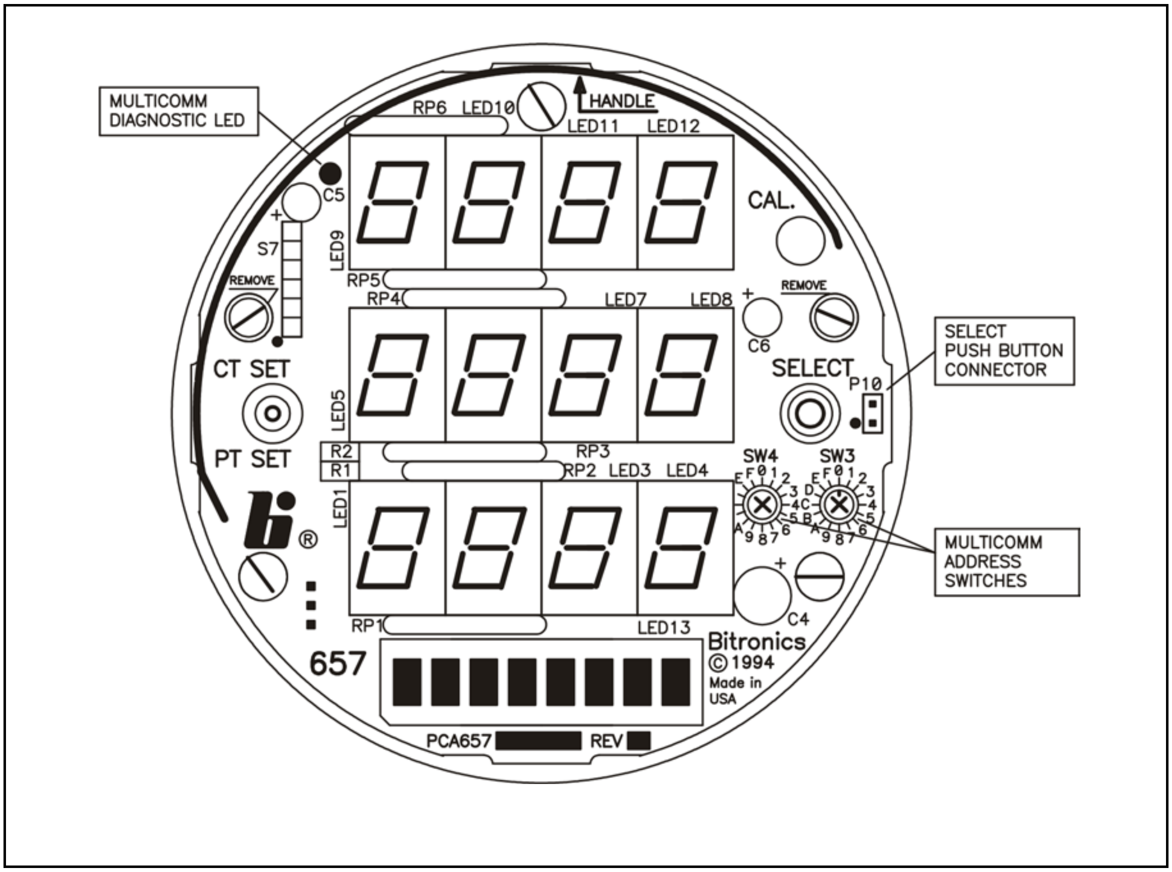


Figure 1 - Switch, Connector and LED Locations

4. Return the toggle to the center position. The alphanumeric display will show a **Select?** prompt for 2 seconds. If the Select button is pressed during the time, the alphanumeric display will indicate **Okay**, and the user will enter the **Display Programming Mode** (refer to the MultiComm Alpha Series User's Manual). If the select button is not pressed, the **Select?** prompt will be followed by a digit check (8888 displayed) and the meter will return to normal operation.

5. Replace gasket, carefully plug in the select switch connector to the two pin connector on the right hand side of the display board. Replace the front cover, being careful to dress the yellow cable to the select switch around the bottom display. Replace the four cover screws. Done!!

ADDR	SW4	SW3
0	0	0
1	0	1
2	0	2
3	0	3
4	0	4
5	0	5
6	0	6
7	0	7
8	0	8
9	0	9
10	0	A
11	0	B
12	0	C
13	0	D
14	0	E
15	0	F
16	1	0
17	1	1
18	1	2
19	1	3
20	1	4
21	1	5
22	1	6
23	1	7
24	1	8
25	1	9
26	1	A
27	1	B
28	1	C
29	1	D
30	1	E
31	1	F

ADDR	SW4	SW3
32	2	0
33	2	1
34	2	2
35	2	3
36	2	4
37	2	5
38	2	6
39	2	7
40	2	8
41	2	9
42	2	A
43	2	B
44	2	C
45	2	D
46	2	E
47	2	F
48	3	0
49	3	1
50	3	2
51	3	3
52	3	4
53	3	5
54	3	6
55	3	7
56	3	8
57	3	9
58	3	A
59	3	B
60	3	C
61	3	D
62	3	E
63	3	F

ADDR	SW4	SW3
64	4	0
65	4	1
66	4	2
67	4	3
68	4	4
69	4	5
70	4	6
71	4	7
72	4	8
73	4	9
74	4	A
75	4	B
76	4	C
77	4	D
78	4	E
79	4	F
80	5	0
81	5	1
82	5	2
83	5	3
84	5	4
85	5	5
86	5	6
87	5	7
88	5	8
89	5	9
90	5	A
91	5	B
92	5	C
93	5	D
94	5	E
95	5	F

ADDR	SW4	SW3
96	6	0
97	6	1
98	6	2
99	6	3
100	6	4
101	6	5
102	6	6
103	6	7
104	6	8
105	6	9
106	6	A
107	6	B
108	6	C
109	6	D
110	6	E
111	6	F
112	7	0
113	7	1
114	7	2
115	7	3
116	7	4
117	7	5
118	7	6
119	7	7
120	7	8
121	7	9
122	7	A
123	7	B
124	7	C
125	7	D
126	7	E
127	7	F

ADDR	SW4	SW3
128	8	0
129	8	1
130	8	2
131	8	3
132	8	4
133	8	5
134	8	6
135	8	7
136	8	8
137	8	9
138	8	A
139	8	B
140	8	C
141	8	D
142	8	E
143	8	F
144	9	0
145	9	1
146	9	2
147	9	3
148	9	4
149	9	5
150	9	6
151	9	7
152	9	8
153	9	9
154	9	A
155	9	B
156	9	C
157	9	D
158	9	E
159	9	F

ADDR	SW4	SW3
160	A	0
161	A	1
162	A	2
163	A	3
164	A	4
165	A	5
166	A	6
167	A	7
168	A	8
169	A	9
170	A	A
171	A	B
172	A	C
173	A	D
174	A	E
175	A	F
176	B	0
177	B	1
178	B	2
179	B	3
180	B	4
181	B	5
182	B	6
183	B	7
184	B	8
185	B	9
186	B	A
187	B	B
188	B	C
189	B	D
190	B	E
191	B	F

ADDR	SW4	SW3
192	C	0
193	C	1
194	C	2
195	C	3
196	C	4
197	C	5
198	C	6
199	C	7
200	C	8
201	C	9
202	C	A
203	C	B
204	C	C
205	C	D
206	C	E
207	C	F
208	D	0
209	D	1
210	D	2
211	D	3
212	D	4
213	D	5
214	D	6
215	D	7
216	D	8
217	D	9
218	D	A
219	D	B
220	D	C
221	D	D
222	D	E
223	D	F

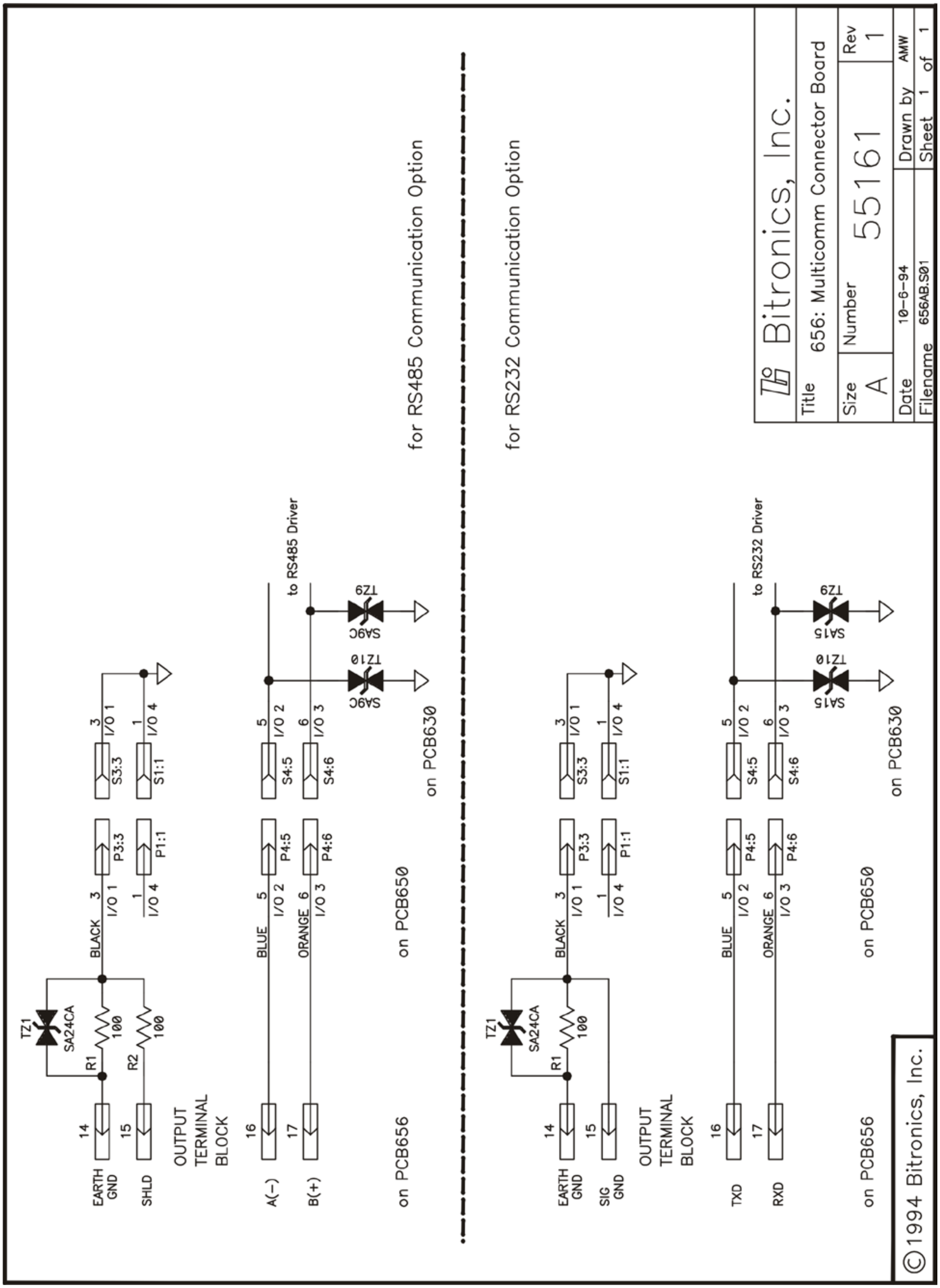
ADDR	SW4	SW3
224	E	0
225	E	1
226	E	2
227	E	3
228	E	4
229	E	5
230	E	6
231	E	7
232	E	8
233	E	9
234	E	A
235	E	B
236	E	C
237	E	D
238	E	E
239	E	F
240	F	0
241	F	1
242	F	2
243	F	3
244	F	4
245	F	5
246	F	6
247	F	7
248	F	8
249	F	9
250	F	A
251	F	B
252	F	C
253	F	D
254	F	E
255	F	F

5.2 DNP RS-232C Link (-S113)

The DNP RS-232C Link connects to the MultiComm instrument via the 4 pin terminal block located on the back of the instrument. Since the RS-232C standard does not allow a transmitter to be disabled, only two devices can be connected to a link (the master and the slave). The pin labeled RXD receives data from the master's transmitter. The instrument sends responses via the TXD pin to the master receiver. Refer to Figure 3 for the connection diagram.

5.3 DNP RS-485 Network (-S123)

The DNP RS-485 Network connects to the MultiComm instrument via the 4 pin terminal block located on the back of the instrument. All instruments must be connected in parallel for multidrop configuration, and all instruments must have different DNP addresses. A 120 ohm terminating resistor must be provided by the user at each end of the RS-485 network. All nodes must be configured to TRISTATE (transmitter disable) when the node is not transmitting. All MultiComm instruments with RS-485 outputs automatically TRISTATE when not transmitting. The "anti-jabber" circuit (refer to section 2.4) ensures that instruments TRISTATE even during a malfunction. MultiComm DNP instruments will delay their response to a request for a minimum of 10 milliseconds. It is **VERY** important that the DNP MASTER device TRISTATE within 10 milliseconds of the last byte of the request being transmitted. Signal polarity of the RS-485 is critical for proper network operation. Connections are made A(-) to A(-), B(+) to B(+) and Shield to Shield. Refer to Figure 4 for the connection diagram.


for RS485 Communication Option
for RS232 Communication Option
EARTH GND
SHLD
SIG GND
A(–)
B(+)
TXD
RXD
OUTPUT TERMINAL BLOCK
TZ1
SA24CA
R1
R2
100
BLACK
BLUE
ORANGE
I/O 1
I/O 2
I/O 3
I/O 4
P3:3
P1:1
P4:5
P4:6
S3:3
S1:1
S4:5
S4:6
TZ10
TZ9
SA9C
SA15
to RS485 Driver
to RS232 Driver
on PCB656
on PCB650
on PCB630
Bitronics, Inc.
Title
656: Multicomm Connector Board
Size
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MultiComm RS-232C Connections

MultiComm Instrument	GE-Harris RTU D20/D200/CPM DB9 (Female)	IBM AT DB9 (Female)	IBM XT DB25 (Female)
GND 14 ——	Shield	Shield	1
SG 15 ——	5	5	7
TXD 16 ——	2	2	3
RXD 17 ——	3	3	2
		┌ 4	┌ 4
		└ 6	└ 5
		┌ 1	┌ 6
		├ 7	├ 8
		└ 8	└ 20

MultiComm RS-485 Connections

MultiComm Instrument	RS-485 Device	RS-485 to RS-232C Converter
GND 14 ——	(See note 1)	(See Note 1)
SHLD 15 ——	SHLD	SHLD
A(—) 16 ——	A	A
B(+) 17 ——	B	B

Notes:
1. To avoid ground currents in the Shield, Ground (GND) should be connected to Earth Ground at only one end of the RS-485 line.

2. Each device on the RS-485 line must be configured for a 2-wire half-duplex interface.

APPENDIX A

DNP Application Messages

This appendix describes MultiComm application level responses to external requests. The MultiComm instrument is a DNP IED responding to external DNP MASTER requests. The following table on the following page describes each object processed by MultiComm DNP.

The objects and formats are detailed in the DNP Basic 4 Documentation set. The request column shows function codes such as "1" for READ and qualifier codes such as "6,Read".
This indicates that only the READ function code using either qualifier code 6 or any other valid qualifier for message which do not contain data objects is allowed in this request. The response column indicates functions codes such as "129" for RESPONSE and qualifier codes such as "0,Read". This indicates that request qualifier 6 (all points) has response 0 (8 bit start and stop indices) and other legal request qualifiers have the same response qualifier as in the request. Qualifier columns marked "Write" indicate that all qualifiers which are legal for messages which contain object.

In addition to the entries in the table, DNP requires support for function codes 3 (SELECT) and 4 (OPERATE) when applied to objects CONTROL-RELAY-OUTPUT-BLOCK or ANALOG-OUTPUT-BLOCK. This combination of function code and object has no meaning in MultiComm instruments. The instrument responds with an internal indication showing PARAMETER-ERROR for any request with these function codes.

DNP allows MASTER devices to issue READ requests by requesting either the default variation (0) or a specific (non-zero) variation. When responding to a request with a default variation, the MultiComm instrument selects the most appropriate data size (either 16 or 32 bit) for the requested object. This size is 32-bit for all COUNTER objects and 16-bit for all other objects. When responding to a request for a specific sized object, DNP requires that the instrument respond with an object of the selected size. When a request for a 16-bit COUNTER is made, MultiComm devices respond with the most significant 16 bits of the counter. When a request for 32-bit ANALOG-INPUT or ANALOG-OUTPUT-STATUS is made, MultiComm instruments return a sign-extended version of the 16 bit value (in other words, the most significant response word will be either all zeros for positive values or all ones for negative values).

OBJECT			REQUEST		RESPONSE	
Obj.	**Var.**	**Description**	**Func Code**	**Qual Codes**	**Func Code**	**Qual Codes**
N/A	N/A	Confirm (for cold/warm restart)	0	N/A	N/A	N/A
10	0	Binary Output	1	6,Read	129	0,Read
10	2	Binary Output Status	1	6,Read	129	0,Read
12	1	Control Relay Output Block	5	Write	5	Write
12	1	Control Relay Output Block	6	Write	None	N/A
20	0	Counter (responds like 20-5)	1	6,Read	129	0,Read
20	1	32-Bit Binary Counter (with flag)	1	6,Read	129	0,Read
20	2	16-Bit Binary Counter (with flag)	1	6,Read	129	0,Read
20	5	32-Bit Binary Counter without flag	1	6,Read	129	0,Read
20	6	16-Bit Binary Counter without flag	1	6,Read	129	0,Read
30	0	Analog Input (responds like 30-2)	1	6,Read	129	0,Read
30	1	32-Bit Analog Input (with flag)	1	6,Read	129	0,Read
30	2	16-Bit Analog Input (with flag)	1	6,Read	129	0,Read
30	3	32-Bit Analog input without flag	1	6,Read	129	0,Read
30	4	16-Bit Analog Input without flag	1	6,Read	129	0,Read
40	0	Analog Output Sts (responds 40-2)	1	6,Read	129	0,Read
40	1	Analog Output Status 16 bit	1	6,Read	129	0,Read
40	2	Analog Output Status	1	6,Read	129	0,Read
41	2	Analog Output Block	5	Write	5	Write
41	2	Analog Output Block	6	Write	None	N/A
N/A	N/A	Cold Restart (responds obj. 52-2)	13	N/A	129	7
N/A	N/A	Warm Restart (responds obj. 52-2)	14	N/A	129	7
60	0	Class - Undefined by DNP	1	6	129	0
60	1	Class-0 (Static Objects)	1	6	129	0
60	2	Class-1 (High Priority Events)	1	6	None	N/A
60	3	Class-2 (Medium Priority Events)	1	6	None	N/A
60	4	Class-3 (Low Priority Events)	1	6	None	N/A
80	1	Internal Indications (point 7 only)	2	Write	129	N/A

Table A-1 : DNP Application Requests and Responses

APPENDIX B

DNP Internal Indications

This appendix describes the conditions which cause internal indications to be returned by the MultiComm DNP instrument. Indications not described are NEVER set.

IIN 00 - All Stations
: Set on the first response AFTER a broadcast to indicate that the broadcast request was received.

IIN 06 - Device Trouble
: This is set whenever the DNP communication processor loses contact with the HOST (instrument) processor. This occurs for the first few seconds after power application, after exiting from CT/PT setup mode, and whenever the instrument displays error code --8 (communication lost).

IIN 07 - Device Restart
: Set whenever DNP processor is re-initialized. This occurs upon power-up or receipt of a COLD RESTART or WARM RESTART function code from the DNP master. The DNP master may clear this by executing a WRITE to object 80, variation 1, point 7.

IIN 08 - Function code not implemented
: This is set whenever an unknown request function code is received.

IIN 09 - Object Unknown
: This is set when a valid function code is received but the object specified is invalid for that function.

IIN 10 - Parameter Error
: A valid function code/object was received but an error exists in the qualifier, range, or data field. It is also set when function code SELECT or OPERATE is applied to objects CONTROL-RELAY-OUTPUT-BLOCK or ANALOG-OUTPUT-BLOCK (this follows the DNP rules requiring support for these function code/object combinations)

IIN 11 - Buffer Overflow
: Set when instrument receives a request before it has completed responding to a previous request.

IIN 12 - Already in progress
: Set when more than 8 valid DIRECT OPERATE (OR DIRECT OPERATE NO ACKNOWLEDGE) requests are received within 0.6 seconds. (“A” Models only)

IIN 13 - Corrupt Configuration
: Set when either configuration register (AO4, AO5) are corrupt. The instrument will use the default configuration.

APPENDIX C
Read Data Flags

This appendix describes data flags set by MultiComm instruments in response to read requests. Four types of objects may be read by the DNP master: BINARY-OUTPUT-STATUS, COUNTER, and ANALOG-INPUT, and ANALOG-OUTPUT-STATUS. MultiComm DNP instruments maintain internal flags which are returned to the DNP master as point flags. Note that if the internal flags indicate a normal status (ON-LINE flag is only bit set), DNP allows COUNTER AND ANALOG-INPUT requests to be returned without flags. The flags are described below:

On-line :

Set when the instrument is continually updating values and is ready to clear the energy values. Clear when the HOST processor has failed or when the instrument is in ratio (CT or PT) setup mode (refer to the base instrument manual).

Over-range :

Set when value returned exceeds the internal range of the instrument. For the FREQUENCY value, this is set when the value is either 0 or 9999. For Power Factor, this is set when the value is 1999 (indicating that signal inputs are too low to measure). For Harmonics (Percents) when value is greater than 9999. For other analog values, this is set when the value is outside of the range -32768 .. +32767.

Reference-check :

Set when the error in the value of the ANALOG-INPUT might exceed the specified accuracy limits for the instrument. This bit is set whenever any appropriate bits within the Health-Check value are set. It is up to the DNP MASTER application to decide whether to use this bit. The reference check bit value within the ANALOG-INPUT points vary depending upon which HEALTH-CHECK bit is set (described below). Refer to Section 3.7 for definitions of the HEALTH-CHECK bits.

Voltage and Current points:	Set upon health bits 1,2,3,5
WATT and VAR points:	Set upon health bits 1,2,3,5,8
CT/PT Ratio points:	Set upon health bit 0
Frequency point:	Set upon health bit 5
Volt-Amp points:	Set upon health bits 1,2,3,5
Power Factor points:	Set upon health bits 1,2,3,5,8
Minimum/Maximum points:	Set upon health bit 10 and value being saturated
K-Factor and %Distortion points:	Set upon health bit 3,5

Remote-Forced-Data:

Set if a Configuration error has been detected. The Configuration Registers will be forced to the factory defaults (AO:4 =7, AO:5=0).

APPENDIX D

DNP Configuration Notes

DNP devices are described using a Device Profile. At the present time, there is no standard method of documenting a instrument profile. This appendix attempts to describe major DNP features which do not conveniently fit in other sections of this manual.

The maximum size of a user data packet is 249 bytes. This is large enough for any reasonable request. Attempting to communicate packets larger than this size will cause IIN 11 (Buffer Overflow) to be set within the response (refer to Appendix B). Responses have a maximum data packet size of 2048.

A response is delayed at least 10 milliseconds from the time of receipt of a request. This time allows the master to TRISTATE an RS-485 driver after a transmission.

MultiComm DNP instruments are configurable for Data Link Layer confirms. The default is NO Data Link Layer Confirms.

Upon the FIRST receipt of a Data Link Layer USER-DATA (with confirm) message, MultiComm DNP instruments will initiate a Reset-Link command back to the DNP master. A timeout of 1.0 seconds and retry limit of 10 is used while waiting for the DNP master response.

MultiComm DNP instruments NEVER send unsolicited messages. Hardware collision avoidance is not supported.

Energy values are presented in PRIMARY transformer units of kiloWATTh (or kiloVARh) as BINARY-COUNTERS. The counters increment to 99,999,999 and then roll over to zero and then continue counting. Since DNP provides no standard method of determining the rollover value, MultiComm DNP instruments **NEVER** set the COUNTER ROLLOVER flag. It is important for users of data to ensure that energy values are read sufficiently often to detect every rollover (ie, new data is less than previous data) and adjust the interpreted value accordingly. It is also vital that no SCADA MASTER unit ever request a DELTA energy COUNTER value from an RTU since the RTU may produce fictitious data across any rollover.

MultiComm DNP instruments never request Application Layer confirms.

MultiComm instruments respond to COLD and WARM RESTART requests. COLD-RESTART or WARM-RESTART functions execute immediately after the Time Delay response is sent. A COLD-RESTART attempts to reset both the instrument (HOST) and DNP (communication) processors within the MultiComm instrument. WARM-RESTART request only reset the communication processor. Note that both restarts cause the RESTART Internal Indication (IIN) bit to be SET.

Implementation Table

OBJECT			REQUEST		RESPONSE	
Obj	Var	Description	Func Codes	Qual Ctgry	Func Codes	Qual Ctgry
10	0	Binary Output - All Variations	1	A		
10	2	Binary Output Status	1	A	129	00 or A
12	1	Control Relay Output Block	5,6	D	129	Echo
20	0	Binary Counter - All Variations	1	A		
20	1	32-Bit Binary Counter	1	A	129	00 or A
20	2	16-Bit Binary Counter	1	A	129	00 or A
20	5	32-Bit Binary Counter without Flag	1	A	129	00 or A
20	6	16-Bit Binary Counter without Flag	1	A	129	00 or A
30	0	Analog Input - All Variations	1	A		
30	1	32-Bit Analog Input	1	A	129	00 or A
30	2	16-Bit Analog Input	1	A	129	00 or A
30	3	32-Bit Analog Input without Flag	1	A	129	00 or A
30	4	16-Bit Analog Input without Flag	1	A	129	00 or A
40	0	Analog Output Status - All Variations	1	A		
40	1	32-Bit Analog Output Status	1	A	129	00 or A
40	2	16-Bit Analog Output Status	1	A	129	00 or A
41	2	16-Bit Analog Output Block	5,6	D	129	Echo
52	2	Time Delay Fine			129	07,Q=1
60	0	Undefined, treated as 60-1	1	B		
60	1	Class 0 Data	1	B		
60	2	Class 1 Data	1	B		
60	3	Class 2 Data	1	B		
60	4	Class 3 Data	1	B		
80	1	Internal Indication	2	C		
No Object			13			
No Object			14			

Qualifier Hex Codes for each Category:

- A - 00,01,02,03,04,05,06,07,08,09,17,18,19,27,28,29,37,38,39
- B - 06 only
- C - 00,01,02,03,04,05,17,18,19,27,28,29,37,38,39,
  40,41,42,43,44,45,50,51,52,53,54,55,60,61,62,63,64,65
- D - 00,01,02,03,04,05,07,08,09,17,18,19,27,28,29,37,38,39,
  40,41,42,43,44,45,50,51,52,53,54,55,60,61,62,63,64,65

Point List Note : No event objects are supported by this instrument

Description	Index	Default Static Variation			Point Name	Comments *For CI1 option, divide value by 5	Model DE or IE	Class 0 Config Bit
		Obj	Var	Desc				
Binary Output	0	10	2	B.O. Sts	Energy Reset	Always reads 0	IE,DE	Always
Binary Output	1	10	2	B.O. Sts	Amp Demand Reset	Always reads 0	IE,DE	Always
Binary Output	2	10	2	B.O. Sts	Volt Demand Reset	Always reads 0	IE,DE	Always
Binary Output	3	10	2	B.O. Sts	Power Demand Reset	Always reads 0	IE,DE	Always
Binary Output	4	10	2	B.O. Sts	Harmonic Demand Reset	Always reads 0	IE,DE	Always
Control Block	0	12	1	CROB	Energy Reset	E. Reset via CROB	IE,DE	Never
Control Block	1	12	1	CROB	Amp Demand Reset	Reset via CROB	DE	Never
Control Block	2	12	1	CROB	Volt Demand Reset	Reset via CROB	DE	Never
Control Block	3	12	1	CROB	Power Demand Reset	Reset via CROB	DE	Never
Control Block	4	12	1	CROB	Harmonic Demand Reset	Reset via CROB	DE	Never
Counter	0	20	1/5	Bin. Ctr.	+ KWatt-hours	Primary Units	IE,DE	0
Counter	1	20	1/5	Bin. Ctr.	- KWatt-hours	Primary Units	IE,DE	0
Counter	2	20	1/5	Bin. Ctr.	+ KVAR-hours	Primary Units	IE,DE	0
Counter	3	20	1/5	Bin. Ctr.	- KVAR-hours	Primary Units	IE,DE	0
Counter	4	20	1/5	Bin. Ctr.	Heartbeat Counter	10msec Ticks	IE,DE	0
Analog Input	0	30	2/4	16-Bit	Health Check	0 = No Errors	IE,DE	Always
Analog Input	1	30	2/4	16-Bit	Amps A	32767=10*A Sec.	IE,DE	Always

Description	Index	Default Static Variation			Point Name	Comments *For Cl1 option, divide value by 5	Model DE or IE	Class 0 Config Bit
		Obj	Var	Desc				
Analog Input	2	30	2/4	16-Bit	Amps B	32767=10*A Sec.	IE,DE	Always
Analog Input	3	30	2/4	16-Bit	Amps C	32767=10*A Sec.	IE,DE	Always
Analog Input	4	30	2/4	16-Bit	Volts A	32767=150V Sec	IE,DE	Always
Analog Input	5	30	2/4	16-Bit	Volts B	32767=150V Sec	IE,DE	Always
Analog Input	6	30	2/4	16-Bit	Volts C	32767=150V Sec	IE,DE	Always
Analog Input	7	30	2/4	16-Bit	Total Watts	32767 = 4500*W 0 = 0W -32768 = -4500* W Secondary	IE,DE	Always
Analog Input	8	30	2/4	16-Bit	Total VARs	32767 = 4500*Var 0 = 0Var -32768 = -4500*Var Secondary	IE,DE	Always
Analog Input	9	30	2/4	16-Bit	Watts A	32767 = 1500*W 0 = 0W -32768 = -1500*W Secondary	IE,DE	Always
Analog Input	10	30	2/4	16-Bit	Watts B			Always
Analog Input	11	30	2/4	16-Bit	Watts C			Always
Analog Input	12	30	2/4	16-Bit	VARs A	32767 = 1500*Var 0 = 0Var -32768 = -1500*Var Secondary	IE,DE	Always
Analog Input	13	30	2/4	16-Bit	VARs B			Always
Analog Input	14	30	2/4	16-Bit	VARs C			Always
Analog Input	15	30	2/4	16-Bit	CT Ratio	Default=5000	IE,DE	Always
Analog Input	16	30	2/4	16-Bit	CT Divisor	Default=1000 (5:5*)	IE,DE	Always
Analog Input	17	30	2/4	16-Bit	PT Ratio	Default=1000	IE,DE	Always
Analog Input	18	30	2/4	16-Bit	PT Divisor	Default=1000 (1:1)	IE,DE	Always

Description	Index	Default Static Variation			Point Name	Comments *For CI1 option, divide value by 5	Model DE or IE	Class 0 Config Bit
		Obj	Var	Desc				
Analog Input	19	30	2/4	16-Bit	Residual Current	32767=15*A	IE,DE	Always
Analog Input	20	30	2/4	16-Bit	Frequency	6000=60.00 Hz	IE,DE	Always
Analog Input	21	30	2/4	16-Bit	VAs A	32767=1500* VAs 0=1500* VAs	IE,DE	1
Analog Input	22	30	2/4	16-Bit	VAs B			1
Analog Input	23	30	2/4	16-Bit	VAs C			1
Analog Input	24	30	2/4	16-Bit	VAs Total	32767=4500* VAs	IE,DE	1
Analog Input	25	30	2/4	16-Bit	Power Factor A	+ 1000 = 1.000 + 500 = 0.500 Lead 0 = Purely reactive -500 = 0.500 Lag 1999 on low signal	IE,DE	1
Analog Input	26	30	2/4	16-Bit	Power Factor B			1
Analog Input	27	30	2/4	16-Bit	Power Factor C			1
Analog Input	28	30	2/4	16-Bit	PF Total			1
Analog Input	29	30	2/4	16-Bit	Amp A Pres. Demand	32767=10*A Sec. (IE models always return 0)	IE,DE	2
Analog Input	30	30	2/4	16-Bit	Amp B Pres. Demand		IE,DE	2
Analog Input	31	30	2/4	16-Bit	Amp C Pres. Demand		IE,DE	2
Analog Input	32	30	2/4	16-Bit	Amp A Max. Demand	32767=10*A Sec. (IE models always return 0)	IE,DE	2
Analog Input	33	30	2/4	16-Bit	Amp B Max. Demand		IE,DE	2
Analog Input	34	30	2/4	16-Bit	Amp C Max. Demand		IE,DE	2
Analog Input	35	30	2/4	16-Bit	Neutral Pres. Demand	32767=15*A Sec. (IE models always return 0)	IE,DE	2
Analog Input	36	30	2/4	16-Bit	Neutral Max. Demand		IE,DE	2
Analog Input	37	30	2/4	16-Bit	Volt A Pres. Dem.	32767=150V Sec. (IE models always return 0)	IE,DE	2
Analog Input	38	30	2/4	16-Bit	Volt B Pres. Dem.		IE,DE	2
Analog Input	39	30	2/4	16-Bit	Volt C Pres. Dem.		IE,DE	2
Analog Input	40	30	2/4	16-Bit	Volt A Max. Dem.	32767=150V Sec. (IE models	IE,DE	2
Analog Input	41	30	2/4	16-Bit	Volt B Max. Dem.		IE,DE	2

Description	Index	Default Static Variation			Point Name	Comments *For CI1 option, divide value by 5	Model DE or IE	Class 0 Config Bit
		Obj	Var	Desc				
Analog Input	42	30	2/4	16-Bit	Volt C Max. Dem.	always return 0)	IE,DE	2
Analog Input	43	30	2/4	16-Bit	Volt A Min. Dem.	32767=150V Sec. (IE models always return 0)	IE,DE	2
Analog Input	44	30	2/4	16-Bit	Volt B Min. Dem.		IE,DE	2
Analog Input	45	30	2/4	16-Bit	Volt C Min. Dem.		IE,DE	2
Analog Input	46	30	2/4	16-Bit	Tot. Watt Pres. Dem.	32767 = 4500*W 0 = 0W -32768 = -4500* W Sec. (IE models always return 0)	IE,DE	2
Analog Input	47	30	2/4	16-Bit	Tot. Watt Max Dem.			2
Analog Input	48	30	2/4	16-Bit	Tot. Watt Min Dem.			2
Analog Input	49	30	2/4	16-Bit	Tot. VAR Pres. Dem.	32767 = 4500*Var 0 = 0Var -32768 = -4500* Var Sec. (IE models always return 0)	IE,DE	2
Analog Input	50	30	2/4	16-Bit	Tot. VAR Max Dem.			2
Analog Input	51	30	2/4	16-Bit	Tot. VAR Min Dem.			2
Analog Input	52	30	2/4	16-Bit	Tot. VA Pres. Dem.	32767 = 4500*VA 0 = 0VA Secondary (IE models always return 0)	IE,DE	2
Analog Input	53	30	2/4	16-Bit	Tot. VA Max Dem.			2
Analog Input	54	30	2/4	16-Bit	Tot. VA Min Dem.			2
Analog Input	55	30	2/4	16-Bit	Instrument ID	See Table 4	IE,DE	3
Analog Input	56	30	2/4	16-Bit	Peer Firmware Version	Packed BCD xx.xx	IE,DE	3
Analog Input	57	30	2/4	16-Bit	Host Firmware Version	Packed BCD xx.xx	IE,DE	3
Analog Input	58	30	2/4	16-Bit	Host LIB Firmware Vers.	Packed BCD xx.xx	IE,DE	3
Analog Input	59	30	2/4	16-Bit	Fundamental Amps A	32767=10*A Sec.	DE	4
Analog Input	60	30	2/4	16-Bit	Fundamental Amps B	32767=10*A	DE	4

Description	Index	Default Static Variation			Point Name	Comments *For CI1 option, divide value by 5	Model DE or IE	Class 0 Config Bit
		Obj	Var	Desc				
						Sec.		
Analog Input	61	30	2/4	16-Bit	Fundamental Amps C	32767=10*A Sec.	DE	4
Analog Input	62	30	2/4	16-Bit	Fund. Residual Current	32767=15*A	DE	4
Analog Input	63	30	2/4	16-Bit	Fundamental Volts A	32767=150V Sec	DE	4
Analog Input	64	30	2/4	16-Bit	Fundamental Volts B	32767=150V Sec	DE	4
Analog Input	65	30	2/4	16-Bit	Fundamental Volts C	32767=150V Sec	DE	4
Analog Input	66	30	2/4	16-Bit	TDD Amps A	0 = 0.0% 9999 = 999.9% Set to 0 on low input signal	DE	4
Analog Input	67	30	2/4	16-Bit	TDD Amps B			4
Analog Input	68	30	2/4	16-Bit	TDD Amps C			4
Analog Input	69	30	2/4	16-Bit	TDD Odd Amps A	0 = 0.0% 9999 = 999.9% Set to 0 on low input signal	DE	4
Analog Input	70	30	2/4	16-Bit	TDD Odd Amps B			4
Analog Input	71	30	2/4	16-Bit	TDD Odd Amps C			4
Analog Input	72	30	2/4	16-Bit	TDD Even Amps A	0 = 0.0% 9999 = 999.9% Set to 0 on low input signal	DE	4
Analog Input	73	30	2/4	16-Bit	TDD Even Amps B			4
Analog Input	74	30	2/4	16-Bit	TDD Even Amps C			4
Analog Input	75	30	2/4	16-Bit	THD Volts A	0 = 0.0% 9999 = 999.9% Set to 0 on low input signal	DE	4
Analog Input	76	30	2/4	16-Bit	THD Volts B			4
Analog Input	77	30	2/4	16-Bit	THD Volts C			4
Analog Input	78	30	2/4	16-Bit	THD Odd Volts A	0 = 0.0% 9999 = 999.9% Set to 0 on low input signal	DE	4
Analog Input	79	30	2/4	16-Bit	THD Odd Volts B			4
Analog Input	80	30	2/4	16-Bit	THD Odd Volts C			4

Description	Index	Default Static Variation			Point Name	Comments *For CI1 option, divide value by 5	Model DE or IE	Class 0 Config Bit
		Obj	Var	Desc				
Analog Input	81	30	2/4	16-Bit	THD Even Volts A	0 = 0.0% 9999 = 999.9% Set to 0 on low input signal	DE	4
Analog Input	82	30	2/4	16-Bit	THD Even Volts B			4
Analog Input	83	30	2/4	16-Bit	THD Even Volts C			4
Analog Input	84	30	2/4	16-Bit	K-Factor Amps A	100 = 1.00 32767 = 327.67 Set to 100 on low input signal	DE	4
Analog Input	85	30	2/4	16-Bit	K-Factor Amps B			4
Analog Input	86	30	2/4	16-Bit	K-Factor Amps C			4
Analog Input	87	30	2/4	16-Bit	Displacement PF A	+ 1000 = 1.000 + 500 = 0.500 Lead 0 = Purely reactive -500 = 0.500 Lag 1999 on low signal	DE	4
Analog Input	88	30	2/4	16-Bit	Displacement PF B			4
Analog Input	89	30	2/4	16-Bit	Displacement PF C			4
Analog Input	90	30	2/4	16-Bit	Displacement PF Total			4
Analog Input	91	30	2/4	16-Bit	Fund. Residual Amps Present Demand	32767=15*A	DE	5
Analog Input	92	30	2/4	16-Bit	Fund. Residual Amps Max Demand	32767=15*A	DE	5
Analog Input	93	30	2/4	16-Bit	TDD Amps A Pres. Demand	0 = 0.0% 9999 = 999.9%	DE	5
Analog Input	94	30	2/4	16-Bit	TDD Amps B Pres. Demand			5
Analog Input	95	30	2/4	16-Bit	TDD Amps C Pres. Demand			5
Analog Input	96	30	2/4	16-Bit	TDD Amps A Max Demand	0 = 0.0% 9999 = 999.9%	DE	5
Analog Input	97	30	2/4	16-Bit	TDD Amps B Max Demand			5
Analog Input	98	30	2/4	16-Bit	TDD Amps C Max Demand			5
Analog Input	99	30	2/4	16-Bit	THD Volts A Pres. Demand	0 = 0.0% 9999 =	DE	5

Description	Index	Default Static Variation			Point Name	Comments *For CI1 option, divide value by 5	Model DE or IE	Class 0 Config Bit
		Obj	Var	Desc				
Analog Input	100	30	2/4	16-Bit	THD Volts B Pres. Demand	999.9%		5
Analog Input	101	30	2/4	16-Bit	THD Volts C Pres. Demand			5
Analog Input	102	30	2/4	16-Bit	THD Volts A Max Demand	0 = 0.0% 9999 = 999.9%	DE	5
Analog Input	103	30	2/4	16-Bit	THD Volts B Max Demand			5
Analog Input	104	30	2/4	16-Bit	THD Volts C Max Demand			5
Analog Input	105	30	2/4	16-Bit	Amps A Distortion Denominator	32767=10*A Sec	DE	6
Analog Input	106	30	2/4	16-Bit	Amps A Distortion Harm 1	0 = 0.0% 9999 = 999.9% Harm 1 = Fundamental Harm 2 = 2x Fundamental etc.	DE	6
Analog Input	107	30	2/4	16-Bit	Amps A Distortion Harm 2			6
Analog Input	108	30	2/4	16-Bit	Amps A Distortion Harm 3			6
Analog Input	109	30	2/4	16-Bit	Amps A Distortion Harm 4			6
Analog Input	110	30	2/4	16-Bit	Amps A Distortion Harm 5			6
Analog Input	111	30	2/4	16-Bit	Amps A Distortion Harm 6			6
Analog Input	112	30	2/4	16-Bit	Amps A Distortion Harm 7			6
Analog Input	113	30	2/4	16-Bit	Amps A Distortion Harm 8			6
Analog Input	114	30	2/4	16-Bit	Amps A Distortion Harm 9			6
Analog Input	115	30	2/4	16-Bit	Amps A Distortion Harm 10			6
Analog Input	116	30	2/4	16-Bit	Amps A Distortion Harm 11			6
Analog Input	117	30	2/4	16-Bit	Amps A Distortion Harm 12			6

Description	Index	Default Static Variation			Point Name	Comments *For Cl1 option, divide value by 5	Model DE or IE	Class 0 Config Bit
		Obj	Var	Desc				
Analog Input	118	30	2/4	16-Bit	Amps A Distortion Harm 13			6
Analog Input	119	30	2/4	16-Bit	Amps A Distortion Harm 14			6
Analog Input	120	30	2/4	16-Bit	Amps A Distortion Harm 15			6
Analog Input	121	30	2/4	16-Bit	Amps A Distortion Harm 16	0 = 0.0% 9999 = 999.9%	DE	7
Analog Input	122	30	2/4	16-Bit	Amps A Distortion Harm 17			7
Analog Input	123	30	2/4	16-Bit	Amps A Distortion Harm 18			7
Analog Input	124	30	2/4	16-Bit	Amps A Distortion Harm 19			7
Analog Input	125	30	2/4	16-Bit	Amps A Distortion Harm 20			7
Analog Input	126	30	2/4	16-Bit	Amps A Distortion Harm 21			7
Analog Input	127	30	2/4	16-Bit	Amps A Distortion Harm 22			7
Analog Input	128	30	2/4	16-Bit	Amps A Distortion Harm 23			7
Analog Input	129	30	2/4	16-Bit	Amps A Distortion Harm 24			7
Analog Input	130	30	2/4	16-Bit	Amps A Distortion Harm 25			7
Analog Input	131	30	2/4	16-Bit	Amps A Distortion Harm 26			7
Analog Input	132	30	2/4	16-Bit	Amps A Distortion Harm 27			7
Analog Input	133	30	2/4	16-Bit	Amps A Distortion Harm 28			7
Analog Input	134	30	2/4	16-Bit	Amps A Distortion Harm 29			7
Analog Input	135	30	2/4	16-Bit	Amps A Distortion Harm 30			7

Description	Index	Default Static Variation			Point Name	Comments *For Cl1 option, divide value by 5	Model DE or IE	Class 0 Config Bit
		Obj	Var	Desc				
Analog Input	136	30	2/4	16-Bit	Amps A Distortion Harm 31			7
Analog Input	137	30	2/4	16-Bit	Amps B Distortion Denominator	32767=10*A Sec	DE	6
Analog Input	138	30	2/4	16-Bit	Amps B Distortion Harm 1	0 = 0.0% 9999 = 999.9% Harm 1 = Fundamental Harm 2 = 2x Fundamental etc.	DE	6
Analog Input	139	30	2/4	16-Bit	Amps B Distortion Harm 2			6
Analog Input	140	30	2/4	16-Bit	Amps B Distortion Harm 3			6
Analog Input	141	30	2/4	16-Bit	Amps B Distortion Harm 4			6
Analog Input	142	30	2/4	16-Bit	Amps B Distortion Harm 5			6
Analog Input	143	30	2/4	16-Bit	Amps B Distortion Harm 6			6
Analog Input	144	30	2/4	16-Bit	Amps B Distortion Harm 7			6
Analog Input	145	30	2/4	16-Bit	Amps B Distortion Harm 8			6
Analog Input	146	30	2/4	16-Bit	Amps B Distortion Harm 9			6
Analog Input	147	30	2/4	16-Bit	Amps B Distortion Harm 10			6
Analog Input	148	30	2/4	16-Bit	Amps B Distortion Harm 11			6
Analog Input	149	30	2/4	16-Bit	Amps B Distortion Harm 12			6
Analog Input	150	30	2/4	16-Bit	Amps B Distortion Harm 13			6
Analog Input	151	30	2/4	16-Bit	Amps B Distortion Harm 14			6
Analog Input	152	30	2/4	16-Bit	Amps B Distortion Harm 15			6
Analog Input	153	30	2/4	16-Bit	Amps B Distortion Harm 16	0 = 0.0% 9999 =	DE	7

Description	Index	Default Static Variation			Point Name	Comments *For CI1 option, divide value by 5	Model DE or IE	Class 0 Config Bit
		Obj	Var	Desc				
Analog Input	154	30	2/4	16-Bit	Amps B Distortion Harm 17	999.9%		7
Analog Input	155	30	2/4	16-Bit	Amps B Distortion Harm 18			7
Analog Input	156	30	2/4	16-Bit	Amps B Distortion Harm 19			7
Analog Input	157	30	2/4	16-Bit	Amps B Distortion Harm 20			7
Analog Input	158	30	2/4	16-Bit	Amps B Distortion Harm 21			7
Analog Input	159	30	2/4	16-Bit	Amps B Distortion Harm 22			7
Analog Input	160	30	2/4	16-Bit	Amps B Distortion Harm 23			7
Analog Input	161	30	2/4	16-Bit	Amps B Distortion Harm 24			7
Analog Input	162	30	2/4	16-Bit	Amps B Distortion Harm 25			7
Analog Input	163	30	2/4	16-Bit	Amps B Distortion Harm 26			7
Analog Input	164	30	2/4	16-Bit	Amps B Distortion Harm 27			7
Analog Input	165	30	2/4	16-Bit	Amps B Distortion Harm 28			7
Analog Input	166	30	2/4	16-Bit	Amps B Distortion Harm 29			7
Analog Input	167	30	2/4	16-Bit	Amps B Distortion Harm 30			7
Analog Input	168	30	2/4	16-Bit	Amps B Distortion Harm 31			7
Analog Input	169	30	2/4	16-Bit	Amps C Distortion Denominator	32767=10*A Sec	DE	6
Analog Input	170	30	2/4	16-Bit	Amps C Distortion Harm 1	0 = 0.0% 9999 = 999.9%	DE	6
Analog Input	171	30	2/4	16-Bit	Amps C Distortion Harm 2			6

Description	Index	Default Static Variation			Point Name	Comments *For Cl1 option, divide value by 5	Model DE or IE	Class 0 Config Bit
		Obj	Var	Desc				
Analog Input	172	30	2/4	16-Bit	Amps C Distortion Harm 3	Harm 1 = Fundamental Harm 2 = 2x Fundamental etc.		6
Analog Input	173	30	2/4	16-Bit	Amps C Distortion Harm 4			6
Analog Input	174	30	2/4	16-Bit	Amps C Distortion Harm 5			6
Analog Input	175	30	2/4	16-Bit	Amps C Distortion Harm 6			6
Analog Input	176	30	2/4	16-Bit	Amps C Distortion Harm 7			6
Analog Input	177	30	2/4	16-Bit	Amps C Distortion Harm 8			6
Analog Input	178	30	2/4	16-Bit	Amps C Distortion Harm 9			6
Analog Input	179	30	2/4	16-Bit	Amps C Distortion Harm 10			6
Analog Input	180	30	2/4	16-Bit	Amps C Distortion Harm 11			6
Analog Input	181	30	2/4	16-Bit	Amps C Distortion Harm 12			6
Analog Input	182	30	2/4	16-Bit	Amps C Distortion Harm 13			6
Analog Input	183	30	2/4	16-Bit	Amps C Distortion Harm 14			6
Analog Input	184	30	2/4	16-Bit	Amps C Distortion Harm 15			6
Analog Input	185	30	2/4	16-Bit	Amps C Distortion Harm 16	0 = 0.0% 9999 = 999.9%	DE	7
Analog Input	186	30	2/4	16-Bit	Amps C Distortion Harm 17			7
Analog Input	187	30	2/4	16-Bit	Amps C Distortion Harm 18			7
Analog Input	188	30	2/4	16-Bit	Amps C Distortion Harm 19			7
Analog Input	189	30	2/4	16-Bit	Amps C Distortion Harm 20			7

Description	Index	Default Static Variation			Point Name	Comments *For CI1 option, divide value by 5	Model DE or IE	Class 0 Config Bit
		Obj	Var	Desc				
Analog Input	190	30	2/4	16-Bit	Amps C Distortion Harm 21			7
Analog Input	191	30	2/4	16-Bit	Amps C Distortion Harm 22			7
Analog Input	192	30	2/4	16-Bit	Amps C Distortion Harm 23			7
Analog Input	193	30	2/4	16-Bit	Amps C Distortion Harm 24			7
Analog Input	194	30	2/4	16-Bit	Amps C Distortion Harm 25			7
Analog Input	195	30	2/4	16-Bit	Amps C Distortion Harm 26			7
Analog Input	196	30	2/4	16-Bit	Amps C Distortion Harm 27			7
Analog Input	197	30	2/4	16-Bit	Amps C Distortion Harm 28			7
Analog Input	198	30	2/4	16-Bit	Amps C Distortion Harm 29			7
Analog Input	199	30	2/4	16-Bit	Amps C Distortion Harm 30			7
Analog Input	200	30	2/4	16-Bit	Amps C Distortion Harm 31			7
Analog Input	201	30	2/4	16-Bit	Volts A Distortion Denominator	32767=150V Sec	DE	8
Analog Input	202	30	2/4	16-Bit	Volts A Distortion Harm 1	0 = 0.0% 9999 = 999.9% Harm 1 = Fundamental Harm 2 = 2x Fundamental etc.	DE	8
Analog Input	203	30	2/4	16-Bit	Volts A Distortion Harm 2			8
Analog Input	204	30	2/4	16-Bit	Volts A Distortion Harm 3			8
Analog Input	205	30	2/4	16-Bit	Volts A Distortion Harm 4			8
Analog Input	206	30	2/4	16-Bit	Volts A Distortion Harm 5			8
Analog Input	207	30	2/4	16-Bit	Volts A Distortion Harm 6			8

Description	Index	Default Static Variation			Point Name	Comments *For CI1 option, divide value by 5	Model DE or IE	Class 0 Config Bit
		Obj	Var	Desc				
Analog Input	208	30	2/4	16-Bit	Volts A Distortion Harm 7			8
Analog Input	209	30	2/4	16-Bit	Volts A Distortion Harm 8			8
Analog Input	210	30	2/4	16-Bit	Volts A Distortion Harm 9			8
Analog Input	211	30	2/4	16-Bit	Volts A Distortion Harm 10			8
Analog Input	212	30	2/4	16-Bit	Volts A Distortion Harm 11			8
Analog Input	213	30	2/4	16-Bit	Volts A Distortion Harm 12			8
Analog Input	214	30	2/4	16-Bit	Volts A Distortion Harm 13			8
Analog Input	215	30	2/4	16-Bit	Volts A Distortion Harm 14			8
Analog Input	216	30	2/4	16-Bit	Volts A Distortion Harm 15			8
Analog Input	217	30	2/4	16-Bit	Volts A Distortion Harm 16	0 = 0.0% 9999 = 999.9%	DE	9
Analog Input	218	30	2/4	16-Bit	Volts A Distortion Harm 17			9
Analog Input	219	30	2/4	16-Bit	Volts A Distortion Harm 18			9
Analog Input	220	30	2/4	16-Bit	Volts A Distortion Harm 19			9
Analog Input	221	30	2/4	16-Bit	Volts A Distortion Harm 20			9
Analog Input	222	30	2/4	16-Bit	Volts A Distortion Harm 21			9
Analog Input	223	30	2/4	16-Bit	Volts A Distortion Harm 22			9
Analog Input	224	30	2/4	16-Bit	Volts A Distortion Harm 23			9
Analog Input	225	30	2/4	16-Bit	Volts A Distortion Harm 24			9

Description	Index	Default Static Variation			Point Name	Comments *For CI1 option, divide value by 5	Model DE or IE	Class 0 Config Bit
		Obj	Var	Desc				
Analog Input	226	30	2/4	16-Bit	Volts A Distortion Harm 25			9
Analog Input	227	30	2/4	16-Bit	Volts A Distortion Harm 26			9
Analog Input	228	30	2/4	16-Bit	Volts A Distortion Harm 27			9
Analog Input	229	30	2/4	16-Bit	Volts A Distortion Harm 28			9
Analog Input	230	30	2/4	16-Bit	Volts A Distortion Harm 29			9
Analog Input	231	30	2/4	16-Bit	Volts A Distortion Harm 30			9
Analog Input	232	30	2/4	16-Bit	Volts A Distortion Harm 31			9
Analog Input	233	30	2/4	16-Bit	Volts B Distortion Denominator	32767=150V Sec	DE	8
Analog Input	234	30	2/4	16-Bit	Volts B Distortion Harm 1	0 = 0.0% 9999 = 999.9% Harm 1 = Fundamental Harm 2 = 2x Fundamental etc.	DE	8
Analog Input	235	30	2/4	16-Bit	Volts B Distortion Harm 2			8
Analog Input	236	30	2/4	16-Bit	Volts B Distortion Harm 3			8
Analog Input	237	30	2/4	16-Bit	Volts B Distortion Harm 4			8
Analog Input	238	30	2/4	16-Bit	Volts B Distortion Harm 5			8
Analog Input	239	30	2/4	16-Bit	Volts B Distortion Harm 6			8
Analog Input	240	30	2/4	16-Bit	Volts B Distortion Harm 7			8
Analog Input	241	30	2/4	16-Bit	Volts B Distortion Harm 8			8
Analog Input	242	30	2/4	16-Bit	Volts B Distortion Harm 9			8
Analog Input	243	30	2/4	16-Bit	Volts B Distortion Harm 10			8

Description	Index	Default Static Variation			Point Name	Comments *For Cl1 option, divide value by 5	Model DE or IE	Class 0 Config Bit
		Obj	Var	Desc				
Analog Input	244	30	2/4	16-Bit	Volts B Distortion Harm 11			8
Analog Input	245	30	2/4	16-Bit	Volts B Distortion Harm 12			8
Analog Input	246	30	2/4	16-Bit	Volts B Distortion Harm 13			8
Analog Input	247	30	2/4	16-Bit	Volts B Distortion Harm 14			8
Analog Input	248	30	2/4	16-Bit	Volts B Distortion Harm 15			8
Analog Input	249	30	2/4	16-Bit	Volts B Distortion Harm 16	0 = 0.0% 9999 = 999.9%	DE	9
Analog Input	250	30	2/4	16-Bit	Volts B Distortion Harm 17			9
Analog Input	251	30	2/4	16-Bit	Volts B Distortion Harm 18			9
Analog Input	252	30	2/4	16-Bit	Volts B Distortion Harm 19			9
Analog Input	253	30	2/4	16-Bit	Volts B Distortion Harm 20			9
Analog Input	254	30	2/4	16-Bit	Volts B Distortion Harm 21			9
Analog Input	255	30	2/4	16-Bit	Volts B Distortion Harm 22			9
Analog Input	256	30	2/4	16-Bit	Volts B Distortion Harm 23			9
Analog Input	257	30	2/4	16-Bit	Volts B Distortion Harm 24			9
Analog Input	258	30	2/4	16-Bit	Volts B Distortion Harm 25			9
Analog Input	259	30	2/4	16-Bit	Volts B Distortion Harm 26			9
Analog Input	260	30	2/4	16-Bit	Volts B Distortion Harm 27			9
Analog Input	261	30	2/4	16-Bit	Volts B Distortion Harm 28			9

Description	Index	Default Static Variation			Point Name	Comments *For Cl1 option, divide value by 5	Model DE or IE	Class 0 Config Bit
		Obj	Var	Desc				
Analog Input	262	30	2/4	16-Bit	Volts B Distortion Harm 29			9
Analog Input	263	30	2/4	16-Bit	Volts B Distortion Harm 30			9
Analog Input	264	30	2/4	16-Bit	Volts B Distortion Harm 31			9
Analog Input	265	30	2/4	16-Bit	Volts C Distortion Denominator	32767=150V Sec	DE	8
Analog Input	266	30	2/4	16-Bit	Volts C Distortion Harm 1	0 = 0.0% 9999 = 999.9% Harm 1 = Fundamental Harm 2 = 2x Fundamental etc.	DE	8
Analog Input	267	30	2/4	16-Bit	Volts C Distortion Harm 2			8
Analog Input	268	30	2/4	16-Bit	Volts C Distortion Harm 3			8
Analog Input	269	30	2/4	16-Bit	Volts C Distortion Harm 4			8
Analog Input	270	30	2/4	16-Bit	Volts C Distortion Harm 5			8
Analog Input	271	30	2/4	16-Bit	Volts C Distortion Harm 6			8
Analog Input	272	30	2/4	16-Bit	Volts C Distortion Harm 7			8
Analog Input	273	30	2/4	16-Bit	Volts C Distortion Harm 8			8
Analog Input	274	30	2/4	16-Bit	Volts C Distortion Harm 9			8
Analog Input	275	30	2/4	16-Bit	Volts C Distortion Harm 10			8
Analog Input	276	30	2/4	16-Bit	Volts C Distortion Harm 11			8
Analog Input	277	30	2/4	16-Bit	Volts C Distortion Harm 12			8
Analog Input	278	30	2/4	16-Bit	Volts C Distortion Harm 13			8
Analog Input	279	30	2/4	16-Bit	Volts C Distortion Harm 14			8

Description	Index	Default Static Variation			Point Name	Comments *For Cl1 option, divide value by 5	Model DE or IE	Class 0 Config Bit
		Obj	Var	Desc				
Analog Input	280	30	2/4	16-Bit	Volts C Distortion Harm 15			8
Analog Input	281	30	2/4	16-Bit	Volts C Distortion Harm 16	0 = 0.0% 9999 = 999.9%	DE	9
Analog Input	282	30	2/4	16-Bit	Volts C Distortion Harm 17			9
Analog Input	283	30	2/4	16-Bit	Volts C Distortion Harm 18			9
Analog Input	284	30	2/4	16-Bit	Volts C Distortion Harm 19			9
Analog Input	285	30	2/4	16-Bit	Volts C Distortion Harm 20			9
Analog Input	286	30	2/4	16-Bit	Volts C Distortion Harm 21			9
Analog Input	287	30	2/4	16-Bit	Volts C Distortion Harm 22			9
Analog Input	288	30	2/4	16-Bit	Volts C Distortion Harm 23			9
Analog Input	289	30	2/4	16-Bit	Volts C Distortion Harm 24			9
Analog Input	290	30	2/4	16-Bit	Volts C Distortion Harm 25			9
Analog Input	291	30	2/4	16-Bit	Volts C Distortion Harm 26			9
Analog Input	292	30	2/4	16-Bit	Volts C Distortion Harm 27			9
Analog Input	293	30	2/4	16-Bit	Volts C Distortion Harm 28			9
Analog Input	294	30	2/4	16-Bit	Volts C Distortion Harm 29			9
Analog Input	295	30	2/4	16-Bit	Volts C Distortion Harm 30			9
Analog Input	296	30	2/4	16-Bit	Volts C Distortion Harm 31			9

Description	Index	Default Static Variation			Point Name	Comments *For CI1 option, divide value by 5	Model DE or IE	Class 0 Config Bit
		Obj	Var	Desc				
A.O. Status	0	40	2	16-Bit	CT Ratio	Same as AI-15	IE,DE	3
A.O. Status	1	40	2	16-Bit	CT Divisor	Same as AI-16	IE,DE	3
A.O. Status	2	40	2	16-Bit	PT Ratio	Same as AI-17	IE,DE	3
A.O. Status	3	40	2	16-bit	PT Divisor	Same as AI-18	IE,DE	3
A.O. Status	4	40	2	16-Bit	Configuration Register #1		IE,DE	Always
A.O. Status	5	40	2	16-Bit	Configuration Register #2	Always Read 0	IE,DE	Always
A.O. Status	6	40	2	16-Bit	Tag Register	0 to 32767	IE,DE	Always
A.O. Status	7	40	2	16-Bit	A TDD Denominator	32767=10*A Sec. (IE Models always return 0)	IE,DE	4,5,6,7,8 or 9
A.O. Status	8	40	2	16-Bit	B TDD Denominator			
A.O. Status	9	40	2	16-Bit	C TDD Denominator			
A.O. Status	10	40	2	16-Bit	Screen Config Register #1	See Table 2	IE,DE	3
A.O. Status	11	40	2	16-Bit	Screen Config Register #2			3
A.O. Status	12	40	2	16-Bit	Screen Config Register #3			3
A.O. Status	13	40	2	16-Bit	Screen Config Register #4			3
A.O. Status	14	40	2	16-Bit	Screen Config Register #5			3
A.O. Block	0	41	2	16-Bit	CT Ratio	Same as AI-15	IE,DE	Never
A.O. Block	1	41	2	16-Bit	CT Divisor	Same as AI-16	IE,DE	Never
A.O. Block	2	41	2	16-Bit	PT Ratio	Same as AI-	IE,DE	Never

Description	Index	Default Static Variation			Point Name	Comments *For Cl1 option, divide value by 5	Model DE or IE	Class 0 Config Bit
		Obj	Var	Desc				
						17		
A.O. Block	3	41	2	16-bit	PT Divisor	Same as AI-18	IE,DE	Never
A.O. Block	4	41	2	16-Bit	Configuration Register #1	See Table 3	IE,DE	Never
A.O. Block	5	41	2	16-Bit	Configuration Register #2		IE,DE	Never
A.O. Block	6	41	2	16-Bit	Tag Register	0 to 32767	IE,DE	Never
A.O. Block	7	41	2	16-Bit	A TDD Denominator	32767=10*A Sec. (Writeable in IE models, but always returns 0)	IE,DE	Never
A.O. Block	8	41	2	16-Bit	B TDD Denominator			Never
A.O. Block	9	41	2	16-Bit	C TDD Denominator			Never
A.O. Block	10	41	2	16-Bit	Screen Config Register #1	See Table 2	IE,DE	Never
A.O. Block	11	41	2	16-Bit	Screen Config Register #2			Never
A.O. Block	12	41	2	16-Bit	Screen Config Register #3			Never
A.O. Block	13	41	2	16-Bit	Screen Config Register #4			Never
A.O. Block	14	41	2	16-Bit	Screen Config Register #5			Never
Dev. Restart	7	80	1	-	Device Restart Bit	Write-only point	IE,DE	N/A

DNP3
DEVICE PROFILE DOCUMENT
This document must be accompanied by a table having the following headings:

Object Group	Request Function Codes	Response Function Codes
Object Variation	Request Qualifiers	Response Qualifiers
Object Name (optional)		

Vendor Name: Bitronics, LLC

Device Name:
MultiComm Alpha Series and PowerPlex Instruments
Firmware Version 4.20 and later with DNP 3.0 Interface Option

Models: MTWIE1B, MTWIE2B, MTWIE3B, MTWIEC1B, MTWIEC2B,
MTWDE1B, MTWDE2B, MTWDE3B, MTWDEC1B, MTWDEC2B
(with -S113 or -S123 options)
MTWIN1B, MTWIN2B, MTWIN3B, MTWDN1B, MTWDN2B,
MTWDN3B
(with -S530 or -S540 options)

Highest DNP Level Supported:	Device Function:
For Requests L1 For Responses L1	☐ Master ■ Slave

Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table):

Instrument supports READs of each object using either all points (Qual=06) or specific points using any qualifier defined in Basic 4 except Qual=11. Supports WARM RESTART. Control Relay Output Block (Energy and Demand Reset Commands) requires specific parameters described in manual. Responds with IIN PARAMETER ERROR if attempt to use FC=SELECT or OPERATE on Objects 12-1 or 41-2. Treats range field of qualifiers 07,08,09 to mean point range [0 .. –1]. Allows configuration of Class 0 Response.

Maximum Data Link Frame Size (octets):	Maximum Application Fragment Size (octets):
Transmitted 292 Received 292	Transmitted 2048 Received 249

Maximum Data Link Re-tries:	Maximum Application Layer Re-tries:
☐ None ■ Fixed at 10 ☐ Configurable, range ____ to ____	■ None ☐ Fixed at ________________________ ☐ Configurable, range ____ to ______

Requires Data Link Layer Confirmation:

☐ Never
☐ Always
☐ Sometimes   If 'Sometimes', when?

____

■ Configurable If 'Configurable', how? Set Bit 14 in Configuration Register #1 (AO 4) to enable

Requires Application Layer Confirmation:

■ Never
☐ Always (not recommended)
☐ When reporting Event Data (Slave devices only)
☐ When sending multi-fragment responses (Slave devices only)

☐ Sometimes   If 'Sometimes', when?

☐ Configurable If 'Configurable', how?

____

Timeouts while waiting for:

Data Link Confirm ☐ None ■ Fixed at 1000mS ☐ Variable ☐ Configurable
Complete Appl. Fragment ■ None ☐ Fixed at ________ ☐ Variable ☐ Configurable
Application Confirm ■ None ☐ Fixed at ________ ☐ Variable ☐ Configurable
Complete Appl. Response ■ None ☐ Fixed at ________ ☐ Variable ☐ Configurable
Others

____

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

Sends/Executes Control Operations:

WRITE Binary Outputs ■ Never ☐ Always ☐ Sometimes ☐ Configurable
SELECT/OPERATE ■ Never ☐ Always ☐ Sometimes ☐ Configurable
DIRECT OPERATE ☐ Never ■ Always ☐ Sometimes ☐ Configurable
DIRECT OPERATE - NO ACK ☐ Never ■ Always ☐ Sometimes ☐ Configurable

Count > 1 ■ Never ☐ Always ☐ Sometimes ☐ Configurable
Pulse On ☐ Never ■ Always ☐ Sometimes ☐ Configurable
Pulse Off ■ Never ☐ Always ☐ Sometimes ☐ Configurable
Latch On ■ Never ☐ Always ☐ Sometimes ☐ Configurable
Latch Off ■ Never ☐ Always ☐ Sometimes ☐ Configurable

Queue ■ Never ☐ Always ☐ Sometimes ☐ Configurable Clear Queue ■ Never ☐ Always ☐ Sometimes ☐ Configurable Attach explanation if 'Sometimes' or 'Configurable' was checked for any operation.	
Reports Binary Input Change Events when no specific variation requested (Slave Only): ■ Never ☐ Only time-tagged ☐ Only non-time-tagged ☐ Configurable to send both, one or the other (attach explanation)	Reports time-tagged Binary Input Change Events when no specific variation requested: ■ Never ☐ Binary Input Change With Time ☐ Binary Input Change With Relative Time ☐ Configurable (attach explanation)
Sends Unsolicited Responses (Slave Only): ■ Never ☐ Configurable (attach explanation) ☐ Only certain objects ☐ Sometimes (attach explanation) ☐ ENABLE/DISABLE UNSOLICITED Function codes supported	Sends Static Data in Unsolicited Responses (Slave Only): ■ Never ☐ When Device Restarts ☐ When Status Flags Change No other options are permitted. Sends Multi-Fragment Responses: ☐ Yes ☐ No
Default Counter Object/Variation: ☐ No Counters Reported ☐ Configurable (attach explanation) ■ Default Object 20 Default Variation 5 ☐ Point-by-point list attached	Counters Roll Over at: ☐ No Counters Reported ☐ Configurable (attach explanation) ☐ 16 Bits ■ 32 Bits - Counter #4 ■ Other Value 99,999,999 Counters #0-3 ☐ Point-by-point list attached
Sends Multi-Fragment Responses (Slave Only): ☐ Yes ■ No	

Revision	Date	Changes	By
A	01/30/2009	Update Bitronics Name, Logo	E. DeMicco
B	08/10/09	Updated logos and cover page	MarCom
C	06/15/2010	Corrected errors for 2, 2 ½ and 3 element equations	E. DeMicco

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