MultiComm™

Modbus® RTU Interface

Option Manual

November 2009
ML0002 Document Revision B

-S093 (Formerly DOS9.3)	RS-232C Modbus RTU Protocol
-S103 (Formerly DOS10.3)	RS-485 Modbus RTU Protocol

Firmware Version 3.70 and Later
Includes Information on CI1 Option (1 Amp Inputs)
Includes VI4-480V ac, VI3-277V ac, VI2 – 240V ac and VD4A, VA2, VA4, and VA8 Options

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FIRMWARE REVISIONS

Modbus 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 support for optional Demand functions. Used with Version 3.40 MultiComm Meter Firmware.
2.00	Added support for optional RTH (harmonic) functions. Added Tag Register. Added network screen setup.
2.10	Added MultiComm RT (instantaneous models) Fixed Watt/VAR/VA over-range (Version 2.0 returns 7FFFh for <-3000 or >3000)

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For assistance, contact Bitronics LLC at:

Telephone: 610.997.5100
Fax: 610.997.5450
Email: bitronics@novatechps.com
Website: www.novatechweb.com/bitronics

Shipping:
261 Brodhead Road
Bethlehem, PA 18017-8698
USA

1.0 DESCRIPTION

1.1 Introduction

The -S093 and -S103 Modbus [1] RTU SLAVE protocol option for the MultiComm family of instruments is designed to allow operation of these instruments on MODBUS networks. The MODBUS protocol is a widely supported open interconnect originally designed by Modicon. The -S093 option provides point-to-point communication using RS-232C as the physical link. The -S103 option provides multi-drop access to networks using RS-485 as the physical link.

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
* Simple command to read any number of instrument quantities
* Simple energy and demand reset commands
* Supports remote setting of CT and PT scaling factors
* "Anti-jabber" hardware on RS-485 transmitter isolates instrument during fault

1.3 Specifications

Resolution:

Amperes:	0.1% of 5* A nominal
Volts:	0.07% of 120V nominal
Frequency:	0.01 Hz
Watts/VARs/VAs:	
Per Phase:	0.1% of 500* secondary Watts nominal
Total:	0.1% of 1500* secondary Watts nominal (2 ½ or 3 ELEMENT)
	0.1% of 1000* secondary Watts nominal (2 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] - MODICON® and MODBUS® are registered trademarks of Schneider Automation

1.3 Specifications, (Cont'd)

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

Modbus

Connector:	4-pin Terminal Block for shielded twisted pair
Communication:	RTU Mode, 9600 Baud, 8 Data, 1 Stop, Even Parity, Half Duplex
Interface:	2 wire RS-485 Option -S103, or 3 wire RS-232C Option -S093
Distance:	4,000 ft (1,200m) RS-485, 50 ft RS-232C
Functions:	Read Holding Registers (FUNC 3) Preset Single Register (FUNC 6) and Preset Multiple Register (FUNC 16) for Writeable Registers Only Diagnostics (FUNC 8 - SUBFUNC 0,0) Diagnostics (Loopback)
Response Time:	Modbus response begins < 50 msec after valid command received
Addressability:	Modbus addresses 1..247 (broadcast address 00 not supported)
Anti-Jabber:	RS-485 line becomes passive 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 Modbus network connects to the output connector board which in turn is driven by the interface transceiver which is controlled by the Modbus interface processor.

2.2 Output Connector Board

The Modbus 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 Figures 7-9 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 Modbus cable. This circuit is an RS-232C transceiver IC for the -S093 option. The -S103 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 Modbus network, as well as communicating with the HOST processor. The HOST processor handles all other functions of the instrument. Approximately every 150 msec (600msec for non “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.

Another function of the MultiComm processor is to handle all the Modbus messages. When the MultiComm processor receives a Modbus message, it checks if the Modbus ADDRESS of the message is the address of this instrument. 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 Modbus ADDRESS matches this instrument, the MultiComm processor generates a response. If the message is a READ HOLDING REGISTER, the MultiComm processor generates the response from its copy of the meter data. If the message is a PRESET SINGLE REGISTER or PRESET MULTIPLE REGISTERS (energy/demand resets or CT/PT ratio setups), the MultiComm processor generates a MODBUS 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 -S103 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 Modbus 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 3.7 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 MODBUS INTERFACE

3.1 Description

The Modbus 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 Modbus device (PLC, Computer, MultiComm instrument, etc.) which is connected to the network. Each SLAVE NODE has an ADDRESS in the range of 1 to 247, and it is this address that allows a MASTER to selectively request data from any other device. Address 0 is a BROADCAST ADDRESS that can be used with certain MODBUS functions to allow the MASTER to address all SLAVE NODES at one time. MultiComm Instruments do not respond to BROADCAST Messages.

The Modbus implementation in the MultiComm instrument conforms to all the standard Modbus specifications and capabilities, such as maximum nodes, distance, signal sensitivity, etc. The MultiComm instrument is classified as a SLAVE DEVICE in the Modbus structure. The data items that are available from the instrument can be obtained via the Modbus Network by issuing a READ HOLDING REGISTERS command from the requesting node.

3.2 Modbus Address

Each MODBUS instrument responds to a single MODBUS ADDRESS. The address is in the range of 1-247, and each instrument must have a unique address. See section 5.1 for instructions on setting the address.

3.3 Transaction Timing

The instrument completes a set of calculations approximately every 100 to 150msec for "B" Models (600msec for "A" Models). At the completion of the calculation the HOST processor services any pending transactions (RESETs and CT/PT ratio setups) and updates the DATA in the MultiComm Processor. Since the MultiComm Processor maintains a copy of the data, all Modbus READs are answered within 50 milliseconds. WRITE requests (reset energy, CT/PT Ratio) are confirmed by the MultiComm processor within 50 milliseconds, but the actual RESET or CT/PT Ratio write will not occur for up to 600 milliseconds, since the MultiComm processor must issue a transaction to the HOST. An additional 10 seconds are required to write to the EEPROM.

3.4 Data Format

The instrument contains a set of holding registers (4XXXX) into which the instrument places values that correspond to the measurements the instrument is making. These holding registers can be read by any other device on the network using a READ HOLDING REGISTER (Function Code 3).

When using HOLDING REGISTER DATA, the Health Check Register 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 data is represented in **OFFSET BINARY** 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 MultiComm Instruments. The available registers depend upon the particular model of MultiComm instrument. The registers have been broken down into four blocks, which are shown in Figure 1. These various blocks are listed on the following pages. Table 1 indicates which blocks pertain to which models. The registers are also divided into two sections by Element Type, 2½ or 3 Element models are in the first section, and 2 Element models are in the second section. Note that unless otherwise specified, all registers are READ-ONLY.

	Instan-taneous	Demand	RTH Summary	RTH Individuals	Element Type
MTWIE(C)1A,3A,1B,3B	X				3 / 2½
MTWIE(C)2A,2B	X				2
MTWDE(C)1A,3A	X	X			3 / 2½
MTWDE(C)2A	X	X			2
MTWDE(C)1B,3B	X	X	X	X	3 / 2½
MTWDE(C)2B	X	X	X	X	2

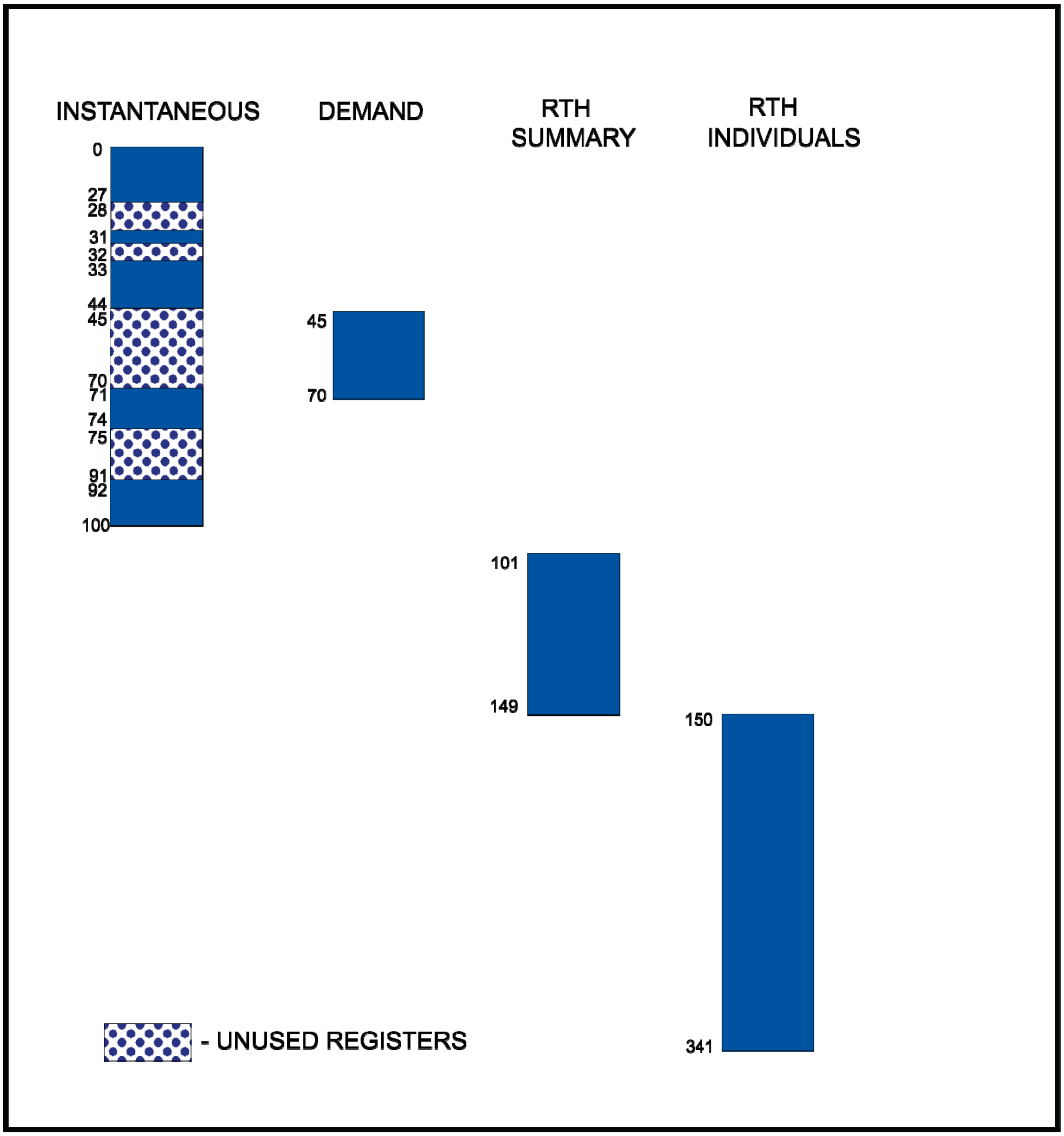

Figure 1 - Register Memory Map

3.4.1 INSTANTANEOUS Data Registers for 2 ½ or 3 Element Models

Quantity	Holding Register	Representation
Health Check	40001	Refer to Section 3.7
Amperes Phase A	40002	2047 = 0Amps; 4095 = 10.0* Amps
Amperes Phase B	40003	
Amperes Phase C	40004	
Volts Phase A-N	40005	2047 = 0Volts; 4095 = 150.0Volts
Volts Phase B-N	40006	
Volts Phase C-N	40007	
Watts Total 3 Phase	40008	0 = -3000* Watts; 2047 = 0Watts; 4095 = +3000* Watts
VARs Total 3 Phase	40009	0 = -3000* VARs; 2047 = 0VARs; 4095 = +3000* VARs
Watts Phase A	40010	0 = -1000* Watts; 2047 = 0Watts 4095 = +1000* Watts
Watts Phase B	40011	
Watts Phase C	40012	
VARs Phase A	40013	0 = -1000* VARs; 2047 = 0VARs 4095 = +1000* VARs
VARs Phase B	40014	
VARs Phase C	40015	
CT Ratio	40016	Normalized ratio (Does not include decimal point) 500< Ratio <9999 (CT:5) or (CT:1 with CT1 option)
PT Ratio	40017	1000 < Ratio < 9999 (PT)
Neutral Current	40018	2047 = 0Amps; 4095 = 15.0* Amps
+ kWatthour (High)	40019	0=0kWh; 9999=99,990,000kWh
+ kWatthour (Low)	40020	0=0kWh; 9999=9,999kWh
- kWatthour (High)	40021	0=0kWh; 9999=-99,990,000kWh
- kWatthour (Low)	40022	0=0kWh; 9999=-9,999kWh
+ kVARhour (High)	40023	0=0kVARh; 9999=99,990,000kVARh
+ kVARhour (Low)	40024	0=0kVARh; 9999=9,999kVARh
- kVARhour (High)	40025	0=0kVARh; 9999=-99,990,000kVARh
- kVARhour (Low)	40026	0=0kVARh; 9999=-9,999kVARh

* - 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	Holding Register	Representation
Frequency	40027	0 = <45.00Hz; 4500 = 45.00Hz 7500 = 75.00Hz; 9999 =>75.00Hz
Unused	40028	|
Unused	40029	| Always 2047
Unused	40030	|
Heartbeat State Counter	40031	See Section 3.9
Unused	40032	Always 2047
VAs Phase A	40033	|
VAs Phase B	40034	| 2047 = 0VA; 4095 = 1000*VA
VAs Phase C	40035	|
VAs Total 3 Phase	40036	2047 = 0VAs; 4095 = 3000*VAs
PF Phase A	40037	| 1047 = -1; 2047 = 0; 3047 = +1
PF Phase B	40038	| 4046 = Amps or Volts too low
PF Phase C	40039	| (-) lagging; (+) leading
PF Total 3 Phase	40040	1047 = -1; 2047 = 0; 3047 = +1 4046 = Amps or Volts too low (-) lagging; (+) leading
CT Ratio	40041	Read/Write normalized ratio, copied to 40016
CT Ratio Divisor	40042	Read/Write; = 1,10,100, or 1000
PT Ratio	40043	Read/Write normalized ratio, copied to 40017
PT Ratio Divisor	40044	Read/Write; = 1,10,100, or 1000
Unused	40045-70	Always 2047

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

3.4.1 INSTANTANEOUS Data Registers for 2 ½ or 3 Element Mode (Cont'd)

Quantity	Holding Register	Representation
Meter Type Identifier	40071	See **Table 4**
Communications Firmware Rev.	40072	Packed BCD XX.XX
Host Firmware Rev.	40073	Packed BCD XX.XX
Host Micro Firmware Rev.	40074	Packed BCD XX.XX
Unused	40075-91	Always 2047
Display Screen Setup Register 1	40092	Read/Write - See **Table 3**
Display Screen Setup Register 2	40093	Read/Write - See **Table 3**
Display Screen Setup Register 3	40094	Read/Write - See **Table 3**
Display Screen Setup Register 4	40095	Read/Write - See **Table 3**
Display Screen Setup Register 5	40096	Read/Write - See **Table 3**
Configuration Setup Register 1	40097	Read/Write - Future Expansion Always returns 0
Configuration Setup Register 2	40098	Read/Write - Future Expansion Always returns 0
User Writeable Tag Register	40099	Read/Write - 0 to 32,767
Energy RESET	40100	Write ONLY; Bit 0 - See **Table 2**
Unused	40101-103	Always 2047

3.4.2 DEMAND Data Registers for 2 ½ or 3 Element Models

Quantity	Holding Register	Representation
Present Demand Amps φA	40045	|
Present Demand Amps φB	40046	| 2047[1] = 0Amps; 4095 = 10.0[*]Amps
Present Demand Amps φC	40047	|
Max Demand Amps φA	40048	|
Max Demand Amps φB	40049	| 2047[1] = 0Amps; 4095 = 10.0[*]Amps
Max Demand Amps φC	40050	|
Present Demand Amps N	40051	2047[1] = 0Amps; 4095 = 15.0[*]Amps
Max Demand Amps N	40052	2047[1] = 0Amps; 4095 = 15.0[*]Amps
Present Demand Volts φA	40053	|
Present Demand Volts φB	40054	| 2047[1] = 0Volts; 4095 = 150.0Volts
Present Demand Volts φC	40055	|
Max Demand Volts φA	40056	|
Max Demand Volts φB	40057	| 2047[1] = 0Volts; 4095 = 150.0Volts
Max Demand Volts φC	40058	|
Min Demand Volts φA	40059	|
Min Demand Volts φB	40060	| 2047[1] = 0Volts; 4095 = 150.0Volts
Min Demand Volts φC	40061	|
Present Demand Watts Total	40062	| 0 = -3000[*]Watts; 2047[1] = 0Watts
Max Demand Watts Total	40063	| 4095 = +3000[*]Watts
Min Demand Watts Total	40064	|
Present Demand VARs Total	40065	| 0 = -3000[*]VARs; 2047[1] = 0VARs
Max Demand VARs Total	40066	| 4095 = +3000[*]VARs
Min Demand VARs Total	40067	|
Present Demand VAs Total	40068	|
Max Demand VAs Total	40069	| 2047[1] = 0VAs; 4095 = +3000[*]VAs
Min Demand VAs Total	40070	|
Amp Demand RESET	40100	Read/Write Bit 1 - See **Table 2**
Volt Demand RESET	40100	Read/Write Bit 2 - See **Table 2**
Power Demand RESET	40100	Read/Write Bit 3 - See **Table 2**

[*] - When CI1 Option (1Amp Input) is installed, divide this value by 5
[1] - MTWIExB models always return the value 2047

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

Quantity	Holding Register	Representation
Amp Demand RESET	40100	Read/Write Bit 1 - See **Table 2**
Volt Demand RESET	40100	Read/Write Bit 2 - See **Table 2**
Power Demand RESET	40100	Read/Write Bit 3 - See **Table 2**
Harmonic Demand RESET	40100	Read/Write Bit 4 - See **Table 2**
TDD Denominator Amps φA	40101	Read/Write 2047[1] = 0Amps;
TDD Denominator Amps φB	40102	4095 = 10.0[*]Amps. If reg = 2047, then
TDD Denominator Amps φC	40103	Fund Amps will be used (THD)
		Factory Default = 5[*] Amps Secondary
Fundamental Amps φA	40104	
Fundamental Amps φB	40105	2047 = 0Amps; 4095 = 10.0[*]Amps
Fundamental Amps φC	40106	
Fundamental Amps Neutral	40107	2047 = 0Amps; 4095 = 15.0[*]Amps
Fundamental Volts φA	40108	
Fundamental Volts φB	40109	2047 = 0Volts; 4095 = 150.0Volts
Fundamental Volts φC	40110	
TDD[2] Amps φA	40111	
TDD[2] Amps φB	40112	0 = 0.0%; 9999 = 999.9%
TDD[2] Amps φC	40113	Set to 0 on low signal
TDD[2] Odd Amps φA	40114	
TDD[2] Odd Amps φB	40115	0 = 0.0%; 9999 = 999.9%
TDD[2] Odd Amps φC	40116	Set to 0 on low signal
TDD[2] Even Amps φA	40117	
TDD[2] Even Amps φB	40118	0 = 0.0%; 9999 = 999.9%
TDD[2] Even Amps φC	40119	Set to 0 on low signal
THD Volts φA	40120	
THD Volts φB	40121	0 = 0.0%; 9999 = 999.9%
THD Volts φC	40122	Set to 0 on low signal
THD Odd Volts φA	40123	
THD Odd Volts φB	40124	0 = 0.0%; 9999 = 999.9%
THD Odd Volts φC	40125	Set to 0 on low signal
THD Even Volts φA	40126	
THD Even Volts φB	40127	0 = 0.0%; 9999 = 999.9%
THD Even Volts φC	40128	Set to 0 on low signal

[*] - When CI1 Option (1Amp Input) is installed, divide this value by 5
[1] - MTWIExB models always return the value 2047
[2] - If TDD Denominator is set to 2047 (0Amps) the TDD calculation will use Fundamental Amps as the Denominator, which will result in all Current Distortions being expressed as THD.

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

Quantity	Holding Register	Representation
K-Factor Amps φA	40129	|
K-Factor Amps φB	40130	| 100 = 1.00; 65535 = 655.35
K-Factor Amps φC	40131	| Set to 100 on low signal
Displacement PF φA	40132	| 1047 = -1; 2047 = 0; 3047 = +1
Displacement PF φB	40133	| 4046 = Amps or Volts too low
Displacement PF φC	40134	| (-) lagging; (+) leading
Displacement PF Total	40135	1047 = -1; 2047 = 0; 3047 = +1 4046 = Amps or Volts too low (-) lagging; (+) leading
Present Demand Fund. Amps N	40136	2047 = 0Amps; 4095 = 15.0* Amps
Max Demand Fund. Amps N	40137	2047 = 0Amps; 4095 = 15.0* Amps
Present Demand TDD[1] Amps φA	40138	|
Present Demand TDD[1] Amps φB	40139	| 0 = 0.0%; 9999 = 999.9%
Present Demand TDD[1] Amps φC	40140	|
Max Demand TDD[1] Amps φA	40141	|
Max Demand TDD[1] Amps φB	40142	| 0 = 0.0%; 9999 = 999.9%
Max Demand TDD[1] Amps φC	40143	|
Present Demand THD Volts φA	40144	|
Present Demand THD Volts φB	40145	| 0 = 0.0%; 9999 = 999.9%
Present Demand THD Volts φC	40146	|
Max Demand THD Volts φA	40147	|
Max Demand THD Volts φB	40148	| 0 = 0.0%; 9999 = 999.9%
Max Demand THD Volts φC	40149	|

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

[1] If TDD Denominator is set to 2047 (0Amps) the TDD calculation will use Fundamental Amps as the Denominator, which will result in all Current Distortions being expressed as THD.

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

Quantity	Holding Register	Representation
φA Amps Distortion Denominator	40150	| 2047 = 0Amps; 4095 = 10.0*Amps | =40101 if TDD, =40104 if THD
φA Amps Demand Distortion[1] - I_1	40151	|
φA Amps Demand Distortion[1] - I_2	40152	|
:	:	| 0 = 0.0%; 9999 = 999.9%
:	:	| Set to 0 on low signal
φA Amps Demand Distortion[1] - I_{30}	40180	|
φA Amps Demand Distortion[1] - I_{31}	40181	|
φA Volts Distortion Denominator	40182	| 2047 = 0Volts; 4095 = 150.0Volts | =40108
φA Volts Harm. Distortion - V_1	40183	|
φA Volts Harm. Distortion - V_2	40184	|
:	:	| 0 = 0.0%; 9999 = 999.9%
:	:	| Set to 0 on low signal
φA Volts Harm. Distortion - V_{30}	40212	|
φA Volts Harm. Distortion - V_{31}	40213	|
φB Amps Distortion Denominator	40214	| 2047 = 0Amps; 4095 = 10.0*Amps | =40102 if TDD, =40105 if THD
φB Amps Demand Distortion[1] - I_1	40215	|
φB Amps Demand Distortion[1] - I_2	40216	|
:	:	| 0 = 0.0%; 9999 = 999.9%
:	:	| Set to 0 on low signal
φB Amps Demand Distortion[1] - I_{30}	40244	|
φB Amps Demand Distortion[1] - I_{31}	40245	|
φB Volts Distortion Denominator	40246	| 2047 = 0Volts; 4095 = 150.0Volts | =40109
φB Volts Harm. Distortion - V_1	40247	|
φB Volts Harm. Distortion - V_2	40248	|
:	:	| 0 = 0.0%; 9999 = 999.9%
:	:	| Set to 0 on low signal
φB Volts Harm. Distortion - V_{30}	40276	|
φB Volts Harm. Distortion - V_{31}	40277	|

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

[1] If TDD Denominator is set to 2047 (0Amps) the TDD calculation will use Fundamental Amps as the Denominator, which will result in all Current Distortions being expressed as THD.

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

Quantity	Holding Register	Representation
φC Amps Distortion Denominator	40278	2047 = 0Amps; 4095 = 10.0*Amps =40103 if TDD, =40106 if THD
φC Amps Demand Distortion[1] - I_1	40279	0 = 0.0%; 9999 = 999.9% Set to 0 on low signal
φC Amps Demand Distortion[1] - I_2	40280	
:	:	
:	:	
φC Amps Demand Distortion[1] - I_{30}	40308	
φC Amps Demand Distortion[1] - I_{31}	40309	
φC Volts Distortion Denominator	40310	2047 = 0Volts; 4095 = 150.0Volts =40110
φC Volts Harm. Distortion - V_1	40311	0 = 0.0%; 9999 = 999.9% Set to 0 on low signal
φC Volts Harm. Distortion - V_2	40312	
:	:	
:	:	
φC Volts Harm. Distortion - V_{30}	40340	
φC Volts Harm. Distortion - V_{31}	40341	

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

[1] If TDD Denominator is set to 2047 (0Amps) the TDD calculation will use Fundamental Amps as the Denominator, which will result in all Current Distortions being expressed as THD.

3.4.5 INSTANTANEOUS Data Registers for 2 Element Mode

Quantity	Holding Register	Representation
Health Check	40001	Refer to Section 3.7
Amperes Phase A Amperes Phase B Amperes Phase C	40002 40003 40004	2047 = 0Amps; 4095 = 10.0*Amps
Volts Phase A-B Volts Phase B-C Volts Phase C-A	40005 40006 40007	2047 = 0Volts; 4095 = 150.0Volts
Watts Total 3 Phase	40008	0 = -2000*Watts; 2047 = 0Watts; 4095 = +2000*Watts
VARs Total 3 Phase	40009	0 = -2000*VARs; 2047 = 0VARs; 4095 = +2000*VARs
Unused Unused Unused	40010 40011 40012	Always 2047
Unused Unused Unused	40013 40014 40015	Always 2047
CT Ratio PT Ratio	40016 40017	Normalized ratio (Does not include decimal point) 500< Ratio <9999 (CT:5) or (CT:1 with CT1 option) 1000 < Ratio < 9999 (PT)
Unused	40018	Always 2047
+ kWatthour (High) + kWatthour (Low)	40019 40020	0=0kWh; 9999=99,990,000kWh 0=0kWh; 9999=9,999kWh
- kWatthour (High) - kWatthour (Low)	40021 40022	0=0kWh; 9999=-99,990,000kWh 0=0kWh; 9999=-9,999kWh
+ kVARhour (High) + kVARhour (Low)	40023 40024	0=0kVARh;9999=99,990,000kVARh 0=0kVARh; 9999=9,999kVARh
- kVARhour (High) - kVARhour (Low)	40025 40026	0=0kVARh; 9999=-99,990,000kVARh 0=0kVARh; 9999=-9,999kVARh

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

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

Quantity	Holding Register	Representation
Frequency	40027	0 = <45.00Hz; 4500 = 45.00Hz 7500 = 75.00Hz; 9999 =>75.00Hz
Unused	40028	
Unused	40029	Always 2047
Unused	40030	
Heartbeat State Counter	40031	See Section 3.9
Unused	40032	
Unused	40033	Always 2047
Unused	40034	
Unused	40035	
VAs Total 3 Phase	40036	2047 = 0VAs; 4095 = 2000*VAs
Unused	40037	
Unused	40038	Always 2047
Unused	40039	
PF Total 3 Phase	40040	1047 = -1; 2047 = 0; 3047 = +1 4046 = Amps or Volts too low (-) lagging; (+) leading
CT Ratio	40041	Read/Write normalized ratio, copied to 40016
CT Ratio Divisor	40042	Read/Write; = 1,10,100, or 1000
PT Ratio	40043	Read/Write normalized ratio, copied to 40017
PT Ratio Divisor	40044	Read/Write; = 1,10,100, or 1000
Unused	40045-70	Always 2047

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

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

Quantity	Holding Register	Representation
Meter Type Identifier	40071	See **Table 4**
Communications Firmware Rev.	40072	Packed BCD XX.XX
Host Firmware Rev.	40073	Packed BCD XX.XX
Host Micro Firmware Rev.	40074	Packed BCD XX.XX
Unused	40075-91	Always 2047
Display Screen Setup Register 1	40092	Read/Write - See **Table 3**
Display Screen Setup Register 2	40093	Read/Write - See **Table 3**
Display Screen Setup Register 3	40094	Read/Write - See **Table 3**
Display Screen Setup Register 4	40095	Read/Write - See **Table 3**
Display Screen Setup Register 5	40096	Read/Write - See **Table 3**
Configuration Setup Register 1	40097	Read/Write - Future Expansion Always returns 0
Configuration Setup Register 2	40098	Read/Write - Future Expansion Always returns 0
User Writeable Tag Register	40099	Read/Write - 0 to 32,767
Energy RESET	40100	Write ONLY; Bit 0 - See **Table 2**
Unused	40101-103	Always 2047

3.4.6 DEMAND Data Registers for 2 Element Mode

Quantity	Holding Register	Representation
Present Demand Amps φA	40045	| 2047[1] = 0Amps; 4095 = 10.0[*]Amps
Present Demand Amps φB	40046	|
Present Demand Amps φC	40047	|
Max Demand Amps φA	40048	| 2047[1] = 0Amps; 4095 = 10.0[*]Amps
Max Demand Amps φB	40049	|
Max Demand Amps φC	40050	|
Unused	40051	Always 2047[1]
Unused	40052	Always 2047[1]
Present Demand Volts φA-B	40053	| 2047[1] = 0Volts; 4095 = 150.0Volts
Present Demand Volts φB-C	40054	|
Present Demand Volts φC-A	40055	|
Max Demand Volts φA-B	40056	| 2047[1] = 0Volts; 4095 = 150.0Volts
Max Demand Volts φB-C	40057	|
Max Demand Volts φC-A	40058	|
Min Demand Volts φA-B	40059	| 2047[1] = 0Volts; 4095 = 150.0Volts
Min Demand Volts φB-C	40060	|
Min Demand Volts φC-A	40061	|
Present Demand Watts Total	40062	| 0 = -2000[*]Watts; 2047[1] = 0Watts
Max Demand Watts Total	40063	| 4095 = +2000[*]Watts
Min Demand Watts Total	40064	|
Present Demand VARs Total	40065	| 0 = -2000[*]VARs; 2047[1] = 0VARs
Max Demand VARs Total	40066	| 4095 = +2000[*]VARs
Min Demand VARs Total	40067	|
Present Demand VAs Total	40068	| 2047[1] = 0VAs; 4095 = +2000[*]VAs
Max Demand VAs Total	40069	|
Min Demand VAs Total	40070	|
Amp Demand RESET	40100	Read/Write Bit 1 - See **Table 2**
Volt Demand RESET	40100	Read/Write Bit 2 - See **Table 2**
Power Demand RESET	40100	Read/Write Bit 3 - See **Table 2**

[*] - When CI1 Option (1Amp Input) is installed, divide this value by 5
[1] - MTWIExB models always return the value 2047

3.4.7 RTH SUMMARY Data Registers for 2 Element Mode

Quantity	Holding Register	Representation
Amp Demand RESET	40100	Read/Write Bit 1 - See **Table 2**
Volt Demand RESET	40100	Read/Write Bit 2 - See **Table 2**
Power Demand RESET	40100	Read/Write Bit 3 - See **Table 2**
Harmonic Demand RESET	40100	Read/Write Bit 4 - See **Table 2**
TDD Denominator Amps φA	40101	Read/Write 2047[1] = 0Amps;
TDD Denominator Amps φB	40102	4095 = 10.0[*]Amps. If reg = 2047, then
TDD Denominator Amps φC	40103	Fund Amps will be used (THD)
		Factory Default = 5[*] Amps Secondary
Fundamental Amps φA	40104	
Fundamental Amps φB	40105	2047 = 0Amps; 4095 = 10.0[*]Amps
Fundamental Amps φC	40106	
Unused	40107	Always 2047
Fundamental Volts φA-B	40108	
Fundamental Volts φB-C	40109	2047 = 0Volts; 4095 = 150.0Volts
Fundamental Volts φC-A	40110	
TDD[2] Amps φA	40111	
TDD[2] Amps φB	40112	0 = 0.0%; 9999 = 999.9%
TDD[2] Amps φC	40113	Set to 0 on low signal
TDD[2] Odd Amps φA	40114	
TDD[2] Odd Amps φB	40115	0 = 0.0%; 9999 = 999.9%
TDD[2] Odd Amps φC	40116	Set to 0 on low signal
TDD[2] Even Amps φA	40117	
TDD[2] Even Amps φB	40118	0 = 0.0%; 9999 = 999.9%
TDD[2] Even Amps φC	40119	Set to 0 on low signal
THD Volts φA-B	40120	
THD Volts φB-C	40121	0 = 0.0%; 9999 = 999.9%
THD Volts φC-A	40122	Set to 0 on low signal
THD Odd Volts φA-B	40123	
THD Odd Volts φB-C	40124	0 = 0.0%; 9999 = 999.9%
THD Odd Volts φC-A	40125	Set to 0 on low signal
THD Even Volts φA-B	40126	
THD Even Volts φB-C	40127	0 = 0.0%; 9999 = 999.9%
THD Even Volts φC-A	40128	Set to 0 on low signal

[*] - When CI1 Option (1Amp Input) is installed, divide this value by 5
[1] - MTWIExB models always return the value 2047
[2] If TDD Denominator is set to 2047 (0Amps) the TDD calculation will use Fundamental Amps as the Denominator, which will result in all Current Distortions being expressed as THD.

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

Quantity	Holding Register	Representation
K-Factor Amps φA	40129	100 = 1.00; 65535 = 655.35 Set to 100 on low signal
K-Factor Amps φB	40130	
K-Factor Amps φC	40131	
Unused	40132	Always 2047
Unused	40133	
Unused	40134	
Displacement PF Total	40135	1047 = -1; 2047 = 0; 3047 = +1 4046 = Amps or Volts too low (-) lagging; (+) leading
Unused	40136	Always 2047
Unused	40137	
Present Demand TDD[1] Amps φA	40138	0 = 0.0%; 9999 = 999.9%
Present Demand TDD[1] Amps φB	40139	
Present Demand TDD[1] Amps φC	40140	
Max Demand TDD[1] Amps φA	40141	0 = 0.0%; 9999 = 999.9%
Max Demand TDD[1] Amps φB	40142	
Max Demand TDD[1] Amps φC	40143	
Present Demand THD Volts φA-B	40144	0 = 0.0%; 9999 = 999.9%
Present Demand THD Volts φB-C	40145	
Present Demand THD Volts φC-A	40146	
Max Demand THD Volts φA-B	40147	0 = 0.0%; 9999 = 999.9%
Max Demand THD Volts φB-C	40148	
Max Demand THD Volts φC-A	40149	

[1] If TDD Denominator is set to 2047 (0Amps) the TDD calculation will use Fundamental Amps as the Denominator, which will result in all Current Distortions being expressed as THD.

3.4.8 RTH INDIVIDUAL Data Registers for 2 Element Mode

Quantity	Holding Register	Representation
φA Amps Distortion Denominator	40150	2047 = 0Amps; 4095 = 10.0* Amps =40101 if TDD, =40104 if THD
φA Amps Demand Distortion[1] - I_1	40151	0 = 0.0%; 9999 = 999.9% Set to 0 on low signal
φA Amps Demand Distortion[1] - I_2	40152	
:	:	
:	:	
φA Amps Demand Distortion[1] - I_{30}	40180	
φA Amps Demand Distortion[1] - I_{31}	40181	
φA-B Volts Distortion Denominator	40182	2047 = 0Volts; 4095 = 150.0Volts =40108
φA-B Volts Harm. Distortion - V_1	40183	0 = 0.0%; 9999 = 999.9% Set to 0 on low signal
φA-B Volts Harm. Distortion - V_2	40184	
:	:	
:	:	
φA-B Volts Harm. Distortion - V_{30}	40212	
φA-B Volts Harm. Distortion - V_{31}	40213	
φB Amps Distortion Denominator	40214	2047 = 0Amps; 4095 = 10.0* Amps =40102 if TDD, =40105 if THD
φB Amps Demand Distortion[1] - I_1	40215	0 = 0.0%; 9999 = 999.9% Set to 0 on low signal
φB Amps Demand Distortion[1] - I_2	40216	
:	:	
:	:	
φB Amps Demand Distortion[1] - I_{30}	40244	
φB Amps Demand Distortion[1] - I_{31}	40245	
φB-C Volts Distortion Denominator	40246	2047 = 0Volts; 4095 = 150.0Volts =40109
φB-C Volts Harm. Distortion - V_1	40247	0 = 0.0%; 9999 = 999.9% Set to 0 on low signal
φB-C Volts Harm. Distortion - V_2	40248	
:	:	
:	:	
φB-C Volts Harm. Distortion - V_{30}	40276	
φB-C Volts Harm. Distortion - V_{31}	40277	

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

[1] If TDD Denominator is set to 2047 (0Amps) the TDD calculation will use Fundamental Amps as the Denominator, which will result in all Current Distortions being expressed as THD.

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

Quantity	Holding Register	Representation
φC Amps Distortion Denominator	40278	2047 = 0Amps; 4095 = 10.0* Amps =40103 if TDD, =40106 if THD
φC Amps Demand Distortion[1] - I_1	40279	0 = 0.0%; 9999 = 999.9% Set to 0 on low signal
φC Amps Demand Distortion[1] - I_2	40280	
:	:	
:	:	
φC Amps Demand Distortion[1] - I_{30}	40308	
φC Amps Demand Distortion[1] - I_{31}	40309	
φC-A Volts Distortion Denominator	40310	2047 = 0Volts; 4095 = 150.0Volts =40110
φC-A Volts Harm. Distortion - V_1	40311	0 = 0.0%; 9999 = 999.9% Set to 0 on low signal
φC-A Volts Harm. Distortion - V_2	40312	
:	:	
:	:	
φC-A Volts Harm. Distortion - V_{30}	40340	
φC-A Volts Harm. Distortion - V_{31}	40341	

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

[1] If TDD Denominator is set to 2047 (0Amps) the TDD calculation will use Fundamental Amps as the Denominator, which will result in all Current Distortions being expressed as THD.

3.5 Writeable Registers

3.5.1 Setting CT and PT Ratios

The MultiComm instrument is capable of internally storing and recalling CT and PT ratios via the network interface, or through the internal toggle/push-button (Refer to Section 4.1 of the MultiComm User Manual). These ratios are used to scale the display values in engineering (primary) units. These ratios are also used to scale the Energy quantities, registers 40019 through 40026 (Refer to Section 3.4 for register assignments) which are also in primary units. When the CT and PT ratios are set, they are written to registers 40041 through 40044, and are stored in non-volatile memory on the CT/PT Board. Each ratio is stored in two registers, one for the normalized format ratio, and the other for the divisor. Allowable constants for CT Value (40041) are 500 to 9999, and 1000 to 9999 for PT Value (40043). 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, use the following equation:

$$CT_{RATIO} = \frac{\textit{CT Value}\ (40041)}{\textit{CT Ratio Divisor}\ (40042) \times \textit{CT Secondary}}$$

$$PT_{RATIO} = \frac{\textit{PT Value}\ (40043)}{\textit{PT Ratio Divisor}\ (40044)}$$

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:

$$AMPEREs = \frac{Value - 2047}{2048} \times \textit{Full Scale Value} \times \textit{CT Ratio}$$

The values stored in registers 40041 and 40043 are duplicated in registers 40016 and 40017 respectively. Registers 40016 and 40017 are READ ONLY and cannot be written to. 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 3.6 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 and Demand registers can be RESET by writing a bit pattern to Holding Register 40100. Any "1" bits in the proper position cause initiation of the corresponding RESET. Multiple RESETs can be accomplished by using either multiple WRITE commands or a single WRITE command with multiple bits set. Table 2 shows the correspondence between the RESET functions and the bits set. The Registers will be reset within 0.6 seconds, however it may take the meter up to 10 seconds to clear the data stored in the EEPROM. The USER must ensure that the power is not interrupted to the meter for this 10 second period after this command is issued.

Bit Position	Value	Description	Registers Affected	Global
0	1	Reset (ZERO) Energy	40019 .. 40026	19..26
1	2	Reset AMP Demands	40045 .. 40052, 40136, 40137	N/A
2	4	Reset Volt Demands	40053 .. 40061	N/A
3	8	Reset Power Demands	40062 .. 40070	N/A
4	16	Reset Harmonic Demands	40138 .. 40149	N/A

Table 2: Reset Register (40100) WRITE data values

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). The denominator values are stored for each phase, and are stored in Registers 40101, 40102, 40103 for 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 written to registers 40101 through 40103 over the Modbus communication port, and are stored in non-volatile memory on the Analog Board. The value that needs to be stored follows the same offset binary equation that is used with the other measurements. For 5A secondary, the equation for amperes becomes:

$$AMPEREs = \frac{Value - 2047}{2048} \times 10 \times \frac{CT\ Value}{CT\ Ratio\ Divisor \times 5}$$

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 3071 which corresponds to 5 Amps Secondary (1 Amp for CI1 option). If the value stored in the denominator register are set to Zero amps (Value = 2047), 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 40101, 40102 and 40103 are duplicated in registers 40150, 40214 and 40278 respectively if the value are non-zero (TDD). If registers 40101,2,3 are set to zero (THD) then the registers 40150, 40214 and 40278 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 3. These registers are 16 bits wide, and are programmed in a binary fashion. The lower 8 bits of the first register (register 92) 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 Register 92 bit 6 (S). If this bit is set (bit=1), then the display is in the scrolling mode. The lower 6 bits of register 92 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 Register 92, 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. Registers 93 through 96 contain the rest of the screen enables as indicated in Table 3. The upper 8 bits of register 96 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 register 93. This is equivalent to writing 0001 0000 0000 0111 Binary or 1007 Hexadecimal to register 93. 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 CONFIGURATION CAN BE CHANGED 1,000,000 TIMES). ONLY WRITE TO THE DISPLAY CONFIGURATION REGISTERS WHEN THE DISPLAY 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 / **Register**	32768	16384	8192	4096	2048	1024	512	256	128	64	32	16	8	4	2	1
40092	7	6	5	4	3	2	1	0	D	S	Screen Number if Stopped, Else 0					
40093	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8
40094	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24

Bit Position																
40095	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40
40096	Unused								63	62	61	60	59	58	57	56

Table 3: Display Configuration Registers (40092 - 40096)

3.5.5 Communication Configuration Registers

MultiComm "B" instruments provide READ/WRITE Communication Configuration Registers that allow the user to configure various parameters within the instrument. These Communication Configuration Registers are currently undefined for Modbus, and will always return 0, however they are stored in non-volatile memory (EEPROM) to allow for future upgrades.

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

3.5.6 Tag Register

MultiComm "B" instruments provide a "TAG" register for user identification purposes. 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.

3.6 Converting Data to Engineering Units

As was mentioned in Section 3.4, the majority of the data in both the Global and Holding Registers is stored in a **12-BIT OFFSET BINARY** format. This format was chosen to allow efficient use of registers, since both positive and negative quantities can be transmitted without the use of a SIGN (polarity) register. In this format, ZERO (0) is represented as 2047 counts, the most negative number is represented by 0 counts and the most positive number is represented by 4095 counts. While it would appear that this format limits the **ACCURACY** of the values transmitted in the registers, the **RESOLUTION** of this method is one part in 2048 which is 0.05%, actually 5 times better than the rated accuracy of the instrument, and therefore has no measurable effect on the accuracy of the transmitted value.

When displaying these values at another location, it may be desirable to convert the offset binary format into **ENGINEERING UNITS**. This conversion is readily accomplished using the following simple scaling equations:

BASIC EQUATION FOR OFFSET BINARY:

$$\text{Engineering Units} = \frac{\text{Value} - 2047}{2048} \times \text{Full Scale}_{\text{SECONDARY}} \times \text{Ratio}$$

The CT and PT ratios are the **NAMEPLATE** ratings of the transducer transformers. The PT ratio in these equations is the same as the PT ratio stored in the transducer 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 Holding Register 40002.

The **ENERGY Registers** are stored in the **BIN8** format, making these values readily usable with the standard **Double Precision Integer Math** functions available on PLCs. Using this data format, the address specifying the **WORD** (both registers) is the address of the first of the two registers in the pair (i.e. the one with the lowest register number). This register will have the most significant portion of the number. If the BIN8 data format is specified, no conversion is required.

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

PHASE is stored as an offset binary value that is the phase difference times 10.

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.

2 ½ or 3 ELEMENT EQUATIONS:

$$AMPEREs_{(Inst, Fund, Demand, \text{Max})} = \frac{Value - 2047}{2048} \; x \; 10^{*} \; x \; CT_{RATIO}$$

$$AMPEREs_{N\ (Inst, Fund, Demand, \text{Max})} = \frac{Value - 2047}{2048} \; x \; 15^{*} \; x \; CT_{RATIO}$$

$$VOLTs_{L\text{-}N\ (Inst, Fund, Demand, \text{Min}, \text{Max})} = \frac{Value - 2047}{2048} \; x \; 150 \; x \; PT_{RATIO}$$

$$VOLTs_{L\text{-}L\ (Inst, Demand, \text{Min}, \text{Max})} (SCALED) = \frac{Value - 2047}{2048} \; x \; 150 \; x \; PT_{RATIO} \; x \sqrt{3}$$

$$WATTs\ (VARs)\ (VAs\ )_{TOTAL\ (Inst, Demand, \text{Min}, \text{Max})} = \frac{Value - 2047}{2048} \; x \; 3000^{*} \; x \; PT_{RATIO} \; x \; CT_{RATIO}$$

$$WATTs\ (VARs)\ (VAs\ )_{PER\ PHASE\ (Inst)} = \frac{Value - 2047}{2048} \; x \; 1000^{*} \; x \; PT_{RATIO} \; x \; CT_{RATIO}$$

$$kWh\ (kVARh) = Value_{HIGH} \; x \; 10{,}000 + Value_{LOW}$$

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

$$PF_{(True, Displacement)} = \frac{Value - 2047}{1000} \quad (- Lag\ , + Lead\ )$$

$$PHASE\ DIFFERENCE = \frac{Value - 2047}{10} \quad (+ Line\ Leading\ Ref)$$

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

$$K\ FACTOR = \frac{Value}{100}$$

** For CT1 Option, divide this value by 5*

2 ELEMENT EQUATIONS:

$$AMPEREs_{(Inst,\,Fund,\,Demand,\,\mathrm{Max}\,)} = \frac{Value - 2047}{2048}\ x\ 10^{*}\ x\ CT_{RATIO}$$

$$VOLTs_{L\text{-}L\ (Inst,\,Fund,\,Demand,\,\mathrm{Min},\,\mathrm{Max}\,)} = \frac{Value - 2047}{2048}\ x\ 150\ x\ PT_{RATIO}$$

$$WATTs\ (VARs)\ (VAs\ )_{TOTAL\ (Inst,\,Demand,\,\mathrm{Min},\,\mathrm{Max}\,)} = \frac{Value - 2047}{2048}\ x\ 2000^{*}\ x\ PT_{RATIO}\ x\ CT_{RATIO}$$

$$kWh\ (kVARh) = Value_{HIGH}\ x\ 10{,}000 + Value_{LOW}$$

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

$$PF_{(True,\,Displacement)} = \frac{Value - 2047}{1000}\ \ (\ \text{-}\ Lag, + Lead\ \ )$$

$$PHASE\ DIFFERENCE = \frac{Value - 2047}{10}\ \ (\ + Line\ Leading\ Ref)$$

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

$$K\ FACTOR = \frac{Value}{100}$$

$$*\ For\ CT1\ Option,\ divide\ this\ value\ by\ 5$$

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 following information is contained in the Health Check register (bit 15 is the high order bit and the description indicates the meaning when the bit is set). **The Health Check Register 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 base instrument MultiComm Users Manual for a full description of the failures.

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

[2] - 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 (CTR = 5:5 & PTR = 1:1).

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

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

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

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

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

[8] - 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 Modbus port on 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 is sent to it from a MASTER, check the network for the following problems:

* Cable open or short circuit

* Defective termination

* Incorrect MODBUS 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 poles, users can also use the difference in this counter to determine the time that has elapsed between poles. A third use of this register as a visual indicator that the data is changing, allows users of certain MMIs to identify disruption in the polling of the instrument. The Heartbeat State Counter is a full 16bit counter that rolls over at 65535 (655.35 seconds - 10.9225 minutes). The counter starts at zero on power-up, and is NOT stored in non-volatile memory.

3.10 Meter ID Register

MultiComm "B" instruments provide an "ID" register for model identification purposes. 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

Table 4: Instrument ID Numbers

4.0 MODBUS PROTOCOL

4.1 Introduction

The MODBUS protocol is an open standard which 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 MODBUS, 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.

The MODBUS protocol specifications define two types of transmission modes: ASCII and RTU. This manual describes only the more common RTU mode. For more information, the manual "MODICON MODBUS PROTOCOL REFERENCE GUIDE" (PI-MBUS-300) may be purchased for a nominal fee directly from Modicon Inc.

4.2 MODBUS RTU Message Framing

Each message from either a master or slave consists of a continuous stream of characters. A silent interval of 3.5 character times (3.5 * 11 bits / 9600 baud = 3.5 millisecond) or more separates these streams. Bitronics instruments implement this requirement by waiting for a 3.5 character time gap between characters. If the stream is valid and is addressed to this instrument, then the instrument responds as follows:

• Enable the output interface drivers (RS-485 option only)
• Wait 5 character times
• Send the response as a continuous stream
• Wait 3.5 character times
• Disable the output interface drivers (RS-485 option only)

4.3 MODBUS RTU Message Content

The MODBUS RTU message stream consists of an address byte, a function code byte, a number of message bytes, and two check bytes. The address byte, which is in the range 1 .. 247, specifies the identity of the slave device. The function code byte in a master command indicates the operation which the slave is to perform. The function code byte in a slave response is the same value as the master command function code if no error occurs, otherwise it has 128 added to it. The message bytes in a command contain additional information needed to perform the command. Message bytes in a response contain the data requested if no error has occurred or a one byte exception code upon errors. The check bytes are generated using the CRC-16 polynomial generator sequence ($x^{16} + x^{15} + x^2 + 1$) with the remainder pre-initialized to all 1's. The most significant byte of the CRC is transmitted first.

4.4 MODBUS Function and Exception Codes

Bitronics instruments currently support the function codes shown in Table 5. Note that the values are shown in hexadecimal (base 16). This table also shows the value which a slave would return upon an error.

Master Function Code	Slave Error Code	Name	Meaning
03_{16}	83_{16}	Read Holding Registers	Read values from meter
06_{16}	86_{16}	Preset Single Register	Write ratio or reset energy/demand
10_{16}	90_{16}	Preset Multiple Registers	Write ratio or reset energy/demand
08_{16}	88_{16}	Diagnostics (0,0)	Return query data (Loopback)

Table 5: Supported MODBUS Function Codes

Bitronics instruments return exception codes back to the master upon certain conditions. All functions codes greater than 127 decimal ($7F_{16}$) indicate a slave error response. The message byte indicates the exception code according to Table 6.

Code	Name	Meaning
1	Illegal Function	Master command contained an unrecognized function code.
2	Illegal Data Address	Starting address is illegal. Note that some registers are read-only and some are read/write ("A" models had some write only registers). Also returned if meter is in CT/PT set mode.
3	Illegal Data Value	Either the register count is invalid or an attempt to write an illegal register value was found. Note that this code can be caused by attempting to read beyond the last instrument register.
4	Slave Device Failure	Instrument has failed. If problem persists, please consult the Bitronics factory for assistance.
6	Slave Device Busy	More than 6 register WRITE commands (ratio setups or energy/demand resets) have been received within 300 milliseconds.

Table 6: Exception Codes

4.5 Supported MODBUS Commands

Bitronics instruments support one read, two write and one diagnostic command. All commands require a register address to be specified in the command. The first register, named 40001 is at hexadecimal address 0000. The energy/demand reset register, named 40100 is at hex address 0063. In commands and responses, the most significant byte of a two byte value is transmitted first. All examples which follow use the hexadecimal values and an instrument address of 001.

Read Holding Registers (Function Code 03)

This function reads any or all quantities from the Bitronics instrument. The command requires a starting register and the number of registers to read. Attempting to read non-existent registers (or write-only registers in “A” models) will cause an exception. The maximum number of registers which can be read is 103 (44 in “A” models) in non-demand instruments and 341 (70 in “A” models) in demand instruments. Modbus read commands are limited to 125 registers maximum per read request, and Master Blocks (MSTR) are limited to 100 registers maximum per read request. The following example shows two registers being read: TOTAL WATTS (register 40008) with +500 watts per element applied and TOTAL VARS (40009) with -100 VARs per element applied.

Byte	Name	Example	Notes
1	Slave Address	01	
2	Function code	03	
3	Start address high	00	Total Watts at register 40008
4	Start address low	07	(40008-40001=07)
5	Register count high	00	
6	Register count low	02	Read 2 registers total
7	CRC-16 low	75	
8	CRC-16 high	CA	

Figure 2 - Function Code 03 command (Read Holding Registers)

Byte	Name	Example	Notes
1	Slave Address	01	
2	Function code	03	
3	Byte count	04	2 registers, 2 bytes each
4	Data high (40008)	0B	Total WATTs = 0BFF hex = 3071 decimal
5	Data low (40008)	FF	
6	Data high (40009)	07	Total VARs = 0732 hex = 1842 decimal
7	Data low (40009)	32	
8	CRC-16 low	4B	
9	CRC-16 high	C2	

Figure 3 - Function Code 03 response (Read Holding Registers)

Preset Single Register (Function Code 06)

This function writes to a single register. An attempt to write to a READ-ONLY register results in an exception. The response is an echo of the command. The following example shows the reset Amp, Volt, and Power demands (writing 14 decimal to register 40100) command.

Byte	Name	Example	Notes
1	Slave Address	01	
2	Function code	06	
3	Start address high	00	0063 hex = 99 decimal
4	Start address low	63	to specify register 40100
5	Data high	00	
6	Data low	0E	000E = 14 decimal =
7	CRC-16 low	F8	2 (bit 1) + 4 (bit 2) + 8 (bit 3)
8	CRC-16 high	10	Amp + Volt + Power Demand reset

Figure 4 - Function Code 06 command and response (Preset Single Registers)

Preset Multiple Registers (Function Code 16)

This function writes one or more contiguous registers. An attempt to write to a READ-ONLY register results in an exception. The following example shows setting the PT ratio to 1000 : 100 (ie: 10 : 1).

Byte	Name	Example	Notes
1	Slave Address	01	
2	Function code	10	10 hex = 16 decimal
3	Start address high	00	002A hex = 42 decimal
4	Start address low	2A	to specify register 40043
5	Register count high	00	We write 2 registers
6	Register count low	02	(40043 and 40044)
7	Byte count	04	Two register, 4 bytes
8	Data high	03	Write 1000 to register 40043 :
9	Data low	E8	03E8 = 1000 decimal
10	Data high	00	Write 100 to register 40044 :
11	Data low	64	0064 = 100 decimal
12	CRC-16 low	F0	
13	CRC-16 high	53	

Figure 5 - Function Code 16 command (Preset Multiple Registers)

Loopback Diagnostic Test (Function Code 08, Subfunction 00)

This function performs a communication test without affecting the Bitronics instrument. The command requires two user-supplied data bytes. The entire response message should be identical to the command. This command is typically used to verify existence of a device at a MODBUS address.

Byte	Name	Example	Notes
1	Slave Address	01	
2	Function code	08	
3	Subfunction high	00	Only legal subfunction
4	Subfunction low	00	is 00,00
5	Data high	55	Any two data bytes
6	Data low	AA	are allowed
7	CRC-16 low	5F	
8	CRC-16 high	24	

Figure 6 - Function Code 08 command (Loopback Diagnostic Test)

Byte	Name	Example	Notes
1	Slave Address	01	
2	Function code	08	
3	Subfunction high	00	
4	Subfunction low	00	
5	Data high	55	These two data bytes
6	Data low	AA	are echoed from command
7	CRC-16 low	5F	
8	CRC-16 high	24	

Figure 7 - Function Code 08 response (Loopback Diagnostic Test)

5.0 INSTALLATION

5.1 Setting Modbus Address

The MultiComm instrument provides for direct connection to a Modbus Network. As was mentioned in Section 3.2, each device on a given network must have a different PHYSICAL 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. 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 Modbus 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.

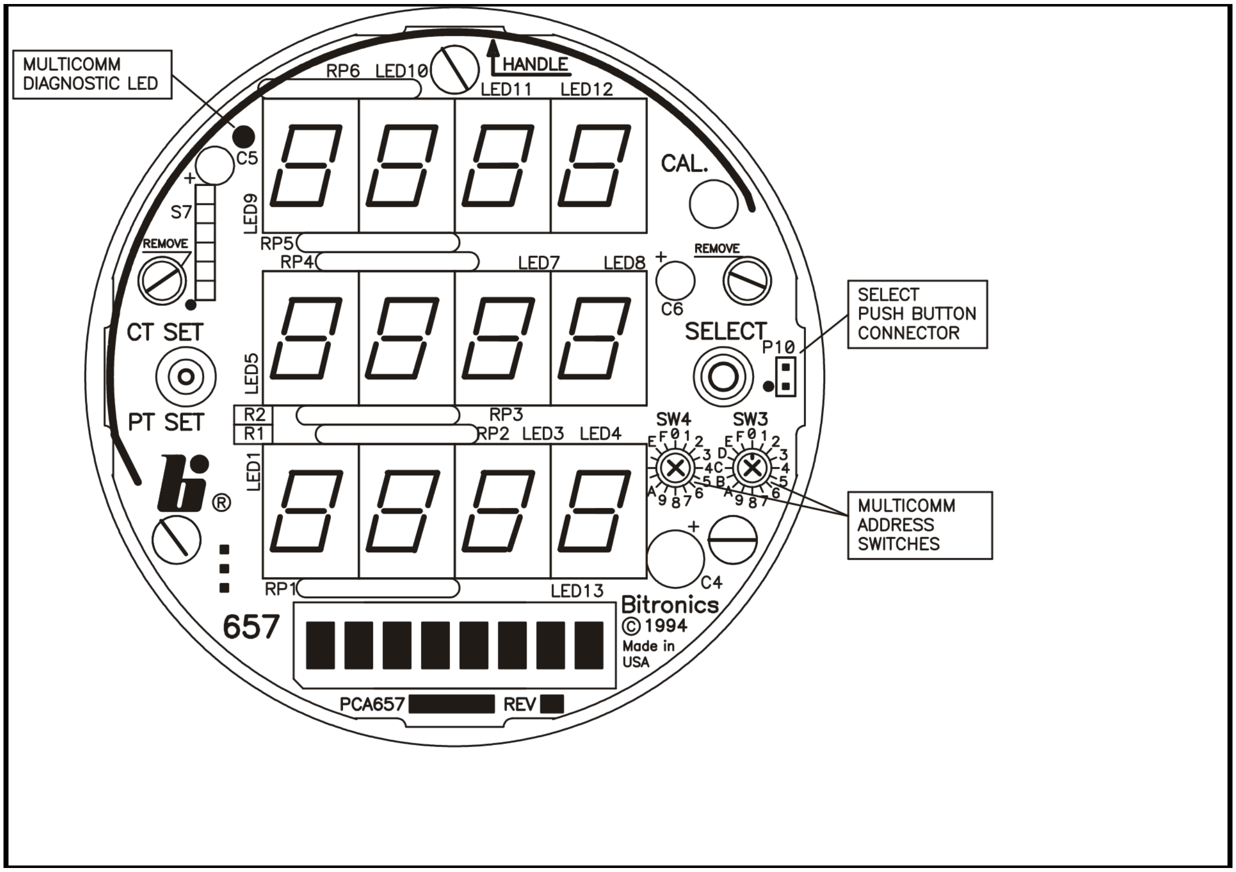

Figure 8 - Switch, Connector and LED Locations

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 MODBUS 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. All illegal addresses are mapped to 247.

ADDR	SW4	SW3
247[1]	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

[1] Illegal MODBUS addresses are converted to ADDRESS 247

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
247[1]	F	8
247[1]	F	9
247[1]	F	A
247[1]	F	B
247[1]	F	C
247[1]	F	D
247[1]	F	E
247[1]	F	F

[1] Illegal MODBUS addresses are converted to ADDRESS 247

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 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!!

5.2 Modbus RS-232C Link (-S093)

The Modbus RS-232C Link connects to the 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 10 for the connection diagram.

5.3 Modbus RS-485 Network (-S103)

The Modbus RS-485 Network connects to the 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 Modbus 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 Modbus instruments will delay their response to a request for a minimum of 10 milliseconds. It is **VERY** important that the Modbus 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 11 for the connection diagram.

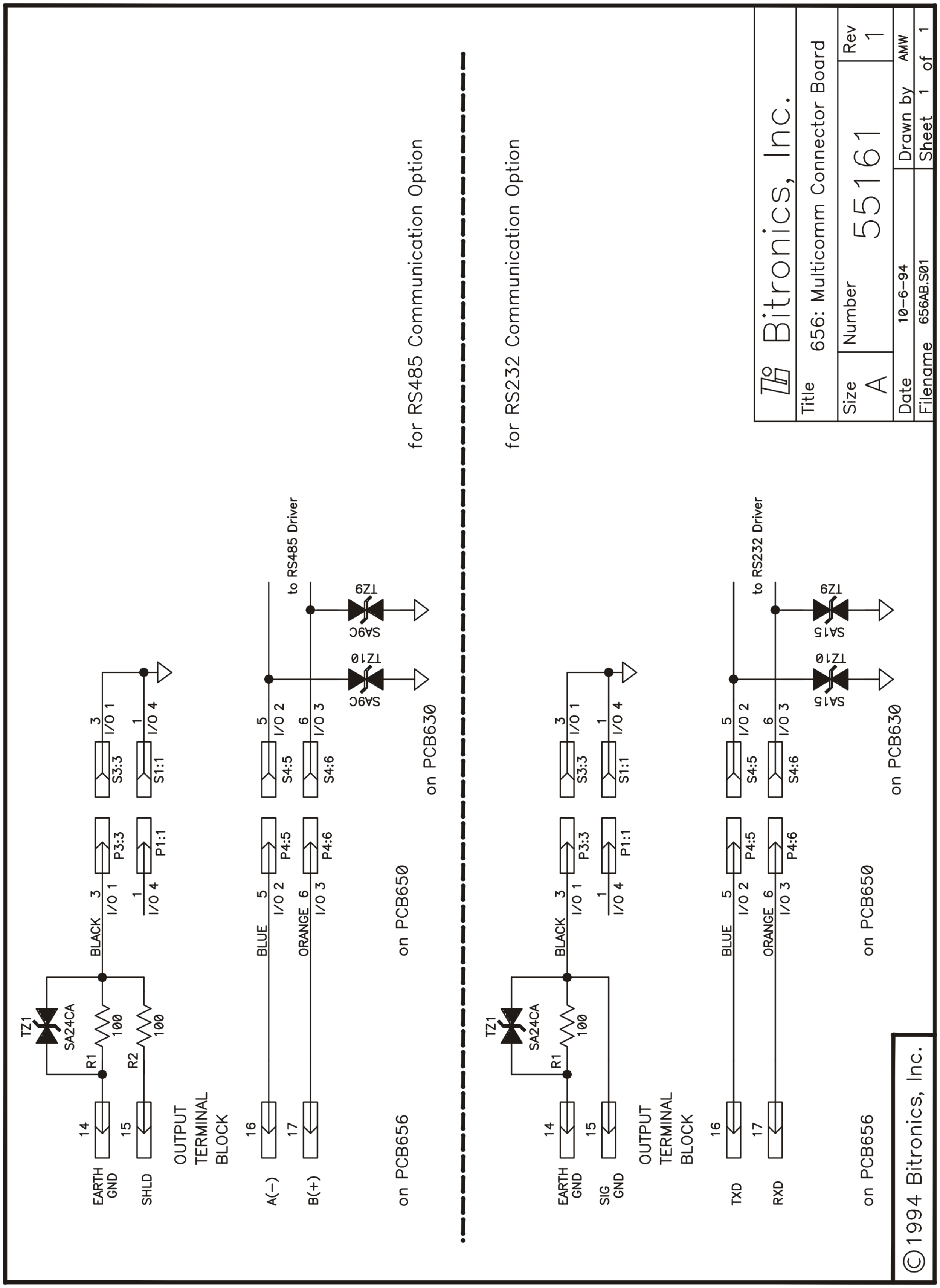

Figure 9 – Output connector board circuit diagram

MultiComm RS-232C Connections

MultiComm Instrument	IBM AT DE9 (Female)	IBM XT DB25 (Female)	Modem DB25 (Male)
GND 14 ——	Shield	1	1
SG 15 ——	5	7	7
TXD 16 ——	2	3	2
RXD 17 ——	3	2	3
	┌ 4	┌ 4	┌ 4
	└ 6	└ 5	└ 5
	┌ 1	┌ 6	
	├ 7	├ 8	
	└ 8	└ 20	

Figure 10 - RS-232 (-S093) Output Connection Diagram

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.

Figure 11 - RS-485 (-S103) Output Connection Diagram

Revision	Date	Changes	By
A	01/30/2009	Update Bitronics Name, Logo	E. Demicco
B	11/17/2009	Updated logos and cover page	MarCom
C			

NovaTech®

Bitronics ◆ D/3 ◆ Orion

Bitronics LLC. 261 Brodhead Road, Bethlehem, PA. 18017
(610) 997-5100 Fax (610) 997-5450
www.novatechweb.com/bitronics