Bitronics

MultiComm™ RTH

3-Phase Multifunction Power Monitor with Demand & Harmonics Manual

June 15, 2009
ML0001 Document Revision B

No. MTWDE1B	3 Element 4 Wire (WYE)
No. MTWDE2B	2 Element 3 Wire (DELTA)
No. MTWDE3B	2½ Element 4 Wire (WYE)
No. MTWDE4B	3 Element 4 Wire (WYE) Modbus Plus™
No. MTWDE5B	2 Element 3 Wire (DELTA) Modbus Plus™
No. MTWDE6B	2½ Element 4 Wire (WYE) Modbus Plus™

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FIRMWARE REVISIONS

MultiComm Meter Firmware	Description
3.00	Original MultiComm Alpha Series Meter Firmware.
3.30	Added VAs, PF, and Network Writeable CT/PT Ratios.
3.40	Added Demand Measurements Option
3.50	Added 2 ½ Element, Parity check on Demand Measurements
3.60	Corrected error of 3-Phase VAs and PF in Delta connected meters. Delta VA calculation now Geometric VAs.
3.70	Corrected Energy roll-over error. All four energy values now roll-over at 99,999,999 to 0. Prior versions incorrectly rolled-over at 16,777,215 to 65,536.
4.10	MultiComm RTH Meter Firmware. Added Harmonic measurements, decreased response time from 600ms to 150ms.
4.20	Added Tag Register, Configuration Registers, Network Screen setup. Changed to FFT fundamental quantities for determination of PF and VARs sign.
4.30	Initial MultiComm RT Meter Firmware. Added Secondary Volts Screen.

CERTIFICATION

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

INSTALLATION AND MAINTENANCE

Bitronics LLC products are designed for ease of installation and maintenance. As with any product of this nature, installation and maintenance can present electrical hazards and should be performed only by properly trained and qualified personnel. If the equipment is used in a manner not specified by Bitronics LLC, the protection provided by the equipment may be impaired.

In order to maintain UL recognition, the following Conditions of Acceptability shall apply:

a) Terminals and connectors that shall be connected to live voltages are restricted to non-field wiring applications only.
b) After installation, all hazardous live parts shall be protected from contact by personnel or enclosed in a suitable enclosure.

WARRANTY AND ASSISTANCE

This product is warranted against defects in materials and workmanship for a period of thirty-six (36) months from the date of their original shipment from the factory. Products repaired at the factory are likewise warranted for eighteen (18) months from the date the repaired product is shipped, or for the remainder of the product's original warranty, whichever is greater. Obligation under this warranty is limited to repairing or replacing, at our designated facility, any part or parts that our examination shows to be defective. Warranties only apply to products subject to normal use and service. There are no warranties, obligations, liabilities for consequential damages, or other liabilities on the part of Bitronics LLC except this warranty covering the repair of defective materials. The warranties of merchantability and fitness for a particular purpose are expressly excluded.

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1.0 DESCRIPTION

1.1 Introduction

Current and voltage, as well as real and reactive power are essential quantities which must be measured accurately in order to optimize the control and delivery of electric power. The use of "State-of the Art" microprocessor technology assures digital accuracy and repeatability across a wide range of input signal levels. The Bitronics Three Phase MultiComm RTH Meters are rugged electronic instruments designed for utility and industrial applications requiring reliable, precise measurements of three-phase power systems. MultiComm RTH instruments provide a wide range of **R**eal **T**ime **H**armonic measurements. True RMS measurements are standard, and include harmonics to the 31st harmonic in both the current and voltage inputs, resulting in accurate measurements, even with distorted waveforms. MultiComm RTH meters are modular in design, with push-button rescaling to display primary values when using any standard current and voltage transformer. Rescaling can be done in the field, in a matter of minutes, without removing the instrument from the panel or the need for any calibration equipment. The MultiComm RTH includes an alphanumeric display which prompts the user with an unambiguous engineering units display. The MultiComm RTH also provides the user with the capability to connect directly with a variety of digital communications protocols. This capability allows users to seamlessly integrate Bitronics MultiComm RTH instruments into an existing or planned SCADA or PLC system.

1.2 Features

* Fast Fourier Transforms (FFTs) for Harmonic measurements are performed by the instrument. Provides continuous harmonic information for operations without time delay from off-line analysis of waveform data.

* % Total Demand Distortion on Current with user-defined denominator. This provides more meaningful harmonic information for various operating conditions.

* Displacement Power Factor allows users to more accurately size and control power factor correction. True Power Factor allows users to measure the effects of harmonics on their system utilization.

* High Speed calculations provide a speed improvement for tighter automated control applications.

* Many more screens added. Any screen can be enabled or disabled for local indication at users discretion.

* Scrolling three-phase at once display with alphanumeric engineering units display shows all measured quantities.

Features (Continued)

- * All measured quantities available over the digital communications channel to SCADA or PLC systems.

- * Front mounted push button stops the display scrolling at a selected measurement, or allows user to "FAST SCROLL" rapidly through all measurements. Also performs lamp test and CT/PT ratio/instrument address display.

- * Push-button rescaling in the field accommodates all ANSI CT and PT ratios. Displays primary or secondary values. (Non-standard ratios available, consult factory.)

- * Push-button programming of display in the field allows user to customize display for a specific application.

- * Push-button can reset demand measurements if front panel demand resets are enabled (demands are always resettable via the network).

- * Front access, field-changeable modular design for easy maintenance under power.

- * Non-volatile memory backup of CT/PT settings, display screens, energy values, and demand measurements. No batteries are needed.

- * Fixed 15 minute Demand Interval (Thermal - Sliding Window).

- * On board diagnostics continually monitor instrument performance. Diagnostic codes available on front display as well as over network.

- * Separate communications microprocessor to off-load the main processor simplifies development of additional protocols.

- * Standard Universal power supply works on AC or DC service, 24, 48, 125 or 250VDC station batteries or 115VAC service.

- * True RMS measurements are standard.

- * Rugged metal housing fits standard 4" round cutout.

- * 4 digit high efficiency LEDs for easy reading.

- * Watchdog timer maximizes system reliability.

- * Optional UL Listed Power Supplies (115Vac or 230Vac)

1.3 Specifications

Input Signals

Amperes:	0 to 5* A ac nominal, (0.25* A ac minimum for PF and Harmonics) three phase, with continuous overload to 10* A ac (15* A ac for Neutral Current), 400A ac for 2 seconds. 1500V ac isolation, minimum.
Volts:	0 to 150V ac nominal, (20V ac minimum for PF and Harmonics) three phase. 1500V ac isolation, minimum.

Signal Burden

Amperes:	4mV ac at 5A ac input (0.02 VA).
Volts:	<1mA ac at 120V ac input (0.1 VA).

Display: 0.56" High Efficiency 7-Segment AlGaAs Red LED Display (3x4)
0.2" High Efficiency Dot Matrix AlGaAs Red LED Display (1x8)

0000 to 9999	(VOLTs and AMPs).
-999 to 000 to 999	(WATTs & VARs)
-.000 to -.999 (lag)	(PF)
.000 to 1.000 (lead)	
000.0 to 999.9	(THD, TDD)
01.00 to 99.99	K-Factor

CT/PT Ratio sets decimal points

Scaling: User selectable using internal CT/PT tables.

Accuracy: 0.25% Class (ANSI Std 460-1988).
Frequency: +/- 0.01 Hertz

Signal Frequency: 45Hz to 75Hz (45Hz to 2325Hz Including Harmonics). 20Vac Min
45.00Hz to 75.00Hz Frequency Measurement

Energy Registers: 0 - 99,999,999 kWattHours Positive and Negative
0 - 99,999,999 kVARHours Leading and Lagging
Energy is calculated continuously, and stored every 90 seconds

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

1.3 Specifications (Continued)

Demand Interval: 15 Minute Thermal Demand - Sliding Window

Communications protocol: Varies with instrument option

Data update rate:

Model	Data Updated	Data Update MAX
MTWDE1B,2B, 3B	150ms[1]	200ms

[1] - READ requests ONLY (no WRITE requests) and input 56Hz to 75Hz, otherwise use Data Update MAX

Model	Response Time MAX (TYP)	Global Data Updated	All 8 Task Paths Serviced MAX
MTWDE4B,5B, 6B	200ms (100ms)	150ms[2]	200ms

[2] - No READ or WRITE requests and input 56Hz to 75Hz, otherwise use Max Response Time

Power Requirements:

VD4A: Universal 55-200 V ac or 20-280 Vdc, 6 Watts (standard)
VA2: 115 V ac +/-20%, 6VA (optional)
VA4: 230 V ac +/-20%, 6VA (optional)

Fuse: 1.5 Ampere, non-time delay (M) fuse, UL listed located in the ungrounded (hot) side of the line, external to meter.

Operating Temperature: -30C to 70C. Humidity: 0-95% non-condensing

Installation Category: IC III (Distribution Level), Pollution Degree 2

Weight: 2.5 pounds (1.14 kilograms)

Size: Industry Standard 4" round case, 7.0 inches long

2.0 PRINCIPLES OF OPERATION

2.1 Modular Construction

The Bitronics MultiComm RTH Meters are composed of two major modules, as shown in the exploded view of the meter (Figure 1). The BASE MODULE consists of the case tube, the back panel, the Output Connector Board, the Current Transformer & Potential Transformer Board and the Power Supply Board. The Base Module contains primarily passive components (transformers, connectors, etc.) and cannot be serviced without removal from the panel. The ELECTRONICS MODULE consists of the Analog Processing Board, Host Microcontroller Board, MultiComm Processor Board and the LED Display Board. Ninety percent of the active electronics (Integrated Circuits, diodes, etc.) are contained within the four boards comprising the Electronics Module. This module can easily be removed for maintenance without the need to remove the meter from the panel, or to remove the meter from service (see section 4.6). Detailed descriptions of each of the boards can be found in the following sections.

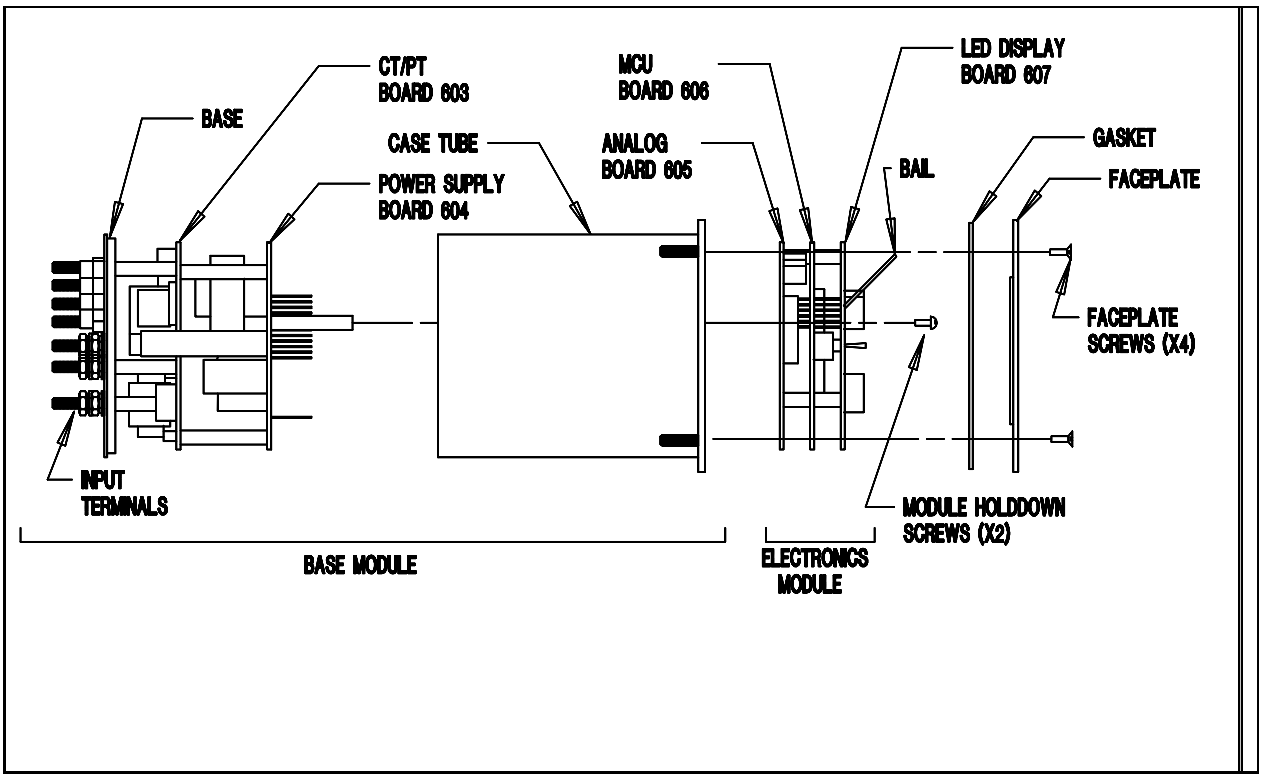


Figure 1 – MultiComm RTH Meter Exploded View

2.1.1 Input Signal Connections

The MultiComm RTH Meters have six independent signal inputs (5 in the MTWDE2B/5B); one current and one voltage for each phase being measured. Current and voltage signals are connected directly to #10-32 brass studs on the rear panel of the instrument. WARNING - DO NOT overtighten the nuts on the input connections, HAND tighten with a standard nutdriver, 12 inch-pounds is recommended, MAXIMUM torque is 15 inch-pounds. The instrument can be connected directly to current transformer (CT) or potential transformer (PT) circuits. The impedance at the MultiComm terminals is nearly a short circuit (2 milliohms) for ammeters and high impedance (> 100 K-ohms) for voltmeters. These ideal impedances provide low burden loads for the CT or PT circuits supplying the signals. The polarity of the applied signals is important to the function of the instrument, and the signal terminals are labeled LO or HI to aid in wiring the units into substation or control panels. A wiring diagram is also provided in the form of a decal on the side of the meter. Grounding of PT & CT signals per ANSI/IEEE C57.13.3-1983 is recommended.

Power is applied to two #10-32 brass studs, also located on the rear cover of the instrument. WARNING - DO NOT overtighten the nuts on the input connections, HAND tighten with a standard nutdriver, 12 inch-pounds is recommended, MAXIMUM torque is 15 inch-pounds. Because of the solid state design, the total load required to operate the unit is only six WATTs. It is therefore possible to power the MultiComm RTH Meter with AC or DC station power or an auxiliary PT, provided the voltage remains above 55 Vac or 20 Vdc. Units are shipped configured with a Universal (AC/DC) supply.

2.1.2 Output Connector Board

The digital communications channel interfaces to the remainder of the instrument via the output connector board. Refer to the appropriate protocol option manual for the specific functions of this board.

2.1.3 Current and Potential Transformer Board (CT/PT Board)

The current and potential transformer (CT/PT) board contains secondary transformers which provide electrical isolation for each of the signal input channels. Current from the current terminals flows though a silver-soldered shunt of negligible resistance to assure that the user's external CT circuit can never open-circuit, even under extreme fault conditions. Potential voltages are carried through 10-32 studs directly to the CT/PT board to guarantee reliable connections to the high-impedance secondary transformer circuits. The use of transformer isolation on all input leads provides excellent isolation (> 1500Vac) between the inputs and any output. In the MTWDE2B/5B, the third phase voltage (C-A) is generated by summing the other two phase voltages (A-B & B-C).

2.1.4 Power Supply Board (PS Board)

The MultiComm RTH instrument has a Universal Power Supply as a standard feature. The universal power supply is a high-efficiency, high-frequency switching power supply with integrated over-current protection. Power from the input terminals is conducted to a full-wave bridge rectifier and capacitor to convert AC power inputs to DC. DC power inputs are unaffected by the bridge rectifier. Input polarities are marked for reference only. The DC voltage across the filter capacitor is alternately connected and disconnected to the isolation/power transformer at a rate of about 60kHz, by a pulse-width controller. A separate feedback winding on the power transformer provides a signal which is used by the controller to vary the time that the transformer is connected to the power source. This allows the supply to provide a relatively constant output voltage over a wide range of input voltages and output loads. The output of the switching supply is then post regulated by a low-drop linear regulator to provide precise supply voltage control under all conditions.

Bitronics MultiComm RTH instruments provide for complete interchangeability among base module and electronics modules. Compensation for normal variations in input circuits is achieved by storing calibration constants in a non-volatile memory (EEPROM) which resides on the PS board. These constants are factory-programmed to provide identical signal gain (attenuation) in each of the six isolated signal input paths. The CT and PT settings for scaling the display to the user's CTs and PTs are also stored in this EEPROM. Checksums are incorporated into the EEPROM which are read periodically by the microcontroller to check the integrity of the calibration constants and the CT and PT setting (See section 4.1). The Energy Registers are also stored in this EEPROM (See section 2.3.4). Checksums are incorporated into the EEPROM which are read periodically by the microcontroller to check the integrity of the energy registers. TDD denominators for the three phase currents are also stored in this EEPROM.

2.1.5 Analog Processing Board (AP Board)

The first function of Analog Processing board is to sum the three low level AC signals from the three CTs to form the Neutral Current Signal (MTWDE1B/3B/4B/6B only). This function is performed by a precision analog summing circuit. The second function of Analog Processing board is to sample and digitize the low level AC signals provided by the CT/PT board, and to provide a digital number to the microcontroller (MCU) for further processing. Calibration constants stored in both the Power Supply EEPROM and the EEPROM located on this board provide drift-free calibration, and complete interchangeability of Analog Processing boards. Checksums are incorporated into both EEPROMs which are read periodically by the microcontroller to check the integrity of the calibration constants and the CT and PT setting (See section 4.1).

All minimum and maximum demands are stored in the Analog Processing board's EEPROM. Each demand measurement is stored with a parity bit to ensure data integrity. Minimum and maximum demand measurements will be lost if the Analog Processing Board is replaced. A "Master Gain" trimpot is also located on the AP board to provide the user with fine tuning capability if it is necessary to match other devices on the power system.

In the MTWDE1B/2B/3B, the communications channel transceiver is also located on this board. This transceiver provides the drive to transmit and receive messages on the communications port on the rear of the instrument. Refer to the appropriate protocol options manual for information concerning the specific drivers for your protocol.

2.1.6 Host Microcontroller Board (MCU Board)

The host microcontroller board consists of an Intel 87C251SB16 microcontroller (MCU), address latch, EPROM memory, SRAM memory and a watchdog timer. All the data acquisition, signal processing and display manipulation are controlled by the microcontroller. Communications to most other boards is accomplished via a serial data link consisting of three lines common to all the other devices (ADC, 2 EEPROMs, 3 Display Drivers, Alphanumeric Display). Individual select lines for each individual device, allow the MCU to communicate with one device at a time. The watchdog timer prevents the MCU from "locking up" in the event of a transient or other type of interference. The watchdog timer also provides a reset on power-up or when resuming from a brownout (low supply). The watchdog timer can be triggered manually, by entering the CT/PT set mode (See section 4.1) and holding down the select push button for approximately 1.2 seconds. In the unlikely event of a microcontroller failure, the watchdog circuit will continuously attempt to restart the processor. A positive indication of this condition is provided by having the watchdog flash the LED displays on the front panel.

A DUAL-PORT RAM is also located on the Host MCU board. The purpose of the DUAL-PORT RAM is to provide a communications channel between the Host MCU and the microprocessor on the MultiComm Processor Board. The two processors pass "messages" through this RAM in order to service specified communications protocol transactions.

2.1.7 MultiComm Processor Board

The MultiComm processor board contains the intelligent interface between the host MCU board and the specified communications protocol. The board content varies with the specific protocol chosen and is fully described in the appropriate protocol option manual.

2.1.8 LED Display Board (LED Board)

The LED Display board consists of three 4 digit displays comprised of high efficiency red LED seven segment common cathode displays. Each 4 digit display is driven in a multiplexed fashion by an MC14499 seven segment decoder driver chip, which accepts serial data from the MCU, and decodes the data into the seven segment and digit select outputs necessary for the multiplexed display. The high current cathode drive is provided by an MC1472 driver for each pair of digits. On power up, or any other time the MCU is reset, a display test will be conducted that displays 8.8.8.8 on the top display, followed by 8.8.8.8 on the middle display, followed by 8.8.8.8 on the bottom display, followed by all dots on the alphanumeric display. The display test can be initiated by entering and then leaving the CT/PT set mode (see sec. 4.1).

An 8 character LED dot matrix display was added to the MultiComm Alpha Series Instruments, and this display is retained in the MultiComm RTH. This display prompts the user during various programming modes such as CT/PT set mode. It also prompts the user as to what quantity is currently being displayed, and also displays the primary engineering units.

2.2 Scrolling Display

The MultiComm RTH meter can display several per-phase and total quantities for the circuit being monitored. Due to the 4" round case constraint, the display is limited to three 4-digit displays. This allows the simultaneous display of all phases for a given quantity such as AMPERES. In order to make all quantities available, the display scrolls from quantity to quantity approximately every 5 seconds. The Alphanumeric display at the bottom of the instrument prompts the user as to what quantity is being displayed. The Alphanumeric display also provides the user with primary engineering units (Watts, kWatts, MWatts, etc.).

INSTANTANEOUS DISPLAY SCREENS

No.	Format	Quantity
0.	0000 0000 0000 Frnt Rst	Master Enable for Front Panel Demand Resets
1.	0000 0000 0000 Amps	Phase A Amperes Phase B Amperes Phase C Amperes
2.	0000 □□□□ □□□□ Amps N	Neutral Amperes [1] Unused Unused
3.	0000 0000 0000 xVolts	Phase A Volts [1] Phase B Volts Phase C Volts
	0000 0000 0000 xVolts	Phase A-B Volts [2] Phase B-C Volts Phase C-A Volts
4.	0000 0000 0000 xVolts √3	Phase A Volts [1,3] Phase B Volts Phase C Volts
5.	0000 0000 0000 xWatts Φ	Phase A Watts [1] Phase B Watts Phase C Watts
6.	0000 0000 0000 xVARs Φ	Phase A VARs [1] Phase B VARs Phase C VARs
7.	0000 0000 □□□□ xW·xVARs	Total Watts Total VARs Unused

No.	Format	Quantity
8.	0000 0000 0000 xVAs Φ	Phase A VAs [1] Phase B VAs Phase C VAs
9.	0000 0000 0000 PF Φ	Phase A PF [1,4] Phase B PF Phase C PF
10.	0000 0000 □□□□ xVAs·PF	Total VAs 3Φ PF[4] Unused
11.	00.00 □□□□ □□□□ Hz	Frequency Unused Unused
12.	1234 5678. □□□□ +kWh	Positive kWh Unused
13.	1234 5678. □□□□ -kWh	Negative kWh Unused
14.	1234 5678. □□□□ +kVARh	Positive kVARh Unused
15.	1234 5678. □□□□ -kVARh	Negative kVARh Unused
16.	0000 0000 0000 xW·PF·Hz	Total Watts 3Φ PF[4] Frequency
61.	0000 0000 0000 SecVolts	Phase A Secondary Volts [1] Phase B Secondary Volts Phase C Secondary Volts
	0000 0000 0000 SecVolts	Phase A-B Secondary Volts [2] Phase B-C Secondary Volts Phase C-A Secondary Volts

[1] - WYE meters only (MTWDE1B/3B/4B/6B)
[2] - DELTA meters only (MTWDE2B/5B)
[3] - Scaled from Line-Neutral Voltage
[4] - Power Factor LAG (-), LEAD (+)
x - indicates blank, (k)ilo, (M)ega, or (G)iga

DEMAND DISPLAY SCREENS

	Format	Quantity
17.	0000 0000 0000 Amps MAX	Phase A Maximum Amperes Demand Phase B Maximum Amperes Demand Phase C Maximum Amperes Demand
18.	0000 0000 □□□□ AmpN · MAX	Neutral Amperes [1] (Also on Screen 2) Maximum Neutral Amperes Demand Unused
19.	0000 0000 0000 xV MAX	Phase A Maximum Volts Demand [1,3] Phase B Maximum Volts Demand Phase C Maximum Volts Demand
	0000 0000 0000 xV MAX	Phase A-B Maximum Volts Demand [2] Phase B-C Maximum Volts Demand Phase C-A Maximum Volts Demand
20.	0000 0000 0000 xV MIN	Phase A Minimum Volts Demand [1,3] Phase B Minimum Volts Demand Phase C Minimum Volts Demand
	0000 0000 0000 xV MIN	Phase A-B Minimum Volts Demand [2] Phase B-C Minimum Volts Demand Phase C-A Minimum Volts Demand
21.	0000 0000 0000 xW · ↑ · ↓	Total Watts (Also on Screen 7) Total Maximum Watt Demand Total Minimum Watt Demand
22.	0000 0000 0000 xVAR · ↑ · ↓	Total VARs (Also on Screen 7) Total Maximum VAR Demand Total Minimum VAR Demand
23.	0000 0000 0000 xVA · ↑ · ↓	Total VAs (Also on Screen 10) Total Maximum VAs Total Minimum VAs

[1] - Screen available on WYE meters only (MTWDE1B/3B/4B/6B)
[2] - Screen available on DELTA meters only (MTWDE2B/5B)
[3] - If Screen 4 is selected, this screen will be the Line-Neutral Voltage scaled by $\sqrt{3}$
x - indicates blank, (k)ilo, (M)ega, or (G)iga

HARMONIC SUMMARY DISPLAY SCREENS

	Format	Quantity
24.	0000	Phase A Fundamental Amperes
	0000	Phase B Fundamental Amperes
	0000	Phase C Fundamental Amperes
	Fnd Amps	
25.	0000	Fundamental Neutral Amperes [1]
	0000	Maximum Fundamental Amperes Demand
	□□□□	Unused
	FndN · MAX	
26.	0000	Phase A Fundamental Volts
	0000	Phase B Fundamental Volts
	0000	Phase C Fundamental Volts
	Fnd xV	
27.	000.0	Phase A Current %Total Demand Distortion (%TDD)
	000.0	Phase B Current %Total Demand Distortion (%TDD)
	000.0	Phase C Current %Total Demand Distortion (%TDD)
	%TDD I	
28.	000.0	Phase A Current %TDD Maximum Demand
	000.0	Phase B Current %TDD Maximum Demand
	000.0	Phase C Current %TDD Maximum Demand
	%TDD I ↑	
29.	000.0	Phase A Current Odd %TDD
	000.0	Phase B Current Odd %TDD
	000.0	Phase C Current Odd %TDD
	%ODD I	
30.	000.0	Phase A Current Even %TDD
	000.0	Phase B Current Even %TDD
	000.0	Phase C Current Even %TDD
	%EDD I	
31.	000.0	Phase A Voltage %Total Harmonic Distortion (%THD)[1]
	000.0	Phase B Voltage %Total Harmonic Distortion (%THD)
	000.0	Phase C Voltage %Total Harmonic Distortion (%THD)
	%THD V	
	000.0	Phase A-B Voltage %Total Harmonic Distortion (%THD)[2]
	000.0	Phase B-C Voltage %Total Harmonic Distortion (%THD)
	000.0	Phase C-A Voltage %Total Harmonic Distortion (%THD)
	%THD V	

[1] - Screen available on WYE meters only (MTWDE1B/3B/4B/6B)
[2] - Screen available on DELTA meters only (MTWDE2B/5B)
x - indicates blank, (k)ilo, (M)ega, or (G)iga

HARMONIC SUMMARY DISPLAY SCREENS (Cont'd)

	Format	Quantity
32.	000.0	Phase A Voltage %THD Maximum Demand[1]
	000.0	Phase B Voltage %THD Maximum Demand
	000.0	Phase C Voltage %THD Maximum Demand
	%THD V ↑	
	000.0	Phase A-B Voltage %THD Maximum Demand[2]
	000.0	Phase B-C Voltage %THD Maximum Demand
	000.0	Phase C-A Voltage %THD Maximum Demand
	%THD V ↑	
33.	000.0	Phase A Voltage Odd %THD[1]
	000.0	Phase B Voltage Odd %THD
	000.0	Phase C Voltage Odd %THD
	%OHD V	
	000.0	Phase A-B Voltage Odd %THD[2]
	000.0	Phase B-C Voltage Odd %THD
	000.0	Phase C-A Voltage Odd %THD
	%OHD V	
34.	000.0	Phase A Voltage Even %THD[1]
	000.0	Phase B Voltage Even %THD
	000.0	Phase C Voltage Even %THD
	%EHD V	
	000.0	Phase A-B Voltage Even %THD[2]
	000.0	Phase B-C Voltage Even %THD
	000.0	Phase C-A Voltage Even %THD
	%EHD V	
35.	00.00	K-Factor Phase A (Current)
	00.00	K-Factor Phase B (Current)
	00.00	K-Factor Phase C (Current)
	K-Factor	
36.	0.000	Phase A Displacement PF [1,4]
	0.000	Phase B Displacement PF
	0.000	Phase C Displacement PF
	DispPF Φ	
37.	0000	3Φ Displacement PF[4]
	□□□□	Unused
	□□□□	Unused
	DispPF T	

[1] - Screen available on WYE meters only (MTWDE1B/3B/4B/6B)
[2] - Screen available on DELTA meters only (MTWDE2B/5B)
[4] - Power Factor LAG (-), LEAD (+)

INDIVIDUAL HARMONIC DISPLAY SCREENS

	Format	Quantity
38.	000.0	Phase A Current % 3rd Harmonic Demand Distortion
	000.0	Phase B Current % 3rd Harmonic Demand Distortion
	000.0	Phase C Current % 3rd Harmonic Demand Distortion
	%3rdDD I	
39.	000.0	Phase A Current % 5th Harmonic Demand Distortion
	000.0	Phase B Current % 5th Harmonic Demand Distortion
	000.0	Phase C Current % 5th Harmonic Demand Distortion
	%5thDD I	
40.	000.0	Phase A Current % 7th Harmonic Demand Distortion
	000.0	Phase B Current % 7th Harmonic Demand Distortion
	000.0	Phase C Current % 7th Harmonic Demand Distortion
	%7thDD I	
41.	000.0	Phase A Current % 9th Harmonic Demand Distortion
	000.0	Phase B Current % 9th Harmonic Demand Distortion
	000.0	Phase C Current % 9th Harmonic Demand Distortion
	%9thDD I	
42.	000.0	Phase A[1], (A-B)[2] Voltage % 3rd Harmonic Distortion
	000.0	Phase B[1], (B-C)[2] Voltage % 3rd Harmonic Distortion
	000.0	Phase C[1] (C-A)[2] Voltage % 3rd Harmonic Distortion
	%3rdHD V	
43.	000.0	Phase A[1], (A-B)[2] Voltage % 5th Harmonic Distortion
	000.0	Phase B[1], (B-C)[2] Voltage % 5th Harmonic Distortion
	000.0	Phase C[1] (C-A)[2] Voltage % 5th Harmonic Distortion
	%5thHD V	
44.	000.0	Phase A[1], (A-B)[2] Voltage % 7th Harmonic Distortion
	000.0	Phase B[1], (B-C)[2] Voltage % 7th Harmonic Distortion
	000.0	Phase C[1] (C-A)[2] Voltage % 7th Harmonic Distortion
	%7thHD V	
45.	000.0	Phase A[1], (A-B)[2] Voltage % 9th Harmonic Distortion
	000.0	Phase B[1], (B-A)[2] Voltage % 9th Harmonic Distortion
	000.0	Phase C[1] (C-A)[2] Voltage % 9th Harmonic Distortion
	%9thHD V	

[1] - Screen available on WYE meters only (MTWDE1B/3B/4B/6B)
[2] - Screen available on DELTA meters only (MTWDE2B/5B)

The screens that are displayed in the scrolling mode can be programmed (ENABLED/DISABLED) by the user (refer to Section 4.2). A "SELECT" button is mounted on the faceplate of the instrument which allows the user to toggle the scrolling of the displays on or off. Momentarily pressing the front mounted SELECT button until the displays show all 8's, causes the scrolling to stop, allowing the user to view a particular quantity continuously. The microprocessor acknowledges the SELECT button by showing 8.8.8.8. on all three displays for 1.2 seconds. The display of all 8's also serves as a lamp test function. If front panel demand resets are disabled (refer to Section 2.6.2 for front panel demand reset disable/enable), momentarily pressing the SELECT button again will resume the scrolling of the display. Again the micro acknowledges the select button by flashing 8's on all three displays for 1.2 seconds.

If front panel demand resets are enabled and the scrolling has been stopped on a demand screen or harmonic demand screen, momentarily pressing the select button again will cause the alpha display to prompt the user for a demand reset. The demand reset message displayed will appear for 0.6 seconds and prompt the user to reset the demand values presently displayed. If the button is pressed again while the reset message appears on the alpha display, the displayed demand measurements will be reset. If the button is not pressed while the reset message appears, the demand values will not be reset and scrolling will resume in 0.6 seconds. For a more detailed description of demand resets refer to Section 2.6.2 of this manual.

If the SELECT button is held down for greater than 1.2 seconds, the meter will begin a FAST SCROLL scheme which allows the user to move quickly through the ENABLED display screens. The fast scroll will begin with the screen that was being displayed when the select button was pressed. The scroll will proceed through the enabled screens, one every 0.6 seconds. When the desired screen appears, the user can stop the scroll on that screen by simply releasing the select button. If the user enters fast scroll mode, the scrolling will ALWAYS be stopped when the user releases the select button. If the user does not release the select button, the entire sequence of enabled screens will be viewed. 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. This feature provides the user with a simple method of verifying the CT/PT ratios, as well as verifying the instrument address without having to remove the faceplate of the instrument. If the user releases the select button during the CT/ID/PT screen, the screen will remain for 2 seconds, at which time the display will return to the screen that was being viewed at the start of fast scroll. If the user continues to hold the select button, the fast scroll will commence again.

The state of the scrolling display is stored in nonvolatile memory (the store takes up to 6 seconds). If the user has stopped the scrolling at a particular screen and the power is interrupted, the meter will return to that screen when the power is re-applied.

For all the Watt, VAR and/or PF displays the "SIGN" of the quantity is indicated by the center segment of the left most digit, which will be illuminated to produce a "-" for negative quantities. Positive quantities will have no polarity indication. This restricts the display to 3 digits in the Watt and/or VAR display, however this is a restriction for the display only, internally the instrument still carries full precision.

The VOLTS display is Line-to-Line in the MTWDE2B/5B (DELTA). In the MTWDE1B/3B/4B/6B (WYE), the VOLTS display may be Line-to-Neutral (L-N), or **SCALED** which includes a square-root of 3 factor that allows the L-N voltage to be displayed in Line-to-Line (L-L) units. This method of display is determined by the selection of the display screen, please refer to Section 4.2 for a more detailed explanation.

2.3 Instantaneous Measurement Principles

All the quantities measured by the MultiComm RTH instrument utilize digital signal processing (DSP). This technique allows the instrument to measure a large number of quantities with a small amount of hardware. It also allows field upgrades, since the signal processing algorithms are in an EPROM, and can be simply changed to provide new features. The following section will give a brief overview of the measurement principles.

2.3.1 Voltage / Current

Signal processing begins with the low level AC signal supplied from the CT/PT board which is about 1 Vac RMS for a full scale input signal. Pure sine wave inputs or complex, distorted, periodic waveforms are handled equally well - a major advantage when computing WATTs and VARs as well as true RMS currents and voltages. This design frees the user from concern about errors which will otherwise occur during the measurement of distorted waveforms with non-true RMS instruments. Voltage of a given phase is sampled first, followed by the current of the same phase. Phases A, B and C are sampled in succession, providing the MCU with instantaneous measurements of all voltage and current inputs. Samples are accumulated for three AC cycles, at which time the MCU calculates the Volts and Amps for each phase. Any Zero Offset or drift is compensated every calculation cycle. Once the Volts and Amps have been calculated, the MCU scales the values by the external PT and CT ratios which have been selected by the user, and displays the values.

2.3.2 Neutral Current (Residual Current)

On the MTWDE1B/3B/4B/6B, the analog voltage signals from the three phase currents are summed on the Analog Board to form a new analog input that represents the Neutral Current (Residual Current). This signal is sampled at the same time as the other six signals (Phase Currents and Voltages). Samples are accumulated for three AC cycles, at which time the RMS value of the Neutral Current (Residual Current) is calculated by the MCU.

2.3.3 Watts / VARs

Instantaneous Watt samples are accumulated for three AC cycles, at which time the MCU calculates the WATTs and VARs for each phase. The VARS quantity for each phase is derived from a power triangle calculation where the WATTS and VAs are known. This technique provides a "true" measure of VARs even with distorted waveforms. Zero offset is also adjusted for each signal channel every 150 milliseconds by the MCU. These per phase quantities are then summed to form the total three phase WATTS and VARS. Once the WATTS and VARS have been calculated, the MCU scales the values by the external PT and CT ratios which have been selected by the user, and displays the values.

2.3.4 Energy

The WATT and VAR values are calculated every 150 milliseconds. These values are then multiplied by a time factor in order to generate WATThours and VARhours. The signs of the WATThour and VARhour values are then checked, and the values are then added to the appropriate registers (Positive/Negative WATThours, Lead/lag VARhours). These registers are updated every 150 milliseconds. In order to retain the energy values during a power failure, the registers must be stored in the EEPROM in the base of the instrument. The EEPROM has a limited number of write cycles, so the energy registers are only written every 90 seconds. At this rate, the EEPROM will last in excess of 15 years at rated conditions. Checksums are incorporated into the EEPROM which are read periodically by the microcontroller to check the integrity of the energy registers. The registers are in primary kilowatt-hours and kiloVAR-hours, and the CT and PT ratio are used to calculate the primary units.

The Energy registers count to a maximum of 99,999,999 units before rolling over to zero. It is the responsibility of the user to ensure that these values are read often enough to detect every rollover.

All the Energy registers can be RESET to 0000 through the communications interface. Refer to the appropriate protocol option manual for the protocol specific RESET command. The energy values will be reset within 150 milliseconds, however it takes the meter 4 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 4 second period after the energy is RESET or the reset may NOT occur.

2.3.5 Frequency

The Frequency measurement is generated by timing zero-crossings of the input Line Voltages or Line Currents over a period of 150msec. The microprocessor uses Phase A voltage (A-B in Delta) if available, for the frequency measurement. If Phase A is not available, the processor will switch to Phase B (B-C) and then to Phase C (C-A). If none of the voltages are available, the processor will attempt to use the Phase A current, then the Phase B current, then the Phase C current. The zero-crossings are determined from the analog samples directly. The samples are first sent through a smoother, which acts as a lowpass filter. Knowing the number of zero-crossings and the time between them, the frequency can be calculated. The input voltage must be greater than 20Vac for the frequency function to determine a value. If the input voltage is too low, or the frequency is below 45Hz, the instrument will return a value of 0Hz. If the frequency is above 75Hz, the instrument will return a value of 99.99Hz.

2.3.6 Volt-Amperes

The per-phase VA measurement is calculated from the product of the per-phase Amp and Volts values. In the 3-element instrument, the three-phase VA measurement is the sum of the per-phase VA values (Arithmetic VAs). In the 2-element instruments, the three-phase VA measurement is calculated from a power triangle $VA^2 = W^2 + VAR^2$ (Geometric VAs).

2.3.7 Power Factor

The per-phase Power Factor measurement is calculated using the "Power Triangle", or the per-phase WATTS divided by the per-phase VAs. The three-phase PF is similar, but uses the three-phase WATTS and VAs instead. The Power Factor measurements require a minimum current of approximately 0.25Aac (0.05Aac with CI1 option) and a minimum voltage of approximately 20Vac to determine an accurate answer. If the input signals are below these values, the instrument will indicate an over/under-range by blinking the display. A negative Power Factor corresponds to a LAGGING PF and a positive Power Factor corresponds to a LEADING PF.

2.4 Demand Measurements

The traditional thermal demand meter displays a value which represents the logarithmic response of a heating element in the instrument driven by the applied signal. The most positive value since the last instrument reset is known as the maximum demand (or peak demand) and the lowest value since the last instrument reset is known as the minimum demand. Since thermal demand is a heating and cooling phenomenon, the demand value has a response time T, defined as the time for the demand function to change 90% of the difference between the applied signal and the initial demand value. For utility applications, the traditional value of T is 15 minutes, and this is the value used in the Bitronics MultiComm meter.

The MultiComm meter generates a demand value using modern microprocessor technology in place of heating and cooling circuits, it is therefore much more accurate and repeatable over a wide range of input values. In operation, the MultiComm meter continuously samples the three-phase Amperes, three-phase Volts, Neutral Current (MTWDE1B/3B/4B/6B only), Total Watts, Total VARs, and Vas, and digitally integrates the samples with a time constant T to obtain the demand value. MultiComm RTH instruments also calculate Fundamental Neutral Current Demand (MTWDE1B/3B/4B/6B only), three-phase Voltage %THD Demand, and three-phase Current %TDD Demand (See Section 2.5). The calculated demand value is continuously checked against the previous maximum and minimum demand values and is displayed on the appropriate display. Present demand values are not displayed but are available via the network interface. This process continues indefinitely or until the demand is reset or the meter is reset (power cycled on meter). The demand reset and power-up algorithms are different for each measurement. These routines are further described as follows (Fundamental Neutral Current Demand, Voltage %THD Demand, and Current %TDD are described in the Harmonic Section).

NOTE: Changing PT or CT ratios resets all demand measurements (Presents, Maximums and Minimums) to zero.

2.4.1 Ampere Demands

Present Ampere Demands are calculated via the sampled data used to calculate the per phase Amperes. The Present Ampere Demands and Maximum Ampere Demands are updated approximately every 150 milliseconds. The Present Ampere Demands are not displayed but are available via the network interface. Maximum Ampere Demands are displayed and are also available via the interface.

Upon power-up, all per-phase Present Ampere Demands are reset to zero. Maximum Ampere Demands are initialized to the maximum values recalled from non-volatile memory (EEPROM). Upon DEMAND RESET, all per-phase Present and Maximum Ampere demands are set to zero. Ampere Demands may be reset via the front panel button when the global demand reset screen is enabled or via the network. When Ampere Demands are reset via the network, Neutral Current Demand and Fundamental Neutral Current Demands are also reset (MTWDE1B/3B/4B/6B only).

2.4.2 Neutral Current Demands

Neutral Current Demands are only available on MTWDE1B/3B/4B/6B models. Present Neutral Current Demands are calculated via the sampled data used to calculate the Neutral Current. The Present Neutral Current Demand and Maximum Neutral Current Demand are updated approximately every 150 milliseconds. The Present Neutral Current Demand is not displayed but is available via the network interface. Maximum Neutral Current Demand is displayed and is also available via the interface.

Upon power-up, the Present Neutral Current Demands is reset to zero. The Maximum Neutral Current Demand is initialized to the maximum value recalled from non-volatile memory (EEPROM). Upon DEMAND RESET all the Present and Maximum Neutral Current Demands are set to zero. The Neutral Current Demands may be reset via the front panel button when the global demand reset screen is enabled or via the network. When the Neutral Current Demands are reset via the network, all per-phase Ampere Demands and Fundamental Neutral Current Demand are also reset.

2.4.3 Volt Demands

Present Volt Demands are calculated via the sampled data used to calculate the per phase Volts. The Present Volt Demands, Maximum Volt Demands, and Minimum Volt Demands are updated approximately every 150 milliseconds. The Present Volt Demands are not displayed but are available via the network interface. Maximum Volt Demands, and Minimum Volt Demands are displayed and are also available via the interface.

Upon power up, all per-phase Present Volt Demands are reset to zero. The Maximum Volt Demands and Minimum Volt Demands are initialized to the minimum and maximum values recalled from non-volatile memory (EEPROM). In order to prevent the recording of false minimums, a new Minimum Volt Demand will not be stored unless two criteria are met. First the instantaneous voltage for that particular phase must be greater than 20Vrms. Second the Present

Demand for that particular phase must have dipped (Present Demand value must be less then previous Present Demand value).

The Maximum Volt Demands and Minimum Volt Demands can be reset independently of each other via the front panel reset (if the global demand front panel reset is enabled). The Maximum Volt Demands are forced to zero upon reset. Minimum Volt Demands are forced to the maximum volt value upon reset. The Present Volt Demands are not affected by resets. The network Volt Demand Reset resets both the Maximum and Minimum Volt Demands.

2.4.4 Watt / VAR / VA Demands

Present Total Watt/VAR/VA Demands are calculated via the sampled data used to calculate Total Watts/VARs/VAs. The Present Total Watt/VAR/VA Demand, Maximum Total Watt/VAR/VA Demand, and Minimum Total Watt/VAR/VA Demand are updated approximately every 150 milliseconds. Present Total Watt/VAR/VA Demands are not displayed but are available via the network interface. Maximum Total Watt/VAR/VA Demands, and Minimum Total Watt/VAR/VA Demands are displayed and are also available via the interface.

Upon power up, Maximum Total Watt/VAR/VA Demands and Minimum Total Watt/VAR/VA Demands are initialized to the maximum and minimum values recalled from non-volatile memory (EEPROM). The Present Total Watt/VAR/VA Demands are initialized to the mid point (or average) between the respective Maximum and Minimum Watt/VAR/VA Demands.

When reset, both the Maximum and Minimum Demands are set to the Present Demand value, the Present Demand remains unchanged. The Maximum and Minimum Demands of any of the power demand measurements (Watt, VAR, or VA) are always reset together. The power demands can be reset via the front panel reset (if the global demand front panel reset is enabled) or via the network. When reset via the front panel, only the measurements being displayed are reset. A reset via the network, resets all power demands (Watt Maximum, Watt Minimum, VAR Maximum, VAR Minimum, VA Maximum, and VA Minimum).

2.5 Harmonic Measurements

MultiComm RTH meters perform a variety of Real Time Harmonic measurements. MultiComm RTH meters perform 64 samples of the input waveforms over 3 cycles. Using Equivalent Time Sampling techniques, these 64 samples over 3 cycles are converted to 64 samples per cycle. The 64 samples are then passed to a 64 point FFT that is executed every 150 milliseconds. While all Instantaneous Measurements (Section 2.3) and all Demand Measurements (Section 2.4) are calculated every 150 milliseconds, Harmonic Measurements are calculated phase by phase on a “round robin” basis every 150 milliseconds. During each 150 millisecond interval, FFTs are run on the Current and Voltage of a given Phase (A,B,C,N), resulting in a 600 millisecond update time for Harmonic Measurements. MultiComm instruments limit the Harmonic Analysis to the 31st harmonic and below.

2.5.1 Voltage Distortion (THD)

Voltage Harmonic Distortion is measured by phase in several different ways. The equation for Total Harmonic Distortion (THD) is given in Equation 1. For Odd Harmonic Distortion, the summation only uses harmonics where h is odd. For Even Harmonic Distortion, the summation only uses harmonics where h is even. For Individual Harmonic Distortions, there is no summation, only one component is used in the numerator. Note the denominator is the fundamental magnitude. If the Voltage inputs are below 20Vac or the input Frequency is out of rated range (45Hz to 75Hz), the THD measurements will be set to 0%. All individual harmonics are available over the network, however display screens are available only for the 3rd, 5th, 7th, and 9th individual harmonics.

$$\%THD = \frac{\sqrt{\sum_{h=2}^{31} V_h^2}}{V_1} * 100\%$$

2.5.2 Current Distortion (TDD)

Current Harmonic Distortion is measured as Demand Distortion as defined by IEEE-519/519A. Demand Distortion differs from traditional Harmonic Distortion in that the denominator of the distortion equation is defined as the average monthly peak demand. By creating a measurement that is based on a fixed value, TDD is a “better” measure of distortion problems. Traditional THD is determined on the ratio of harmonics to the fundamental. While this is acceptable for voltage measurements, where the fundamental only varies slightly, it is ineffective for current measurements since the fundamental varies over a wide range. Using traditional THD, 30%THD may mean a 1Amp load with 30% Distortion, or a 100Amp load with 30% Distortion. By using TDD, these same two loads would exhibit 0.3%TDD for the 1Amp load and 30%TDD for the 100Amp load (if the Denominator was set at 100Amps). In the MultiComm RTH instrument, Current Demand Distortion is implemented using Equation 2. The TDD equation is similar to Harmonic Distortion (Equation 1), except that the denominator in the equation is a user defined number. This number, I_L, is meant to represent the average load on the system. The denominator I_L is different for each phase, and is set by writing to 3 denominator registers within the MultiComm instrument (please refer to the protocol manual for the exact location and format of these registers). Note that in Equation 2, if I_L equals the fundamental, this Equation becomes Equation 1 - Harmonic Distortion. In the instrument this can be achieved by setting the denominator registers to zero amps, in which case the instrument will substitute the fundamental, and calculate Current THD. For Odd Harmonic Distortion, the summation only uses harmonics where h is odd. For Even Harmonic Distortion, the summation only uses harmonics where h is even. For Individual Harmonic Distortions, there is no summation, only one component is used in the numerator. All individual harmonics are available over the network, however display screens are available only for the 3rd, 5th, 7th, and 9th individual harmonics.

$$\%TDD = \frac{\sqrt{\sum_{h=2}^{31} I_h^2}}{I_L} * 100\%$$

The TDD Denominator Registers are set by the factory to 5Amps secondary (1Amp for CI1 Option), which is the nominal full load of the CT input. If the Current inputs are below 0.25Aac (0.05Aac with CI1 option) or the input Frequency is out of rated range (45Hz to 75Hz), the TDD measurements will be set to 0%.

These writeable denominators can be used in conjunction with the distortion measurements to obtain the magnitudes of harmonics, in other words, convert from percent to amps. This is simply done by multiplying the %TDD by the TDD Denominator for that phase, and the result will be the actual RMS magnitude of the selected harmonic(s). This technique can also be used if the THD mode (zero denominator register) is used, by multiplying the %THD by the Fundamental Amps for that phase.

2.5.3 Fundamental Current

Fundamental Amps are the 60Hz (or 50Hz) component of the waveform. The MultiComm RTH instrument measures the magnitude of the fundamental amps for each phase. These measurements can be used in conjunction with the distortion measurements to obtain the magnitudes of harmonics, in other words, convert from percent to amps. As was mentioned previously, this is simply done by multiplying the %THD by the Fundamental Amps for that phase (which is the denominator), and the result will be the actual RMS magnitude of the selected harmonic. If the Line input Frequency is out of rated range (45Hz to 75Hz), the Fundamental Current measurements will be set to 0Aac.

2.5.4 Fundamental Voltage

Fundamental Volts are the 60Hz (or 50Hz) component of the waveform. The MultiComm RTH instrument measures the magnitude of the fundamental volts for each phase. These measurements can be used in conjunction with the distortion measurements to obtain the magnitudes of harmonics, in other words, convert from percent to volts. This is simply done by multiplying the %THD by the Fundamental Volts for that phase (which is the denominator), and the result will be the actual RMS magnitude of the selected harmonic. If the Line input Frequency is out of rated range (45Hz to 75Hz), the Fundamental Voltage measurements will be set to 0Vac.

Fundamental Volts and Amps can be used in conjunction to obtain Fundamental Vas, and when used with Displacement Power Factor, can yield Fundamental Watts and Fundamental Vars.

2.5.5 Fundamental Neutral Current

The MultiComm RTH instrument measures the magnitude of the Fundamental Neutral Current, which is the magnitude of the 60Hz (50Hz) component of neutral current. This measurement is only available on 2½ or 3 Element instruments (MTWDE1B/4B/6B). The measurement is in Amperes, and it is a measure of the load imbalance in a three phase system. If the Line input Frequency is out of rated range (45Hz to 75Hz), the Fundamental Neutral Current measurement will be set to 0A ac.

2.5.6 K-Factor

$$K\text{-}Factor = \frac{\sum_{h=1}^{31} I_h^2 * h^2}{\sum_{h=1}^{31} I_h^2}$$

K-Factor is a measure of the heating effects on transformers, and it is defined in ANSI/IEEE C57.110-1986. Equation 3 is used by the MultiComm RTH to determine K-Factor, where *'h'* is the harmonic number and 'I_h' is the magnitude of the h^th harmonic. K-Factor is measured on each of the three phases of amps, however there is no "Total" K-Factor. K-Factor, like THD and PF do not indicate the actual load on a device, since all three of these measurements are ratios. Given the same harmonic ratio, the calculated K-Factor for a lightly loaded transformer will be the same as the calculated K-Factor for a heavily loaded transformer, although the actual heating on the transformer will be significantly different. If the Current inputs are below 0.25Aac (0.05Aac with CI1 option) or the input Frequency is out of rated range (45Hz to 75Hz), the K-Factor measurements will be set to 1.00.

2.5.7 Displacement Power Factor

Displacement Power Factor is defined as the cosine of the angle (phi) between the Fundamental Voltage Vector and the Fundamental Current Vector. Per-phase Displacement Power Factor measurements are available on 2½ or 3 Element instruments (MTWDE1B/4B/6B). The sign convention for Displacement Power Factor is the sign of sin(phi), i.e. a negative Power Factor corresponds to a LAGGING PF and a positive Power Factor corresponds to a LEADING PF. If the Current inputs are below 0.25Aac (0.05Aac with CI1 option), the Voltage inputs are below 20Vac or the input Frequency is out of rated range (45Hz to 75Hz), the Displacement Power Factor measurements will be set to 1.999, and the instrument will indicate an over/under-range by blinking the display.

The Total Displacement Power Factor measurement is calculated using the "Power Triangle", or the three-phase Fundamental WATTS divided by the three-phase Fundamental Vas. The per-phase Fundamental VA measurement is calculated from the product of the per-phase Fundamental Amp and Fundamental Volts values. In the 2½ and 3-element instrument, the three-phase Fundamental VA measurement is the sum of the per-phase Fundamental VA values (Arithmetic VAs). In the 2-element instruments, the three-phase VA measurement is calculated from a power triangle $VA^2 = W^2 + VAR^2$ (Geometric VAs). The sign convention for Total Displacement Power Factor is the opposite sign of the Total Fundamental VARs, i.e. a negative Power Factor corresponds to a LAGGING PF and a positive Power Factor corresponds to a LEADING PF. If all Current inputs are below 0.25Aac (0.05Aac with CI1 option), all Voltage inputs are below 20Vac or the input Frequency is out of rated range (45Hz to 75Hz), the Total Displacement Power Factor measurements will be set to 1.999, and the instrument will indicate an over/under-range by blinking the display.

2.5.8 Fundamental Neutral Demand

Fundamental Neutral Current Demands are only available on MTWDE1B/3B/4B/6B models. Present Fundamental Neutral Current Demands are calculated via the sampled data used to calculate the Fundamental Neutral Current. The Present Fundamental Neutral Current Demand and Maximum Fundamental Neutral Current Demand are updated approximately every 600 milliseconds. The Present Fundamental Neutral Current Demand is not displayed but is available via the network interface. Maximum Fundamental Neutral Current Demand is displayed and is also available via the interface.

Upon power-up, the Present Fundamental Neutral Current Demands is set to zero. The Maximum Fundamental Neutral Current Demand is initialized to the maximum value recalled from non-volatile memory (EEPROM). Upon DEMAND RESET all the Present and Maximum Fundamental Neutral Current Demands are set to zero. The Fundamental Neutral Current Demands may be reset via the front panel button when the global demand reset screen is enabled or via the network. When the Fundamental Neutral Current Demand is reset via the network, all per-phase Ampere Demands and Fundamental Neutral Current Demand are also reset.

2.5.9 Current TDD Demand

Present Current TDD Demands are calculated via the sampled data used to calculate the per phase Current TDDs. The Present Current TDD Demands and Maximum Current TDD Demands are updated approximately every 600 milliseconds. By applying a thermal demand to the TDD measurement, the MultiComm RTH provides a more effective method of determining the severity of a harmonic problem. If a harmonic occurs in a small burst, traditional level detection schemes would alarm. However lower levels of distortion that exist for longer durations actually are more damaging due to the heating effect on transformers. The thermal demand function is an indicator of the thermal effects of the harmonics, and the maximum detector allows the user to assess conditions that occurred at times that were not directly observed. The Present Current TDD Demands are not displayed but are available via the network interface. Maximum Current TDD Demands are displayed and are also available via the interface.

Upon power-up, all per-phase Present Current TDD Demands are reset to zero. Maximum Current TDD Demands are initialized to the maximum values recalled from non-volatile memory (EEPROM). Upon DEMAND RESET, all per-phase Present and Maximum Current TDD Demands are set to zero. Current TDD Demands may be reset via the front panel button when the global demand reset screen is enabled or via the network. When Current TDD Demands are reset via the network, Voltage THD Demands are also reset.

2.5.10 Voltage THD Demand

Present Voltage THD Demands are calculated via the sampled data used to calculate the per phase Voltage THDs. The Present Voltage THD Demands and Maximum Voltage THD Demands are updated approximately every 600 milliseconds. By applying a thermal demand to the THD measurement, the MultiComm RTH provides a more effective method of determining the severity of a harmonic problem. The maximum detector allows the user to assess conditions that occurred at times that were not directly observed. The Present Voltage THD Demands are not displayed but are available via the network interface. Maximum Voltage THD Demands are displayed and are also available via the interface.

Upon power-up, all per-phase Present Voltage THD Demands are reset to zero. Maximum Voltage THD Demands are initialized to the maximum values recalled from non-volatile memory (EEPROM). Upon DEMAND RESET, all per-phase Present and Maximum Voltage THD Demands are set to zero. Voltage THD Demands may be reset via the front panel button when the global demand reset screen is enabled or via the network. When Voltage THD Demands are reset via the network, Current TDD Demands are also reset.

2.6 Measurement Resets

Certain measurements such as energy and demands may require to be reset. The reset processes are described in this manual. The network reset commands differ depending on which protocol the MultiComm Alpha Series meter supports. Refer to your protocol options manual to obtain the specific network reset commands.

2.6.1 Energy Reset

The energy registers can only be reset via the network interface. When reset, all energy registers (positive kilowatthours, negative kilowatthours, positive kilovarhours, and negative kilovarhours) are set to zero. The energy values will be reset within 0.6 seconds, however it takes the meter 4 seconds to clear the energy stored in non-volatile memory (EEPROM). If the power is interrupted to the meter within 4 seconds from the reset request, the reset may not occur.

2.6.2 Demand Resets

Demand resets can be initiated via the front panel button or via the network interface. The global demand front panel reset must be enabled in order to reset demands via the front panel button. The global demand front panel reset is enabled by activating the FRONT PANEL RESET (Frnt Rst) screen in the display setup mode. The FRONT PANEL RESET screen only appears in the setup mode and does not appear during the normal scroll or fast scroll modes. Additionally, the specific demand screen (screens 17 - 23, 25, 28, 32) that you desire to reset must be selected. Refer to Section 4.2, Programming Display, for more information on enabling the global demand front panel reset and other screens. Demand resets via the network are always enabled.

Demand resets via the front panel only reset the demand values presently being displayed. Demand values must be displayed in order to reset them via the front panel. To reset demand values via the front panel, first stop the scroll on the screen that displays the demand measurements you wish to reset. Press the panel button again (as to normally start scrolling). The alpha display will prompt you with a reset request message. If you wish to reset the demand measurements presently being displayed press the button again. The alpha display will acknowledge the reset by displaying the RESET! message, and the value displays will momentarily display all dashes. The value displays will then show the new values of reset demand measurements, and then begin normal scroll mode. If you wish to remain in non scroll mode after the reset, stopped on the demand display you just reset, continue to press the button during the demand reset until the engineering units appear on the alpha display.

If you do not wish to reset the demand measurements being displayed, do not press the button while the reset request message appears on the alpha display. The reset request message will only appear for a few seconds. If the button is not pressed, the reset request will timeout and the meter will return to normal scroll mode. If the global front panel demand reset is enabled, the meter will prompt for a demand reset each time scrolling begins while stopped on a demand screen. If front panel demand resets are never to be used, it is strongly suggested that they be disabled by deselecting the FRONT PANEL screen in the display setup.

Demands may also be reset via the network. Network demand resets are preferred to front panel demand resets because there are less chances of accidental demand resets. Demand resets via the network occur in groups (AMPs, VOLTs, POWER, OR HARMONICS). When resetting demands via the network all demands in a group are reset concurrently. The AMP DEMAND NETWORK RESET resets all three phases of Amp Demand, Neutral Current Demand and Fundamental Neutral Current Demand. The VOLT DEMAND NETWORK RESET resets the minimum and maximum of all three phases of Volt Demands. The POWER DEMAND NETWORK RESET resets the minimum and maximum of Total Watt, Total VAR and Total VA Demands. The HARMONIC NETWORK RESET resets the Voltage THD Demands and the Current TDD Demands. Refer to the protocol options manual for the specific network demand reset required.

The demand values will be reset within 0.6 seconds, however it takes the meter up to 10 seconds to clear the demand values stored in non-volatile memory (EEPROM). If the power is interrupted to the meter within 10 seconds from the reset request, the reset may not occur.

3.0 INSTALLATION

WARNING - INSTALLATION AND MAINTENANCE SHOULD ONLY BE PERFORMED BY PROPERLY TRAINED OR QUALIFIED PERSONNEL.

3.1 Initial Inspection

Bitronics' instruments are carefully checked and "burned in" at the factory before shipment. Damages can occur, however, so please check the instrument for shipping damage as it is unpacked. Notify Bitronics immediately if any damage has occurred, and save any damaged shipping containers.

3.2 Power Requirements

MultiComm Meters are normally equipped with Universal (AC/DC) power supplies. Optional 115Vac and 230Vac power supplies are available at time of order. Power is connected to the two labeled terminals at the rear of the case as shown in Figures 4 thru 10. Both terminals are electrically isolated from the meter case and from the electronic circuitry. Variations of the auxiliary supply voltage that are within the supply specifications will not affect the performance of the instrument. The power supply and regulators provide constant dc power to the modules independent of variations in auxiliary supply voltage over this range. If the supply voltage drops below the point at which the regulators can function properly, the watchdog timer will cause the displays to flash as described previously.

3.3 Overcurrent Protection

A UL listed 1.5 Ampere non-time delay (M) fuse is to be series connected in the ungrounded (hot) side of mains input as part of installation of this product.

3.4 Mains Disconnect

Equipment shall be provided with a Mains Disconnect, that can be actuated by the operator and simultaneously open both sides of the mains input line. The Disconnect shall be UL Recognized and acceptable for the application.

3.5 Instrument Mounting

The instrument may be mounted into a standard 4" panel opening as shown in Figure 2. Adapter plates are available for larger panel openings.

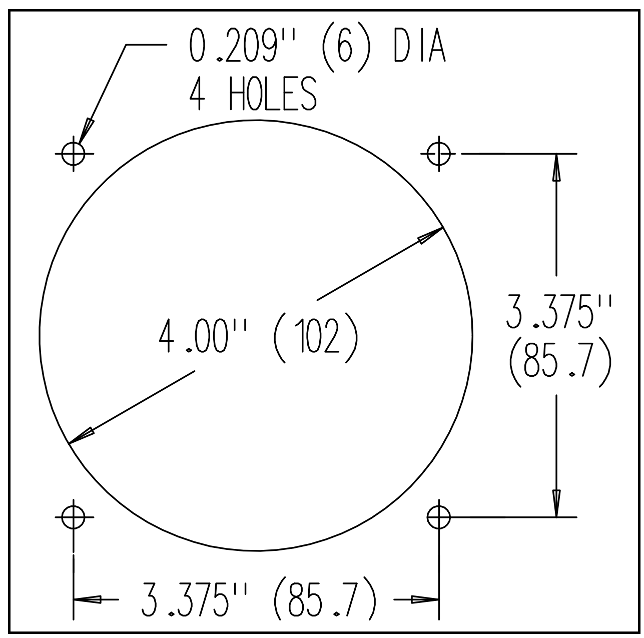


Figure 2 - Mounting Dimensions

Figure 3 shows the overall dimensions of the MultiComm Alpha Series Meter. WARNING - DO NOT overtighten the nuts on the mounting studs, HAND tighten with a standard nut driver, 12 inch-pounds is recommended, MAXIMUM torque is 15 inch-pounds.

3.6 Surge Protection

It is recommended that a metal oxide varistor (MOV) be placed across the power supply input to protect the meter in the event of high voltage surges or lightning strikes. MultiComm Alpha Series Meters are shipped with a transient suppression network already attached as a standard design. An MOV provides an added measure of protection against heavy switching transients occasionally experienced in the field. The MOV is designed to clamp applied power voltages above 270 V ac RMS. A single MOV protects the meter Line to Line, and two high voltage capacitors are provided to protect each Line to Ground. To avoid damaging the MOV protector, maintain continuously applied power voltages within the ratings of the instrument. The GREEN lead of the MOV assembly should be connected to a good earth ground. In most instances, this is usually accomplished by connecting the GREEN lead to the panel via the indicated front mounting stud. This mounting stud is a safety ground for the instrument, and should be connected to a protective earth circuit (refer to Figure 3). Although the Line to Ground capacitors are 3kV and UL rated, users of DC power may not want the transient protection connected from the DC supply to earth ground. In this case the GREEN lead of the MOV assembly can be clipped at the board, or the GREEN lead may be connected to either of the meter power studs. Mounting of the MOV board external to the instrument allows easy access so that the MOV and Caps may be readily inspected for damage. If the unit is to be powered from a PT, it is recommended that one side of the PT be grounded at the instrument following ANSI/IEEE C57.13.3-1983. The MOV board voltage rating is indicated on the MOV board, and must match the voltage supply rating of the instrument.

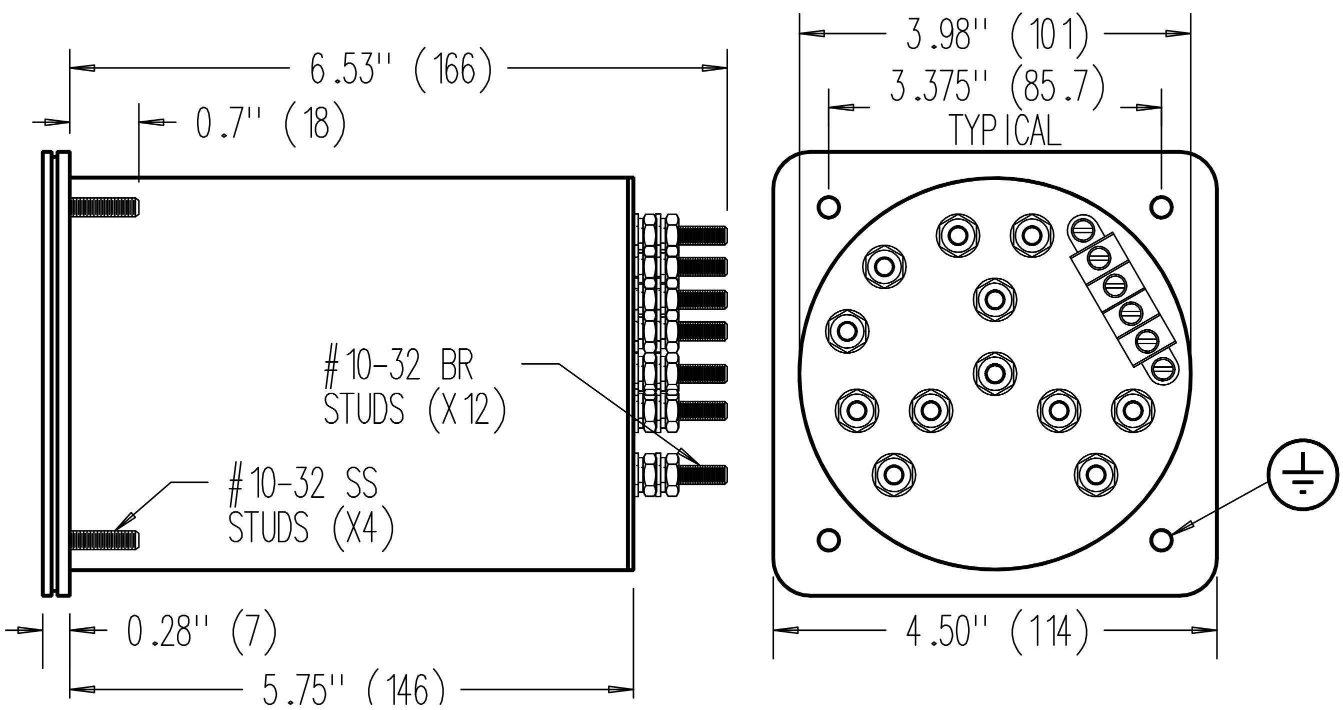


Figure 3 – Overall Dimensions

3.7 Setting Instrument Address

The MultiComm RTH Meters instruments require an address to be set within the instrument before any communications can begin. Refer to the appropriate protocol option manual for address setup instructions.

4.0 FIELD ADJUSTMENTS

WARNING - INSTALLATION AND MAINTENANCE SHOULD ONLY BE PERFORMED BY PROPERLY TRAINED OR QUALIFIED PERSONNEL.

The Bitronics MultiComm RTH Meters have been factory calibrated to display 000 +/- one digit for zero signal input. PT and CT values are set to customer values if specified, or to 5:5 CT and 1:1 PT otherwise.

4.1 Rescaling

One of the most powerful features of the MultiComm RTH Meters is the extreme ease of rescaling the instrument on the bench or in the field. No calibrator is needed. Even though the units are factory scaled to customer CT/PT ratios, these ratios may be changed in the field as transformers are "tapped down". Rescaling should also be checked anytime the meter is altered by the replacing of either the Electronics Module or the EPROM firmware. Two methods are available to the user for rescaling.

The first method is the conventional method utilizing the CT/PT toggle switch and the Select pushbutton inside the meter. **Note: THE communications interface is NOT operational during rescaling.** Rescaling is simple and is carried out in the panel as follows:

WARNING!: Any change in PT or CT ratios will zero all demand measurements!

1. With the MultiComm RTH 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 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.

3. Index through the available CT/PT ratios by repeatedly pushing the select button. All CT ratios are assumed to have 5 amps as their secondary nominal output (1 amp if CI1 option). Therefore 10.00 on the display corresponds to a 10:5 CT for a 5amp CT, or 10:1: for a 1amp CT. PTs are represented by a ratio to 1, so 20.00 on the display would correspond to a 20:1 PT. Powers of ten can also be set as the decimal point moves from left to right by using the select button. A momentary push of the button will cause the display to increment to the next power of ten, or to the next ratio. Holding the push button down longer than 1.2 seconds will cause the watchdog timer to reset the MCU, indicated by the display test, followed by the version number of the instrument software, followed by the display of the current CT & PT ratios. This is not a problem, and can be used to reset the MCU, check for proper watchdog operation, check software version number, or return to the current CT & PT ratio. Be sure to observe the proper position of the decimal point.

CT ratios 5.000 to 9.000 have two sets of values. The first value allows maximum resolution, but does not allow the full 2X overload range to be displayed (the serial output is still accurate). A second set of values has been shifted over one digit, and allows the full 2X overload, but sacrifices one digit of resolution (only on the display). The table of CT ratios is listed below:

1.000, 10.00, 100.0, 1000.	
1.100, 11.00, 110.0, 1100.	
1.200, 12.00, 120.0, 1200.	
1.500, 15.00, 150.0, 1500.	
1.600, 16.00, 160.0, 1600.	
2.000, 20.00, 200.0, 2000.	
2.200, 22.00, 220.0, 2200.	
2.400, 24.00, 240.0, 2400.	
2.500, 25.00, 250.0, 2500.	
3.000, 30.00, 300.0, 3000.	
3.500, 35.00, 350.0, 3500.	
4.000, 40.00, 400.0, 4000.	
4.500, 45.00, 450.0, 4500.	
5.000, 50.00, 500.0, 5000.	
0.500, 05.00, 050.0, 0500.	Expanded 5.000 range for 2X overload
6.000, 60.00, 600.0, 6000.	
0.600, 06.00, 060.0, 0600.	Expanded 6.000 range for 2X overload
7.500, 75.00, 750.0, 7500.	
0.750, 07.50, 075.0, 0750.	Expanded 7.500 range for 2X overload
8.000, 80.00, 800.0, 8000.	
0.800, 08.00, 080.0, 0800.	Expanded 8.000 range for 2X overload
9.000, 90.00, 900.0, 9000.	
0.900, 09.00, 090.0, 0900.	Expanded 9.000 range for 2X overload

4. Return the toggle to the center position. The alphanumeric display will show a **Select?** prompt for 2 seconds at which time the user may elect to program the display (refer to the next section for a description of this mode). The Select? prompt will be followed by a digit check (8888 displayed) and the new CT ratio will be "locked" into the meter.

5. Repeat steps 2 through 4 with the CT/PT switch in the down position to set the PT ratio. A table of the PT ratios is listed below. The ratios are for displaying the phase voltages as line-to-neutral (L-N) voltage from the L-N PTs (MTWDE1B/3B/4B/6B) or line-to-line (L-L) voltage from L-L PTs (MTWDE2B/5B). The MTWDE1B/3B/4B/6B has a separate display screen that multiplies the L-N value by a square-root of 3 **SCALE FACTOR**, this allows the user to display the L-N voltage in L-L units (refer to section 4.3). The RTH series instruments (Version 4.30 and later) contain a Secondary Volts screen (screen 61) that allows the user to display the voltage in secondary units. **The PT ratio must still be set even if secondary volts is selected** to allow the power measurements (Watts, VARs, Energy) to be calculated and displayed correctly.

PT ratios for displaying L-N in L-N units (MTWDE1B/3B/4B/6B) or L-L in L-L units (MTWDE2B/5B):

1.000, 10.00, 100.0, 1000.	
1.100, 11.00, 110.0, 1100.	
1.155, 11.55, 115.5, 1155.	relay ratio
1.200, 12.00, 120.0, 1200.	
1.375, 13.75, 137.5, 1375.	
1.400, 14.00, 140.0, 1400.	
1.500, 15.00, 150.0, 1500.	
1.732, 17.32, 173.2, 1732.	relay ratio
1.750, 17.50, 175.0, 1750.	
1.800, 18.00, 180.0, 1800.	
2.000, 20.00, 200.0, 2000.	
2.309, 23.09, 230.9, 2309.	relay ratio
2.400, 24.00, 240.0, 2400.	
2.500, 25.00, 250.0, 2500.	
2.511, 25.11, 251.1, 2511.	relay ratio
3.000, 30.00, 300.0, 3000.	
3.464, 34.64, 346.4, 3464.	relay ratio
3.500, 35.00, 350.0, 3500.	
3.750, 37.50, 375.0, 3750.	
4.000, 40.00, 400.0, 4000.	
4.350, 43.50, 435.0, 4350.	
4.500, 45.00, 450.0, 4500.	
5.000, 50.00, 500.0, 5000.	
5.774, 57.74, 577.4, 5774.	relay ratio
6.000, 60.00, 600.0, 6000.	
6.250, 62.50, 625.0, 6250.	
6.350, 63.50, 635.0, 6350.	
6.642, 66.42, 664.2, 6642.	
6.928, 69.28, 692.8, 6928.	relay ratio
7.000, 70.00, 700.0, 7000.	
8.000, 80.00, 800.0, 8000.	
8.083, 80.83, 808.3, 8083.	relay ratio

As was mentioned previously, the MTWDE1B/3B/4B/6B contains a special voltage display screen which includes a square-root of 3 factor, which allows the user to display the L-N voltage in L-L units. **WARNING: This is a scaled value only, and does not represent the true line-to-line voltage, except under ideal conditions.**

6. 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!!

The second method of setting the ratios became available starting with Firmware Version 3.30. This method allows the user to program the CT and PT ratios via the network communications protocol. Please refer to the appropriate communications protocol manual for a detailed description of this feature.

The position of the decimal point for all the displayed quantities are automatically calculated by the microcontroller. The microcontroller also calculates the engineering units for the primary units display. The microprocessor will adjust the decimal and alter the alphanumeric display to indicate in Watts/Vars, kilowatts/kilovars, Megawatts/MegaVars or Gigawatts/Gigavars, etc.

4.2 Programming Display

The MultiComm RTH Meters can be programmed to provide only certain information on the front display (screens). This programming DOES NOT affect the measurements that the meters make, or the information available over the network, it only affects what is being displayed. The display can be programmed using the toggle switch and pushbutton inside the instrument, or it can be programmed over the network. For information on programming the display over the network, refer to the appropriate protocol manual. The procedure for programming the display screens using the internal switches is as follows:

1. With the MultiComm RTH 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.**

3. 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**. 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.

4. Once the Programming Mode is entered, each available screen will appear in sequence just as it does in the normal scroll mode. As each screen is presented in the programming mode, the current state (selected/deselected) of that screen will be indicated. A screen that is SELECTED, that is a display that will be shown, is indicated by zeros in the main display, and the alphanumeric prompt display will be at high intensity. A screen that is DESELECTED, that is a display that will NOT be shown, is indicated by a blank main display and the alphanumeric prompt will be at low intensity.

Note - The first screen displayed in the programming (set-up) mode is the "FRNT RST". This screen enables/disables the demand front panel reset feature. When this screen is enabled, front panel demand resets are allowed. Likewise, when this screen is disabled, front panel demand resets are dis-allowed. This screen only appears in programming (set-up) mode.

5. As each screen is presented, pressing the Select button will toggle the indicated screen between SELECTED and DESELECTED. If the user is satisfied with the current status of the screen, nothing needs to be done for that screen. As long as the select button is pushed within 2 seconds, the user may toggle the screen between Select and Deselect continually. After the user is satisfied with the selection on a particular screen, no activation of the select button for 2 seconds will signal the processor to proceed to the next screen, where the user can again decide on the Select/Deselect for that screen. This procedure is repeated until all the available screens have been programmed. **NOTE - If ALL screens are DESELECTED, the meter display will always be blank with the prompt "No Screen" on the alphanumeric display.**

6. When all the available screens have been reviewed, the display test (8888 displayed) will be executed and the new display program will be "locked" into the meter.

7. 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!!

4.3 Calibration

Routine recalibration is not recommended, or required. However some drift or aging may cause slight errors after years of use. Additionally, users may wish to have a MultiComm RTH Meter "agree" with other instruments. To accommodate both these instances, a "Master Gain" trimpot has been provided. This trim adjusts the overall scale factor by +/- 10%, and is accessed in the following manner:

1. Remove the four cover screws. Remove the front cover and gasket, being careful to unplug the select switch.

2. Remove calibration seal located in upper right-hand corner of the display board, this will allow access to the trimpot located on the Analog Processing board.

3. Insert a small screwdriver through the opening, and into the slot of the screw on the trimpot.

4. With the meter powered, AND WITH A PRECISION KNOWN INPUT, rotate the screw clockwise to increase the measurement, or counter-clockwise to decrease the indicated

measurement. NOTE: Because these Multifunction meters are a full 2 or 3 elements, the instrument can be calibrated with a single phase source, all current inputs should be connected in series, and all potential inputs should be connected in parallel. When MTWDE2B/5B meters are connected with a single phase voltage source as described above, the third phase voltage (C-A) will read zero (A-B minus B-C). If the two voltage (PT) inputs are connected with opposite polarities, the third phase voltage (C-A) will read two times the input (A-B plus B-C). When MTWIE3B/6B meters are connected with a single phase voltage source as described above, the third phase voltage (B-N) will read two times the input (A-N plus C-N). If the two voltage (PT) inputs are connected with opposite polarities, the third phase voltage (B-N) will read zero (A-N minus C-N). The PT signals should be kept below 75Vac in this single phase configuration, since all voltage phases have a maximum input limit of 150Vac. The Neutral (Residual) Current (MTWDE1B/3B/4B/6B only) is the sum of the three phase currents. In a single phase configuration the currents will all add in phase, therefore the currents should be kept below 5Aac if all three phases are energized with a single phase source. These restrictions are only for single phase testing.

5. Remove the screwdriver, and replace the calibration seal.

6. 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.

The serial communications data output will track the display, so recalibrating the display automatically recalibrates the output. The output data cannot be calibrated independently.

4.4 Self Test Modes

The MultiComm RTH instruments are based on a microcontroller, and therefore can capitalize on the power of such a device. One of the areas where the power of the microcontroller enhances the overall performance of the instrument is in the area of "self-testing". The MultiComm RTH meters have several self tests built in to assure that the instrument is performing accurately. Table I on the following page lists possible faults that would be detected by the self tests, how the fault is indicated, the effects of the fault and any necessary corrective actions.

Note that some protocols allow remote devices to initiate instrument restarts. During the restart process, communications between the HOST and MultiComm processors will cease causing the interface crash code to be displayed. This does **NOT** indicate abnormal operation unless the error code persists for more than 65 seconds.

4.5 Cleaning

Cleaning the exterior of the instrument shall be limited to the wiping of the instrument using a soft damp cloth applicator with cleaning agents that are not alcohol based, and are nonflammable, nonexplosive.

TABLE I - SELF TEST RESULT SUMMARY FOR MultiComm RTH METERS

Fault	Fault Indication	Effects of Fault	Corrective Action
1. Display Overflow	Display flashes 9999	Measured quantity is too large to be displayed. Communication option output may still be accurate, if overload does not exceed meter input ratings.	Correct fault external to instrument.
Display Underflow	Display flashes 0000	Frequency is to low to be measured, or Phase B (B-C) voltage too low to permit frequency measurement (< 10volts).	Correct fault external to instrument.
Input out of range (PF)	Display flashes 1.999	Input signal(s) is too large or too small to accurately determine Power Factor. Communication output indicates unity PF.	Correct fault external to instrument.
2. CT/PT ratio checksum error	Top display alternately displays 4 dashes (----) and fault code 1 (---1).	Scaling of the display cannot occur due to the loss of the CT and/or PT ratios. The communication option outputs are still functional and accurate except the CT & PT ratio.	Attempt to reset the CT&PT ratios. If Fault continues, replace Power Supply Board and recalibrate the instrument, or replace the Base Module.
3. CT/PT board calibration checksum error	Top display alternately displays reading and fault code 2 (---2).	Calibration constants for the CT/PT Board are in error. The display and the communication option output are reduced in accuracy to approximately +/-3%.	Replace Power Supply Board and recalibrate the instrument, or replace the Base Module.
4. Analog board calibration checksum error	Top display alternately displays reading and fault code 3 (---3).	Calibration constants for the Analog Processing Board are in error. The display and the communication option output are reduced in accuracy to approximately +/-3%.	Replace Analog Processing Board or the Electronics Module.
5. Watchdog timer timeout	All displays alternately display readings and blanks.	The watchdog timer is attempting to reset the microcontroller due to low supply voltage, or a fault in the microcontroller. Displayed values are inaccurate and communication option will cease transmitting.	Check input supply voltage to verify it is within specifications. If supply is OK, replace Host Microcontroller Board, or replace Electronics Module.

TABLE I - SELF TEST RESULT SUMMARY FOR MultiComm RTH METER (continued)

Fault	Fault Indication	Effects of Fault	Corrective Action
6. Input Over-Range	Top display alternately displays reading and fault code 4 (---4).	Peak input quantity exceeds the range of the instrument. Both display and communication option output accuracy reduced by an amount depending upon the degree of over-range.	Verify input signals are within range. If within range, replace analog processing board or the electronics module.
7. Program memory error	Top display indicates fault code 5 (---5) then executes power-up display sequence.	The microcontroller has detected a fault in program memory and is attempting to restart itself. Communication option will cease transmitting as long as the fault exists.	Replace Host Microcontroller board or electronics module.
8. Analog-to-Digital converter (ADC) self-test error	Top display alternately displays 4 dashes (----) and fault code 6 (---6), other displays show 4 dashes (----).	Instrument cannot read any signals. Data returned by communications option will be corrupted.	Replace analog processing board or the electronics module.
9. XRAM failure	Top display alternately displays reading and fault code 7 (---7).	Displayed quantities will no longer be averaged, accuracy may degrade to 0.5%. Data returned by communications option may be corrupted.	Replace Host Microcontroller Board or Electronics Module.
10. HOST-MultiComm interface crash	Top display alternately displays reading and fault code 8 (---8).	Displayed quantities are still accurate. Communications data will not be available. Host processor will attempt to restart interface every 30 seconds.	If failure continues, replace MultiComm Processor Board, or Electronics Module.
11. Energy Checksum Failure	Top display alternately displays reading and fault code 9 (---9).	Energy values that are stored and recalled at powerup may be corrupted and inaccurate.	Replace Power Supply Board and recalibrate the instrument, or replace the Base Module.
12. Demand Parity Error Failure	Top display alternately displays reading and fault code 10 (--10).	Demand values that are stored and recalled at powerup may be corrupted and inaccurate.	Reset all demand measurements. If error remains, replace analog board or electronics module.
13. Configuration Parity Error	Top display alternately displays reading and fault code 11 (--11).	Instrument configuration may be corrupted and inaccurate. This may cause communication errors.	Reset Configuration. If error remains, replace analog board or electronics module.

4.6 Electronics Module Removal

The Electronics Module consists of the Analog Processing Board (AP), the Host Microcontroller Board (MCU), the MultiComm Processor Board and LED Display Board (LED). In the unlikely event of a board failure, it may be necessary to remove the Electronics Module from the instrument. Bitronics has designed the Multifunction meters in a modular fashion to facilitate this repair in the field, by allowing the module to be removed with the meter powered and in the panel. The procedure is as follows:

1. 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. On MTWDE4B/5B/6B, disconnect the Modbus Plus flexible circuit connector located in the lower left hand corner (7 o'clock) by pulling it straight out about 1 inch. Carefully lay the connector and flex circuit to the side so that it will not be damaged when the module is removed.

3. Remove the two roundhead screws located at 3 and 9 o'clock (labeled "REMOVE").

4. A wire bail is located at the top of the module, pull gently on the bail, and the Electronics Module will pull out (a slight rocking motion may be required). On MTWDE4B/5B/6B only, be careful of the Modbus Plus flex circuit. Do not bend any of the connector pins in the Base Module. **CAUTION - when the Electronics Module is removed with the instrument powered, instrument power is present on the circuit boards that remain in the Base Module. DO NOT touch or insert metallic objects into the Base Module while the instrument is powered.**

5. To reinsert the Electronics Module, first make sure the Modbus Plus flex circuit and connector are carefully dressed to the side, so that they are not damaged when the module is inserted. Next align the two 0.25" round guide rails with the two holes in the bottom board of the Electronics Module. Gently push the Electronics Module in until the module is fully seated (DO NOT FORCE!!).

6. On MTWDE4B/5B/6B, reconnect the Modbus Plus flex circuit to the three pin connector located at 7 o'clock, making sure that the flex circuit is neatly dressed along the side of the module.

7. Replace the two roundhead screws located at 3 o'clock and at 9 o'clock. Push the wire bail back into the meter.

8. Check CT and PT ratios and reset if necessary (See section 4.1 Rescaling).

9. 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.

5.0 QUESTIONS AND ANSWERS

1. What happens if the applied CT signal exceeds 5A?

   The MULTIFUNCTION meters are accurate to twice the normal full scale limit (to 10A). The unit will operate at 100% overload without damage, however on some CT/PT settings the display will over-range, causing the display to flash with 9999. The communications output is still accurate.

2. Can the Electronics Module be removed under power?

   Yes. Neither input signals nor power need be disconnected to remove or rescale the Electronics Module. Removing the module DOES NOT open the CTs or PTs.

3. Is routine calibration necessary?

   No, nor is it recommended. More problems are caused by improper calibration than by faulty meters. A calibration check every few years in the field is good assurance, however. If there is a question about the meter, exchanging a module may help verify performance.

4. HI and LO are marked on the inputs. Does polarity matter?

   Yes! Correct wiring with proper polarity is essential for proper operation.

5. Can I put MULTIFUNCTION meters in an outdoor cabinet?

   Yes. Many Bitronics meters are installed that way. The temperature range of -20C to 70C covers most applications. The case is gasketed, but not waterproof, so it must be placed within an enclosure that provides ingress protection acceptable for the application in accordance with IEC 529, UL 840 or the equivalent NEMA Standard.

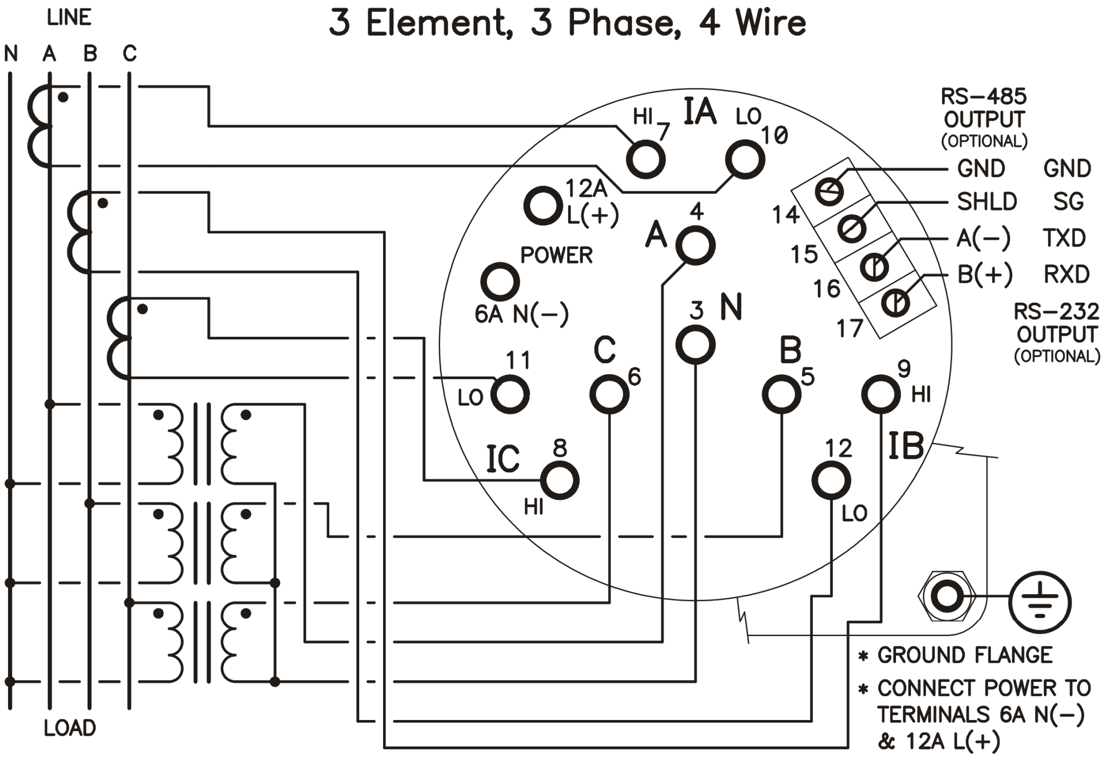
6. How long will MULTIFUNCTION meters save the CT/PT ratio without power?

   The data is saved in a nonvolatile memory (EEPROM) which does not require battery backup. Retention is estimated by the manufacturer to exceed 10 years without refreshing. In any event, long enough to exceed an outage, or for any inactive storage period.

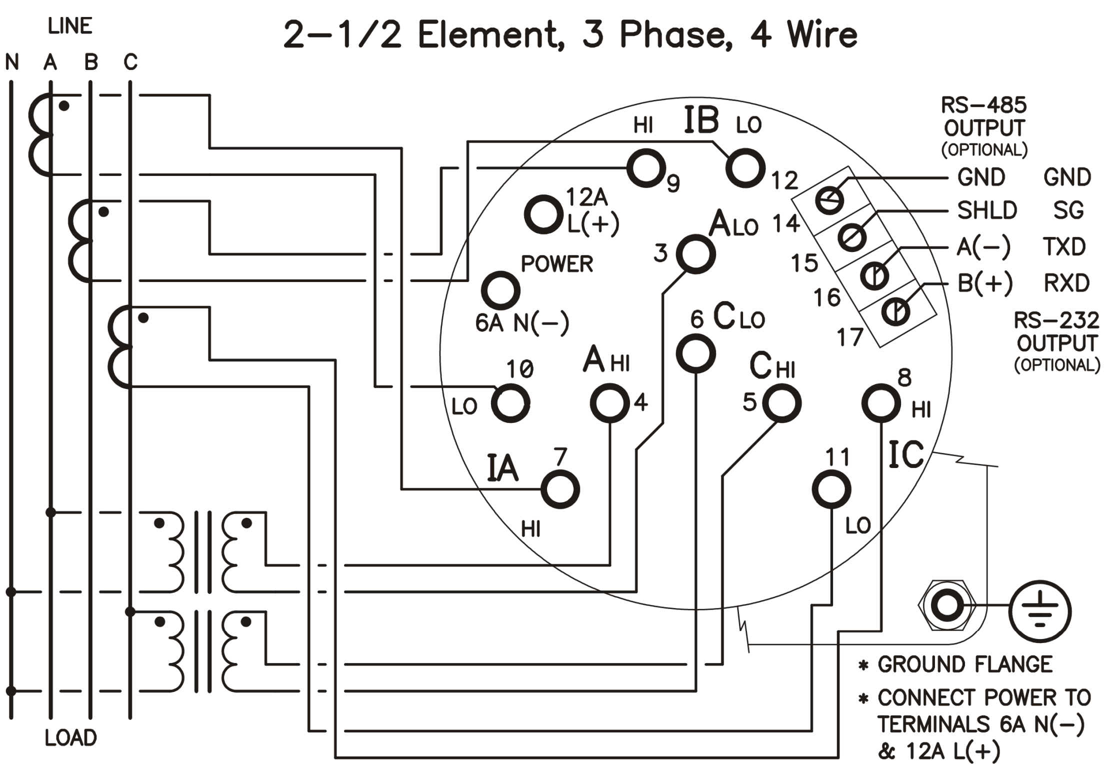
7. I have a low voltage circuit, can I operate MULTIFUNCTION meters without the use of CTs and PTs?

   Although the MULTIFUNCTION meter has been optimized for use with CTs and PTs, it can be connected directly to a load provided that the voltages and currents do not exceed the rating of the device. The internal CT should be set to 5 (5:5) and the internal PT should be set to 1 (120:120).

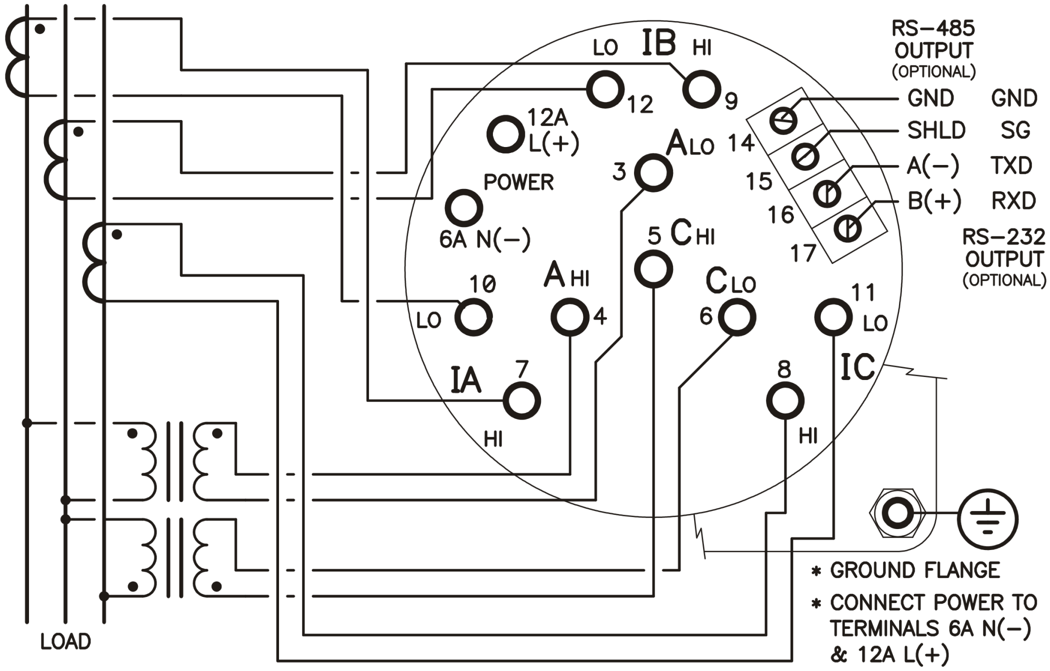
3 Element, 3 Phase, 4 Wire



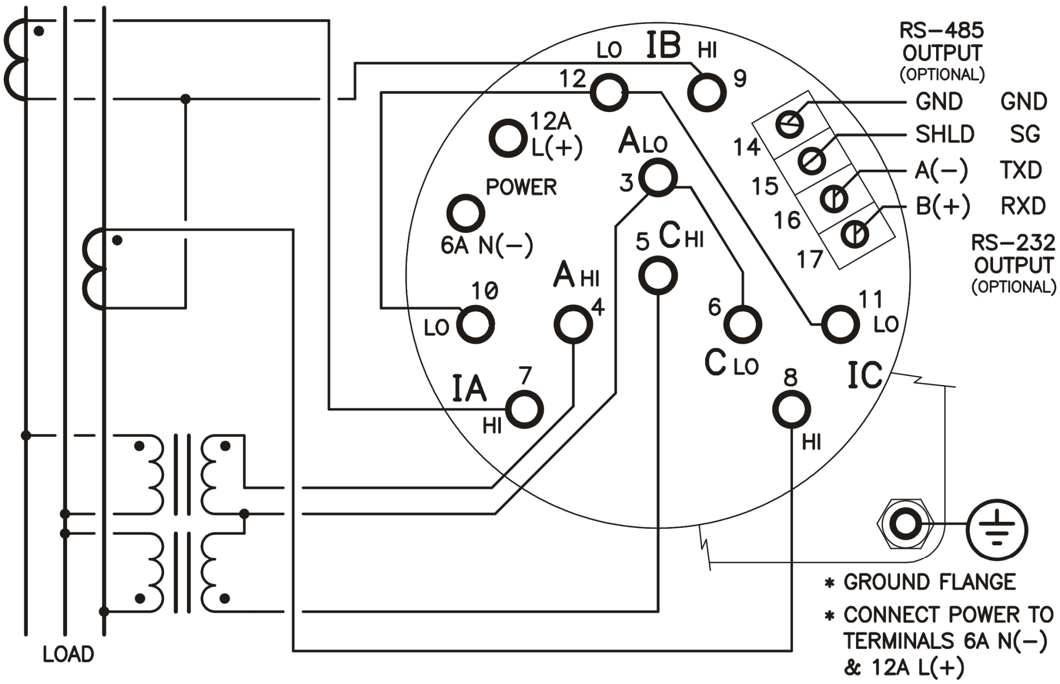
2−1/2 Element, 3 Phase, 4 Wire



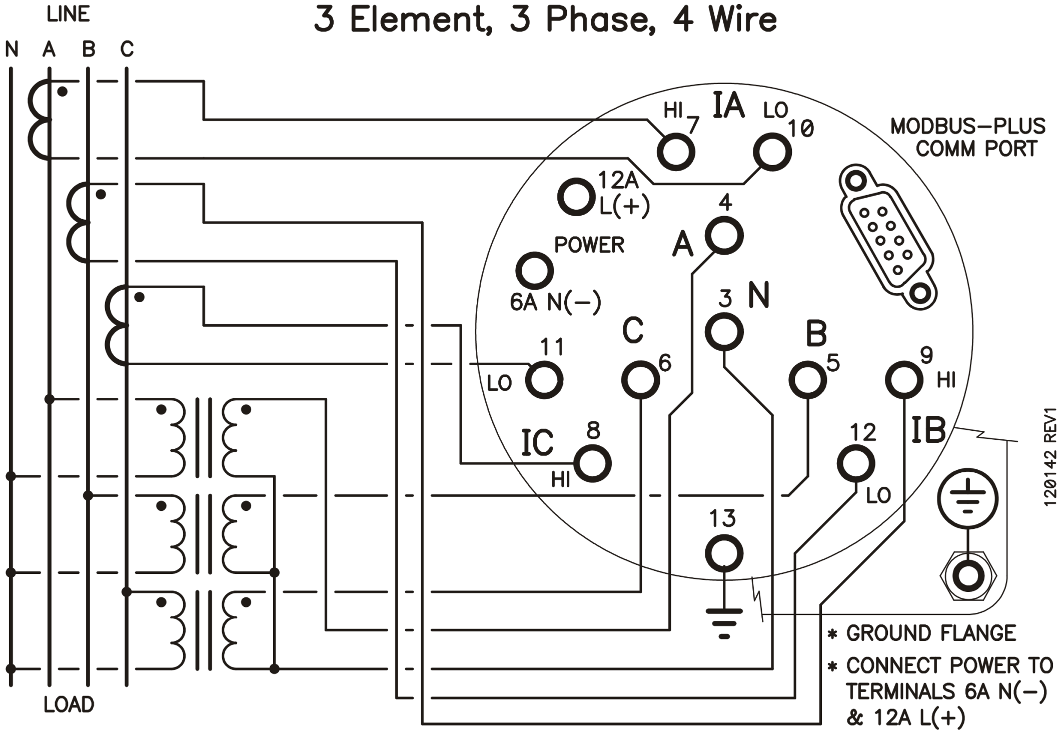
2 Element, 3 Phase, 3 Wire



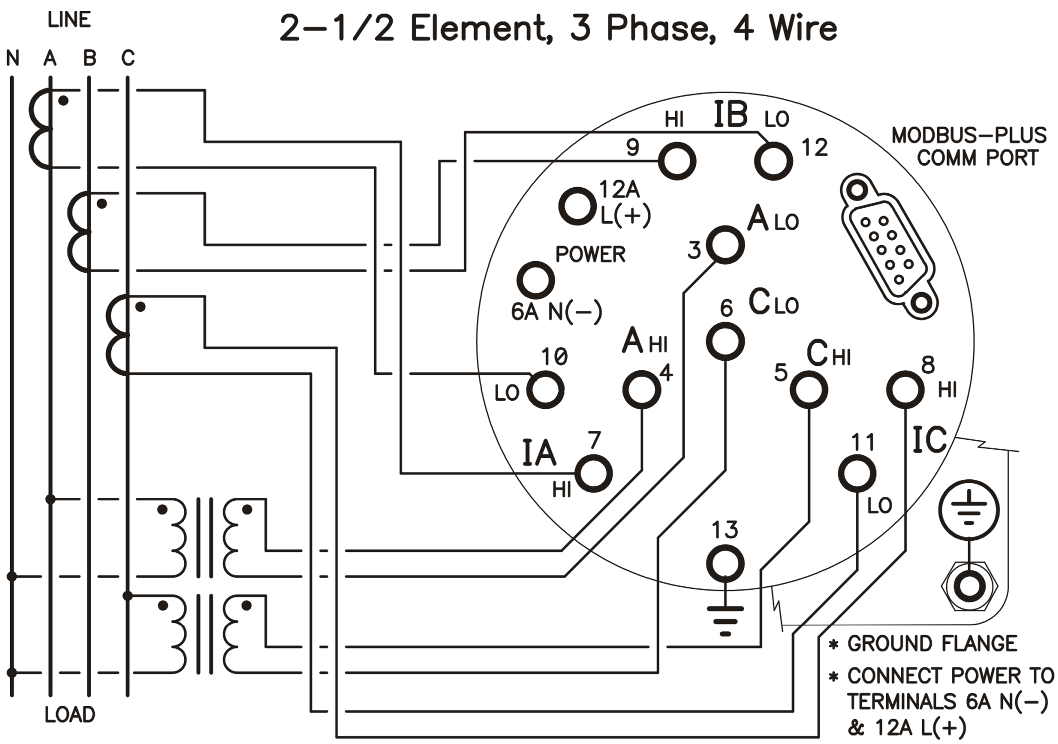
2 Element, 3 Phase, 3 Wire



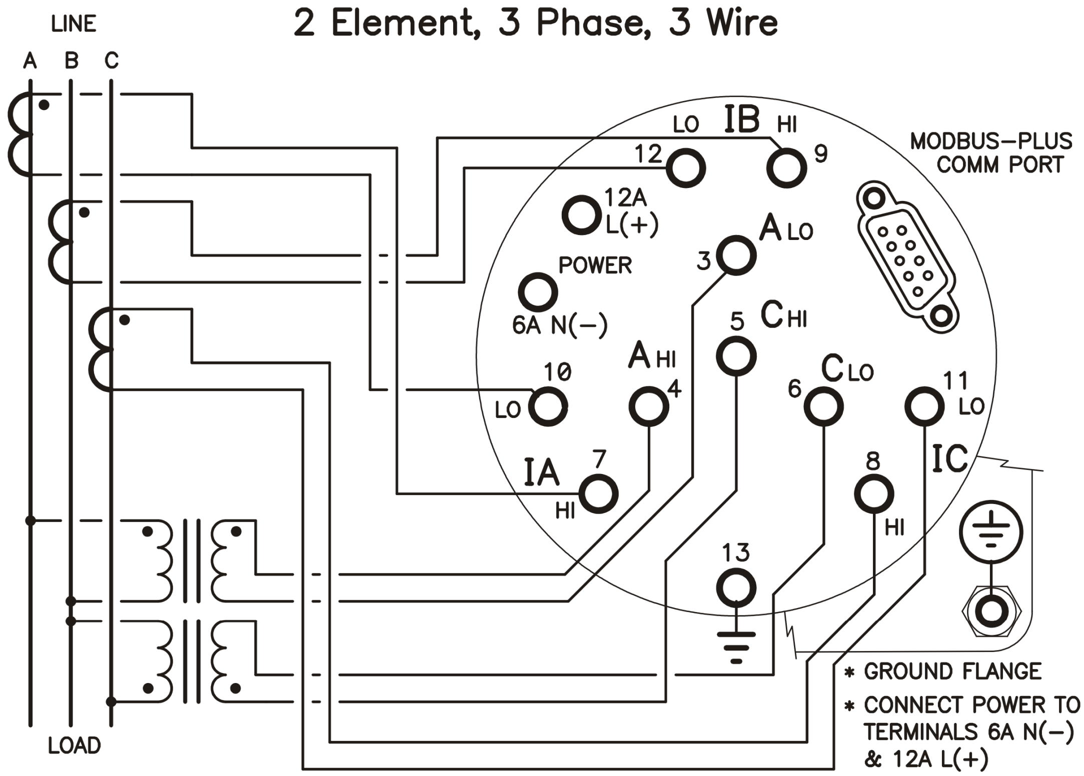
3 Element, 3 Phase, 4 Wire



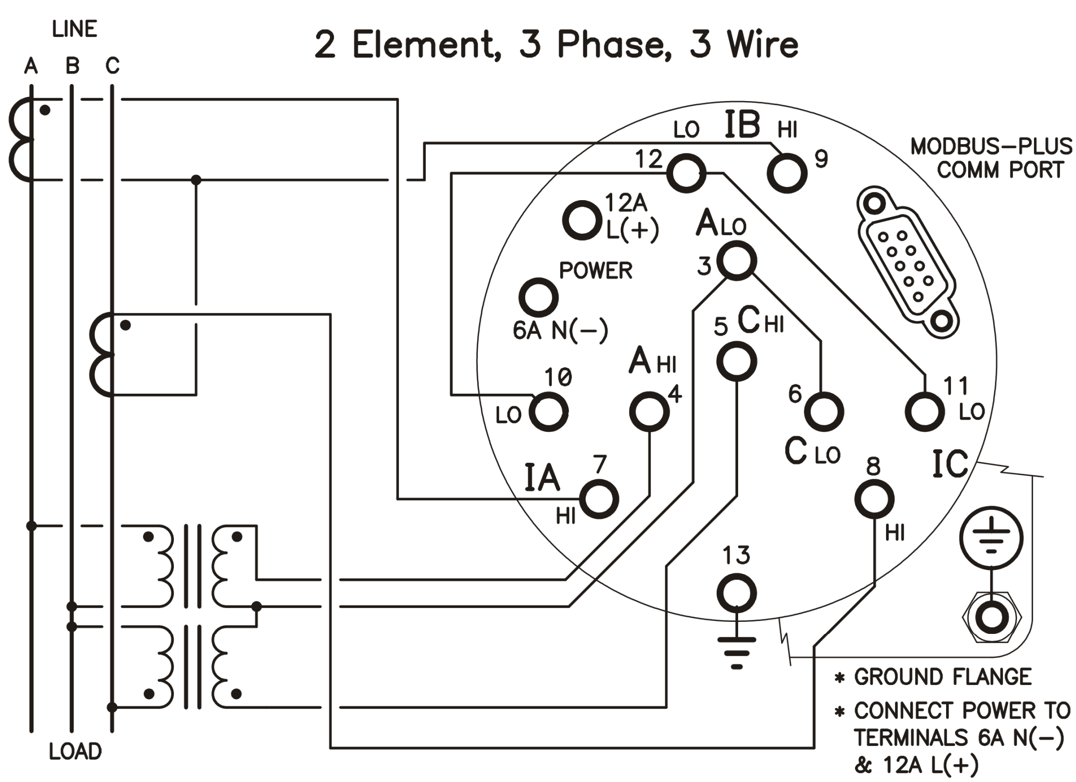
2–1/2 Element, 3 Phase, 4 Wire



2 Element, 3 Phase, 3 Wire



2 Element, 3 Phase, 3 Wire



Revision	Date	Changes	By
A	01/30/2009	Update Bitronics Name, Logo	E. Demicco
B	06/15/2009	Updated logos and cover page	MarCom
C			

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