MTM Plus
METER TRANSDUCER MODULE

Instruction Manual

Software Rev: MTM.E1.88
Manual P/N: 1601-0022-ED

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TABLE OF CONTENTS

Chapter 1: INTRODUCTION

MTM Plus Overview 1-1
Ordering Information 1-1
Technical Specifications 1-2

Chapter 2: INSTALLATION

Mounting 2-1
Wiring 2-1

Chapter 3: SETUP AND USE

Keypad 3-1
Message Overview 3-3
Setpoint Message Abbreviations 3-5
Setpoints Messages 3-6
Message Overview 3-18
Actual Values Message Abbreviations 3-20
Actual Values Messages 3-21
Alarm Features 3-26
Demand Features 3-26
Output Relay 3-26
Directional Power 3-26
Undervoltage 3-27
Unbalance 3-27
Analog Outputs 3-27
Neutral Current 3-27
Total Harmonic Distortion (THD) 3-28

Chapter 4: TESTING

Primary Injection Testing 4-1
Secondary Injection Testing 4-1
Phase Voltages and Current Functions 4-1
Power Functions and Analog Outputs 4-1
Switch Inputs 4-3
Pulse Output 4-3

Chapter 5: COMMUNICATIONS

Overview 5-1
Electrical Interface 5-1
Data Frame Format and Rate 5-1
Data Packet Format 5-1
Error Checking 5-2
Timing 5-2
Error Responses 5-4

APPENDIX A

Address Space A-1

APPENDIX B

Analog Output Parameters B-1

APPENDIX C

MTM Plus Commissioning Summary C-1

APPENDIX D

MTM Plus Quick Check List D-1

TABLE OF CONTENTS

APPENDIX E

Troubleshooting Guide E-1

MTM Plus Overview

The Multilin Meter and Transducer Module (MTM Plus) can be used in almost any application where continuous metering of a three phase system is required. Examples include three phase motors, feeders and transformers. Current and voltage signals are input to the MTM Plus through phase current transformers (CTs) and voltage transformers (VTs). Currents and voltages, as well as active power (watts), reactive power (vars), apparent power (kVA), power factor, watt-hours, var-hours, power direction, frequency, Total Harmonic Distortion (THD), and demand values can be viewed on the MTM Plus display. The reactive power can only be accurately read for balanced systems due to the limitations of the MTM Plus. The MTM has the capability to record the phase currents as a statistic on every occurrence of an alarm.

A nine position keypad gives full front panel programmability. All MTM Plus setpoints are stored in EEPROM for permanent storage even on loss of power. A 32 character liquid crystal display offers English language description of all setpoints and metered values.

The MTM Plus contains an isolated group of four analog current outputs (4-20 mA). These signals can be fed into programmable controllers or other devices for a variety of monitoring and control applications. If 0-1 mA analog outputs are required, consult the factory.

The MTM Plus contains two independent contact switch inputs which can be used together as 52a and 52b to indicate breaker status or configured independently for general use.

The MTM Plus also has a pulse output to create a 100ms 24VDC pulse for an external counter. The pulse occurs when kWH or kvarH reaches a certain value defined by the user.

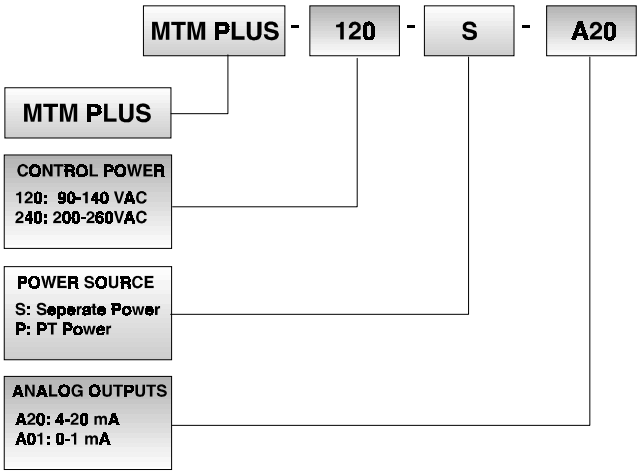
The MTM Plus can be used to give alarm indications via a front panel LED indicator and the change in state of a dedicated on-board alarm output relay (N/O and N/C). Possible alarm conditions include over/undervoltage, power factor leading or lagging beyond desirable limits, positive/negative watts/vars exceeded, phase sequence reversal, overcurrent, phase unbalance, over/ underfrequency, demand values, and external switch.

The MTM Plus also offers a two wire RS485 serial communication port for remote programming and monitoring. A front panel LED can be used to signal a break in serial communication.

NOTE: The MTM Plus is a metering device which should not be used for any type of protection. Where protection is required a Multilin Protection Relay should be used. Consult the factory for the appropriate relay for your application.

Ordering Information

The Multilin MTM Plus is entirely field programmable. The order code is as shown below.



Technical Specifications

MEASURED VALUES			
PARAMETER	ACCURACY	RESOLUTION	RANGE
VOLTAGE	±0.5% of 240xVT	1 VOLT	20% of VT to 100% of VT *
CURRENT	±0.5% of 2xCT	1 AMP	3.6% of CT to 200% of CT
VOLTAGE UNBALANCE	±0.5% of displayed	0.1%	0.0 - 100.0%
CURRENT UNBALANCE	±0.5% of displayed	0.1%	0.0 - 100.0%
kW	±1.0% of 2xCTx240xVTx3	0.1 kW	0 - 5,999,999.9 kW **
kvar	±1.0% of 2xCTx240xVTx3	0.1 kvar	0 - 5,999,999.9 kvar **
kVA	±1.0% of 2xCTx240xVTx3	0.1 kVA	0 - 5,999,999.9 kVA **
kWH	±1.0% of 2xCTx240xVTx3	1 kWH	0 - 999,999.999 MWH
kvarH	±1.0% of 2xCTx240xVTx3	1 kvarH	0 - 999,999.999 MvarH
POWER FACTOR	±0.02	0.01	0.00 LAG to 1.00 to 0.00 LEAD
FREQUENCY	±0.01 Hz	0.01 Hz	0.00 - 75.00 Hz
kW DEMAND	±1.0% of 2xCTx240xVTx3	0.1 kW	5,999,999.9 kW
kvar DEMAND	±1.0% of 2xCTx240xVTx3	0.1 kvar	5,999,999.9 kvar
kVA DEMAND	±1.0% of 2xCTx240xVTx3	0.1 kVA	5,999,999.9 kVA
AMPS DEMAND	±0.5% of 2xCT	1 AMP	0 - 10,000 AMPS
AMPS THD	±2.0% > 50% of CT	0.1%	0.0 - 100.0%
VOLTS THD	±2.0% > 40% of VT	0.1%	0.0 - 100.0%

NOTE: THE RANGE IS BASED ON MAXIMUM INPUT OF 240VAC/10AMPS INTO MTM PLUS .
* Reads in kV if VT RATIOxVT SECONDARY is greater than 9204.
** Reads in MW, Mvar, MVA if VT RATIOxCT PRIMARY is greater than 16500.

POWER SUPPLY	
RANGE	90 - 140 VAC
FREQUENCY	50/60 Hz
MAX. VA DRAWN	24 VA

VOLTAGE AND CURRENT INPUTS		
PARAMETER	**FULL SCALE**	**BURDEN**
VT INPUT	120 VAC IF USED TO POWER THE UNIT	12 VA PER VT (MAX)
	240 VAC IF SEPARATE POWER SELECTED	0.2 VA PER VT
CT INPUT	2 A IF 1 A INPUT USED	0.2 VA AT FULL LOAD
	10 A IF 5 A INPUT USED	

ALARMS	
UNDER/OVER FREQUENCY ALARMS	±0.1s OR 2% OF TOTAL TIME (WHICHEVER IS LESS)
ALL OTHER ALARMS	±1.0s OR 2% OF TOTAL TIME (WHICHEVER IS GREATEST)

OUTPUT RELAY	
TYPE	FORM C (NO-COM-NC) FAILSAFE/NON-FAILSAFE (SELECTABLE)
MAX LOAD	5A/250 VAC RESISTIVE 5A/30 VDC RESISTIVE 0.4A/125 VDC (L/R=7ms)

ANALOG OUTPUTS	
MAX. LOAD AT 4-20 mA	600 OHMS
MAX. LOAD AT 0-1 mA	12 kOHMS
ACCURACY	±1.0% OF FULL SCALE

SWITCH INPUTS	
TYPE	SELF-EXCITED
RESPONSE TIME	100 ms

PULSE OUTPUT	
PULSE AMPLITUDE	24 VDC ±5%
PULSE WIDTH	100 ms ±5%
MIN. LOAD	4 kOHMS
MAX. LOAD	7 kOHMS
MAX. PULSE RATE	500 ms

ENVIRONMENT	
OPERATING TEMP.	-10°C - +60°C
STORAGE TEMP.	-30°C - +70°C
BURN-IN TEMP.	+50°C FOR 24 HRS

NOTE: It is recommended that all MTM Plus relays be powered up at least once per year to avoid deterioration of electrolytic capacitors in the power supply.

E83849 LR 41286

NOTE: Specifications subject to change without notice.

Mounting

The MTM Plus can be mounted in a panel cutout as shown in figure 2.2. Use the #8-32 screws provided with the MTM Plus to secure the unit to the panel.

Wiring

THE MTM PLUS *MUST* BE WIRED AS SHOWN IN FIGURES 2.5 TO 2.9 IN ORDER TO OPERATE CORRECTLY. EACH OF THE CONNECTIONS IS DESCRIBED BELOW.

Ground (terminal #1):
This terminal must be connected to a reliable system ground for safety reasons and for bypassing of transient energy.

Power (terminals #34,35)
The MTM Plus can be powered in two different ways:

- separate 120VAC via terminals 34 and 35.
- via the PT input terminals.

The first option is the factory setting. This option allows the PT input voltage to be 0–260VAC. To alter the configuration, refer to figure 2.4.

If using the second option the input voltage must be maintained between 90–140VAC and terminals 34 and 35 left unconnected.

Phase to Phase Voltage Transformer (VT) Inputs (terminals #2-5):
These terminals are used by the MTM Plus for voltage sensing. All voltage metering is done from the VT input terminals to the MTM Plus. The VT input terminals must be at 120V, if the same voltage is used to power up the unit, or 0–240V if the the unit is powered using a separate power supply as described above. The primary should be chosen to correspond to the system voltage.

Current Transformer (CT) Inputs (terminals #6-14):
The MTM Plus can be used with either 5 A or 1 A secondary phase CTs. If 5 A secondary CTs are used they must be wired to the terminals labelled “5A” and “COM” for each phase (ie. terminals #6 and 7, #9 and 10, #12 and 13). If 1 A secondary CTs are used they must be wired to the terminals labelled “1A” and “COM” for each phase (ie. terminals #6 and 8, #9 and 11, #12 and 14). COM for all CTs must be grounded.

Serial Communication Port (terminals #15-17):
The MTM Plus has an RS485 serial communication port that is configurable to communicate via a MODBUS® RTU Compatible Protocol or with the Multilin 269 Motor Protection Relay. Up to 32 MTM Plus units (SLAVES) may be connected to either a PC, DCS or PLC (MASTER) using a Belden 9841, 24AWG, shielded twisted pair with a characteristic impedance of 120Ω, or equivalent. The total length of the communication link should not exceed 4000 ft. Correct polarity is essential for proper operation of the serial port. Terminal 15(“+”) of every

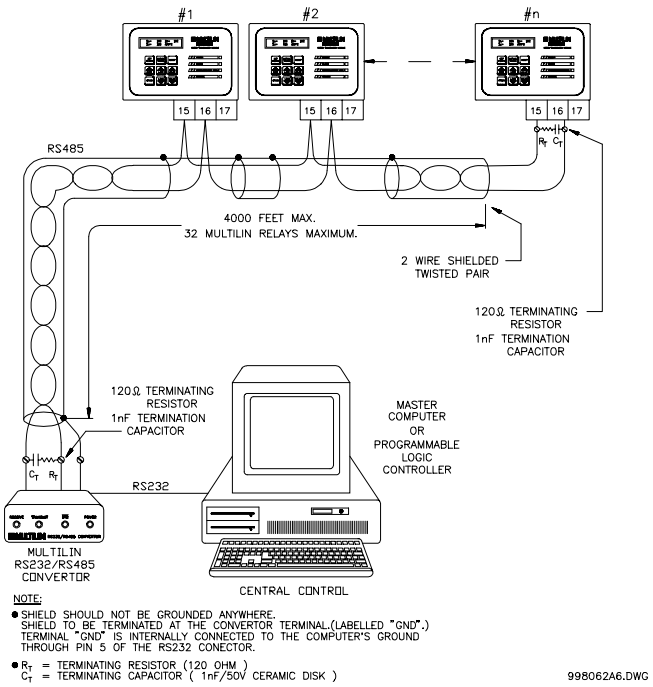


Figure 2.1 Serial Communication Link

MTM Plus in the serial communication link must be connected together. Similarly, terminal 16 (“–”) of every MTM Plus must be connected together. The shield wire should only be connected at the Multilin RS232/RS485 Convertor because the MTM Plus serial port (terminal 17) is not isolated. As shown in Figure 2-1, the first and last devices in the link should have a terminating resistor and a 1nF capacitor placed across terminals 15 and 16. The resistors should match the characteristic impedance of the wire and are used to reduce communication errors caused by signal reflection at the ends of the link.

When linking an MTM Plus with the 269 Motor Protection Relay, the shield must be connected to terminal #17 of the MTM Plus.

NOTE: If you are using a Multilin RS232/RS485 convertor that has no ground terminal, the shield must then be connected to only the first MTM Plus in the link.

Isolated Analog Outputs (terminals #18-26):
The MTM Plus has four isolated analog outputs. These programmable outputs are isolated from the rest of the MTM Plus circuitry, however they are not isolated from each other.

Output Relay (terminals #27–29)
This is a failsafe/non-failsafe (programmable) relay of form C type used to indicate various alarm conditions. It can be configured for latched or unlatched operation.

Pulse Output (terminal #30)
This output provides a 24VDC 100ms pulse to a 4k–7kΩ load every time kWH or kvarH reaches a user defined interval.

NOTE: The load must be maintained within 4–7kΩ to maintain the voltage at 24VDC. Any of the Analog out common terminals (19, 21, 23, 25) may be used with this output. Therefore, this output is isolated from the rest of the circuitry except for analog outputs. If this feature is not being used leave terminal #30 open (NEVER short it to common).

Switch Inputs (terminals #31–33)
The two switch inputs share one common terminal but may be configured totally independent of each other. The switches can also be configured to indicate breaker status and appropriate setpoints must be configured accordingly.

Note that these switches are dry contact, therefore no live input should be connected to them.

Contrast Control
The MTM Plus is equipped with a multiangle viewing display, therefore in most situations no contrast adjustment should be required. In cases where minor adjustment may be necessary, the contrast control on the back of the unit can be adjusted for optimum clarity.

The contrast control is located between terminals 14 and 15. It can be accessed using a small slot screwdriver.

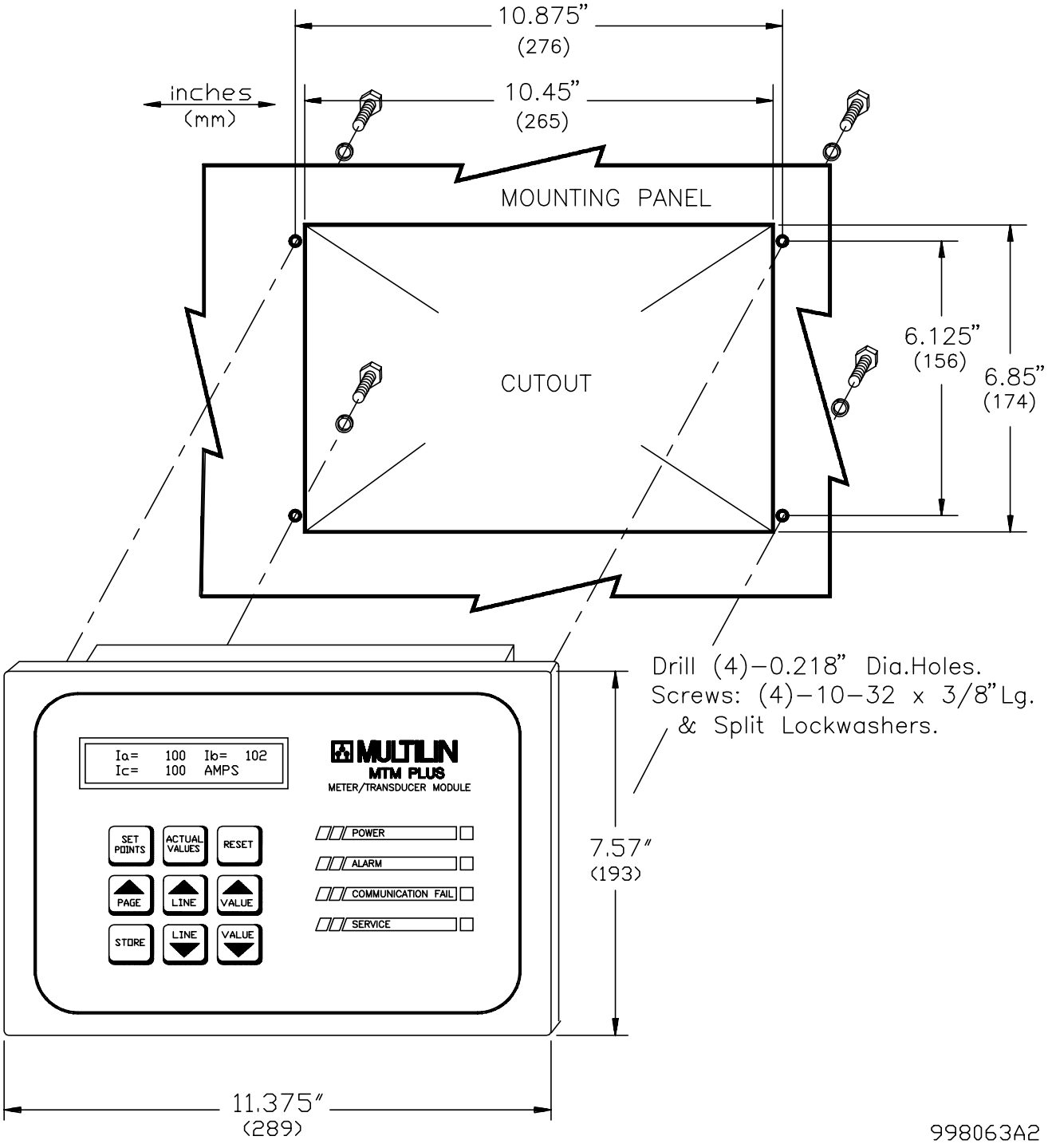


Figure 2.2 Mounting Details

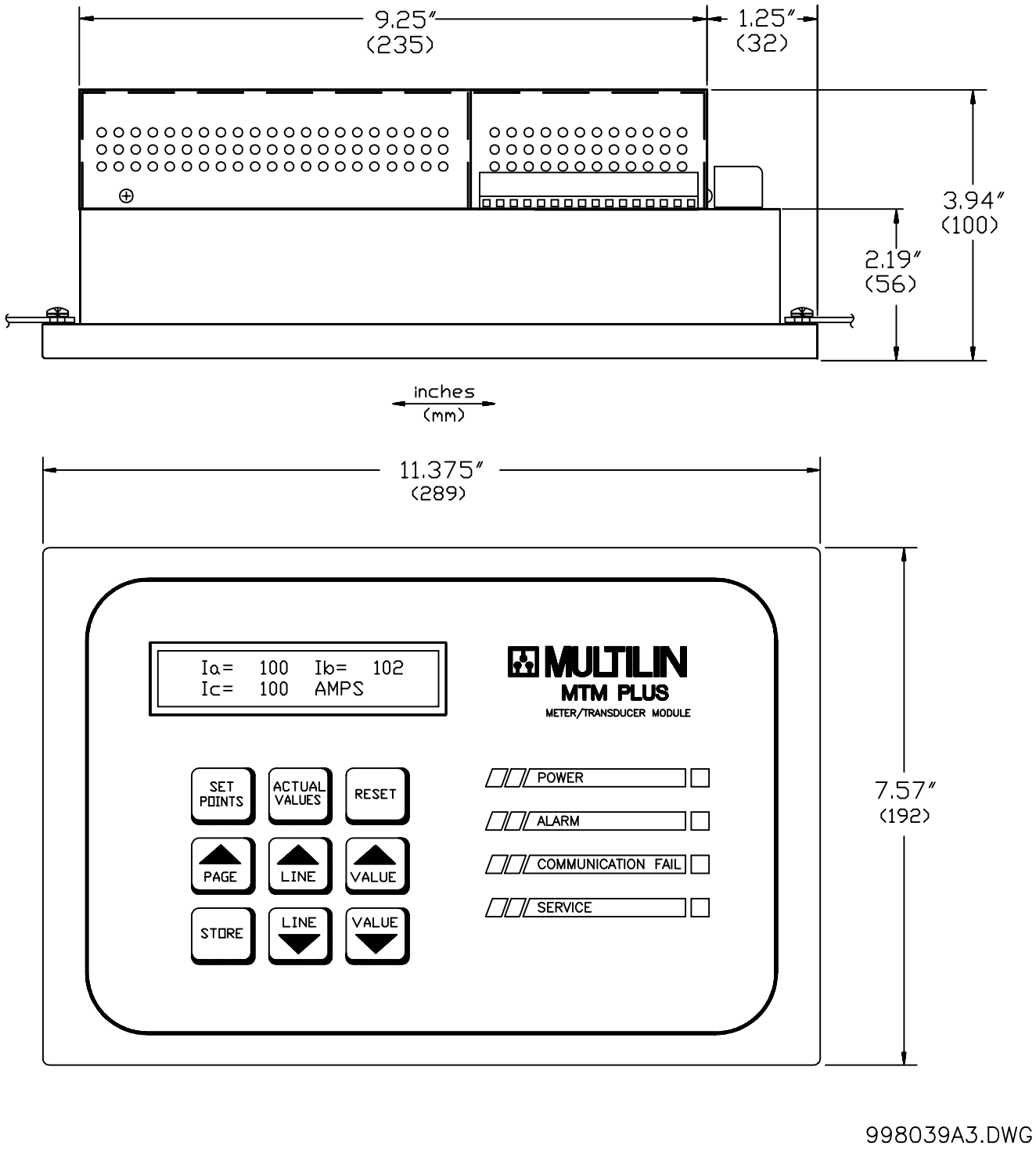
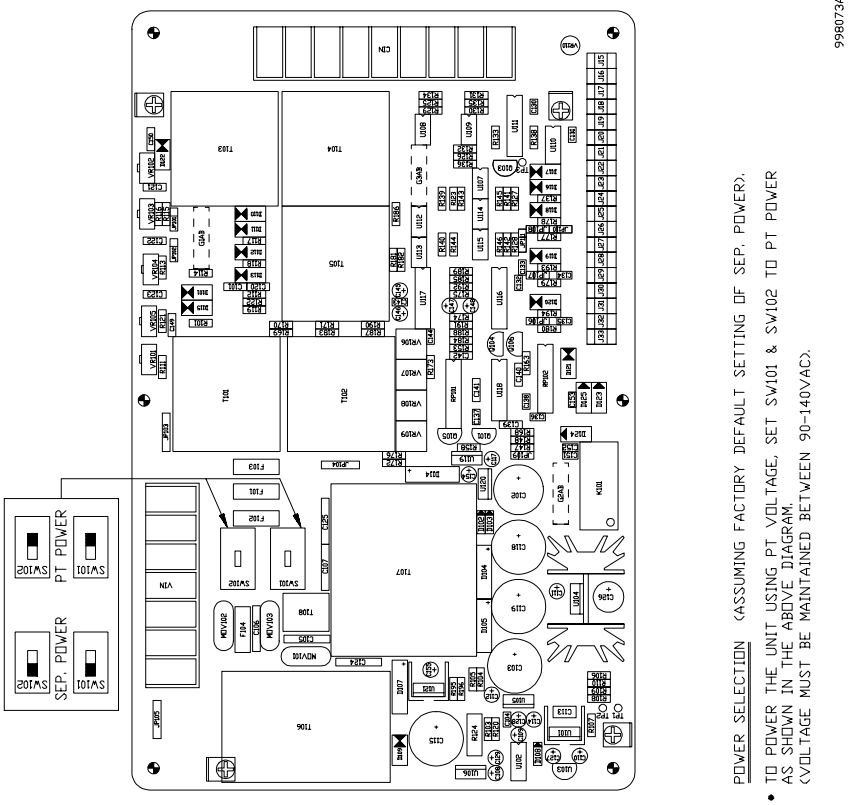


Figure 2.3 Physical Dimensions



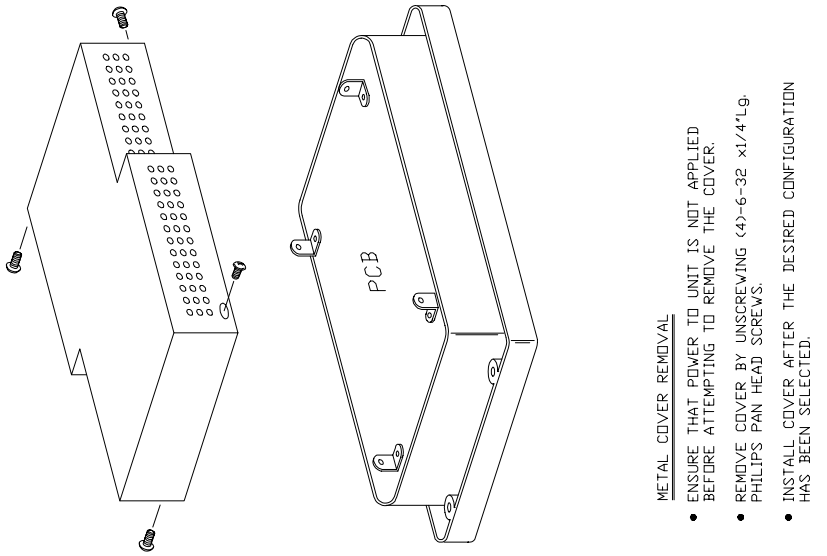
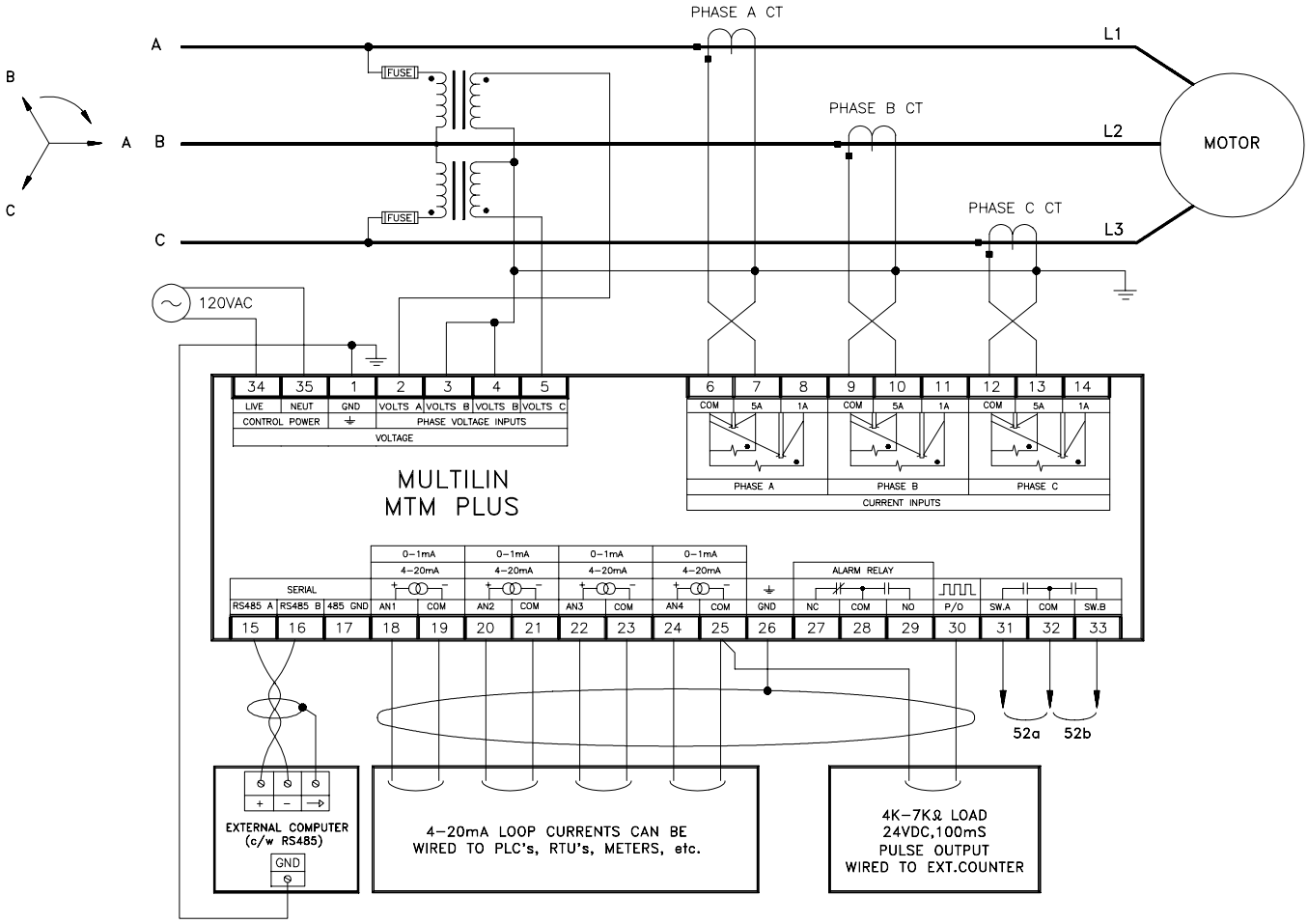


Figure 2.4 MTM Plus Power Configuration Selection



NOTES:

1. TYPICAL WIRING FOR METERING TRANSFORMERS AND ANALOG OUTPUTS.
2. GROUND OF MTM SHOULD BE AT SAME GROUND POTENTIAL AS EXTERNAL COMPUTER.
3. GROUNDING OF CT SECONDARIES SHOULD BE AT ONE LOCATION ONLY.
4. TERMINALS 17 & 26 ARE INTERNALLY CONNECTED TO TERMINAL 1 AND ONLY TERMINAL 1 SHOULD BE EXTERNALLY GROUNDED.
5. SHIELDED WIRE MUST BE USED FOR RS485 AND ISOLATED ANALOG OUTPUTS. THE SHIELD MUST BE GROUNDED AT ONE END ONLY.
6. ANALOG OUTPUTS ARE PROGRAMMABLE.

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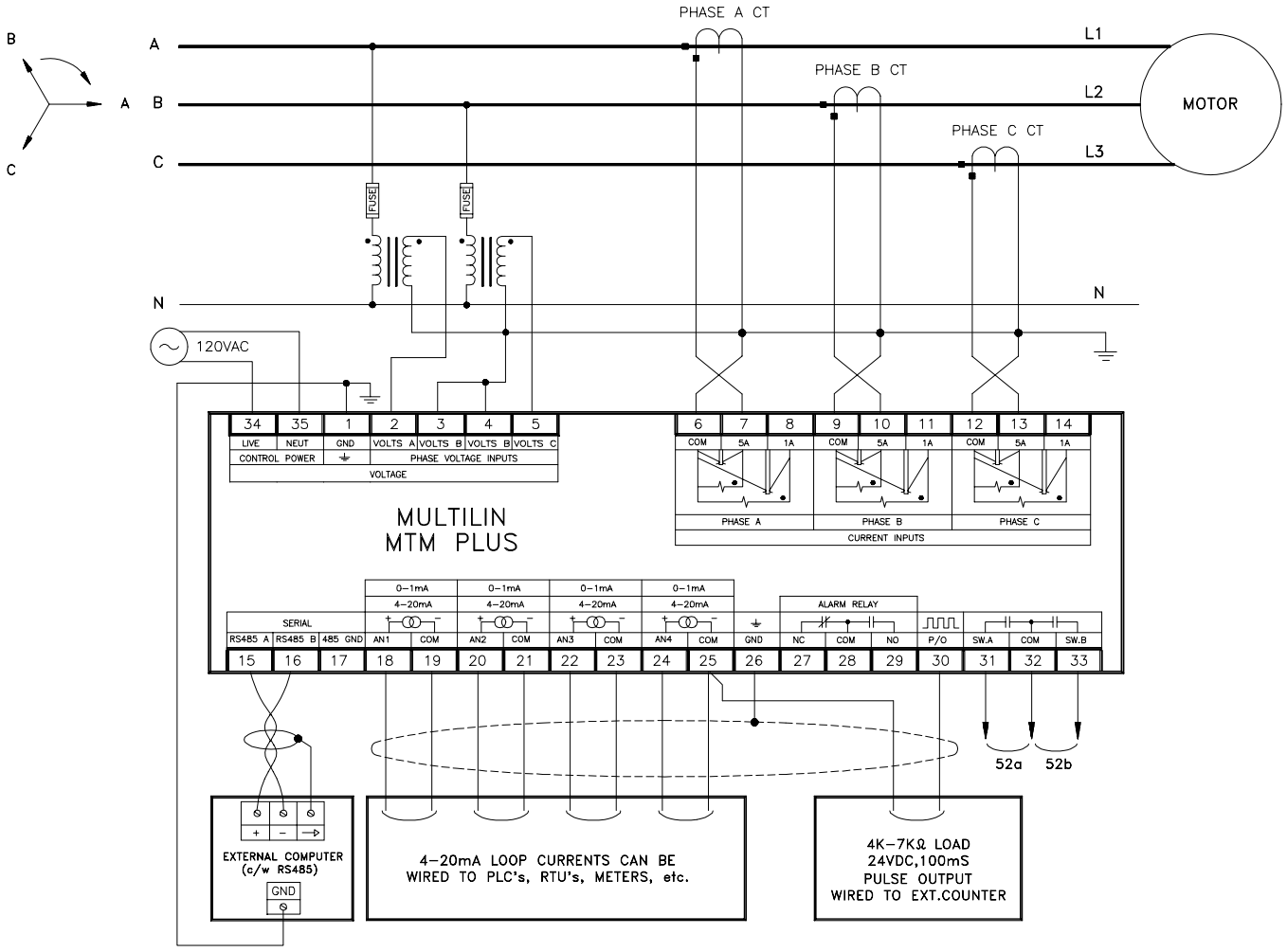
Figure 2.5 Typical Wiring (Open Delta)



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1. TYPICAL WIRING FOR METERING TRANSFORMERS AND ANALOG OUTPUTS.
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5. SHIELDED WIRE MUST BE USED FOR RS485 AND ISOLATED ANALOG OUTPUTS. THE SHIELD MUST BE GROUNDED AT ONE END ONLY.
6. WHEN USING A TWO INPUT WYE CONNECTION, A BALANCED SYSTEM MUST BE MAINTAINED TO ENSURE CORRECT READINGS.
7. ANALOG OUTPUTS ARE PROGRAMMABLE.

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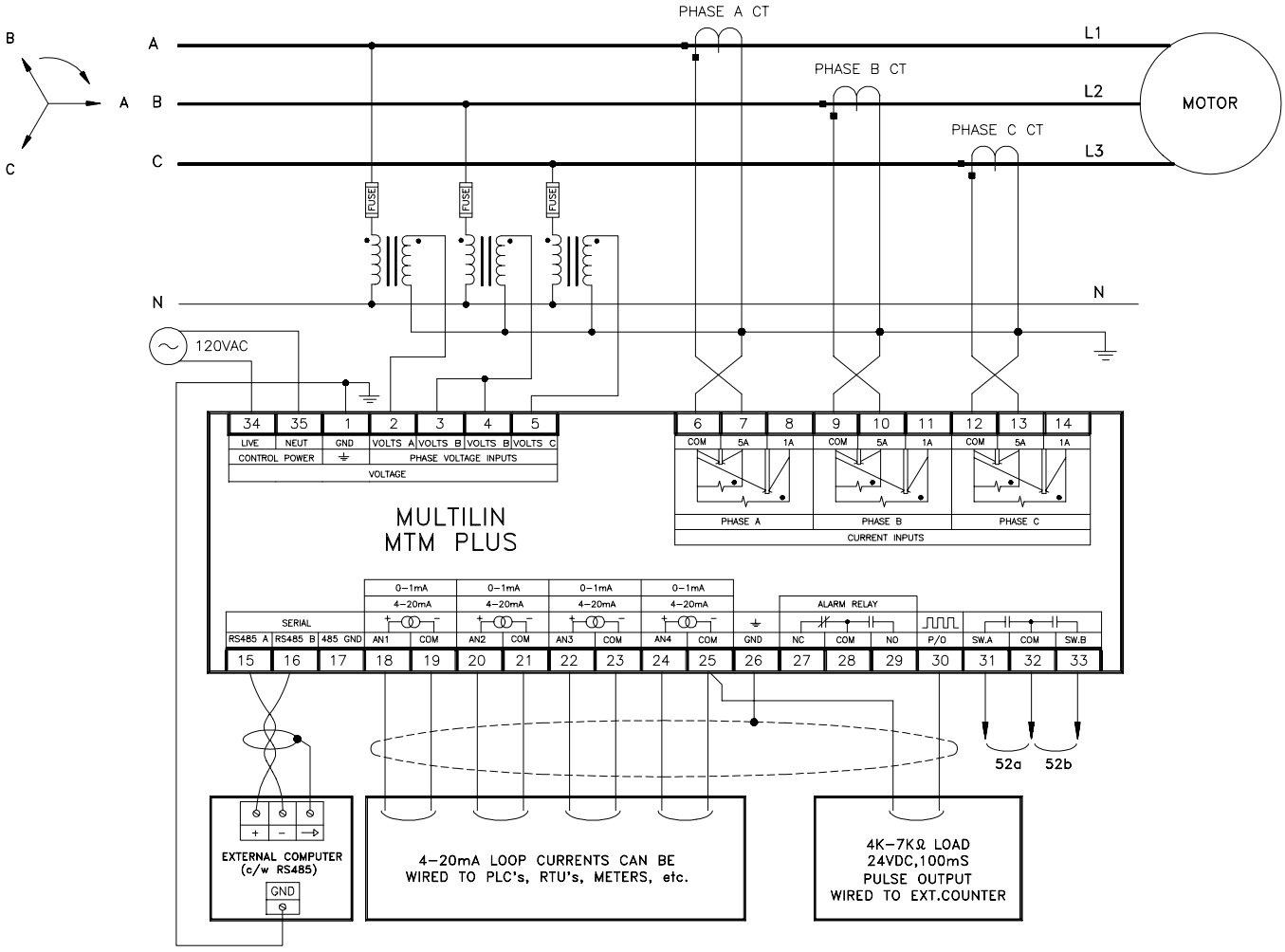
Figure 2.6 Typical Wiring (2 Input Wye)



NOTES:

1. THE SECONDARY WINDINGS FOR THE PTs MUST NOT EXCEED 80 VOLTS, IF ALSO USED TO POWER UP THE UNIT.
2. TYPICAL WIRING FOR METERING TRANSFORMERS AND ANALOG OUTPUTS.
3. GROUND OF MTM SHOULD BE AT SAME GROUND POTENTIAL AS EXTERNAL COMPUTER.
4. GROUNDING OF CT SECONDARIES SHOULD BE AT ONE LOCATION ONLY.
5. TERMINALS 17 & 26 ARE INTERNALLY CONNECTED TO TERMINAL 1 AND ONLY TERMINAL 1 SHOULD BE EXTERNALLY GROUNDED.
6. SHIELDED WIRE MUST BE USED FOR RS485 AND ISOLATED ANALOG OUTPUTS. THE SHIELD MUST BE GROUNDED AT ONE END ONLY.
7. MTM PLUS SETPOINT MUST BE PROGRAMMED FOR OPEN–DELTA OPERATION.

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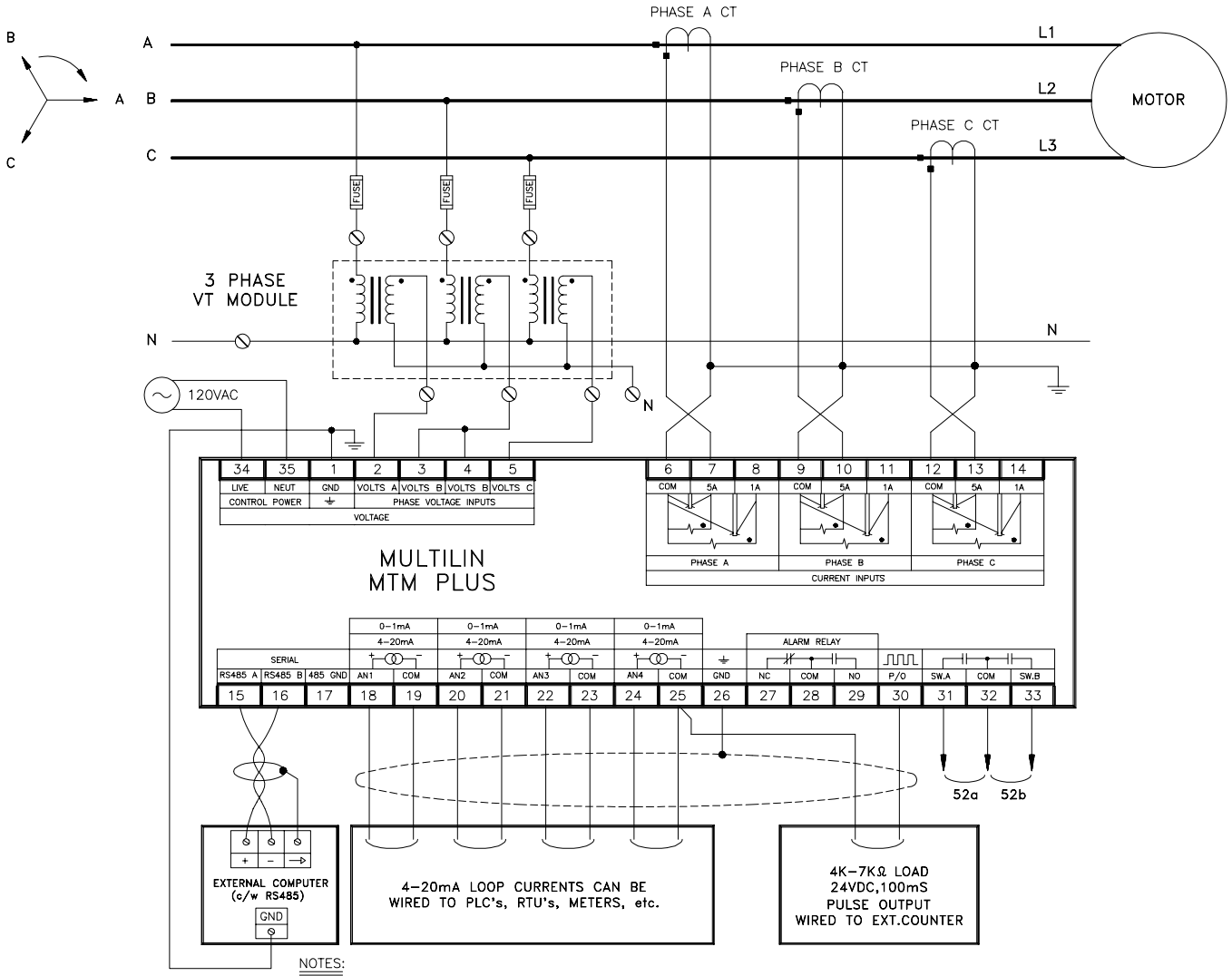
Figure 2.7 Wye/Delta Connection



NOTES:

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7. MTM PLUS SETPOINT MUST BE PROGRAMMED FOR OPEN–DELTA OPERATION.

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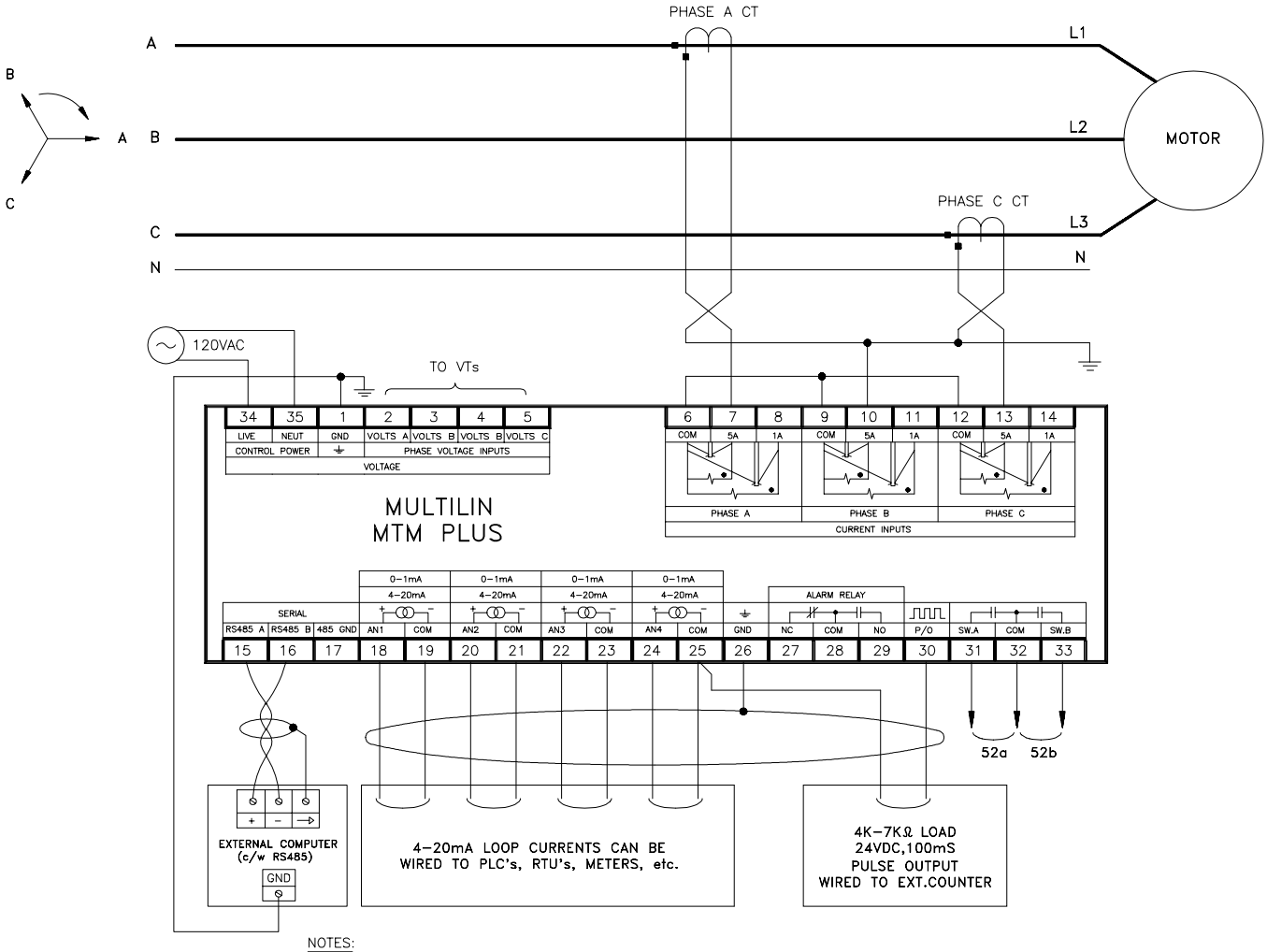
Figure 2.8 3 Phase VT Module Wye/Delta Connection



NOTES:

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3. GROUNDING OF CT SECONDARIES SHOULD BE AT ONE LOCATION ONLY.
4. TERMINALS 17 & 26 ARE INTERNALLY CONNECTED TO TERMINAL 1 AND ONLY TERMINAL 1 SHOULD BE EXTERNALLY GROUNDED.
5. SHIELDED WIRE MUST BE USED FOR RS485 AND ISOLATED ANALOG OUTPUTS. THE SHIELD MUST BE GROUNDED AT ONE END ONLY.
6. ANALOG OUTPUTS ARE PROGRAMMABLE.

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Figure 2.9 2 CT Connection

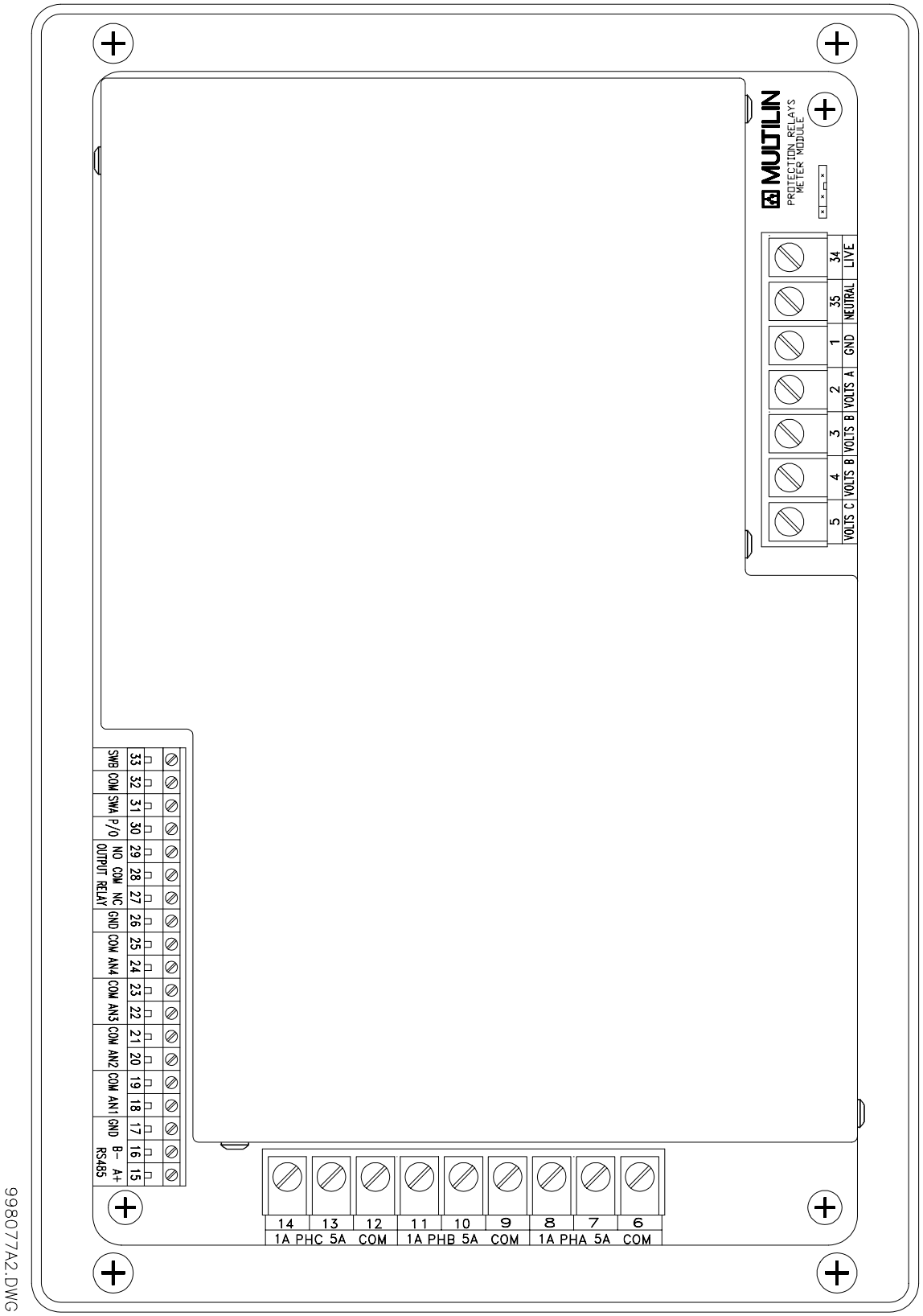

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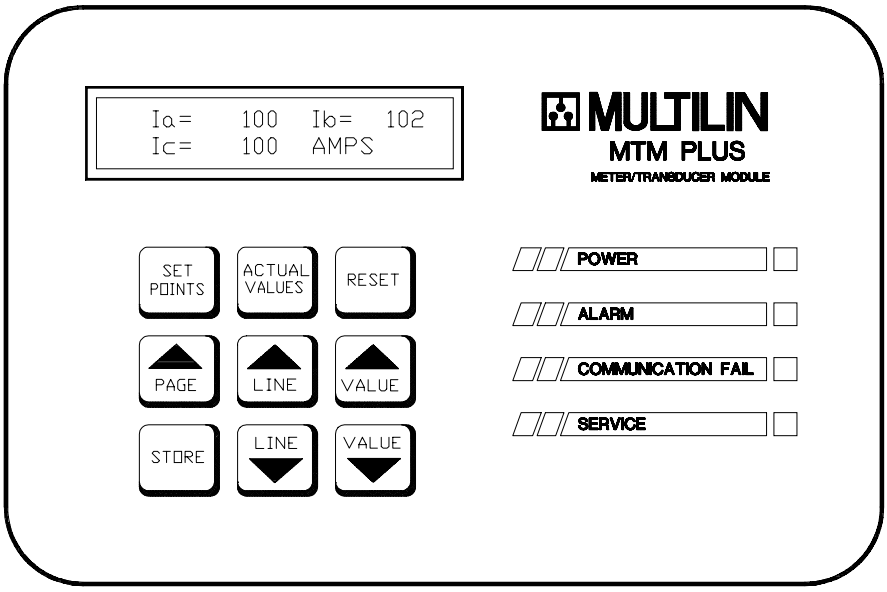
Figure 2.10 Terminal Layout

Keypad



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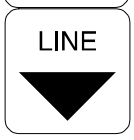
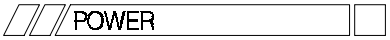
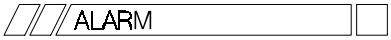
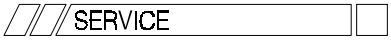
The MTM Plus has a nine position keypad as shown in the figure. The functions of the keys are described below.

Name	Description
SET POINTS	**FUNCTION**: The SETPOINTS key allows the examination of all configuration and alarm setpoints. There are four "pages" of setpoints data: Page 1: Setpoint Access Page 2: Configuration Page 3: Alarms Page 4: Analogs
	EFFECT: Pressing this key will cause the MTM Plus to display the first line of the first page of setpoints.
	USE: This key can be pressed at any time to view or alter MTM Plus setpoints. All setpoints will increment and decrement to predetermined limits. When the desired value is reached, the STORE key must be pressed to save the new setpoint.
ACTUAL VALUES	**FUNCTION**: The ACTUAL VALUES key allows for the examination of all the actual data measured by the MTM Plus. Page 1: Data Page 2: Alarms Page 3: Switch Status
	EFFECT: Pressing this key will cause the MTM Plus to display the first line of actual values.
	USE: This key can be pressed at any time to view actual metered data.
RESET	**FUNCTION**: The RESET key allows an alarm condition to be reset if the condition no longer exists.
	EFFECT: Pressing this key will cause the MTM Plus to return the output relay to its inactive state, and turn off the alarm indicator on the front display.
	USE: This key can be used any time to reset an alarm that is no longer present (when relay is in latched mode).
▲ PAGE	**FUNCTION**: The PAGE UP key allows the setpoints page number to be changed.
	EFFECT: Pressing this key will cause the MTM Plus display to show the first line of the next page of information.
	USE: This key can be used to select the next page of setpoints.

Name	Description
 	**FUNCTION**: The LINE UP and LINE DOWN keys allow the currently displayed MTM Plus message line to be changed. **EFFECT**: Pressing the LINE DOWN key will cause the display to show the next line of the currently selected page of information. Pressing the LINE UP key will cause the display to show the line immediately before the currently displayed line. If either key is held for more than one second the next or previous lines will be selected at a fast rate. **USE**: These keys can be used at any time to display the next or previous line of information. If the display shows the first line of a page the LINE UP key will have no effect. If the display shows the last line of a page the LINE DOWN key will have no effect.
 	**FUNCTION**: The VALUE UP and VALUE DOWN keys allow setpoints to be changed. **EFFECT**: Pressing the VALUE UP key will cause the currently displayed setpoint value to increment. Pressing the VALUE DOWN key will cause the currently displayed setpoint to decrement. If either key is held for more than one second the displayed setpoint will change at a fast rate. **USE**: These keys can be used any time a setpoint is displayed. Any changed setpoint can be reset to its original value by pressing the RESET key. The STORE key must be pressed in order for the MTM Plus to use the new setpoint. These keys have no effect when an actual value is displayed.
	**FUNCTION**: The STORE key allows new setpoints to be stored in the MTM Plus internal memory. **EFFECT**: When this key is pressed and a setpoint is displayed, the new setpoint will immediately be used by the MTM Plus. **USE**: The STORE key can be used any time a setpoint is displayed. The STORE key is also used to select the default display. To select a default display, select the actual values line you wish as the display and press the STORE key twice. A flash message NEW DEFAULT MESSAGE STORED will be displayed.

LED Indicators

The MTM Plus has the following LED indicators:

	This LED indicates that the correct voltage is present for the MTM Plus to operate.
	When an alarm condition is present this LED will be illuminated. See the section on Alarm Features for details (pg. 36).
	When a communications alarm condition is present this LED will be illuminated. See the Setpoints section for more details (pg. 16).
	If this LED is illuminated then an internal fault has occurred. The MTM Plus should be returned to the factory for service.

Message Overview

SETPOINTS

"SETPOINT PAGE 1 "	"SETPOINT PAGE 2 "	"SETPOINT PAGE 3 "	"SETPOINT PAGE 4 "
"SETPOINT ACCESS "	"CONFIGURATION "	"ALARMS "	"ANALOGS "
"SETPOINT ACCESS "	"PHASE CT PRIMARY"	"UNDERVOLT. ALARM"	"ANALOG OUTPUT 1:"
" "	"CT PRI = A"	"U/V= %VT"	" "
"ENTER NEW ACCESS"	"PHASE VT RATIO "	"UNDERVOLT. TIME "	"CH1: 4mA EQUALS "
"CODE "	" :1 "	"DELAY = s "	" "
"ENCRYPTED ACCESS"	"VT NOMINAL SEC "	"OVERVOLT. ALARM "	"CH1: 20mA EQUALS"
"CODE: "	"VOLTAGE V "	"O/V= %VT"	" "
"FACTORY SERVICE "	"kW DEMAND "	"OVERVOLT. TIME "	"ANALOG OUTPUT 2:"
" "	"PERIOD = MIN"	"DELAY = s "	" "
" MTM PLUS "	"kvar DEMAND "	"PF LEAD ALARM "	"CH2: 4mA EQUALS "
" 21E188B1.000 "	"PERIOD = MIN"	"PF = "	" "
"END OF PAGE 1 "	"kVA DEMAND "	"PF LAG ALARM "	"CH2: 20mA EQUALS"
"SETPOINT VALUES "	"PERIOD = MIN"	"PF = "	" "
	"CURRENT DEMAND "	"PF ALARM TIME "	"ANALOG OUTPUT 3:"
	"PERIOD = MIN"	"DELAY = s "	" "
	"CLEAR DEMAND "	"POSITIVE kvar "	"CH3: 4mA EQUALS "
	"VALUES: "	"ALARM kvar"	" "
	"CLEAR kvarH AND "	"NEGATIVE kvar "	"CH3: 20mA EQUALS"
	"kWH? "	"ALARM kvar"	" "
	"COMM PROTOCOL "	"kvar ALARM "	"ANALOG OUTPUT 4:"
	" "	"DELAY = s "	" "
	"COMMUNICATIONS "	"CURRENT ALARM "	"CH4: 4mA EQUALS "
	"AT BAUD "	" % OF CT "	" "
	"COMMUNICATIONS "	"CURRENT ALARM "	"CH4: 20mA EQUALS"
	"ADDRESS "	"DELAY s "	" "
	"ALARM RELAY "	"UNDER FREQUENCY "	"END OF PAGE 4 "
	" "	"ALARM Hz "	"SETPOINT VALUES "
	"ALARM RELAY "	"UNDER FREQUENCY "	
	" "	"DELAY SEC "	
	"ZERO VOLTS ALARM"	"OVER FREQUENCY "	
	"DETECT? "	"ALARM Hz "	
	"VOLTAGES WIRED "	"OVER FREQUENCY "	
	"AS "	"DELAY s "	
	"COMPUTE T.H.D.? "	"POSITIVE POWER "	
	" "	"ALARM kW "	
	"SWITCHA&B CONFIG"	"NEGATIVE POWER "	
	" "	"ALARM kW "	
	"PULSE OUTPUT "	"POWER ALARM "	
	"VARIABLE= "	"DELAY s "	
	"PULSE OUT EVERY "	"kW MAX DMND ALM "	
	" k_ _H"	"LEVEL kW "	
	"SAMPLING "	"var MAX DMND ALM"	
	"FREQUENCY Hz"	"LEVEL kvar"	

```
"END OF PAGE 2   "    "kVA MAX DMND ALM"
"SETPOINT VALUES "    "LEVEL       kVA "

                      "AMP PK DMND ALM "
                      "LEVEL       AMPS"

                      "UNBALANCE (volt)"
                      "ALARM         % "

                      "UNBALANCE (volt)"
                      "DELAY       s   "

                      "UNBALANCE (amps)"
                      "ALARM         % "

                      "UNBALANCE (amps)"
                      "DELAY       s   "

                      "NEUTRAL CURRENT "
                      "ALARM        A  "

                      "NEUTRAL CURRENT "
                      "DELAY        s  "

                      "VOLTAGE PHASE   "
                      "REVERSAL:       "

                      "COMM FAIL ALARM "
                      "              s  "

                      "SWITCH A ALARM  "
                      "DELAY        s  "

                      "SWITCH B ALARM  "
                      "DELAY        s  "

                      "END OF PAGE 3   "
                      "SETPOINT VALUES "
```

Setpoint Message Abbreviations

AMPS,A,AMP	Amperes
CH1,CH2,CH3,CH4	Channel 1,2,3,4
COMM	Communication
CONFIG	Configuration
CT	Current Transformer
DMND	Demand
Hz	Hertz
kVA	Kilovoltamps
kvar, var	Kilovars
kvarH	Kilovarhours
kW	Kilowatts
kWH	Kilowatthours
mA	Milliamp
MAX	Maximum
MIN	Minutes
O/V,OVERVOLT	Overvoltage
PF	Power Factor
PK	Peak
PRI	Primary
s	Second
SEC	Secondary
T.H.D.	Total Harmonic Distortion
U/V,UNDERVOLT	Undervoltage
V	Volts
VOLT	Voltage
VT	Voltage Transformer

Setpoints Messages

S 1.1
```
SETPOINTS PAGE 1
SETPOINT ACCESS
```
This page of setpoints contains messages for Setpoint Access

S 1.2
```
SETPOINTS ACCESS
      DISABLE
```
This setpoint is used to enable or disable access to setpoints. When access is disabled, setpoints can be viewed but not altered. Before setpoint access can be enabled, a three digit numeric code must be entered.

Range: ENABLED, DISABLED
Factory value: DISABLED

NOTE: Setpoint Access will default to disabled if no key is pressed for a period of 4 minutes.

Message S 1.3 will only appear if ENABLED is selected in message S 1.2

S 1.3
```
ENTER ACCESS
CODE:
```
Once this message is displayed, enter your three digit access code using the keyboard organized as follows:

1	2	3
4	5	6
7	8	9

Once the correct code is entered, Setpoint Access can be enabled.

Range: 111-999
Factory value: 111

Message S 1.4 will only appear when Setpoint Access has been enabled by entering the correct code in message S 1.3.

S 1.4
```
ENTER NEW ACCESS
CODE:     NO
```
This message allows the user to enter their own personalized access code.

Range: YES, NO
Factory value: NO

S 1.5
```
ENCRYPTED ACCESS
CODE:  2553
```
This setpoint is used by Multilin Service personnel only. If the access code is forgotten, give the encrypted access code to Multilin Service Personnel.

S 1.6
```
FACTORY SERVICE
  DISABLE
```
This setpoint is used by Multilin Service personnel only.

S 1.7
```
    MTM PLUS
21E188B1.000
```
This message identifies the MTM Plus firmware revision

S 1.8
```
END OF PAGE 1
SETPOINT VALUES
```
This is the end of the MTM Plus access setpoints.

S 2.1

```
SETPOINTS PAGE 2
CONFIGURATION
```

This page of SETPOINTS contains messages for important MTM Plus configuration parameters. Setpoints in this page must be set properly in order for the MTM Plus to function correctly.

S 2.2

```
PHASE CT PRIMARY
CT PRI =    100 A
```

The primary amps rating of the three phase CTs connected to the MTM Plus must be entered here. The CTs should be connected as shown in the MTM Plus wiring diagram.

Range: 20-5000, steps of 1.
Factory value: 100.

S 2.3

```
PHASE VT RATIO
      1.0 :1
```

The voltage transformer ratio must be entered here. The VTs should be connected as shown in the MTM Plus wiring diagram.

Range: 1-800, steps of 0.1.
Factory value: 1

S 2.4

```
VT NOMINAL SEC
VOLTAGE   120 V
```

The nominal secondary voltage of the transformer must be entered here for under/overvoltage alarms to work correctly.

Range: 40-240V, steps of 1.
Factory value: 120V

S 2.5

```
kW DEMAND
PERIOD =  15 MIN
```

This setpoint selects the time period for the kilowatt Demand measurement feature. The MTM Plus calculates the average active power (kilowatts) over the time interval selected here and displays the maximum average value in the ACTUAL VALUES messages.

Range: 5-60, steps of 1.
Factory value: 15.

S 2.6

```
kvar DEMAND
PERIOD =  15 MIN
```

This setpoint selects the time period for the kilovar Demand measurement feature. The MTM Plus calculates the average reactive power (kilovars) over the time interval selected here and displays the maximum average value in the ACTUAL VALUES messages.

Range: 5-60, steps of 1.
Factory value: 15.

S 2.7

```
kVA DEMAND
PERIOD =  15 MIN
```

This setpoint selects the time period for the kilova Demand measurement feature. The MTM Plus calculates the average apparent power (kilova) over the time interval selected here and displays the maximum average value in the ACTUAL VALUES messages.

Range: 5-60, steps of 1.
Factory value: 15.

S 2.8

```
CURRENT DEMAND
PERIOD =  15 MIN
```

This setpoint selects the time period for the current Demand measurement feature. The MTM Plus calculates the average current over the time interval selected here and displays the maximum average value in the ACTUAL VALUES messages.

Range: 5-60, steps of 1.
Factory Value: 15.

S 2.9

```
CLEAR DEMAND
VALUES?  NO
```

The maximum kilowatt demand and maximum kilovar demand values displayed in the ACTUAL VALUES messages can be cleared using this setpoint. After storing a value of YES the maximum demand values will be cleared and this setpoint will revert to a value of NO.

Range: NO, YES.
Factory Value: NO.

S 2.10

```
CLEAR kvarH AND
kWH?  NO
```

The kvarH and kWH displayed in Actual Values messages can be cleared using this setpoint. After storing a value of YES, the varH and WH values will be cleared and this setpoint will revert to a value of NO.

Range: NO, YES.
Factory Value: NO.

S 2.11

```
COMM PROTOCOL
MODBUS RTU
```

This message allows the user to select the desired protocol for communication. Select MODBUS RTU to communicate via Modbus protocol. Select 269/565 to communicate with the Multilin 269 Motor Protection Relay or 565/575 Feeder Management Relay.

Range: MODBUS RTU/(269/565)
Factory value: MODBUS RTU

Messages S 2.12 and S 2.13 will only appear if MODBUS RTU is selected in message S 2.11.

S 2.12

```
COMMUNICATIONS
AT 1200 BAUD
```

This message selects the speed for communication. NOTE: This message will default to 1200 BAUD if 269/565 protocol is selected in the message above.

Range: 1200-19.2K baud.
Factory Value: 1200.

S 2.13

```
COMMUNICATIONS
ADDRESS    1
```

The Communications Address must be entered here. When information is sensed on the RS485 communications port, the MTM Plus checks the first byte received. If the first byte is the same as the communications address, the information is accepted. If it is different, the information is discarded.

Range: 1-255, steps of 1
Factory value: 1

S 2.14

```
ALARM RELAY
     UNLATCHED
```

The type of alarm relay must be entered here. If the relay is selected as latched, the reset key must be used to reset the relay. If unlatched is selected, the relay will reset when the fault condition disappears.

Range: LATCHED, UNLATCHED
Factory value: UNLATCHED

S 2.15

```
ALARM RELAY
  FAILSAFE
```

This message allows the output relay to be FAILSAFE or NON-FAILSAFE. If FAILSAFE is selected the relay will energize on power up and de-energize on each power down. If NON-FAILSAFE is selected the relay will remain de-energized upon power up.

Range: FAILSAFE, NON-FAILSAFE
Factory value: FAILSAFE

S 2.16

```
ZERO VOLTS ALARM
DETECT?    NO
```

This setpoint allows the MTM Plus to be configured to detect undervoltage alarms when voltage in all three phases drops to 0V and underfrequency alarms when the frequency drops below 40Hz.

Range: NO, YES
Factory Value: NO

S 2.17

```
VOLTAGES WIRED
AS  OPEN-DELTA
```

This message allows the user to select either an OPEN DELTA or 2 INPUT WYE voltage connection. See wiring diagrams for more information.

Range: OPEN DELTA, 2 INPUT WYE
Factory Value: OPEN DELTA.

S 2.18

```
COMPUTE T.H.D.?
 NO
```

This message allows the user to enable or disable Total Harmonic Distortion calculations.

NOTE: Alarm time delays below 1 sec may increase when THD is enabled.

Range: NO, YES
Factory Value: NO.

S 2.19

```
SWITCHA&B CONFIG
 BREAKER STATUS
```

This setpoint allows the two external switches to be configured to indicate breaker status or for general independent use. If configured for BREAKER STATUS, switch A will act as 52a and switch B will act as 52b. The two switches can be used independently to alarm when a closure is detected on the switch. Note there is a 0–300 sec time delay associated with this feature.

Range: BREAKER STATUS/GENERAL USE
Factory value: BREAKER STATUS

S 2.20

```
PULSE OUTPUT
VARIABLE=kWH
```

This setpoint allows the pulse output to be controlled by kWH or kvarH.

Range: kWH/kvarH.
Factory value: kWH

S 2.21

```
PULSE OUT EVERY
    100 k__H
```

Every time kWH or kvarH increases by a value stored in this setpoint, a 24VDC 100ms pulse is output to a 4–7kΩ external load. The two underscores in k_ _H stand for watt or var depending upon the variable selected in Message S 2.20.

Range: 1–65000 kWH, or 1–65000 kvarH, steps of 1; OFF
Factory value: OFF

S 2.22

```
SAMPLING
FREQUENCY= 60 Hz
```

When the VT voltage input on phase A drops below 20% of VT Ratio setting the frequency entered in this setpoint is used for internal sampling. The frequency entered here must match the line frequency, otherwise the current readings will be unstable.

Range: 50/60 Hz
Factory value: 60 Hz

S 2.23

```
END OF PAGE 2
SETPOINT VALUES
```

This is the end of the MTM Plus configuration setpoints.

S 3.1
```
SETPOINTS PAGE 3
ALARMS
```
This page of SETPOINTS contains messages for MTM Plus alarm indication parameters.

S 3.2
```
UNDERVOLT. ALARM
U/V=     % VT
```
This setpoint is used to set the level below which the MTM Plus will give an Undervoltage Alarm indication. The level is expressed as a percentage of the VT primary.

NOTE: If PT POWER selection is used to power the MTM Plus, the minimum voltage that will keep the MTM Plus alive is 90 VAC. Therefore the undervoltage alarm level should be set accordingly.

Range: 30-95, steps of 1, or OFF.
Factory Value: OFF.

S 3.3
```
UNDERVOLT. TIME
DELAY =    S
```
This setpoint is used to set a time delay for the indication of an Undervoltage Alarm condition. The undervoltage condition must persist for the length of time selected by this setpoint in order for the MTM Plus to indicate an Undervoltage Alarm.

Range: 0.5-60.0, steps of 0.5.
Factory Value: 10.

S 3.4
```
OVERVOLT. ALARM
O/V      % VT
```
This setpoint is used to set the level above which the MTM Plus will give an Overvoltage Alarm indication. The level is expressed as a percentage of VT Primary.

Range: 100-115, steps of 1, or OFF.
Factory Value: OFF.

S 3.5
```
OVERVOLT. TIME
DELAY =    S
```
This setpoint is used to set a time delay for the indication of an Overvoltage Alarm condition. The Overvoltage condition must persist for the length of time selected by this setpoint in order for the MTM Plus to indicate an Overvoltage Alarm.

Range: 0.5-60.0, steps of 0.5.
Factory Value: 10.

S 3.6
```
PF LEAD ALARM
PF =
```
This setpoint is used to set the value of power factor below which the MTM Plus will give a Power Factor Lead Alarm indication. If the power factor is leading (ie. current is leading voltage) and below this setpoint for at least the time delay selected below, then the MTM Plus will indicate a Power Factor Lead Alarm.

Range: 0.05-0.99, steps of 0.01, or OFF.
Factory Value: OFF.

S 3.7
```
PF LAG ALARM
PF =
```
This setpoint is used to set the value of power factor below which the MTM Plus will give a Power Factor Lag Alarm indication. If the power factor is lagging (ie. current is lagging voltage) and below this setpoint for at least the time delay selected below, then the MTM Plus will indicate a Power Factor Lag Alarm.

Range: 0.05-0.99, steps of 0.01, or OFF.
Factory Value: OFF.

S 3.8

```
PF ALARM TIME
DELAY =    s
```

This setpoint is used to set a time delay for the indication of either of the Power Factor Alarm conditions (ie. PF Lead Alarm or PF Lag Alarm). The power factor must remain below the PF Lead or PF Lag Alarm setpoint for the length of time selected by this setpoint in order for the MTM Plus to indicate a Power Factor Alarm.

Range: 1-255, steps of 1.
Factory Value: 10.

S 3.9

```
POSITIVE kvar
ALARM     kvar
```

This setpoint sets the value at which the MTM Plus will give a positive kvar alarm. When the measured positive kvars exceeds the selected level, an alarm occurs.

Range: 0-65000, steps of 1; OFF
Factory value: OFF

S 3.10

```
NEGATIVE kvar
ALARM     kvar
```

This setpoint sets the value at which the MTM Plus will give a negative kvar alarm. When the measured negative kvars exceeds the selected level, an alarm occurs.

Range: 0-65000, steps of 1; OFF
Factory value: OFF

S 3.11

```
kvar ALARM
DELAY =    s
```

This setpoint is used to set a time delay for the indication of a negative/ positive kvar Alarm condition. The measured reactive power (kilovars) must remain above the alarm level for the length of time selected by this setpoint in order for the MTM Plus to indicate a kvar Alarm.

Range: 1-255, steps of 1.
Factory Value: 5.

S 3.12

```
CURRENT ALARM
      % OF CT
```

This setpoint sets the value for an overcurrent alarm. When one or more of the three phase currents exceeds the programmed level, an alarm occurs.

Range: 50-200, steps of 1; or OFF
Factory value: OFF

S 3.13

```
CURRENT ALARM
DELAY     s
```

This setpoint is used to set a time delay for the indication of an overcurrent alarm. The overcurrent must remain above the alarm level for the length of time selected before an alarm will occur.

Range: 1-255, steps of 1
Factory value: 5

S 3.14

```
UNDER FREQUENCY
ALARM     Hz
```

This setpoint sets the value for an underfrequency alarm. When the frequency drops below the setpoint value, an alarm will occur.

Range: 45-60, steps of 0.1; or OFF
Factory value: OFF

S 3.15

```
UNDER FREQUENCY
DELAY     s
```

This setpoint is used to set a time delay for an under frequency alarm. The frequency must remain below the alarm level for the selected time before an alarm will occur.

Range: 0.2-30.0, steps of 0.1
Factory value: 5.0

S 3.16

```
OVER FREQUENCY
ALARM      Hz
```

This setpoint sets the value for an overfrequency alarm. When the frequency rises above the setpoint value, an alarm will occur.

Range: 50-70, steps of 0.1; or OFF.
Factory value: OFF

S 3.17

```
OVER FREQUENCY
DELAY      s
```

This setpoint is used to set a time delay for an overfrequency alarm. The frequency must remain above the alarm level for the selected time before an alarm will occur.

Range: 0.2-30.0, steps of 0.1.
Factory value: 5.0

S 3.18

```
POSITIVE POWER
ALARM      kW
```

This setpoint sets the value at which the MTM Plus will give a Positive Power Alarm. When the measured Positive Power exceeds the selected level, an alarm will occur.

Range: 0-65000, steps of 1; or OFF.
Factory value: OFF.

S 3.19

```
NEGATIVE POWER
ALARM      kW
```

This setpoint sets the value at which the MTM Plus gives a Negative Power Alarm. When the measured negative power exceeds the selected level, an alarm will occur.

Range: 0-65000, steps of 1; or OFF.
Factory value: OFF.

S 3.20

```
POWER ALARM
DELAY      s
```

This setpoint is used to set a time delay for a negative/positive power alarm. The alarm condition must remain above the alarm level for the selected time before an alarm will occur.

Range: 1-255, steps of 1.
Factory value: 5.

S 3.21

```
kW MAX DMND ALM
LEVEL      kW
```

This setpoint sets the value at which the MTM Plus will give a Maximum kW Demand Alarm. When the maximum kW demand exceeds the selected level, an alarm will occur.

Range: 1-65000, steps of 1; or OFF.
Factory value: OFF.

S 3.22

```
var MAX DMND ALM
LEVEL      kvar
```

This setpoint sets the value at which the MTM Plus will give a Maximum kvar Demand Alarm. When the maximum kvar demand exceeds the selected level, an alarm will occur.

Range: 1-65000, steps of 1; or OFF.
Factory value: OFF.

S 3.23

```
kVA MAX DMND ALM
LEVEL      kVA
```

This setpoint sets the value at which the MTM Plus will give a Maximum kVA Demand Alarm. When the maximum kVA demand exceeds the selected level, an alarm will occur.

Range: 1-65000, steps of 1; or OFF.
Factory value: OFF.

S 3.24

```
AMP PK DMND ALM
LEVEL     A
```

This setpoint sets the value at which the MTM Plus will give a Peak Amps Demand Alarm. If the peak demand value of any phase current exceeds the selected level, an alarm will occur.

Range: 1-11000, steps of 1; or OFF.
Factory value: OFF.

S 3.25

```
UNBALANCE (volt)
ALARM     %
```

This setpoint is used to set the value for voltage phase unbalance. When an unbalance in phase voltages exceeds the setpoint value, an alarm condition will occur.

Range: 1-50, steps of 1; or OFF
Factory value: OFF

S 3.26

```
UNBALANCE (volt)
DELAY     s
```

This setpoint is used to set a time delay for a voltage unbalance alarm. The unbalance condition must remain above the alarm threshold value for the selected time before an alarm will occur.

Range: 1-255, steps of 1
Factory value: 5

S 3.27

```
UNBALANCE (amps)
ALARM     %
```

This setpoint is used to set the value for current phase unbalance. When an unbalance in phase currents exceeds the setpoint value, an alarm condition will occur.

Range: 1-50, steps of 1; or OFF.
Factory value: OFF.

S 3.28

```
UNBALANCE (amps)
DELAY     s
```

This setpoint is used to set a time delay for a current unbalance alarm. The unbalance condition must remain above the alarm threshold value for the selected time before an alarm will occur.

Range: 1-255, steps of 1.
Factory value: 5.

S 3.29

```
NEUTRAL CURRENT
ALARM     A
```

This setpoint is used to set the value for a neutral current alarm. When the neutral current exceeds the setpoint value, an alarm condition will occur.

Range: 1-30000, steps of 1; or OFF.
Factory value: OFF.

S 3.30

```
NEUTRAL CURRENT
DELAY     s
```

This setpoint is used to set a time delay for a neutral current alarm. The neutral current must remain above the alarm value for the specified time before an alarm will occur.

Range: 1-255, steps of 1.
Factory value: 5.

S 3.31

```
VOLTAGE PHASE
REVERSAL:  NO
```

The MTM Plus can be set to give an alarm indication if the supply phases are not in the correct sequence. The MTM Plus expects to see the phases in the sequence 1-2-3 or A-B-C. If the phases are connected in the sequence 2-1-3 or B-A-C the MTM Plus will give a Phase Reversal Alarm indication. Phase reversal sensing is done via the VTs.

Range: NO, YES.
Factory Value: NO.

S 3.32

```
COMM FAIL ALARM
      S
```

This setpoint is used to determine if a communications failure has occurred. If no communications has occurred within the specified time, an alarm condition will occur.

Range: 5-30, steps of 1; or OFF
Factory Value: OFF

S 3.33

```
SWITCH A ALARM
DELAY     S
```

If switch A input remains closed for a period of time longer than programmed in this setpoint, a switch A alarm will occur.

Range: 0-300, steps of 1; or OFF
Factory value: OFF

S 3.34

```
SWITCH B ALARM
DELAY     S
```

If switch B input remains closed for a period of time longer than programmed in this setpoint, a switch B alarm will occur.

Range: 0-300, steps of 1; or OFF
Factory value: OFF

S 3.35

```
END OF PAGE 3
SETPOINTS VALUE
```

This is the end of the MTM Plus alarm setpoints.

S 4.1

```
SETPOINTS PAGE 4
ANALOG OUTPUTS
```

This page of setpoints contains messages for MTM Plus Analog outputs configuration.

S 4.2

```
ANALOG OUTPUT 1:
```

This message is used to select the parameter which will be assigned to Analog Output #1. The following selections are available:

PARAMETER	RANGE
FIXED LEVEL	4-20mA / 0-1mA
POWER FACTOR	-0.00 - +0.00
kVA	0 - 65000
ABSOLUTE kVARS	0 - 65000
kW	-32000 - +32000
ABSOLUTE KW	0 - 65000
AVERAGE AMPS	0 - 200%
PHASE A AMPS	0 - 200%
PHASE B AMPS	0 - 200%
PHASE C AMPS	0 - 200%
AVERAGE VOLTS	0 - 200%
PHASE A VOLTS	0 - 200%
PHASE B VOLTS	0 - 200%
PHASE C VOLTS	0 - 200%
MAX kW DEMAND	0 - 65000
MAX kvar DEMAND	0 - 65000
MAX kVA DEMAND	0 - 65000
kW DEMAND	0 - 65000
kvar DEMAND	0 - 65000
kVA DEMAND	0 - 65000
MAX AMP DEMAND A	0 - 11000
MAX AMP DEMAND B	0 - 11000
MAX AMP DEMAND C	0 - 11000
AMP DEMAND A	0 - 11000
AMP DEMAND B	0 - 11000
AMP DEMAND C	0 - 11000
NEUTRAL CURRENT	0 - 30000
FREQUENCY	00.00 - 72.00
UNBALANCE (VOLT)	0 - 100%
UNBALANCE (AMP)	0 - 100%
kWH	0 - 65000
kvarH	0 - 65000
kvar	-32000 - 32000
Mvar	-1000 - 1000
MW	-1000 - 1000

Factory Value: Average Amps.

S 4.3

```
CH1: 4mA EQUALS
     XXXXX
```

This message allows a value to be assigned to the 4mA end of the 4-20mA signal range.

Range: varies depending upon which parameter is selected. See message S4.2.
Factory Value: 0%.

S 4.4
```
CH1: 20mA EQUALS
     XXXXX
```
This message allows a value to be assigned to the 20mA end of the 4-20mA signal range.

Range: varies depending upon which parameter is selected. See message S4.2.
Factory Value: 200%.

S 4.5
```
ANALOG OUTPUT 2:
```
This message is used to select the parameter which will be assigned to Analog Output #2. See Analog Output 1 for selection of parameters.

Factory Value: Absolute kW.

S 4.6
```
CH2: 4mA EQUALS
     XXXXX
```
This message allows a value to be assigned to the 4mA end of the 4-20mA signal range.

Range: varies depending upon which parameter is selected. See message S4.2.
Factory Value: 0 kW.

S 4.7
```
CH2: 20mA EQUALS
     XXXXX
```
This message allows a value to be assigned to the 20mA end of the 4-20mA signal range.

Range: varies depending upon which parameter is selected. See message S4.2.
Factory Value: 1000 kW.

S 4.8
```
ANALOG OUTPUT 3:
```
This message is used to select the parameter which will be assigned to Analog Output #3. See Analog Output 1 for selection of parameters.

Factory Value: Absolute kvar.

S 4.9
```
CH3: 4mA EQUALS
     XXXXX
```
This message allows a value to be assigned to the 4mA end of the 4-20mA signal range.

Range: varies depending upon which parameter is selected. See message S4.2.
Factory Value: 0 kvar.

S 4.10
```
CH3: 20mA EQUALS
     XXXXX
```
This message allows a value to be assigned to the 20mA end of the 4-20mA signal range.

Range: varies depending upon which parameter is selected. See message S4.2.
Factory Value: 1000 kvar.

S 4.11
```
ANALOG OUTPUT 4:
```
This message is used to select the parameter which will be assigned to Analog Output #4. See Analog Output 1 for selection of parameters.

Factory Value: Power Factor.

S 4.12
```
CH4: 4mA EQUALS
     XXXXX
```
This message allows a value to be assigned to the 4mA end of the 4-20mA signal range.

Range: varies depending upon which parameter is selected. See message S4.2.
Factory Value: 0.00.

S 4.13

```
CH4: 20mA EQUALS
     XXXXX
```

This message allows a value to be assigned to the 20mA end of the 4-20mA signal range.

Range: varies depending upon which parameter is selected. See message S4.2.
Factory Value: 0.00.

S 4.14

```
END OF PAGE 4
SETPOINT VALUES
```

This is the end of the MTM Plus Analog setpoints.

Message Overview

ACTUAL VALUES

"ACTUAL VALUES "	"ACTUAL VALUES "	"ACTUAL VALUES "
"PG1: DATA "	"PG2: ALARMS "	"PG3: SW. STATUS "
"Ia= Ib= "	"XXXXX ALARM "	"SWITCH A STATUS "
"Ic= AMPS "	"UNDERVOLTAGE "	" "
"NEUTRAL CURRENT "	"XXXXX ALARM "	"SWITCH B STATUS "
"In= AMPS "	"PWR FACTOR LEAD "	" "
"a= b= "	"XXXXX ALARM "	"END OF PAGE 3 "
"c= kV (L-L) "	"PWR FACTOR LAG "	"ACTUAL VALUES "
"kW= "	"XXXXX ALARM "	
"kvar= "	"POSITIVE kvar "	
"APPARENT POWER "	"XXXXX ALARM "	
" kVA "	"PHASE REVERSAL "	
"POWER FACTOR "	"XXXXX ALARM "	
" "	"OVERCURRENT "	
"MWH= "	"XXXXX ALARM "	
"MvarH= "	"UNDERFREQUENCY "	
"FREQUENCY "	"XXXXX ALARM "	
" Hz "	"VOLT UNBALANCE "	
"kW DMD= "	"XXXXX ALARM "	
"MAX D= "	"COMM FAILED "	
"kvar D= "	"XXXXX ALARM "	
"MAX D= "	"OVERVOLTAGE "	
"kVA D= "	"XXXXX ALARM "	
"MAX D= "	"OVERFREQUENCY "	
"DEMAND a= "	"XXXXX ALARM "	
"b= c= A"	"HIGH kW DEMAND "	
"PK DMND a= "	"XXXXX ALARM "	
"b= c= A"	"HIGH kvar DEMAND"	
"UNBALANCE "	"XXXXX ALARM "	
"V= I= %"	"HIGH kVA DEMAND "	
"ab= bc= "	"XXXXX ALARM "	
"%THD (VOLTAGE) "	"HIGH PH-A DEMAND"	
" "	"XXXXX ALARM "	
"%THD (CURRENT) "	"HIGH PH-B DEMAND"	
"END OF PAGE 1 "	"XXXXX ALARM "	
"ACTUAL VALUES "	"HIGH PH-C DEMAND"	
	"XXXXX ALARM "	
	"POSITIVE POWER "	
	"XXXXX ALARM "	
	"NEGATIVE POWER "	
	"XXXXX ALARM "	
	"NEUTRAL CURRENT "	
	"XXXXX ALARM "	
	"NEGATIVE kvar "	

```
"XXXXX ALARM     "
"SWITCH A CLOSED "

"XXXXX ALARM     "
"SWITCH B CLOSED "

"PRE-ALM Ia=     "
"Ib=     Ic=     "

"END OF PAGE 2   "
"ACTUAL VALUES   "
```

Actual Values Message Abbreviations

%	Percent
L-L	line-to-line voltage
L-N	line-to-neutral voltage
A,AMPS	Amperes
COMM	Communication
D,DMD	Demand
I	Current
In	Neutral current
kVA	Kilovoltamps
kvar	Kilovars
kW	Kilowatts
LAG	Lagging
LEAD	Leading
MAX	Maximum
MvarH	Megavarhours
MWH	Megawatthours
PG	Page
PH-A,PH-B,PH-C,a, b,c,Ia,Ib,Ic	Phase A,B,C current
PK-DMND	Peak demand
PWR	Power
THD	Total Harmonic Distortion
V	Voltage

Actual Values Messages

A 1.1
```
ACTUAL VALUES
PG1: DATA
```
The ACTUAL VALUES messages display all of the data measured by the MTM Plus.

A 1.2
```
Ia=250  Ib=256
Ic=253   AMPS
```
The three phase currents are displayed on this line. The MTM Plus calculates and displays the true RMS values for the phase currents.

A 1.3
```
NEUTRAL CURRENT
In=     25  AMPS
```
The calculated neutral current is displayed on this line. Neutral Current is calculated using the vector addition of Ia+Ib+Ic.

A 1.4
```
a=72.00 b=72.00
c=72.00 kV  L-L
```
The three phase to phase voltages are displayed on this line. The MTM Plus calculates and displays the true RMS values for these voltages.

A 1.5
```
kW    = 15000
kvar  = 4000
```
The total three phase active (kilowatts) and reactive power (kilovars) are displayed on this line. The MTM Plus shows direction of flow by displaying the signed value of vars and watts.

A 1.6
```
APPARENT POWER
1400     kVA
```
The total three phase apparent power (kilovas) is displayed on this line. The apparent power is calculated as the product of the RMS value of voltage and the RMS value of the current. The MTM Plus calculates the apparent power in each phase and displays the total power on this line.

A 1.7
```
POWER FACTOR
  0.90 LAGGING
```
The power factor of the system is displayed on this line. The power factor is calculated as the total active power divided by the total apparent power of the system.

A 1.8
```
MWH    = 15.234
MvarH  =  4.321
```
The total three phase megawatthours and megavarhours of the system are displayed on this line. Once the value reaches 999999.999 it will start over at 0 again.

NOTE: The MTM Plus will remember the value on this line upon a power loss.

Both values can be cleared by entering YES in message S 2.10.

A 1.9
```
FREQUENCY
60.00 Hz
```
The frequency of the system is displayed on this line. The MTM Plus calculates frequency from the VT inputs.

A 1.10
```
kW DMD  = 2500
MAX   D = 30000
```
The current and maximum active power (kW) demand are displayed on this line. The demand period can be selected in message S 2.5. Both demand values can be cleared by entering YES in message S 2.9.

NOTE: Maximum demand value will be remembered upon a power loss.

A 1.11
```
kvar D = 5000
MAX  D = 5000
```
The current and maximum reactive power (kvar) demand are displayed on this line. The demand period can be selected in message S 2.6. Both demand values can be cleared by entering YES in message S 2.9.

NOTE: Maximum demand value will be remembered upon a power loss.

A 1.12
```
kVA  D = 5000
MAX  D = 5000
```
The current and maximum apparent power (kVA) demand are displayed on this line. The demand period can be selected in message S 2.7. Both demand values can be cleared by entering YES in message S 2.9.

NOTE: Maximum demand value will be remembered upon a power loss.

A 1.13

```
DEMAND a=1000
b=1000 c=1000  A
```

The current demand value of each phase current is displayed on this line. The demand period can be selected in message S 2.8. The values can be cleared by entering YES in message S 2.9.

A 1.14

```
PK DMND a=1000
b=1000  c=1000  A
```

The maximum demand value of each phase current is displayed on this line. The demand period can be selected in message S 2.8. The values can be cleared by entering YES in message S 2.9.

NOTE: The values on this line will be remembered upon a power loss.

A 1.15

```
   UNBALANCE
V=99.0 I=55.5%
```

The percentage of voltage and current unbalance are displayed on this line.

Messages A 1.16 and A 1.17 will only appear if YES is selected in message S 2.18.

A 1.16

```
ab= 1.6  bc= 3.8
%THD (VOLTAGE)
```

The percentage of Total Harmonic Distortion (THD) for the two measured voltages is displayed on this line.

A 1.17

```
 2.8   3.1   2.7
%THD (CURRENT)
```

The percentage of Total Harmonic Distortion (THD) for the three measured currents is displayed on this line.

A 1.18

```
END OF PAGE 1
ACTUAL VALUES
```

This is the end of the MTM Plus actual values data messages.

A 2.1

```
ACTUAL VALUES
PG2: ALARMS
```

This Actual Values page is used to display alarms, and pre-alarm phase currents.

NOTE: Multiple alarms can occur and the order of occurrence will be indicated in the alarm message. “FIRST ALARM” indicates the first alarm that has occurred. “SECOND ALARM” indicates the next alarm. If the first alarm condition is cleared, the second alarm will then become the first. A maximum of 6 alarms can be displayed at one time.

The following is a list of possible alarms.

A 2.2

```
FIRST ALARM
UNDERVOLTAGE
```

One or more of the voltage inputs dropped below the setpoint for the specified time.

A 2.3

```
SECOND ALARM
PWR FACTOR LEAD
```

The leading power factor value has dropped below the setpoint value for the specified time.

A 2.4

```
THIRD ALARM
PWR FACTOR LAG
```

The lagging power factor value has dropped below the setpoint value for the specified time.

A 2.5

```
FOURTH ALARM
POSITIVE kvar
```

The positive kvar limit value has exceeded the setpoint value.

A 2.6

```
FIFTH ALARM
NEGATIVE kvar
```

The negative kvar limit value has exceeded the setpoint value.

A 2.7

```
SIXTH ALARM
PHASE REVERSAL
```

Voltage phase reversal has occurred.

A 2.8

```
XXXX ALARM
OVERCURRENT
```

One or more of the phase current inputs has exceeded the setpoint value for the specified time.

A 2.9

```
XXXX ALARM
UNDERFREQUENCY
```

The value of frequency has dropped below the setpoint value for the specified time.

A 2.10

```
XXXX ALARM
VOLT UNBALANCE
```

The percentage of voltage unbalance has exceeded the setpoint value.

A 2.11

```
XXXX ALARM
AMP UNBALANCE
```

The percentage of current unbalance has exceeded the setpoint value.

A 2.12

```
XXXX ALARM
COMM FAILED
```

No communications has occurred within the specified time.

A 2.13

```
XXXX ALARM
OVERVOLTAGE
```

One or more of the voltage inputs has risen above the setpoint value for the specified time.

A 2.14
```
XXXX ALARM
OVERFREQUENCY
```
The value of frequency has risen above the setpoint value for the specified time.

A 2.15
```
XXXX ALARM
HIGH kW DEMAND
```
The kW demand has exceeded the setpoint value.

A 2.16
```
XXXX ALARM
HIGH kvar DEMAND
```
The kvar demand has exceeded the setpoint value.

A 2.17
```
XXXX ALARM
HIGH kVA DEMAND
```
The kVA demand has exceeded the setpoint value.

A 2.18
```
XXXX ALARM
HIGH PH-A DEMAND
```
The Phase A Demand has exceeded the setpoint value.

A 2.19
```
XXXX ALARM
HIGH PH-B DEMAND
```
The Phase B Demand has exceeded the setpoint value.

A 2.20
```
XXXX ALARM
HIGH PH-C DEMAND
```
The Phase C Demand has exceeded the setpoint value.

A 2.21
```
XXXX ALARM
POSITIVE POWER
```
The positive power has exceeded the setpoint value.

A 2.22
```
XXXX ALARM
NEGATIVE POWER
```
The negative power has exceeded the setpoint value.

A 2.23
```
XXXX ALARM
NEUTRAL CURRENT
```
The neutral current has exceeded the setpoint value.

A 2.24
```
XXXX ALARM
SWITCH A CLOSED
```
Switch A has remained closed longer than the time specified in message S 3.33.

A 2.25
```
XXXX ALARM
SWITCH B CLOSED
```
Switch B has remained closed longer than the time specified in message S 3.34.

A 2.26
```
PRE-ALM  Ia=10000
Ib= 9000 Ic= 9000
```
Each phase current will be recorded here upon occurrence of an alarm. The values are updated upon each new alarm.

NOTE: Upon power loss the values on this line default to zero.

A 2.27
```
END OF PAGE 2
ACTUAL VALUES
```
This is the end of MTM Plus Actual Values alarm messages.

A 3.1

```
ACTUAL VALUES
PG3: SW. STATUS
```

This Actual Values page is used to display the status of the external switch inputs.

Message A 3.2 is only displayed if GENERAL USE is selected in message S 2.19.

A 3.2

```
SWITCH A STATUS
    OPEN
```

This line indicates the status of switch input A.

Message A 3.3 is only displayed if BREAKER STATUS is selected in message S 2.19.

A 3.3

```
SWITCH A STATUS
52a: OPEN
```

This line indicates the status of the breaker 52a auxiliary contact.

Message A 3.4 is only displayed if GENERAL USE is selected in message S 2.19.

A 3.4

```
SWITCH B STATUS
    OPEN
```

This line indicates the status of switch input B.

Message A 3.5 is only displayed if BREAKER STATUS is selected in message S 2.19.

A 3.5

```
SWITCH B STATUS
52b: OPEN
```

This line indicates the status of the breaker 52b auxiliary contact.

A 3.6

```
END OF PAGE 3
ACTUAL VALUES
```

This is the end of the MTM Plus switch status messages.

Alarm Features

The MTM Plus provides alarm indications for the following conditions:

1. Phase to phase voltage below or above setpoint (under-voltage/overvoltage).
2. Leading power factor below setpoint.
3. Lagging power factor below setpoint.
4. Positive or negative kvar value exceeded.
5. Phases not connected in proper phase sequence.
6. Current value that exceeds setpoint.
7. Frequency below/above setpoint value.
8. Phase unbalance that exceeds setpoint (voltage and current).
9. Communications Failure.
10. Demand values that exceed setpoint (current, kW, kvar, kVA).
11. Positive or negative kWatts value exceeded.
12. External switch inputs closed.

All alarm features except the Phase Reversal Alarm and Demand values have adjustable time delays. The alarm condition must persist for a time greater than the alarm time delay in order for the MTM Plus to indicate an alarm. When an alarm condition occurs the MTM Plus will display the appropriate alarm message, will illuminate the ALARM LED indicator and will energize the ALARM output relay. When no alarm conditions are present the MTM Plus ALARM LED indicator will turn off and the ALARM output relay will de-energize, if set to unlatched. If the relay is selected as latched, the RESET key must be pressed to clear an alarm.

Alarms will be displayed on page 2 of Actual Values. Multiple alarms can occur and they will be displayed in order of occurrence; the first one displayed is the most recent.

Demand Features

Once a new demand period has been entered, or on power up, the unit will begin sampling kWs, kvars, kVA and current once every 5 secs. Every minute (12 samples), the MTM will average the 12 samples and determine an average value for kWs/kvars/kVA/current. Using these values, the demand can now be calculated using the following formula:

$$\text{DEMAND} = \frac{(1^{\text{ST}}\ \text{MINUTE AVG})}{(\text{DEMAND PERIOD})} + \frac{(2^{\text{ND}}\ \text{MINUTE AVG})}{(\text{DEMAND PERIOD})} + \ldots + \frac{(\text{DEMAND PERIOD MINUTE AVG})}{(\text{DEMAND PERIOD})}$$

Example: Demand period selected as 5 minutes. KWs steady at 100 KW.

After the first minute, the displayed Demand value will be:

$$\text{DEMAND} = \frac{100}{5} + \frac{0}{5} + \frac{0}{5} + \frac{0}{5} + \frac{0}{5} = 20$$

After the second minute, the displayed Demand value will be:

$$\text{DEMAND} = \frac{100}{5} + \frac{100}{5} + \frac{0}{5} + \frac{0}{5} + \frac{0}{5} = 40$$

This will continue every minute until the demand period is reached. For this example, the Demand after 5 minutes would be 100.

Once the initial demand value for the selected period is calculated, the MTM Plus will then begin to use a “sliding window” average. The first minute value will be discarded, and the sixth minute value will be used and therefore, a continuous 5 minute window value will be updated every minute. NOTE: Although a new value is calculated every minute, the display will always show the maximum value displayed since the value was last cleared.

Output Relay

The user can select the form C output relay as latched or unlatched and failsafe or non-failsafe. If unlatched is selected, the relay will only be energized when the alarm condition is present. If latched is selected, once an alarm occurs, the reset key must be pressed to reset the relay. Secondly, if failsafe is selected the relay will energize upon power up and de-energize upon power down. If non-failsafe is selected the relay will not be affected by power up or power down.

Directional Power

The MTM Plus has the ability to determine the direction of power flow. If power is flowing in the reverse direction (negative) the Actual Values message for power will display a minus sign “-” before the number. If power is flowing in the normal direction (positive) the Actual Values message for power will not display a sign. Typically, when monitoring load from induction motors, power flow will be in the normal direction (positive).

NOTE: Correct polarity and phase sequence of CTs/VTs is essential for proper monitoring of power direction.

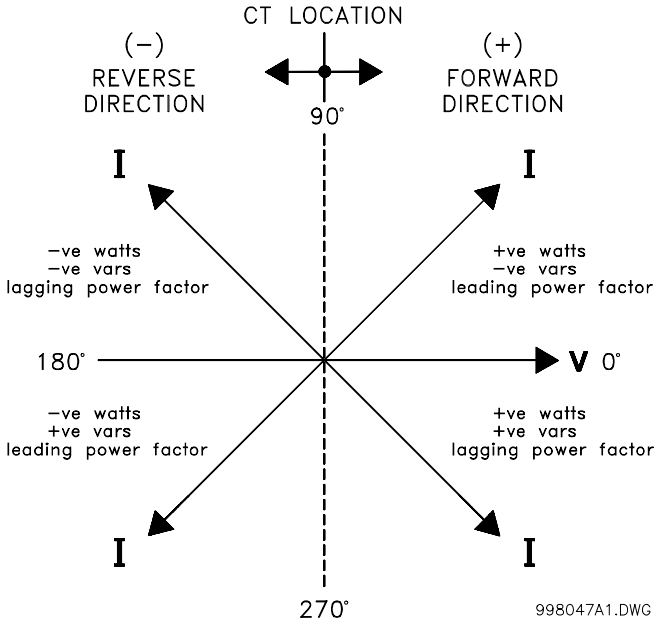


Figure 3.1 Directional Power

Undervoltage

Undervoltage will be calculated using the three measured voltages. All three values will be compared with the VT ratio selected in setpoints and if the percent difference in any phase drops below the programmed setting for the programmed time, an alarm occurs. The undervoltage alarm will not occur if all three phases drop to 0V, and the ZERO VOLTS ALARM DETECT is not enabled.

Unbalance

Unbalance will be calculated using measured voltages and currents. An unbalance condition will exist if the maximum deviation from average divided by average, times 100%, exceeds the setpoint value for the specified time.

$$\text{Voltage UB} = \frac{\text{Maximum deviation from } V_{avg}}{\text{average volts}} \times 100\%$$

$$\text{Current UB} = \frac{\text{Maximum deviation from } I_{avg}}{\text{average current}} \times 100\%$$

Analog Outputs

The MTMPlus has 4 isolated analog outputs which can be selected to provide a 4-20mA (or 0-1mA) signal representing any of the following parameters:

1) Average Amps
2) Phase A Amps
3) Phase B Amps
4) Phase C Amps
5) Average Volts
6) Phase A Volts
7) Phase B Volts
8) Phase C Volts
9) Max kW Demand
10) Max kvar Demand
11) Max kVA Demand
12) kW Demand
13) kvar Demand
14) kVA Demand
15) Max Amp Demand A
16) Max Amp Demand B
17) Max Amp Demand C
18) Amps Demand A
19) Amps Demand B
20) Amps Demand C
21) Neutral Current
22) Frequency
23) Unbalance (Volt)
24) Unbalance (Amp)
25) Fixed Level
26) Power Factor
27) kVA
28) Absolute kvar
29) kW
30) Absolute kW
31) kWH
32) kvarH
33) kvar
34) Mvar
35) MW

Once the parameter which is to be monitored is selected, the user must then define the range of values which are to correspond with the 4-20mA range. An example of this is if the user would like Analog Output #1 to indicate a phase A current with a 100 Amp Primary which varies between 0-100 Amps. First, Phase A current would be the parameter selected to correspond to Analog Output #1. Next, the smallest percentage of current you wish to indicate on the analog output is selected to correspond to 4mA, in this case 0% is selected. The next setting is the largest percentage of current you wish to indicate on the Analog Output. This value will correspond to 20mA and in this case 100% is selected. Now, when the Phase A current varies between 0-100 Amps, the Analog Output #1 will vary between 4-20mA accordingly.

Neutral Current

Neutral current is calculated in the MTM Plus by using vector addition to sum the three phase currents. Normally with a balanced system, the three phase currents will sum to zero. If an unbalance condition occurs, eg. fault to neutral or ground, the three phase currents will not equal zero. The result when summing the three phase currents during an unbalance will be neutral or ground current. This method of sensing neutral or ground current is similar to residual sensing. With residual

sensing, the three phase currents are summed in the return line, whereas in the MTM Plus, they are summed in software.

Total Harmonic Distortion (THD)

% THD can be computed for any sinewave entity read by the MTM Plus. These include:

- each of the three phase currents (Ia, Ib, Ic).
- each of the two phase to phase voltages (Vab, Vcb), or phase to neutral voltages (Van, Vbn) depending on the VT connection.

The method the MTM Plus uses to calculate % THD is as follows:

1. Sample one cycle of the waveform into a table.
2. Determine the true RMS amplitude of the sampled waveform.
3. Extract the real and imaginary fundamental RMS components of the sampled waveform
4. Determine the fundamental RMS of the sampled waveform.
5. The difference (distortion) RMS is measured as the true RMS amplitude minus the fundamental RMS amplitude.
6. The % THD is the square root of the square of the distortion RMS amplitude divided by the fundamental RMS amplitude.

NOTE: The MTM Plus requires true three phase currents and voltages to correctly calculate system parameters.

Primary Injection Testing

Prior to relay commissioning at an installation, complete system operation can be verified by connecting three phase voltage and injecting three phase current to the MTMPlus. To accomplish this a three phase injection test set is required.

Secondary Injection Testing

Operation of the entire relay system, except the phase CTs and the voltage VTs, can be checked by applying input signals to the MTMPlus from a three phase secondary injection set as described in the following sections.

Figure 4.1 shows a simple three phase secondary injection test circuit that can be used to perform all the tests described in the following sections. Tests should be performed to verify the correct operation and wiring of the MTMPlus. All functions are firmware driven and this testing is required only to verify correct firmware/hardware interaction.

All tests described in the following sections will be applicable with factory setpoints and configurations left unchanged. Similar tests can be performed after new setpoints have been stored in the MTMPlus relay.

Phase Voltages and Current Functions

All metering functions are based on the ability of the MTMPlus to accurately read phase currents and voltages. Adjust the three phase voltages to be 69.3 VAC from phase to neutral, then connect these voltages to the MTMPlus. This will give phase to phase voltages equal to 120 VAC. The voltage values can be viewed on page 1 of ACTUAL VALUES. Adjust the voltages to different values and verify the corresponding display in ACTUAL VALUES. To determine if the relay is reading the correct phase current values, inject different phase currents into the 5A CT inputs and view the current readings in ACTUAL VALUES, page 1. The displayed current should be:

displayed current = actual injected current × 100/5 (phase CT ratio)

(eg. if 3 amps are injected, the phase current readings should be 3 × 100/5 = 60 Amps.)

Similar phase accuracy testing can be performed on the phase 1A CT inputs by re-wiring the phase CT inputs and multiplying the actual injected current by a phase CT ratio of 100/1.

Once the accuracy of the phase CT inputs has been verified, the overcurrent alarm feature can be tested.

To perform the overcurrent test, go to page 3 SETPOINTS ALARMS and alter and store CURRENT ALARM = 150%. If any of the three phase currents exceeds 150% of the CT rating (150 Amps), an alarm will occur. Inject 7.5 Amps into the CT inputs (7.5 × 100/5 = 150 Amps). The CURRENT ALARM DELAY is factory set to 5 seconds, therefore a current alarm will occur in 5 seconds. The MTMPlus will display FIRST ALARM CURRENT, the alarm LED on the front panel will light and the relay will energize. NOTE: The alarm relay is factory set to unlatched and therefore will de-energize when the current is removed.

Power Functions and Analog Outputs

To test kwatts, kvars and Power Factor, set up the relay as follows:

In SETPOINTS, page 2, set the VT Ratio to 10:1. Inject 5 Amps in the 5A CT inputs and ensure the phase to phase voltages are equal to 120 VAC. When the above setup is complete, the MTMPlus should display 1.2 kV for all three ACTUAL VALUES voltages and 100 Amps for ACTUAL VALUES current. Adjust the phase angle between current and voltage so that current leads voltage by 30 degrees. At these input values, the MTMPlus will display the following values:

Analog Output #1 default setpoints are set up to monitor average phase current from 0%-100% CT, therefore with 100 Amps displayed, analog output #1 will be displaying 20 mA.

POWER (three phase kwatts) = ((voltage × current) × 3/1.732) × cos (-30°) = ((1200 × 100) × 3/1.732) × cos 30° = 180 Kwatts.

Analog Output #2 default setpoints are set up to monitor absolute kwatts from 0-1000 kwatts, therefore with 180 kwatts displayed, analog output #2 will be displaying 6.88 mA.

Three phase kvars = ((voltage × current) × 3/1.732) × sin (-30°) = ((1200 × 100) × 3/1.732) × sin (-30°) = -104 kvars.

Analog Output #3 default setpoints are set up to monitor kvars from 0-1000 kvars, therefore with 104 kvars displayed, analog output #3 will be displaying 5.66 mA.

Power Factor = kwatts/kVA = kwatts/((voltage × current) × 3/1.732) = 180000/((1200 × 100) × 3/1.732) = 0.87 LEADING.

Analog Output #4 default setpoints are set up to monitor power factor from -0.00 - +0.00, therefore with a power factor of 0.87 leading displayed, analog output #4 will be displaying 13.07 mA.

The above test can be performed at different phase angles, using the same calculations. NOTE: These calculcations are used for a quick check and are only valid if all phase currents are the same and if all voltages are the same.

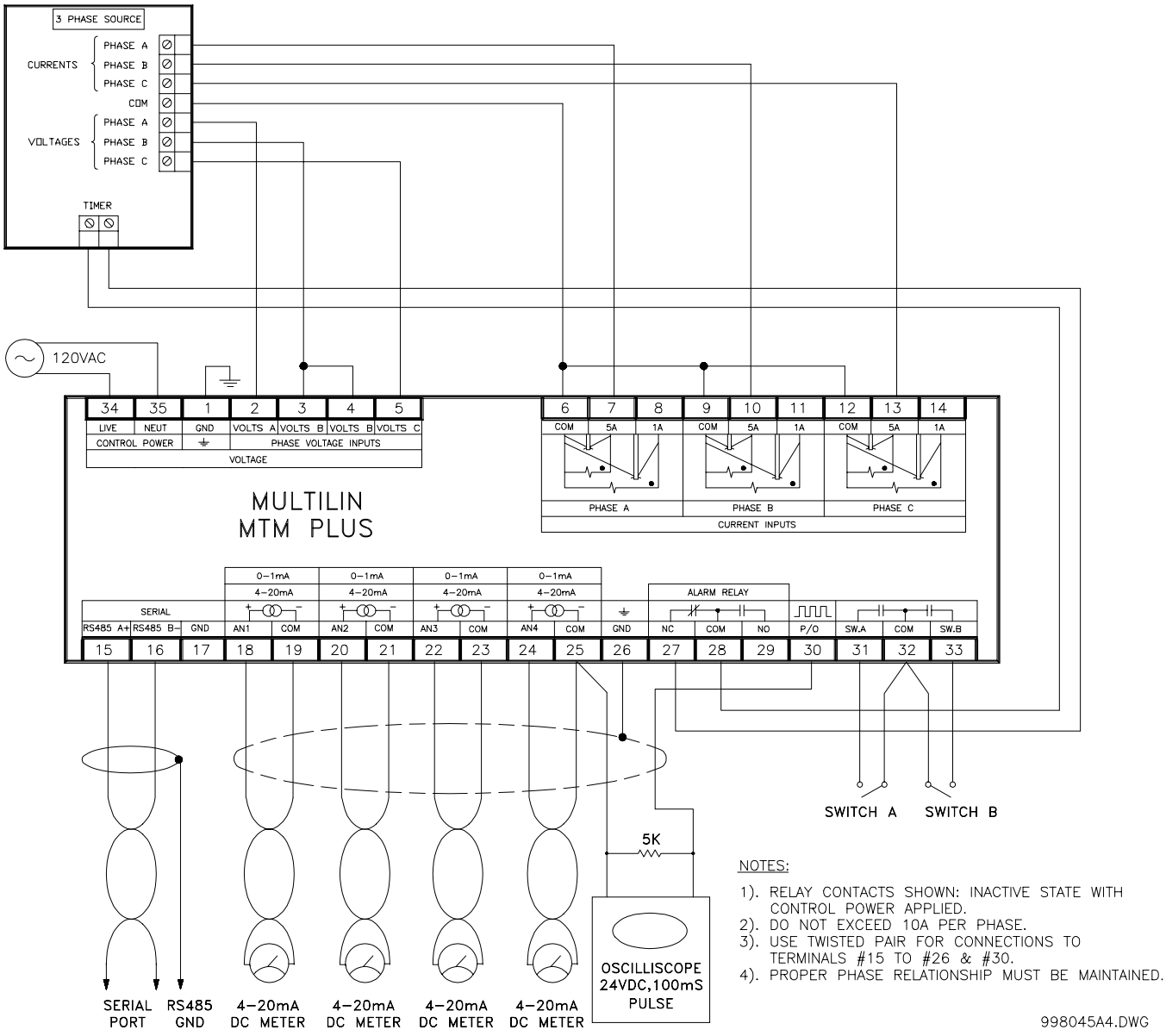


Figure 4.1 Secondary Injection Test Setup

Switch Inputs

To test the operation of the Switch Inputs, set up the relay as follows:

In SEPOINTS CONFIGURATION page set SWITCH A&B CONFIG to GENERAL USE, and SWITCH A ALARM DELAY to 10 seconds, and SWITCH B ALARM DELAY to 0 seconds in SETPOINTS ALARMS page.

Close the switch connected to input A and notice an alarm will occur if switch A remains closed longer than 10 seconds. Now close B and observe that an alarm will occur instantaneously. Upon opening either switch the appropriate alarm will disappear.

Pulse Output

Set up the relay as follows:

In SETPOINTS CONFIGURATION page set PULSE OUTPUT VARIABLE to kWH and PULSE OUT EVERY xxx kWH to 10 kWH.

Clear any MWH that may have accumulated from previous tests.

Inject some current and voltage. Once the MWH value reaches 10 kWH a 100ms, +24V pulse will be outputted.

To avoid false pulsing, 10 kWH should not accumulate faster than 500 ms.

Overview

The MTM Plus Relay implements a subset of the AEG Modicon Modbus serial communications standard. Modbus protocol is hardware-independent. That is, the physical layer can be any of a variety of standard hardware configurations. This includes RS232, RS422, RS485, fibre optics, etc. Modbus is a single master/multiple slave type of protocol suitable for a multi-drop configuration as provided by RS485 hardware. The MTM Plus Relay Modbus implementation employs two-wire RS485 hardware. Using RS485, up to 32 slaves can be daisy-chained together on a single communication channel.

MTM Plus Relays are always Modbus slaves. They cannot be programmed as Modbus masters. Computers or PLCs are commonly programmed as masters.

Modbus protocol exists in two versions: Remote Terminal Unit (RTU, binary) and ASCII. Only the RTU version is supported by the MTM Plus Relay.

Both monitoring and control are possible using read and write register commands. Additional commands are supported to provide additional functions.

Electrical Interface

The hardware or electrical interface in the MTM Plus Relay is two-wire RS485. In a two-wire link data flow is bidirectional. That is, data is transmitted and received over the same two wires. This means that the data flow is half duplex. That is, data is never transmitted and received at the same time.

RS485 lines should be connected in a daisy chain configuration with terminating resistors and capacitors installed at each end of the link (ie. at the master end and at the slave farthest from the master) as shown in Figure 2.1 in the Wiring section. The value of the terminating resistors should be equal to the characteristic impedance of the line. This will be 120 ohms for standard Belden 9841 24AWG stranded twisted pair wire. Shielded wire should always be used to minimize noise.

NOTE: Polarity is important in RS485 communications. The '+' terminals of every device must be connected together.

Data Frame Format and Rate

One data frame of an asynchronous transmission to or from an MTM Plus Relay consists of 1 start bit, 8 data bits, and 1 stop bit. This produces a 10 bit data frame. This is important for transmission through modems at high bit rates (11 bit data frames are not supported by Hayes modems at bit rates of greater than 300 bps).

Modbus protocol can be implemented at any standard communication speed. The MTM Plus Relay supports operation at 1200, 2400, 4800, 9600, and 19,200 baud.

Data Packet Format

A complete request/response sequence consists of the following bytes (transmitted as separate data frames):

Master Request Transmission:

SLAVE ADDRESS	- 1 byte
FUNCTION CODE	- 1 byte
DATA	- variable number of bytes depending on function code
CRC	- 2 bytes

Slave Response Transmission

SLAVE ADDRESS	- 1 byte
FUNCTION CODE	- 1 byte
DATA	- variable number of bytes depending on function code.
CRC	- 2 bytes

SLAVE ADDRESS - This is the first byte of every transmission. This byte represents the user-assigned address of the slave device that is to receive the message sent by the master. Each slave device must be assigned a unique address and only the addressed slave will respond to a transmission that starts with its address.

In a master request transmission the SLAVE ADDRESS represents the address of the slave to which the request is being sent.

In a slave response transmission the SLAVE ADDRESS represents the address of the slave that is sending the response.

NOTE: A master transmission with a SLAVE ADDRESS of 0 indicates a broadcast command. All slaves on the communication link will take action based on the transmission but no response will be made.

FUNCTION CODE - This is the second byte of every transmission. Modbus defines function codes of 1 to 127. The MTM Plus Relay implements some of these functions.

In a master request transmission the FUNCTION CODE tells the slave which action to perform.

In a slave response transmission if the FUNCTION CODE sent from the slave is the same as the FUNCTION CODE sent from the master then the slave performed the function as requested. If the high order bit of the FUNCTION CODE sent from the slave is 1 (ie. if the FUNCTION CODE is greater than 127) then the slave did not perform the function as requested and is sending an error or exception response.

DATA - This will be a variable number of bytes depending on the FUNCTION CODE. This may be addresses, actual values or setpoints sent by the master to the slave or by the slave to the master.

CRC - This is a two-byte error checking code.

Error Checking

The RTU version of Modbus includes a two byte CRC-16 (16 bit cyclic redundancy check) with every transmission. The CRC-16 algorithm essentially treats the entire data stream (data bits only; start, stop and parity are ignored) as one continuous binary number. This number is first shifted left 16 bits and then divided by a characteristic polynomial (1100000000000101B). The 16 bit remainder of the division is appended to the end of the transmission, MS byte first. The resulting message including CRC, when divided by the same polynomial at the receiver will give a zero remainder if no transmission errors have occurred.

If an MTM Plus Relay Modbus slave device receives a transmission in which an error is indicated by the CRC-16 calculation, the slave device will not respond to the transmission. A CRC-16 error indicates that one or more bytes of the transmission were received incorrectly and thus the entire transmission should be ignored in order to avoid the slave device performing any incorrect operation.

The CRC-16 calculation is an industry standard method used for error detection. An algorithm is included here to assist programmers in situations where no standard CRC calculation routines are available.

CRC-16 Algorithm

Once the following algorithm is complete, the working register "A" will contain the CRC value to be transmitted. Note that this algorithm requires the characteristic polynomial to be reverse bit ordered. The MS bit of the characteristic polynomial is dropped since it does not affect the value of the remainder. The following symbols are used in the algorithm:

—> data transfer
A 16 bit working register
AL low order byte of A
AH high order byte of A
CRC 16 bit CRC-16 value
i,j loop counters
(+) logical "exclusive or" operation
Di i-th data byte (i=0 to N-1)
G 16 bit characteristic polynomial = 1010000000000001 with MS bit dropped and bit order reversed
shr(X) shift right (the LS bit if the low order byte of X shifts into a carry flag, a '0' is shifted into the MS bit of the high order byte of X, all other bits shift right one location.)

algorithm:

1. FFFF hex —> A
2. 0 —> i
3. 0 —> j
4. Di (+) AL —> AL
5. j+1 —> j
6. shr(A)
7. is thera a carry? NO: go to 8.
   YES: G (+) A —> A
8. is j=8? NO: go to 5
   YES: go to 9.
9. i+1 —> i
10. is i=N? NO: go to 3.
    YES: go to 11.
11. A —> CRC

Timing

Data packet synchronization is maintained by timing constraints. The receiving device must measure the time between the reception of characters. If three and one half character times elapse without a new character or completion of the packet, then the communication link must be reset (ie. all slaves start listening for a new transmission from the master). Thus at 9600 baud a delay of greater than

$$3.5 \times \frac{1}{9600} \times 10 = 3.65 \text{ ms}$$

will cause the communication link to be reset.

The following Modbus commands are supported:

Number	Modbus Definition	MTM+ Definition
03,04	Read holding and input registers	Read setpoints/actual values
05	Force single coil	Execute operation
06	Preset single register	Store single setpoint
07	Read exception status	Read device status
16	Preset multiple registers	Store multiple setpoints

These functions are described in detail as follows:

FUNCTIONS 03,04, READ SETPOINTS, AND ACTUAL VALUES.

Modbus "Read Holding Registers" and "Read Input Registers" are used by the Master computer to read the relaying parameters and measured and calculated data from the MTM Plus. Up to 125 consecutive registers (250 bytes) can be read with one command. Broadcast command is not allowed with this function. The MTM Plus Setpoint and Actual Values register map is given in Appendix A. This appendix represents the registers as inserted in the packet to be communicated. They are 16-bit words. The format of the packets communicated is given, with the following example:

The Master computer, in order to read the 3 consecutive setpoint registers starting from register address 1100h from slave number 02h, sends the command:

		HI LO	HI LO	LO HI
02h	03h	11h 00h	00h 03h	00h C4h
ADDRESS	FUNCTION	START REG	COUNT	CRC

slave number 02h replies with:

02h	03h	06h	HI LO 00h 64h	HI LO 00h 0Ah	HI LO 00h 0Fh	LO HI 24h 4Bh
ADDRESS	FUNCTION	BYTE COUNT	REG DATA	REG DATA	REG DATA	CRC

(the successive registers are the setpoint values as identified in the setpoint map.)

The Master computer, in order to read the 1 actual value registers starting from register address 0100h from slave number 02h, sends the command:

02h	04h	HI LO 01h 00h	HI LO 00h 01h	LO HI 30h 05h
ADDRESS	FUNCTION	START REG	COUNT	CRC

slave number 02h replies with:

02h	04h	02h	HI LO 00h 00h	LO HI FDh 30h
ADDRESS	FUNCTION	BYTE COUNT	REG DATA	CRC

NOTE: Functions 03 and 04 can be interchanged to read Setpoints or Actual Values.

FUNCTION 05, EXECUTE OPERATION.

Modbus "Force Single Coil" is used by the Master computer to request that the MTMPlus preform a specific operation. Broadcast command is not allowed with this function. The operations that can be preformed by the MTMPlus are as follows:

00 - reset alarms
01 - reset MWH and MvarH
02 - reset demand values

The format of the packets communicated is given, with the following example:

The Master computer, in order to reset an overcurrent alarm on slave number 02h, sends the command:

02h	05h	HI LO 00h 00h	HI LO FFh 00h	LO HI 8Ch 09h
ADDRESS	FUNCTION	OPERATION	PERFORM OPERATION	CRC

slave number 02h replies with:

02h	05h	HI LO 00h 00h	HI LO FFh 00h	LO HI 8Ch 09h
ADDRESS	FUNCTION	OPERATION	PERFORM OPERATION	CRC

FUNCTION 06, STORE SINGLE SETPOINT.

Modbus "Preset Single Register" is used by the Master computer to store a single setpoint into the memory of the MTMPlus. Broadcast command is not allowed with this function. The response from the MTMplus will be the echo of the entire master transmission. The format of the packets communicated is given, with the following example:

The Master computer, in order to store one setpoint at address 1100h to slave number 02h, sends the command:

02h	06h	HI LO 11h 00h	HI LO 00h 64h	LO HI 8Dh 2Eh
ADDRESS	FUNCTION	SETPOINT ADDRESS	DATA	CRC

slave number 02h replies with:

02h	06h	HI LO 11h 00h	HI LO 00h 64h	LO HI 8Dh 2Eh
ADDRESS	FUNCTION	SETPOINT ADDRESS	DATA	CRC

FUNCTION 07, READ DEVICE STATUS.

Modbus "Read Exception Status" is used by the Master computer to quickly read the status of the MTMPlus. A short message allows for rapid reading of the status. The status byte returned will have individual bits set to 1 or 0 depending on the status of the MTMPlus. Broadcast command is not allowed with this function.

The status byte contains the following information:

Bit 0 - set if alarms are present.
Bit 1 - set if setpoint access is enabled.
Bit 2 - set if switch A is closed.
Bit 3 - set if switch B is closed.
Bit 4 - not used.
Bit 5 - not used.
Bit 6 - not used.
Bit 7 - not used.

The format of the packets communicated is given, with the following example:

The Master computer, in order to read the status of slave number 02h, sends the command:

02h	07h	LO HI 41h 12h
ADDRESS	FUNCTION	CRC

slave number 02h replies with:

02h	07h	00h	LO HI D2h 30h
ADDRESS	FUNCTION	DEVICE STATUS	CRC

FUNCTION 16 (10h), STORE MULTIPLE SETPOINTS.

Modbus "Preset multiple Registers" is used by the Master computer to remotely program the MTMPlus setpoint registers. The maximum number of registers that may be written in a single command is 60. Care must be taken when using this command to ensure new setpoints are stored correctly. Broad-

cast command is not allowed with this function. The format of the packets communicated is given, with the following example:

The Master computer, in order to store two setpoints starting at address 1100h to slave number 02h, sends the command:

		HI LO	HI LO		HI LO	HI LO	LO HI
02h	10h	11h 00h	00h 02h	04h	00h 64h	00h 14h	70h 6Bh
ADDR.	FUNC.	START REG	REG COUNT	BYTE COUNT	DATA	DATA	CRC

slave number 02h replies with:

		HI LO	HI LO	LO HI
02h	10h	11h 00h	00h 02h	44h C7h
ADDRESS	FUNCTION	START REG	REG COUNT	CRC

Error Responses

When the master command received by the MTMPlus cannot be preformed, the MTMPlus replies with an error code. This is different from detecting communications related errors such as parity or CRC errors for which the MTMPlus ignores the command.

The format of an error reply is to return the received address and function back to the master with the most significant bit of the function code set. Also, a one byte error code is added to the reply packet to identify the problem.

The error codes supported by the MTM Plus relay are:

01 - illegal function ⇒ The function code transmitted is not one of the functions supported by the MTMPlus.

02 - illegal data address ⇒ The master has requested to store a value, or read a value from an illegal address, or the requested number of registers does not match the total length of referenced internal registers.

03 - illegal data value ⇒ The master has requested that the MTMPlus store a setpoint which is out of range.

An example involving an error replay is:

Master sending a setpoint which is out of range:

		HI LO	HI LO	LO HI
02h	06h	11h 00h	64h 64h	A7h EEh
ADDRESS	FUNCTION	SETPOINT ADDRESS	DATA	CRC

slave number 02h replies with:

			LO HI
02h	86h	03h	F2h 61h
ADDRESS	FUNCTION	ERROR CODE	CRC

The value 6464h exceeds the range of the setpoint that is located at address 1100h.

MTMPLUS Address Space / Memory Map (Revision 21E188B1.000)

REGISTER ADDRESS			CONTENTS	RANGE	UNITS	DEFAULT
MODICON	(hex)	(dec)				

*****NOTE: NEGATIVE NUMBERS ARE EXPRESSED USING 2'S COMPLIMENT.

ACTUAL VALUES - READ

40001	0000	0	MULTILIN PRODUCT CODE	21	--	-
40002	0001	1	MTMPLUS HARDWARE REVISION CODE 00 00H = NOT AVAILABLE 00 01H = "A" 00 02H = "B" 00 03H = "C" 00 04H = "D" 00 05H = "E" etc.....	0000H - FFFFH	--	-
40003	0002	2	MTMPLUS FIRMWARE REVISION CODE 01 00H = 1.0 01 01H = 1.1 01 02H = 1.2 etc... 01 70H = 1.70 01 80H = 1.80 etc... 01 86H = 1.86 etc...	0000H - FFFFH	--	-
40004	0003	3	MULTILIN MOD. FILE NUMBER 00 00H = NO MODIFICATION 01 44H = MOD #324 01 48H = MOD #328 01 52H = MOD #338 etc...	0000H - FFFFH	--	-
40005 to 40256	0004 to 009F	4 to 255	UNDEFINED			
40257	0100	256	PHASE A CURRENT	0 - 11000	amps	-
40258	0101	257	PHASE B CURRENT	0 - 11000	amps	-
40259	0102	258	PHASE C CURRENT	0 - 11000	amps	-
40260	0103	259	VOLTAGE AB	0 - 84000 (4 bytes)	volts	-
40262	0105	261	VOLTAGE BC	0 - 84000 (4 bytes)	volts	-
40264	0107	263	VOLTAGE CA	0 - 84000 (4 bytes)	volts	-
40266	0109	265	SIGNED POWER FACTOR	-100 - +100	--	-
40267	010A	266	KILOWATTS	±0 - 99999999 (4 bytes)	0.1x kW	-
40269	010C	268	KILOVARS	±0 - 99999999 (4 bytes)	0.1x kvar	-
40271	010E	270	KILOVAS	0 - 99999999 (4 bytes)	0.1x kVA	-
40273	0110	272	MEGAWATT HOURS	0 - 1000000000 (4 bytes)	kWH	-
40275	0112	274	MEGAVAR HOURS	0 - 1000000000 (4 bytes)	kvarH	-
40277	0114	276	MAX kW DEMAND	0 - 99999999 (4 bytes)	0.1x kW	-
40279	0116	278	MAX kvar DEMAND	0 - 99999999 (4 bytes)	0.1x kvar	-
40281	0118	280	MAX kVA DEMAND	0 - 99999999 (4bytes)	0.1x kVA	-
40283	011A	282	kW DEMAND	0 - 99999999 (4 bytes)	0.1x kW	-
40285	011C	284	kvar DEMAND	0 - 99999999 (4bytes)	0.1x kvar	-
40287	011E	286	kVA DEMAND	0 - 99999999 (4 bytes)	0.1x kVA	-
40289	0120	288	FREQUENCY	0 - 7500	x0.01 hz	-
40290	0121	289	PHASE REVERSAL	0 - 1		-
40291	0122	290	UNBALANCE (VOLT)	0 - 1000	x0.1%	-
40292	0123	291	UNBALANCE (AMP)	0 - 1000	x0.1%	-
40293	0124	292	SPARE			
40294	0125	293	NEUTRAL CURRENT	0 - 30000	amps	-

MTMPLUS Address Space / Memory Map (Revision 21E188B1.000)						
REGISTER ADDRESS			CONTENTS	RANGE	UNITS	DEFAULT
MODICON	(hex)	(dec)				
40295 to 40304	0126 to 012F	294 to 303	UNDEFINED			
40305	0130	304	THD - Ia	0 - 1000	x0.1%	-
40306	0131	305	THD - Ib	0 - 1000	x0.1%	-
40307	0132	306	THD - Ic	0 - 1000	x0.1%	-
40308	0133	307	THD - Vab	0 - 1000	x0.1%	-
40309	0134	308	THD - Vbc	0 - 1000	x0.1%	-
40310 to 40320	0135 to 013F	309 to 319	UNDEFINED			
40321	0140	320	MAX PHASE A DEMAND	0 - 11000	amps	-
40322	0141	321	MAX PHASE B DEMAND	0 - 11000	amps	-
40323	0142	322	MAX PHASE C DEMAND	0 - 11000	amps	-
40324	0143	323	PHASE A DEMAND	0 - 11000	amps	-
40325	0144	324	PHASE B DEMAND	0 - 11000	amps	-
40326	0145	325	PHASE C DEMAND	0 - 11000	amps	-
40327 to 40512	0146 to 01FF	326 to 511	UNDEFINED			
THE FOLLOWING SECTION INDICATES IF AN ALARM IS INACTIVE, TIMING OUT, OR ACTIVE. 0 = INACTIVE 1 = TIMING OUT 2 = ACTIVE						
40513	0200	512	UNDERVOLTAGE ALARM	0 - 2	--	-
40514	0201	513	OVERVOLTAGE ALARM	0 - 2	--	-
40515	0202	514	POWER FACTOR LAG ALRAM	0 - 2	--	-
40516	0203	515	POWER FACTOR LEAD ALARM	0 - 2	--	-
40517	0204	516	POSITIVE kvar ALARM	0 - 2	--	-
40518	0205	517	PHASE REVERSAL ALARM	0 - 2	--	-
40519	0206	518	OVERCURRENT ALARM	0 - 2	--	-
40520	0207	519	UNDER FREQUENCY ALARM	0 - 2	--	-
40521	0208	520	OVER FREQUENCY ALARM	0 - 2	--	-
40522	0209	521	UNBALANCE (VOLT) ALARM	0 - 2	--	-
40523	020A	522	UNBALANCE (AMP) ALARM	0 - 2	--	-
40524	020B	523	COMMUNICATIONS FAIL ALARM	0 - 2	--	-
40525	020C	524	MAX kW DEMAND ALARM	0 - 2	--	-
40526	020D	525	MAX kvar DEMAND ALARM	0 - 2	--	-
40527	020E	526	MAX kVA DEMAND ALARM	0 - 2	--	-
40528	020F	527	MAX PHASE A ALARM	0 - 2	--	-
40529	0210	528	MAX PHASE B ALARM	0 - 2	--	-
40530	0211	529	MAX PHASE C ALARM	0 - 2	--	-
40531	0212	530	kW NEGATIVE ALARM	0 - 2	--	-
40532	0213	531	kW POSITIVE ALARM	0 - 2	--	-
40533	0214	532	NEUTRAL CURRENT ALARM	0 - 2	--	-
40534	0215	533	NEGATIVE kvar ALARM	0 - 2	--	-
40535	0216	534	SWITCH A CLOSED ALARM	0 - 2	--	-
40536	0217	535	SWITCH B CLOSED ALARM	0 - 2	--	-
THE FOLLOWING SECTION SHOWS ALARM IN ORDER OF OCCURRENCE. THE NUMBER STORED AT EACH OF THESE LOCATIONS INDICATES THE TYPE OF ALARM: 00 = NO ALARM 01 = UNDERVOLTAGE ALARM 02 = OVERVOLTAGE ALARM 03 = POWER FACTOR LAG ALARM 04 = POWER FACTOR LEAD ALARM						

MTMPLUS Address Space / Memory Map (Revision 21E188B1.000)

REGISTER ADDRESS			CONTENTS	RANGE	UNITS	DEFAULT
MODICON	(hex)	(dec)				
			05 = POSITIVE kvar ALARM 06 = PHASE REVERSAL ALARM 07 = OVERCURRENT ALARM 08 = UNDER FREQUENCY ALARM 09 = OVER FREQUENCY ALARM 10 = UNBALANCE (VOLT) ALARM 11 = UNBALANCE (AMP) ALARM 12 = COMMUNICATIONS FAIL ALARM 13 = MAX kW DEMAND ALARM 14 = MAX kvar DEMAND ALARM 15 = MAX kVA DEMAND ALARM 16 = MAX PHASE A DEMAND ALARM 17 = MAX PHASE B DEMAND ALARM 18 = MAX PHASE C DEMAND ALARM 19 = kW NEGATIVE ALARM 20 = kW POSITIVE ALARM 21 = NEUTRAL CURRENT ALARM 22 = NEGATIVE kvar ALARM 23 = SWITCH A CLOSED ALARM 24 = SWITCH B CLOSED ALARM			
40537 to 40768	0218 to 02FF	536 to 767	UNDEFINED			
40769	0300	768	FIRST ALARM	0 - 24	--	-
40770	0301	769	SECOND ALARM	0 - 24	--	-
40771	0302	770	THIRD ALARM	0 - 24	--	-
40772	0303	771	FOURTH ALARM	0 - 24	--	-
40773	0304	772	FIFTH ALARM	0 - 24	--	-
40774	0305	773	SIXTH ALARM	0 - 24	--	-
40775	0306	774	SEVENTH ALARM	0 - 24	--	-
40776	0307	775	EIGHTH ALARM	0 - 24	--	-
40777	0308	776	NINTH ALARM	0 - 24	--	-
40778	0309	777	TENTH ALARM	0 - 24	--	-
40779	030A	778	ELEVENTH ALARM	0 - 24	--	-
40780	030B	779	TWELFTH ALARM	0 - 24	--	-
40781 to 40800	030C to 031F	780 to 799	UNDEFINED			
40801	0320	800	PHASE A PRE-ALARM	0 - 11000	amps	-
40802	0321	801	PHASE B PRE-ALARM	0 - 11000	amps	-
40803	0322	802	PHASE C PRE-ALARM	0 - 11000	amps	-
40804 to 41025	0323 to 0400	803 to 1024	UNDEFINED			
41026	0401	1025	MAXIMUM CURRENT	0 - 200	% CT	-
41027	0402	1026	MINIMUM VOLTAGE	0 - 200	% VT	-
41028	0403	1027	UNSIGNED PF LAG	0 - 100	--	-
41029	0404	1028	UNSIGNED PF LEAD	0 - 100	--	-
41030	0405	1029	MEGAWATT HOURS	0 - 10000	MWH	-
41031	0406	1030	MEGAVAR HOURS	0 - 10000	MvarH	-
41032	0407	1031	KILOWATT HOURS	0 - 10000	kWH	-
41033	0408	1032	KILOVAR HOURS	0 - 10000	kvarH	-
THE FOLLOWING FOUR ACTUAL VALUES INDICATE THE TYPE OF ANALOG OUTPUT. 0 = 0 - 1mA 1 = 4 - 20mA						
41034	0409	1033	ANALOG OUTPUT 1	0 - 1	--	-
41035	040A	1034	ANALOG OUTPUT 2	0 - 1	--	-

MTMPLUS Address Space / Memory Map (Revision 21E188B1.000)						
REGISTER ADDRESS			CONTENTS	RANGE	UNITS	DEFAULT
MODICON	(hex)	(dec)				
41036	040B	1035	ANALOG OUTPUT 3	0 - 1	--	-
41037	040C	1036	ANALOG OUTPUT 4	0 - 1	--	-
41038 to 41280	040D to 04FF	1037 to 1279	UNDEFINED			
THE FOLLOWING TWO ACTUAL VALUES INDICATE THE STATUS OF SWITCH INPUTS. 0 = OPEN 1 = CLOSED						
41281	0500	1280	SWITCH A STATUS	0 - 1	--	-
41282	0501	1281	SWITCH B STATUS	0 - 1	--	-
41283 to 44096	0502 to 0FFF	1282 to 4095	UNDEFINED			

MTMPLUS Address Space / Memory Map (Revision 21E188B1.000)

REGISTER ADDRESS			CONTENTS	RANGE	UNITS	DEFAULT
MODICON	(hex)	(dec)				
SETPOINTS - READ/WRITE						
44097 to 44352	1000 to 10FF	4096 to 4351	RESERVED			
44353	1100	4352	PHASE CT PRIMARY	20 - 5000	x1	100
44354	1101	4353	PHASE VT RATIO	10 - 8000	x0.1	10
44355	1102	4354	kW DEMAND PERIOD	5 - 60	minutes	15
44356	1103	4355	kvar DEMAND PERIOD	5 - 60	minutes	15
44357	1104	4356	kVA DEMAND PERIOD	5 - 60	minutes	15
44358	1105	4357	CURRENT DEMAND PERIOD	5 - 60	minutes	15
44359	1106	4358	ALARM RELAY 0 = UNLATCHED 1 = LATCHED	0 - 1	--	0
44360	1107	4359	VT WIRING 0 = 2 INPUT WYE 1 = OPEN DELTA	0 - 1	--	0
44361	1108	4360	DISPLAY THD 0 = NO 1 = YES	0 - 1	--	0
44362	1109	4361	VT NOMINAL SECONDARY VOLTAGE	40 - 240	volts	120
44363	110A	4362	CLEAR DEMAND VALUES 0 = NO 1 = YES	0 - 1	--	0
44364	110B	4363	CLEAR varH AND WH 0 = NO 1 = YES	0 - 1	--	0
44365	110C	4364	SWITCH A AND B CONFIGURATION 0 = BREAKER STATUS 1 = GENERAL USE	0 - 1	--	0
44366	110D	4365	PULSE OUTPUT VARIABLE 0 = kWH 1 = kvarH	0 - 1	--	0
44367	110E	4366	PULSE OUTPUT INTERVAL	1 - 65000 (FFFFH = OFF)	kWH, kvarH	OFF
44368	110F	4367	SAMPLING FREQUENCY	50 - 60	Hz	60
44369	1110	4368	ALARM RELAY 0 = FAILSAFE 1 = NON-FAILSAFE	0 - 1	--	0
44370	1111	4369	ZERO VOLTS ALARM DETECT 0 = NO 1 = YES	0 - 1	--	0
44371	1112	4370	RESERVED			
44372	1113	4371	RESERVED			
44373	1114	4372	RESERVED			
44374 to 44608	1115 to 11FF	4373 to 4607	UNDEFINED			
44609	1200	4608	UNDERVOLTAGE ALARM LEVEL	30 - 95 (FFFFH = OFF)	% PT	OFF
44610	1201	4609	UNDERVOLTAGE ALARM DELAY	5 - 600 (steps of 0.5s)	x0.1 secs	10
44611	1202	4610	OVERVOLTAGE ALARM LEVEL	100 - 115 (FFFFH = OFF)	% PT	OFF
44612	1203	4611	OVERVOLTAGE ALARM DELAY	5 - 600 (steps of 0.5s)	x0.1 secs	10
44613	1204	4612	PF LEAD ALARM	5 - 99 (FFFFH = OFF)	x0.01	OFF
44614	1205	4613	PF LAG ALARM	5 - 99 (FFFFH = OFF)	x0.01	OFF
44615	1206	4614	PF ALARM DELAY	1 - 255	seconds	10

MTMPLUS Address Space / Memory Map (Revision 21E188B1.000)

REGISTER ADDRESS			CONTENTS	RANGE	UNITS	DEFAULT
MODICON	(hex)	(dec)				
44616	1207	4615	POSITIVE kvar ALARM LEVEL	0 - 65000 (FFFFH = OFF)	kvar	OFF
44617	1208	4616	kvar ALARM DELAY	1 - 255	seconds	5
44618	1209	4617	CURRENT ALARM	50 - 200	% CT	OFF
44619	120A	4618	CURRENT ALARM DELAY	1 - 255	seconds	5
44620	120B	4619	UNDER FREQUENCY ALARM	4500 - 6000 (FFFFH = OFF) (steps of 0.1Hz)	x0.01Hz	OFF
44621	120C	4620	UNDER FREQUENCY ALARM DELAY	2 - 300	x0.1 secs	50
44622	120D	4621	OVER FREQUENCY ALARM	5000 - 7000 (FFFFH = OFF) (steps of 0.1Hz)	x0.01Hz	OFF
44623	120E	4622	OVER FREQUENCY ALARM DELAY	2 - 300	x0.1 secs	50
44624	120F	4623	POSITIVE POWER ALARM	0 - 65000 (FFFFH = OFF)	kW	OFF
44625	1210	4624	NEGATIVE POWER ALARM	0 - 65000 (FFFFH = OFF)	kW	OFF
44626	1211	4625	POWER ALARM DELAY	1 - 255	seconds	5
44627	1212	4626	kW DEMAND ALARM	0 - 65000 (FFFFH = OFF)	kW	OFF
44628	1213	4627	kvar DEMAND ALARM	0 - 65000 (FFFFH = OFF)	kvar	OFF
44629	1214	4628	kVA DEMAND ALARM	0 - 65000 (FFFFH = OFF)	kVA	OFF
44630	1215	4629	AMP DEMAND ALARM	0 - 65000 (FFFFH = OFF)	amps	OFF
44631	1216	4630	UNBALANCE (VOLT) ALARM	1 - 50 (FFFFH = OFF)	%	OFF
44632	1217	4631	UNBALANCE ALARM DELAY	1 - 255	seconds	5
44633	1218	4632	UNBALANCE (AMP) ALARM	1 - 50 (FFFFH = OFF)	%	OFF
44634	1219	4633	UNBALANCE ALARM DELAY	1 - 255	seconds	5
44635	121A	4634	NEUTRAL CURRENT ALARM	0 - 30000 (FFFFH = OFF)	amps	OFF
44636	121B	4635	NEUTRAL CURRENT ALARM DELAY	10 - 2550	x0.1 secs	5
44637	121C	4636	PHASE REVERSAL 0 = NO 1 = YES	0 - 1	--	OFF
44638	121D	4637	COMM FAIL ALARM	5 - 30 (FFFFH = OFF)	seconds	OFF
44639	121E	4638	NEGATIVE kvar ALARM LEVEL	0 - 65000 (FFFFH = OFF)	kvar	OFF
44640	121F	4639	SWITCH A ALARM DELAY	0 - 300 (FFFFH = OFF)	seconds	OFF
44641	1220	4640	SWITCH B ALARM DELAY	0 - 300 (FFFFH = OFF)	seconds	OFF
44642 to 44864	1221 to 12FF	4641 to 4863	UNDEFINED			
44865	1300	4864	ANALOG OUTPUT #1 TYPE 0 = FIXED LEVEL 1 = POWER FACTOR 2 = kVA 3 = ABSOLUTE kvar 4 = kW 5 = ABSOLUTE kW 6 = AVERAGE AMPS 7 = PHASE A AMPS 8 = PHASE B AMPS 9 = PHASE C AMPS 10 = AVERAGE VOLTS 11 = PHASE A VOLTS 12 = PHASE B VOLTS 13 = PHASE C VOLTS 14 = MAX kW DEMAND 15 = MAX kvar DEMAND 16 = MAX kVA DEMAND 17 = kW DEMAND 18 = kvar DEMAND 19 = kVA DEMAND 20 = MAX PHASE A DEMAND 21 = MAX PHASE B DEMAND 22 = MAX PHASE C DEMAND	0 - 35	--	6

MTMPLUS Address Space / Memory Map (Revision 21E188B1.000)						
REGISTER ADDRESS			CONTENTS	RANGE	UNITS	DEFAULT
MODICON	(hex)	(dec)				
			23 = PHASE A DEMAND 24 = PHASE B DEMAND 25 = PHASE C DEMAND 26 = NEUTRAL CURRENT 27 = FREQUENCY 28 = UNBALANCE (VOLT) 29 = UNBALANCE (AMP) 30 = kWH 31 = kvarH 32 = kvar 33 = Mvar 34 = MW			
44866	1301	4865	ANALOG OUTPUT #1 MIN	SEE APPENDIX B FOR RANGES		0
44867	1302	4866	ANALOG OUTPUT #1 MAX	SEE APPENDIX B FOR RANGES		200
44868	1303	4867	ANALOG OUTPUT #1 FIXED	SEE APPENDIX B FOR RANGES		
44869	1304	4868	ANALOG OUTPUT #2 TYPE 0 = FIXED LEVEL 1 = POWER FACTOR 2 = kVA 3 = ABSOLUTE kvar 4 = kW 5 = ABSOLUTE kW 6 = AVERAGE AMPS 7 = PHASE A AMPS 8 = PHASE B AMPS 9 = PHASE C AMPS 10 = AVERAGE VOLTS 11 = PHASE A VOLTS 12 = PHASE B VOLTS 13 = PHASE C VOLTS 14 = MAX kW DEMAND 15 = MAX kvar DEMAND 16 = MAX kVA DEMAND 17 = kW DEMAND 18 = kvar DEMAND 19 = kVA DEMAND 20 = MAX PHASE A DEMAND 21 = MAX PHASE B DEMAND 22 = MAX PHASE C DEMAND 23 = PHASE A DEMAND 24 = PHASE B DEMAND 25 = PHASE C DEMAND 26 = NEUTRAL CURRENT 27 = FREQUENCY 28 = UNBALANCE (VOLT) 29 = UNBALANCE (AMP) 30 = kWH 31 = kvarH 32 = kvar 33 = Mvar 34 = MW	0 - 35	--	5
44870	1305	4869	ANALOG OUTPUT #2 MIN	SEE APPENDIX B FOR RANGES		0
44871	1306	4870	ANALOG OUTPUT #2 MAX	SEE APPENDIX B FOR RANGES		1000
44872	1307	4871	ANALOG OUTPUT #2 FIXED	SEE APPENDIX B FOR RANGES		--
44873	1308	4872	ANALOG OUTPUT #3 TYPE 0 = FIXED LEVEL 1 = POWER FACTOR	0 - 35	--	3

MTMPLUS Address Space / Memory Map (Revision 21E188B1.000)						
REGISTER ADDRESS			CONTENTS	RANGE	UNITS	DEFAULT
MODICON	(hex)	(dec)				
			2 = kVA 3 = ABSOLUTE kvar 4 = kW 5 = ABSOLUTE kW 6 = AVERAGE AMPS 7 = PHASE A AMPS 8 = PHASE B AMPS 9 = PHASE C AMPS 10 = AVERAGE VOLTS 11 = PHASE A VOLTS 12 = PHASE B VOLTS 13 = PHASE C VOLTS 14 = MAX kW DEMAND 15 = MAX kvar DEMAND 16 = MAX kVA DEMAND 17 = kW DEMAND 18 = kvar DEMAND 19 = kVA DEMAND 20 = MAX PHASE A DEMAND 21 = MAX PHASE B DEMAND 22 = MAX PHASE C DEMAND 23 = PHASE A DEMAND 24 = PHASE B DEMAND 25 = PHASE C DEMAND 26 = NEUTRAL CURRENT 27 = FREQUENCY 28 = UNBALANCE (VOLT) 29 = UNBALANCE (AMP) 30 = kWH 31 = kvarH 32 = kvar 33 = Mvar 34 = MW			
44874	1309	4873	ANALOG OUTPUT #3 MIN	SEE APPENDIX B FOR RANGES		0
44875	130A	4874	ANALOG OUTPUT #3 MAX	SEE APPENDIX B FOR RANGES		1000
44876	130B	4875	ANALOG OUTPUT #3 FIXED	SEE APPENDIX B FOR RANGES		--
44877	130C	4876	ANALOG OUTPUT #4 TYPE 0 = FIXED LEVEL 1 = POWER FACTOR 2 = kVA 3 = ABSOLUTE kvar 4 = kW 5 = ABSOLUTE kW 6 = AVERAGE AMPS 7 = PHASE A AMPS 8 = PHASE B AMPS 9 = PHASE C AMPS 10 = AVERAGE VOLTS 11 = PHASE A VOLTS 12 = PHASE B VOLTS 13 = PHASE C VOLTS 14 = MAX kW DEMAND 15 = MAX kvar DEMAND 16 = MAX kVA DEMAND 17 = kW DEMAND 18 = kvar DEMAND 19 = kVA DEMAND	0 - 35	--	1

MTMPLUS Address Space / Memory Map (Revision 21E188B1.000)						
REGISTER ADDRESS			CONTENTS	RANGE	UNITS	DEFAULT
MODICON	(hex)	(dec)				
			20 = MAX PHASE A DEMAND 21 = MAX PHASE B DEMAND 22 = MAX PHASE C DEMAND 23 = PHASE A DEMAND 24 = PHASE B DEMAND 25 = PHASE C DEMAND 26 = NEUTRAL CURRENT 27 = FREQUENCY 28 = UNBALANCE (VOLT) 29 = UNBALANCE (AMP) 30 = kWH 31 = kvarH 32 = kvar 33 = Mvar 34 = MW			
44878	130D	4877	ANALOG OUTPUT #4 MIN	SEE APPENDIX B FOR RANGES		-100
44879	130E	4878	ANALOG OUTPUT #4 MAX	SEE APPENDIX B FOR RANGES		100
44880	130F	4879	ANALOG OUTPUT #4 FIXED	SEE APPENDIX B FOR RANGES		--

Analog Output Parameters

The following is a list of Analog Output parameters with their corresponding ranges:

PARAMETER	RANGE	SCALING FACTOR FOR SERIAL PORT
FIXED LEVEL	4-20mA / 0-1mA	4-20 = ×10mA 0-1 = ×100mA
POWER FACTOR	-0.00 - +0.00	×100
kVA	0 - 65000	×1
ABSOLUTE kVARS	0 - 65000	×1
kW	-32000 - +32000	×1
ABSOLUTE KW	0 - 65000	×1
AVERAGE AMPS	0 - 200%	×1
PHASE A AMPS	0 - 200%	×1
PHASE B AMPS	0 - 200%	×1
PHASE C AMPS	0 - 200%	×1
AVERAGE VOLTS	0 - 200%	×1
PHASE A VOLTS	0 - 200%	×1
PHASE B VOLTS	0 - 200%	×1
PHASE C VOLTS	0 - 200%	×1
MAX kW DEMAND	0 - 65000	×1
MAX kvar DEMAND	0 - 65000	×1
MAX kVA DEMAND	0 - 65000	×1
kW DEMAND	0 - 65000	×1
kvar DEMAND	0 - 65000	×1
kVA DEMAND	0 - 65000	×1
MAX AMP DEMAND A	0 - 11000	×1
MAX AMP DEMAND B	0 - 11000	×1
MAX AMP DEMAND C	0 - 11000	×1
AMP DEMAND A	0 - 11000	×1
AMP DEMAND B	0 - 11000	×1
AMP DEMAND C	0 - 11000	×1
NEUTRAL CURRENT	0 - 30000	×1
FREQUENCY	00.00 - 72.00	×100
UNBALANCE (VOLT)	0 - 100%	×1
UNBALANCE (AMP)	0 - 100%	×1
kWH	0 - 65000	×1
kvarH	0 - 65000	×1
kvar	-32000 - 32000	×1
Mvar	-1000 - 1000	×1
MW	-1000 - 1000	×1

NOTE: Due to the problem with -0 and +0 both existing for power factor, the value stored in the MTMPlus register will be the opposite of the value shown on the display. The following examples illustrate this:

The range -0.23 to +0.35 is required for analog output #4. The user must send the following values through the serial port. Min value -0.77 (opposite of -0.23). Max value +0.65 (opposite of +0.35).

PAGE 1:SETPOINT VALUES SETPOINT ACCESS		PAGE 2:SETPOINT VALUES CONFIGURATION		PAGE 3:SETPOINT VALUES ALARMS		PAGE 4:SETPOINT VALUES ANALOGS	
SETPOINT ACCESS CODE		PHASE CT PRIMARY CT PRI		UNDERVOLT. ALARM		ANALOG OUTPUT 1	
ENCRYPTED ACCESS CODE		PHASE VT RATIO :1		UNDERVOLT. TIME DELAY		CH1: 4mA EQUALS	
		VT NOMINAL SEC VOLTAGE		OVERVOLT. ALARM		CH1: 20mA EQUALS	
		kW DEMAND PERIOD		OVERVOLT. TIME DELAY		ANALOG OUTPUT 2	
		kvar DEMAND PERIOD		PF LEAD ALARM		CH2: 4mA EQUALS	
		kVA DEMAND PERIOD		PF LAG ALARM		CH2: 20mA EQUALS	
		AMPS DEMAND PERIOD		PF ALARM TIME DELAY		ANALOG OUTPUT 3	
		COMMUNICATIONS AT		POSITIVE kvar ALARM		CH3: 4mA EQUALS	
		COMMUNICATIONS ADDRESS		NEGATIVE kvar ALARM		CH3: 20mA EQUALS	
		ALARM LATCH/UNLATCHED		kvar ALARM DELAY		ANALOG OUTPUT 4	
		ALARM FAILSAFE/ NON-FAILSAFE		CURRENT ALARM		CH4: 4mA EQUALS	
		ZERO VOLTS ALARM DETECT		CURRENT ALARM DELAY		CH4: 20mA EQUALS	
		VOLTAGES WIRED AS		UNDER FREQUENCY ALARM			
		COMPUTE THD?		UNDER FREQUENCY DELAY			
		SWITCH A&B CONFIG		OVER FREQUENCY ALARM			
		PULSE OUTPUT VARIABLE		OVER FREQUENCY DELAY			
		PULSE OUT EVERY		POSITIVE POWER ALARM			
		SAMPLING FREQUENCY		NEGATIVE POWER ALARM			
				POWER ALARM DELAY			
				kW MAX DMND ALM LEVEL			
				var MAX DMND ALM LEVEL			
				kVA MAX DMND ALM LEVEL			

PAGE 1:SETPOINT VALUES SETPOINT ACCESS	PAGE 2:SETPOINT VALUES CONFIGURATION	PAGE 3:SETPOINT VALUES ALARMS		PAGE 4:SETPOINT VALUES ANALOGS
		AMP PK DMND ALM LEVEL		
		UNBALANCE (VOLT) ALARM		
		UNBALANCE (VOLT) DELAY		
		UNBALANCE (AMP) ALARM		
		UNBALANCE (AMP) DELAY		
		NEUTRAL CURRENT ALARM		
		NEUTRAL CURRENT DELAY		
		VOLTAGE PHASE REVERSAL		
		COMM FAIL ALARM		
		SWITCH A ALARM DELAY		
		SWITCH B ALARM DELAY		

MTM Plus Do's and Don'ts Checklist

This is a quick check list for the proper installation of an MTM Plus. In order for the MTM Plus to operate effectively, the following steps should be taken into consideration where applicable:

- ***SYSTEM GROUND (terminal #1)***

Terminal #1 MUST be solidly grounded at one location. The main GROUND BUS is a preferred location.

Following this practice will keep all circuits properly referenced to ground.

If terminal #1 is not grounded, the communications network may not operate effectively.

- ***PHASE CT GROUNDING (terminals #6, #9, #12)***

The phase CT 'com' inputs for the MTM Plus, must be grounded preferably near the external current transformers and only at one point. If the CT is grounded at more than one point, stray currents may circulate through the ground loop created.

The ground prevents high voltages from being coupled onto an ungrounded system. Note that between the primary and the secondary sides of the transformer and between the secondary and ground, capacitive coupling may occur.

- ***SERIAL COMMUNICATION PORT (terminals #15, #16, #17)***

When linking the MTM Plus with a master computer, the cable shield must only be connected at the master computer. When linking multiple MTM Plus's, a daisy chain link must be incorporated. The "+" terminal must be connected to the "+" terminal of any other item in the link, and likewise for the "-" terminal.

***NOTE: If you are using a Multilin RS232/RS485 convertor that has no ground terminal, the shield must then be connected to only the first MTM Plus in the link.**

If the MTM Plus is being linked with a Multilin 269 Motor Protection Relay or a Multilin 565/575 Feeder Management Relay, the shield must only be connected to terminal #17 of the MTM Plus.

- ***EXTERNAL POTENTIAL TRANSFORMERS***

The external PTs, regardless of the wiring configuration being used, must be wired in phase. All this basically means is that H1-H2 must be transformed into X1-X2 and not X2-X1. If the H1-X1 methodology is not followed, the calculations will be untrue.

- ***PHASE SEQUENCE***

The phase sequence must be the same for both the phase voltages and the phase currents, that is, A-B-C voltages and A-B-C currents.

Before commissioning an MTM Plus, it is important to verify that the voltages and the currents are wired in phase. The most noticeable symptom of improper phase wiring, is the appearance of a low power factor reading.

Troubleshooting Guide

The troubleshooting guide is a list of some questions that have been asked at some time or other by users of the MTM Plus.

QUESTION	ANSWER
Phase currents display 0 amps?	• Current may be below the minimum operating range of 3.6% of CT. Mod #500 operates from 1.2% of CT to 100% of CT. • CT terminals are not connected.
Phase voltages display 0 volts?	• Voltages may be below the minimum operating range of 20% of PT.
kW reading is very low?	• Currents and/or voltages are not in correct phase sequence.
kvar reading is very high?	• Currents and/or voltages are not in correct phase sequence.
Incorrect power factor reading?	• Currents and/or voltages are not in correct phase sequence
Do the kWH and kvarH decrease in value when operating in the opposite direction?	• No. The energy used displayed is an absolute value, therefore, regardless of the direction of flow, the energy will always accumulate. • Mod #502 shows the directional kWH but no kvarH. If power is flowing in a positive direction, then “+ve kWH” will increase and “–ve kWH” will not increment. If power is flowing in a negative direction, then “–ve kWH” will increase and “+ve kWH” will not increment.
Communication failure?	• Baud rate and/or slave address not correct. • The shield is not connected at the master computer only. • Reverse polarity at the terminals. • Broken wire in the link. Check for continuity. • Terminal #1 is not grounded.
Communication respond with an illegal address when trying to communicate?	• The register address requested is in an undefined region as shown in Appendix A. • The register address offset for the Modbus® protocol is $40001 as shown in Appendix A. Example: for phase A current, use $40257.
What is the maximum secondary inrush current allowed?	• An inrush of 20A into the meter is allowable.
What is a recommended relay for the pulse output?	• The G2R-14-12VDC is a recommended relay. It has a coil impedance of 276Ω. The pulse output circuit has a series resistance of 300Ω and a pulsed voltage of 24VDC. With this relay, the voltage appearing across the coil is ≈ 12 VDC.
Actual values line being displayed defaults to another line after 2 minutes.	• Select desired line, then press the STORE key twice. “NEW DEFAULT LINE SELECTED” should be momentarily displayed.
Analog output appears to operate too low?	• Ensure that the load impedance does not exceed 600Ω.
For a 269/MTM Plus link, the phase currents differ?	• Ensure that the same CTs are used for both products in a series connection.

#

2 input wye 2-7, 3-9
269/565 3-8

A

abbreviations. *See* setpoints: abbreviations
active power 3-21
actual values 3-21. *See also* keypad: actual values
  message abbreviations 3-20
  message overview 3-18
address. *See* communications: address
alarm. *See* LED indicators: alarm
alarm features 3-26
alarm relay 3-8
amps demand alarm 3-13
analog outputs 2-1, 3-15, 3-27, 4-1
apparent power 3-21
average phase current 4-1

B

baud. *See* communications: baud
breaker status 3-9

C

clear demand 3-7
clear kvarH and kWH 3-8
communications
  address 3-8
  baud 3-8
  failure alarm 3-14
  port 2-1
contrast control 2-2
CT connection 2-10
current demand 3-22
current demand measurement 3-7
current transformer 2-1

D

default display 3-2
demand 3-21
demand features 3-26
demand values 3-26
directional power 3-26

E

encrypted access code 3-6

F

failsafe 3-8, 3-26
firmware revision 3-6
frequency 3-21. *See also* sampling frequency

G

ground 2-1

I

induction motors 3-26

K

keypad 3-1
  actual values 3-1
  line up 3-2
  page up 3-1
  reset 3-1
  setpoints 3-1
  store 3-2
  value down 3-2
  value up 3-2
kilova demand measurement 3-7
kilovar demand measurement 3-7
kilowatt demand measurement 3-7
kVA demand alarm 3-12
kvar alarm 3-11
kvar demand alarm 3-12
kvars 4-1
kW demand alarm 3-12
kwatts 4-1

L

lagging 3-10
latched 3-8
leading 3-10
LED indicators 3-2
  alarm 3-26
line up. *See* keypad: line up

M

megavarhours 3-21
megawatthours 3-21
modbus RTU 3-8
mounting 2-1

N

neutral current 3-21, 3-27
  alarm 3-13
nominal secondary voltage 3-7
non-failsafe 3-8, 3-26

O

open delta 2-6, 3-9
output relay 2-1, 3-26
overcurrent alarm 3-11
overfrequency alarm 3-12
overvoltage alarm 3-10

P

page up. *See* keypad: page up
phase angle 4-1
phase currents 3-21
phase reversal alarm 3-13, 3-26
phase sequence 3-26

phase voltages 3-21
phase voltages and current functions 4-1
port. *See* communications: port
power 2-1
power alarm 3-12
power factor 3-21, 4-1
  lag alarm 3-10
  lead alarm 3-10
power functions 4-1
primary amps rating 3-7
primary injection testing 4-1
pulse output 2-1, 3-9, 4-3

R

reactive power 3-21
reset. *See* keypad: reset

S

sampling frequency 3-9
secondary injection testing 4-1
setpoint access 3-6
setpoints 3-6. *See also* keypad: setpoints
  abbreviations 3-5
  message overview 3-3
setpoints messages 3-6
store. *See* keypad: store
switch A&B configuration 3-9
switch A alarm 3-14
switch B alarm 3-14
switch inputs 2-1, 4-3
switches 3-9

T

technical specifications 1-2
testing
  primary injection 4-1
  secondary injection 4-1
total harmonic distortion 3-9, 3-22, 3-28

U

unbalance 3-13, 3-27
underfrequency 3-8
  alarm 3-11
undervoltage 3-8, 3-27
  alarm 3-10
unlatched 3-8

V

value down. *See* keypad: value down
value up. *See* keypad: value up
vars 3-21
vector addition 3-27
voltage transformer 2-1
  ratio 3-7

W

watts 3-21
wiring 2-1
wye/delta 2-8

Z

zero volts alarm 3-8

LIST OF FIGURES

Figure 2.1 Serial Communication Link 2-1
Figure 2.2 Mounting Details 2-3
Figure 2.3 Physical Dimensions 2-4
Figure 2.4 MTM Plus Power Configuration Selection 2-5
Figure 2.5 Typical Wiring (Open Delta) 2-6
Figure 2.6 Typical Wiring (2 Input Wye) 2-7
Figure 2.7 Wye/Delta Connection 2-8
Figure 2.8 3 Phase VT Module Wye/Delta Connection 2-9
Figure 2.9 2 CT Connection 2-10
Figure 2.10 Terminal Layout 2-11
Figure 3.1 Directional Power 3-27

INTENT

This manual describes the function, operation and use of the Multilin Model MTM Plus Meter Transducer Module.

REVISION HISTORY

Manual Part No.	Software Revision	Release Date
Revision A1	Revision D1	
Revision A2	Revision D1.1	
Revision A3	Revision D1.2	
1601-0022-D1	Revision MTM.D1.3	03/18/92
1601-0022-D2	Revision MTM.D1.4	04/14/92
1601-0022-D3	Revision MTM.D1.4	08/13/92
1601-0022-D4	Revision MTM.D1.5	10/26/92
1601-0022-D5	Revision MTM.D1.6	01/27/93
1601-0022-E1	Revision MTM.E1.7	03/29/93
1601-0022-E2	Revision MTM.E1.8	08/30/93
1601-0022-E3	Revision MTM.E1.8	09/28/93
1601-0022-E4	Revision MTM.E1.81	03/16/94
1601-0022-E5	Revision MTM.E1.82	07/25/94
1601-0022-E6	Revision MTM.E1.83	08/23/94
1601-0022-E7	Revision MTM.E1.84	09/30/94
1601-0022-E8	Revision MTM.E1.85	03/16/95
1601-0022-E9	Revision MTM.E1.85	04/26/95
1601-0022-EA	Revision MTM.E1.86	05/10/95
1601-0022-EB	Revision MTM.E1.86	09/12/95
1601-0022-EC	Revision MTM.E1.87	11/08/95
1601-0022-ED	Revision MTM.E1.88	02/14/96

MULTILIN RELAY WARRANTY

Multilin warrants each relay it manufactures to be free from defects in material and workmanship under normal use and service for a period of 24 months from date of shipment from factory.

In the event of a failure covered by warranty, Multilin will undertake to repair or replace the relay providing the warrantor determined that it is defective and it is returned with all transportation charges prepaid to an authorized service centre or the factory. Repairs or replacement under warranty will be made without charge.

Warranty shall not apply to any relay which has been subject to misuse, negligence, accident, incorrect installation or use not in accordance with instructions nor any unit that has been altered outside a Multilin authorized factory outlet.

Multilin is not liable for contingent or consequential damages or expenses sustained as a result of a relay malfunction, incorrect application or adjustment.