



Powering Business Worldwide

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## MP-4000 Motor Protection Relay

Instruction Bulletin for Installing, Operating, and Maintaining the Eaton MP-4000 Motor Protection Relay



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## SECTION 1 - INTRODUCTION

### 1.0 General

The MP-4000 is an advanced microprocessor-based motor protection relay that is easy to set up and use. It monitors, controls, and protects motors against overload, thermal damage to rotor or stator, electrical faults, and excessive starting, and many process equipment failures. Advanced algorithms and thermal models give safe operation over a wide range of conditions.

The MP-4000 protects 50 or 60 Hz three-phase motors of any size or voltage level. It can protect induction or synchronous motors, with or without RTDs. It is frequently installed in motor starters or switchgear.

The MP-4000 Motor Protection relay provides the following protection, alarm, and control functions. ANSI device numbers are in parentheses.

#### Protection

- Intel-I-Trip I2t overload protection (49/51)
- Locked rotor protection (49S/51)
- Ultimate trip current (51)
- Negative sequence current/phase unbalance and reverse phase protection (46)
- Instantaneous overcurrent trip (50)
- Ground fault protection (50G)
- RTD trip with accessory URTD module (49/38)
- Underload trip power and current (37)
- Phase unbalance (47)
- Under voltage (27)
- Over voltage (59)
- Over and under frequency (81)
- Power factor (55)
- Starts per time limit (66)
- Jam or stall trip (51R)
- Zero speed switch trip (14)
- I2t auto or manual reset (86)
- Fail-safe or non-fail-safe trip modes
- Current unbalance (46)
- Voltage unbalance (47)

#### Alarming

- Ground fault
- I2t overload
- Jam / stall
- Underload
- Phase unbalance
- RTD temperature with URTD module
- Power factor under and over voltage
- Under and over frequency
- Under power

#### Control Features

- Transition control for reduced voltage starters
- Incomplete sequence (process feedback) detection and trip
- Permits User-set number of cold starts
- Limits number of starts per time
- User sets minimum time between starts
- Antibackspin (time from stop to next start) delay
- Current-based process load shedding and restoration
- Long acceleration timing feature
- Motor stop input for synchronous motor and condenser applications
- Remote trip input
- Differential trip input
- Emergency override clears blocks to motor restarting (if enabled)

- Program settings while motor runs, with controlled change-over (if enabled)
- Disarmed mode for commissioning and checking in a running process.

### 1.1 Replacing the IQ 1000 II or MP-3000 with the MP-4000

The MP-4000 Motor Protection Relay serves as a direct replacement for the prior-generation Westinghouse or Cutler-Hammer IQ 1000 II or MP-3000. The cutout and mounting are compatible. The relay terminal configuration and wiring connections are similar. When replacing the IQ 1000 II or MP-3000 with the MP-4000, additional terminals are provided for voltage inputs.



#### CAUTION

**TERMINAL 6 (SEE FIGURE 6.3) WAS REMOTE COMMON IN THE IQ1000II. THIS TERMINAL PROVIDED A CONNECTION TO NEUTRAL IF 120 VAC CONTROL POWER WAS USED, AND A 120 VAC SOURCE IF 240 VAC CONTROL POWER WAS USED. THE IQ1000 II HAD A FACTORY INSTALLED JUMPER BETWEEN TERMINAL 6 AND TERMINAL 9 - THE COMMON RETURN OF THE DISCRETE INPUT CHANNELS. DO NOT INSTALL THIS JUMPER ON THE MP-4000. THE MP-4000 USES TERMINAL 6 FOR DISCRETE SOURCE AND IT IS A CONNECTION TO 120 VAC IN BOTH CASES OF 120 VAC AND 240 VAC CONTROL POWER USE. REFER TO SECTION 6, INSTALLATION AND WIRING FOR PROPER WIRING OF THE DISCRETE INPUTS.**

### 1.2 MP-4000 Features and Enhancements

The MP-4000 Motor Protection Relay incorporates the field proven motor thermal models and sequence component measurement techniques that were pioneered in the MP-3000 and IQ 1000 II relay thermal models. The MP-4000 also adds several enhancements. Significant enhancements and features include:

1. Phase voltage monitoring and protection (new for MP-4000).
2. Power and Power Factor monitoring and protection (new for MP-4000).
3. Frequency monitoring and protection (new for MP-4000).
4. Optional Quick Release Drawout Case that makes removal and replacement fast and easy.
5. New Armed/Disarmed feature for trip-free installation with Quick Release Drawout Case.
6. User selectable trip or alarm only on relay internal failure detection.
7. Real time clock for date and time stamping of trips, alarms, and events (Y2K compliant).
8. Expanded memory for extensive recording and logging of events, trips, alarms, history, and motor starting current profiles.
9. Motor starting profile plot versus protection limits.
10. Easy-to-use faceplate and User interface. Settings and data are organized into pages under six main modes. The modes are Default (motor state), Monitor, View Settings, History, Logs, and Program (change settings).
11. **Intel-I-Trip** Intelligent Overload Protection with adaptive trip characteristics based on RTD readings and motor operating history.

- 12. RTD diagnostics and communications error checking for additional security against operation from RTD failures.
- 13. Mechanical Process Load Shedding feature provides overload indication to control upstream processes, averting unnecessary motor overload shutdown or jam trips, and maintaining process continuity.
- 14. Download settings or retrieve metered and historical values via the communications port.
- 15. Flexible User-configurable inputs and outputs for broader application.
- 16. Options for transition function control and monitoring on time and/or current.
- 17. Emergency override function resets jogging limit functions and clears thermal-model bucket to permit restart with a time-tagged event log. Unit uses a secured button; this function can be disabled.
- 18. MP-4000 can be programmed while the motor runs, and new settings are all put into effect at once in a controlled fashion. Or, the User can set the unit so programming is allowed only after motor stop.

**1.3 Use of This Manual**

This manual contains the following sections:

- Section 1 - Introduction - Describes the upgrade changes from the existing MP-3000 to the MP-4000 including retrofit and new features list.
- Section 2 - Product Overview - Includes benefits, feature list, use of manual, and list of options.
- Section 3 - Specifications - Provides hardware specifics
- Section 4 - Operator Panel - Describes the pushbuttons, LEDs, display window, and security door on the MP-4000's faceplate plus the different modes of operation and detailed mode description tables.
- Section 5 - Programming the MP-4000 - Gives specific guidance for selecting and setting values.
- Section 6 - Installation and Wiring - Outlines procedures for the plant electrician to follow when installing and wiring the MP-4000.
- Section 7 - Start-Up - Lists step-by-step procedures for energizing the MP-4000 for the first time after installation.

- Section 8 - Motor Thermal Protection Basics—Gives an overview of how the hardware and software function together to control, monitor, and protect the motor.
- Section 9 - Application and Settings - Is intended as an aid to the application engineer considering how and when to apply the various features of the MP-4000.
- Section 10 - Data Communications - Describes what is needed for the MP-4000 to communicate with host computer systems.
- Section 11 - Testing - Describes how to use the MP-4000 test functions and details recommended maintenance.
- Section 12 - Troubleshooting - Provides information on how to use the Operator Panel to recognize malfunctions. Also, gives specific troubleshooting procedures.
- Section 13 - Drawout Case Option - Describes installing and using MP-4000 drawout case models.

Once the User is familiar with the basics of operating the MP-4000, Tables 4.1 through 4.5 can be used as guides to program and monitor the MP-4000.

The following accessories and options are covered in other instruction manuals:

URTD module for connecting RTDs to the MP-4000 <sup>(1)</sup>	I.L. 17367
IQ DC Power Supply, 100-150 Vdc	I.L. 17286
INCOM PONI (IPONI)	I.L. 17547
Ethernet PONI (EPONI)	I.L. 17560
Other PONI Types	Consult Eaton distributor or Eaton.com website
DPONI Types	I.L. 17559

<sup>(1)</sup> This MP-4000 Instruction Manual (IM) gives all basic information on installing the URTD module.

**NOTE:** Some manuals will be supplied electronically on the CD shipped with the MP-4000.



**Table 1.2 MP-4000 Motor Protection Relay Ordering Information.**

Catalog Number	Description	Style Number
MP4010	Fixed Case, 5A CT	66D2206G01
MP4010INCOM	Fixed Case, 5A CT, with INCOM Communications	66D2206G02
MP4010MODBUS	Fixed Case, 5A CT, with Modbus Communications	66D2206G03
MP4010DEVICEN	Fixed Case, 5A CT, with DeviceNet Communications	66D2206G04
MP4110	Fixed Case, 1A CT, Communications Capable with PONI	66D2206G05
MP4110INCOM	Fixed Case, 1A CT, with INCOM Communications	66D2206G06
MP4110MODBUS	Fixed Case, 1A CT, with Modbus Communications	66D2206G07
MP4110DEVICEN	Fixed Case, 1A CT, with DeviceNet Communications	66D2206G08
MP4011	Drawout Case, 5A CT, No Communications	66D2209G01
MP4012	Drawout Case, 5A CT, with INCOM Communications	66D2209G02
MP4013	Drawout Case, 5A CT, with Modbus Communications	66D2209G03
MP4014	Drawout Case, 5A CT, with DeviceNet Communications	66D2209G04
MP4111	Drawout Case, 1A CT, No Communications	66D2209G05
MP4112	Drawout Case, 1A CT, with INCOM Communications	66D2209G06
MP4113	Drawout Case, 1A CT, with Modbus Communications	66D2209G07
MP4114	Drawout Case, 1A CT, with DeviceNet Communications	66D2209G08
MP4010VPI	Fixed Case, 5A CT, with INCOM, URTD and FOC	66D2143G11
MP4010VPM	Fixed Case, 5A CT, with Modbus, URTD and FOC	66D2143G12
MP4010VPD	Fixed Case, 5A CT, with DeviceNet, URTD and FOC	66D2143G13
MP4110VPI	Fixed Case, 1A CT, with INCOM, URTD and FOC	66D2143G14
MP4110VPM	Fixed Case, 1A CT, with Modbus, URTD and FOC	66D2143G15
MP4110VPD	Fixed Case, 1A CT, with DeviceNet, URTD and FOC	66D2143G16

**Table 1.3 MP-4000 Motor Protection Relay Accessories.**

Catalog Number	Description	Style Number
URTD Module	Universal RTD Module	2D78559G01
IQDCPS	IQ DC dc to ac power supply converter, 100 - 150 Vdc	66C2462G01
MPFO-1	1 Meter precut optical fiber link for URTD with connectors	66D2037G01
MPFO-5	5 Meter precut optical fiber link for URTD with connectors	66D2037G02
MPFO-10	10 Meter precut optical fiber link for URTD with connectors	66D2037G03
MPFO-25	25 Meter precut optical fiber link for URTD with connectors	66D2037G04
MPFO-50	50 Meter precut optical fiber link for URTD with connectors	66D2037G07
MPFO-75	75 Meter precut optical fiber link for URTD with connectors	66D2037G10
MPFO-76	76 Meter precut optical fiber link for URTD with connectors	66D2037G11
MPFO-100	100 Meter precut optical fiber link for URTD with connectors	66D2037G13
MPFO-120	120 Meter precut optical fiber link for URTD with connectors	66D2037G14
MP3BRACKET	PONI Mounting Bracket	66D2053G01
MPML	Relay mounting plate adapter with 0.50 in. Stud - fits GE Multilin® 269 cutout	66D2044G01
MPML-L	Relay mounting plate adapter with 1.0 in. Stud - fits GE Multilin® 269 cutout	66D2044G02
EPONI	Ethernet communications module	66D2028G01
EPONIF	Ethernet optical fiber communications module	66D2028G02
IPONI	INCOM communications module	8793C36G03
DPONI	Data communications module	6D2132G01
RS-485 PONI	Modbus RTU communications module	66D2042G01
MD3000	Motor/Generator Differential Relay Fixed Case	66D2126G01
MD3000	Motor/Generator Differential Relay Drawout Case	66D2127G01

**Table 1.4 MP-4000 Renewal Parts.**

Catalog Number	Description	Style Number
MP4011-IC	MP-4011 Inner Chassis, 5A CT, No Communications	66D2210G11
MP4012-IC	MP-4012 Inner Chassis, 5A CT, with INCOM Communications	66D2210G12
MP40013-IC	MP-4013 Inner Chassis, 5A CT, with Modbus Communications	66D2210G13
MP4014-IC	MP-4014 Inner Chassis, 5A CT, with DeviceNet Communications	66D2210G14
MP4111-IC	MP-4111 Inner Chassis, 1A CT, No Communications	66D2210G15
MP4112-IC	MP-4112 Inner Chassis, 1A CT, with INCOM Communications	66D2210G16
MP4113-IC	MP-4113 Inner Chassis, 1A CT, with Modbus Communications	66D2210G17
MP4114-IC	MP-4114 Inner Chassis, 1A CT, with DeviceNet Communications	66D2210G18
MP4X11-OC	MP-4XXX Outer Chassis, for Use with No Communications or INCOM Communications Inner Chassis	66D2139G01
MP4X13-OC	MP-4XXX Outer Chassis, for Use with Modbus Communications Inner Chassis	66D2139G02
MP4X14-OC	MP-4XXX Outer Chassis, for Use with DeviceNet Communications Inner Chassis	66D2139G03

## SECTION 2 - PRODUCT OVERVIEW

### 2.0 General Overview

The MP-4000 Motor Protection Relay is available in either a fixed mount, semi-flush case, or in a semi-flush, Quick Release drawout case. Both housings are compact and fit a standard IQ cutout.

The optional Quick Release drawout case features 2-stage contact disconnects and self-shorting current transformer (CT) circuit terminal blocks. The optional communications modules (PONIs) are externally mounted on the fixed mount case and internally mounted in the drawout case.

The MP-4000 has 3-phase current inputs and one ground current input. Both 5 A and 1 A versions are available. The ground protection and metering functions are best used with a zero-sequence ground CT, rather than from the residual connection of the phase CTs. The zero-sequence ground CT provides greater ground fault sensitivity. The unit is User-programmable for 60 Hz or 50 Hz operation.

The MP-4000 has 3-phase voltage inputs and one ground voltage input. The ground input must be earth-grounded. The voltage inputs are User-programmable for 50 or 60 Hz.

The MP-4000 has two discrete inputs, four form C (1 N.O. and 1 N.C.) output contacts, and one 4 to 20 mA analog output. The relay lets the User program the operation of all the I/O points, except for the trip output. In addition, the relay has ten LEDs for the indication of protection on, program mode, monitor mode, view setting mode, history mode, log mode, trip, alarm, and Aux 1 and Aux 2 output relay operation. A test page in the program mode provides a display indication of the discrete input states and testing of the output relays, target LEDs, and analog output circuit.

A User-friendly operator interface provides quick access to the settings, monitored values, motor history, and operational logs. A large LED alphanumeric display provides easy viewing from any angle. Simple keypad operations provide quick and easy navigation through all settings and stored data. The program mode and emergency override buttons are access restricted via a seal and latched cover. An integrated context-sensitive help button provides an online descriptive display of functions, abbreviations, and operations.

### 2.1 Optimum Motor Protection

The MP-4000 Motor Protection Relay has been designed for maximum motor utilization and protection. It is desirable to run the motor as close as possible to its design limits, while protecting it against excessive heating and damaging overload conditions. The MP-4000 has field-proven protection algorithms developed from basic motor design principles and operating parameters.

The MP-4000 protects against rotor and stator overheating, short circuits or insulation faults, excessive starting duty, and abnormal operating conditions.

#### 2.1.1 Intel-I-Trip (Adaptive I<sup>2</sup>t Motor Overload Protection)

Motor operation is typically limited by the rotor thermal capabilities, but the measuring quantities are stator currents. This requires accurate measurements and good motor thermal models to provide maximum utilization and reliable protection.

The MP-4000 uses the field-proven Intel-I-Trip overload measurement and motor thermal protection model that uses the manufacturer's nameplate data to develop an overload protection curve specifically for the motor being protected. When RTDs are used, the Intel-I-Trip over-

load protection curve becomes adaptive. The overload trip times will change based on the modeling impact of the motor's internal temperature data. It also trips directly for high stator temperature.

The relay samples the current waveforms 36 times per cycle providing accurate measurements of the positive and negative sequence currents, as well as harmonic components that add to rotor and stator heating. The negative sequence component of current causes far greater heating effect on the rotor and has a greater impact on the thermal model in the relay, as compared to the balanced or positive sequence component.

#### 2.1.2 Instantaneous Overcurrent Protection

The MP-4000 has an instantaneous phase overcurrent function to trip the motor for fault currents, sometimes saving the fuses for medium-current faults. This function can be disabled and has an adjustable start time delay on starting to avoid nuisance tripping on inrush.

#### 2.1.3 Phase Current Unbalance Protection

Motor supply circuits are often fed through fuses and may be energized with one fuse blown, causing single phasing of the motor. The MP-4000 measures the current unbalance and can be used to alarm or trip the motor before heating and a thermal-model trip. Pickup, start and run timers, and separate alarm settings are provided.

#### 2.1.4 Ground Fault Protection

A separate monitoring circuit is used to measure ground current. A zero sequence ground CT is recommended for more sensitive protection against winding insulation failure to ground. The relay ground CT input can be connected residually from the three phase CTs, but with much inferior protection sensitivity. The ground fault protection has adjustable pickup and time delay setpoints, and it can be disabled.

#### 2.1.5 Jam Protection

The User-selectable Jam function protects motors that are running against a sudden mechanical jam or stall condition. The common application is on motors used on crushers, chippers, or conveyors. It detects an increase of motor current to a level above full load. Pickup, start and run timers and a separate alarm setting are provided.

#### 2.1.6 Underload Protection

The User-selectable underload function is used to detect the loss of load on the motor. Coupling failure is a common cause for loss of load. Pickup, start and run timers, and a separate alarm setting are provided.

#### 2.1.7 Remote and Differential Trip

One of the discrete inputs can be programmed to accept a contact input from a separate differential relay or other device to trip the motor. This provides local and remote target (logging) information, and utilizes the trip contacts of the MP-4000. It also records and logs the motor information at the time of the trip. For differential tripping, the Eaton MD-3000 is recommended.

#### 2.1.8 Zero Speed Switch Trip

One of the discrete inputs can be programmed to accept a contact input from a zero speed switch connected to the motor shaft. This provides faster tripping for a motor that remains completely stalled when energized for a start. It provides backup protection for motors with long acceleration timing.

### 2.1.9 Under and Over Voltage Protection

The MP 4000 has under (27) and over (59) voltage protection. Under and over voltage protection have separate start delays to prevent nuisance tripping during startup. Separate alarm functions are also provided.

#### 2.1.10 Under Power Protection

The MP 4000 has under power (32) protection. Trip, start and run timers, and a separate alarm threshold setting are provided.

#### 2.1.11 Power Factor

The MP-4000 has power factor (55) protection. Separate setpoints are provided for leading and lagging power factors. For both leading and lagging power factors, threshold settings are provided. The start and run timers are shared by both leading and lagging, while the threshold settings are distinct. A separate alarm threshold setting is provided.

## 2.2 Motor Starting and Control Functions

The MP-4000 Motor Protection Relay includes logic to control the number of starts that can occur on the motor in a given time period for cold and hot motor conditions. Settable timers are provided to control the time between starts and to restart a motor after a stop. Additional logic is included for transition control of reduced-voltage starters.

### 2.2.1 Start Control Timers

Motors typically have limits on the number of cold starts, starts per time period, and time between starts that are permitted without damage. The MP-4000 incorporates these checks to prevent excessive starting of the motor.

### 2.2.2 Reduced Voltage Starting

The MP-4000 provides transition and incomplete sequence detection function for reduced voltage starting. The User can select to transition based on four logical combinations of starting current and time sequence. The incomplete sequence function can be used independently for feedback indication from the process to trip the motor if expected action does not occur.

### 2.2.3 Anti-backspin Timing

For certain applications, such as pumping a fluid up a pipe, the motor may be driven backward for a period of time after it stops. The MP-4000 provides an anti-backspin timer (minimum time between stop and restart) to prevent starting the motor while it is spinning in the reverse direction. The relay displays the timer countdown from the moment a stop is declared by the relay.

### 2.2.4 Load Shedding

The MP-4000 provides a mechanical load shedding feature that can be used to control the driven process. The load shedding function closes a contact on an overload condition to stop addition of load until the overload condition subsides by a set amount. Then the load shedding contact opens and the load is restored.

### 2.2.5 Emergency Override

The MP-4000 has a User-programmable feature that lets the operator reset certain trip conditions, including the jogging timers and thermal-model overload bucket. This function is for use in emergency conditions only and may result in motor damage or failure. The override action is logged with time-tag. The pushbutton is located behind a security door. The function can be disabled.

### 2.2.6 Long Acceleration Motors

Large motors with high inertia loads, such as centrifuges and large fans, may experience starting currents that greatly exceed the full load current for greater than the locked rotor time. The MP-4000 has a timing feature that holds off thermal tripping during the long acceleration. This should be used with a zero speed switch input.

### 2.2.7 Motor Starting Profile

The MP-4000 records the average current and voltage versus time for the last four starting cycles. This information is available via the communications port. The PowerNet host plots the motor current versus the motor cold-start protection curve, as shown in Figure 2.1.

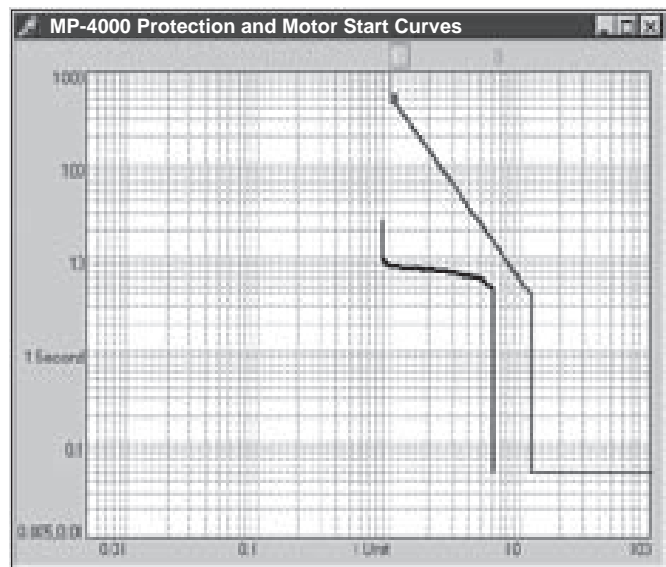


Figure 2.1 Motor Starting Profile

## 2.3 User Interface

The MP-4000 Motor Protection Relay has a User-friendly interface that makes it easy to retrieve important information or to make setting changes. LEDs provide visual indication of display mode. The pushbutton access scheme is easy to learn, and quickly accesses the large volumes of setting, monitoring, logging, and historical information.

The User may also access settings via the front panel RS-232 port. The JTAG port is for factory use only.

**SECTION 3 - MP-4000 TECHNICAL SPECIFICATIONS****Control Power**

Nominal Voltage:	120 Vac or 240 Vac (+10%, -25%)
Operating Range:	120 Vac: 90 - 132 Vac 240 Vac: 180 - 264 Vac
Interruption Ride Through Time:	Complete drop of power for minimum of 13 cycles at nominal 60 Hz control power voltage, and 11 cycles at nominal 50 Hz control power voltage.
Frequency:	60 Hz nominal, 57-63 Hz 50 Hz nominal, 47-53 Hz
Power Consumption:	24 VA max URTD: 6 VA max. IPONI: 1 VA max.

**Current Inputs**

Nominal ( $I_n$ ):	1 A or 5 A
CT Rating:	2 x $I_n$ continuous 50 x $I_n$ for 1 sec.
CT Burdens:	< 0.25 VA @ 5 A (nominal) < 0.05 VA @ 1 A (nominal)

**Voltage Inputs**

Nominal:	120 Vac
Range:	69-150 Vac

**Metering Accuracy**

Phase Current Accuracy:	$\pm 1\%$ of $I_n$ (from 0 to $I_n$ A) $\pm 1\%$ of reading (from $I_n$ to $10I_n$ A)
Ground Current Accuracy:	$\pm 1.5\%$ of $I_n$ (0 to 55% of $I_n$ A) $\pm 2\%$ of $I_n$ (55% $I_n$ to $I_n$ A) $\pm 2\%$ of reading (from $I_n$ to 4 $I_n$ A)
Phase Voltage Accuracy:	$\pm 1\%$ of reading, 3 V min.
Phase Angle Accuracy:	$\pm 1^\circ$ of reading ( $P_f = 1$ )
Power Accuracy:	$\pm 5\%$ of reading ( $0.5 < P_f < 1$ )

**Discrete Inputs**

Number of inputs:	2 programmable
Rating:	1.2 VA @ 120 Vac Max. off = 36 Vac Min. on = 86 Vac

**Output Contacts**

Number of Outputs:	4 form C, programmable
Momentary:	Make 30 A ac/dc for 0.25 sec. Break 0.25 A @ 250 Vdc (resistive) Break 5 A @ 120/240 Vac
Continuous:	5A @ 120/240 Vac 5A @ 30 Vdc

**Analog Output**

Rating:	$\pm 4$ to 20 mA, programmable
Max Load:	1 kilohm
Accuracy:	1%

**Motor Overload Protection (I<sup>2</sup>t)**

Full Load Amps:	10 to 3,000 A
Locked Rotor Current:	300 to 1,200% FLA
Locked Rotor Time:	1 to 120 sec.
Ultimate Trip Current:	85 to 150% FLA
Phase CT Ratio:	10 to 4,000: $I_n$
Ground CT Ratio:	10 to 4,000: $I_n$
Timing Accuracy:	The greater of $\pm 2.5\%$ or $\pm 100$ ms for current > 1.1 X UTC

**Trip Setting Ranges**

Ground Fault (GF):	Off, 2% to 55% of CT ratio primary
GF Start Delay:	2 to 60 cycles
GF Run Delay:	0 to 60 cycles
Timer Accuracy:	$\pm 2.5$ cycles, -1/2 cycle
Instantaneous Overcurrent:	Off, 300 to 1,600% FLA
IOC Start Time Delay:	2 to 60 cycles
Timer Accuracy:	$\pm 2.5$ cycles, -1/2 cycle
Jam Trip:	Off, 100 to 1,200% FLA
Underload Trip:	Off, 6 to 90% FLA
Phase Unbalance Trip (I):	Off, $I_2/I_1 = 4$ to 40%
Start Delay Timers:	0 to 120 sec. - underload and phase unbalance 0 to 1,200 sec. - jam
Run Delay Timers:	0 to 240 sec.
Timer Accuracy:	$\pm .5\% + 250$ ms For phase unbalance, add 200 ms for zero setting For underload, add 480 ms for zero setting

**Phase Unbalance V**

Trip:	1 to 100 V, Off
Trip Run Delay:	1 to 480 sec., Off
Trip and Alarm Start Delay:	0 to 480 sec., Off

**Underfrequency**

Trip Threshold:	15 to 60 Hz, Off
Trip Run Delay:	0 to 60 sec., Off
Trip and Alarm Start Delay:	0 to 60 sec., Off

**Overfrequency**

Trip Threshold:	15 to 70 Hz, Off
Trip Run Delay:	0 to 60 sec., Off
Trip Alarm Start Delay:	0 to 60 sec., Off

**Overvoltage**

Main Trip Threshold:	10 to 150 V, Off
Main Run Delay:	0 to 480 sec., Off
Neutral Trip Threshold:	10 to 150 V, Off

**Undervoltage**

Main Undervoltage Threshold:	10 to 150 V
Main UV Trip Run Delay:	0 to 60 sec.
Main Undervoltage Threshold:	10 to 150 V
Under Voltage Start Delay:	0 to 60 sec.
Ratio of V2 to V1:	4% to 40%

**Underpower**

Underpower Trip Threshold:	0.06 to 0.90 *FLA*VT
Underpower Trip/Alarm Start Delay:	0 to 60 sec.
Underpower Trip Run Delay:	0 to 480 sec.
Leading PF Trip:	0.05 to 0.99
Lagging PF Trip:	0.05 to 0.99
PF Trip Start Delay:	0 to 60 sec.
PF Trip Run Delay:	0 to 60 sec.

**Alarm Setting Range**

Ground Fault:	Off, 2% to 55% CT Ratio
Overload I <sup>2</sup> t:	Off, 60 to 99% I <sup>2</sup> t
Jam:	Off, 100 to 1,200% FLA
Underload:	Off, 6 to 90% FLA
Phase Unbalance:	Off, 4 to 40% I <sub>2</sub> /I <sub>1</sub>
Run Delay Timers:	Off, 0 to 240 sec.
Phase Unbalance Alarm Threshold	Off, 1 to 100 V
Phase Unbalance Alarm Run Delay	Off, 1 to 1,200 sec.
Underfrequency Alarm Threshold	Off, 15 to 60 Hz
Under frequency Alarm run Delay	Off, 0 to 60 sec.
Voltage Unbalance Alarm	Off, 0 to 480 sec.
Overfrequency Alarm Threshold	Off, 15 to 70 Hz
Overfrequency Alarm Run Delay	0 to 60 sec.
Overvoltage Main Alarm Threshold	Off, 10 to 150 V
Overvoltage Main Alarm Run Delay	Off, 0 to 480 sec.
Main UV Alarm Run Delay	Off, 0 to 60 sec.
Under Power Alarm Threshold	Off, 0.06 to .90 *FLA *VT
Underpower Alarm Run Delay	Off, 0 to 480 sec.
Leading Power Factor Alarm Threshold 1	Off, 0.05 to 0.99
Lagging Power Factor Alarm Threshold 2	Off, 0.05 to 0.99
Power Factor Alarm Start Delay	Off, 0 to 60 sec.
Power Factor Alarm Run Delay	Off, 0 to 60 sec.

**Start Control Functions**

Starts per Time:	1 to 10 starts
Time for Starts per Time:	Off, 1 to 240 min.
Time Between Starts:	Off, 1 to 240 min.
Number of Cold Starts:	1 to 5 starts
Motor Transition Current:	10 to 300% FLA
Time for Transition:	0 to 1,200 sec.
Incomplete Sequence Timer:	Off, 1 to 240 sec.
Long Acceleration Timer:	Off, 1 to 1,200 sec.
Antibackspin Timer:	Off, 1 to 3,600 sec.

**RTD Inputs (Requires URTD module)**

Sensor Types:	10 ohm copper
	100 ohm nickel
	120 ohm nickel
	100 ohm platinum

**URTD Module Communications**

Interface:	Plastic optical fiber (preferred)
	Electrical (3-wire)
Fiber Optic Cable:	Type HFBR-ELS (length) - precut low-loss with connectors
	Type HBFR-EUS (length) - bulk low-loss without connectors
	Type HBFR-RLS (length) - standard-loss, acceptable for <10m (<32.8 ft)

**Clock**

Accuracy:	Freerunning ± 1 min./mo. @ 25°C (77°F). Automatically updated by PowerNet host.
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**IPONI Communications (Section 10 contains more protocols.)**

Type:	2-wire, 115.2 kHz carrier
Baud Rate:	1,200 ASK or 9,600 FSK
Max. Distance:	10,000 ft (3048 m)
Protocol:	INCOM
Functions:	Read/write setpoints
	Read metered values
	Read trip/alarms
	Read events
	Read history
	Reset history
	Reset functions
	Emergency override
	Trip
	View starting profile

**Logging**

Log Book:	100 events
Log Event:	20 trips and alarms
Log Start:	Last 4 starts
Start Profile:	Last 4 starts (communications port only)
History Records:	Motor, trips, alarms, and totals

**Environmental Ratings**

Operating Temp.:	-20 to + 60°C (-4 to +140°F)
Storage Temp.:	-45 to + 85°C (-49 to +185°F)
Humidity:	0 to 95% non-condensing

**Dimensions (Fixed Mount Case Only)**

Height:	10.25 in. (260.4 mm)
Width:	6.72 in. (170.7 mm)
Depth:	4.3 in. (109.2 mm)
Weight:	5 lbs. (2.3 kg)
	8.0 lbs. (3.6 kg) (with URTD and PONI)

**Standards**

ANSI/IEEE C37.90-1989	Standard for Relay Systems Associated with Electric Power Apparatus.
ANSI/IEEE C37.90.1-1989	Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems
ANSI/IEEE C37.90.2-1995	Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers
UL-1053	Ground Fault Sensing and Relaying Equipment
Emissions (EN-50081-2)	EN 50011 CISPR-11, Class A, CFR 47 FCC Part 15 Subpart b Class A
EN-61000-6-2	Immunity
EN 61000-4-2	ESD
EN 61000-4-3	RF Radiated Immunity
EN 61000-4-4	EFT/Burst Immunity
EN 61000-4-5	Surge Immunity
EN 61000-4-6	RF Conducted Immunity
EN 61000-4-8	Power Frequency Magnetic Field Immunity
EN 61000-4-11	Voltage Variation Immunity

## SECTION 4 - OPERATOR PANEL

### 4.0 General Description

The faceplate of the MP-4000 contains the display, indicators, and pushbuttons that make up the Operator Panel (Figures 4.1 and 4.2).

The Operator Panel is used to:

- Monitor the metered values on the Display Window;
- Enter or modify settings;
- View motor history or statistics;
- View a log of recent events;
- Determine that a trip or alarm condition exists by means of two distinct LEDs and the cause of the trip by means of the Display Window;
- Reset the unit after a trip condition has occurred by means of a Reset pushbutton;
- Get help on any display; and
- Override start lockouts during emergencies.

#### 4.0.1 Display Window

All available displays are discussed in Subsections 4.1 through 4.5.

#### 4.0.2 Protected Pushbuttons

A security door located on the bottom left corner of the operator panel covers two pushbuttons: the program pushbutton and the emergency override pushbutton. This door will accept a lead seal to prevent unauthorized setting changes and the overriding of start lockout functions.

#### 4.0.3 Mode Pushbuttons

The four mode pushbuttons near the middle of the operator panel provide access to the four different modes used by the MP-4000. The Monitor, View Setting, History, and Log modes are detailed in Subsections 4.2 through 4.5.

#### 4.0.4 Navigation Pushbuttons

The six buttons with up and down arrows, located beneath the mode buttons, are used to navigate through the modes by page, line, and value. The up arrow buttons are used to advance through the displays, and the down arrow buttons are used to return to the previous display. Refer to the mode examples in Subsections 4.2 through 4.5 for an explanation on the proper use of the navigation buttons.

#### 4.0.5 Help Pushbutton

The Help pushbutton provides a scrolling explanation of the displayed message, including units of measure, for any of the messages from the MP-4000. The complete list of help messages for each function mode is included in Tables 4.1 through 4.5. The help message may be terminated by pressing the Reset or Help pushbutton.

#### 4.0.6 Reset Pushbutton

The Reset pushbutton is primarily used to reset the MP-4000 after a trip condition. If the cause of the trip has been corrected, the displayed trip condition will be cleared. If a trip condition is not present, pressing the Reset pushbutton to step out of Line, Page, or Mode will bring up the Default mode displaying the status of the motor.

In the Program mode, pressing the Reset pushbutton will allow the User to exit out of the Program mode without saving any entered settings.

#### 4.0.7 Operator Panel LEDs

There are 10 LEDs on the operator panel.

The *Protection* LED is lit when the MP-4000 is in the Protection mode. The MP-4000 provides protection when the relay is in the Program mode; therefore, the only time the Protection LED is extinguished is when the DISARMED feature is used and also for the brief time it takes to calculate all settings when leaving the Program mode.

The *Program* LED is lit when the MP-4000 is in the Program mode.

The *Trip* LED is lit when a trip condition has occurred.

The *Alarm*, *Aux 1*, and *Aux 2* LEDs are lit when these auxiliary relays are activated. (The Program mode is used to specify what will cause these relays to activate.)

The remaining LEDs are on the mode select buttons and indicate the mode of the MP-4000 display: Monitor, View Setting, History, and Log. If none of these four LEDs is lit and the relay is not in Program Mode, the display is in the Motor State (Default) Mode.

#### 4.0.8 Programming Ports

Programming Ports are located behind the lower right security door. The RS-232 port allows the User to program the unit via the front panel using PowerPort. To perform programming, the RS-232 setpoint must be manually set to 1. Note that when the RS-232 setpoint is manually set to 1, communication with the URTD are disabled, and thermal models are used in place of RTD data. The RS-232 port must always be manually set - not remotely set. The JTAG port is for factory use only.



### CAUTION

**MAKE SURE TO RETURN THE RS-232 SETPOINT TO ZERO AFTER THE COMPLETION OF PROGRAMMING. OTHERWISE, URTD MOTOR PROTECTION WILL BE DISABLED AND THE THERMAL MODEL WILL BE USED.**

### 4.1 Default Mode

In the Motor State or Default mode, basic messages concerning the state of the motor and relay are displayed. The following events reset the system to Default mode:

- Cycling power;
- Pressing any mode button a second time;
- Pressing the Reset pushbutton the required number of times to step out of Line, Page, or Mode;
- A change in the state of the motor, except when in the Monitor mode; and
- An alarm or trip.

When in the Motor State mode, the display normally shows READY - 3 (stopped), START, or RUN. If the relay is disarmed, the DISARMED display will alternate with the motor state (see Table 4.1). Self-diagnostics and trip or alarm data are also displayed. If more than one event has occurred, the messages alternate.

An alarm or trip always causes the display to return to the Default mode. As soon as any mode button is pressed, the flashing stops, and the Mode, Page, and Line displays are available. Returning to the default display again show the alarm and/or trip condition until the condition is cleared and is acknowledged with the Reset pushbutton. If the relay is in Monitor mode when a change of motor state occurs,

the new state flashes on the display for five seconds, and the display returns to the value being monitored.

## 4.2 Monitor Mode

The Monitor mode displays real-time data as listed in Table 4.2.

For example, to view the motor bearing temperatures:

- Press the Monitor pushbutton; the display shows MONITOR as listed at the top of Table 4.2.
- Press the Page up button once to advance to MONT I.
- Press the Page up button a second time to advance to MONT RTD. As the table indicates, the motor bearing temperatures are part of the MONT RTD page.
- Press the Line up button to advance to winding temperature 1.
- Press the Line up button six more times to advance to motor bearing temperature 1. The display shows motor bearing temperature 1 as MT1 XXXX, where XXXX is the actual temperature.
- Press the Line up button again to advance to motor bearing temperature 2.

**NOTE:** Pressing the Line down button returns the display to the previous Line, and pressing the Page down button returns the display to the previous Page. The Value pushbuttons are not used in the Monitor Mode.

## 4.3 View Setting and Program Mode

These modes display the same information, but the settings cannot be changed in the View Setting mode.

### 4.3.1 View Setting Mode

Pressing the View Setting pushbutton only displays the programmed settings listed in Table 4.3. The displays and help messages are the same as in the Program mode.

### 4.3.2 Program Mode

The Program mode permits the User to change the settings. Table 4.3 is a guide for programming; it is also a setting record sheet. Section 5 contains a description of the Program mode.

## 4.4 History Mode

Pressing the History mode pushbutton displays the past history of the motor as listed in Table 4.4.

For example, to view the number of under load trips and phase unbalance trips:

- Press the History mode pushbutton; the display shows HISTORY as listed at the top of Table 4.4.
- Press the Page up button twice to advance to HIST TRP.
- Press the Line up button five times to advance to UL T XX, where XX is the underload trip count since the last reset.
- Press the Value up button once to view the date of the last reset, and a second time to view the time of the last reset. Pressing the Value up button one more time returns the display back to the underload trip count.
- Press the Line up button once to advance to UB T XX, where XX is the number of phase unbalance trips since the last reset.
- Repeatedly press the Value up button to cycle through the date of reset, the time of reset, and the number of phase unbalance trips.

## 4.5 Log Mode

The Log mode displays a record of detected events that have happened to the motor. The following are considered events:

- Start;
- Stop;
- Entering into Program mode;
- Using the emergency override button;
- Alarm condition; and
- Trip condition.

Unlike the other modes, the Line column function order varies with the number of events, since the actual event information is stored as it happens. Table 4.5 lists examples of event information as a guide to retrieving log information. Refer to the examples given for the History mode in Section 4.4 on the use of the navigation buttons.



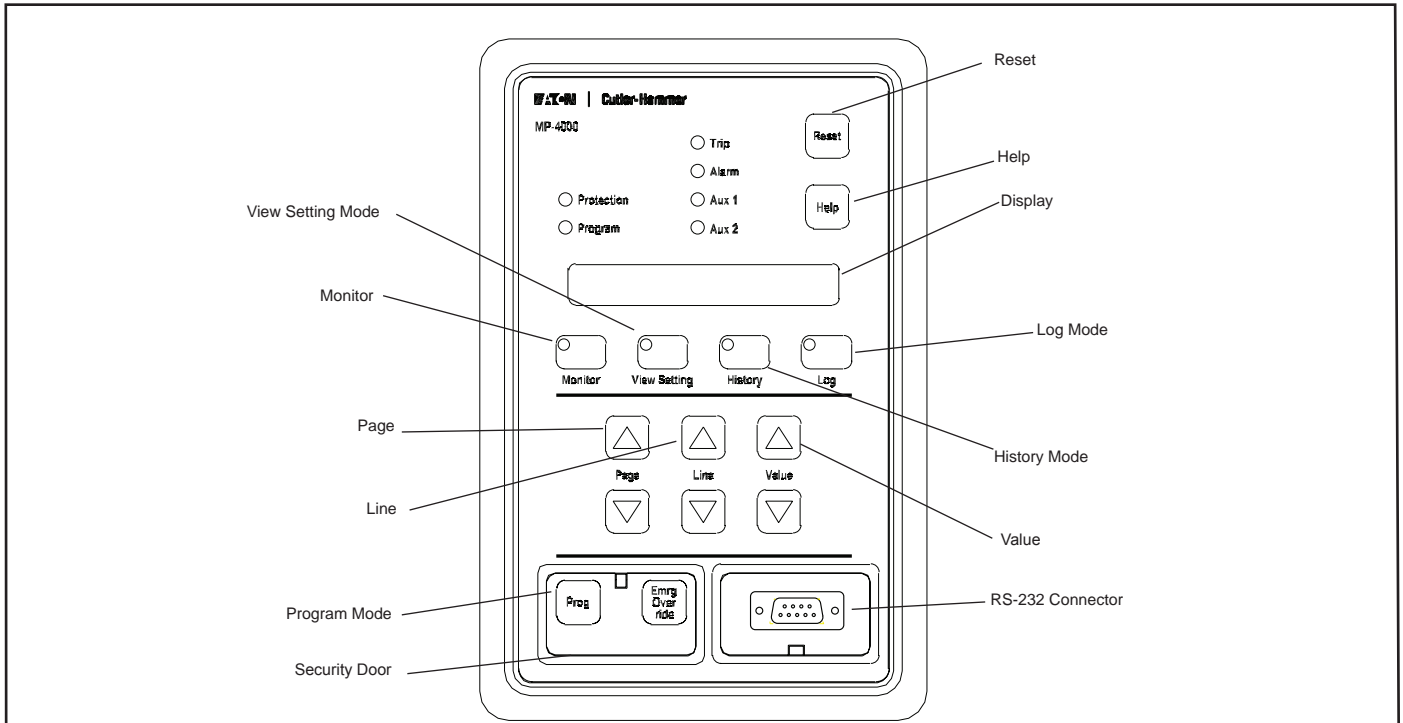


Figure 4.1 MP-4000 Pushbuttons.

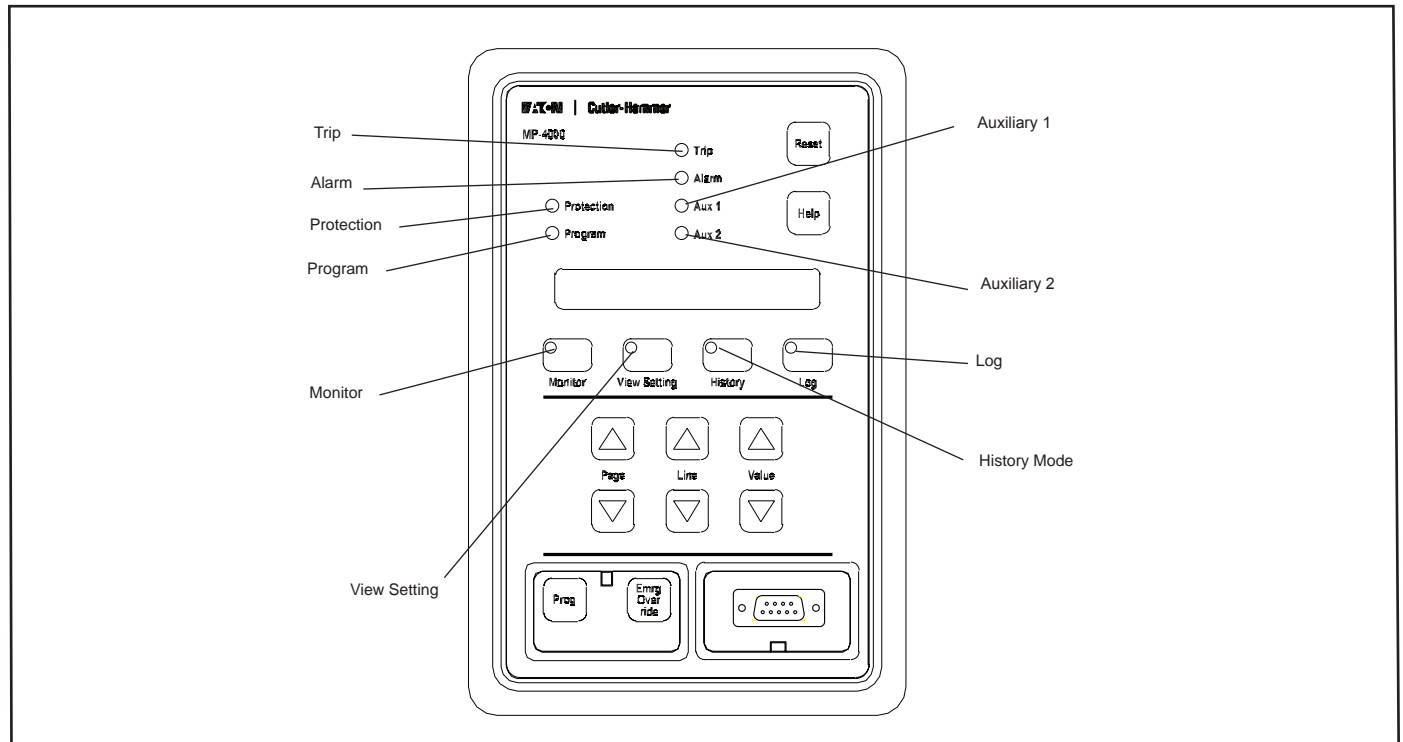


Figure 4.2 MP-4000 LED Indicators.

Table 4.1 Motor State (Default Mode) Display.

Display	Complete Help Message	Description
READY--1	READY TO START MOTOR, SINGLE PHASE TEST MODE	<b>WARNING</b> MP-4000 has been set to 1 PHASE for bench testing only. Will not protect a 3-phase motor. Change setting P13L1 to 3 PHASE for normal motor protection.
READY--3	READY TO START MOTOR, THREE PHASE TEST MODE	Motor is stopped and MP-4000 is ready for a start, 3-phase mode.
RUN	MOTOR IS RUNNING	Motor is running, as indicated by phase currents.
START	ATTEMPTING TO START MOTOR	Motor is starting, and has not yet reached transition to RUN as defined by User settings.
DISARMED	WARNING RELAY IS DISARMED AND CAN NOT TRIP	<b>WARNING</b> Protection functions have been blocked from operating the trip relay by User setting P12L18. MOTOR IS UNPROTECTED. This mode of operation is for commissioning in a critical process only. Refer to Subsection 5.12.18.
ABKSP XX	ANTI-BACKSPIN ACTIVE, REMAINING MINUTES ACTIVE SHOWN	The motor is stopped, and the trip contact has been opened to prevent restarting until the anti-backspin time delay has expired. XX is the remaining minutes before restarting is allowed.
ILLEGAL	AN ILLEGAL REQUEST WAS MADE	Response to request for an action that the relay cannot perform. Setpoints were not properly stored. Reprogram the unit and save settings.

Table 4-2. Monitor Mode Display.

SUB-MENU	LINE	DISPLAY	COMPLETE HELP MESSAGE	DESCRIPTION
			MONITOR REAL TIME VALUES	Monitor mode.
MONT I			REAL TIME DATA FROM CURRENT MEASUREMENTS	Current monitoring data follows.
	1	IAV XXX	AVERAGE CURRENT OF THE THREE PHASES	Average RMS current of 3-phase currents in amps.
	2	IA XXX	PHASE A CURRENT IN AMPS	Actual ac line motor RMS current.
	3	IB XXX	PHASE B CURRENT IN AMPS	Actual ac line motor RMS current.
	4	IC XXX	PHASE C CURRENT IN AMPS	Actual ac line motor RMS current.
	5	IG XXX	GROUND FAULT CURRENT IN AMPS	Actual ground current.
	6	%IA XXX	PHASE A CURRENT AS A PERCENT OF FULL LOAD AMPS	Percentage of actual monitored current in amps.
	7	%IB XXX	PHASE B CURRENT AS A PERCENT OF FULL LOAD AMPS	Percentage of actual monitored current in amps.
	8	%IC XXX	PHASE C CURRENT AS A PERCENT OF FULL LOAD AMPS	Percentage of actual monitored current in amps.
	9	%UB XXX	PHASE UNBALANCE - IF POSITIVE THE RATIO OF NEGATIVE TO POSITIVE SEQUENCE CURRENT - IF NEGATIVE THE INVERSE	Ratio of negative sequence current to positive sequence current in percent. If a phase reversal exists, the ratio is inverted and a negative sign is displayed.
MONT RTD			REAL TIME DATA FROM RTD MODULE	RTD monitoring data follows. (Page only visible when URTD communicates with MP-4000.)
	1	WT1 XXX	WINDING TEMP 1 IN DEGREES F or C	RTD reading - terminals 1, 2, 3.
	2	WT2 XXX	WINDING TEMP 2 IN DEGREES F or C	RTD reading - terminals 4, 5, 6.
	3	WT3 XXX	WINDING TEMP 3 IN DEGREES F or C	RTD reading - terminals 7, 8, 9.
	4	WT4 XXX	WINDING TEMP 4 IN DEGREES F or C	RTD reading - terminals 10, 11, 12.
	5	WT5 XXX	WINDING TEMP 5 IN DEGREES F or C	RTD reading - terminals 13, 14, 15.
	6	WT6 XXX	WINDING TEMP 6 IN DEGREES F or C	RTD reading - terminals 17, 18, 19.
	7	MT1 XXXX	MOTOR BEARING TEMP 1 IN DEGREES F or C	RTD reading - terminals 20, 21, 22.
	8	MT2 XXXX	MOTOR BEARING TEMP 2 IN DEGREES F or C	RTD reading - terminals 23, 24, 25.
	9	LT1 XXXX	LOAD BEARING TEMP 1 IN DEGREES F or C	RTD reading - terminals 26, 27, 28.

**Table 4-2. Monitor Mode Display.**

SUB-MENU	LINE	DISPLAY	COMPLETE HELP MESSAGE	DESCRIPTION
	10	LT2 XXXX	LOAD BEARING TEMP 2 IN DEGREES F or C	RTD reading - terminals 29, 30, 31.
	11	AXT XXXX	AUXILIARY TEMP IN DEGREES F or C	RTD reading - terminals 33, 34, 35.
MONT MTR			REAL TIME MOTOR DATA	Motor monitoring data follows.
	1	VER XXXX	SOFTWARE VERSION NUMBER	MP-4000 software version in use.
	2	%I2T XXX	PERCENT OF I2T TRIP LEVEL	Percentage of thermal bucket used.
	3	TUS XXX	TIME IN MINUTES UNTIL NEXT START CAN OCCUR	Displays largest amount of time in minutes among three functions: anti-backspin, starts per unit time and time between starts.
	4	RMST XX	REMAINING STARTS	Number of starts remaining if starts per time is programmed.
	5	OST XXX	TIME LEFT ON OLDEST START IN MINUTES	Remaining time allowed on oldest start for starts per time if programmed. If motor start/time is exceeded, this is time in minutes before restart is permitted.
	6	ICM XXXX	ADDRESS ON THE IMPACC NETWORK IN HEXADECIMAL	Address of device if on INCOM communications network; only visible if on network.
	7	DI 1 OFF or DI 1 ON	STATE OF DISCRETE INPUT 1	Current state of discrete input 1; ON = 120 Vac present, OFF = 120 Vac not present.
	8	DI 2 OFF or DI 2 ON	STATE OF DISCRETE INPUT 2	Current state of discrete input 2; ON = 120 Vac present, OFF = 120 Vac not present.
MONT TIM			DATE AND TIME	Current date and time with display format as programmed.
	1	HH.MM XM	CURRENT TIME	12-hour format.
		or		or
		HH.MM		24-hour format.
	2	MM/DD/YY	CURRENT DATE	Common format
		or		or
		DD/MM/YY		European / military format.
MONT V			REAL TIME DATA FROM VOLTAGE RMS MEASUREMENTS	
	1	VA XXXX	PHASE A TO GROUND VOLTAGE	VAG RMS phase voltage.
	2	VB XXXX	PHASE B TO GROUND VOLTAGE	VBG RMS phase voltage.
	3	VC XXXX	PHASE C TO GROUND VOLTAGE	VCG RMS phase voltage.
	4	VG XXXX	GROUND VOLTAGE	Neutral voltage differential (neutral to ground).
	5	VPAV XXXX	AVERAGE OF PHASE VOLTAGES	Average of the RMS line to neutral voltages VL avg. (Va+Vb+Vc)/3).
	6	VAB XXXX	LINE TO LINE VOLTAGE VAB	RMS line to line voltage VAB.
	7	VBC XXXX	LINE TO LINE VOLTAGE VBC	RMS line to line voltage VBC.
	8	VCA XXXX	LINE TO LINE VOLTAGE VCA	RMS line to line voltage VCA.
	9	VLAV XXXX	AVERAGE OF THE LINE TO LINE VOLTAGES	VLL average.
	10	FRQ XXXX	MEASURED FREQUENCY	Frequency as measured on phase A voltage input.
MONT VSQ			REAL TIME DATA FROM SEQUENCE VOLTAGES PHASOR MEASUREMENTS	
	1	V1MG XXXX	V1 PHASOR MAGNITUDE	Magnitude of positive sequence voltage.
	2	V2MG XXXX	V2 PHASOR MAGNITUDE	Magnitude of negative sequence voltage.
	3	3V0 XXXX	3V0 PHASOR MAGNITUDE	Magnitude of zero sequence voltage.
	4	V1AG XXXX	V1 PHASE ANGLE	Phase angle of positive sequence voltage.
	5	V2AG XXXX	V2 PHASE ANGLE	Phase angle of negative sequence voltage.
	6	V0AG XXXX	V0 PHASE ANGLE	Phase angle of zero sequence voltage.
	7	%VUB XXXX	VOLTAGE PHASE UNBALANCE - IF POSITIVE THE RATIO OF NEGATIVE TO POSITIVE SEQUENCE VOLTAGE - IF NEGATIVE THE INVERSE	Voltage unbalance.

Table 4-2. Monitor Mode Display.

SUB-MENU	LINE	DISPLAY	COMPLETE HELP MESSAGE	DESCRIPTION
MONT IPH			REAL-TIME DATA FROM CURRENT PHASOR MEASUREMENTS	
	1	IAMG XXXX	IA PHASOR MAGNITUDE	Phase A current magnitude.
	2	IBMG XXXX	IB PHASOR MAGNITUDE	Phase B current magnitude.
	3	ICMG XXXX	IC PHASOR MAGNITUDE	Phase C current magnitude.
	4	IXMG XXXX	IX PHASOR MAGNITUDE	Phase IX current magnitude.
	5	IAAG XXXX	IA PHASE ANGLE	Phase A current phase angle.
	6	IBAG XXXX	IB PHASE ANGLE	Phase B current phase angle.
	7	ICAG XXXX	IC PHASE ANGLE	Phase C current phase angle.
	8	IXAG XXXX	IX PHASE ANGLE	Phase IX current phase angle.
MONT ISQ			REAL TIME DATA FROM SEQUENCE CURRENT PHASOR MEASUREMENTS	
	1	I1MG XXXX	I1 PHASOR MAGNITUDE	Magnitude of positive sequence current.
	2	I2MG XXXX	I2 PHASOR MAGNITUDE	Magnitude of negative sequence current.
	3	3I0 XXXX	3I0 PHASOR MAGNITUDE	Magnitude of zero sequence current.
	4	I1AG XXXX	I1 PHASE ANGLE	Phase angle of positive sequence current.
	5	I2AG XXXX	I2 PHASE ANGLE	Phase angle of negative sequence current.
	6	I0AG XXXX	I0 PHASE ANGLE	Phase angle of zero sequence current.
MONT VPH			REAL TIME DATA FROM SEQUENCE VOLTAGE PHASOR MEASUREMENTS	
	1	VAMG XXXX	VA PHASOR MAGNITUDE	Phase A voltage magnitude
	2	VBMG XXXX	VB PHASOR MAGNITUDE	Phase B voltage magnitude
	3	VCMG XXXX	VC PHASOR MAGNITUDE	Phase B voltage magnitude
	4	VAAG XXXX	VA PHASE ANGLE	Phase A phase angle
	5	VBAG XXXX	VB PHASE ANGLE	Phase B phase angle
	6	VCAG XXXX	VC PHASE ANGLE	Phase C phase angle
	7	VABM XXX	VAB PHASOR MAGNITUDE	
	8	VBCM XXXX	VBC PHASOR MAGNITUDE	
	9	VCAM XXXX	VCA PHASOR MAGNITUDE	
	10	VABA XXXX	VAB PHASE ANGLE	
	11	VBCA XXXX	VBC PHASE ANGLE	
	12	VCAA XXXX	VCA PHASE ANGLE	
MONT PW			REAL TIME DATA FROM POWER MEASUREMENTS	
	1	MPWR XXXX	3 PHASE REAL POWER	Real power from measured voltage and current
	2	KVA - XXXX	3 PHASE REACTIVE POWER	Reactive power from measured voltage and current
	3	KVA XXXX	THREE PHASE APPARENT POWER	Apparent power from measured voltage and current
	4	PF XXXX	3 PHASE APPARENT POWER FACTOR	Power factor
MONT EG			REAL TIME DATA FROM ENERGY MEASUREMENTS	
	1	GWH XXXX	3 PHASE WATT HOURS	Watt-hours kilo or rollover to mega
	2	MVRH XXXX	3 PHASE VAR HOURS	VAR hours
	3	VAH	3 PHASE VA HOURS	VA hours

Program Date \_\_\_\_\_ Control Schematic \_\_\_\_\_  
 Unit ID/Starter Type \_\_\_\_\_ Work Order # \_\_\_\_\_  
 Motor HP \_\_\_\_\_ Mfgr. \_\_\_\_\_ Serial # \_\_\_\_\_ Volts \_\_\_\_\_  
 FLA \_\_\_\_\_ LRC \_\_\_\_\_ Stall Time/LRT \_\_\_\_\_ Accel. Time \_\_\_\_\_  
 SF \_\_\_\_\_ RTD Type \_\_\_\_\_ Other \_\_\_\_\_

**Table 4-3. View Setting Mode/Program Worksheet.**

SUB-MENU	LINE #	DISPLAY	HELP MESSAGE	SETTING RANGE/VALUE (DEFAULT SELECTION AND VALUE AS SHIPPED IN BOLD)	VALUE SELECTED
VIEW SP			VIEW PROGRAM SETTINGS		
<b>PAGE 1, SP MOTOR SETTINGS FOR MOTOR CONSTANTS</b>					
	1	FLA XXXX	FULL LOAD AMPS	10-3,000 amps in 1 amp. increments <b>(10)</b>	
	2	LRC XXXX	LOCKED ROTOR CURRENT % OF FLA	300-1,200% in 1% increments <b>(300)</b>	
	3	LRT XXX	MAXIMUM ALLOWABLE STALL TIME IN SECONDS	1-120 sec. in 1 sec. increments <b>(300)</b>	
	4	UTC XXX	ULTIMATE TRIP CURRENT IN %FLA	85-150% in 1% increments <b>(1)</b>	
	5	PCT XXXX	PHASE CT RATIO NUMERATOR IN PRIMARY AMP	10-4,000 A in increments of 1 <b>(10)</b>	
	6	GCT XXXX	GROUND CT RATIO NUMERATOR IN PRIMARY AMP	10-4,000 A in increments of 1 <b>(50)</b>	
	7	FREQ 50 or FREQ 60	50 - FOR 50 HERTZ LINE FREQUENCY 60 - FOR 60 HERTZ LINE FREQUENCY	Toggles between FREQ 50 and <b>FREQ 60</b>	
	8	REV or NON REV	REVERSING OR NON REVERSING STARTER	Toggles between REV and <b>NON REV</b>	
	9	STOP X	MOTOR STOP CURRENT LEVEL IN % OF PHASE CT RATIO NUMERATOR	2-20% of phase CT ratio numerator in 1% increments <b>(5%)</b>	
<b>PAGE 2, SP RTD SETTINGS FOR RTD INPUTS</b>					
	1	RTD IN C or RTD in F	DISPLAYED IN DEGREES C OR F	Toggles between <b>RTD IN C</b> and RTD IN F	
	2	WD T XXX	WINDING TEMP TRIP	0-199 C, OFF/32-390 F, OFF in 1 increments <b>(100)</b>	
	3	WD A XXX	WINDING TEMP ALARM	0-199 C, OFF/32-390 F, OFF in 1 increments <b>(80)</b>	
	4	MB T XXX	MOTOR BEARING TRIP	0-199 C, OFF/32-390 F, OFF in 1 increments <b>(100)</b>	
	5	MB A XXX	MOTOR BEARING ALARM	0-199 C, OFF/32-390 F, OFF in 1 increments <b>(80)</b>	
	6	LB T XXX	LOAD BEARING TRIP	0-199 C, OFF/32-390 F, OFF in 1 increments <b>(80)</b>	
	7	LB A XXX	LOAD BEARING ALARM	0-199 C, OFF/32-390 F, OFF in 1 increments <b>(80)</b>	
	8	AX T XXX	AUXILIARY TRIP	0-199 C, OFF/32-390 F, OFF in 1 increments <b>(100)</b>	
	9	AX A XXX	AUXILIARY ALARM	0-199 C, OFF/32-390 F, OFF in 1 increments <b>(80)</b>	
	10	DIAG ON or DIAG OFF	ALARM ON RTD FAILURE DIAGNOSTIC	Toggles between <b>DIAG ON</b> and DIAG OFF	
<b>PAGE 3, SP TRIP SETTINGS FOR TRIP EVENTS</b>					
	1	GFT XXX	GROUND FAULT TRIP LEVEL IN % OF GROUND CT RATIO NUMERATOR	2-55% OF Ground CT ration numerator, OFF (1% increments) <b>(24%)</b>	

**Table 4-3. View Setting Mode/Program Worksheet.**

SUB-MENU	LINE #	DISPLAY	HELP MESSAGE	SETTING RANGE/VALUE (DEFAULT SELECTION AND VALUE AS SHIPPED IN BOLD)	VALUE SELECTED
	2	GFSD XX	GROUND FAULT START DELAY IN CYCLES	2-60 ac cycles (1 cycle increments) <b>(5)</b>	
	3	GFRD XX	GROUND FAULT RUN DELAY IN CYCLES	0-60 ac cycles (1 cycle increments) <b>(2)</b>	
	4	IOC XXX	INSTANTANEOUS OVERCURRENT IN % FLA	300-1,600%, <b>OFF</b> (1% increments)	
	5	IOCSX XX	INSTANTANEOUS OVERCURRENT START DELAY IN CYCLES	2-60 ac cycles (1 cycle increments) <b>(3)</b>	
	6	JMT XXX	JAM TRIP LEVEL IN % FLA	100-1,200%, <b>OFF</b> (1% increments) <b>(1,000%)</b>	
	7	JMSD XX	JAM TRIP AND ALARM START DELAY IN SECONDS	0-1,200 sec. (1 sec. increments) <b>(60)</b>	
	8	JMTR XX	JAM TRIP RUN DELAY IN SECONDS	0-240 sec. (1 sec. increments) <b>(60)</b>	
	9	ULT XXX	UNDERLOAD TRIP LEVEL IN % FLA	6-90%, <b>OFF</b> (1% increments)	
	10	ULSD XXX	UNDERLOAD TRIP AND ALARM START DELAY IN SECONDS	0-120 sec. (1 sec. increments) <b>(10)</b>	
	11	ULTR XXX	UNDERLOAD TRIP RUN DELAY IN SECONDS	0-240 sec. (1 sec. increments) <b>(10)</b>	
	12	UBT XXX	PHASE UNBALANCE TRIP LEVEL	4-40%, <b>OFF</b> (1% increments)	
	13	UBSD XXX	PHASE UNBALANCE TRIP AND ALARM START DELAY IN SECONDS	0-120 sec. (1 sec. increments) <b>(10)</b>	
	14	UBTR XXX	PHASE UNBALANCE TRIP RUN DELAY IN SECONDS	0-240 sec. (1 sec. increments) <b>(2)</b>	
<b>PAGE 4, SP ALARM SETTINGS FOR ALARM EVENTS</b>					
	1	GFA XXX	GROUND FAULT ALARM LEVEL IN % OF GROUND CT RATIO NUMERATOR	2-55% OF Ground CT ration numerator, <b>OFF</b> (1% increments)	
	2	I2TA XXX	I2T ALARM LEVEL IN % FULL OF I2T TRIP CAPACITY	60-99%, <b>OFF</b> (1% increments) <b>(80)</b>	
	3	JMA XXX	JAM ALARM LEVEL IN % FLA	100-1,200%, <b>OFF</b> (1% increments) <b>(1,000%)</b>	
	4	JMAR XXX	JAM ALARM RUN DELAY IN SECONDS	0-240 sec. (1 sec. increments) <b>(2)</b>	
	5	ULA XXX	UNDERLOAD ALARM LEVEL IN % FLA	6-90%, <b>OFF</b> (1% increments)	
	6	ULAR XXX	UNDERLOAD ALARM RUN DELAY IN SECONDS	0-240 sec. (1 sec. increments) <b>(10)</b>	
	7	UBA XXX	PHASE UNBALANCE ALARM LEVEL	4-40%, <b>OFF</b> (1% increments) <b>(10)</b>	
	8	UBAR XXX	PHASE UNBALANCE ALARM RUN DELAY IN SECONDS	0-240 sec. (1 sec. increments) <b>(10)</b>	
<b>PAGE 5, SP START SETTINGS FOR START EVENTS</b>					
	1	ST/T XXX	STARTS PER TIME ALLOWED	1-10 starts/time (increments of 1) <b>(1)</b>	
	2	T/ST XXX	TIME ALLOWED FOR STARTS COUNT IN MINUTES	1-240 minutes, <b>OFF</b> (1 minute increments)	
	3	TBS XXX	TIME BETWEEN STARTS IN MINUTES	1-240 minutes, <b>OFF</b> (1 minute increments)	
	4	NOCS X	NUMBER OF COLD STARTS ALLOWED	1-5 starts (increments of 1) <b>(1)</b>	
	5	TRNC XXX	MOTOR START TRANSITION CURRENT LEVEL IN %FLA	10-300% (1% increments) <b>(130)</b>	
	6	TRNT XXX	MOTOR START TRANSITION TIME IN SECONDS	0-1,200 sec. (1 sec. increments) <b>(10)</b>	
	7	Choose:  TRN TIME TRN I TRN T+C TRN T/C	TRANSITION ON EVENT  TRN TIME - ON TIME ONLY TRN I - ON CURRENT ONLY TRN T+C - ON TIME OR CURRENT TRN T/C - ON TIME AND CURRENT	Choose one of the four conditions that determine a start-to-run transition: TRN TIME, TRN I, <b>TRN T+C</b> , or TRN T/C  Refer to settings P5L5 and P5L6.	

**Table 4-3. View Setting Mode/Program Worksheet.**

SUB-MENU	LINE #	DISPLAY	HELP MESSAGE	SETTING RANGE/VALUE (DEFAULT SELECTION AND VALUE AS SHIPPED IN BOLD)	VALUE SELECTED
	8	INSQ XXX	INCOMPLETE SEQUENCE REPORT BACK TIME IN SECONDS ON DISCRETE INPUT 2	1-240 sec., OFF (1 sec. increments)  NOTE: Choosing a time value here (not OFF) also locks P7L1 to INC SEQ and no other choices are available there. Also, if this is set to OFF, a later setting of P7L1 to INC SEQ will force a setting of <b>1 second</b> here.	
	9	INSQ TRN or INSQ ST	INCOMPLETE SEQUENCE START TIME EVENT INSQ TRN - START TO RUN TRANSITION INSQ ST - STOP TO START TRANSITION	Toggles between INSQ TRN and <b>INSQ ST</b>	
	10	LAT XXX	LONG ACCELERATION TIME IN SECONDS	1-200 sec., <b>OFF</b> (1 sec. increments) <b>Danger</b> - Set to OFF unless absolutely needed. If used, connect zero speed switch. Refer to settings P5L11 and P6L1.	
	11	ZSW ON or ZSW OFF	ZERO SPEED SWITCH ON DISCRETE INPUT 1 ON OR OFF	Toggles between ZSW ON and <b>ZSW OFF</b> . NOTE: Choosing ZSW ON here also locks P6L1 to ZERO SW and no other choices are available there. Also, setting P6L1 to ZERO SW will force ZSW ON here.	
	12	ABK XXXX	ANTI-BACKSPIN DELAY TIME IN SECONDS	1-3,600 seconds, <b>OFF</b> (1 sec. increments)	
<b>PAGE 6, SP DI 1 SETTING FOR DISCRETE INPUT NUMBER 1</b>					
	1	Choose:  REM RST REM TRIP DIF TRIP MTR STOP RST DBL ZERO SW  EMG OVR	CONFIGURE DISCRETE INPUT 1 -- REM RESET - REMOTE RESET REM TRIP - REMOTE TRIP DIF TRIP - DIFFERENTIAL TRIP MTR STOP - MOTOR STOP DETECTION RST DBL - RESET DISABLE ZERO SW - ZERO SPEED SWITCH TO GET ANY OTHER EMG OVR - EMERGENCY OVERRIDE	Choose from the seven selections for the function of Discrete Input 1. If ZERO SW is selected here, P5L11 will be forced to ZSW ON.  If P5L11 was already set to ZSW ON, this setting is automatically set to ZERO. SW and no other selections are visible. <b>(REM RST)</b>	
<b>PAGE 7, SP DI 2 SETTING FOR DISCRETE INPUT NUMBER 2</b>					
	1	Choose: REM RST REM TRIP DIF TRIP MTR STOP RST DBL INC SEQ EMG OVR	CONFIGURE DISCRETE INPUT 2 -- REM RST - REMOTE RESET REM TRIP - REMOTE TRIP DIF TRIP - DIFFERENTIAL TRIP MTR STOP - MOTOR STOP DETECTION RST DBL - RESET DISABLE INC SEQ - INCOMPLETE SEQUENCE EMG OVR - EMERGENCY OVERRIDE	Choose from the seven selections for the function of Discrete Input 2.  If <b>INC SEQ</b> is selected here, P5L8 will be turned on and set to 1 second.  If P5L8 was already set to a time value (not OFF), this setting is automatically set to INC SEQ and no other selections are visible.	
<b>PAGE 8, SP AREL SETTINGS FOR ALARM RELAY OUTPUT CONFIGURATION</b>					
	1	Choose: GF A ON GFT ON or GF OFF	ENABLE GROUND FAULT ALARM OR TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between <b>GF A ON</b> , GF T ON, and GF T OFF	
	2	Choose: I2T A ON I2T T ON or I2T OFF	ENABLE I2T ALARM OR TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between <b>I2T A ON</b> , I2T T ON, and I2T OFF	
	3	Choose: JAM A ON JAM T ON or JAM OFF	ENABLE JAM ALARM OR TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between <b>JAM A ON</b> , JAM T ON, and JAM OFF	
	4	Choose: UL A ON UL T ON or UL OFF	ENABLE UNDER LOAD ALARM OR TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between <b>UL A ON</b> , UL T ON, and UL OFF	

Table 4-3. View Setting Mode/Program Worksheet.

SUB-MENU	LINE #	DISPLAY	HELP MESSAGE	SETTING RANGE/VALUE (DEFAULT SELECTION AND VALUE AS SHIPPED IN BOLD)	VALUE SELECTED
	5	Choose: UB A ON UB T ON or UB OFF	ENABLE PHASE UNBALANCE ALARM OR TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between <b>UB A ON</b> , UB T ON, and UB OFF	
	6	Choose: WD A ON WD T ON or WD OFF	ENABLE WINDING TEMP ALARM OR TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between <b>WD A ON</b> , WD T ON, and WD OFF	
	7	Choose: MB A ON MB T ON or MB OFF	ENABLE MOTOR BEARING ALARM OR TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between <b>MB A ON</b> , MB T ON, and MB OFF	
	8	Choose: LB A ON LB T ON or LB OFF	ENABLE LOAD BEARING ALARM OR TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between <b>LB A ON</b> , LB T ON, and LB OFF	
	9	Choose: AX A ON AX T ON or AX OFF	ENABLE AUXILIARY RTD TEMP ALARM OR TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between <b>AX A ON</b> , AX T ON, and AX OFF	
	10	Choose: SX A ON SX T ON or SX OFF	ENABLE STARTS PER TIME TRIP OR ALARM TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between <b>SX A ON</b> , SX T on, and SX OFF	
	11	Choose: TBS T ON or TBS OFF	ENABLE TIME BETWEEN STARTS TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between TBS T ON and <b>TBS OFF</b>	
	12	RTDF ON or RTDF OFF	ENABLE INDIVIDUAL RTD CHANNEL FAILURE TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between <b>RTDF ON</b> and RTDF OFF	
	13	RCOM ON or RCOM OFF	ENABLE RTD MODULE COMMUNICATION FAILURE TO ACTIVATE ALARM RELAY OR DISABLE	Toggles between <b>RCOM ON</b> and RCOM OFF	
	14	IOCT ON or IOCT OFF	ENABLE INSTANTANEOUS TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between IOCT ON and <b>IOCT OFF</b>	
	15	PH R ON or PH R OFF	ENABLE PHASE REVERSAL TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between PH R ON and <b>PH R OFF</b>	
	16	INSQ ON or INSQ OFF	ENABLE INCOMPLETE SEQUENCE TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between INSQ ON and <b>INSQ OFF</b>	
	17	REMT ON or REMT OFF	ENABLE REMOTE TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between REMT ON and <b>REMT OFF</b>	
	18	DIFT ON or DIFT OFF	ENABLE DIFFERENTIAL TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between DIFT ON and <b>DIFT OFF</b>	
	19	INCT ON or INCT OFF	ENABLE INCOM TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between INCT ON and <b>INCT OFF</b>	
	20	TRNT ON or TRNT OFF	ENABLE TRANSITION TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between TRNT ON and <b>TRNT OFF</b>	
	21	ZSWT ON or ZSWT OFF	ENABLE ZERO SPEED SWITCH TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between ZSWT ON and <b>ZSWT OFF</b>	
	22	TBYP ON or TBYP OFF	ENABLE TRIP BYPASS TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between TBYP ON and <b>TBYP OFF</b>	



**Table 4-3. View Setting Mode/Program Worksheet.**

SUB-MENU	LINE #	DISPLAY	HELP MESSAGE	SETTING RANGE/VALUE (DEFAULT SELECTION AND VALUE AS SHIPPED IN BOLD)	VALUE SELECTED
<b>PAGE 9, SP AUX 1 SETTINGS FOR AUX 1 RELAY OUTPUT CONFIGURATION</b>					
	1	LSPU XXX	LOAD SHED PICK-UP CURRENT AS % OF FLA	50-150%, <b>OFF</b> (1% increments) NOTE: P9L1 and P9L2 are forced to be coherent. Refer to Section 5 for details.	
	2	LSDO XXX	LOAD SHED DROP-OUT CURRENT AS % OF FLA	50-LSPU Value %, <b>OFF</b> (1% increments) NOTE: P9L1 and P9L2 are forced to be coherent. Refer to Section 5 for details.	
	3	LSDL XX	LOAD SHED DELAY IN SECONDS	0-5 sec. (0.1 sec. Increments) If LSPU and LSDO are both set to OFF, the SP AUX1 functions below are available and visible. <b>(1)</b>	
	4	Choose: GF A ON GFT ON or GF OFF	ENABLE GROUND FAULT ALARM OR TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between GF A ON, GF T ON, and <b>GF OFF</b>	
	5	Choose: I2T A ON I2T T ON or I2T OFF	ENABLE I2T ALARM OR TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between I2T A ON, <b>I2T T ON</b> , and I2T OFF	
	6	Choose: JAM A ON JAM T ON or JAM OFF	ENABLE JAM ALARM OR TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between JAM A ON, JAM T ON, and <b>JAM OFF</b>	
	7	Choose: UL A ON UL T ON or UL OFF	ENABLE UNDERLOAD ALARM OR TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between UL A ON, UL T ON, and <b>UL OFF</b>	
	8	Choose: UB A ON UB T ON or UB OFF	ENABLE PHASE UNBALANCE ALARM OR TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between UB A ON, UB T ON, and <b>UB OFF</b>	
	9	Choose: WD A ON WD T ON or WD OFF	ENABLE WINDING TEMP ALARM OR TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between WD A ON, WD T ON, and <b>WD OFF</b>	
	10	Choose: MB A ON MB T ON or MB OFF	ENABLE MOTOR BEARING ALARM OR TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between MB A ON, MB T ON, and <b>MB OFF</b>	
	11	Choose: LB A ON LB T ON or LB OFF	ENABLE LOAD BEARING ALARM OR TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between LB A ON, LB T ON, and <b>LB OFF</b>	
	12	Choose: AX A ON AX T ON or AX OFF	ENABLE AUXILIARY RTD TEMP ALARM OR TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between AX A ON, AX T ON, and <b>AX OFF</b>	
	13	Choose: SX A ON SX T ON or SX OFF	ENABLE STARTS PER TIME TRIP OR ALARM TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between SX A ON, SX T ON, and <b>SX OFF</b>	
	14	Choose: TBS T ON or TBS OFF	ENABLE TIME BETWEEN STARTS TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between TBS T ON and <b>TBS OFF</b>	
	15	RTDF ON or RTDF OFF	ENABLE INDIVIDUAL RTD CHANNEL FAILURE TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between RTDF ON and <b>RTDF OFF</b>	

**Table 4-3. View Setting Mode/Program Worksheet.**

SUB-MENU	LINE #	DISPLAY	HELP MESSAGE	SETTING RANGE/VALUE (DEFAULT SELECTION AND VALUE AS SHIPPED IN BOLD)	VALUE SELECTED
	16	RCOM ON or RCOM OFF	ENABLE RTD MODULE COMMUNICATION FAILURE TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between RCOM ON and <b>RCOM OFF</b>	
	17	IOCT ON or IOCT OFF	ENABLE INSTANTANEOUS TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between IOCT ON and <b>IOCT OFF</b>	
	18	PH R ON or PH R OFF	ENABLE PHASE REVERSAL TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between PH R ON and <b>PH R OFF</b>	
	19	INSQ ON or INSQ OFF	ENABLE INCOMPLETE SEQUENCE TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between INSQ ON and <b>INSQ OFF</b>	
	20	REMT ON or REMT OFF	ENABLE REMOTE TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between REMT ON and <b>REMT OFF</b>	
	21	DIFT ON or DIFT OFF	ENABLE DIFFERENTIAL TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between DIFT ON and <b>DIFT OFF</b>	
	22	INCT ON or INCT OFF	ENABLE INCOM TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between INCT ON and <b>INCT OFF</b>	
	23	TRNT ON or TRNT OFF	ENABLE TRANSITION TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between TRNT ON and <b>TRNT OFF</b>	
	24	ZSWT ON or ZSWT OFF	ENABLE ZERO SPEED SWITCH TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between ZSWT ON and <b>ZSWT OFF</b>	
	25	TBYP ON or TBYP OFF	ENABLE TRIP BYPASS TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between TBYP ON and <b>TBYP OFF</b>	

**PAGE 10, SP AUX2 SETTINGS FOR AUX 2 RELAY OUTPUT CONFIGURATION**

	1	TRN ON or TRN OFF	ENABLE TRANSITION OUTPUT IF ENABLED ALL OTHER FUNCTIONS FOR AUX 2 ARE DISABLED	Toggles between <b>TRN ON</b> and TRN OFF. If TRN is set to OFF, then the following SP AUX2 functions are available and visible.	
	2	Choose: GF A ON GF T ON or GF OFF	ENABLE GROUND FAULT ALARM OR TRIP TO ACTIVATE AUX 2 RELAY OUTPUT OR DISABLE	Toggles between GF A ON, GF T ON, and <b>GF OFF</b>	
	3	Choose: I2T A ON I2T T ON or V	ENABLE I2T ALARM OR TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between I2T A ON, I2T T ON, and <b>I2T OFF</b>	
	4	Choose: JAM A ON JAM T ON or JAM OFF	ENABLE JAM ALARM OR TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between JAM A ON, JAM T ON, and <b>JAM OFF</b>	
	5	Choose: UL A ON UL T ON or UL OFF	ENABLE UNDERLOAD ALARM OR TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between UL A ON, UL T ON, and <b>UL OFF</b>	
	6	Choose: UB A ON UB T ON or UB OFF	ENABLE PHASE UNBALANCE ALARM OR TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between UB A ON, UB T ON, and <b>UB OFF</b>	
	7	Choose: WD A ON WD T ON or WD OFF	ENABLE WINDING TEMP ALARM OR TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between WD A ON, WD T ON, and <b>WD OFF</b>	

**Table 4-3. View Setting Mode/Program Worksheet.**

SUB-MENU	LINE #	DISPLAY	HELP MESSAGE	SETTING RANGE/VALUE (DEFAULT SELECTION AND VALUE AS SHIPPED IN BOLD)	VALUE SELECTED
	8	Choose: MB A ON MB T ON or MB OFF	ENABLE MOTOR BEARING ALARM OR TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between MB A ON, MB T ON, and <b>MB OFF</b>	
	9	Choose: LB A ON LB T ON or LB OFF	ENABLE LOAD BEARING ALARM OR TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between LB A ON, LB T ON, and <b>LB OFF</b>	
	10	Choose: AX A ON AX T ON or AX OFF	ENABLE AUXILIARY RTD TEMP ALARM OR TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between AX A ON, AX T ON, and <b>AX OFF</b>	
	11	Choose: SX A ON SX T ON or SX OFF	ENABLE STARTS PER TIME TRIP OR ALARM TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between SX A ON, SX T ON, and <b>SX OFF</b>	
	12	Choose: TBS T ON or TBS OFF	ENABLE TIME BETWEEN STARTS TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between TBS T ON and <b>TBS OFF</b>	
	13	RTDF ON or RTDF OFF	ENABLE INDIVIDUAL RTD CHANNEL FAILURE TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between RTDF ON and <b>RTDF OFF</b>	
	14	RCOM ON or RCOM OFF	ENABLE RTD MODULE COMMUNICATION FAILURE TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between RCOM ON and <b>RCOM OFF</b>	
	15	IOC A ON IOC T ON or IOC OFF	ENABLE INSTANTANEOUS TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between IOCT ON and <b>IOCT OFF</b>	
	16	PH R ON or PH R OFF	ENABLE PHASE REVERSAL TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between PH R ON and <b>PH R OFF</b>	
	17	INSQ ON or INSQ OFF	ENABLE INCOMPLETE SEQUENCE TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between INSQ ON and <b>INSQ OFF</b>	
	18	REMT ON or REMT OFF	ENABLE REMOTE TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between REMT ON and <b>REMT OFF</b>	
	19	DIFT ON or DIFT OFF	ENABLE DIFFERENTIAL TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between DIFT ON and <b>DIFT OFF</b>	
	20	INCT ON or INCT OFF	ENABLE INCOM TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between INCT ON and <b>INCT OFF</b>	
	21	TRNT ON or TRNT OFF	ENABLE TRANSITION TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between TRNT ON and <b>TRNT OFF</b>	
	22	ZSWT ON or ZSWT OFF	ENABLE ZERO SPEED SWITCH TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between ZSWT ON and <b>ZSWT OFF</b>	
	23	TBYP ON or TBYP OFF	ENABLE TRIP BYPASS TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between TBYP ON and <b>TBYP OFF</b>	
<b>PAGE 11, SP A OUT SETTING FOR ANALOG OUTPUT CONFIGURATION</b>					
	1	MAX 100	4-20 mA OUTPUT	Select one of MAX 100, <b>MAX 125</b> , MAX WRTD or MAX %I2T	
		MAX 125	MAX 100-20 mA FOR 100% FLA		
		MAX WRTD	MAX 125-20 mA FOR 125% FLA		
		MAX %I2T	MAX WRTD - 20 mA FOR TRIP LEVEL MAX %I2T - 20 mA FOR 100% I2T		

Table 4-3. View Setting Mode/Program Worksheet.

SUB-MENU	LINE #	DISPLAY	HELP MESSAGE	SETTING RANGE/VALUE (DEFAULT SELECTION AND VALUE AS SHIPPED IN BOLD)	VALUE SELECTED
<b>PAGE 12, SP SYS SETTINGS FOR SYSTEM CONFIGURATION</b>					
	1	TP MODE X	CONFIGURE TRIP RELAY OUTPUT TO BE MODE 1 -- TRIP RELAY ENERGIZES ON TRIP EVENT OR MODE 2 --TRIP RELAY ENERGIZES ON POWER UP AND DE-ENERGIZES ON TRIP EVENT	Toggles between TP MODE 1 and <b>TP MODE2</b>	
	2	AL MODE X	CONFIGURE ALARM RELAY OUTPUT TO BE MODE 1 - ALARM RELAY ENERGIZES ON ALARM EVENT OR MODE 2 - ALARM RELAY ENERGIZES ON POWER UP AND DE-ENERGIZES ON ALARM EVENT	Toggles between AL MODE1 and <b>AL MODE2</b>	
	3	AX1 MOD X	CONFIGURE AUX1 RELAY OUTPUT TO BE MODE 1 - AUX1 RELAY ENERGIZES ON AUX1 EVENT OR MODE 2 - AUX1 RELAY ENERGIZES ON POWER UP AND DE-ENERGIZES ON AUX1 EVENT	Toggles between <b>AX1 MOD1</b> and AX1 MOD2	
	4	AX2 MOD X	CONFIGURE AUX2 RELAY OUTPUT TO BE MODE 1 - AUX2 RELAY ENERGIZES ON AUX2 EVENT OR MODE 2 - AUX2 RELAY ENERGIZES ON POWER UP AND DE-ENERGIZES ON AUX2 EVENT	Toggles between <b>AX2 MOD1</b> and AX2 MOD2	
	5	MAN I2T or AUTO I2T	AUTO OR MANUAL I2T RESET	Toggles between <b>MAN I2T</b> and AUTO I2T	
	6	RUN PGM or STOP PGM	ENABLE UNIT TO BE PROGRAMMED WHILE MOTOR IS RUNNING	Toggles between RUN PGM and <b>STOP PGM</b>	
	7	EMRG EN or EMRG DIS	EMERGENCY OVERRIDE ENABLE EMRG EN - ENABLE EMERGENCY OVERRIDE EMRG DIS - DISABLE EMERGENCY OVERRIDE	Toggles between EMRG EN and <b>EMRG DIS</b>	
	8	12 HOUR or 24 HOUR	SET MONITOR MODE CLOCK DISPLAY 12 HOUR - AM/PM TIME DISPLAYED 24 HOUR - 24 HOUR TIME DISPLAYED	Toggles between <b>12 HOUR</b> and 24 HOUR	
	9	MONTH XX	SET REAL TIME CLOCK MONTH	Month 1-12 (1 month increments) <b>(none)</b>	
	10	DAY XX	SET REAL TIME CLOCK DAY	Day 1-31 (1 day increments) <b>(none)</b>	
	11	YEAR XX	SET REAL TIME CLOCK YEAR	Year 0-99 (1 year increments) <b>(none)</b>	
	12	HOUR XX	SET REAL TIME CLOCK HOUR	Hour 0-23 (1 hour increments) <b>(none)</b>	
	13	MIN XX	SET REAL TIME CLOCK MIN	Minute 0-59 (1 min. increments) <b>(none)</b>	
	14	M D Y D M Y	SET REAL TIME DATE DISPLAY - MONTH DAY YEAR OR DAY MONTH YEAR	<b>M D Y</b> or D M Y	
	15	MP3K DIS	INCOM COMMUNICATIONS MODE	Toggle between <b>DIS</b> or EN	
			MP3K EN - MP3000 EMULATION		
			MP3K DIS - MP4000 COMMUNICATION		
	16	RLYF TRP RLYF ALM or RLYF T+A	INTERNAL DIAGNOSTIC FAILURE ACTIVATES TRIP AND OR ALARM RELAY	Toggles between RLYF TRP, RLYF ALM and <b>RLYF T+A</b>	
	17	INCT DIS or INCT EN	INCOM TRIP DISABLED OR ENABLED	Toggles between INCT DIS and <b>INCT EN</b>	
	18	DISARMED or ARMED	ARM OR DISARM TRIP RELAY WARNING DISARM WILL NOT ALLOW TRIP RELAY TO FUNCTION	Toggles between <b>ARMED</b> and DISARMED	
<b>PAGE 13, SP TEST SETTINGS FOR TESTING INPUTS AND OUTPUTS</b>					
	1	3 PHASE or 1 PHASE	SINGLE PHASE TEST MODE OR THREE PHASE PROTECTION MODE	Toggles between <b>3-PHASE</b> and 1-PHASE NOTE: 1-PHASE is for bench testing ONLY.	

**Table 4-3. View Setting Mode/Program Worksheet.**

SUB-MENU	LINE #	DISPLAY	HELP MESSAGE	SETTING RANGE/VALUE (DEFAULT SELECTION AND VALUE AS SHIPPED IN BOLD)	VALUE SELECTED
	2	TRP ENER or TRP DENR	TRP ENER - ENERGIZE TRIP RELAY TRP DENR - DE-ENERGIZE TRIP RELAY	Toggles between TRP ENER and TRP DENR Press and hold <b>Reset</b> button to perform selected test ( <b>none</b> )	
	3	ALM ENER or ALM DENR	ALM ENER - ENERGIZE ALARM RELAY ALM DENR - DE-ENERGIZE ALARM RELAY	Toggles between ALM ENER AND ALM DENR Press and hold <b>Reset</b> button to perform selected test ( <b>none</b> )	
	4	AX1 ENER or AX1 DENR	AX1 ENER - ENERGIZE AUXILIARY RELAY 1 AX1 DENR - DE-ENERGIZE AUXILIARY RELAY 1	Toggles between AX1 ENER and AX1 DENR Press and hold <b>Reset</b> button to perform selected test ( <b>none</b> )	
	5	AX2 ENER or AX2 DENR	AX2 ENER - ENERGIZE AUXILIARY RELAY 2 AX2 DENR - DE-ENERGIZE AUXILIARY RELAY 2	Toggles between AX2 ENER and AX2 DENR Press and hold <b>Reset</b> button to perform selected test ( <b>none</b> )	
	6	Choose: AOUT 4 AOUT 12 or AOUT 20	FORCE ANALOG OUTPUT 4 - FORCE A 4 mA OUTPUT 12 - FORCE A 12 mA OUTPUT 20 - FORCE A 20 mA OUTPUT	Toggle between AOUT 4, AOUT 12, and AOUT 20 Press and hold <b>Reset</b> button to output forced value ( <b>none</b> )	
	7	DI 1 OFF or DI 1 ON	STATE OF DISCRETE INPUT 1	Read only ( <b>none</b> )	
	8	DI 2 OFF or DI 2 ON	STATE OF DISCRETE INPUT 2	Read only ( <b>none</b> )	

**Page 14, SP RESET SETTINGS FOR RESETTING HISTORY MODE PAGES**

	1	MTR RST or PUSH RST	MTR RST - PUSH RAISE TO ENABLE MOTOR HISTORY RESET PUSH RST - PUSH RESET TO EXECUTE RESET OF MOTOR HISTORY OR PUSH RAISE TO NOT RESET	Change to PUSH RST and press <b>Reset</b> button, or return to MTR RST ( <b>none</b> )	
	2	TRIP RST or PUSH RST	TRIP RST - PUSH RAISE TO ENABLE TRIP HISTORY RESET PUSH RST - PUSH RESET TO EXECUTE RESET OF TRIP HISTORY OR PUSH RAISE TO NOT RESET	Change to PUSH RST and press <b>Reset</b> button, or return to TRIP RST ( <b>none</b> )	
	3	ALRM RST or PUSH RST	ALRM RST - PUSH RAISE TO ENABLE ALARM HISTORY RESET PUSH RST - PUSH RESET TO EXECUTE RESET OF ALARM HISTORY OR PUSH RAISE TO NOT RESET	Change to PUSH RST and press <b>Reset</b> button, or return to ALRM RST ( <b>none</b> )	
	4	MTR2 RST or MTR2 PUSH RST	MTR2 RST - PUSH RAISE TO ENABLE MP4000 MOTOR HISTORY RESET PUSH RST - PUSH RESET TO EXECUTE RESET OF MP4000 MOTOR HISTORY OR PUSH RAISE TO NOT RESET	Change to PUSH RST and press <b>Reset</b> button, or return to MTR2 RST ( <b>none</b> )	
	5	TRP2 RST or TRP2 PUSH RST	TRP2 RST - PUSH RAISE TO ENABLE MP4000 TRIP HISTORY RESET PUSH RST - PUSH RESET TO EXECUTE RESET OF MP4000 TRIP HISTORY OR PUSH RAISE TO NOT RESET	Change to PUSH RST and press <b>Reset</b> button, or return to TRP2 RST ( <b>none</b> )	
	6	ALM2 RST or ALM2 PUSH RST	ALM2 RST - PUSH RAISE TO ENABLE MP4000 ALARM HISTORY RESET PUSH RST - PUSH RESET TO EXECUTE RESET OF MP4000 ALARM HISTORY OR PUSH RAISE TO NOT RESET	Change to PUSH RST and press <b>Reset</b> button, or return to ALM2 RST ( <b>none</b> )	
	7	TOT RST or PUSH RST	TOT RST - PUSH RAISE TO ENABLE TOTAL HISTORY RESET PUSH RST - PUSH RESET TO EXECUTE RESET OF TOTAL HISTORY OR PUSH RAISE TO NOT RESET	Change to PUSH RST and press <b>Reset</b> button, or return to TOT RST ( <b>none</b> )	

**Table 4-3. View Setting Mode/Program Worksheet.**

SUB-MENU	LINE #	DISPLAY	HELP MESSAGE	SETTING RANGE/VALUE (DEFAULT SELECTION AND VALUE AS SHIPPED IN BOLD)	VALUE SELECTED
	8	ENG RST or PUSH RST	ENG RST - PUSH RAISE TO ENABLE ENERGY RESET PUSH RST - PUSH RESET TO EXECUTE RESET OF ENERGY OR PUSH RAISE TO NOT RESET	Change to PUSH RST and press <b>Reset</b> button, or return to ENG RST ( <b>none</b> )	
<b>Page 15, SP VUTRP SETTINGS FOR VOLTAGE UNBALANCE</b>					
	1	VPNT XXXX	V1,V2 TRIP THRESHOLD	Phase Unbalance (47-1) V1 Trip threshold 1 to 100 V in 1 V increments ( <b>50</b> )	
	2	VUT XXXX	RATIO OF V2 TO V1 TRIP THRESHOLD	4% - 40%, off 1% increments ( <b>OFF</b> )	
	3	VUSD XXXX	VOLTAGE PHASE UNBALANCE TRIP AND ALARM START DELAY	Phase Unbalance Trip & Alarm Start Delay 0-480 sec., 1 sec. increments ( <b>0</b> )	
	4	VUTR XXXX	VOLTAGE PHASE UNBALANCE TRIP RUN DELAY	47-1 Phase Unbalance Run Delay 1 to 480 sec. (1 sec. steps) ( <b>1 sec</b> )	
	5	VPNA XXXX	V1,V2 ALARM THRESHOLD	Phase Unbalance. (47-2) V2 Alarm threshold 1 to 100 V, 1 V increments ( <b>50</b> )	
	6	VUA XXXX	RATIO OF V2 TO V1 ALARM THRESHOLD	4% - 40%, off 1% increments ( <b>ON</b> )	
	7	VUAR XXXX	VOLTAGE PHASE UNBALANCE ALARM RUN DELAY	47-2 Phase unbalance Run delay 1 to 480 sec. (1 sec. steps) ( <b>1</b> )	
<b>Page 16, SP UFTRP SETTINGS FOR UNDER FREQUENCY</b>					
	1	UFT XXXX	UNDERFREQUENCY TRIP THRESHOLD	Under Frequency Trip Threshold 15 to 60, 0.01 Hz increments, <b>OFF</b>	
	2	UFSD XXXX	UNDERFREQUENCY TRIP AND ALARM START DELAY	Under Frequency Trip / Alarm Start delay <b>0-60</b> sec.) 0.1 sec. increments	
	3	UFTR XXXX	UNDERFREQUENCY TRIP RUN DELAY	Under Frequency Time Delay <b>0-60</b> sec., 0.1 sec. increments	
	4	UFA XXXX	UNDERFREQUENCY ALARM THRESHOLD	Under Frequency Threshold 15 - 60 Hz, 0.01 Hz increments, <b>OFF</b>	
	5	UFAR XXXX	UNDERFREQUENCY ALARM RUN DELAY SETTINGS FOR OVERFREQUENCY	Under Frequency Time Delay <b>0-60</b> sec., 0.1 sec. increments	
<b>Page 17, SP OFTRP SETTINGS FOR OVERFREQUENCY</b>					
	1	OFT XXXX	OVERFREQUENCY TRIP THRESHOLD	Over Frequency Trip Threshold 15 to 70, 0.1 sec. increments, <b>OFF</b>	
	2	OFSD XXXX	OVERFREQUENCY TRIP AND ALARM START DELAY	Over Frequency Trip / Alarm Start Delay <b>0-60</b> sec.	
	3	OFTR XXXX	OVERFREQUENCY TRIP RUN DELAY	Over Frequency Trip Time Delay <b>0-60</b> sec., 0.1 sec. increments	
	4	OFA XXXX	OVERFREQUENCY ALARM THRESHOLD	Over Frequency Alarm Threshold 15-70 sec., 0.1 sec. increments, <b>OFF</b>	
	5	OFAR XXXX	OVERFREQUENCY ALARM RUN DELAY	Over Frequency Alarm Time Delay <b>0-60</b> sec., 0.1 sec. increments	
<b>PAGE 18, SP SP OVTRP SETTINGS FOR OVER VOLTAGE</b>					
	1	OVPT XXXX	OVERVOLTAGE TRIP PICKUP CRITERION - SELECT - 1 - ANY PHASE 2 - ANY TWO PHASES 3 - ALL THREE PHASES	Over voltage 59 M-1 on <b>1</b> to 3 phases trip	
	2	OVT XXXX	OVERVOLTAGE MAIN TRIP THRESHOLD	Main over voltage 59 M-1 trip threshold 10 to 150 V (1 V increments) <b>OFF</b>	
	3	OVTRXXX.X	OVERVOLTAGE MAIN TRIP RUN DELAY	Main over voltage 59 M-1 delay 0 to 480 sec. ( <b>100 msec.</b> increments)	
	4	OVPA XXXX	OVERVOLTAGE ALARM PICKUP CRITERION - SELECT - 1 - ANY PHASE 2 - ANY TWO PHASES 3 - ALL THREE PHASES	Over voltage 59 M-2 on <b>1</b> to 3 phases alarm	

**Table 4-3. View Setting Mode/Program Worksheet.**

SUB-MENU	LINE #	DISPLAY	HELP MESSAGE	SETTING RANGE/VALUE (DEFAULT SELECTION AND VALUE AS SHIPPED IN BOLD)	VALUE SELECTED
	5	OVA XXXX	OVERVOLTAGE MAIN ALARM THRESHOLD	Main over voltage alarm (59 M-2) 10 - 150 V or <b>OFF</b>	
	6	OVARXXXX.X	OVERVOLTAGE MAIN ALARM RUN DELAY	Main over voltage alarm (59 M-2) time delay 0 - 480 sec., ( <b>0.1 sec.</b> increments)	
	7	OVNT XXXX	OVERVOLTAGE NEUTRAL TRIP THRESHOLD SETTING FOR UNDERVOLTAGE	Neutral over voltage trip (59 N-1) threshold 10 - 150 V, or <b>OFF</b>	
<b>PAGE 19, SP UVTRP SETTINGS FOR UNDER VOLTAGE</b>					
	1	UVPT XXXX	UNDERVOLTAGE TRIP PICKUP CRITERION - SELECT - 1 - ANY PHASE 2 - ANY TWO PHASES 3 - ALL THREE PHASES	Under voltage (27 M-1) pickup criterion <b>1</b> to 3 phases	
	2	UVT XXXX	MAIN UNDERVOLTAGE TRIP THRESHOLD	Under voltage (27 M-1) threshold 10 - 150 V, increments 1 V or <b>OFF</b>	
	3	UVTR XXXX	MAIN UNDERVOLTAGE TRIP RUN DELAY	Under voltage (27 M-1) trip run delay 0 - 60 sec., increments <b>.1 sec.</b> on mains	
	4	UVPA XXXX	UNDERVOLTAGE ALARM PICKUP CRITERION - SELECT - 1 - ANY PHASE 2 - ANY TWO PHASES 3 - ALL THREE PHASES	Under voltage (27 M-2) pickup criterion <b>1</b> - 3 phases	
	5	UVA XXXX	MAIN UNDERVOLTAGE ALARM THRESHOLD	Under voltage (27 M-2) threshold 10 - 150 V, or disabled, 1 V increments on mains ( <b>OFF</b> )	
	6	UVAR XXXX	MAIN UNDERVOLTAGE ALARM RUN DELAY	Under voltage (27 M-2) run delay 0 - 60 sec., <b>0.1 sec.</b> increments	
	7	UVSD XXXX	UNDER VOLTAGE TRIP AND ALARM START DELAY	Under voltage trip & alarm start delay <b>0</b> - 60 sec., 0.1 sec. increments	
<b>PAGE 20, SP UPTRP SETTINGS FOR UNDER POWER</b>					
	1	UPT XXXX	UNDERPOWER TRIP THRESHOLD	Under power (32) trip threshold 0.06 - 0.90 *FLA *VT, or disable ( <b>OFF</b> )	
	2	UPTR XXXX	UNDERPOWER TRIP RUN DELAY	Under power trip run delay 0 - 480 sec. ( <b>0.1 sec.</b> )	
	3	UPA XXXX	UNDERPOWER ALARM THRESHOLD	Under power (32) alarm threshold 0.06 - 0.90 *FLA *VT, or disable ( <b>OFF</b> )	
	4	UPAR XXXX	UNDERPOWER ALARM RUN DELAY	Under power alarm run delay ( <b>0</b> )	
	5	UPSD XXXX	UNDERPOWER TRIP AND ALARM START DELAY	Under power trip start delay <b>0</b> - 60 sec.	
<b>PAGE 21, SP PFTRP SETTINGS FOR POWER FACTOR</b>					
	1	PFLDE XXXX	LEADING POWER FACTOR TRIP ENABLE OR DISABLE	Power factor (55) ON or <b>OFF</b> select	
	2	PFLDT XXXX	LEADING POWER FACTOR TRIP THRESHOLD	Power factor trip threshold range from (0.05 - 0.99) leading, 0.01 increments ( <b>.90</b> )	
	3	PFLGE XXXX	LAGGING POWER FACTOR TRIP ENABLE OR DISABLE	Power factor (55) ON or <b>OFF</b> select	
	4	PFLGT XXXX	LAGGING POWER FACTOR TRIP THRESHOLD	Power factor trip threshold range from 0.05 - 0.99 lagging, 0.01 increments ( <b>0.90</b> )	
	5	PFTS XXXX	POWER FACTOR TRIP START DELAY	Power factor start delay 0 - 60 sec., 100 msec. increments	
	6	PFTR XXXX	POWER FACTOR TRIP RUN DELAY	Power factor trip run delay <b>0</b> - 60 sec., 100 msec. increments	
	7	LDPFE XXXX	LEADING POWER FACTOR ALARM ENABLE OR DISABLE	Power factor (55) alarm enable or disable select, leading ( <b>ON</b> )	
	8	PFLDA XXXX	LEADING POWER FACTOR ALARM THRESHOLD	Power factor alarm threshold range from 0.05 - 0.99 leading, 0.01 increments ( <b>.90</b> )	

**Table 4-3. View Setting Mode/Program Worksheet.**

SUB-MENU	LINE #	DISPLAY	HELP MESSAGE	SETTING RANGE/VALUE (DEFAULT SELECTION AND VALUE AS SHIPPED IN BOLD)	VALUE SELECTED
	9	LGPFE XXXX	LAGGING POWER FACTOR ALARM ENABLE OR DISABLE	Power factor (55) alarm enable or disable select lagging ( <b>ON</b> )	
	10	PFLGA XXXX	LAGGING POWER FACTOR ALARM THRESHOLD	Power factor alarm threshold range from 0.05 - 0.99 lagging, 0.01 increments ( <b>0.90</b> )	
	11	PFAS XXXX	POWER FACTOR ALARM START DELAY	Power factor alarm start delay <b>0</b> - 60 sec., 100 msec. increments	
	12	PFAR XXXX	POWER FACTOR ALARM RUN DELAY	Power factor alarm run delay <b>0</b> - 60 sec , 100 msec. increments	

**PAGE 22, SP2 AREL SETTINGS FOR ALARM RELAY OUTPUT CONFIGURATION**

	1	Choose: VU T ON VU A ON VU OFF	ENABLE VOLTAGE UNBALANCE ALARM OR TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between VUT ON, VUA ON, <b>VU OFF</b>	
	2	Choose: OV T ON OV A ON OV OFF	ENABLE OVERVOLTAGE ALARM OR TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between OVT ON, OVA ON, <b>OV OFF</b>	
	3	Choose: UV T ON UV A ON UV OFF	ENABLE UNDERVOLTAGE ALARM OR TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between UVT ON, UVA ON, <b>UV OFF</b>	
	4	Choose: OFT ON OFA ON OF OFF	ENABLE OVERFREQUENCY ALARM OR TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between OF T ON, OF A ON, <b>OF OFF</b>	
	5	Choose: UF T ON UF A ON UF OFF	ENABLE UNDERFREQUENCY ALARM OR TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between UF T ON, UF A ON, <b>UF OFF</b>	
	6	Choose: UP T ON UP A ON UP OFF	ENABLE UNDERPOWER ALARM OR TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between UP T ON, UP A ON, <b>UP OFF</b>	
	7	Choose: PF T ON PF A ON PF OFF	ENABLE POWER FACTOR ALARM OR TRIP TO ACTIVATE ALARM RELAY OUTPUT OR DISABLE	Toggles between PF T ON, PF A ON, <b>PF OFF</b>	

**PAGE 23, SP2 AUX1 SETTINGS FOR AUX 1 RELAY OUTPUT CONFIGURATION**

	1	Choose: VU A ON VU T ON VU OFF	ENABLE VOLTAGE UNBALANCE ALARM OR TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between VUT ON, VUA ON, <b>VU OFF</b>	
	2	Choose: OV A ON OV T ON OV OFF	ENABLE OVERVOLTAGE ALARM OR TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between OVT ON, OVA ON, <b>OV OFF</b>	
	3	Choose: UV A ON UV T ON UV OFF	ENABLE UNDERVOLTAGE ALARM OR TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between UVT ON, UVA ON, <b>UV OFF</b>	
	4	Choose: OF A ON OF T ON OF OFF	ENABLE OVERFREQUENCY ALARM OR TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between OF T ON, OF A ON, <b>OF OFF</b>	
	5	Choose: UF A ON UF T ON UF OFF	ENABLE UNDERFREQUENCY ALARM OR TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between UF T ON, UF A ON, <b>UF OFF</b>	



**Table 4-3. View Setting Mode/Program Worksheet.**

SUB-MENU	LINE #	DISPLAY	HELP MESSAGE	SETTING RANGE/VALUE (DEFAULT SELECTION AND VALUE AS SHIPPED IN BOLD)	VALUE SELECTED
	6	Choose: UP A ON UP T ON UP OFF	ENABLE UNDERPOWER ALARM OR TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between UP T ON, UP A ON, <b>UP OFF</b>	
	7	Choose: PF A ON PF T ON PF OFF	ENABLE POWER FACTOR ALARM OR TRIP TO ACTIVATE AUX1 RELAY OUTPUT OR DISABLE	Toggles between PF T ON, PF A ON, <b>PF OFF</b>	
<b>PAGE 24, SP2 AUX2 SETTINGS FOR AUX 2 RELAY OUTPUT CONFIGURATION</b>					
	1	Choose: VU A ON VU T ON VU OFF	ENABLE VOLTAGE UNBALANCE ALARM OR TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between VUT ON, VUA ON, <b>VU OFF</b>	
	2	Choose: OV A ON OV T ON OV OFF	ENABLE OVERVOLTAGE ALARM OR TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between OVT ON, OVA ON, <b>OV OFF</b>	
	3	Choose: UV A ON UV T ON UV OFF	ENABLE UNDERVOLTAGE ALARM OR TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between UVT ON, UVA ON, <b>UV OFF</b>	
	4	Choose: OF A ON OF T ON OF OFF	ENABLE OVERFREQUENCY ALARM OR TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between OF T ON, OF A ON, <b>OF OFF</b>	
	5	Choose: UF A ON UF T ON UF OFF	ENABLE UNDERFREQUENCY ALARM OR TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between UF T ON, UF A ON, <b>UF OFF</b>	
	6	Choose: UP A ON UP T ON UP OFF	ENABLE UNDERPOWER ALARM OR TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between UP T ON, UP A ON, <b>UP OFF</b>	
	7	Choose: PF A ON PF T ON PF T OFF	ENABLE POWER FACTOR ALARM OR TRIP TO ACTIVATE AUX2 RELAY OUTPUT OR DISABLE	Toggles between PF T ON, PF A ON, <b>PF OFF</b>	
<b>PAGE 25, SP2 SYS SETTINGS FOR SYSTEM CONFIGURATION</b>					
	1	WH XXX	SETTING FOR ACTIVE ENERGY WATT- HOUR DISPLAY - NORMAL OR KILO OR GIGA	Select <b>KILO</b> , MEGA, or GIGA	
	2	VARH XX	SETTING FOR REACTIVE ENERGY VARH DISPLAY - NORMAL OR KILO OR GIGA	Select <b>KILO</b> , MEGA, or GIGA	
	3	VAH XXX	SETTING FOR APPARENT ENERGY VAH DISPLAY - NORMAL OR KILO OR GIGA	Select <b>KILO</b> , MEGA, or GIGA	
	4	WATT XXX	SETTING FOR ACTIVE POWER WATT DISPLAY - NORMAL OR KILO OR MEGA	Select NORMAL, <b>KILO</b> , or MEGA	
	5	VAR XXX	SETTING FOR REACTIVE POWER VAR DISPLAY - NORMAL OR KILO OR MEGA	Select NORMAL, <b>KILO</b> , or MEGA	
	6	VA XXX	SETTING FOR APPARENT POWER VA DISPLAY - NORMAL OR KILO OR MEGA	Select NORMAL, <b>KILO</b> , or MEGA	
	7	PTR XXX	RATIO OF EXTERNAL PT	1 - 250:1, 0.01 increments ( <b>34.6</b> )	
	8	XFMR XXX	XFMR CONFIGURATION - SELECT - WYE, DELTA, OPEN DELTA	Select 0 = WYE, 1= DELTA, 2 = <b>OPEN DELTA</b>	
	9	VOLT XXX	SETTING FOR VOLTAGE DISPLAY - VOLTS OR KILO VOLTS	Select VOLTS or <b>KILOVOLTS</b>	
<b>PAGE 26, SP COMM SETTINGS FOR RS-232 COMMUNICATIONS</b>					
	1	232 XXX	RS232 COMMUNICATION - ON OR OFF	Select RS-232 communications, either ON or <b>OFF</b>	

**Table 4.4 History Mode Display.**

PAGE	LINE	DISPLAY	COMPLETE HELP MESSAGE	DESCRIPTION
HIST MTR			HISTORY OF MOTOR STATISTICS	
	OCNT XX	OCNT XX	OPERATION COUNT SINCE LAST RESET	Number of motor starts logged since last reset.
		MM/DD/YY	DATE OF RESET	Date when OCNT was reset.
		HH:MM:SS	TIME OF RESET	Time when OCNT was reset.
	RT XXXX	RT XXXX	RUN TIME IN HOURS SINCE LAST RESET	Total motor run time accumulated since last reset.
		MM/DD/YY	DATE OF RESET	Date when RT was reset.
		HH:MM:SS	TIME OF RESET	Time when RT was reset.
	IMS XXXX	IMS XXXX	HIGHEST STARTING PHASE CURRENT	Highest starting phase current monitored since last reset.
		MM/DD/YY	DATE OF EVENT	Date of highest IMS.
		HH:MM:SS	TIME OF EVENT	Time of highest IMS.
	IMR XXXX	IMR XXXX	HIGHEST RUNNING PHASE CURRENT	Highest running phase current monitored since last reset.
		MM/DD/YY	DATE OF EVENT	Date of highest IMR.
		MM/DD/YY	TIME OF EVENT	Time of highest IMR.
	UBM XXX	UBM XXX	HIGHEST PHASE UNBALANCE	Maximum phase unbalance monitored since last reset.
		MM/DD/YY	DATE OF EVENT	Date of highest phase unbalance.
		HH:MM:SS	TIME OF EVENT	Time of highest phase unbalance.
	WMX XXXX	WMX XXXX	HIGHEST MOTOR WINDING TEMPERATURE IN DEGREES C (F)	Maximum motor winding temperature monitored since last reset.
		MM/DD/YY	DATE OF EVENT	Date of highest WMX.
		HH:MM:SS	TIME OF EVENT	Time of highest WMX.
	MBX XXXX	MBX XXXX	HIGHEST MOTOR BEARING TEMPERATURE IN DEGREES C (F)	Maximum motor bearing temperature monitored since last reset.
		MM/DD/YY	DATE OF EVENT	Date of highest MBX.
		HH:MM:SS	TIME OF EVENT	Time of highest MBX.
	LBX XXXX	LMX XXXX	HIGHEST LOAD BEARING TEMPERATURE IN DEGREES C (F)	Maximum load bearing temperature monitored since last reset.
		MM/DD/YY	DATE OF EVENT	Date of highest LMX.
		HH:MM:SS	TIME OF EVENT	Time of highest LMX.
	EMOR XXX	EMOR XXX	NUMBER OF EMERGENCY OVERRIDES SINCE LAST RESET	Total number of emergency overrides performed since reset.
		MM/DD/YY	DATE OF RESET	Date EMOR was reset.
		HH:MM:SS	TIME OF RESET	Time EMOR was reset.
	VUM XXXX	VUM XXXX	HIGHEST VOLTAGE UNBALANCE SINCE LAST RESET	Time stamped maximum voltage unbalance since last reset.
		MM/DD/YY	DATE OF RESET	Date when VMU was reset.
		HH:MM:SS	TIME OF RESET	Time when VMU was reset.
	VPL XXXX	VPL	LOWEST RUNNING PHASE VOLTAGE SINCE LAST RESET	Lowest run time phase voltage since last reset.
		MM/DD/YY	DATE OF RESET	Date when VPL was reset.
		HH:MM:SS	TIME OF RESET	Time when VPL was reset.
	VPM XXXX	VPM XXXX	HIGHEST PHASE VOLTAGE SINCE LAST RESET	
		MM/DD/YY	DATE OF RESET	Date when VPM was reset.
		HH:MM:SS	TIME OF RESET	Time when VPM was reset.
HIST TRP			HISTORY OF TRIP EVENTS	
	GF T XX	GF T XX	NUMBER OF GROUND FAULT TRIPS SINCE LAST RESET	Total number of respective trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when respective trip function was reset.
		HH:MM:SS	TIME OF RESET	Time when respective trip function was reset.

**Table 4.4 History Mode Display.**

PAGE	LINE	DISPLAY	COMPLETE HELP MESSAGE	DESCRIPTION
	I2TT XX	I2TT XX	NUMBER OF I2T TRIPS SINCE LAST RESET	Total number of I2T trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when I2T trip function was reset.
		HH:MM:SS	TIME OF RESET	Time when I2T trip function was reset.
	IOCT XX	IOCT XX	NUMBER OF INSTANTANEOUS OVER CURRENT TRIPS SINCE LAST RESET	Total number of instantaneous over current trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when instantaneous over current trip function was reset.
		HH:MM:SS	TIME OF RESET	Time when instantaneous over current trip function was reset.
	JAMT XX	JAMT XX	NUMBER OF JAM TRIPS SINCE LAST RESET	Total number of jam trips that occurred since reset.
		MM/DD/YY	DATE FO RESET	Date when jam trip function was reset.
		HH:MM:SS	TIME OF RESET	Time when jam trip function was reset.
	UL T XX	UL T XX	NUMBER OF UNDERLOAD TRIPS SINCE LAST RESET	Total number of underload trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when underload trip function was reset.
		HH:MM:SS	TIME OF RESET	Time when underload trip function was reset.
	UB T XX	UB T XX	NUMBER OF PHASE UNBALANCE TRIPS SINCE LAST RESET	Total number of phase unbalance trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when phase unbalance trip function was reset.
		HH:MM:SS	TIME OF RESET	Time when phase unbalance trip function was reset.
	WD T XX	WD T XX	NUMBER OF WINDING TEMPERATURE TRIPS SINCE LAST RESET	Total number of winding temperature trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when winding temperature trip function was reset.
		HH:MM:SS	TIME OF RESET	Time when winding temperature trip function was reset.
	MB T XX	MB T XX	NUMBER OF MOTOR BEARING TEMPERATURE TRIPS SINCE LAST RESET	Total number of motor bearing temperature trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when motor bearing temperature trip function was reset.
		HH:MM:SS	TIME OF RESET	Time when motor bearing temperature trip function was reset.
	LB T XX	LB T XX	NUMBER OF LOAD BEARING TEMPERATURE TRIPS SINCE LAST RESET	Total number of load bearing temperature trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when load bearing temperature trip function was reset.
		HH:MM:SS	TIME OF RESET	Time when load bearing temperature trip function was reset.
	AX T XX	AX T XX	NUMBER OF AUXILIARY TEMPERATURE TRIPS SINCE LAST RESET	Total number of auxiliary temperature trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when auxiliary temperature trip function was reset.
		HH:MM:SS	TIME OF RESET	Time when auxiliary temperature trip function was reset.
	PHRT XX	PHRT XX	NUMBER OF PHASE REVERSAL TRIPS SINCE LAST RESET	Total number of phase reversal trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when phase reversal trip function was reset.
		HH:MM:SS	TIME OF RESET	Time when phase reversal trip function was reset.
	ISQT XX	ISQT XX	NUMBER OF INCOMPLETE SEQUENCE TRIPS SINCE LAST RESET	Total number of incomplete sequence trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when incomplete sequence trip function was reset.
		HH:MM:SS	TIME OF RESET	Time when incomplete sequence trip function was reset.
	REMT XX	REMT XX	NUMBER OF REMOTE TRIPS SINCE LAST RESET	Total number of remote trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when remote trip function was reset.
		HH:MM:SS	TIME OF RESET	Time when remote trip function was reset.
	DIFT XX	DIFT XX	NUMBER OF DIFFERENTIAL TRIPS SINCE LAST RESET	Total number of differential trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when differential trip function was reset.
		HH:MM:SS	TIME OF RESET	Time when differential trip function was reset.

**Table 4.4 History Mode Display.**

PAGE	LINE	DISPLAY	COMPLETE HELP MESSAGE	DESCRIPTION
	INCT XX	INCT XX	NUMBER OF INCOM REMOTE TRIPS SINCE LAST RESET	Total number of INCOM remote trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when INCOM remote trip function was reset.
		HH:MM:SS	TIME OF RESET	Time when INCOM remote trip function was reset.
	STXT XX	STXT XX	NUMBER OF STARTS PER TIME SINCE LAST RESET	Total number of starts per time that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when number of starts per time function was reset.
		HH:MM:SS	TIME OF RESET	Time when number of starts per time function was reset.
	TBST XX	TBST XX	NUMBER OF TIME BETWEEN STARTS PER TIME TRIPS SINCE LAST RESET	Total number of time between starts per time trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when time between starts per time trips function was reset.
		HH:MM:SS	TIME OF RESET	Time when time between starts per time trips function was reset.
	TRNT XX	TRNT XX	NUMBER OF TRANSITION TRIPS SINCE LAST RESET	Total number of transition trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when transition trips function was reset.
		HH:MM:SS	TIME OF RESET	Time when transition trips function was reset.
	TBYT XX	TBYT XX	NUMBER OF TRIP BYPASS TRIPS SINCE LAST RESET	Total number of trip bypass trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when trip bypass trips function was reset.
		HH:MM:SS	TIME OF RESET	Time when trip bypass trips function was reset.
	ZSWT XX	ZSWT XX	NUMBER OF ZERO SPEED SWITCH TRIPS SINCE LAST RESET	Total number of zero speed switch trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when zero speed switch trips function was reset.
		HH:MM:SS	TIME OF RESET	Time when zero speed switch trips function was reset.
	VU T XX	VU T XX	NUMBER OF VOLTAGE UNBALANCE TRIPS SINCE LAST RESET	Total number of voltage unbalance trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when voltage unbalance trips function was reset.
		HH:MM:SS	TIME OF RESET	Time when voltage unbalance trips function was reset.
	UF T XX	UF T XX	NUMBER OF UNDERFREQUENCY TRIPS SINCE LAST RESET	Total number of under frequency trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when under frequency trips function was reset.
		HH:MM:SS	TIME OF RESET	Time when under frequency trips function was reset.
	OF T XX	OF T XX	NUMBER OF OVERFREQUENCY TRIPS	Total number of over frequency trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when over frequency trips function was reset.
		HH:MM:SS	TIME OF RESET	Time when over frequency trips function was reset.
	OV T XX	OV T XX	NUMBER OF OVERVOLTAGE TRIPS SINCE LAST RESET	Total number of over voltage trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when over voltage trips function was reset.
		HH:MM:SS	TIME OF RESET	Time when over voltage trips function was reset.
	UV T XX	UV T XX	NUMBER OF UNDERVOLTAGE TRIPS SINCE LAST RESET	Total number of under voltage trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when under voltage trips function was reset.
		HH:MM:SS	TIME OF RESET	Time when under voltage trips function was reset.
	UP T XX	UP T XX	NUMBER OF UNDERPOWER TRIPS SINCE LAST RESET	Total number of under power trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when under power trips function was reset.
		HH:MM:SS	TIME OF RESET	Time when under power trips function was reset.
	PF T XX	PF T XX	NUMBER OF POWER FACTOR TRIPS SINCE LAST RESET	Total number of power factor trips that occurred since reset.
		MM/DD/YY	DATE OF RESET	Date when power factor trip function was reset.
		HH:MM:SS	TIME OF RESET	Time when power factor function was reset.
HIST ALM			HISTORY OF ALARM EVENTS	
	GFA XX	GFA XX	NUMBER OF GROUND FAULT ALARMS SINCE LAST RESET	Total number of ground fault alarms that occurred since reset.

**Table 4.4 History Mode Display.**

PAGE	LINE	DISPLAY	COMPLETE HELP MESSAGE	DESCRIPTION
		MM/DD/YY	DATE OF RESET	Date when ground fault alarms function was reset.
		HH:MM:SS	TIME OF RESET	Time when ground fault alarms function was reset.
	I2TA XX	I2TA XX	NUMBER OF I2T ALARMS SINCE LAST RESET	Total number of I2T alarms that occurred since last reset.
		MM/DD/YY	DATE OF RESET	Date when I2T alarms function was reset.
		HH:MM:SS	TIME OF RESET	Time when I2T alarms function was reset.
	JAMA XX	JAMA XX	NUMBER OF JAM ALARMS SINCE LAST RESET	Total number of jam alarms that occurred since last reset.
		MM/DD/YY	DATE OF RESET	Date when jam alarms function was reset.
		HH:MM:SS	TIME OF RESET	Time when jam alarms function was reset.
	ULA XX	ULA XX	NUMBER OF UNDERLOAD ALARMS SINCE LAST RESET	Total number of underload alarms that occurred since last reset.
		MM/DD/YY	DATE OF RESET	Date when underload alarms function was reset.
		HH:MM:SS	TIME OF RESET	Time when jam alarms function was reset.
	UBA XX	UBA XX	NUMBER OF PHASE UNBALANCE ALARMS SINCE LAST RESET	Total number of phase unbalance alarms that occurred since last reset.
		MM/DD/YY	DATE OF RESET	Date when phase unbalance alarms function was reset.
		HH:MM:SS	TIME OF RESET	Time when phase unbalance alarms function was reset.
	WDA XX	WDA XX	NUMBER OF WINDING TEMPERATURE ALARMS SINCE LAST RESET	Total number of winding temperature alarms that occurred since last reset.
		MM/DD/YY	DATE OF RESET	Date when winding temperature alarms function was reset.
		HH:MM:SS	TIME OF RESET	Time when winding temperature alarms function was reset.
	MBA XX	MBA XX	NUMBER OF MOTOR BEARING TEMPERATURE ALARMS SINCE LAST RESET	Total number of motor bearing temperature alarms that occurred since last reset.
		MM/DD/YY	DATE OF RESET	Date when motor bearing temperature alarms function was reset.
		HH:MM:SS	TIME OF RESET	Time when motor bearing temperature alarms function was reset.
	LBA XX	LBA XX	NUMBER OF LOAD BEARING TEMPERATURE ALARMS SINCE LAST RESET	Total number of load bearing temperature alarms that occurred since last reset.
		MM/DD/YY	DATE OF RESET	Date when load bearing temperature alarms function was reset.
		HH:MM:SS	TIME OF RESET	Time when load bearing temperature alarms function was reset.
	AX A XX	AX A XX	NUMBER OF AUXILIARY TEMPERATURE ALARMS SINCE LAST RESET	Total number of auxiliary temperature alarms that occurred since last reset.
		MM/DD/YY	DATE OF RESET	Date when auxiliary temperature alarms function was reset.
		HH:MM:SS	TIME OF RESET	Time when auxiliary temperature alarms function was reset.
	STXA XX	STXA XX	NUMBER OF STARTS PER TIME ALARMS SINCE LAST RESET	Total number of starts per time alarms that occurred since last reset.
		MM/DD/YY	DATE OF RESET	Date when starts per time alarms function was reset.
		HH:MM:SS	TIME OF RESET	Time when starts per time alarms function was reset.
	RTDF XX	RTDF XX	NUMBER OF RTD CHANNEL FAILURE ALARMS SINCE LAST RESET	Total number of RTD channel failure alarms that occurred since last reset.
		MM/DD/YY	DATE OF RESET	Date when RTD channel failure alarms function was reset.
		HH:MM:SS	TIME OF RESET	Time when starts per time alarms function was reset.
	URTD XX	URTD XX	NUMBER OF URTD COMMUNICATION FAILURE ALARMS SINCE LAST RESET	Total number of URTD communication failure alarms that occurred since last reset.
		MM/DD/YY	DATE OF RESET	Date when URTD communication failure alarms function was reset.
		HH:MM:SS	TIME OF RESET	Time when URTD communication failure alarms function was reset.
	VU A XX	VU A XX	NUMBER OF VOLTAGE UNBALANCE ALARMS SINCE LAST RESET	Total number of voltage unbalance alarms that occurred since last reset.
		MM/DD/YY	DATE OF RESET	Date when voltage unbalance failure alarms function was reset.
		HH:MM:SS	TIME OF RESET	Time when voltage unbalance failure alarms function was reset.
	UF A XX	UF A XX	NUMBER OF UNDERFREQUENCY ALARMS SINCE LAST RESET	Total number of voltage unbalance alarms that occurred since last reset.
		MM/DD/YY	DATE OF RESET	Date when voltage unbalance failure alarms function was reset.

**Table 4.4 History Mode Display.**

PAGE	LINE	DISPLAY	COMPLETE HELP MESSAGE	DESCRIPTION
		HH:MM:SS	TIME OF RESET	Time when voltage unbalance failure alarms function was reset.
	OF A XX	OF A XX	NUMBER OF OVERFREQUENCY ALARMS SINCE LAST RESET	Total number of over frequency alarms that occurred since last reset.
		MM/DD/YY	DATE OF RESET	Date when over frequency failure alarms function was reset.
		HH:MM:SS	TIME OF RESET	Time when over frequency failure alarms function was reset.
	OV A XX	OV A XX	NUMBER OF OVERVOLTAGE ALARMS SINCE LAST RESET	Total number of over voltage alarms that occurred since last reset.
		MM/DD/YY	DATE OF RESET	Date when over voltage failure alarms function was reset.
		HH:MM:SS	TIME OF RESET	Time when over voltage failure alarms function was reset.
	UV A XX	UV A XX	NUMBER OF UNDERVOLTAGE ALARMS SINCE LAST RESET	Total number of under voltage alarms that occurred since last reset.
		MM/DD/YY	DATE OF RESET	Date when under voltage failure alarms function was reset.
		HH:MM:SS	TIME OF RESET	Time when under voltage failure alarms function was reset.
	UP A XX	UP A XX	NUMBER OF UNDERPOWER ALARMS SINCE LAST RESET	Total number of under power alarms that occurred since last reset.
		MM/DD/YY	DATE OF RESET	Date when under power failure alarms function was reset.
		HH:MM:SS	TIME OF RESET	Time when under power failure alarms function was reset.
	FP A XX	FP A XX	NUMBER OF POWER FACTOR ALARMS SINCE LAST RESET	Total number of power factor alarms that occurred since last reset.
		MM/DD/YY	DATE OF RESET	Date when power factor alarms function was reset.
		HH:MM:SS	TIME OF RESET	Time when power factor alarms function was reset.
HIST TOT			HISTORY TOTALS FOR MOTOR	
	TRPS		TOTAL NUMBER OF TRIPS SINCE RESET	Total number of trips that occurred since last reset.
			DATE OF RESET	Date when trips function was reset.
			TIME OF RESET	Time when trips function was reset.
	TRT XXXX		TOTAL RUN TIME SINCE RESET	Total motor run time since last reset.
			DATE OF RESET	Date when total motor run time function was reset.
			TIME OF RESET	Time when total motor run time function was reset.
	TOCS XXXX		TOTAL OPERATION COUNT SINCE RESET	Total operation count since last reset.
			DATE OF RESET	Date when total operation function was reset.
			TIME OF RESET	Time when total operation function was reset.

**Table 4-5. Log Mode Display.**

SUB-MENU	LINE	DISPLAY	COMPLETE HELP MESSAGE	DESCRIPTION
LOG			LOG OF EVENTS MODE	
LOG BOOK			LOG BOOK OF THE LAST 100 EVENTS	
	START		START EVENT - A STOP TO START TRANSITION WAS MADE	First event recorded. For example, the event could be any of the following six types: Start, stop, emergency override, exiting program mode, alarm condition, or trip condition. The events listed in the Line column show all of the different types of events. But a true LOG BOOK page has any number of different events in the order that they occur. From the LOG BOOK display, press line up pushbutton to see the latest event. Press it again for the next most recent event and so on. From the LOG BOOK display, press the line down pushbutton to see the oldest logged event. Press it again to see the next oldest and so on.
		MM/DD/YY	DATE OF LOGGED EVENT	Date that event occurred.
		HH.MM.SS	TIME OF LOGGED EVENT	Time that event occurred.
	STOP		STOP EVENT - A TRANSITION TO THE STOP STATE WAS MADE	
		MM/DD/YY	DATE OF LOGGED EVENT	Date that event occurred.
		HH.MM.SS	TIME OF LOGGED EVENT	Time that event occurred.

**Table 4-5. Log Mode Display.**

SUB-MENU	LINE	DISPLAY	COMPLETE HELP MESSAGE	DESCRIPTION
	EMRG OVR		EMERGENCY OVERRIDE EVENT - AN EMERGENCY OVERRIDE WAS PERFORMED	Emergency override can be activated from the front face plate, from a programmed discrete input, or over the communications network.
			DATE OF LOGGED EVENT	Date that event occurred.
			TIME OF LOGGED EVENT	Time that event occurred.
	SET CHNG		PROGRAM MODE EXIT - POSSIBLE SET POINT CHANGES	Recorded every time the program mode is normally exited. This can occur with the second press of the Prog pushbutton, or over the communications network.
		MM/DD/YY	DATE OF LOGGED EVENT	Date that event occurred.
		HH.MM.SS	TIME OF LOGGED EVENT	Time that event occurred.
	RESET		RESET EVENT - A RESET EVENT CLEARED A TRIP OR ALARM	Logged only when a trip or alarm event was cleared. This can be done through the front face panel Reset pushbutton, by a programmed discrete input activation, or over the communications network.
		MM/DD/YY	DATE OF LOGGED EVENT	Date that event occurred.
	TRIP BYPASS		TRIP BYPASS < JUMPER BYPASS OF MP-4000 TRIP RELAY >	
		MM/DD/YY	DATE OF LOGGED EVENT	Date that event occurred.
		HH.MM.SS	TIME OF LOGGED EVENT	Time that event occurred.
	PH UNBAL		PHASE UNBALANCE TRIP	
		HH.MM	TIME OF LOGGED EVENT	Time that event occurred.
	TRIP		(Description of trip event)	For a complete list of trips with help messages, refer to the trip conditions in Table 12.2 and the internal diagnostics failure messages in Table 12.4.
		MM/DD/YY	DATE OF LOGGED EVENT	Date that event occurred.
		HH.MM	TIME OF LOGGED EVENT	Time that event occurred.
	ALARM		(Description of alarm event)	For a complete list of alarms with help messages, refer to the alarm conditions in Table 12.2 and the internal diagnostics failure messages in Table 12.4.
		MM/DD/YY	DATE OF LOGGED EVENT	Date that event occurred.
		HH.MM	TIME OF LOGGED EVENT	Time that event occurred.
LOG EVNT			DETAILED LOG OF THE LAST 20 ABNORMAL EVENTS	This page contains detailed troubleshooting information for all trip and alarm events. The events are logged chronologically. From this display, press the line up pushbutton to get the most recent event. Press it again for the next most recent event and so on. From this display, press the line down pushbutton to get the oldest event. Press it again for the next oldest event.
	T BYPASS		TRIP BYPASS < JUMPER BYPASS OF MP-4000 TRIP RELAY >	A trip or alarm event was logged. For a complete list, refer to the trip conditions in Table 12.2 and the internal diagnostics failure messages in Table 12.4.
		MM/DD/YY	DATE OF EVENT	Date that event occurred.
		HH.MM.SS	TIME OF EVENT	Time that event occurred.
		IA XXX	PHASE A CURRENT IN AMPS AT TIME OF EVENT	Phase current in amps at time of trip.
		IB XXX	PHASE B CURRENT IN AMPS AT TIME OF EVENT	
		IC XXX	PHASE C CURRENT IN AMPS AT TIME OF EVENT	
		IG XXX	GROUND FAULT CURRENT IN AMPS AT TIME OF EVENT	Ground fault current in amps at time of trip.
		%I2T XXX	PERCENT OF I2T TRIP LEVEL AT TIME OF EVENT	Percentage of thermal bucket used at time of trip.
		%UB XXX	PHASE UNBALANCE AT TIME OF THE EVENT - IF POSITIVE THE RATIO OF NEGATIVE TO POSITIVE SEQUENCE CURRENT - IF NEGATIVE THE INVERSE	Percentage of sequence current unbalance at time of trip.
		WT1 XXX	WINDING TEMP 1 IN DEGREES (F OR C) AT TIME OF EVENT	RTD temperatures at time of trip.
		WT2 XXX	WINDING TEMP 2 IN DEGREES (F OR C) AT TIME OF EVENT	RTD temperatures at time of trip.
		WT3 XXX	WINDING TEMP 3 IN DEGREES (F OR C) AT TIME OF EVENT	RTD temperatures at time of trip.

Table 4-5. Log Mode Display.

SUB-MENU	LINE	DISPLAY	COMPLETE HELP MESSAGE	DESCRIPTION
		WT4 XXX	WINDING TEMP 4 IN DEGREES (F OR C) AT TIME OF EVENT	RTD temperatures at time of trip.
		WT5 XXX	WINDING TEMP 5 IN DEGREES (F OR C) AT TIME OF EVENT	RTD temperatures at time of trip.
		WT6 XXX	WINDING TEMP 6 IN DEGREES (F OR C) AT TIME OF EVENT	RTD temperatures at time of trip.
		MT1 XXX	MOTOR BEARING TEMP 1 IN DEGREES (F OR C) AT TIME OF EVENT	RTD temperatures at time of trip.
		MT2 XXX	MOTOR BEARING TEMP 2 IN DEGREES (F OR C) AT TIME OF EVENT	RTD temperatures at time of trip.
		LT1 XXX	LOAD BEARING TEMP 1 IN DEGREES (F OR C) AT TIME OF EVENT	RTD temperatures at time of trip.
		LT2 XXX	LOAD BEARING TEMP 2 IN DEGREES (F OR C) AT TIME OF EVENT	RTD temperatures at time of trip.
		AXT XXX	AUXILIARY TEMP IN DEGREES (F OR C) AT TIME OF EVENT	RTD temperatures at time of trip.
	TRIP OR ALARM			
		VAB XXX	PHASE TO PHASE VAB VOLTAGE AT TIME OF EVENT	Phase-to-phase voltage VAB at time of event.
		VBC XXX	PHASE TO PHASE VBC VOLTAGE AT TIME OF EVENT	Phase-to-phase voltage VBC at time of event.
		VCA XXX	PHASE TO PHASE VCA VOLTAGE AT TIME OF EVENT	Phase-to-phase voltage VCA at time of event.
		VA XXX	PHASE TO PHASE VAN AT TIME OF EVENT	Voltage phase A to neutral at time of event.
		VB XXX	PHASE TO PHASE VBN AT TIME OF EVENT	Voltage phase B to neutral at time of event.
		VC XXX	PHASE TO PHASE VCN AT TIME OF EVENT	Voltage phase C to neutral at time of event.
		%VUB XXX	PERCENTAGE VOLTAGE PHASE UNBALANCE	% voltage phase unbalance.



## SECTION 5 - PROGRAMMING THE MP-4000

### 5.0 General

You can change MP-4000 settings in the Program mode. Before changing settings, read this entire section as well as Section 9 - Application and Settings, for a full understanding of the settings and the relay functions they control. This section summarizes the functions of all of the settings. Section 9 provides more detailed engineering explanation for selected settings that require it.

Open the front panel security door and press the Prog(ram) pushbutton to place the MP-4000 into the Program mode (see Figure 4.1). Table 4.3 can be used as both a guide and a worksheet for programming. The Page and Line pushbuttons permit the User to navigate through the Program mode. The Value pushbuttons allow the setting values to be changed.

An MP-4000, which is protecting a running motor, can only be re-programmed after pressing the Prog pushbutton, pressing the Page pushbutton 12 times, and pressing the Line pushbutton 6 times. Refer to Subsection 5.12.6.

The MP-4000 continues to protect the motor with its prior settings as the values are manipulated in the Program mode. Changes to the settings do not take effect until the Prog button is pressed a second time to exit the Program mode.

Make sure the motor is in a stable state before programming. If the operating state of the motor changes during a programming operation, the MP-4000 exits the program mode without actually making any of the changes entered to that time. State changes include any transition to start, run, stop, alarm, or trip.

In the following sections, the notation PnLm designates the setting on page n, line m.

Note that if the unit is powered down for more than 30 days the real-time clock may need to be reset and the histories may need cleared.

#### 5.0.1 Conditional Setting Ranges

Program settings have individual ranges and setting increments, or selections, listed in Table 4.3. However, note that seven of the settings have linked ranges. Because of this, it may be possible to set unacceptable combinations of values during the programming operation. If this error is made, pressing the Prog pushbutton does not cause the MP-4000 to exit the programming mode. Instead, the display indicates which setting is out of range, and the Help message indicates the fix. Also, see individual descriptions for each of these linked settings:

- The ratio of Motor Full Load Amperes nameplate value (FLA; P1L1) to Phase CT-ratio numerator (PCT, P1L5) must be between 0.25 and 1.5. Both of these values are dictated by the design of the protected motor. The error can be corrected only by installing an appropriate current transformer set for the motor. See FLA CT L and FLA CT H in Table 5-1; also refer to Subsection 5.1.5 for guidance on CT ratio selection.
- The instantaneous overcurrent trip setting (IOC, P3L4) must be below  $(1,130 * PCT / FLA)\%$  or 1,600%, whichever is less. See IOC OUT in Table 5-1.
- The jam trip and alarm current levels (JMT, P3L6 and JMA, P4L3) must be below  $(1,130 * PCT / FLA)\%$  or 1,200%, whichever is less. See JAMT OUT and JAMA OUT in Table 5-1.

- The underload trip (ULT, P3L9) and alarm (ULA, P4L5) levels must be greater than the programmed Stop Current Threshold (STOP XX, P1L9). Remember that underload trip and alarm functions are programmed as a percentage of the FLA, while the Stop Current Threshold is programmed as a percentage of the PCT. For comparison, multiply the Stop Current Threshold by PCT/FLA.
- A motor start is declared when the current is initially seen with a magnitude greater than 30% of FLA (see Subsection 9.2.1). Make sure that the Stop Current Threshold is less than this value. Remember the Stop Current Threshold is programmed as a percentage of the PCT. For comparison, multiply the Stop Current Threshold by PCT/FLA. This number must be less than 30%.
- The Motor Start Transition Current Level (TRNC, P5L5) must be greater than the programmed Stop Current Threshold. Remember that the TRNC is programmed as a percentage of FLA, while the Stop Current Threshold is programmed as a percentage of the PCT. For comparison, multiply the Stop Current Threshold by PCT/FLA.



### CAUTION

**FLA IS A FIXED PROPERTY OF THE MOTOR. SELECT A CT WHOSE RATIO IS SUITABLE FOR THIS MOTOR.**

#### 5.0.2 Viewing Settings

Most of the following settings can be viewed without accessing the Prog button. To view the settings, use the View Setting display mode button.

Note that certain settings without logical display values are not visible in the View Setting mode. These are on setting pages 12, 13, and 14, and are indicated by dashes in the Factory Default column of Table 4.3. They include testing settings and time values. Check the setting of the calendar/clock using the Monitor Tim(e) page of the Monitor Mode.

### 5.1 Page 1, SP MOTOR, Settings P1L1 to P1L8

These settings, which are motor constants, are usually obtained from the motor nameplate or manufacturer-supplied data. They must be correct for the MP-4000 to adequately protect the motor.

#### 5.1.1 Setting P1L1, Full-Load Amperes (FLA)

FLA is set to the maximum stator continuous RMS current in the primary (actual motor winding) amperes in each phase. The motor nameplate or manufacturer's data provides the value of this setting.

**NOTE:** Do not vary the FLA setting from motor nameplate value, even if the motor has a service factor different from 1.0. See UTC, P1L4 for the consideration of the service factor.



### CAUTION

**MANY OF THE PROTECTION FUNCTIONS OF THE MP-4000, INCLUDING THE MOTOR THERMAL PROTECTION ALGORITHM, USE THE FLA SETTING VALUE TO CALCULATE TRIP POINTS. IF THE USER ENTERS AN INCORRECT SETTING, MANY PROTECTION FUNCTIONS MAY NOT OPERATE AS DESIGNED AND THE MOTOR MAY BE DAMAGED.**

**Table 5.1 Inconsistent Settings Messages.**

Display	Complete Help Messages
FLA CT L	THE RATIO OF FLA TO CT RATIO IS BELOW 0.25 - INCREASE FLA OR DECREASE CT RATIO - PRESS PROGRAM TO CONTINUE
FLA CT H	THE RATIO OF FLA TO CT RATIO IS ABOVE 1.5 - DECREASE FLA OR INCREASE CT RATIO - PRESS PROGRAM TO CONTINUE
IOC OUT	IOC SETTING IS OUT OF RANGE - DECREASE IOC OR DECREASE FLA OR INCREASE CT RATIO - PRESS PROGRAM TO CONTINUE
JAMT OUT	AM TRIP SETTING IS OUT OF RANGE - DECREASE JAM TRIP OR DECREASE FLA OR INCREASE CT RATIO - PRESS PROGRAM TO CONTINUE
MA OUT	JAM ALARM SETTING IS OUT OF RANGE - DECREASE JAM ALARM OR DECREASE FLA OR INCREASE CT RATIO - PRESS PROGRAM TO CONTINUE
ULT LOW	UNDERLOAD TRIP SETTING IS LESS THAN STOP CURRENT LEVEL - DECREASE STOP CURRENT LEVEL OR INCREASE UNDERLOAD TRIP LEVEL - PRESS PROGRAM TO CONTINUE
ULA LOW	UNDERLOAD ALARM SETTING IS LESS THAN STOP CURRENT LEVEL - DECREASE STOP CURRENT LEVEL OR INCREASE UNDERLOAD ALARM LEVEL - PRESS PROGRAM TO CONTINUE
STP HIGH	STOP CURRENT LEVEL IS ABOVE THE START LEVEL - DECREASE STOP CURRENT LEVEL - PRESS PROGRAM TO CONTINUE
TRNS LOW	STOP CURRENT LEVEL IS ABOVE THE TRANSITION LEVEL - DECREASE STOP CURRENT LEVEL OR INCREASE TRANSITION LEVEL - PRESS PROGRAM TO CONTINUE

**5.1.2 Setting P1L2, Locked-Rotor Current (LRC)**

LRC is set to the locked-rotor current, which is the current the motor draws when stalled, in percentage of **FLA** (see P1L1). Use the motor nameplate or manufacturer's data.

**5.1.3 Setting P1L3, Maximum Allowable Stall or Locked-Rotor Time (LRT)**

LRT specifies how long a locked-rotor or stall condition can be maintained before the motor is damaged, in seconds, for a cold start. Use motor nameplate or manufacturer's data.

**LRC** and **LRT** combine to specify a point on the motor damage curve (Figure 9.4) which, when reached during a start, causes a locked-rotor trip. Refer to Subsection 9.1.3 for a detailed explanation.



**CAUTION**

**INCORRECT SETTING VALUES FOR THESE FUNCTIONS CAN RESULT IN EXCESSIVE ROTOR TEMPERATURES AND MOTOR DAMAGE.**

**5.1.4 Setting P1L4, Ultimate Trip Current (UTC)**

UTC sets the current level above which a trip eventually occurs when no RTD stator temperature data is available, in percentage of FLA. This value represents the limit line on the running (upper) portion of the non-RTD motor damage curve shown in Figure 9.4.

**NOTE:** This UTC setting is where the User considers the service factor rating of the motor. *Never* adjust the **FLA** setting P1L1 according to the service factor (see Subsection 9.1.3.3).

For normal use, set UTC to the *service factor* times 100%. The available range is 85% to 150%. The service factor is found on the motor nameplate or in manufacturer's data.

Note that the relay does not trip at the moment the current goes above UTC during motor running. Instead, it models the gradual stator heating for currents above UTC, and trips only after some time has passed. The trip time depends on a variety of setting and operating factors, including motor nameplate data contained in other setting values.

Use a conservative, or lower, value of UTC than that dictated by the service factor if motor ambient temperatures may rise above 40°C (104°F) and the optional URTD Module is not used (see Subsection 9.1.1). Also, consider lowering the UTC value if the motor is suitably rated, yet additional safety is critical for the application.



**CAUTION**

**IF UTC IS SET ABOVE 100% TIMES THE SERVICE FACTOR, MOTOR DAMAGE COULD RESULT.**

**5.1.5 Setting P1L5, Phase Current Transformer Ratio (PCT)**

PCT specifies the numerator of the turns ratio of the main phase current transformers. Obtain the value from the current transformer (CT) nameplate or from the installation drawings. PCT is not the CT rating, but the actual turns ratio, which may depend on a CT ratio tap.

**Explanation of CT Ratio Presentation**

The MP-4000 motor relay is available in multiple styles designed for use with current transformers (CTs) having a nominal or rated secondary current of either 5 amperes or 1 ampere. Check the relay labeling or the catalog number, and the CT secondary rating, to confirm a match.

All displayed information is the same for either of the two types of MP-4000 relays. When CT ratios are to be set, the value entered is the *numerator* of the main CT ratio. The denominator is assumed to be either 5 or 1, depending on the style of MP-4000 used.

For example, a set of three 400:5 phase CTs might be used with an MP-4000 specified for 5 A CTs. The phase CT ratio is then set to 400. Alternatively, a set of three 400:1 CTs could be used with an MP-4000 rated for 1 A CTs. Use a setting of 400 in this case as well.

## CT Ratio Selection

Check the following criteria to ensure a suitable current transformer ratio.

For a 5 ampere CT set:

For optimum metering accuracy at low loads, the CT should deliver between 3.5 and 4 A at 100% FLA. Attempt to achieve 3.75 A.

For reliable motor protection, the CT must deliver between 2.5 and 4 A to 5 A MP-4000 at 100% FLA.

For example, if the motor has an FLA value of 300 A, a 400:5 CT will supply:

$$300 \times 5/400 = 3.75 \text{ A, an ideal value.}$$

For a 1 ampere CT set:

For optimum metering accuracy with low loads, use a 1 A MP-4000. The primary of the CT should deliver between 0.7 A and 0.8 A at 100%percent FLA. Attempt to achieve 0.75 A.

For reliable motor protection, the CT should deliver between 0.5 A and 0.8 A at 100% FLA.

For example, if the motor has an FLA of 300 A, a 400:1 CT will supply:

$$300 \times 1/400 = 0.75 \text{ A, an ideal value.}$$

Note that **FLA/PCt** must lie between 0.25 and 1.5 for successful programming - the User will not be able to exit Program Mode until one or the other value is adjusted. Refer to Subsection 5.0.1.

## CAUTION

**BE CAREFUL WHEN DETERMINING CT TURNS RATIO. AN IMPROPER VALUE CAN CAUSE THE MP-4000 TO RECEIVE INCORRECT MOTOR CURRENT DATA. MOTOR DAMAGE COULD RESULT.**

### 5.1.6 Setting P1L6, Ground Fault CT Ratio (GCT)

GCT specifies the numerator of the turns ratio of the single ground current transformer used only for ground fault protection and ground current metering. The User should obtain the GCT from the CT nameplate or from the installation drawings, watching for the use of taps on CTs that have tapped windings.

Typically, the three-phase power conductors pass through the single window of a ground fault CT, whose ratio is usually much lower than that of the phase CTs for good ground fault sensitivity. A very common type of ground fault CT has a ratio of 50:5 or 50:1, but the User should check the CT in use.

Ground fault protection by the residual connection of phase CTs is possible, but it does not give high sensitivity. Refer to Subsection 9.1.10.

### 5.1.7 Setting P1L7, Frequency (FREQ)

FREQ sets the MP-4000 for either a 60 Hz or 50 Hz ac supply frequency. The device assumes the supply and phase currents are at the same nominal frequency. No hardware settings are necessary. The MP-4000 can protect the motor during the limited frequency excursions of a power system in emergency conditions, but it is not intended for use with variable-frequency motor drives.

### 5.1.8 Setting P1L8, Reversing or Non-reversing Starter (REV/NONREV)

REV/NONREV specifies whether or not the starter for this motor is designed to reverse phase sequence and make the motor run in either direction.

Setting to REV indicates that starting with a reversed phase sequence is an acceptable operating condition. The MP-4000 accepts either sequence at the time of a start, and assigns the role of a positive sequence to the larger of the two sequence components. When the motor runs in reverse, any phase current unbalance is displayed with a negative sign. This is not a negative number; it should be viewed as a notation that the unbalance was measured on a motor running in reverse.

If set to NONREV, the MP-4000 checks the phase sequence at the beginning of the START cycle only, and accepts only a positive phase sequence (ABC). It trips the motor for a reversed sequence of ACB and displays the message "PH REVRS".

### 5.1.9 Setting P1L9, Stop Current Threshold

This setting controls the current magnitude threshold in which the MP-4000 declares a stop state if the actual current is below the threshold for at least 280 milliseconds. If a stop state occurs, the jogging functions Starts per Time Allowed (**ST/T P5L1, T/ST P5L2**), Time Between Starts (**TBS P5L3**), and Anti-Backspin (**ABK, P5L12**) are enforced. All phases of the current must be below this level before a stop will be declared. The setting is programmed as percentage of the CT ratio numerator (**PCT P1L5**). For example if 400:5 CTs are used and the setting is programmed as 5%, all phase currents must be below 20 A before a stop is declared. It is possible that if power factor correction capacitors are used, a high inertial motor may generate current after the motor contacts open. Make sure to set the stop current level to be above the level of current generated by the motor free spinning.

The Stop Current Threshold must be below the current that causes a starting condition to be declared, which is 30% of FLA. In addition, the Stop Current Threshold setting must be below the Underload trip (**ULT P3L9**), Underload alarm (**ULA P3L5**), and Motor Start Transition Current Level (**TRNC P5L5**). The User should be mindful that the Stop Current Threshold is programmed as a percentage of **PCT**. To convert this setting to be a percentage of **FLA**, multiply the Stop Current Threshold by **PCT/FLA**.

## 5.2 Page 2, SP RTD, Settings P2L1 to P2L10

This page contains all of the settings needed to use the RTD temperature inputs from the optional URTD accessory module.

**NOTE:** For direct temperature tripping, alarming, and displays to function, a URTD module must be connected and communicating with the MP-4000. However, the settings for temperature can be viewed or adjusted with or without a URTD module connected.

Pay attention to the specific labeled assignments of the 11 URTD input channels. The first six are specifically intended for up to six RTDs embedded in the motor stator winding. Inputs 7 and 8 are specifically for motor bearing RTDs. Inputs 9 and 10 are specifically for load bearings. Input 11 is an auxiliary general-use input.

All RTD inputs have alarm and trip values set below. But, note that only the maximum of the values read via stator RTD channels 1 through 6 is used by the MP-4000 motor thermal modeling algorithm.

## CAUTION

**THE MP-4000 CANNOT COMMUNICATE WITH THE URTD IF THE SETTING "RS-232 MODE" IS ENABLED (ON).**

### 5.2.1 Setting P2L1, RTD Display Information (RTD IN C or RTD IN F)

P2L1 specifies the temperature displays in degrees Celsius or degrees Fahrenheit.

### 5.2.2 Setting P2L2, Winding Temp Trip (WD T)

WD T specifies the motor stator winding temperature limit above which the hottest winding RTD causes the relay to trip the motor. This trip can also be set to OFF. Trip temperature values are in degrees C or F, depending on Setting P2L1. There are six specifically-labeled stator RTD inputs on the URTD module whose readings can trigger this particular type of trip. See Subsection 9.1.8 for setting advice.



**IF WD T IS SET TO OFF, THE THERMAL-MODEL PROTECTION REVERTS TO THE NON-RTD ALGORITHM EVEN IF A URTD IS CONNECTED.**

### 5.2.3 Setting P2L3, Winding Temp Alarm (WD A)

Specifies the motor stator winding temperature limit above which any winding RTD produces an alarm output from the relay. This alarm can also be set to OFF. Alarm temperature values are in degrees C or F, depending on Setting P2L1. There are six specifically-labeled stator RTD inputs on the URTD module whose readings can trigger this particular type of alarm.

### 5.2.4 Setting P2L4, Motor Bearing Trip (MB T)

P2L4 specifies the motor bearing temperature limit above which either of the two motor bearing RTDs causes the relay to trip the motor. This trip can also be set to OFF. Trip temperature values are in degrees C or F, depending on Setting P2L1. There are two specifically-labeled motor bearing RTD inputs on the URTD module whose readings can trigger this particular type of trip.

### 5.2.5 Setting P2L5, Motor Bearing Alarm (MB A)

P2L5 specifies the motor bearing temperature limit above which either of the two motor bearing RTDs produces an alarm output from the relay. This alarm can also be set to OFF. Alarm temperature values are in degrees C or F, depending on Setting P2L1. There are two specifically-labeled motor bearing RTD inputs on the URTD module whose readings can trigger this particular type of alarm.

### 5.2.6 Setting P2L6, Load Bearing Trip (LB T)

P2L6 specifies the load bearing temperature limit above which either of the two load bearing RTDs causes the relay to trip the motor. This trip can also be set to OFF. Trip temperature values are in degrees C or F, depending on Setting P2L1. There are two specifically-labeled load bearing RTD inputs on the URTD module whose readings can trigger this particular type of trip.

### 5.2.7 Setting P2L7, Load Bearing Alarm (LB A)

This setting specifies the load bearing temperature limit above which either of the two load bearing RTDs produces an alarm output from the relay. This alarm can also be set to OFF. Alarm temperature values are in degrees C or F, depending on Setting P2L1. There are two specifically-labeled load bearing RTD inputs on the URTD module whose readings can trigger this particular type of alarm.

### 5.2.8 Setting P2L8, Auxiliary RTD Temp Trip (AX T)

AX T specifies the auxiliary RTD temperature limit above which the relay trips the motor. This trip can also be set to OFF. Trip temperature

values are in degrees C or F, depending on Setting P2L1 above. There is one specifically-labeled auxiliary RTD input on the URTD module whose readings can trigger this particular type of trips.

### 5.2.9 Setting P2L9, Auxiliary RTD Temp Alarm (AX A)

This setting specifies the auxiliary RTD temperature limit above which the relay produces an alarm output. This alarm can also be set to OFF. Alarm temperature values are in degrees C or F, depending on Setting P2L1. There is one specifically-labeled auxiliary RTD input on the URTD module whose readings can trigger this particular type of alarm.

### 5.2.10 Setting P2L10, RTD Diagnostic (DIAG ON or DIAG OFF)

P2L10 sets the RTD diagnostic alarm ON or OFF. If set to ON, the relay alarms on any RTD failure or URTD communications failure.

## 5.3 Page 3, SP TRIP, Settings P3L1 to P3L14

This page contains the settings that configure the trip functions. Any trip function can be turned off, as listed in Table 4.3. Start and run delays are used to block these tripping functions for the set time to avoid nuisance tripping:

- Start delays - Begin when the MP-4000 first sees motor current and declares a START. The start delay completely inhibits operation of the governed function for the set time after the start. A single setting serves for both tripping and alarming functions.
- Run delays - Also known as pickup delays. These delays prevent momentary disturbances in the system from causing nuisance trips.
- When the motor starts, all of the start delays begin timing. As each start delay expires, the associated protection or alarm function is enabled.
- The pickup of a measurement element begins the timing of its run delay, which must expire before the relay can actually trip or alarm. Once the run delay timing has begun, the driving condition must remain for the full run delay time. If the condition goes away and then returns during run delay timing, the run delay timer resets and begins timing over again.
- Note that the transition of the motor or the MP-4000 relay from START to RUN state has no bearing on any of these time delays.

#### Timing Example:

Assume the MP-4000 jam trip function (see Subsection 5.3.6) is set for a start delay of 15 seconds and a run delay of 5 seconds. If the motor is jammed at start, the jam function will not begin to time until after the start delay. Therefore, the unit will not take action until 15 seconds (start delay) plus 5 seconds (run delay), a total of 20 seconds. After the run delay has timed out, the unit will provide protection in case of a jam in 5 seconds based on the start delay only.

### 5.3.1 Setting P3L1, Ground Fault Trip Level (GFT)

P3L1 sets the ground fault trip current pickup in percentage of ground CT ratio numerator (CT rated primary current). For example, with a 50:5 ground fault CT and a setting of 24%, the GFT function picks up at 24% of 50 A, or 12 A actual ground fault current in the motor. The start and/or run delays must expire before the trip occurs.

## NOTICE

**THIS IS THE ONLY PROTECTIVE CURRENT SETTING THAT DOES NOT USE FLA AS THE BASIS FOR THE SETTING.**

### 5.3.2 Setting P3L2, Ground Fault Start Delay (GFSD)

P3L2 sets the time from a motor start until the ground fault trip and alarm functions are enabled, in power cycles. Use this to block GFT operation until the ground current of power factor correction capacitors decays after a start.

### 5.3.3 Setting P3L3, Ground Fault Run Delay (GFRD)

P3L3 sets the number of power cycles that a ground fault trip or alarm operation must be maintained before the relay produces an output.

### 5.3.4 Setting P3L4, Instantaneous Overcurrent Trip Level (IOC)

P3L4 sets the instantaneous overcurrent trip limit in percentage of FLA above which the relay trips. This trip type can be set to OFF. For currents clearly above the setting, the IOC function picks up in two power cycles or less. IOC operates only for high-current faults, and no run delay is needed. Use this function with IOC Start Delay. Normally, set IOC 1.5 times above LRC. Refer to Subsection 9.1.3.1.

The IOC setting must be below  $(1,130 * PCT / FLA)$  or 1,600%, whichever is less. PCT is Setting P1L5; FLA is Setting P1L1. If this constraint is exceeded, the program mode cannot be exited, but a specific warning message is displayed instead.

### 5.3.5 Setting P3L5, Instantaneous Overcurrent Start Delay (IOCSD)

P3L5 sets the number of power cycles after a start is recognized until the instantaneous overcurrent trip and alarm functions are enabled. Use this delay to inhibit IOC tripping on a current peak caused by magnetic inrush when the motor is first energized - usually two to three cycles.

### 5.3.6 Setting P3L6, Jam Trip Level (JMT)

P3L6 sets the motor jam current trip limit in percentage of FLA. This element can be set to OFF. Use it with the jam start and run delays.

The jam trip function operates if the current rises well above FLA during running, perhaps due to a mechanical jam in the load or a sudden larger-than-intended load. For example, see the jam trip limits set at 180% of FLA in the upper RUN portions of the protection curves in Figures 9.4 and 9.5.

The JMT setting must be below  $(1,130 * PCT / FLA)$  or 1,200%, whichever is less. PCT is Setting P1L5; FLA is Setting P1L1. If this constraint is exceeded, the program mode cannot be exited, but a specific warning message is displayed instead.

### 5.3.7 Setting P3L7, Jam Start Delay (JMSD)

P3L7 sets the number of seconds after a start is recognized until the jam trip and alarm functions are enabled.

Use JMSD to block jam trips during starting. Use even larger values in high-inertia load situations where the acceleration time is longer than the start time. In these cases, the motor current may remain above FLA or JMT for some time after the transition from start to run.

### 5.3.8 Setting P3L8, Jam Trip Run Delay (JMTR)

P3L8 sets the number of seconds that a jam trip current level must be maintained before the trip output occurs.

Use JMTR to block undesired jam trips for temporary large loads that are normal for the process. An example of this would be a heavy load suddenly placed on a conveyor belt that the motor must accelerate.

### 5.3.9 Setting P3L9, Underload Trip Level (ULT)

P3L9 sets the current level in percentage of FLA below which the MP-4000 determines that the motor has lost its load and trips the motor. This element can be set to OFF. Use with the underload start and run delays.

The Underload trip setting must be set at a value above the Stop Current Threshold (**STOP XX, P1L9**) setting. The User should remember that the Stop Current Threshold is programmed as a percentage of **PCT**. To convert this setting to be a percentage of **FLA**, multiply the Stop Current Threshold by **PCT/FLA**. For example, if a 1,000:5 CT was used with a motor that has a full load current of 500 A, and a Stop Current Threshold of 5% was programmed, the Underload Trip function must be set above 10% of **FLA**.

### 5.3.10 Setting P3L10, Underload Start Delay (ULSD)

P3L10 sets the number of seconds after a start until the underload trip and alarm functions are enabled.

### 5.3.11 Setting P3L11, Underload Trip Run Delay (ULTR)

P3L11 sets the number of seconds that current below the underload trip setting must be maintained before a trip output occurs.

### 5.3.12 Setting P3L12, Phase Unbalance Trip Level (UBT)

P3L12 sets the percentage of phase unbalance above which the relay trips. This element can be set to OFF. The percentage unbalance is calculated from the ratio of negative sequence current to positive sequence current. Use with the phase unbalance trip start and run delays.

For reversing starter applications (see Setting P1L8), the MP-4000 assumes that the larger sequence current is the positive sequence current, and can trip for unbalance with the motor turning in either direction.

### 5.3.13 Setting P3L13, Phase Unbalance Start Delay (UBSD)

P3L13 sets the number of seconds after a start until the phase unbalance trip and alarm elements are enabled.

### 5.3.14 Setting P3L14, Phase Unbalance Trip Run Delay (UBTR)

P3L14 sets the number of seconds that a high phase unbalance must be sustained before a trip output occurs.

## 5.4 Page 4, SP ALARM, Settings P4L1 to P4L8

This page contains the settings needed to configure the alarm functions. Each alarm function can be disabled.

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## NOTICE

**EVEN IF AN ALARM FUNCTION IS ENABLED ON THIS PAGE, IT MUST ALSO BE DIRECTED TO AN OUTPUT RELAY TO PRODUCE CONTACT OPERATION FOR REMOTE OR ANNUNCIATOR ALARMING. NORMALLY (AND BY FACTORY DEFAULT SETTINGS), THE CONDITIONS SHOULD ALL BE DIRECTED TO THE ALARM RELAY BY THE 22 SETTINGS ON PROGRAM MODE PAGE 8. THEY MAY ALSO BE SELECTIVELY DIRECTED TO THE AUX1 AND/OR AUX 2 OUTPUT RELAYS USING THE SETTINGS ON PROGRAM MODE PAGES 9 AND 10, RESPECTIVELY.**

If the User configures an alarm here, but does not set it to activate any output relay on Pages 8 to 10, alarm conditions still appear in all displays and logs, and in communications information sent to a PowerNet host.

#### 5.4.1 Setting P4L1, Ground Fault Alarm Level (GFA)

P4L1 sets the ground fault alarm current pickup level in percentage of ground CT ratio numerator. For example, with a 50:5 ground fault CT and a setting of 10%, the GFA function picks up at 10% of 50 A, or 5 A of actual ground fault current in the motor. The start and/or run delays must expire before the alarm output occurs.

#### 5.4.2 Setting P4L2, I2T Alarm Level (I2TA)

P4L2 sets the I2T model thermal accumulator or thermal bucket level at which the relay alarms, in percent of I2T bucket trip value. This important alarm indicates that the MP-4000 thermal model is progressing toward a thermal protective trip (thermal capacity bucket is filling), so that the User can act to reduce loading or protect the process.

This setting also determines when the I2T trip condition can reset. After a trip, the I2T bucket or thermal accumulator must cool below the I2T alarm level before the thermal trip can reset. Refer to setting P12L5 for more on resetting of this thermal trip.

#### 5.4.3 Setting P4L3, Jam Alarm Level (JMA)

Sets the current limit in percent of FLA at which the jam alarm picks up. This alarm can be set to OFF. JMA is set to a lower level than the jam trip level P3L6. The start delay is the same as for the jam trip function; refer to P3L7. Use with the run delay described in the next subsection.

#### 5.4.4 Setting P4L4, Jam Alarm Run Delay (JMAR)

P4L4 sets the number of seconds that the jam alarm level must be maintained before the alarm occurs.

#### 5.4.5 Setting P4L5, Underload Alarm Level (ULA)

P4L5 specifies the current level in percentage of FLA below which the MP-4000 alarms. The start delay is the same as for underload trip; refer to P3L10. Use with the underload run delay described in the next subsection. Note that ULA must be set to a higher current value than the underload trip level P3L9.

#### 5.4.6 Setting P4L6, Underload Alarm Run Delay (ULAR)

P4L6 sets the number of seconds that the current must remain below the underload alarm limit before the alarm occurs.

#### 5.4.7 Setting P4L7, Phase Unbalance Alarm Level (UBA)

P4L7 sets the percent of phase current unbalance above which the MP-4000 alarms. This alarm can be set to OFF. The start delay is the same as for the phase unbalance trip (refer to P3L13). Use with unbalance alarm run delay described in the next subsection. Refer to P3L12, Unbalance Trip Level, above for more information.

#### 5.4.8 Setting P4L8, Phase Unbalance Alarm Run Delay (UBAR)

P4L8 sets the number of seconds that a phase unbalance above UBA must be maintained before an alarm occurs.

### 5.5 Page 5, SP START, Settings P5L1 to P5L12

Page 5 contains the settings that control motor starting and jogging functions.

#### 5.5.1 Setting P5L1, Starts Per Time Allowed (ST/T)

P5L1 sets the maximum number of motor starts permitted within the time set in P5L2 described in the next subsection. To disable this function, set P5L2 to OFF.

The record of recent start times is kept in a memory stack. The oldest starts in the memory are deleted as they age beyond the time limit set in P5L2. If the maximum number of starts is reached within the set

time window, the relay raises an alarm with STEX A on the display. To observe the per time limiting values, check the remaining starts (RMST) and time until start (TUS) displays on the monitor page.

After the motor stops, the MP-4000 trips with the message STEX XXX, where XXX is the number of minutes before the oldest start is deleted from the memory stack, allowing the motor to start. XXX can be observed to count down as the motor sits idle.

#### 5.5.2 Setting P5L2, Time Allowed For Starts Count (T/ST)

P5L2 sets the number of minutes within which the maximum number of starts cannot be exceeded. This function can be set to OFF.

#### 5.5.3 Setting P5L3, Time Between Starts (TBS)

P5L3 sets the time in minutes that must expire from one start until the next is permitted. This function can be set to OFF.

#### 5.5.4 Setting P5L4, Number of Cold Starts Allowed (NOCS)

P5L4 sets the number of cold starts allowed from one to five. Most motors can tolerate some number of consecutive cold starts before the time between starts is enforced. The MP-4000 treats a start as the first in a sequence of cold starts if the motor has been stopped for at least the time period which is the greatest of:

- Setting P5L2, Time Allowed For Starts Count (T/ST);
- Setting P5L3, Time Between Starts (TBS); or
- One hour.

Subsequent starts are treated as additional cold starts in the same sequence, only if they follow the previous start by 10 minutes or less, until the set number of cold starts is reached. Starts after this are subject to time and count limits imposed by settings P5L1 through P5L3 above.

#### 5.5.5 Setting P5L5, Motor Start Transition Current Level (TRNC)

P5L5 sets the current level defining the transition from the START to the RUN state. This setting, along with settings P5L6 and P5L7, determine when the MP-4000 declares a transition from START to RUN.

The TRNC setting must be greater than the Stop Current Threshold (STOP XX, P1L9) setting. Remember that the Stop Current Threshold is programmed as a percentage of PCT. To convert this setting to be a percentage of FLA, multiply the Stop Current Threshold by PCT/FLA.

#### 5.5.6 Setting P5L6, Motor Start Transition Timeout (TRNT)

P5L6 sets the maximum duration of the START state of the motor before transition to RUN. Refer to P5L7 in the next subsection for further details.

#### 5.5.7 Setting P5L7, Transition on Event (TRN TIME, TRN I, TRN T+C, or TRN T/C)

This setting is used with P5L5 and P5L6 to determine what events must happen for the MP-4000 to declare a transition from START to RUN. Select one of four choices:

**TRN TIME** - Transition to RUN after time setting (P5L6) only. Ignore current.

**TRN I** - Transition when starting current drops below setting (P5L5) only. If the time set in TRNT P5L6 expires before the current transition, the motor trips.

**TRN T+C** - Transition on time or current, whichever comes first.

**TRN T/C** - Transition on time and current. Both must occur, and the current must drop below the setting before the time delay expires. If the timer expires before the current falls below the set transition level, the motor trips.

In addition, the MP-4000 provides a transition control signal to a reduced-voltage starter, allowing it to raise the voltage to the running value. To do this, the transition function activates the contact output AUX2 (unless the function of AUX2 has been redefined by setting changes in the AUX2 configuration settings on page 10).

## NOTICE

**EVEN IF THE TRANSITION CONTROL OUTPUT IS NOT USED, SET THE TRANSITION FUNCTION TO PROVIDE CLEAR INDICATIONS OF THE ACTUAL STATE OF THE MOTOR (START; RUN) ON THE FRONT PANEL DISPLAY AND VIA DATA COMMUNICATIONS. A GOOD WAY TO DO THIS IS TO USE THE SETTINGS OF P5L7 = TRN T+C AND P5L5 = 130% OF FLA. MODIFY THE LATTER, IF NEEDED, TO LIE AT A TRANSITION VALUE BETWEEN THE STARTING CURRENT AND POST-START MAXIMUM LOAD CURRENT.**

### 5.5.8 Setting P5L8, Incomplete Sequence Report Back Time (INSQ)

P5L8 sets the required process report-back time in seconds. This function can be set to OFF.

The incomplete sequence function requires a report back contact from the process that the motor runs - any indication that the process has proceeded to operate as expected some time after the motor start. If the process does not start up correctly, the contact does not close within the expected time. If a problem develops later on, the report-back contact opens. In either case, the open contact state indicates that the motor should be tripped.

To use this function, set a time limit for report back here. Set P5L9 (covered in the next subsection) to define the start of report back timing. Connect the report back contact to MP-4000 Discrete Input 2. If this input is not energized before the set time expires, the relay will trip for incomplete sequence.

Note that the input must be energized continuously after the time delay has expired to hold off this trip.

Note that Discrete Input 2 setting P7L1 (see Subsection 5.7.1) is automatically assigned to the function INC SEQ if a time delay is set here. All other alternate uses for Discrete Input 2 (setting P7L1) are suppressed and not visible until INSQ is set to OFF.

### 5.5.9 Setting P5L9, Incomplete Sequence Start Timer Event (INSQ TRN or INSQ ST)

Choose either to start the incomplete-sequence timer when the motor start is declared (INSQ ST), or when the transition from start to run is declared (INSQ TRN).

### 5.5.10 Setting P5L10, Long Acceleration Time (LAT)

P5L10 sets a time interval during which the motor is permitted to accelerate a high-inertia load, which is longer than the locked-rotor time. This function can be (and usually should be) set to OFF. If the thermal-model accumulator bucket fills to 100% during the long acceleration time, it is limited to that value and the thermal trip is held off until the LAT delay expires. By then, the thermal bucket level must have decreased (thermal model cooled) below 100% or the motor trips.

The LAT function should be used only on motors with a zero speed switch (a normally-closed contact that opens when the motor actually begins to spin). Connect the zero speed switch contact to MP-4000 Discrete Input 1. The zero speed switch function must be enabled (ZSW ON). Refer to setting P5L11 in the next subsection. The MP-4000 requires the zero speed switch to open within LRT/2 (one-half of locked-rotor time setting P1L3) after a start, or the motor is tripped by the ZSW function. This protects a completely stalled motor

from being damaged when the LAT timer blocks the locked-rotor thermal trip.



**CAUTION**

**THE LONG ACCELERATION TIME (LAT) FUNCTION CAN BLOCK THE CRITICAL LRC-LRT ROTOR THERMAL PROTECTION DURING A START AND DESTROY THE MOTOR. TURN LAT OFF UNLESS ABSOLUTELY NEEDED AND THE MOTOR'S SUITABILITY FOR THIS STARTING DUTY HAS BEEN CONFIRMED. USE ONLY WITH ZERO SPEED SWITCH FUNCTION ZSW ON AND SWITCH INPUT CONNECTED TO PROTECT A STALLED MOTOR.**

### 5.5.11 Setting P5L11, Zero Speed Switch On or Off (ZSW ON or ZSW OFF)

P5L11 enables the function that verifies if the motor begins to physically spin after a start. It requires a zero speed switch on the motor, which is closed at rest and opens as the rotor begins to turn. Connect the zero speed switch contact to MP-4000 Discrete Input 1. If the contact fails to open within LRT/2 (one-half of locked-rotor time setting P1L3) after a start, the relay trips with a zero speed switch trip message.

This protection is always useful, but is essential if the Long Acceleration Time (LAT) function set by P5L10 is used.

Note that if the ZSW function is set to ON, Discrete Input 1 is automatically configured to be the zero speed switch input. All other alternate function settings for Discrete Input 1 (P6L1) are suppressed and not visible until ZSW is set to OFF.

With ZSW ON, the MP-4000 checks Discrete Input 1 for voltage at the very moment it sees a start - it wants to sense the initially closed zero speed switch, which opens shortly thereafter as the motor spins. If it fails to find the closed contact, it trips immediately with a zero speed switch trip message. Check the wiring and contact for problems.

### 5.5.12 Setting P5L12, Anti-Backspin Delay Time (ABK)

P5L12 sets the time in seconds before a motor restart is permitted after a trip or stop condition. This function can be set to OFF.

This function is used with a motor driving a pump working into a head, or any other load that tends to spin in a reverse direction (backspin) when the motor is de-energized. It blocks starting during the time when the motor might be rotating in reverse following a trip. Also, this function may be used simply to set idle time (time between stop and start) before a restart is permitted.

## 5.6 Page 6, SP DI 1

This page contains the single setting that configures Discrete Input 1 (DI 1). The input must be a 120 Vac signal. A 120 Vac source for wetting dry contacts is provided on the MP-4000 terminal block for convenience. Refer to the wiring diagrams in Section 6.

### 5.6.1 Setting P6L1 (REM RST, REM TRIP, DIF TRIP, MTR STOP, RST DBL, EMG OVR, or ZERO SW)

If the zero speed switch (ZSW) function is ON in the SP START page (P5L11), this DI 1 input is automatically configured to be zero speed switch contact input, ZERO SW, and no other setting option is visible.

If ZSW is set to OFF, the available choices for Discrete Input 1 are:

**REM RST - Remote Reset** - When voltage is applied, the MP-4000 resets its active functions and displays, just as if the reset pushbutton on the faceplate was pressed.

**REM TRIP - Remote Trip** - When voltage is applied, the MP-4000 trips the motor and displays the message "REMOTE". The trip resets only if the input voltage is removed.

**DIF TRIP - Differential Trip** - When voltage is applied, the MP-4000 trips the motor and displays the message "DIF TRIP". This is used with an external motor differential relay whose trip contact is normally open, but closes when it detects a fault. The trip can be reset only after the voltage is removed. It can be used for tripping by any auxiliary function with a normally-open contact.

**MTR STOP - Motor Stop Detection Blocking** - With this setting, a voltage input to DI 1 keeps the MP-4000 in the RUN mode, even when the motor current drops below 100 mA secondary. This feature is used mainly with a synchronous motor operating as synchronous condenser, for power factor correction. The current may approach zero during normal sustained operation.

**RST DBL - Reset Disable** - With this setting, the MP-4000 front panel Reset pushbutton is disabled following a trip or alarm condition. The only way to reset the unit is to apply voltage to DI 1. This feature prevents unauthorized personnel from resetting the relay or restarting the motor after a trip. Use a secure reset contact to apply voltage to DI 1.

**EMG OVR - Emergency Override** - The DI 1 input will mimic the functionality of the Emergency Override pushbutton.

## 5.7 Page 7, SP DI 2

This page contains the single setting which configures Discrete Input 2 (DI 2). The input must be a 120 Vac signal. A 120 Vac source for wetting dry contacts is provided on the MP-4000 terminal block. Refer to the wiring diagrams in Section 6.

### 5.7.1 Setting P7L1 (INC SEQ, REM RST, REM TRIP, DIF TRIP, MTR STOP, RST DBL, or EMG OVR)

If the incomplete sequence function INSQ is on and set for some time delay (setting P5L8), DI 2 is automatically configured to control incomplete sequence timing, INC SEQ, and no other setting is possible.

If INSQ is turned OFF, the other choices for DI 2 are available. These are the same choices as for Discrete Input 1, P6L1, covered in Subsection 5.6.1.

## 5.8 Page 8, SP AREL, Settings P8L1 to P8L22

Use Page 8 to configure which events activate the alarm relay.

The factory default setting is for every alarm event to activate the alarm relay, and for the alarms to reset automatically when the condition disappears. Trip events do not activate the alarm relay; nor does Time Between Starts blocking, which frequently goes true during normal operating cycles. Check the settings to be sure they agree with the factory defined values (the Values as Shipped column in Table 4.3) or change them as needed.

## NOTICE

**EVEN THOUGH A PARTICULAR ALARM CONDITION IS DIRECTED TO THE ALARM RELAY ON THIS PAGE, IT CAN FUNCTION ONLY IF IT IS TURNED ON IN THE SP ALARM PAGE 4.**

Settings control the following 22 alarm assignments. Any or all can be turned OFF:

- Ground fault alarm, or trip;
- I2T alarm, or trip;
- Jam alarm, or trip;
- Underload alarm, or trip;

- Phase unbalance alarm, or trip;
- Winding temperature alarm, or trip (with URTD);
- Motor bearing temperature alarm, or trip (with URTD);
- Load bearing temperature alarm, or trip (with URTD);
- Auxiliary temperature alarm, or trip (with URTD);
- Starts per time alarm, or trip;
- Time between starts trip;
- Individual RTD channel failure alarm;
- URTD overall communications failure alarm;
- IOC trip;
- Phase reversal trip;
- Incomplete sequence trip;
- Remote trip (via discrete input);
- Differential trip;
- INCOM (data communications) trip;
- Transition trip;
- Zero speed switch trip; and
- Trip bypass (contactor fails to interrupt current after trip).

## 5.9 Page 9, SP AUX1, Settings P9L1 to P9L25

Use Page 9 to configure the events that will activate the AUX1 output relay. It also includes the three settings to configure the load shedding function.

The factory default setting is for a thermal trip (I2T trip) only to activate this relay. Many Users choose to change this. If the load shed function is turned on, using settings P9L1 to P9L3 as explained, the relay AUX1 is dedicated to this function and other uses are not available or visible.

The load shed function provides a contact output signal that the User connects to the process equipment, to reduce loading on the motor if it becomes too large. For example, the contact might be used to temporarily stop the flow of heavy materials onto a conveyor driven by the protected motor. In this way, the MP-4000 tries to alleviate an overload before it reaches an outright thermal protective trip. When the load is reduced, the contact returns to the normal state and the process can resume loading of the motor.

The load shed function, which is active only during the RUN state of the motor, is configured with settings P9L1, P9L2, and P9L3.

### 5.9.1 Setting P9L1, Load Shed Pickup Current (LSPU)

P9L1 sets current level above which the load shed output is activated.

### 5.9.2 Setting P9L2, Load Shed Dropout Current (LSDO)

P9L2 sets the current level below which the load shed output is deactivated.

### 5.9.3 Setting P9L3, Load Shed Delay (LSDL)

P9L3 sets both the pickup and dropout delays in seconds for the load shed output. That is, it sets the time for which the current must be above LSPU before the output is activated. It also sets the time for which the current must be below LSDO before the output is deactivated.

The LSPU and LSDO settings are forced to be coherent:

- If the User sets either to OFF, the other is automatically set to OFF as well.
- If LSPU is set to any pickup value with LSDO OFF, LSDO is set to its minimum on-setting, 50 percent of FLA. The User can set it to a different value if desired.
- If LSDO is set to any dropout value with LSPU OFF, the LSPU is set to its maximum value, 150 percent of FLA. The User can set it to a different value if desired.
- LSPU must be greater than LSDO. The setting range of either may be limited to enforce this.



### 5.9.4 Settings P9L4 through P9L25, Alarm and Trip Assignments to AUX1

If LSPU and LSDO are both set to OFF, all other available functions for AUX1 become visible and can be individually turned on or off. AUX1 is activated if any of the designated functions picks up, with an OR logic function. Other than the three load shed function settings, the remaining settings are the same as the 22 listed for SP AREL page in Subsection 5.8. The AUX1 output operates if any of the selected functions become true.

### 5.10 Page 10, SP AUX2, Settings P10L1 to P10L23

This page determines which events activate the output relay AUX2. It also includes the setting to enable the transition function. The factory settings configure AUX2 to pick up for the transition function.

## NOTICE

**THE OPERATING SPECIFICS OF THE TRANSITION FUNCTION MUST BE CONFIGURED ON THE SP START PAGE 5, SETTINGS P5L5 TO P5L9, IF THE TRANSITION FUNCTION IS SET ON HERE WITH P10L1.**

#### 5.10.1 Setting P10L1, Enable Transition Control Output (TRN ON or TRN OFF)

P10L1 enables the transition function through output relay AUX2. If ON, the AUX2 relay is activated when the motor transitions from the START state to the RUN state, and deactivated when the next motor STOP is declared. Consider MODE 1 versus MODE 2 activation as set by P12L4 described in Subsection 5.12.4.

#### 5.10.2 Settings P10L2 through P10L23, Alarm and Trip Assignments to AUX2

If the transition function is OFF, all the other functions for AUX2 are visible. The settings are the same 22 selections as those in the SP AREL page. Refer to Subsection 5.8. The AUX2 output operates if any of the selected functions become true.

### 5.11 Page 11, SP A OUT

This page configures the operation of the 4-20 mA analog output.

#### 5.11.1 Setting P11L1, Analog Output Function (MAX XXXX)

P11L1 selects the internal MP-4000 parameter represented by the 4-20 mA analog output. Select one of these choices:

**MAX 100–100 percent of FLA** - Proportional to the average of the three-phase current values, with 100% of FLA = 20 mA and 0% = 4 mA.

**MAX 125–125 percent of FLA** - Proportional to the average of the three-phase current values, with 125% of FLA = 20 mA and 0% = 4 mA.

**MAX %I2T - Percent of I2T Trip Level** - Proportional to the percent I2T trip level (thermal-model accumulator bucket), with 100% of the I2T Trip Level = 20 mA and 0% = 4 mA.

**MAX WRTD - Winding temperature** - Proportional to the maximum winding RTD temperature from the URTD module. The winding RTD trip level (setting P2L2) = 20 mA and 0°C or 32°F = 4 mA.

### 5.12 Page 12, SP SYS, Settings P12L1 to P12L18

Page 12 configures overall operation of the MP-4000.

### 5.12.1 Setting P12L1, Configure Trip Relay Output (TP MODE1 or TP MODE2)

P12L1 selects Mode 1 or Mode 2.

**MODE 1** - The trip relay is normally de-energized. The trip relay energizes on a trip event.

**MODE 2** - The trip relay energizes on power up and de-energizes on a trip event. Mode 2 is also called the fail-safe (factory set) mode.

Each of the output relays has a form C (SPDT) contact set, so that combining output modes and contact choices gives four logical combinations. Note the key difference in using Mode 2 with the normally-open contact versus using Mode 1 with the normally-closed contact. With Mode 2 and a normally open contact, the external circuit closes during normal non-trip operation. It opens for a trip, if the MP-4000 power supply is de-energized, or the unit fails. With Mode 1 and a normally closed contact, the external circuit opens only for an overt trip decision, and is maintained when the MP-4000 is de-energized.

The MP-4000 is normally set for Mode 2 operation of the TRIP and ALARM relays.

#### 5.12.2 Setting P12L2, Configure Alarm Relay Output (AL MODE1 or AL MODE2)

Select Mode 1 or Mode 2 operation of the alarm relay (see Subsection 5.12.1). The factory default is fail-safe MODE 2.

#### 5.12.3 Setting P12L3, Configure AUX1 Relay Output (AX1 MOD1 or AX1 MOD2)

Select Mode 1 or Mode 2 operation of the AUX1 relay (see Subsection 5.12.1). The factory default is MODE 1.

#### 5.12.4 Setting P12L4, Configure AUX2 Relay Output (AX2 MOD1 or AX2 MOD2)

Select Mode 1 or Mode 2 operation of the AUX2 relay (see Subsection 5.12.1). The factory default is MODE 1.

#### 5.12.5 Setting P12L5, Auto or Manual I2T Reset (MAN I2T or AUTO I2T)

Select AUTO I2T to set this particular alarm function to automatically reset when the thermal-model bucket level drops below alarm setting P4L2 (I2TA XX). Select MAN I2T to perform a reset only after the thermal model bucket level drops below the alarm setting P4L2 (I2TA XX) and a manual reset command is given. The RESET command can come from the front panel Reset button, the PowerNet communications host, or a remote contact. A remote reset contact, if used, is connected to one of the digital input channels. That channel must be programmed for REM RST (remote reset) or RST DBL (reset disable).

#### 5.12.6 Setting P12L6, Enable Programming with a Running Motor (RUN PGM or STOP PGM)

If RUN PGM is selected, the motor may be started and/or run during programming of the MP-4000 settings. If STOP PGM is selected, the motor must be stopped in order to enter the PROGRAM mode, and starting is blocked while in the Program mode.

## NOTICE

**IF THE USER WANTS TO TAKE FULL ADVANTAGE OF THE ARMED/DISARMED CAPABILITY OF THE MP-4000 AS DESCRIBED IN P12L18 BELOW, BE SURE TO SET P12L6 TO RUN PGM.**

With RUN PGM, if the User reprograms the MP-4000 while the motor runs, the relay continues to protect with the all the old settings. All setting changes are stored in a scratchpad area and not immediately used. Finally, when the reprogramming is finished, the User exits the PROGRAM mode by pushing the Program button again (see Section 4). Only at this moment does the MP-4000 recalculate its internal values and put the new settings into effect. Note what happens when it does so:

- The thermal-model accumulator bucket is dumped and resets to 40°C (104°F).
- Any active run delay timers are reset and must start timing again.
- All jogging functions are reset - time between starts, cold starts, and starts per time limits are all cleared.
- The MP-4000 remembers that it was in the RUN state when the program mode was exited, and continues that state. The transition function will not reset, or trigger a reduced voltage starter to switch to reduced voltage.

#### 5.12.7 Setting P12L7, Emergency Override Enable (EMRG EN or EMRG DIS)

Select P12L7 if the emergency override button is enabled or disabled. If enabled, an emergency override can be executed by pushing the Emrg Override button behind the front panel security door. In any case, an emergency override can be performed by a remote contact connected to either of the discrete inputs DI1 or DI2 programmed as EMG OVR, or via data communications from a PowerNet host. The as-shipped setting is disabled.

Emergency Override allows a panic restart of a tripped motor without completely disabling protection. When the override request is received, the thermal-model accumulator bucket is drained to its initial level of 40°C (104°F). Jogging limit counters and timing, including antibackspin timing, are reset. Cold starts are fully restored.

The motor protection is now in the state it would be in if the motor had been standing for a long time prior to the moment of the override. This allows an immediate restart of the motor. The override can also delay an impending thermal trip of a running motor. The emergency override action is counted in the history record, and noted with its time tag in the logbook record.

### CAUTION

**THE EMERGENCY OVERRIDE FUNCTION CLEARS AND RESTARTS ALL PROTECTIVE FUNCTIONS OF THE MP-4000. USING THIS FUNCTION CAN DAMAGE THE MOTOR. USE IT ONLY FOR TRUE EMERGENCIES, WHEN IT KNOWN WHAT CAUSED THE TRIP. OVERRIDE PERMITS THE RISK OF MOTOR DAMAGE TO AVOID AN EVEN MORE DANGEROUS PROCESS SITUATION CAUSED BY THE TRIPPING OF THE MOTOR.**

#### 5.12.8 Setting P12L8, Set Real Time Clock Display (12-HOUR or 24-HOUR)

P12L8 selects the time display to be the 12-hour format (with AM or PM) or the 24-hour (military time or international time) format.

#### 5.12.9 Setting P12L9, Month (MONTH)

P12L9 sets the real-time clock month, 1 to 12.

#### 5.12.10 Setting P12L10, Day (DAY)

P12L10 sets the real-time clock day of the month. The MP-4000 tracks leap years to the year 2100.

#### 5.12.11 Setting P12L11, Year (YEAR)

P12L11 sets the real-time clock year.

#### 5.12.12 Setting P12L12, Hour (HOUR)

P12L12 sets the real-time clock hour (0 to 23). Use 13 to 23 for setting, even if the 12-hour AM/PM mode was selected above for display.

#### 5.12.13 Setting P12L13, Minute (MIN)

P12L13 sets the real-time clock minute. Since the minute does not update on its own while the relay is in program mode, make this the last setting to adjust before exiting.

### NOTICE

**THERE IS NO SETTING FOR SECONDS. THE CLOCK SECONDS ARE SET TO ZERO WHEN THE USER EXITS THE PROGRAM MODE. TO SYNCHRONIZE THE SECONDS, SET THE MINUTE VALUE AHEAD, AND EXIT (PRESS THE PROG BUTTON) AS THE NEXT MINUTE BEGINS.**

#### 5.12.14 Setting P12L14, Date Display Format (M D Y or D M Y)

P12L14 selects a display of either MONTH DAY YEAR, or DAY MONTH YEAR.

#### 5.12.15 Setting P12L15, IMPACC Communications Mode (MP3 EN or MP3 DIS)

To configure the MP-4000 to communicate in a manner limited to that of the preceding MP 3000 product, choose MP3K EN. This is the factory default setting. It is needed for operation with older IMPACC host systems. To take full advantage of MP-4000 capabilities with a newer PowerNet host, choose MP3K DIS. Refer to Section 10, Data Communications, for more details. This setting has no influence on performance or protection behavior of the protective relay itself.

#### 5.12.16 Setting P12L16, Internal Diagnostic Failure Action (RLYF TRP, RLYF ALM, RLYF T+A)

P12L16 selects the action to take if any of the MP-4000 internal background self-monitoring programs detect a problem with the relay. The factory setting is to trip and alarm. However, Users with critical processes may prefer to set for alarm only so that the motor can continue to run while maintenance personnel attend to the relay.

### CAUTION

**IF THE RLYF ALM SETTING IS CHOSEN, BE SURE TO CONNECT AN EFFECTIVE ALARM TO THE ALARM RELAY OUTPUT, AND TEST IT PERIODICALLY. OTHERWISE, THE MOTOR RUNS WITHOUT PROTECTION IF THE RELAY SUFFERS A HARDWARE FAILURE.**

#### 5.12.17 Setting P12L17, INCOM Trip Enabled or Disabled (INCT EN or INCT DIS)

P12L17 selects whether or not the MP-4000 accepts and executes a motor trip command from a remote PowerNet or IMPACC operator via data communications. This is dictated by security concerns and operating procedures of Users who connect the MP-4000 to a facility control system.

#### 5.12.18 Setting P12L18, Arm or Disarm Trip Relay (ARMED or DISARMED)

This maintenance function blocks the MP-4000 trip output, while all the tripping functions continue to operate internally. If DISARMED is

selected, the MP-4000 still displays all alarms and trips, but the trip output relay contact remains in its non-tripped state.

For safety purposes when the unit is DISARMED, the MP-4000 scrolls a warning message - "WARNING MP-4000 WILL BE DISARMED UPON EXIT OF PROGRAM MODE AND WILL NOT PROTECT THE MOTOR - ENTER ARMED INTO SETTING TO PROTECT THE MOTOR". The default display reads DISARMED, and the Protection LED turns off. Any alarm or trip messages on the display alternate with the word DISARMED.

In the ARMED mode, the MP-4000 works normally.

The DISARMED mode is useful for commissioning a new relay or new settings on a running motor, when a false trip output would disrupt the process. The User can commission the MP-4000 in the DISARMED mode and observe its behavior, noting any trip operations or filling of the I2t thermal bucket without suffering the consequence of an undesired trip. Once the User confirms that the settings are suitable, set the MP-4000 to ARMED and true protection is enabled.

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## NOTICE

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**THE ALARM, AUX1, AND AUX2 OUTPUT CONTACTS ALL FUNCTION NORMALLY, EVEN WHEN THE MP-4000 IS DISARMED.**

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## NOTICE

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**TO GET THE FULL USE OF THE DISARMED/ARMED CAPABILITY OF THE MP-4000, BE SURE TO SET P12L6 TO RUN PGM (ALLOW THE MP-4000 TO BE PROGRAMMED WHILE THE MOTOR RUNS), SO THAT THE RELAY CAN BE ARMED WITHOUT STOPPING THE MOTOR.**

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## CAUTION

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**WHEN DISARMED FOR MAINTENANCE REASONS, THE MP-4000 IS NOT PROTECTING THE MOTOR. AFTER PROPER OPERATION IS CONFIRMED, BE SURE TO SET TO ARMED. BE WATCHFUL AT ALL TIMES FOR THE DISARMED MESSAGE ON THE DISPLAY.**

### 5.13 Page 13, SP TEST, Settings P13L1 to P13L8

Page 13 is used to test the MP-4000.

#### 5.13.1 Setting P13L1, Operating Mode (3 PHASE or 1 PHASE)

This function allows the MP-4000 to be bench-tested using a single-phase current source (1 PHASE) if a three-phase source is unavailable at the test bench. The phase unbalance functions cannot be tested in 1 PHASE mode. For three-phase testing and all normal operation, select the three-phase mode (3 PHASE).



## CAUTION

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**IN SERVICE, THE MP-4000 DISPLAYS READY - 3 WHEN READY TO START IN THE THREE-PHASE MODE. IF IT DISPLAYS READY - 1, THE USER IS WARNED THAT THE RELAY IS IN THE SINGLE-PHASE TEST MODE, WHICH IS NOT SUITABLE FOR PROTECTION OF A REAL THREE-PHASE MOTOR.**

#### 5.13.2 Setting P13L2, Trip Relay Test (TRP ENER or TRP DENR)

P13L2 permits the User to directly energize or de-energize the trip relay for testing purposes. To use this function:

1. Stop the motor first. The test is blocked if the motor is running.
2. Determine whether the MP-4000 trip relay is configured for MODE 1 or MODE 2 operation. Refer to Setting P12L1 in Sub-section 5.12.1.
3. If MODE 1, the trip relay is normally de-energized. Set up for the test by selecting TRP ENER.
4. If MODE 2, the trip relay is normally energized. Set up for the test by selecting TRP DENR.
5. Press the Reset button to test the relay. The Trip LED also lights. Release the button to revert to the prior output state.

#### 5.13.3 Setting P13L3, Alarm Relay Test (ALM ENER or ALM DENR)

P13L3 lets the User directly energize or de-energize the alarm relay for testing purposes. Use it in the same way as the trip relay test. Check the Alarm relay MODE Setting P12L2. Unlike the trip output, this output can be tested with the motor running.

#### 5.13.4 Setting P13L4, AUX1 Relay Test (AX1 ENER or AX1 DENR)

P13L4 permits the User to directly energize or de-energize the AUX1 relay for testing purposes. Use it in the same way as the trip relay test. Check the AUX1 relay MODE Setting P12L3. Unlike the trip output, this output can be tested with the motor running.

#### 5.13.5 Setting P13L5, AUX2 Relay Test (AX2 ENER or AX2 DENR)

Lets the User directly energize or de-energize the AUX2 relay for testing purposes. Use it in the same way as the trip relay test. Check the AUX2 relay MODE Setting P12L4. Unlike the trip output, this output can be tested with the motor running.

#### 5.13.6 Setting P13L6, Force Analog Output Current Value (AOUT 4, AOUT 12, or AOUT 20)

To test the analog output, first select the value to force (either 4, 12, or 20 mA). When ready to test, push and hold the Reset button to observe the forced output value. When the Reset button is released, the analog output returns to normal operation.

#### 5.13.7 Setting P13L7, State of Discrete Input 1 (DI1 ON or OFF)

P13L7 is read only - it is not a setting. Use this to determine if Discrete Input 1 is ON (energized) or OFF.

#### 5.13.8 Setting P13L8, State of Discrete Input 2 (DI2 ON or OFF)

P13L8 is read only - it is not a setting. Use this to determine if Discrete Input 2 is ON (energized) or OFF.

### 5.14 Page 14, SP RESET, Settings P14L1 to P14L4

Page 14 is used to reset or clear the accumulated history mode statistics on the History pages:

- Press the line button on the History page to clear.
- Press either Value button to get the PUSH RST display.
- Press the Reset pushbutton to clear the History page.
- To escape without clearing, don't push Reset. Use a Value button to change from PUSH RST back to [History Page Name] RST, then navigate elsewhere or exit the Program Mode.

The four History pages are:

- Setting P14L1, Motor History Reset (MTR RST)
- Setting P14L2, Trip History Reset (TRIP RST)
- Setting P14L3, Alarm History Reset (ALRM RST)
- Setting P14L4, History Totals Reset (TOT RST)

Refer to Section 4 for more information on the History Mode displays that can be cleared.

## 5.15 Page 15, SPVUTRP, Settings P15L1 to P15L7

### 5.15.1 Setting P15L1, V1,V2 Threshold (VPNT)

P15L1 sets the voltage threshold (in volts) above which the phase unbalance ratio (VUT, P15L2) trip function becomes active.

### 5.15.2 Setting P15L2, Ratio of V2 TO V (VUT)

P15L2 sets the ratio of V2 to V1 (in percentage) above which the unit trips.

### 5.15.3 Setting P15L3, Phase Unbalance Trip and Alarm Start Delay (VUSD)

P15L3 sets the number of seconds after a start until the voltage unbalance trip and alarm elements are enabled.

### 5.15.4 Setting P15L4, Phase Unbalance Trip Run Delay (VUTR)

Sets the number of seconds that the voltage ratio must remain above the VUT setpoint before a trip event occurs. This timer will not begin until after the Phase Unbalance Trip & Alarm Start Delay (VUSD, P15L6) alarm function becomes active.

### 5.15.5 Setting P15L5, V2 Threshold (VPNA)

Sets the voltage threshold for V1 or V2 (in volts) above which the phase unbalance (VUA, P15L6) alarm function becomes active.

### 5.15.6 Setting P15L6, Ratio of V2 to V1 (VUA)

Sets the ratio of V2 to V1 (in percentage) above which the unit will alarm.

### 5.15.7 Setting P15L7 Phase Unbalance Run Alarm Delay (VUAR)

Sets the number of seconds that the voltage ratio must remain above the VUA setpoint before an alarm event occurs. This timer does not begin until after the Phase Unbalance Trip & Alarm Start Delay (VUSD) has timed out.

## 5.16 Page 16, SPVUTRP, Settings P16L1 to P16L5

### 5.16.1 Setting P16L1, Under Frequency Trip Threshold (UFT)

P16L1 sets the value (in Hz) below which the under frequency trip function begins to time out.

### 5.16.2 Setting P16L2, Under Frequency Trip Alarm Start Delay (UFSD)

P16L2 sets the number of seconds after a start until the under frequency trip and alarm elements are enabled.

### 5.16.3 Setting P16L3, Under Frequency Trip Run Delay (UFTR)

P16L3 sets the number of seconds that the frequency must remain below the Under Frequency Trip Threshold (UFT) setpoint before a trip event occurs. This timer does not begin until after the Under Frequency Trip & Alarm Start Delay (UFSD) has timed out.

### 5.16.4 Setting P16L4, Under Frequency Alarm Threshold (UFA)

P16L4 sets the number of seconds that the frequency must remain above the UFA setpoint before an alarm event occurs. This timer does not begin until after the Over Frequency Trip & Alarm Start Delay (UFSD) has timed out.

### 5.16.5 Setting P16L5, Under Frequency Alarm Run Delay (UFAR)

P16L5 sets the number of seconds that the frequency must remain below the UFA setpoint before an alarm event occurs. This timer will not begin until after the Under Frequency Trip & Alarm Start Delay (UFSD) has timed out.

## 5.17 Page 17, SP OFTRP, Settings P17L1 to P17L5

### 5.17.1 Setting P17L1, Over Frequency Trip Threshold (OFT)

P17L1 sets the value (in Hz) above which the over frequency trip function begins to time out.

### 5.17.2 Setting P17L2, Over Frequency Trip / Alarm Start Delay (OFSD)

P17L2 sets the number of seconds after a start before the over frequency trip and alarm elements are enabled.

### 5.17.3 Setting P17L3, Over Frequency Trip Run Delay (OFTR)

P17L3 sets the number of seconds that the frequency must remain above the Over Frequency Trip Threshold (OFT) setpoint before a trip event occurs. This timer does not begin until after the Over Frequency Trip & Alarm Start Delay (OFSD) has timed out.

### 5.17.4 Setting P17L4, Over Frequency Alarm Threshold (OFA)

P17L4 sets the frequency (in Hz) above which the unit alarms.

### 5.17.5 Setting P17L5, Over Frequency Alarm Run Delay (OFAR)

P17L5 sets the number of seconds that the frequency must remain above the OFA setpoint before an alarm event occurs. This timer does not begin until after the Over Frequency Trip & Alarm Start Delay (OFSD) has timed out.

## 5.18 Page 18, SP OVTRP, Settings P18L1 to P18L7

### 5.18.1 Setting P18L1, Over Voltage Trip Pickup Criterion (OVPT)

P18L1 sets the number of phases required to cause an overvoltage trip event.

### 5.18.2 Setting P18L2, Over Voltage Main Trip Threshold (OVT)

P18L2 sets the voltage threshold (in volts) above which the MP-4000 trips.

### 5.18.3 Setting P18L3, Over Voltage Main Run Delay (OVTR)

P18L3 sets the number of seconds that the voltage must remain above the Over Voltage Trip Threshold (OVT) set point before a trip event occurs. There is no start delay for this function.

#### 5.18.4 Setting P18L4, Over Voltage Alarm Criterion (OVPA)

P18L4 sets the number of phases required to cause an over voltage alarm event.

#### 5.18.5 Setting P18L5, Over Voltage Alarm Threshold (OVA)

P18L5 sets the voltage level (in volts) above which the MP-4000 alarms.

#### 5.18.6 Setting P18L6, Over Voltage Alarm Run Delay (OVAR)

P18L6 sets the number of seconds that the voltage must remain above the Over Voltage Alarm Threshold (OVT) set point before an alarm event occurs.

#### 5.18.7 Setting P18L7, Over Voltage Neutral Trip Threshold (OVNT)

P18L7 sets the neutral voltage (in volts) above which the MP-4000 trips.

### 5.19 Page 19, SP UVTRP, Settings P19L1 to P19L7

#### 5.19.1 Setting P19L1, Undervoltage Trip Pickup Criterion (UVPT)

P19L1 sets the number of phases required to cause an under voltage trip event.

#### 5.19.2 Setting P19L2, Main Undervoltage Threshold (UVT)

P19L2 sets the voltage level (in volts) below which the MP-4000 trips.

#### 5.19.3 Setting P19L3, Main Undervoltage Trip Run Delay (UVTR)

P19L3 sets the number of seconds that the voltage must remain below the Under Main Trip Threshold (UVT) setpoint before a trip event occurs. There is no start delay for this function.

#### 5.19.4 Setting P19L4, Under Voltage Alarm Pickup Criterion (UVPA)

P19L4 sets the number of phases required to cause an under voltage alarm event.

#### 5.19.5 Setting P19L5, Main Under Voltage Threshold (UVA)

P19L5 sets the voltage level (in volts) below which the MP-4000 alarms.

#### 5.19.6 Setting P19L6, Main Undervoltage Alarm Run Delay (UVAR)

P19L6 sets the number of seconds that the voltage must remain below the Under Voltage Alarm Threshold (UVA) setpoint before an alarm event occurs. There is no start delay for this function.

#### 5.19.7 Setting P19L7, Under Voltage Start Delay (UVSD)

P19L7 sets the number of seconds after a start before the over frequency trip and alarm elements are enabled.

### 5.20 Page 20, SP UPTRP, Settings P20L1 to P20L5

#### 5.20.1 Setting P20L1, Underpower Trip Threshold (UPT)

P20L1 sets the power (in %FLA\*VT) below which the relay trips.

#### 5.20.2 Setting P20L2, Underpower Trip Run Delay (UPTR)

P20L2 sets the number of seconds that the power must be below the Under Power Trip Threshold (UPT) setpoint before a trip event occurs. This timer does not begin until after the Under Power Trip & Alarm Start Delay (UTSD) has timed out.

#### 5.20.3 Setting P20L3, Under Power Alarm threshold (UPA)

P20L3 sets the power (in %FLA\*VT) below which the relay alarms.

#### 5.20.4 Setting P20L4, Under Power Alarm Run Delay (UPAR)

P20L4 sets the number of seconds that the power must be below the Under Power Alarm Threshold (UPA) setpoint before a trip event occurs. This timer does not begin until after the Under Power Trip & Alarm Start Delay (UTSD) has timed out.

#### 5.20.5 Setting P20L5, Underpower Trip/Alarm Start Delay (UTSD)

P20L5 sets the number of seconds after a start before the over frequency trip and alarm elements are enabled.

### 5.21 Page 21, SP PFTRP, Settings P21L1 to P21L12

#### 5.21.1 Setting P21L1, Leading Power Factor Trip Enable or Disable (PFLDE)

P21L1 enables or disables the Leading Power Factor protective trip function.

#### 5.21.2 Setting P21L2, Leading Power Factor Trip Threshold (PFLDT)

P21L2 sets the trip threshold for the Leading Power Factor Trip Threshold.

#### 5.21.3 Setting P21L3, Lagging Power Factor Trip Enable or Disable (PFLGE)

P21L3 enables or disables the Lagging Power Factor protective trip function.

#### 5.21.4 Setting P21L4, Lagging Power Factor Trip Threshold (PFLGT)

P21L4 sets the trip threshold for the Lagging Power Factor Trip Threshold.

#### 5.21.5 Setting P21L5, Power Factor Trip Start Delay (PFTS)

P21L5 sets the number of seconds after a start before the over frequency trip and alarm elements are enabled.

#### 5.21.6 Setting P21L6, Power Factor Trip Run Delay (PFTR)

P21L6 sets the number of seconds that the power must be below the PFLDT or PFLGT set points before a trip event occurs. This time does not begin until after the power factor trip start delay times out.

#### 5.21.7 Setting P21L7, Leading Power Factor Alarm Enable Disable (LDPFE)

P21L7 enables or disables the Leading Power Factor protective power alarm function.

#### 5.21.8 Setting P21L8, Leading Power Factor Alarm Threshold 1 (PFLDA)

P21L8 sets the alarm threshold for the Leading Power Factor Alarm threshold.

### 5.21.9 Setting P21L9, Lagging Power Factor Alarm Enable Disable (LGPFE)

P21L9 enables or disables the Lagging Power Factor Alarm function.

### 5.21.10 Setting P21L10, Lagging Power Factor Alarm Threshold 2 (PFLGA)

P21L10 sets the alarm threshold for the Lagging Power Factor Alarm Threshold.

### 5.21.11 Setting P21L11, Power Factor Alarm Start Delay (PFAS)

At the start, P21L11 sets the number of seconds before the over frequency alarm and alarm elements are enabled.

### 5.21.12 Setting P21L12, Power Factor Alarm Run Delay (PFAR)

P21L12 sets the number of seconds that the power must be below the PFLDA or PFLGA set points before an alarm event occurs. This timer does not begin until after the Power Factor Alarm Start Delay (PFAS) has timed out.

## 5.22 Page 22, AREL, Settings P22L1 to L7

### 5.22.1 Setting P22L1

P22L1 allows the Voltage Unbalance Alarm or Trip to activate the alarm relay output. This function can be disabled by setting this set point to "OFF".

### 5.22.2 Setting P22L2

Setting P22L2 allows the Overvoltage Alarm or Trip to activate the alarm relay output. This function can be disabled by setting this set point to "OFF".

### 5.22.3 Setting P22L3

Setting P22L3 allows the Undervoltage Alarm or Trip to activate the alarm relay output. This function can be disabled by setting this set point to "OFF".

### 5.22.4 Setting P22L4

Setting P22L4 allows the Over Frequency Alarm or Trip to activate the alarm relay output. This function can be disabled by setting this setpoint to "OFF".

### 5.22.5 Setting P22L5

Setting P22L5 allows the Under Frequency Alarm or Trip to activate the alarm relay output. This function can be disabled by setting this setpoint to "OFF".

### 5.22.6 Setting P22L6

Setting P22L6 allows the Underpower Alarm or Trip to activate the alarm relay output. This function can be disabled by setting this setpoint to "OFF".

### 5.22.7 Setting P22L7

Setting P22L7 allows the Power Factor Alarm or Trip to activate the alarm relay output. This function can be disabled by setting this setpoint to "OFF".

## 5.23 Page 23, SP UPTRP, Settings P23L1 to P23L7

### 5.23.1 Setting P23L1

P23L1 allows the Voltage Unbalance Alarm or Trip to activate the AUX 1 Relay Output. This function can be disabled by setting this setpoint to "OFF".

### 5.23.2 Setting P23L2

P23L2 allows the Overvoltage Alarm or Trip to activate the AUX 1 Relay Output. This function can be disabled by setting this setpoint to "OFF".

### 5.23.3 Setting P23L3

P23L3 allows the Undervoltage Alarm or Trip to activate the Aux1 Relay Output. This function can be disabled by setting this setpoint to "OFF".

### 5.23.4 Setting P23L4

P23L4 allows the Over Frequency Alarm or Trip to Activate Aux1 Relay Output. This function can be disabled by setting this setpoint to "OFF".

### 5.23.5 Setting P23L5

P23L5 allows the Under Frequency Alarm or Trip to activate the AUX 1 Relay Output. This function can be disabled by setting this setpoint to "OFF".

### 5.23.6 Setting P23L6

P23L6 allows the Underpower Alarm or Trip to activate the AUX 1 Relay Output. This function can be disabled by setting this setpoint to "OFF".

### 5.23.7 Setting P23L7

P23L7 allows the Power Factor Alarm or Trip to activate AUX 1 Relay Output. This function can be disabled by setting this setpoint to "OFF".

## 5.24 Page 24, SP2 AUX 2, Settings P24L1 to L7

### 5.24.1 Setting P24L1

P24L1 allows the Voltage Unbalance Alarm or Trip to activate the AUX 2 Relay Output. This function can be disabled by setting this setpoint to "OFF".

### 5.24.2 Setting P24L2

P24L2 enables the Overvoltage Alarm or Trip to activate the AUX 2 Relay Output. This function can be disabled by setting this setpoint to "OFF".

### 5.24.3 Setting P24L3

P23L3 enables the Undervoltage Alarm or Trip to activate the AUX 2 Relay Output. This function can be disabled by setting this setpoint to "OFF".

### 5.24.4 Setting P24L4

P24L4 enables the Over Frequency Alarm or Trip to activate the AUX 2 Relay Output. This function can be disabled by setting this setpoint to "OFF".

#### 5.24.5 Setting P24L5

P24L5 enables the Under Frequency Alarm or Trip to activate the AUX 2 Relay Output. This function can be disabled by setting this setpoint to "OFF".

#### 5.24.6 Setting P24L6

P24L6 enables the Underpower Alarm or Trip to activate the AUX 2 Relay Output. This function can be disabled by setting this setpoint to "OFF".

#### 5.24.7 Setting P24L7

P24L7 enables the Power Factor Alarm or Trip to activate the AUX 2 Relay Output. This function can be disabled by setting this setpoint to "OFF".

### 5.25 Page 25, SP2 SYS, P25L1 to L9, WATT Hours Display

#### 5.25.1 Setting P25L1, Watt Hours Display

P25L1 sets the watt hours display to kilo, mega, or giga.

#### 5.25.2 Setting P25L2, Volt-amps Reactive Display

P25L2 sets the volt-amps reactive display to kilo, mega, or giga.

#### 5.25.3 Setting P25L3, Volt-amps Display

P25L3 sets the volt-amps display to kilo, mega, or giga.

#### 5.25.4 Setting P25L4, 3-Phase Watts Display

P25L4 sets the 3-phase watts display to kilo or mega.

#### 5.25.5 Setting P25L5, 3-Phase Volt-amp Reactive Display

P25L5 sets the 3-phase volt-amps reactive display to kilo or mega.

#### 5.25.6 Setting P25L6, 3-Phase Volt-amp Display

P25L6 sets the 3-phase volt-amps display to kilo or mega.

#### 5.25.7 Setting P25L7, External PT Ratio

P25L7 sets the external PT Ratio display to a value from 1-250:1. The external PT should step the voltage down to 120 Vac nominal at the voltage inputs of the MP-4000.

#### 5.25.8 Setting P25L8, PT Configuration

P25L8 selects between WYE (0), delta (1), or open delta (2).

#### 5.25.9 Setting P25L9, Voltage Display

P25L9 sets the voltage display to volts or kilovolts.

### 5.26 Page 26, SP COMM Settings for RS232 Communications

P26L1 enables (on) or disables (off) the RS-232 communications mode. Note that URTD and PONI communications are disabled when the MP-4000 is in the RS-232 mode.

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## SECTION 6 - INSTALLATION AND WIRING

### 6.0 Mounting the MP-4000 Motor Protection Relay

The following subsections describe the mounting of the MP-4000 motor protection relay, and its optional URTD and PONI communications modules.

#### 6.0.1 Mounting Locations

Mount the unit vertically on a flat panel. The location should be as free as possible of water, chemicals, dust, and excessive heat and vibration. The panel should protect the User from accidental contact with live terminals on the back of the MP-4000. A 0.125-in. (3.2-mm) steel panel or door, solidly grounded, is recommended.

Before actually cutting the panel, check the required three-dimensional clearances for the MP-4000 case, particularly behind the panel. Figures 6.3 and 6.4 show these clearances. If mounting the unit on a swinging door, check the swinging clearance of rear projections and wired connections.

Figure 6.2 shows dimensions for the panel cutout and mounting holes. Cutout tolerances and mounting screw hole placement are critical. In particular, the tolerance of the horizontal dimension between the center of the mounting holes and the vertical edge of the cutout must be between 0 and +0.050 in. (1.273 mm).

**NOTE:** The cutout is the same as for the previous-generation IQ 1000 II and MP-3000 motor relays, and other Eaton, Inc. IQ products of this case size. The six mounting holes that secure these older products are still correctly located for the MP-3000, but the four additional new holes should be added.

Secure the MP-4000 to the panel with the special self-tapping plastic screws using moderate torque - 8 in.-lbs (0.9 N-m). Use the 0.375-in. (9.5-mm) long screws supplied with the MP-4000 to mount the unit on a 0.125-in. (3.2-mm) panel. Do not attempt to tap the screw holes, and do not use machine screws.

#### 6.0.2 Mounting the URTD Module

The optional URTD module provides temperature data to the MP-4000 from up to 11 RTDs embedded in the motor and driven equipment. Refer to URTD I.L. 17367 for further information.

The URTD module may be mounted either on the back of the MP-4000 by using the URTD mounting bracket and machine screws (supplied with the URTD module), or mounted remotely from the MP-4000. If mounting the URTD module on the back of the MP-4000, see Figure 6.4 for overall depth dimensions. Figure 6.5 shows the URTD stand-alone mounting dimensions.

Consider the benefit of mounting the URTD module away from the MP-4000, as close as possible to the motor. The RTD wiring, consisting of a large bundle of wires, is thus much shorter. The URTD conveys multiplexed temperature data back to the MP-4000 via a single optical fiber (recommended), or by a 3-wire communications conductor. The URTD may be placed up to 400 ft (121.9 m) from the MP-4000 with the optical fiber connection (recommended), or up to 499 ft (152 m) away with a wired communications connection. Note that the URTD requires 120 Vac power (6 VA) at its remote location. It may be mounted in any orientation.

#### 6.0.3 Mounting the PONI Communications Module

Refer to Section 10 for a description of the various types of optional PONI communications modules that can be used with the MP-4000. Check the I.L. for the selected PONI to confirm dimensions and communications network connection requirements.

Figure 6.4 shows clearance dimensions to the rear of an I-PONI, M-PONI, or D-PONI. An E-PONI is 0.5 in. (12.7 mm) deeper.

The PONI, if used, is always mounted on the back of the MP-4000. If no URTD is mounted there, use the mounting bracket supplied with the MP-4000, as shown in Figure 6.4. The bracket gives a convenient space to run CT wires underneath the PONI to the adjacent CT terminal block.

If a URTD is mounted on the back of the MP-4000, the PONI piggybacks directly to the URTD module as shown. Use the machine screws supplied with the PONI in the molded plastic mounting holes of the URTD.

### 6.1 Wiring - General Information

When routing wires between the starter and the associated machine or process equipment, follow these guidelines:

- Do not route the control or RTD wiring through the high-voltage compartment of the motor starter. However, the starter manufacturer may be able to recommend or provide specific measures for doing this if it is really necessary.
- Separate the lower voltage (120 Vac) from the higher voltage (440 Vac or higher) conductors as much as possible. In general, maintain a minimum distance of 1.5 feet (45 cm) between the two types.
- Any low-voltage control wiring routed out of the motor starter cabinet should be at least #14 AWG (2.6 mm<sup>2</sup>) stranded copper wire.
- Communications circuits may use thinner conductors, as recommended in installation literature for those circuits.



## WARNING

**BEFORE WORKING WITH THE WIRING, MAKE SURE POWER IS DISCONNECTED FROM THE MOTOR STARTER, MP-4000, AND ALL REMOTE CONNECTIONS, INCLUDING CONTACT OUTPUT CONTROL CIRCUITS AND REMOTE INPUT CONTACTS. OTHERWISE, HAZARDOUS VOLTAGES COULD CAUSE INJURY OR DEATH. ALSO, UNEXPECTED MOTOR CONTROL ACTION COULD INJURE PERSONNEL OR DESTROY EQUIPMENT.**

Figure 6.6 shows rear terminal connections of the MP-4000.

Connect terminal 5 to the closest solid electrical-safety grounding point with a heavy wire or braid (#14 AWG [2.6mm<sup>2</sup>] or larger). Do not use a current-carrying or neutral conductor for this grounding. Also, do not tie terminal 5 to neutral terminal 7 at the relay. Note that terminal 5 is internally connected to the outer case and to the conductive faceplate of the relay.

#### 6.1.1 CT Wiring

Carefully read the advice in Subsection 5.1.5 on the choice of CT ratios for a particular motor application. An inappropriate CT ratio results in poor measurement accuracy and limited protection. More serious errors in ratio choice make it impossible to set the relay properly.

Connect the phase and optional ground CTs as shown in Figures 6.7, 6.8, and 6.9. Pay attention to the phase identification and sequence, and check for consistent polarity among the three phases. The MP-4000 may not allow the motor to run, and cannot protect the motor properly, if two phases are swapped or if the polarity of any CT is reversed with respect to the other two.

Pass the motor phase conductors through the window of the flux-canceling ground CT. The ground CT need not have any particular polarity relationship to the phase CTs.

To minimize problems with CT saturation during faults, keep the CT wiring as short as possible and use very heavy wire. The total resistance of the connecting wire should not be much larger than the secondary resistance of the CT itself. The MP-4000 presents a very low burden.

Every phase and ground CT circuit must have one and only one grounding point. Figures 6.7, 6.8, and 6.9 show the common neutral connection of the 3-phase CTs, and the ground fault CT, connected at one point to a non-current-carrying ground. Do not use a neutral or current carrying conductor for this grounding, because the noise resulting from this connection would disrupt MP-4000 measurements.

Residual connection of the phase CT secondaries that form a ground current signal do not provide a sensitivity approaching that of the flux-canceling ground CT (refer to Subsection 9.1.10).

### 6.1.2 PT Wiring

Connect the PTs as shown in Figures 13.4, 13.5 and 13.6. For optimal performance, the external PTs should be selected such that the voltage inputs to the MP-4000 are 120 Vac nominal. The voltage inputs are clamped at 220 Vac. Continuous voltages above this level should never be applied to the MP-4000, and may result in failure of the unit. The voltage inputs to the MP-4000 should be fused.

## CAUTION

**CONTINUOUS VOLTAGES ABOVE 220 VAC SHOULD NEVER BE APPLIED TO THE MP-4000; THEY MAY RESULT IN FAILURE OF THE UNIT. THE VOLTAGE INPUTS TO THE MP-4000 SHOULD BE FUSED.**

**FOR PROPER OPERATION OF VOLTAGE MONITORING AND PROTECTION, THE NEUTRAL/GROUND PT INPUT MUST BE SOLIDLY CONNECTED TO EARTH GROUND.**

### 6.1.3 Output Contact Wiring

Refer to the Technical Specifications in Section 3 for ratings of output contacts, and check them against controlled loads.

Figure 6.7 shows a typical connection of MP-4000 output relay contacts in the motor control circuits. However, the outputs other than the trip relay are completely programmable, so there can be nearly infinite choice in the connection and use of these outputs for tripping, alarming, and auxiliary control.

The installation design engineer must study Sections 5 and 9 to understand the available output functions and programming options. This engineer must record and confirm the settings, and also design a consistent connection of the form C contacts of the four output relays to the motor control system.

Pay attention to these features of the programming and contact use:

- Each relay can be set as Mode 1 (normally de-energized; energized to activate), or Mode 2 (normally energized/de-energize to activate). Weigh this against the use of NO versus NC contacts in the control scheme (refer to Subsection 5.12.1).
- All trips are steered to the trip relay (terminals 11-12-13) without choice - connect this to the contactor or trip coil. For all other relays and functions, the User chooses what function activates which relay.
- It is recommended that the alarm relay be used in Mode 2; all alarm conditions should be directed to it. Connect the annunciator to terminals 17 and 18. With this connection, an alarm is given if the relay or its power supply fails, or when any other problems the MP-4000 can actively report arise. However, if the MP-4000 is de-energized routinely in service,

use the alarm relay in Mode 1, and connect the annunciator to terminals 18 and 19 to avoid nuisance alarms.

- If the relay AUX 1 is set for the process load shedding function, it can not be used for anything else.
- If the relay AUX 2 is set for transition control of a reduced-voltage starter, it can not be used for anything else.

### 6.1.4 AC Supply Wiring

See Figure 6.10. Connect terminals 4 and 7 to a source of control power rated at either 120 Vac or 240 Vac. The MP-4000 automatically configures its power supply to work with one or the other value. *Nominal* values other than 120 Vac or 240 Vac are not recommended. However, the MP-4000 can handle depressions, dips, and limited sustained variations in the normal course of service. Refer to the Technical Specifications in Section 3.

The optional URTD module can operate *only* from 120 Vac. For a 240 Vac source, use a step-down transformer suitable for a load of 6 VA. Do not attempt to power the URTD from the MP-4000 120 Vac discrete source. That source is for contact reading only, and cannot handle the URTD burden.

If the supply is a dc battery system, use the optional IQ DC power supply (Cat. # IQDCPS). The IQ DC supply can power the MP-4000, the URTD, if used, and the discrete input circuits of the MP-4000. The total burden capability of the IQ DC module is 30 VA; the unit can operate from nominal voltages of 100 Vdc to 150 Vdc.

### 6.1.5 Discrete Input Contact Wiring

See Figures 6.10 and 6.11. The particular contacts to be connected depend on the settings programmed in the MP-4000. There is a long list of functions that can be assigned to each of these inputs.

The engineer who designs the installation should study Sections 5 and 9 to understand and designate the use, if any, of the discrete contact-sensing inputs. Note that only one use can be assigned to each input.

## CAUTION

**THE DISCRETE INPUTS SHOULD BE ENERGIZED ONLY FROM 120 VAC. THE MP-4000 TERMINAL 6 IS ALWAYS A SOURCE OF 120 VAC, WHICH CAN BE USED TO WET REMOTE CONTACTS, EVEN WHEN THE MP-4000 IS POWERED FROM 240 VAC.**

The discrete input circuits are totally isolated from the other circuits in the MP-4000, and have their own common connection, terminal 9. If the 120 Vac discrete contact-wetting source from terminal 6 is used, tie the discrete input common terminal 9 to the ac supply neutral terminal 7, as shown in Figure 6.12.

Figure 6.11, lower portion, shows an alternate scheme for using a remote contact wetting source. The source must be 120 Vac. The contact signal(s) *and the remote neutral* must be brought to the MP-4000 discrete inputs. For noise immunity and safety, do not connect the discrete common terminal 9 to terminal 7 or any other nearby neutral if a remote wetting source is in use.

## CAUTION

**BEWARE OF LARGE SHUNT CAPACITANCE ACROSS CONTACTS OR IN SOLID-STATE RELAYS CONNECTED TO THE MP-4000 DISCRETE INPUTS. CHARGING CURRENT THROUGH THE CAPACITOR COULD CAUSE A FALSE INDICATION OF A CLOSED CONTACT. KEEP TOTAL CAPACITANCE BELOW 0.05 MICROFARADS.**

6.1.6 Analog Output Wiring

Terminals 24 and 25 provide an isolated source of dc current between 4 and 20 mA, the exact value indicating an internal MP-4000 measurement. This current source, if used, is typically connected to a remote panel meter or a programmable logic controller.

The measurement selection is made via an MP-4000 setting. Choices include motor current, stator winding temperature, and fill level of the rotor thermal model bucket between cool level and trip level (refer to setting P11L1 in Section 5).

The burden of the connected current loop should be less than 1,000 ohms. See the Analog Output Technical Specification in Section 3 and Figure 6.1.

**NOTE:** The external device driven by the analog output must be fully isolated. The resistance to ground of the circuit driven by the analog output must be greater than 1 megohm. The accuracy of the analog output decreases rapidly below 1 megohm.

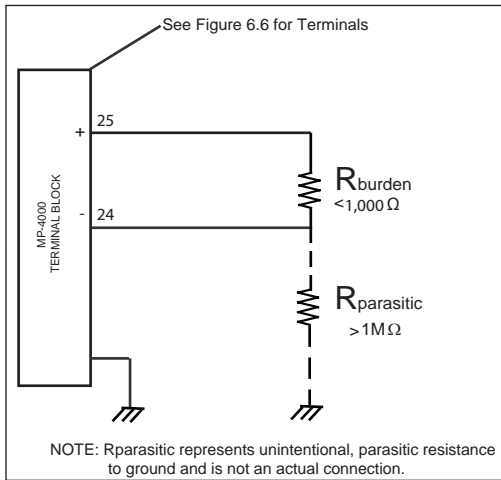


Figure 6.1 Max. Burden - Characteristics of an Attached Device.

6.1.7 URTD Wiring

Connect a source of 120 Vac only to the power terminals of connector J3 on the URTD module. Connect either terminal 16 or terminal 32 (but not both) to a non-current-carrying safety ground.

Length (Meters)	Catalog Number	Number
1	MPFO-1	HBFR-ELS001 or HBFR-RLS001
5	MPFO-5	HBFR-ELS005 or HBFR-RLS005
10	MPFO-10	HBFR-ELS010 or HBFR-RLS010
25	MPFO-25	HBFR-ELS025
50	MPFO-50	HBFR-ELS050
75	MPFO-75	HBFR-ELS075
76	MPFO-76	HBFR-ELS076
100	MPFO-100	HBFR-ELS100
120	MPFO-120	HBFR-ELS120

Figure 6.10 shows connections between the URTD and the MP-4000. Use either the optical fiber or the electrical 3-wire connection. It is not necessary to connect both. If both are connected, the MP-4000 uses data from the optical fiber. It defaults to the wired connection, only if the fiber is removed or fails.

**NOTE:** The optical fiber is the preferred method of transmitting temperature data from the URTD to the MP-4000. It is also easier to install.

Preassembled plastic optical fibers with connectors can be ordered from Eaton Inc., or from any distributor of Agilent Technologies® optical fiber products. In addition, these same distributors offer long rolls of cable with connectors that can be installed in the field. Some distributors will make custom lengths to order.

The fiber length should not exceed 400 ft (121.9 m). For long runs over 33 ft (10 m), be sure to use H-P extra low loss plastic fiber HBFR-ELS or -EUS. Do not splice fiber. Maximum short-term pulling force is 11.3 lbf (50 N). Surplus length of a precut fiber causes no problems. Simply coil and tie the excess fiber at a convenient point. Avoid high tie pressure. The bending radius of the fiber should be greater than 2 in. (50.8 mm). The fiber terminations simply snap into or out of the connectors of the URTD and MP-4000.

When using 3-wire shielded cable, wire according to the connection guidelines in Table III of the Universal RTD Module IL 17367. The 3-wire shielded cable should be #16 AWG or #18 AWG (1.31 mm<sup>2</sup> or 0.823 mm<sup>2</sup>). Connect the cable shield *only* at the MP-4000 end, at terminal 23. Insulate the shield, and do not connect it at the URTD end.

**CAUTION**

**IF THE MP-4000 IS SUPPLIED FROM 240 VAC, THE URTD COMMUNICATIONS COMMON TERMINAL 22 IS AT 120 VAC WITH RESPECT TO THE SUPPLY NEUTRAL.**

The maximum cable length is 500 ft (152 m).

6.1.8 Wiring RTDs to the URTD Module

Consult URTD Module Instruction Leaflet I.L.17367.

Three URTD terminals are provided for each RTD input. Terminals 1-15 and 17-19 are inputs for up to 6-winding RTDs. Terminals 20-25 accept up to two motor bearing RTDs. Terminals 26-31 accept up to two load bearing RTDs. Terminals 33-35 accept an auxiliary RTD.

The three terminals for any unused RTD input channel should be wired together. For example, if MW5 and MW6 are unused, MW5 terminals 13-15 should be wired together; and MW6 terminals 17-19 should be separately wired together.

Figure 6.12 shows the wiring of RTDs to the URTD inputs. Use #18 AWG (0.823 mm<sup>2</sup>), three-conductor shielded cable. Note the connection rules in the figure. When making connections to a two-lead RTD, connect two of the cable conductors to one of the RTD leads as shown. Make this connection as close to the motor as possible. Connect the third cable conductor to the remaining RTD lead.

Connect the shield and drain wire, along with the one cable conductor, to the middle of the three RTD input channel terminals, as shown in Figure 6.12. The RTD cable shield should be connected only at the URTD end, and insulated at the RTD end. The RTDs themselves must not be grounded at the motor.

Remember to set the URTD module DIP switches according to the types of RTDs in each of the winding, motor bearing, load bearing, and auxiliary groups. Refer to URTD Module Instruction Leaflet I.L. 17367.

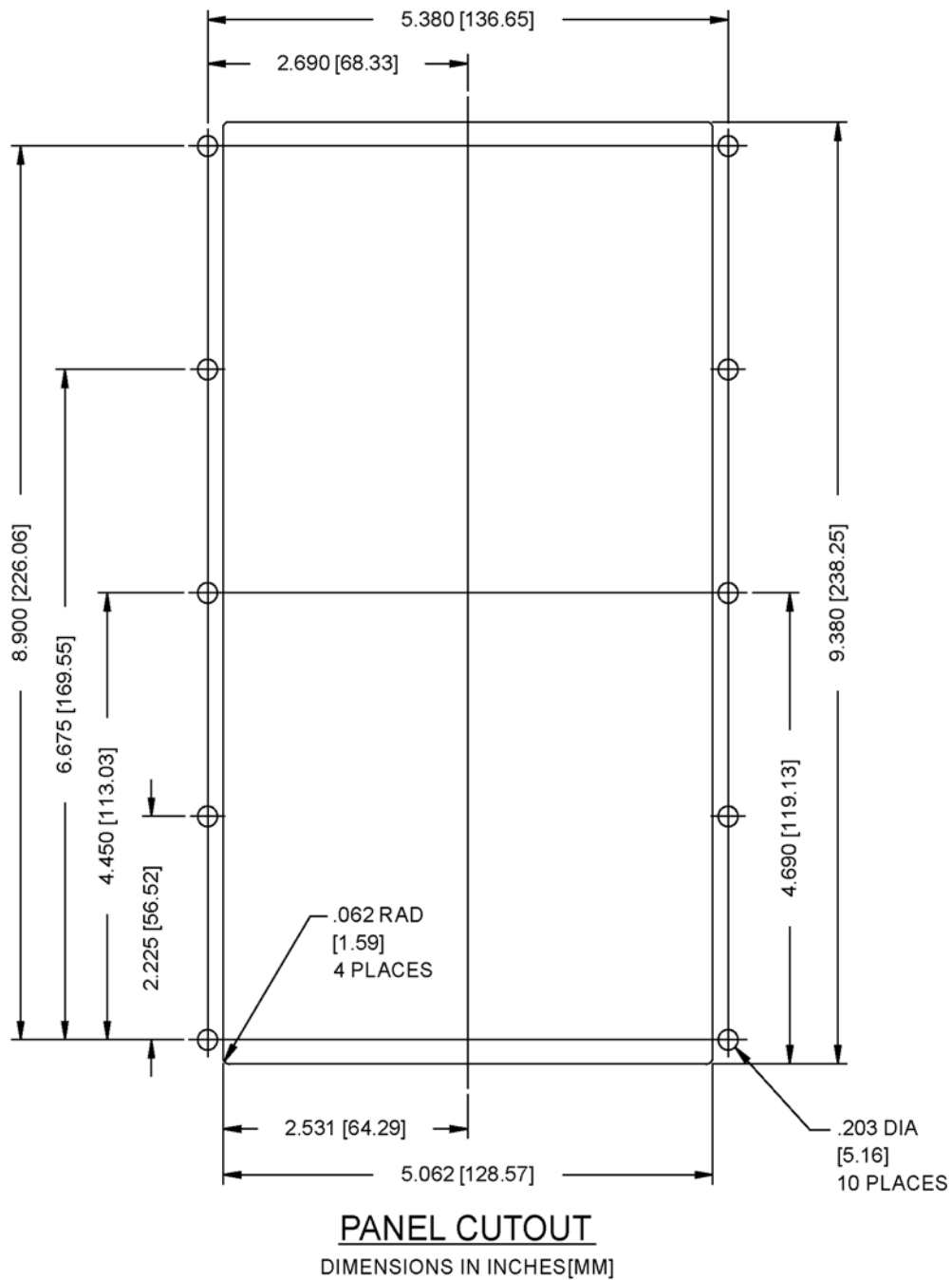
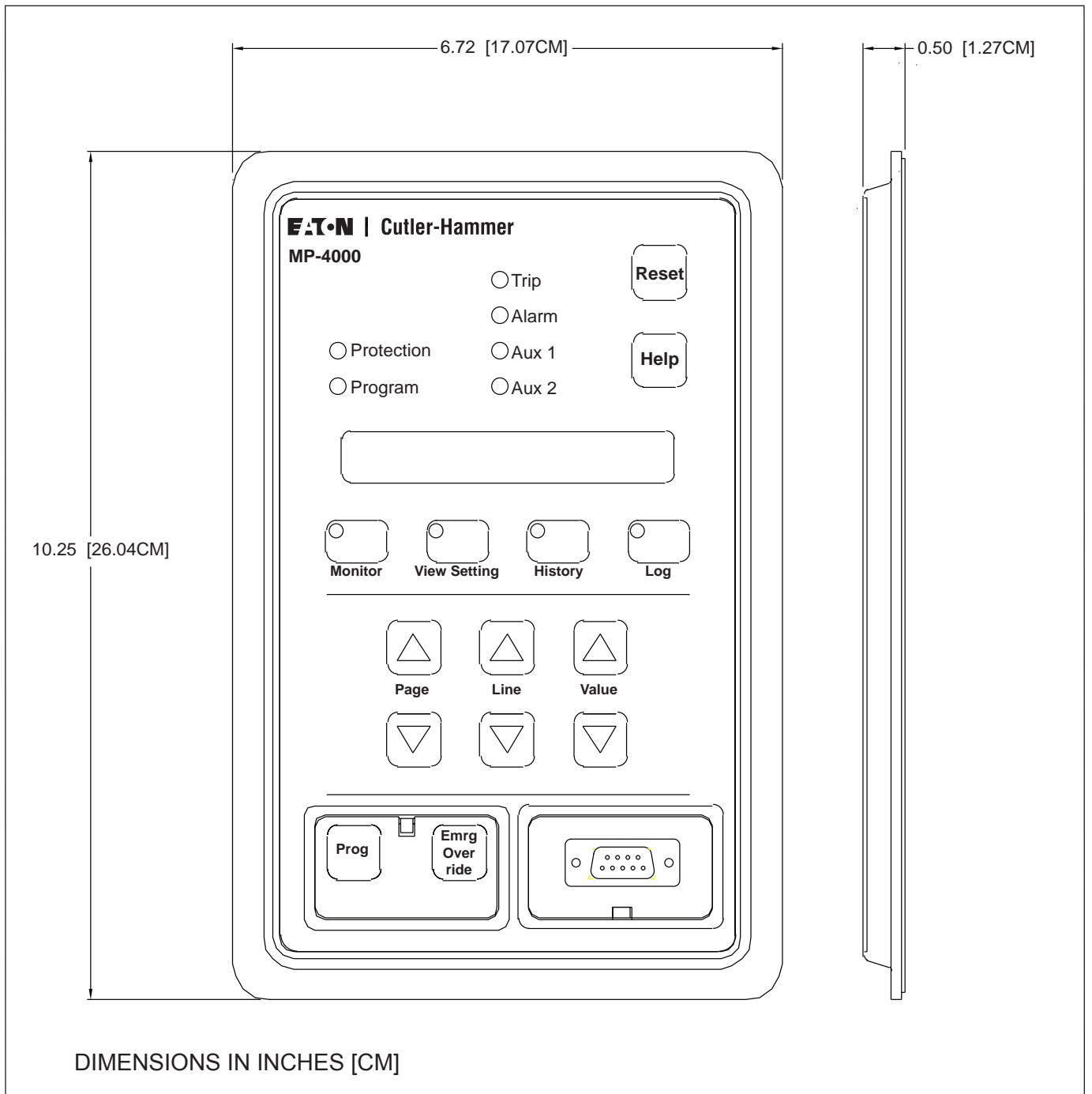


Figure 6.2 Panel Cutout Dimensions.



**Figure 6.3 Faceplate Dimensions.**

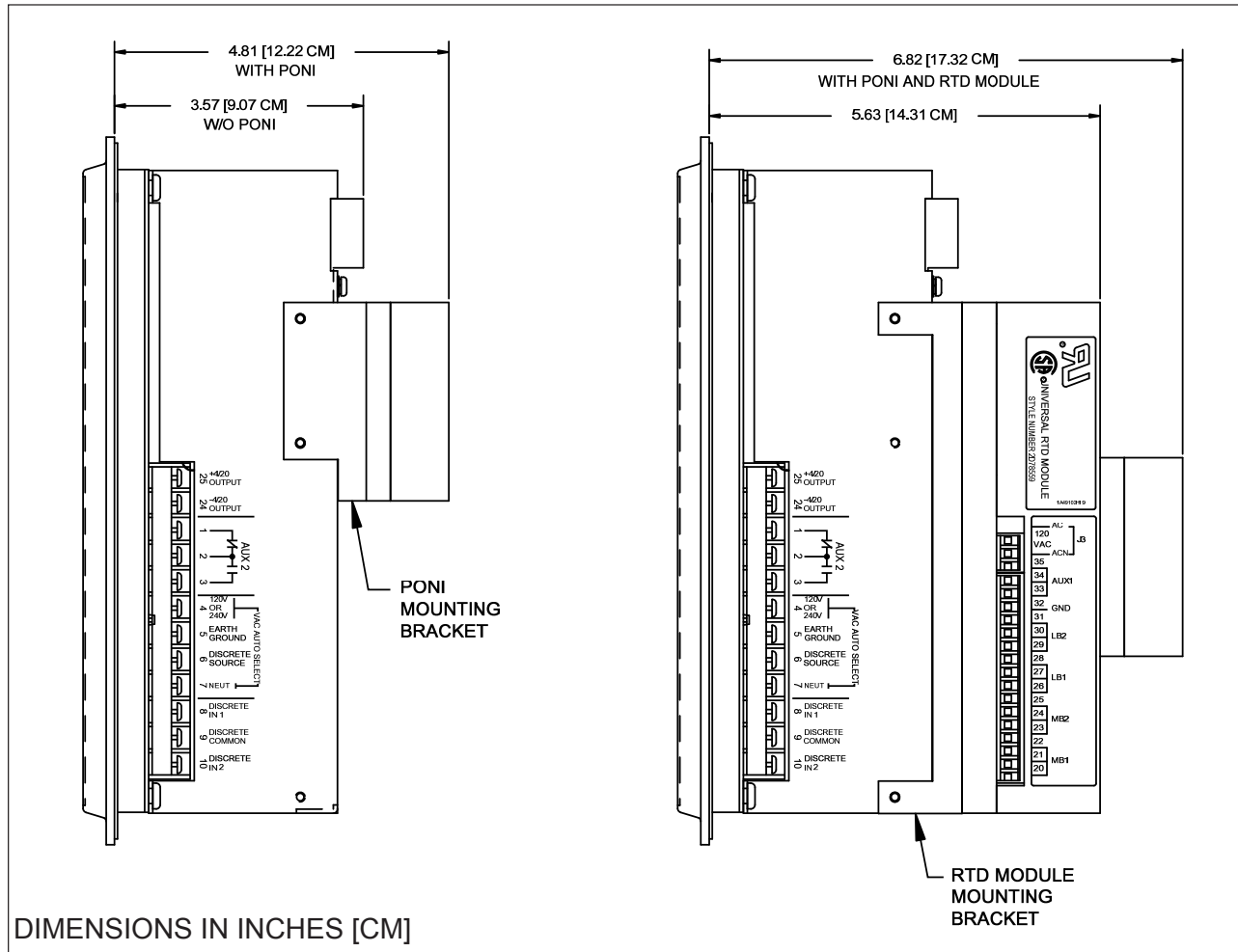


Figure 6.4 MP-4000 Case Depth Dimensions.



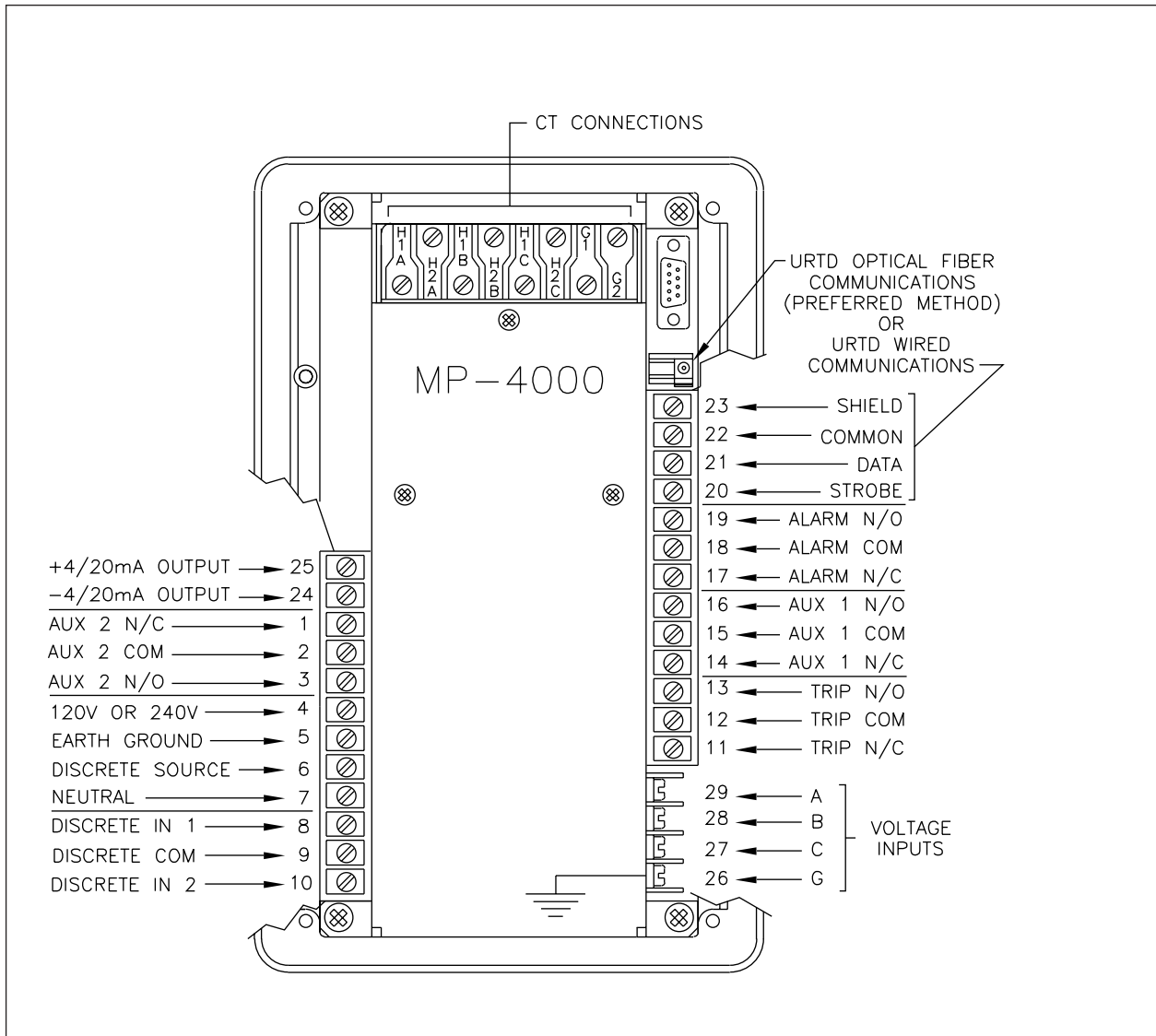
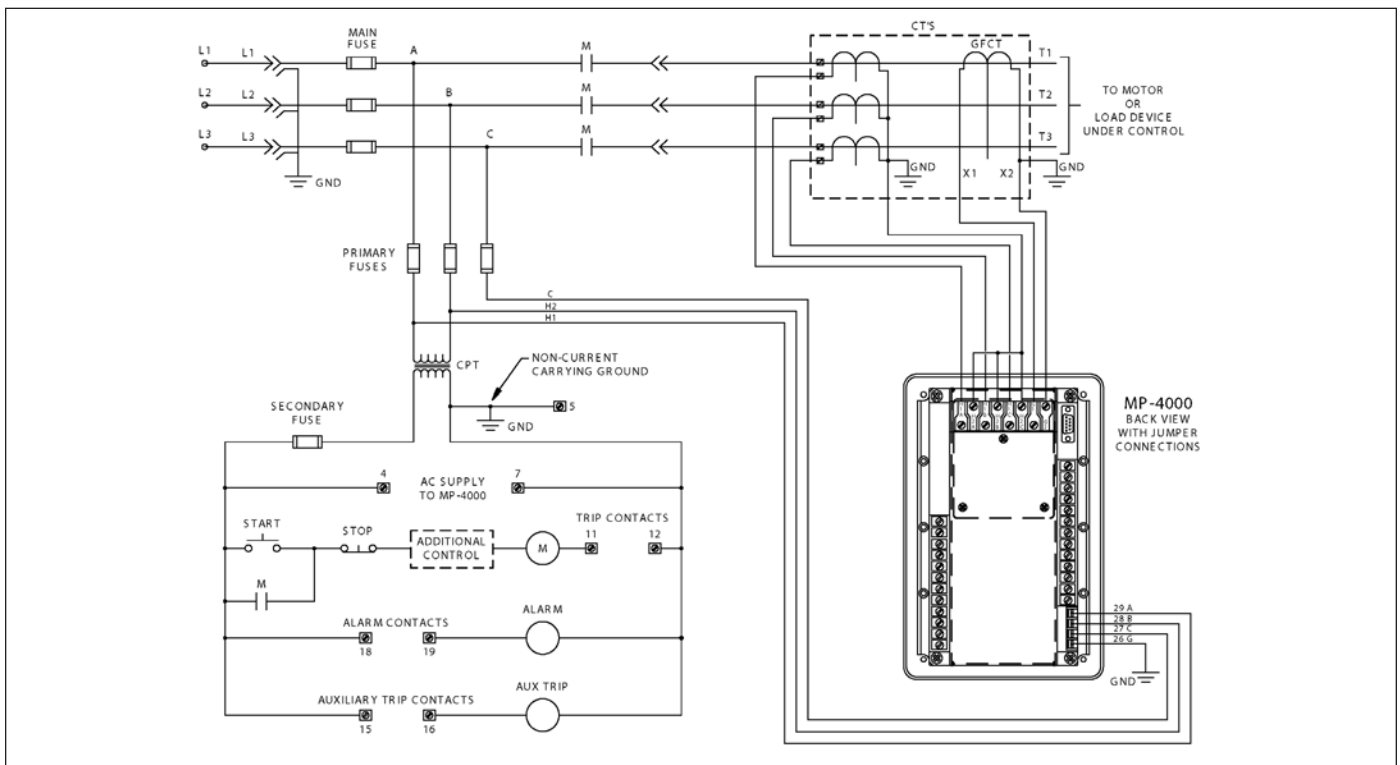


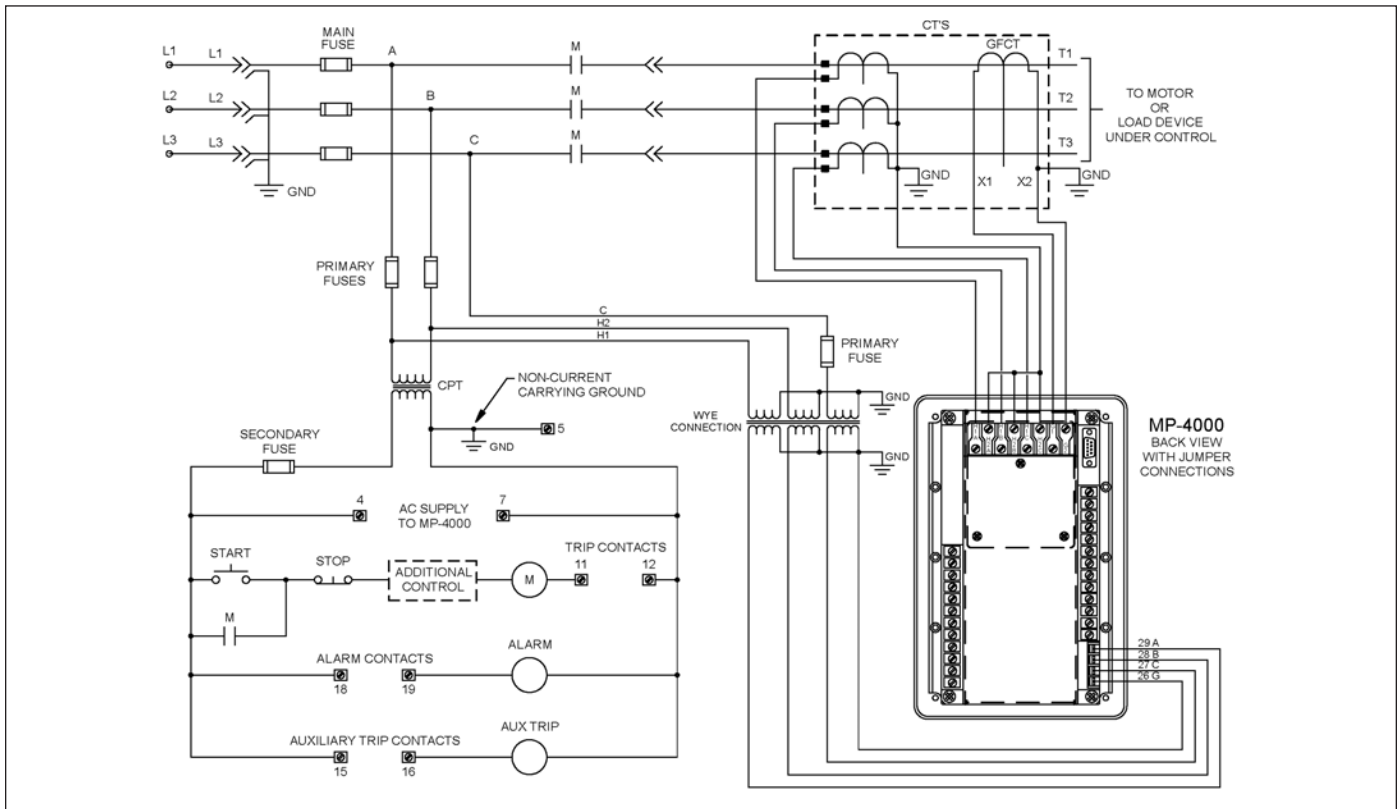
Figure 6.6 Rear Panel Terminals.





**Figure 6.7 MP-4000 Typical CT & PT Circuits and Motor Control Wiring.**

Note: Voltage Inputs Are 120 Nominal, Limited to 150 Vac.



**Figure 6.8 MP-4000 Typical CT & PT Circuits and Motor Control Wiring (WYE-WYE).**

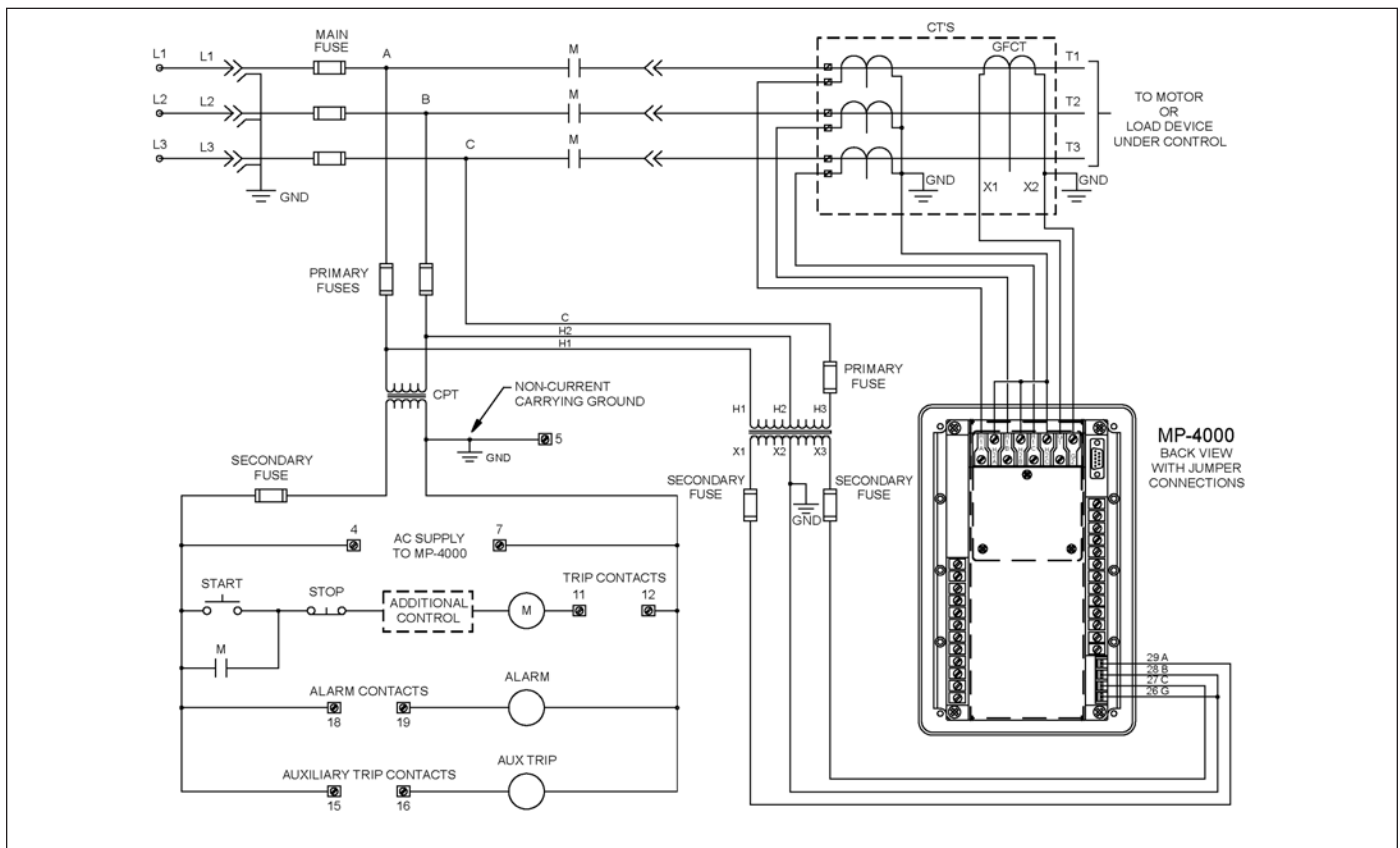


Figure 6.9 MP-4000 Typical CT and PT Circuits and Motor Control Wiring (Open Delta).

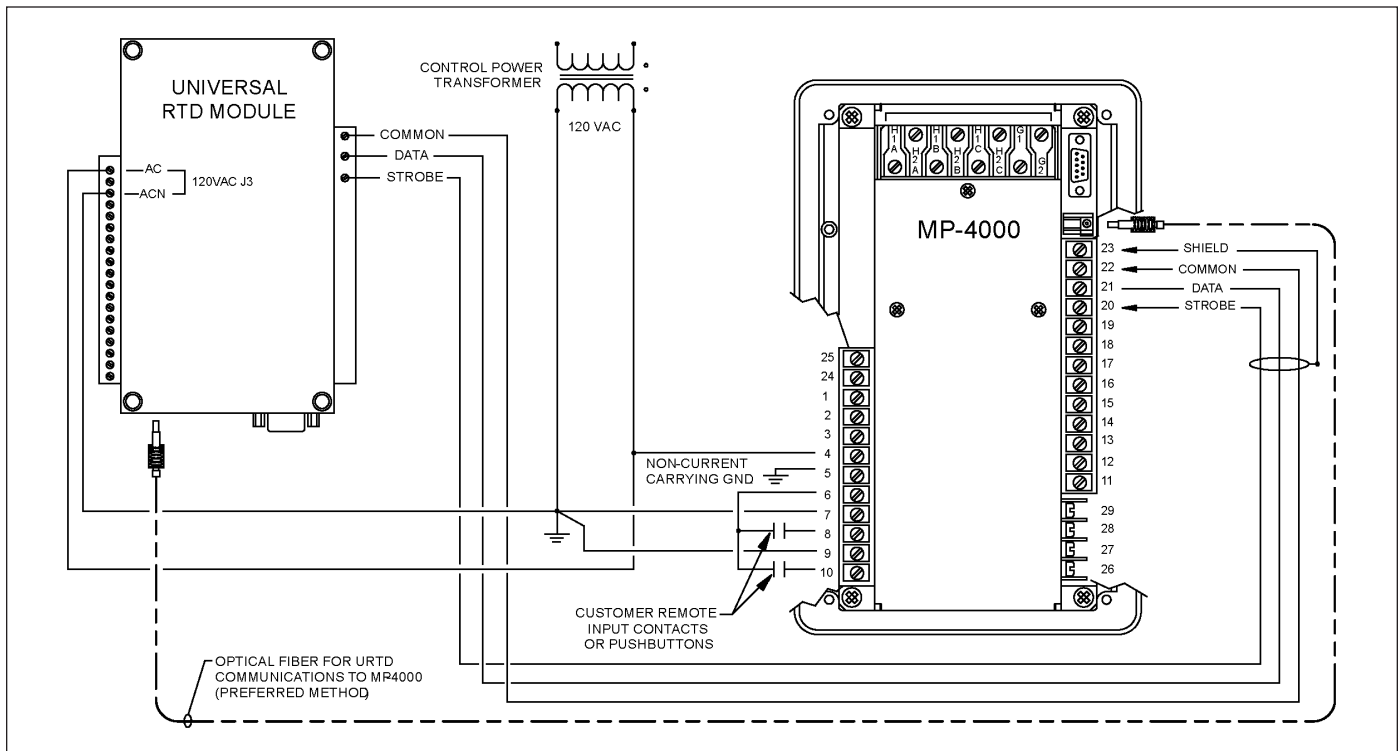
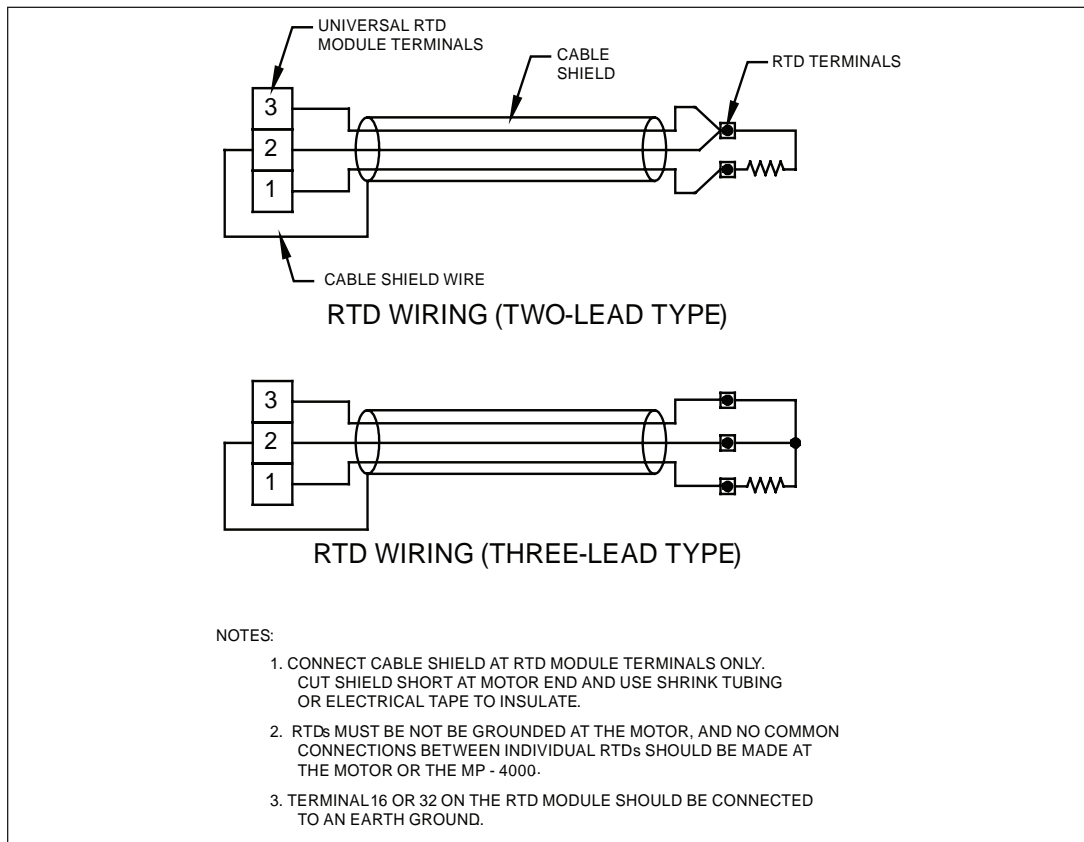


Figure 6.10 Typical AC Supply and URTD Wiring.





**Figure 6.12 Wiring to URTD Module.**

## SECTION 7 - STARTUP

### 7.0 General

This section provides procedures for applying ac power to an MP-4000 for the first time. The procedures can be used as checklists to reduce the chance of skipping steps.



### DANGER

**ONLY QUALIFIED PERSONNEL FAMILIAR WITH THE MP-4000, THE MOTOR STARTER, AND ITS ASSOCIATED MECHANICAL EQUIPMENT, SHOULD PERFORM THESE STARTUP PROCEDURES. FAILURE TO COMPLY CAN RESULT IN SERIOUS OR FATAL INJURY AND/OR EQUIPMENT DAMAGE.**



### CAUTION

**DO NOT USE A MEGGER® OR OTHER HIGH-VOLTAGE INSULATION TESTER ON CIRCUITS CONNECTED TO THE MP-4000 TERMINALS. FAILURE TO COMPLY COULD RESULT IN EQUIPMENT DAMAGE. IF WIRING INSULATION IS TO BE TESTED, DO SO BEFORE CONNECTING THE RELAY, ITS OPTIONAL ACCESSORY MODULES, OR OTHER VULNERABLE DEVICES IN THE MOTOR CONTROL SYSTEM.**

### 7.1 Power-Off Checks

With the incoming ac power isolation switch locked off, perform these checks:

1. Open the isolation switch feeding control power to the MP-4000.
2. Check to be sure there is no possibility of back feeding control power through the control transformer, which will result in voltage being present on the primary of the transformer.
3. Make sure that any foreign sources of power, such as those connected to the MP-4000 output relay terminals or discrete input terminals, are off.
4. Check the wiring for conformance to the wiring plan developed for the application.
5. Make sure that the CT secondary current rating and the MP-4000 CT input rating style agree (either 5 A or 1 A).

### 7.2 Initial AC Power Checks

Check Figure 6.11, MP-4000 Rear Panel Terminals, as necessary, before performing the following checks. Also, look at the URTD terminals in Figure 6.10, and URTD Instruction Leaflet I.L.17367.

1. With the power still off, disconnect the ac control power lead to terminal 4 (120 or 240 Vac power input to relay).
2. Disconnect and insulate the contactor lead from the trip relay terminal 12, to prevent contactor energization during most of this testing.
3. If the optional URTD is used, disconnect the 120 Vac power connector J3 from the URTD module.
4. Connect an ac voltmeter between the wire just disconnected from terminal 4, and terminal 7 (neutral of power input to relay).

5. Turn ac power on to the MP-4000, and to the separate remote contact-wetting source, if one is used. Usually, the contacts to be read by the discrete inputs are energized from terminal 6 of the MP-4000, rather than from a separate remote source.
6. Verify that either 120 Vac or 240 Vac on the lead disconnected from terminal 4. The MP-4000 automatically configures its power supply to work with one or the other value. Nominal values other than 120 Vac or 240 Vac, including values between 120 and 240, are not recommended. However, the MP-4000 is able to handle depressions, dips, and limited sustained variations in the normal course of service. Refer to the Technical Specifications in Section 3.
7. If the optional URTD module is to be powered from terminals 4 and 7 of the MP-4000, the supply must be 120 Vac only. The URTD is rated only for 120 Vac, and cannot operate from 240 Vac. If necessary, use an auxiliary 240 V/120 V step-down transformer for the URTD, able to handle a 6 VA burden.
8. Turn off ac power. Troubleshoot wiring if necessary.
9. Once the ac supply voltage is correct, reconnect the lead disconnected from terminal 4.
10. Disconnect the discrete input leads, if used, to terminals 8 and 10.
11. Connect voltmeters between the leads just disconnected from terminals 8 and 10, and terminal 9, the discrete input common.
12. Close or jumper the contacts that are read by the discrete inputs, if used.



### WARNING

**IF THE UNIT HAS BEEN POWERED DOWN FOR MORE THAN 20 DAYS, THE LOGS AND HISTORY SHOULD BE RESET.**

### 7.3 Initial Checking with AC Power to Relay

1. Turn on ac power again. The MP-4000 is now energized.
2. Check the voltage between MP-4000 terminals 6 and 7. It should be approximately 120 Vac, regardless of 120 V or 240 V supply.
3. If discrete input 1 is used, verify that 120 Vac is present on the lead disconnected from terminal 8, measured with respect to terminal 9.
4. If discrete input 2 is used, verify that 120 Vac is present on the lead disconnected from terminal 10, measured with respect to terminal 9.
5. Place the relay in Program mode. Navigate to the SP TEST page.
6. Page to P13L7, the state of discrete input 1. It should report DI 1 OFF.
7. Page to P13L8, the state of discrete input 2. It should report DI 2 OFF.
8. Check the voltage across the power terminals of the URTD power connector plug removed from J3. Confirm 120 Vac is present.

9. Turn off ac power again. Troubleshoot the discrete input and/or URTD wiring, if necessary.
10. Reinstall the power plug into J3 of the URTD.
11. Check the URTD configuration DIP switches, to insure they are set for the types of RTDs actually installed in the motor and load equipment. See URTD I.L. 17367 for specifics.
12. Reconnect the leads disconnected from terminals 8 and 10
13. Turn on ac power again.
14. Recheck P13L7, the state of discrete input 1, if used. It should report DI 1 ON.
15. Recheck P13L8, the state of discrete input 2, if used. It should report DI 2 ON.
16. Turn off ac power again. Troubleshoot the discrete input wiring.
17. Remove the jumpers on the remote contacts or set them to the normal state.
18. Use the MP-4000 discrete input test page indications to test the actual operation of the contacts, if possible.

#### 7.4 Further Checking of the Relay with AC Power

1. Apply ac power to the relay and optional URTD.
2. The MP-4000 quickly initializes and displays its status, usually READY - 3, unless the relay sample has been subjected to an unusual combination of settings and recent prior service or testing. Usually, one or more output relays can be heard to click as they are energized.
3. The Protection LED on the faceplate should light.
4. If the URTD is connected, press the Monitor mode button and navigate to the MONT RTD page. If the MONT RTD page cannot be accessed, the URTD module is dead or is not communicating with the relay at all. Troubleshoot the communications wiring or optical fiber as well as the URTD power.
5. Check the 11 temperature display lines. Each connected RTD should display an appropriate value (e.g.: 25 at room temperature). Non-functioning or unused RTD inputs display a — character for a value.

#### 7.5 Checking Data Communications

1. If the relay is equipped with a PONI, check it to confirm that the communications network is connected.
2. Visit the PowerNet or other host and check the monitoring displays for the particular MP-4000.
3. Confirm that the displays in view are for the correct relay. This is easily done by disconnecting and reconnecting the network connector.
4. If communications can not be established, check for address conflicts on the network (multiple devices set to the same address) or incorrect setting of the address switches on the PONI.

#### 7.6 Entering Relay Settings

1. Make a copy of Table 4.3 as a worksheet for recording setting choices.
2. Read Sections 5 and 9 carefully for guidance in selecting settings.
3. If desired, PowerNet or PowerPort data communications can be used to download a pre-configured setting record to the relay from a disk file or from a convenient worksheet on the host display. IMPACC cannot be used to enter settings to an MP-4000.
4. If electronic communications are not used, enter the settings through the front panel in Program mode, using the Prog button behind the security door.
5. After settings have been entered, exit the program mode by pressing the Program button again.
6. Verify that the settings have been correctly entered using the View SP mode button.
7. Reconfirm that the motor nameplate values agree with the corresponding relay settings.
8. Reconfirm that the ratios of the phase and ground CTs in the gear agree with the PCT and GCT settings of the relay.



#### CAUTION

**THE MP-4000 HAS 154 SETTINGS, WHICH ARE EASY TO CONFUSE. DO NOT ATTEMPT TO ENTER VALUES WITHOUT USING THE APPROPRIATE SETPOINT RECORD SHEET. IMPROPER OPERATION AND/OR PERSONAL INJURY COULD RESULT IF THIS PROCEDURE IS NOT FOLLOWED.**

#### 7.7 Checking Contact Outputs



#### DANGER

**BE AWARE OF WHETHER CONTROL POWER IS APPLIED TO THE OUTPUT CONTACTS BEFORE TESTING. AVOID UNEXPECTED OPERATION OF THE MOTOR CONTACTOR OR OTHER CONTROLLED DEVICES DURING TESTING. PERSONAL INJURY OR DAMAGE COULD RESULT.**

1. Determine the mode of each of the output relays. Look at settings P12L1 through P12L4.
2. If possible and safe, use a live test of the actual wiring or devices operated by the MP-4000 output contacts to verify contact operation and check wiring.
3. A voltmeter can be used to check energized contacts. Use an ohmmeter or continuity checker *only* on dead, disconnected circuits.
4. With MP-4000 power applied, each output relay set for Mode 1 should have its NO contact open and its NC contact closed.
5. Each relay set for Mode 2 should have its NO contact closed, and its NC contact open.
6. Enter the Program mode. Navigate to Page 13, SP TEST. Settings P13L2 to P13L5 can be used to set up each of the output relays for test.

7. Press the Reset button, as explained in Section 5, to toggle the state of each of the relays in turn. Check the switching of the output relay, and the energization of controlled circuits if possible.
8. Exit the Program mode.

## 7.8 Checking the Complete Motor Drive System



**DANGER**

**THE CONTACTOR CONTROL CIRCUIT IS TO BE RECONNECTED. AT THIS TIME, THE MOTOR ASSOCIATED WITH THE APPLICATION CAN BE STARTED. IT IS IMPORTANT TO ENSURE THAT ALL SAFETY PRECAUTIONS ASSOCIATED WITH ROTATING EQUIPMENT AND THE ASSOCIATED DRIVEN MECHANISM ARE TAKEN. FAILURE TO DO SO CAN RESULT IN SERIOUS OR FATAL INJURY AND/OR EQUIPMENT DAMAGE.**

1. Disconnect all ac power from the system.
  2. Reconnect the contactor lead to MP-4000 trip relay terminal 12.
  3. Check all rotating components and driven mechanisms associated with the motor for secure connections.
  4. Clear away any loose or foreign objects.
  5. Clear all personnel from the area of the motor and driven mechanisms.
  6. Turn on all ac power.
  7. Make sure the MP-4000 Protection LED is on, and that the display reads READY - 3.
  8. Follow any startup procedures for the load equipment.
  9. Start the motor using the external start switch or contacts.
  10. Using the information supplied by the application engineer or equipment manufacturer, verify that the motor is operating properly.
11. With the motor running, use a clamp-on type ammeter to measure the ac current on each of the motor phases.
  12. Verify that the  $I_A$ ,  $I_B$ , and  $I_C$  currents, as indicated by the MP-4000 on the MONT I Page of the Monitor mode are within approximately 5% of the ammeter values.
  13. If the current during this test is well below FLA, or if the CTs are far from the optimum ratio, errors may be larger. This test is intended to show incorrectly set CT ratios or faulty wiring, rather than the precision of measurements.
    - If a ground CT is connected, check ground current IG. Investigate the cause of any abnormal ground leakage current flow.
    - Using a voltmeter, verify  $V_A$ ,  $V_B$ ,  $V_C$ , as indicated by the MP-4000 on the MONT V page of the monitor mode are within 5% of the voltmeter value.
    - Check the percent unbalance display %UB for consistency with the ammeter measurements, given the acceptable error ranges.
    - When the reverse setpoint is set, this is indicated by a negative sign preceding the unbalance display and the MP-4000 relay does not trip when sensing an ACB phase rotation, but trips when sensing an ABC phase rotation.
    - If the analog transducer output is connected, determine which measurement it is transmitting - view Setting P11L1.
    - Check that the analog output current corresponds to the displayed value of the selected parameter.
    - If a PowerNet data communications host is connected, upload the starting current profile and check for coordination with cold-start protection curves on the PowerNet display.
    - It is wise to verify the ability of the MP-4000 to open the contactor and trip the motor. The easiest way is by remote trip, via remote trip contact or data communications. Many other internal functions can be manipulated to force a relay trip. One technique is to connect a shorting jumper across the relay current terminals for one of the three phases. This short should produce an unbalance trip, or a thermal trip after some time.

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## SECTION 8 - MOTOR THERMAL PROTECTION BASICS

### 8.0 General

This section describes how the MP-4000 hardware and software function together to control, monitor, and protect the motor.

#### 8.1 Sensing Inputs

The MP-4000 receives motor phase currents from three main motor phase current transformers (see Figure 8-1). If an optional ground fault transformer is used, the MP-4000 monitors ground leakage or fault current as well.

The MP-4000 takes 36 samples per power cycle of the input current signals, digitizes each sample, and stores it in the microprocessor memory. From these samples, the MP-4000 computes RMS currents and average currents. It also performs phasor calculations leading to direct and precise measurement of positive and negative sequence currents. Refer to Subsection 8.2 for further details. The high sampling rate, plus a unique patented sample-shifting technique, allows the MP-4000 to properly measure and account for the impact of harmonics in heating the motor.

The MP-4000 receives motor phase voltages from three motor phase power transformers. The MP-4000 takes 36 samples per power cycle. From these samples, the MP-4000 calculates RMS and average voltages. The MP-4000 also performs phase calculations that allow precise measurement of positive and negative sequence voltages, power factor, and power.

If the optional URTD module is used, the MP-4000 gathers winding temperature data from up to six resistance temperature detectors (RTDs) embedded in the stator windings of the motor. It can monitor four RTDs associated with the motor bearings and load bearings. It can also monitor one auxiliary RTD, such as motor case temperature.

#### 8.2 Protective Functions

Protective functions continuously monitor motor operating conditions, such as current history and temperature. When measured or derived measurements exceed User-selected levels, an alarm condition is initiated, and then, if necessary, a trip output opens the motor contactor or trips a breaker.

The MP-4000 can protect the motor, starter, and load in the following ways:

- Incomplete sequence protection (missing status feedback from load or starter);
  - Trip-bypass output for failure of contactor to interrupt current after a trip command;
  - Zero speed switch stalled-motor trip protection;
  - Process load shedding function to forestall impending jam or thermal trips; and
  - Jogging protection - minimum time between starts, maximum number of starts per set time, maximum number of consecutive cold starts, and minimum time between stop and start (anti-backspin protection).
- Many of these functions also have separate alarm thresholds to warn the User, who may be able to act before a trip occurs.
- The MP-4000 has four output relays. The Trip relay is connected in series with the motor contactor and de-energizes the contactor or blocks motor starting for any MP-4000 trip condition. All trips are steered to this relay.
- The three other relays are designated as Alarm, Auxiliary 1, and Auxiliary 2. Normally, all alarm and warning conditions are steered to the Alarm relay. However, the Alarm relay and the two Auxiliary relays are all fully programmable. They can be set by the User to operate for a designated list of internal MP-4000 measured or calculated conditions.
- ##### 8.2.1 Direct Load-Based Protection
- The monitored level of actual motor current is used to determine when the instantaneous over current trip, jam trip, load shedding, underload trip, transition trip, and load-shedding settings have been reached. Also, direct temperature feedback from the stator, load bearing, motor bearing, and auxiliary RTDs are compared with respective settings. If necessary, the relay gives alarm and/or trip outputs.
- ##### 8.2.2 Thermal Model and Rotor Temperature Protection
- Each motor has a specific damage curve. Usually it is called the  $I^2 t$  (current squared multiplied by time) curve. With larger horsepower motors, the thermal capability is usually rotor-limited, so it is important to track the total heating of the rotor. In ac motors, the current balance between phases is of major concern due to the additional rotor heating associated with the negative sequence component of an unbalanced phase current condition. Current unbalance is usually caused by voltage unbalance, the result of single-phase loads on a three-phase system, and/or motor winding unbalance.
- Any unbalanced set of three-phase currents or voltages can be mathematically transformed into a linear combination of positive, negative, and zero sequence components. The measured current phasor in each phase is the sum of the three sequence component phasors in that phase. The zero sequence component is a common mode component which is equal in the three phases, and requires a neutral or ground path for return. So, in a motor without a neutral return, no zero sequence current is seen unless there is a ground fault. Thus, the focus is on the positive and negative sequence components that can routinely be present.
- For analysis and understanding, consider the motor to have two tandem virtual rotors as shown in Figure 8.2. One is driven only by the positive sequence current  $I_1$ , which is symmetrical and balanced. The other is driven only by counter-rotating negative sequence current  $I_2$ , directly related to unbalanced current, and produces a proportional torque in the reverse direction. If perfect current balance and phase angle symmetry exists among the three phases,  $I_1$  would be the only component of line current squared, with no effect from the second rotor. This positive sequence component of current produces the motor output torque and work.
- Stator and rotor thermal protection by modeling of heating and cooling effects, including heating by negative sequence currents;
  - Stator over temperature protection by direct measurement (with optional URTD module);
  - Instantaneous over current protection for faults;
  - Ground fault protection;
  - Phase reversal protection;
  - Phase unbalance protection;
  - Motor bearing, load bearing, and auxiliary RTD temperature protection (with optional URTD module);
  - Jam protection;
  - Underload protection;
  - Transition trip for abnormal starting time-versus-current behavior;

The negative sequence current  $I_2$  is a three-phase current component with a reverse phase rotation compared to that of the ac source. This current generates a reverse torque in the second rotor, and works against the main action of the motor, doing negative work. Because the negative work caused by  $I_2$  stays within the rotor, it is completely absorbed as heat and, therefore, has a far more significant effect on the rotor heating than the balanced  $I_1$ .

Phasor analysis is used to determine the sequence currents from physical phase current phasors. Any three-phase ac current without external ground or neutral return path can be represented by the addition of  $I_1$  and  $I_2$  phasors in each phase. For an example, refer to the unbalanced motor currents of Figure 8.3. In this case, the three-phase currents in the motor are  $I_A$ ,  $I_B$ , and  $I_C$ . Note that  $I_B$  and  $I_C$  are of about the same *magnitude* as  $I_A$ , yet are noticeably displaced in *phase position*. This is an example of a serious negative sequence condition that is threatening to the rotor, yet is not reflected in the current magnitudes alone.

To calculate the positive sequence component in phase A, rotate the phase B current phasor 120 degrees in the positive direction and the phase C phasor 240 degrees in the positive direction. See Figure 8.4. The formula for  $I_{A1}$  is:

$$I_{A1} = \frac{I_A + (I_B \angle 120^\circ) + (I_C \angle 240^\circ)}{3}$$

Note that these are phasor (vector) operations with a phasor result. The positive sequence phasors in phases B and C have the same magnitude as the phase A positive sequence phasor, but lag the phase A component by exactly 120 and 240 degrees, respectively. This balanced set of phasors drives the motor's useful work.

To calculate the negative sequence component in phase A, rotate the phase B current phasor 120 degrees in the negative direction and the phase C phasor 240 degrees in the negative direction. See Figure 8.5. The formula for  $I_{A2}$  is:

$$I_{A2} = \frac{I_A + (I_B \angle -120^\circ) + (I_C \angle -240^\circ)}{3}$$

The negative sequence phasors in phases B and C have the same magnitude as the phase A positive sequence phasor, but lead the phase A component by exactly 120 and 240 degrees, respectively. This balanced set of phasors represents the net effect of magnitude or phase unbalance and only heats the rotor.

Certain harmonics in the phase currents produce torques in the rotor, just like positive and negative sequence currents. In particular, the 7<sup>th</sup> and 13<sup>th</sup> and certain higher harmonics act like positive sequence. The 5<sup>th</sup>, 11<sup>th</sup>, and certain other higher harmonics act like negative sequence. This can also influence motor performance and heating. The MP-4000 sequence calculations also capture these harmonic currents and include their effect in the thermal modeling.

Prior to the use of a microprocessor in a multifunction motor protection relay, there was no reasonable way of modeling the total heating effects of the positive and negative sequence components on a continuous basis. Therefore, oversimplified assumptions were used with available relays. This resulted both in nuisance tripping and in motor burnouts or life reduction. The MP-4000 uses a unique, patented calculation for determining these values from current samples and modeling their effects. The effective current squared, as used in the calculation for rotor heating, is:

$$I^2 = I_1^2 + kI_2^2$$

Here,  $I_2$  is weighted by  $k$  because of the disproportionate heating caused by the negative sequence current component. The effects of both the positive and negative sequence currents are accurately taken into account. Their combined effect is incorporated into a rotor protection algorithm that effectively keeps track of the temperature of the rotor.

It is not necessary to pick an arbitrary phase unbalance setting to trip the motor, although such an unbalance trip function is additionally included in the relay to speed up tripping without heating for grossly unbalanced conditions. As long as the combined effect of the positive and negative sequence currents does not approach the values in the motor protection curve, the MP-4000 allows the motor to run.

### 8.2.3 Thermal Bucket

The MP-4000 models heating as the filling of a thermal reservoir or accumulating bucket whose size is determined by the thermal capacity of the motor. This capacity is calculated in the relay from motor nameplate constants. The filling is proportional to effective  $I^2$  over time, where effective  $I^2$  includes the disproportionate heating effect of negative sequence currents. Cooling is also modeled as draining of the bucket. The loss of equilibrium between heating and cooling leads to an eventual thermal trip. The thermal bucket filling in percent can be observed continuously on the MP-4000 display, via data communications, or via the 4-20 mA transducer output.

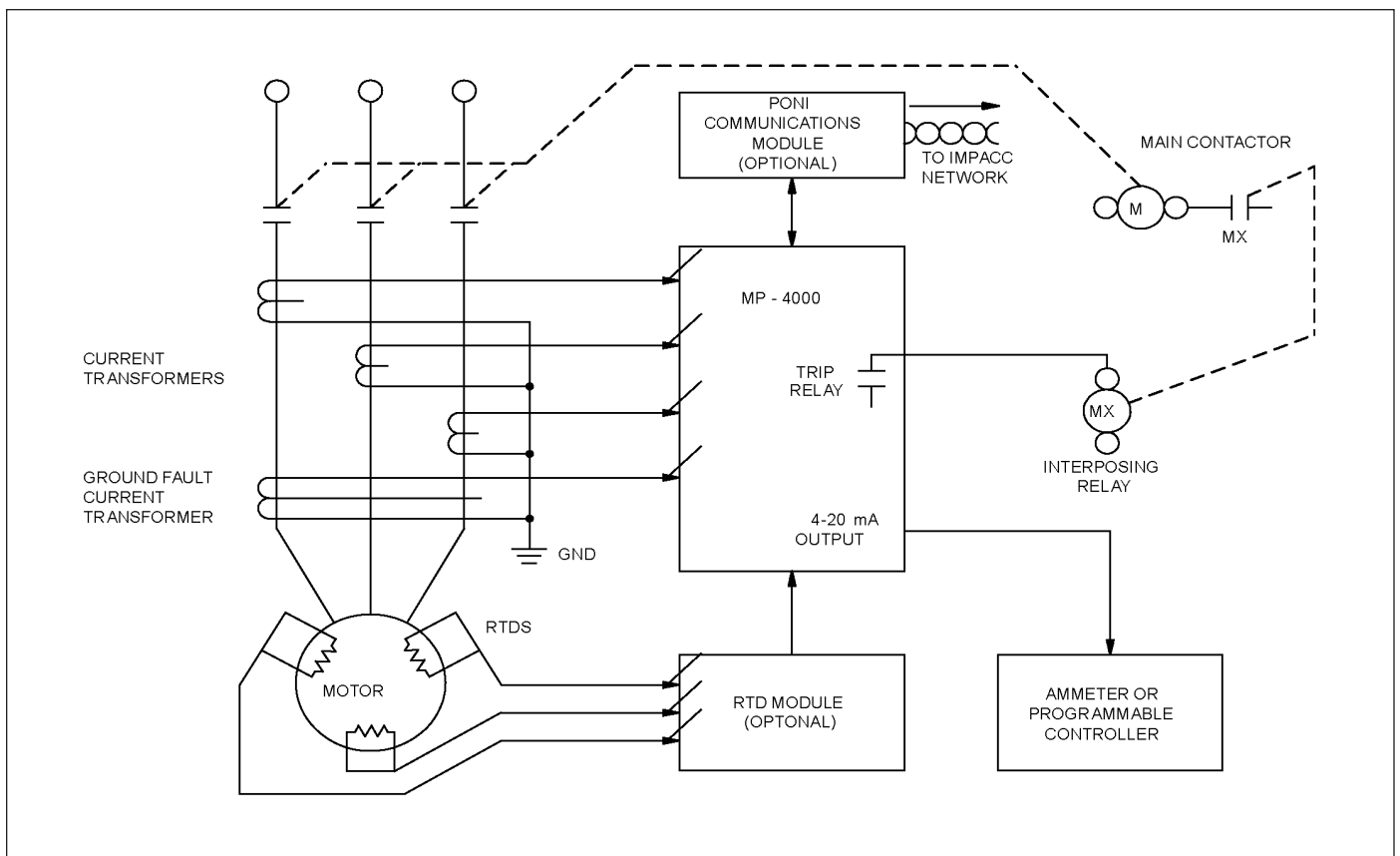


Figure 8.1 Motor Phase Currents from Three Main Motor Phase CTs.

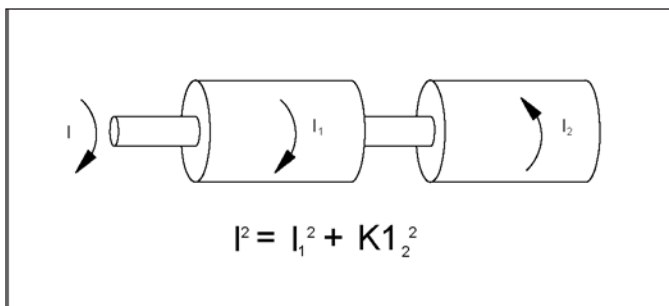


Figure 8.2 Torques from Sequence Currents.

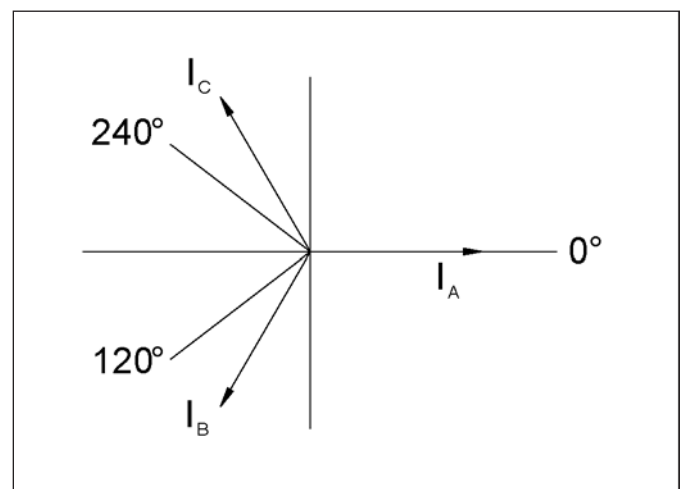


Figure 8.3 Unbalanced Motor Current Example.

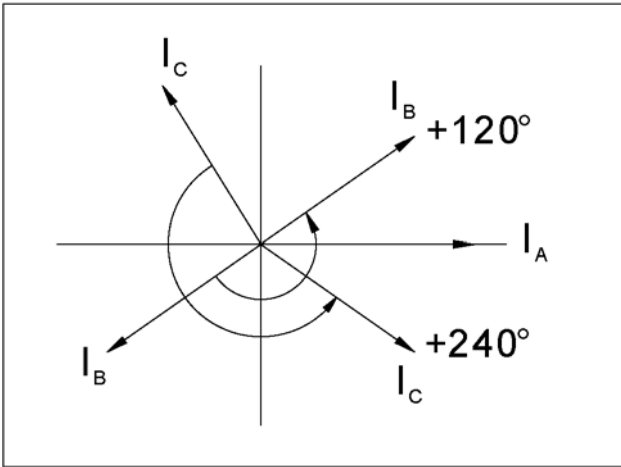


Figure 8.4 Positive Sequence Component Calculation.

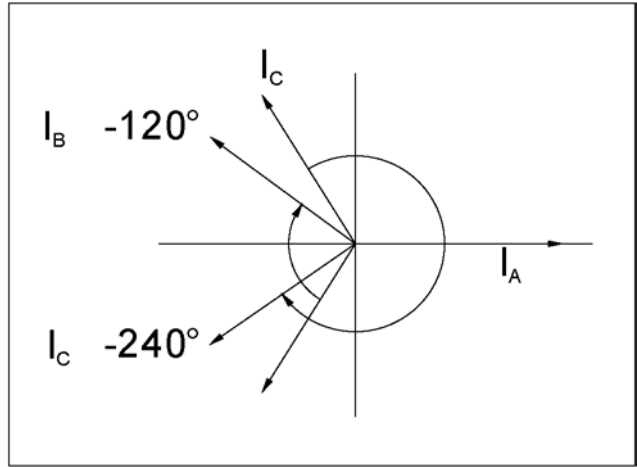


Figure 8.5 Negative Sequence Component Calculation.

## SECTION 9 - APPLICATIONS AND SETTINGS

### 9.0 General

This section is a supplement to Section 5, providing more engineering and application guidance for particular MP-4000 functions and settings.

Use this data in conjunction with Section 5 and Table 4.3 to develop settings for the MP-4000, as well as to make appropriate wiring design. Note that particular settings are designated as PnLm, where Pn is the page number and Lm is the line number of the particular setting in Table 4.3, and in the page-line-value scheme of accessing settings on the front panel of the MP-4000.

### 9.1 Motor Protection

The MP-4000 protects the motor, starter, and load in the following ways:

- Stator and rotor thermal protection by modeling of heating and cooling effects, including heating by negative sequence currents;
- Stator over-temperature protection by direct measurement (with optional URTD module);
- Instantaneous over current protection for faults;
- Ground fault protection;
- Over and under voltage protection;
- Over and under frequency protection;
- Leading and lagging power factor protection;
- Phase reversal protection;
- Phase unbalance protection;
- Motor bearing and load bearing temperature protection (with optional URTD module);
- Jam protection;
- Underload protection;
- Incomplete sequence protection (missing status feedback from load); and
- Trip-bypass output for failure of contactor to interrupt current after a trip.

#### 9.1.1 Thermal Modeling and Overload Protection without RTDs

The motor overload protection function, called the I<sup>2</sup>T algorithm, calculates the rotor and stator temperature based on effective heating current, integrated over time (see Figure 9.1). Positive and negative sequence current magnitudes are calculated in separate accurate algorithms. The effective heating current is the sum of the positive and negative sequence currents, with a heavy weighting factor on the negative sequence contribution. This models the disproportionate rotor heating effect of the negative sequence current (see Motor Thermal Protection Basics, Section 8). Certain harmonic currents, such as the 5<sup>th</sup> and 11<sup>th</sup>, also produce the same heating effects as fundamental frequency negative sequence current. This harmonic heating effect is also measured and modeled.

The temperature rise caused by current flow is modeled with a thermal accumulator or bucket whose size or capacity is derived from motor nameplate data entered as settings. The flow of effective heating current into the bucket causes it to fill. Cooling is modeled by a gradual emptying of the bucket. The settings that influence the heating and cooling models are:

- Full load amperes (FLA, P1L1);
- Locked rotor current (LRC, P1L2);
- Maximum allowable stall or locked rotor time (LRT, P1L3);
- Ultimate trip current (UTC, P1L4), which is usually service factor times 100%.

The MP-4000 thermal bucket fills and proceeds towards a trip only when the effective heating current is above the ultimate trip current

setting P1L4. The modeling is based on an ambient temperature of 40°C (104°F). A programmable I<sup>2</sup>T alarm I2TA, P4L2 informs the User when the bucket reaches the User-set level between 60% and 100% full.

Without manual process load reduction, automatic process load shedding (refer to Subsection 9.1.5), or other remedial action after an alarm, the relay eventually trips and displays the message LRC/I<sup>2</sup>T (Locked Rotor/Thermal Overload). The trip contact blocks motor re-starting until the temperature, as reflected in the thermal accumulator bucket level, cools below the alarm level setting I2TA, P4L2.

**NOTE:** If stator RTDs are not used and the ambient may rise above 40°C (104°F), the ultimate trip current should be set *below* that indicated by the nameplate service factor to avoid stator insulation damage or loss of motor life.

#### 9.1.2 Overload Protection with RTDs

Connect from one to six stator RTDs to the optional URTD module, and connect the URTD data communications output to the MP-4000 using an optical fiber (recommended) or wired connection. The MP-4000 can then perform enhanced motor protection in two ways:

1. Direct measurements of the winding temperature are checked against User-programmed alarm and trip temperature settings.
2. The thermal modeling combines the measured temperature with the effective heating current and the motor constants to more accurately model cooling as a function of temperature (more heat is dissipated as the temperature rises). Loadability of the motor is much improved.

If more than one RTD is connected, the hottest of up to six *stator* RTD temperature measurements is used for protection. Note that motor bearing, load bearing, and auxiliary RTD inputs are ignored by the motor thermal algorithm. These other RTD inputs have their own alarm and trip settings.

If stator temperature measurements are available, the algorithm may keep from tripping, even if the effective current is above the ultimate trip current setting, depending on stator temperature reports. It is still important to set a correct ultimate trip current, so that the motor is well protected. If the RTDs, the module, or its communications to the relay fail, the algorithm falls back to use of UTC. Also, note that if the winding trip temperature WD T is set to OFF, the algorithm reverts to the non-RTD calculation, which is based strictly on UTC.

**NOTE:** Many Users have the false impression that connecting RTDs makes the motor relay more conservative and more likely to trip under heavy load conditions. *The reverse is actually true* - use of RTDs greatly increases motor loadability. With RTD measurements, the MP-4000 can allow the motor to operate safely with significantly higher sustained levels of loading at normal ambient temperatures. Along with this, it can effectively protect the motor when the ambient rises to any level above 40°C (104°F) (refer to Subsection 9.1.4).

Note that when in the RS-232 mode, thermal modeling is used since the MP-4000 is not able to communicate with the URTD.

#### 9.1.3 Protection Curve

Figure 9.2 shows an example motor protection curve. A protection curve defines the current versus time limit that the MP-4000 develops from programmed setting values. Ideally, this curve is located as close as possible to the motor protection curve for maximum utilization of the motor capacity. When the integrated effective heating current squared exceeds this limit curve at any time in the start or run cycle, the MP-4000 trips the motor.

The MP-4000 automatically calculates the correct motor protection curve from nameplate or manufacturer values of full load amperes (FLA, P1L1), locked-rotor current (LRC, P1L2), maximum allowable stall or locked rotor time (LRT, P1L3); and service factor as used to set ultimate trip current (UTC, P1L4). The following subsections describe how such a typical curve is obtained.

Note that, for now, it is assumed that the three phase currents are balanced and have proper 120 degree phase relationship (i.e.: only positive sequence current). If negative sequence current reflecting unbalance is present, the MP-4000 gives much heavier weighting to the heating effect of these currents, and tripping occurs sooner than expected from balanced-current curves.

### 9.1.3.1 Instantaneous Over current Function

This function is intended mainly to trip for high-current faults. The example instantaneous over current setting used in Figure 9.2 is 12 times (1,200%) of FLA. In general, the instantaneous over current setting (IOC, P3L4) should be at least 1.5 times LRC, well above the locked rotor current normally seen at the moment of a start.



## CAUTION

**MOST CONTACTORS ARE NOT RATED TO INTERRUPT HIGH-CURRENT FAULTS. FREQUENTLY, THE MOTOR CONTROL CENTER ALSO CONTAINS FUSES, WHICH CAN INTERRUPT THESE FAULT CURRENTS.**

**THE MP-4000 TRIP COMMAND IS INTENDED TO OPEN ALL THREE PHASES VIA THE CONTACTOR AND BLOCK FURTHER STARTING, BUT THE FUSES MUST INTERRUPT THE LARGE CURRENT IN FAULTED PHASE(S). IF THE CONTACTOR INTERRUPTING RATING IS EXCEEDED WHEN THE MP-4000 TRIPS WITHOUT THIS FUSE BACKUP, THE CONTACTOR OR MOTOR CONTROL CENTER COULD BE DESTROYED IN A HAZARDOUS OR EXPLOSIVE CASCADING FAULT SITUATION.**

**ANOTHER ACCEPTABLE APPLICATION IS TO CONNECT THE MP-4000 TO DIRECTLY TRIP A CIRCUIT BREAKER THAT HAS AN INTERRUPTING RATING EXCEEDING THE HIGHEST AVAILABLE BOLTED-FAULT CURRENT.**

IOC should trip fast; no run or pickup delay is provided. A start delay (IOCS D, P3L5) is set at a minimum of two cycles, or more if needed to block IOC tripping on magnetizing inrush when the motor is first energized. Note that the entered IOCS D value is the total IOC trip time, including pickup time of the basic IOC measurement algorithm, and cannot be set below two cycles.

### 9.1.3.2 Locked-Rotor Function

The family of curves shown in Figure 9.2 is based upon a locked rotor current setting (LRC, P1L2) of 6.1 times (610%) of FLA (P1L1) and a family of locked rotor or stall time settings (LRT, P1L3).

All curves shown in Figure 9.2 are based on a maximum allowable stall time from a *cold* start. The nameplate LRT used for setting is normally a cold start value. Since the thermal algorithm actually retains recent operating history as reflected in the thermal bucket level, it is not necessary to program the MP-4000 for hot starts because hot start protection is automatic. Note that the effective limit curve for a hot start is actually more restrictive, (i.e.: more limiting in time and current, than the cold-start curve in Figure 9.2).

The Emergency Override function, if invoked, lowers the thermal bucket to cold level, regardless of recent history, and restores the cold start curve. Use this only for a *real* process emergency because it defeats the thermal modeling protection, and the motor is at risk.

### 9.1.3.3 Ultimate Trip

The setting for the ultimate trip function is the value of current above which the motor can be damaged over time. Figure 9.2 shows a setting of 100%, reflecting a nameplate service factor of 1.0 and an ambient temperature that does not rise above 40°C (104°F). If the motor has a service factor different from 1.0, the ultimate trip current level is adjusted accordingly. Other common service factors are 0.85 (UTC=85%) and 1.15 (UTC=115%).

As explained above and in Section 5, UTC sets the upper continuous limit if stator RTD temperature measurements are not available. The time to trip after the UTC threshold is crossed depends on recent operating history, and on the thermal bucket size defined by settings. With stator RTDs reporting acceptable temperature, the algorithm can allow sustained operation above UTC. Make sure the winding direct thermal trip temperature setting (WD T) is not turned OFF, or the algorithm reverts to strict use of UTC.

### 9.1.3.4 Underload Functions

When the motor is running, a current reduction might indicate a malfunction in the load. Underload protection recognizes mechanical problems, such as a blocked flow or loss of back pressure in a pump, or a broken drive belt or drive shaft.

Refer to the underload protection limit - the left vertical line in the Underload Jam Protection Curve example in Figure 9.3. Here, the underload trip is set at 60% of FLA. The MP-4000 has settings for underload alarm (ULA, P4L5), and underload trip (ULT, P3L9). Each can be disabled by setting it to OFF. These would be represented by two such vertical lines, both below the normal load current. Be sure to set the alarm level *above* the trip level. Both trips and alarms are held off by start delay (ULSD, P3L10). Each has its own run or pickup delay (ULTR, P3L11 and ULAR, P4L4). Use the start delay to block tripping until the load stabilizes after a start. Use run delays to avoid nuisance alarms or trips for load transients.

**Note:** Underload protection is also available via the Under Power function described in Subsection 5.20.

### 9.1.3.5 Jam Functions

When the motor is running, a current increase above normal load might indicate a malfunction in the load. Jam protection recognizes mechanical problems, such as broken drive gears.

Refer to the jam protection limit - the right vertical line in the Underload Jam protection curve example in Figure 9.3. Here, the jam trip is set at 150% of FLA. The MP-4000 has settings for jam alarm (JMA, P4L3) and jam trip (JMT, P3L6). Each can be disabled by setting it to OFF. These would be represented by two such vertical lines, both well above the normal load current. Be sure to set the alarm level *below* the trip level. Both trips and alarms are held off by start delay (JMSD, P3L7). Each has its own run delay (JMTR, P3L8 and JMAR, P4L4). Use the start delay to block tripping until the motor current drops to continuous load level. Use run delays to avoid nuisance alarms or trips for load transients.

## 9.1.4 Complete Motor Protection Curves

To illustrate the protection features of the MP-4000, two sample curves are given. Using specific motor data, typical motor protection curves for the MP-4000 without RTDs are shown in Figure 9.4. The use of RTDs is assumed in Figure 9.5. The following data were used:

- Balanced currents during start and run cycles;
- Instantaneous over current limit IOC of 12 times FLA;
- Locked-rotor amperes of 6.1 times FLA;
- Maximum allowable stall or locked-rotor time of 15 seconds, cold start;
- Ultimate trip level of 100% of FLA (service factor = 1.0);

- Motor running; normally loaded at 90% of FLA;
- Underload protection at 60% of FLA with a 5-second run delay; and
- Jam protection at 180% of FLA with a 5-second run delay.

The MP-4000 recognition of the transition from start to run has no impact on this protection curve, but defines when the displays and indications change from START to RUN. For a reduced voltage starter, the transition function also defines when the AUX2 output relay switches the starter from reduced to normal running voltage (refer to Subsection 9.2.1). The User might elect to transition on time (e.g.: set P5L7 to TRN TIME and P5L6, TRNT=10 seconds) or on current (e.g.: set P5L7 to TRN I and P5L5, TRNC to 130 % of FLA), among other options.

Figure 9.5 shows the impact of a stator RTD measurement. Look at the time period after 60 seconds (near the top). When RTDs report low stator temperature, the motor can run continuously with current well above (to the right of) the UTC line. The lower the stator temperature, the higher the acceptable sustained current moves beyond UTC (200% of FLA in the example). A hotter stator, perhaps caused by a high ambient temperature or a cooling blockage, shifts the curve to the left and lowers the acceptable level of I<sup>2</sup>t. Be sure to set a suitable RTD temperature trip value (WD T) according to Subsection 9.1.8. An OFF setting causes the MP-4000 relay to revert to the non-RTD algorithm, even if RTDs are connected.

**9.1.5 Load Shedding Function**

In some applications, the MP-4000 can forestall a jam alarm or trip, or a thermal trip, by sending a signal to the process to reduce loading. The load-shedding function, if enabled, closes or opens the AUX1 contact to shed process load when the motor load current goes above the load-shed threshold LSPU, P9L1, for a time exceeding the load-shed run delay LSDL, P9L3. This could, for example, be connected to stop flow of material into the driven process until the load current drops below the load-shed dropout threshold LSDO, P9L2 for time LSDL, P9L3.

Set the load-shed pickup current LSPU, P9L1 comfortably below the jam trip level. It may be useful to set it below UTC, P1L4, particularly if RTDs are not used. Refer to Section 5, explanations for settings P9L1 to P9L3, and for imposed relationship rules on load shedding pickup, dropout, and time delay settings.

**9.1.6 Long Acceleration Time**

The User can temporarily defeat the I<sup>2</sup>t thermal protection limit after a start by setting a Long Acceleration Time delay (LAT, P5L10). This can be a dangerous setting that blocks thermal tripping and holds the bucket at a 100% level if the load takes a long time to reach running speed. An example is a motor spinning a large centrifuge. In using LAT, the User can take advantage of the partial cooling from airflow produced by motor spinning at below normal speed, as compared to unfanned heating of a locked rotor. The motor must be rated for this severe starting duty. Also, the User must ensure that the motor actually has begun to spin well before the locked-rotor time has expired. This is accomplished by connecting a zero speed switch to Discrete Input 1 and setting P5L11 ZSW = ON. The zero speed switch is a contact that is closed when the motor is at rest, and opens as the motor begins to spin, usually at 5 to 10% of running speed. If ZSW is set to ON and the MP-4000 does not sense the contact open in one-half the locked rotor time setting, it trips the motor.



**WARNING**

**TURN OFF LAT UNLESS THE APPLICATION SPECIFICALLY DEMANDS IT. USE A ZERO SPEED SWITCH WITH LAT. USING AN LAT SETTING GREATER THAN LOCKED-ROTOR TIME WITHOUT A ZERO SPEED SWITCH TEMPORARILY DEFEATS THERMAL PROTECTION, AND DAMAGES THE MOTOR IF THE ROTOR ACTUALLY IS LOCKED.**

If LAT is used, check the settings of transition time TRNT, P5L6 and jam start delay JMSD, P3L7 to be sure they are coordinated with the prolonged starting cycle.

**9.1.7 Using the Starting Current Profile Function**

If the MP-4000 is communicating with an Eaton PowerNet host computer, the User can upload the actual time history of the starting current from the moment of a particular start to a time well past the set locked rotor time. The actual current-versus-time profile can be visually checked against the cold start protection curve, which PowerNet plots for comparison. The PowerNet plot also includes the long acceleration extension of the thermal curve, and the jam trip limit. The profiled starting current is the average RMS phase current.

The MP-4000 stores the last four starting current profiles. This profile data cannot be read on the front panel display.

**9.1.8 Thermal Protection by Direct Measurement**

The effects of the motor winding temperature alarm and trip (P2L2 and P2L3) settings, which can be used with RTDs, are not shown in Figure 9.5. These direct temperature functions protect independently of the I<sup>2</sup>t algorithm. For the thermal algorithm to take advantage of the stator RTDs, the thermal direct tripping must be turned on by setting a suitable temperature for trip, not OFF. The settings for these functions should be based on the recommended maximum stator insulation temperature, as indicated by the motor manufacturer's insulation classification on the nameplate. Note that the RS-232 must be set to disabled to communicate with the URTD.

**Table 9-1 Example Insulation Temperature Classes (from NEMA MG-1).**

Class	A	B	F	H
Ambient Temperature °C/°F	40/104	40/104	40/104	40/104
Allowable Rise °C/°F	60/140	80/176	105/221	125/257
Hot Spot Allowance °C/°F	5/41	10/50	10/50	15/59
Hot Spot Temperature °C/°F	105/221	130/266	155/311	180/356

**NOTE:** Rising winding temperature has to travel through the insulation and stator iron to heat the RTD. When setting the stator temperature alarm and direct thermal trip temperatures, keep in mind that the actual hottest spot insulation temperature may be 5 to 15°C (41 to 59°F) above the hottest RTD measurement. This additional temperature rise above the insulation rating may cause the insulation to age twice as quickly as it would if kept within the rating. Set the thermal trip temperature a little below the insulation rating for longest motor life.

**9.1.9 Unbalance Protection**

Unbalanced or negative sequence currents are usually caused by unbalanced supply voltage. Certain harmonics, such as 5<sup>th</sup> and 11<sup>th</sup>, also cause the same undesirable effects in the motor even though the harmonics are balanced.

The thermal algorithm incorporates the accentuated heating effect of negative sequence currents or these certain harmonics, and trips more rapidly for unbalanced conditions than would be expected from the cold-start balanced protection curve.

In *addition* to the thermal algorithm, the MP-4000 includes a percent unbalance function that alarms and/or trips based on direct measurement of unbalance. This can be used to speed up tripping and avoid motor heating for a gross problem, such as depressed voltage on one phase, loss of a phase, or an uncleared power-system fault external to the protected motor.

The unbalance is the ratio of negative sequence to positive sequence current. If the motor can be started in either direction (P1L8 = REV), the MP-4000 takes the larger of the two sequence currents at the time of the start as the positive sequence current.

The sequence currents are accurately calculated according to the definition, which relates directly to heating. Note that significant negative sequence current is present if the phase angles are not symmetrical, even though the three-phase current magnitudes are equal.

The unbalance trip and alarm functions can each be set from 4% to 40%, or OFF. A common start delay is provided (UBSD, P3L13), plus separate trip (UBTR, P3L14) and alarm (UBAR, P4L8) run delays. Use the run delays to ride through external-system unbalanced faults, which could last for several seconds. Check the time curve settings of feeder relays or fuses. Keep in mind that high-resistance or arcing faults, which may take a longer time to clear, have less tendency to severely depress voltage than a solid fault.

#### 9.1.10 Ground Fault Protection Application

Use this fault-protection function with a flux-canceling ground fault CT. This CT has a large primary window through which all three-phase conductors can pass. The most common ground fault CTs have a ratio of 50:5 or 50:1.

The MP-4000 is recognized to UL 1053, Ground Fault Protective Device standard. This may eliminate the need for a separate ground fault protector in many applications that formerly required it.

Note that the ground fault trip and alarm current settings GFT, P3L1 and GFA, P4L1 are based on percentage of ground CT rated primary current, not on FLA or the phase CT ratio. For example, setting 10% gives a trip or alarm for an actual ground leakage current of 5 A with a 50:5 CT (GCT, P1L6 = 50).

This function is only useful for a grounded power system. The ground return is normally made from the neutral of the secondary wire winding of the supply power transformer. Resistance grounding is acceptable, as long as the resulting fault current is at a level the relay can be set to detect.

The ground CT, which provides sensitive protection for high-resistance ground faults, may saturate for a robust heavy-current ground fault in a solidly-grounded system. Minimize the saturation problem by minimizing the burden. Use the shortest and heaviest leads possible between the ground CT and the relay. The MP-4000 itself has very low burden, usually much lower than the connecting wiring. Calculate the current magnitude which saturates the ground CT. Consider the CT secondary voltage capability and the total burden of the CT secondary winding itself, the connecting wires, and the relay. Make sure this saturation current is well above the minimum sensitivity of the *phase IOC* function and/or the motor fuses.

A residual connection – the wired summation of the phase CT circuits through the ground CT input – requires a much higher GFT setting to avoid false tripping. Thus, sensitivity is not nearly as good as with a separate flux-canceling CT. If the MP-4000 relay is installed where a residual connection is used, GCT should be set to the same value as PCT. The User must then set the ground fault trip level at a high

value to avoid nuisance tripping from CT ratio errors, third harmonic and certain higher harmonics, or other measurement errors producing false residual currents. Monitor the metered ground current during various loading conditions to ensure a good margin between these error currents and the ground fault trip current setting GFT, P3L1. Also, watch out for phase CTs that saturate during motor starting. The saturation produces a large residual current and a ground fault trip. This may be a problem if the CTs have a low voltage capability (e.g.: C5 or C10), have long wiring runs, or are otherwise heavily burdened.

#### 9.1.11 Voltage Functions

Voltage functions are triggered if the measured voltage exceeds the over voltage threshold setting or drops below the under voltage setting for a period of time exceeding the associated run delay setting.

#### 9.1.12 Frequency Functions

Frequency functions are triggered if the measured frequency exceeds the over frequency setting or drops below the under frequency setting for a period of time exceeding the associated run delay setting.

#### 9.1.13 Power Factor Functions

Power factor functions are triggered if the measured power factor exceeds the leading or lagging power factor setting.

## 9.2 Motor Cycle Monitoring

This refers to the MP-4000 functions that monitor the motor during periods of normal operation. Normal operation includes the start cycle, run cycle, and stop cycle. Trips may occur at any time. The MP-4000 time tags many critical changes of state, and stores them with supporting data in log books and history records.

The primary function of the MP-4000 is to alarm, as well as to trip and block, the motor contactor for faults and abnormal or dangerous operating conditions. It can also exercise some active control of a normally functioning motor and/or its load. Active control functions include transition control to full running voltage for a reduced-voltage starter as explained in Subsection 9.2.1. Process load shedding that reduces overload is covered in Subsection 9.1.5. Other functions can be programmed by assigning a particular internal MP-4000 measurement to a contact output with output relay settings.

### 9.2.1 Start Cycle and Transition Tripping

Figure 9.6 shows an example of how the MP-4000 reacts to a normal operating-cycle current profile. Initially, the motor is stopped and the current is zero. As long as the MP-4000 is not in a trip state, it permits contactor energization by closing its trip contact in series with the contactor. The contactor is energized by the operator or process control system through a normal two-wire or three-wire motor control scheme, external to the MP-4000. The MP-4000 declares a motor start when it senses a motor current that exceeds 305 of the FLA setting (P1L1). The message START is displayed and the transition timer (TRNT, P5L6) begins to run. Also, the MP-4000 monitors the large starting current, noting when the current falls below the transition level TRNC, P5L5.

Using the TRN XXX setting P5L7, the User can select one of four transition behaviors:

TRN TIME - Transition to RUN after time setting (P5L6) only. Current is ignored.

TRN I - Transition when starting current drops below setting (P5L5) only. If the time set in TRNT P5L6 expires before the current transition, the motor trips.

TRN T+C - Transition on time or current, whichever comes first.



TRN T/C - Transition on time and current. Both must occur, and the current must drop below the setting before the time delay expires. If the timer expires before the current falls below the set transition level, trip the motor.

If there is no transition trip, and the MP-4000 relay declares a successful transition, the display and data communications messages indicate RUN. If P10L1 is set to TRN ON, the AUX 2 output relay operates its contact when the transition is declared. This contact controls a reduced-voltage starter, switching to full running voltage.

Even if the transition control output contact is not used, set the transition function to provide clear indications of the actual state of the motor (START versus RUN) on the front panel display and via data communications. A good way to do this is to use the settings of P5L7 = TRN T+C and P5L5 = 130% of FLA. Modify the latter, if needed, to lie at a transition value between the starting current and post-start maximum load current. Set the transition timer well beyond the normal start time to avoid a transition trip.

### 9.2.2 Start Delays

When the MP-4000 declares a START, all start timers of enabled functions begin to time. Each of these timers blocks the respective function until the set delay expires. These start timers are affected by transitions - they run for the set time, which may be less than or greater than the time of transition. These timers include:

- Ground fault start delay (GFSD, P3L2);
- Instantaneous over current start delay (IOCSD, P3L5);
- Jam trip and alarm start delay (JMSD, P3L7);
- Underload trip and alarm start delay (ULSD, P3L10);
- Unbalance trip and alarm start delay (UBSD, P3L13);
- Voltage unbalance start delay (VUSD, P15L3);
- Under frequency start delay (UFSD, P16L2);
- Over frequency start delay (OFSD, P17L2);
- Under voltage start delay (UVSD, P19L7);
- Under power start delay (UTSD, P20L5); and
- Power factor start delay (PFTS, P21L5).

Also, at the time of the start, the counters and timers for the jogging controls are updated. These include starts allowed per time (ST/T and T/ST, P5L1 and P5L2), time between starts (TBS, P5L3), and number of cold starts allowed (NOCS, P5L4). If a jogging limit is reached, only a STEX alarm occurs, but if the limit still applies when the motor next stops, the motor is tripped and blocked at that time.

### 9.2.3 Run Cycle

When the transition occurs, the MP-4000 declares the run state for the motor. A RUN message is displayed and communicated to the PowerNet host.

### 9.2.4 Run Delays

Note that run delays on trip and alarm functions don't have any particular relationship to the transition to the RUN state of the relay. Run delays are pickup delays on active functions, which are able to measure as soon as the respective start delay has expired. Refer to Subsection 9.2.2 for start delay details. The primary function of run or pickup delays is to prevent nuisance tripping. These delays are:

- Ground fault run delay (GFRD, P3L3);
- Jam trip run delay (JMTR, P3L8);
- Underload run delay (ULTR, P3L11);
- Phase unbalance alarm run delay (UBTR, P3L14);
- Jam alarm run delay (JMAR, P4L4);
- Underload alarm run delay (ULAR, P4L6);
- Unbalance alarm run delay (UBAR, P4L8);
- Load shed delay for pickup and dropout (LSDL, P9L3);

- Voltage unbalance run delay (VUTR, P15L4);
- Under frequency run delay (UFTR, P16L3);
- Over frequency run delay (OFTR, P17L3);
- Over voltage run delay (OVTR, P18L13);
- Under voltage run delay (UVTR, P19L3);
- Under power run delay (UTTR, P20L2); and
- Power factor run delay (PFTR, P21L6).

### 9.2.5 Stop Cycle

The run cycle continues until the motor current level falls below the Stop Current Threshold (STOP XX, P1L9) setting current on all three phases. Then, a stop is declared. Jogging limits, as listed in Subsection 9.2.2, and the anti-backspin time delay (ABKS, P5L12) are checked. If required, the MP-4000 trips with the appropriate display message(s). Remaining jogging block times are displayed and counted down, indicating how long to wait. If there are no such starting block conditions in effect, the MP-4000 closes (or never opens) the trip contact and displays READY - 3.

### 9.2.6 Trips and Trip Bypass

If any of the motor protective functions operate while the motor starts or runs, the MP-4000 opens its trip contact and displays the cause(s) of the trip. It may also open its trip contact *after* a stop is recognized if any jogging function time limit is blocking the next start. In either case, the MP-4000 expects that the contactor has opened in response and that no current flows.

If the MP-4000 senses noticeable current for more than about a second whenever it is tripped, it declares a *trip bypass* and displays a message. This means that the relay blocking of the contactor has been circumvented by the User to start the motor. If the current fails to stop when the MP-4000 trips a running motor, it may be because of a User trip bypass, or a stuck contactor.

Consider the possibility of backup protection for a contactor opening failure. Configure the AUX1 or AUX2 output relay to pick up for a trip bypass. Connect the contact to trip an upstream breaker. This protects the motor from damage in case of a stuck contactor (at the cost of interrupting other loads connected to the same breaker).

### 9.2.7 Armed/Disarmed Mode

If the MP-4000 is DISARMED (P12L18), trip messages are displayed, but the trip relay is not operated. This is useful in a critical process, if it is imperative to keep the motor running while settings are changed or the relay is replaced. Commission the new relay or settings in the DISARMED state. Make sure the relay is also set for RUN PGM (P12L6) before commissioning. Watch for any trip messages and observe the contents of the thermal bucket for a while. When it is apparent that the relay behavior is secure and stable, change P12L18 to ARMED.

## 9.3 AC Line Interruptions

The MP-4000 has an exceptional ability to ride through voltage sags and interruptions, even longer than a delayed-dropout contactor it controls. With this capability, most Users can avoid the addition of a dc battery supply or an uninterruptible power supply (UPS).

The MP-4000 relay operates continuously for ac supply voltages down to 55% of rated value (66 Vac for a 120 Vac supply system; 132 Vac for a 240 Vac supply).

For a complete supply interruption, the nominal ride-through rating is 13 cycles. The relay typically continues to operate for 13 to 20 power cycles, depending on power supply loading variables:

- Number of output relays picked up;
- Current being delivered by the 4-20 mA analog transducer output port;
- Type of PONI communications module powered by the MP-4000, if any; and
- Electrical URTD communications (using recommended optical communications lowers this burden slightly).

The one load that may depress the MP-4000 ride-through times below 13 cycles is the use of an Eaton Ethernet PONI (EPONI) for communications, particularly the EPONI with optical fiber communications. In this case, ride-through could fall to below 10 cycles. However, this is easily remedied by powering the EPONI from its own optional external power transformer. The MP-4000 ride-through then returns to its 13 to 30 cycle range.

In applying this ride through capability, consider these external factors.

- Typical utility feeder fault tripping and reclosing systems on overhead medium- or high-voltage feeder lines up to 161 kV cause interruptions of 15 to 20 cycles, especially during thunderstorms.
- For higher or extra-high voltage supply circuits to large plants, interruptions may be longer, up to 30 cycles. Determine if the power system has special mitigating features like multiple well-separated sources, or local paralleled generation.
- Conventional motor contactors drop out in 3 to 5 cycles, stopping the motor.
- Special delayed-dropout contactors that store energy are available, and ride through interruptions of 15 to 20 cycles.
- Latching contactors or motor breakers may also be used. They trip only by active unlatching or trip coil energization.

The MP-4000 declares a motor stop after about 20 cycles of no current. The only way to extend this time is to assign the MOTOR STOP function to one of the discrete inputs, and connect an external stop-indicating contact (refer to Subsection 5.6.1 for details).

If the ac supply returns after the stop declaration, but before the MP-4000 microprocessor shuts down, the MP-4000 relay can go through another start cycle and return to the RUN state without ever tripping the motor. However, this on-the-fly restart declaration won't happen if the relay has anti-backspin or other jogging timer blocking in effect. The relay trips at the moment the MP-4000 declares a stop.



## WARNING

**BEWARE OF RE-ENERGIZING MANY LARGER MOTORS AFTER AN INTERRUPTION OF MORE THAN 20 CYCLES, BUT LESS THAN SEVERAL SECONDS. THE INDUCED ROTOR CURRENT DECAYS SLOWLY, YET THE ROTOR SLOWS ITS ROTATION AND DEVELOPS A LARGE ANGULAR DIFFERENCE FROM THE DISCONNECTED STATOR FIELD. WHEN THE STATOR IS REENERGIZED AFTER 30 TO 40 CYCLES, THE SUDDEN TORQUE SHOCK CAN BREAK A SHAFT KEY, OR DO MORE SERIOUS MECHANICAL DAMAGE. USE A CONTACTOR WITH AN APPROPRIATE DROP OUT DELAY.**

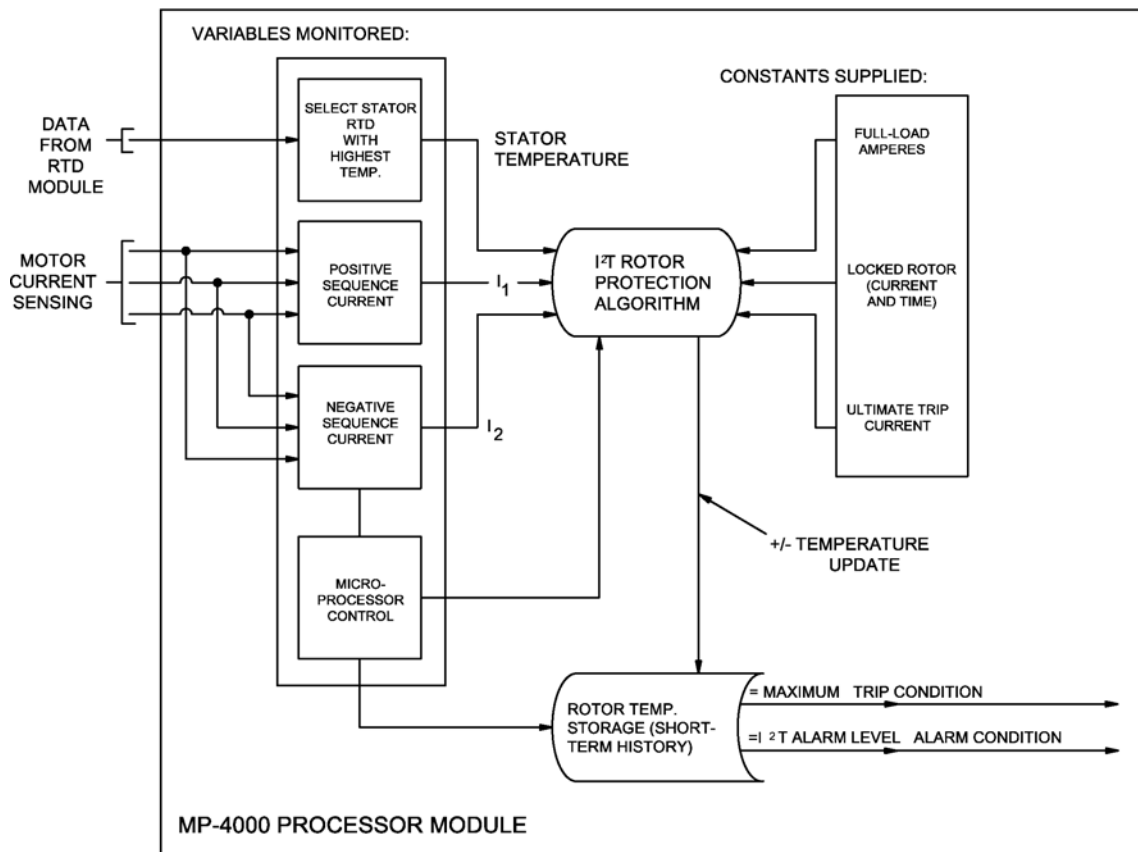


Figure 9.1 Rotor Temperature Tracking.

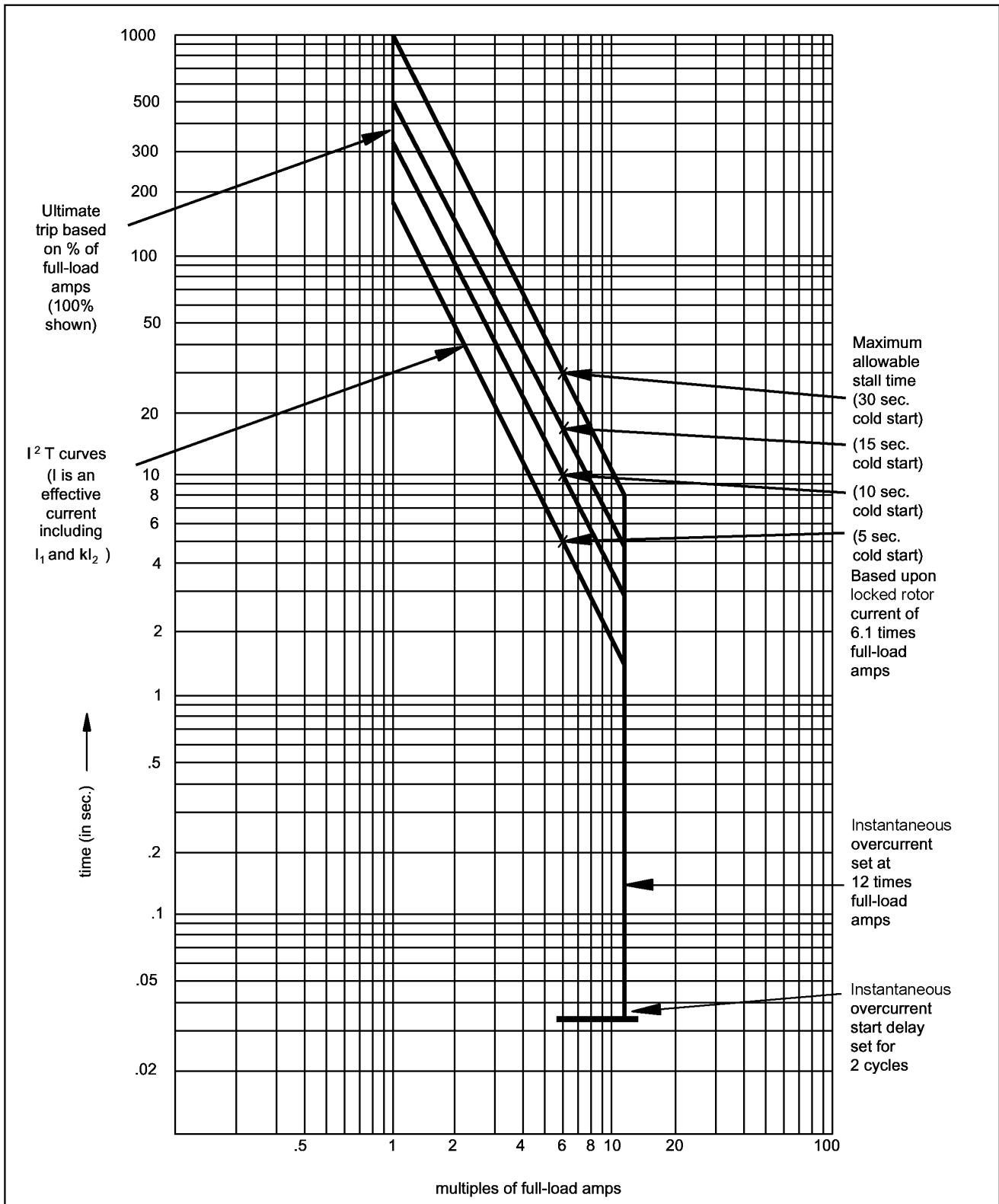


Figure 9.2 Motor Protection Curve.

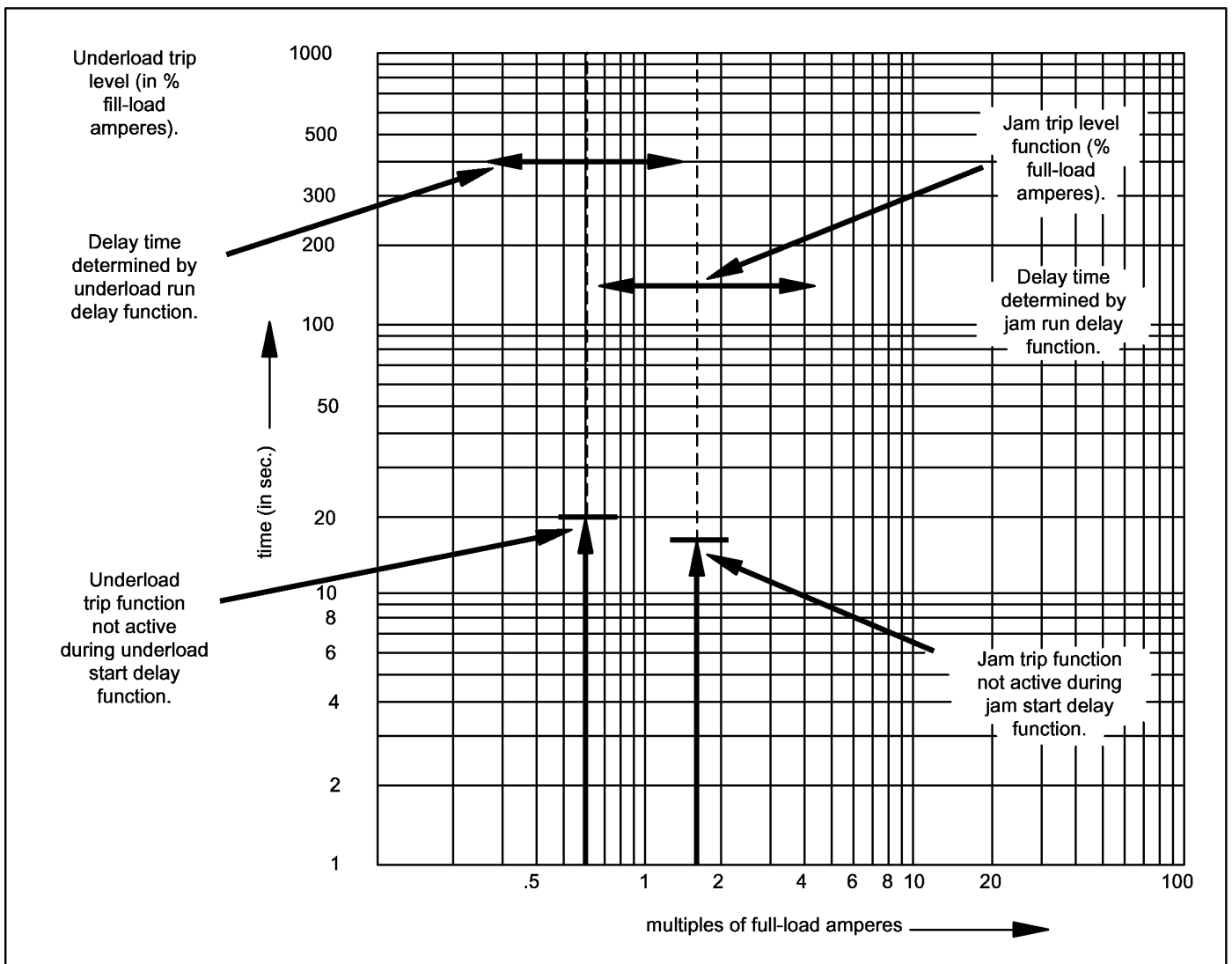


Figure 9.3 Underload Jam Protection Curve.

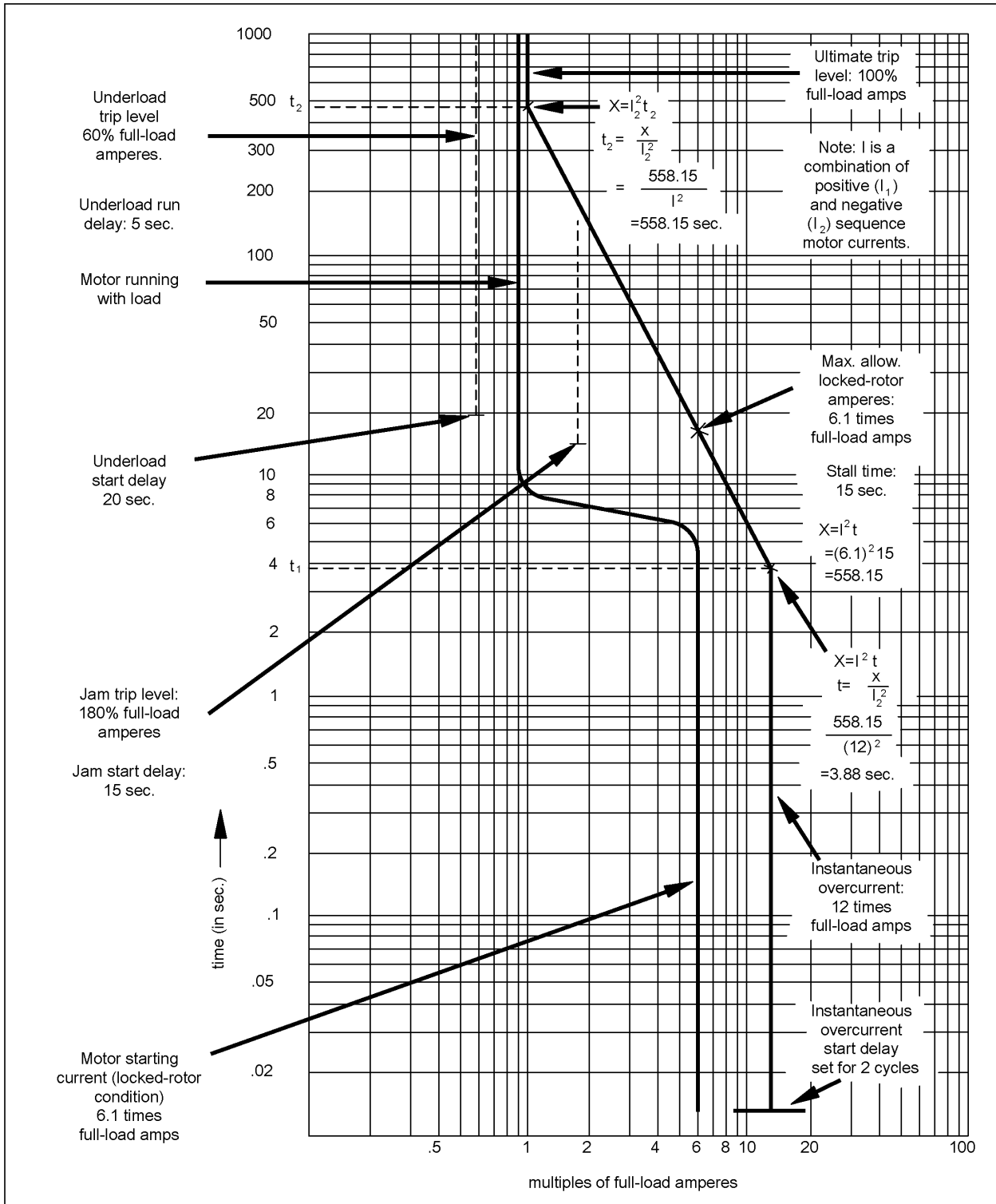


Figure 9.4 Motor Protection Curve Example (without RTDs).

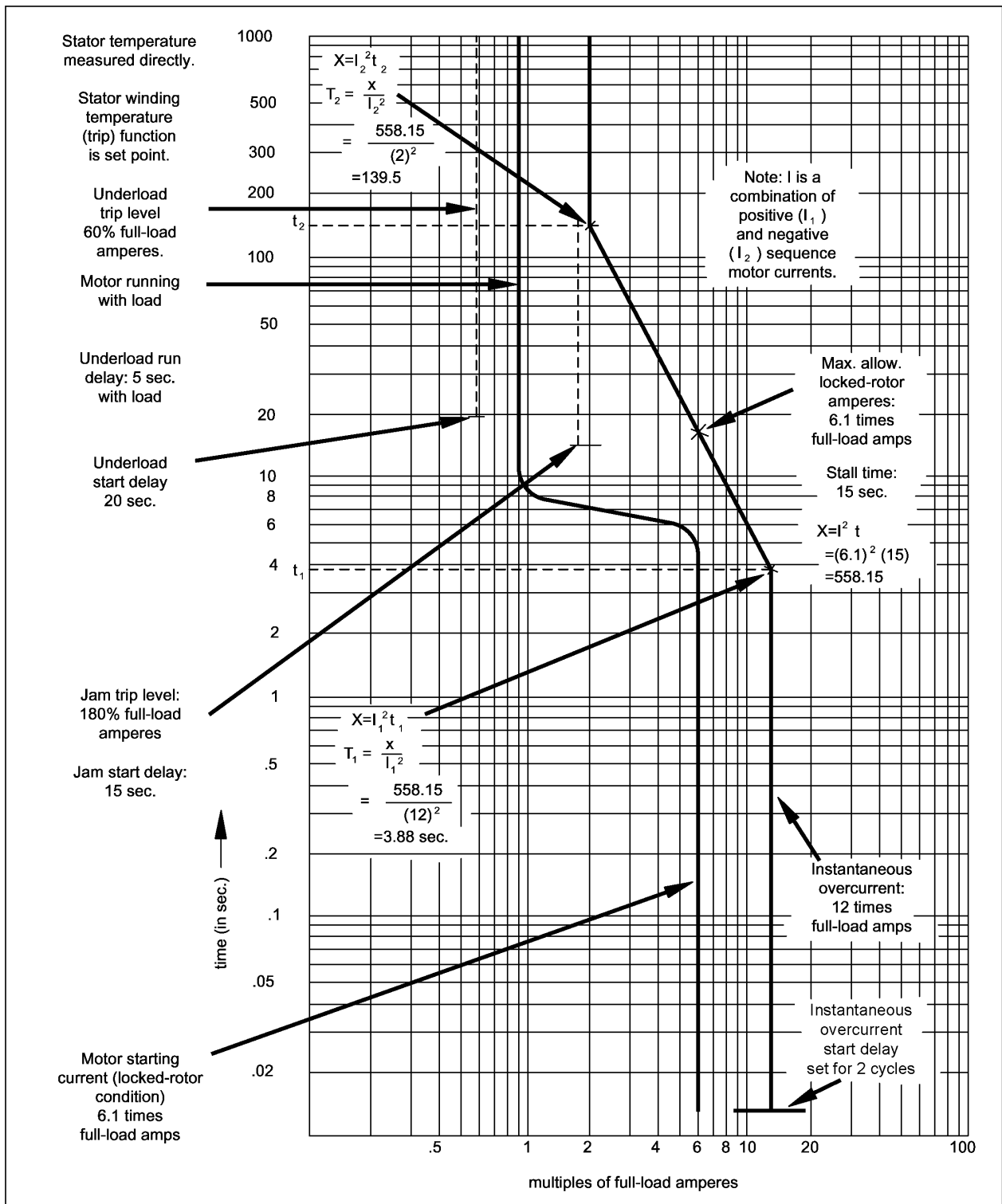


Figure 9.5 Motor Protection Curve Example (with RTDs).

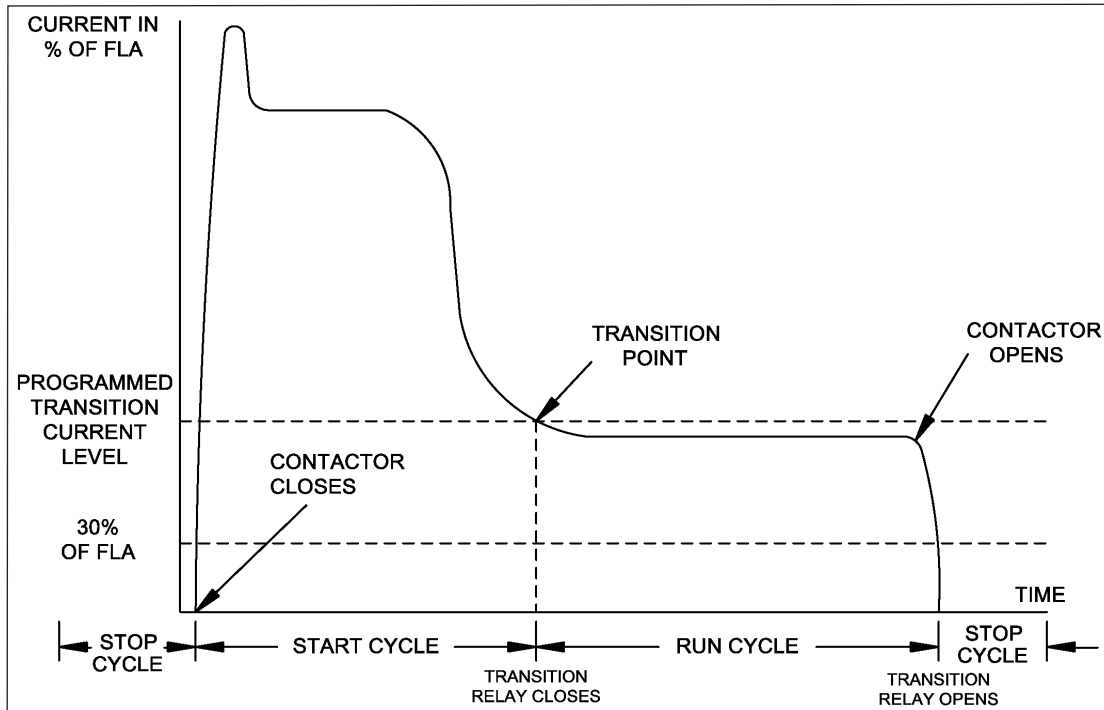


Figure 9.6 Motor Start and Run Cycles.



## SECTION 10 - DATA COMMUNICATIONS

### 10.0 General

Most MP-4000 settings and operating data can be viewed or changed on the front-panel alphanumeric display. However, with the large volume of information and settings, many Users find it more convenient to view or manipulate the data on a host computer that has a large graphic display.

The MP-4000 can communicate with Eaton, Inc. PowerNet®, PowerPort®, or host software via its communications port and an optional accessory PONI module mounted on or near the back of the unit.

The MP-4000 can also be programmed via the front panel RS-232 port using PowerNet. However, using the RS-232 port disables PONI and URTD communications.

PowerNet is a high speed, Ethernet based power management system that networks state-of-the-art meters, relays, trip units, motor protectors, starters, and transfer switch controllers for efficient energy management, real-time monitoring, alarming, and trending of electrical distribution systems.

PowerPort is free software that can be downloaded from the Eaton, Inc. web site at [www.Eaton.com](http://www.Eaton.com). PowerPort is a portable, scaled-down version of the flexible and powerful PowerNet Power Management Software. Whereas PowerNet communicates to multiple devices over a network, PowerPort communicates to one device at a time via a direct connection. With PowerPort, the User can configure a single device and view both real time and historical data from that device. The physical connection between an MP-4000 and a personal computer (PC) can be made by an I-PONI (refer to Subsection 10.2). Either a MINT II or a PMCOM5 can be used to connect the INCOM network to the serial port of a PC. For details, refer to Technical Data Sheet TD.17B.01.T.E at the above web site.

In addition to monitoring and programming, PowerNet and PowerPort can execute control through communications, including remote tripping, resetting, and emergency override.

One particular logging function, the starting current profile display, cannot be viewed on the MP-4000 relay front panel. The profile data must be uploaded to a host computer using PowerNet, or PowerPort after the motor start. PowerNet and PowerPort provide an informative plot of the actual starting current curve, plotted along with the cold-start protection limit curve, for checking of coordination. Profiles are saved for the last four starts.

Older IMPACC systems do not directly support the MP-4000.

### CAUTION

**THE MP-4000 WILL NOT COMMUNICATE VIA PONIS WHEN THE RS-232 IS ENABLED. TO ALLOW COMMUNICATIONS, DISABLE THE RS-232 SETPOINT.**

### 10.1 Choosing a PONI

The PONI (Product Operated Network Interface) module is interchangeable among a number of available styles. It provides the physical and electrical interface to several communications links or networks. The MP-4000 can work with at least these PONI types:

- I-PONI - INCOM Network PONI - The recommended means of connecting to the robust INCOM communications network;
- RS-485-PONI - Allows the MP-4000 to communicate via Modbus RTM over a standard RS-485 network;
- D-PONI - Allows the MP-4000 to communicate over the

- DeviceNet at 125, 250, or 500 kilobaud; and
- E-PONI - Ethernet PONI with 10BaseT or optical-fiber network connections - for direct connection to a facility LAN that ties the MP-4000 to a PowerNet host client computer.

Contact an Eaton sales engineer or the Power Management Products factory for updated information on availability of PONI types.

Each type of PONI has its own instruction leaflet, with information on mounting and connection.

### 10.2 Mounting the PONI

Attach the PONI to the back of the MP-4000 using the mounting bracket supplied with the relay. If the URTD module is to be mounted on the back of the relay, mount the URTD module with its own bracket first. Then attach the PONI to the back of the URTD module without the PONI mounting bracket. Figure 6.3 in Section 6 shows the depth of the MP-4000, with or without the URTD module and PONI attached to the back.

**NOTE:** Figure 6.3 applies to I-PONI, RS485-PONI, and D-PONI. The E-PONI is 0.5 inch deeper than Figure 6.4 shows, as well as having larger dimensions.

### 10.3 Connecting the PONI to the Relay

Each PONI type has a ribbon cable with a 9-pin D-sub connector. This plugs into the mating 9-pin D connector above the right (rear view) terminal block of the MP-4000. Secure the connection with the captive screws.

The PONI gets its operating power from the MP-4000 through the ribbon cable.

**NOTE:** The E-PONI draws more power from the relay than the other PONI types. This can reduce the ability of the MP-4000 to ride through prolonged interruptions in the ac supply (refer to Section 9.3 for further details).

If voltage interruption ride-through is important and the E-PONI is used, power the E-PONI through its external-power connector from a separate power supply. This unburdens the MP-4000 power supply, and restores full ride-through capability. Refer to E-PONI instructions for connection information.

**NOTE:** PONIs can be "hot-plugged" (that is, connected or disconnected) with the MP-4000 powered. Hot-plugging may or may not be allowed with various combinations of other communicating products and PONI types. Check the instructions for each type of device.

### 10.4 Connecting the PONI to the Network or Host

Figure 10.1 shows an outline of the I-PONI. The INCOM network comprises a shielded twisted-pair conductor that is daisy-chained from one communicating device to the next as shown. There is only one INCOM network master, which is either a MINT (INCOM network to RS-232 port converter) or a CONI/CONI III (ISA card for PC with INCOM port on the rear flange) or NetLink Device Server.

INCOM provides full galvanic isolation of every communicating device from the network, and works reliably in noisy industrial environments (refer to IMPACC Systems Communications Manual I.L 17384). For best results, follow the network wiring rules in the PONI I.L. and in the IMPACC Wiring Specification T.D. 17513. Proper handling of shield grounds is important to good noise immunity. However, do not ground the shields everywhere.

For INCOM, every communicating device must be set to a unique ad-

dress on the network, using address switches on the I-PONI as shown in Figure 10.1. Also, all devices must be communicating at the same baud rate, which is usually be 9,600 baud, unless some old devices are on the network.

For Modbus RTU, DeviceNet, and Ethernet connections, refer to the instructions for those PONIs for further information.

PowerNet software is supplied with its own comprehensive instructions, which explain how to access MP-4000 data and control capabilities at the host client computer.

### 10.5 PowerNet INCOM Communications Protocol

The communications messaging protocol specification for the MP-4000 is open and available to Users and communications systems integrators without charge. Check the Eaton Power Management Products web site, your distributor, or the factory for detailed specifications and documentation.

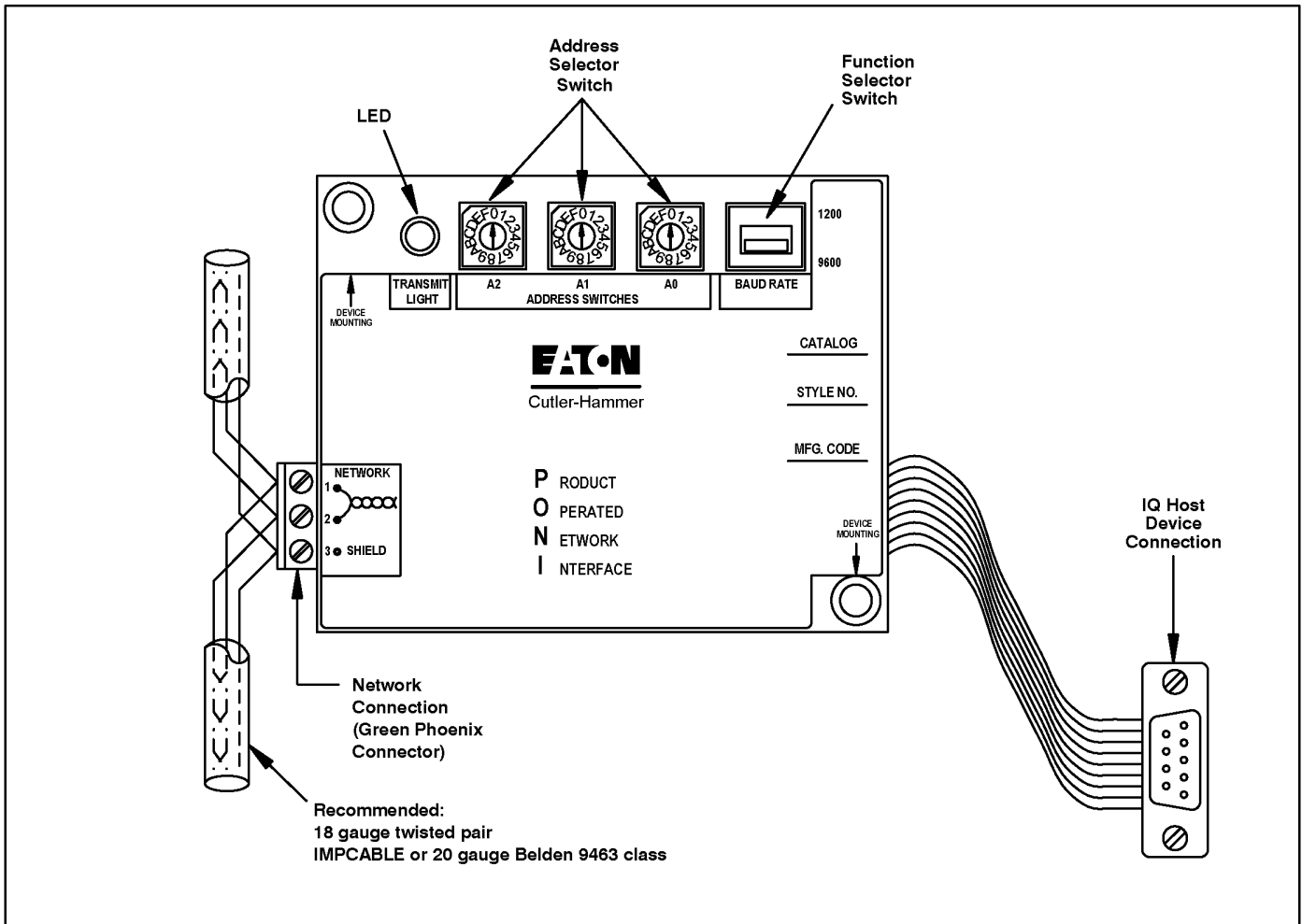


Figure 10.1 PONI Communications Module.

## SECTION 11 - TESTING

### 11.0 General

The MP-4000 requires no maintenance. Do not remove its rear cover. In most applications, normal cycles of use demonstrate that the relay is functioning properly. Use the procedures in this section for bench checkout, and for verification of inputs and outputs that have not been observed to function for one year or more. Users with normally trouble-free applications should check the alarm relay and the annunciator to which it is connected, at least annually.

### 11.1 What to Test

The MP-4000 microprocessor routinely checks most of its own electronics, program memory, and the writable, nonvolatile data storage memory. If it detects malfunctions, the microprocessor reports specific messages, and has settings to alarm the User and/or trip the motor as desired. Refer to Setting P12L16 in Table 4.3 and Subsection 5.12.16.

It is neither necessary nor beneficial to test individual functions of a multifunction microprocessor relay for maintenance purposes. All functions are performed by the same microprocessor electronics. It is important only to make sure the settings are correct (use the View Setting mode any time), and to confirm that the inputs and outputs are working with the application wiring.

To test the MP-4000 inputs and outputs, use the SP TEST page in the Program mode. Refer to Subsections 5.0 and 5.13 and to Table 4.3 for details on using the Program mode to activate test settings P13L1 to P13L8.

### 11.2 Tests on a Running Motor

To use any of the test settings on a running motor, the MP-4000 must be set to allow programming while running. Refer to STOP PGM versus RUN PGM in Subsection 5.12.6 and Setting P12L6.

To test the *trip output* relay, the motor must be stopped in any case. An attempt to test this while the motor runs causes an ILLEGAL message to be displayed.

All other inputs and outputs can be tested while the motor runs.



## DANGER

**USING THE TEST SETTINGS CHANGES THE STATE OF THE OUTPUTS, REGARDLESS OF THE FUNCTIONS NORMALLY OPERATING THOSE OUTPUTS. UNLESS TESTING IS URGENT, WAIT UNTIL THE MOTOR IS STOPPED TO RUN TESTS. IF THE MOTOR IS RUNNING, MAKE SURE THAT CHANGING THE OUTPUT STATE WILL NOT CREATE A DANGEROUS SITUATION IN THE MOTOR, STARTER, OR PROCESS.**

### 11.3 Verifying Current Inputs

If the motor current readings were checked at the time of commissioning as described in Section 7, it is often adequate just to periodically observe the motor load current readings during normal motor operation. Use the phase current values on the MONT I page of the Monitor mode, or check values by remote communications. If a clip-on ammeter is used, allow tolerance for errors in the clip-on CT and in the main CTs of the motor starter.

### 11.4 Bench Test of Current Inputs

Use a three-phase source or relay test set to simulate motor load current. Check the correctness of all readings, considering the scaling of the PCT and GCT CT ratio settings P1L5 and P1L6.

If a three-phase source is not available, use the single-phase test mode of the MP-4000. Set P13L1 to 1 PHASE. A single current around 3.5 A to 4 A can be applied to all four CT inputs, daisy-chained in series. Observe the metered values, considering PCT and GCT.



## WARNING

**BE SURE TO RETURN SETTING P13L1 TO THREE-PHASE BEFORE RETURNING THE RELAY TO SERVICE. ALL PROTECTION FUNCTIONS THAT CHECK PHASE BALANCE OR SEQUENCE ARE DISABLED IN SINGLE-PHASE TEST MODE. SEEING THE DISPLAY READY - 1 IN THE MOTOR STATE MODE WHEN THE MOTOR IS STOPPED IS A WARNING THAT THE SETTING IS AT SINGLE-PHASE. THE CORRECT DISPLAY IS READY - 3.**

### 11.5 Testing the Trip Relay

Stop the motor—this test is blocked if the motor is running. Enter the Program mode and go to test setting P13L2. The trip relay contacts (terminals 11 through 13) can be monitored for proper operation, or observe the controlled-circuit operation. See Figure 6.6 for the rear panel terminal layout.

To use this function:

- Determine whether the MP-4000 trip relay is configured for MODE 1 or MODE 2 operation. Refer to SYSTEM Page Setting P12L1.
- In MODE 1, the trip relay is normally de-energized. Set up for the test by selecting TRP ENER in P13L2.
- In MODE 2, the trip relay is normally energized. Set up for the test by selecting TRP DENR in P13L2.
- Press the Reset pushbutton to test the relay. The Trip LED also lights. Release the pushbutton to revert to the prior output state.

### 11.6 Testing the Alarm Relay

Use setting P13L3 to test the alarm relay. The procedure is the same as for the trip relay test. Press the Reset pushbutton to light the Alarm LED and activate the alarm contacts (terminals 17 through 19). If the MP-4000 is set for RUN PGM, this output can be tested while the motor runs.

### 11.7 Testing the AUX1 Relay

Use setting P13L4 to test the AUX1 relay. The procedure is the same as for the trip relay test. Press the Reset pushbutton to light the Aux 1 LED and activate the AUX1 contacts (terminals 14 through 16). If the MP-4000 is set for RUN PGM, this output can be tested while the motor runs.

### 11.8 Testing the AUX2 Relay

Use setting P13L5 to test the AUX2 relay. The procedure is the same as for the trip relay test. Press the Reset pushbutton to light the Aux 2 LED and activate the AUX2 contacts (terminals 1 through 3). If the MP-4000 is set for RUN PGM, this output can be tested while the motor runs.

### 11.9 Testing the Analog Output

To test the 4-20 mA analog transducer output at terminals 24 and 25, use P13L6. Set the test output current level to be 4, 12, or 20 mA. Press the Reset pushbutton to force the selected test output current. Release the pushbutton to return to the normal measurement-driven output. Note that the MP-4000 analog output must drive an isolated external circuit.

### 11.10 Checking Discrete Input 1

Use P13L7 to determine if discrete input 1 is on or off. Apply or remove 120 Vac to check both states.

### 11.11 Checking Discrete Input 2

Use P13L8 to determine if discrete input 2 is on or off. Apply or remove 120 Vac to check both states.

### 11.12 Verify Voltage Inputs

A DVM can be used to verify readings displayed by the MP-4000. Measure voltage between the ground input connection and each voltage input. Allow tolerance for errors in the DVM and the PTs of the motor starter.

## SECTION 12 - TROUBLESHOOTING

### 12.0 General

This section is designed to assist maintenance personnel in carrying out troubleshooting procedures. It gives three general areas of information:

- Operator panel monitoring procedures (Subsection 12.1);
- Troubleshooting monitored equipment (Subsection 12.2); and
- Troubleshooting the MP-4000 (Subsection 12.3).



### WARNING

**ALL MAINTENANCE PROCEDURES MUST ONLY BE PERFORMED BY QUALIFIED PERSONNEL WHO ARE FAMILIAR WITH THE MP-4000 AND ITS ASSOCIATED MOTOR AND MACHINES. FAILURE TO OBSERVE THIS WARNING CAN RESULT IN SERIOUS OR FATAL PERSONAL INJURY AND/OR EQUIPMENT DAMAGE.**

**ALL CORRESPONDENCE WITH EATON, INC., WHETHER VERBAL OR WRITTEN, SHOULD INCLUDE THE SOFTWARE VERSION NUMBER WHICH APPEARS AS THE FIRST DISPLAY ON THE MONT MTR PAGE OF THE MONITOR MODE DISPLAY. REFER TO TABLE 4.2.**

### 12.1 Panel Operations

The Operator Panel performs the following operations:

- Reporting of system status messages (Subsection 12.1.1);
- Programming setting values (Subsection 12.1.2);
- Reviewing setting values (Subsection 12.1.3);
- Monitoring motor operating parameters (Subsection 12.1.4);
- Retrieving motor history data (Subsection 12.1.5); and
- Retrieving the logs of motor events (Subsection 12.1.6).

Viewing the motor starting current profile (Subsection 12.1.7) is available only through PowerNet and not on the front panel.

#### 12.1.1 System Status Messages

The Display Window provides a reporting function during the normal operation of the MP-4000 with the Default Mode display. This group of messages is referred to as the system status messages. Table 4.1 lists the normal operation reporting messages.

#### 12.1.2 Programming Settings

The Operator Panel is used to enter setting values. Refer to Section 5 for a detailed procedure for entering or modifying setting values.

#### 12.1.3 Reviewing Settings

Of the 152 settings that actually configure the MP-4000 functions, 141 can be reviewed at any time, even with the motor running. Press the View Setting mode pushbutton, and navigate through the settings in the same way as in the Program mode. Table 4.3 lists the settings. The View Setting mode does not allow any changes.

To check settings of the real-time clock, use the MONT TIM page of the Monitor mode.

#### 12.1.4 Monitoring Motor Operation

The Monitor mode allows maintenance personnel or operators to observe motor operating conditions, including phase currents, unbalance, motor temperatures, thermal-model bucket level, and time limits on restarting imposed by jogging functions. Refer to Table 4.2 for a listing

and description of these parameters. Note that the software version number appears in this mode.

#### 12.1.5 Reviewing Motor History Data

Press the History mode pushbutton. Refer to Table 4.4 for the four pages of information available for review in the History mode, including the numbers of each of the different types of trips and alarms, and the highest currents and temperatures with time tags. The accumulation of these historical values can be selectively cleared and restarted using settings P14L1 to P14L4 in the Program mode (refer to Subsection 5.14).

#### 12.1.6 Reviewing the Logged Motor Data

Press the Log mode pushbutton. Pages include a log book of the last 100 events, a log of the last 20 abnormal events with more details, and a detailed log of the last four starts. The MP-4000 logs motor events in chronological order with details and time tag as listed in Table 4.5.

#### 12.1.7 Reviewing the Motor Starting Current Profile Curve

One particular logging function, the starting current profile display, cannot be viewed on the MP-4000 front panel. The profile data must be uploaded via data communications to a PowerNet host computer after the start. PowerNet provides an informative plot of the actual starting current curve, plotted along with the cold-start protection limit curve, for checking of coordination (see Figure 2.1 for an example). The MP-4000 stores the profiles for the last four starts. See the PowerNet Help function or the Users Manual for instructions on viewing the profile. Refer to Section 10 for information on connecting data communications to the MP-4000.

## 12.2 Troubleshooting MP-4000 Monitored Equipment

If the monitored equipment malfunctions, certain troubleshooting information from the MP-4000 assists in localizing the problem. The description is given in two categories - alarm conditions (Subsection 12.2.1) and trip conditions (Subsection 12.2.2).



### WARNING

**TROUBLESHOOTING PROCEDURES INVOLVE WORKING AT TIMES IN EQUIPMENT AREAS WHERE POTENTIALLY LETHAL VOLTAGES ARE PRESENT. PERSONNEL MUST HAVE ADEQUATE TRAINING AND SHOULD EXERCISE EXTREME CAUTION TO AVOID INJURY, INCLUDING POSSIBLE FATAL INJURY.**

#### 12.2.1 Alarm Conditions

An alarm condition occurs when one of the electrical characteristics exceeds its programmed setting value. Start delays, and run or pickup delays, must expire before the alarm occurs. The red alarm LED lights and a message appears in the display window to assist with the isolation process. Multiple alarms are alternated or cycled in the display.

Connect external devices, such as an annunciator, to the Alarm relay of the MP-4000, to get the attention of operators who can act to solve the problem. The form C alarm relay contacts are brought out to terminals 17, 18, and 19 (see Figure 6.6).

Setting Page 8, settings P8L1 to P8L22, permits the selection of the alarm or trip events that will operate the alarm relay. Normally, the User should direct all alarms of functions in use to the alarm relay by these settings.

The alarm relay should be used in Mode 2, and all alarm conditions should be directed to it.

The annunciator connects to terminals 17 and 18. With this connection, an alarm occurs if the relay or its power supply fails. All other problems the MP-4000 can actively report are alarmed in the same manner.

However, if the MP-4000 is de-energized routinely in service, use the alarm relay in Mode 1 and connect the annunciator to terminals 18 and 19 to avoid nuisance alarms.

The alarm condition is automatically cleared if the measurement causing the condition falls below the alarm setting. At this time, the Alarm LED and alarm relay reset.

All possible alarm conditions are listed in Table 12.1. Related probable causes and solutions are also included in this table.

### 12.2.2 Trip Conditions

A trip condition operates the trip relay contact. Other contacts are programmed to respond to the particular offending condition. These conditions fall into two groups:

- The measurement is greater than the programmed setting value. Start delays, and run or pickup delays, must expire before the function can trip. The red Trip LED lights and a message appears in the Display Window to assist the operator.
- The MP-4000 may detect a malfunction, which is usually external to the motor control – such as a broken report back signal circuit from the machine or process. There are also conditions that may be internal to the control system, such as a bypass of the trip contact or an MP-4000 internal self-monitoring failure (refer to Subsection 12.3).

Note that the STEX alarm is conditional. While the motor is running, it is an alarm. If the motor is stopped before it clears, it becomes a trip. Refer to Subsections 5.5.1 and 5.5.2.

Trip conditions have these features:

- A time tag and a listing of the metering values just prior to the occurrence of a trip is stored in memory, and they can be recalled by using the Log Mode Display (refer to Table 4.5).
- For IOC and ground fault trips, the offending transient fault over current values are saved in the log with the time tag.
- The Display Window automatically alternates between the last item displayed and the cause of the trip condition. If two or more trip conditions occur at the same time, the display alternates between or among the menu item and the cause of each trip.
- The internal trip relay is always actuated. The other three output relays may be actuated, depending on the output configuration settings and which specific trip occurred.
- The trip condition must be manually reset by pressing the Reset pushbutton. The remote reset input (terminal 8), the REMOTE INPUT or INCOM command, can also be used to reset the trip condition.

**NOTES:** A thermal-model trip (I2T trip) cannot be reset until the thermal bucket level drops (cools) below the I2T *alarm* setting.

A trip caused by a jogging function (starts per time exceeded, anti-backspin timing, time between starts) is not cleared by resetting, and counts down with the remaining time visible on the display. The trip then clears itself.

Trip conditions from operating causes or motor problems are listed in Table 12.2. Related probable causes and solutions are also listed in this table.

**NOTE:** If the MP-4000 is in the Program mode with the motor running and a trip condition occurs, the unit exits the Program mode without saving any setting changes that might have been entered in the scratch pad area up to that time. After diagnosing the trip, the reprogramming task must be repeated. Note that the relay was protecting the motor with only its old settings at the time of the trip.

## 12.3 Troubleshooting the MP-4000

Troubleshooting the MP-4000 is straightforward. If the Operator Panel is inoperative (either the LEDs and the Display Window are off or they are not responding properly), check Table 12.3. When doing so, keep in mind that the most likely and easy to check problems are listed first.

### WARNING

**IF THE MP-4000 IS REPLACED, THE USER MUST REPROGRAM ALL SETTING VALUES FOR THE SPECIFIC APPLICATION IN THE NEW UNIT. DO NOT ATTEMPT TO RESTART THE MOTOR UNTIL ALL VALUES ARE ENTERED AND CHECKED. DAMAGE TO EQUIPMENT AND/OR PERSONAL INJURY MAY OCCUR IF THIS PROCEDURE IS NOT FOLLOWED.**

The MP-4000 can prevent saving settings that are inconsistent with proper protection. If a programming error of this type occurs, the User cannot exit the programming mode by pressing the Prog pushbutton (refer to Section 5.0.1, Conditional Setting Ranges, for more information).

The MP-4000 performs continuous internal diagnostic checks. If a malfunction is detected during a diagnostic check, the MP-4000 displays one of the messages listed in Table 12.4. The User setting P12L16 determines whether the MP-4000 only alarms for these problems, or if it both alarms and trips the motor.

### WARNING

**IF THE USER HAS A CRITICAL PROCESS, THE USER MAY CHOOSE TO ALARM ONLY, BUT IT IS ESSENTIAL TO REPLACE THE MP-4000 AS SOON AS POSSIBLE. ASSUME THAT THE UNIT IS NOT PROTECTING THE MOTOR IF ONE OF THESE ALARMS OCCUR. MANUALLY MONITOR THE MOTOR AND PROCESS CLOSELY. DO NOT RELY ON MP-4000 DISPLAYS IN THIS CASE.**

If the motor trips or alarms for one of these failures, the MP-4000 must be replaced. Return the unit to the factory for repair. There are no User service procedures.

## 12.4 Technical Assistance

For information, technical assistance, referral to an authorized distributor, or instructions for returning products for repair, contact Eaton's Power Management Applications Support at 1-800-809-2772, Option 4. Or visit [www.eaton.com](http://www.eaton.com) to access our searchable database that provides self-help solutions with troubleshooting information. Select the appropriate country in the drop-down box, and choose the Product eXpert option on the following page.

**Table 12.1 Alarm Conditions.**

<b>Display</b>	<b>Complete Help Message</b>	<b>Probable Cause</b>	<b>Solution</b>
GND FAULT	GROUND FAULT ALARM	Insulation failure - ground current leakage.	DANGER: Personnel hazard. Stop and isolate the motor as soon as possible to avoid more dangerous or damaging fault. Get expert evaluation of motor insulation condition.
%I2T	I2T ALARM	The thermal-model bucket level has exceeded the alarm setting (60% to 100% of trip level).	<ul style="list-style-type: none"> <li>• Determine if the motor is seeing larger than expected sustained loading.</li> <li>• Check for an unbalance in supply currents or voltages causing negative sequence heating.</li> <li>• Check for an abnormal system voltage level.</li> <li>• Check for cooling air blockage or abnormal ambient.</li> <li>• Monitor the bucket level in Monitor mode to be sure level does not continue to rise to trip level.</li> </ul>
STEX A	ALLOWED STARTS EXCEEDED, WAIT IN MINUTES	All of the allowed count of starts in the set time period have been used.  In each case, the temperature is equal to or greater than the alarm setting value.	<ul style="list-style-type: none"> <li>• Wait the number of minutes shown on the display before restarting.</li> <li>• Check the problem value in the Monitor mode and determine the cause.</li> <li>• Stator heat may be due to overload, or to cooling air flow blockage.</li> <li>• Bearing heat usually indicates impending failure or lack of lubrication.</li> </ul>
WD TEMP	STATOR WINDING TEMPERATURE ALARM		
MB TEMP	MOTOR BEARING TEMPERATURE ALARM		
LB TEMP	LOAD BEARING TEMPERATURE ALARM		
AX TEMP	AUXILIARY OVER TEMPERATURE ALARM		
PH UNBAL JAM UNDER L	PHASE UNBALANCE ALARM LOAD JAM ALARM UNDER LOAD RUN ALARM	The electrical value has crossed the alarm threshold.	For unbalance, check source voltage balance, single-phase external loads, and uncleared unbalanced faults. Jam and underload - look for mechanical failures in driven process equipment.
RTDF 3W RTDF FIB URTDF	FAILED RTD COMMUNICATION -FIB- FIBER CHAN -3W- THREE WIRE CHAN  FAILED URTD COMMUNICATION (log display only)	RTD temperature information reporting through designated medium has been lost.	<ul style="list-style-type: none"> <li>• Check the wire or fiber channel medium for damage or disconnection.</li> <li>• Check the URTD module for power or malfunction.</li> </ul>
RTF XX	RTD CHANNEL FAILED ALARM (xx = channel that failed)	A particular RTD or input to the URTD has failed.	Troubleshoot the designated RTD.
<b>Alarm Flags</b>			
PH UNB V	VOLTAGE PHASE UNBALANCE ALARM	A voltage phase unbalance occurred.	
OVR VOLT	OVERVOLTAGE ALARM	An over voltage condition occurred.	

Table 12.1 Alarm Conditions.

Display	Complete Help Message	Probable Cause	Solution
UND VOLT	UNDERVOLTAGE ALARM	An under voltage condition occurred.	
OVR FREQ	OVER FREQUENCY ALARM	An over frequency condition occurred.	
UND FREQ	UNDER FREQUENCY ALARM	An over frequency condition occurred.	
UND POWER	UNDER POWER ALARM	An under power condition occurred.	
PWR FCTR	POWER FACTOR ALARM	A power factor alarm condition occurred.	
<b>Trip Flags</b>			
PH UNV B	VOLTAGE PHASE UNBALANCE TRIP	A voltage phase unbalance occurred.	
OVR V	OVER VOLTAGE TRIP	An over voltage condition occurred.	
UND V	UNDER VOLTAGE TRIP	An under voltage condition occurred.	
OVER FREQ	OVER FREQUENCY TRIP	An over frequency condition occurred.	
UND FREQ	UNDER FREQUENCY TRIP	An under frequency condition occurred.	
UND PWR	UNDER POWER TRIP	An under power condition occurred.	
PW FCTR	POWER FACTOR TRIP	A power factor alarm condition occurred.	



Table 12.2 Trip Conditions.

Display	Complete Help Message	Probable Cause	Solution
IOC  GND FLT	INSTANTANEOUS OVERCURRENT TRIP  GROUND FAULT TRIP	An electrical fault (short circuit) exists in the insulation of motor or connecting circuits.  <b>NOTE:</b> If a motor trips on IOC at the moment of starting, and an expert has confirmed no fault, the trip may be due to magnetic inrush. Adjust the IOC trip level and start a delay to ride through the inrush peak.	<b>DANGER:</b> Shut down and lock out the motor. Get expert help in evaluating the condition of the motor and repair needs. Do not try to restart the motor without expert evaluation. After or during repair or replacement of the motor, check the fuses in the starter and replace blown fuses.
JAM	LOAD JAM TRIP	A breakage or malfunction in the process driven equipment or drive shaft has occurred.	Lock out the motor starter for safety. Check the process equipment.
UNDER L	UNDER LOAD RUN TRIP	A breakage or malfunction in the process driven equipment or drive shaft has occurred.	Lock out the motor starter for safety. Check shaft couplings, shaft keys for breakage. Look for blockage of process material flow to motor-driven equipment.
MB TEMP LB TEMP WD TEMP AX TEMP	MOTOR BEARING OVER TEMP TRIP LOAD BEARING OVER TEMP TRIP TRIP STATOR WINDING OVER TEMP TRIP AUXILIARY OVER TEMP TRIP	Bearings or the bearing lubrication system has failed. Also, check RTD integrity.  Sustained overloading of the motor or cooling air flow blockage has occurred.	If the RTD is OK, the bearing probably needs replacement.  Check the airflow path. Look for the cause of abnormal loading. Check for abnormal supply voltage.
LRC/I2T	LOCKED ROTOR/ THERMAL OVERLOAD TRIP	The thermal-model bucket has filled to the trip level. <b>NOTE:</b> This trip cannot be reset until the thermal-model bucket has cooled (emptied) below the user-set I2T alarm level. This time depends on motor nameplate values entered as settings.	<ul style="list-style-type: none"> <li>• Determine if the motor is seeing larger than expected sustained loading.</li> <li>• Check for unbalance in supply currents or voltages causing negative sequence heating.</li> <li>• Check for abnormal system voltage level.</li> <li>• Check for cooling air blockage or abnormal ambient.</li> </ul>
INC SEQ	INCOMPLETE SEQUENCE TRIP	Discrete input 2 (DI 2) has been set for the incomplete sequence timing function via setting P7L1. The 120 Vac feedback signal from the process or starter, expected within the user-set time delay, was not received in time after the start or transition. An interruption (of 20 seconds minimum to 40 seconds maximum) causes an incomplete sequence trip.	<ul style="list-style-type: none"> <li>• Check to be sure this function has been intentionally enabled.</li> <li>• Check process feedback wiring to be sure 120 Vac signal is delivered in the expected time.</li> <li>• Use DI 2 test to confirm that the MP-4000 sees an input.</li> <li>• Check setting P5L8 against the process feedback time.</li> <li>• Check setting P5L9 to be sure the correct timing start point is selected - start or transition.</li> <li>• If timing from transition, be sure transition current and time settings are correct.</li> </ul>

Table 12.2 Trip Conditions.

Display	Complete Help Message	Probable Cause	Solution
ZSW TRIP	ZERO SPEED SWITCH INPUT FAILED TO BE FALSE WITHIN 1/2 OF LOCKED ROTOR TIME, OR WAS FALSE AT START	Discrete input 1 has been set for zero speed switch sensing via setting P6L1. The 120 Vac zero speed switch contact input was not present at the moment of the start. Or, it did not go away in one-half of the set locked rotor or stall time P1L3. This may be due to a motor unable to start spinning when it is energized.	<ul style="list-style-type: none"> <li>• Make sure this function has been intentionally enabled.</li> <li>• If ZSW trip occurs at the moment of starting, check process wiring and contacts to be sure a 120 Vac signal is applied to DI 1 when the motor is stopped.</li> <li>• Make sure the motor is not stalled and actually begins to spin.</li> <li>• If a ZSW trip occurs after one-half the locked rotor time setting, check to be sure the contact on the motor opens and the 120 Vac signal goes away before this time. Usually, a zero speed switch should open when the motor has reached 5% to 10% of its normal running speed.</li> <li>• Use the DI 1 test to confirm that the relay sees the expected input voltage.</li> </ul>
REMOTE	REMOTE TRIP	Either or both of discrete input 1 and/or discrete input 2 are set to indicate remote trip contact input. The input configured in this way was energized with 120 Vac.	Determine the source of the remote contact operation requesting the trip.
DIF TRIP	DIFFERENTIAL TRIP	Either or both discrete input 1 and/or discrete input 2 are set to indicate remote trip contact input. The input configured in this way was energized with 120 Vac.	<p><b>DANGER:</b> Shut down and lock out the motor. A differential relay operation indicates an electrical fault. Get expert help in evaluating the condition of motor and repair needs. Do not try to restart the motor without expert evaluation.</p> <p>After or during repair or replacement of the motor, check the fuses in the starter and replace blown fuses.</p>
PH UNBAL	PHASE UNBALANCE TRIP	<ul style="list-style-type: none"> <li>• Source voltage unbalance due to remote fault or single-phase loading.</li> <li>• Single phasing of the motor.</li> </ul>	<ul style="list-style-type: none"> <li>• Check for voltage balance.</li> <li>• Check the integrity of feeder connections.</li> <li>• Check the fuses in the starter.</li> <li>• Do not attempt to restart the motor until the cause of single-phasing is found.</li> </ul>

**Table 12.2 Trip Conditions.**

PH REVRS	PHASE REVERSAL TRIP	<p>At the time of starting, the phase sequence was reversed.</p> <p>The MP-4000 is set for non-reversing starter; the motor is never supposed to run backwards.</p>	<p><b>DANGER:</b> Careless diagnosis and correction could lead to starting the motor in the wrong direction. The causes are:</p> <ul style="list-style-type: none"> <li>• An incoming source has swapped phases. Swap two of the incoming power leads L1, L2, or L3 to correct the condition.</li> <li>• CT wiring has swapped phases. Check the wiring at the CT and relay end. Change the MP-4000 current transformer wiring by swapping the current transformer wiring terminals H1B-H2B with H1C-H2C.</li> <li>• Clearly mark the new wiring, and update the drawings for future reference.</li> <li>• Check the motor for the correct direction of rotation at the moment of starting.</li> </ul>
T BYPASS	TRIP BYPASS	<p>The MP-4000 tripped, yet continued to sense current flowing to the motor for more than a second after the trip.</p>	<ul style="list-style-type: none"> <li>• The contactor or breaker is stuck or jammed.</li> <li>• Or, the trip contact has been bypassed so that the contactor remained energized after the trip.</li> <li>• Immediately open the upstream source breaker or load break switch. Lock out this switch and diagnose the problem or find the bypass in the starter.</li> </ul>
INCOM	INCOM REMOTE TRIP	<p>A remote PowerNet or other data communications host requested a motor trip.</p>	<p>Determine the cause of the remote trip.</p>
STEX MMM	MAX NUMBER OF STARTS PER TIME REACHED, REMAINING MINUTES ACTIVE SHOWN	<p>Too many starts were performed in the user-set period of time.</p>	<p>Wait for the oldest start to clear from the stack. Observe the countdown on the display. Refer to settings P5L1 and P5L2.</p>
STEX X	STARTS PER TIME TRIP (log display only)		
TBS MMM	TIME BETWEEN STARTS TRIP, REMAINING ACTIVE MINUTES SHOWN	<p>Restarting is blocked until the user-set time between starts has expired.</p>	<p>Wait the indicated time before restarting. <b>NOTE:</b> The number of cold starts (NOCS) setting may suppress this blocking during the first 'n' cold starts.</p>

**Table 12.3 Troubleshooting Operator Panel Malfunctioning.**

Symptom	Probable Cause	Solution
All LEDs and displays are off or unintelligible.	Incoming ac deficient.  MP-4000 malfunctioning.	The MP-4000 operates down to 55% of rated voltage, but such a low voltage is not normal and should be diagnosed. Verify that 120 or 240 Vac ( $\pm 15\%$ ) exists between terminals 4 and 7.  Remove ac power completely for 10 seconds and reapply it. If the problem persists, return the MP-4000 to the factory for repair.
OPTO ERR message	An optocoupler failure trip based on bad timing of ac input waveform zero crossings	Check the frequency setting P1L7 for 50 or 60 Hz, as appropriate. Make sure 120 Vac is used for discrete inputs. Energizing with dc causes this error message.

**Table 12.4 Internal Diagnostic Failure Messages.**

Display	Complete Help Message
A/D ERR	A/D CONVERTER ERROR TRIP
RAM ERR	RAM ERROR TRIP
ROM ERR	ROM ERROR TRIP
OPTO ERR	OPTOCOUPLER FAILURE TRIP <sup>1</sup>
ZRAM ERR	NON VOLATILE MEMORY ELEMENT SHOULD BE REPLACED
FLASHERR	FLASH WRITING ERROR

**NOTES:**

1. Refer to Table 12.3 for OPTO ERR.
2. Setting P12L16 permits a choice as to whether these internal failures produce alarm plus trip, or just an alarm.

**SECTION 13 - DRAWOUT CASE OPTION FOR THE MP-4000 MOTOR PROTECTION RELAY**



**COMPLETELY READ AND UNDERSTAND THIS INSTRUCTION MANUAL BEFORE ATTEMPTING INSTALLATION, OPERATION, OR APPLICATION OF THE EQUIPMENT. IN ADDITION, ONLY QUALIFIED PERSONS SHOULD BE PERMITTED TO PERFORM ANY WORK ASSOCIATED WITH THE EQUIPMENT. ANY WIRING INSTRUCTIONS PRESENTED IN THIS DOCUMENT MUST BE FOLLOWED CLOSELY. FAILURE TO DO SO COULD CAUSE PERMANENT EQUIPMENT DAMAGE.**

**13.0 Introduction**

This section describes the Drawout Case option for the MP-4000 Motor Protection Relay.

The basic operation of the MP-4000 relay is applicable to all styles of the drawout case. Table 13.1 lists the Drawout Case versions.

Description	Catalog Number
MP-4000 Drawout Relay, 5 A, No Communications	MP-4011
MP-4000 Drawout Relay, 5 A, Built-in INCOM Communications	MP-4012
MP-4000 Drawout Relay, 5 A, Modbus	MP-4013
MP-4000 Drawout Relay, 5 A, DeviceNet	MP-4014
MP-4000 Drawout Relay, 1 A, No Communications	MP-4111
MP-4000 Drawout Relay, 1 A, built-in INCOM communications	MP-4112
MP-4000 Drawout Relay, 1 A, Modbus	MP-4113
MP-4000 Drawout Relay, 5 A, DeviceNet	MP-4114
MP-4000 Drawout Outer Chassis, for Use with No Communications or INCOM Communications Inner Chassis	MP4X11-OC
MP-4000 Drawout Outer Chassis, for Use with Modbus Communications Inner Chassis	MP4X13-IC
MP-4000 Drawout Outer Chassis, for Use with DeviceNet Communications Inner Chassis	MP4X14-IC

**13.1 General Description**

The Quick Release Drawout Case permits the relay to be removed from service without disconnecting the wires. The MP-4000 Drawout Relay maintains the same electrical and operating specifications as the standard MP-4000. Specifications for the Drawout connectors are shown in Table 13.2.

Description	Value
Make/Break Rating	10 A @ 240 Vac nominal 0.25 A @ 280 Vdc maximum
Terminal Wire Gauge	No. 14 to No. 10 AWG (2.5 mm <sup>2</sup> to 6.0 mm <sup>2</sup> )
Screw Torque Requirements	18 lb-in. (2.0 Nm)

The MP-4000 Drawout consists of two assemblies: an inner chassis, and an outer chassis. The outer chassis consists of an aluminum housing with terminal blocks, a molded plastic flange with quick-release actuators, and a locking mechanism.

The drawout terminal blocks feature self-shorting, or short-before-break set of contacts, for CT connections that maintain circuit continuity when the device is removed. These self-shorting contacts prevent damaging voltages from existing across the current transformer windings.

An extra set of self-shorting terminals can be used to keep the motor running while the relay is out of its case, or to provide a No Protection Alarm (refer to Subsection 13.4 for more information).

**13.2 Installation**

**NOTICE**

The following material supplements installation information in Subsections 6.0.1 through 6.0.3, and Figures 6.2 and 6.4. Refer to these sections and figures first.

**13.2.1 Panel Preparation**

The Drawout Case uses the same panel cutout as the fixed mount MP-3000, IQ1000II, and IQ1000. When mounting the Drawout Case in a panel, it is necessary to prepare a cutout for the device per Figure 13.1. If a standard IQ cutout exists, no additional panel setup is required. The Drawout mounts securely in an existing 6-hole or 10-hole cutout.

**13.2.2 MP-4000 Drawout Relay Parts List**

Before mounting the Drawout Relay, check the contents of the box against the parts listed in Table 13.3 and shown in Figure 13.2.

Description	Quantity
MP-4000 Drawout Inner Chassis	1
MP-4000 Drawout Outer Case	1
Outer Flange	1
Mounting Hardware – #10-32 nuts and lock washers	6 each
MP-4000 Instruction Book	1

### 13.2.3 Mounting the MP-4000 Drawout Relay

1. Remove the Drawout Inner Chassis from the outer case.
2. Place the outer case flush against the backside of the panel so that the case studs project through their respective holes. Figure 13.2 shows the panel mounting diagram.
3. The plastic outer flange is seated on the front of the panel. It is attached to the top, center, and bottom studs that protrude through the panel with the #10-32 hex nuts and lock washers included with the relay.

NOTE: Use only the supplied narrow-profile nuts. Standard-width 10-32 hex nuts interfere with the insertion of the inner chassis.

4. The relay inner chassis can now be inserted into the case and checked for proper seating into the latching mechanism.

### 13.2.4 Mounting the URTD Module

There are no provisions for mounting the URTD module on the MP-4000 Drawout Case. The URTD module must be mounted remotely from the MP-4000 Drawout Case.

The URTD module has both an electrical and fiber optic communication interface to the MP-4000 relay. The electrical connections are made through the terminal blocks. The fiber optic cable is run through the opening in the back of the outer case and connected directly to the inner chassis before it is fully inserted. Refer to Subsection 13.3.1.

### 13.2.5 Mounting the PONI Communications Module

The MP-4000 Drawout Relay must be ordered with the communications module as it is integral to the inner chassis construction and wired through the terminal connectors.

The communications address is set via switches accessible on the inner chassis.

## 13.3 Wiring and Setup



### WARNING

**ENSURE THAT THE INCOMING AC POWER SOURCES ARE DISCONNECTED BEFORE PERFORMING ANY WORK ON THE MP-4000 PROTECTIVE RELAY OR ITS ASSOCIATED EQUIPMENT. FAILURE TO OBSERVE THIS PRACTICE COULD RESULT IN SERIOUS INJURY, DEATH, AND/OR EQUIPMENT DAMAGE.**

The following material supplements the information in Subsection 6.1.

Figures 13.3 through 13.9 show the typical connection and wiring diagrams for the MP-4000 Drawout. Note the following:

1. Direct wire connections to the terminal blocks must be sizes #14 AWG to #10 AWG (2.5 mm<sup>2</sup> to 6.0 mm<sup>2</sup>). The appropriate sized spade and ring lugs should also be used to accommodate the wires.
2. In each terminal block, wire the lower tier terminals before the upper tier terminals.
3. All contacts are shown in the de-energized position.

NOTE: Each output relay may be configured for Mode 1 or Mode 2 operation. In Mode 2, the relay is energized when control power is applied to the MP-4000. For Mode 2 operation, the contacts are normally in the opposite state from that shown. Refer to Subsection 13.4.

4. The INCOM communications LED can be seen through a hole in the outer case on the left side.

NOTE: All wiring must conform to applicable federal, state, and local codes.

### 13.3.1 Fiber Optic Installation

The URTD fiber optic cable connects directly to the inner chassis. The installation procedure is as follows:

1. Remove the relay inner chassis from the outer case assembly.
2. Route the fiber optic cable through the grommets hole in the back of the outer case (see Figure 13.3).
3. The fiber should be long enough to extend 2 to 3 in. (50.8 to 76.2 mm) out of the front of the case.
4. Carefully hold the fiber to the left inner side of the case and insert the relay inner chassis half-way into the case.
5. Connect the fiber cable to the fiber optic connector on the relay inner chassis. The fiber plug on the cable has a latching mechanism that locks the fiber cable into the fiber outlet.
6. Carefully push the relay inner chassis the rest of the way into the case until the quick-release latches engage.

NOTE: Be careful not to kink or bend the fiber cable when inserting the relay inner chassis.

### 13.3.2 Fiber Cable Disconnection

To remove the relay inner chassis from the case when the fiber cable is used, perform the following procedure:

1. Unlatch the inner chassis from the case and remove it half-way out.
2. Disconnect the fiber cable by squeezing the connector latch and gently pull the fiber plug from the fiber socket.

NOTE: Failure to disconnect the fiber cable from the relay inner chassis may result in damage to the fiber and, possibly, to the fiber socket.

3. Continue to remove the relay inner chassis.

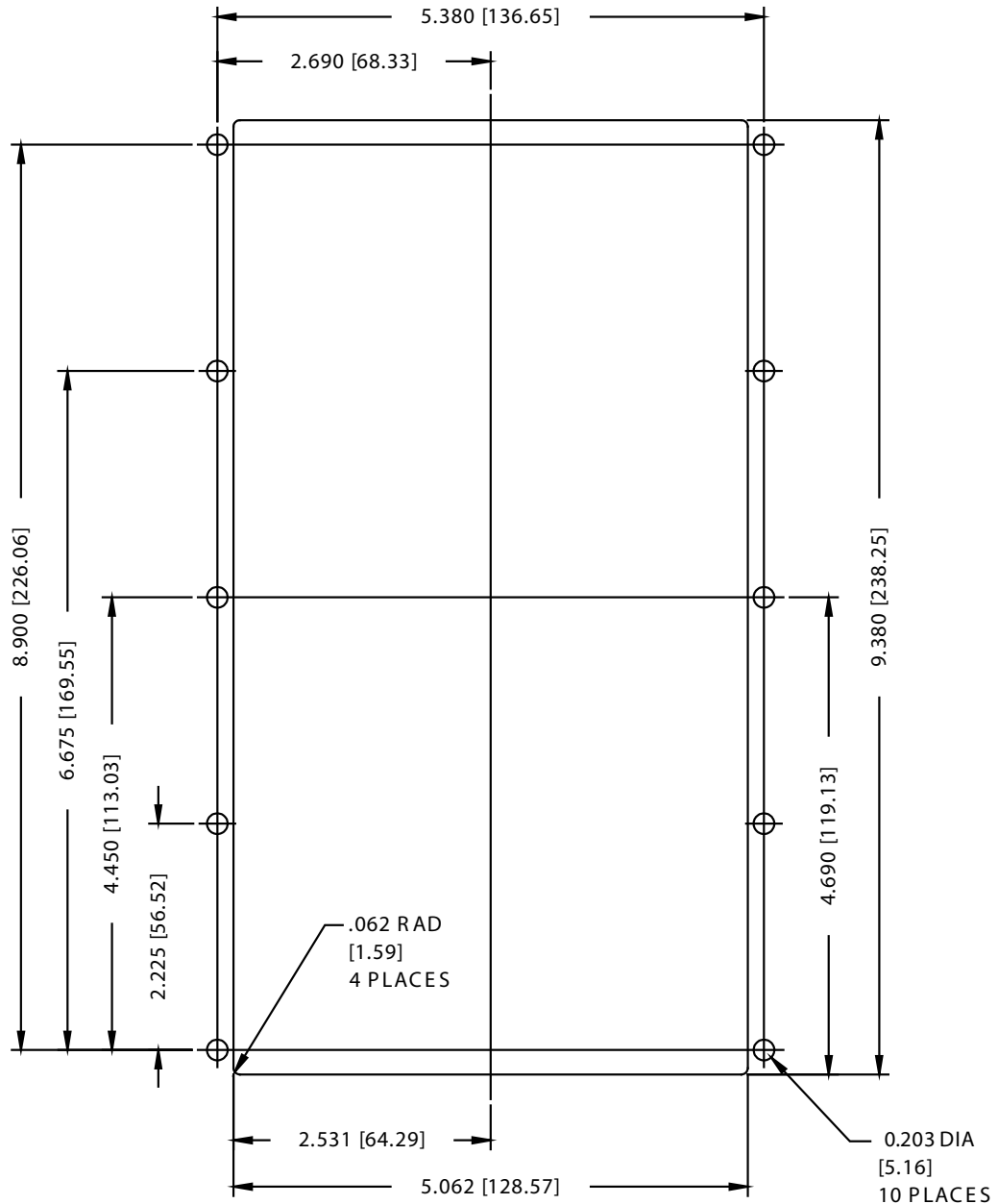
## 13.4 Application Considerations

### 13.4.1 Mode 1 and Mode 2 Output Contacts

The outputs of the MP-4000 relay can be configured in either Mode 1 or Mode 2 operation. Refer to Subsections 5.12.1 and 6.2.3 for more information on the functionality of modes 1 and 2.

### 13.4.2 Continuous Motor Operation

The MP-4000 normally closed trip contact has been provided with a shorting contact to allow for continuous motor operation when the inner chassis is removed. The trip relay must be set for Mode 1 operation (refer to Subsection 5.12.1).



**PANEL CUTOUT**  
 DIMENSIONS IN INCHES [MM]

Figure 13.1 Panel Cutout Dimensions.

When the trip relay is operating in Mode 2, the normally closed contact, which would be open during normal operation in Mode 2, shorts when the inner chassis is removed.

The "relay out of service" alarm available in the MP-3000 is no longer available in the MP-4000.

### 13.4.3 Armed/Disarmed Operation

The ARMED/DISARMED feature is most useful when the relay is fitted in the optional drawout case. This feature blocks operation of the trip output contacts, but not the protection displays. This permits the insertion of the relay without risk of tripping a critical motor due to improper setting. The relay provides a relay alarm and trip status indication. If this occurs upon insertion, the User has the option to review applicable protection settings to verify they are correct. Refer to Subsections 5.12.18 and 9.2.7 for more information on the proper application and considerations of the ARM/DISARM feature.

**NOTE:** The relay must be placed into the ARMED mode before completing the installation. Failure to do so disables the motor protection, and may result in serious motor and equipment damage.

## 13.5 Drawout Operation

### 13.5.1 Inserting the Relay

Before the MP-4000 is inserted into the Drawout Outer Case:

- Verify that all wiring is correct as shown in the wiring diagram.
- Set the INCOM communication device address.
- If the URTD fiber optic cable is used, refer to Subsection 13.3.1 for special instructions concerning the proper installation of the fiber.

When inserting the MP-4000 Inner Chassis in the drawout outer case, use the guides to align the exterior of the inner chassis with the interior of the outer case. Slide the unit into the case using the guides, pressing firmly until all four latches on the sides of the device are seated and latched into place. Tabs on the MP-4000 Drawout Inner Chassis prevent the inner chassis from being inserted upside down or being inserted into an outer case of another relay or IQ metering product.

## CAUTION

**THE MP-4000 INNER CHASSIS MUST BE FULLY INSERTED AND FULLY LATCHED INTO ITS DRAWOUT OUTER CASE FOR PROPER OPERATION OF THE DEVICE.**

When the unit is seated properly, the quick release buttons at the top and bottom of the unit return to their non-compressed position. The device can now be secured in the outer case by inserting a locking ring or meter seal in the provided slot.

### 13.5.2 Removing the Relay

## WARNING

**REMOVAL OF THE MP-4000 INNER CHASSIS FROM THE DRAWOUT OUTER CASE EXPOSES LIVE PARTS, WHERE THE HAZARD OF A FATAL ELECTRIC SHOCK IS PRESENT. ALWAYS DISCONNECT ANY CONTROL OR SOURCE POWER BEFORE TOUCHING ANYTHING ON THE INTERNAL OR EXTERNAL PARTS OF THE DRAWOUT OUTER CASE.**

When removing the Inner Chassis from the Drawout Outer Case, first remove any locking ring that has been installed. Press the top and bottom quick release buttons simultaneously, and pull the relay out by its front panel.

**NOTE:** If the URTD fiber cable is used, refer to Subsection 13.3.2 for proper removal of the relay to prevent damage to the fiber optics.

### 13.6 Warranty and Liability Information

NO WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OF MERCHANTABILITY, OR WARRANTIES ARISING FROM COURSE OF DEALING OR USAGE OF TRADE ARE MADE REGARDING THE INFORMATION, RECOMMENDATIONS, AND DESCRIPTIONS CONTAINED HEREIN.

In no event will Eaton Inc. be responsible to the purchaser or User in contract, in tort (including negligence), strict liability, otherwise for any special, indirect, incidental, or consequential damage or loss whatsoever, including but not limited to damage or loss of use of equipment, plant or power system, cost of capital, loss of power, additional expenses in the use of existing power facilities, or claims against the purchaser or User by its customers resulting from the use of the information and descriptions contained herein.

### 13.7 Technical Assistance

For additional information, technical assistance, or referral to a local authorized distributor, contact Power Management Applications Support at 1-800-809-2772, Option 4, or [www.eaton.com](http://www.eaton.com) and follow the power management products link.



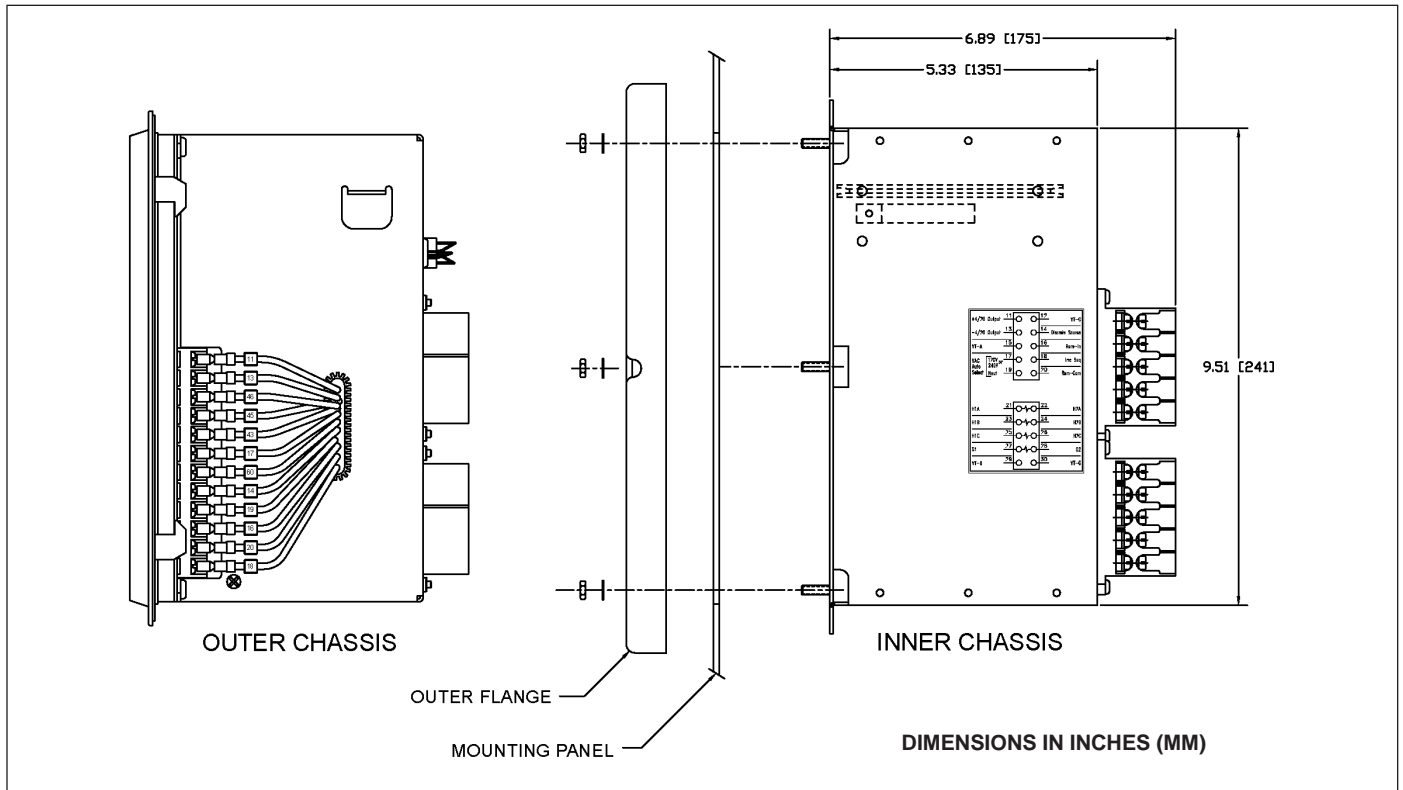


Figure 13.2 MP-4000 Drawout Panel Mounting.

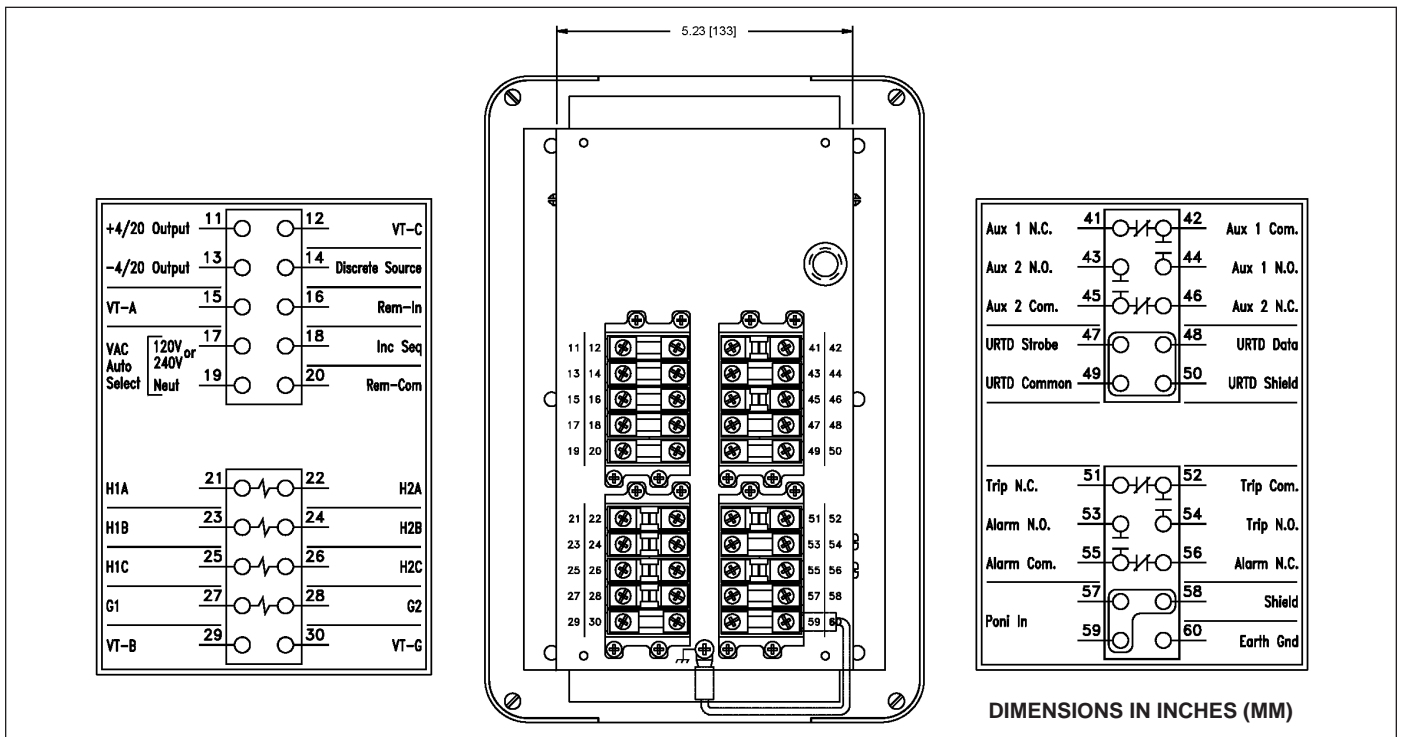
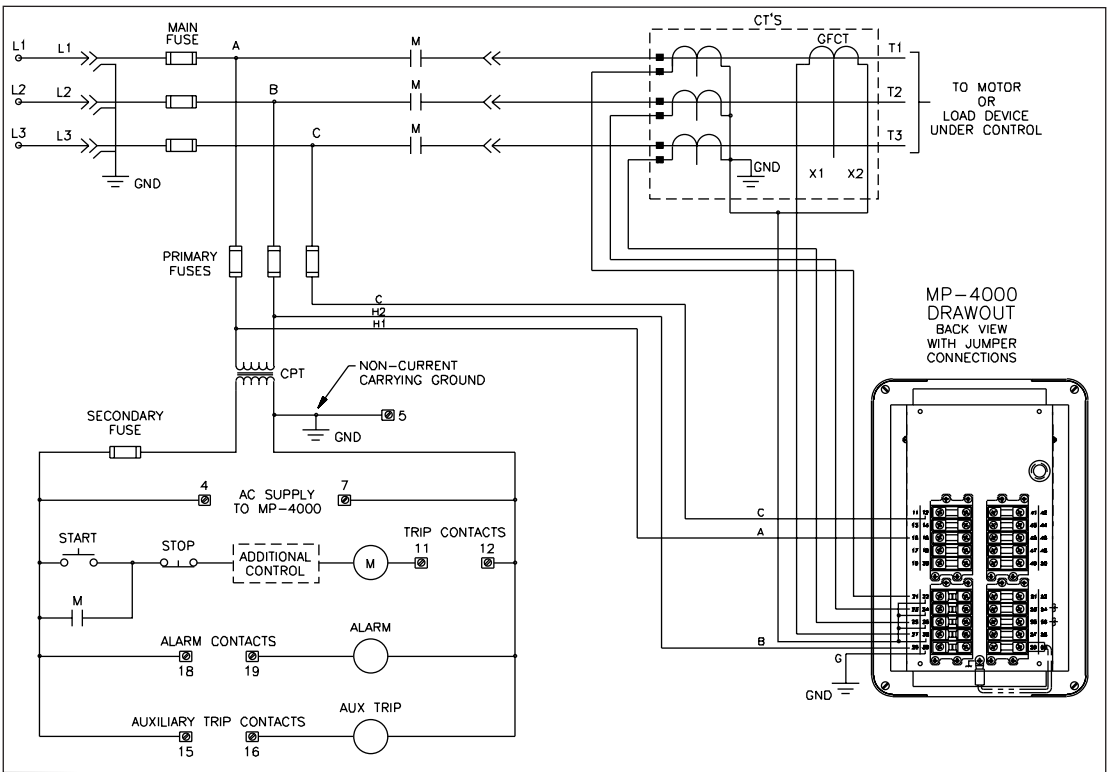
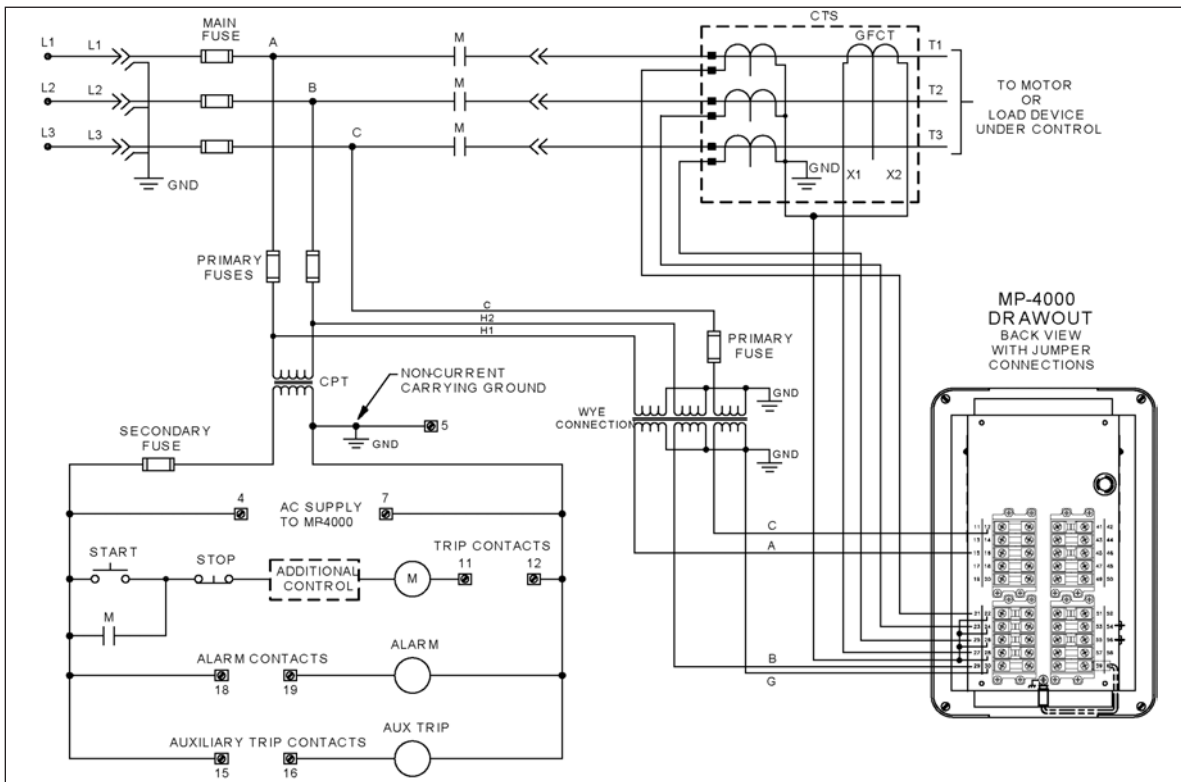


Figure 13.3 Rear View of MP-4000 Drawout Outer Case.



**Figure 13.4 MP-4000 Drawout Typical Circuits and Motor Control Wiring (Direct Connect).**  
Note: Voltage Inputs Are 120 Vac Nominal, Limited to 150 Vac.



**Figure 13.5 MP-4000 Drawout Typical CT Circuits and Motor Control Wiring (Wye-Wye).**

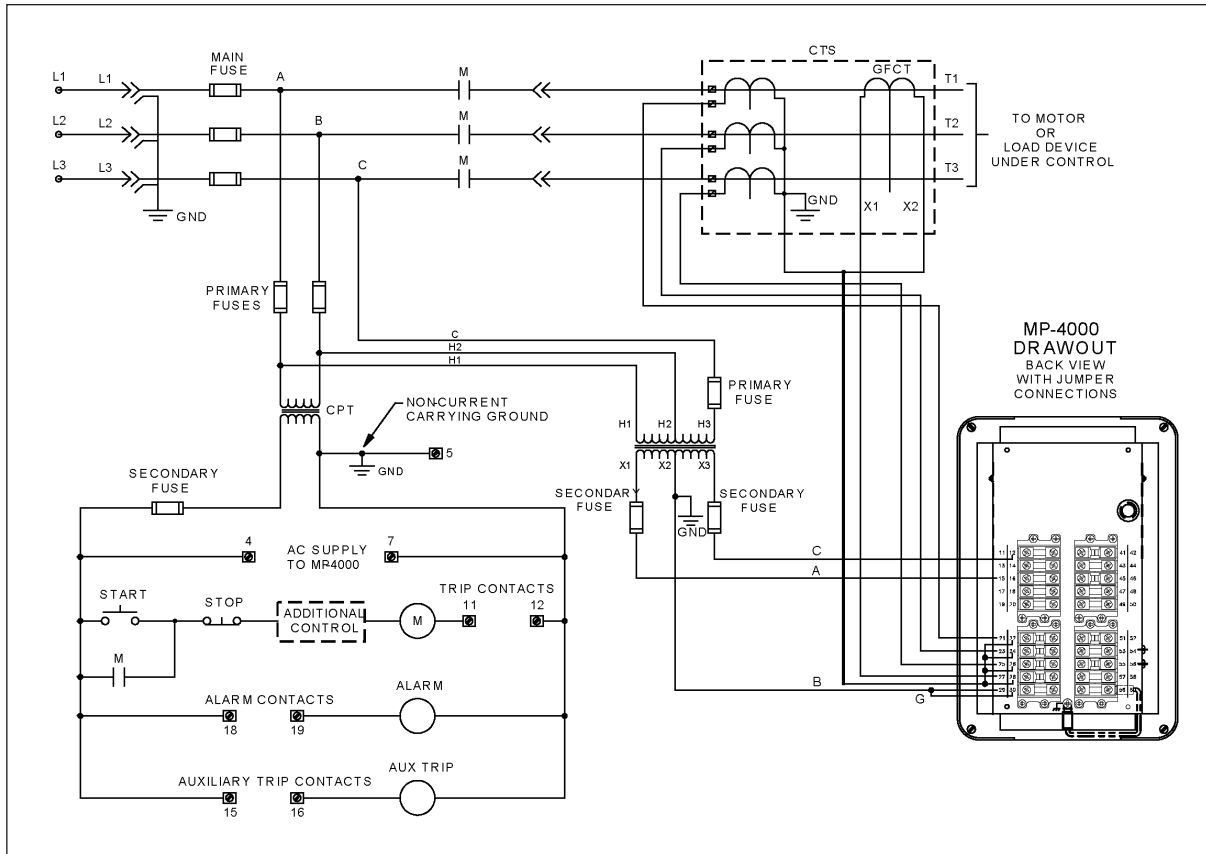


Figure 13.6 MP-4000 Drawout Typical CT Circuits and Motor Control Wiring (Open Delta).

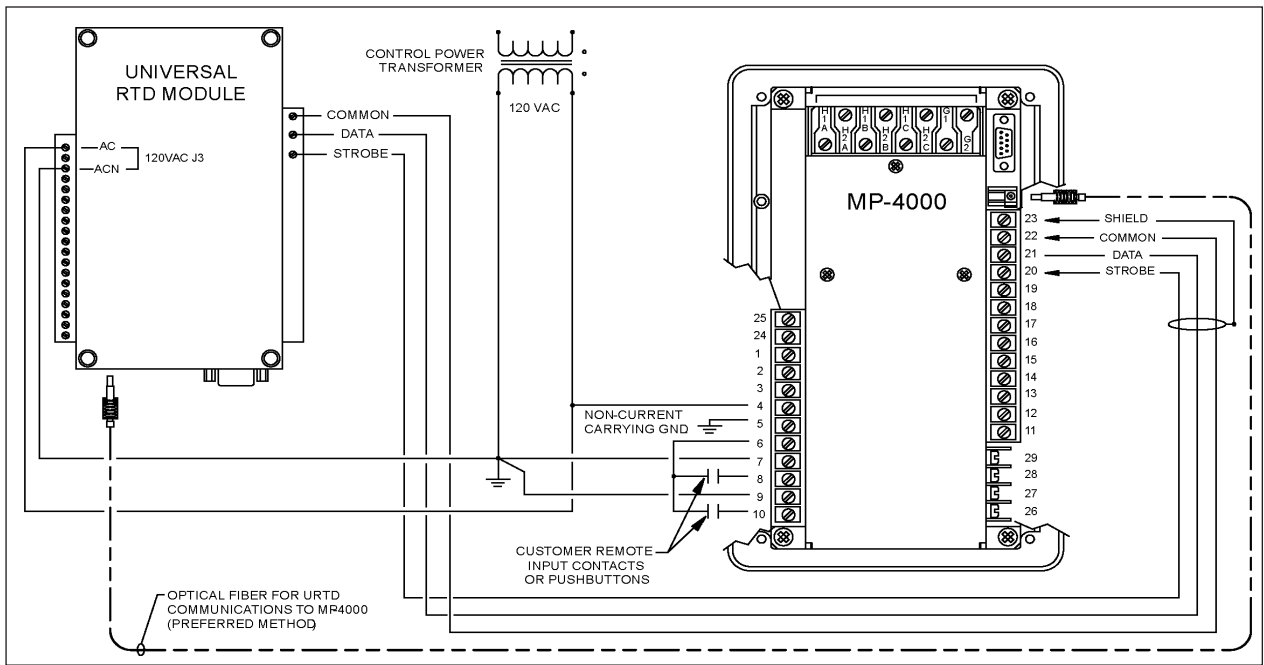


Figure 13.7 MP-4000 Drawout Typical AC Supply and URTD Wiring.

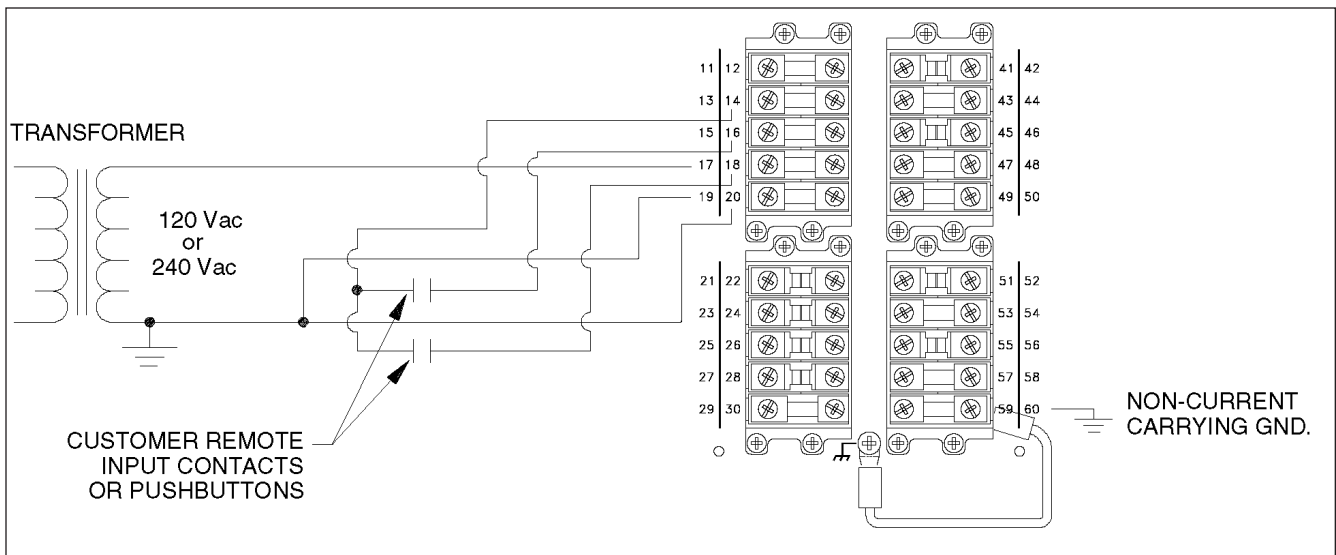


Figure 13.8 MP-4000 Drawout Alternatives for Discrete Input Wiring.

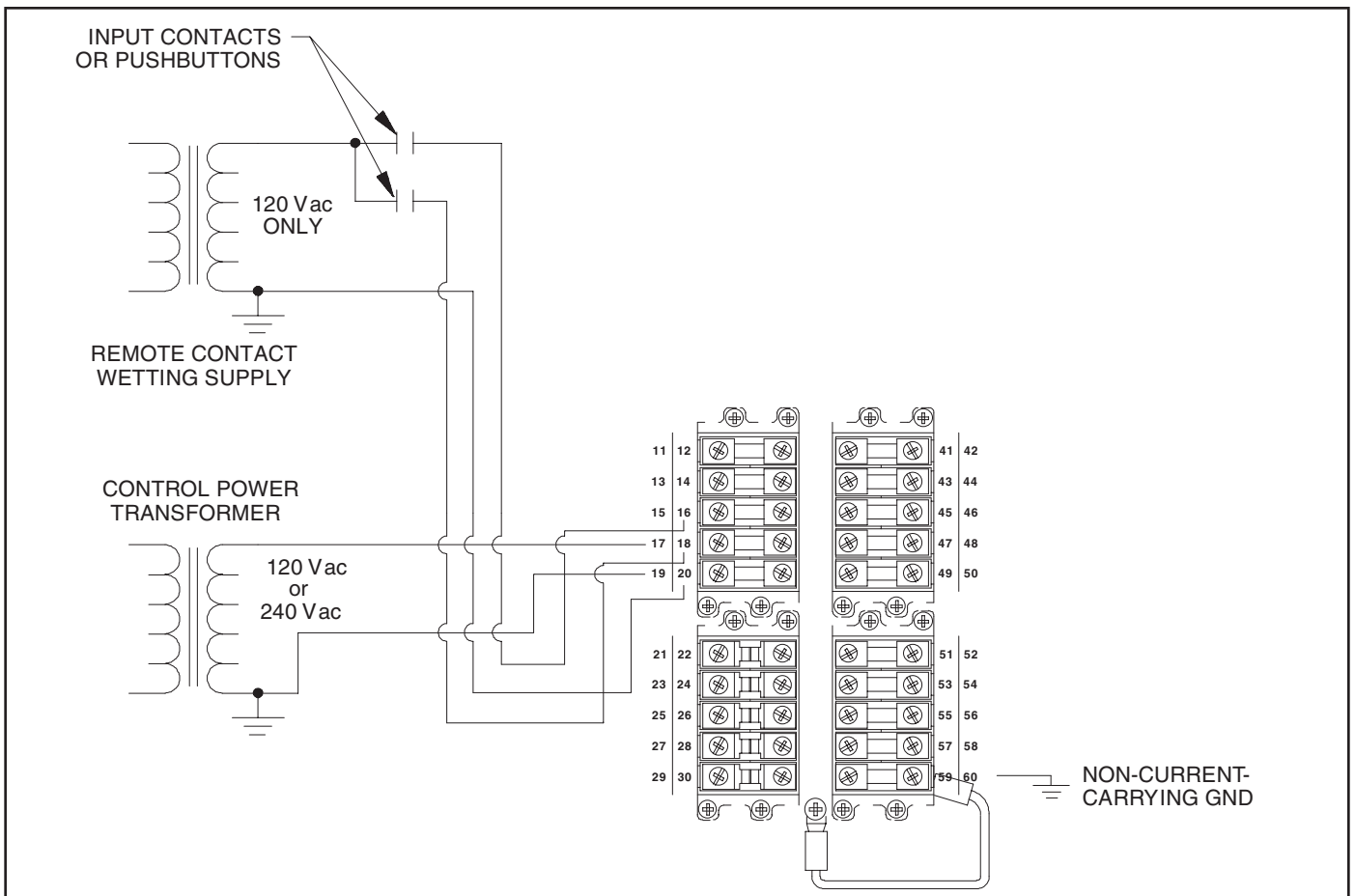


Figure 13.9 MP-4000 Drawout Alternatives for Discrete Input Wiring.

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## Contact Information

Power Quality Technical Support (PQTS) at  
1-800-809-2772, Option 4.

Fax: 1-412-494-3721

E-mail: [PQSUPPORT@EATON.COM](mailto:PQSUPPORT@EATON.COM), or

Internet: [www.eaton.com](http://www.eaton.com) and follow the power  
management products link.

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