GE Industrial Systems

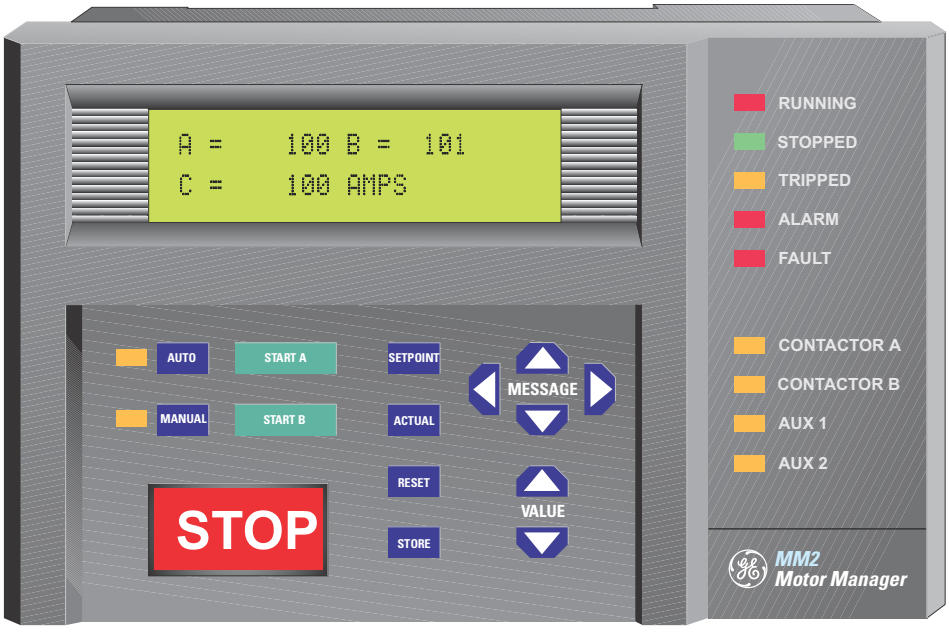
MM2

MOTOR MANAGER 2®
Instruction Manual

MM2 Firmware Revision: 5.2x
MM2 Software Revision: 5.2x or newer

Manual P/N: 1601-0056-DV (GEK-106294G)

Copyright © 2014 GE Multilin



GE Digital Energy
650 Markland Street
Markham, Ontario
Canada L6C 0M1
Tel: +1 905 927 7070 Fax: +1 905 927 5098
Internet: http://www.gedigitalenergy.com

E83849
LISTED
IND.CONT. EQ.
52TL

GE Multilin's Quality Management System is registered to ISO9001:2000

QMI # 005094
UL # A3775

TABLE OF CONTENTS

1. INTRODUCTION

1.1 OVERVIEW
1.1.1 DESCRIPTION 1-1
1.1.2 FEATURES 1-1

1.2 ORDERING
1.2.1 ORDER CODES 1-2
a MOUNTING 1-2
b OPTION 1 1-2
c OPTION 2 1-2
1.2.2 ACCESSORIES 1-3
1.2.3 SPECIAL ORDER 1-3

1.3 SPECIFICATIONS
1.3.1 MM2 SPECIFICATIONS 1-4

2. INSTALLATION

2.1 MOUNTING
2.1.1 DESCRIPTION 2-1

2.2 INPUTS AND OUTPUTS
2.2.1 PHASE CT INPUTS 2-5
2.2.2 GROUND FAULT CT INPUT 2-5
2.2.3 SUPPLY VOLTAGE 2-5
2.2.4 GROUND SURGE 2-5
2.2.5 EXTERNAL CONNECTIONS 2-5
2.2.6 THERMISTOR INPUT 2-6
2.2.7 ANALOG INPUT 2-6
2.2.8 AUX 2 COIL 2-6
2.2.9 OUTPUT RELAYS 2-6
2.2.10 SWITCH INPUTS 2-6
2.2.11 PROGRAMMABLE SWITCH INPUTS 2-6
2.2.12 SERIAL COMMUNICATION PORT 2-7
2.2.13 STOP 2-7
2.2.14 START A / START B 2-8
2.2.15 LOCAL ISOLATOR N/O 2-8
2.2.16 CONTACTOR STATUS 2-8
2.2.17 SWITCH COMMON 2-8
2.2.18 DIELECTRIC STRENGTH TESTING 2-8

3. HARDWARE

3.1 FACEPLATE FUNCTIONS
3.1.1 DESCRIPTION 3-1
3.1.2 MESSAGE DISPLAY 3-1
3.1.3 INDICATOR LEDs 3-2

3.2 KEYPAD
3.2.1 SETPOINTS KEY 3-3
3.2.2 ACTUAL VALUES KEY 3-3
3.2.3 STORE KEY 3-4
3.2.4 STOP KEY 3-4
3.2.5 RESET KEY 3-4
3.2.6 START A KEY 3-4
3.2.7 START B KEY 3-5
3.2.8 MESSAGE UP/DOWN KEYS 3-5
3.2.9 MESSAGE LEFT/RIGHT KEYS 3-5
3.2.10 VALUE UP/DOWN KEYS 3-5

3.3 THEORY OF OPERATION

3.3.1 HARDWARE DESCRIPTION 3-6

4. SETPOINTS

4.1 OVERVIEW

4.1.1 DESCRIPTION 4-1
4.1.2 ABBREVIATIONS 4-1

4.2 S1 CONFIGURATION

4.2.1 DESCRIPTION 4-3
4.2.2 MOTOR IDENTIFICATION 4-3
4.2.3 STARTER 4-4
4.2.4 CT / VT INPUTS 4-6
4.2.5 THERMISTOR 4-7
4.2.6 FAULT MODE 4-7
4.2.7 STATISTICS 4-8
4.2.8 PROGRAMMABLE MESSAGE 4-8
4.2.9 PREFERENCES 4-8

4.3 S2 PROTECTION

4.3.1 DESCRIPTION 4-9
4.3.2 STANDARD OVERLOAD CURVES 4-9
4.3.3 NEMA COMPATIBLE OVERLOAD CURVES 4-11
4.3.4 MOTOR PROTECTION – THERMAL 4-13
4.3.5 MOTOR PROTECTION – GROUND FAULT 4-14
4.3.6 MOTOR PROTECTION – OPTIONS 4-16
4.3.7 LOAD PROTECTION 4-18
4.3.8 UNDER/OVERVOLTAGE PROTECTION 4-20

4.4 S3 PROCESS

4.4.1 DESCRIPTION 4-21
4.4.2 PROGRAMMABLE INPUTS 4-21
4.4.3 INTERLOCK NAMES 4-26
4.4.4 STOP CONFIGURATION 4-26
4.4.5 ANALOG INPUT 4-27

4.5 S4 CONTROL

4.5.1 DESCRIPTION 4-29
4.5.2 UNDERVOLTAGE AUTORESTART 4-29
4.5.3 AUX RELAY 1/2 CONFIG 4-30

4.6 S5 MONITORING

4.6.1 DESCRIPTION 4-33
4.6.2 PLANT CONDITION 4-33
4.6.3 PRESET COUNTERS AND TIMERS 4-34

4.7 S6 FACTORY DATA

4.7.1 DESCRIPTION 4-35
4.7.2 PRODUCT FIRMWARE 4-35
4.7.3 PRODUCT MODEL IDENTIFICATION 4-35
4.7.4 FACTORY SERVICE DATA 4-35

5. COMMUNICATIONS

5.1 MM2 MODBUS PROTOCOL

5.1.1 OVERVIEW 5-1
5.1.2 ELECTRICAL INTERFACE 5-1
5.1.3 DATA FRAME FORMAT AND DATA RATE 5-1

5.1.4 DATA PACKET FORMAT 5-2
5.1.5 ERROR CHECKING 5-2
5.1.6 CRC-16 ALGORITHM 5-3
5.1.7 TIMING 5-4
5.1.8 MM2 SUPPORTED FUNCTIONS 5-4

5.2 MODBUS FUNCTIONS

5.2.1 FUNCTION CODE 01H 5-5
5.2.2 FUNCTION CODE 03H 5-6
5.2.3 FUNCTION CODE 04H 5-7
5.2.4 FUNCTION CODE 05H 5-8
5.2.5 FUNCTION CODE 06H 5-9
5.2.6 FUNCTION CODE 07H 5-10
5.2.7 FUNCTION CODE 08H 5-11
5.2.8 FUNCTION CODE 10H 5-12

5.3 ERROR RESPONSES

5.3.1 DESCRIPTION 5-13

5.4 APPLICATIONS

5.4.1 PERFORMING COMMANDS USING FUNCTION CODE 10H 5-14
5.4.2 STORING COMM ADDRESS VIA BROADCAST COMMAND 5-15
5.4.3 USING THE USER DEFINABLE MEMORY MAP 5-16
5.4.4 USER DEFINABLE MEMORY MAP DEFAULT VALUES 5-17

5.5 MEMORY MAP

5.5.1 DESCRIPTION 5-19
5.5.2 MEMORY MAP TABLE 5-20

5.6 DATA FORMATS

5.6.1 DATA FORMATS TABLE 5-41

6. ACTUAL VALUES

6.1 OVERVIEW

6.1.1 DESCRIPTION 6-1
6.1.2 DEFAULT MESSAGE SELECTION 6-1
6.1.3 ABBREVIATIONS 6-2

6.2 A1 DATA

6.2.1 DESCRIPTION 6-3
6.2.2 MOTOR DATA 6-3
6.2.3 PROCESS DATA 6-4
6.2.4 PROGRAMMABLE MESSAGE 6-4

6.3 A2 STATUS

6.3.1 DESCRIPTION 6-5
6.3.2 TRIP DATA 6-5
6.3.3 ALARM DATA 6-6
6.3.4 MOTOR STATUS 6-8

6.4 A3 INPUTS

6.4.1 DESCRIPTION 6-9
6.4.2 INPUT CONTACTS STATUS 6-9

6.5 A4 STATISTICS

6.5.1 DESCRIPTION 6-11
6.5.2 TIMERS 6-11
6.5.3 COUNTERS 6-11

7. TESTING

7.1 INJECTION TESTING
7.1.1 PRIMARY INJECTION TESTING 7-1
7.1.2 SECONDARY INJECTION TESTING 7-1

7.2 FUNCTIONAL TESTS
7.2.1 PHASE CURRENT FUNCTIONS 7-3
7.2.2 UNBALANCE EXAMPLES 7-4
a EXAMPLE #1 7-4
b EXAMPLE #2 7-4
7.2.3 GROUND FAULT CURRENT FUNCTIONS 7-5
7.2.4 INPUT FUNCTIONS 7-5
7.2.5 THERMISTOR INPUT TESTS 7-6
7.2.6 POWER FAIL TEST 7-6

8. STARTER TYPES

8.1 FV NON-REVERSING STARTER
8.1.1 DESCRIPTION 8-1
8.1.2 MM2 SEQUENCES 8-1

8.2 FV REVERSING STARTER
8.2.1 DESCRIPTION 8-3
8.2.2 MM2 SEQUENCES 8-4
8.2.3 NOTES 8-4

8.3 TWO SPEED STARTER
8.3.1 DESCRIPTION 8-6
8.3.2 MM2 SEQUENCES 8-7

8.4 SLIP RING STARTER
8.4.1 DESCRIPTION 8-11
8.4.2 MM2 SEQUENCES 8-12

8.5 PRIMARY RESISTANCE STARTER
8.5.1 DESCRIPTION 8-14
8.5.2 MM2 SEQUENCE 8-15

8.6 INVERTER STARTER
8.6.1 DESCRIPTION 8-17
8.6.2 MM2 SEQUENCES 8-18

8.7 AUTOTRANSFORMER OPEN TRANSITION STARTER
8.7.1 DESCRIPTION 8-20
8.7.2 MM2 SEQUENCES 8-21

8.8 AUTOTRANSFORMER CLOSED TRANSITION STARTER
8.8.1 DESCRIPTION 8-24
8.8.2 MM2 SEQUENCES 8-25

8.9 PART WINDING STARTER
8.9.1 DESCRIPTION 8-28
8.9.2 MM2 SEQUENCE 8-28

8.10 WYE-DELTA OPEN TRANSITION STARTER
8.10.1 DESCRIPTION 8-29
8.10.2 MM2 SEQUENCES 8-30

8.11 WYE-DELTA CLOSED TRANSITION STARTER
8.11.1 DESCRIPTION 8-32
8.11.2 MM2 SEQUENCE 8-33

8.12 DUTY/STANDBY STARTER
8.12.1 DESCRIPTION....8-35
8.12.2 MM2 SEQUENCES....8-35
8.12.3 NOTES....8-36

8.13 SOFT STARTER
8.13.1 DESCRIPTION....8-38
8.13.2 MM2 SEQUENCE....8-38

9. MM2PC SOFTWARE

9.1 OVERVIEW
9.1.1 DESCRIPTION....9-1
9.1.2 HARDWARE & SOFTWARE REQUIREMENTS....9-1
9.1.3 CHECKING IF INSTALLATION/UPGRADE IS REQUIRED....9-2

9.2 INSTALLING MM2PC
9.2.1 SOFTWARE INSTALLATION/UPGRADE....9-3

9.3 CONFIGURATION
9.3.1 CONFIGURING MM2PC....9-4
9.3.2 MM2PC PROGRAM MENUS....9-6

9.4 USING MM2PC
9.4.1 SAVING SETPOINTS TO A FILE....9-7
9.4.2 MM2 FIRMWARE UPGRADES....9-8
9.4.3 LOADING SETPOINT FILES....9-9
9.4.4 ENTERING SETPOINTS....9-10
9.4.5 VIEWING ACTUAL VALUES....9-11

9.5 CHASSIS MOUNT UNITS
9.5.1 DESCRIPTION....9-13
9.5.2 SETTING THE BAUD RATE AND PARITY....9-13

10. CONTROL WIRE APPLICATIONS

10.1 TWO WIRE CONTROL
10.1.1 DESCRIPTION....10-1
10.1.2 CONTROL OPERATION....10-1

10.2 HAND/OFF/AUTO CONFIGURATION
10.2.1 2-WIRE HAND / 2-WIRE AUTO....10-3
10.2.2 CONTROL OPERATION....10-3
10.2.3 3-WIRE HAND / 2-WIRE AUTO....10-5
10.2.4 CONTROL OPERATION....10-5
10.2.5 3 WIRE HAND / 3 WIRE AUTO....10-7
10.2.6 CONTROL OPERATION....10-7

10.3 HAND/AUTO CONFIGURATION
10.3.1 3-WIRE HAND / 2-WIRE AUTO....10-9
c CONTROL OPERATION....10-9

A. MM2 COMMISSIONING

A.1 COMMISIONING SUMMARY
A.1.1 DESCRIPTION....A-1

B. DO'S AND DONT'S

B.1 DO'S AND DONT'S

B.1.1 CHECKLIST B-1
- a MM2 GROUNDING B-1
- b GROUNDING OF PHASE AND GROUND CTS B-1
- c RS485 COMMUNICATIONS PORT B-1
- d SWITCH INPUTS B-2
- e THERMISTOR AND ANALOG INPUTS B-2
- f STOP SWITCH INPUT B-2
- g CONTACTOR STATUS FEEDBACK B-2

C. ASYMMETRICAL CURRENT

C.1 ASYMMETRICAL CURRENT

C.1.1 OVERVIEW C-1

D. MM2 FAQ

D.1 MM2 FAQ

D.1.1 QUESTIONS AND ANSWERS D-1

E. CT ISOLATION

E.1 CT ISOLATION

E.1.1 MM2 CT WITHSTAND E-1
E.1.2 CT SIZE AND SATURATION E-1

F. FIGURES AND TABLES

F.1 LISTS

F.1.1 LIST OF FIGURES F-1
F.1.2 LIST OF TABLES F-2

G. MISCELLANEOUS

G.1 EU DECLARATION OF CONFORMITY

G.2 GE MULTILIN WARRANTY

1.1.1 DESCRIPTION

The MM2 combines control functions normally found in a low voltage motor control center (MCC) with motor protection. This compact, microprocessor-based device provides sophisticated control and protective relaying at significant cost savings over an MCC design using discrete devices.

Standard features in every MM2 simplify maintenance and plant expansion. One MM2 is required for every starter unit in the MCC. The contactor can be energized and de-energized using the MM2's direct-wired inputs, or via the serial port. Full Voltage Non-reversing, Full Voltage Reversing, Two Speed, Autotransformer, Inverter, Wye-Delta, Slip Ring, and Part Winding type starters may be completely controlled by the MM2 using the two contactor outputs.

Motor protection is included for the most common causes of failure to prevent costly shutdowns and rewinds. These include 3 phase overload, stalled rotor, ground fault and loss of phase.

A two wire RS485 Modbus protocol communications port is provided for high-speed communications with a complete line-up of MCCs. Any MM2 may be interrogated on demand, to determine both Actual and Setpoint operating parameters. Fast response time to a request for alarm or trip status makes real time control of a complete process possible. Statistical recording of running hours and number of starts and trips assists with predictive maintenance scheduling.

1.1.2 FEATURES

The MM2 has been developed with economy in mind. The customer is able to choose from different options to achieve maximum benefit from the relay when integrated into the process environment.

The basic MM2 comes with 3 phase overload protection (49/51), single phase, 4 control inputs (Start, Stop, Local Isolator, Contactor A status) plus 2 programmable inputs. Depending upon which option is ordered, the following additional features are available:

- 20 × 2 alphanumeric display (Option PD)
- 8 additional programmable inputs (Option 1)
- 2 additional electromechanical relays: Aux Relay 1 and Aux Relay 2 (Option 1)
- 4 to 20 mA process analog input (Option 1)
- programmable undervoltage restart of motors following an undervoltage condition (Option 1)
- diagnostics which includes pretrip data and historical statistics (Option 1)
- 2nd contactor control (wye/delta, two speed, reversing, etc.) which includes all timers, relays and control inputs (Option 2)
- ground fault trips (50G/51G) (Option 2)
- stalled rotor protection (48) (Option 2)
- single voltage input which allows the MM2 to calculate and display kW and kWh (Option 2)
- undercurrent/underpower protection (37) (Option 2)
- thermistor (49) input which accepts PTC and NTC thermistor types (Option 2)
- overvoltage (59) and undervoltage (27) protection (Option 2)

1.2.1 ORDER CODES

NOTE

This instruction manual describes the features of a MM2 with all options included.

Table 1–1: SELECTION GUIDE

	MM2	g	g	g	g	
Base Unit	MM2	|	|	|	|	Product Family
Mounting		PD	|	|	|	Panel Mount with display (only available when **both** options are ordered)
		C	|	|	|	Chassis Mount (Black Box)
Option 1			1	|	|	Option 1: Process control, 10 process inputs, undervoltage autorestart, diagnostics
Option 2				2	|	Option 2: Enhanced protection, power (kW), thermistor, 2nd contactor control, 2 process inputs
Power					120	120 V AC Control Voltage
					240	240 V AC Control Voltage

NOTE

All models contain three phase overload protection (49/51), single phase, 4 control inputs (start, stop, local isolator, contactor A status), plus two programmable inputs and one output relay. The control voltage can be changed in the field.

a) MOUNTING

Chassis Mount: "Black box" version of the MM2 mounted inside the MCC starter.

Panel Mount with Display: Mounted on a panel with a 20 × 2 display, LEDs, and keypad. This feature is only available with both options

b) OPTION 1

Process Control and Process Inputs: Includes 10 programmable switch inputs, 2 extra electromechanical relays (Aux1 and Aux2), and a 4 to 20 mA input.

Undervoltage Auto-Restart: Programmable undervoltage restart following undervoltage condition.

Diagnostics: Alarms, pretrip data, and historical statistics about the motor or drive performance.

c) OPTION 2

2nd Contactor Control: Includes all timers, contactor A and B relays, and 2 programmable switch inputs for two-contactor starter types such as wye/delta, two-speed, and reversing.

Enhanced Protection: Includes ground fault, stalled rotor, and undercurrent protection.

Power (kW): Includes a single VT input allowing for calculation of kW and kWhrs, as well as underpower alarm.

Thermistor: Includes a thermistor input with alarm or trip settings for NTC and PTC type thermistors.

1.2.2 ACCESSORIES

MM2PC Software:	Software package to aid in setting up MM2 operating parameters (free)
RS-232/485:	RS232 to RS485 converter box designed for harsh industrial environments
5A Phase CT:	50,75,100,150,200,250,300,350,400,500,600,750,1000
1A Phase CT:	50,75,100,150,200,250,300,350,400,500,600,750,1000
50:0.025 Ground CT:	For sensitive ground detection on high resistance grounded systems
Collar:	For reduced depth mounting

1.2.3 SPECIAL ORDER

MOD601 – 240 V AC Switch Inputs: Allows use of external 240 V AC supply to power switch inputs.

MOD602 – 24 to 48 V DC Switch Inputs: Allows use of external 24 to 48 V DC supply to power switch inputs.

MOD603 – ESD Relay: Converts AUX Relay 2 into an Emergency Shutdown Relay.

MOD605 – Removable Rear Terminals: Allows terminals 13 to 58 to be unplugged from the MM2.

MOD610 – Conformal: Provides protection in harsh environments.

MOD613 – 240 VAC VT Input: Allows 240 V AC to be applied to the VT input.

MOD614 – 7200 VT Primary Setting: VT PRIMARY setpoint up to 7200 V and Variable Overload Curve setting.

MOD615 – 7200 VT Primary Setting: VT PRIMARY setpoint up to 7200 V and Backspin Timer.

NOTE

Design and specifications are subject to change without notice.

PHASE CURRENT INPUTS

CONVERSION:	true RMS, sample time 1.67ms
RANGE:	0.1 to 8 × **PHASE CT PRIMARY AMPS** setpoint
FULL SCALE:	8 × **PHASE CT PRIMARY AMPS** setpoint
ACCURACY:	±0.1 A or ±2% of **PHASE CT PRIMARY AMPS** setpoint or ±2% of reading, whichever is greater

GROUND FAULT CURRENT INPUT

CONVERSION:	true RMS, sample time 1.67 ms
RANGE:	0.1 to 1.0 × **G/F CT PRIMARY AMPS** setpoint (for 5 A secondary CT) 0.5 to 15.0 A (for 50:0.025 CT)
FULL SCALE:	1.5 × **G/F CT PRIMARY AMPS** setpoint (for 5 A secondary CT) 15 A (for 50:0.025 CT)
ACCURACY:	for 5A CT: ±0.1 A or ±2% of full scale (5A CT) whichever is greater for 50:0.025 CT: ±0.20 A (0.5 to 15.00 A)

VOLTAGE INPUT / POWER READING

CONVERSION:	true RMS, sample time 1.67ms
VOLTAGE FULL SCALE:	1.5 × VT Primary
VOLTAGE ACCURACY:	±2% of VT Primary or ±2% of reading, whichever is greater
POWER ACCURACY:	±5% of nominal or ±5% of reading, whichever is greater
INPUT VOLTAGE:	Nominal: 120 V AC or 110 V AC Maximum: 150 V AC
VT BURDEN:	0.01 VA

OVERLOAD CURVES

TRIP TIME ACCURACY:	±200 ms up to 10 seconds ±2% of trip time over 10 seconds
DETECTION LEVEL:	±0.1 A or ± 2% of primary CT amps, whichever is greater

GROUND FAULT TRIP TIME

ACCURACY:	–0 ms / +50 ms, 0.0 = less than 50 ms

ACCELERATION TIME

RANGE:	0.5 to 125 seconds or OFF
ACCURACY:	±0.5 seconds

SINGLE PHASE

RANGE:	greater than 30% U/B
ACCURACY:	± 2 percentage points
TRIP DELAY:	5 seconds ± 1 second
CALCULATION METHOD:	if $I_{AV} \geq I_{FLC}$: $UB\% = \frac{\lvert I_M - I_{AV} \rvert}{I_{AV}} \times 100\%$ if $I_{AV} < I_{FLC}$: $UB\% = \frac{\lvert I_M - I_{AV} \rvert}{I_{FLC}} \times 100\%$

where I_{AV} = average phase current
I_M = current in a phase with maximum deviation from I_{AV}
I_{FLC} = **MOTOR FULL LOAD CURRENT** setpoint

THERMAL COOLING TIMES

RANGE: 5 to 1080 min. when motor is stopped;
50% of motor stopped value when motor is running.

ACCURACY: ± 1 minute

UNDERCURRENT

RANGE: 10 to 100% × motor FLC or OFF

DELAY RANGE: 1 to 60 seconds

ACCURACY: ±1 second

STALLED ROTOR

RANGE: 1.15 to 4.50 × FLC or OFF

DELAY RANGE: 0.5 to 5 seconds

ACCURACY: ±0.5 second

THERMISTOR INPUTS

SENSOR TYPES: positive temperature coefficient PTC; R_{HOT} =100 to 30000 Ω
negative temperature coefficient NTC; R_{HOT} =100 to 30000 Ω

DELAY: 1 second

ACCURACY: ±5% or 100 Ω (whichever is greater)

ANALOG INPUT

RANGE: 4 to 20 mA

ACCURACY: ±1% of full scale

ALARM: programmable 4 to 20 mA

TRIP: programmable 4 to 20 mA

COMMUNICATIONS

TYPE: RS485 2 wire, half duplex

BAUD RATE: 1200 to 19200 baud

PROTOCOL: Modbus RTU

FUNCTIONS: Read/write setpoints, Read coil status, Read actual values, Read device status, Execute commands, Loopback Test

MM2 CONTACTOR A & B AND AUX 2 OUTPUT RELAY CONTACTS

VOLTAGE		BREAK	MAKE/CARRY CONTINUOUS	MAKE/CARRY 0.2 seconds
RESISTIVE	30 V DC	10 A	10 A	30 A
	125 V DC	0.5 A		
	250 V DC	0.3 A		
INDUCTIVE (L/R = 7 ms)	30 V DC	5 A		
	125 V DC	0.25 A		
	250 V DC	0.15 A		
RESISTIVE	120 V AC	10 A		
	240 V AC			
INDUCTIVE (PF = 0.4)	120 V AC	10 A		
	225 V AC	8 A		

CONFIGURATION: CONTACTOR A AND B: Form A
AUX RELAY 2: Form C
CONTACT MATERIAL: Silver Alloy (AgCdO)
MAX. OPERATING VOLTAGE: 280 V AC, 250 V DC
MAXIMUM PERMISSIBLE LOAD: 5 V DC, 100 mA

MM2 AUX 1 OUTPUT RELAY CONTACTS

VOLTAGE		BREAK	MAKE/CARRY CONTINUOUS	MAKE/CARRY 0.2 seconds
RESISTIVE	30 V DC	5 A	5 A	15 A
	125 V DC	0.25 A		
INDUCTIVE (L/R = 7 ms)	30 V DC	2.5 A		
	125 V DC	0.1 A		
RESISTIVE	120 V AC	5 A		
	240 V AC			
INDUCTIVE (PF = 0.4)	120 V AC	5 A		
	225 V AC	3 A		

CONFIGURATION: Dual Form C
CONTACT MATERIAL: Silver Alloy (AgCdO)
MAX. OPERATING VOLTAGE: 280 V AC, 125 V DC

UNDERVOLTAGE – SUPPLY VOLTAGE

UNDERVOLTAGE: 65% of nominal (120 V AC or 240 V AC);
Immediate restart for maximum dip time of 0.1 to 0.5 seconds or OFF;
Delayed restart for maximum dip time of 0.1 to 10.0 seconds or UNLIMITED time
DELAY RESTART RANGE: 0.2 to 300 seconds
DELAY RESTART ACCURACY: ±0.2 seconds

CT BURDEN

CT INPUT	CURRENT	BURDEN	
		VA	OHMS
1 A PHASE CT	1 A	0.009	0.01
	5 A	0.2	
	20 A	3.5	
5 A PHASE CT	5 A	0.04	0.002
	25 A	0.9	
	100 A	16	
5 A GROUND CT	5 A	0.04	0.002
	25 A	1.1	
	100 A	17	
50:0.025 GROUND CT	0.025 A	0.07	116
	0.1 A	1.19	119
	0.5 A	30.5	122

CT WITHSTAND (1 A / 5 A PHASE CTs; 5 A GROUND CT)

CT INPUT	1 SEC	5 SEC	CONTINUOUS
1 A PHASE CT	100 × CT	40 × CT	3 × CT
5 A PHASE CT			
5 A GROUND CT			

CT WITHSTAND (50:0.025 A GROUND CT)

CONTINUOUS: 150 mA

MAXIMUM: 12 A for 3 cycles

SUPPLY VOLTAGE

AC NOMINAL: 120 V AC, range 80 to 135 V AC
240 V AC, range 150 to 250 V AC

FREQUENCY: 50/60 Hz

POWER CONSUMPTION: Maximum: 27 VA (19 W), Nominal: 18.5 VA (12.5 W)

TYPE TESTS

TRANSIENTS: ANSI/IEEE C37.90.1 Oscillatory/Fast Risetime Transients
IEC 61000-4-4/IEC 60255-22-4 Electrical Fast Transient/Burst Requirements

IMPULSE: IEC 60255-5 5 kV Impulse Voltage Test

RFI: 150 MHz, 450 MHz 5 W Handheld Transmitter at 25 cm

STATIC: IEC 61000-4-2/IEC 60255-22-2 Electrostatic Discharge

HI-POT: 1500 V, 1 minute; all inputs > 30 V

PRODUCTION TESTS

DIELECTRIC STRENGTH: 2200 VAC for 1 second (as per UL & CE)

ENVIRONMENT/GENERAL INFORMATION

POLLUTION DEGREE:	2
OVERVOLTAGE CATAGORY:	2
INSULATION VOLTAGE:	300 V
OPERATING TEMPERATURE RANGE:	0°C to 60°C
DUST & MOISTURE RATING:	NEMA Type 12 and 12K
IP CLASS:	IEC 529 - IP53

WEIGHT

MAX WEIGHT:	4 lbs. (1.8 kg)
SHIPPING BOX SIZE:	8.30” (211 mm) × 5.625” (143 mm) × 5.80” (147 mm)

FUSE TYPE/RATING

0.5 A; 250 V Fast Blow, High breaking capacity

INSTALLATION

WARNING:	HAZARD may result if the product is not used for its intended purpose
VENILATION REQUIREMENTS:	None
CLEANING REQUIREMENTS:	None

CERTIFICATION/COMPLIANCE

CE:	IEC 947-1,IEC 1010-1
UL:	E83849 UL listed for the USA and Canada

NOTE

It is recommended that all MM2 relays are powered up at least once per year to avoid deterioration of electrolytic capacitors in the power supply.

2.1.1 DESCRIPTION

Cut the panel as shown below to mount the MM2. Use either the #8-32 or #6 × ½" mounting screws provided to mount the MM2 to the panel.

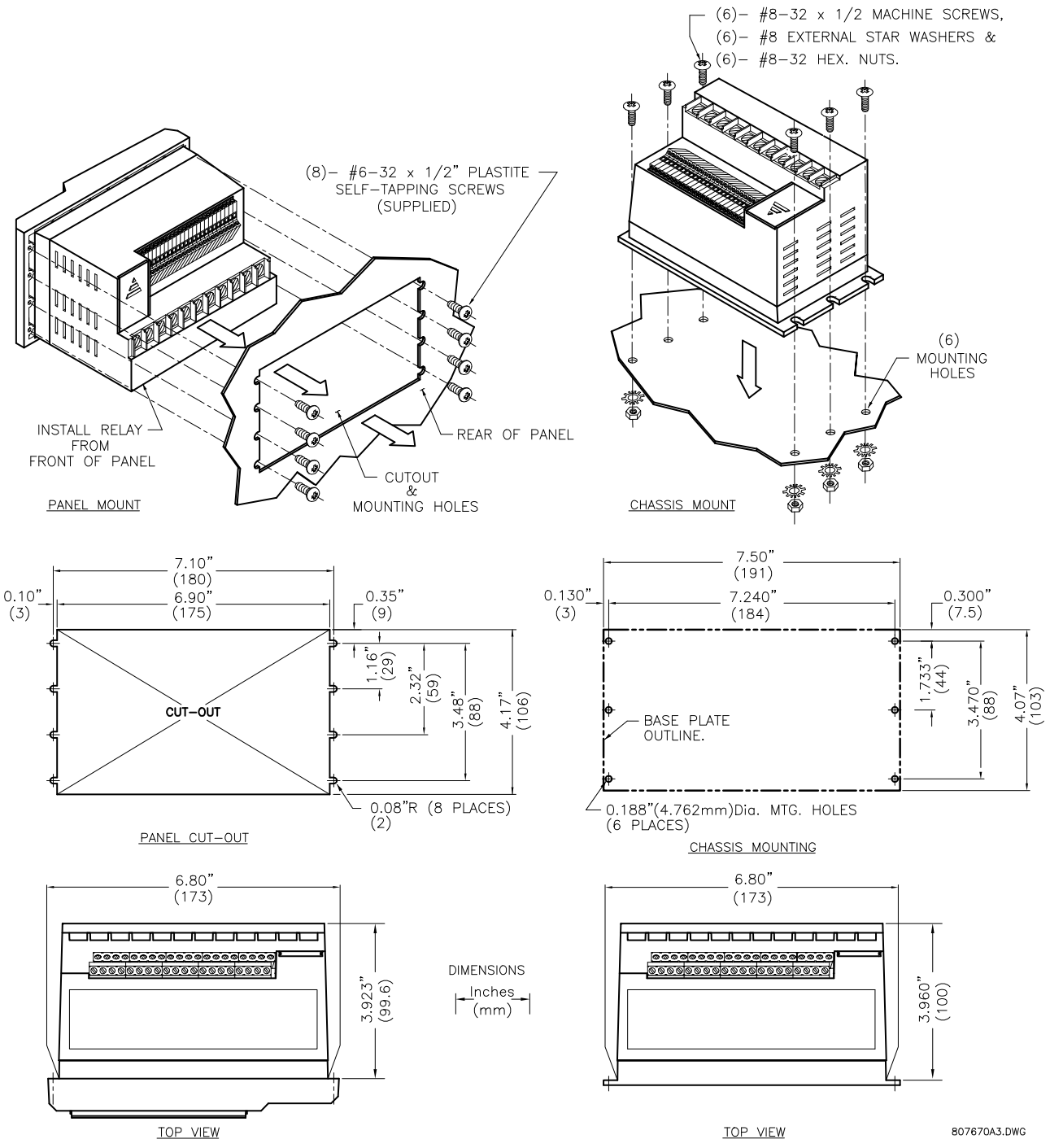


Figure 2–1: MM2 MOUNTING INSTRUCTIONS

The dimensions for the standard MM2 and the MM2 with reduced mounting collar are shown below:

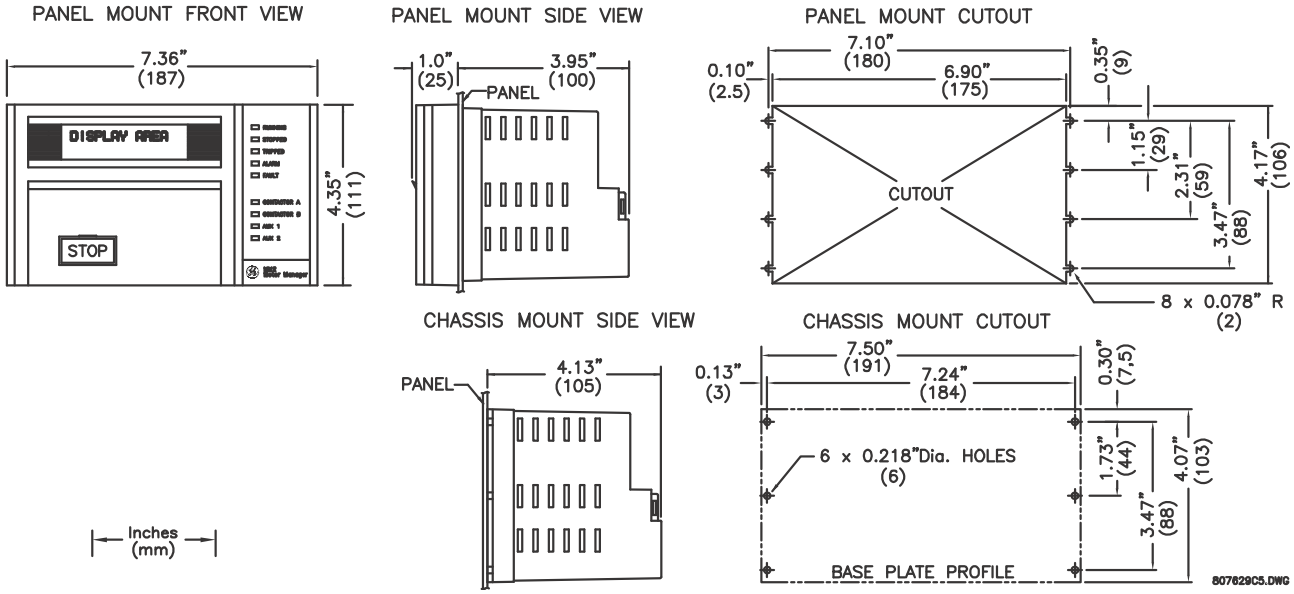


Figure 2–2: MM2 DIMENSIONS

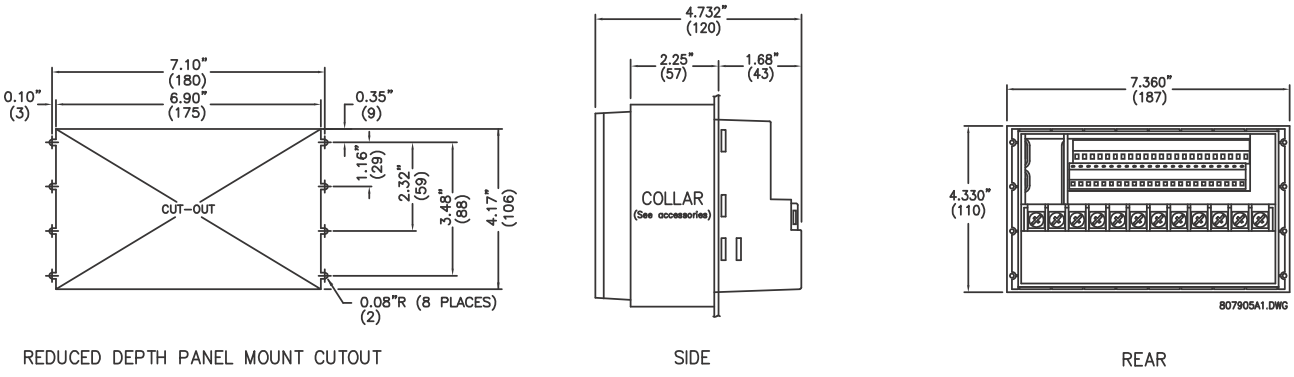


Figure 2–3: MM2 WITH DEPTH REDUCTION COLLAR DIMENSIONS

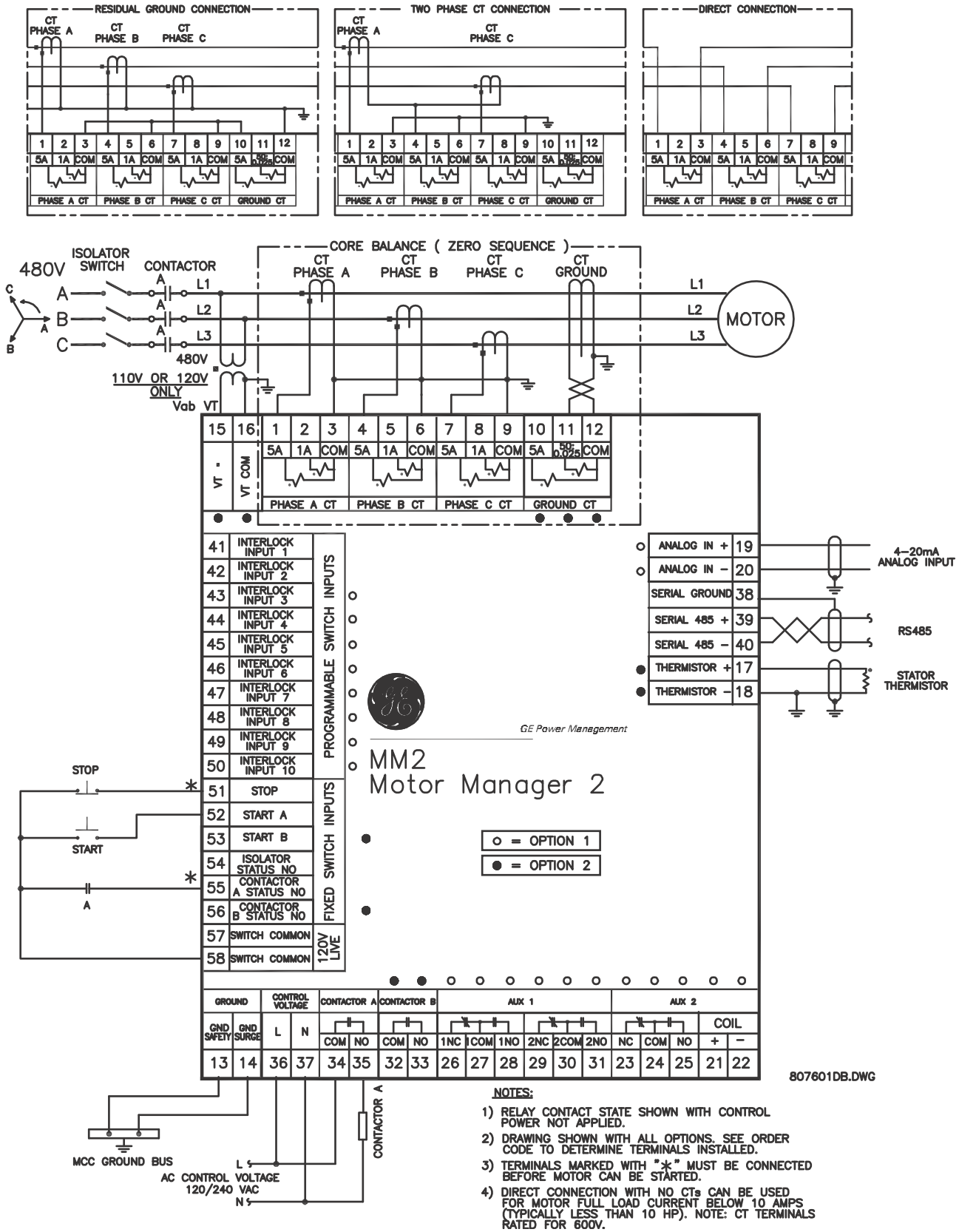


Figure 2–4: TYPICAL WIRING DIAGRAM

2

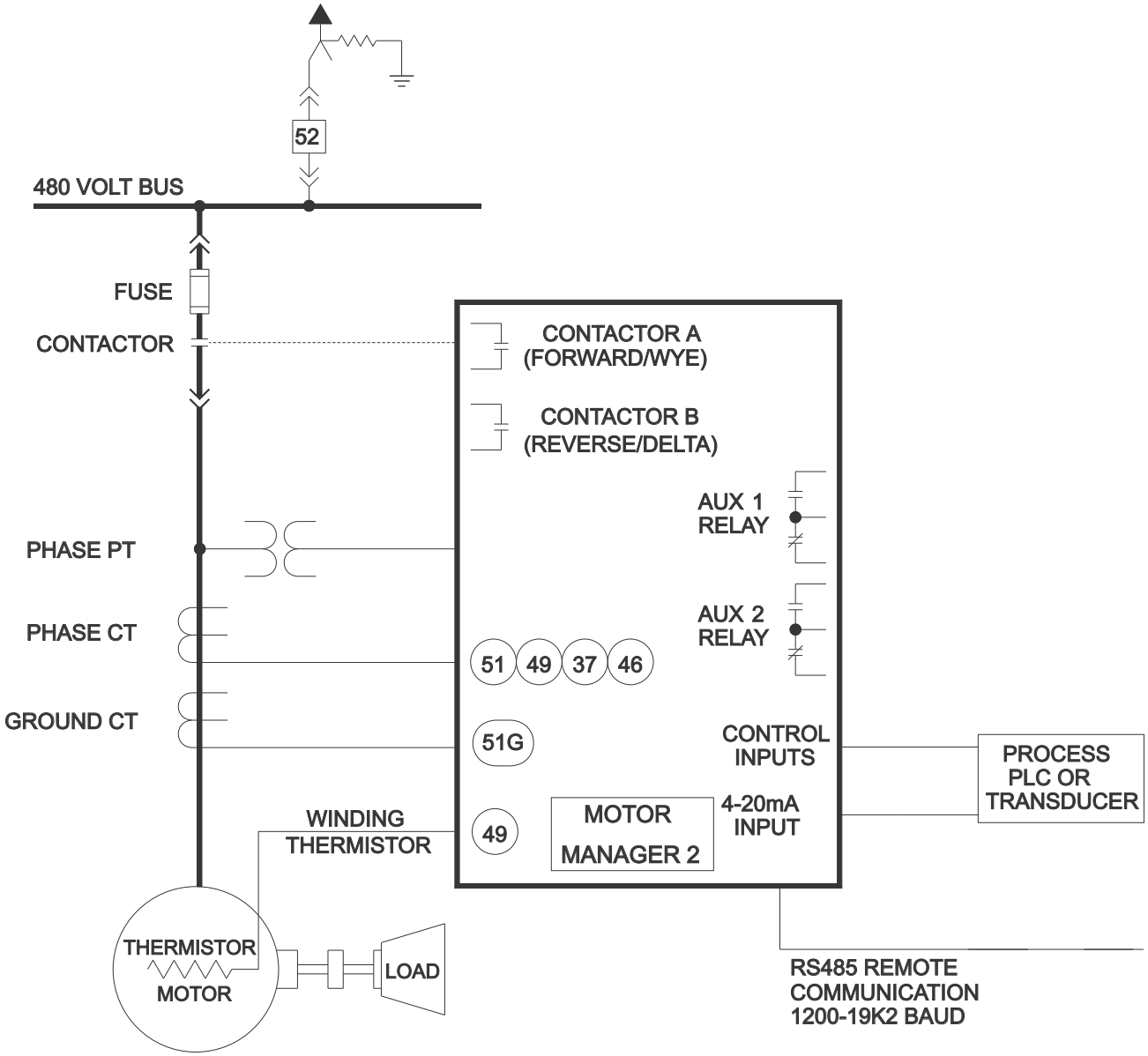


Figure 2–5: MM2 FUNCTIONAL BLOCK DIAGRAM

2.2.1 PHASE CT INPUTS

Both 5 A and 1 A current transformer secondaries are accommodated by the MM2. Each phase current input to the MM2 has 3 terminals: 5 A input, 1 A input, and the common input. For example, if the phase CTs are 200:5, connect phase 1, 2, and 3 CT secondaries to terminals 1/3, 4/6, and 7/9, respectively. For motor full-load currents up to 10 A, the phase conductors can be direct connected to the MM2 with no phase CTs required providing that the voltage at the CT terminals does not exceed 600 V RMS.

CTs should be selected to be capable of supplying the required current to the total secondary load which includes the MM2 relay burden at rated secondary current and the connection wiring burden. The CT must not saturate under maximum current conditions which can be up to 8 times motor full load during starting

2.2.2 GROUND FAULT CT INPUT

The ground CT has a 5 A input, a 50:0.025 input, and a common input. The 5 A input on the ground CT is used for 5 A secondary CTs or for residual connection of phase CTs. Residual ground fault protection provides a sensitivity of 5% of motor Phase CT Primary. The 50:0.025 core balance (zero-sequence) CT input can be used for improved sensitivity when measuring the ground fault current.

NOTE

Care must be taken when turning ON the Ground Fault Trip feature. If the interrupting device (contactor or circuit breaker) is not rated to break ground fault current (low resistance or solidly grounded systems), the feature should be disabled. The 50:025 input is only recommended to be used on resistance grounded systems. Where the system is solidly grounded or high levels of current are to be detected use the 5 A ground input.

2.2.3 SUPPLY VOLTAGE

Supply voltage of 120/240 V AC, 50 or 60 Hz, is required to power the MM2. The label on the back of the unit will specify the voltage which has been internally set inside the MM2. To change the voltage setting, open the sliding door on the back of the MM2 and locate the supply voltage selector slide switch. The selector slide switch has a label affixed to show the 120/240 V AC positions. Set the slide switch to the desired voltage.

2.2.4 GROUND SURGE

This is an additional ground terminal provided for dissipating transient signals and surges. This must be connected by a thick wire or braid to the system ground for reliable operation.

2.2.5 EXTERNAL CONNECTIONS

Signal wiring is to box terminals that can accommodate wire as large as 12 gauge. CT connections are made using #8 screw ring terminals that can accept wire as large as 8 gauge. Consult Figure 2–4: TYPICAL WIRING DIAGRAM on page 2–3. Other features can be wired as required.

Please note that the maximum torque that can be applied to terminals 13 to 58, is 0.5 Nm (4.4 in-lb). The maximum torque for terminals 1 to 12 is 2.0 Nm (17 in-lb).

2.2.6 THERMISTOR INPUT

Either a Positive Temperature Coefficient (PTC) or Negative Temperature Coefficient (NTC) thermistor may be directly connected to the MM2. By specifying the hot and cold thermistor resistance, the MM2 automatically determines the thermistor type as NTC or PTC. Use thermistors with hot and cold resistance values in the range 100 to 30000 Ω. If no thermistor is connected, the thermistor alarm and trip detection must be set to DISABLE in the **S1: CONFIGURATION \ THERMISTOR** page.

2.2.7 ANALOG INPUT

The analog input accepts an input from a standard 4 to 20 mA source. This input can be used for process control monitoring to provide status and/or alarm and tripping signals related to the level of the input signal. The analog input messages (**S3: PROCESS \ ANALOG INPUT**) can be programmed to show a user defined name and units.

2.2.8 AUX 2 COIL

The AUX Relay 2 can be internally energized by the MM2 or externally energized by applying a 24 V DC signal to these terminals. Correct polarity is required (Terminal 21 = +24 V DC, Terminal 22 = 0 V DC).

2.2.9 OUTPUT RELAYS

There are up to 4 output relays on the MM2. Contact switching rating for the output relays as well can be found in Section 1.3: SPECIFICATIONS on page 1–4.

- Contactor A Relay (34/35): non-reversing, forward, low speed, etc.
- Contactor B Relay (32/33): reversing, high speed, etc.
- AUX Relay 1 (26/27/28, 29/30/31): field programmable
- AUX Relay 2 (23/24/25): field programmable or hard-wired 24 V DC coil

2.2.10 SWITCH INPUTS

SWITCH INPUT COMMON TERMINALS 57 AND 58 ARE LIVE 120 V AC.

All switch inputs are opto-isolated and operate at a voltage of 120 V AC. The switch will read closed when 120 VAC is applied to the switch terminal. This 120 V AC can be supplied from the switch common terminals (57, 58) or from an external source providing that the source is in phase with the supply voltage of the MM2.

2.2.11 PROGRAMMABLE SWITCH INPUTS

These 10 inputs can be programmed to one of a number of different functions. Some of the available functions are: Setpoint Access, Lockout Reset, Plant Interlock, Auto Start, Remote Permissive, and Test. See the **S3: PROCESS \ PROGRAMMABLE INPUTS** page for complete list of available functions.

2.2.12 SERIAL COMMUNICATION PORT

A serial port provides communication capabilities to the MM2. Multiple MM2s can be connected together with a 24 AWG stranded, shielded twisted pair with a characteristic impedance of 120 Ω such as Belden 9841 or equivalent. The total length of communications wiring should not exceed 4000 feet. Care should be used when routing the communications wiring to keep away from high power AC lines and other sources of electrical noise.

Correct polarity is essential for the communications port to operate. Terminal 39 ("+") of every MM2 in a serial communication link must be connected together. Similarly, Terminal 40 ("–") of every MM2 must also be connected together. The shield wire must be connected to Terminal 38 (485 SERIAL GROUND) on every unit in the link to provide a common ground potential for all units. Each relay should be "daisy chained" to the next one. Avoid star or stub connected configurations if possible to avoid potential communication problems.

A terminating resistor and capacitor network is required to prevent communication errors. Only the last MM2 and the master computer driver should have the terminating network to ensure proper matching. Using terminating resistors and capacitors on all the MM2s would load down the communication network while omitting them at the ends could cause reflections resulting in communication errors.

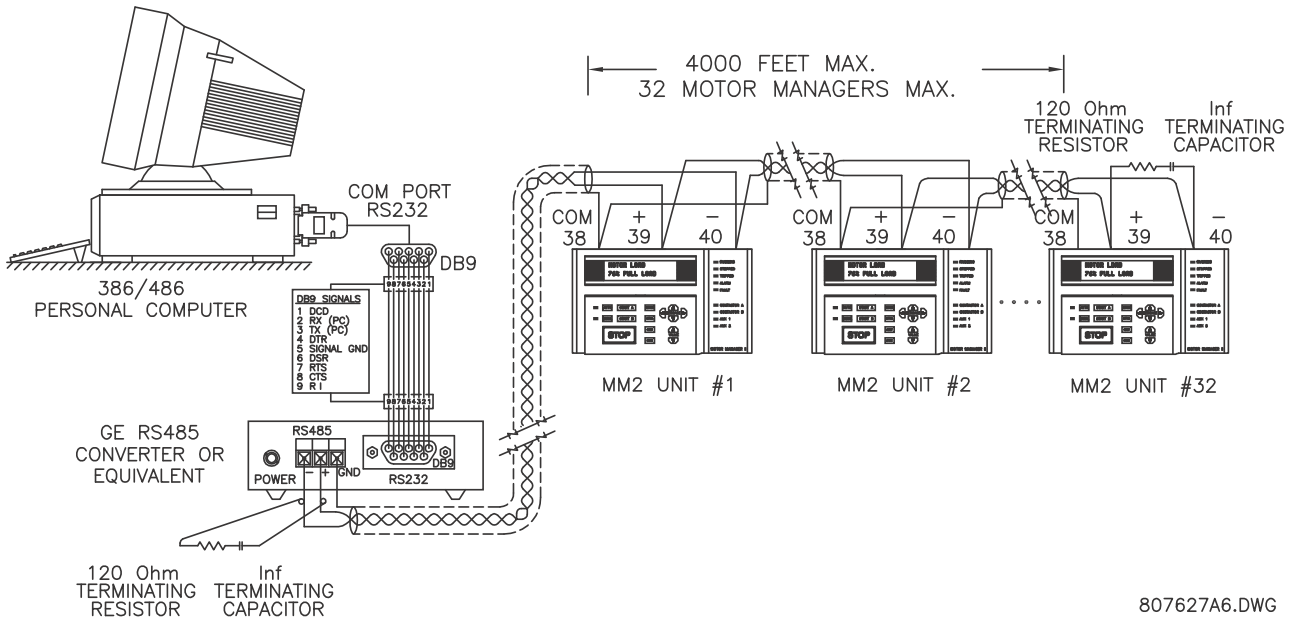


Figure 2–6: RS485 TERMINATION

2.2.13 STOP

If this terminal is de-energized, both contactor A and contactor B output relays will open causing the contactor coils to de-energize. The stop input must be energized before the MM2 will process any start commands.

2.2.14 START A / START B

When the start input terminals are energized, the corresponding contactor output relay will be energized provided all other valid start conditions are met. If any trip occurs, both contactor outputs will be de-energized. Start A input is used for all types of contactors, that is: Full Voltage Non-reversing, Reversing, Two Speed (low speed), Wye Delta Open Transition, Inverter, Slip Ring, Autotransformer, Part Winding or Wye Delta Closed Transition. Start B input is used for Reversing and Two Speed (high speed) contactor control. Start inputs are usually momentary unless Two Wire control is selected. Start A and B commands may also be initiated via the serial link.

2.2.15 LOCAL ISOLATOR N/O

The local isolator NO auxiliary contacts are used to prevent motor starts in the event of the Local Isolator being in the “open” position. To prevent starts, the MM2 produces a trip when the Local Isolator input is open. A Local Isolator Trip is automatically reset when the Local Isolator is re-closed. The Local Isolator input can be enabled or disabled as required. The factory default is disabled.

2.2.16 CONTACTOR STATUS

The MM2 **must** know the state of the contactor at all times in order to detect discrepancies in contactor close/open commands and also to display the state of the contactor. There are two contactor status inputs on the MM2, one for contactor A, the other for contactor B.

Auxiliary contacts mechanically linked to the contactor itself are used to feed back to the contactor status inputs. No status change following a "start" command indicates an open contactor control circuit and no status change following "stop" command indicates a welded contactor. Appropriate messages and alarms are displayed for these conditions and the status can be read via the serial port.

If the motor contactor is externally energized, the MM2 will seal in the output relay and display an “EXTERNAL START” message. If the motor contactor is externally de-energized, the MM2 will drop out the output relay and display an “EXTERNAL STOP” message.

2.2.17 SWITCH COMMON

These two terminals serve as the common for all switches. The MM2 switch inputs operate at 120 VAC which is supplied from these terminals.

2.2.18 DIELECTRIC STRENGTH TESTING

It may be required to test a complete MCC with MM2s installed for dielectric strength. This is also known as “flash” or “hi-pot” testing. The MM2 is rated for 1500 V AC for 1 minute or 1800 V AC for 1 second isolation between switch inputs, relay outputs, VT voltage input, supply voltage inputs and ground terminal 13.

When performing dielectric tests, the connection to the surge ground terminal (14) must be removed. A filter network is used on the AC input to filter out RF and EMI noise. The filter capacitors and transient absorbers could be damaged by the high voltages relative to surge ground on the AC input.

Under no circumstances should any inputs other than switches, relays, supply voltage, VT input, and CT inputs be dielectric tested.

3.1.1 DESCRIPTION

Once the MM2 has been wired and powered on, it is ready to be programmed for a specific application. Local programming is done using the front panel keypad and the 40 character alphanumeric display. Remote programming via the serial port is also possible using the MM2PC software.

3.1.2 MESSAGE DISPLAY

A 40 character display is used to communicate all information about the system to the user. Trip and alarm messages will automatically override the currently-displayed message. If no key is pressed for 2 minutes, a user-selected default messaging sequence will be displayed. If the motor is currently stopped, the Motor Status message will be the default message. Once the motor is started, the first user-selected message will appear.

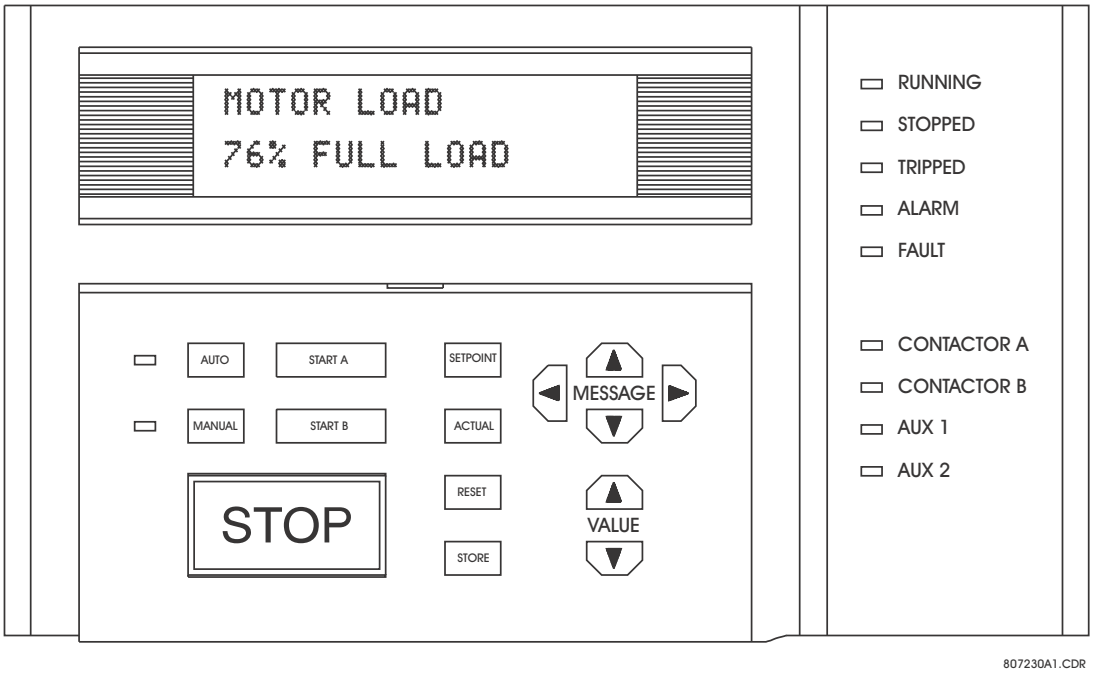


Figure 3–1: FRONT PANEL

3.1.3 INDICATOR LEDs

- **RUNNING**: Whenever contactor A and/or B relays are closed and the contactor status inputs acknowledge the correct state, the RUNNING indicator will be on. Current flow does not affect the indicator, only contactor status.
- **STOPPED**: If both contactors A and B are in the OFF state, the STOPPED indicator will be on.
- **TRIPPED**: If a trip condition causes the A or B contactor relays to de-energize, this indicator will be on. As long as this indicator is on, the motor cannot be started. It is cleared using the reset key, lockout reset facility or serial port reset, dependent on the type of trip.
- **ALARM**: If an alarm condition is present this indicator will be on. Use the **A2: ALARM DATA** actual values to view current alarm status.
- **FAULT**: If an internal fault within the MM2 is detected by self-checking, this indicator will be on. The MM2 must be replaced or repaired.
- **CONTACTOR A**: If the Contactor A Relay is energized, this indicator will be on.
- **CONTACTOR B**: If the Contactor B Relay is energized, this indicator will be on.
- **AUX 1**: If Auxiliary Relay # 1 is on, this indicator will be on.
- **AUX 2**: If Auxiliary Relay # 2 is on, this indicator will be on.
- **AUTO**: If the MM2 is in Auto control mode or the Hard-Wired Auto mode, this indicator will be on. In Auto mode the Start A / Start B switch inputs and START A / START B keypad keys are non-operational but serial port start commands are operational. In the Hardwired Auto Mode, the Auto Start A and Auto Start B switch inputs are functional in conjunction with the Auto Permissive switch input. Serial, faceplate and remote starts are disabled. STOP commands from any location are always operational.
- **MANUAL**: If the MM2 is in Manual control mode, this indicator will be on. In Manual mode the Start A / Start B switch inputs, and START A / START B keypad keys are operational but serial port start commands are ignored. All stop commands are operational.

3.2.1 SETPOINTS KEY

FUNCTION: The SETPOINT key allows the user to examine and alter all trip, alarm, and other MM2 setpoints. There are 6 pages of Setpoints:

- Page 1: Configuration
- Page 2: Protection
- Page 3: Process
- Page 4: Control
- Page 5: Monitoring
- Page 6: Factory Data

EFFECT: Pressing this key will cause the display to show the beginning of the next page of setpoints data. If Actual Values data was on the display before pressing the SETPOINT key, setpoints page S1 will be shown:

```
]] SETPOINTS
]] S1: CONFIGURATION
```

USE: This key can be pressed at any time to view MM2 setpoints. To scroll through the setpoint pages, press the SETPOINT key. To go from section to section within a page, press the MESSAGE UP and MESSAGE DOWN keys. To go from line to line within a section, press the MESSAGE LEFT and MESSAGE RIGHT keys.

To alter a setpoint, the VALUE UP and VALUE DOWN keys can be used. All setpoints can be incremented or decremented to pre-determined limits. When the desired value is reached, the STORE key must be used to save the new setpoint. If an altered setpoint is not stored, the previous value will still be in effect. All control and protection features continue to operate while setpoints data is displayed.

3.2.2 ACTUAL VALUES KEY

FUNCTION: The ACTUAL key allows the user to examine all of the actual motor operating parameters. There are 4 pages of ACTUAL VALUES data:

- Page 1: Data
- Page 2: Status
- Page 3: Inputs
- Page 4: Statistics

EFFECT: Pressing this key will cause the display to show the beginning of the next page of Actual Values data. If setpoints data was on the display before pressing the ACTUAL key, page A1 of Actual Values will be shown:

```
]] ACTUAL VALUES
]] A1: DATA
```

USE: This key can be pressed at any time to view MM2 actual values. To scroll through the actual values pages, press the ACTUAL key. To go from section to section within a page, press the MESSAGE UP and MESSAGE DOWN keys. To go from line to line within a section, press the MESSAGE LEFT and MESSAGE RIGHT keys.

The VALUE UP and VALUE DOWN keys have no effect when actual values data is displayed.

3.2.3 STORE KEY

FUNCTION: The STORE key allows the user to store new setpoints into the MM2 internal memory.

EFFECT: When this key is pressed the currently displayed Setpoint will be stored in non-volatile memory and will immediately come into effect. When a Setpoint is stored, the following flash message will appear on the display:

```
NEW SETPOINT
STORED
```

USE: The STORE key can be used only in SETPOINTS mode to store new setpoints, or in ACTUAL VALUES mode to select a new default message.

3.2.4 STOP KEY

FUNCTION: The STOP key will allow the user to stop the motor from the faceplate of the MM2.

EFFECT: Pressing this key will cause the Contactor A and Contactor B output relays to de-energize therefore dropping out the motor contactor.

USE: The STOP key is used to stop the motor.

3.2.5 RESET KEY

FUNCTION: The RESET key allows the user to reset MM2 trips.

EFFECT: Pressing this key will reset a tripped state on the MM2. A message indicating that a reset is not possible will be displayed if the condition causing the trip is still present.

USE: The RESET key can be used to reset all trip conditions from the faceplate of the MM2. A Ground Fault, Stalled Rotor and Overload Trip can be assigned to the LOCKOUT RESET feature on one of the programmable switch inputs for added safety. The factory default allows the resetting of all trips using the front panel reset key.

3.2.6 START A KEY

FUNCTION: The START A key can be used to start the motor.

EFFECT: Pressing this key will cause the programmed start sequence to begin.

USE: The START A key is used to start the motor from the faceplate of the MM2. Start A can also be initiated from the start switch inputs at the back of the MM2 or from the serial port.

3.2.7 START B KEY

FUNCTION: The START B key can be used to start the motor.

EFFECT: Pressing this key will cause the programmed start sequence to begin.

USE: This START B key is used to start a reversing or two speed motor from the faceplate of the MM2. Start B can also be initiated from the start switch input at the back of the MM2 or from the serial port.

3.2.8 MESSAGE UP/DOWN KEYS

FUNCTION: The MESSAGE UP and MESSAGE DOWN keys allow the user to move to the next or previous section of the currently selected page.

EFFECT: Pressing the MESSAGE DOWN key will cause the display to move to the next section of the current page. Pressing the MESSAGE UP key will cause the display to move to the previous section of the current page. Note: If either key is held for more than 1 second, the next or previous sections will be selected at a fast rate. When the current display is at a page heading, the MESSAGE UP key has no effect. When the current display is at the end of the page, the MESSAGE DOWN key has no effect.

USE: These keys are used to move through the sections of the currently selected page.

3.2.9 MESSAGE LEFT/RIGHT KEYS

FUNCTION: The MESSAGE LEFT and MESSAGE RIGHT keys allow the user to scan the next or previous line of the currently selected section.

EFFECT: Pressing the MESSAGE RIGHT key displays the next line of the current section. Pressing the MESSAGE LEFT key displays the previous line of the current section. If either key is held for more than 1 second, the next or previous line will be selected at a faster rate. If the display shows a section heading, the MESSAGE LEFT key has no effect. If the MESSAGE RIGHT key has no effect, the display is showing the last line of a section.

USE: These keys are used to move through the lines of the currently selected section.

3.2.10 VALUE UP/DOWN KEYS

FUNCTION: The VALUE UP and VALUE DOWN keys allow the user to change setpoint values prior to pressing the STORE key.

EFFECT: Pressing the VALUE UP key will increment the currently displayed setpoint value. Pressing the VALUE DOWN key will decrement the currently displayed setpoint value. If the display shows an Actual Value these keys will have no effect

USE: These keys can be used any time to change the value displayed in the setpoint messages.

3.3.1 HARDWARE DESCRIPTION

A 16 bit 68HC16 microcontroller IC performs program execution and control logic for the MM2. Refer to the block diagram for a complete overview of the MM2 circuitry. It has an 8 or 16 bit bus width which can be selected dynamically with each external memory fetch allowing a mix of 8 and 16 bit devices. Internal clock rate is 16 Mhz. Instructions are stored in two 128K × 8 bit flash memory, data is stored in an 32K × 8 RAM while Setpoints and accumulated data are stored in a 8K × 8 EEPROM.

An intelligent display module with its own microprocessor, memory and command set is accessed through a buffer on the data bus. The display, a 4 × 4 keypad and the front panel LEDs are multiplexed through the same buffer.

External switch inputs are driven with 120 VAC which triggers an optocoupler for isolation. All control logic based on the state of these inputs determines operation of up to 4 output relays which are also driven from a latch under program control. Like the inputs, the relay outputs are driven from an isolated power supply and optocoupler to prevent switching transient energy from affecting the CPU.

A 10 bit successive approximation A/D on the 68HC16 CPU with 8 channels is used to measure all analog signals. Separate AC inputs for phase 1, phase 2, phase 3, and ground fault signals are sampled at a 1.67 ms rate, squared and summed. RMS current is then determined by deriving the square root of the sampled waveform over several cycles. The sampling time is set to measure an integral number of cycles to reduce the affects of noise and harmonics. Thermistor, analog input, VT voltage, control supply voltage and internal reference voltage are also monitored. An external precision 5V DC reference is used as the input reference for the A/D converter.

When power to the unit is removed, a small 8-bit processor (68HC705) will continue to operate for a period of at least 1 hour. This processor is powered from a large backup capacitor. The 68HC705 accurately measures the time that the MM2 has been without control power. When power is reapplied the main processor will read the time off from the small processor and then very accurately calculate the thermal capacity value. This time off value is also used for the undervoltage restart feature.

Serial communications at up to 19200 baud is implemented with UART circuitry internal to the 68HC16 microcomputer. All necessary timing and control is performed inside the chip. An external transceiver chip converts the digital data to an RS485 interface. Direction, receive data and transmit data are on the input side with a two wire twisted pair driver on the output.

AC control voltage to power the MM2 can be selected as 120 or 240 V AC using a switch and dual wound primary transformer. A filter is incorporated between the incoming supply and transformer primary to prevent transients from affecting the circuitry.

Separate, isolated secondary supplies are used for CPU power, I/O and communication drivers. Optocoupling and transformer coupling are used between isolated circuits to prevent transients from upsetting program execution. The 68HC705 is used to provide separate watchdog timer and power fail monitoring control to ensure that the main CPU starts and operates under any input voltage conditions. Should normal program execution fail, the 68HC705 resets the main CPU.

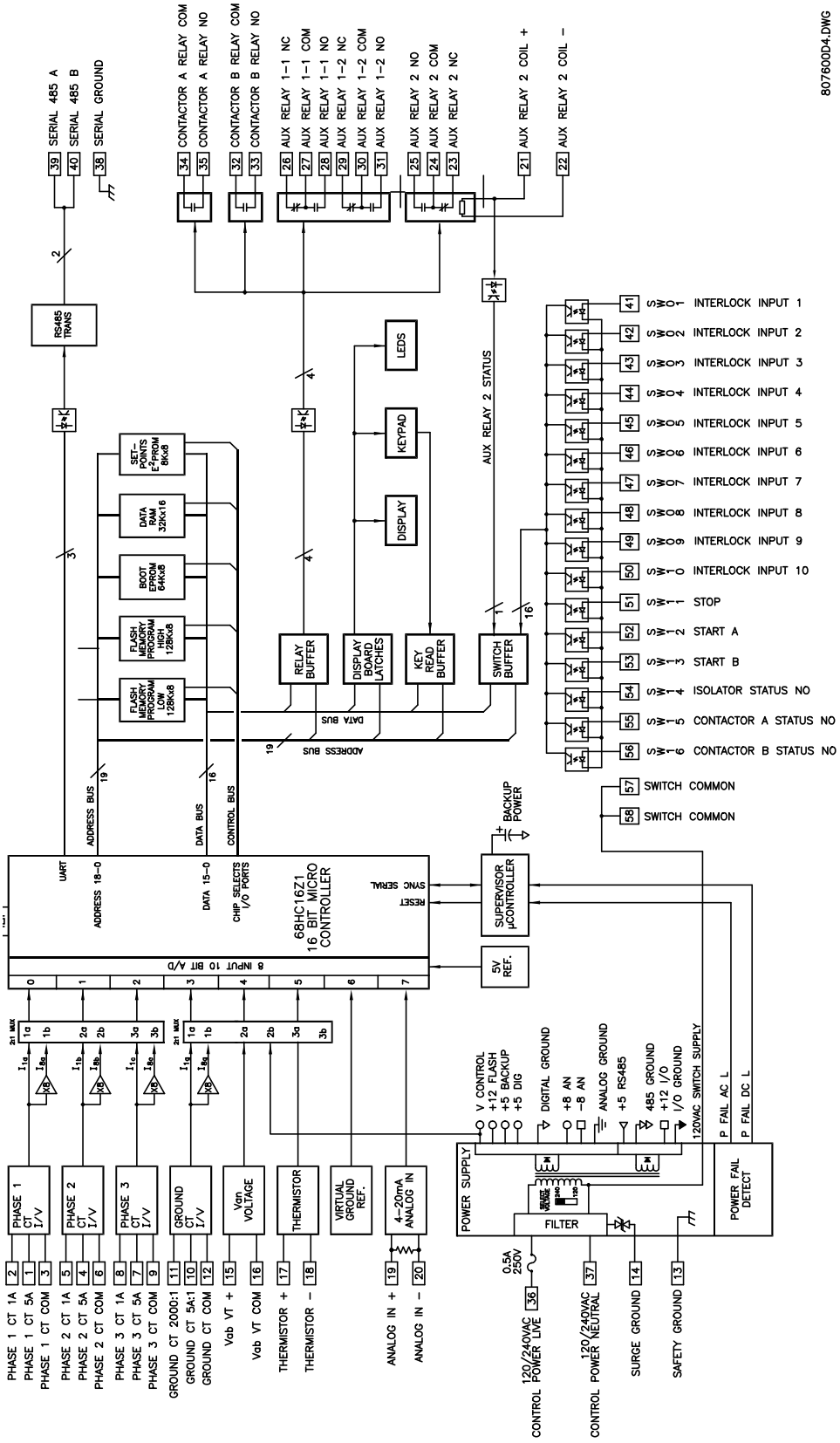


Figure 3–2: BLOCK DIAGRAM

4.1.1 DESCRIPTION

By pressing the SETPOINT key, any of the motor trip/alarm Setpoints may be viewed or altered. Setpoints data is divided into six pages. Information about the configuration of the motor as well as other connected devices is entered in page one, S1: CONFIGURATION. Information for programming the protection features is located in page two, S2: PROTECTION. Information describing the process control functions is described in page three, S3: PROCESS. Information for programming the control functions in the MM2 is contained in page four, S4: CONTROL. Information to aid with plant maintenance is contained in page five, S5: MONITORING. Information about the internal configuration of the MM2 as well as the software version is contained in page, S6: FACTORY DATA.

To scroll through the Setpoint pages, press the SETPOINT key. When this key is pressed for the first time the following message will appear on the display:

```
]] SETPOINTS
]] S1: CONFIGURATION
```

This is the first page of Setpoints. The MESSAGE RIGHT, MESSAGE LEFT, MESSAGE UP and MESSAGE DOWN keys may be used to view all of the setpoints data.

The Setpoint values themselves are changed by pressing the VALUE UP or VALUE DOWN keys until the desired value is reached. When a Setpoint is adjusted to its proper value the STORE key must be pressed in order to store the Setpoint into the MM2 non-volatile memory. Once the STORE key is pressed the flash message shown below will appear on the display and the new Setpoint value will be permanently saved.

```
NEW SETPOINT
STORED
```

Setpoints may be changed while the motor is running; however it is not recommended to change important protection parameters without first stopping the motor.

Setpoints will remain stored indefinitely in the MM2 internal non-volatile memory even when control power to the unit is removed. Protection parameters are based on the entered data. This data must be complete and accurate for the given system for reliable protection and operation of the motor.

All Setpoint messages shown contain the factory default settings.

4.1.2 ABBREVIATIONS

The following abbreviations are used in the messages in the setpoints pages.

- A, AMPS: Amperes
- AUX: Auxiliary
- CBCT: Core Balance Current Transformer
- COM, COMMS: Communication
- CT: Current Transformer
- FLC: Full Load Current
- FV: Full Voltage
- G/F: Ground Fault

- GND: Ground
- Hz: Hertz
- KOHMS: kiloOhms
- MAX: Maximum
- MIN: Minimum
- SEC, s: Seconds
- UV: Undervoltage
- VT: Voltage Transformer

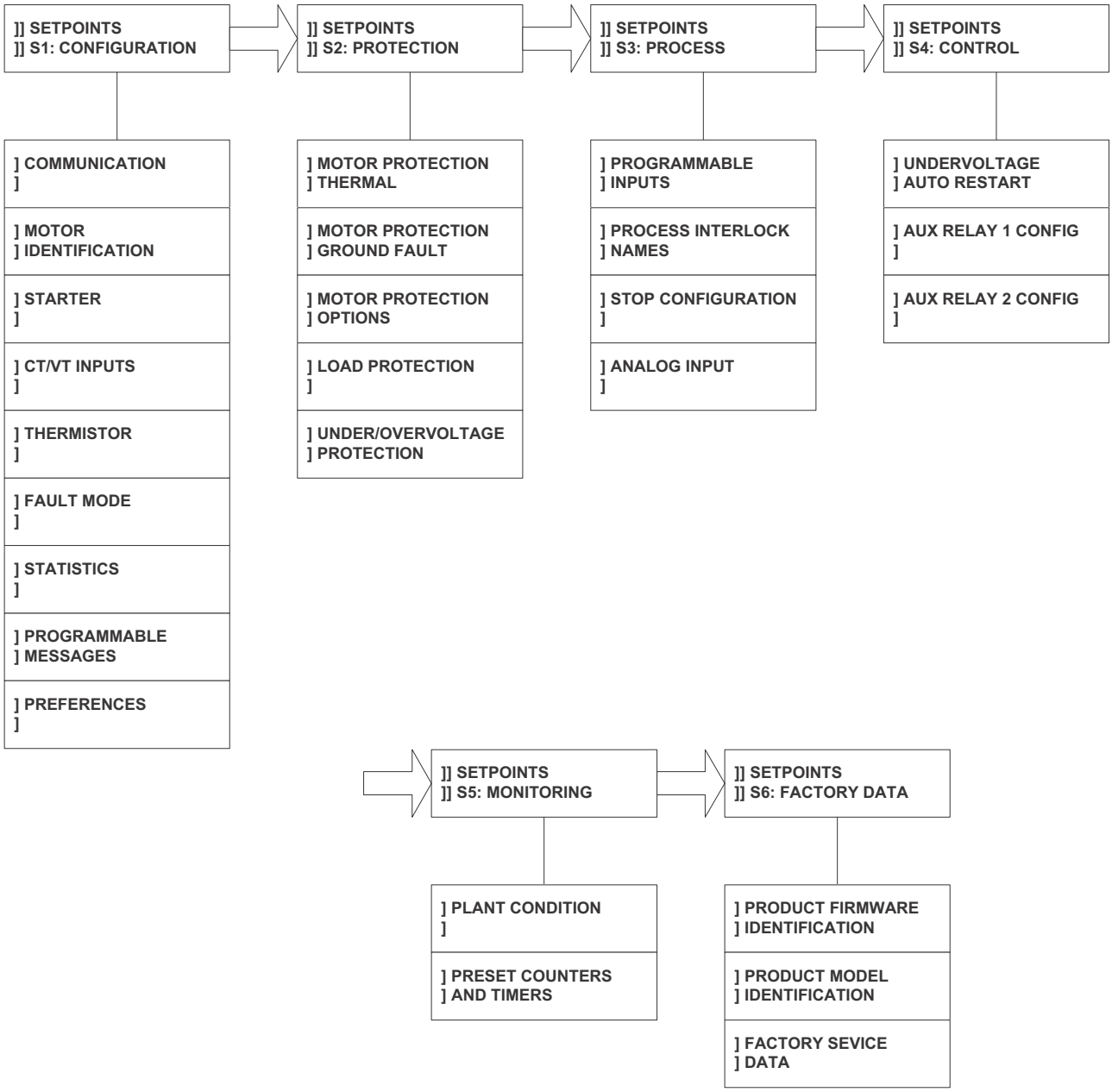


Figure 4–1: SETPOINTS MESSAGES

4.2.1 DESCRIPTION

This page is used to enter all information about the configuration of the MM2 and the motor being protected by the MM2. Setpoints Page 1 is divided into eight sections, COMMUNICATIONS, MOTOR IDENTIFICATION, STARTER, CT / VT INPUTS, THERMISTOR, FAULT MODE, STATISTICS, PROGRAMMABLE MESSAGE and PREFERENCES.

COMMUNICATIONS

PATH: SETPOINTS ▼ S1: CONFIGURATION ▼ COMMUNICATIONS

```
COMMUNICATIONS
ADDRESS:  OFF
```

Range: 1 to 255 or OFF, Step: 1

Each MM2 on the same serial communication network must have a unique address in the range of 1 to 255. Computer software driving the serial network must be configured to recognize each separate address.

```
BAUD RATE:  9600
```

Range: 1200, 2400, 4800, 9600, 19200

Selects the data transfer rate for Modbus serial communications.

```
PARITY: NONE
```

Range: NONE, ODD, EVEN

This setpoint determines what type of parity checking is used when communicating to the MM2.

4.2.2 MOTOR IDENTIFICATION

PATH: SETPOINTS ▼ S1 CONFIGURATION ▼▼ MOTOR IDENTIFICATION

```
MOTOR NAME:
MOTOR
```

Range: 20 ASCII characters

Enter a motor name that will appear in the actual values message **A1: DATA \ MOTOR DATA \ MOTOR STATUS**.

```
MOTOR RATING
  OFF kW
```

Range: 0.3 kW to 1100 kW or OFF; Step: 0.1 kW

Enter the motor rating (or low speed motor rating for two speed starters) in kWs on this line. This message is for reference only and does not affect operation of the MM2.

```
HIGH SPEED MOTOR
RATING: OFF kW
```

Range: 0.3 kW to1100 kW or OFF, Step: 0.1 kW

Enter the high speed motor rating (applicable for Two Speed starters only) in kWs on this line. This message is for reference only and does not affect operation of the MM2.

```
SYSTEM SUPPLY:
  480 V
```

Range: 110 V to 600 V; Step: 1 V

Enter system supply voltage on this line. This message is for reference only and does not affect operation of the MM2.

4.2.3 STARTER

PATH: SETPOINTS ▼ S1: CONFIGURATION ▼▼▼ STARTER

```
STARTER TYPE:
OFF
```

Range: OFF, FV NON-REVERSING, FV REVERSING, WYE DELTA OPN TRANS, TWO SPEED, INVERTER, SLIP RING, AUTO-TRANS OPN TRANS, PART WINDING, WYE DELTA CLS TRANS, AUTOTRANS CLS TRANS, DUTY/STANDBY, SOFT STARTER

Select a type according to the configuration that the MM2 is controlling. This will determine the control logic used for Contactor A and Contactor B start and stop sequences. See Chapter 8: STARTER TYPES for a detailed description of each starter type.

```
CHANGE OVER CURRENT
 1.5 xFLC
```

Range: 1.0 to 5.0 x FLC or OFF; Step: 0.1 x FLC

Appears only when **STARTER TYPE** is WYE DELTA OPN TRNS or WYE DELTA CLS TRANS. Before **CHANGE OVER CURRENT** comes into effect on a wye delta start, a minimum of 25% of the **CHANGE OVER TIME** must have expired. After 25% of the time has expired and the average of the three phase currents has dropped below the **CHANGE OVER CURRENT** value, the transition from wye (Contactor A) to delta (Contactor B) will occur. If this setpoint is OFF, 100% of the **CHANGE OVER TIME** must expire for the wye to delta transition to occur.

```
CHANGE OVER TIME:
 30 s
```

RANGE: 1 to 100 seconds; Step: 1 second

Appears only if **STARTER TYPE** is set as WYE DELTA OPN TRNS or WYE DELTA CLS TRANS. See **CHANGE OVER CURRENT** setpoint above for operation.

```
TRANSFER TIME:
   10 s
```

Range: 1 to 125 seconds; Step: 1 second

Appears only if **STARTER TYPE** is set as FV REVERSING or TWO SPEED. With two-speed starters, this delay is required when the motor is switched from high speed (Contactor B) to low speed (Contactor A). The delay starts when Contactor B drops out. With a reversing starter, this delay occurs when switching from forward (Contactor A) to reverse (Contactor B) and from reverse to forward.

```
HIGH SPEED START
BLOCK: DISABLE
```

Range: ENABLE, DISABLE

Appears only if **STARTER TYPE** is TWO SPEED. When disabled, the MM2 allows the motor to be started directly to high speed. When enabled, the motor must be started in low speed before switching to high speed.

```
RAMP UP TIME:
  5 s
```

Range: 1 to 125 seconds; Step: 1 second

Appears only if **STARTER TYPE** is selected as INVERTER or SOFT STARTER. See the description of these starter types for details on functionality.

```
RAMP DOWN TIME:
  5 s
```

Range: 1 to 125 seconds; Step: 1 second

Appears only if **STARTER TYPE** is selected as INVERTER or SOFT STARTER. See the description of these starter type for details on functionality.

```
STAGE ONE SHORTING
TIME: 5 s
```

Range: 1 to 125 seconds; Step: 1 second

Appears only if **STARTER TYPE** is SLIP RING or PART WINDING. This is the time delay from the closure of Contactor A to the closure of Contactor B.

```
CONTACTOR SEQUENCE:
  1S-2S
```

Range: 1S-2S, 2S-1S.

Appears only if **STARTER TYPE** is AUTOTRANS OPN TRANS. The 1S-2S value closes the 1S contactor ahead of the 2S contactor as per some manufacturer wiring practices. The 2S-1S value means that the 2S contactor will close ahead of the 1S contactor, another common wiring practice.

```
CHANGE OVER TIME:
5 s
```

Range: 1 to 125 seconds; Step: 1 second.

Appears only if **STARTER TYPE** is AUTOTRANS OPN TRANS or AUTOTRANS CLS TRANS. This is the time delay from the closure of Contactor A until the opening of Contactor A.

```
STARTS/HOUR CONFIG:
Fixed Interval
```

Range: Fixed Interval, Number.

This setpoint switches between the two types of Starts per Hour. If set to Fixed Interval, the number of starts per hour is set by the **STARTS PER HOUR** setpoint. If set to Number, then the number of starts per hour, as well as the permissible time between starts, can be set.

```
MAX STARTS/HOUR
PERMISSIBLE: 5
```

Range: 1 to 5 or OFF; Step: 1

Appears only if the **STARTS/HOUR CONFIG** is set to Number.

A motor start is assumed to be occurring when the MM2 measures the transition of no motor current to some value of motor current. At this point, one of the Starts/Hour timers is loaded with 60 minutes. Even unsuccessful start attempts will be logged as starts for this feature. Once the motor is stopped, the number of starts within the past hour is compared to the number of starts allowable. If the two are the same, an inhibit will occur. If an inhibit occurs, the lockout time will be equal to one hour less the longest time elapsed since a start within the past hour. An Emergency restart will clear the oldest start time remaining.

```
TIME BETWEEN STARTS
PERMISSIBLE: 3 MIN
```

Range: 1 to 500 MIN or OFF; Step: 1

Appears only if the **STARTS/HOUR CONFIG** is set to Number.

A motor start is assumed to be occurring when the MM2 measures the transition of no motor current to some value of motor current. At this point, the Time Between Starts timer is loaded with the entered time. Even unsuccessful start attempts will be logged as starts for this feature. Once the motor is stopped, if the time elapsed since the most recent start is less than this setpoint, an inhibit will occur. If an inhibit occurs, the lockout time will be equal to the time elapsed since the most recent start subtracted from this setpoint.

In some cases, the motor manufacturer will specify the time between motor starts. If this information is given, then the times provided on the motor data sheets should be programmed.

```
STARTS PER HOUR:
5
```

Range: 1 to 40 or OFF; Step: 1

Appears only if the **STARTS/HOUR CONFIG** is set to Fixed Interval. Limits the number of starts per hour to prevent over heating of windings.

NOTE In the event of control power loss, the Time Between Starts and all Starts/Hour values will be saved. The elapsed time will be recorded and decremented from these timers whether control power is applied or not.

NOTE Upon loss and reapplication of control power, the Time Between Starts counter value will increase to the next highest multiple of two minute increments. For example: if 0 min. and 12 sec. remain, cycling power returns the counter to 2 min. and 0 sec.; if 489 min. and 5 sec. remain, cycling power returns the counter to 500 min. and 0 sec.

4.2.4 CT / VT INPUTS

PATH: SETPOINTS ▼ S1: CONFIGURATION ▼▼▼▼ CT/VT INPUTS

```
PHASE CT PRIMARY
AMPS:    100
```

Range: 1 to 1000 A; Step: 1 A

Enter the phase CT rated primary amps; e.g. if the phase CTs are rated 500:5, enter 500. The CT secondary must be connected to the correct input, i.e. 1 A or 5 A.

```
HIGH SPEED PHASE CT
PRIMARY AMPS:  100
```

Range: 1 to 1000 A; Step: 1A

Appears only if **STARTER TYPE** is TWO SPEED. Enter the high speed CT rated primary amps. In effect only when Contactor B is energized.

```
GROUND FAULT CT
INPUT:50:0.025 CBCT
```

Range: 50:0.025 CBCT, 5 A SEC CBCT, 5 A RESIDUAL

Enter the ground sensing used, either sensitive 50:0.025 core balanced ground fault CT, 5 A sec. core balanced CT, or 5 A Residual for residual ground fault current sensing from the 5 A phase CT secondaries.

```
GROUND CT PRIMARY
AMPS:    100
```

Range: 1 to 1000 A; Step: 1 A

Appears only if 5A SEC CBCT is selected for the **GROUND FAULT CT INPUT**. Enter the GFCT rated primary amps.

```
50:0.025 HI-RES
DISPLAY: DISABLE
```

Range: Enable, Disable

Increases the displayed resolution to 2 decimal points for the 50:0.025 ground input.

```
VT PRIMARY VOLTAGE:
OFF V
```

Range: 110 to 600 V or OFF; Step: 1 V

Enables/disables the voltage/power features and sets VT primary volts.

```
VT CONNECTION TYPE:
PHASE (A-N)
```

Range: PHASE (A-N), LINE (A-B)

Appears only if the **VT PRIMARY VOLTAGE** setpoint is not set to OFF. Enter the type of VT connection: PHASE A-N (V_{an}) or LINE A-B (V_{ab}).

```
VT SECONDARY
VOLTAGE: 120V
```

Range: 110 to 240 V; Step: 10

Appears only if the **VT PRIMARY VOLTAGE** setpoint is not set to OFF.

```
NOMINAL FREQUENCY:
60 Hz
```

Range: 50 Hz, 60 Hz

4.2.5 THERMISTOR

PATH: SETPOINTS ▼ S1: CONFIGURATION ▼▼▼▼▼ THERMISTOR

```
COLD RESISTANCE:
 0.1 kOHMS
```

Range: 0.1 to 30.0 kOHMS; Step: 0.1

For a PTC thermistor, enter the resistance that the thermistor must drop below before a Thermistor Trip or Alarm can be cleared. For a NTC thermistor, enter the resistance that the thermistor must rise above before a Thermistor Trip or Alarm can be cleared.

```
HOT RESISTANCE
 5.0 kOHMS
```

Range: 0.1 to 30.0 kOhms, STEP: 0.1

For a PTC thermistor, enter the resistance that the thermistor must rise above before a Thermistor Trip or Alarm will occur. For a NTC thermistor, enter the resistance that the thermistor must drop below before a Thermistor Trip or Alarm will occur.

```
THERMISTOR TRIP:
DISABLE
```

Range: ENABLE, DISABLE

When a thermistor is used, it can be selected for an Alarm or Trip or both. Choose ENABLE to allow Thermistor Trips to occur.

```
THERMISTOR ALARM:
DISABLE
```

Range: ENABLE, DISABLE

When a thermistor is used, it can be selected for an Alarm or Trip or both. Choose ENABLE to allow Thermistor Alarms to occur.

4.2.6 FAULT MODE

PATH: SETPOINTS ▼ S1: CONFIGURATION ▼▼▼▼▼▼ FAULT MODE

```
INTERNAL FAULT TRIP
ENABLE
```

Range: ENABLE, DISABLE

An internal fault during self-checking will cause an alarm. Since operation may be erratic depending on the fault condition, it may be desirable to trip the motor by setting this setpoint to ENABLE. The MM2 continues to run the motor with an internal fault present if set to DISABLE.

```
SERIAL COMM FAILURE
TRIP: OFF s
```

Range: 5 to 25 seconds or OFF; Step: 5 seconds

If using serial communications to control a process with several motors working together, it may be desirable to shut down the motor if communication control is lost. When no activity occurs on the communications port for 5 to 25 seconds, it will trip if this feature is enabled.

```
SERIAL COMM FAILURE
ALARM: OFF
```

Range: 5 to 25 seconds or OFF; Step: 5 seconds

Sets an alarm when the serial communication link is interrupted.

```
CHANGE COMMAND MODE
ON ALARM: DISABLE
```

Range: ENABLE, DISABLE

Allows the command mode to automatically switch from AUTO to MANUAL when the **SERIAL COMMS FAILURE ALARM** is active. If the motor was running when the alarm occurred it will be stopped and will restart based on manual start inputs only. When serial communication is restored the MM2 will remain in MANUAL command mode.

4.2.7 STATISTICS

PATH: SETPOINTS ▼ S1: CONFIGURATION ▼▼▼▼▼▼▼ STATISTICS

```
CLEAR TIMERS:
DISABLE
```

Range: ENABLE, DISABLE

Select ENABLE and press STORE to clear the **RUNNING TIME** and **STOPPED TIME** timers on page **A4: STATISTICS \ TIMERS**.

```
CLEAR START/TRIP
COUNTERS: DISABLE
```

Range: ENABLE, DISABLE

Select ENABLE and press STORE to clear the start and trip counters on page **A4: STATISTICS \ COUNTERS**.

```
CLEAR INTERLOCK
COUNTER: DISABLE
```

Range: ENABLE, DISABLE

Select ENABLE and press STORE to clear the interlock counter on page **A4: STATISTICS \ COUNTERS**.

```
CLEAR ENERGY USED:
DISABLE
```

Range: ENABLE, DISABLE

Select ENABLE and press STORE to clear the energy used (kWhrs) on page **A1: DATA \ MOTOR DATA**.

4.2.8 PROGRAMMABLE MESSAGE

PATH: SETPOINTS ▼ S1: CONFIGURATION ▼▼▼▼▼▼▼▼ PROGRAMMABLE MESSAGE

```
PROGRAMMABLE MESSAGE
SAMPLE TEXT
```

Range: 40 ASCII characters

Enter a 40 character message using the VALUE UP/DOWN and STORE keys. Message is displayed in **A1: PROGRAMMABLE MESSAGE**.

4.2.9 PREFERENCES

PATH: SETPOINTS ▼ S1: CONFIGURATION ▼▼▼▼▼▼▼▼▼ PREFERENCES

```
DEFAULT MESSAGE
DELAY: 10 s
```

Range: 3 to 300 seconds in steps of 1

The default message delay can now be adjusted with this setpoint.

```
DEFAULT MESSAGE
BRIGHTNESS: 60%
```

Range: 0 to 100% in steps of 20

The display brightness can now be adjusted when it is not in use.

NOTE

This setpoint is only applicable for MM2 units with the VFD display.

4.3.1 DESCRIPTION

This page is used to enter all information about the protection of the motor and the load. Setpoints Page 2 is divided into four sections, MOTOR PROTECTION THERMAL, MOTOR PROTECTION GROUND FAULT, MOTOR PROTECTION OPTIONS, LOAD PROTECTION and UNDER/OVER-VOLTAGE PROTECTION.

4.3.2 STANDARD OVERLOAD CURVES

Table 4–1: STANDARD OVERLOAD CURVE TRIP TIMES (IN SECONDS)

OVERLOAD LEVEL	CURVE NUMBER							
	1	2	3	4	5	6	7	8
1.05	7200	7200	7200	7200	7200	7682	10243	12804
1.10	416	833	1250	1666	2916	3750	5000	6250
1.20	198	397	596	795	1392	1789	2386	2982
1.30	126	253	380	507	887	1141	1521	1902
1.40	91	182	273	364	638	820	1093	1367
1.50	70	140	210	280	490	630	840	1050
1.75	42	84	127	169	297	381	509	636
2.00	29	58	87	116	204	262	350	437
2.25	21	43	64	86	150	193	258	323
2.50	16	33	50	66	116	150	200	250
2.75	13	26	39	53	93	119	159	199
3.00	10	21	32	43	76	98	131	164
3.50	7.8	15	23	31	54	69	93	116
4.00	5.8	11	17	23	40	52	69	87
4.50	4.5	9	13	18	31	40	54	68
5.00	3.6	7.2	10	14	25	32	43	54
5.50	3	6	9	12	20	26	35	44
6.00	2.5	5	7.5	10	17	22	30	37
6.50	2.1	4.2	6.3	8.4	14	19	25	31
7.00	1.8	3.6	5.4	7.2	12	16	21	27
7.50	1.6	3.2	4.8	6.4	11	14	19	23
8.00	1.4	2.8	4.2	5.6	9.8	12	16	20

The standard overload curves are shown in the following chart. Note that K+E 11” x 17” format of time/overcurrent curves are available from factory upon request.

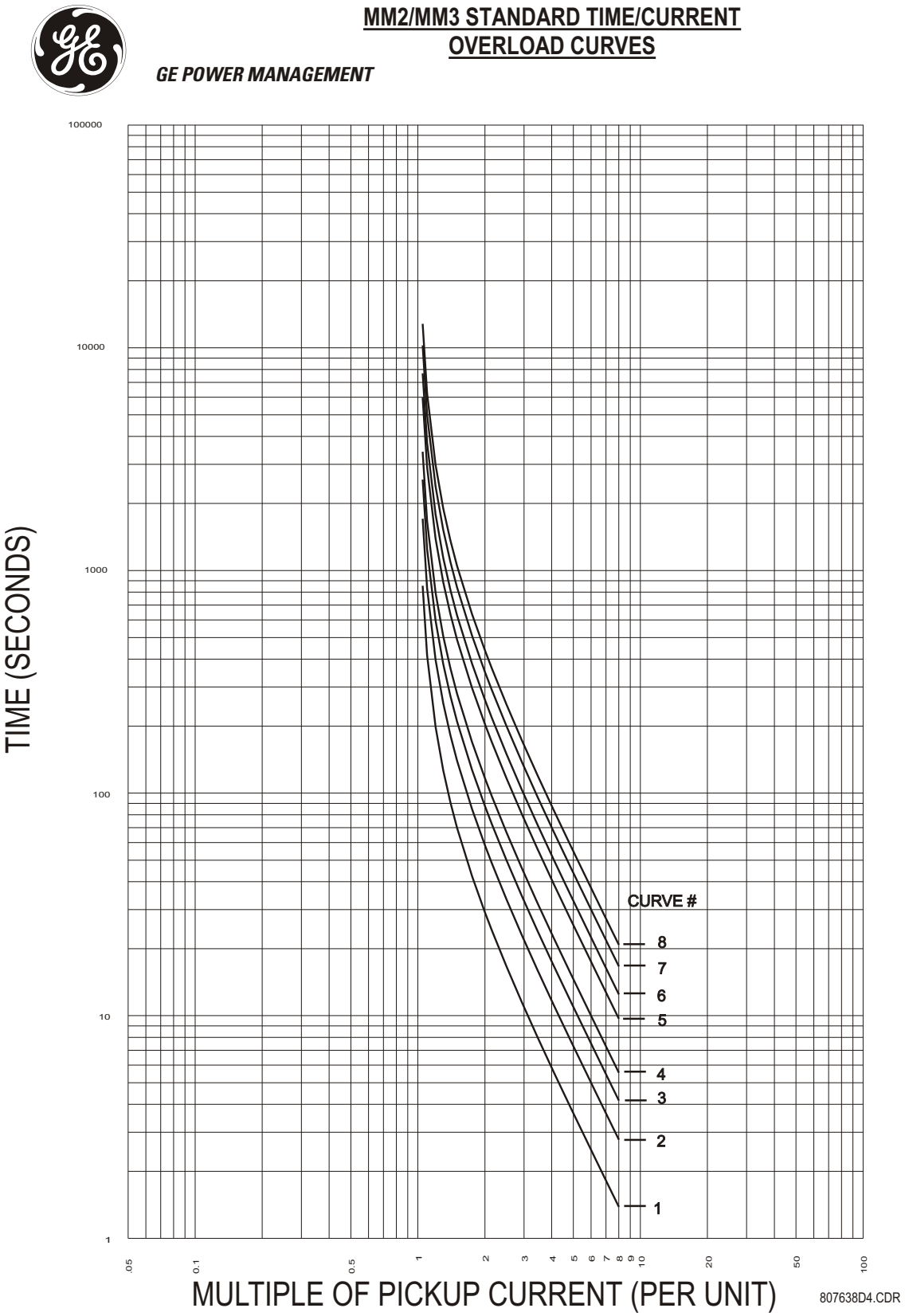


Figure 4–2: GE MULTILIN TIME/OVERCURRENT CURVES

Table 4–2: NEMA COMPATIBLE OVERLOAD CURVE TRIP TIMES (IN SECONDS)

OVERLOAD LEVEL	CURVE			
	CLASS 10	CLASS 15	CLASS 20	CLASS 30
1.05	3349	5024	6698	10047
1.10	1635	2452	3269	4904
1.20	780	1170	1560	2340
1.30	497	746	995	1492
1.40	358	536	715	1073
1.50	275	412	549	824
1.75	166	250	333	499
2.00	114	172	229	343
2.25	84	127	169	253
2.50	65	98	131	196
2.75	52	78	105	157
3.00	43	64	86	129
3.50	30	46	61	91
4.00	23	34	46	67
4.50	17.8	27	36	53
5.00	14.3	21	29	43
5.50	11.7	17.6	23	35
6.00	9.8	14.7	19.6	29.4
6.50	8.3	12.4	16.6	24.9
7.00	7.1	10.7	14.3	21.4
7.50	6.2	9.3	12.4	18.6
8.00	5.4	8.1	10.9	16.3

The NEMA compatible overload curves are shown in the following chart. Note that K+E 11” x 17” format of time/overcurrent curves are available from factory upon request.

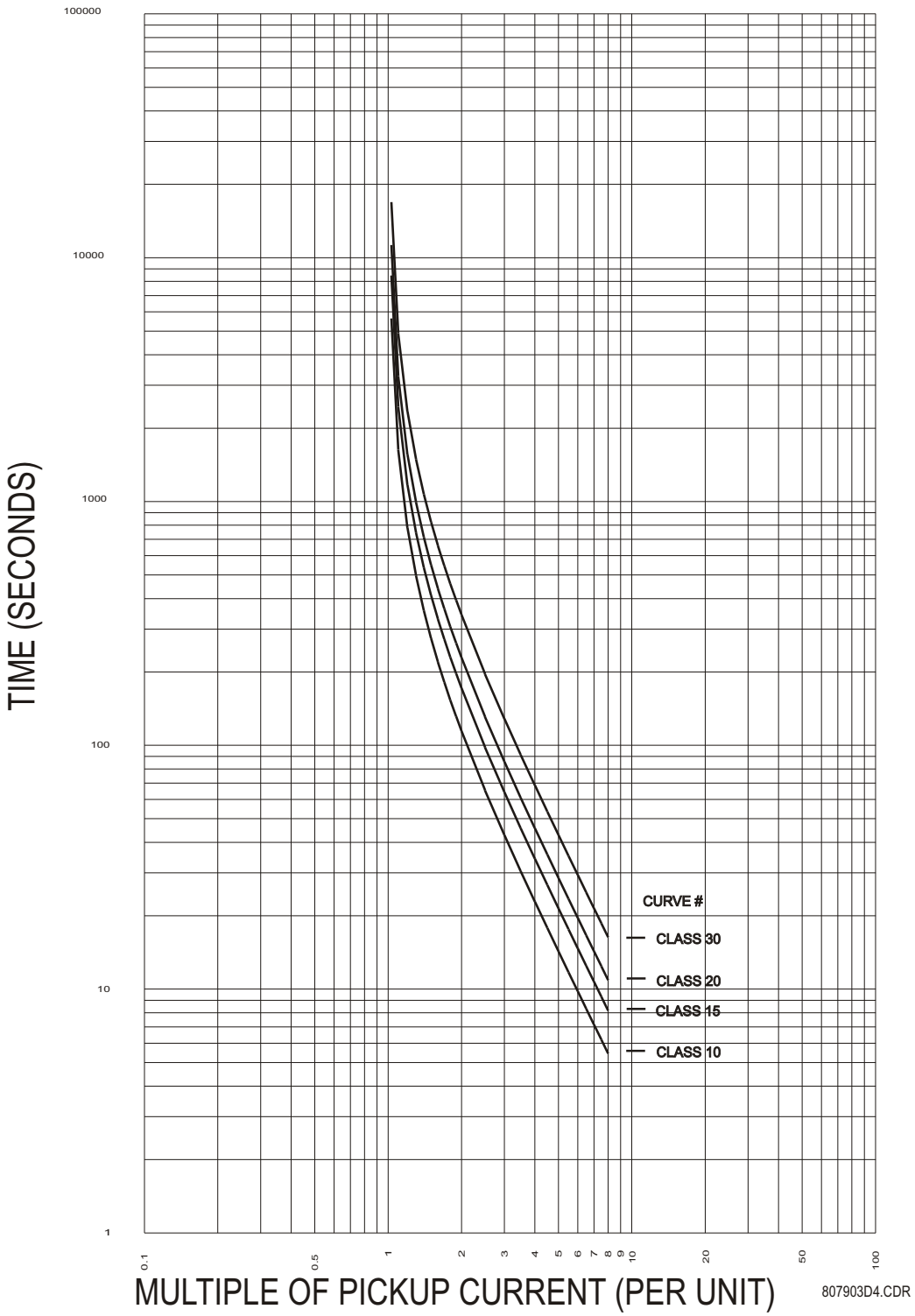


Figure 4–3: NEMA COMPATIBLE TIME/OVERCURRENT CURVES

4.3.4 MOTOR PROTECTION – THERMAL

PATH: SETPOINTS ▼▼ S2 PROTECTION ▼ MOTOR PROTECTION THERMAL

```
FULL LOAD CURRENT:
  100 A
```

*Range: 5 to 1000 A or OFF, Step 1, for **CT PRIMARY** > 50 A*
*0.5 to 100.0 A or OFF, Step 0.1, for **CT PRIMARY** ≤ 50 A*

Usually the rated current on the motor nameplate is entered as the full load current value. A lower value effectively overprotects the motor. It is not advisable to enter a value higher than the motor nameplate rating. When the actual motor current exceeds this value, the thermal capacity starts to be used up and the motor will eventually trip according to the overload curve selected.

```
HIGH SPEED FULL LOAD
CURRENT:  100 A
```

*Range: 5 to 1000 A or OFF, Step 1, for **CT PRIMARY** > 50 A*
*0.5 to 100.0 A or OFF, Step 0.1, for **CT PRIMARY** ≤ 50 A*

This setpoint functions the same way as **FULL LOAD CURRENT**, but refers to the high speed FLC of a two-speed motor, and is only in effect while contactor B is energized.

```
OVERLOAD PICKUP
LEVEL: 1.00
```

Range: 1.00 to 1.25; Step: 0.01

This setpoint dictates where the overload curve begins as the motor enters an overload condition. This is useful for service factor motors as it allows the pickup level to be defined. The curve is effectively cut off at current values below this pickup.

```
OVERLOAD CURVE
NUMBER:  4
```

Range: 1 to 8, CLASS 10, CLASS 15, CLASS 20, CLASS 30

Select 1 of 12 different I^2t time-overcurrent overload curves. Consult the overload curve figures and tables in this manual (see pages 4–34 to 4–37) to match the curve number to a particular motor. If no motor curve data is available, select the curve which has a 6 times overload trip time equal to the motor nameplate stall time. The MM2 also has four NEMA class curves which can be selected should these curves be suggested by the manufacturer.

```
HOT/COLD CURVE
RATIO: 75
```

Range: 20 to 100%; Step: 1%

Defines the ratio of motor "hot" thermal characteristic to the motor "cold" characteristic. It is used to thermally model the heating in the motor when running at or below full load current. This is often determined from motor thermal damage curves or Locked Rotor Time Hot and Locked Rotor Time Cold data. **HOT/COLD CURVE RATIO** determines the thermal capacity used when a motor has run at its full load current long enough for the motor temperature to reach its steady state value, which is defined as the hot temperature. Note that the thermal capacity used is reduced according to the actual motor current.

For example, given the following motor information: motor FLC = 100 A, actual motor current = 80 A, LRT Hot = 7 seconds, and LRT Cold = 10 seconds, the thermal capacity used can be determined from the **HOT/COLD CURVE RATIO** as follows:

$$\text{HOT/COLD CURVE RATIO} = \frac{\text{LRT Hot}}{\text{LRT Cold}} \times 100 = \frac{7 \text{ sec.}}{10 \text{ sec.}} \times 100 = 70\%$$

Therefore:

$$\text{Thermal Capacity Used} = \frac{\text{actual motor current}}{\textbf{FULL LOAD CURRENT}} \times (100\% - \textbf{HOT/COLD CURVE RATIO})$$
$$= \frac{80\ \text{A}}{100\ \text{A}} \times (100\% - 70\%) = 24\%$$

4.3.5 MOTOR PROTECTION – GROUND FAULT

PATH: SETPOINTS ▼▼ S2: PROTECTION ▼▼ MOTOR PROTECTION GROUND FAULT

NOTE

Care must be taken when turning ON the GROUND FAULT TRIP feature. If the interrupting device (contactor or circuit breaker) is not rated to break ground fault current (low resistance or solidly grounded systems), the feature should be disabled. Alternately, the feature may be assigned to an auxiliary relay and connected such that it trips an upstream device that is capable of breaking the fault current. Be aware that the MM2 will energize the auxiliary relay and de-energize contactor A at the same time when the ground fault trip occurs. Unless a contactor trip delay setting has been chosen (see AUX RELAY 1 CONFIG for details).

NOTE

A change has been made in the way the MM2 calculates the 5A G/F alarm and trip levels. On all software revisions prior to 3.30, the levels are based upon a percentage of FULL LOAD CURRENT. From software revisions 3.30 and up, the levels are based on a percentage of CT PRIMARY.

```
GROUND FAULT ALARM
LEVEL:  OFF %CT
```

Range: 3 to 100% CT or OFF; Step: 1%

This message will appear if the **GROUND FAULT CT INPUT** is set to 5A SEC CBCT or 5A RESIDUAL. Set the **GROUND FAULT ALARM LEVEL** to some arbitrary amount below the **GROUND FAULT TRIP LEVEL** to get an early warning of insulation breakdown. For maximum sensitivity, the value selected should be just high enough to prevent nuisance alarms. If the 5A SEC CBCT value is selected, the level is calculated as a percentage of the **G/F CT PRIMARY** setting; if the 5A RESIDUAL value is selected, the level is calculated as a percentage of the **PHASE CT PRIMARY** setting.

OR

NOTE

The resulting **GROUND FAULT ALARM LEVEL** setting should be greater than 0.1A to avoid nuisance Ground Fault Alarms.

```
GROUND FAULT ALARM
LEVEL:  OFF A
```

Range: 0.1 to 15.0 A or OFF; Step: 0.1 A

This message will appear if the Ground Fault CT Input is set to 50:0.025 CBCT. See **GROUND FAULT ALARM LEVEL** (%CT) above for details.

GROUND FAULT ALARM DELAY ON RUN: 10 s

Range: 1 to 60 seconds; Step: 1 second

This delay is used when the motor is in a RUNNING condition. If the ground current is equal to or above the **GROUND PRIMARY ALARM PICKUP** setpoint value and remains this way for the time delay programmed in this setpoint while the motor is running, the alarm relay will activate and the GROUND ALARM message will be displayed.

NOTE

When the phase current increases from 0, the GROUND ALARM DELAY ON START setpoint below is used until the MM2 determines whether the motor is RUNNING or STARTING.

Refer to the **ACCELERATION TIME** setpoint in Section 4.3.7: LOAD PROTECTION for details on how the MM2 detects a start condition.

GROUND FAULT ALARM: DLY ON START: 10 s

Range: 1 to 60 seconds; Step: 1 second

This delay is used when the motor is in a STARTING condition. If the ground current is equal to or above the **GROUND PRIMARY ALARM PICKUP** setpoint value and remains this way for the time delay programmed in this setpoint while the motor is starting, the alarm relay will activate and the GROUND ALARM message will be displayed.

NOTE

When the phase current increases from 0, this delay is used until the MM2 determines whether the motor is RUNNING or STARTING.

Refer to the **ACCELERATION TIME** setpoint in Section 4.3.7: LOAD PROTECTION for details on how the MM2 detects a start condition.

GROUND FAULT TRIP LEVEL: OFF %CT

Range: 3 to 100% CT or OFF; Step: 1%

This message will appear if the **GROUND FAULT CT INPUT** is set to 5A SEC CBCT or 5A RESIDUAL. Some leakage current will always flow between the 3 phases and ground due to capacitance, insulation, resistance, etc. On resistance limited ground systems, the value selected must be below the maximum resistance limited current that can flow or a trip will never occur. If no optimum value is known, monitor actual leakage current then enter a current somewhat above this value. Ground Fault Trips at a later time would indicate a deterioration in the system and insulation integrity should be verified. Persistent, high values of leakage current pose a threat to personnel and equipment and should not be left unchecked. If the 5A CBCT RESIDUAL value is selected, the level is calculated as a percentage of the **G/F CT PRIMARY** setting; if the 5A RESIDUAL value is selected, the level is calculated as a percentage of the **PHASE CT PRIMARY** setting.

OR

NOTE

The resulting **GROUND FAULT TRIP LEVEL** setting should be greater than 0.1A to avoid nuisance Ground Fault Trips.

GROUND FAULT TRIP LEVEL: OFF A

Range: 0.1 to 15.0 A, “0.5 A MAX”, or OFF; Step: 0.1 A

This message will appear if the Ground Fault CT Input is set to 50:0.025 CBCT. See description for **GROUND FAULT TRIP LEVEL** (%CT) for details. When set to 0.5 A MAX, the MM2 will trip at <u>less</u> than 0.5 A.

GROUND FAULT TRIP DELAY ON RUN: 1.0 s

Range: 0.0 to 10.0 seconds; Step: 0.1 second

This delay is used when the motor is in a RUNNING condition. If the ground current is equal to or above the **GROUND PRIMARY TRIP PICKUP** setpoint value and remains this way for the time delay programmed in this setpoint while the motor is running, the assigned relay(s) will activate and the CAUSE OF TRIP: GROUND FAULT message will be displayed.

NOTE

When the phase current increases from 0 A, the GROUND TRIP DELAY ON START setpoint below is used until the MM2 determines whether the motor is RUNNING or STARTING.

Refer to the **ACCELERATION TIME** setpoint in Section 4.3.7: LOAD PROTECTION for details on how the MM2 detects a start condition.

GROUND FAULT TRIP DLY ON START: 1.0s

Range: 0.0 to 10.0 seconds; Step: 0.1 second

This delay is used when the motor is in a STARTING condition. If the ground current is equal to or above the **GROUND PRIMARY TRIP PICKUP** setpoint value and remains this way for the time delay programmed in this setpoint while the motor is starting, the assigned relay(s) will activate and the CAUSE OF TRIP: GROUND FAULT message will be displayed.

NOTE

When the phase current increases from 0, this delay is used until the MM2 determines whether the motor is RUNNING or STARTING.

Refer to the **ACCELERATION TIME** setpoint in Section 4.3.7: LOAD PROTECTION for details on how the MM2 detects a start condition.

4.3.6 MOTOR PROTECTION – OPTIONS

PATH: SETPOINTS ▼▼ S2: PROTECTION ▼▼▼ MOTOR PROTECTION OPTIONS

MINIMIZE RESET TIME: ENABLE

Range: ENABLE, DISABLE

The MM2 measures the motor thermal capacity used during a start. This data can be used to minimize the lockout time following an Overload Trip. This allows the motor to be restarted after it has cooled to a safe starting temperature. When set to DISABLE, the lockout time after an Overload Trip will be the time required for the thermal memory to reduce to 15%.

For example, if the thermal capacity used during the previous start is 40%, then after an occurrence of an Overload Trip, a RESET can be accomplished when the thermal capacity decreases to 58% as shown:

100% – TC used during start – 2% Safety Margin
= 100% – 40% – 2% = 58%

STOPPED MOTOR COOL TIME: 30 MINUTES

Range: 5 to 1080 minutes; Step: 1 minute

The **STOPPED MOTOR COOL TIME** determines how long it takes for a stopped motor to reach steady state ambient temperature from its maximum allowable temperature. The maximum allowable temperature occurs when the thermal capacity used reaches 100% (e.g. at the occurrence of an Overload Trip). The Thermal Capacity value will decrease exponentially to model the cooling characteristic of the motor. The **STOPPED MOTOR COOL TIME** thus represents the time for the thermal capacity value to decay through 5 time constants. Note that an Overload Trip can normally be reset when the thermal capacity value decreases to 15%.

For example, given:

Maximum Thermal Capacity = 100% (Overload Trip)
STOPPED MOTOR COOL TIME = 30 minutes

The time to reach 15% Thermal Capacity Used can be calculated by:

$$\text{Thermal Capacity} = |100| \times e^{-t/T}$$

Therefore, the time that must pass until the Thermal Capacity reaches 15% can be calculated as shown:

$$\text{Thermal Capacity} = |100| \times e^{-t/T}$$

$$15 = |100| \times e^{-t/T} \Rightarrow 0.15 = e^{-t/T} \Rightarrow \frac{t}{T} = -\ln(0.15) \Rightarrow t = -T\ln 0.15$$

$$\Rightarrow t = 11.4 \text{ minutes}$$

OVERLOAD TRIP RESET: MANUAL

Range: MANUAL, AUTO

If this Setpoint is set to AUTO, an automatic reset of Overload Trips will occur after the motor has cooled to a thermal capacity value below 15%. When set to MANUAL, the keypad RESET key must be pressed to reset the trip after the motor has cooled to a thermal capacity value below 15%.

RESET LOCKOUT USING RESET KEY: ENABLE

Range: ENABLE, DISABLE

If this setpoint is set to ENABLE, the RESET key on the faceplate of the MM2 will reset all trips providing that the trip condition is not still present. When set to DISABLE, the RESET key on the faceplate will not reset the three lockout trips (Overload, Ground Fault, and Locked Rotor); one of the interlock inputs will have to be used to reset these three trips. Note: when the "Lockout Reset" function is configured, the RESET key will no longer be able to reset the three lockout trips.

PHASE UNBALANCE ALARM: ENABLE

Range: ENABLE, DISABLE

When an unbalance in phase currents exceeds the internally set threshold, an alarm condition will be generated if this value is set to ENABLE. The internal threshold is 15% and the unbalance must be above this threshold for at least 5 seconds for the alarm to occur.

THERMAL CAPACITY ALARM: OFF %

Range: 1 to 100% or OFF; Step: 1

When the thermal capacity used exceeds the level set, an alarm will be generated. This alarm can be assigned to a dedicated AUX Relay if desired.

OPEN CONTROL CIRCUIT TRIP: ENABLE

Range: ENABLE, DISABLE

In two-wire control applications where a constant start signal is provided, the MM2 should be configured to trip on an open control circuit. An Open Control Circuit occurs when feedback on Contactor Status (terminal 55) stays open when a start operation is executed. This condition may occur if a control wiring problem develops or because of an AUX contact failure. The **OPEN CONTROL CIRCUIT TRIP** feature should be used in conjunction with the **RESET ALARMS USING RESET KEY** function.

RESET ALARMS USING RESET KEY: ENABLE

Range: ENABLE, DISABLE

The MM2 will now allow the Acceleration Alarm, Open Control Circuit Alarm, Motor Greasing, Contactor Inspection and Motor Stopped Time Alarms to be reset using the Faceplate Reset Key. All other alarms will reset when the Alarm condition clears.

4.3.7 LOAD PROTECTION

PATH: SETPOINTS ▼▼ S2: PROTECTION ▼▼▼▼ LOAD PROTECTION

UNDERPOWER ALARM LEVEL: OFF kW

Range: 0.2 to 1100.0 kW or OFF; Step: 0.1 kW

Appears if **VT PRIMARY VOLTAGE** is not set to OFF. This feature functions the same as the Underpower Trip feature but produces an alarm indication instead of a trip.

UNDERPOWER ALARM DELAY: 10 s

Range: 1 to 60 seconds; Step: 1 second

Appears if **VT PRIMARY VOLTAGE** and **UNDERPOWER ALARM LEVEL** are not set to OFF. Enter a delay for activation of the Underpower Alarm.

UNDERPOWER TRIP LEVEL: OFF kW

Range: 0.2 to 1100.0 kW or OFF; Step: 0.1 kW

Appears if **VT PRIMARY VOLTAGE** is not set to OFF. For applications such as pumps, the Underpower Trip feature or the Undercurrent Trip feature can be selected to detect loss of load. The advantage of the Underpower Trip feature is that it allows for more accurate sensing if the loss of load results in only a small change in current and a power factor shift. If the power remains below this value while the motor is running for the time specified in **UNDERPOWER TRIP DELAY**, the MM2 will trip. Set this value to OFF if no Underpower Trip is required.

UNDERPOWER TRIP DELAY: 10 s

Range: 1 to 60 seconds; Step: 1 second

Appears if **VT PRIMARY VOLTAGE** and **UNDERPOWER TRIP LEVEL** are not set to OFF. Set the **UNDERPOWER TRIP DELAY** long enough to prevent nuisance trips from momentary power dips.

```
ACCELERATION TIME
ALARM: OFF s
```

Range: 0.5 to 125.0 seconds or OFF; Step: 0.5 second

Enter a time longer than the actual acceleration time of the motor. This is defined as the length of time required for the average motor current to drop below Full Load Current after a start command.

```
ACCELERATION TIME
TRIP:  OFF s
```

Range: 0.5 to 125.0 seconds or OFF; Step: 0.5 second

Enter the maximum allowable acceleration time of the motor. This is defined as the length of time required for the average motor current to drop below Full Load Current after a start command.

```
LOAD INCREASE ALARM:
 OFF %FLC
```

Range: 20 to 130% FLC or OFF; Step: 1% FLC

Set to a suitable level if a warning is required when motor current is approaching, or in, an overload condition. When current exceeds this value, a Load Increase Alarm will occur. Set to OFF if not required.

```
UNDERCURRENT ALARM
LEVEL: OFF %FLC
```

Range: 10 to 100% FLC or OFF; Step: 1% FLC

This feature functions the same as the Undercurrent Trip feature but produces an alarm indication instead of a trip.

```
UNDERCURRENT ALARM
DELAY:  10 s
```

Range: 1 to 60 seconds; Step: 1 second

Enter the delay for activation of the Undercurrent Alarm.

```
UNDERCURRENT TRIP:
LEVEL: OFF %FLC
```

Range: 10 to 100% FLC or OFF; Step: 1% FLC

For applications such as pumps an Undercurrent Trip can be selected. If the current remains below this value while the motor is running for the time specified in the **UNDERCURRENT TRIP DELAY**, the MM2 will trip. Set this value to OFF if no Undercurrent Trip is required.

```
UNDERCURRENT TRIP
DELAY:  10 s
```

Range: 1 to 60 seconds; Step: 1 second

Set the **UNDERCURRENT TRIP DELAY** long enough to prevent nuisance trips from momentary current dips when the Undercurrent Trip feature is used.

```
STALLED ROTOR TRIP
LEVEL: 4.50 xFLC
```

Range: 1.15 to 4.50 x FLC or OFF; Step: 0.05 x FLC

Mechanical equipment such as pumps or fans can be quickly damaged if it jams, resulting in a locked rotor stall. Even though the motor may be able to withstand the locked rotor for a longer time, it may be desirable to trip the motor quickly as soon as the stall condition occurs. The MM2 will trip when the running current exceeds this value after the Stalled Rotor Time. Set this value to OFF if stall protection of driven equipment is not required since the thermal overload protection will protect the motor. This feature is defeated during the inrush of motor starting.

```
STALLED ROTOR TRIP
DELAY:  3.0 s
```

Range: 0.5 to 5.0 seconds; Step: 0.5 seconds

If the **STALLED ROTOR TRIP LEVEL** is set to a value other than OFF, the MM2 will trip after the time specified by this setpoint.

4.3.8 UNDER/OVERVOLTAGE PROTECTION

PATH: SETPOINTS ▼▼ S2: PROTECTION ▼▼▼▼▼ UNDER/OVERVOLTAGE PROTECTION

```
UNDERVOLTAGE ALARM
LEVEL:  OFF V
```

Range: 0 to 600 V or OFF; Step: 1 V

Appears if **VT PRIMARY VOLTAGE** is not set to OFF. This feature functions the same as the Undervoltage Trip feature but produces an alarm indication instead of a trip.

```
UNDERVOLTAGE ALARM
DELAY: 10 s
```

Range: 1 to 60 seconds; Step: 1 second

Appears if **VT PRIMARY VOLTAGE** is not set to OFF. Enter the delay for activation of the Undervoltage Alarm.

```
UNDERVOLTAGE TRIP
LEVEL:  OFF V
```

Range: 0 to 600 V or OFF; Step: 1 V

Appears if **VT PRIMARY VOLTAGE** is not set to OFF. If the voltage remains below this value while the motor is running for the time specified in the **UNDERVOLTAGE TRIP DELAY**, the MM2 will trip. Set this value to OFF if no Undervoltage Trip is required.

```
UNDERVOLTAGE TRIP
DELAY: 10 s
```

Range: 1 to 60 seconds; Step: 1 second

Appears if **VT PRIMARY VOLTAGE** is not set to OFF. Set the **UNDERVOLTAGE TRIP DELAY** long enough to prevent nuisance trips from momentary voltage dips when the Undervoltage Trip feature is used.

```
OVERVOLTAGE ALARM
LEVEL:  OFF V
```

Range: 0 to 600 V or OFF; Step: 1 V

Appears if **VT PRIMARY VOLTAGE** is not set to OFF. This feature functions the same as the Overvoltage Trip feature but produces an alarm indication instead of a trip.

```
OVERVOLTAGE ALARM
DELAY:  10 s
```

Range: 1 to 60 seconds; Step: 1 second

Appears if **VT PRIMARY VOLTAGE** is not set to OFF. Enter the delay for activation of the Overvoltage Alarm.

```
OVERVOLTAGE TRIP
LEVEL:  OFF V
```

Range: 0 to 600 V or OFF; Step: 1 V

Appears if **VT PRIMARY VOLTAGE** is not set to OFF. If the voltage remains above this value while the motor is running for the time specified in the **OVERVOLTAGE TRIP DELAY**, the MM2 will trip. Set this value to OFF if no Overvoltage Trip is required.

```
OVERVOLTAGE TRIP
DELAY:  10 s
```

Range: 1 to 60 seconds; Step: 1 second

Appears if **VT PRIMARY VOLTAGE** is not set to OFF. Set the **OVERVOLTAGE TRIP DELAY** long enough to prevent nuisance trips from momentary voltage dips when the Undervoltage Trip feature is used.

4.4.1 DESCRIPTION

This page is used to enter all process information. Setpoints Page 3 is divided into four sections, PROGRAMMABLE INPUTS, INTERLOCK NAMES, FIELD STOP and ANALOG INPUT.

4.4.2 PROGRAMMABLE INPUTS

PATH: SETPOINTS ▼▼▼ S3: PROCESS ▼ PROGRAMMABLE INPUTS

NOTE

The first five messages are repeated for all ten interlock outputs.

```
INTERLOCK INPUT 1:
NOT USED
```

Range: NOT USED, PROCESS INTERLOCK A to PROCESS INTERLOCK J, PLANT INTERLOCK, LOCKOUT RESET, SETPOINT ACCESS, AUTO PERMISSIVE, AUTO START A, AUTO START B, RESET EMERGENCY STOP TRIP, RESET UNDERCURRENT TRIP, TWO WIRE CONTROL, TEST SWITCH, REMOTE PERMISSIVE, COMMUNICATIONS SELECT, INTERLOCK COUNTER, AUX RELAY 1 INHIBIT, WYE-DELTA 1M CONTACT, WYE-DELTA 2S CONTACT, U/V RESTART INHIBIT, AUTOTRANS 2S CONTACT, STOP A, STOP B, REMOTE RESET, MOTOR SELECTOR A/B, DUTY SELECT MANUAL/AUTO, BYPASS CONTACT, SWITCH INPUT MONITOR

Note that interlock input functions are active when the applicable switch input is closed and energized. See the following page for explanation of the range options.

```
STARTUP OVERRIDE
DELAY:  0 s  IL1
```

Range: 0 to 3600 seconds or OFF; Step: 1 second

See PROCESS INTERLOCK A. The corresponding Interlock Input number is shown as IL1 to IL10

```
RUNNING OVERRIDE
DELAY:  0 s
```

Range: 0 to 3600 seconds or OFF; Step: 1 second

See PROCESS INTERLOCK A.

```
OPERATION:
INTERLOCK STOP
```

Range: INTERLOCK STOP, LATCHED TRIP

See PROCESS INTERLOCK A.

```
INSTANTANEOUS ALARM:
DISABLE
```

Range: ENABLE, DISABLE

See PROCESS INTERLOCK A.

```
IL1 SWITCH TYPE:
N.O.
```

Range: N.O., N.C.

This setpoint allows the user to configure the type of switch used for the programmable switch inputs as normally open (N.O.) or normally closed (N.C.). When set to N.O. (factory default), if the switch input is closed, it is in the 'healthy' position; if the switch is open, it is in the 'unhealthy' position. When set to N.C., if the switch input is open, it is in the 'healthy' position; if it is closed, it is in the 'unhealthy' position.

```
LOCAL ISOLATOR:
DISABLE
```

Range: ENABLE, DISABLE

The Local Isolator switch input can be enabled or disabled using this Setpoint. When set to ENABLE a Local Isolator Trip will occur whenever the Local Isolator switch input is open. The trip will automatically reset when the switch input is closed.

AUTO PERMISSIVE INDICATION: MANUAL

Range: MANUAL, AUTO

AUTO MODE = SERIAL

Range: SERIAL, HARD-WIRED

SERIAL PERMISSIVE: DISABLE

Range: ENABLE, DISABLE

Allows serial commands to block all start commands (serial or manual) until the unblock command is received. This setpoint must be enabled before serial start block commands are executed. When set to DISABLE, any start blocks in effect are automatically unblocked. The **START BLOCK ALARM** setpoint can be used to indicate when a start was attempted while a block was in effect.

START BLOCK ALARM: DISABLE

Range: ENABLE, DISABLE

DISABLE COMMAND MODE CHANGE WHEN RUNNING

Range: ENABLE, DISABLE

This setpoint allows the active command mode to be changed while the motor is running. When set to DISABLE, the motor must first be stopped before the command mode can be changed (Auto or Manual).

NOTE

Interlock input functions are active when the applicable switch input is closed and energized.

The MM2 has 10 programmable switch inputs. Each input can have one of many functions assigned to it. Once a function is assigned to one Interlock input, that function cannot be assigned to any other Interlock input. The Interlock functions are:

- **NOT USED:** This is stored if this Interlock switch input is not used.
- **PROCESS INTERLOCK A-J:** The Process Interlock functions are used to provide time dependent trip / alarm / stop features based on a switch input. This function is used together with the **STARTUP OVERRIDE DELAY**, **RUNNING OVERRIDE DELAY**, **OPERATION**, and **INSTANTANEOUS ALARM** setpoints. The **STARTUP OVERRIDE** Delay setpoint sets the amount of time that the Process Interlock switch can remain open on the occurrence of a motor start. If the switch remains unhealthy for longer than this time, a Process Interlock Trip or Process Interlock Stop will occur. If the Startup Override Delay is set to 0 the Process Interlock switch must be healthy in order for the MM2 to allow the motor to start. If the Startup Override Delay is set to OFF this timer is disabled. The **RUNNING OVERRIDE DELAY** setpoint sets the amount of time that the Process interlock switch can be unhealthy during normal running. If the Process Interlock switch goes unhealthy after a motor start and remains unhealthy for longer than the Running Override Delay, a Process Interlock Trip or Process Interlock Stop will occur. If the **RUNNING OVERRIDE DELAY** is set to OFF, and the Process Interlock switch goes unhealthy after the motor has started, no Process Interlock Trip or Process Interlock Stop will occur. The **OPERATION** setpoint determines whether the Process Interlock feature is a Process Interlock Trip (reset required in order to restart the motor) or a Process Interlock Stop (no reset required). The **INSTANTANEOUS ALARM** setpoint is used to create an alarm whenever the Process Interlock switch is unhealthy. There is no time delay associated with this alarm feature. Note that the names of the Process Interlock features can be changed to any 20 alphanumeric character sequence. See **S3: PROCESS \ INTERLOCK NAMES** for further detail.

- **PLANT INTERLOCK:** This function is used to provide a switch input trip feature similar to the Local Isolator. When this switch is unhealthy a Plant Interlock Trip will occur. The Plant Interlock Trip is automatically cleared when the Plant Interlock switch goes healthy.
- **LOCKOUT RESET:** This function is used to provide a separate reset facility for lockout trips (i.e. Overload, Ground Fault and Stalled Rotor). These trips are considered to be more serious than other MM2 trips. When used, this switch will reset Overload Trips (regardless of Lockout Time), Ground Fault Trips and Stalled Rotor Trips only. All other trips must be reset using the RESET key. Note that the **RESET LOCKOUT USING RESET** setpoint in **S2: PROTECTION \ MOTOR PROTECTION OPTIONS** allows lockout trips to be reset using the RESET key if required.
- **SETPOINT ACCESS:** This function is used to provide security against unauthorized changing of MM2 setpoints. When this switch is unhealthy setpoints cannot be changed from the MM2 keypad. When this switch is healthy setpoints can be changed from the keypad. If this feature is not used Setpoints can always be changed from the keypad.
- **AUTO PERMISSIVE:** This function is used together with the AUTO START A / AUTO START B functions and can be further defined using the **AUTO PERMISSIVE INDICATION** and **AUTO MODE** setpoints. If the Auto Permissive Switch is healthy, start commands can come from the Auto Start A / Auto Start B switches. When the Auto Permissive Switch is unhealthy the Auto Start A / Auto Start B switches are ignored. When the Auto Permissive Switch is healthy, start commands via the Start A and B switch inputs and the faceplate are blocked. See **AUTO PERMISSIVE INDICATION** and **AUTO MODE** setpoint descriptions for further functionality.
- **AUTO START A:** This function is used in conjunction with the AUTO PERMISSIVE function described above. When the Auto Permissive switch is healthy, the Auto Start A switch can be used to start the motor.
- **AUTO START B:** This function is used together with the AUTO PERMISSIVE function. When the Auto Permissive switch is healthy, the Auto Start B switch can be used to start the motor in applications where Start B is used (Two Speed and Reversing starter types).
- **AUTO PERMISSIVE INDICATION:** This setpoint determines whether the AUTO or MANUAL indicator LED is illuminated when in the auto permissive mode. This allows the AUTO LED to be used for auto permissive and serial control, or just for serial control.
- **AUTO MODE:** This setpoint can be configured to either 'SERIAL' or 'HARD-WIRED'. When in the 'SERIAL' mode and the 'AUTO' button is pressed with the 'AUTO PERMISSIVE' switch unhealthy, the MM2 will execute start commands from the RS485 serial link only. When in the 'HARD-WIRED' mode and the 'AUTO' key is pressed, the MM2 will execute start commands from the 'AUTO START A' and 'AUTO START B' switch inputs only. Note: The 'AUTO PERMISSIVE' switch input must be healthy in order to do auto starts. This setpoint allows the user to change the control mode from MANUAL to HARD-WIRED AUTO via the AUTO/MANUAL buttons instead of having it done automatically when the Auto Permissive switch input is put into the healthy position.
- **RESET EMERGENCY STOP TRIP:** This function is used when a separate Emergency Stop Trip Reset switch is required. When this switch is healthy and an Emergency Stop Trip is present, the trip will be reset.
- **RESET UNDERCURRENT TRIP:** This function is used when a separate Undercurrent Trip Reset switch is required. When this switch is healthy and an Undercurrent Trip is present, the trip will be reset.

- **TWO WIRE CONTROL:** This function is used to provide a means to switch from normal pulsed three wire start / stop control to maintained two wire start / stop control. When this switch is healthy, start commands (Start A / Start B switch inputs Auto Start A / Auto Start B switch inputs) must be maintained in the closed state in order for the MM2 to keep the motor running. When the Start input is opened, the MM2 sees this as a STOP command and both contactor outputs will open. This is useful in applications with limit switches, PLC control or Hand/Off/Auto control.
- **TEST SWITCH:** This function is used to create a Test switch facility. When the Test switch input is healthy statistical counters (see actual values **A4: STATISTICS** \ **COUNTERS**) are not incremented with the exception of the interlock counter. This is used when control tests on the contactor are being performed and counters should not be updated. Note: if the motor is running when this switch is put into the healthy position, both contactors will open.
- **REMOTE PERMISSIVE:** This function provides a means to interlock between the keypad START A / START B keys and the Start A / Start B switch inputs. When a Remote Permissive switch is not used both of these start command sources will operate when the MM2 is in Manual mode (MANUAL LED on). When the Remote Permissive switch is healthy, the Start A / Start B switch inputs are functional but the START A / START B keypad keys are disabled. When the Remote Permissive switch is unhealthy, the START A / START B keypad keys are functional but the Start A / Start B switch inputs are disabled. Note: Auto mode or Hardwired Auto mode (AUTO LED on) disables both the Start A / Start B switches and the START A / START B keypad keys.
- **COMMUNICATION SELECT:** This function provides a facility to override the keypad AUTO / MANUAL keys. When this switch is healthy the MM2 is forced into Auto Serial mode (AUTO LED on). When this switch is unhealthy, the MM2 reverts back to the mode that was present before the switch was closed (Manual mode-MANUAL LED on or Hard-Wired Auto mode-AUTO LED on).
- **INTERLOCK COUNTER:** This function provides a means to count switch closures when assigned to one of the programmable switch inputs. When the switch input is put into the healthy position, the counter will increment by one. The counter can be viewed on page **A4: STATISTICS** \ **COUNTERS**. The interlock counter name and units can be programmed on page **S3: PROCESS** \ **INTERLOCK NAMES**. The digital input coming into the MM2 must have an ON time of no less than 100 ms and an OFF time of no less than 100 ms. This means that the MM2 can count up to 5 pulses per second = 5 Hz. The counter will count up to 65535 and then roll over. The counter can be cleared on page **S1: CONFIGURATION** \ **STATISTICS** or via the serial communications link.
- **AUX RELAY 1 INHIBIT:** This function will override/inhibit AUX Relay 1. When healthy, it will prevent AUX Relay 1 from turning ON, or turn OFF AUX Relay 1 after it is already ON.
- **WYE-DELTA 1M CONTACT:** This function is used as a status feedback input for the wye-delta closed transition starter type. See Section 8.11: WYE-DELTA CLOSED TRANSITION STARTER.
- **WYE-DELTA 2S CONTACT:** This function is used as a status feedback input for the wye-delta closed transition start type. See Section 8.11: WYE-DELTA CLOSED TRANSITION STARTER.
- **U/V RESTART INHIBIT:** This function disables the undervoltage restart feature when the switch is in the healthy position and allows U/V restarts to take place when the switch is unhealthy. Note that the undervoltage restart feature must be activated in **S4: CONTROL** for this interlock function to have any effect.
- **AUTO TRANS 2S CONTACT:** This function Is used as a status feedback input for the autotransformer open/closed transition starter type. See Section 8.7: AUTOTRANSFORMER OPEN

TRANSITION STARTER on page 8–20 and 8.8: AUTOTRANSFORMER CLOSED TRANSITION STARTER on page 8–24.

- **STOP A:** This function is used for end of travel applications. When an interlock configured for STOP A opens the corresponding output relay will open. When the STOP A input is open the motor cannot be started using start A commands or switch inputs.
- **STOP B:** This function is used for end of travel applications. When an interlock configured for STOP B opens the corresponding output relay will open. When the STOP B input is open the motor cannot be started using start B commands or switch inputs.
- **REMOTE RESET:** This function replaces the faceplate reset key. When configured the faceplate reset key will not reset any trips. When other switch inputs are used to reset specific trips the remote reset switch input will not reset those trips, i.e. Undercurrent Trip, Emergency Stop Trip, Lockout Trips.
- **MOTOR SELECTOR A/B:** This setting is used in conjunction with the Duty/Standby starter type. In the Manual mode the state of this interlock determines which of the two motors is used for starting (Healthy = Motor B). When A is selected only the contactor A output relay will respond to start commands. When B is selected only the contactor B output relay will respond to start commands.
- **DUTY SELECT MAN/AUTO:** This setting is used in conjunction with the Duty/Standby starter type. This input determines the mode of operation for the Duty/Standby starter type either Manual or Auto. In the Auto mode the MM2 will alternatively start Motor A and Motor B. When the number of starts is an even number Motor A will be started the next time a start command is issued. When the number of starts is odd Motor B will be started the next time a start command is issued. In the event of a trip on either motor, the motor that tripped will be prevented from starting until reset is pressed. All starts will default to the untripped motor. When the trip occurs the MM2 automatically resets the trip to allow the other motor to be started. The trip message becomes an alarm message which must be reset to allow the tripped motor to start. If the second motor trips the MM2 will remain tripped until reset is pressed. The details of the Manual mode are described above under MOTOR SELECTOR A/B above.

NOTE

Faceplate Stop trips, Process Stop trips and ESD Stop trips MUST be manually reset regardless of the Duty/Standby mode. Local Isolator and Plant Interlock trips reset only when the input is healthy.

- **SWITCH INPUT MONITOR**: When assigned, the application of the switch input monitor feature requires an input to be permanently wired closed via a hardware jumper. When the Switch Input Monitor feature is assigned to an Interlock, the MM2 continually reads the switches as it normally would and then checks the switch monitor input to check if it is still healthy. If so, the MM2 updates the switch data with the new switch read and performs any necessary functions. If not, the MM2 assumes the unit is in an undervoltage situation and disregards the switch data until the Switch Input Monitor becomes healthy again. This feature improves the reliability of the Undervoltage Restart element to successfully restart the motor under very specific voltage dips and durations (approximately 56 to 62% of nominal 100 ms duration).
- **BYPASS CONTACT**: This function is used as a status feedback input for the soft starter. See Section 8.13: SOFT STARTER on page 8–38 for functionality.

4.4.3 INTERLOCK NAMES

PATH: SETPOINTS ▼▼▼ S3 PROCESS ▼▼ INTERLOCK NAMES

```
PROCESS INTLK A NAME:
PROCESS INTERLOCK A
```

Range: 20 alphanumeric characters

The MM2 allows programming of user defined names for the process interlock functions. To store a name, use the VALUE UP/DOWN keys to change the cursor to the desired letter or number. Press the STORE key. This stores the character and moves the cursor to the next position. Repeat until the entire message has been entered. A space can be used to replace characters if no new character is required. If the cursor is at the end of the message, pressing STORE wraps around to the first position. This message will now appear on any actual values message relating to process interlock A.

```
PROCESS INTLK B NAME:
PROCESS INTERLOCK B
```

Range: 20 alphanumeric characters

See **PROCESS INTERLOCK A NAME**.

↓ ↓

```
PROCESS INTLK J NAME:
PROCESS INTERLOCK J
```

Range: 20 alphanumeric characters

See **PROCESS INTERLOCK A NAME**.

```
INTLK COUNTER NAME:
INTERLOCK COUNTER
```

Range: 20 alphanumeric characters

This setpoint allows defining the name of the interlock counter. See **PROCESS INTERLOCK A NAME** for directions on entering characters.

```
INTLK COUNTER UNITS:
UNITS
```

Range: 20 alphanumeric characters

This setpoint allows defining the units of the interlock counter. See **PROCESS INTLK A NAME** for directions on entering characters.

4.4.4 STOP CONFIGURATION

PATH: SETPOINTS ▼▼▼ S3 PROCESS ▼▼▼ STOP CONFIGURATION

```
FIELD STOP:
  UNLATCHED
```

Range: LATCHED, UNLATCHED

If the MM2 detects that either Contactor A or Contactor B has dropped out without receiving a Stop command, an External Stop sequence has occurred. If the **FIELD STOP** setpoint is set to UNLATCHED the message EXTERNAL STOP will be displayed. If the **FIELD STOP** setpoint is set to LATCHED the MM2 will initiate an Emergency Stop Trip. This trip condition must be reset before the motor can be restarted.

```
FACEPLATE STOP:
  UNLATCHED
```

Range: LATCHED, UNLATCHED

When set to LATCHED, pressing the STOP button causes a latched trip. Pressing RESET allows the motor to restart. If the MM2 is receiving a constant start signal, the motor will start as soon as reset is pressed.

```
PROCESS STOP:
  UNLATCHED
```

Range: LATCHED, UNLATCHED

When set to latched, a momentary opening of a contact connected to Terminal 51 will cause a latched trip condition. Pressing the reset key will allow the motor to restart. If the MM2 is receiving a constant start signal the motor will start as soon as reset is pressed.

4.4.5 ANALOG INPUT

PATH: SETPOINTS ▼▼▼ S3 PROCESS ▼▼▼▼ ANALOG INPUT

```
ANALOG INPUT NAME:
ANALOG INPUT
```

Range: 20 alphanumeric characters

The MM2 allows the user to program user defined names for the analog input and units. To store the name, use VALUE UP/DOWN keys to change cursor to the desired letter or number. Press STORE. This stores the character and moves the cursor to the next position. Repeat this sequence until the entire message has been entered. One of the characters is a blank space which can be used if no new character is required. If the cursor is at the end of the message, pressing STORE causes the cursor to wrap around to the first position. This message will now appear on any actual values message relating to analog input.

```
ANALOG INPUT UNIT:
UNITS
```

Range: 20 alphanumeric characters

See **ANALOG INPUT NAME** for details on storing user defined units.

```
MINIMUM SCALE:
4 mA:  0
```

Range: 0 to 20000; Step: 10

The analog input can be scaled to user defined values. Minimum (4 mA) and maximum (20 mA) scale values must be specified. Enter the minimum scale value with this setpoint.

```
MAXIMUM SCALE:
20 mA: 1000
```

Range: 10 to 20000; Step: 10

Enter the maximum scale value corresponding to a 20 mA analog input.

```
ANALOG ALARM LOW
LEVEL:  OFF
```

Range: 1 to 20000 or OFF; Step: 1

If the analog input scaled value drops below the level set by this setpoint, an Analog Input Low Alarm will occur. Note that the alarm level must be a value between the **MINIMUM SCALE** and **MAXIMUM SCALE** values.

```
ANALOG ALARM LOW
DELAY: 5 s
```

Range: 1 to 600 seconds or OFF; Step: 1 second

The analog input scaled value must be below the **ANALOG ALARM LOW LEVEL** for the time specified by this setpoint before an alarm will occur.

```
ANALOG ALARM HIGH
LEVEL:  OFF
```

Range: 1 to 20000 or OFF; Step: 1

If the analog input scaled value exceeds the level set by this setpoint, an Analog Input High Alarm will occur. Note that the alarm level must be a value between the **MINIMUM SCALE** and **MAXIMUM SCALE** values.

```
ANALOG ALARM HIGH
DELAY:  5 s
```

Range: 1 to 600 seconds or OFF; Step: 1 second

The analog input scaled value must be above the **ANALOG ALARM HIGH LEVEL** for the time specified by this setpoint before an alarm will occur.

```
ANALOG TRIP LOW
LEVEL: OFF
```

Range: 1 to 20000 or OFF; Step: 1

If the analog input scaled value drops below the level set by this setpoint, an Analog Input Low Trip will occur. Note that the trip level must be a value between the **MINIMUM SCALE** and **MAXIMUM SCALE** values.

```
ANALOG TRIP LOW
OVERRIDE: 5 s
```

Range: 1 to 600 seconds or OFF; Step: 1

The analog level must reach a healthy state (greater than trip level) after a start within the amount of time set by this setpoint. If the value is 0, the analog level must be healthy when a start is initiated or an analog trip will occur immediately. If set to OFF, the trip will occur if the analog level is unhealthy, regardless if the motor is running or stopped.

```
ANALOG TRIP LOW
DELAY: 5 s
```

Range: 1 to 600 seconds or OFF; Step: 1 second

The analog input scaled value must be below the **ANALOG TRIP LOW LEVEL** for the time specified by this setpoint before a trip will occur.

```
ANALOG TRIP HIGH
LEVEL: OFF
```

Range: 1 to 20000 or OFF; Step: 1

If the analog input scaled value exceeds the level set by this setpoint, an Analog Input High Trip will occur. Note that the trip level must be a value between the **MINIMUM SCALE** and **MAXIMUM SCALE** values.

```
ANALOG TRIP HIGH
OVERRIDE: 5 s
```

Range: 1 to 600 seconds or OFF; Step: 1

The analog level must reach a healthy state (less than trip level) after a start within the amount of time set by this setpoint. If the value is 0, the analog level must be healthy when a start is initiated or an analog trip will occur immediately. If the value is set to OFF, the trip will occur if the analog level is unhealthy, regardless if the motor is running or stopped.

```
ANALOG TRIP HIGH
DELAY: 5 s
```

Range: 1 to 600 seconds or OFF; Step: 1 second

The analog input scaled value must be above the **ANALOG TRIP HIGH LEVEL** for the time specified by this setpoint before a trip will occur.

4.5.1 DESCRIPTION

This page is used to configure all control features in the MM2. Setpoints Page 4 is divided into three sections, UNDERVOLTAGE AUTO-RESTART, AUX RELAY 1 CONFIG and AUX RELAY 2 CONFIG.

4.5.2 UNDERVOLTAGE AUTORESTART

PATH: SETPOINTS ▼▼▼▼ S4: CONTROL ▼ UNDERVOLTAGE AUTO RESTART

```
UNDERVOLTAGE
RESTART: ENABLE
```

Range: ENABLE, DISABLE

It is possible to restart the motor after a momentary power loss if this feature is enabled. When the control voltage (derived from the incoming motor supply) drops below the dropout voltage, both contactors are de-energized. Voltage thresholds for the two internally set control voltage levels are 80 V for 120 V setting and 150 V for 240 V setting. At nominal voltage, the MM2 rides through a power outage less than 135 ms (varies according to the number of output relays energized at the time of power failure). Critical data is saved to E^2PROM at this time. A power outage that exceeds the MM2 ride-through initializes a backup timer that continues to run without power for approximately 1 hour. Once control power is restored, the MM2 can take up to 300 ms to initialize; this time includes the initializing of the microprocessor, variables in the code, the determination that a restart is required, and the closure of the internal output relay. The reaction time of the contactor will be in addition to the 300 ms power-up time. If control voltage is restored within the **IMMED. RESTART POWER LOSS TIME** (0.1 to 0.5 sec.), the motor will be restarted immediately. If the supply is restored after the **IMMED. RESTART POWER LOSS TIME** but before the **DELAY RESTART POWER LOSS TIME**, the motor will be restarted after the **RESTART TIME DELAY**. If a delayed restart is always required, set the **DELAY RESTART POWER LOSS TIME** to UNLIMITED. Select DISABLE if this feature is not required.

```
IMMED. RESTART POWER
LOSS TIME:  200 ms
```

Range: 100 to 500 ms or OFF; Step: 20 ms

This is the time measured by the MM2 backup processor; it is not the time the AC power has been off. See **UNDERVOLTAGE RESTART** for details.

```
DELAY RESTART POWER
LOSS TIME:  2.0 s
```

Range: 0.1 to 10 seconds or TIME UNLIMITED; Step: 0.1 sec.

This is the time measured by the MM2 backup processor; it is not the time the AC power has been off. See **UNDERVOLTAGE RESTART** for details.

```
RESTART TIME DELAY
  2.0 s
```

Range: 0.2 to 1200.0 seconds; Step: 0.2 seconds

See **UNDERVOLTAGE RESTART** for details.

NOTE

The MM2 will not initiate an undervoltage autorestart if there is a start inhibit active. After the start inhibit has expired, a manual restart is allowed.

4.5.3 AUX RELAY 1/2 CONFIG

PATH: SETPOINTS ▼▼▼▼ S4 CONTROL ▼▼ AUX 1/2 RELAY CONFIG

The MM2 has two auxiliary programmable output relays. These two outputs can be assigned any of the functions listed below. Once a function has been assigned to one of the auxiliary relays it cannot be assigned to the other with the exception of the SERIAL CONTROL function which can be set to both auxiliary relays.

NOTE

The setpoints listed under the AUX RELAY 2 CONFIG page operate in the same manner as the setpoints shown for AUX RELAY 1 CONFIG.


```
AUX RELAY 1 FUNCTION:
 SERIAL CONTROL
```

Range: SERIAL CONTROL, TRIPS, ALARMS, PRE CONTACTOR A, POST CONTACTOR A, POST CONTACTOR B, MOTOR AVAILABLE-MAN, LOAD INCREASE ALARM, UNDERCURRENT TRIP, UNDER-POWER TRIP, KEYPAD RESET, INTERLOCK 1 to INTERLOCK 10, AUTO MODE, MOTOR RUNNING, GROUND FAULT TRIP, WYE-DELTA CLS TRANS, AUTOTRANSFORMER 2S, NOT USED, PRE CONTACTOR B, SEGREGATED G/F ALARM, THERMAL CAPACITY ALARM, MOTOR AVAILABLE AUTO, MOTOR AVAILABLE, OVER-LOAD TRIP, SOFT STARTER BYPASS

The dual form "C" AUX Relay 1 can be configured to activate on various conditions as described below.

```
AUX RELAY 1 DELAY
    5 s
```

Range: 0 to 125 sec.; Step: 1

Provides a delayed energization of AUX Relay 1 when POST CONTACTOR A or POST CONTACTOR B is selected as the **AUX RELAY 1 FUNCTION**.

```
AUX RELAY 1 PRE
START DELAY: 5 s
```

Range: 0 to 900 sec.; Step: 1

Determines how long the AUX Relay 1 will energize before energizing Contactor A. When set to 0, both AUX Relay 1 and Contactor A will energize at the same time.

```
AUX RELAY 1 POST
START DELAY: OFF s
```

Range: 0 to 125 sec. or OFF; Step: 1

Determines how long AUX 1 remains energized after Contactor A closes. When set to 0, AUX 1 de-energizes as soon as Contactor A closes. When set to OFF, AUX 1 remains energized until Contactor A opens.

```
ENERGIZE ON MOTOR
START DELAY: 5 s
```

Range: 0 to 125 sec.; Step: 1

Provides a delayed energization of the AUX Relay 1 when MOTOR RUNNING is selected as the **AUX RELAY 1 FUNCTION**. The AUX Relay 1 energizes after this time delay on the occurrence of a motor start.

```
DE-ENERGIZE ON MOTOR
STOP DELAY: 5 s
```

Range: 0 to 125 sec.; Step: 1

Provides a delayed de-energization of the AUX Relay 1 when MOTOR RUNNING is selected as the **AUX RELAY 1 FUNCTION**. The AUX Relay 1 will de-energize after this time delay on the occurrence of a motor stop.

```
AUX 1 OPERATION:
NON-FAILSAFE
```

Range: FAILSAFE, NON-FAILSAFE

Choose between NON-FAILSAFE or FAILSAFE operation of AUX Relay 1. In NON-FAILSAFE mode, the relay will be de-energized in its inactive state and energized in its active state. In FAILSAFE mode, the relay will be energized in its inactive state and de-energized in its active state.

```
DELAY CONTACTOR G/F
TRIP BY: 0 ms
```

Range: 0 to 1000 ms; Step: 100 ms

- **SERIAL CONTROL**: The AUX Relay 1 can be energized or de-energized via the serial port.
- **TRIPS**: The AUX Relay 1 will be energized when the MM2 is tripped. Resetting the MM2 will de-energize the AUX Relay 1.
- **ALARMS**: The AUX Relay 1 will be energized while any alarm is present.
- **PRE CONTACTOR A**: The AUX Relay 1 will energize when the MM2 receives a start command. The Contactor A relay will start the motor after the delay specified in the **AUX RELAY 1 PRE START DELAY** setpoint. The AUX Relay 1 will de-energize after the **AUX RELAY 1 POST START DELAY** times out or when Contactor A de-energizes.
- **PRE CONTACTOR B**: The AUX Relay will energize when the MM2 receives a start B command. The Contactor B relay will start the motor after the delay specified in the **AUX RELAY 1 PRE START DELAY** setpoint. The Aux Relay will de-energize after the **AUX RELAY 1 POST START DELAY** times out or when Contactor B de-energizes. Pre Contactor B is active for the TWO SPEED, FV REVERSING and DUTY/STANDBY starter types only.
- **POST CONTACTOR A**: The AUX Relay 1 will energize after the Contactor A relay in the time specified by the **AUX RELAY 1 DELAY** setpoint. The AUX Relay 1 will de-energize when Contactor A de-energizes.
- **POST CONTACTOR B**: The AUX Relay 1 will energize after the Contactor B relay in the time specified by the **AUX RELAY 1 DELAY** setpoint. The AUX Relay 1 will de-energize when Contactor B de-energizes.
- **MOTOR AVAILABLE MANUAL**: When the Motor Status message indicates that the motor can be started manually the AUX Relay 1 will be energized. Any other Motor Status indication will cause the AUX Relay 1 to be de-energized.
- **LOAD INCREASE**: The AUX Relay 1 will energize while a Load Increase Alarm is present.
- **UNDERCURRENT TRIP**: The AUX Relay 1 will energize while an Undercurrent Trip is present.
- **UNDERPOWER TRIP**: The AUX Relay 1 will energize while an Underpower Trip is present.
- **KEYPAD RESET**: The AUX Relay 1 will energize while the RESET key is pressed.
- **INTERLOCK 1**: The AUX Relay 1 will energize while the Interlock 1 switch input is closed.
- **INTERLOCK 2**: The AUX Relay 1 will energize while the Interlock 2 switch input is closed.
- **INTERLOCK 3**: The AUX Relay 1 will energize while the Interlock 3 switch input is closed.
- **INTERLOCK 4**: The AUX Relay 1 will energize while the Interlock 4 switch input is closed.
- **INTERLOCK 5**: The AUX Relay 1 will energize while the Interlock 5 switch input is closed.
- **INTERLOCK 6**: The AUX Relay 1 will energize while the Interlock 6 switch input is closed.

- **INTERLOCK 7**:The AUX Relay 1 will energize while the Interlock 7 switch input is closed.
- **INTERLOCK 8**: The AUX Relay 1 will energize while the Interlock 8 switch input is closed.
- **INTERLOCK 9**: The AUX Relay 1 will energize while the Interlock 9 switch input is closed.
- **INTERLOCK 10**: The AUX Relay 1 will energize while the Interlock 10 switch input is closed.
- **AUTO MODE**: The AUX Relay 1 will energize when the AUTO LED is on.
- **MOTOR RUNNING**: The AUX Relay 1 will energize while the motor is running in conjunction with the Motor Start Delay and Motor Stop Delay.
- **GROUND FAULT TRIP**: The AUX Relay 1 will energize when a ground fault trip occurs.

WARNING

The MM2 energizes the auxiliary relay and de-energizes contactor A at the same time the ground fault trip occurs. See the warning notes under Motor Protection/ Ground Fault for more details. Use the Delay Contactor Ground Fault Trip By setting for coordination.

- **WYE DELTA CLS TRANS**: This function must be configured when using the wye delta closed transition starter type. See Section 8.11: WYE-DELTA CLOSED TRANSITION STARTER on page 8–32 for more details.
- **AUTOTRANSFORMER 2S**: This function must be configured when using the autotransformer open/closed transition starter type. See Section 8.7: AUTOTRANSFORMER OPEN TRANSITION STARTER on page 8–20 and 8.8: AUTOTRANSFORMER CLOSED TRANSITION STARTER on page 8–24 for more details.
- **NOT USED**: This function may be stored if the AUX Relay is not used. Factory default is serial control.
- **SEGREGATED G/F ALARM**: This function will energize the AUX Relay when a ground fault alarm occurs. If the other AUX Relay is configured for ALARMS it will not operate until another alarm occurs that is not a ground fault alarm.
- **THERMAL CAPACITY ALARM**: The AUX Relay 1 will energize when a thermal capacity alarm is present.
- **MOTOR AVAILABLE AUTO**: This AUX Relay function will activate the AUX Relay when the motor is available to start in Auto Mode.
- **MOTOR AVAILABLE:** This AUX Relay function will activate the AUX Relay when the motor is available to start regardless of which mode the MM2 is presently in (Auto or Manual). The AUX Relay will remain active when the motor is running to indicate normal operation (that is, no stop inputs or trips).
- **OVERLOAD TRIP**: This AUX Relay function will activate the Aux Relay when the motor is tripped on overload.
- **SOFT STARTER BYPASS**: This AUX Relay function can be configured when using soft starter type. See Section 8.13: SOFT STARTER on page 8–38 for more details.

4.6.1 DESCRIPTION

This page is used to enter setpoints for monitoring and motor maintenance. Setpoints Page 5 has two sections, PLANT CONDITION and PRESET COUNTERS AND TIMERS.

4.6.2 PLANT CONDITION

PATH: SETPOINTS ▼▼▼▼▼ S5 MONITORING ▼ PLANT CONDITION

```
MOTOR GREASING
INTERVAL: OFF hrs
```

Range: 100 to 50000 hours or OFF; Step: 100 HOURS

Enter the interval at which the motor bearings must be lubricated. When the Motor Running Time exceeds this setpoint a MOTOR GREASING INTERVAL ALARM is generated. Use the **CLEAR TIMERS** setpoint in **S1: CONFIGURATION** \ **STATISTICS** to clear the Motor Running Hours. If this feature is not required set this setpoint to OFF.

```
CONTACTOR INSPECTION
  OFF x 1000 OPS
```

Range: 1000 to 10000000 operations or OFF; Step: 1000 ops.

Enter the interval at which the contactor contacts must be inspected for wear. When the **NUMBER OF STARTS** counter exceeds this setpoint a CONTACTOR INSPECTION INTERVAL ALARM is generated. Use the **S1: CONFIGURATION** \ **STATISTICS** \ **CLEAR COUNTERS** setpoint to clear the **NUMBER OF STARTS** counter. If this feature is not required set this setpoint to 0FF.

```
MAX MOTOR STOPPED
TIME: OFF hrs
```

Range: 10 to 10000 hours or OFF; Step: 10 hours

Enter the maximum interval that the motor can be left not running. When the Motor Stopped Time exceeds this setpoint, a MAXIMUM MOTOR STOPPED TIME ALARM is generated. Start the motor to clear the Motor Stopped Time. If this feature is not required set this setpoint to 0FF.

4.6.3 PRESET COUNTERS AND TIMERS

PATH: SETPOINTS ▼▼▼▼▼ S5 MONITORING ▼▼ PRESET COUNTERS AND TIMERS

PRESET RUNNING HOURS: 0 HRS	*Range: 0 to 65535; Step 1* Sets the number of Running Hours to a predetermined value.
PRESET STOPPED HOURS: 0 HRS	*Range: 0 to 65535; Step 1* Sets the number of Stopped Hours to a predetermined value.
PRESET NUMBER OF STARTS: X100	*Range: 0 to 65535; Step 1* Sets the Number Of Starts to a predetermined value within 100 starts.
PRESET OVERLOAD TRIPS: 0	*Range: 0 to 65535; Step 1* Sets the number of Overload Trips to a predetermined value.
PRESET THERMISTOR TRIPS: 0	Range: 0 to 65535; Step 1 Sets the number of Thermistor Trips to a predetermined value.
PRESET GROUND FAULT TRIPS: 0	Range: 0 to 65535; Step 1 Sets the number of Ground Fault trips to a predetermined value.
PRESET SINGLE PHASE TRIPS: 0	Range: 0 to 65535; Step 1 Sets the number of Single Phase trips to a predetermined value.
PRESET ACCELERATION TRIPS: 0	Range: 0 to 65535; Step 1 Sets the number of Acceleration trips to a predetermined value.
PRESET UNDERCURRENT TRIPS: 0	Range: 0 to 65535; Step 1 Sets the number of Undercurrent trips to a predetermined value.
PRESET UNDERPOWER TRIPS: 0	Range: 0 to 65535; Step 1 Sets the number of Underpower trips to a predetermined value.
PRESET STALLED ROTOR TRIPS: 0	Range: 0 to 65535; Step 1 Sets the number of Stalled Rotor trips to a predetermined value.
PRESET CONTROL TRIPS: 0	Range: 0 to 65535; Step 1 Sets the number of Control trips to a predetermined value.
PRESET INTERLOCK COUNTER: 0	Range: 0 to 65535; Step 1 Sets the number of Interlock Counter operations to a predetermined value.

4.7.1 DESCRIPTION

This page contains information about the version of the MM2 and data for GE Multilin service technicians. Setpoints Page 6 is divided into two sections, PRODUCT IDENTIFICATION and FACTORY SERVICE DATA.

4.7.2 PRODUCT FIRMWARE

PATH: SETPOINTS ▼▼▼▼▼▼ S6 FACTORY DATA ▼ PRODUCT FIRMWARE IDENTIFICATION

```
MOD NUMBER(S): 000
```

Range: for identification only

If the MM2 has been modified so that it is no longer a standard model, a modification number will be displayed in this message.

```
MOTOR MANAGER 2
VERSION: X.XX
```

Range: for identification only

This message identifies the MM2 main firmware version.

```
BOOT PROGRAM
VERSION: X.XX
```

Range: for identification only

This message identifies the MM2 Boot Program version.

```
SUPERVISOR PROGRAM
VERSION: X.XX
```

Range: for identification only

This message identifies the MM2 Supervisor Program version.

```
MM2 HARDWARE
REVISION: X.XX
```

Range: for identification only

This message identifies the Hardware revision the currently loaded firmware was compiled for.

4.7.3 PRODUCT MODEL IDENTIFICATION

PATH: SETPOINTS ▼▼▼▼▼▼ S6 FACTORY DATA ▼▼ PRODUCT MODEL IDENTIFICATION

```
SERIAL NUMBER:
D7191234
```

Range: for identification only

This message identifies the MM2 serial number.

```
DATE OF MANUFACTURE:
February 1, 1996
```

Range: for identification only

This message identifies the date of manufacture.

4.7.4 FACTORY SERVICE DATA

PATH: SETPOINTS ▼▼▼▼▼▼ S6 FACTORY DATA ▼▼▼ FACTORY SERVICE DATA

```
FACTORY SERVICE
PASSCODE: 0
```

Range: 0 to 9999

For use by GE Multilin personnel for testing and calibration purposes.

5.1.1 OVERVIEW

The MM2 implements a subset of the Modicon Modbus RTU serial communication standard. The Modbus protocol is hardware-independent. That is, the physical layer can be any of a variety of standard hardware configurations. This includes RS232, RS422, RS485, fibre optics, etc. Modbus is a single master / multiple slave type of protocol suitable for a multi-drop configuration as provided by RS485 hardware. The MM2 Modbus implementation employs two-wire RS485 hardware. Using RS485, up to 32 MM2s can be daisy-chained together on a single communication channel.

The MM2 is always a Modbus slave. They can not be programmed as Modbus masters. Computers or PLCs are commonly programmed as masters.

Modbus protocol exists in two versions: Remote Terminal Unit (RTU, binary) and ASCII. Only the RTU version is supported by the MM2. Both monitoring and control are possible using read and write register commands. Other commands are supported to provide additional functions.

5.1.2 ELECTRICAL INTERFACE

The hardware or electrical interface in the MM2 is two-wire RS485. In a two-wire link, data is transmitted and received over the same two wires. Although RS485 two wire communication is bi-directional, the data is never transmitted and received at the same time. This means that the data flow is half duplex.

RS485 lines should be connected in a daisy chain configuration with terminating networks installed at each end of the link (i.e. at the master end and at the slave farthest from the master). The terminating network should consist of a 120 Ω resistor in series with a 1 nF ceramic capacitor when used with Belden 9841 RS485 wire. Shielded wire should always be used to minimize noise. The shield should be connected to all of the MM2s as well as the master, then grounded at one location only. This keeps the ground potential at the same level for all of the devices on the serial link.

Polarity is important in RS485 communications. The '+' (positive) terminals of every device must be connected together.

See Figure 2–6: RS485 TERMINATION on page 2–7 and Chapter 2: INSTALLATION for more information.

5.1.3 DATA FRAME FORMAT AND DATA RATE

One data frame of an asynchronous transmission to or from a MM2 typically consists of 1 start bit, 8 data bits, and 1 stop bit. This produces a 10 bit data frame. This is important for transmission through modems at high bit rates (11 bit data frames are not supported by Hayes modems at bit rates of greater than 300 bps). The MM2 has the capability of adding an odd or even parity bit if necessary.

Modbus protocol can be implemented at any standard communication speed. The MM2 supports operation at 1200, 2400, 4800, 9600, and 19200 baud.

5.1.4 DATA PACKET FORMAT

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

Master Request Transmission:

SLAVE ADDRESS: 1 byte
FUNCTION CODE: 1 byte
DATA: variable number of bytes depending on FUNCTION CODE
CRC: 2 bytes

Slave Response Transmission:

SLAVE ADDRESS: 1 byte
FUNCTION CODE: 1 byte
DATA: variable number of bytes depending on FUNCTION CODE
CRC: 2 bytes

SLAVE ADDRESS: This is the first byte of every transmission. This byte represents the user-assigned address of the slave device that is to receive the message sent by the master. Each slave device must be assigned a unique address and only the addressed slave will respond to a transmission that starts with its address. In a master request transmission the SLAVE ADDRESS represents the address of the slave to which the request is being sent. In a slave response transmission the SLAVE ADDRESS represents the address of the slave that is sending the response. Note: A master transmission with a SLAVE ADDRESS of 0 indicates a broadcast command. Broadcast commands can be used only in certain situations; see Section 5.4: APPLICATIONS on page 5–14 for details.

FUNCTION CODE: This is the second byte of every transmission. Modbus defines function codes of 1 to 127. The MM2 implements some of these functions. See Section 5.1.8: MM2 SUPPORTED FUNCTIONS on page 5–4 details of the supported function codes. In a master request transmission the FUNCTION CODE tells the slave what action to perform. In a slave response transmission the FUNCTION CODE tells the master what function was performed as requested. If the high order bit of the FUNCTION CODE sent from the slave is a 1 (i.e. if the FUNCTION CODE is > 127) then the slave did not perform the function as requested and is sending an error or exception response.

DATA: This will be a variable number of bytes depending on the FUNCTION CODE. This may be Actual Values, Setpoints, or addresses sent by the master to the slave or by the slave to the master. See Section 5.1.8: MM2 SUPPORTED FUNCTIONS for a description of the supported functions and the data required for each.

CRC: This is a two byte error checking code.

5.1.5 ERROR CHECKING

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

If a MM2 Modbus slave device receives a transmission in which an error is indicated by the CRC-16 calculation, the slave device will not respond to the transmission. A CRC-16 error indicates than one or more bytes of the transmission were received incorrectly and thus the entire transmission should be ignored in order to avoid the MM2 performing any incorrect operation.

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

5.1.6 CRC-16 ALGORITHM

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

—>: data transfer

A: 16 bit working register

AL: low order byte of A

AH: high order byte of A

CRC: 16 bit CRC-16 value

i, j: loop counters

(+): logical exclusive or operator

Di: i-th data byte (i = 0 to N-1)

G: 16 bit characteristic polynomial = 1010000000000001 with MSbit dropped and bit order reversed

shr(x): shift right (the LSbit of the low order byte of x shifts into a carry flag, a '0' is shifted into the MSbit of the high order byte of x, all other bits shift right one location

The algorithm is:

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

5.1.7 TIMING

Data packet synchronization is maintained by timing constraints. The receiving device must measure the time between the reception of characters. If 3.5 character times elapse without a new character or completion of the packet, then the communication link must be reset (i.e. all slaves start listening for a new transmission from the master). Thus at 9600 baud a delay of greater than $3.5 \times 1 / 9600 \times 10 \times = \times 3.65 \times$ ms will cause the communication link to be reset.

5.1.8 MM2 SUPPORTED FUNCTIONS

The following functions are supported by the MM2:

- FUNCTION CODE 01 - Read Coil Status
- FUNCTION CODE 03 - Read Setpoints and Actual Values
- FUNCTION CODE 04 - Read Setpoints and Actual Values
- FUNCTION CODE 05 - Execute Operation
- FUNCTION CODE 06 - Store Single Setpoint
- FUNCTION CODE 07 - Read Device Status
- FUNCTION CODE 08 - Loopback Test
- FUNCTION CODE 10 - Store Multiple Setpoints

5.2.1 FUNCTION CODE 01H

Modbus implementation: Read Coil Status
MM2 implementation: Read Last Command Operation

This function code allows the master to read back which command operation was last performed using Modbus function code 05: force single coil/execute operation. Upon request of coil/operation status, the MM2 will set a bit corresponding to the last operation performed. The operation commands are in the Modbus Data Formats table under code F22.

Note: Operation 0 will be set (1) if no operations have been performed since the MM2 has been powered up.

For example, a request slave 17 to respond with status of 6 operations, starting at operation 10, after performing command operation 13 (Manual Inhibit) has the following format:

Table 5–1: MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 01H

MASTER TRANSMISSION	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	11	message for slave 17
FUNCTION CODE	1	01	read last command operation
OPERATION STARTING ADDRESS	2	00 0A	start at operation 10
NUMBER OF OPERATIONS TO READ	2	00 06	read 6 operations
CRC	2	9E 9A	CRC error code

SLAVE RESPONSE	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	11	message from slave 17
FUNCTION CODE	1	01	read last command operation
BYTE COUNT	1	01	6 operations = 6 bits: only 1 byte required
DATA 1 (see definition below)	1	08	bit set corresponding to command 13
CRC	2	54 83	CRC error code

The DATA 1 definition is as follows:

Data 1 = 08 (hex) =	0	0	0	0	1	0	0	0
command operation #	N/A	N/A	15	14	13	12	11	10

5.2.2 FUNCTION CODE 03H

Modbus implementation: Read Holding Registers
MM2 implementation: Read Setpoints and Actual Values

For the MM2 implementation of Modbus, this command can be used to read any setpoints ("holding registers") or actual values ("input registers"). Holding and input registers are 16 bit (two byte) values transmitted high order byte first. Thus all MM2 Setpoints and Actual Values are sent as two bytes. The maximum number of registers that can be read in one transmission is 125. This function code is identical to function code 04.

The slave response to this function code is the slave address, function code, a count of the number of data bytes to follow, the data itself and the CRC. Each data item is sent as a two byte number with the high order byte sent first.

For example, consider a request for slave 17 to respond with 3 registers starting at address 006B. For this example the register data in these addresses is as follows:

Address	Data
006B	022B
006C	0000
006D	0064

The master/slave packets have the following format:

Table 5–2: MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 03H

MASTER TRANSMISSION	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	11	message for slave 17
FUNCTION CODE	1	03	read registers
DATA STARTING ADDRESS	2	00 6B	data starting at 006B
NUMBER OF SETPOINTS	2	00 03	3 registers = 6 bytes total
CRC	2	76 87	CRC error code

SLAVE RESPONSE	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	11	message from slave 17
FUNCTION CODE	1	03	read registers
BYTE COUNT	1	06	3 registers = 6 bytes
DATA 1 (see definition above)	2	02 2B	value in address 006B
DATA 2 (see definition above)	2	00 00	value in address 006C
DATA 3 (see definition above)	2	00 64	value in address 006D
CRC	2	54 83	CRC error code

5.2.3 FUNCTION CODE 04H

Modbus Implementation: Read Input Registers
MM2 implementation: Read Setpoints and Actual Values

For the MM2 implementation of Modbus, this command can be used to read any setpoints (“holding registers”) or actual values (“input registers”). Holding and input registers are 16 bit (two byte) values transmitted high order byte first. Thus all MM2 Setpoints and Actual Values are sent as two bytes. The maximum number of registers that can be read in one transmission is 125. This function code is identical to function code 03.

The slave response to this function code is the slave address, function code, a count of the data bytes to follow, the data itself and the CRC. Each data item is sent as a two byte number with the high order byte sent first.

For example, request slave 17 to respond with 1 register starting at address 0008. For this example the value in this register (0008) is 0000.

Table 5–3: MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 04H

MASTER TRANSMISSION	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	11	message for slave 17
FUNCTION CODE	1	04	read registers
DATA STARTING ADDRESS	2	00 08	data starting at 0008
NUMBER OF ACTUAL VALUES	2	00 01	1 register = 2 bytes
CRC	2	B2 98	CRC error code

SLAVE RESPONSE	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	11	message from slave 17
FUNCTION CODE	1	04	read registers
BYTE COUNT	1	02	1 register = 2 bytes
DATA (see definition above)	2	00 00	value in address 0008
CRC	2	78 F3	CRC error code

5.2.4 FUNCTION CODE 05H

Modbus Implementation: Force Single Coil
MM2 Implementation: Execute Operation

This function code allows the master to request a MM2 to perform specific command operations. The commands supported by the MM2 are listed in Section 5.4: APPLICATIONS on page 5–14.

For example, to request slave 17 to execute operation code 1 (reset), we have the following master/slave packet format:

Table 5–4: MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 05H

MASTER TRANSMISSION	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	11	message for slave 17
FUNCTION CODE	1	05	execute operation
OPERATION CODE	2	00 01	operation code 1
CODE VALUE	2	FF 00	perform function
CRC	2	DF 6A	CRC error code

SLAVE RESPONSE	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	11	message from slave 17
FUNCTION CODE	1	05	execute operation
OPERATION CODE	2	00 01	operation code 1
CODE VALUE	2	FF 00	perform function
CRC	2	DF 6A	CRC error code

The commands that can be performed by the MM2 using function code 05 can also be initiated by using function code 10.

See Section 5.2.8: FUNCTION CODE 10H on page 5–12 for an example of performing commands using function code 10.

Modbus Implementation: Preset Single Register
MM2 Implementation: Store Single Setpoint

This command allows the master to store a single setpoint into the memory of a MM2. The slave response to this function code is to echo the entire master transmission.

For example, request slave 17 to store the value 01F4 in setpoint address 1020. After the transmission in this example is complete, setpoints address 1020 will contain the value 01F4. The master/slave packet format is shown below:

Table 5–5: MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 06H

MASTER TRANSMISSION	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	11	message for slave 17
FUNCTION CODE	1	06	store single setpoint
DATA STARTING ADDRESS	2	10 20	setpoint address 1020
DATA	2	01 F4	data for setpoint address 1020
CRC	2	8E 47	CRC error code

SLAVE RESPONSE	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	11	message from slave 17
FUNCTION CODE	1	06	store single setpoint
DATA STARTING ADDRESS	2	10 20	setpoint address 1020
DATA	2	01 F4	data stored in setpoint address 1020
CRC	2	8E 47	CRC error code

5.2.6 FUNCTION CODE 07H

Modbus Implementation: Read Exception Status
MM2 Implementation: Read Device Status

This is a function used to quickly read the status of a selected device. A short message length allows for rapid reading of status. The status byte returned will have individual bits set to 1 or 0 depending on the status of the slave device. For this example, consider the following MM2 general status byte:

LSBit:	B0: Alarm condition = 1
	B1: Trip condition = 1
	B2: Internal fault = 1
	B3: Auto mode selected = 1
	B4: Contactor A N/O (input closed = 1, open = 0)
	B5: Contactor B N/O (input closed = 1, open = 0)
	B6: AUX Relay 1 Status
MSBit:	B7: AUX Relay 2 Status

The master/slave packets have the following format:

Table 5–6: MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 07H

MASTER TRANSMISSION	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	11	message for slave 17
FUNCTION CODE	1	07	read device status
CRC	2	4C 22	CRC error code

SLAVE RESPONSE	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	11	message from slave 17
FUNCTION CODE	1	07	read device status
DEVICE STATUS (see definition above)	1	2C	status = 00101100 (in binary)
CRC	2	22 28	CRC error code

5.2.7 FUNCTION CODE 08H

Modbus Implementation: Loopback Test
MM2 Implementation: Loopback Test

This function is used to test the integrity of the communication link. The MM2 will echo the request.

For example, consider a loopback test from slave 17:

Table 5–7: MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 08H

MASTER TRANSMISSION	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	11	message for slave 17
FUNCTION CODE	1	08	loopback test
DIAG CODE	2	00 00	must be 00 00
DATA	2	00 00	must be 00 00
CRC	2	E0 0B	CRC error code

SLAVE RESPONSE	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	11	message from slave 17
FUNCTION CODE	1	08	loopback test
DIAG CODE	2	00 00	must be 00 00
DATA	2	00 00	must be 00 00
CRC	2	E0 0B	CRC error code

5.2.8 FUNCTION CODE 10H

Modbus Implementation: Preset Multiple Registers
MM2 Implementation: Store Multiple Setpoints

This function code allows multiple Setpoints to be stored into the MM2 memory. Modbus "registers" are 16-bit (two byte) values transmitted high order byte first. Thus all MM2 setpoints are sent as two bytes. The maximum number of Setpoints that can be stored in one transmission is dependent on the slave device. Modbus allows up to a maximum of 60 holding registers to be stored. The MM2 response to this function code is to echo the slave address, function code, starting address, the number of Setpoints stored, and the CRC.

For example, consider a request for slave 17 to store the value 01F4 to setpoint address 1028 and the value 2710 to setpoint address 1029. After the transmission in this example is complete, MM2 slave 17 will have the following setpoints information stored:

Address	Data
1028	01F4
1029	2710

The master/slave packets have the following format:

Table 5–8: MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 10H

MASTER TRANSMISSION	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	11	message for slave 17
FUNCTION CODE	1	10	store setpoints
DATA STARTING ADDRESS	2	10 28	setpoint address 1028
NUMBER OF SETPOINTS	2	00 02	2 setpoints = 4 bytes total
BYTE COUNT	1	04	4 bytes of data
DATA 1	2	01 F4	data for setpoint address 1028
DATA 2	2	27 10	data for setpoint address 1029
CRC	2	33 23	CRC error code

SLAVE RESPONSE	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	11	message from slave 17
FUNCTION CODE	1	10	store setpoints
DATA STARTING ADDRESS	2	10 28	setpoint address 1028
NUMBER OF SETPOINTS	2	00 02	2 setpoints
CRC	2	C7 90	CRC error code

5.3.1 DESCRIPTION

When a MM2 detects an error other than a CRC error, a response will be sent to the master. The MSBit of the FUNCTION CODE byte will be set to 1 (i.e. the function code sent from the slave will be equal to the function code sent from the master plus 128). The following byte will be an exception code indicating the type of error that occurred.

Transmissions received from the master with CRC errors will be ignored by the MM2.

The slave response to an error (other than CRC error) will be:

SLAVE ADDRESS: 1 byte

FUNCTION CODE: 1 byte (with MSbit set to 1)

EXCEPTION CODE: 1 byte

CRC: 2 bytes

The MM2 implements the following exception response codes.

- 01 - ILLEGAL FUNCTION
  The function code transmitted is not one of the functions supported by the MM2.
- 02 - ILLEGAL DATA ADDRESS
  The address referenced in the data field transmitted by the master is not an allowable address for the MM2.
- 03 - ILLEGAL DATA VALUE
  The value referenced in the data field transmitted by the master is not within range for the selected data address.

5.4.1 PERFORMING COMMANDS USING FUNCTION CODE 10H

Commands can be performed using function code 16 as well as function code 5. When using FUNCTION CODE 16, the Command Function register must be written with a value of 5. The Command Operation register must be written with a valid command operation number. The Command Data registers must be written with valid data; this is dependent upon the command operation.

The commands supported by the MM2 are listed in Section 5.6: DATA FORMATS on page 5–41 under code F22.

For example, consider a request for slave 17 to perform command operation 1 (RESET): The master/slave packets have the following format:

Table 5–9: MASTER/SLAVE PACKET FORMAT FOR PERFORMING COMMANDS

MASTER TRANSMISSION	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	11	message for slave 17
FUNCTION CODE	1	10	store multiple setpoints
DATA STARTING ADDRESS	2	11 60	setpoint address 1160
NUMBER OF SETPOINTS	2	00 02	2 setpoints = 4 bytes total
BYTE COUNT	1	04	4 bytes of data
DATA 1	2	00 05	data for address 1160
DATA 2	2	00 01	data for address 1161
CRC	2	76 87	CRC error code

SLAVE RESPONSE	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	11	message from slave 17
FUNCTION CODE	1	10	store multiple setpoints
DATA STARTING ADDRESS	2	11 60	setpoint address 1160
NUMBER OF SETPOINTS	2	00 02	2 setpoints
CRC	2	46 7A	CRC error code

5.4.2 STORING COMM ADDRESS VIA BROADCAST COMMAND

The default setting for the communications address from the factory and after a 'Setpoint Dump' is OFF. The communication speed and parity default settings are 9600 baud, no parity. We have provided a facility to store the communications address to any MM2 without using the keypad and display (typically chassis mount MM2s).

Make sure the master is transmitting to the MM2 at 9600 baud, no parity. After installing the MM2 and ensuring communications is hooked up, cycle control voltage to the MM2 you wish to set the address for. This will allow you to send a broadcast command with the new communications address for the MM2. The address must be set within 2 minutes of cycling power. Once the new address is stored or the 2 minutes have elapsed, the MM2 will ignore all further attempts at changing the communications address unless power is cycled again. The address is changed using a broadcast command to communications address 0 and a command function code. Note: This procedure can be accomplished using the MM2PC software. See Chapter 9: MM2PC SOFTWARE for details.

For example, to store communications address 25 to a new MM2 without a display, we have the following master/slave packet format. The master/slave packets have the following format:

Table 5–10: MASTER/SLAVE PACKET FORMAT (BROADCAST)

MASTER TRANSMISSION	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	00	broadcast command for all units
FUNCTION CODE	1	10	store setpoints
DATA STARTING ADDRESS	2	11 60	setpoints address 1160
NUMBER OF SETPOINTS	2	00 03	3 setpoints = 6 bytes total
BYTE COUNT	1	06	6 bytes of data
DATA 1	2	00 05	data for address 1160
DATA 2	2	00 10	data for address 1161
DATA 3	2	00 19	data for address 1162
CRC	2	0B 8C	CRC error code

SLAVE RESPONSE	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	00	message from slave responding
FUNCTION CODE	1	10	store setpoints
DATA STARTING ADDRESS	2	11 60	setpoint address 1160
NUMBER OF SETPOINTS	2	00 03	3 setpoints
CRC	2	84 FB	CRC error code

5.4.3 USING THE USER DEFINABLE MEMORY MAP

The MM2 contains a User Definable area in the memory map. This area allows re-mapping of the addresses of any Actual Values or Setpoints registers. The User Definable area has two sections:

1. A Register Index area (memory map addresses 1280H-12F7H) that contains 120 Actual Values or Setpoints register addresses.
2. A Register area (memory map addresses 0100H-0177H) that contains the data at the addresses in the Register Index.

Register data that is separated in the rest of the memory map may be re-mapped to adjacent register addresses in the User Definable Registers area. This is accomplished by writing to register addresses in the User Definable Register Index area. This allows for improved throughput of data and can eliminate the need for multiple read command sequences. The User Definable Register Index is stored as a setpoint and therefore it is “remembered” even when the power is removed.

For example, if the values of Phase A Current (register address 0031H) and DRIVE STATUS (register address 0023H) are required to be read from a MM2, their addresses may be re-mapped as follows:

1. Write 0031H to address 1280H (User Definable Register Index 0000) using function code 06 or 16.
2. Write 0023H to address 1281H (User Definable Register Index 0001) using function code 06 or 16.

The MM2PC software can be used to write these locations to the User Definable Register Index.

1. Select the **Communication > Troubleshooting** menu item.
2. At the bottom of the screen, under the title “User Memory Map Insertion (write)”, enter “1280” in the first index address box.
3. In the values box put the address of the data you want to read, i.e. 0x0031 (Type 0x to indicate a hex address).
4. Press **Send**.
5. Press **OK**.
6. Repeat the above steps for the other data registers you want to read, changing the index address each time.

It is now possible to read these two data registers with one read, at addresses 0100H, 0101H. Address 0100H will contain Phase A Current. Address 0x0101 will contain DRIVE STATUS.

5.4.4 USER DEFINABLE MEMORY MAP DEFAULT VALUES

For convenience default User Map values have been added. However, the User Definable Memory Map is still fully customizable. The defaults are separated into three sections. Regular Polling data items, data that is read when a Trip, Stop or Alarm occurs, and data that can be monitored as time permits.

Table 5–11: MM2 MEMORY MAP USER DEFINABLE OUTPUTS (Sheet 1 of 2)

MODICON	REGULAR ADDRESS		DESCRIPTION	REGISTER VALUE RANGE	STEP VALUE	UNITS AND SCALE	FORMAT	USER MAP DEFAULT ADDRESS (HEX)
	DEC	HEX						
30021	20	0014	Gen Alarm Active Status Flags 1				F104	100
30022	21	0015	Gen Alarm Active Status Flags 2				F105	101
30023	22	0016	Interlock Alarm Active Status Flags				F106	102
30027	26	001A	Interlock Start Block Status Flags				F106	103
30028	27	001B	Trip Active Status Flags 1				F107	104
30029	28	001C	Trip Active Status Flags 2				F108	105
30035	34	0022	Command Mode				F6	106
30036	35	0023	Drive Status				F7	107
30037	36	0024	Motor Mode				F8	108
30049	48	0030	Phase Current Scale Factor				F1	109
30050	49	0031	Phase A Current				F1	10A
30051	50	0032	Phase B Current				F1	10B
30052	51	0033	Phase C Current				F1	10C
30053	52	0034	Ground Current				F1	10D
30054	53	0035	Motor Load			%FLC	F1	10E
30055	54	0036	Thermal Capacity			%	F1	10F
30056	55	0037	Current Unbalance			%	F1	110
30017	16	0010	Switch Input Status				F100	111
30020	19	0013	Operation Status Flags				F103	112
30034	33	0021	Cause of Stop				F5	113
30057	56	0038	Acceleration Time			0.1 x s	F1	114
30058	57	0039	Last Starting Current				F1	115
30059	58	003A	O/L Time to Trip				F1	116
30081	80	0050	Cause of Trip				F9	117
30082	81	0051	Time to Reset			min.	F1	118
30083	82	0052	Pre Trip Phase A Current				F1	119
30084	83	0053	Pre Trip Phase B Current				F1	11A
30085	84	0054	Pre Trip Phase C Current				F1	11B
30086	85	0055	Pre Trip Ground Current				F1	11C
30087	86	0056	Cause of Last Trip				F1	11D
30062	61	003D	Power (scaled)			kW	F21	11E
30063	62	003E	Energy Used - high order			0.1 x kWhr	F2	11F

Shading codes:

Regular Polling

Upon a Trip, Alarm, Stop

Monitor as time permits

Table 5–11: MM2 MEMORY MAP USER DEFINABLE OUTPUTS (Sheet 2 of 2)

MODICON	REGULAR ADDRESS		DESCRIPTION	REGISTER VALUE RANGE	STEP VALUE	UNITS AND SCALE	FORMAT	USER MAP DEFAULT ADDRESS (HEX)
	DEC	HEX						
30064	63	003F	Energy Used - low order			0.1 x kWhr	F2	120
30065	64	0040	Voltage			V	F1	121
30073	72	0048	Analog Input			units	F1	122
30089	88	0058	Running Time			hr.	F1	123
30090	89	0059	Stopped Time			hr.	F1	124
30097	96	0060	Number of Starts - high order				F2	125
30098	97	0061	Number of Starts - low order				F2	126
30099	98	0062	Total Trips				F1	127
30100	99	0063	Overload Trips				F1	128
30101	100	0064	Thermistor Trips				F1	129
30102	101	0065	Ground Fault Trips				F1	12A
30103	102	0066	Single Phase Trips				F1	12B
30104	103	0067	Acceleration Time Trips				F1	12C
30105	104	0068	Undercurrent Trips				F1	12D
30106	105	0069	Underpower Trips				F1	12E
30107	106	006A	Stalled Rotor Trips				F1	12F
30108	107	006B	Control Command Trips				F1	130
30109	108	006C	Interlock Counter				F1	131

Shading codes:

Regular Polling

Upon a Trip, Alarm, Stop

Monitor as time permits

5.5.1 DESCRIPTION

The data stored in the MM2 is grouped into two areas: setpoints and actual values. Setpoints can be read and written by a master computer. Actual Values can be read only. All Setpoints and Actual Values are stored as two byte values. That is, each register address is the address of a two byte value. Addresses are listed in hexadecimal. Data values (Setpoint ranges, increments, factory values) are in decimal.

Table 5–12: MODBUS MEMORY MAP (Sheet 1 of 21)

GROUP	MOD-ICON	ADDRESS		DESCRIPTION	RANGE	STEP VALUE	UNITS AND SCALE	FOR-MAT	DEFAULT VALUE (CONVERTED)
		DEC	HEX						
Actual Values (Input Registers) Addresses - 0000-0FFF									
PRODUCT ID	30001	0	0000	GE Product Device Code	---	---	---	F1	60
	30002	1	0001	Hardware Version Code	---	---	---	F4	current version
	30003	2	0002	Main Software Version Code	---	---	---	F1	current version
	30004	3	0003	Modification File Number	---	---	---	F1	mod. file no.
	30005	4	0004	Boot Software Version Code	---	---	---	F1	current version
	30006	5	0005	Supervisor Processor Version Code	---	---	---	F1	current version
	30007	6	0006	GE Product Options	---	---	---	F111	from order code
	30008	7	0007	Serial Number char. 1 and 2	---	---	ASCII	F10	char. 1 and 2
	30009	8	0008	Serial Number char. 3 and 4	---	---	ASCII	F10	char. 1 and 2
	30010	9	0009	Serial Number char. 5 and 6	---	---	ASCII	F10	char. 1 and 2
	30011	10	000A	Serial Number char. 7 and 8	---	---	ASCII	F10	char. 1 and 2
	30012	11	000B	Manufacture Month/day	---	---	---	F33	manuf. mo./day
	30013	12	000C	Manufacture year	---	---	---	F34	manuf. year
	30014	13	000D	...Reserved...	...	...	...	...	...
	30015	14	000E	Display Processor F/W Version Code				F1	current version
	30016	15	000F	...Reserved...	...	...	...	...	...
STATUS	30017	16	0010	Switch Input Status	---	---	---	F100	N/A
	30018	17	0011	LED Status Flags 1	---	---	---	F101	N/A
	30019	18	0012	LED Status Flags 2	---	---	---	F102	N/A
	30020	19	0013	Operation Status Flags	---	---	---	F103	N/A
	30021	20	0014	General Alarm Active Status Flags 1	---	---	---	F104	N/A
	30022	21	0015	General Alarm Active Status Flags 2	---	---	---	F105	N/A
	30023	22	0016	Interlock Alarm Active Status Flags	---	---	---	F106	N/A
	30024	23	0017	General Alarm Pickup Status Flags 1	---	---	---	F104	N/A
	30025	24	0018	General Alarm Pickup Status Flags 2	---	---	---	F105	N/A
	30026	25	0019	Interlock Alarm Pickup Status Flags	---	---	---	F106	N/A
	30027	26	001A	Interlock Start Block Status Flags	---	---	---	F106	N/A
	30028	27	001B	Trip Active Status Flags 1	---	---	---	F107	N/A
	30029	28	001C	Trip Active Status Flags 2	---	---	---	F108	N/A
	30030	29	001D	Trip Pickup Status Flags 1	---	---	---	F107	N/A
	30031	30	001E	Trip Pickup Status Flags 2	---	---	---	F108	N/A
	30032	31	001F	Start Status Flags	---	---	---	F109	N/A

Notes:
* – Maximum setpoint value and 65535 represent OFF
** – 1/Phase Current Scale Factor x A
*** – 101 represents unlimited
† – Minimum setpoint value represents OFF
†† – This register is only applicable to units with the VFD display
~* – 0.1 x A when Hi resolution mode is disabled; 0.01 x A when enabled

Table 5–12: MODBUS MEMORY MAP (Sheet 2 of 21)

GROUP	MOD-ICON	ADDRESS		DESCRIPTION	RANGE	STEP VALUE	UNITS AND SCALE	FOR-MAT	DEFAULT VALUE (CONVERTED)
		DEC	HEX						
STATUS continued	30033	32	0020	Speed Status Flags	---	---	---	F110	N/A
	30034	33	0021	Cause of Stop	---	---	---	F5	N/A
	30035	34	0022	Command Mode	---	---	---	F6	N/A
	30036	35	0023	Motor Status	---	---	---	F7	N/A
	30037	36	0024	Motor Mode	---	---	---	F8	N/A
	30038	37	0025	Active Full Load Current	---	---	---	F1	N/A
	30039	38	0026	Active Phase CT Primary	---	---	---	F1	N/A
	30040	39	0027	Cause Of Duty Trip Alarm	---	---	---	F9	N/A
	30041	40	0028	Cause of Last Stop	---	---	---	F5	N/A
	30042	41	0029	Trip Type				F114	N/A
	30043	42	002A	Quick Status				F115	N/A
	30044	43	002B	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	30048	47	002F	...Reserved...	...	...	...	...	...
MOTOR DATA	30049	48	0030	Phase Current Scale Factor	---	---	---	F1	N/A
	30050	49	0031	Phase A Current	---	---	**	F1	N/A
	30051	50	0032	Phase B Current	---	---	**	F1	N/A
	30052	51	0033	Phase C Current	---	---	**	F1	N/A
	30053	52	0034	Ground Current	---	---	0.1 x A	F1	N/A
	30054	53	0035	Motor Load	---	---	%FLC	F1	N/A
	30055	54	0036	Thermal Capacity	---	---	%	F1	N/A
	30056	55	0037	Current Unbalance	---	---	%	F1	N/A
	30057	56	0038	Acceleration Time	---	---	0.1 x s	F1	N/A
	30058	57	0039	Last Starting Current	---	---	**	F1	N/A
	30059	58	003A	O/L Time to Trip	---	---	s	F1	N/A
	30060	59	003B	Power - high order	---	---	0.1 x kW	F3	N/A
	30061	60	003C	Power - low order	---	---	0.1 x kW	F3	N/A
	30062	61	003D	Power (scaled)	---	---	kW	F21	N/A
	30063	62	003E	Energy Used - high order	---	---	0.1 xkWh	F2	N/A
	30064	63	003F	Energy Used - low order	---	---	0.1 xkWh	F2	N/A
	30065	64	0040	Voltage	---	---	V	F1	N/A
STARTS PER HOUR	30066	65	0041	Starts Per Hour Timer 1	---	---	sec.	F1	N/A
	30067	66	0042	Starts Per Hour Timer 2	---	---	sec.	F1	N/A
	30068	67	0043	Starts Per Hour Timer 3	---	---	sec.	F1	N/A
	30069	68	0044	Starts Per Hour Timer 4	---	---	sec.	F1	N/A
	30070	69	0045	Starts Per Hour Timer 5	---	---	sec.	F1	N/A
	30071	70	0046	Time Between Starts Timer	---	---	sec.	F1	N/A
	30072	71	0047	...Reserved...	...	...	...	...	...

Notes:
* – Maximum setpoint value and 65535 represent OFF
** – 1/Phase Current Scale Factor x A
*** – 101 represents unlimited
† – Minimum setpoint value represents OFF
†† – This register is only applicable to units with the VFD display
~* – 0.1 x A when Hi resolution mode is disabled; 0.01 x A when enabled

Table 5–12: MODBUS MEMORY MAP (Sheet 3 of 21)

GROUP	MOD-ICON	ADDRESS		DESCRIPTION	RANGE	STEP VALUE	UNITS AND SCALE	FOR-MAT	DEFAULT VALUE (CONVERTED)
		DEC	HEX						
PROCESS DATA	30073	72	0048	Analog Input	---	---	units	F1	N/A
	30074	73	0049	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	30080	79	004F	...Reserved...	...	...	...	...	...
TRIP DATA	30081	80	0050	Cause of Trip	---	---	---	F9	N/A
	30082	81	0051	Time to Reset	---	---	min.	F1	N/A
	30083	82	0052	Pre Trip Phase A Current	---	---	**	F1	N/A
	30084	83	0053	Pre Trip Phase B Current	---	---	**	F1	N/A
	30085	84	0054	Pre Trip Phase C Current	---	---	**	F1	N/A
	30086	85	0055	Pre Trip Ground Current	---	---	0.1 x A	F1	N/A
	30087	86	0056	Cause of Last Trip	---	---	---	F1	N/A
	30088	87	0057	...Reserved...	...	...	...	...	...
MAINTEN-ANCE TIMERS	30089	88	0058	Running Time	---	---	hr.	F1	0
	30090	89	0059	Stopped Time	---	---	hr.	F1	0
	30110	109	006D	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	30110	109	006D	...Reserved...	...	...	...	...	...
MAINTEN-ANCE COUNTERS	30097	96	0060	Number of Starts - high order	---	---	---	F2	0
	30098	97	0061	Number of Starts - low order	---	---	---	F2	0
	30099	98	0062	Total Trips	---	---	---	F1	0
	30100	99	0063	Overload Trips	---	---	---	F1	0
	30101	100	0064	Thermistor Trips	---	---	---	F1	0
	30102	101	0065	Ground Fault Trips	---	---	---	F1	0
	30103	102	0066	Single Phase Trips	---	---	---	F1	0
	30104	103	0067	Acceleration Time Trips	---	---	---	F1	0
	30105	104	0068	Undercurrent Trips	---	---	---	F1	0
	30106	105	0069	Underpower Trips	---	---	---	F1	0
	30107	106	006A	Stalled Rotor Trips	---	---	---	F1	0
	30108	107	006B	Control Command Trips	---	---	---	F1	0
	30109	108	006C	Interlock Counter	---	---	---	F1	0
	30110	109	006D	...Reserved...	...	...	...	...	...
	30111	110	006E	...Reserved...	...	...	...	...	...
	30112	111	006F	...Reserved...	...	...	...	...	...

Notes:
* – Maximum setpoint value and 65535 represent OFF
** – 1/Phase Current Scale Factor x A
*** – 101 represents unlimited
† – Minimum setpoint value represents OFF
†† – This register is only applicable to units with the VFD display
~* – 0.1 x A when Hi resolution mode is disabled; 0.01 x A when enabled

Table 5–12: MODBUS MEMORY MAP (Sheet 4 of 21)

GROUP	MOD-ICON	ADDRESS		DESCRIPTION	RANGE	STEP VALUE	UNITS AND SCALE	FOR-MAT	DEFAULT VALUE (CONVERTED)
		DEC	HEX						
TIMERS	30113	112	0070	Undervoltage Restart Timer	---	---	0.1 x s	F1	N/A
	30114	113	0071	AUX1 Post Contactor A Delay Timer	---	---	s	F1	N/A
	30115	114	0072	Transfer Timer	---	---	0.5 x s	F1	N/A
	30116	115	0073	First Stage Timer	---	---	0.5 x s	F1	N/A
	30117	116	0074	Second Stage Timer	---	---	0.5 x s	F1	N/A
	30118	117	0075	Start Inhibit Timer	---	---	s	F1	N/A
	30119	118	0076	AUX2 Post Contactor A Delay Timer	---	---	s	F1	N/A
	30120	119	0077	AUX 1+2 Pre Con. A Delay Timer	---	---	s	F1	N/A
	30121	120	0078	AUX1 Pre Con A Post Start Dly Timer	---	---	s	F1	N/A
	30122	121	0079	AUX2 Pre Con A Post Start Dly Timer	---	---	s	F1	N/A
	30123	122	007A	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	30128	127	007F	...Reserved...	...	...	...	...	...
DEBUG DATA	30129	128	0080	ADC Reference	---	---	---	F1	N/A
	30130	129	0081	Thermistor Reading	---	---	kOhms	F1	N/A
	30131	130	0082	Power Loss Fine Time	---	---	10 ms	F1	N/A
	30132	131	0083	Power Loss Coarse Time	---	---	0.1 min	F1	N/A
	30133	132	0084	Current key press	---	---	---	F24	N/A
	30134	133	0085	Internal Fault Error Code	---	---	---	---	N/A
	30135	134	0086	Phase A Current (fast update)	---	---	**	F1	N/A
	30136	135	0087	Phase B Current (fast update)	---	---	**	F1	N/A
	30137	136	0088	Phase C Current (fast update)	---	---	**	F1	N/A
	30138	137	0089	Ground Current (fast update)	---	---	0.1 x A	F1	N/A
	30139	138	008A	Voltage (fast update)	---	---	V	F1	N/A
	30140	139	008B	Current Display Line	---	---	---	F1	N/A
	30141	140	008C	Current Display Mode	---	---	---	F1	N/A
	30142	141	008D	...Reserved...	...	...	...	...	...
	30143	142	008E	...Reserved...	...	...	...	...	...
	30144	143	008F	...Reserved...	...	...	...	...	...
	30145	144	0090	Message Buffer characters 1 and 2	---	---	ASCII	F10	N/A
	30146	145	0091	Message Buffer characters 3 and 4	---	---	ASCII	F10	N/A
	30147	146	0092	Message Buffer characters 5 and 6	---	---	ASCII	F10	N/A
	30148	147	0093	Message Buffer characters 7 and 8	---	---	ASCII	F10	N/A
	30149	148	0094	Message Buffer characters 9 and 10	---	---	ASCII	F10	N/A

Notes:
* – Maximum setpoint value and 65535 represent OFF
** – 1/Phase Current Scale Factor x A
*** – 101 represents unlimited
† – Minimum setpoint value represents OFF
†† – This register is only applicable to units with the VFD display
~* – 0.1 x A when Hi resolution mode is disabled; 0.01 x A when enabled

Table 5–12: MODBUS MEMORY MAP (Sheet 5 of 21)

GROUP	MOD-ICON	ADDRESS		DESCRIPTION	RANGE	STEP VALUE	UNITS AND SCALE	FOR-MAT	DEFAULT VALUE (CONVERTED)
		DEC	HEX						
DEBUG DATA con't	30150	149	0095	Msg. Buffer characters 11 and 12	---	---	ASCII	F10	N/A
	30151	150	0096	Msg. Buffer characters 13 and 14	---	---	ASCII	F10	N/A
	30152	151	0097	Msg. Buffer characters 15 and 16	---	---	ASCII	F10	N/A
	30153	152	0098	Msg. Buffer characters 17 and 18	---	---	ASCII	F10	N/A
	30154	153	0099	Msg. Buffer characters 19 and 20	---	---	ASCII	F10	N/A
	30155	154	009A	Msg. Buffer characters 21 and 22	---	---	ASCII	F10	N/A
	30156	155	009B	Msg. Buffer characters 23 and 24	---	---	ASCII	F10	N/A
	30157	156	009C	Msg. Buffer characters 25 and 26	---	---	ASCII	F10	N/A
	30158	157	009D	Msg. Buffer characters 27 and 28	---	---	ASCII	F10	N/A
	30159	158	009E	Msg. Buffer characters 29 and 30	---	---	ASCII	F10	N/A
	30160	159	009F	Msg. Buffer characters 31 and 32	---	---	ASCII	F10	N/A
	30161	160	00A0	Msg. Buffer characters 33 and 34	---	---	ASCII	F10	N/A
	30162	161	00A1	Msg. Buffer characters 35 and 36	---	---	ASCII	F10	N/A
	30163	162	00A2	Msg. Buffer characters 37 and 38	---	---	ASCII	F10	N/A
	30164	163	00A3	Msg. Buffer characters 39 and 40	---	---	ASCII	F10	N/A
	30165	164	00A4	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	30176	175	00AF	...Reserved...	...	...	...	...	...
	30177	176	00B0	Second Mod File Number	---	---	---	F1	N/A
	30178	177	00B1	Third Mod File Number	---	---	---	F1	N/A
	30179	178	00B2	Fourth Mod File Number	---	---	---	F1	N/A
	30180	179	00B3	Fifth Mod File Number	---	---	---	F1	N/A
	30181	180	00B4	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	30256	255	00FF	...Reserved...	...	...	...	...	...
USER DEF. DATA	30257	256	0100	User Definable Data 0000					
	30258	257	0101	User Definable Data 0001					
	30259	258	0102	User Definable Data 0002					
	30260	259	0103	User Definable Data 0003					
	30261	260	0104	User Definable Data 0004					
	30262	261	0105	User Definable Data 0005					
	30263	262	0106	User Definable Data 0006					
	30264	263	0107	User Definable Data 0007					
	30265	264	0108	User Definable Data 0008					
	30266	265	0109	User Definable Data 0009					

Notes: * – Maximum setpoint value and 65535 represent OFF
** – 1/Phase Current Scale Factor x A
*** – 101 represents unlimited
† – Minimum setpoint value represents OFF
†† – This register is only applicable to units with the VFD display
~* – 0.1 x A when Hi resolution mode is disabled; 0.01 x A when enabled

Table 5–12: MODBUS MEMORY MAP (Sheet 6 of 21)

GROUP	MOD-ICON	ADDRESS		DESCRIPTION	RANGE	STEP VALUE	UNITS AND SCALE	FOR-MAT	DEFAULT VALUE (CONVERTED)
		DEC	HEX						
USER DEF. DATA con't	30267	266	010A	User Definable Data 000A					
	30268	267	010B	User Definable Data 000B					
	30269	268	010C	User Definable Data 000C					
	30270	269	010D	User Definable Data 000D					
	30271	270	010E	User Definable Data 000E					
	30272	271	010F	User Definable Data 000F					
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	30376	375	0177	User Definable Data 0077					
Setpoint Values (Holding Registers) Addresses - 1000-1FFF									
MOTOR ID	44097	4096	1000	Motor Name characters 1 and 2	32-127	1	ASCII	F10	"MO"
	44098	4097	1001	Motor Name characters 3 and 4	32-127	1	ASCII	F10	"TO"
	44099	4098	1002	Motor Name characters 5 and 6	32-127	1	ASCII	F10	"R "
	44100	4099	1003	Motor Name characters 7 and 8	32-127	1	ASCII	F10	" "
	44101	4100	1004	Motor Name characters 9 and 10	32-127	1	ASCII	F10	" "
	44102	4101	1005	Motor Name characters 11 and 12	32-127	1	ASCII	F10	" "
	44103	4102	1006	Motor Name characters 13 and 14	32-127	1	ASCII	F10	" "
	44104	4103	1007	Motor Name characters 15 and 16	32-127	1	ASCII	F10	" "
	44105	4104	1008	Motor Name characters 17 and 18	32-127	1	ASCII	F10	" "
	44106	4105	1009	Motor Name characters 19 and 20	32-127	1	ASCII	F10	" "
	44107	4106	100A	Motor Power Rating	3-11001	1	0.1 xkW	F1*	65535 = OFF
	44108	4107	100B	High Speed Motor Power Rating	3-11001	1	0.1 xkW	F1*	65535 = OFF
	44109	4108	100C	System Supply Voltage	110-600	1	V	F1	480
	44110	4109	100D	...Reserved...	...	...	...	...	...
	44111	4110	100E	...Reserved...	...	...	...	...	...
	44112	4111	100F	...Reserved...	...	...	...	...	...
STARTER	44113	4112	1010	Starter Type	0-11	1	---	F11	0 = OFF
	44114	4113	1011	Change-over Current	10-51	1	0.1 xFLC	F1*	15 = 1.5 xFLC
	44115	4114	1012	Change-over Time	1-100	1	s	F1	30
	44116	4115	1013	Transfer Time	1-125	1	s	F1	10
	44117	4116	1014	Ramp Up Time	1-125	1	s	F1	5
	44118	4117	1015	Ramp Down Time	1-125	1	s	F1	5
	44119	4118	1016	Stage One Shorting Time	1-125	1	s	F1	5

Notes:
* – Maximum setpoint value and 65535 represent OFF
** – 1/Phase Current Scale Factor x A
*** – 101 represents unlimited
† – Minimum setpoint value represents OFF
†† – This register is only applicable to units with the VFD display
~* – 0.1 x A when Hi resolution mode is disabled; 0.01 x A when enabled

Table 5–12: MODBUS MEMORY MAP (Sheet 7 of 21)

GROUP	MOD-ICON	ADDRESS		DESCRIPTION	RANGE	STEP VALUE	UNITS AND SCALE	FOR-MAT	DEFAULT VALUE (CONVERTED)
		DEC	HEX						
STARTER continued	44120	4119	1017	Changeover Time	1-125	1	s	F1	5
	44121	4120	1018	Reserved					
	44122	4121	1019	Starts per Hour	1-41	1	s	F1*	5
	44123	4122	101A	High Speed Start Block	0-1	1	--	F14	0 = DISABLE
	44124	4123	101B	Contactor Sequence	0-1	1	--	F32	0 = 1S-2S
	44125	4124	101C	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	44128	4127	101F	...Reserved...	...	...	...	...	...
CT/VT INPUTS	44129	4128	1020	Phase CT Primary	0-1000	5	A	F1†	0 = OFF
	44130	4129	1021	High Speed Phase CT Primary	5-1000	5	A	F1	100
	44131	4130	1022	Ground CT Primary	5-1000	5	A	F1	100
	44132	4131	1023	Ground Fault CT	0-2	1	---	F13	0=50:0.025
	44133	4132	1024	VT Primary Voltage	110-601	1	---	F1*	601 = OFF
	44134	4133	1025	VT Connection Type	0-1	1	---	F15	0=PHS (A-N)
	44135	4134	1026	VT Secondary Voltage	110-120	10	V	F1	120
	44136	4135	1027	Nominal Frequency	50-60	10	Hz	F1	60
THERMIS-TOR	44137	4136	1028	Cold Resistance	1-300	1	0.1 x kΩ	F1	1 = 0.1 kΩ
	44138	4137	1029	Hot Resistance	1-300	1	0.1 x kΩ	F1	50 = 5.0 kΩ
	44139	4138	102A	Thermistor Trip	0-1	1	---	F14	0 = DISABLE
	44140	4139	102B	Thermistor Alarm	0-1	1	---	F14	0 = DISABLE
	44141	4140	102C	...Reserved...	...	...	...	...	...
	44142	4141	102D	...Reserved...	...	...	...	...	...
	44143	4142	102E	...Reserved...	...	...	...	...	...
	44144	4143	102F	...Reserved...	...	...	...	...	...
FAULT MODE	44145	4144	1030	Internal Fault Trip	0-1	1	---	F14	1 = ENABLE
	44146	4145	1031	Serial Comms Failure Trip	5-30	5	---	F1*	30 = OFF
	44147	4146	1032	Serial Comms Failure Alarm	5-30	5	---	F1*	30 = OFF
	44148	4147	1033	Change command mode on Alarm	0-1	1	---	F14	0 = DISABLE
	44149	4148	1034	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	44152	4151	1037	...Reserved...	...	...	...	...	...
MOTOR PROTEC-TION THERMAL	44153	4152	1038	Full Load Current	0-1000	1	**	F1†	0 = OFF
	44154	4153	1039	High Speed Full Load Current	5-1000	1	**	F1	100
	44155	4154	103A	Overload Curve Number	1-12	1	---	F1	4
	44156	4155	103B	Hot / Cold Curve Ratio	20-100	1	%	F1	75
	44157	4156	103C	Overload Pickup Level	100-125	1	0.01FLC	F1	100=1.00xFLC
	44158	4157	103D	...Reserved...	...	...	...	...	...
	44159	4158	103E	...Reserved...	...	...	...	...	...
	44160	4159	103F	...Reserved...	...	...	...	...	...

Notes:
* – Maximum setpoint value and 65535 represent OFF
** – 1/Phase Current Scale Factor x A
*** – 101 represents unlimited
† – Minimum setpoint value represents OFF
†† – This register is only applicable to units with the VFD display
~* – 0.1 x A when Hi resolution mode is disabled; 0.01 x A when enabled

Table 5–12: MODBUS MEMORY MAP (Sheet 8 of 21)

GROUP	MOD-ICON	ADDRESS		DESCRIPTION	RANGE	STEP VALUE	UNITS AND SCALE	FOR-MAT	DEFAULT VALUE (CONVERTED)
		DEC	HEX						
MOTOR PROTEC-TION GROUND	44161	4160	1040	Ground Fault Alarm Level (5 A CT)	3-101	1	% CT	F1*	65535 = OFF
	44162	4161	1041	Gnd Fault Alarm Level (50:0.025 CT)	1-151	1	0.1 x A	F1*	65535 = OFF
	44163	4162	1042	Ground Fault Alarm Delay on Run	1-60	1	s	F1	10
	44164	4163	1043	Ground Fault Trip Level (residual)	3-101	1	% CT	F1*	65535 = OFF
	44165	4164	1044	Gnd Fault Trip Level (50:0.025 CT)	0-151	1	0.1 x A	F1*	65535 = OFF
	44166	4165	1045	Ground Fault Trip Delay on Run	0-100	1	0.1 x s	F1	10 = 1.0
	44167	4166	1046	Delay Contactor GF Trip By (Aux1)	0-1000	100	ms	F1	0
	44168	4167	1047	Delay Contactor GF Trip By (Aux2)	0-1000	100	ms	F1	0
	44169	4168	1048	...Reserved...	...	...	...	...	...
MOTOR PROTECTI ON OPTIONS	44170	4169	1049	Minimize Reset Time	0-1	1	---	F14	1 = ENABLE
	44171	4170	104A	Stopped Motor Cooling Time	5-1080	1	minutes	F1	30
	44172	4171	104B	Overload Trip Reset	0-1	1	---	F16	0 = MANUAL
	44173	4172	104C	Phase Unbalance Alarm	0-1	1	---	F14	1 = ENABLE
	44174	4173	104D	Thermal Capacity Alarm	1-101	1	%	F1*	101 = OFF
	44175	4174	104E	Open Control Circuit Trip	0-1	1	---	F14	0 = Disable
	44176	4175	104F	Reset Alarms using the Reset Key	0-1	1	---	F14	0 = Disable
LOAD PROTEC-TION	44177	4176	1050	Under Power Alarm Level	2-11001	1	0.1 xkW	F1*	65535 = OFF
	44178	4177	1051	Under Power Alarm Delay	1-60	1	s	F1	10
	44179	4178	1052	Under Power Trip Level	2-11001	1	0.1 xkW	F1*	65535 = OFF
	44180	4179	1053	Under Power Trip Delay	1-60	1	s	F1	10
	44181	4180	1054	Acceleration Time Alarm Delay	5-1255	5	0.1 x s	F1*	65535 = OFF
	44182	4181	1055	Acceleration Time Trip Delay	5-1255	5	0.1 x s	F1*	65535 = OFF
	44183	4182	1056	Load Increase Alarm Level	20-111	1	% FLC	F1*	65535 = OFF
	44184	4183	1057	Undercurrent Alarm Level	10-101	1	% FLC	F1*	65535 = OFF
	44185	4184	1058	Undercurrent Alarm Delay	1-60	1	s	F1	10
	44186	4185	1059	Undercurrent Trip Level	10-101	1	% FLC	F1*	65535 = OFF
	44187	4186	105A	Undercurrent Trip Delay	1-60	1	s	F1	10

Notes:
* – Maximum setpoint value and 65535 represent OFF
** – 1/Phase Current Scale Factor x A
*** – 101 represents unlimited
† – Minimum setpoint value represents OFF
†† – This register is only applicable to units with the VFD display
~* – 0.1 x A when Hi resolution mode is disabled; 0.01 x A when enabled

Table 5–12: MODBUS MEMORY MAP (Sheet 9 of 21)

GROUP	MOD-ICON	ADDRESS		DESCRIPTION	RANGE	STEP VALUE	UNITS AND SCALE	FOR-MAT	DEFAULT VALUE (CONVERTED)
		DEC	HEX						
LOAD PROTEC-TION con't	44188	4187	105B	Stalled Rotor Trip Level	115-455	5	0.01FLC	F1*	450=4.50xFLC
	44189	4188	105C	Stalled Rotor Trip Delay	5-50	5	0.1 x s	F1	30 = 3.0 s
	44190	4189	105D	...Reserved...	...	...	...	...	...
	44191	4190	105E	...Reserved...	...	...	...	...	...
	44192	4191	105F	...Reserved...	...	...	...	...	...
CONFIG. INPUTS	44193	4192	1060	Interlock Input 1 Function	0-35	1	---	F17	0 = NOT USED
	44194	4193	1061	Startup Override Delay	0-3601	1	s	F1*	0
	44195	4194	1062	Running Override Delay	0-3601	1	s	F1*	0
	44196	4195	1063	Operation	0-1	1	---	F18	0 = IL STOP
	44197	4196	1064	Instantaneous Alarm	0-1	1	---	F14	0 = DISABLE
	44198	4197	1065	...Reserved...	...	...	...	...	...
	44199	4198	1066	...Reserved...	...	...	...	...	...
	44200	4199	1067	...Reserved...	...	...	...	...	...
	44201	4200	1068	Interlock Input 2 Function	0-35	1	---	F17	0 = NOT USED
	44202	4201	1069	Startup Override Delay	0-3601	1	s	F1*	0
	44203	4202	106A	Running Override Delay	0-3601	1	s	F1*	0
	44204	4203	106B	Operation	0-1	1	---	F18	0 = IL STOP
	44205	4204	106C	Instantaneous Alarm	0-1	1	---	F14	0 = DISABLE
	44206	4205	106D	...Reserved...	...	...	...	...	...
	44207	4206	106E	...Reserved...	...	...	...	...	...
	44208	4207	106F	...Reserved...	...	...	...	...	...
	44209	4208	1070	Interlock Input 3 Function	0-35	1	---	F17	0 = NOT USED
	44210	4209	1071	Startup Override Delay	0-3601	1	s	F1*	0
	44211	4210	1072	Running Override Delay	0-3601	1	s	F1*	0
	44212	4211	1073	Operation	0-1	1	---	F18	0 = IL STOP
	44213	4212	1074	Instantaneous Alarm	0-1	1	---	F14	0 = DISABLE
	44214	4213	1075	...Reserved...	...	...	...	...	...
	44215	4214	1076	...Reserved...	...	...	...	...	...
	44216	4215	1077	...Reserved...	...	...	...	...	...
	44217	4216	1078	Interlock Input 4 Function	0-35	1	---	F17	0 = NOT USED
	44218	4217	1079	Startup Override Delay	0-3601	1	s	F1*	0
	44219	4218	107A	Running Override Delay	0-3601	1	s	F1*	0
	44220	4219	107B	Operation	0-1	1	---	F18	0 = IL STOP
	44221	4220	107C	Instantaneous Alarm	0-1	1	---	F14	0 = DISABLE
	44222	4221	107D	...Reserved...	...	...	...	...	...

Notes:
* – Maximum setpoint value and 65535 represent OFF
** – 1/Phase Current Scale Factor x A
*** – 101 represents unlimited
† – Minimum setpoint value represents OFF
†† – This register is only applicable to units with the VFD display
~* – 0.1 x A when Hi resolution mode is disabled; 0.01 x A when enabled

Table 5–12: MODBUS MEMORY MAP (Sheet 10 of 21)

GROUP	MOD-ICON	ADDRESS		DESCRIPTION	RANGE	STEP VALUE	UNITS AND SCALE	FOR-MAT	DEFAULT VALUE (CONVERTED)
		DEC	HEX						
CONFIG. INPUTS con't	44223	4222	107E	...Reserved...	...	...	...	...	...
	44224	4223	107F	...Reserved...	...	...	...	...	...
	44225	4224	1080	Interlock Input 5 Function	0-35	1	---	F17	0 = NOT USED
	44226	4225	1081	Startup Override Delay	0-3601	1	s	F1*	0
	44227	4226	1082	Running Override Delay	0-3601	1	s	F1*	0
	44228	4227	1083	Operation	0-1	1	---	F18	0 = IL STOP
	44229	4228	1084	Instantaneous Alarm	0-1	1	---	F14	0 = DISABLE
	44230	4229	1085	...Reserved...	...	...	...	...	...
	44231	4230	1086	...Reserved...	...	...	...	...	...
	44232	4231	1087	...Reserved...	...	...	...	...	...
	44233	4232	1088	Interlock Input 6 Function	0-35	1	---	F17	0 = NOT USED
	44234	4233	1089	Startup Override Delay	0-3601	1	s	F1 *	0
	44235	4234	108A	Running Override Delay	0-3601	1	s	F1*	0
	44236	4235	108B	Operation	0-1	1	---	F18	0 = IL STOP
	44237	4236	108C	Instantaneous Alarm	0-1	1	---	F14	0 = DISABLE
	44238	4237	108D	...Reserved...	...	...	...	...	...
	44239	4238	108E	...Reserved...	...	...	...	...	...
	44240	4239	108F	...Reserved...	...	...	...	...	...
	44241	4240	1090	Interlock Input 7 Function	0-35	1	---	F17	0 = NOT USED
	44242	4241	1091	Startup Override Delay	0-3601	1	s	F1*	0
	44243	4242	1092	Running Override Delay	0-3601	1	s	F1*	0
	44244	4243	1093	Operation	0-1	1	---	F18	0 = IL STOP
	44245	4244	1094	Instantaneous Alarm	0-1	1	---	F14	0 = DISABLE
	44246	4245	1095	...Reserved...	...	...	...	...	...
	44247	4246	1096	...Reserved...	...	...	...	...	...
	44248	4247	1097	...Reserved...	...	...	...	...	...
	44249	4248	1098	Interlock Input 8 Function	0-35	1	---	F17	0 = NOT USED
	44250	4249	1099	Startup Override Delay	0-3601	1	s	F1*	0
	44251	4250	109A	Running Override Delay	0-3601	1	s	F1*	0
	44252	4251	109B	Operation	0-1	1	---	F18	0 = IL STOP
	44253	4252	109C	Instantaneous Alarm	0-1	1	---	F14	0 = DISABLE
	44254	4253	109D	...Reserved...	...	...	...	...	...
	44255	4254	109E	...Reserved...	...	...	...	...	...
	44256	4255	109F	...Reserved...	...	...	...	...	...
	44257	4256	10A0	Interlock Input 9 Function	0-35	1	---	F17	0 = NOT USED

Notes:
* – Maximum setpoint value and 65535 represent OFF
** – 1/Phase Current Scale Factor x A
*** – 101 represents unlimited
† – Minimum setpoint value represents OFF
†† – This register is only applicable to units with the VFD display
~* – 0.1 x A when Hi resolution mode is disabled; 0.01 x A when enabled

Table 5–12: MODBUS MEMORY MAP (Sheet 11 of 21)

GROUP	MOD-ICON	ADDRESS		DESCRIPTION	RANGE	STEP VALUE	UNITS AND SCALE	FOR-MAT	DEFAULT VALUE (CONVERTED)
		DEC	HEX						
CONFIG. INPUTS con't	44258	4257	10A1	Startup Override Delay	0-3601	1	s	F1*	0
	44259	4258	10A2	Running Override Delay	0-3601	1	s	F1*	0
	44260	4259	10A3	Operation	0-1	1	---	F18	0 = IL STOP
	44261	4260	10A4	Instantaneous Alarm	0-1	1	---	F14	0 = DISABLE
	44262	4261	10A5	...Reserved...	...	...	...	...	...
	44263	4262	10A6	...Reserved...	...	...	...	...	...
	44264	4263	10A7	...Reserved...	...	...	...	...	...
	44265	4264	10A8	Interlock Input 10 Function	0-35	1	---	F17	0 = NOT USED
	44266	4265	10A9	Startup Override Delay	0-3601	1	s	F1*	0
	44267	4266	10AA	Running Override Delay	0-3601	1	s	F1*	0
	44268	4267	10AB	Operation	0-1	1	---	F18	0 = IL STOP
	44269	4268	10AC	Instantaneous Alarm	0-1	1	---	F14	0 = DISABLE
	44270	4269	10AD	Auto Mode Definition	0-1	1	---	F27	0 = SERIAL
	44271	4270	10AE	Local Isolator	0-1	1	---	F14	0 = DISABLE
	44272	4271	10AF	Auto Permissive Indication	0-1	1	---	F16	0 = MANUAL
PROCESS INTER-LOCK NAMES	44273	4272	10B0	Process Intlk A Name chars 1 and 2	32-127	1	ASCII	F10	"PR"
	44274	4273	10B1	Process Intlk A Name chars 3 and 4	32-127	1	ASCII	F10	"OC"
	44275	4274	10B2	Process Intlk A Name chars 5 and 6	32-127	1	ASCII	F10	"ES"
	44276	4275	10B3	Process Intlk A Name chars 7 & 8	32-127	1	ASCII	F10	"S "
	44277	4276	10B4	Process Intlk A Name chars 9 & 10	32-127	1	ASCII	F10	"IN"
	44278	4277	10B5	Process Intlk A Name chars 11 & 12	32-127	1	ASCII	F10	"TE"
	44279	4278	10B6	Process Intlk A Name chars 13 & 14	32-127	1	ASCII	F10	"RL"
	44280	4279	10B7	Process Intlk A Name chars 15 & 16	32-127	1	ASCII	F10	"OC"
	44281	4280	10B8	Process Intlk A Name chars 17 & 18	32-127	1	ASCII	F10	"K "
	44282	4281	10B9	Process Intlk A Name chars 19 & 20	32-127	1	ASCII	F10	"A "
	44283	4282	10BA	Serial Permissive	0-1	1	---	F14	0 = DISABLE
	44284	4283	10BB	Start Block Alarm	0-1	1	---	F14	0 = DISABLE
	44285	4284	10BC	Cmd mode change when running	0-1	1	---	F14	0 = DISABLE
	44286	4285	10BD	...Reserved...	...	...	...	...	...
	44287	4286	10BE	...Reserved...	...	...	...	...	...
	44288	4287	10BF	...Reserved...	...	...	...	...	...
	44289	4288	10C0	Process Intlk B Name chars 1 and 2	32-127	1	ASCII	F10	"PR"
	44290	4289	10C1	Process Intlk B Name chars 3 and 4	32-127	1	ASCII	F10	"OC"
	44291	4290	10C2	Process Intlk B Name chars 5 and 6	32-127	1	ASCII	F10	"ES"
	44292	4291	10C3	Process Intlk B Name chars 7 and 8	32-127	1	ASCII	F10	"S "

Notes:
* – Maximum setpoint value and 65535 represent OFF
** – 1/Phase Current Scale Factor x A
*** – 101 represents unlimited
† – Minimum setpoint value represents OFF
†† – This register is only applicable to units with the VFD display
~* – 0.1 x A when Hi resolution mode is disabled; 0.01 x A when enabled

Table 5–12: MODBUS MEMORY MAP (Sheet 12 of 21)

GROUP	MOD-ICON	ADDRESS		DESCRIPTION	RANGE	STEP VALUE	UNITS AND SCALE	FOR-MAT	DEFAULT VALUE (CONVERTED)
		DEC	HEX						
PROCESS INTER-LOCK NAMES continued	44293	4292	10C4	Process Intlk B Name chars 9 & 10	32-127	1	ASCII	F10	"IN"
	44294	4293	10C5	Process Intlk B Name chars 11 & 12	32-127	1	ASCII	F10	"TE"
	44295	4294	10C6	Process Intlk B Name chars 13 & 14	32-127	1	ASCII	F10	"RL"
	44296	4295	10C7	Process Intlk B Name chars 15 & 16	32-127	1	ASCII	F10	"OC"
	44297	4296	10C8	Process Intlk B Name chars 17 & 18	32-127	1	ASCII	F10	"K "
	44298	4297	10C9	Process Intlk B Name chars 19 & 20	32-127	1	ASCII	F10	"B "
	44299	4298	10CA	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	44304	4303	10CF	...Reserved...	...	...	...	...	...
	44305	4304	10D0	Process Intlk C Name chars 1 and 2	32-127	1	ASCII	F10	"PR"
	44306	4305	10D1	Process Intlk C Name chars 3 and 4	32-127	1	ASCII	F10	"OC"
	44307	4306	10D2	Process Intlk C Name chars 5 and 6	32-127	1	ASCII	F10	"ES"
	44308	4307	10D3	Process Intlk C Name chars 7 and 8	32-127	1	ASCII	F10	"S "
	44309	4308	10D4	Process Intlk C Name chars 9 & 10	32-127	1	ASCII	F10	"IN"
	44310	4309	10D5	Process Intlk C Name chars 11 & 12	32-127	1	ASCII	F10	"TE"
	44311	4310	10D6	Process Intlk C Name chars 13 & 14	32-127	1	ASCII	F10	"RL"
	44312	4311	10D7	Process Intlk C Name chars 15 & 16	32-127	1	ASCII	F10	"OC"
	44313	4312	10D8	Process Intlk C Name chars 17 & 18	32-127	1	ASCII	F10	"K "
	44314	4313	10D9	Process Intlk C Name chars 19 & 20	32-127	1	ASCII	F10	"C "
	44315	4314	10DA	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	44320	4319	10DF	...Reserved...	...	...	...	...	...
	44321	4320	10E0	Process Intlk D Name chars 1 and 2	32-127	1	ASCII	F10	"PR"
	44322	4321	10E1	Process Intlk D Name chars 3 and 4	32-127	1	ASCII	F10	"OC"
	44323	4322	10E2	Process Intlk D Name chars 5 and 6	32-127	1	ASCII	F10	"ES"
	44324	4323	10E3	Process Intlk D Name chars 7 and 8	32-127	1	ASCII	F10	"S "
	44325	4324	10E4	Process Intlk D Name chars 9 & 10	32-127	1	ASCII	F10	"IN"
	44326	4325	10E5	Process Intlk D Name chars 11 & 12	32-127	1	ASCII	F10	"TE"
	44327	4326	10E6	Process Intlk D Name chars 13 & 14	32-127	1	ASCII	F10	"RL"
	44328	4327	10E7	Process Intlk D Name chars 15 & 16	32-127	1	ASCII	F10	"OC"
	44329	4328	10E8	Process Intlk D Name chars 17 & 18	32-127	1	ASCII	F10	"K "
	44330	4329	10E9	Process Intlk D Name chars 19 & 20	32-127	1	ASCII	F10	"D "
	44331	4330	10EA	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	44336	4335	10EF	...Reserved...	...	...	...	...	...

Notes:
* – Maximum setpoint value and 65535 represent OFF
** – 1/Phase Current Scale Factor x A
*** – 101 represents unlimited
† – Minimum setpoint value represents OFF
†† – This register is only applicable to units with the VFD display
~* – 0.1 x A when Hi resolution mode is disabled; 0.01 x A when enabled

Table 5–12: MODBUS MEMORY MAP (Sheet 13 of 21)

GROUP	MOD-ICON	ADDRESS		DESCRIPTION	RANGE	STEP VALUE	UNITS AND SCALE	FOR-MAT	DEFAULT VALUE (CONVERTED)
		DEC	HEX						
FIELD STOP	44337	4336	10F0	Field Stop Mode	0-1		---	F19	0=Unlatched
	44338	4337	10F1	ESD Stop Mode	0-1		---	F19	0=Unlatched
	44339	4338	10F2	ESD Indication	0-1		---	F29	1=ON/Healthy
	44340	4339	10F3	Faceplate Stop	0-1		---	F19	0=Unlatched
	44341	4340	10F4	Process Stop	0-1		---	F19	0=Unlatched
	44342	4341	10F5	...Reserved...	...	...	...	...	...
	44343	4342	10F6	...Reserved...	...	...	...	...	...
	44344	4343	10F7	...Reserved...	...	...	...	...	...
ANALOG INPUT	44345	4344	10F8	Analog Input Name chars 1 and 2	32-127	1	ASCII	F10	"AN"
	44346	4345	10F9	Analog Input Name chars 3 and 4	32-127	1	ASCII	F10	"AL"
	44347	4346	10FA	Analog Input Name chars 5 and 6	32-127	1	ASCII	F10	"OG"
	44348	4347	10FB	Analog Input Name chars 7 and 8	32-127	1	ASCII	F10	" I"
	44349	4348	10FC	Analog Input Name chars 9 and 10	32-127	1	ASCII	F10	"NP"
	44350	4349	10FD	Analog Input Name chars 11 and 12	32-127	1	ASCII	F10	"UT"
	44351	4350	10DE	Analog Input Name chars 13 and 14	32-127	1	ASCII	F10	" "
	44352	4351	10FF	Analog Input Name chars 15 and 16	32-127	1	ASCII	F10	" "
	44353	4352	1100	Analog Input Name chars 17 and 18	32-127	1	ASCII	F10	" "
	44354	4353	1101	Analog Input Name chars 19 and 20	32-127	1	ASCII	F10	" "
	44355	4354	1102	Analog Input Units chars 1 and 2	32-127	1	ASCII	F10	"UN"
	44356	4355	1103	Analog Input Units chars 3 and 4	32-127	1	ASCII	F10	"IT"
	44357	4356	1104	Analog Input Units chars 5 and 6	32-127	1	ASCII	F10	"S "
	44358	4357	1105	Analog Input Units chars 7 and 8	32-127	1	ASCII	F10	
	44359	4358	1106	Analog Input Units chars 9 and 10	32-127	1	ASCII	F10	
	44360	4359	1107	Minimum Scale	0-20000	10	---	F1	0
	44361	4360	1108	Maximum Scale	10-20000	10	---	F1	1000
	44362	4361	1109	Analog Alarm Low Level	1-20001	1	---	F1*	65535 = OFF
	44363	4362	110A	Analog Alarm Low Delay	1-600	1	s	F1	5
	44364	4363	110B	Analog Alarm High Level	1-20001	1	---	F1*	65535 = OFF
	44365	4364	110C	Analog Alarm High Delay	1-600	1	s	F1	5
	44366	4365	110D	Analog Trip Low Level	1-20001	1	---	F1*	65535 = OFF
	44367	4366	110E	Analog Trip Low Delay	1-600	1	s	F1	5
	44368	4367	110F	Analog Trip High Level	1-20001	1	---	F1*	65535 = OFF
	44369	4368	1110	Analog Trip High Delay	1-600	1	s	F1	5
	44370	4369	1111	Analog Low Override Delay	1-600	1	s	F1*	5

Notes:
* – Maximum setpoint value and 65535 represent OFF
** – 1/Phase Current Scale Factor x A
*** – 101 represents unlimited
† – Minimum setpoint value represents OFF
†† – This register is only applicable to units with the VFD display
~* – 0.1 x A when Hi resolution mode is disabled; 0.01 x A when enabled

Table 5–12: MODBUS MEMORY MAP (Sheet 14 of 21)

GROUP	MOD-ICON	ADDRESS		DESCRIPTION	RANGE	STEP VALUE	UNITS AND SCALE	FOR-MAT	DEFAULT VALUE (CONVERTED)
		DEC	HEX						
ANALOG INPUT continued	44371	4370	1112	Analog High Override Delay	1-600	1	s	F1*	5
	44372	4371	1113	...Reserved...	...	...	...	...	...
	44373	4372	1114	...Reserved...	...	...	...	...	...
	44374	4373	1115	...Reserved...	...	...	...	...	...
	44375	4374	1116	...Reserved...	...	...	...	...	...
	44376	4375	1117	...Reserved...	...	...	...	...	...
	44377	4376	1118	...Reserved...	...	...	...	...	...
	44378	4377	1119	...Reserved...	...	...	...	...	...
	44379	4378	111A	...Reserved...	...	...	...	...	...
	44380	4379	111B	...Reserved...	...	...	...	...	...
	44381	4380	111C	...Reserved...	...	...	...	...	...
	44382	4381	111D	...Reserved...	...	...	...	...	...
	44383	4382	111E	...Reserved...	...	...	...	...	...
	44384	4383	111F	...Reserved...	...	...	...	...	...
U / V AUTO RESTART	44385	4384	1120	Undervoltage Restart	0-1	1	---	F14	1 = ENABLE
	44386	4385	1121	Immediate Restart Power Loss Time	100-520	20	ms	F1*	200
	44387	4386	1122	Delayed Restart Power Loss Time	1-101	1	0.1 x s	F1***	20 = 2.0 s
	44388	4387	1123	Restart Time Delay	2-12000	2	0.1 x s	F1	20 = 2.0 s
	44389	4388	1124	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	44392	4391	1127	...Reserved...	...	...	...	...	...
AUX 1 RELAY	44393	4392	1128	AUX Relay 1 Function	0-33	1	---	F20	0=SERIAL CNTL
	44394	4393	1129	AUX Relay 1 Delay	0-125	1	s	F1	5
	44395	4394	112A	AUX Relay 1 Motor Start Delay	0-125	1	s	F1	5
	44396	4395	112B	AUX Relay 1 Motor Stop Delay	0-125	1	s	F1	5
	44397	4396	112C	AUX Relay 1 Pre Delay	0-900	1	s	F1	5
	44398	4397	112D	AUX Relay 1 Post Delay	0-126	1	s	F1*	126 = OFF
	44399	4398	112E	AUX Relay 1 Operation	0-1	1	---	F12	0=non-failsafe
	44400	4399	112F	...Reserved...	...	...	...	...	...
PLANT CONDI-TION	44401	4400	1130	Drive Greasing Interval	100-50100	100	hours	F1*	65535 = OFF
	44402	4401	1131	Contactor Inspection Interval	1-10001	1	x1000 Op	F1*	65535 = OFF
	44403	4402	1132	Maximum Drive Stopped Time	100-10100	100	hours	F1*	65535 = OFF
	44404	4403	1133	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	44408	4407	1137	...Reserved...	...	...	...	...	...
MOTOR PROT. OPTIONS	44409	4408	1138	Reset Lockout Using RESET Key	0-1	1	---	F14	1 = ENABLE

Notes:
* – Maximum setpoint value and 65535 represent OFF
** – 1/Phase Current Scale Factor x A
*** – 101 represents unlimited
† – Minimum setpoint value represents OFF
†† – This register is only applicable to units with the VFD display
~* – 0.1 x A when Hi resolution mode is disabled; 0.01 x A when enabled

Table 5–12: MODBUS MEMORY MAP (Sheet 15 of 21)

GROUP	MOD-ICON	ADDRESS		DESCRIPTION	RANGE	STEP VALUE	UNITS AND SCALE	FOR-MAT	DEFAULT VALUE (CONVERTED)
		DEC	HEX						
COMMS	44410	4409	1139	Modbus Baud Rate	0-5	1	---	F25	3 = 9600
	44411	4410	113A	...Reserved...	...	...	...	...	...
	44412	4411	113B	...Reserved...	...	...	...	...	...
	44413	4412	113C	...Reserved...	...	...	...	...	...
	44414	4413	113D	...Reserved...	...	...	...	...	...
UV/OV	44415	4414	113E	Undervoltage Pickup Level	0-950	1	---	F1	0
	44416	4415	113F	...Reserved...	...	...	...	...	...
	44417	4416	1140	...Reserved...	...	...	...	...	...
	44418	4417	1141	...Reserved...	...	...	...	...	...
	44419	4418	1142	...Reserved...	...	...	...	...	...
	44420	4419	1143	...Reserved...	...	...	...	...	...
	44421	4420	1144	...Reserved...	...	...	...	...	...
PREFER-ENCES	44422	4421	1145	Default Message Delay	3 - 300	1	seconds	F1	120
	44423	4422	1146	Factory Use					
COMMS	44424	4423	1147	Parity	0-2	1	---	F31	0 = NONE
FLASH MESSAGE	44425	4424	1148	Flash message characters 1 and 2	32-255	1	ASCII	F10	" "
	44426	4425	1149	Flash message characters 3 and 4	32-255	1	ASCII	F10	" "
	44427	4426	114A	Flash message characters 5 and 6	32-255	1	ASCII	F10	" "
	44428	4427	114B	Flash message characters 7 and 8	32-255	1	ASCII	F10	" "
	44429	4428	114C	Flash message characters 9 and 10	32-255	1	ASCII	F10	" "
	44430	4429	114D	Flash message characters 11 and 12	32-255	1	ASCII	F10	" "
	44431	4430	114E	Flash message characters 13 and 14	32-255	1	ASCII	F10	" "
	44432	4431	114F	Flash message characters 15 and 16	32-255	1	ASCII	F10	" "
	44433	4432	1150	Flash message characters 17 and 18	32-255	1	ASCII	F10	" "
	44434	4433	1151	Flash message characters 19 and 20	32-255	1	ASCII	F10	" "
	44435	4434	1152	Flash message characters 21 and 22	32-255	1	ASCII	F10	" "
	44436	4435	1153	Flash message characters 23 and 24	32-255	1	ASCII	F10	" "
	44437	4436	1154	Flash message characters 25 and 26	32-255	1	ASCII	F10	" "
	44438	4437	1155	Flash message characters 27 and 28	32-255	1	ASCII	F10	" "
	44439	4438	1156	Flash message characters 29 and 30	32-255	1	ASCII	F10	" "
	44440	4439	1157	Flash message characters 31 and 32	32-255	1	ASCII	F10	" "

Notes:
* – Maximum setpoint value and 65535 represent OFF
** – 1/Phase Current Scale Factor x A
*** – 101 represents unlimited
† – Minimum setpoint value represents OFF
†† – This register is only applicable to units with the VFD display
~* – 0.1 x A when Hi resolution mode is disabled; 0.01 x A when enabled

Table 5–12: MODBUS MEMORY MAP (Sheet 16 of 21)

GROUP	MOD-ICON	ADDRESS		DESCRIPTION	RANGE	STEP VALUE	UNITS AND SCALE	FOR-MAT	DEFAULT VALUE (CONVERTED)
		DEC	HEX						
FLASH MESSAGE continued	44441	4440	1158	Flash message characters 33 and 34	32-255	1	ASCII	F10	" "
	44442	4441	1159	Flash message characters 35 and 36	32-255	1	ASCII	F10	" "
	44443	4442	115A	Flash message characters 37 and 38	32-255	1	ASCII	F10	" "
	44444	4443	115B	Flash message characters 39 and 40	32-255	1	ASCII	F10	" "
	44445	4444	115C	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	44448	4447	115F	...Reserved...	...	...	...	...	...
COM-MANDS	44449	4448	1160	Command Function Code	5	---	---	F1	5
	44450	4449	1161	Command Operation Code	1-32	1	---	F22	0
	44451	4450	1162	Command Data 1	0-65535	1	---	F1/F23/ F26	0
	44452	4451	1163	Command Data 2	0-65535	1	---	F1	0
	44453	4452	1164	Command Data 3	0-65535	1	---	F1	0
	44454	4453	1165	Command Data 4	0-65535	1	---	F1	0
	44455	4454	1166	Command Data 5	0-65535	1	---	F1	0
	44456	4455	1167	Command Data 6	0-65535	1	---	F1	0
	44457	4456	1168	Command Data 7	0-65535	1	---	F1	0
	44458	4457	1169	Command Data 8	0-65535	1	---	F1	0
	44459	4458	116A	Command Data 9	0-65535	1	---	F1	0
	44460	4459	116B	Command Data 10	0-65535	1	---	F1	0
	44461	4460	116C	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	44464	4463	116F	...Reserved...	...	...	...	...	...
UNDER/ OVER VOLTAGE PROTEC-TION	44465	4464	1170	Undervoltage Alarm Level	0-601	1	V	F1 *	601 = 0FF
	44466	4465	1171	Undervoltage Alarm Delay	1-60	1	s	F1	10
	44467	4466	1172	Undervoltage Trip Level	0-601	1	V	F1 *	601 = 0FF
	44468	4467	1173	Undervoltage Trip Delay	1-60	1	s	F1	10
	44469	4468	1174	Overvoltage Alarm Level	0-601	1	V	F1 *	601 = 0FF
	44470	4469	1175	Overvoltage Alarm Delay	1-60	1	s	F1	10
	44471	4470	1176	Overvoltage Trip Level	0-601	1	V	F1 *	601 = 0FF
	44472	4471	1177	Overvoltage Trip Delay	1-60	1	s	F1	10
	44473	4472	1178	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	44480	4479	117F	...Reserved...	...	...	...	...	...

Notes:
* – Maximum setpoint value and 65535 represent OFF
** – 1/Phase Current Scale Factor x A
*** – 101 represents unlimited
† – Minimum setpoint value represents OFF
†† – This register is only applicable to units with the VFD display
~* – 0.1 x A when Hi resolution mode is disabled; 0.01 x A when enabled

Table 5–12: MODBUS MEMORY MAP (Sheet 17 of 21)

GROUP	MOD-ICON	ADDRESS		DESCRIPTION	RANGE	STEP VALUE	UNITS AND SCALE	FOR-MAT	DEFAULT VALUE (CONVERTED)
		DEC	HEX						
PROG. MESSAGE	44481	4480	1180	Programmable msg chars 1 and 2	32-255	1	ASCII	F10	"PR"
	44482	4481	1181	Programmable msg chars 3 and 4	32-255	1	ASCII	F10	"OG"
	44483	4482	1182	Programmable msg chars 5 and 6	32-255	1	ASCII	F10	"RA"
	44484	4483	1183	Programmable msg chars 7 and 8	32-255	1	ASCII	F10	"MM"
	44485	4484	1184	Programmable msg chars 9 and 10	32-255	1	ASCII	F10	"AB"
	44486	4485	1185	Programmable msg chars 11 & 12	32-255	1	ASCII	F10	"LE"
	44487	4486	1186	Programmable msg chars 13 & 14	32-255	1	ASCII	F10	" M"
	44488	4487	1187	Programmable msg chars 15 & 16	32-255	1	ASCII	F10	"ES"
	44489	4488	1188	Programmable msg chars 17 & 18	32-255	1	ASCII	F10	"SA"
	44490	4489	1189	Programmable msg chars 19 & 20	32-255	1	ASCII	F10	"GE"
	44491	4490	118A	Programmable msg chars 21 & 22	32-255	1	ASCII	F10	"SA"
	44492	4491	118B	Programmable msg chars 23 & 24	32-255	1	ASCII	F10	"MP"
	44493	4492	118C	Programmable msg chars 25 & 26	32-255	1	ASCII	F10	"LE"
	44494	4493	118D	Programmable msg chars 27 & 28	32-255	1	ASCII	F10	" T"
	44495	4494	118E	Programmable msg chars 29 & 30	32-255	1	ASCII	F10	"EX"
	44496	4495	118F	Programmable msg chars 31 & 32	32-255	1	ASCII	F10	"T "
	44497	4496	1190	Programmable msg chars 33 & 34	32-255	1	ASCII	F10	" "
	44498	4497	1191	Programmable msg chars 35 & 36	32-255	1	ASCII	F10	" "
	44499	4498	1192	Programmable msg chars 37 & 38	32-255	1	ASCII	F10	" "
	44500	4499	1193	Programmable msg chars 39 & 40	32-255	1	ASCII	F10	" "
	44501	4500	1194	...Reserved...	...	...	...	...	...
	44502	4501	1195	...Reserved...	...	...	...	...	...
	44503	4502	1196	Default Message 1 Line Number	0-65535	1	---	F1	3
	44504	4503	1197	Default Message 2 Line Number	0-65535	1	---	F1	0
	44505	4504	1198	Default Message 3 Line Number	0-65535	1	---	F1	0
	44506	4505	1199	Default Message 4 Line Number	0-65535	1	---	F1	0
	44507	4506	119A	Default Message 5 Line Number	0-65535	1	---	F1	0
PREFER-ENCES	44508	4507	119B	Display Brightness ††	0-100	20	%	F1	60%
	44509	4508	119C	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	44512	4511	119F	...Reserved...	...	...	...	...	...

Notes:
* – Maximum setpoint value and 65535 represent OFF
** – 1/Phase Current Scale Factor x A
*** – 101 represents unlimited
† – Minimum setpoint value represents OFF
†† – This register is only applicable to units with the VFD display
~* – 0.1 x A when Hi resolution mode is disabled; 0.01 x A when enabled

Table 5–12: MODBUS MEMORY MAP (Sheet 18 of 21)

GROUP	MOD-ICON	ADDRESS		DESCRIPTION	RANGE	STEP VALUE	UNITS AND SCALE	FOR-MAT	DEFAULT VALUE (CONVERTED)
		DEC	HEX						
PROCESS INTER-LOCK NAMES	44513	4512	11A0	Intlck Counter Name chars 1 and 2	32-255	1	ASCII	F10	“IN”
	44514	4513	11A1	Intlck Counter Name chars 3 and 4	32-255	1	ASCII	F10	“TE”
	44515	4514	11A2	Intlck Counter Name chars 5 and 6	32-255	1	ASCII	F10	“RL”
	44516	4515	11A3	Intlck Counter Name chars 7 and 8	32-255	1	ASCII	F10	“OC”
	44517	4516	11A4	Intlck Counter Name chars 9 and 10	32-255	1	ASCII	F10	“K “
	44518	4517	11A5	Intlck Counter Name chars 11 & 12	32-255	1	ASCII	F10	“CO”
	44519	4518	11A6	Intlck Counter Name chars 13 & 14	32-255	1	ASCII	F10	“UN”
	44520	4519	11A7	Intlck Counter Name chars 15 & 16	32-255	1	ASCII	F10	“TE”
	44521	4520	11A8	Intlck Counter Name chars 17 & 18	32-255	1	ASCII	F10	“R “
	44522	4521	11A9	Intlck Counter Name chars 19 & 20	32-255	1	ASCII	F10	““
	44523	4522	11AA	Intlck Counter Units chars 1 and 2	32-255	1	ASCII	F10	“UN”
	44524	4523	11AB	Intlck Counter Units chars 3 and 4	32-255	1	ASCII	F10	“IT”
	44525	4524	11AC	Intlck Counter Units chars 5 and 6	32-255	1	ASCII	F10	“S “
	44526	4525	11AD	Intlck Counter Units chars 7 and 8	32-255	1	ASCII	F10	““
	44527	4526	11AE	Intlck Counter Units chars 9 and 10	32-255	1	ASCII	F10	““
	44528	4527	11AF	...Reserved...	...	...	...	...	...
AUX 2 RELAY	44529	4528	11B0	AUX Relay 2 Function	0-33	1	---	F20	0=serial cntl
	44530	4529	11B1	AUX Relay 2 Delay	0-125	1	s	F1	5
	44531	4530	11B2	AUX Relay 2 Motor Start Delay	0-125	1	s	F1	5
	44532	4531	11B3	AUX Relay 2 Motor Stop Delay	0-125	1	s	F1	5
	44533	4532	11B4	AUX Relay 2 Pre Delay	0-900	1	s	F1	5
	44534	4533	11B5	AUX Relay 2 Post Delay	0-126	1	s	F1 *	126 = OFF
	44535	4534	11B6	AUX Relay 2 Operation	0-1	1	---	F12	0=non-failsafe
	44536	4535	11B7	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	44544	4543	11BF	...Reserved...	...	...	...	...	...
PROG. INPUTS	44545	4544	11C0	Interlock 1 Switch Type	0-1	1	-	F30	0 = N.O.
	44546	4545	11C1	Interlock 2 Switch Type	0-1	1	-	F30	0 = N.O.
	44547	4546	11C2	Interlock 3 Switch Type	0-1	1	-	F30	0 = N.O.
	44548	4547	11C3	Interlock 4 Switch Type	0-1	1	-	F30	0 = N.O.
	44549	4548	11C4	Interlock 5 Switch Type	0-1	1	-	F30	0 = N.O.
	44550	4549	11C5	Interlock 6 Switch Type	0-1	1	-	F30	0 = N.O.
	44551	4550	11C6	Interlock 7 Switch Type	0-1	1	-	F30	0 = N.O.
	44552	4551	11C7	Interlock 8 Switch Type	0-1	1	-	F30	0 = N.O.
	44553	4552	11C8	Interlock 9 Switch Type	0-1	1	-	F30	0 = N.O.

Notes:
* – Maximum setpoint value and 65535 represent OFF
** – 1/Phase Current Scale Factor x A
*** – 101 represents unlimited
† – Minimum setpoint value represents OFF
†† – This register is only applicable to units with the VFD display
~* – 0.1 x A when Hi resolution mode is disabled; 0.01 x A when enabled

Table 5–12: MODBUS MEMORY MAP (Sheet 19 of 21)

GROUP	MOD-ICON	ADDRESS		DESCRIPTION	RANGE	STEP VALUE	UNITS AND SCALE	FOR-MAT	DEFAULT VALUE (CONVERTED)
		DEC	HEX						
PROG. INPUTS continued	44554	4553	11C9	Interlock 10 Switch Type	0-1	1	-	F30	0 = N.O.
	44555	4554	11CA	Ground Alarm Delay on Start	1-60	1	s	F1	10
	44556	4555	11CB	Ground Trip Delay on Start	0-100	1	s	F1	10
	44557	4556	11CC	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	44560	4559	11CF	...Reserved...	...	...	...	...	...
PROCESS INTER-LOCK NAMES	44561	4560	11D0	Process Intlk E Name chars 1 and 2	32-127	1	ASCII	F10	'PR'
	44562	4561	11D1	Process Intlk E Name chars 3 and 4	32-127	1	ASCII	F10	'OC'
	44563	4562	11D2	Process Intlk E Name chars 5 and 6	32-127	1	ASCII	F10	'ES'
	44564	4563	11D3	Process Intlk E Name chars 7 and 8	32-127	1	ASCII	F10	'S '
	44565	4564	11D4	Process Intlk E Name chars 9 & 10	32-127	1	ASCII	F10	'IN'
	44566	4565	11D5	Process Intlk E Name chars 11 & 12	32-127	1	ASCII	F10	'TE'
	44567	4566	11D6	Process Intlk E Name chars 13 & 14	32-127	1	ASCII	F10	'RL'
	44568	4567	11D7	Process Intlk E Name chars 15 & 16	32-127	1	ASCII	F10	'OC'
	44569	4568	11D8	Process Intlk E Name chars 17 & 18	32-127	1	ASCII	F10	'K '
	44570	4569	11D9	Process Intlk E Name chars 19 & 20	32-127	1	ASCII	F10	'E '
	44571	4570	11DA	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	44576	4575	11DF	...Reserved...	...	...	...	...	...
	44577	4576	11E0	Process Intlk F Name chars 1 and 2	32-127	1	ASCII	F10	'PR'
	44578	4577	11E1	Process Intlk F Name chars 3 and 4	32-127	1	ASCII	F10	'OC'
	44579	4578	11E2	Process Intlk F Name chars 5 and 6	32-127	1	ASCII	F10	'ES'
	44580	4579	11E3	Process Intlk F Name chars 7 and 8	32-127	1	ASCII	F10	'S '
	44581	4580	11E4	Process Intlk F Name chars 9 & 10	32-127	1	ASCII	F10	'IN'
	44582	4581	11E5	Process Intlk F Name chars 11 & 12	32-127	1	ASCII	F10	'TE'
	44583	4582	11E6	Process Intlk F Name chars 13 & 14	32-127	1	ASCII	F10	'RL'
	44584	4583	11E7	Process Intlk F Name chars 15 & 16	32-127	1	ASCII	F10	'OC'
	44585	4584	11E8	Process Intlk F Name chars 17 & 18	32-127	1	ASCII	F10	'K '
	44586	4585	11E9	Process Intlk F Name chars 19 & 20	32-127	1	ASCII	F10	'F '
	44587	4586	11EA	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	44592	4591	11EF	...Reserved...	...	...	...	...	...
	44593	4592	11F0	Process Intlk G Name chars 1 and 2	32-127	1	ASCII	F10	'PR'
	44594	4593	11F1	Process Intlk G Name chars 3 and 4	32-127	1	ASCII	F10	'OC'
	44595	4594	11F2	Process Intlk G Name chars 5 and 6	32-127	1	ASCII	F10	'ES'

Notes:
* – Maximum setpoint value and 65535 represent OFF
** – 1/Phase Current Scale Factor x A
*** – 101 represents unlimited
† – Minimum setpoint value represents OFF
†† – This register is only applicable to units with the VFD display
~* – 0.1 x A when Hi resolution mode is disabled; 0.01 x A when enabled

Table 5–12: MODBUS MEMORY MAP (Sheet 20 of 21)

GROUP	MOD-ICON	ADDRESS		DESCRIPTION	RANGE	STEP VALUE	UNITS AND SCALE	FOR-MAT	DEFAULT VALUE (CONVERTED)
		DEC	HEX						
PROCESS INTER-LOCK NAMES continued	44596	4595	11F3	Process Intlk G Name chars 7 and 8	32-127	1	ASCII	F10	'S '
	44597	4596	11F4	Process Intlk G Name chars 9 & 10	32-127	1	ASCII	F10	'IN'
	44598	4597	11F5	Process Intlk G Name chars 11 & 12	32-127	1	ASCII	F10	'TE'
	44599	4598	11F6	Process Intlk G Name chars 13 & 14	32-127	1	ASCII	F10	'RL'
	44600	4599	11F7	Process Intlk G Name chars 15 & 16	32-127	1	ASCII	F10	'OC'
	44601	4600	11F8	Process Intlk G Name chars 17 & 18	32-127	1	ASCII	F10	'K '
	44602	4601	11F9	Process Intlk G Name chars 19 & 20	32-127	1	ASCII	F10	'G '
	44603	4602	11FA	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	44608	4607	11FF	...Reserved...	...	...	...	...	...
	44609	4608	1200	Process Intlk H Name chars 1 and 2	32-127	1	ASCII	F10	'PR'
	44610	4609	1201	Process Intlk H Name chars 3 and 4	32-127	1	ASCII	F10	'OC'
	44611	4610	1202	Process Intlk H Name chars 5 and 6	32-127	1	ASCII	F10	'ES'
	44612	4611	1203	Process Intlk H Name chars 7 and 8	32-127	1	ASCII	F10	'S '
	44613	4612	1204	Process Intlk H Name chars 9 & 10	32-127	1	ASCII	F10	'IN'
	44614	4613	1205	Process Intlk H Name chars 11 & 12	32-127	1	ASCII	F10	'TE'
	44615	4614	1206	Process Intlk H Name chars 13 & 14	32-127	1	ASCII	F10	'RL'
	44616	4615	1207	Process Intlk H Name chars 15 & 16	32-127	1	ASCII	F10	'OC'
	44617	4616	1208	Process Intlk H Name chars 17 & 18	32-127	1	ASCII	F10	'K '
	44618	4617	1209	Process Intlk H Name chars 19 & 20	32-127	1	ASCII	F10	'H '
	44619	4618	120A	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	44624	4623	120F	...Reserved...	...	...	...	...	...
	44625	4624	1210	Process Intlk I Name chars 1 and 2	32-127	1	ASCII	F10	'PR'
	44626	4625	1211	Process Intlk I Name chars 3 and 4	32-127	1	ASCII	F10	'OC'
	44627	4626	1212	Process Intlk I Name chars 5 and 6	32-127	1	ASCII	F10	'ES'
	44628	4627	1213	Process Intlk I Name chars 7 and 8	32-127	1	ASCII	F10	'S '
	44629	4628	1214	Process Intlk I Name chars 9 and 10	32-127	1	ASCII	F10	'IN'
	44630	4629	1215	Process Intlk I Name chars 11 & 12	32-127	1	ASCII	F10	'TE'
	44631	4630	1216	Process Intlk I Name chars 13 & 14	32-127	1	ASCII	F10	'RL'
	44632	4631	1217	Process Intlk I Name chars 15 & 16	32-127	1	ASCII	F10	'OC'
	44633	4632	1218	Process Intlk I Name chars 17 & 18	32-127	1	ASCII	F10	'K '
	44634	4633	1219	Process Intlk I Name chars 19 & 20	32-127	1	ASCII	F10	'I '
	44635	4634	121A	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓

Notes:
* – Maximum setpoint value and 65535 represent OFF
** – 1/Phase Current Scale Factor x A
*** – 101 represents unlimited
† – Minimum setpoint value represents OFF
†† – This register is only applicable to units with the VFD display
~* – 0.1 x A when Hi resolution mode is disabled; 0.01 x A when enabled

Table 5–12: MODBUS MEMORY MAP (Sheet 21 of 21)

GROUP	MOD-ICON	ADDRESS		DESCRIPTION	RANGE	STEP VALUE	UNITS AND SCALE	FOR-MAT	DEFAULT VALUE (CONVERTED)
		DEC	HEX						
PROCESS INTER-LOCK NAMES continued	44640	4639	121F	...Reserved...	...	...	...	...	...
	44641	4640	1220	Process Intlk J Name chars 1 and 2	32-127	1	ASCII	F10	'PR'
	44642	4641	1221	Process Intlk J Name chars 3 and 4	32-127	1	ASCII	F10	'OC'
	44643	4642	1222	Process Intlk J Name chars 5 and 6	32-127	1	ASCII	F10	'ES'
	44644	4643	1223	Process Intlk J Name chars 7 and 8	32-127	1	ASCII	F10	'S '
	44645	4644	1224	Process Intlk J Name chars 9 & 10	32-127	1	ASCII	F10	'IN'
	44646	4645	1225	Process Intlk J Name chars 11 & 12	32-127	1	ASCII	F10	'TE'
	44647	4646	1226	Process Intlk J Name chars 13 & 14	32-127	1	ASCII	F10	'RL'
	44648	4647	1227	Process Intlk J Name chars 15 & 16	32-127	1	ASCII	F10	'OC'
	44649	4648	1228	Process Intlk J Name chars 17 & 18	32-127	1	ASCII	F10	'K '
	44650	4649	1229	Process Intlk J Name chars 19 & 20	32-127	1	ASCII	F10	'J '
	44651	4650	122A	...Reserved...	...	...	...	...	...
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	44656	4655	122F	...Reserved...	...	...	...	...	...
PRESET CNTRS & TIMERS	44657	4656	1230	Preset Running Hours	0-65535	1	---	F1	0
	44658	4657	1231	Preset Stopped Hours	0-65535	1	---	F1	0
	44659	4658	1232	Preset Number of Starts - High Order	0-65535	1	---	F1	0
	44660	4659	1233	Preset Number of Starts - Low Order	0-65535	1	---	F1	0
	44661	4660	1234	Preset Overload Trips	0-65535	1	---	F1	0
	44662	4661	1235	Preset Thermistor Trips	0-65535	1	---	F1	0
	44663	4662	1236	Preset Ground Fault Trips	0-65535	1	---	F1	0
	44664	4663	1237	Preset Single Phase Trips	0-65535	1	---	F1	0
	44665	4664	1238	Preset Acceleration Trips	0-65535	1	---	F1	0
	44666	4665	1239	Preset Undercurrent Trips	0-65535	1	---	F1	0
	44667	4666	123A	Preset Under Power Trips	0-65535	1	---	F1	0
	44668	4667	123B	Preset Stalled Rotor Trips	0-65535	1	---	F1	0
	44669	4668	123C	Preset Control Command Trips	0-65535	1	---	F1	0
	44670	4669	123D	Preset Interlock Counter	0-65535	1	---	F1	0
	...	...	...	...Reserved...	...	...	...	...	...
STARTS PER HOUR	44676	4675	1243	Starts/Hour Configuration	0-1	1	---	F1	0 = Fixed
	44677	4676	1244	Starts/Hour Permissible	0-5	1	---	F1†	0 = OFF
	44678	4677	1245	Time Between Starts Permissible	0-500	1	min.	F1†	0 = OFF
	...	...	...	...Reserved...	...	...	...	...	...
USER DEF. MEM. MAP DATA	44737	4736	1280	Address - User Definable Data 0100	0-12FF	1	---	F1	0
	44738	4737	1281	Address - User Definable Data 0101	0-12FF	1	---	F1	0
	44739	4738	1282	Address - User Definable Data 0102	0-12FF	1	---	F1	0
	44740	4739	1283	Address - User Definable Data 0103	0-12FF	1	---	F1	0
	↓	↓	↓	↓	↓	↓	↓	↓	↓
	44856	4855	12F7	Address - User Definable Data 0177	0-12FF	1	---	F1	0

Notes:
* – Maximum setpoint value and 65535 represent OFF
** – 1/Phase Current Scale Factor x A
*** – 101 represents unlimited
† – Minimum setpoint value represents OFF
†† – This register is only applicable to units with the VFD display
~* – 0.1 x A when Hi resolution mode is disabled; 0.01 x A when enabled

Table 5–13: DATA FORMATS (Sheet 1 of 15)

CODE	DESCRIPTION	BITMASK
F1	Unsigned Integer: Numerical Data	FFFF
F2	Unsigned Long Int: Numerical Data	FFFFFFFF
F3	Signed Long Integer: Numerical Data	FFFFFFFF
F4	Hardware Version Code	---
	1 = A	---
	↓	↓
	26 = Z	---
F5	Unsigned Integer: Cause of Stop	FFFF
	0 = No Stop	---
	1 = Process Interlock A Stop	---
	2 = Process Interlock B Stop	---
	3 = Process Interlock C Stop	---
	4 = Process Interlock D Stop	---
	5 = External Stop	---
	6 = ESD Stop	---
	7 = Process Interlock E Stop	---
	8 = Process Interlock F Stop	---
	9 = Process Interlock G Stop	---
	10 = Process Interlock H Stop	---
	11 = Process Interlock I Stop	---
	12 = Process Interlock J Stop	---
	13 = Faceplate Stop	---
	14 = Process Stop	---
	15 = Serial Stop	---
	16 = Two-Wire Stop	---
	17 = Stop A Interlock Stop	---
	18 = Stop B Interlock Stop	---
F6	Unsigned Integer: Command Mode	FFFF
	0 = Manual	---
	1 = Auto	---
	2 = Manual Inhibit	---
	3 = Manual and Auto	---
	4 = Hard-Wire Auto	---

Table 5–13: DATA FORMATS (Sheet 2 of 15)

CODE	DESCRIPTION	BITMASK
F7	Unsigned Integer - Drive Status	FFFF
	0 = Unavailable	---
	1 = Available - Auto	---
	2 = Available - Manual	---
	3 = Available (Manual & Auto)	---
	4 = Running	---
	5 = ESD TRIP or STOP (Mod)	
F8	Unsigned Integer: Motor Mode	FFFF
	0 = Starting	---
	1 = Stopped	---
	2 = Running	---
F9	Unsigned Integer - Cause of Trip	FFFF
	0 = No Trip	---
	1 = Process Interlock A	---
	2 = Process Interlock B	---
	3 = Process Interlock C	---
	4 = Process Interlock D	---
	5 = Parameters Not Set	---
	6 = Faceplate Stop	---
	7 = Process Stop	---
	11 = Overload	---
	12 = Single Phase	---
	13 = Thermistor	---
	14 = Acceleration Time	---
	15 = Ground Fault	---
	16 = Stalled Rotor	---
	17 = Not Used	---
	18 = Local Isolator	---
	19 = Serial Communications Failure	---
	20 = Internal Fault	---
	21 = Undercurrent	---
	22 = Emergency Stop	---
	23 = Underpower	---
	24 = Analog Input High	---
	25 = Analog Input Low	---
	26 = Plant Interlock	---
	27 = Process Interlock E	---

Table 5–13: DATA FORMATS (Sheet 3 of 15)

CODE	DESCRIPTION	BITMASK
F9 con't	28 = Process Interlock F	---
	29 = Process Interlock G	---
	30 = Process Interlock H	---
	31 = Process Interlock I	---
	32 = Process Interlock J	---
F10	Two ASCII Characters	FFFF
	32 to 127 = ASCII Character	7F00
	32 to 127 = ASCII Character	007F
F11	Unsigned Integer: Starter Type	FFFF
	0 = Off	---
	1=Full Voltage (Direct On Line) Non-Reversing	---
	2 = Full Voltage (Direct On Line) Reversing	---
	3 = Wye-Delta Open Transition	---
	4 = Two Speed	---
	5 = Inverter	---
	6 = Slip Ring	---
	7 = Autotransformer Open Transition	---
	8 = Part Winding	---
	9 = Wye Delta Closed Transition	---
	10 = Autotransformer Closed Transition	---
	11 = Duty/Standby	---
	12 = Soft Starter	---
F12	Unsigned Integer: AUX Relay Operation	FFFF
	0 = Non-Failsafe	
	1 = Failsafe	
F13	Unsigned Integer - Ground CT Type	FFFF
	0 = 50:0.025 CBCT	---
	1 = 5A Secondary CBCT	---
	2 = Residual	---
F14	Unsigned Integer: Enable/Disable	FFFF
	0 = Disable	---
	1 = Enable	---
F15	Unsigned Integer: VT Connection Type	FFFF
	0 = Line (A-B)	---
	1 = Phase (A-N)	---
F16	Unsigned Integer: Manual/Auto	FFFF
	0 = Manual	---
	1 = Auto	---

Table 5–13: DATA FORMATS (Sheet 4 of 15)

CODE	DESCRIPTION	BITMASK
F17	Interlock Input function	FFFF
	0 = Not Used	---
	1 = Process Interlock A	---
	2 = Process Interlock B	---
	3 = Process Interlock C	---
	4 = Process Interlock D	---
	5 = Plant Interlock	---
	6 = Lockout Reset	---
	7 = Setpoint Access	---
	8 = Auto Permissive	---
	9 = Auto Start A	---
	10 = Auto Start B	---
	11 = Reset Emergency Stop Trip	---
	12 = Reset Undercurrent Trip	---
	13 = Two Wire Control	---
	14 = Test Switch	---
	15 = Remote Permissive	---
	16 = Communication Select	---
	17 = Interlock Counter	---
	18 = AUX Relay 1 Inhibit	---
	19 = Wye Delta 1M Contact	---
	20 = Wye Delta 2S Contact	---
	21 = U/V Restart Inhibit	---
	22 = Autotransformer 2S Contact	---
	23 = Process Interlock E	---
	24 = Process Interlock F	---
	25 = Process Interlock G	---
	26 = Process Interlock H	---
	27 = Process Interlock I	---
	28 = Process Interlock J	---
	29 = Stop A	---
	30 = Stop B	---
	31 = Remote Reset	---
	32 = Motor Selector A/B	---
	33 = Duty Select Man/Auto	---
	34 = Bypass Contact	---
	35 = Switch Input Monitor	---
F18	Unsigned Integer: Interlock Stop / Latched Trip	FFFF
	0 = Interlock Stop	---
	1 = Latched Trip	---

Table 5–13: DATA FORMATS (Sheet 5 of 15)

CODE	DESCRIPTION	BITMASK
F19	Unsigned Integer: Unlatched / Latched	FFFF
	0 = Unlatched	---
	1 = Latched	---
F20	Unsigned Integer: Auxiliary Relay Function	FFFF
	0 = Serial Control	---
	1 = Trips	---
	2 = Alarms	---
	3 = Pre Contactor A	---
	4 = Post Contactor A	---
	5 = Post Contactor B	---
	6 = Drive Available Manual	---
	7 = Load Increase Alarm	---
	8 = Undercurrent Trip	---
	9 = Underpower Trip	---
	10 = Keypad Reset	---
	11 = Interlock 1	---
	12 = Interlock 2	---
	13 = Interlock 3	---
	14 = Interlock 4	---
	15 = Interlock 5	---
	16 = Interlock 6	---
	17 = Interlock 7	---
	18 = Interlock 8	---
	19 = Interlock 9	---
	20 = Interlock 10	---
	21 = AUTO Mode	---
	22 = Motor Running	---
	23 = Ground Fault Trip	---
	24 = Wye Delta Closed Transition	---
	25 = Autotransformer 2S	---
	26 = Not Used	---
	27 = Pre Contactor B	---
	28 = Segregated Ground Fault Alarm	---
	29 = Thermal Capacity Alarm	---
	30 = Motor Available	---
	31 = Motor Available Auto	---
	32 = Overload	---
	33 = Soft Starter Bypass	---
F21	Signed Integer	FFFF

Table 5–13: DATA FORMATS (Sheet 6 of 15)

CODE	DESCRIPTION	BITMASK
F22	Command	FFFF
	1 = Reset	---
	2 = Lockout Reset	---
	3 = Stop	---
	4 = Start A	---
	5 = Start B	---
	6 = AUX Relay 1 = On	---
	7 = AUX Relay 1 = Off	---
	8 = Clear Maintenance Timers	---
	9 = Clear Maintenance Counters	---
	10 = Clear Energy Data	---
	11 = Display Message	---
	12 = Simulate Keypress	---
	13 = Manual Inhibit	---
	14 = Manual Restore	---
	15 = Not used	---
	16 = Store New Address	---
	17 = Upload Mode Entry 2	---
	18 = Upload Mode Entry 1	---
	19 = Reload Factory Setpoints 2	---
	20 = Reload Factory Setpoints 1	---
	21 = Test Relays and LEDs	---
	22 = Clear Interlock Counter	---
	23 = AUX Relay 2 = On	---
	24 = AUX Relay 2 = Off	---
	25 = Factory Use	---
	26 = Factory Use	---
	27 = Factory Use	---
	28 = Factory Use	---
	29 = Factory Use	---
	30 = Factory Use	---
	31 = Factory Use	---
	32 = Factory Use	---
	33 = Store Preset Values	---
	34 = Start Inhibit (Block)	---
	35 = Start Restore (Unblock)	---

Table 5–13: DATA FORMATS (Sheet 7 of 15)

CODE	DESCRIPTION	BITMASK
F23	Unsigned Integer: Keypress Simulation Data	FFFF
	0x3100 = SETPOINT	---
	0x3200 = ACTUAL	---
	0x3300 = RESET	---
	0x3400 = STORE	---
	0x3500 = MESSAGE UP	---
	0x3600 = MESSAGE DOWN	---
	0x3700 = MESSAGE LEFT	---
	0x3800 = MESSAGE RIGHT	---
	0x3900 = VALUE UP	---
	0x6100 = VALUE DOWN	---
F24	Unsigned Integer: Current key press	FFFF
	0000 = no key	---
	FE01 = AUTO	---
	FE02 = MANUAL	---
	FE04 = START A	---
	FE08 = START B	---
	FD01 = STOP 1	---
	FD02 = STOP 2	---
	FD04 = RESET	---
	FD08 = STORE	---
	FB01 = SETPOINT	---
	FB02 = ACTUAL	---
	FB04 = MESSAGE UP	---
	FB08 = MESSAGE DOWN	---
	F701 = MESSAGE LEFT	---
	F702 = MESSAGE RIGHT	---
	F704 = VALUE UP	---
	F708 = VALUE DOWN	---
F25	Unsigned Integer: Modbus Baud Rate	FFFF
	0 = 1200	---
	1 = 2400	---
	2 = 4800	---
	3 = 9600	---
	4 = 19200	---

Table 5–13: DATA FORMATS (Sheet 8 of 15)

CODE	DESCRIPTION	BITMASK
F26	Unsigned Integer: Relay / LED Test Data	FFFF
	0 = Normal operation mode	---
	1 = Contactor A On	---
	2 = Contactor B On	---
	3 = AUX Relay 1 On	---
	4 = AUX Relay 2 On	---
	5 = All Relays On	---
	6 = Running LED On	---
	7 = Stopped LED On	---
	8 = Tripped LED On	---
	9 = Alarm LED On	---
	10 = Fault LED On	---
	11 = Auto LED On	---
	12 = Manual LED On	---
	13 = All LEDs On	---
	14 = Flash Voltage On	---
F27	Unsigned Integer: Auto Mode Definition	FFFF
	0 = Serial	---
	1 = Hard-Wired	---
F28	Unsigned Integer: Overload Curve	FFFF
	1 = Curve # 1	---
	2 = Curve # 2	---
	3 = Curve # 3	---
	4 = Curve # 4	---
	5 = Curve # 5	---
	6 = Curve # 6	---
	7 = Curve # 7	---
	8 = Curve # 8	---
	9 = NEMA Class 10	---
	10 = NEMA Class 15	---
	11 = NEMA Class 20	---
	12 = NEMA Class 30	---
F29	Unsigned Integer: ESD Indication	FFFF
	0 = OFF when healthy	---
	1 = ON when healthy	---
F30	Unsigned Integer: Normally Open / Normally Closed	FFFF
	0 = N.O.	---
	1 = N.C.	---

Table 5–13: DATA FORMATS (Sheet 9 of 15)

CODE	DESCRIPTION	BITMASK
F31	Parity Type	FFFF
	0 = NONE	---
	1 = EVEN	---
	2 = ODD	---
F32	Contactor Sequence	FFFF
	0 = 1S-2S	---
	1 = 2S-1S	---
F33	Manufacture Month/Day	FFFF
	Month: 1 = January, 2 = February... 12 = December	---
	Day: 1 to 31 in steps of 1	---
F34	Manufacture Year: Unsigned Integer	FFFF
	Year: 1995, 1996	---
F36	Simulated Switch State	FFFF
	0 = OPEN	---
	1 = CLOSED	---
F37	Unsigned Integer: On / Off	FFFF
	0 = Off	---
	1 = On	---
F100	Switch Input Status:	FFFF
	Interlock Input 1	0001
	Interlock Input 2	0002
	Interlock Input 3	0004
	Interlock Input 4	0008
	Interlock Input 5	0010
	Interlock Input 6	0020
	Interlock Input 7	0040
	Interlock Input 8	0080
	Interlock Input 9	0100
	Interlock Input 10	0200
	Stop	0400
	Start A	0800
	Start B	1000
	Local Isolator N/O	2000
	Contactor A N/O	4000
	Contactor B N/O	8000

Table 5–13: DATA FORMATS (Sheet 10 of 15)

CODE	DESCRIPTION	BITMASK
F101	LED Status Flags 1	FFFF
	Running	0001
	Stopped	0002
	Tripped	0004
	Alarm	0008
	Fault	0010
	Test 1	0020
	Test 2	0040
	Not Used	0080
	Not Used	0100
	Not Used	0200
	Not Used	0400
	Not Used	0800
	Not Used	1000
	Not Used	2000
	Not Used	4000
	Not Used	8000
F102	LED Status Flags 2	FFFF
	Contactor A Relay	0001
	Contactor B Relay	0002
	AUX 1 Relay	0004
	AUX 2 Relay	0008
	Auto	0010
	Manual	0020
	Beeper	0040
	VFD/LCD test mode	0080
	Not Used	0100
	Not Used	0200
	Not Used	0400
	Not Used	0800
	Not Used	1000
	Not Used	2000
	Not Used	4000
	Not Used	8000

Table 5–13: DATA FORMATS (Sheet 11 of 15)

CODE	DESCRIPTION	BITMASK
F103	Operation Status	FFFF
	External Start	0001
	External Stop	0002
	ESD Stop	0004
	Not Used	0008
	Not Used	0010
	Not Used	0020
	Not Used	0040
	Not Used	0080
	Not Used	0100
	Not Used	0200
	Not Used	0400
	Not Used	0800
	Not Used	1000
	Not Used	2000
	Not Used	4000
	Not Used	8000
F104	Alarm Status Flags 1	FFFF
	Load Increase Alarm	0001
	Phase Unbalance Alarm	0002
	Thermistor Alarm	0004
	Underpower Alarm	0008
	Undercurrent Alarm	0010
	Acceleration Time Alarm	0020
	Ground Fault Alarm	0040
	Analog Input High Alarm	0080
	Analog Input Low Alarm	0100
	Drive Greasing Interval Exceeded Alm	0200
	Contactor Inspection Interval Exceeded Alarm	0400
	Maximum Drive Stopped Time Exceeded Alarm	0800
	Internal Fault Alarm	1000
	Thermal Capacity Alarm	2000
	UnderVoltage Alarm	4000
	Overvoltage Alarm	8000

Table 5–13: DATA FORMATS (Sheet 12 of 15)

CODE	DESCRIPTION	BITMASK
F105	Alarm Status Flags 2	FFFF
	Open Control Circuit	0001
	Welded Contactor	0002
	Inverter Tripped	0004
	Drive Failed to Start	0008
	Drive Failed to Stop	0010
	Incomplete Start	0020
	Duty Motor Trip Alarm	0040
	Start Block Alarm	0080
	Serial Communication Alarm	0100
	Switch Voltage High Alarm	0200
	Not Used	0400
	Not Used	0800
	Not Used	1000
	Not Used	2000
	Not Used	4000
	Not Used	8000
F106	Interlock Flags	FFFF
	Not Used	0001
	Process Interlock A	0002
	Process Interlock B	0004
	Process Interlock C	0008
	Process Interlock D	0010
	Process Interlock E	0020
	Process Interlock F	0040
	Process Interlock G	0080
	Process Interlock H	0100
	Process Interlock I	0200
	Process Interlock J	0400
	Not Used	0800
	Not Used	1000
	Not Used	2000
	Not Used	4000
	Not Used	8000

Table 5–13: DATA FORMATS (Sheet 13 of 15)

CODE	DESCRIPTION	BITMASK
F107	Trip Flags 1	FFFF
	Ground Fault	0001
	Overload	0002
	Single Phase	0004
	Acceleration Time	0008
	Thermistor	0010
	Stalled Rotor	0020
	Undercurrent	0040
	Underpower	0080
	Analog Input High	0100
	Analog Input Low	0200
	Local Isolator	0400
	Plant Interlock	0800
	Serial Communication Failure	1000
	Internal Fault	2000
	Emergency Stop	4000
	ESD Stop (Mod)	8000
F108	Trip Flags 2	FFFF
	Process Interlock A	0001
	Process Interlock B	0002
	Process Interlock C	0004
	Process Interlock D	0008
	Parameters Not Set	0010
	Faceplate Stop	0020
	Process Stop	0040
	Process Interlock E	0080
	Process Interlock F	0100
	Process Interlock G	0200
	Process Interlock H	0400
	Process Interlock I	0800
	Process Interlock J	1000
	Open Control Circuit	2000
	Undervoltage	4000
	Overvoltage	8000

Table 5–13: DATA FORMATS (Sheet 14 of 15)

CODE	DESCRIPTION	BITMASK
F109	Start Flags	FFFF
	Wye Delta start complete	0001
	Two Wire Stop requested	0002
	Serial Permissive (Starts Blkd if set)	0004
	Not Used	0008
	Not Used	0010
	Not Used	0020
	Not Used	0040
	Not Used	0080
	Not Used	0100
	Not Used	0200
	Not Used	0400
	Not Used	0800
	Not Used	1000
	Not Used	2000
	Not Used	4000
	Not Used	8000
F110	Speed Status:	FFFF
	Speed at last Trip (0 = low, 1 = high)	0001
	Speed at last Inrush calculation (0 = low, 1 = high)	0002
	Not Used	0004
	Not Used	0008
	Not Used	0010
	Not Used	0020
	Not Used	0040
	Not Used	0080
	Not Used	0100
	Not Used	0200
	Not Used	0400
	Not Used	0800
	Not Used	1000
	Not Used	2000
	Not Used	4000
	Not Used	8000

Table 5–13: DATA FORMATS (Sheet 15 of 15)

CODE	DESCRIPTION	BITMASK
F111	GE MM2 Options	FFFF
	Option group 1	0001
	Not Used	0002
	Option group 2	0004
	Not Used	0008
	Option E	0010
	Option N	0020
	120	0040
	240	0080
	Not Used	0100
	Not Used	0200
	Not Used	0400
	Not Used	0800
	Not Used	1000
	Not Used	2000
	Not Used	4000
	Not Used	8000
F112	Internal Fault Error Code	FFFF
	ADC Reference Out of Range	0001
	HC705 Processor not Responding	0002
	Switch Input Circuit Fault	0004
	HC705 processor MOR byte not programmed	0008
	Not Used	0010
	Not Used	0020
	Not Used	0040
	Not Used	0080
	Not Used	0100
	Not Used	0200
	Not Used	0400
	Not Used	0800
	Not Used	1000
	Not Used	2000
	Not Used	4000
	Not Used	8000
F113	Unsigned Integer: Auto Mode Definition	FFFF
	0 = Serial	---
	1 = Hard-Wire	---

6.1.1 DESCRIPTION

All Actual Values messages displayed by the MM2 are listed and explained in this chapter. Messages are organized into logical groups of pages. Each page contains sections of related messages. Actual Values has 4 pages which contain the following information:

- Page 1: Data
- Page 2: Status
- Page 3: Inputs
- Page 4: Statistics

The following pages show the actual message which can be read from the display on the front panel of the MM2. Quantities shown, are typical values only. Different quantities will be displayed in each particular application.

When finished viewing a message in a particular section, press the MESSAGE RIGHT key to view the next line. When the last line of a section is reached, press the MESSAGE DOWN key to view the next section in the page. When the last line of the last section within a page is reached, press the ACTUAL key to select the next page.

6.1.2 DEFAULT MESSAGE SELECTION

Up to 5 default messages can be selected to automatically scan sequentially when the motor is running and the MM2 is left unattended. If no keys are pressed for 2 minutes and the motor is running then the currently displayed message will automatically be overwritten by the first default message. After 3 seconds, the next default message in the sequence will display if more than one is selected. Alarm and trip messages will override default message display. Any Actual Value or Setpoint can be selected as a default message. For example, the MM2 could be programmed to display these messages in sequence: 3 phase current, ground current, motor status, motor current as a percentage of full load and analog input.

Messages are displayed in the order they are selected. To add a default message, use the MESSAGE keys to display any Actual Values or Setpoints message to be added to the default queue. Press the STORE key twice in rapid succession. The display will prompt:

```
TO ADD THIS DEFAULT
MESSAGE PRESS STORE
```

Press the STORE key again and the display will confirm that the default message has been added. If 5 default messages are already selected, the first message is erased and the new message added to the end of the queue.

To delete a default message, first wait for 2 minutes and note which messages are displayed in sequence. Use the MESSAGE keys to display the default message to be erased. Press the STORE then RESET key in rapid succession. The display will prompt:

```
TO DELETE THIS
MESSAGE PRESS STORE
```

Press the STORE key and the display will confirm that the default message has been deleted. If the message was not a current default message, the display will read:

```
NOT A SELECTED
DEFAULT MESSAGE
```

6.1.3 ABBREVIATIONS

The following abbreviations are used in the Actual Values messages.

- A, AMPS: Amperes
- kW: Kilowatts
- kWhr: Kilowatt hours
- MIN: Minutes
- N/O: Normally Open
- O/L: Overload
- s: Seconds

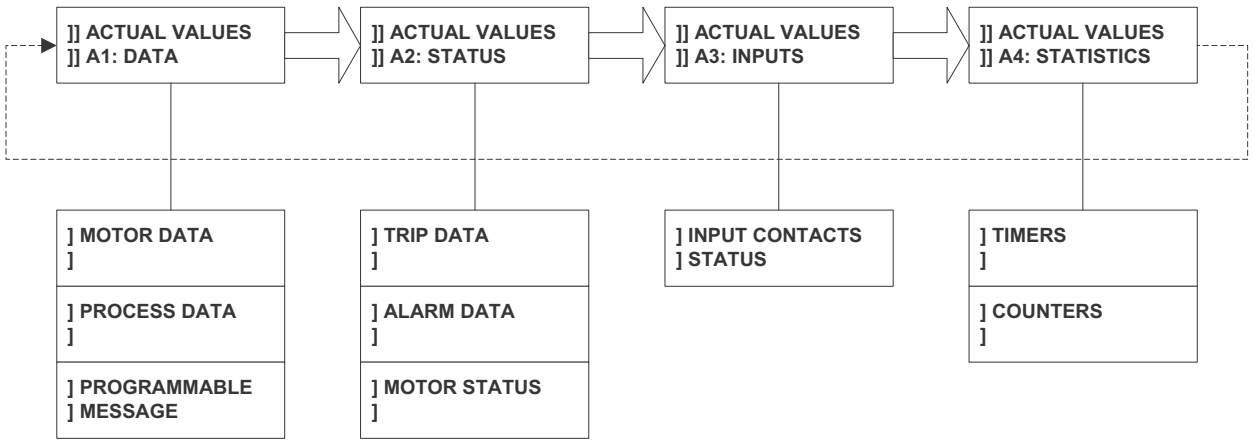


Figure 6–1: MESSAGE SUMMARY

6.2.1 DESCRIPTION

This page contains the real-time data as measured by the MM2. Actual Values Page 1 is divided into three sections, MOTOR DATA, PROCESS DATA, and PROGRAMMABLE MESSAGE.

6.2.2 MOTOR DATA

PATH: ACTUAL VALUES ▼ A1: DATA ▼ MOTOR DATA

```
MOTOR
STATUS:
```

This message indicates the name and status of the motor. The top line of the display (20 characters) can be programmed to a user defined alphanumeric name. The second line indicates motor status. The following list shows the possible motor status indications:

- *Unavailable*: There is at least one condition present that is preventing start commands from operating. Possible conditions are: a trip is present, the STOP key is being pressed, the Stop Switch input is open, one of the Process Interlock switches is open, an undervoltage delayed restart is in progress, an Autotransformer Start Inhibit is in progress, or the **STARTER TYPE** setpoint is 0FF.
- *Available-Auto*: Start commands from the serial port or the Auto Start A / Auto Start B interlock switch inputs will be performed. Start commands from the Start A / Start B switch inputs and the START A/ START B keys will be ignored.
- *Available-Manual*: Start commands from the Start A / Start B switch inputs and/or the START A/ START B keys will be performed. Start commands from the serial port and Auto Start A / Auto Start B switch inputs will be ignored.
- *Running*: At least one contactor output relay is closed.

```
A= 74     B= 74
C= 74     AMPS
```

This message displays the actual RMS current in each phase in amps.

Format: 10.0 at CT Primary ≤ 50 A; 100 at CT Primary > 50 A.

```
GROUND CURRENT =
2.4 AMPS
```

This message displays the ground fault leakage current flowing from any phase to ground in amps.

```
MOTOR LOAD =
 74% FULL LOAD
```

This message displays the motor load as a percentage of full load current (FLC). The motor load is calculated as the average of the three motor phase currents. When the value exceeds 100%, an overload condition exists. The MM2 eventually trips if the current is not reduced below 100% of FLC × SERVICE FACTOR.

```
THERMAL CAPACITY
USED =  21 %
```

This message displays the thermal memory accumulated according to motor I^2t history and chosen overload curve. A thermal capacity value equal to 100% causes an Overload Trip.

```
PHASE CURRENT
UNBALANCE =   1 %
```

Displays the percentage unbalance in the motor phase currents. The unbalance is calculated as shown in Section 1.2.1: MM2 SPECIFICATIONS on page 1–4.

ACCELERATION TIME = 0.0 s	This message displays the motor acceleration time from the last motor start. This value is determined by the amount of time required for the average phase current to go below 1.0 × **FULL LOAD CURRENT** after a motor start.
LAST STARTING CURRENT = 340 AMPS	This message displays the maximum current measured during the last motor start. This value is saved until the next start or until power is cycled on the MM2.
O/L TIME TO TRIP = ---- s	This message displays the estimated time to trip based on the present overload level and thermal capacity used. This message is only used in conjunction with overload trips.
POWER = +1000 kW	This message displays the three phase power, calculated using phase A current and voltage V_{an} or V_{ab}. This message will appear only if the **VT PRIMARY VOLTAGE** setpoint is programmed.
ENERGY USED = 10600 kWhr	This message displays the total accumulated energy used since last cleared. This value is updated once every minute. This message will appear only if the **VT PRIMARY VOLTAGE** setpoint is programmed.
VT VOLTAGE = 480 V	This message displays the voltage present at the primary of the VT. This message will appear only if the **VT PRIMARY VOLTAGE** setpoint is programmed.

6.2.3 PROCESS DATA

PATH: ACTUAL VALUES ▼ A1: DATA ▼▼ PROCESS DATA:

ANALOG INPUT= 142 UNITS	This message displays the 4 to 20 mA analog input value scaled to the minimum and maximum values as specified in setpoints. The analog input name and units are user definable in the setpoints area of the MM2 messages.

6.2.4 PROGRAMMABLE MESSAGE

PATH: ACTUAL VALUES ▼ A1: DATA ▼▼▼ PROGRAMMABLE MESSAGE:

PROGRAMMABLE MESSAGE SAMPLE TEXT	This message displays the 4 to 20 mA analog input value scaled to the minimum and maximum values as specified in setpoints. The analog input name and units are user definable in the setpoints area of the MM2 messages.

6.3.1 DESCRIPTION

This page contains information on the status of the MM2 following an alarm and/or trip. Information such as cause of alarm/trip and the motor values prior to a trip are included. The page also contains a section describing the control status of the motor. Actual Values Page 2 is divided into three sections, TRIP DATA, ALARM DATA and MOTOR STATUS.

6.3.2 TRIP DATA

PATH: ACTUAL VALUES ▼▼ A2 STATUS ▼ TRIP DATA

```
CAUSE OF TRIP:
NO TRIP
```

This message displays the cause of the current trip. If no trip is present, the display indicates NO TRIP. When a trip occurs, the cause of trip message will override the currently selected default message. The possible causes of trip are:

OVERLOAD	GROUND FAULT
SINGLE PHASE	THERMISTOR
ACCELERATION TIME	STALLED ROTOR
PLANT INTERLOCK	LOCAL ISOLATOR
UNDERCURRENT	UNDERPOWER
SERIAL LINK FAIL	INTERNAL FAULT
ANALOG INPUT LOW	ANALOG INPUT HIGH
EMERGENCY STOP	PROCESS INTERLOCK A-J
PROCESS STOP	FACEPLATE STOP
OPEN CONTROL	CIRCUIT UNDER VOLTAGE
OVERVOLTAGE	PARAMETERS NOT SET

```
CAUSE OF LAST TRIP:
PARAMETER NOT SET
```

This message displays the last trip to take place. It is used as a reference for the pretrip phase and ground currents.

```
TIME TO RESET =
 10 MINUTES
```

This message is visible only when an Overload Trip is present. The time left before the Overload Trip can be reset is displayed. Note that the Lockout Reset Interlock feature can be used to override this time.

```
PRETRIP    A = 238
B =  74    C =  74
```

This message displays the motor phase current that was flowing at the time of trip.

```
PRETRIP GROUND
CURRENT = 2.4 AMPS
```

This message displays the ground leakage current that was flowing from any phase to ground at the time of trip.

NOTE

Pretrip values for current related trips are stored in the EEPROM at the time of trip. This enables the MM2 to "remember" pretrip values if power is removed. This feature is enabled for overload, single-phase, undercurrent, underpower, acceleration time, stalled rotor, and ground fault trips. When a trip not listed above occurs and power is removed, the MM2 displays zero for pretrip values.

6.3.3 ALARM DATA

PATH: ACTUAL VALUES ▼▼ A2 STATUS ▼▼ ALARM DATA

Any alarm conditions that are currently active will be displayed. This could be one or more of the following:

NO ACTIVE ALARMS	This message is displayed only when there are no alarms currently active. If at least one alarm has occurred, the most recent alarm message will override the currently selected default message and this message will not be displayed.
LOAD INCREASE ALARM	Load Increase Alarm Level has been exceeded.
INTERNAL FAULT ALARM	Self-test checking detected an internal hardware fault.
PHASE UNBALANCE ALARM	Phase current unbalance of greater than 15% has existed for more than 5 seconds.
THERMISTOR ALARM	The Thermistor Hot resistance has been exceeded.
UNDERPOWER ALARM	The power has dropped below the Underpower Alarm Level for the Underpower Alarm time delay.
UNDERCURRENT ALARM	The average phase current has dropped below the Undercurrent Alarm Level for the Undercurrent Alarm Time Delay.
ACCELERATION TIME ALARM	The measured motor acceleration time has exceeded the Acceleration Time Alarm Level.
GROUND FAULT ALARM	The ground current has exceeded Ground Fault Alarm Level for the Ground Fault Alarm Time Delay.
OPEN CONTROL CIRCUIT	While performing a start, the MM2 did not see a change in contactor status (open to closed) within 1 sec. of energizing the output relay.
WELDED CONTACTOR	While performing a stop, the MM2 did not see a change in contactor status (closed to open) within 1 sec. of de-energizing the output relay.
INVERTER TRIPPED	An inverter trip has been detected by the MM2. This occurs on an inverter starter when Contactor B opens and Contactor A stays closed with no stop command processed by the MM2.
DRIVE FAILED TO START	An Inverter starter has failed to complete a start sequence. This occurs on an inverter starter when, during a start sequence, Contactor A closes as expected but Contactor B fails to close.
DRIVE FAILED TO STOP	An Inverter starter has failed to complete its stop sequence. This occurs on an inverter starter when Contactor B fails to open during a stop sequence.
INCOMPELTE START	An Autotransformer starter has failed to complete its start sequence. This occurs on an autotransformer starter start sequence when Contactor A closes as expected but Contactor B fails to close.
MOTOR GREASING INTERVAL EXCEEDED	The Motor Greasing Interval time has been exceeded.

CONTACT INSPECTION INTERVAL EXCEEDED	The number of contactor operations has exceeded the Contactor Inspection Interval Alarm count.
MAXIMUM MOTOR STOP TIME EXCEEDED	The time that the motor has remained stopped has exceeded the Maximum Motor Stopped Time alarm level. This can be cleared by starting the motor.
ANALOG HIGH ALARM	The Analog Input value has exceeded the Analog Input High Alarm Level for the Analog Input High Alarm Time Delay.
ANALOG LOW ALARM	The Analog Input value has dropped below the Analog Input Low Alarm Level for the Analog Input Low Alarm Time Delay.
PROCESS INTERLOCK A ALARM	An open Process Interlock A switch input has been detected.
PROCESS INTERLOCK B ALARM	An open Process Interlock B switch input has been detected.
PROCESS INTERLOCK C ALARM	An open Process Interlock C switch input has been detected.
PROCESS INTERLOCK D ALARM	An open Process Interlock D switch input has been detected.
PROCESS INTERLOCK E ALARM	An open Process Interlock E switch input has been detected.
PROCESS INTERLOCK F ALARM	An open Process Interlock F switch input has been detected.
PROCESS INTERLOCK G ALARM	An open Process Interlock G switch input has been detected.
PROCESS INTERLOCK H ALARM	An open Process Interlock H switch input has been detected.
PROCESS INTERLOCK I ALARM	An open Process Interlock I switch input has been detected.
PROCESS INTERLOCK J ALARM	An open Process Interlock J switch input has been detected.
MOTOR A TRIP ALARM = OVERLOAD	A Duty/Standby starter type motor has tripped. The cause of the trip is displayed on the bottom line.
THERMAL CAPACITY ALARM	The thermal capacity used has exceeded the Alarm level.
UNDERVOLTAGE ALARM	The primary voltage measurement has dropped below the Alarm level.
OVERVOLTAGE ALARM	The primary voltage measurement has exceeded the Alarm level.
START BLOCK ALARM	A Start Block is in effect.

6.3.4 MOTOR STATUS

PATH: ACTUAL VALUES ▼▼ A2: STATUS ▼▼▼ MOTOR STATUS

MOTOR STATUS: RUNNING	This message has the same possible values as the Motor Status message in page **A1: DATA \ MOTOR DATA**.
DELAYED RESTART IN PROGRESS: 15 s	This message will appear if a delayed undervoltage restart is in progress. The displayed time indicates the time remaining until the start sequence will begin.
DELAYED START IN PROGRESS: 15 s	This message will appear if a delayed start is in progress. This occurs if one of the auxiliary relays is set to Pre Contactor A OR B operation. The displayed time indicates the time remaining until contactor A energizes.
TRANSFER TIME IN PROGRESS: 10 s	This message will appear if a high speed to low speed transition is occurring on a Two Speed starter or if a direction change is occurring on Reversing starter. The displayed time indicates either the time remaining until the low speed output relay (Contactor A) will energize, or the time remaining until the forward output relay (Contactor A) or the reverse output relay (Contactor B) will energize.
RESTART INHIBIT 25 s	This message will appear when an autotransformer start is inhibited. The restart inhibit time is determined from the autotransformer starts per hour setpoint.
EXTERNAL START	This message will appear if the contactor closed without receiving a start command from the MM2. The MM2 will close the corresponding output relay to seal in the contactor.
CAUSE OF STOP	This message will appear to indicate the cause of the current stop condition.
CAUSE OF LAST STOP	This message indicates the cause of the last stop operation.
EXTERNAL STOP	This message indicates that the stop operation was caused externally to the MM2, i.e. The contactor coil de-energized

6.4.1 DESCRIPTION

This page contains information on the 16 switch inputs to the MM2. Actual Values Page 3 contains one section, INPUT CONTACTS STATUS.

6.4.2 INPUT CONTACTS STATUS

PATH: ACTUAL VALUES ▼▼▼ A3 INPUTS ▼ INPUT CONTACTS STATUS

START A INPUT: OPEN	Start A switch input status. **CLOSED**: Start A switch closed; **OPEN**: Start A switch open
START B INPUT: OPEN	Start B switch input status. **CLOSED**: Start B switch closed; **OPEN**: Start B switch open
STOP INPUT: OPEN	Stop switch input status. **CLOSED**: Stop switch closed; **OPEN**: Stop switch open
CONTACTOR A N/O: OPEN	Contactor A N/O switch input status. **CLOSED**: Contactor A N/O switch closed; **OPEN**: Contactor A N/O switch open
CONTACTOR B N/O: OPEN	Contactor B N/O switch input status. **CLOSED**: Contactor B N/O switch closed; **OPEN**: Contactor B N/O switch open
LOCAL ISOLATOR N/O: OPEN	Local Isolator switch input status. **CLOSED**: Local Isolator switch closed; **OPEN**: Local Isolator switch open
INTERLOCK 1: OPEN NOT USED	Interlock 1 switch input status. **CLOSED**: Interlock 1 switch closed; **OPEN**: Interlock 1 switch open This message also shows the function, if any, assigned to Interlock 1
INTERLOCK 2: OPEN NOT USED	Interlock 2 switch input status. **CLOSED**: Interlock 2 switch closed; **OPEN**: Interlock 2 switch open This message also shows the function, if any, assigned to Interlock 2
INTERLOCK 3: OPEN NOT USED	Interlock 3 switch input status. **CLOSED**: Interlock 3 switch closed; **OPEN**: Interlock 3 switch open This message also shows the function, if any, assigned to Interlock 3
INTERLOCK 4: OPEN NOT USED	Interlock 4 switch input status. **CLOSED**: Interlock 4 switch closed; **OPEN**: Interlock 4 switch open This message also shows the function, if any, assigned to Interlock 4
INTERLOCK 5: OPEN NOT USED	Interlock 5 switch input status. **CLOSED**: Interlock 5 switch closed; **OPEN**: Interlock 5 switch open This message also shows the function, if any, assigned to Interlock 5

```
INTERLOCK 6: OPEN
NOT USED
```

Interlock 6 switch input status.

CLOSED: Interlock 6 switch closed; **OPEN**: Interlock 6 switch open

This message also shows the function, if any, assigned to Interlock 6

```
INTERLOCK 7: OPEN
NOT USED
```

Interlock 7 switch input status.

CLOSED: Interlock 7 switch closed; **OPEN**: Interlock 7 switch open

This message also shows the function, if any, assigned to Interlock 7

```
INTERLOCK 8: OPEN
NOT USED
```

Interlock 8 switch input status.

CLOSED: Interlock 8 switch closed; **OPEN**: Interlock 8 switch open

This message also shows the function, if any, assigned to Interlock 8

```
INTERLOCK 9: OPEN
NOT USED
```

Interlock 9 switch input status.

CLOSED: Interlock 9 switch closed; **OPEN**: Interlock 9 switch open

This message also shows the function, if any, assigned to Interlock 9

```
INTERLOCK 10: OPEN
NOT USED
```

Interlock 10 switch input status.

CLOSED: Interlock 10 switch closed; **OPEN**: Interlock 10 switch open

This message also shows the function, if any, assigned to Interlock 10

6.5.1 DESCRIPTION

This page gives detailed information on the running time and accumulated number of various types of trips. Actual Values Page 4 is divided into two sections, TIMERS and COUNTERS.

6.5.2 TIMERS

PATH: ACTUAL VALUES ▼▼▼▼ A4 STATISTICS ▼ TIMERS

RUNNING TIME = 2338 HOURS	The total accumulated time the motor has been running. Whenever Contactor A and/or B is closed, the motor is considered to be running.
STOPPED TIME = 2 HOURS	This is the non-accumulated motor stopped time. This is the amount of time that the motor has been stopped since the last time it was running. This value will clear to zero the next time the motor is started.
STARTS/HOUR TIMERS= 12 0 0 0 0	Indicates how many starts/hour timers are currently counting down. Appears only if **STARTS/HOUR CONFIG** is set to Number.
TIME BETWEEN STARTS TIMER:34 min 17 sec	Indicates the elapsed time between starts for the starts/hour timers. Appears only if **STARTS/HOUR CONFIG** is set to Number.

6.5.3 COUNTERS

PATH: ACTUAL VALUES ▼▼▼▼ A4 STATISTICS ▼▼ COUNTERS

INTERLOCK COUNTER = 34765 UNITS	This is the total number of switch closures read by the MM2 on a programmable input that has been configured to **INTERLOCK COUNTER**.
NUMBER OF STARTS = 26	This is the total number of contactor operations. When the MM2 receives feedback into either contactor status input to confirm that one of the main contactors have closed, this counter will increment.
TOTAL TRIPS = 6	When the MM2 trips for any reason, this value is incremented. It is the sum of all of the individual causes of trip.
OVERLOAD TRIPS = 1	When an overload trip occurs, this value is incremented.
THERMISTOR TRIPS = 2	When a thermistor trip occurs, this value is incremented.
GROUND FAULT TRIPS= 0	When a ground fault trip occurs, this value is incremented.
SINGLE PHASE TRIPS= 0	When a single phase trip occurs, this value is incremented.
ACCELERATION TRIPS= 0	When a single phase trip occurs, this value is incremented.
UNDERCURRENT TRIPS= 0	When an undercurrent trip occurs, this value is incremented.
UNDERPOWER TRIPS: 0	When an underpower trip occurs, this value is incremented.

STALLED ROTOR TRIPS 0

If a stalled rotor trip occurs, this value is incremented.

CONTROL COMMAND TRIPS: 3

If a control trip occurs, this value is incremented (i.e. Plant Interlock, Local Isolator etc.)

7.1.1 PRIMARY INJECTION TESTING

Prior to MM2 commissioning, complete system operation can be verified by injecting current through the phase and ground fault CTs. To accomplish this, a current injection test set is required.

Operation of the entire MM2 control/protection system, except the phase and ground fault CTs, can be checked by applying input signals to the MM2 from a secondary injection test set as described in this chapter.

7.1.2 SECONDARY INJECTION TESTING

A simple, single-phase secondary injection test circuit is shown below. Tests should be performed to verify correct operation and wiring. All functions are firmware driven and this testing is required only to verify correct firmware/hardware interaction.

The tests described in this chapter can be repeated and modified using setpoints and current levels more closely suited to the actual installation.

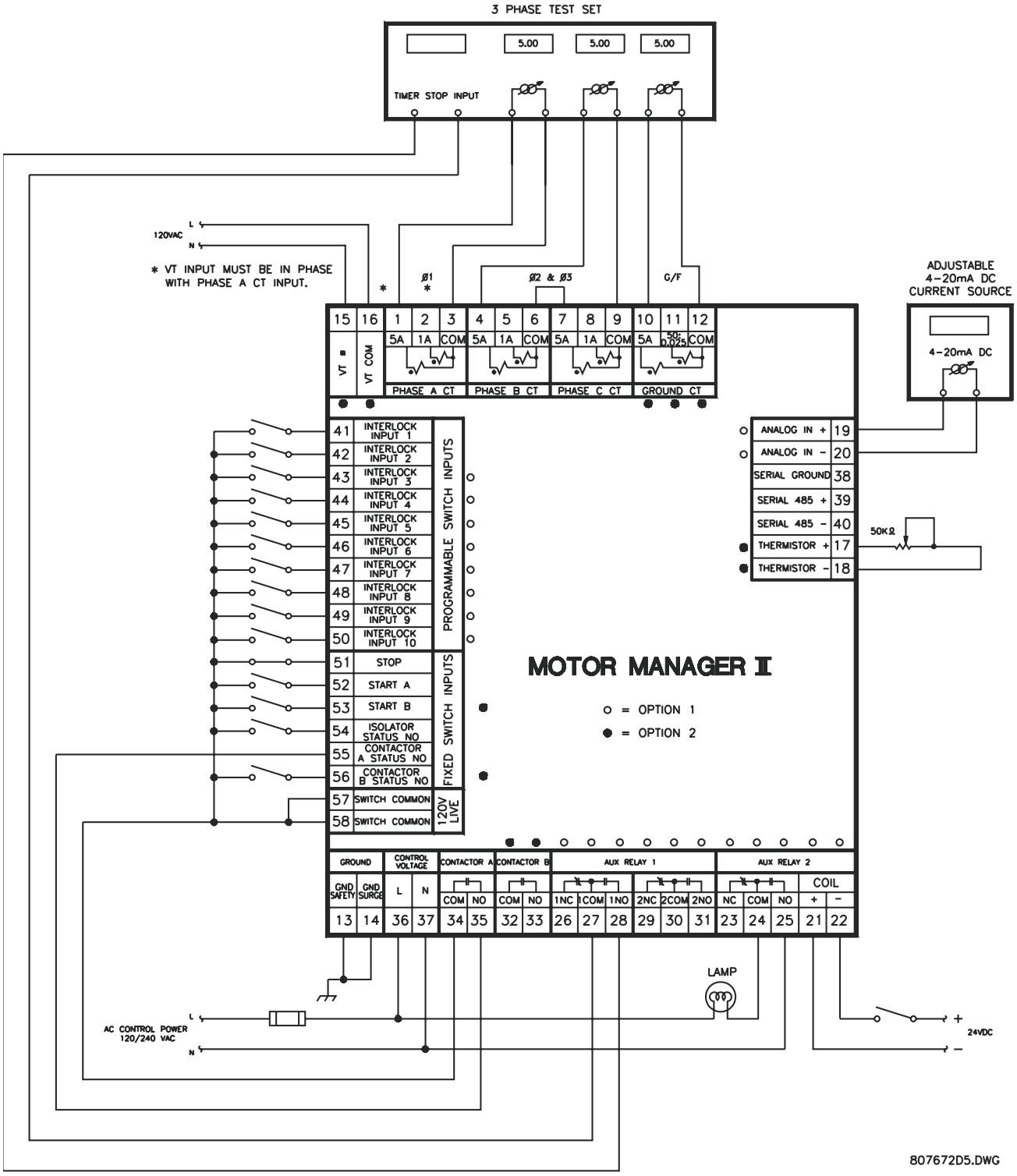


Figure 7–1: SECONDARY INJECTION TEST SETUP

7.2.1 PHASE CURRENT FUNCTIONS

Any phase current protection is based on the ability of the MM2 to read phase input currents accurately. Make the following settings:

S2: PROTECTION \ MOTOR PROTECTION THERMAL \ FULL LOAD CURRENT = 100A.
S1: CONFIGURATION \ STARTER \ STARTER TYPE = FV NON REVERSING.

To determine if the relay is reading the proper input current values, inject different phase currents into the CT inputs and view the current readings in **A1: DATA \ MOTOR DATA**. The displayed current should be equal to the actual injected current.

Phase current values will be displayed even if the motor status is stopped; that is, contactor A has not been activated by a start command. Very low currents are displayed as 0 A.

Once the accuracy of the phase CT inputs has been established, various phase alarm and trip condition tests can be performed by altering setpoints and injected phase currents.

To simulate an overload condition, enter **S2: PROTECTION \ MOTOR PROTECTION THERMAL** and alter and store **OVERLOAD CURVE NUMBER** = 4 and **FULL LOAD CURRENT** = 50A. **PHASE CT PRIMARY AMPS** should be set to 100A. Close the start A input and note that the RUNNING LED goes on. Inject a current of 10 A into all three phases. The relay will display a current value of:

displayed current = actual injected current $\times$ 100/5 = 10 $\times$ 100 / 5 = 200 A.

This represents 4 times the phase **FULL LOAD CURRENT** setpoint. Therefore, based on a 400% overload and curve #4, Contactor A will change state 23 seconds after the overload is first applied. When this occurs, the Running LED turns off and the Tripped and Stopped LEDs are lit. After the trip has occurred, use the **A1: DATA \ MOTOR DATA** actual values to verify that the thermal capacity used is now 100%. Press the RESET key to reset the MM2.

To prepare the MM2 to simulate an unbalance alarm, make the following settings:

S2 PROTECTION \ MOTOR PROTECTION OPTIONS \ PHASE UNBALANCE ALARM = ENABLE
S4 CONTROL \ AUX RELAY 1 CONFIG \ AUX RELAY 1 FUNCTION = ALARMS
S4 CONTROL \ AUX RELAY 2 CONFIG \ AUX RELAY 2 FUNCTION = TRIPS

Inject 5.0 A into all three phase CTs. The MM2 displays a balanced phase current of 100 A for each phase. While still viewing actual values, slowly begin decreasing phase 1 current until the UNBALANCE ALARM message comes on. AUX Relay 1 should energize when the alarm is present. Unbalance is calculated as follows:

For average currents greater than motor full load:

$$\left|\frac{I_n - I_{av}}{I_{av}}\right| > 15\% \quad \text{(alarm)} \qquad 30\% \text{ trip}$$

For average currents less than the motor full load:

$$\left|\frac{I_n - I_{av}}{I_{fl}}\right| > 15\% \quad \text{(alarm)} \qquad 30\% \text{ trip} \qquad \text{with} \quad I_{av} = \frac{I_a + I_b + I_c}{3}$$

where: I_n = RMS current in any phase with maximum deviation from the average current I_{av}
I_{av} = average of the 3 phase currents; I_{fl} = motor full load current
I_a = phase A current; I_b = phase B current; I_c = phase C current

7.2.2 UNBALANCE EXAMPLES

a) EXAMPLE #1

Find the percentage unbalance given the following information:

VALUE	PRIMARY	SECONDARY (5A)
I_a	73 A	3.65 A
I_b	100 A	5 A
I_c	100 A	5 A

We have I_{av} given by: $I_{av} = \frac{I_a + I_b + I_c}{3} = \frac{73 + 100 + 100 \text{ A}}{3} = \frac{273}{3} \text{ A} = 91 \text{ A}$

Since $I_{av} < I_{fl}$, the following formula is used: $\%\text{ unbalance} = \frac{|I_n - I_{av}|}{I_{fl}} \times 100 = \frac{|73 - 91|}{100} \times 100 = 18\%$

Since the unbalance is greater than 15%, an UNBALANCE alarm will occur if this condition persists for longer than 5 seconds and the AUX Relay 1 will energize.

b) EXAMPLE #2

Find the percentage of unbalance given the following information:

VALUE	PRIMARY	SECONDARY (5A)
I_a	100 A	5 A
I_b	80 A	4 A
I_c	150 A	7.5 A

We have I_{av} given by: $I_{av} = \frac{I_a + I_b + I_c}{3} = \frac{100 + 80 + 150 \text{ A}}{3} = \frac{330}{3} \text{ A} = 110 \text{ A}$

Since $I_{av} > I_{fl}$, the following formula is used: $\%\text{ unbalance} = \frac{|I_n - I_{av}|}{I_{av}} \times 100 = \frac{|150 - 110|}{110} \times 100 = 36.4\ \%$

Since unbalance is greater than 30%, a SINGLE PHASE trip will occur if this condition persists for longer than 5 seconds and the AUX Relay 2 will energize.

7.2.3 GROUND FAULT CURRENT FUNCTIONS

Test the Ground Fault CT (Residual / 50:0.025) in a similar manner to phase currents for accuracy at various injected current levels. To check alarm and trip levels, make the following settings:

S1 CONFIGURATION \ CT/VT INPUTS \ GROUND FAULT CT INPUT: Residual
S2 PROTECTION \ MOTOR PROTECTION GROUND FAULT \ GROUND FAULT ALARM LEVEL = 40 %FLC
S2 PROTECTION \ MOTOR PROTECTION GROUND FAULT \ GROUND FAULT TRIP LEVEL = 80 %FLC
S2 PROTECTION \ MOTOR PROTECTION THERMAL\ FULL LOAD CURRENT = 100 A

While displaying **A1 DATA \ MOTOR DATA \ GROUND CURRENT**, begin injecting current into the 5 A Ground Fault CT input. The Alarm LED lights and the AUX Relay 1 change state at 40 A corresponding to the 40% FLC alarm setting. Change the display back to **GROUND CURRENT** and continue increasing injected secondary current. When the measured Ground Current reaches 80 A, a Ground Fault Trip occurs. This trip causes the MM2 to change its indicators and output relay status. The Running LED turns off, the Tripped and Stopped LEDs turn on, and the Contactor A relay de-energizes. The AUX Relay 1 remains energized as long as the alarm is present and AUX Relay 2 energizes after the ground fault trip. The MM2 displays a Ground Fault Trip message. Turn the Ground Fault current off and press the reset key to reset the trip.

7.2.4 INPUT FUNCTIONS

Operation of each MM2 switch input can be verified on the display. Go to **A3 INPUTS \ INPUT CONTACT STATUS** and using the MESSAGE LEFT/RIGHT keys, view the status of each input one at a time. Open and close each switch input and note that the display reflects the present status of the input terminals. The status is shown as either OPEN or CLOSED.

7.2.5 THERMISTOR INPUT TESTS

Begin testing by storing the following thermistor values:

S1 CONFIGURATION \ THERMISTOR \ HOT RESISTANCE: 30 kOHMS
S1 CONFIGURATION \ THERMISTOR \ COLD RESISTANCE: 0.1 kOHMS
S1 CONFIGURATION \ THERMISTOR \ THERMISTOR ALARM: ENABLE
S1 CONFIGURATION \ THERMISTOR \ THERMISTOR TRIP: DISABLE

Place a variable 50 K potentiometer or resistance box across thermistor terminals 17 and 18 as shown in Figure 7–1: SECONDARY INJECTION TEST SETUP on page 7–2. With the input resistance set to zero, start increasing the resistance until a thermistor alarm occurs. Verify that the Alarm LED becomes lit and a THERMISTOR ALARM message is displayed. Use an ohmmeter to verify that the thermistor resistance agrees with the **THERMISTOR HOT** setpoint value.

NOTE

The thermistor will have to be removed from the MM2 to accurately measure its resistance. When the resistance has decreased below the **COLD RESISTANCE** setpoint value, the alarm will disappear.

To check the thermistor trip function, enable the thermistor trip by making the following settings changes:

S1 CONFIGURATION \ THERMISTOR \ THERMISTOR ALARM: DISABLE
S1 CONFIGURATION \ THERMISTOR \ THERMISTOR TRIP: ENABLE

With the thermistor resistance initially set to zero, begin increasing resistance until a thermistor trip occurs. Note that the Tripped and Stopped LEDs are lit, the contactor A relay has de-energized, the Running LED is off, and a THERMISTOR TRIP message is displayed. Use an ohmmeter to verify that the thermistor resistance value agrees with the **THERMISTOR HOT** setpoint value. Decrease the thermistor resistance below the **THERMISTOR HOT** value but not below the **THERMISTOR COLD** value. Press the RESET key and verify that the MM2 still indicates a trip. Reduce thermistor resistance below the **THERMISTOR COLD** value. Press the RESET key again, noting that the Tripped LED turns off and the default display message returns. Issue a Start A command via the keypad or switch input and note that Contactor A contacts now close and the Running LED becomes lit.

7.2.6 POWER FAIL TEST

To test the Power Fail circuit, connect the supply voltage to the MM2 through a variac and begin decreasing control voltage. When the control voltage drops below 80 V for 120 V AC input or 150 V for 240 V AC input, the fault light comes on and the MM2 ceases to operate. The MM2 has insufficient voltage to continue accurately monitoring the motor. All output relays will change to their power off state. Decrease control voltage to zero and then return voltage to its normal operating level. Verify that the MM2 resumes its normal operation. Check the power fail memory circuit by verifying that setpoints and statistical data have not been altered.

8.1.1 DESCRIPTION

This starter type is a full voltage or across-the-line non-reversing starter. When the start button is pressed the 1M coil is picked up, starting the motor and is sealed in by the 1M contact. When the stop button is pressed the 1M coil is dropped out and the motor stops.

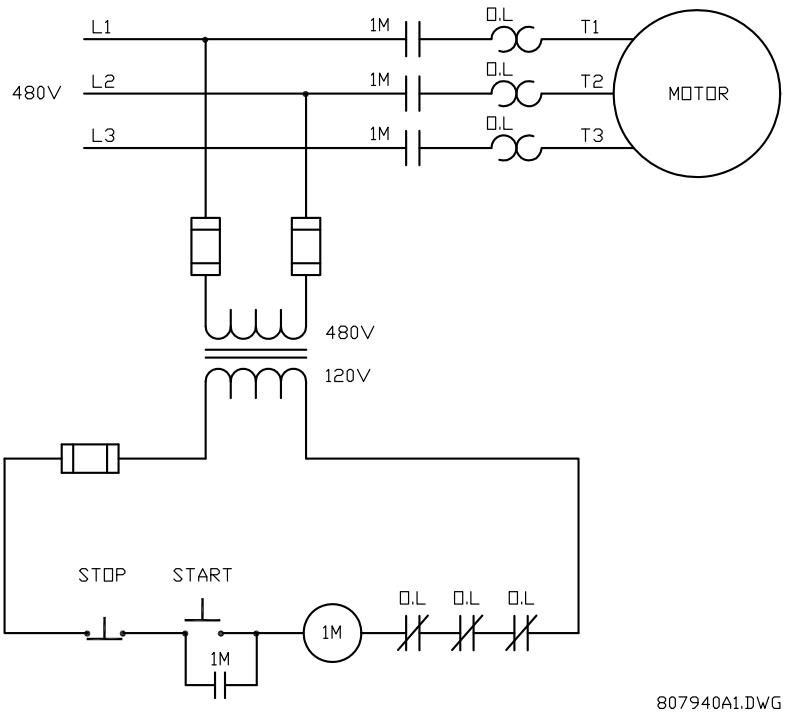


Figure 8–1: FULL-VOLTAGE NON-REVERSING ELEMENTARY STARTER

To program the MM2 for full-voltage non-reversing starter, set:

S1 CONFIGURATION\STARTER\STARTER TYPE: FV NON-REVERSING

8.1.2 MM2 SEQUENCES

START:

1. Start command received by the MM2 (serial, switch input or faceplate).
2. Close and maintain Contactor A output relay – the motor is now across the line.

STOP/TRIP:

1. Stop command received or trip occurs.
2. Open Contactor A output relay – the motor is now off line.

When the power to the MM2 is interrupted, the contactor A output relay de-energizes, causing it to open and stop the motor. The MM2 can only be wired for fail-safe operation.

If feedback is not received from the 1M contact to the Contactor A Status N.O. input on the MM2 within one second of closing the Contactor A output relay, an OPEN CONTROL CIRCUIT alarm occurs. This causes the Contactor A output relay to open. If feedback remains at the Contactor A Status N.O. input for more than 1 second after opening the Contactor A output relay, a WELDED CONTACTOR alarm occurs.

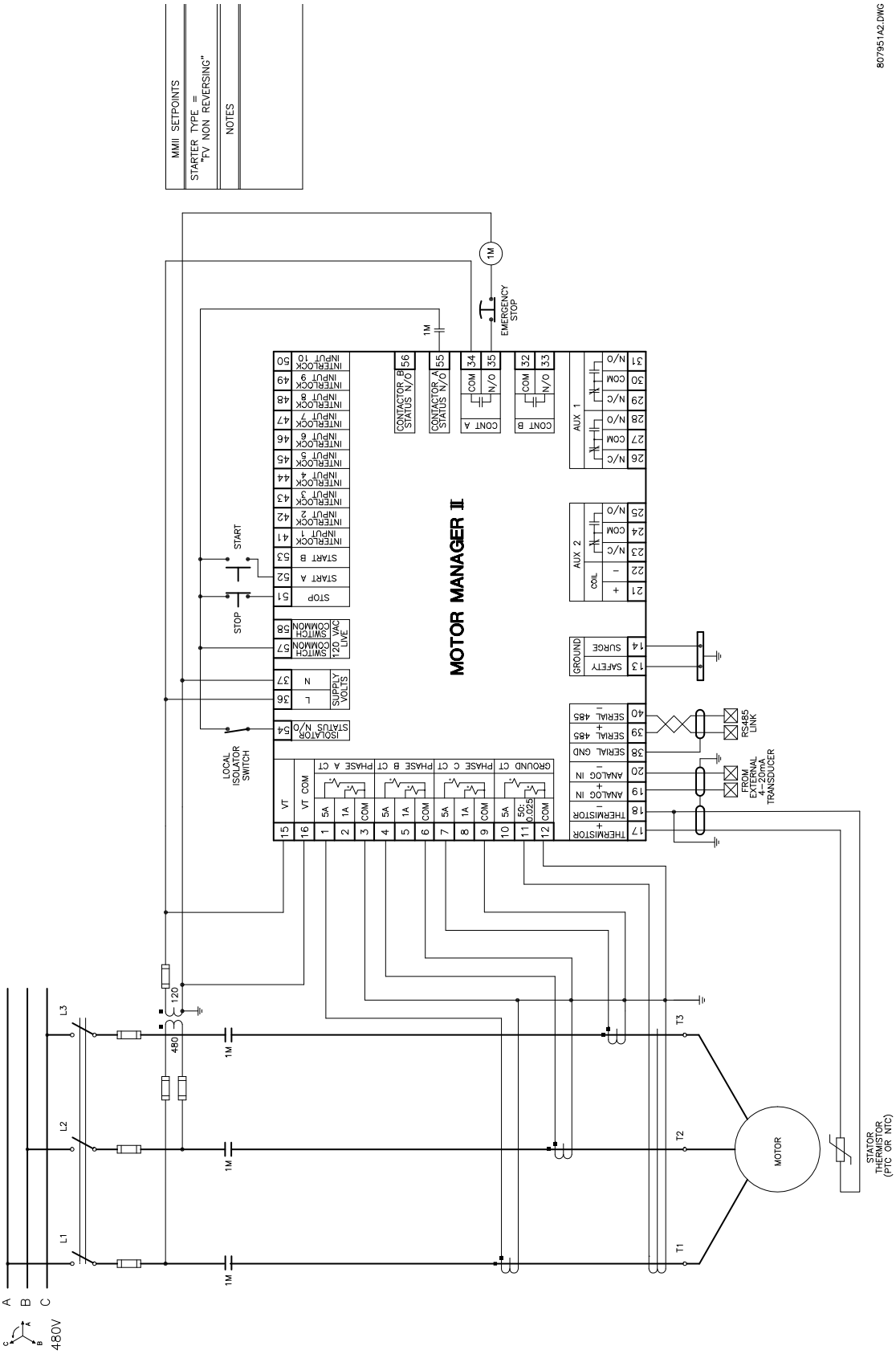


Figure 8–2: FV NON-REVERSING STARTER WIRING DIAGRAM

8.2.1 DESCRIPTION

This starter type is a full voltage or across-the-line reversing starter. When the forward button is pressed, the F coil is picked up and sealed in by CR1. The TR1 timing relay coil is also picked up, thus preventing a change in direction until TR1 drops out and closes again. When the R button is pressed, the R coil picks up and is sealed-in by CR2. The TR2 timing relay is also picked up. The motor will reverse direction, provided TR1 has timed out and closed the circuit.

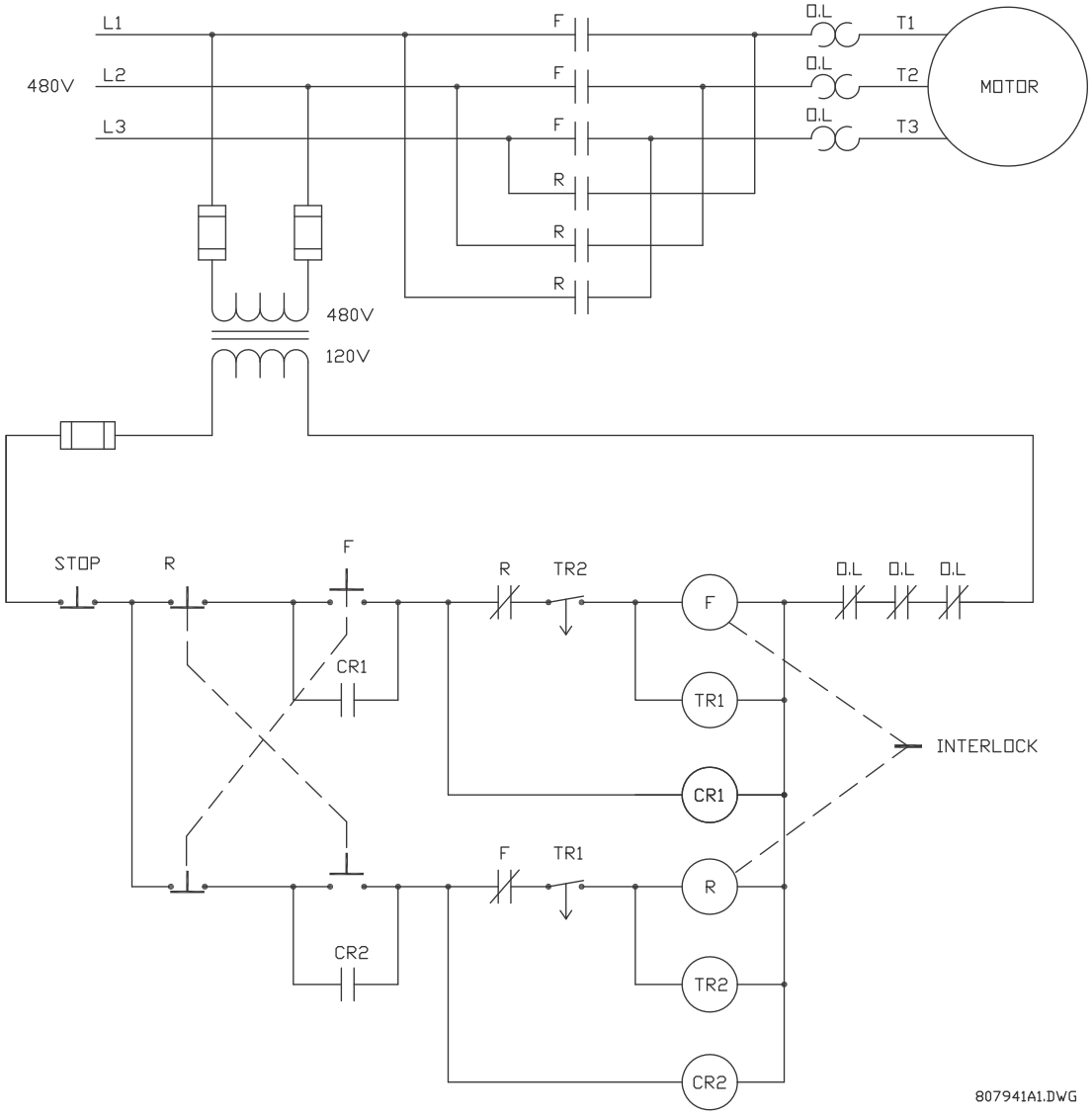


Figure 8–3: FULL VOLTAGE REVERSING STARTER

To program the MM2 for full-voltage reversing starter, set:

S1 CONFIGURATION\STARTER\STARTER TYPE: FV REVERSING
S1 CONFIGURATION\STARTER\TRANSFER TIME: 1 to 125 seconds

The **TRANSFER TIME** setpoint appears if the FV REVERSING starter type has been selected. This delay occurs when the motor is running in the forward direction (Contactor A) and the MM2 receives a Start B command to run in the reverse direction (Contactor B) and vice versa.

8.2.2 MM2 SEQUENCES

START:

1. Start A command received by the MM2 (serial, switch input or faceplate).
2. Close and maintain Contactor A output relay – the motor is now across the line in the forward direction.

STOP/TRIP:

1. Stop command received by the MM2 or a trip occurs.
2. Open the currently closed Contactor output relay – the motor stops.

REVERSE (if the motor is running in the forward direction):

1. Start B command is received by the MM2 (serial, switch input or faceplate).
2. Open Contactor A relay – the motor is now off line
3. Wait the required transfer time.
4. Close and maintain Contactor B output relay – the motor is now across the line in the reverse direction.

8.2.3 NOTES

All output relays de-energize when the MM2 power is interrupted, causing them to open and stop the motor. The MM2 can only be wired for fail-safe operation.

If used, the VT input must have a separate PT so that the current and voltage inputs remain in phase regardless of which direction the motor is running. See Figure 8–4: FV REVERSING STARTER on page 8–5.

If feedback is not received from either the F or the R contactor to Contactor Status N.O. inputs within one second of closing Contactor A or B output relays, an OPEN CONTROL CIRCUIT alarm will occur. This will cause the currently closed relay to open.

If feedback remains at the Contactor (A or B) Status N.O. input more than one second after opening Contactor A or B output relays, a WELDED CONTACTOR alarm will occur.

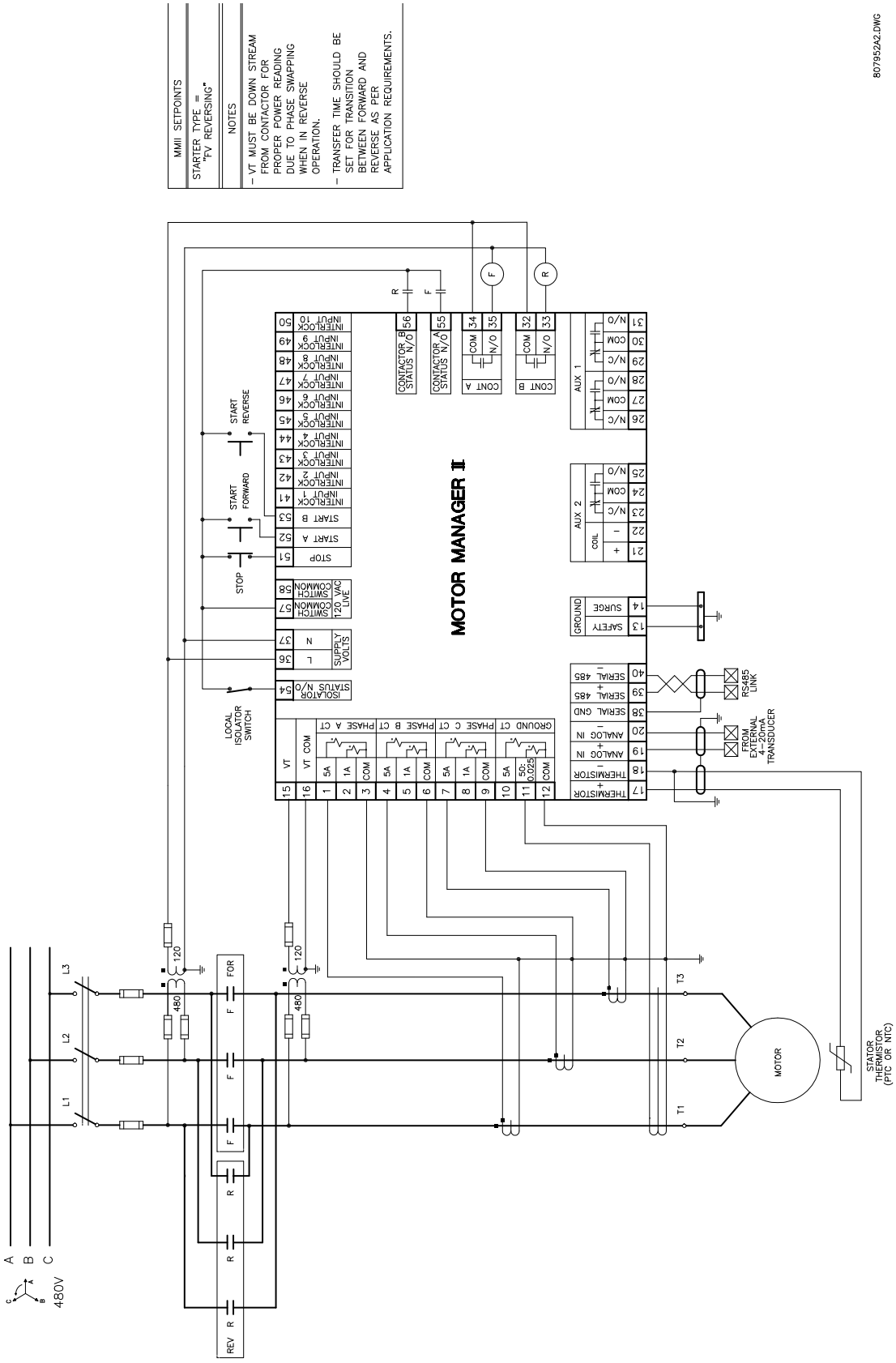


Figure 8–4: FV REVERSING STARTER

8.3.1 DESCRIPTION

When the low speed button is pressed, the CR coil will pick up and seal itself in. The L contactor is then picked up and the motor starts in low speed. When the high speed button is pressed, the L contactor drops out and the H contactor picks up and seals itself in. Timing relay TR is also picked up. If the low speed button is pressed, the TR relay will prevent the motor from going to low speed until it times out and the motor has had time to slow down.

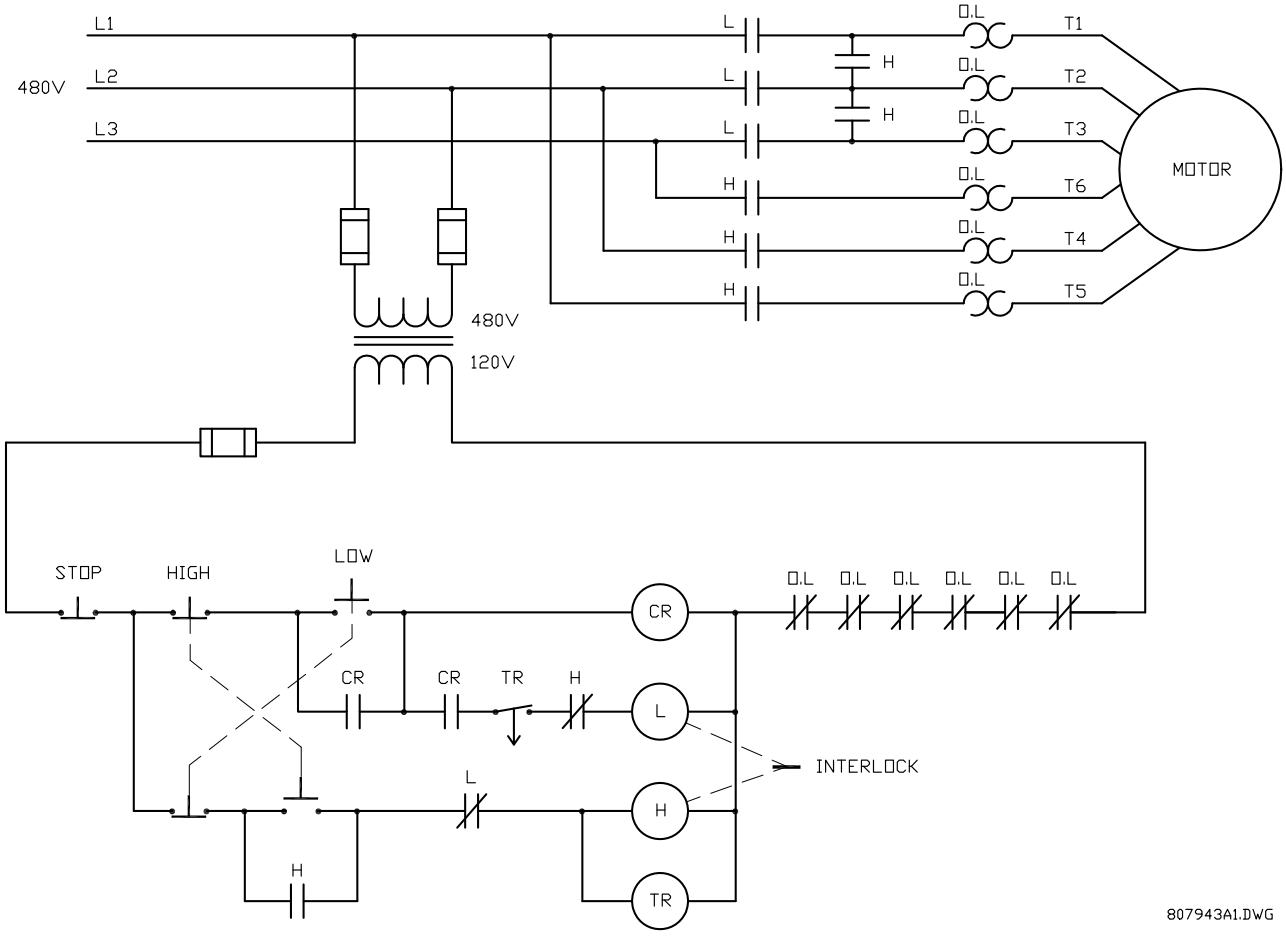


Figure 8–5: ELEMENTARY TWO SPEED MAGNETIC STARTER

To program the MM2 for two-speed starter, set:

S1 CONFIGURATION\STARTER\STARTER TYPE: TWO-SPEED
S1 CONFIGURATION\STARTER\TRANSFER TIME: 1 to 125 sec.
S1 CONFIGURATION\STARTER\HIGH SPEED START BLOCK: ENABLE or DISABLE

The **TRANSFER TIME** setpoint appears when the **STARTER TYPE** has been selected as TWO-SPEED. This delay may be required when the motor is switched from high-speed (Contactor B) directly to low-speed (Contactor A). The delay starts when Contactor B drops out.

The **HIGH SPEED START BLOCK** setpoint appears when the **STARTER TYPE** has been selected as TWO-SPEED. When set to DISABLED, the MM2 allows the motor to be started directly to high speed. When set to ENABLED, the motor must be started in low-speed before switching to high-speed.

START LOW SPEED sequence:

1. Start A command received by the MM2 (serial, switch input or faceplate).
2. Close and maintain Contactor A relay – the motor is now in low speed.

START DIRECTLY TO HIGH SPEED (motor stopped, **HIGH SPEED START BLOCK** not enabled) sequence:

1. Start B command received by the MM2 (serial, switch input or faceplate).
2. Close and maintain Contactor B relay – the motor is now in high speed.

START DIRECTLY TO HIGH SPEED (motor stopped, **HIGH SPEED START BLOCK** enabled) sequence:

1. Start B command received by the MM2 (serial, switch input or faceplate).
2. No response to start B commands.

LOW TO HIGH SPEED TRANSITION sequence:

1. Start B command is received (serial, switch input or faceplate).
2. Open contactor A output relay.
3. Close and maintain Contactor B relay – the motor is now in high speed.

HIGH TO LOW SPEED TRANSITION sequence:

1. Start A command is received (serial, switch input or faceplate).
2. Open contactor B output relay.
3. Wait for the programmed transfer time.
4. Close and maintain contactor A.

STOP/TRIP sequence:

1. Stop command received by the MM2 or a trip occurs.
2. Open the currently closed contactor output relay.

There are many different configurations for the TWO SPEED starter type. Three of the more popular ones are illustrated here: two-speed one winding constant or variable torque, two-speed one winding constant horsepower, and two-speed two winding. See the two speed starter diagrams on the following pages.

When the power to the MM2 is interrupted, all MM2 output relays de-energize, causing them to open and stop the motor. The MM2 can only be wired for fail-safe operation.

If feedback is not received from the L or H contacts to the Contactor A or B Status N.O. input within one second of closing Contactor A relay, an OPEN CONTROL CIRCUIT alarm will occur. This will cause Contactor A and B output relays to open.

If feedback remains at the Contactor A or B Status N.O. input more than one second after opening the Contactor A or B output relays, a WELDED CONTACTOR alarm will occur.

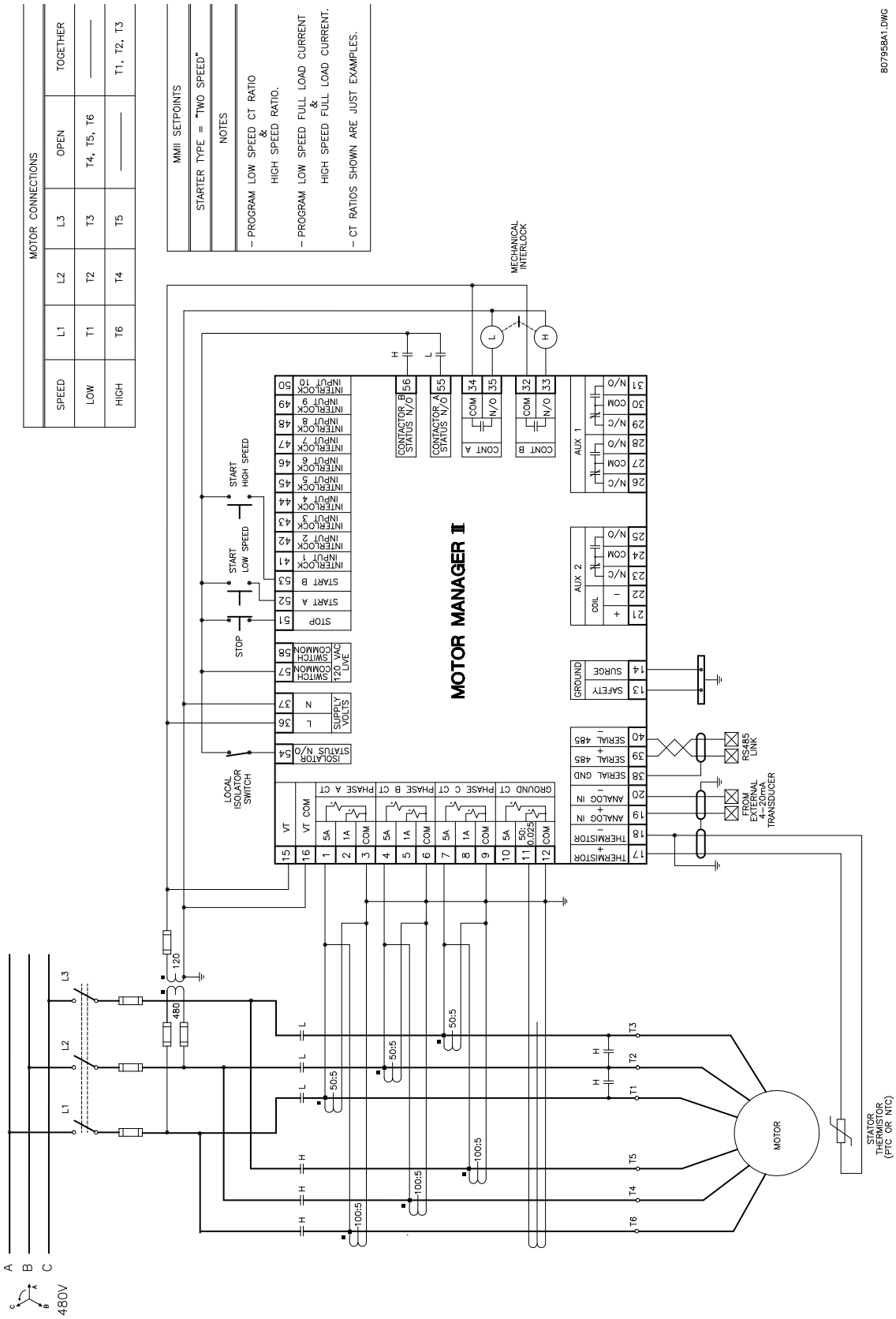


Figure 8–6: TWO SPEED ONE WINDING CONSTANT OR VARIABLE TORQUE STARTER

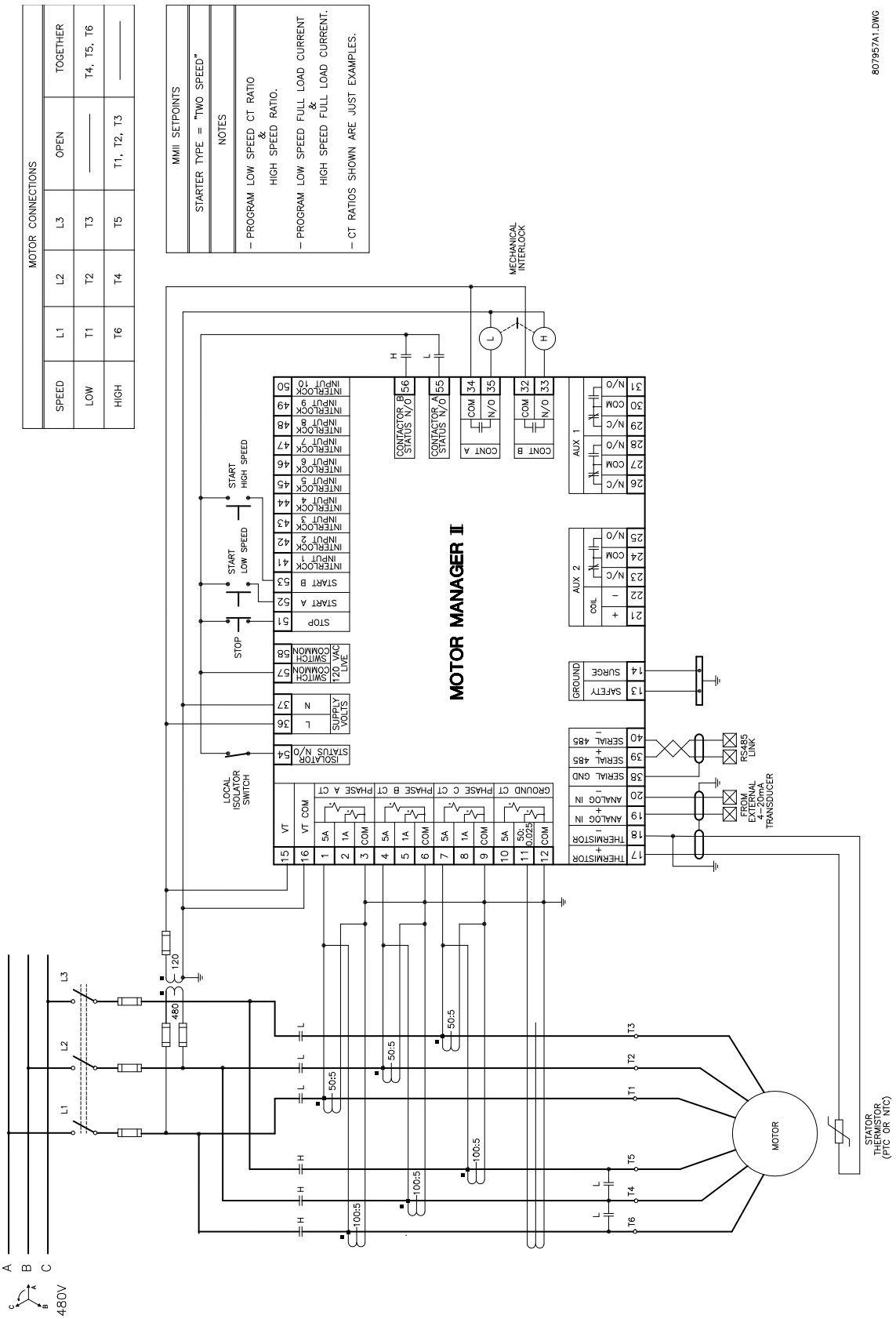


Figure 8–7: TWO SPEED ONE WINDING CONSTANT HORSEPOWER STARTER

8

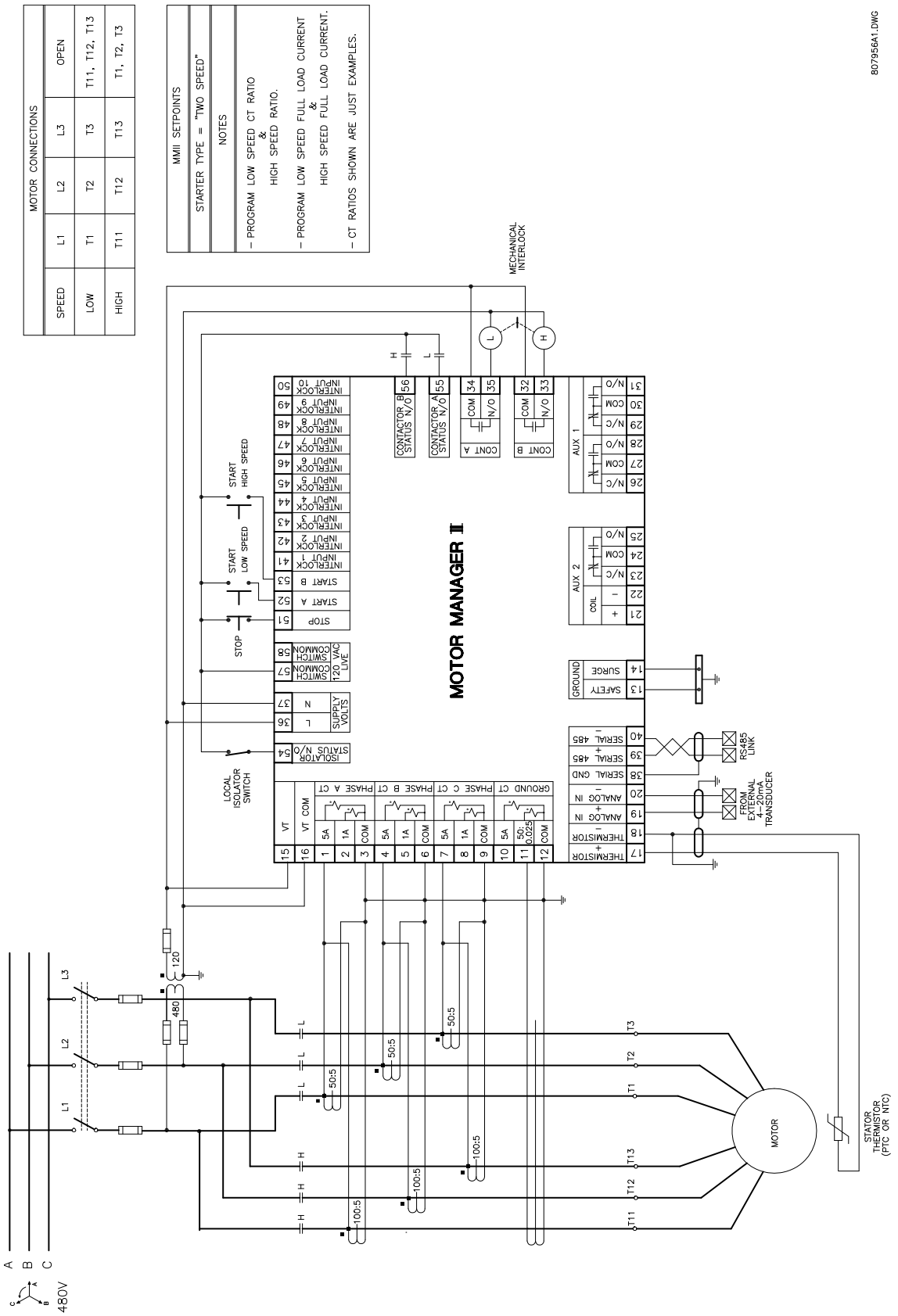


Figure 8–8: TWO SPEED TWO WINDING STARTER

8.4.1 DESCRIPTION

The slip ring starter is a secondary resistance starter used with wound rotor motors. When the start button is pressed, the S coil is picked up and seals itself in. The motor is now starting at a reduced current with the secondary resistors in circuit. Timing relay TR is also picked up and closes after a set time period, shorting out the resistors in the motor windings. Pressing the stop button drops out the S and R contactors and the motor stops.

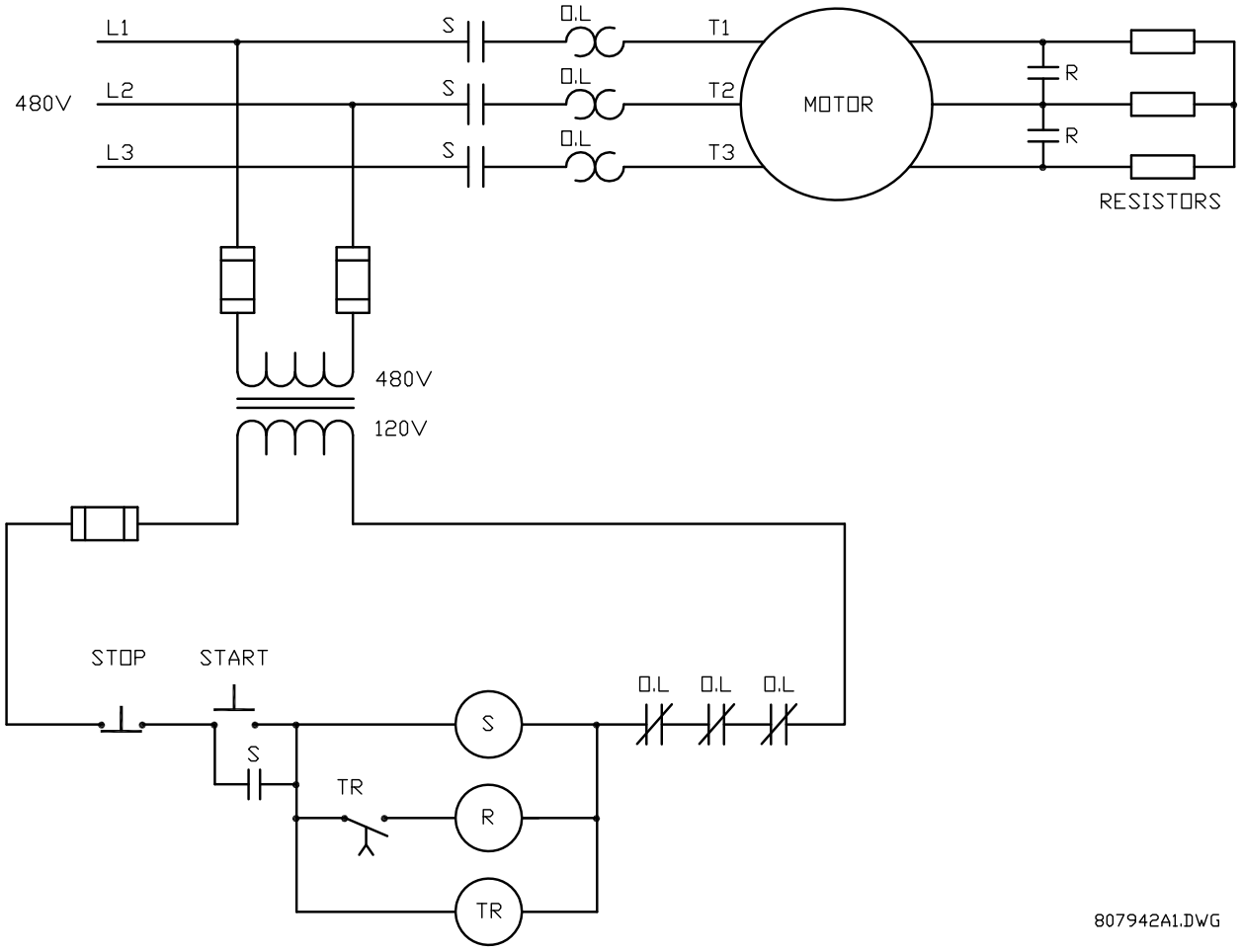


Figure 8–9: ELEMENTARY SLIP RING MAGNETIC STARTER

To program the MM2 for slip-ring starter, set:

S1 CONFIGURATION\STARTER\STARTER TYPE: SLIP RING
S1 CONFIGUARATION\STAGE ONE SHORTING TIME: 1 to 125 sec.

The **STAGE ONE SHORTING TIME** setpoint appears when the **STARTER TYPE** has been selected as SLIP RING. It represents the time delay from the closure of Contactor A until the closure of Contactor B.

START sequence:

1. The start command is received by the MM2 (serial, switch input, or faceplate).
2. Close and maintain Contactor A relay – the motor is now starting with the secondary resistors in circuit.
3. Wait **STAGE ONE SHORTING TIME** delay.
4. Close and maintain Contactor B relay – the motor is now running with the secondary resistors shorted out.

STOP/TRIP sequence:

1. Stop command received by the MM2 or a trip occurs.
2. Open Contactor A and B output relays.

When the power to the MM2 is interrupted, all output relays on the MM2 will de-energize causing them to open and stop the motor. The MM2 can only be wired for fail-safe operation.

If feedback is not received from the S or R contacts to the Contactor A or B Status N.O. inputs within one second of closing Contactor A or B output relays, an OPEN CONTROL CIRCUIT alarm will occur. This will cause Contactor A and B output relays to open. If feedback remains at the Contactor A or B Status N.O. input more than one second after opening the Contactor A or B output relays, a WELDED CONTACTOR alarm will occur.

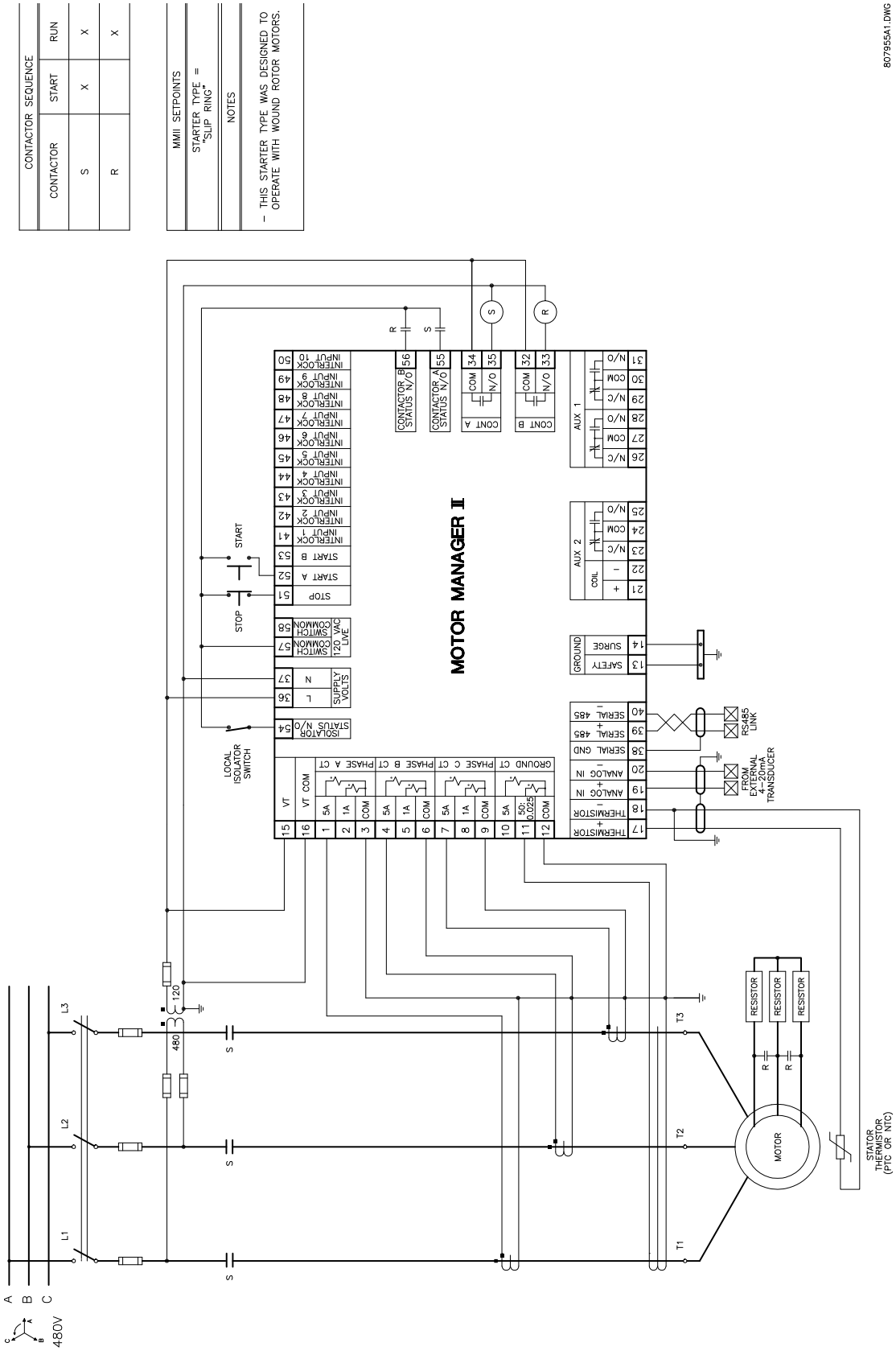


Figure 8–10: SLIP RING STARTER

8.5.1 DESCRIPTION

This starter type is a reduced voltage starter. When the start button is pressed the S coil is picked up and seals itself in. Timing relay TR is also picked up and closes after a set time period providing full voltage to the motor. Pressing the stop button drops out the S and R contactors and the motor stops.

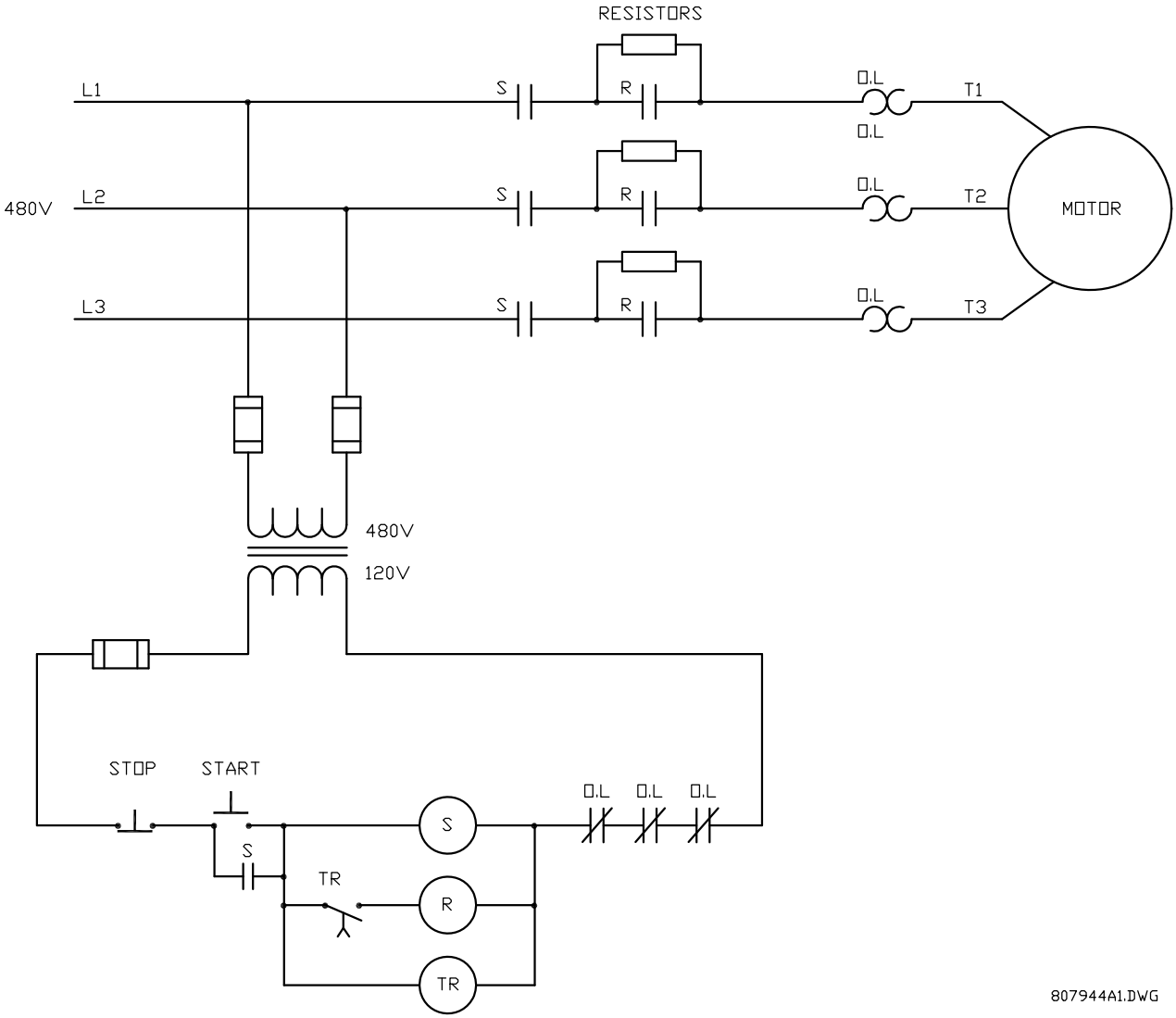


Figure 8–11: ELEMENTARY PRIMARY RESISTANCE MAGNETIC STARTER

To program the MM2 for primary resistance magnetic starter, set:

S1 CONFIGURATION\STARTER\STARTER TYPE: SLIP RING
S1 CONFIGURATION\STARTER\STAGE ONE SHORTING TIME: 1 to 125 sec.

This **STAGE ONE SHORTING TIME** setpoint appears when the **STARTER TYPE** setpoint is selected as SLIP RING. This is the time delay from the closure of Contactor A until the closure of Contactor B.

8.5.2 MM2 SEQUENCE

START sequence:

1. Start command received by the MM2 (serial, switch input or faceplate).
2. Close and maintain Contactor A relay – the motor is now starting at reduced voltage
3. Wait **STAGE ONE SHORTING TIME** delay.
4. Close and maintain Contactor B relay – the motor is now running at full voltage.

STOP/TRIP sequence:

1. Stop command received by the MM2 or a trip occurs.
2. Open Contactor A and B output relays.

The slip ring starter type can be used for the PRIMARY RESISTANCE STARTER type since it has the same logic as the slip ring starter.

When the power to the MM2 is interrupted, all output relays on the MM2 will de-energize causing them to open and stop the motor. The MM2 can only be wired for fail-safe operation.

If feedback is not received from the S or R contacts to the Contactor A or B Status N.O. inputs within one second of closing Contactor A or B output relays, an OPEN CONTROL CIRCUIT alarm will occur. This will cause Contactor A and B output relays to open. If feedback remains at the Contactor A or B Status N.O. input more than one second after opening the Contactor A or B output relays, a WELDED CONTACTOR alarm will occur.

A separate voltage transformer must be used for the VT input to accurately measure the voltage at the motor. See Figure 8–12: PRIMARY RESISTANCE STARTER on page 8–16.

CONTACTOR SEQUENCE		
CONTACTOR	START	RUN
S	X	X
R		X

MMII SETPOINTS

STARTER TYPE = "SLIP RING"

NOTES

– ALTHOUGH THIS MOTOR DOES NOT HAVE ANY SLIP RINGS, THE PRIMARY RESISTANCE STARTER HAS THE SAME LOGIC AS THE SLIP RING STARTER.

807954A1.DWG

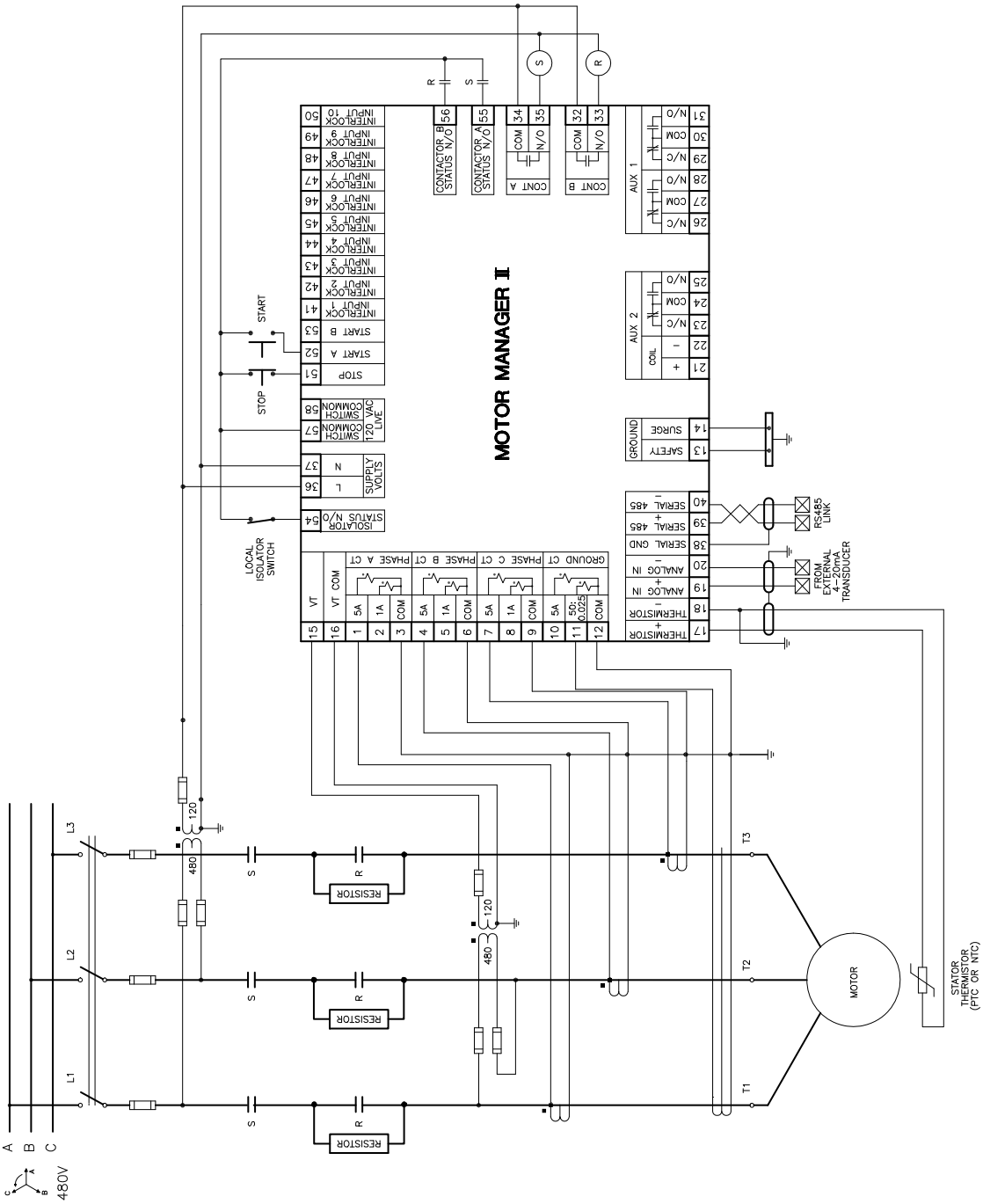


Figure 8–12: PRIMARY RESISTANCE STARTER

8.6.1 DESCRIPTION

When the RUN contact closes the inverter ramps up the motor to the programmed speed. When the RUN contact opens, the inverter ramps down the motor to a stop.

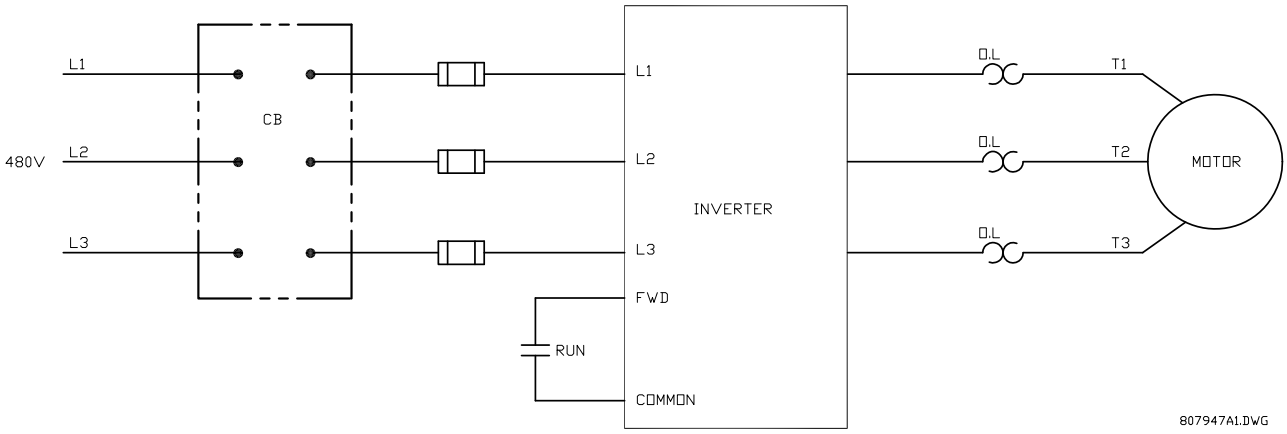


Figure 8–13: ELEMENTARY INVERTER STARTER

To program the MM2 for inverter starter, set:

S1 CONFIGURATION\STARTER\STARTER TYPE: INVERTER
S1 CONFIGURATION\STARTER\RAMP UP TIME: 1 to 125 sec.
S1 CONFIGURATION\STARTER\RAMP DOWN TIME: 1 to 125 sec.

The **RAMP UP TIME** and **RAMP DOWN TIME** setpoints appear when the **STARTER TYPE** is selected as INVERTER. See the next section for details on functionality.

START sequence:

1. Start command is received by the MM2. (serial, switch input or faceplate).
2. Close and maintain Contactor A output relay. - provide power to the inverter
3. Wait for one second.
4. Close and maintain Contactor B output relay. - signal the inverter to start the motor.
5. Wait for the RAMP UP TIME for Contactor B Status N.O. to close.

STOP/TRIP sequence:

1. Stop command is received or a trip occurs. (serial, switch input or faceplate)
2. Open contactor B output relay.
3. Wait for the RAMP DOWN TIME for Contactor B Status N.O. to open.
4. When Contactor B Status N.O. reads open, open Contactor A output relay.

If feedback is not received from the 1M contact to the Contactor A Status N.O. input within 1 second of closing Contactor A output relay, an OPEN CONTROL CIRCUIT alarm occurs. This causes the Contactor A and B output relays to open.

If Contactor B Status N.O. does not receive feedback from the up to speed contact on the inverter within the RAMP UP TIME setpoint during a start, a DRIVE FAILED TO START alarm will be generated. If Contactor B Status N.O. feedback remains at the MM2 after the **RAMP DOWN TIME** has expired during a stop, a DRIVE FAILED TO STOP alarm will be generated.

If feedback remains at Contactor A Status N.O. input more than one second after opening the Contactor A output relay, a WELDED CONTACTOR alarm will occur.

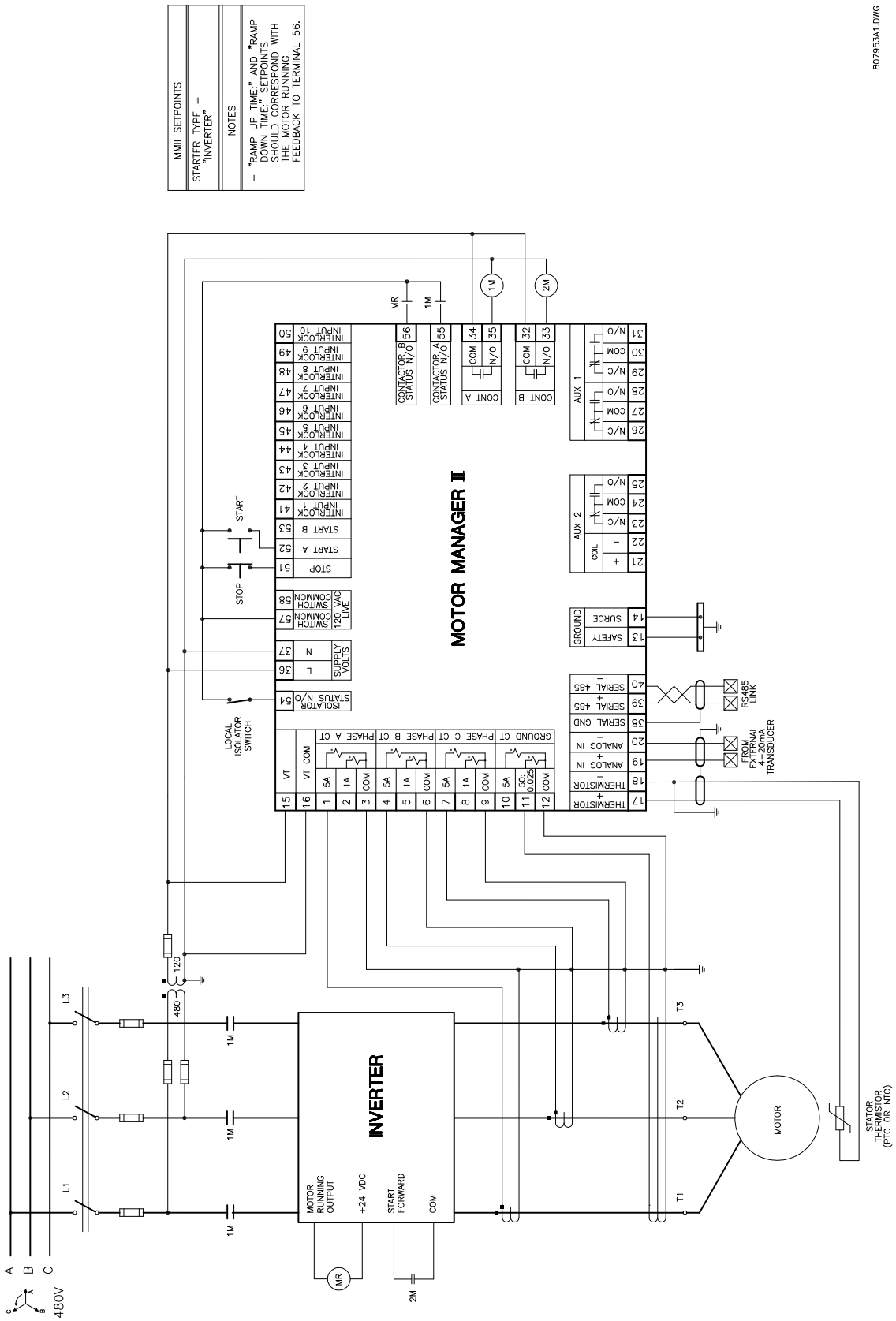
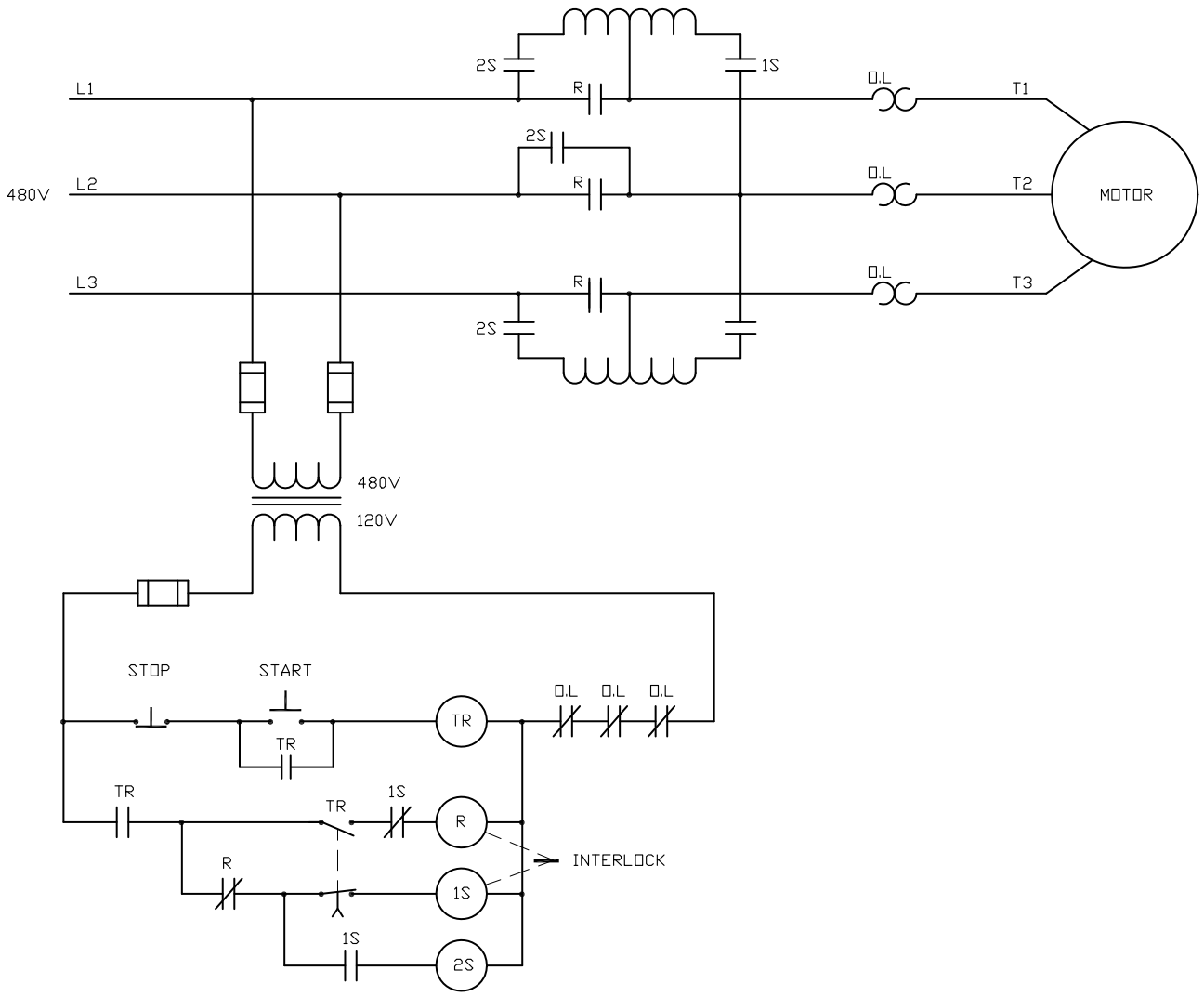


Figure 8–14: INVERTER (VARIABLE SPEED DRIVE) STARTER

8.7.1 DESCRIPTION

This starter type is a reduced voltage starter. When the start button is pressed, timing relay TR is picked up and seals itself in. The 1S coil is also picked up which then picks up the 2S coil. The 1S contacts configure the autotransformer windings into an open delta for two winding or wye for three winding autotransformers. The 2S contacts bring the autotransformer on line providing reduced voltage to the motor. When the timing relay TR times out 1S and 2S drop out and then contactor coil R picks up and full voltage is applied to the motor.



807948A1.DWG

Figure 8–15: ELEMENTARY AUTOTRANSFORMER OPEN TRANSITION STARTER

To program the MM2 for autotransformer open transition starter, set:

S1 CONFIGURATION\STARTER\STARTER TYPE: AUTOTRANS OPN TRANS
S1 CONFIGURATION\STARTER\CHANGE OVER TIME: 1 to 125 sec.
S1 CONFIGURATION\STARTER\CONTACTOR SEQUENCE: 1S-2S, 2S-1S
S1 CONFIGURATION\STARTER\STARTS PER HOUR: 1 to 40

S3 PROCESS\PROGRAMMABLE INPUTS\INTERLOCK INPUT 10: AUTOTRANS 2S CONTACT

S4 CONTROL\AUX 1 RELAY CONFIG\AUX RELAY 1 FUNCTION: AUTOTRANSFORMER 2S

The **CONTACTOR SEQUENCE** setpoint appears when **STARTER TYPE** is selected as AUTOTRANS OPN TRANS. The 1S-2S value closes the 1S contactor ahead of the 2S contactor as per some manufacturer's wiring practices. The 2S-1S value closes the 2S contactor ahead of the 1S contactor, another common wiring practice.

The **CHANGE OVER TIME** setpoint appears when **STARTER TYPE** is selected as AUTOTRANS OPN TRANS. This represents the time delay from the closure of Contactor A until the opening of Contactor A.

The **STARTS PER HOUR** setpoint appears only when **STARTER TYPE** is selected as AUTOTRANS OPN TRANS. This setpoint limits the number of starts per hour to prevent overheating of the autotransformer windings.

8.7.2 MM2 SEQUENCES

START (**CONTACTOR SEQUENCE** set to 1S-2S) sequence:

1. Start command received by the MM2 (serial, switch input or faceplate).
2. Close and maintain Contactor A output relay – close 1S contactor.
3. Wait 20 ms, close and maintain Aux. 1 output relay – power is applied to the autotransformer.
4. Wait for the time set in the **CHANGE OVER TIME** setpoint.
5. Open Contactor A and Aux. output relays.
6. Wait 20 ms.
7. Close and maintain Contactor B output relay.

START (**CONTACTOR SEQUENCE** set to 2S-1S) sequence:

1. Start command received by the MM2 (serial, switch input or faceplate).
2. Close and maintain Aux. 1 output relay – power is applied to the autotransformer.
3. Wait 20 ms, close and maintain Contactor A output relay – close the 1S contactor.
4. Wait for the time set in the CHANGE OVER TIME setpoint.
5. Open Contactor A and Aux. output relays.
6. Wait 20 ms.
7. Close and maintain Contactor B output relay.

STOP/TRIP sequence:

1. Stop command received by the MM2 or a trip occurs.
2. Open Contactor B output relay.

If feedback is not received from the 1S, 2S or R contacts to the Contactor A, B or auxiliary relay Status N.O. inputs within one second of closing Contactors A, B or the auxiliary relay, an OPEN CONTROL CIRCUIT alarm will occur. This will cause Contactors A, B and the auxiliary relay to open.

If feedback remains at any of the Status N.O. inputs for more than one second after opening the its respective relay, a WELDED CONTACTOR alarm will occur.

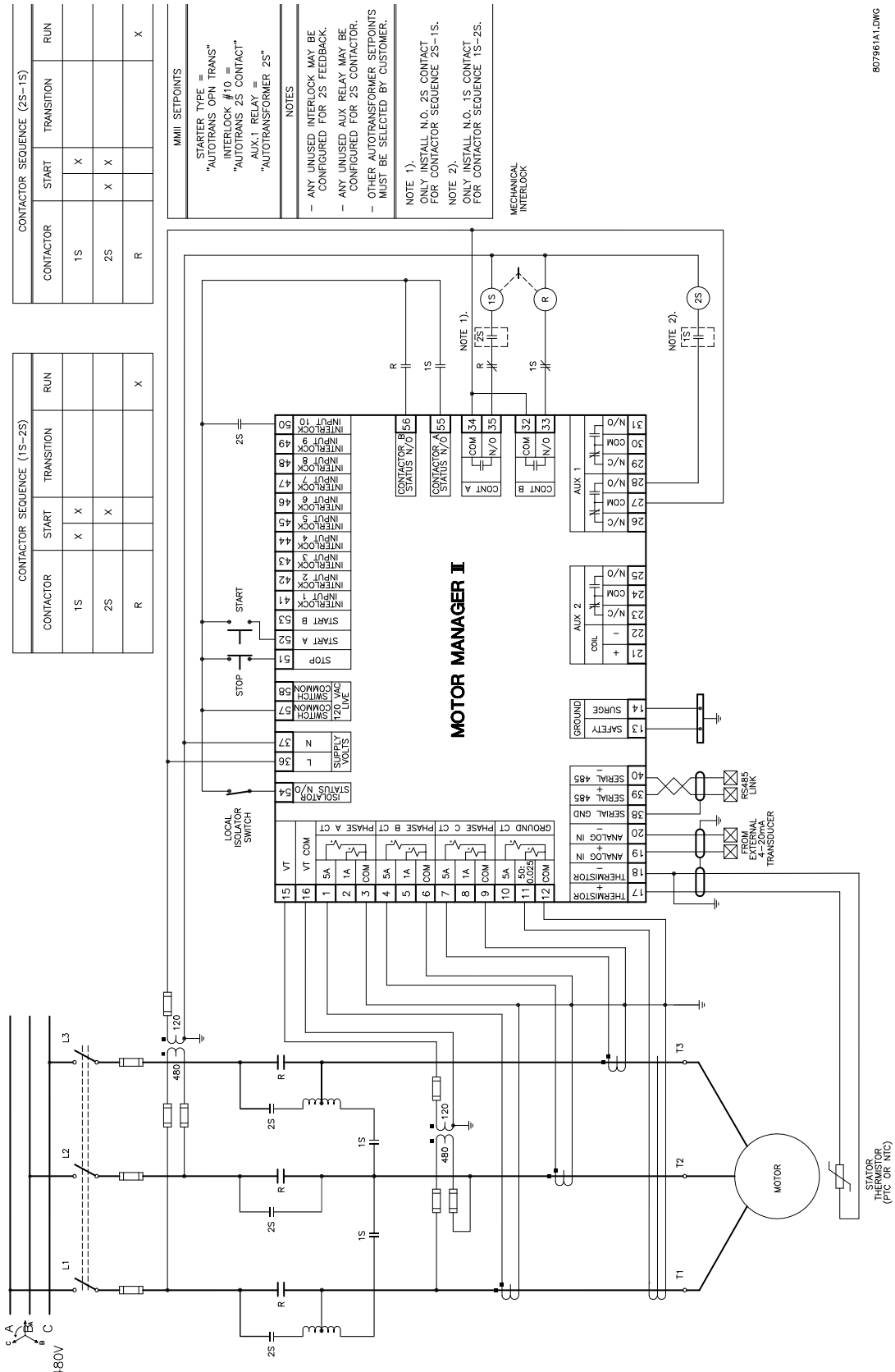


Figure 8–16: AUTOTRANSFORMER OPEN TRANSITION TWO WINDING

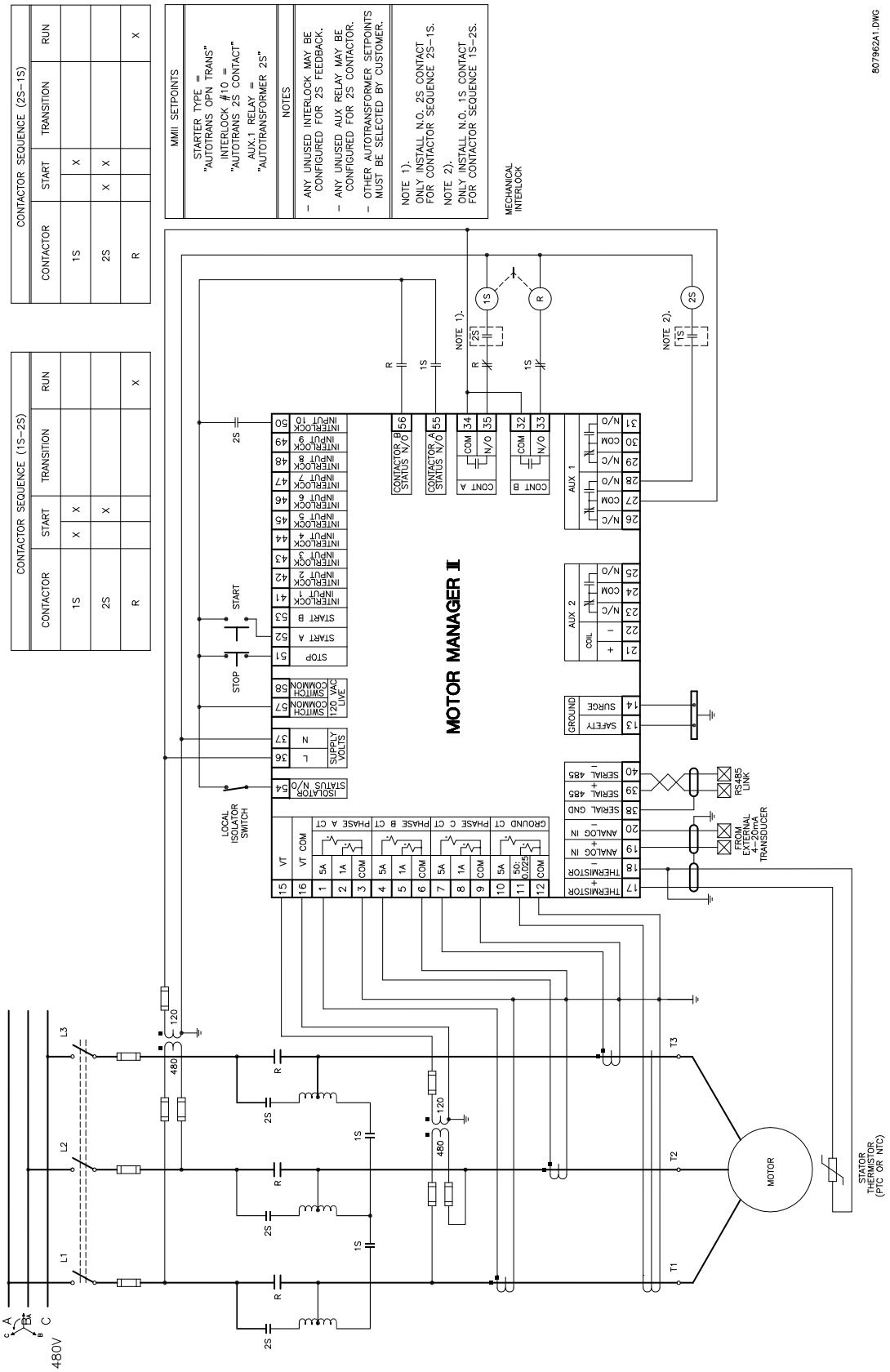


Figure 8–17: AUTOTRANSFORMER OPEN TRANSITION THREE WINDING

8.8.1 DESCRIPTION

This starter type is a reduced voltage starter. When the start button is pressed, timing relay TR is picked up and seals itself in. The 1S coil is also picked up which in turn picks up the 2S coil. The 2S coil seals itself in. The 1S contacts configure the autotransformer windings into an open delta for two winding or wye for three winding autotransformers. The 2S contacts bring the autotransformer on line, providing reduced voltage to the motor. When timing relay TR times out the 1S coil drops out and then R is picked up. When the R contacts pick up then 2S is dropped out. The motor now has full voltage applied.

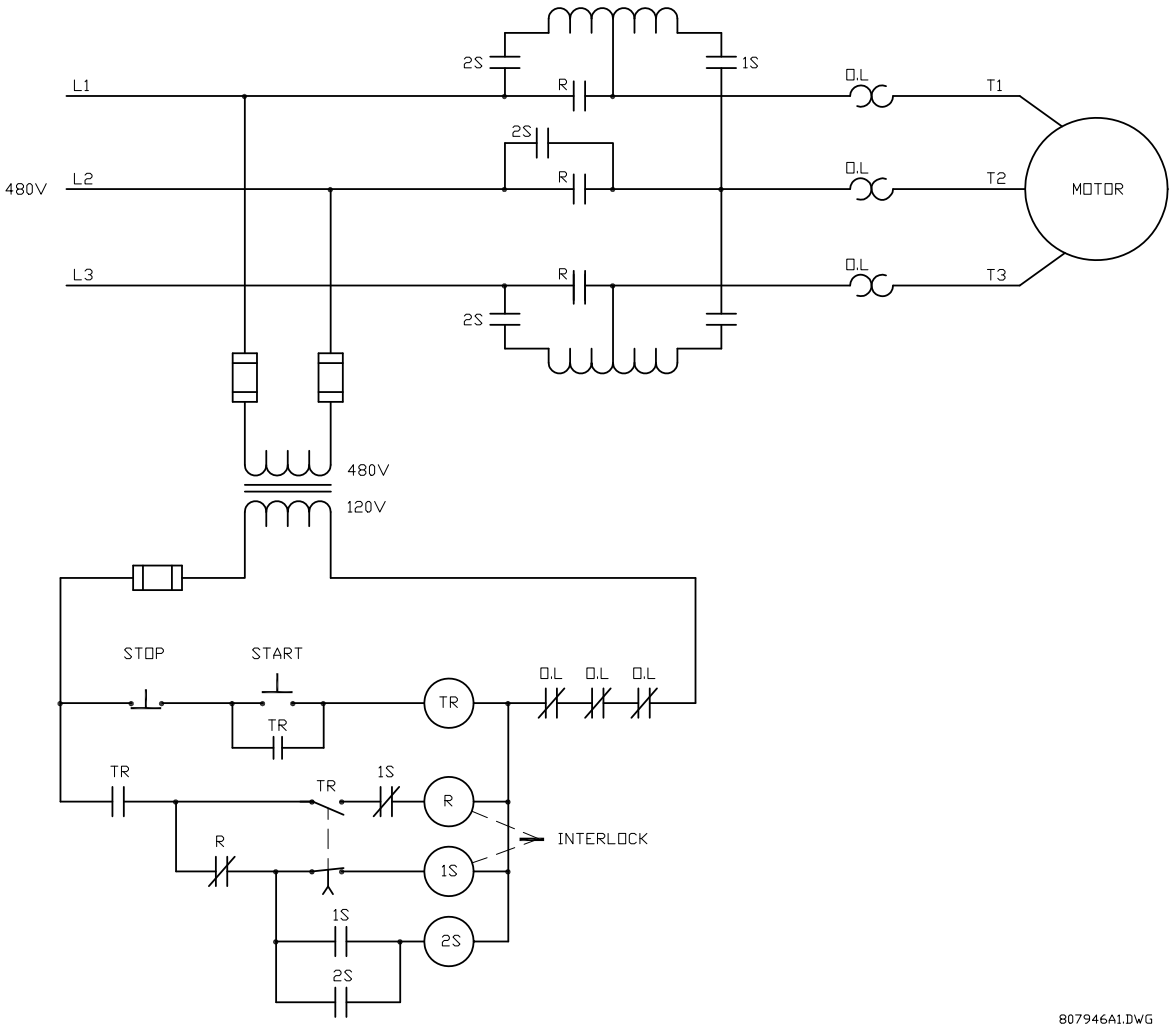


Figure 8–18: ELEMENTARY AUTOTRANSFORMER CLOSED TRANSITION STARTER

To program the MM2 for autotransformer closed transition starter, set:

S1 CONFIGURATION\STARTER\STARTER TYPE: AUTOTRANS CLS TRANS
S1 CONFIGURATION\STARTER\CHANGE OVER TIME: 1 to 125 sec.
S1 CONFIGURATION\STARTER\CONTACTOR SEQUENCE; 1S-2S, 2S-1S
S1 CONFIGURATION\STARTER\STARTS PER HOUR: 1 to 40

S3 PROCESS\PROGRAMMABLE INPUTS\INTERLOCK INPUT 10: AUTOTRANS 2S CONTACT

S4 CONTROL\AUX RELAY 1 CONFIG\AUX RELAY 1 FUNCTION: AUTOTRANSFORMER 2S

The **CONTACTOR SEQUENCE** setpoint appears when the Autotransformer Closed Transition starter type has been selected. The 1S-2S value means that the 1S contactor will close ahead of the 2S contactor as per some manufacturers wiring practices. The 2S-1S value means that the 2S contactor will close ahead of the 1S contactor as this is another common wiring practice.

The **CHANGE OVER TIME** setpoint appears only if the Autotransformer Open or Closed Transition starter types have been selected. For the Autotransformer starter type, this is the time delay from the closure of Contactor A output relay until the opening of Contactor A output relay.

The **STARTS PER HOUR** setpoint only if the Autotransformer starter type has been selected. This setpoint limits the number of starts per hour to prevent overheating of the autotransformer windings.

8.8.2 MM2 SEQUENCES

START (**CONTACTOR SEQUENCE** set to 1S-2S) sequence:

1. Start command received by the MM2 (serial, switch input or faceplate).
2. Close and maintain Contactor A output relay – close 1S contactor.
3. Wait 40 ms, close and maintain Aux. 1 relay – power is applied to the autotransformer.
4. Wait for the time set in the **CHANGE OVER TIME** setpoint.
5. Open contactor A output relay and wait 20 ms.
6. Close and maintain Contactor B output relay.
7. Wait 40 ms.
8. Open Aux. 1 output relay.

START (**CONTACTOR SEQUENCE** set to 2S-1S) sequence:

1. Start command received by the MM2 (serial, switch input or faceplate).
2. Close and maintain Aux. 1 output relay – power is applied to the autotransformer.
3. Wait 40 ms, close and maintain Contactor A relay – close the 1S contactor.
4. Wait for the time set in the **CHANGE OVER TIME** setpoint.
5. Open contactor A output relay and wait 20 ms.
6. Close and maintain Contactor B output relay.
7. Wait 40 ms.
8. Open Aux. 1 output relay.

STOP/TRIP sequence:

1. Stop command received by the MM2 or a trip occurs.
2. Open Contactor B output relay.

If feedback is not received by the Contactor A, B or auxiliary relay Status N.O. inputs within one second of closing Contactors A, B or the auxiliary output relays, an OPEN CONTROL CIRCUIT alarm will occur. This will cause Contactors A, B and the auxiliary relay to open.

If feedback remains at any of the Status N.O. inputs for more than one second after opening its respective relay, a WELDED CONTACTOR alarm will occur.

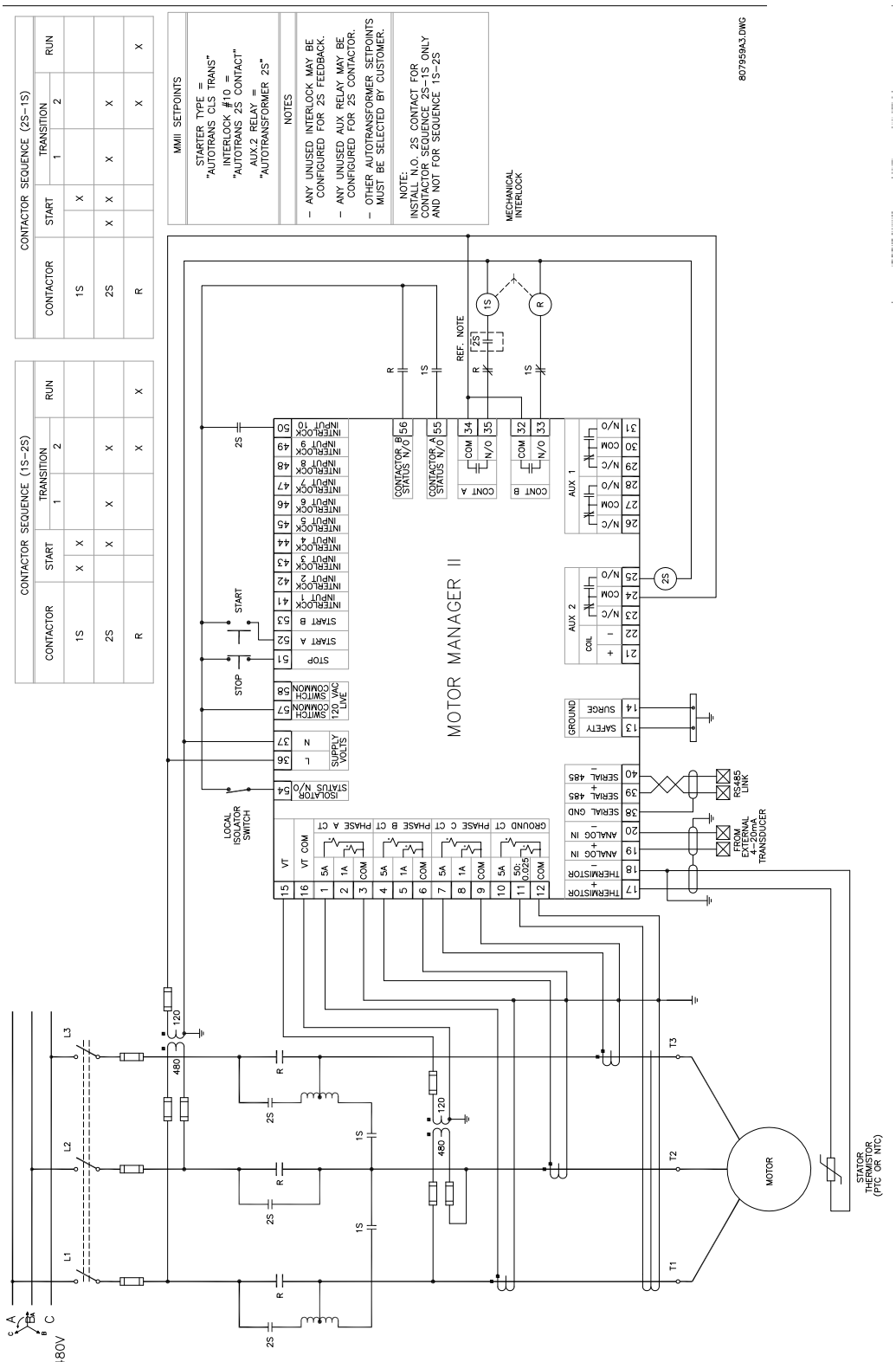


Figure 8–19: AUTOTRANSFORMER CLOSED TRANSITION TWO WINDING

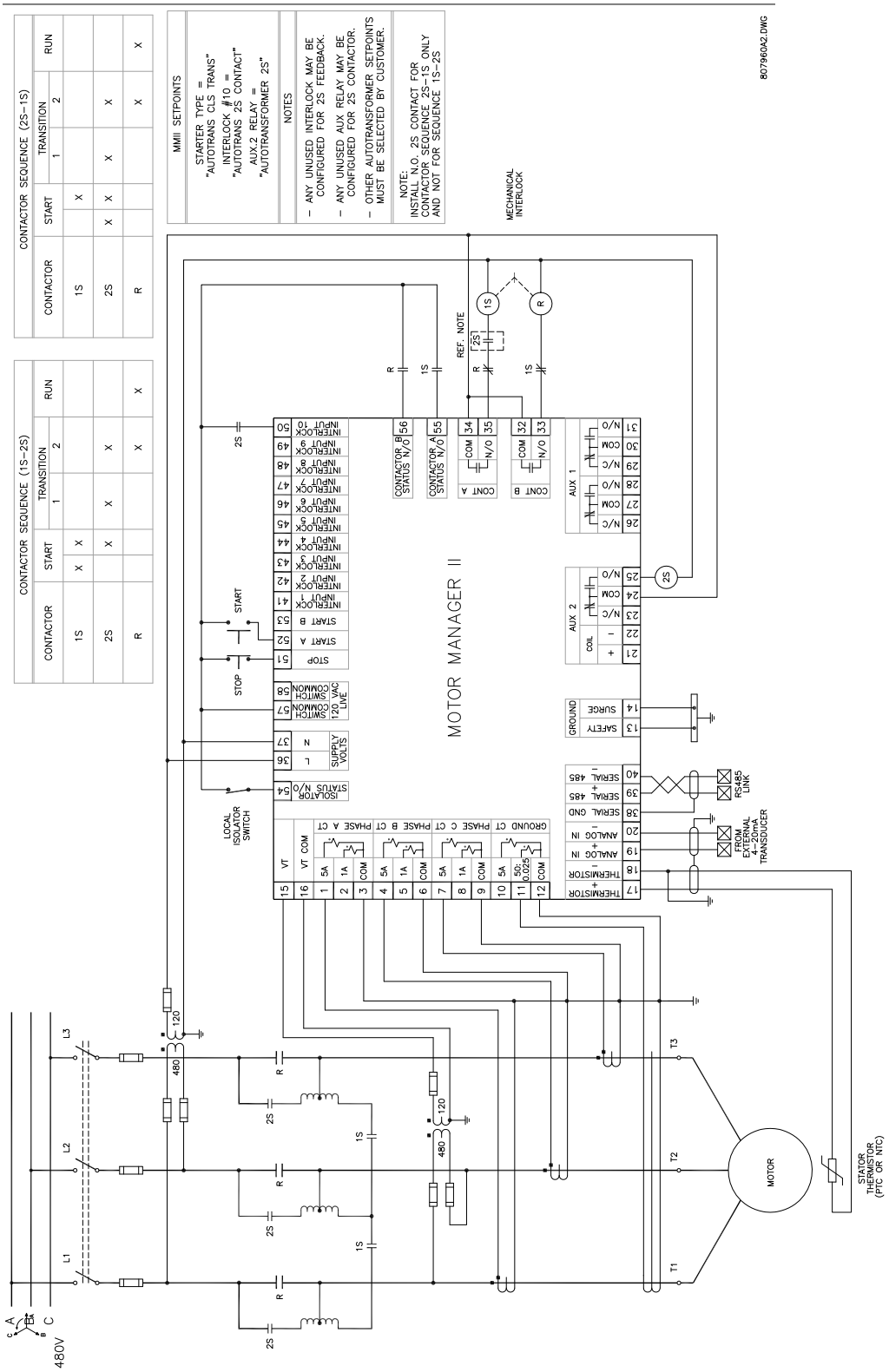


Figure 8–20: AUTOTRANSFORMER CLOSED TRANSITION THREE WINDING

8.9.1 DESCRIPTION

NOTE

The functionality of this starter is currently under review.

To program the MM2 for part winding starter, set:

1. **S1 CONFIGURATION\STARTER\STARTER TYPE:** PART WINDING
   S1 CONFIGURATION\STARTER\STAGE ONE SHORTING TIME: 1 to 125 sec.

The **STAGE ONE SHORTING TIME** setpoint appears when the **STARTER TYPE** is selected as PART WINDING. This is the time delay from the closure of Contactor A until the closure of Contactor B.

8.9.2 MM2 SEQUENCE

START sequence:

1. Start command received by the MM2 (serial, switch input or faceplate).
2. Close and maintain Contactor A output relay.
3. Wait for the time set in the **STAGE ONE SHORTING TIME DELAY** setpoint.
4. Close and maintain Contactor B output relay.

STOP/TRIP sequence:

1. Stop command is received by the MM2 or a trip occurs.
2. Open contactors A and B output relays.

If feedback is not received from the Contactor A and B Status N.O. inputs within one second of closing Contactor A and B output relays, an OPEN CONTROL CIRCUIT alarm will occur. This will cause Contactor A and B output relays to open.

If feedback remains at Contactor A or B Status N.O. input more than one second after opening the Contactor A or B output relays, a WELDED CONTACTOR alarm will occur.

8.10.1 DESCRIPTION

This starter type is a reduced voltage starter. When the start button is pressed timing relay TR is picked up and sealed in. The 1S coil is picked up which in turn picks up the 1M coil which seals itself in. When timing relay TR times out the 2S coil is picked up which then drops out the 1S coil. The 2M coil now picks up and the 2S coil is dropped out. The motor is now running in a delta configuration.

To program the MM2 for wye-delta open transition starter, set:

S1 CONFIGURATION\STARTER\STARTER TYPE: WYE DELTA OPN TRANS
S1 CONFIGURATION\STARTER\CHANGE OVER CURRENT: 1.0 to 5.0 x FLC
S1 CONFIGURATION\STARTER\CHANGE OVER TIME: 1 to 125 sec.

S3 PROCESS\PROGRAMMABLE INPUTS\INTERLOCK INPUT 9: WYE DELTA 1M CONTACT

S4 CONTROL\AUX RELAY 1 CONFIG\AUX. RELAY 1 FUNCTION: WYE DELTA CLS TRANS

The **CHANGE OVER CURRENT** setpoint appears when **STARTER TYPE** is selected as WYE DELTA OPN TRANS or WYE DELTA CLS TRANS. Before the **CHANGE OVER CURRENT** setpoint comes into effect on a Wye delta start, a minimum of 25% of the **CHANGE OVER TIME** setpoint must have expired. After 25% of the time has expired and the average of the three phase currents has dropped below the **CHANGE OVER CURRENT** setpoint, the transition from Wye (Contactor A) to delta (Contactor B) will occur. If this setpoint is set to OFF, 100% of the **CHANGE OVER TIME** must expire before the Wye to delta transition will occur.

The **CHANGE OVER TIME** setpoint appears only if **STARTER TYPE** is selected as WYE DELTA OPN TRANS or WYE DELTA CLS TRANS. See **CHANGE OVER CURRENT** setpoint description above for operation.

START sequence:

1. Start command received by the MM2 (serial, switch input or faceplate).
2. Close Contactor A output relay – the motor is now in a wye configuration.
3. Close Aux. output relay 1M contact.
4. Maintain 1S contactor until **CHANGE OVER CURRENT** or **CHANGE OVER TIME** initiates a transition from wye to delta. See **CHANGE OVER CURRENT** and **CHANGE OVER TIME** descriptions above for more detail.
5. Open Contactor A output relay – change over delay 20 ms wye to delta.
6. Close and maintain Contactor B output relay – the motor is now in a delta configuration.

STOP/TRIP sequence:

1. Stop command received by the MM2 or a trip occurs.
2. Open contactor B output relay.
3. Open Aux. output relay 1M contact

When the power to the MM2 is interrupted, all output relays on the MM2 will de-energize causing them to open and stop the motor. The MM2 can only be wired for fail-safe operation.

If feedback is not received from the Contactor A Status N.O. input within one second of closing Contactor A relay, an OPEN CONTROL CIRCUIT alarm will occur. This will cause All starter output relays to open. If feedback remains at the Contactor A Status N.O. input more than one second after opening the Contactor A output relay, a WELDED CONTACTOR alarm will occur.

If feedback is not received from the Contactor B Status N.O. input within one second of closing Contactor B relay, an OPEN CONTROL CIRCUIT alarm will occur. This will cause All starter output relays to open. If feedback remains at the Contactor B Status N.O. input more than one second after opening the Contactor B output relay, a WELDED CONTACTOR alarm will occur.

If feedback is not received from the Wye Delta 1M contact interlock input within one second of closing Contactor A relay, an OPEN CONTROL CIRCUIT alarm will occur. This will cause All starter output relays to open. If feedback remains at the Wye Delta 1M contact interlock input more than one second after opening the AUX. output relay, a WELDED CONTACTOR alarm will occur.

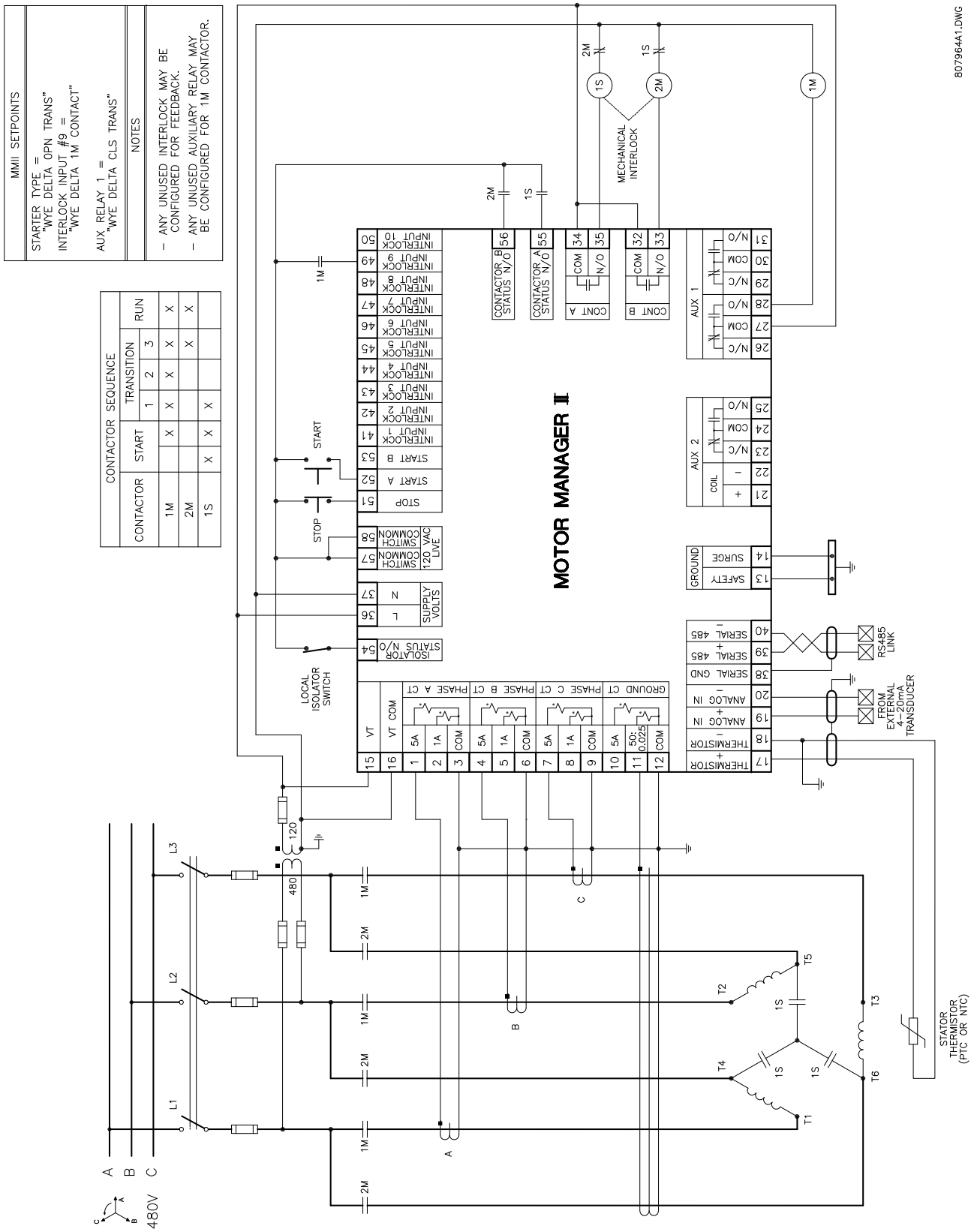


Figure 8–21: WYE-DELTA OPEN TRANSITION STARTER

8.11.1 DESCRIPTION

This starter type is a reduced voltage starter. When the start button is pressed timing relay TR is picked up and sealed in. The 1S coil is picked up which in turn picks up the 1M coil which seals itself in. When timing relay TR times out the 2S coil is picked up which then drops out the 1S coil. The 2M coil now picks up and the 2S coil is dropped out. The motor is now running in a delta configuration.

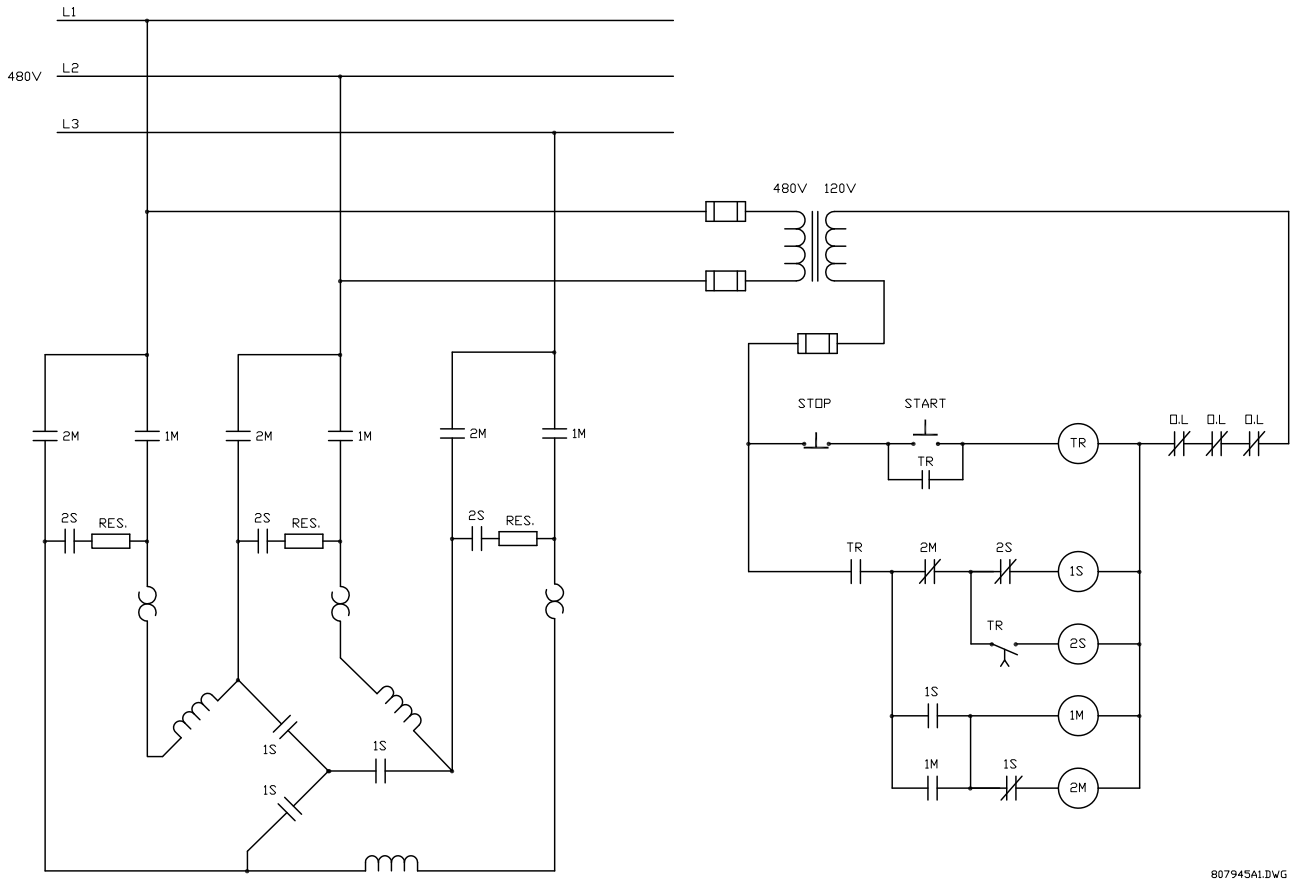


Figure 8–22: ELEMENTARY WYE-DELTA CLOSED TRANSITION MAGENTIC STARTER

To program the MM2 for wye-delta closed transition starter, set:

S1 CONFIGURATION\STARTER\STARTER TYPE: WYE DELTA CLS TRANS
S1 CONFIGURATION\STARTER\CHANGE OVER CURRENT: 1.0 to 5.0 x FLC
S1 CONFIGURATION\STARTER\CHANGE OVER TIME: 1 to 125 sec.

S3 PROCESS\PROGRAMMABLE INPUTS\INTERLOCK INPUT 10: WYE DELTA 2S CONTACT
S3 PROCESS\PROGRAMMABLE INPUTS\INTERLOCK INPUT 9: WYE DELTA 1M CONTACT

S4 CONTROL\AUX RELAY 1 CONFIG\AUX RELAY 1 FUNCTION: WYE DELTA CLS TRANS

The **CHANGE OVER CURRENT** setpoint appears only if either of the Wye Delta starter types have been selected. Before the **CHANGE OVER CURRENT** setpoint comes into effect on a Wye delta start, a minimum of 25% of the **CHANGE OVER TIME** setpoint must have expired. After 25% of the time has expired and the average of the three phase currents has dropped below the **CHANGE OVER CURRENT** value, the transition from Wye (Contactor A) to delta (Contactor B) will occur. If this Setpoint is set to OFF, 100% of the **CHANGE OVER TIME** must expire before the Wye to delta transition will occur.

The **CHANGE OVER TIME** setpoint appears only if the Wye Delta starter type has been selected. See the **CHANGE OVER CURRENT** setpoint description above for operation.

8.11.2 MM2 SEQUENCE

START sequence:

1. Start command received by the MM2.
2. Close Contactor A relay – this causes the 1S wye contactor to pick up which connects the motor windings in the wye configuration.
3. Wait approximately 20 ms.
4. Close AUX Relay 1 – this causes the 1M main contactor to pick up which starts the motor.
5. Maintain 1S and 1M contactors until **CHANGE OVER CURRENT** or **CHANGE OVER TIME** initiates a transition from wye to delta. See **CHANGE OVER CURRENT** and **CHANGE OVER TIME** descriptions above for more detail.
6. Close Contactor B relay – this causes the 2S resistor contactor to pick up which connects the resistors across the line.
7. Wait approximately 20 ms.
8. Open Contactor A output relay. This causes the 1S wye contactor to drop out. The normally closed auxiliary contacts on the 1S wye contactor pick up the 2M delta contactor which connects the motor in the delta configuration. The normally closed auxiliary contacts on the 2M contactor drop out the 2S resistor contactor.

STOP/TRIP sequence:

1. Stop command received by the MM2 or a trip occurs.
2. Open 1M and 2M contactors.

When the power to the MM2 is interrupted, all output relays on the MM2 will de-energize causing them to open and stop the motor. The MM2 can only be wired for fail-safe operation.

If feedback is not received by the Contactor A Status N.O., Contactor B Status N.O. or the WYE DELTA 1M CONTACT inputs within one second of closing the corresponding output relay, an OPEN CONTROL CIRCUIT alarm will occur. This will open all three output relays which will stop the motor.

If feedback remains at the programmable switch input that has been configured to WYE DELTA 2S CONTACT for more than one second, a WELDED CONTACTOR alarm will occur. This will open all three output relays which will stop the motor. This will prevent the resistors from burning out if the 2S contactor does not open after switching to the delta configuration.

If feedback remains at Contactor A Status N.O., Contactor B Status N.O. or WYE DELTA 1M CONTACT inputs for more than one second after opening the corresponding output relay, a WELDED CONTACTOR alarm will occur.

CONTACTOR SEQUENCE				
CONTACTOR	START	TRANSITION		RUN
		1	2	3
1M	X	X	X	X
2M			X	X
1S	X	X	X	
2S		X	X	X

MMI SETPOINTS

STARTER TYPE = "WYE DELTA CLS TRANS"

INTERLOCK INPUT #9 = "WYE DELTA 1M CONTACT"

INTERLOCK INPUT #10 = "WYE DELTA 2S CONTACT"

AUX. RELAY 1 = "WYE DELTA CLS TRANS"

NOTES

– ANY UNUSED INTERLOCK MAY BE CONFIGURED FOR FEEDBACK.

– ANY UNUSED AUXILIARY RELAY MAY BE CONFIGURED FOR 1M CONTACTOR.

807950A3.DWG

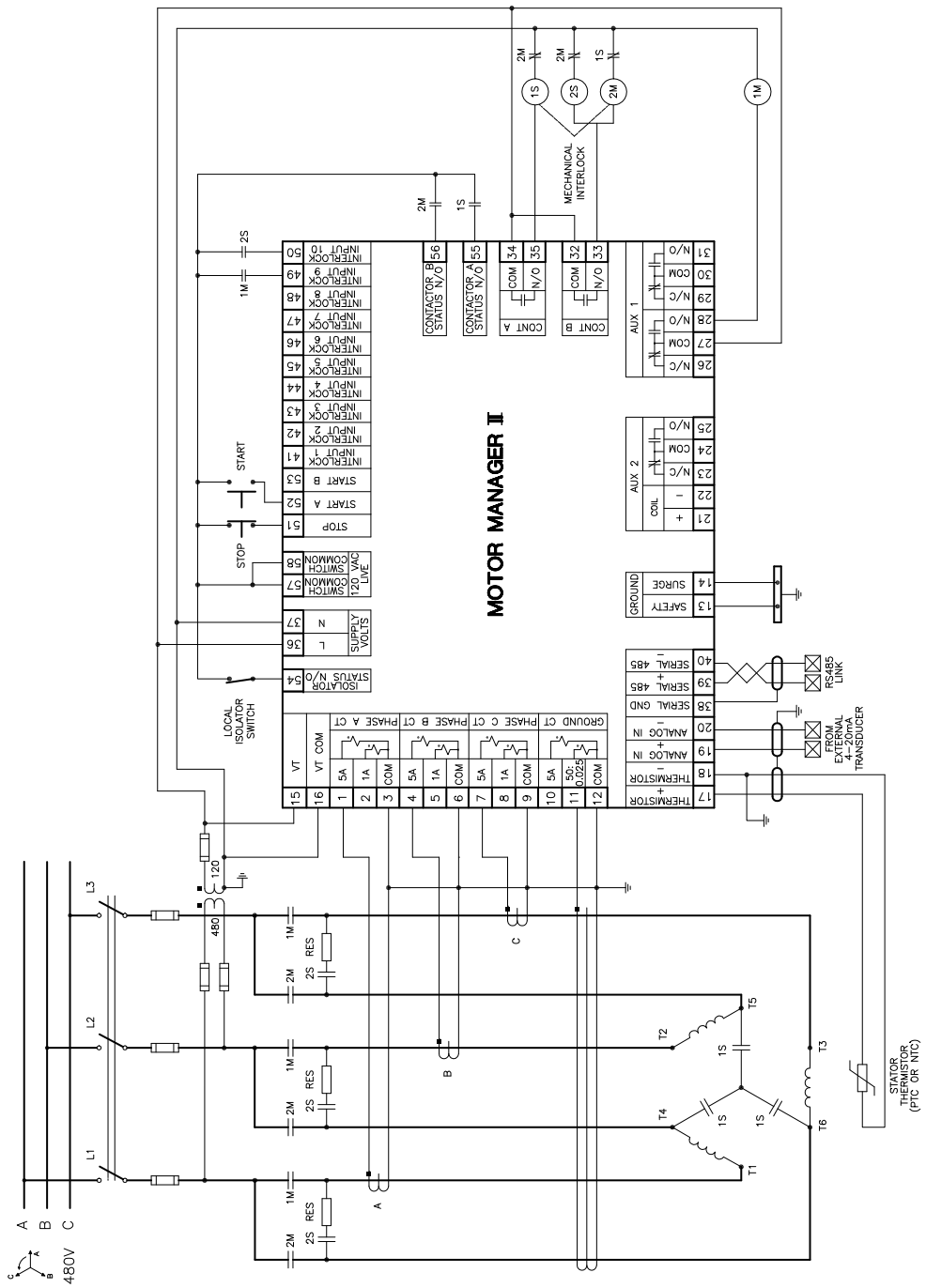


Figure 8–23: WYE-DELTA CLOSED TRANSITION STARTER

8.12.1 DESCRIPTION

This starter type is a full voltage starter and allows a single MM2 to control two identical motors. This starter type has two modes, manual and automatic. In manual mode a switch input determines which of the two motors is available for operation. In automatic mode the MM2 selects which motor should run based on the number of starts performed. An even number of starts will start motor A and an odd number will start motor B.

To program the MM2 for duty/standby starter, set:

S1 CONFIGURATION\STARTER\STARTER TYPE: DUTY/STANDBY

S3 PROCESS\PROGRAMMABLE INPUTS\INTERLOCK INPUT 1: DUTY SELECT MAN/AUTO
S3 PROCESS\PROGRAMMABLE INPUTS\INTERLOCK INPUT 2: MOTOR SELECTOR A/B

8.12.2 MM2 SEQUENCES

START (manual) sequence:

1. Duty Select MAN/AUTO open.
2. Motor Selector A/B open.
3. Start A command received by the MM2.
4. Close Contactor A relay – Motor A is now running.
5. Stop command.
6. Motor Selector A/B closed.
7. Start A command received by the MM2.
8. Close Contactor B relay – Motor B is now running.

START (auto) sequence:

1. Duty Select MAN/AUTO closed.
2. Motor Selector A/B has no effect.
3. Start A command received by the MM2 (number of starts = 0, even).
4. Close Contactor A relay – Motor A is now running.
5. Stop command.
6. Start A command received by the MM2 (number of starts = 1, odd).
7. Close Contactor B relay – Motor B is now running.

STOP/TRIP sequence:

1. Stop command received by the MM2 or a trip occurs.
2. Open the active contactor A or B.

8.12.3 NOTES

When the power to the MM2 is interrupted, all output relays on the MM2 will de-energize causing them to open and stop the motor. The MM2 can only be wired for fail-safe operation.

If feedback is not received by the Contactor A Status N.O. or Contactor B Status N.O. inputs within one second of closing the corresponding output relay, an OPEN CONTROL CIRCUIT alarm will occur. This will open the active output relay which will stop the motor.

If feedback remains at Contactor A Status N.O. or Contactor B Status N.O. inputs for more than one second after opening the corresponding output relay, a WELDED CONTACTOR alarm will occur.

The Start A input and key are used to start motors A and B. The Start B input and faceplate key have no effect.

Serial Control starts override the mode of operation of the Duty/Standby starter. For example a serial start B command will always start motor B and a serial start A will always start motor A. This is true for AUTO START A and AUTO START B programmable interlock functions as well.

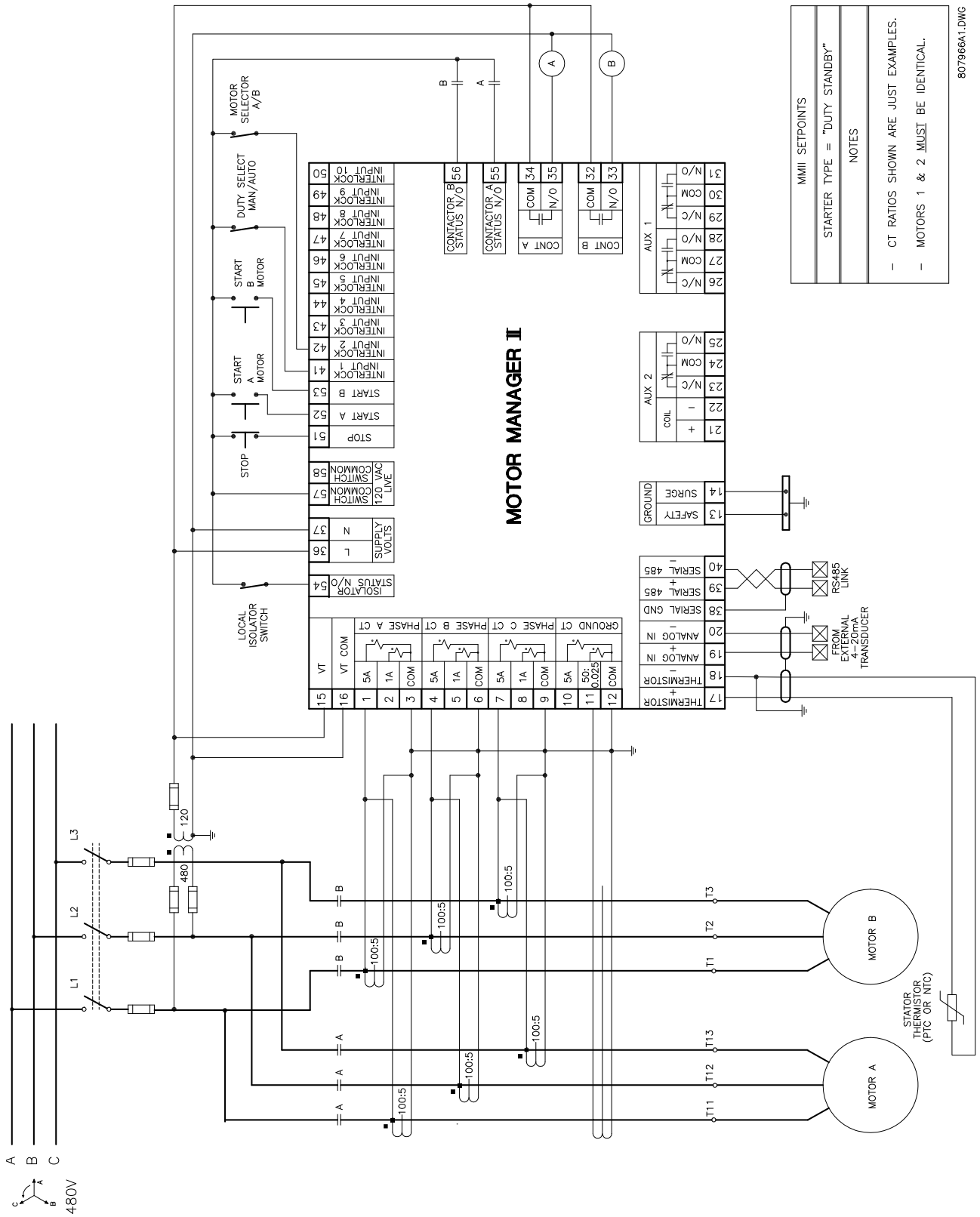


Figure 8–24: DUTY/STANDBY STARTER

8.13.1 DESCRIPTION

When the RUN contact closes the soft starter ramps up the motor to the programmed speed. When the RUN contact opens, the soft starter ramps down the motor to a stop.

To program the MM2 for soft starter, set:

S1 CONFIGURATION\STARTER\STARTER TYPE: SOFT STARTER
S1 CONFIGURATION\STARTER\RAMP UP TIME: 1 to 125 sec.
S1 CONFIGURATION\STARTER\RAMP DOWN TIME: 1 to 125 sec.
S3 PROCESS\PROGRAMMABLE INPUTS\INTERLOCK INPUT 10: BYPASS CONTACT (optional)
S4 CONTROL\AUX RELAY 1 CONFIG\AUX. RELAY 1 FUNCTION: SOFT STARTER BYPASS (optional)

The **RAMP UP TIME** and **RAMP DOWN TIME** setpoints appear when **STARTER TYPE** has been selected as SOFT STARTER. See the MM2 sequence below for details on functionality.

8.13.2 MM2 SEQUENCE

START:

1. Start command received by the MM2 (serial, switch input or faceplate).
2. Close and maintain Contactor A output relay – provide power to the SOFT STARTER.
3. Wait for one second.
4. Close and maintain Contactor B output relay – signal the SOFT STARTER to start the motor.
5. Wait for the **RAMP UP TIME** for Contactor B Status N.O. to close.
6. Close Bypass contact AUX. relay (optional)

STOP/TRIP:

1. Stop command is received or a trip occurs (serial, switch input or faceplate).
2. Open contactor B output relay.
3. Open Bypass contact AUX. relay (optional).
4. Wait for the **RAMP DOWN TIME** for Contactor B Status N.O. to open.
5. When Contactor B Status N.O. reads open, open Contactor A output relay.

If feedback is not received from the 1M contact to the Contactor A Status N.O. input within one second of closing Contactor A output relay, an OPEN CONTROL CIRCUIT alarm will occur. This will cause Contactor A and B output relays to open.

If Contactor B Status N.O. does not receive feedback from the up to speed contact on the SOFT STARTER within the RAMP UP TIME setpoint during a start, a DRIVE FAILED TO START alarm will be generated. If Contactor B Status N.O. feedback remains at the MM2 after the **RAMP DOWN TIME** has expired during a stop, a DRIVE FAILED TO STOP alarm will be generated.

If feedback remains at Contactor A Status N.O. input more than 1 second after opening the Contactor A output relay, a WELDED CONTACTOR alarm occurs. If feedback remains at the Interlock configured for BYPASS CONTACT more than one second after opening the Aux output relay, a WELDED CONTACTOR alarm occurs. If feedback is not received from the BYPASS CONTACT interlock input within one second of closing Aux output relay, an OPEN CONTROL CIRCUIT alarm occurs. This will cause Contactor A and B output relays to open.

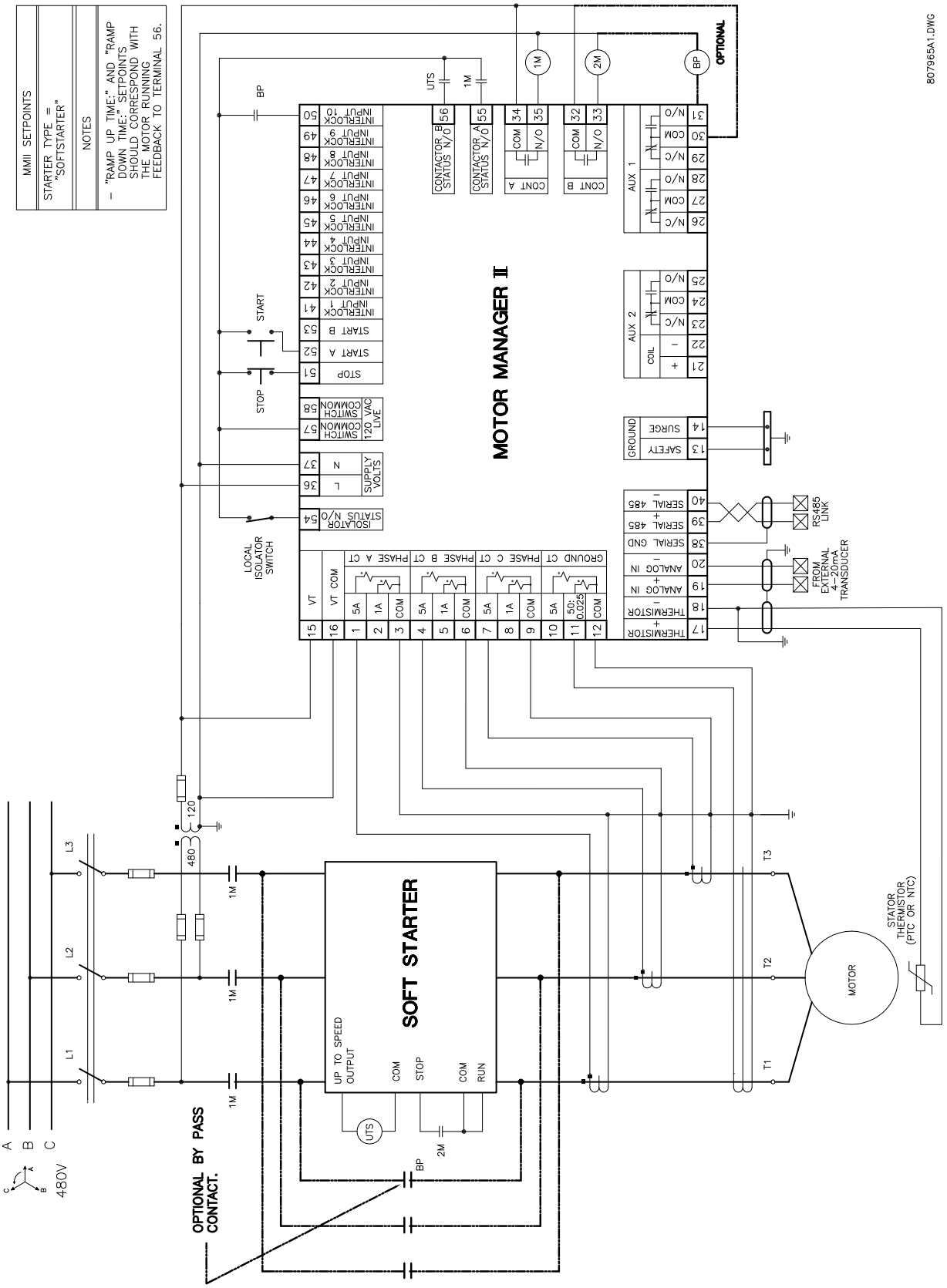


Figure 8–25: SOFT STARTER

9.1.1 DESCRIPTION

Although setpoints can be entered manually using the front panel keys, it is much easier to use a computer to download values through the communications port. The MM2PC software is available from GE Multilin to make this as convenient as possible. With MM2PC running, it is possible to:

- Program/modify setpoints
- Load/save setpoint files from/to disk
- Read actual values
- Monitor status
- Read pre-trip data and trip record
- Get help on any topic
- Upgrade MM2 firmware
- View the instruction manual as a Help file

The MM2PC software allows immediate access to all MM2 features with easy to use pull down menus in the familiar Windows environment. This chapter provides the necessary information to install MM2PC, upgrade the relay firmware, and write/edit setpoint files.

The MM2PC software can run without a MM2 connected to the computer. In this case, settings may be saved to a file for future use. If an MM2 is connected to a PC and communications are enabled, the MM2 can be programmed from the setpoint screens. In addition, measured values, status and trip messages can be displayed with the actual value screens.

9.1.2 HARDWARE & SOFTWARE REQUIREMENTS

The following minimum requirements must be met for the PC program to operate on the computer.

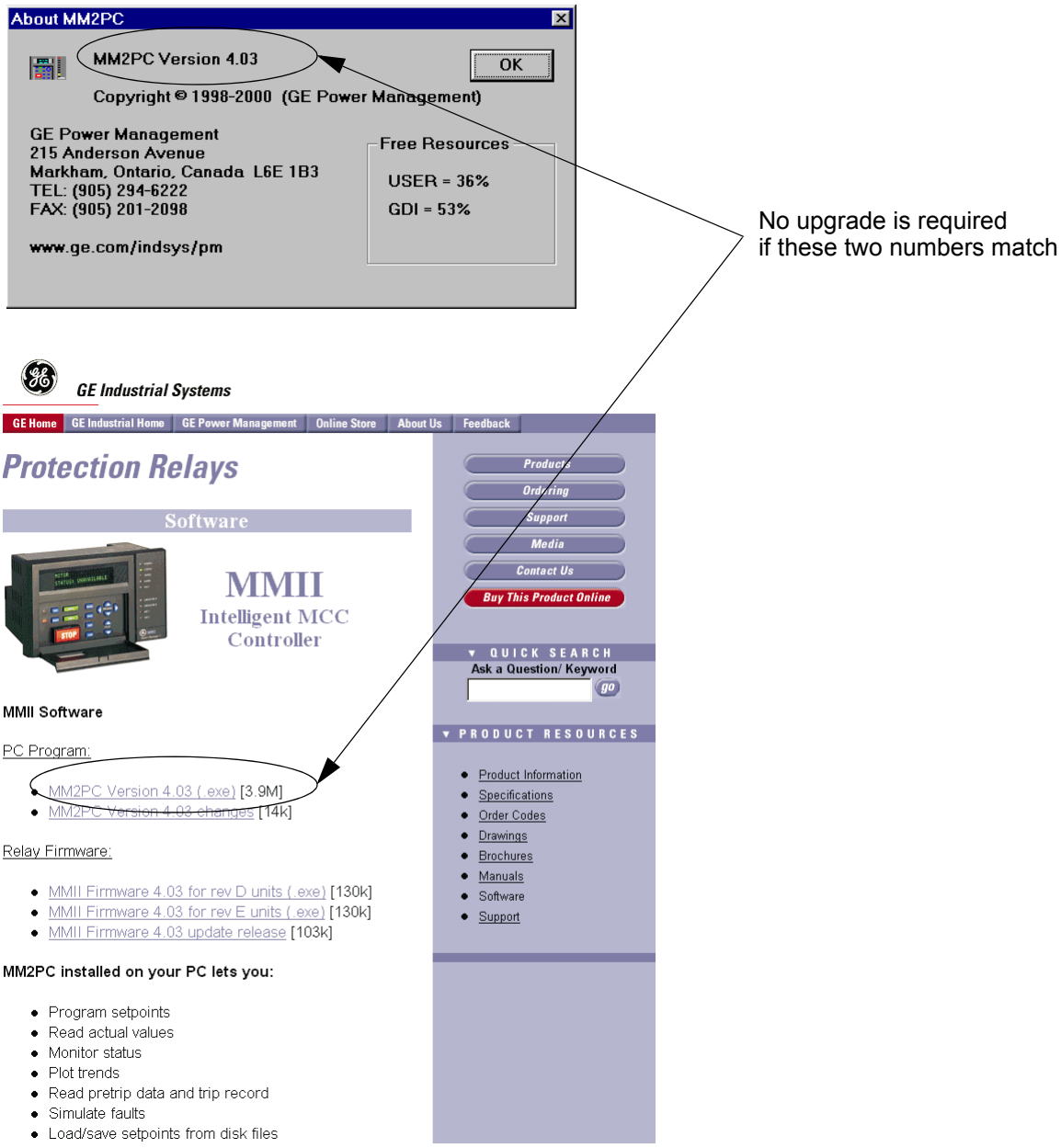
- Windows™ 3.1/95/98 is installed and running properly
- at least 6 MB hard disk space is available

MM2PC can be installed from either the GE Multilin Products CD or the GE Multilin website at **www.GEindustrial.com/multilin**. If you are using legacy equipment without web access or a CD drive, 3.5” floppy disks can be ordered from the factory.

9.1.3 CHECKING IF INSTALLATION/UPGRADE IS REQUIRED

If MM2PC is already installed it may require upgrading. Run the software and follow the procedure below:

1. While MM2PC is running, insert the GE Multilin Products CD and allow it to autostart (alternately, load the index.htm file into your web browser) **OR**
2. Go to the GE Multilin website at www.GEindustrial.com/multilin (preferred method).
3. Select the **Software** menu item then select **MM2 Motor Manager 2** from the list of products.
4. Verify that the software version shown on this page is identical to the installed version as shown below. Select the **Help > About MM2PC** menu item to determine which version is installed on the local PC.



Installation/upgrade of MM2PC is accomplished as follows:

1. Insert the GE Multilin Products CD into your CD-ROM drive or direct your web browser to the GE Multilin website at www.GEindustrial.com/multilin. With Windows 95/98, the Products CD will automatically launch the welcome screen; with Windows 3.1, open the Products CD menu by opening the `index.htm` file in the CD root directory.

   The Products CD is essentially a "snapshot" of the GE Multilin website at the date printed on the CD. As such, the installation from the CD and the web are identical. However, to ensure the newest version of MM2PC, installation from the web is preferred.

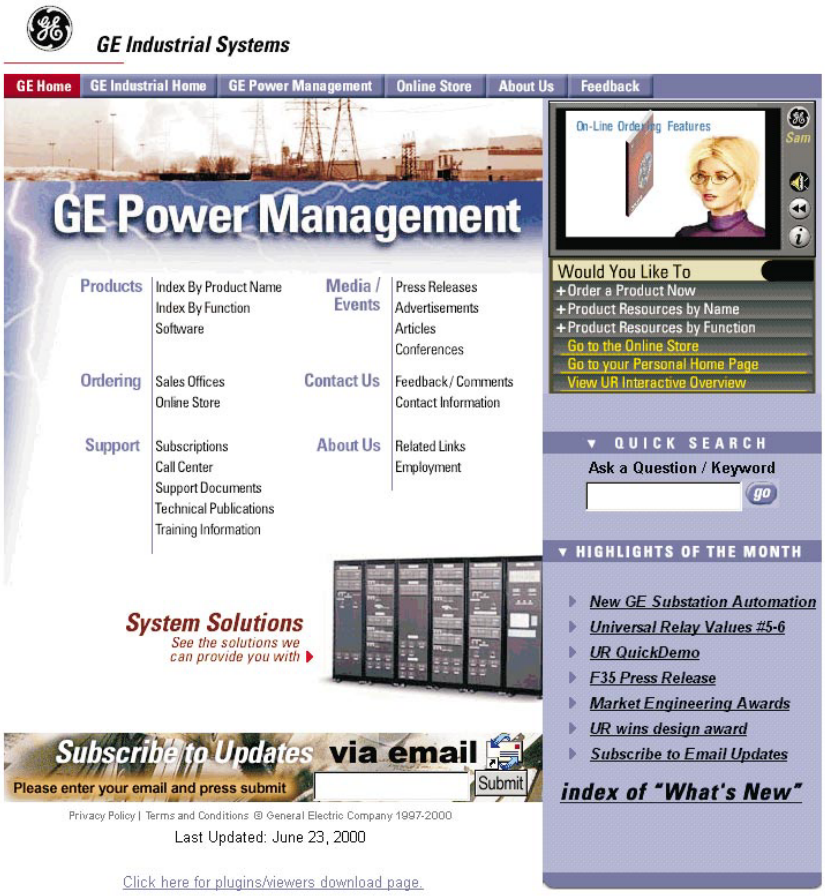


Figure 9–1: GE MULTILIN WELCOME SCREEN

2. Select the **Index by Product Name** item from the main page then select **MM2 Motor Manager 2** from the product list to open the MM2 product page.
3. Click the **Software** menu item from the Product Resources list to go to the MM2 software page.
4. The latest software version is shown. Click on the **MM2PC Program** menu item to download the installation program to your local PC. Run the installation program and follow the prompts to install to a desired directory. When the installation is complete, the GE Multilin group window will appear containing the MM2PC icon. MM2PC will also be added to the start menu.

1. Connect a GE Multilin RS232/485 converter module to the COM1 or COM2 PC port and wire the RS485 +/– terminals on the box to MM2 terminals 25/26. Be careful to observe correct polarity of the RS485 connections. See Figure 2–6: RS485 TERMINATION on page 2–7 for connection details.
2. Start the MM2PC software. MM2PC will attempt to communicate with the MM2. The MM2 to PC communications status is displayed on the bottom right of the MM2PC window.
3. To configure communications, select the **Communications > Computer** menu item. The COMMUNICATION / COMPUTER window appears containing the various communications settings for the local PC. Modify these settings as shown below:

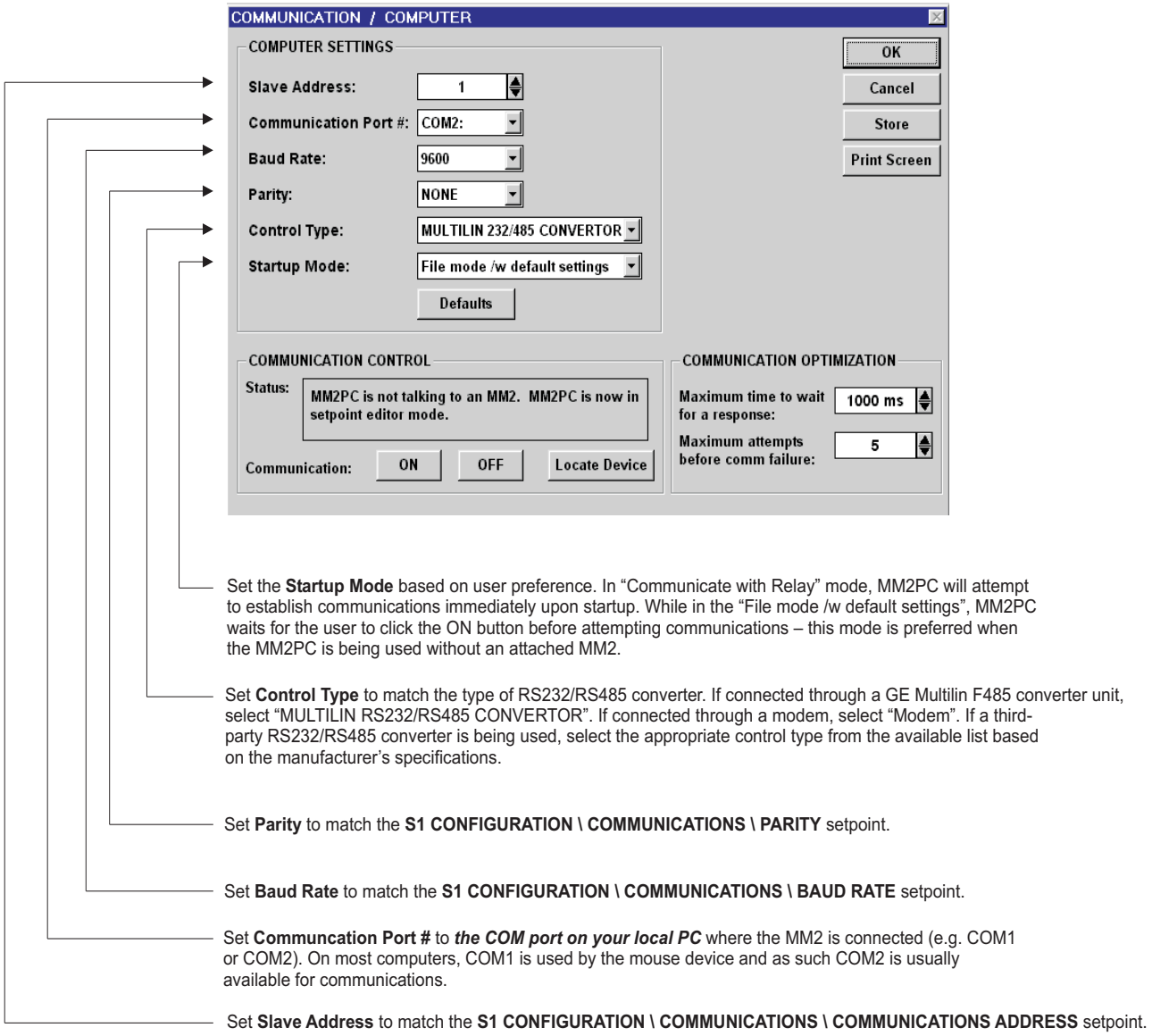


Figure 9–2: COMMUNICATION / COMPUTER WINDOW

4. Ensure the computer is properly connected to the RS232/485 converter and the transmit and DTR indicators on the front flash when the software attempts to communicate with the MM2. If the indicators do not flash, the RS232/485 converter may not be connected to the correct communications port. Serial communication ports on a computer are usually 9 or 25-pin male connectors. Ensure that the RS232/485 converter box is connected to the correct computer port.
5. Click on the **ON** button to communicate with relay. MM2PC will notify when it has established communication link with the relay. If it fails to communicate check the following:
   - review the settings above to ensure they match the relay settings
   - the COM Port setting matches the COM Port being used
   - the hardware connection is setup as in Figure 2–6: RS485 TERMINATION on page 2–7.
   - the RS485 wire polarity is correct and is connected to the right terminals

Once the communication has been established click **OK** to return to the main screen

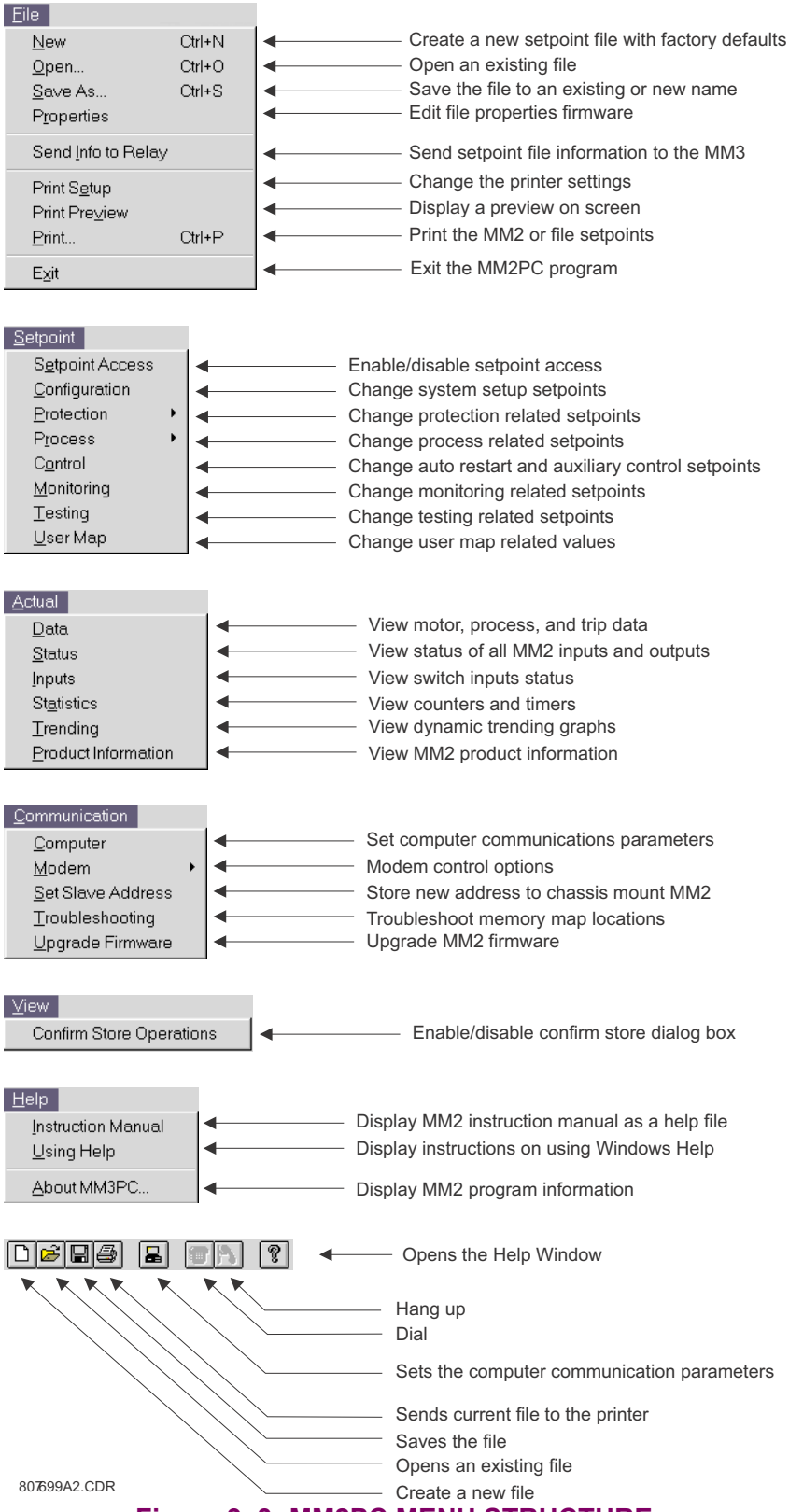


Figure 9–3: MM2PC MENU STRUCTURE

NOTE

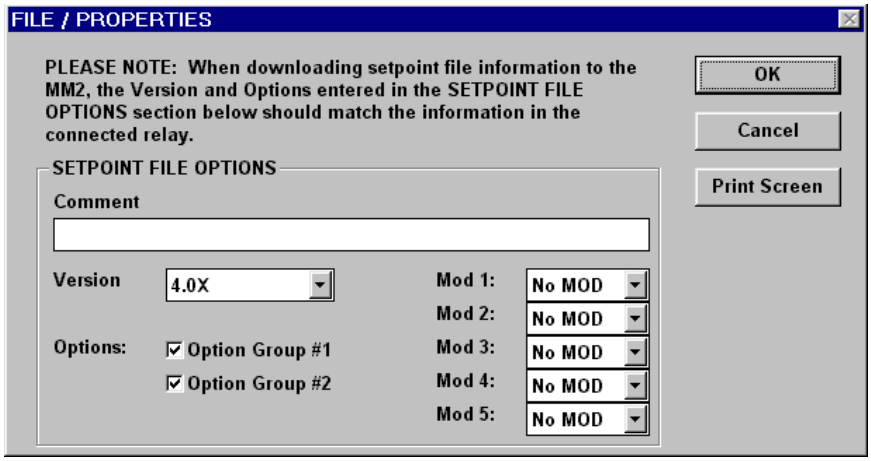
MM2 setpoint filenames should follow standard DOS file naming convention: eight characters, a period, and a three character extension (for example, `SPF_V340.MM2`).

Use the following procedure to save the current setpoints for use at a later date:

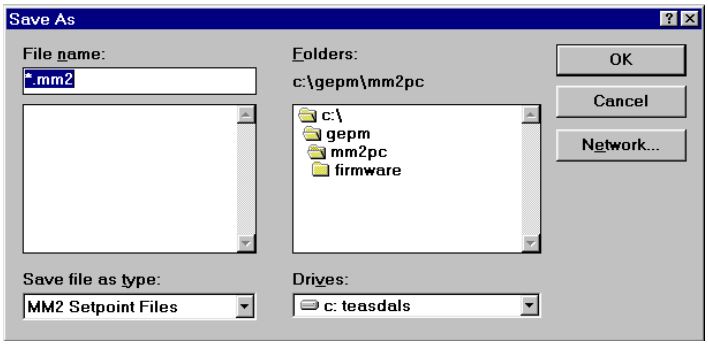
1. Start MM2PC and establish communications with the MM2.
2. Select the **File > Save As** menu item. Enter the filename for the saved setpoints in the File Name box or select any of the displayed file names to update them. All MM2 setpoint files should have the extension `MM2` (for example, `MOTOR5.MM2`). Click **OK** to save the setpoint file.

Use the following procedure when setting commissioning values for multiple MM2s or when an MM2 is not communicating or connected to the computer.

1. Start MM2PC and select **File > New** to enter setpoint values for the specific off-line MM2. If the software is communicating with the MM2, communications will be halted during the new file creation. The window shown below appears which allows the user to configure MM2 for the options ordered with a particular MM2 unit. MM2PC needs to know the correct options when creating a setpoint file so that setpoints not available for a particular unit are not downloaded.



2. Select the installed options and firmware version then make the appropriate setpoints changes. After configuration, select the **File >Save As** menu item. This launches the dialog box shown below. Enter the file name for the saved setpoints or select a displayed file name for updating. All MM2 setpoint files should have the extension MM2 (e.g., MOTOR4.MM2). Click **OK** to proceed.



3. MM2PC reads the entered setpoint values and saves them in the selected file.

CAUTION

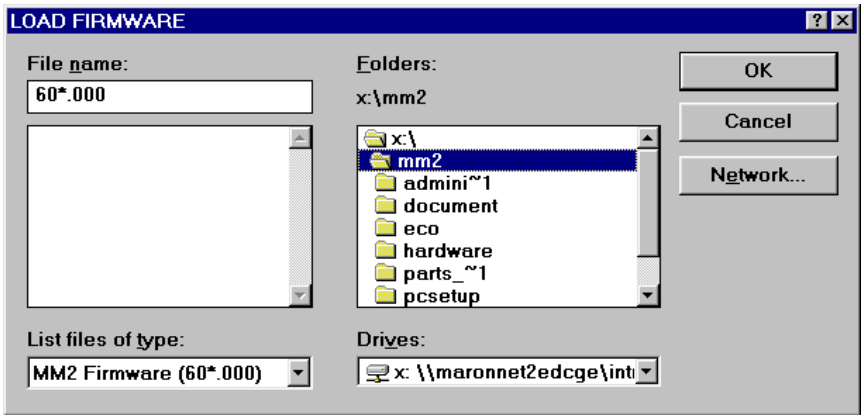
Upgrading the relay firmware may cause relay operation to change! Print and save the original setpoints to a file that can be reloaded into the relay before proceeding with the firmware upgrade.

NOTE

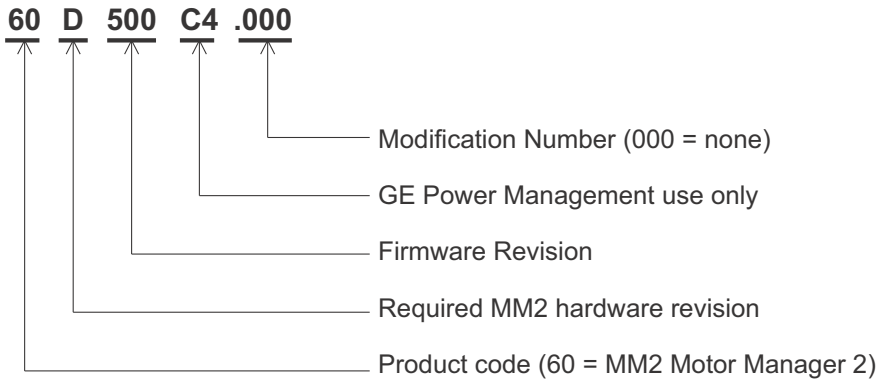
For MM2 relays with Boot code versions 4.00 and higher, the Upload message will not appear during the upload process if the display is a VFD (Vacuum Florescent Display); it only appears for units with an LCD (Liquid Crystal Display).

Prior to downloading new firmware to the MM2, it is necessary to save the current MM2 setpoints to a file (see the previous section). Please save the setpoints before continuing. Loading new firmware into the MM2 flash memory is accomplished as follows:

1. Select the **Communications > Upgrade Firmware** menu item. The opens the Firmware Upload window shown below.



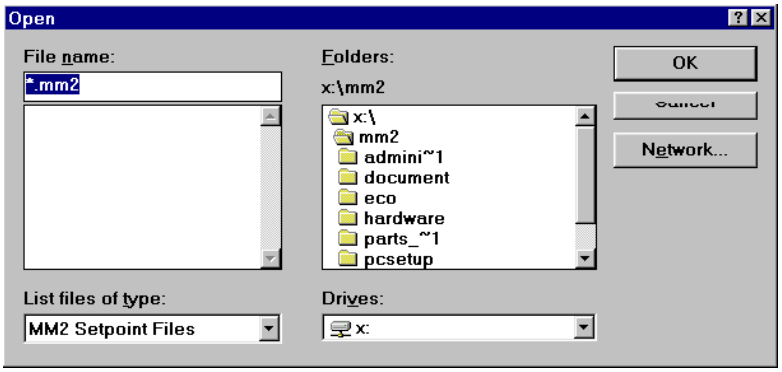
2. Locate the firmware file to load into the relay. Filenames for released MM2 firmware have the following format:



3. MM2PC automatically lists all filenames beginning with **71**. Select the appropriate file and click **Start Upload** to continue.
4. MM2PC will prompt with a final warning. This will be the last chance to cancel the firmware upgrade before the flash memory is erased. Click **Yes** to continue.
5. Upon completion, it will be necessary to reload the previously saved setpoints back into the MM2. See the following section for additional details.

Loading an MM2 setpoint file is accomplished as follows:

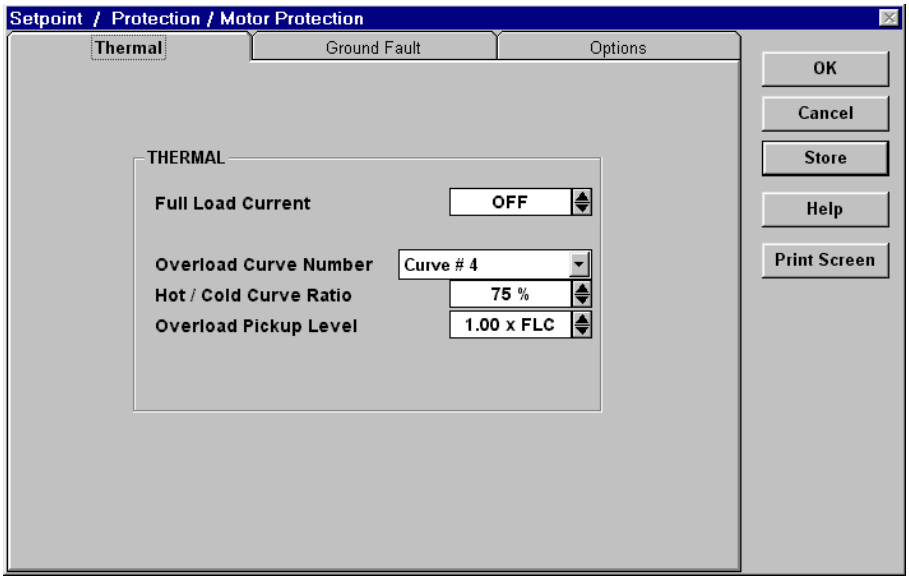
1. Select the **File > Open** menu item
2. MM2PC launches the Open window listing all filenames in the MM2 default directory with the extension MM2. Select a setpoint file and click **OK** to continue.



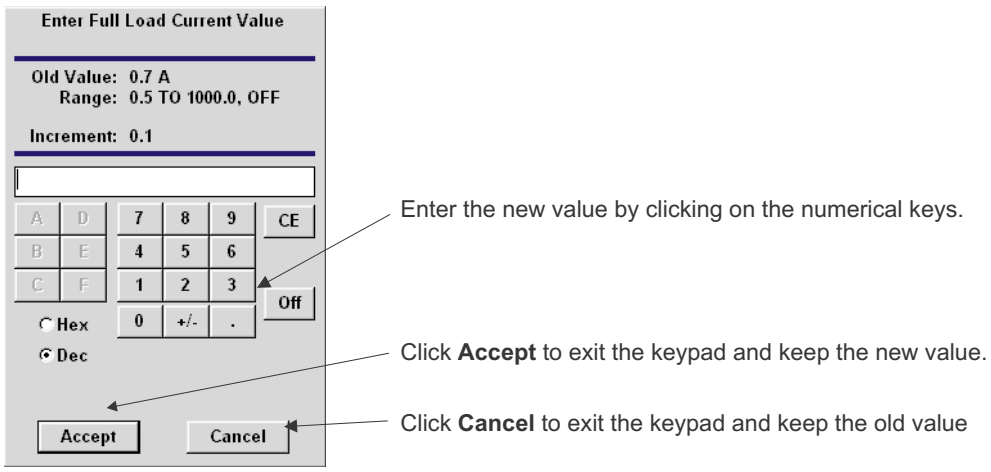
3. Select the **File > Send Info To Relay** menu item. MM2PC will prompt to confirm or cancel the setpoint file load. Click **Yes** to download the setpoints to the MM2 or **No** to cancel.

The following *example* illustrates how to enter setpoints from MM2PC.

1. Select the **Setpoint > Protection > Motor Protection** menu item.
2. The following window prompts the user for motor protection information.



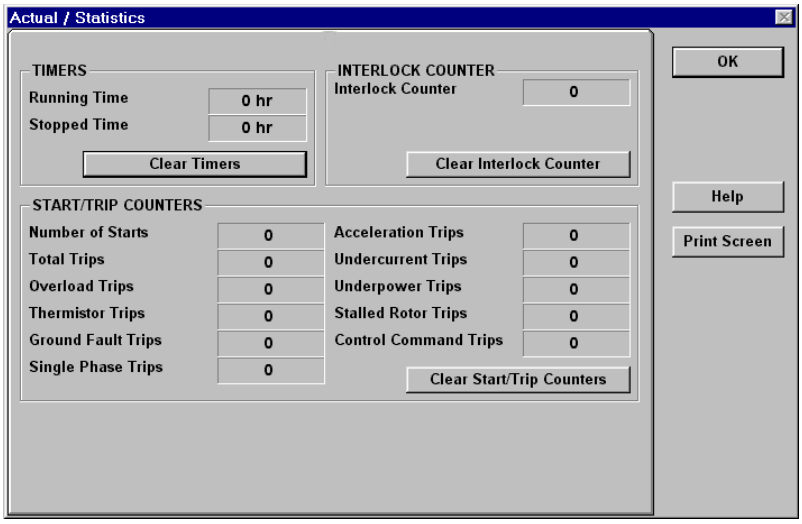
3. For numerical setpoints (in the example above, **FULL LOAD CURRENT**, **HOT/COLD CURVE RATIO**, and **OVERLOAD PICKUP LEVEL**), click the ▲/▼ arrow keys at the end of the dialog box to increment/decrement the setpoint by its step value. Alternately, click the mouse pointer anywhere inside the setpoint box to display a numerical keypad showing the OLD value, RANGE, and INCREMENT of the setpoint value being modified.



4. For setpoints requiring a non-numeric value (in the example above, **OVERLOAD CURVE NUMBER**), click anywhere inside the setpoint box to open a drop-down menu. An appropriate setpoint may then be selected.
5. After setpoint modifications are complete, click the **OK** to save the values into the local PC memory, Cancel to return to the previous values, or Store to send the values to the MM2 (if connected). Clicking on Help displays help topics related to the setpoints being modified.

The following example shows how to view and trend MM2 actual values.

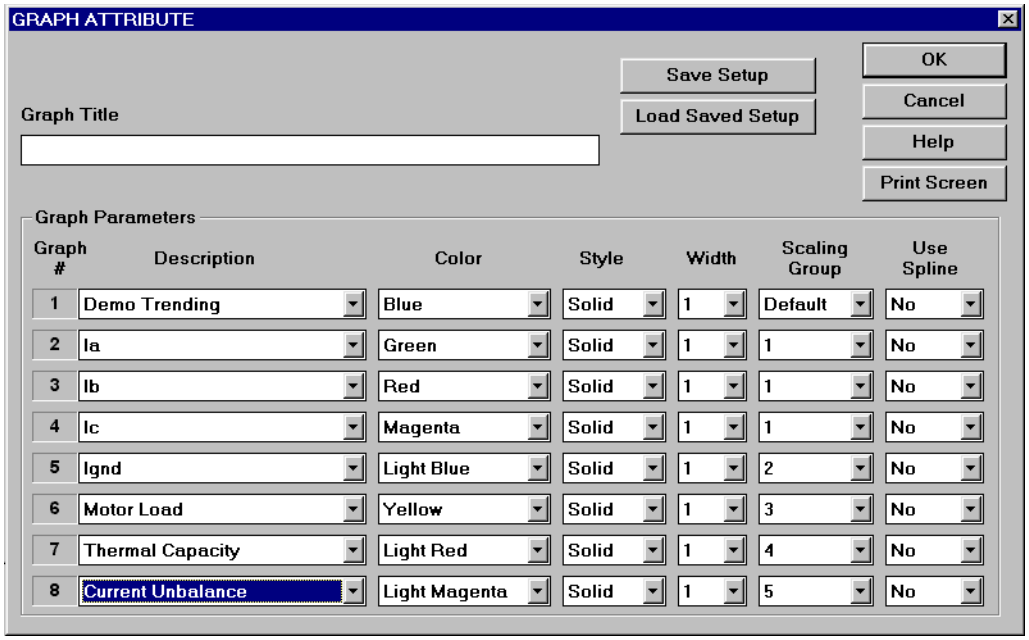
1. Establish communications with the MM2 unit and select the **Actual > Statistics** menu item. This opens the window showing the relevant monitored values. These values are continuously updated while the window is open.



2. The MM2PC trending feature can be used to plot measured parameters. The following values can be trended:

   - Phase currents (I_a, I_b, I_c), ground current (I_{gnd}), motor load, thermal capacity, current unbalance, analog input, voltage, and power.

3. Select the **Actual > Trending** menu item to open the trending window (see figure on following page). Press the **Setup** button on the lower left of the window to enter the Graph Attribute page.



4. Program the displayed values with the pull-down menu beside each Graph Description. Change the **Color**, **Style**, **Width**, **Group#**, and **Spline** selection as desired.
5. Select the same **Group#** for all parameters to be scaled together.
6. Select **Save** to Store the Graph Attributes then click **OK** to close the window.
7. In the Trending Window, select the **Sample Rate**, click the checkboxes of the values to be displayed, and click **RUN** to begin the trending sampling.
8. The Trending File Setup button can be used to write the graph data to a file in a standard spreadsheet format. Ensure that the **Write Trended Data to File** box is checked and that the **Sample Rate** is at a minimum of 5 seconds. Select the file capacity limit to the amount of memory available for trended data.

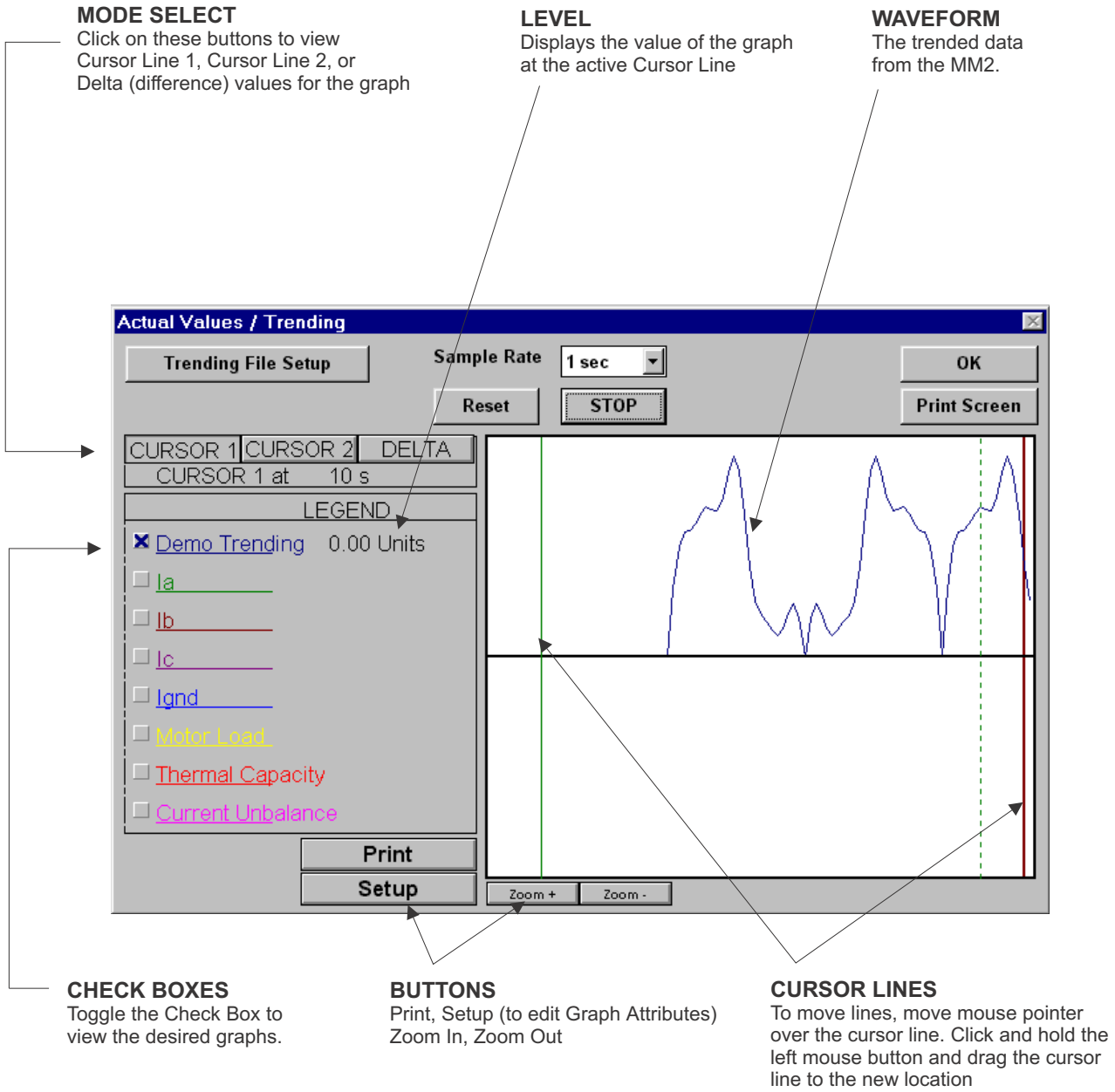


Figure 9–4: TRENDING VIEW

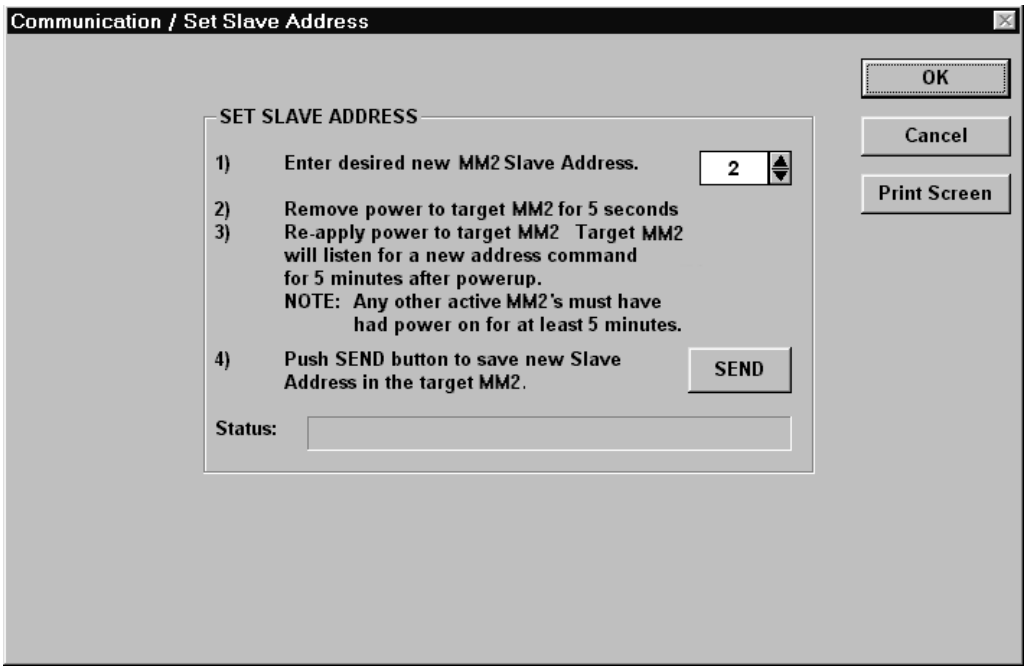
9.5.1 DESCRIPTION

MM2 chassis mount units no longer support automatic baud rate linking. The default communication settings are 9600 baud, 8 data bits, one stop bit, no parity. It is necessary to initially communicate with these settings and change them one at a time. After each change the master must be changed to match the communication setting change in the MM2.

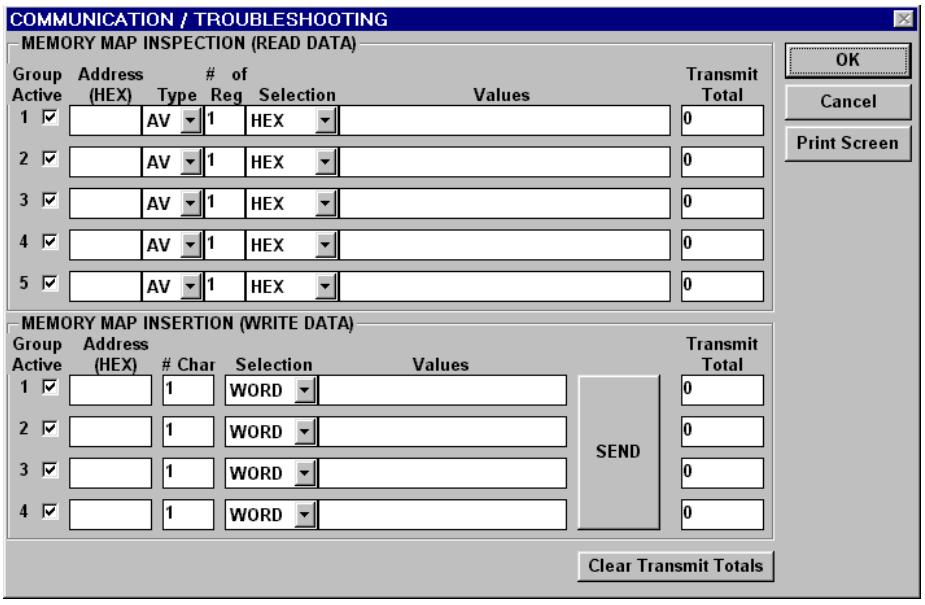
9.5.2 SETTING THE BAUD RATE AND PARITY

Assume your system communicates at 19200 baud and even parity.

1. Use MM2PC to establish communications with the chassis mount MM2 at 9600 baud and no parity.
2. Select the **Communication > Set Slave Address** menu item and follow the on screen instructions to store the communication address of the MM2. When completed, select **OK** to exit.



3. Select the **Communication > Troubleshooting** menu. This opens the Memory Map Inspection window shown below:



4. Type **1139** (the address of baud rate setpoint) in the address box and **4** (4 = 19200 baud) in the values box in the Memory Map Insertion section. Refer to Section 5.5: MEMORY MAP on page 5–19 for details.
5. Click **Send** and then **Yes** to confirm the setpoint write action. All communications will immediately be lost – ignore any errors.
6. Select **OK** to exit the Troubleshooting window.
7. Select the **Communication > Computer** menu item.
8. Change the baud rate setting to 19200, click **Store**, then click **OK**. Select the **Communication > Computer** menu item again and click **ON** in the Communication Control section. The status should now read “Program is now talking to Multilin device.”
9. Select **OK** to exit the Communication/Computer window and select the **Communication > Troubleshooting** menu item.
10. Enter **1147** (address of the parity setpoint) in the address box and **1** (1 = even) in the values box in the Memory Map Insertion section. Refer to Section 5.5: MEMORY MAP on page 5–19 for details.
11. Click **Send** and then **Yes** to confirm the setpoint write action. All communications will immediately be lost – ignore any errors.
12. Select **OK** to exit the Troubleshooting window.
13. Select the **Communication > Computer** menu item.
14. Change the parity setting to even, click **Store**, then click **OK**. Select the **Communication > Computer** menu item again and click **ON** in the Communication Control section. The status should now read “Program is now talking to Multilin device.”
15. Select **OK** to exit the Communication/Computer window.

10.1.1 DESCRIPTION

This control scheme is used when a maintained contact is in series with the starter coil. When the PLC contact is closed the motor runs. When the PLC contact opens the motor stops.

To program the MM2 for two-wire control, set:

S3 PROCESS\PROGRAMMABLE INPUTS\INTERLOCK INPUT 1: TWO WIRE CONTROL
S3 PROCESS\STOP CONFIGURATION\FACEPLATE STOP: LATCHED

NOTE

The **INTERLOCK INPUT 1** setpoint was chosen to match the wiring diagram provided. Any of the available Interlocks 1 through 10 could be programmed for TWO WIRE CONTROL.

10.1.2 CONTROL OPERATION

START:

- Start command received (switch input) and maintained.

STOP:

- Start command removed.
- Pressing the STOP key causes a latched trip. The motor cannot be restarted until the RESET key is pressed.

Terminal 51 (Stop input) must be closed to allow a start. The MM2 display will read “Motor Status Unavailable” when the stop input is open.

If feedback is not received by the Contactor A relay Status N.O. inputs within 1 second of closing Contactor A output relay, an OPEN CONTROL CIRCUIT alarm will occur. This will cause Contactor A output relay to open.

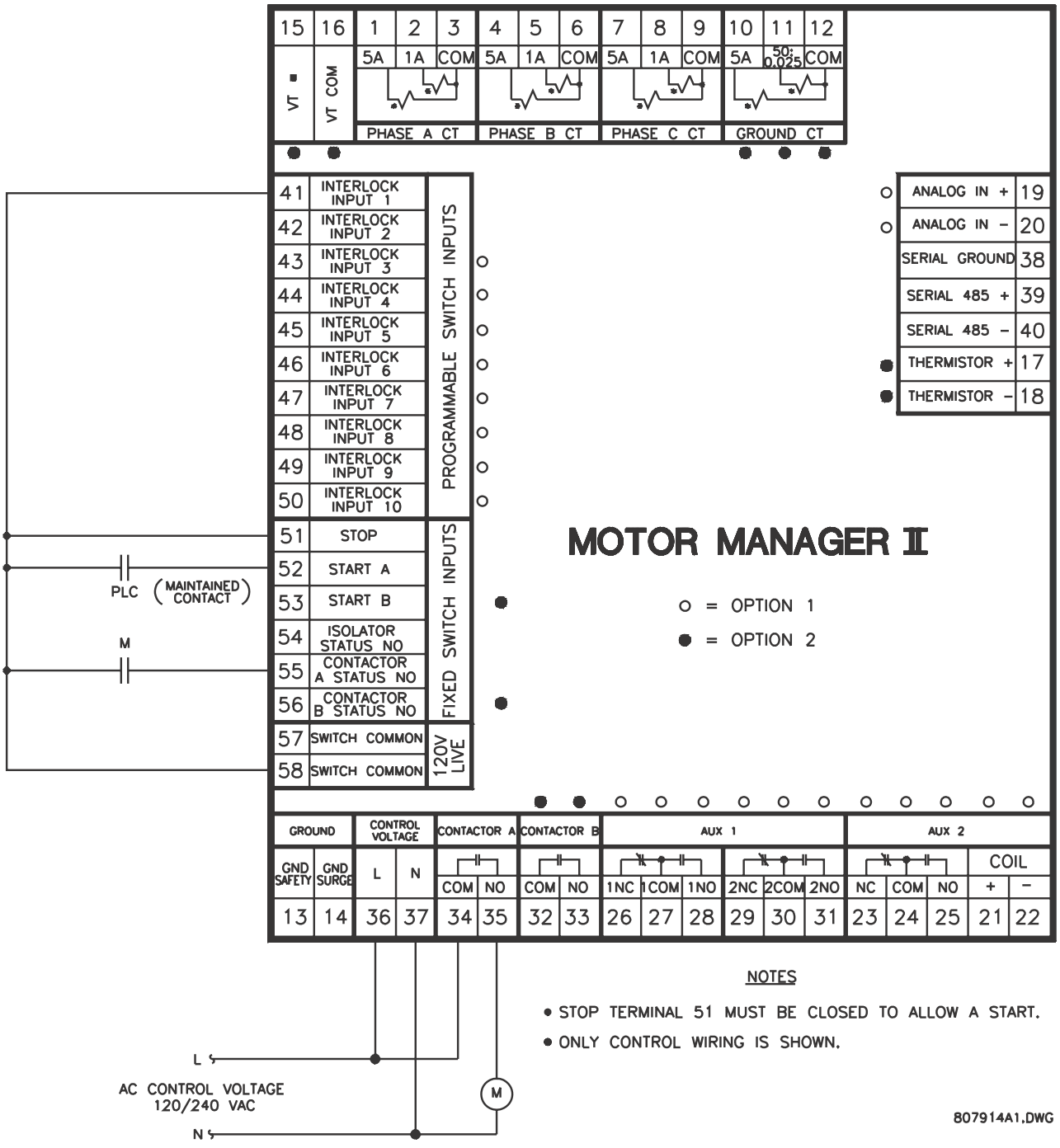


Figure 10–1: TWO WIRE CONTROL

10.2.1 2-WIRE HAND / 2-WIRE AUTO

This control scheme is used when it is desirable to operate the starter manually and automatically. In the Hand position, the starter coil is energized immediately. In the auto position, the starter is energized by the maintained PLC contact. When the PLC contact opens, the motor stops.

To program the MM2 for two-wire hand / two-wire auto control, set:

S3 PROCESS\PROGRAMMABLE INPUTS\INTERLOCK INPUT 1: TWO WIRE CONTROL
S3 PROCESS\STOP CONFIGURATION\FACEPLATE STOP: LATCHED

NOTE

The **INTERLOCK INPUT 1** setpoint was chosen to match the wiring diagram provided. Any of the available Interlocks 1 through 10 could be programmed for TWO WIRE CONTROL.

10.2.2 CONTROL OPERATION

HAND:

- In the hand position, the motor will run.
- Pressing the STOP key causes a latched trip. The motor cannot be restarted until the RESET key is pressed.

OFF:

- In the off position, the motor will stop.

AUTO:

- In the auto position, the motor is available to start.
- When the PLC contact closes, the motor runs.
- When the PLC contact opens, the motor stops.
- Pressing the STOP key causes a latched trip. The motor cannot be restarted until the RESET key is pressed.

Terminal 51 (Stop input) must be closed to allow a start. The MM2 display will read “Motor Status Unavailable” when the stop input is open.

If feedback is not received by the Contactor A Status N.O. input within one second of closing the Contactor A output relays, an OPEN CONTROL CIRCUIT alarm will occur. This causes the Contactor A output relay to open.

In the case of a FACEPLATE STOP trip, the start signal to Terminal 52 should be removed if restarting is not desired. When the reset key is pressed on the MM2, the motor will be restarted based on Terminal 52.

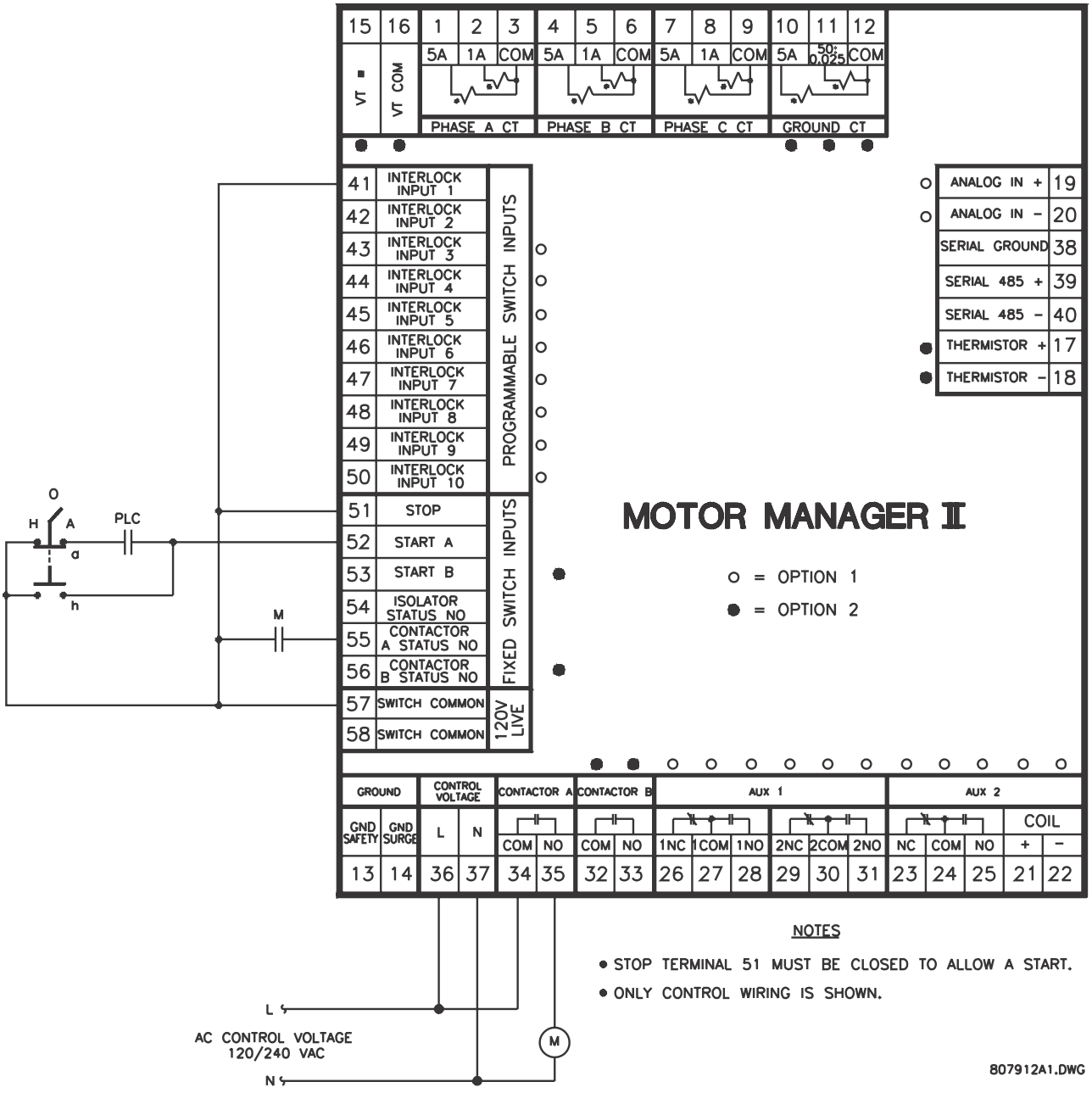


Figure 10–2: HOA TWO-WIRE HAND / TWO-WIRE AUTO

10.2.3 3-WIRE HAND / 2-WIRE AUTO

This control scheme is used when it is desirable to operate the starter manually and automatically. In the Hand position, the starter coil is energized via the START button and de-energized via the STOP button. In the auto position, the starter is energized by the maintained PLC contact. When the PLC contact opens, the motor stops.

To program the MM2 for three-wire hand / two-wire auto control, set:

S3 PROCESS\PROGRAMMABLE INPUTS\INTERLOCK INPUT 1: TWO WIRE CONTROL
S3 PROCESS\STOP CONFIGURATION\FACEPLATE STOP: LATCHED

NOTE

The **INTERLOCK INPUT 1** setpoint was chosen to match the wiring diagram provided. Any of the available Interlocks 1 through 10 could be programmed for TWO WIRE CONTROL.

10.2.4 CONTROL OPERATION

HAND:

- In the hand position, the motor is available to start.
- When the START button is pressed, the motor will run.
- When the STOP button is pressed, the motor will stop.
- Pressing the STOP key causes a latched trip. The motor cannot be restarted until the RESET key is pressed.

OFF:

- In the off position, the motor will stop.

AUTO:

- In the auto position, the motor is available to start.
- When the PLC contact closes the motor runs.
- When the PLC contact opens the motor stops.
- When the faceplate stop key is pressed, it causes a latched trip. The motor cannot be restarted until reset is pressed.

Terminal 51 (Stop input) must be closed to allow a start. The MM2 display will read “Motor Status Unavailable” when the stop input is open.

If feedback is not received by the Contactor A Status N.O. input within one second of closing Contactor A output relay, an OPEN CONTROL CIRCUIT alarm will occur. This will cause Contactor A output relay to open.

In the auto position the STOP push button at the motor **will not STOP** the motor.

In the case of a faceplate stop trip, the start signal to Terminal 52 should be removed if restarting is not desired. When the reset key is pressed on the MM2, the motor will be restarted based on Terminal 52.

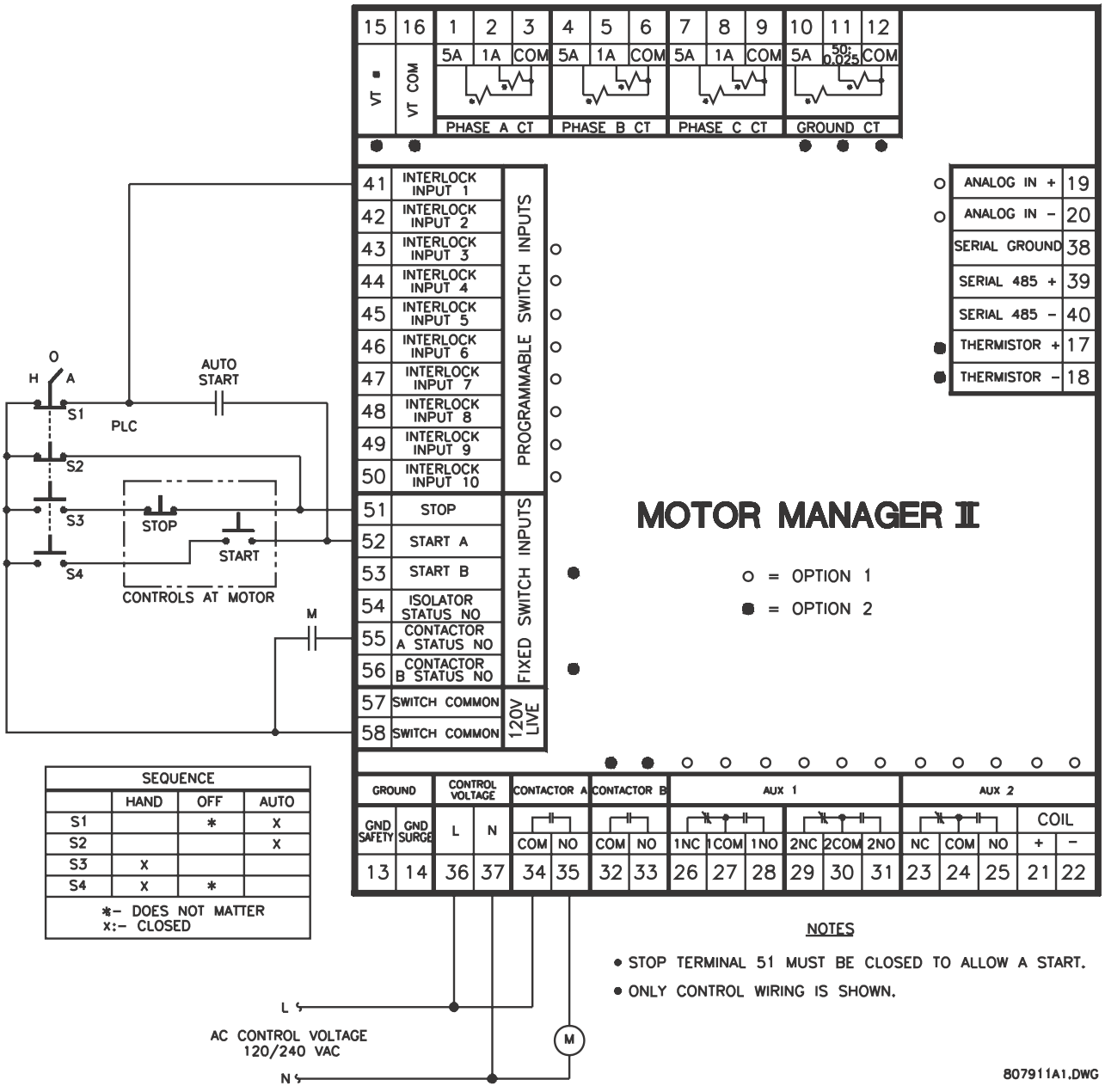


Figure 10–3: HOA THREE WIRE HAND / TWO WIRE AUTO

10.2.5 3 WIRE HAND / 3 WIRE AUTO

This control scheme is used when it is desirable to operate the starter manually and automatically. In the Hand position, the starter coil is energized via the START button and de-energized via the STOP button. In the auto position, the starter is energized automatically when the PLC1 contact is pulsed closed. When the PLC2 contact is pulsed open, the motor stops.

To program the MM2 for three-wire hand / three-wire auto control, set the MM2 to the default settings.

10.2.6 CONTROL OPERATION

HAND:

- In the hand position, the motor is available to start.
- When the START button is pressed, the motor runs.
- When the STOP button is pressed, the motor stops.

OFF:

- In the off position, the motor will stop.

AUTO:

- In the auto position, the motor is available to start.
- When the PLC contact is pulsed closed, the motor runs.
- When the PLC contact is pulsed open, the motor stops.
- When the STOP button is pressed, the motor stops.

Terminal 51 (Stop input) must be closed to allow a start. The MM2 display will read “Motor Status Unavailable” when the stop input is open.

If feedback is not received by the Contactor A Status N.O. input within one second of closing Contactor A output relay, an OPEN CONTROL CIRCUIT alarm will occur. This will cause Contactor A output relay to open.

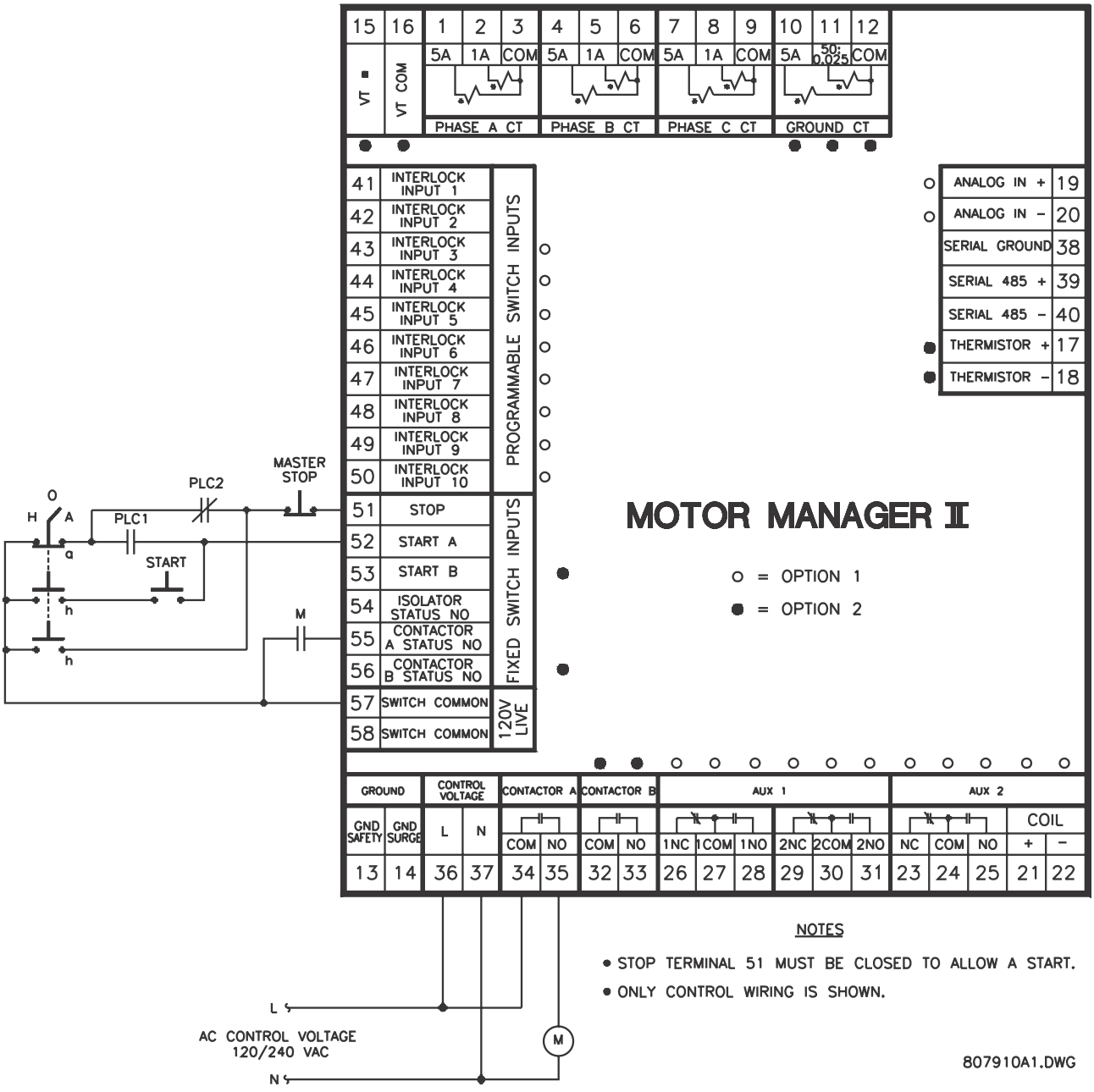


Figure 10–4: HOA THREE WIRE HAND / THREE WIRE AUTO

This control scheme is used when it is desirable to operate the starter manually and automatically. In the Hand position the starter coil is energized via the START button and de-energized via the STOP button. In the auto position the starter is energized automatically by the maintained PLC contact. When the PLC contact opens, the motor stops.

To program the MM2 for three-wire hand / two-wire auto control (hand/auto configuration), set:

S3 PROCESS\PROGRAMMABLE INPUTS\INTERLOCK INPUT 1: TWO WIRE CONTROL
S3 PROCESS\PROGRAMMABLE INPUTS\INTERLOCK INPUT 2: AUTO PERMISSIVE
S3 PROCESS\PROGRAMMABLE INPUTS\INTERLOCK INPUT 3: AUTO START A
S3 PROCESS\STOP CONFIGURATION\FACEPLATE STOP: LATCHED
S3 PROCESS\STOP CONFIGURATION\PROCESS STOP: LATCHED

The **INTERLOCK INPUT 1/2/3** setpoints were chosen to match the wiring diagram provided. Any of the available Interlocks 1 through 10 could be programmed for TWO WIRE CONTROL, AUTO-PERMISSIVE, or AUTO START A

c) CONTROL OPERATION

HAND:

- In the hand position, the motor is available to start.
- When the START button is pressed, the motor runs.
- When the STOP button is pressed, the motor stops and a latched trip is generated. The motor cannot be restarted until reset is pressed.
- When the faceplate stop key is pressed, it causes a latched trip. The motor cannot be restarted until reset is pressed.

AUTO:

- In the auto position, the motor is available to start.
- When the PLC contact closes, the motor runs.
- When the PLC contact opens, the motor stops and a latched trip is generated. The motor cannot be restarted until reset is pressed.
- When the faceplate stop key is pressed, it causes a latched trip. The motor cannot be restarted until reset is pressed.
- Start commands from the faceplate, serial port and terminals 12 and 53 are blocked.

Terminal 51 (Stop input) must be closed to allow a start. The MM2 display will read “Motor Status Unavailable” when the stop input is open.

If feedback is not received by the Contactor A Status N.O. input within 1 second of closing Contactor A output relay, an OPEN CONTROL CIRCUIT alarm will occur. This will cause Contactor A output relay to open.

In the case of a faceplate *or* process stop trip, the start signal to Terminal 52 should be removed if restarting is not desired. When the MM2 reset key is pressed, the motor will be restarted based on Terminal 52.

The STOP button at the motor remains active in the auto mode.

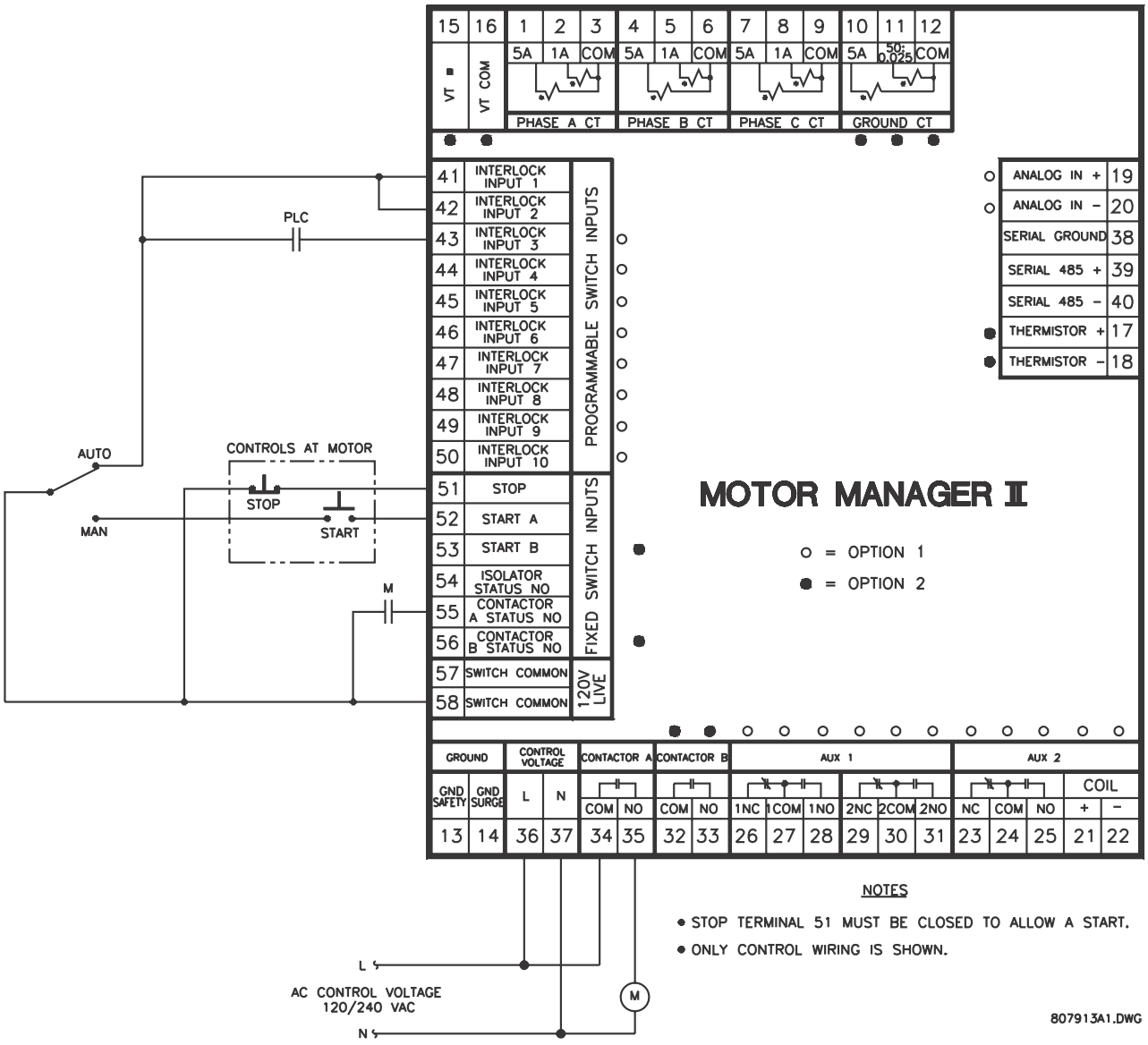


Figure 10–5: HA THREE WIRE HAND / TWO WIRE AUTO

A.1.1 DESCRIPTION

The following table lists all of the MM2 setpoints. Your application of the MM2 may not use all of them.

Table A–1: MM2 COMMISSIONING (Sheet 1 of 8)

DESCRIPTION	DEFAULT	VALUE
S1: SYSTEM CONFIGURATION		
COMMUNICATIONS		
Communications Address	Off	
Baud Rate	9600	
Parity	None	
MOTOR IDENTIFICATION		
Motor Name	Motor	
Motor Rating	Off	
High Speed Motor Rating	Off	
System Supply	480 V	
STARTER		
Starter Type	Off	
Change Over Current	1.5 x FLC	
Change Over Time	30 sec.	
Transfer Time	10 sec.	
High Speed Start Block	Disable	
Ramp Up Time	5 sec.	
Ramp Down Time	5 sec.	
Stage One Shorting Time	5 sec.	
Contactor Sequence	1S-2S	
Change Over Time (Autotrans)	5 sec.	
Starts Per Hour	5	
CT/VT INPUTS		
Phase CT Primary Amps	100 A	
Hi Speed Phase CT Primary A	100 A	
Ground Fault CT Inputs	50:0.025 CBCT	
Ground CT Primary Amps	100 A	
50:0.025 Hi-Res Display	Disable	
VT Primary Voltage	Off	

Table A–1: MM2 COMMISSIONING (Sheet 2 of 8)

DESCRIPTION	DEFAULT	VALUE
VT Connection Type	Phase (A-N)	
VT Secondary Voltage	120 V	
Nominal Frequency	60 Hz	
THERMISTOR		
Cold Resistance	0.1 KΩ	
Hot Resistance	5.0 KΩ	
Thermistor Trip	Disable	
Thermistor Alarm	Disable	
FAULT MODE		
Internal Fault Trip	Enable	
Serial Comms Failure Trip	Off	
Serial Comms Failure Alarm	Off	
Chg Command Mode on Alm	Disable	
PROGRAMMABLE MESSAGE		
Programmable Message	Sample Text	
PREFERENCES		
Default Message Display	10 sec.	
Default Message Brightness (applicable to VFD units only)	60%	
S2: PROTECTION		
MOTOR PROTECTION – THERMAL		
Full Load Current	100 A	
High Speed Full Load Current	100 A	
Overload Pickup Level	1.00 x FLA	
Overload Curve Number	4	
Hot/Cold Curve Ratio	75%	
MOTOR PROTECTION – GROUND FAULT		
Ground Fault Alarm Level	Off	
Gnd Fault Alarm Delay On Run	10 sec.	

Table A–1: MM2 COMMISSIONING (Sheet 3 of 8)

DESCRIPTION	DEFAULT	VALUE
Gnd Fault Alarm Dly On Start	10 sec.	
Ground Fault Trip Level	Off	
Gnd Fault Trip Delay On Run	1.0 sec.	
Gnd Fault Trip Delay On Start	1.0 sec.	
MOTOR PROTECTION – OPTIONS		
Minimize Reset Time	Enable	
Stopped Motor Cool Time	30 min.	
Overload Trip Reset	Manual	
Reset Lockout using Reset Key	Enable	
Phase Unbalance Alarm	Enable	
Thermal Capacity Alarm	Off	
Open Control Circuit Trip	Enable	
Reset Alarms Using Reset Key	Enable	
LOAD PROTECTION		
Underpower Alarm Level	Off	
Underpower Alarm Delay	10 sec.	
Underpower Trip Level	Off	
Underpower Trip Delay	10 sec.	
Acceleration Time Alarm	Off	
Acceleration Time Trip	Off	
Load Increase Alarm	Off	
Undercurrent Alarm Level	Off	
Undercurrent Alarm Delay	10 sec.	
Undercurrent Trip Level	Off	
Undercurrent Trip Delay	10 sec.	
Stalled Rotor Trip Level	4.50 x FLC	
Stalled Rotor Trip Delay	3.0 sec.	
UNDER/OVERVOLTAGE PROTECTION		
Undervoltage Alarm Level	Off	
Undervoltage Alarm Delay	10 sec.	
Undervoltage Trip Level	Off	
Undervoltage Trip Delay	10 sec.	
Overvoltage Alarm Level	Off	

Table A–1: MM2 COMMISSIONING (Sheet 4 of 8)

DESCRIPTION	DEFAULT	VALUE
Overvoltage Alarm Delay	10 sec.	
Overvoltage Trip Level	Off	
Overvoltage Trip Delay	10 sec.	
S3: PROCESS		
PROGRAMMABLE INPUTS		
Interlock Input 1	Not Used	
Startup Override Delay 1	0 sec.	
Running Override Delay 1	0 sec.	
Operation 1	Stop	
Instantaneous Alarm 1	Disable	
IL1 Switch Type	N.O.	
Interlock Input 2	Not Used	
Startup Override Delay 2	0 sec.	
Running Override Delay 2	0 sec.	
Operation 2	Stop	
Instantaneous Alarm 2	Disable	
IL2 Switch Type	N.O.	
Interlock Input 3	Not Used	
Startup Override Delay 3	0 sec.	
Running Override Delay 3	0 sec.	
Operation 3	Stop	
Instantaneous Alarm 3	Disable	
IL3 Switch Type	N.O.	
Interlock Input 4	Not Used	
Startup Override Delay 4	0 sec.	
Running Override Delay 4	0 sec.	
Operation 4	Stop	
Instantaneous Alarm 4	Disable	
IL4 Switch Type	N.O.	
Interlock Input 5	Not Used	
Startup Override Delay 5	0 sec.	
Running Override Delay 5	0 sec.	
Operation 5	Stop	

Table A–1: MM2 COMMISSIONING (Sheet 5 of 8)

DESCRIPTION	DEFAULT	VALUE
Instantaneous Alarm 5	Disable	
IL5 Switch Type	N.O.	
Interlock Input 6	Not Used	
Startup Override Delay 6	0 sec.	
Running Override Delay 6	0 sec.	
Operation 6	Stop	
Instantaneous Alarm 6	Disable	
IL6 Switch Type	N.O.	
Interlock Input 7	Not Used	
Startup Override Delay 7	0 sec.	
Running Override Delay 7	0 sec.	
Operation 7	Stop	
Instantaneous Alarm 7	Disable	
IL7 Switch Type	N.O.	
Interlock Input 8	Not Used	
Startup Override Delay 8	0 sec.	
Running Override Delay 8	0 sec.	
Operation 8	Stop	
Instantaneous Alarm 8	Disable	
IL8 Switch Type	N.O.	
Interlock Input 9	Not Used	
Startup Override Delay 9	0 sec.	
Running Override Delay 9	0 sec.	
Operation 9	Stop	
Instantaneous Alarm 9	Disable	
IL9 Switch Type	N.O.	
Interlock Input 10	Not Used	
Startup Override Delay 10	0 sec.	
Running Override Delay 10	0 sec.	
Operation 10	Stop	
Instantaneous Alarm 10	Disable	
IL10 Switch Type	N.O.	
Local Isolator	Disable	

Table A–1: MM2 COMMISSIONING (Sheet 6 of 8)

DESCRIPTION	DEFAULT	VALUE
Auto Permissive Indication	Manual	
Auto Mode	Serial	
Serial Permissive	Disable	
Start Block Alarm	Disable	
Disable Cmd Mode Change	Disable	
INTERLOCK NAMES		
Process Interlock A Name	Interlock A	
Process Interlock B Name	Interlock B	
Process Interlock C Name	Interlock C	
Process Interlock D Name	Interlock D	
Process Interlock E Name	Interlock E	
Process Interlock F Name	Interlock F	
Process Interlock G Name	Interlock G	
Process Interlock H Name	Interlock H	
Process Interlock I Name	Interlock I	
Process Interlock J Name	Interlock J	
Intlk Counter Name	Intlk Counter	
Intlk Counter Units	Units	
STOP CONFIGURATION		
Field Stop	Unlatched	
Faceplate Stop	Unlatched	
Process Stop	Unlatched	
ANALOG INPUT		
Analog Input Name	Analog Input	
Analog Input Units	Units	
Minimum Scale: 4 mA	0	
Maximum Scale: 20 mA	1000	
Analog Alarm Low Level	Off	
Analog Alarm Low Delay	5 sec.	
Analog Alarm High Level	Off	
Analog Alarm HIgh Delay	5 sec.	
Analog Trip Low Level	Off	
Analog Trip Low Override	5 sec.	

Table A–1: MM2 COMMISSIONING (Sheet 7 of 8)

DESCRIPTION	DEFAULT	VALUE
Analog Trip Low Delay	5 sec.	
Analog Trip High Level	Off	
Analog Trip High Override	5 sec.	
Analog Trip High Delay	5 sec.	
S4: CONTROL		
UNDERVOLTAGE AUTO RESTART		
Undervoltage Restart	Enable	
Immed. Restart Pwr Loss Time	200 ms	
Delay Restart Pwr Loss Time	2.0 sec.	
Restart Time Delay	2.0 sec.	
AUX 1 RELAY CONFIG		
Aux. Relay 1 Function	Serial Control	
Aux. Relay 1 Delay	5 sec.	
Aux. Relay 1 Pre Start Delay	5 sec.	
Aux. Relay 1 Post Start Delay	Off	
Energize On Motor Start Delay	5 sec.	
De-energize on Motor Stop Dly	5 sec.	
Aux. 1 Operation	Non-failsafe	
Delay Contactor G/F Trip By	0 ms	
AUX 2 RELAY CONFIG		
Aux. Relay 2 Function	Serial Control	
Aux. Relay 2 Delay	5 sec.	
Aux. Relay 2 Pre Start Delay	5 sec.	
Aux. Relay 2 Post Start Delay	Off	
Energize On Motor Start Delay	5 sec.	
De-energize on Motor Stop Dly	5 sec.	
Aux. 2 Operation	Non-failsafe	
Delay Contactor G/F Trip By	0 ms	
S5: MONITORING		
PLANT CONDITION		
Motor Greasing Interval	Off	
Contactor Inspection	Off	
Max Motor Stopped Time	Off	

Table A–1: MM2 COMMISSIONING (Sheet 8 of 8)

DESCRIPTION	DEFAULT	VALUE
PRESET COUNTERS AND TIMERS		
Preset Running Hours	0	
Preset Stopped Hours	0	
Preset Number Of Starts	0	
Preset Overload Trips	0	
Preset Thermistor Trips	0	
Preset Ground Fault Trips	0	
Preset Single Phase Trips	0	
Preset Acceleration Trips	0	
Preset Undercurrent Trips	0	
Preset Underpower Trips	0	
Preset Stalled Rotor Trips	0	
Preset Control Trips	0	
Preset Interlock Counter	0	
S6: FACTORY DATA		
PRODUCT FIRMWARE IDENTIFICATION		
Mod Number(s)	000	
Motor Manager 3 Version	---	
Boot Program Version	---	
Display Program Version	---	
Supervisor Program Version	---	
MM2 Hardware Revision	---	
PRODUCT MODEL IDENTIFICATION		
Order Code	---	
Serial Number	---	

For proper and reliable operation of the GE Multilin MM2 Motor Manager 2, it is imperative that the steps, recommendations and practices listed below be adhered to at all times. This DO's and DON'Ts checklist has been compiled as a result of years of trouble free operation by a variety of GE Multilin products.

a) MM2 GROUNDING

Users are requested to ground terminals 13 (safety ground) and 14 (Filter ground) directly to the GROUND BUS using a heavy gauge wire or braided cable. Terminals 13 and 14 will accept up to #12 AWG wire. These terminals must be grounded for proper filtering of noise, and protection against transient conditions.

b) GROUNDING OF PHASE AND GROUND CTS

All external phase CT and ground CT secondary windings must be grounded to the GROUND BUS to keep the potential difference to a minimum. If the CT secondary windings are not grounded, capacitive coupling could allow the CT secondary voltage to float up to the voltage of the mains. This is a serious safety hazard. Note: Terminal 12 of the External Ground CT is internally grounded therefore do not ground terminal 11 since the Ground CT signal would then be shunted.

It is also recommended that, in addition to the solid grounding of the ground CT described above, a shielded twisted pair cable be employed when using the GE Multilin 50:0.025 ground CT. The reasoning behind this recommendation is that the 50:0.025 ground CTs are typically used on high resistance grounded systems where the fault currents are limited to less than 200 A. The alarm and trip levels on these systems are usually between 0.5 A and 15.0 A. This equates to a secondary current of 0.25 mA to 7.5 mA. Due to the very low levels that must be monitored by the MM2, any noise picked up by these secondary wires must be kept to a minimum.

c) RS485 COMMUNICATIONS PORT

The MM2 interfaces with PCs, PLCs, and DCSs using the Modicon Modbus RTU protocol. The MM2 supports Modbus function codes 01, 03, 04, 05, 06, 07, 08, and 16. The communications port is a very important part of the MM2's process and control applications. The port allows reading and writing of data as well as full control to start and stop the motor from a remote location. For these reasons, proper wiring practices are critical.

- A shielded, twisted pair cable, such as 24 gauge Belden 9841 (120 Ω characteristic impedance) or equivalent, **MUST** be used for the communications link. The cable should be routed away from all power carrying cables, such as the motor mains, power supply wiring, CT wiring and noisy contactors or breakers.
- When using the GE Multilin 232/485 converter box at the MASTER, **GE Multilin recommends placing no more than 32 GE Multilin devices** on the same data link which should be of **no greater length than 4000 ft**. The devices on the data link should be daisy chained for reliable operation. Star or stub connections are **not recommended**. If more than 32 devices are required to go onto the data link, or the distance must be greater than 4000 feet, consult the EIA 485 standard for more details on specific calculations. Another way to increase the number of units on the data link or the transmission length is to utilize a RS485 Repeater.
- The **shields** of the cable should be daisy chained to all of the MM2 serial commons (Terminal 38) and grounded **at the MASTER only.** This provides a common reference for all of the devices on

the data link, as well as, grounding the data link without creating the potential for ground loops. The potential difference between the MM2 safety ground (terminal 14) and the MM2 serial common (Terminal 38) **should not** exceed 36 V.

- A terminating network consisting of a 120 Ω / 0.25 W resistor in series with a 1 nF / 50 V general purpose mono ceramic or equivalent capacitor **MUST** be placed across the positive and negative terminals at both ends of the data link (terminals 39 and 40 on the MM2). This is to provide the 200 mV separation between the +ve and –ve terminals of the device, as well as to eliminate any reflected signals and ringing.

d) SWITCH INPUTS

The MM2 has 16 switch inputs that operate on 120 V AC when the control voltage switch is set to 120 V AC and 240 V AC when the control voltage switch is set 240 V AC.

Terminals 57 and 58 are live at 120 V AC!

An external source can be used to supply the circuitry into the MM2 switch inputs providing that the external source is *in phase* with the control voltage of the MM2. The MM2 switches the inputs on and off internally, to minimize power consumption, at a frequency determined by the control voltage. If the external source is not in phase with the control voltage to the MM2, the timing will be off which could cause errors when reading the switch inputs. If an external source is used to supply the control signals to the MM2 switch inputs, the source should be fused to protect against fault conditions in the circuitry.

e) THERMISTOR AND ANALOG INPUTS

Due to the small voltage levels coming into the MM2 from the thermistor and external analog device, shielded cable is recommended to minimize any noise that may be picked up. These wires should be routed away from any power carrying cables.

f) STOP SWITCH INPUT

The STOP switch input on the MM2 **MUST** be energized before the MM2 is available to perform a start. If the contactor is being energized and de-energized externally to the MM2, this terminal will need a jumper from terminal 57 or 58 before the MM2 will seal in Contactor A.

g) CONTACTOR STATUS FEEDBACK

The MM2 **MUST** see feedback from Contactor A and Contactor B auxiliary contacts into the applicable status switch inputs (Terminals 55 and 56) within 1 second of closing the contactor. If this feedback is not received, the MM2 will open the contactor instead of sealing it in, and will alarm with an OPEN CONTROL CIRCUIT.

C.1.1 OVERVIEW

It is commonly known that current lags voltage by 90° when a voltage is applied to a purely inductive load. As can be seen below, if the AC voltage is applied at a peak, the current will rise from 0 A to its peak, 90° later in time. It may also be seen that during the time voltage completes a positive or negative half-cycle, current has made the transition from one peak to another.

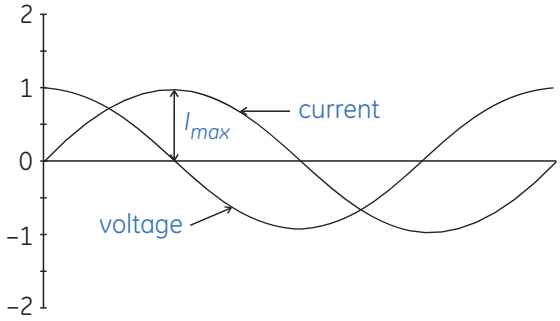


Figure C–1: CURRENT-VOLTAGE PHASE DIFFERENCE

Thus, as shown in the second figure below, if voltage is applied at a zero crossing, current will make the transition from minimum peak to maximum peak. Current of course, cannot instantaneously be at its minimum value, it must begin at zero.

Thus it rises from zero to a value that is equal to 2 times the peak value ($2 \times I_{max}$).

Depending on when the voltage is applied, the RMS current may vary by as much as 1.73 times.

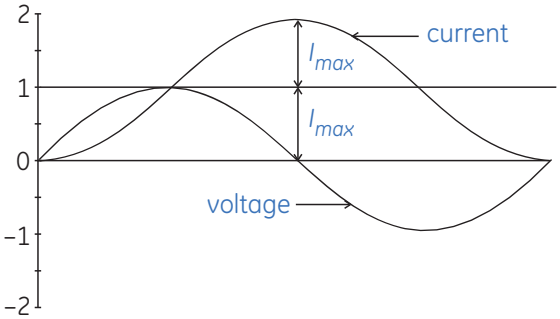


Figure C–2: MAXIMUM CURRENT WHEN VOLTAGE APPLIED AT ZERO CROSSING

The asymmetrical RMS current is defined by:

$$I_{RMSassym} = \sqrt{DC^2 + AC^2}$$
$$= \sqrt{\sqrt{2} \cdot I_{RMS}{}^2 + I_{RMS}^2}$$

Squaring both sides gives:

$$I_{RMSassym}^2 = (\sqrt{2} \cdot I_{RMS})^2 + I_{RMS}^2$$
$$= (3 \cdot I_{RMS}^2)$$

Which results in:

$$I_{RMSassym} = \sqrt{3} \cdot I_{RMS}$$

Where I_{RMS} is the current when voltage is applied at a maximum – or the symmetrical current.

A motor or a transformer is never a perfect inductor, therefore, the value of 1.73 will never be reached. The DC offset will die away as a function of the X/R ratio (typically a few cycles). The following figure represents an exaggeration of the three phase current of a motor starting.

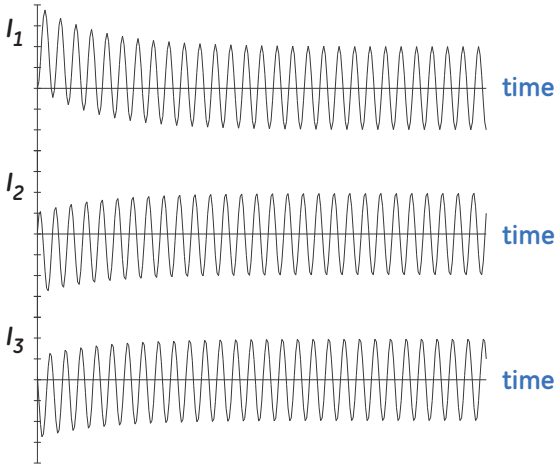


Figure C–3: MOTOR START THREE PHASE CURRENT

When is this 'asymmetrical current' a concern?

When setting instantaneous relays, care must be taken to ensure that the instantaneous element does not operate during normal operating conditions such as a motor start. Symptoms of an instantaneous element that is set too sensitive are nuisance or intermittent tripping of the relay during energizing of the system.

Furthermore, CTs do not react predictably when a DC current is applied. The waveform that is shown above is not necessarily the waveform that each of three phase CTs would output. If there is a residual connection for ground fault detection, that element could operate when asymmetrical currents are present.

D.1.1 QUESTIONS AND ANSWERS

Listed below are some of the more frequently asked questions by MM2 users. The list includes questions asked by consultants before the MM2 has even been specified to the end user and after the MM2 is installed and controlling a motor.

Q **Does the MM2 support ladder logic as in a PLC?**

A No. The MM2 switch inputs do not allow total programmability as in PLCs; however, it does have a range of over 30 different dedicated functions that can be assigned for typical applications. These functions come complete with built in timers if necessary for that particular function. For example: Auto Permissive and Auto Start for PLC hard wired control, Two Wire Control for PLC starts or jogging, Process Interlocks with starting and running override timers for pressure and flow monitoring. All the programmable switch inputs may be configured as normally open or normally closed.

Q **Does the MM2 have any hot winding protection?**

A Yes. The MM2 has a single thermistor input to protect the motor against hot windings. These thermistors are typically wound into stator windings of the motor when manufactured and can be Positive Temperature Coefficient (PTC) of Negative Temperature Coefficient (NTC).

Q **After wiring the MM2 into the control circuit, it remains UNAVAILABLE for starts. What does this mean?**

A Three conditions can cause the MM2 to remain UNAVAILABLE for starts”

The MM2 has tripped on a trip condition

The STOP switch input (Terminal 51) is not energized.

If a Process Interlock function is assigned to one of the programmable switch inputs and the startup override is set to 0 seconds, the MM2 will remain UNAVAILABLE until that switch input is energized.

Q **When a start is attempted, the motor starts for a second then shuts off. The MM2 displays an OPEN CONTROL CIRCUIT alarm. What is the problem?**

A The MM2 must see feedback from the Contactor A and, if used, Contactor B within 1 second of the MM2 closing the contactor or the MM2 will stop the motor as it assumes that there is a problem in the circuitry for the motor contactor coil. The feedback from the contactors go to the status inputs (terminals 15 & 16) of the MM2. NOTE: This condition will result in the toggling of the motor contactor when the MM2 is in the Two Wire mode as there can be a constant start signal from the two wire device. Use the Open Control Circuit trip feature to prevent the toggling of the motor contactor.

Q **After connecting the MM2 through an interface device to a PLC network, communications to the MM2 cannot be established. What is the problem?**

A Verify the following:

1. if master communicating with Modbus® RTU protocol
2. wiring between interface device and MM2
3. MM2 communications address
4. master polling address
5. MM2 baud rate
6. master baud rate
7. MM2 parity setpoint
8. master parity settings

If the problem persists, call GE Multilin for technical support.

Q **Can the MM2 interface with an external analog device?**

A Yes. The MM2 has a single analog input that can be used to monitor an external transducer. Alarm and trip setpoints can be configured to warn the user or shut down the motor.

Q **Can the MM2 be used on medium voltage motors?**

A No. The MM2 was designed specifically for the low voltage market (600 V or less). The protection features offered in the MM2 are typically not advanced enough for larger, more expensive motors. The power measuring will only accommodate 600 V systems.

Q **Can the control transformer in the MCC be used for the VT input on the MM2 as well as for control voltage?**

A Yes, provided that control transformer secondary voltage is 110 V or 120 V, which corresponds to the **VT SECONDARY VOLTAGE** setpoint.

Q **Can the START keys on the faceplate of the MM2 be disabled?**

A Yes. One of the programmable switch inputs can be configured to REMOTE PERMISSIVE and a jumper placed from Switch Common to permanently energize that switch input. This will allow starts from the switch inputs of the MM2 only, when in the MANUAL mode.

E.1.1 MM2 CT WITHSTAND

When is withstand important?

Withstand is important when the phase or ground CT has the capability of driving a large amount of current into the interposing CTs in the relay. This typically occurs on retrofit installations when the CTs are not sized to the burden of the relay. New electronic relays have typically low burdens, while the older electromechanical relays have typically high burdens (e.g. 1 Ω).

For high current ground faults, the system will be either low resistance or solidly grounded. The limiting factor that determines the amount of ground fault current that can flow in these types of systems is the capacity of the source. Withstand is not important for ground fault on high resistance grounded systems. On these systems, a resistor makes the connection from source to ground at the source (generator, transformer). The resistor value is chosen such that in the event of a ground fault, the current that flows is limited to a low value, typically 5, 10, or 20 A.

Since the potential for very large faults exists (ground faults on high resistance grounded systems excluded), the fault must be cleared as quickly as possible.

Care must he taken to ensure that the interrupting device is capable of interrupting the potential fault. If not, some other method of interrupting the fault should be used, and the feature in question should be disabled (e.g. a fused contactor relies on fuses to interrupt large faults).

E.1.2 CT SIZE AND SATURATION

How do I know how much current my CTs can output?

CT characteristics may be acquired by one of two methods.

The rating (as per ANSI/IEEE C57.13.1) for relaying class CTs may be given in a format such as these: 2.5C100, 10T200, T1OO, 10C50, or C200. The number preceding the letter represents the maximum ratio correction; no number in this position implies that the CT accuracy remains within a 10% ratio correction from 0 to 20 times rating. The letter is an indication of the CT type. A 'C' (formerly L) represents a CT with a low leakage flux in the core where there is no appreciable effect on the ratio when used within the limits dictated by the class and rating. The 'C' stands for calculated; the actual ratio correction should be different from the calculated ratio correction by no more than 1%. A 'C' type CT is typically a bushing, window, or bar type CT with uniformly distributed windings. A 'T' (formerly H) represents a CT with a high leakage flux in the core where there is significant effect on CT performance. The 'T' stands for test; since the ratio correction is unpredictable, it is to be determined by test. A 'T' type CT is typically primary wound with unevenly distributed windings. The subsequent number specifies the **secondary terminal voltage** that may be delivered by the full winding at 20 times rated secondary current without exceeding the ratio correction specified by the first number of the rating. (Example: a 10C100 can develop 100 V at 20 × 5A, therefore an appropriate external burden would be 1 Ω or less to allow 20 times rated secondary current with less than 10% ratio correction). Note that the voltage rating is at the secondary terminals of the CT and the internal voltage drop across the secondary resistance must be accounted for in the design of the CT. There are seven voltage ratings: 10, 20, 50, 100, 200, 400, and 800. If a CT comes close to a higher rating, but does not meet or exceed it, then the CT must be rated to the lower value.

The curve below represents a typical excitation curve for a CT. The Y-axis represents secondary exciting voltage; the X-axis represents the secondary exciting current. When the CT secondary exciting voltage level is picked off the graph, the corresponding secondary exciting current is the amount of current required to excite the core of the CT. With respect to the ideal CT that conforms perfectly to its ratio, the exciting current could be considered loss.

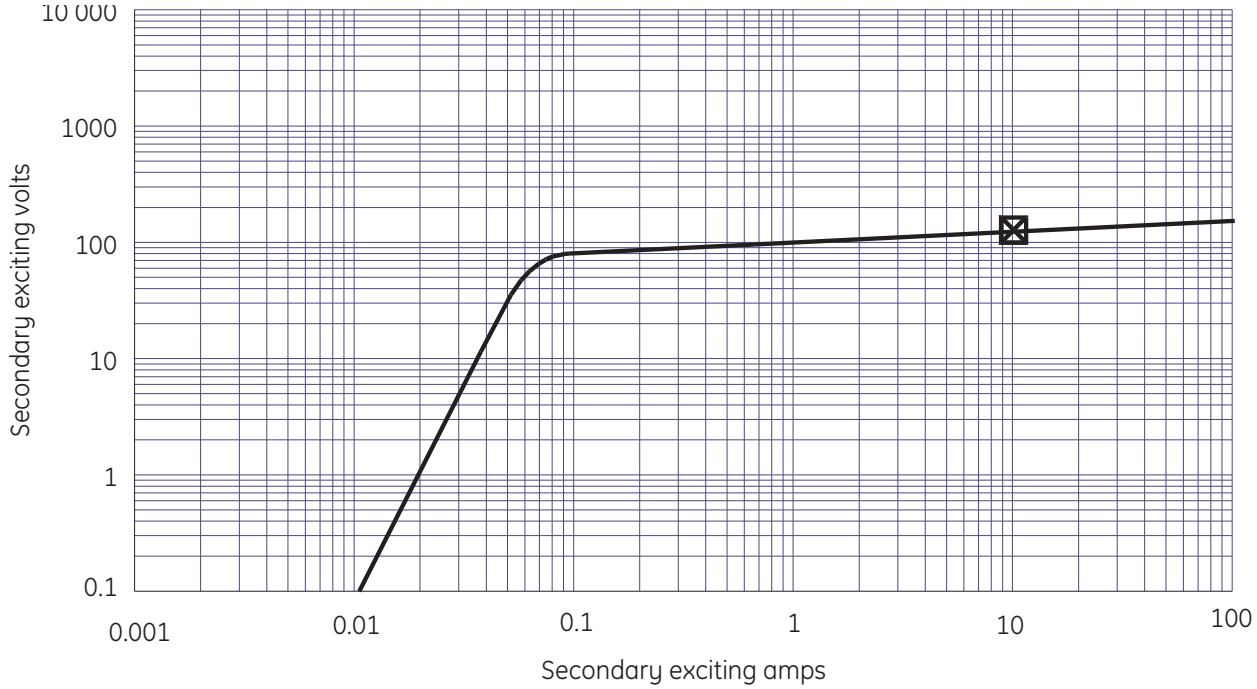


Figure E–1: EXCITATION CURVES

For a Protection Class CT with a 5A secondary and maximum 10% ratio error correction, it is probable that the design point for 20 times rated secondary will be at or slightly lower than the 10 A secondary exciting current point (10% of 20 × 5 A). To design such that the 20 times rated secondary current is in the linear region would be more expensive.

In order to determine how much current CTs can output, the secondary resistance of the CTs is required. This resistance will be part of the equation as far as limiting the current flow. This is determined by the maximum voltage that may be developed by the CT secondary divided by the entire secondary resistance, CT secondary resistance included.

The easiest method of evaluating a CT is by the Excitation Curves Method, as illustrated by the curves shown below. The Y-axis represents secondary exciting voltage; the X-axis represents the secondary exciting current. These curves may be obtained from the CT manufacturer, or by experimentation (see ANSI/IEEE C57.13.1 for procedures). The curves illustrate the values of secondary volts for which the output of the CT will be linear. The desired operating secondary voltage is below the kneepoint (A or B on the graph (ANSI or IEC respectively) or just slightly above it, staying within 10% CT ratio error correction at 20 times rating. Using this information, it is important to recognize that the secondary exciting voltage is the total voltage that the CT can develop at the secondary. In this case, that voltage will drop across the secondary winding resistance as well as any load that is applied to the unit. Therefore, the secondary winding resistance must always be included with the excitation curves, or the information is incomplete.

A curve with a knee at 100 V for example could drive a total burden of:

$$\frac{100\ \text{V}}{20 \times 5\ \text{A}} = 1\ \Omega$$

Evaluation of CT performance is best determined from the excitation curves. They present the complete story and eliminate any guess work. Most CT manufacturers will provide excitation curves upon request.

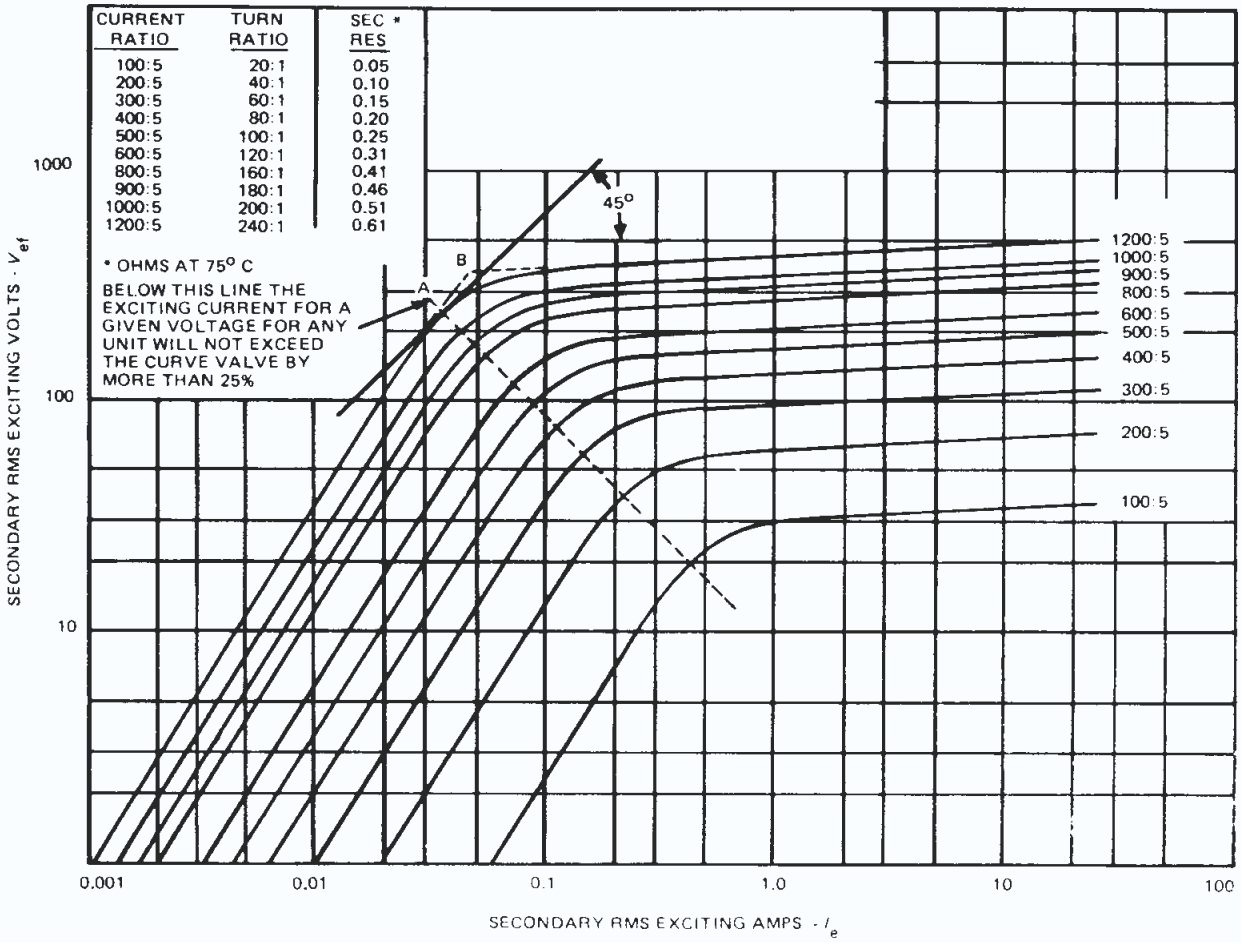


Figure E–2: EXCITATION CURVES METHOD

F.1.1 LIST OF FIGURES

FIGURE 2–1: MM2 MOUNTING INSTRUCTIONS 2-1
FIGURE 2–2: MM2 DIMENSIONS 2-2
FIGURE 2–3: MM2 WITH DEPTH REDUCTION COLLAR DIMENSIONS 2-2
FIGURE 2–4: TYPICAL WIRING DIAGRAM 2-3
FIGURE 2–5: MM2 FUNCTIONAL BLOCK DIAGRAM 2-4
FIGURE 2–6: RS485 TERMINATION 2-7
FIGURE 3–1: FRONT PANEL 3-1
FIGURE 3–2: BLOCK DIAGRAM 3-7
FIGURE 4–1: SETPOINTS MESSAGES 4-2
FIGURE 4–2: GE MULTILIN TIME/OVERCURRENT CURVES 4-10
FIGURE 4–3: NEMA COMPATIBLE TIME/OVERCURRENT CURVES 4-12
FIGURE 6–1: MESSAGE SUMMARY 6-2
FIGURE 7–1: SECONDARY INJECTION TEST SETUP 7-2
FIGURE 8–1: FULL-VOLTAGE NON-REVERSING ELEMENTARY STARTER 8-1
FIGURE 8–2: FV NON-REVERSING STARTER WIRING DIAGRAM 8-2
FIGURE 8–3: FULL VOLTAGE REVERSING STARTER 8-3
FIGURE 8–4: FV REVERSING STARTER 8-5
FIGURE 8–5: ELEMENTARY TWO SPEED MAGNETIC STARTER 8-6
FIGURE 8–6: TWO SPEED ONE WINDING CONSTANT OR VARIABLE TORQUE STARTER 8-8
FIGURE 8–7: TWO SPEED ONE WINDING CONSTANT HORSEPOWER STARTER 8-9
FIGURE 8–8: TWO SPEED TWO WINDING STARTER 8-10
FIGURE 8–9: ELEMENTARY SLIP RING MAGNETIC STARTER 8-11
FIGURE 8–10: SLIP RING STARTER 8-13
FIGURE 8–11: ELEMENTARY PRIMARY RESISTANCE MAGNETIC STARTER 8-14
FIGURE 8–12: PRIMARY RESISTANCE STARTER 8-16
FIGURE 8–13: ELEMENTARY INVERTER STARTER 8-17
FIGURE 8–14: INVERTER (VARIABLE SPEED DRIVE) STARTER 8-19
FIGURE 8–15: ELEMENTARY AUTOTRANSFORMER OPEN TRANSITION STARTER 8-20
FIGURE 8–16: AUTOTRANSFORMER OPEN TRANSITION TWO WINDING 8-22
FIGURE 8–17: AUTOTRANSFORMER OPEN TRANSITION THREE WINDING 8-23
FIGURE 8–18: ELEMENTARY AUTOTRANSFORMER CLOSED TRANSITION STARTER ... 8-24
FIGURE 8–19: AUTOTRANSFORMER CLOSED TRANSITION TWO WINDING 8-26
FIGURE 8–20: AUTOTRANSFORMER CLOSED TRANSITION THREE WINDING 8-27
FIGURE 8–21: WYE-DELTA OPEN TRANSITION STARTER 8-31
FIGURE 8–22: ELEMENTARY WYE-DELTA CLOSED TRANSITION MAGENTIC STARTER 8-32
FIGURE 8–23: WYE-DELTA CLOSED TRANSITION STARTER 8-34
FIGURE 8–24: DUTY/STANDBY STARTER 8-37
FIGURE 8–25: SOFT STARTER 8-39
FIGURE 9–1: GE MULTILIN WELCOME SCREEN 9-3
FIGURE 9–2: COMMUNICATION / COMPUTER WINDOW 9-4
FIGURE 9–3: MM2PC MENU STRUCTURE 9-6
FIGURE 9–4: TRENDING VIEW 9-12
FIGURE 10–1: TWO WIRE CONTROL 10-2
FIGURE 10–2: HOA TWO-WIRE HAND / TWO-WIRE AUTO 10-4
FIGURE 10–3: HOA THREE WIRE HAND / TWO WIRE AUTO 10-6
FIGURE 10–4: HOA THREE WIRE HAND / THREE WIRE AUTO 10-8
FIGURE 10–5: HA THREE WIRE HAND / TWO WIRE AUTO 10-10
FIGURE C–1: CURRENT-VOLTAGE PHASE DIFFERENCE C-1

F

FIGURE C–2: MAXIMUM CURRENT WHEN VOLTAGE APPLIED AT ZERO CROSSING C-1
FIGURE C–3: MOTOR START THREE PHASE CURRENT C-2
FIGURE E–1: EXCITATION CURVES.....E-2
FIGURE E–2: EXCITATION CURVES METHOD E-3

F.1.2 LIST OF TABLES

TABLE: 1–1 SELECTION GUIDE 1-2
TABLE: 4–1 STANDARD OVERLOAD CURVE TRIP TIMES (IN SECONDS)..... 4-9
TABLE: 4–2 NEMA COMPATIBLE OVERLOAD CURVE TRIP TIMES (IN SECONDS)..... 4-11
TABLE: 5–1 MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 01H..... 5-5
TABLE: 5–2 MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 03H..... 5-6
TABLE: 5–3 MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 04H..... 5-7
TABLE: 5–4 MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 05H..... 5-8
TABLE: 5–5 MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 06H..... 5-9
TABLE: 5–6 MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 07H..... 5-10
TABLE: 5–7 MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 08H..... 5-11
TABLE: 5–8 MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 10H..... 5-12
TABLE: 5–9 MASTER/SLAVE PACKET FORMAT FOR PERFORMING COMMANDS..... 5-14
TABLE: 5–10 MASTER/SLAVE PACKET FORMAT (BROADCAST) 5-15
TABLE: 5–11 MM2 MEMORY MAP USER DEFINABLE OUTPUTS 5-17
TABLE: 5–12 MODBUS MEMORY MAP 5-20
TABLE: 5–13 DATA FORMATS 5-41
TABLE: A–1 MM2 COMMISSIONING.....A-1

F

EU DECLARATION OF CONFORMITY

Applicable Council Directives:

73/23/EEC	The Low Voltage Directive
89/336/EEC	The EMC Directive

Standard(s) to Which Conformity is Declared:

IEC 947-1	Low Voltage Switchgear and Controlgear
IEC1010-1:1990+ A 1:1992+ A 2:1995	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use
CISPR 11 / EN 55011:1997	Class A – Industrial, Scientific, and Medical Equipment
EN 50082-2:1997	Electromagnetic Compatibility Requirements, Part 2: Industrial Environment
IEC100-4-3 / EN 61000-4-3	Immunity to Radiated RF
EN 61000-4-6	Immunity to Conducted RF

Manufacturer's Name: General Electric Multilin Inc.

Manufacturer's Address: 215 Anderson Ave.
Markham, Ontario, Canada
L6E 1B3

Manufacturer's Representative in the EU: Christina Bataller Mauleon
GE Multilin
Avenida Pinoa 10
48710 Zamudio, Spain
Tel.: 34-94-4858835 Fax: 34-94-4858838

Type of Equipment: Protection & Control Relay

Model Number: MM2

First Year of Manufacture: 1999

I the undersigned, hereby declare that the equipment specified above conforms to the above Directives and Standards

Full Name: John Saunders

Position: Manufacturing Manager

Signature:

Place: GE Multilin Inc.

Date: 09/28/1999

GE MULTILIN RELAY WARRANTY

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

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

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

GE Multilin is not liable for special, indirect or consequential damages or for loss of profit or for expenses sustained as a result of a relay malfunction, incorrect application or adjustment.

For complete text of Warranty (including limitations and disclaimers), refer to GE Multilin Standard Conditions of Sale.

Numerics

2-SPEED STARTER 8-6, 8-8, 8-9, 8-10
2-WIRE CONTROL 4-24

A

ACCELERATION TIME
  actual values 6-4
  alarm 4-19
  trip 4-19
ALARM RESET 4-18
ANALOG ALARM
  high delay 4-27
  high level 4-27
  low delay 4-27
  low level 4-27
ANALOG INPUT 2-6
ANALOG INPUTS B-2
  maximum scale 4-27
  minimum scale 4-27
ANALOG TRIP
  high delay 4-28
  high level 4-28
  high override 4-28
  low delay 4-28
  low level 4-27
  low override 4-28
APPLICATIONS 5-14
ASYMMETRICAL CURRENT C-1
AUTOTRANSFORMER 8-20, 8-22, 8-23, 8-24, 8-26, 8-27
AUX 2 COIL 2-6

B

BAUD RATE 9-13
BOOT PROGRAM VERSION 4-35
BROADCAST COMMAND 5-15

C

CAUSE OF TRIP 6-5
CHANGE COMMAND MODE ON ALARM 4-7
CHANGE OVER CURRENT 4-4
CHANGE OVER TIME 4-4
CHASSIS MOUNT UNITS 9-13
CLEAR ENERGY USED 4-8
CLEAR INTERLOCK COUNTER 4-8
CLEAR START/TRIP COUNTERS 4-8
CLEAR TIMERS 4-8
COMMISIONING A-1
COMMUNICATIONS
  error checking 5-2
  failure setpoints 4-7
  MM2PC 9-13
  Modbus 5-1
  RS485 ..... B-1
COMMUNICATIONS ADDRESS 4-3
CONTACTOR INSPECTION 4-33
CONTACTOR SEQUENCE 4-5
CONTACTOR STATUS 2-8
CONTACTOR STATUS FEEDBACK B-2
CONTROL SCHEMES
  three wire hand / three wire auto 10-8
  three wire hand / two wire auto 10-6
  two wire 10-10
  two wire hand / two wire auto 10-3, 10-4
CRC-16 ALGORITHM 5-3
CT INPUTS 2-5
CT ISOLATION E-1
CT SATURATION E-1
CT SIZE E-1
CTs
  excitation curves E-2
  isolation E-1
  saturation E-1
  size E-1
CURRENT-VOLTAGE PHASE DIFFERENCE C-1

D

DATA FORMATS
  frame format 5-1
  modbus 5-41
  packet format 5-2
DATA PACKET SYNCHRONIZATION 5-4
DATA RATE 5-1
DATA SHEETS A-1
DIELECTRIC STRENGTH TESTING 2-8
DO'S AND DONT'S B-1
DUTY/STANDBY STARTER 8-35, 8-37

E

ELECTRICAL INTERFACE 5-1
ENERGY USED 4-8, 6-4
ERROR CHECKING 5-2
ERROR RESPONSES 5-13
EU DECLARATION OF CONFORMITY G-1
EXTERNAL CONNECTIONS 2-5

F

FACEPLATE STOP 4-26
FIELD STOP 4-26
FREQUENCY 4-6
FULL LOAD CURRENT 4-13
FULL VOLT REVERSING STARTER 8-3, 8-5
FULL-VOLT NON-REVERSING STARTER 8-1, 8-2
FUNCTIONAL TESTS 7-3

G

GE OVERLOAD CURVES 4-10
GROUND CURRENT 6-3
GROUND FAULT ALARM 4-14
GROUND FAULT CT 2-5
GROUND FAULT CT INPUT 4-6
GROUND FAULT CURRENT FUNCTIONS 7-5
GROUND FAULT TRIP 4-15
GROUND SURGE 2-5
GROUNDING
  phase and ground CTs B-1

H

HARDWARE REVISION....4-35
HIGH SPEED START BLOCK 4-4
HI-POT TESTING 2-8
HOT/COLD CURVE RATIO 4-13

I

INPUT FUNCTIONS 7-5
INPUTS
  analog B-2
  stop switch B-2
  switch B-2
  thermistor B-2
INSTALLATION 2-1
INTERLOCK COUNTER
  clearing 4-8
INTERLOCK INPUTS 1-10 4-21
INTERNAL FAULT TRIP 4-7
INVERTER STARTER....8-17, 8-19

L

LAST STARTING CURRENT.... 6-4
LOAD INCREASE ALARM 4-19
LOCAL ISOLATOR....2-8, 4-21

M

MAXIMUM MOTOR STOPPED TIME....4-33
MEMORY MAP 5-19, 5-20
MINIMIZE RESET TIME....4-16
MM2PC
  communications 9-13
  configuring 9-4
  setpoints 9-9, 9-10
MOD NUMBER 4-35
MODBUS.... 1-1
  data formats 5-41
  function code 01 5-5
  function code 03 5-6
  function code 04 5-7
  function code 05 5-8
  function code 06 5-9
  function code 07 5-10
  function code 08 5-11
  function code 10 5-12
  memory map....5-19
  supported functions 5-4
MODEL NUMBERS 1-2
MOTOR GREASING INTERVAL 4-33
MOTOR LOAD 6-3
MOTOR NAME 4-3
MOTOR RATING 4-3
MOTOR START THREE PHASE CURRENT..... C-2
MOTOR STATUS 6-3

N

NOMINAL FREQUENCY....4-6

O

OPEN CONTROL CIRCUIT TRIP 4-18
OPTIONS 1-1
ORDER CODES 1-2
ORDER INFORMATION 4-35
OUTPUT RELAYS 2-6
OVERLOAD CURVE NUMBER 4-13
OVERLOAD CURVES
  setpoints 4-13
OVERLOAD PICKUP LEVEL....4-13
OVERLOAD TRIP RESET 4-17

P

PARITY 4-3, 9-13
PART WINDING STARTER 8-28
PHASE CT INPUTS 2-5
PHASE CT PRIMARY AMPS....4-6
PHASE CURRENT FUNCTIONS 7-3
PHASE CURRENTS....6-3
PHASE UNBALANCE....6-3
PHASE UNBALANCE ALARM 4-17
POWER FAIL TEST 7-6
PRIMARY INJECTION TESTING 7-1
PRIMARY RESISTANCE STARTER.... 8-14, 8-16
PROCESS STOP....4-26
PROGRAMMABLE SWITCH INPUTS 2-6

Q

QUESTIONS AND ANSWERS D-1

R

RAMP DOWN TIME 4-4
RAMP UP TIME 4-4
RESET ALARMS 4-18
RESET LOCKOUT 4-17
RS485
  communications port B-1
RUNNING TIME 6-11

S

SECONDARY INJECTION TESTING 7-1, 7-2
SELECTION GUIDE 1-2
SERIAL COMMS FAILURE 4-7
SERIAL COMMUNICATION PORT 2-7
SERIAL NUMBER 4-35
SERIAL PERMISSIVE 4-22
SETPOINTS
  commissioning A-1
  data sheets A-1
  entering with MM2PC 9-10
  loading with MM2PC 9-9
SLIP RING STARTER 8-11, 8-13
SOFT STARTER 8-38, 8-39
SPECIFICATIONS 1-4
STAGE ONE SHORTING TIME 4-4
STALLED ROTOR 4-19
START A/B KEY 2-8
START BLOCK 4-22
START COUNTER
  clearing 4-8
STARTER TYPE SETPOINT 4-4
STARTER TYPES
  autotransformer 8-20, 8-22, 8-23, 8-24, 8-26, 8-27
  duty/standby 8-35, 8-37
  full-voltage non-reversing 8-1, 8-2
  full-voltage reversing 8-3, 8-5
  inverter 8-17, 8-19
  part winding 8-28
  primary resistance 8-14, 8-16
  slip ring 8-11, 8-13
  soft 8-38, 8-39
  two speed 8-6, 8-8, 8-9, 8-10
  two-speed 8-6
  wye-delta 8-29, 8-31, 8-32, 8-34
STARTS PER HOUR 4-5
STARTUP OVERRIDE 4-21
STOP 2-7
STOP KEY 2-7
STOP SWITCH INPUT B-2
STOPPED MOTOR COOL TIME 4-17
STOPPED TIME 6-11
SUPPLY VOLTAGE 2-5, 4-3
SWITCH COMMON 2-8
SWITCH INPUTS 2-6, B-2
SYSTEM FREQUENCY 4-6
SYSTEM SUPPLY 4-3

T

TECHNICAL SPECIFICATIONS 1-4
TESTING
  functional 7-3
  primary injection 7-1
  secondary injection 7-2
THERMAL CAPACITY ALARM 4-18
THERMAL CAPACITY USED 6-3
THERMISTOR 2-6
  input tests 7-6
  troubleshooting B-2
THERMISTOR ALARM 4-7
THERMISTOR INPUT TESTS 7-6
THERMISTOR TRIP 4-7
THREE WIRE HAND/2 WIRE AUTO CONTROL 10-6
THREE WIRE HAND/AUTO CONTROL 10-8
TIME TO TRIP 6-4
TIMERS
  clearing 4-8
TOC CURVES 4-10
TRANSFER TIME 4-4
TRIP COUNTER
  actual values 6-11
  clearing 4-8
TRIP TIMES 4-9
TROUBLESHOOTING B-1
TWO SPEED STARTER 8-6, 8-8, 8-9, 8-10
TWO WIRE CONTROL
  control schemes 10-1
  description 10-2
  setpoints 4-24
TWO WIRE HAND/AUTO CONTROL 10-3, 10-4

U

UNBALANCE 6-3
UNBALANCE ALARM 4-17
UNDERCURRENT
  setpoints 4-19
UNDERPOWER 4-18

V

VT CONNECTION TYPE 4-6
VT PRIMARY VOLTAGE 4-6
VT SECONDARY VOLTAGE 4-6
VT VOLTAGE 6-4

W

WARRANTY G-2
WYE-DELTA STARTER 8-29, 8-31, 8-32, 8-34

INDEX

FIGURE 2–1: MM2 MOUNTING INSTRUCTIONS 2-1
FIGURE 2–2: MM2 DIMENSIONS 2-2
FIGURE 2–3: MM2 WITH DEPTH REDUCTION COLLAR DIMENSIONS 2-2
FIGURE 2–4: TYPICAL WIRING DIAGRAM 2-3
FIGURE 2–5: MM2 FUNCTIONAL BLOCK DIAGRAM 2-4
FIGURE 2–6: RS485 TERMINATION 2-7
FIGURE 3–1: FRONT PANEL 3-1
FIGURE 3–2: BLOCK DIAGRAM 3-7
FIGURE 4–1: SETPOINTS MESSAGES 4-2
FIGURE 4–2: GE MULTILIN TIME/OVERCURRENT CURVES 4-10
FIGURE 4–3: NEMA COMPATIBLE TIME/OVERCURRENT CURVES 4-12
FIGURE 6–1: MESSAGE SUMMARY 6-2
FIGURE 7–1: SECONDARY INJECTION TEST SETUP 7-2
FIGURE 8–1: FULL-VOLTAGE NON-REVERSING ELEMENTARY STARTER 8-1
FIGURE 8–2: FV NON-REVERSING STARTER WIRING DIAGRAM 8-2
FIGURE 8–3: FULL VOLTAGE REVERSING STARTER 8-3
FIGURE 8–4: FV REVERSING STARTER 8-5
FIGURE 8–5: ELEMENTARY TWO SPEED MAGNETIC STARTER 8-6
FIGURE 8–6: TWO SPEED ONE WINDING CONSTANT OR VARIABLE TORQUE STARTER 8-8
FIGURE 8–7: TWO SPEED ONE WINDING CONSTANT HORSEPOWER STARTER 8-9
FIGURE 8–8: TWO SPEED TWO WINDING STARTER 8-10
FIGURE 8–9: ELEMENTARY SLIP RING MAGNETIC STARTER 8-11
FIGURE 8–10: SLIP RING STARTER 8-13
FIGURE 8–11: ELEMENTARY PRIMARY RESISTANCE MAGNETIC STARTER 8-14
FIGURE 8–12: PRIMARY RESISTANCE STARTER 8-16
FIGURE 8–13: ELEMENTARY INVERTER STARTER 8-17
FIGURE 8–14: INVERTER (VARIABLE SPEED DRIVE) STARTER 8-19
FIGURE 8–15: ELEMENTARY AUTOTRANSFORMER OPEN TRANSITION STARTER 8-20
FIGURE 8–16: AUTOTRANSFORMER OPEN TRANSITION TWO WINDING 8-22
FIGURE 8–17: AUTOTRANSFORMER OPEN TRANSITION THREE WINDING 8-23
FIGURE 8–18: ELEMENTARY AUTOTRANSFORMER CLOSED TRANSITION STARTER ... 8-24
FIGURE 8–19: AUTOTRANSFORMER CLOSED TRANSITION TWO WINDING 8-26
FIGURE 8–20: AUTOTRANSFORMER CLOSED TRANSITION THREE WINDING 8-27
FIGURE 8–21: WYE-DELTA OPEN TRANSITION STARTER 8-31
FIGURE 8–22: ELEMENTARY WYE-DELTA CLOSED TRANSITION MAGENTIC STARTER 8-32
FIGURE 8–23: WYE-DELTA CLOSED TRANSITION STARTER 8-34
FIGURE 8–24: DUTY/STANDBY STARTER 8-37
FIGURE 8–25: SOFT STARTER 8-39
FIGURE 9–1: GE MULTILIN WELCOME SCREEN 9-3
FIGURE 9–2: COMMUNICATION / COMPUTER WINDOW 9-4
FIGURE 9–3: MM2PC MENU STRUCTURE 9-6
FIGURE 9–4: TRENDING VIEW 9-12
FIGURE 10–1: TWO WIRE CONTROL 10-2
FIGURE 10–2: HOA TWO-WIRE HAND / TWO-WIRE AUTO 10-4
FIGURE 10–3: HOA THREE WIRE HAND / TWO WIRE AUTO 10-6
FIGURE 10–4: HOA THREE WIRE HAND / THREE WIRE AUTO 10-8
FIGURE 10–5: HA THREE WIRE HAND / TWO WIRE AUTO 10-10
FIGURE C–1: CURRENT-VOLTAGE PHASE DIFFERENCE C-1
FIGURE C–2: MAXIMUM CURRENT WHEN VOLTAGE APPLIED AT ZERO CROSSING C-1
FIGURE C–3: MOTOR START THREE PHASE CURRENT C-2

FIGURE E–1: EXCITATION CURVES.....E-2
FIGURE E–2: EXCITATION CURVES METHOD.....E-3

TABLE: 1–1 SELECTION GUIDE 1-2
TABLE: 4–1 STANDARD OVERLOAD CURVE TRIP TIMES (IN SECONDS) 4-9
TABLE: 4–2 NEMA COMPATIBLE OVERLOAD CURVE TRIP TIMES (IN SECONDS) 4-11
TABLE: 5–1 MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 01H 5-5
TABLE: 5–2 MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 03H 5-6
TABLE: 5–3 MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 04H 5-7
TABLE: 5–4 MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 05H 5-8
TABLE: 5–5 MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 06H 5-9
TABLE: 5–6 MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 07H 5-10
TABLE: 5–7 MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 08H 5-11
TABLE: 5–8 MASTER/SLAVE PACKET FORMAT FOR FUNCTION CODE 10H 5-12
TABLE: 5–9 MASTER/SLAVE PACKET FORMAT FOR PERFORMING COMMANDS 5-14
TABLE: 5–10 MASTER/SLAVE PACKET FORMAT (BROADCAST) 5-15
TABLE: 5–11 MM2 MEMORY MAP USER DEFINABLE OUTPUTS 5-17
TABLE: 5–12 MODBUS MEMORY MAP 5-20
TABLE: 5–13 DATA FORMATS 5-41
TABLE: A–1 MM2 COMMISSIONING A-1