MULTILIN

301

MOTOR MANAGER RELAY

INSTRUCTION MANUAL

Software Rev: 301.D1.20
Manual P/N: 1601-0014-D4

The 301 is CSA approved.

LR41286

CANADA
Multilin
Division of Derlan Manufacturing Inc.
215 Anderson Avenue
Markham, Ontario, Canada
L3P 4C7

Tel: (905) 294-6222
Fax: (905) 294-8512

USA
Multilin
Division of Derlan Manufacturing Inc.
9746 Whithorn Dr.
Houston, Texas, USA
77095

Tel: (713) 855-1000
Fax: (713) 859-1091

INTENT

This manual describes the function, operation and use of the Multilin Model 301 Motor Manager Relay.

REVISION HISTORY

Manual Part No.	269 Software Revision	Release Date
1601-0014-D1	Revision 301.D1.0	11/27/92
1601-0014-D2	Revision 301.D1.1	03/31/93
1601-0014-D3	Revision 301.D1.20	08/11/93
1601-0014-D4	Revision 301.D1.20	09/28/93

TABLE OF CONTENTS

LIST OF FIGURES

OVERVIEW

The Motor Manager combines control functions normally found in a low voltage motor control centre (MCC) with comprehensive motor protection to replace most of the internal devices found in an MCC. Using this compact, microprocessor based device, sophisticated control and protective relaying is possible at significant cost savings over an MCC design using discrete devices. Standard features in every Motor Manager simplify maintenance and plant expansion. Total control of the contactor is possible using the Motor Manager's flexible inputs and outputs, either locally or remotely via the serial communication port.

One Motor Manager is required for every motor control centre. The contactor can be energized and de-energized using the Motor Manager's direct-wired inputs, or via the serial port. Direct-on-line, Reversing, Two Speed and Star-Delta type starters may be completely controlled by the Motor Manager.

The Motor Manager is an intelligent motor management device, incorporating modbus communications protocol to enable it to communicate to a high-speed serial link communications network. A total of 255 Motor Managers or similar devices may be included in the communications network which uses a half-duplex, 2-wire RS485 interface. Any Motor Manager may be interrogated on demand, to determine both actual and setpoint operating parameters. Continuous event logging of all drives is communicated to the central P.L.C. or monitoring computer. Trend analysis recording of up to 32 motors simultaneously provides a valuable plant condition monitoring facility. Statistical recording of hours run and number of starts and trips assists with predictive maintenance scheduling.

FEATURES OVERVIEW

- All setpoints and configurations are keypad programmable.
- English Language display (2 × 16 LCD alphanumeric)
  - Default Display - Motor Phase current
  - Fault Override - Fault description
- Complete Motor Protection:
  - Overload
  - Phase Current Unbalance or Single Phasing
  - Ground Fault Current
  - Thermistor
  - Undercurrent
  - Stalled Rotor Condition
  - Acceleration Time
  - Undervoltage
- Non-volatile setpoint memory (no battery)
- Self diagnostics
- Serial port
  - any analog or digital value/status
  - any alarm or trip condition
  - read or write to any setpoint value within the Motor Manager

TECHNICAL SPECIFICATIONS

Phase Current Inputs
conversion: true RMS, sample time 1.6ms
range: 0.1 to 8 x phase CT primary amps setpoint
full scale: 8 x phase CT primary amps setpoint
accuracy: ± 2% of full scale

Ground Fault Current Input
conversion: true RMS, sample time 1.6ms
range: 0.1 to 1.4 x G/F CT primary amps setpoint (5 Amp secondary CT)
1.0 to 16.0 amps (2000:1 CT)
full scale: 1.4 x G/F CT primary amps setpoint (5 Amp secondary CT)
16 amps (2000:1 CT)
accuracy: ± 2% of full scale (5 Amp secondary CT)
± 0.3 amps (2000:1 CT)

Overload Curves
trip time accuracy: ± 1 sec. up to 60 sec.
± 2% of trip time over 60 sec.
detection level: ± 1% of primary CT amps

Relay Lock-out Time
Control Power Applied
range: 10-120 min when motor stopped (adjustable)
50% of motor stopped value when motor running
accuracy: ± 1 minute

No Control Power Applied
value: 30 minutes (fixed)
accuracy: ± 20% of total lockout time

Unbalance
calculation method: $\left|\frac{I_n - I_{av}}{I_{av}}\right| \quad I_{av} > I_{fl}$

or $\left|\frac{I_n - I_{av}}{I_{fl}}\right| \quad I_{av} \le I_{fl}$

Where In=RMS current in any phase with maximum deviation from average
Iav=average of 3 phase currents
Ifl=motor full load current

Unbalance Alarm
level: greater than 15% U/B
accuracy: ± 2 percentage points
alarm delay: 5 sec, ±1 sec

Single Phase Trip
level: greater than 30% U/B
accuracy: ± 2 percentage points
trip delay: 5 sec, ± 1 sec

Acceleration Time
range: 0.5 to 125 seconds or OFF
accuracy: ± 1 sec

Undercurrent
range: 10% - 100% x motor FLC
delay range: 1 to 60 seconds or OFF
accuracy: ± 1 sec

Ground Fault Trip Time
accuracy: ± 100 ms, 0.0 causes < 50 ms delay

Stalled Rotor
range: 1.5 to 4.5 x FLC
delay range: 0.5 to 5 seconds or OFF
accuracy: ± 1 sec

Thermistor	
range:	100 - 30,000 ohms
accuracy:	± 100 ohms up to 9,000 ohms
	± 5% of thermistor resistance >9,000 ohms
Thermistor Inputs	
sensor types:	positive temperature coefficient PTC
	R_{HOT}=100 - 30,000 ohms
	negative temperature coefficient NTC
	R_{HOT}=100 - 30,000 ohms
Relay Contacts	
type:	N/O (contactor A, B)
	single pole changeover for programmable relays
rated load:	10 A @ 250 VAC / 10 A @ 30 VDC (resistive load)
	7.5 A @ 250 VAC / 5 A @ 30 VDC (inductive load)
	10 A @ 125 VDC (resistive load, contacts closing)
	0.1 A @ 125 VDC (resistive load, contacts opening)
	0.3 A @ 125 VDC (inductive load)
maximum operating voltage:	380 VAC, 125 VDC
maximum operating current:	10 Amps
minimum permissible load:	5 VDC, 100 mA
note:	AC inductive load PF = 0.4
	DC inductive load L/R = 7 ms
Control Power	
AC nominal:	120 VAC, range 85 - 135 VAC
	240 VAC, range 170 - 270 VAC
frequency:	50/60 Hz
maximum power consumption:	40 VA
Control Power - Undervoltage	
undervoltage:	85 VAC ± 5 VAC for 120 VAC nominal
	170 VAC ± 5 VAC for 240 VAC nominal
	immediate restart for maximum dip time of 0.2 seconds
pulsed start:	delayed restart for maximum dip time of 0.2 - 4.5 seconds or 0.2 - time unlimited depending on the setpoint selected.
delay restart range:	0.2 - 300 seconds
delay restart accuracy:	5% of total time
Environment	
operating temperature range:	-40°C to 60°C
display operating range:	-20°C to 50°C
CT Burden	
phase CT:	1 amp or 5 amp input: less than 0.50 VA at rated load
	resistance: less than 0.1 ohms
ground fault CT:	5 amp input: less than 0.50 VA at rated load
	resistance: less than 0.3 ohms
	2000:1 input:can be driven by Multilin 2000:1 CT

Design and specifications subject to change without notice

MOUNTING

Cut the panel as shown below to mount the Motor Manager. Use the #8-32 mounting screws provided to mount the Motor Manager to the panel.

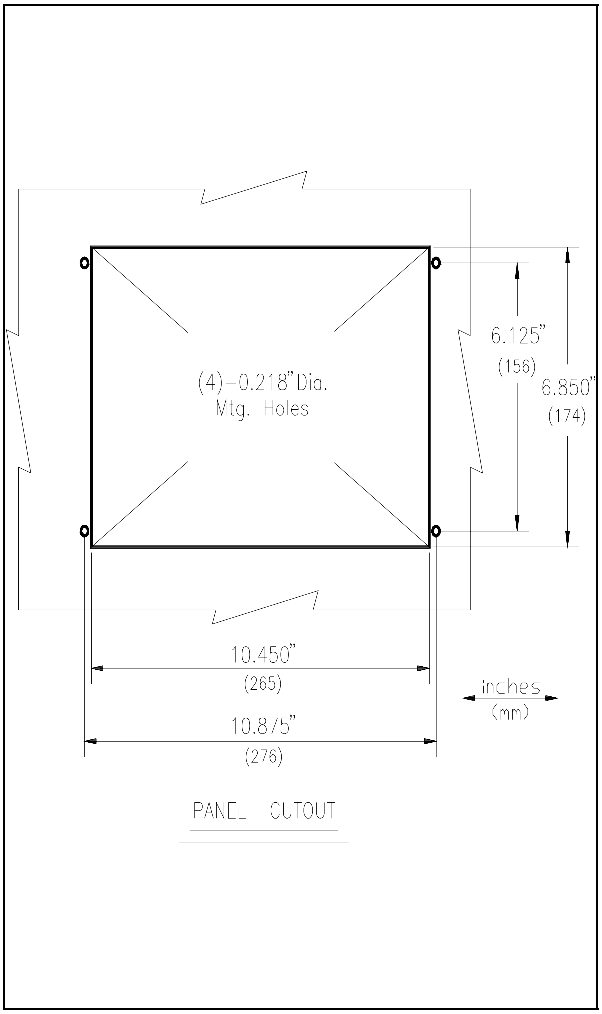

Figure 2-1 Panel Cutout

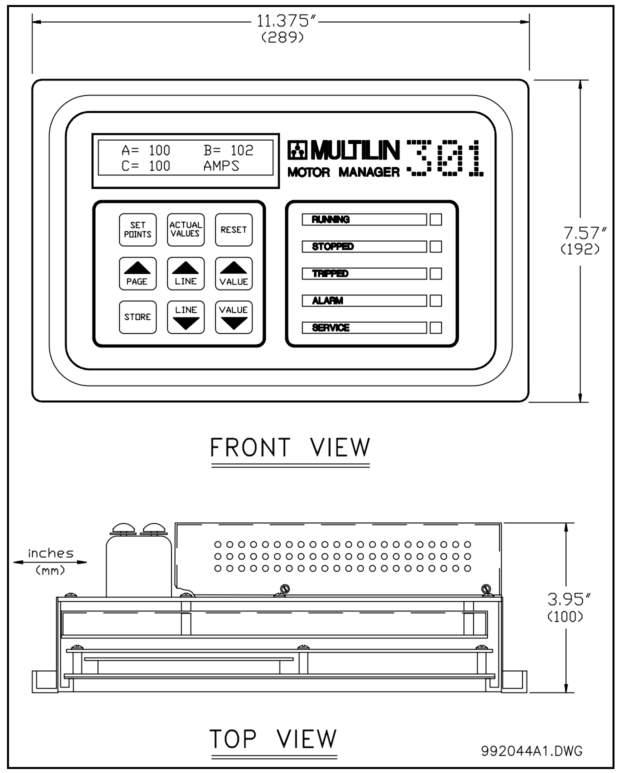

Figure 2-2 Motor Manager Dimensions

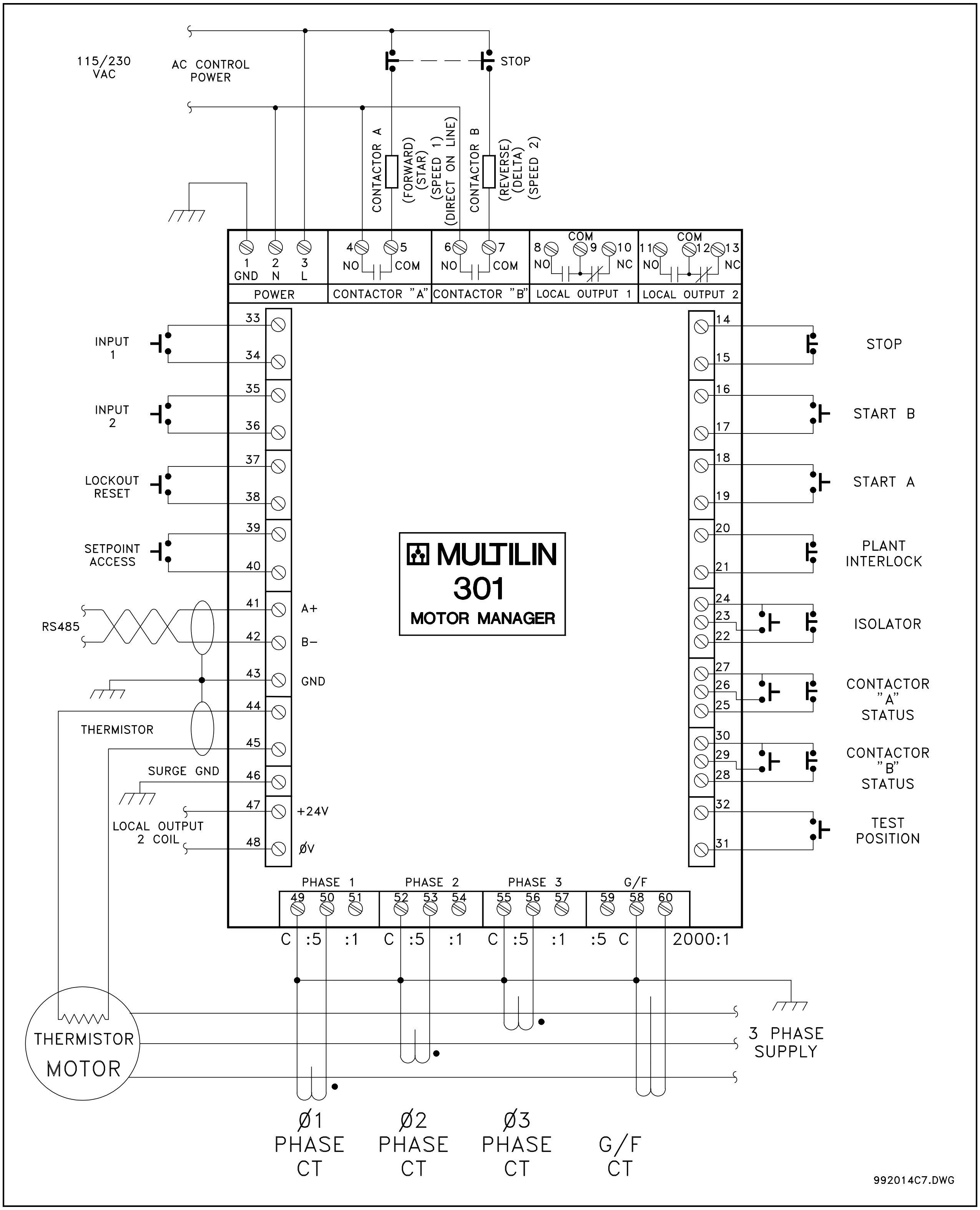

Figure 2-3 Typical Wiring Diagram

GENERAL INPUT/OUTPUT OVERVIEW

PHASE CT INPUTS (49/50/51, 52/53/54, 55/56/57)

Both 5A and 1A current transformer secondaries are accommodated by the Motor Manager. Each phase current input to the Motor Manager has 3 terminals - one for 5 amp inputs, one for 1 amp inputs and the other is common to both inputs. For example, if the phase CT's are 200:5, connect phase 1, 2, 3 CT secondaries to terminals 49/50, 52/53, 55/56 respectively. For motor full-load currents up to 5 amps, power connections are direct-connected to the Motor Manager. ie. Phase 1, 2, 3 are connected to terminals 49/50, 52/53, 55/56.

GROUND FAULT CT INPUT (58/59/60)

The ground fault CT has a 5A input, a 2000:1 input and a common input. The 5A input on the ground fault CT is used for 5A secondary zero sequence CT's or for residual connection of phase CT's, providing sensitivity of 20% of C.T. primary rating. A sensitive 2000:1 core balanced CT is also available. A core-balanced CT is used for improved sensitivity.

THERMISTOR INPUT (43/44/45)

Either a positive thermal coefficient or negative thermal coefficient type thermistor may be directly connected to the Motor Manager. By specifying the hot and cold thermistor resistance, the Motor Manager automatically determines the thermistor type as NTC or PTC. Use thermistors with hot and cold resistance values in the range 100-30,000 ohms. If no thermistor is connected, the thermistor alarm and trip detection must be set to off.

UNDER VOLTAGE

The Motor Manager will detect an undervoltage (85VAC for 120 VAC setting or 170VAC for 240VAC setting) and both contactors will be de-energized. On supply restoration the Motor Manager may be used to provide immediate restart for voltage dip or loss times less than 0.2 seconds or may be used to provide delayed restart for dips or loss times of up to 4.5 seconds or an unlimited amount of time depending upon the selected setpoint. Restart delay is programmable between 0.2 seconds and 300 seconds. Sensing is done internally from the control voltage supply, which should be derived from the incoming MCC three phase motor supply.

SERIAL COMMUNICATION PORT (41/42/43)

A serial port provides communication capabilities to the Motor Manager. Multiple Motor Managers must be connected together with a Belden 9841, 24 AWG stranded, shielded twisted pair with a characteristic impedance of 120 ohms, or equivalent. Correct polarity is essential for the communications port to operate. Terminal 41 ("+") of every 301 in a serial communication link must be connected together. Similarly, terminal 42 ("-") of every 301 must also be connected together. The shield wire must also be connected to every unit, terminal 43, in the link to provide a common ground potential for all units. Each relay must be "daisy chained" to the next one. Avoid star or stub connected configurations.

The last relay in the chain needs an internal terminating resistor to prevent communication errors. Only the last Motor Manager and the master computer driver should have terminating resistors to ensure proper matching. Using terminating resistors on all the Motor Managers would load down the communication network while omitting them at the ends could cause reflections resulting in garbled data. If the relay is the last one in the chain, remove the top cover and set the two jumpers (J105, J106) labelled OFF-C-ON as shown in Fig. 2-5 to ON. Otherwise, set these to OFF to remove the internal terminating resistor.

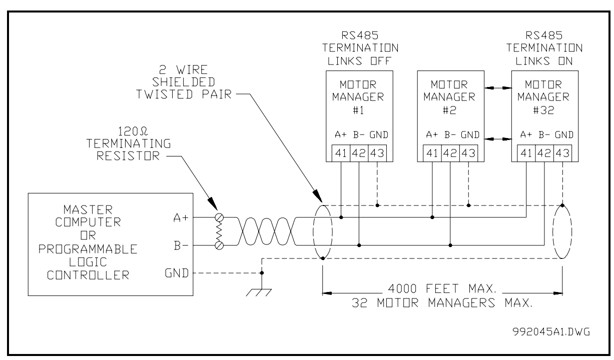

Figure 2-4 RS485 Termination

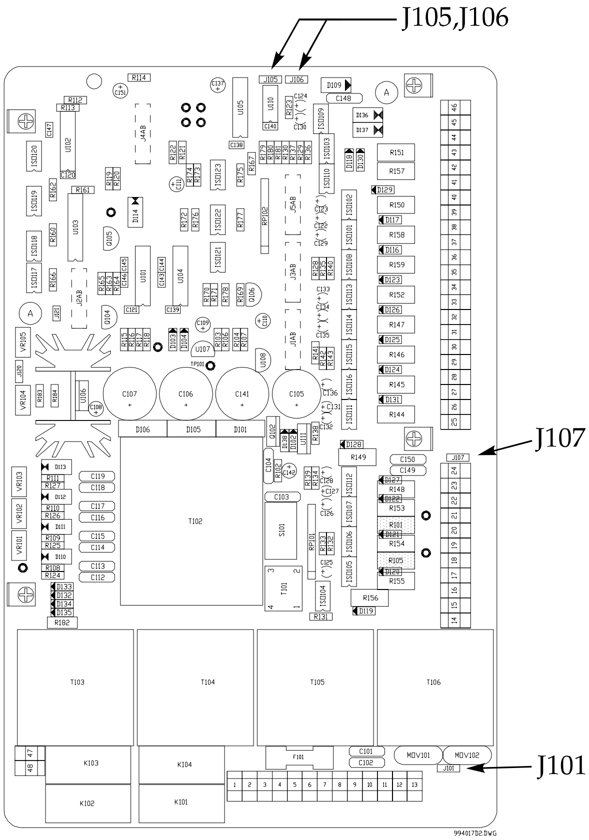

Figure 2-5 RS485 and Hipot Jumpers

OUTPUT RELAYS

There are up to 4 output relays on the Motor Manager. Contact rating for each relay is 10A resistive, 7.5A inductive at 250V AC. These are assigned as follows:

Contactor A (4/5) - direct on line, forward, speed 1 or star contactor control
Contactor B (6/7) - reversing, speed 2 or delta contactor control
Local Output 1 (8/9/10) - user assigned application
Local Output 2 (11/12/13) - hardwired 24VDC coil

CONTROL POWER (1/2/3)

Control power of 240/120V AC, 50 or 60Hz, is required to power the Motor Manager. The label on the back cover will specify the control voltage which has been internally set inside the Motor Manager. To change the voltage, remove the top cover and locate the control voltage selector slide switch. The control voltage selector slide switch has a label affixed to show the 240VAC position. Put the slide switch towards the 4 current transformers for 240V operation and in the other position for 120V supply. Be sure to modify the back cover label to show the voltage set internally.

The power supply also provides 120V AC for all external contact inputs. Therefore, it must be connected to a stable source of supply for reliable operation of the Motor Manager.

GROUND (1) CHASSIS

Connect the ground to a reliable system ground within the MCC for safety and for bypassing of transient energy.

GROUND (46) SURGE

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

SWITCH INPUTS

CAUTION: ALL SWITCH INPUTS ARE LIVE 120 VAC.

TEST POSITION (31/32)

When a starter is placed in the test position, a test switch closes to indicate this state. A message in the ACTUAL VALUES PAGE 3: INPUTS will give the test position status as "OPEN" (normal), or "CLOSED" (test position). The Motor Manager display will indicate the "Test Position" state. When a starter is in the test position, the Motor Manager will disable statistic updating of running hours, number of starts, number of trips, and trip types caused by test position operation. Switching this input from "CLOSED" to "OPEN" will cause both contactors to drop out.

LOCKOUT RESET (37/38)

The keypad reset provides reset after a trip for the following fault conditions:

- Single phasing
- Thermistor (now cool)
- Over current (no thermal lock-out existing)
- Under-current
- Acceleration time
- Serial link failure

When a Motor Manager trips and then loses control power, all trip functions except thermal lockout and ground fault will be reset once control power is re-applied. During loss of power after a thermal lockout trip, the Motor Manager internally continues to compute motor cool down. It will use the correct value when power is re-applied and remain tripped.

When a lock-out trip occurs as a result of ground fault, stalled rotor or overload only the lockout reset input or serial communications port can be used to reset the Motor Manager. When the Motor Manager has tripped due to an Overcurrent, using the lockout reset input causes the Thermal Capacity to be 0%.

SETPOINT ACCESS (39/40)

The ACCESS terminals must be shorted in order for the faceplate keypad to have the ability to store new relay setpoints. The access terminals would typically be connected to a security keyswitch to allow authorized access only. The access terminals may be disabled through the serial port (until re-enabled through the serial port). Serial port commands to store a new setpoint will operate even if the access jumper terminals are not shorted.

LOCAL ISOLATOR OPEN/ISOLATOR CLOSED (22/23/24)

The local isolator used in the MCC may not be rated to make or break the current required by the contactor load. Because of the isolator's inability to close onto a connected load, an open state for the isolator causes the Motor Manager to open the contactor. If the isolator is detected as 'open', the Motor Manager display indicates this isolator state on the ACTUAL VALUES PAGE 3: INPUTS page.

Two auxiliary contacts are used as isolator status inputs - one to detect a closed state, the other to detect the open state. Using the two inputs guarantees that the Motor Manager will know the exact state of the isolator (i.e. definitely open, definitely closed). The contacts used would be early make/ early break for this purpose. A N/O contact only may be used if required for incoming isolator status indication. If local isolator N/O terminal changes from close to open and/or N/C terminal changes from open to closed while the contactor is in the energized state, the Motor Manager will de-energize the contactor.

PLANT INTERLOCK (20/21)

Many peripheral plant conditions may have to be met before a contactor is allowed to close. The plant Interlock input to the Motor Manager will inform the Motor Manager that these conditions have been met. The Plant Interlock terminals must be shorted in order for the Motor Manager to energize the contactor. If the Plant Interlock terminals change state from closed to open while the contactor is in the energized state, the Motor Manager will de-energize both contactors.

START A (18/19) AND START B (16/17)

When the start input terminals are shorted, the corresponding contactor output relay will be energized provided all other valid close 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: direct on line, reversing, speed 1 or star. Start B input is used for a reversing and a speed 2 contactor. Start inputs are momentary. Start A and B commands may also be initiated via the serial link.

STOP (14/15)

If these terminals are open circuited, the contactor output relay presently selected will be de-energized. In addition, there should always be an emergency stop button wired in series with both contactor coils. If the emergency stop button is used, then the contactor status input change will inform the Motor Manager to open both contactor output relays.

CONTACTOR STATUS (A: 25/26/27, B: 28/29/30)

The Motor Manager 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 sets of contactor status inputs to the Motor Manager, one for contactor A, the other for contactor B. Since the Motor Manager can be configured to control several different contactors, some consisting of two separate contactor mechanisms, two contactor status inputs are required.

Two auxiliary contacts mechanically linked to the contactor itself are used as contactor status inputs - one to detect a closed state, the other to detect the open state. Using the two inputs guarantees that the Motor Manager will know the exact state of the contactor (i.e. definitely open, definitely closed). Non-status change following "start" commands indicates an open-circuit contactor control circuit and non-status change following "stop" command indicates a welded contactor. Appropriate messages are displayed and transmitted via the serial port.

STATUS INPUT 1 (33/34)

This input is used to specify local or remote motor start control. If Status Input 1 is open then the Motor Manager will respond to local start commands. If Status Input 1 is closed then the Motor Manager will respond to serial port start commands but will ignore local start commands.

STATUS INPUT 2 (35/36)

This input can be used for a 2-wire control input, or plant interlock latched. If this feature is enabled, and 2-wire control is selected, closing the switch will cause contactor A to energize, and opening the switch will cause contactor A to de-energize.

NOTE: This feature is only available when Direct-on-Line starter type is selected. Start A input can still be used to start the motor, but this will cause input 2 to be disabled until a trip or stop has been detected.

If plant interlock is selected, opening the switch will cause plant interlock to become latched, and closing the switch will cause plant interlock to become unlatched.

CONTACTOR A (4/5)

Connect the coil of the contactor used for direct on line, forward, speed 1, or star to the normally open relay contact used to switch these terminals. Rated coil load is 7.5A @ 120VAC.

CONTACTOR B (6/7)

When reversing, speed 2, or star/delta changeover schemes are used, connect the coil of the reversing, speed 2, or delta contactor to this output. Rated coil load is 7.5A @ 120VAC.

PROGRAMMABLE RELAY 1 (8/9/10)

A separate relay with NO/NC form C contacts is available for a user defined application. This might be configured as an output alarm, trip or as a switchable output under remote software control. When configured as an alarm, the contact status on occurrence of an alarm is:

8/9 - closed
9/10 - open

HARDWIRED RELAY 2 (11/12/13, 47/48)

The coil of this relay is directly connected to terminals 47 and 48. 24 VDC is required to activate this relay.

DIELECTRIC STRENGTH TESTING

It may be required to test a complete MCC with the Motor Manager installed for dielectric strength. This is also known as "flash" or "hipot" testing. The Motor Manager is rated for 1500 VAC isolation between switch, relay and control power inputs and ground. Some precautions are necessary to prevent damage to the Motor Manager during these tests.

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 ground on the AC input.

Consequently, when doing dielectric tests between the AC input terminals 2 and 3 and ground these must be isolated. Remove the FILTER shorting links (J101, J107) as shown in Fig. 2-5 during tests and re-install them once the test has been completed. This removes the filter components from the input during testing.

Relay contact outputs 4-13 and switch inputs 14-40 can be dielectric tested with no special precautions.

Under no circumstances should the RS485 (terminals 41-43) or thermistor (terminals 44-45) be tested in this way.

CONTRAST CONTROL

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

The contrast control is located on the side of the Motor Manager opposite the long row of terminal blocks. It can be accessed using a small slot screwdriver through a hole in the metal case.

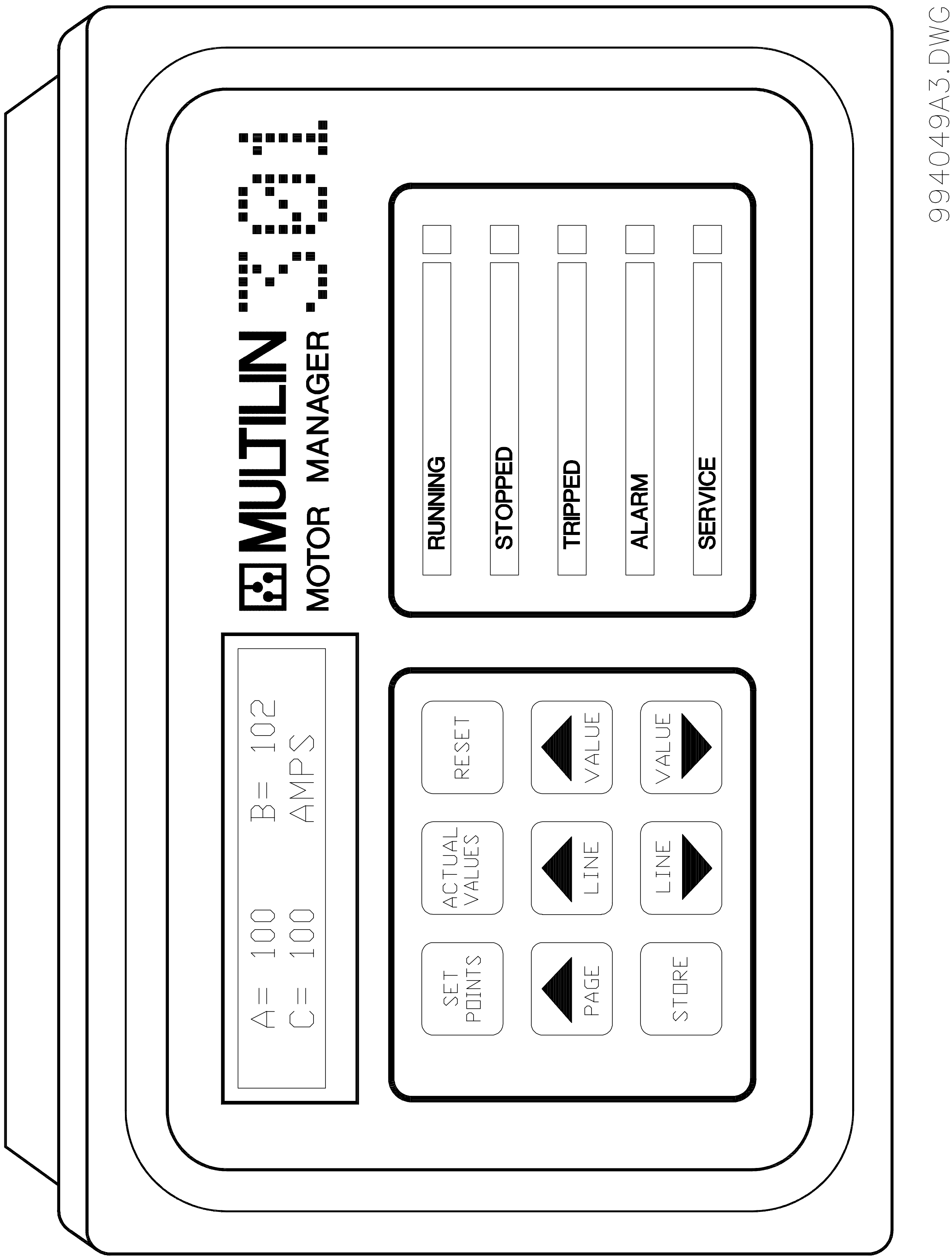

Figure 3-1 Front Panel

CONTROLS AND INDICATIONS

Once the Motor Manager relay has been wired and control power supplied, it is ready to be programmed for the given application. Programming is accomplished using the 9 position keypad and 32 character alphanumeric display shown in Figure 3-1. The function of each key on the keypad and each of the indicators is briefly explained below.

Name	Description
A= 100 B= 102 C= 100 AMPS	A backlit 32 character multiangle viewing display is used to communicate all information about the system. A contrast control at the back of the unit can be adjusted for optimum clarity. Alarm and trip messages will automatically override the currently displayed message. If no key is pressed for 2 minutes and no alarm/trip is present, the user selected default message will be displayed.
SET POINTS	**FUNCTION**: The SETPOINTS key allows the user to examine and alter all trip, alarm, and other relay setpoints. There are 3 pages of setpoints data: page 1: Motor Data page 2: Configuration page 3: Advanced Level
	EFFECT: Pressing this key will put the relay into SETPOINTS mode. The beginning of page 1 of SETPOINTS will then be shown: SETPOINTS PAGE 1 MOTOR DATA
	USE: This key can be pressed at any time, in any mode, to view or alter relay setpoints. To go from page to page the PAGE key can be used. To go from line to line within a page the LINE UP and LINE DOWN keys can be used. To alter a setpoint, the VALUE UP and VALUE DOWN keys can be used. All setpoints will increment and decrement 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. If the Access jumper is not installed a STORE will not be allowed. All control and protection features continue to operate while in setpoints mode.
ACTUAL VALUES	**FUNCTION**: The ACTUAL VALUES key allows the user to examine all of the actual motor operating parameters. There are 4 pages of ACTUAL VALUES data: page 1: Current Data page 2: System Status page 3: Input Switch Status page 4: Statistics
	EFFECT: Pressing this key will put the relay into ACTUAL VALUES mode. The beginning of page 1 of ACTUAL VALUES mode will then be shown: ACTUAL VALUES PG1: DATA
	USE: This key can be pressed at any time, in any mode, to view actual motor values. To go from page to page the PAGE key can be used. To go from line to line within a page, the LINE UP and LINE DOWN keys can be used. The VALUE UP and VALUE DOWN keys have no effect in this mode.

RESET	**FUNCTION**: The RESET key allows the user to reset the Motor Manager after a trip to allow motor starting.
	EFFECT: Pressing this key will reset a tripped state allowing a start of the motor. A message indicating that reset is not possible will be displayed if any active output relays cannot be reset.
	USE: As long as the Motor Manager is tripped, the start contactor command cannot be executed. A ground fault trip, stalled rotor or overload lockout trip can only be reset using the external reset terminals on the back of the unit or the serial port.
▲ PAGE	**FUNCTION**: The PAGE key allows the user to scan the next page of either ACTUAL VALUES or SETPOINTS modes. If the key is held for more than 1 second the next page will be selected at a fast rate.
	EFFECT: Pressing the PAGE key will cause the display to show the first line of the next page of information.
	USE: This key can be used any time the relay is in either the ACTUAL VALUES or SETPOINTS modes.
▲ LINE LINE ▼	**FUNCTION**: The LINE DOWN and LINE UP keys allow the user to scan the next or previous lines of the currently selected page. If either key is held for more than 1 second, the next or previous lines will be selected at a fast rate.
	EFFECT: Pressing the LINE DOWN key will cause the display to show the next line of the currently selected page of information. Pressing the LINE UP key will cause the display to show the line immediately in front of the currently displayed line.
	USE: These keys can be used at any time in any relay mode of operation. If the display shows the last line of a page the LINE DOWN key will have no effect. If the display shows the first line of a page the LINE UP key will have no effect.
▲ VALUE VALUE ▼	**FUNCTION**: The VALUE UP and VALUE DOWN keys allow the user to alter the currently selected setpoint. If either key is held for more than 1 second the setpoint selected will increment or decrement at a fast rate.
	EFFECT: Pressing the VALUE UP key will cause the currently displayed setpoint value to increment. Pressing the VALUE DOWN key will cause the currently selected setpoint value to decrement. For ENABLE/DISABLE questions, pressing either key will cause the answer to change. Any changed setpoint will not be used internally until the STORE key is pressed.
	USE: These keys can be pressed any time a setpoint is displayed in SETPOINTS mode. When the desired setpoint value is reached the STORE key is used to save it. If an altered setpoint is not stored the previous value will still be in effect. These keys have no effect when in ACTUAL VALUES mode.

STORE

FUNCTION: The STORE key allows the user to store new setpoints into the Motor Manager's internal memory.

EFFECT: When this key is pressed in SETPOINTS mode the currently displayed setpoint will be stored in non-volatile memory and will immediately come into effect. When a setpoint is stored, the flash message

```
NEW SETPOINT
    STPORED
```

will appear on the display.

If no key is pressed for 2 minutes, a default message will override whatever message was left on the screen. Any of the ACTUAL VALUE messages, except for page 2, can be selected as the new default message by pressing the STORE key twice while the desired message is being displayed.

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. This key will have no effect on storing setpoints unless the back Access terminals (39/40) are shorted together and the flash message ILLEGAL ACCESS will be displayed for 2 seconds. Note that the access terminals do not have to be shorted to select a new default setting.

RUNNING	Whenever contactor A or B is closed and the contactor status input acknowledges the correct state, the RUNNING indicator will be on. Current flow does not affect the indicator, only contactor status.
STOPPED	If both contactor A and B are in the off state, the STOPPED indicator will be on.
TRIPPED	If a trip condition causes the A and B contactor to open, this indicator will be on. As long as this indicator is on, the motor cannot be started. Use ACTUAL VALUES: PG 2 to view current trip status. PROGRAMMABLE RELAY 1 can be programmed to pick up on any trip. In this case, PROGRAMMABLE RELAY 1 relay will be energized whenever this indicator is on. To clear the trip and to reset PROGRAMMABLE RELAY 1 relay, if it's active, use the RESET key, rear terminal lockout reset, or serial port reset.
ALARM	If any alarm condition is present this indicator will be on. Use ACTUAL VALUES:PG 2 to view current alarm status. PROGRAMMABLE RELAY 1 relay can be programmed to pick up on any alarm. In this case, PROGRAMMABLE RELAY 1 relay will be energized whenever this indicator is on.
SERVICE	An internal self test failure will cause this indicator to be on. The Motor Manager may need to be serviced.

ACTUAL VALUES MODE.

All the messages displayed by the Motor Manager in the Actual Values Mode are listed and explained in this section. The messages are laid out in book form with pages containing lines, each of which displays one message.

The Actual Value Mode has 4 pages which contain the following information:

Page	Contents.
1.	Current Data
2.	System Status
3.	Input Switch Status
4.	Statistics

The figure in the "Location" column to the left of each message gives the page and line of that message in the Motor Manager's memory. For example, the message to the right of A 1.3 in the "Location" column will appear on page 1 and line 3 when the Motor Manager is in Actual Values Mode and is referred to as "message A 1.3".

The "Message" column shows the actual message which can be read from the LCD display on the front panel of the unit. Quantities shown, such as 44.6, are typical values only. Different quantities will be displayed in each particular application.

Note: When finished viewing a message, press the LINE DOWN key to view the next line. When the last line of a page is reached, press the PAGE key to view the first line of the next page. When the last line of the last page in actual values is reached, pressing the PAGE key will return the display to the first page again.

DEFAULT MESSAGE SELECTION.

The default message is the message which will be displayed by the Motor Manager under normal operating conditions. The display will show the selected message if no key on the keypad is pressed for more than two minutes and no alarm or trip condition is present. Any message in actual values, with the exception of page 2, may be selected as the default message. To select any message as the default message, proceed as follows:

Use the NEXT PAGE key to select the page on which the required message is located, in actual values, and use the LINE DOWN key to display the message. Press the STORE key twice which will cause the following message to be displayed:

```
NEW DEFAULT
LINE SELECTED
```

This message will now be displayed if no key is pressed for a 2 minute period.

NOTE: If the control power is removed from the 301, the default message will return to phase currents.

Actual Values Message Abbreviations

The following abbreviations are used in the Actual Values messages.

A,AMPS	Amperes
MIN	Minutes
SEC	Seconds

Actual Values Message Summary

Page	Contents
1	Current Data
	Phase Currents Ground Fault Current % Phase Unbalance % Motor Load Peak Inrush Current % Thermal Capacity Used Time to Trip Acceleration Time
2	System Status
	Cause of Last Trip Cause of Present Alarms Phase Trip Current Ground Fault Trip Current Delayed Start
3	Inputs
	Switch Input Status
4	Statistics
	Motor Running Time Number of Starts Total Number of Trips Number of Overload Trips Number of Thermistor Trips Number of Ground Fault Trips Number of Single Phase Trips Number of Acceleration Trips Number of Undercurrent Trips Number of Stalled Rotor Trips Number of Control Command Trips

ACTUAL VALUES MESSAGES

Location	Message	Description
A 1.1	ACTUAL VALUES PG 1: DATA	Actual values of measured parameters are displayed with these messages.
A 1.2	A= *22* B= *20* C= *10* AMPS	Actual current in each phase in Amps.
A 1.3	GROUND FAULT CURRENT *63.2* A	Ground fault leakage current flowing from any phase to ground.
A 1.4	PHASE UNBALANCE *5* %	The actual percentage unbalance in the motor phase currents is shown here. This is calculated as shown in the Technical Specifications section.

$$\text{Motor Load} = \frac{\text{Actual Motor Current}}{\text{Full Load}}$$

Location	Message	Description
A 1.5	MOTOR LOAD *15* % FULL LOAD	Normally the full load current which is entered in setpoints is the rated maximum continuous operating current of the motor. When the motor current is above this value, the motor is considered to be in an overload. The actual motor current is the average of the three motor phase currents. When the value exceeds 100%, an overload condition exists. The motor will automatically trip if the current is not reduced.
A 1.6	PEAK INRUSH *500* AMPS	The maximum current that occurred on the last motor start. This value is saved until the next start. This is typically the locked rotor or stall current.
A 1.7	THERMAL CAPACITY USED *80* %	Thermal modelling of the motor is used to predict heat buildup. A cool motor has a thermal capacity used of 0%, a hot motor at point of trip has 100%. This is the value computed by the thermal memory and can be used to determine how close the motor is to tripping.
A 1.8	TIME TO TRIP *11* SEC	Based on the current overload level and thermal capacity used, this value indicates the time before a trip will occur. It is a useful indicator of how much trip time is available for corrective action before a trip will occur.
A 1.9	ACCELERATION TIME *14* SEC	Actual motor acceleration time determined from the last motor start.
A 1.10	END OF PAGE 1 ACTUAL VALUES	The last line of page 1. Press PAGE key to view next page.

Location	Message	Description
A 2.1	ACTUAL VALUES PG 2: STATUS	Motor Manager trip, alarm and pre-trip status information is displayed on this page
A 2.2	CAUSE OF TRIP *OVERLOAD TRIP*	After a trip, a message will be displayed stating the condition which caused the last trip. If the Motor Manager is not tripped, this will be the cause of the previous trip. The possible causes of trip messages are: OVERLOAD, GROUND FAULT, SINGLE PHASE, THERMISTOR, ACCELERATION TIME, STALLED ROTOR, PLANT INTERLOCK, LOCAL ISOLATOR, UNDERCURRENT, SERIAL LINK FAIL, INTERNAL FAULT.
A 2.3		Any alarm conditions that are currently present will be displayed. This could be one of the following:
	LOAD INCREASE ALARM	Load Increase Alarm level has been exceeded.
A 2.4	GROUND FAULT ALARM	Ground fault current exceeded alarm setpoint.
A 2.5	UNBALANCE ALARM	Phase current unbalance exceeded the internally set phase unbalance threshold. This is calculated as: IA = 76 IB = 100 $\frac{\lvert 76-92 \rvert}{100} = 16\%$ (>15% alarm level) IC = 100 Iav = 92 IFL = 100
A 2.6	THERMISTOR ALARM	The thermistor alarm resistance is greater than the Thermistor Hot setting for PTC thermistor, or less than the Thermistor HOT setting for the NTC thermistor.
A 2.7	INTERNAL FAULT	Self-test checking detected an internal hardware fault. The Motor Manager relay should be returned to the factory for service.
A 2.8	OPEN CONTROL CIRCUIT	The contactor did not respond to a switch closure from the Motor Manager commanding it to close. Check wiring, contactor or contactor supply voltage.
A 2.9	WELDED CONTACTOR	The contactor did not open in response to a contactor stop command from the Motor Manager. Check wiring or the contactor.
A 2.10	UNDERCURRENT ALARM	Average current has been below the Undercurrent Alarm Level for the Undercurrent Time Delay.
A 2.11	EXTERNAL STOP	The contactor opened without receiving a stop command from the Motor Manager.

Location	Message	Description
A 2.12	EXTERNAL START	The contactor closed without receiving a start command from the Motor Manager.
A 2.13	PRETRIP A= 15 B= 10 C= 2 A	At the moment of trip the 3 motor phase currents that were flowing are shown in this message.
A 2.14	PRETRIP GROUND CURRENT: 305 A	At the moment of trip the ground leakage current that was flowing from any phase to ground is shown with this message.

Message A 2.15 will only appear if PRE-CONTACTOR A has been selected in message S 2.18 and a start is in progress.

Location	Message	Description
A 2.15	DELAYED START 25 SECONDS	The displayed time indicates the time remaining until contactor A energizes.
A 2.16	END OF PAGE 2 ACTUAL VALUES	End of Actual Values page 2. Press PAGE key to view next page.

Location	Message	Description
A 3.1	ACTUAL VALUES PG 1: INPUTS	Status of each input to the Motor Manager relay is shown with these messages.
A 3.2	CONTACTOR A N/O *OPEN*	Switch input terminals 26-27 - open if contactor open State of contactor A N/O terminals: "OPEN" - contactor open; forward/star/direct-on-line/speed 1 motor not energized. "CLOSED" - contactor closed; forward/star/direct-on-line/ speed 1 motor energized.
A 3.3	CONTACTOR A N/C *CLOSED*	Switch input terminals 25-27 - closed if contactor open State of contactor A N/C terminals: "OPEN" - contactor closed; forward/star/direct-on-line/speed 1 motor energized "CLOSED" - contactor open; forward/star/direct-on-line/speed 1 motor not energized
A 3.4	CONTACTOR B N/O *CLOSED*	Switch input terminals 29-30 - open if contactor open State of contactor B N/O terminals: "OPEN" - contactor open; reverse/delta/speed 2 motor not energized. "CLOSED" - contactor closed; reverse/delta/speed 2 motor energized.
A 3.5	CONTACTOR B N/C *OPEN*	Switch input terminals 28-30 - closed if contactor open State of contactor B N/C terminals: "OPEN" - contactor closed; reverse/delta/speed 2 motor energized. "CLOSED" - contactor open; reverse/delta/speed 2 motor not energized.
A 3.6	LOCAL ISOLATOR N/O *OPEN*	Status of the MCC isolator is shown as terminals 23-24 open if isolator open.
A 3.7	LOCAL ISOLATOR N/C *CLOSED*	Status of the MCC isolator is shown as terminals 22-24 closed if isolator open.
A 3.8	PLANT INTERLOCK *CLOSED*	Plant interlock may be a series of contacts corresponding to conditions preventing the motor from starting. If plant interlock terminals 20-21 are open the motor cannot be started. "OPEN" - cannot start motor "CLOSED" - start enabled
A 3.9	START A *OPEN*	When a switch closure is placed across terminals 18-19 contactor A output relay closes to start the motor. ie. the normally open contact across terminals 4-5 closes. This causes the forward/star/direct-on-line/speed 1 contactor to operate. "CLOSED" - start A switch closed "OPEN" - start A switch open

Location	Message	Description
A 3.10	START B *OPEN*	When a switch closure is placed across terminals 16-17 contactor B output relay closes. ie. the normally open contact across terminals 6-7 closes. This will reverse the motor, energize the delta configuration or change to speed 2. "CLOSED" - start B switch closed "OPEN" - start B switch open
A 3.11	STOP INPUT *OPEN*	A Stop signal to cause both contactors to open is generated by putting an open circuit across terminals 14-15. "OPEN" - stop. ie. open both contactors "CLOSED" - no stop signal
A 3.12	TEST POSITION *OPEN*	During commissioning or testing a switch closure ("CLOSED") across terminals 31-32 disables statistics gathering for starts, trips, etc. This prevents incorrect historic data from being collected. "CLOSED" - test mode, statistics disabled "OPEN" - normal operation
A 3.13	SETPOINT ACCESS *CLOSED*	Setpoints can only be entered when there is a switch closure ("CLOSED") across terminals 39-40. If an attempt is made to store a setpoint in the open state, an error message will flash. A keyswitch or jumper is normally used for this input. "CLOSED" - switch closed; setpoints can be stored. "OPEN" - switch open; setpoints cannot be stored.
A 3.14	LOCKOUT RESET *OPEN*	After a ground fault, stalled rotor, or thermal memory trip (thermal capacity used = 100%) the Motor Manager relay is latched in a trip condition. A contact closure across terminals 37-38 will clear the condition and reset the Motor Manager. "CLOSED" - switch closure; reset relay. "OPEN" - switch open; no reset.
A 3.15	STATUS INPUT 1 *OPEN*	If Status Input 1 (terminals 33-34) is open then the Motor Manager will respond to local start commands but will ignore serial port start commands. If Status Input 1 is closed then the Motor Manager will respond to serial port Start commands and ignore local start commands. "CLOSED" - switch input closed - remote mode "OPEN" - switch input open - local mode
A 3.16	STATUS INPUT 2 *CLOSED*	If Status Input 2 (terminals 35-36) is closed, the Motor Manager will close contactor A and start the motor. If Status Input 2 is opened, the Motor Manager will open contactor A and stop the motor. NOTE: Status Input 2 start/stop only functions if Two Wire Start has been enabled in Setpoints, and the starter type is direct-on-line.
A 3.17	END OF PAGE 3 ACTUAL VALUES	Last line of page 3. Press PAGE key to view next page.

Location	Message	Description
A 4.1	ACTUAL VALUES PG 4: STATISTICS	Historic information about motor operation, starts, trips, etc is displayed in this page.
A 4.2	RUNNING TIME *12* HOURS	Total time motor has been running. Whenever motor current exceeds 7% of the full load setting, it is considered to be running.
A 4.3	NUMBER OF STARTS *352*	Each time the motor current goes from zero to an operating current value the number of starts is incremented.
A 4.4	TOTAL NUMBER OF TRIPS *38*	Every time the motor trips for any reason, this value is incremented. It is the sum of all the individual causes of trip.
A 4.5	OVERLOAD TRIPS: *8*	Every time the motor trips due to an overload; that is, the thermal capacity reaches 100%, this value is incremented.
A 4.6	THERMISTOR TRIPS: *0*	Each time the thermistor resistance exceeds the hot temperature for PTC thermistors or falls below the hot temperature for NTC thermistors causing a trip, this value is incremented.
A 4.7	GROUND FAULT TRIPS: *11*	Each time the ground fault current exceeds the trip setpoint causing a trip, this value is incremented.
A 4.8	SINGLE PHASE TRIPS: *50*	When the phase unbalance exceeds the internally preset level for the required time to cause a trip, this value is incremented. The trip unbalance threshold is set to a single phase condition value.
A 4.9	ACCELERATION TRIPS: *1*	Each time the motor takes longer to reach full load current on startup than specified by the acceleration time setpoint, the motor is tripped and this value is incremented.
A 4.10	UNDERCURRENT TRIPS: *7*	If undercurrent trip is enabled, when the motor current falls below the undercurrent setpoint long enough to cause a trip, this value will be incremented. Undercurrent trip is disabled when the motor is not running.
A 4.11	STALLED ROTOR TRIPS: *0*	Stalled rotor is a special case of overload. If during running only, the current continuously exceeds the stalled rotor setpoint, the motor will be tripped and this value will be incremented.
A 4.12	CONTROL COMMAND TRIPS: *3*	If a control condition causes a trip to occur this message along with the number of control condition trips will appear. Possible causes are: PLANT INTERLOCK - Plant interlock input open during motor operation. ISOLATOR OPEN - Isolator open during motor operation.
A 4.13	END OF PAGE 4 ACTUAL VALUES	Last line of page 4. Press PAGE key to view page 1.

SETPOINTS MODE

In setpoints mode any or all of the motor trip/alarm setpoints may be viewed or altered. This mode is divided into three pages of data. Information about the motor is entered in the MOTOR DATA page to match its characteristics. System information describing what devices are used and how the motor is to operate are entered in the CONFIGURATION page, and detailed motor information is entered in the ADVANCED LEVEL page.

To enter setpoints mode the SETPOINTS key must be pressed. When in this mode, if no key is pressed for more than two minutes, the default display will automatically override the existing message. To return to setpoints mode, the SETPOINTS key must be pressed again. When this key is pressed the following message will appear on the display:

```
SETPOINTS PAGE 1
 MOTOR DATA
```

which is the first line of the first page of setpoints mode. The PAGE, LINE UP, and LINE DOWN keys may be used to view all of the setpoints data.

When setpoints are to be changed, the VALUE UP and VALUE DOWN keys are used. The Access terminals (39/40) must first be shorted together. The PAGE, LINE UP, and LINE DOWN keys are used to display the setpoints that are to be changed. The setpoints themselves are changed by pressing the VALUE UP or VALUE DOWN keys until the desired value is reached. When the setpoint is adjusted to its proper value the STORE key must be pressed in order to store the setpoint into the Motor Manager's internal memory. Once the STORE key is pressed the flash message

```
NEW SETPOINT
 STORED
```

will appear on the display and the new setpoint value is now permanently saved.

If an attempt is made to store a new setpoint value without the Access terminals shorted together, the new value will not be stored and the flash message

```
 ILLEGAL ACCESS
```

will appear on the display. To make the setpoints tamperproof the Access terminals should be shorted together only when setpoints are to be changed.

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 Motor Manager's 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.

Setpoint Message Abbreviations

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

A,AMPS	Amperes
ALRM	Alarm
COM	Communication
CT	Current transformer
FLC	Full load current
G/F	Ground fault
GND	Ground
INCR	Increase
KOHMS	Kiloohms
MAX	Maximum
MIN	Minimum
PRI	Primary
PROG	Programmable
SEC	Seconds
TRP	Trip
U/CURRENT	Undercurrent
UV	Undervoltage

Setpoints Message Summary

Page	Contents
1	Motor Data
	Communication Address Baud Rate Overload Curve Number Full Load Current Acceleration Time Ground Fault Trip Ground Fault Alarm Stalled Rotor Trip Undercurrent Trip Undercurrent Alarm Load Increase Alarm Undervoltage Restart
2	Configuration
	Phase CT Primary Rating High Sensitivity Gnd Fault CT Ground Fault CT Ratio Thermistor Trip Thermistor Alarm Unbalance Alarm Overload Reset Method Starter Type Serial Communication Fail Trip Internal Fault Trip Programmable Relay #1 Clear Statistics Status Input #2 for 2-wire start Firmware Revision
3	Advanced Level
	Hot/Cold Curve Ratio Stopped Motor Cool Time Minimize Reset Time

Setpoints Name	Factory Setpoint	Range	Step
1. Motor Data			
Communication Address	1	1-255	1
Baud Rate	1200 baud	1200,2400,4800,9600 baud	
Overload Curve	1	1-8	1
Full Load Current (Phase CT Primary≤50)	10.0A	1.0-100.0A	0.1A
Full Load Current (Phase CT Primary>50)	100A	10-1000A	1A
High Speed FLC (High Speed CT Primary≤50)	10.0A	1.0-100.0A	0.1A
High Speed FLC (High Speed CT Primary>50)	100A	10-1000A	1A
Acceleration Time	OFF	0.5-125.0 sec, OFF	0.5 sec
Gnd. Fault Trip Level (2000:1 CT)	OFF	1-10A, OFF	1A
Gnd. Fault Trip Level (x:5 CT)	OFF	10-100%, OFF	5%
Gnd. Fault Trip Delay	1.0 sec	0.0-2.0 sec	0.1 sec
Gnd. Fault Alarm Level (2000:1 CT)	OFF	1-10A, OFF	1.0A
Gnd. Fault Alarm Level (x:5 CT)	OFF	10-100%, OFF	5%
Gnd. Fault Alarm Delay	5 sec	1-60 sec	1 sec
Stalled Rotor Level	OFF	1.5-4.5 xFLC, OFF	0.1 xFLC
Stalled Rotor Delay	2.0 sec	0.5-5.0 sec	0.5 sec
Undercurrent Trip Level	OFF	10-100%, OFF	5%
Undercurrent Trip Delay	10 sec	1-60 sec	1 sec
Undercurrent Alarm Level	OFF	10-100%, OFF	5%
Undercurrent Alarm Delay	10 sec	1-60 sec	1 sec
Load Increase Alarm Level	OFF	60-110%	1%
Undervoltage Restart	Disable	Enable/Disable	
Pulse Start	UV 4.5 Sec Max	UV 4.5 Sec Max/Time Unlimited	
Restart Time Delay	2.0 sec	0.2-300.0 sec	0.2 sec
2. Configuration Data			
Phase CT Primary Current	100A	5-1000A	5A
High Speed Phase CT Primary Current	100A	5-1000A	5A
High Sensitivity Gnd Fault CT	Enable	Enable/Disable	
Ground Fault CT Ratio	50:5	5-1000	5
Thermistor Hot Level	20.0 kohms	0.1-30.0 kohms	0.1 kohms
Thermistor Cold Level	0.1 kohms	0.1-30.0 kohms	0.1 kohms
Thermistor Alarm	Disable	Enable/Disable	
Thermistor Trip	Disable	Enable/Disable	
Unbalance Alarm	Disable	Enable/Disable	
Overload Reset	Manual	Manual/Auto	
Starter Type	Direct on line	Direct on line, Reversing, Star-Delta, Two Speed	
Transition Time	0 sec	0-125 sec	1 sec
Star-Delta Changeover Time	30 sec	2-100 sec	1 sec
Serial Com Fail Trip Delay	OFF	5-25 sec, OFF	5 sec
Internal Fault Trip	Disable	Enable/Disable	
Programmable Relay #1 Assignment	Alarms	Alarms, Trips, Status Input 2, Contactor C, Load Increase, Pre Contactor A, OFF, Post Contactor B, Post Contactor A	
Programmable Relay #1 Delay	0 sec	0–125	1
Clear Statistics	Disable	Enable/Disable	
Status Input #2	OFF	OFF, 2 Wire Control, Plant Interlock	
Firmware Revision	Current Rev.	—	—

Setpoints Name	Factory Setpoint	Range	Step
3. Advanced Level			
Enhanced Motor Data	Disable	Enable/Disable	
Hot/Cold Curve Ratio	75%	20-100%	1%
Stopped Motor Cool Time	30 min	10-120 min	1 min
Minimize Reset Time	Disable	Enable/Disable	

SETPOINTS MESSAGES

Location	Message	Description
S 1.1	SETPOINTS PAGE 1 MOTOR DATA	Information about the motor characteristics and desired alarm levels is entered on this page of messages.
S 1.2	COMMUNICATION ADDRESS: *1*	Range: 1-255 Each Motor Manager on the same serial communication network must have a unique address from 1-255. Computer software driving the serial network must be configured to recognize each separate address. Use the next sequential available address on the system.
S 1.3	COMMUNICATIONS AT *1200* BAUD	Range: 1200,2400,4800,9600 baud This setpoint is used to select the data transfer rate for serial communications. Use the VALUE UP or VALUE DOWN key to select.
S 1.4	OVERLOAD CURVE NUMBER: *2*	Range: 1-8 It is possible to select 1 of 8 different I2t time-overcurrent overload curves. The higher the number, the longer the stall time. Consult the overload curve figure in this manual 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.
S 1.5	FULL LOAD CURRENT: *300*	Range: 10-1000 amps (if CT primary setting in message S2.3 $\geq$ 50) or 1.0-100.0 amps (if CT primary setting in message S2.3 $<$ 50) Usually the rated current on the motor nameplate is entered as the full load current value. A lower value will effectively overprotect 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 will start to be used up and the motor will eventually trip according to the timed-overcurrent curve selected.

Message S1.6 will only appear if TWO SPEED starter is selected in message S2.13.

Location	Message	Description
S 1.6	HIGH SPEED FLC *600* AMPS	Range: 10-1000 amps or 1.0-100.0 amps 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.
S 1.7	ACCELERATION TIME: *15.0* SEC	Range: 0.5-125/OFF seconds When motor current goes from zero to an operating value greater than full load the motor is considered to be in a start mode. When current drops to an operating value below the full load current setting it is considered to be out of start and in a run mode. If the motor current remains in start mode longer than the acceleration time selected here then an acceleration time trip will result. Acceleration time has no effect on the time-overcurrent thermal capacity modelling which operates at all times. Normally the motor nameplate locked rotor time is entered for this setting.

Location	Message	Description
S 1.8	GROUND FAULT TRIP LEVEL: 10.0 A	Range: 10% - 100%/OFF Motor FLC (x:5 CT) 1-10 A/OFF (2000:1 CT) 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 leakage trips at a later time would indicate a deterioration in the system; insulation integrity should be verified. Persistent, high values of leakage current pose a threat to personnel and equipment and should not be left unchecked.

Message S1.9 will not appear if OFF is selected in message S1.8.

S 1.9	GROUND FAULT TRIP DELAY: 2.0 SEC	Range: 0.0-2.0 seconds Ground fault trip must be co-ordinated with other protective relaying. As a guideline, on resistance grounded systems, the delay line should be 1-2 seconds to prevent nuisance trips. Use the shortest delay available on solidly grounded systems to minimize damage under a heavy fault and to prevent upstream protection from opening a feeder thus shutting down other equipment.
S 1.10	GROUND FAULT ALRM LEVEL: 5 A	Range: 10% - 100%/OFF Motor FLC (x:5 CT) 1-10 A/OFF (2000:1 CT) Set the ground leakage alarm level to some arbitrary amount below the 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.

Message S1.11 will not appear if OFF is selected in message S1.10.

S 1.11	GROUND FAULT ALRM DELAY: 3 SEC	Range: 1-60 seconds Select a delay long enough to prevent nuisance alarms for momentary surges.
S 1.12	STALLED ROTOR LEVEL: 3 xFLC	Range: 1.5-4.5/OFF Mechanical equipment such as pumps or fans can be quickly damaged if they get jammed 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 Motor Manager will trip when the running current exceeds this value after the STALLED ROTOR TIME (next message). 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.

Message S1.13 will not appear if OFF is seleceted in message S1.12.

S 1.13	STALLED ROTOR DELAY: 3.0 SEC	Range: 0.5-5 seconds If the stalled rotor level is set to a value other than OFF, the Motor Manager will trip after the time specified by this setpoint.

Location	Message	Description
S 1.14	UNDERCURRENT TRP LEVEL: 30 %FLC	Range: 10% - 100% x FLC/OFF 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 motor will be tripped. Set this value to "OFF" if no undercurrent trip is required.

Message S1.15 will not appear if OFF is selected in message S1.14.

Location	Message	Description
S 1.15	UNDERCURRENT TRP DELAY: 2 SEC	Range: 1-60 seconds Set the undercurrent trip delay long enough to prevent nuisance trips from momentary current dips when the undercurrent trip feature is used.
S 1.16	U/CURRENT ALARM LEVEL: 70 %FLC	Range: 10% - 100% x FLC/OFF This feature functions the same as the Undercurrent Trip feature but produces an alarm indication instead of a trip.

Message S1.17 will not appear if OFF is selected in message S1.16.

Location	Message	Description
S 1.17	U/CURRENT ALARM DELAY: 3 SEC	Range: 1-60 seconds Delay for activation of Undercurrent Alarm.
S 1.18	LOAD INCR. ALARM LEVEL: 70 % FLC	Range: 60-110%/OFF If a warning is required for sensing when motor current is approaching or in an overload condition, this value can be set to a suitable level. When current exceeds this value, local output relay terminals 8, 9, and 10 will energize if selected as an alarm or load increase output to provide a remote warning or as a process signal. Set it to "OFF" if not required.
S 1.19	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, which is derived from the incoming motor supply, drops below the dropout voltage, both contactors will be de-energized. Voltage thresholds for the two internally set control voltage levels are: 85V for 120V setting and 170V for 240V setting. If control voltage is restored within 0.2 seconds, the contactor will be energized immediately. If the supply is restored after 0.2 seconds but less than 4.5 seconds later, if 4.5 Max is selected in message S1.20, the contactor will be energized after the restart time delay. Select DISABLE if this feature is not required. NOTE: When using Undervoltage Restart with Direct-on-line Starter type, the unused contactor B NC status input (terminals 28, 30) must be shorted.

Messages S1.20-S1.21 will only appear if ENABLE is selected in message S1.19.

Location	Message	Description
S 1.20	PULSE START: UV 4.5 SECS MAX	Range: TIME UNLIMITED/UV 4.5 SECS MAX UV 4.5 SECS MAX causes a delayed restart for any power loss time between 0.2 and 4.5 sec. TIME UNLIMITED causes a delayed restart for any power loss time >0.2 seconds.

Location	Message	Description
S 1.21	RESTART TIME DELAY: *2.2* SEC	Range: 0.2-300 seconds This is the delay time, after contact de-energization, that contactor A or B will be activated after motor voltage is restored.
S 1.22	END OF PAGE 1 SETPOINTS	The last line of page 1. Press the PAGE key to view page 2.
S 2.1	SETPOINTS PAGE 2 CONFIGURATION	Information about external components and how the Motor Manager is to be configured are entered on this page.
S 2.2	PHASE CT PRI AMPS: *500*	Range: 5-1000 amps Enter the phase CT rated primary amps. For example, if the phase CT's are rated 500:5, enter 500. The secondary of the CT must be connected to the correct input. ie. 1 amp or 5 amp.

Message S2.3 will only appear if TWO SPEED starter is selected in message S2.13.

S 2.3	HIGH SPEED CT PRI AMPS: *700*	Range: 5-1000 amps Enter the high speed CT rated primary amps. This setpoint is only in effect while contactor B is energized.
S 2.4	HIGH SENSITIVITY G/F CT: *ENABLE*	Range: ENABLE/DISABLE A sensitive 2000:1 core balance ground fault CT is available. If this is used, select ENABLED. If residual sensing of the phase CT's or a separate core balance CT with a 5 amp secondary is used, select DISABLE.

Message S2.5 will only appear if DISABLE is selected in message S2.4.

S 2.5	GROUND FAULT CT RATIO *25* :5	Range: 5-1000 amps When a separate zero sequence or core balance CT is used for ground fault sensing, or if resident sensing is used, enter the primary ratio here.

Message S2.6 will only appear if DISABLE is selected in message S2.4 and TWO SPEED starter is selected in message S2.13.

S 2.6	HIGH SPEED G/F CT RATIO *55*:5	Range: 5-1000 amps Enter the high-speed primary ratio here. This setpoint is only in effect while contactor B is energized.
S 2.7	THERMISTOR HOT: *3.0* kOHMS	Range: 0.1-30 kΩ Enter the hot (trip) and cold (untripped) thermistor threshold values in these two messages. For example, if a positive temperature coefficient thermistor (PTC) has a cold resistance of 200 ohms and a hot resistance of 3000 ohms, enter: HOT - 3.0 k COLD - .2 k
S 2.8	THERMISTOR COLD: *0.2* kOHMS	
S 2.9	THERMISTOR ALARM: *ENABLE*	Range: ENABLE/DISABLE When a thermistor is used, it can be selected for an alarm or trip or both. Choose "ENABLED" to cause the thermistor exceeding the hot value to generate an alarm.

Location	Message	Description
S 2.10	THERMISTOR TRIP: *ENABLE*	Range: ENABLE/DISABLE When a thermistor is used, it can be selected for an alarm or trip or both. Choose "ENABLED" to cause the thermistor exceeding the hot value to generate a trip.
S 2.11	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 ENABLED. The internal threshold is 15% and the unbalance must be above this threshold for at least 5 sec. for the alarm to occur.
S 2.12	OVERLOAD RESET: *MANUAL*	Range: MANUAL/AUTO If this message 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%. NOTE: Lockout reset terminals (37, 38) can be shorted to reset the overload trip at any time. The lockout reset feature will work whether the setting is MANUAL or AUTO.
S 2.13	STARTER TYPE: *DIRECT ON LINE*	Range: DIRECT ON LINE - contactor = A REVERSING - forward = A reverse = B STAR-DELTA - star = A (start) delta = B (changeover) TWO SPEED - speed 1 = A speed 2 = B Select a type according to the configuration installed. This will determine the control logic used for contactor A and contactor B control.

Message S2.14 will only appear if STAR-DELTA starter is selected in message S2.13.

Location	Message	Description
S 2.14	STAR-DELTA CHANGE: *30* SEC	Range: 2-100 seconds After the time selected in this message contactor A will de-energize and contactor B will energize to reconnect the motor winding from STAR to DELTA.

Message S2.15 will only appear if TWO SPEED or REVERSING starter is selected in message S2.13.

Location	Message	Description
S 2.15	TRANSITION TIME *125* SECS	Range: 0-125 seconds This delay is required for when the motor is switched from a high speed to a low speed. (Delay between when contactor B drops out to when contactor A energizes.) When using a reversing starter type, the delay will exist in both direction after the initial start. NOTE: This timer is disabled when the programmable relay #1 is assigned to Pre Contactor A.
S 2.16	SERIAL COM FAIL TRIP: *OFF*	Range: 5-25/OFF If the serial communications link is used to control a process with several motors working together, it may be desirable to shut down the motor if communication control is lost. When the Motor Manager senses no activity on the communications port for 5-25 seconds, it will shut off the motor if this feature is enabled.

Location	Message	Description
S 2.17	INTERNAL FAULT TRIP: *DISABLE*	Range: ENABLE/DISABLE When the Motor Manager detects an internal fault during self checking it will cause an alarm. Since operation is erratic depending on the fault condition, it may be desirable to also trip by enabling this setpoint. If it is desirable the Motor Manager will continue to run the motor with an internal fault present, if this setpoint is disabled.
S 2.18	PROG. RELAY #1: *ALARMS*	Range: ALARMS, TRIPS, POST CONTACTOR A, POST CONTACTOR B, OFF, LOAD INCREASE, PRE CONTACTOR A, CONTACTOR C, STATUS INPUT 2. A local output relay connected to terminals 8, 9, 10 is provided for user applications. It can be configured to activate on various conditions as described below.

SETTING	ACTION
ALARMS	Active while an alarm is present.
TRIPS	Active if a trip occurs. It will only de-energize when the trip is RESET.
POST CONTACTOR A	Active after delay expires in message S2.19 when contactor A is energized. Note that the relay de-energizes when contactor A drops out.
POST CONTACTOR B	Active after delay expires in message S2.19 when contactor B is energized. Note that the relay de-energizes when contactor B drops out.
OFF	Controlled through serial port.
LOAD INCREASE	Active while LOAD INCREASE alarm present.
PRE CONTACTOR A	Active as soon as signal is sent to energize contactor, but contactor A energizes after the delay in message S2.19 has expired. Note that the relay de-energizes when contactor A drops out.
CONTACTOR C	Active while either contactor A or contactor B is energized.
STATUS INPUT 2	Active while Input 2 terminals (35/36) are closed.

Message S2.19 will only appear if PRE CONTACTOR A, POST CONTACTOR A, or POST CONTACTOR B is selected in message S2.18.

Location	Message	Description
S 2.19	PROG RELAY #1 DELAY: *3* SEC	Range: 0 - 125 sec This setpoint can be used to provide a delayed activation of Programmable Output Relay #1 following the energization of the contactor if POST CONTACTOR A or POST CONTACTOR B is selected in message S2.18. If PRE CONTACTOR A is selected in message S2.18 the output relay #1 will energize as soon as the signal is sent to energize contactor A but contactor A will energize after the delay in this setpoint has elapsed.

MULTILIN

Location	Message	Description
S 2.20	CLEAR STATISTICS? *DISABLE*	Range: ENABLE/DISABLE Running hours, starts and trip counts will be continuously accumulated. When a Motor Manager is first installed or if a motor is replaced, all statistics should be cleared using this message. To implement the clear action, select ENABLE using the VALUE UP key and press STORE.

Message S2.21 will only appear if DIRECT ON LINE starter is selected in message S2.13.

Location	Message	Description
S 2.21	STATUS INPUT #2 *2 WIRE CONTROL*	Range: OFF, 2 WIRE CONTROL, PLANT INTERLOCK Status Input #2 (35/36) can be used to provide a 2 WIRE START or latch the PLANT INTERLOCK trip as described below.

SETTING	ACTION
OFF	Feature disabled.
2 WIRE CONTROL	Shorting the terminals (35/36) of Input 2 will cause contactor A to energize and opening them will cause contactor A to drop out. Note that START A input (18/19) can still be used to energize contactor A but this will cause Input 2 to be disabled until a trip or stop has been detected.
PLANT INTERLOCK	if Input 2 terminals (35/36) are open and a PLANT INTERLOCK trip occurs, the trip will be latched even if the trip condition has been removed. The trip can be cleared either by shorting the Input 2 terminals or by pressing the RESET key on the keypad.

Location	Message	Description
S 2.22	301 MOTOR MNGR. REV XX.XX	This message identifies the 301 firmware revision. This message is also displayed upon power up.
S 2.23	FACTORY SERVICE DATA: *ENABLE*	Range: ENABLE/DISABLE This setpoint should only be used by service personnel

Message S2.24 will only appear if ENABLE is selected in message S2.23.

Location	Message	Description
S 2.24	ENTER SERVICE CODE *XXXX*	Range: 0000-9999 Factory setup messages are used to configure the Motor Manager during production. Modification by users could cause incorrect operation of the product. To prevent accidental entry, a passcode must be entered. Once the message is displayed enter the 4 digit passcode using the keys as a keypad organized as:

1	2	3
4	5	6
7	8	9

Once the correct code is entered, factory service messages can be displayed.

Location	Message	Description
S 2.25	END OF PAGE 2 SETPOINTS	The last line of page 2. Press the PAGE key to view page 3.

Location	Message	Description
S 3.1	SETPOINTS PAGE 3 ADVANCED LEVEL	This page contains setpoints requiring detailed motor information.
S 3.2	ENHANCED MOTOR DATA: *DISABLE*	Range: ENABLE/DISABLE This setpoint is used to access the setpoints contained in the remaining lines of this page. This setpoint must be ENABLED each time when re-entering this page.

Messages S3.3-S3.5 will only appear if ENABLE is selected in message S3.2.

S 3.3 — HOT/COLD CURVE RATIO: *75%*

Range: 20-100%
This setpoint defines the ratio of motor "hot" thermal characteristic to the motor "cold" characteristic. 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 or below its full load current long enough for the motor temperature to reach its steady state value, which is defined as the HOT temperature.

Example:
Motor Load = 80% FLC
Hot/Cold Curve Ratio = 50%

$$\text{Thermal Capacity Used} = \left|\frac{\text{Motor Load}}{100}\right| \times \left|100 - \text{Hot / Cold Curve Ratio}\right|$$
$$= \left|\frac{80}{100}\right| \times \left|100 - 50\right|$$
$$= 0.8 \times 50$$
$$\text{Thermal Capacity Used} = 40\%$$

S 3.4 — STOPPED MOTOR COOL TIME: *30* MIN

Range: 10-120 minutes
The Stopped Motor Cool Time determines how long it takes for a motor running at or below its full load current to reach the steady state temperature.

Example:
Maximum Thermal Capacity = 40%
Stopped Motor Cool Time = 30 min

$$\text{Time to reach steady state} = \left|\frac{\text{maximum TC}}{100}\right| \times \left|\frac{\text{stopped Motor Cool Time}}{2}\right|$$
$$= \left|\frac{40}{100}\right| \times \left|\frac{30\ \text{min}}{2}\right|$$
$$= 0.4 \times 15$$
$$= 6.0\ \text{min}$$

The cooling time set here will also be the amount of time the motor thermal capacity will take to decrease from 100% to 0% after an OVERLOAD trip. Note that the overload trip can be reset after the thermal capacity falls below the internally set 15%.

Location	Message	Description
S 3.5	MINIMIZE LOCKOUT TIME: *DISABLE*	Range: ENABLE/DISABLE The Motor Manager can be set to measure the motor thermal capacity used during a start. This data can be used to minimize the lockout time following an Overload Trip to allow 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 complete motor cooling time chosen in the previous setpoint. Example: If maximum thermal capacity used during a start is 40%, then after an occurrence of an overload trip, a RESET can be accomplished while 60% of thermal capacity is still remaining as shown below. 100% - max TC used during a start 100%-40% = 60%
S 3.6	END OF PAGE 3 SETPOINTS	The last line of page 3. Press the PAGE key to view page 1.

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

OVERLOAD CURVE TRIP TIMES

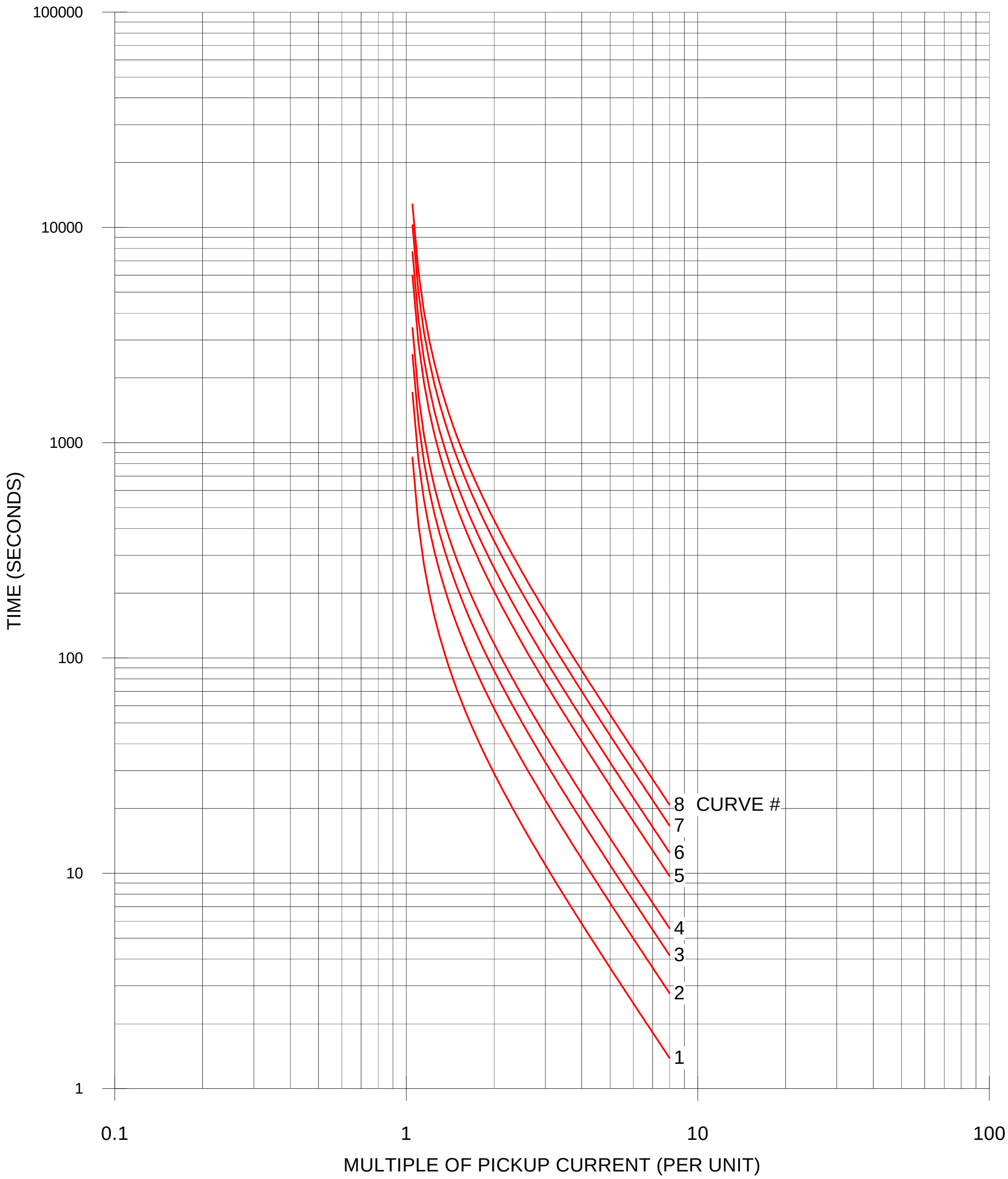

Figure 3-2 Time/Overcurrent Trip Times

PRIMARY INJECTION TESTING

Prior to relay commissioning at an installation, complete system operation can be verified by injecting current through the phase and ground fault CTs. To accomplish this a high current injection test set is required.

Operation of the entire relay system, except the phase and ground fault CTs, can be checked by applying input signals to the Motor Manager from a secondary injection test set as described in the following sections.

SECONDARY INJECTION TESTING

Figure 4-1 shows a simple, single phase secondary injection test circuit that can be used to perform all tests described in the following sections. Tests should be performed to verify the 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 the following sections can be repeated and modified using setpoints and current levels more closely suited to the actual installation.

PHASE CURRENT FUNCTIONS

Any phase current protection is based on the ability of the Motor Manager to read phase input currents accurately. In SETPOINTS PAGE 2 alter and store PHASE CT PRI AMPS = 100A. To determine if the relay is reading the proper input current values inject different phase currents into the 5A CT inputs and view the current readings in ACTUAL VALUES mode, page 1. The displayed current should be:

displayed current = actual injected current x 100/5 (phase CT ratio) (eg. if 3 amps are injected, the phase current reading should be 3 x 100/5 = 60 amps)

Similar phase accuracy testing can be conducted on the phase 1A CT input by re-wiring the phase CTs and

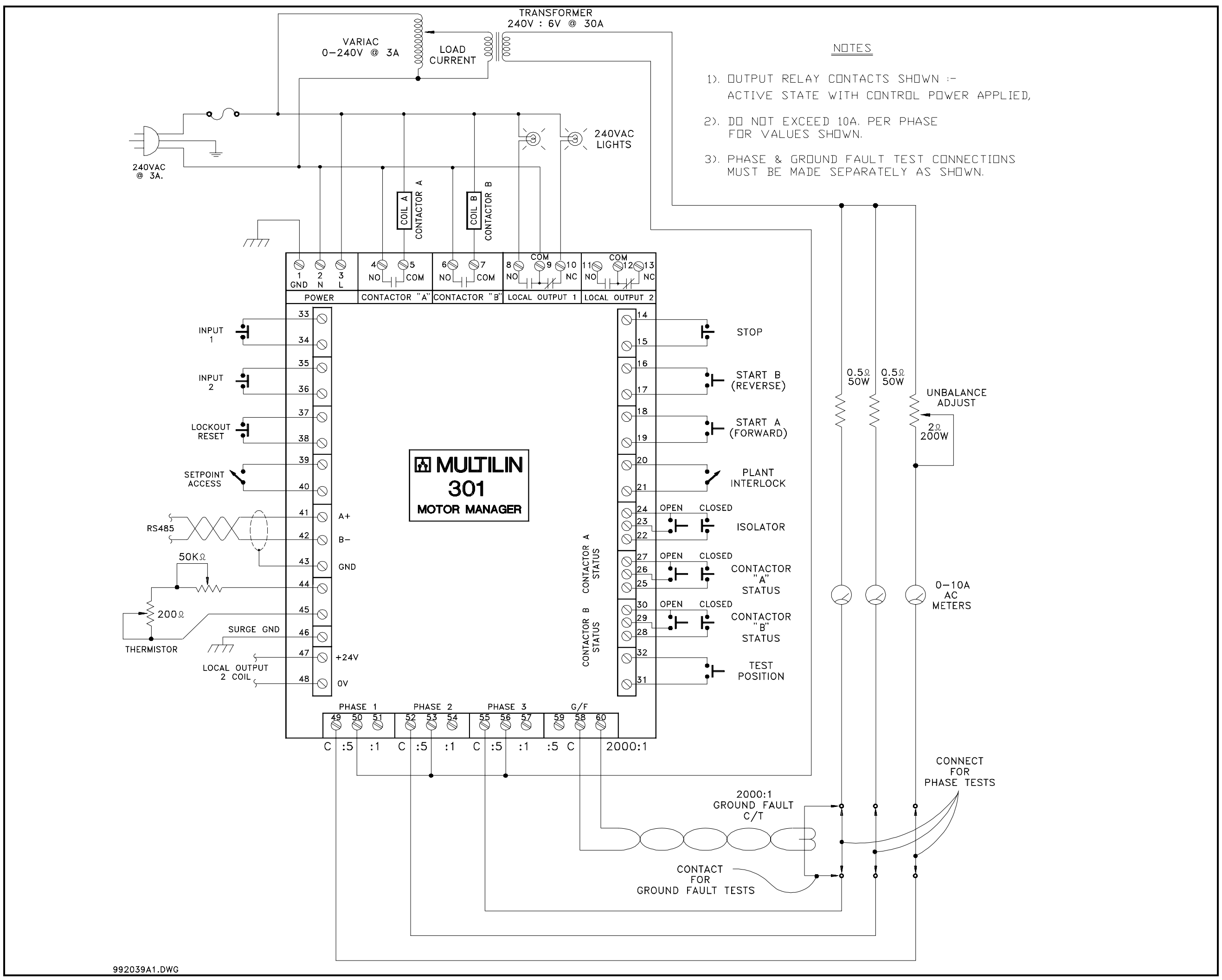

Figure 4-1 Secondary Injection Test Setup

multiplying the actual injected current by a phase CT ratio of 100/1.

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 will be displayed as 0.

Once the accuracy of the 1A/5A phase CT inputs has been established, various phase alarm and trip condition testing can be performed on the relay by altering relay setpoints and injected phase currents.

To simulate an overload condition, enter page 1 of SETPOINTS and alter and store OVERLOAD CURVE NUMBER = 4 and FULL LOAD CURRENT = 50A. Phase CT Primary Amps should still be set to 100A. Put a contact closure across the start 1 input and note that the RUNNING LED goes on. Inject a current of 10 Amps into all three phases. The relay will display a current value of:

displayed current = actual injected current x 100/5 = 10 x 100/5 = 200 Amps.

This represents four 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, verify using the ACTUAL VALUES mode, that the Thermal Capacity used is now 100%. Press Lockout Reset to reset the unit.

To prepare the relay to simulate an unbalance alarm, enter page 2 of SETPOINTS and alter & store UNBALANCE ALARM = ENABLE and set PROG. RELAY 1 = ALARMS. Inject 5.0 Amps into all three phase CTs. The Motor Manager will display a balanced phase current of 100 Amps for each phase. While still viewing Actual Values begin slowly decreasing phase 1 current until the UNBALANCE ALARM message comes on. Unbalance is calculated as follows:

For average currents greater than the motor full load:

$$\left|\frac{I_n - I_{av}}{I_{av}}\right| > 15\% \text{ (alarm)} \qquad 30\% \text{ trip}$$

For average currents less than motor full load:

$$\left|\frac{I_n - I_{av}}{I_{fl}}\right| > 15\% \text{ (alarm)} \qquad 30\% \text{ trip}$$

$$I_{av} = \frac{(I_A + I_B + I_C)}{3}$$

Where:

In = RMS current in any phase with maximum deviation from the average current Iav
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

Example 1: To find % unbalance given the following information:

Primary	Secondary (5A)
I_A=73	3.65A
I_B=100	5A
I_C=100	5A

$$I_{av} = \frac{(I_A + I_B + I_C)}{3} = \frac{273}{3}$$

I_{av} = 91A

Since: $I_{av} < I_{fl}$

Use: % unbalance $= \frac{|I_n - I_{av}|}{I_{fl}} \times 100 = \frac{|73 - 91|}{100} \times 100$ = 18%

Since % unbalance is >15% an UNBALANCE alarm will occur if this condition persists for longer than 5 seconds.

Example 2:

Primary	Secondary (5A)
I_A=100A	5A
I_B=80A	4A
I_C=150A	7.5A

$$I_{av} = \frac{(I_A + I_B + I_C)}{3} = \frac{330}{3}$$

I_{av} = 110A

Since: $I_{av} > I_{fl}$

% unbalance $= \frac{|I_n - I_{av}|}{I_{fl}} \times 100 = \frac{|150 - 110|}{100} \times 100$ = 36.4%

Since % unbalance is >30% a SINGLE PHASE trip will occur if the unbalance persists for longer than 5 seconds.

GROUND FAULT CURRENT FUNCTIONS

Test the Ground Fault CT, (5A / 2000:1) in a similar manner to phase currents for accuracy at various injected current levels.

To check alarm and trip levels go to page 2 of SETPOINTS, set 2000:1 G/F CT:DISABLED and GROUND FAULT CT PRI = 100:5, then move to page 2 of SETPOINTS and alter and store a G/F ALRM LEVEL = 40 Amps and a GROUND FAULT TRIP LEVEL = 80 Amps.

While displaying Actual Values, Ground Fault current, begin injecting current into the 5 Amp Ground Fault CT input. The Alarm LED will become lit and the Prog. Status Relay will change state at one half the trip setting, ie. at a displayed Ground Fault current of 40 Amps. With the display showing a GROUND FAULT ALARM message, change the display to read Actual Values, Ground Fault current and continue increasing current. At a relay display current of 80 Amps, the Tripped and Stopped LEDs become lit. The Running LED turns off and Contactor A relay contacts will change state to the stopped position. The Motor Manager will display a Ground Fault Trip message. Turn Ground Fault current off and momentarily short the Lockout Reset input terminals to reset the relay.

Momentarily close the START A input to cause the RUN light to come on.

INPUT FUNCTIONS

Operation of each relay switch input can be verified using the Motor Manager display. Go to page 3, Actual Values, Status and with the LINE UP and LINE DOWN key view the status of each input one at a time. Switch each of the corresponding displayed inputs noting that the display reflects the present status of the input terminals. The status is shown as either OPEN or CLOSED. Note: exercise caution when testing these inputs as 120 VAC is internally supplied to the terminals by the relay.

THERMISTOR INPUT TESTS

Begin thermistor testing by first entering page 2 of the Motor Manager setpoints and storing the following thermistor values:

THERMISTOR HOT : 30 kOHMS
THERMISTOR COLD : 0.1 kOHMS
THERMISTOR ALARM : ENABLE
THERMISTOR TRIP : DISABLE

Place a variable 50K pot or resistance box across thermistor terminals 44/45 as shown in the secondary injection wiring diagram. With the input resistance initially 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 by the relay. Check with an ohm meter that the thermistor resistance agrees with the stored Thermistor Hot setpoint value. When the resistance is decreased below the resistance setpoint the alarm will disappear.

To check the thermistor trip function go back to page 2 of SETPOINTS and enable the thermistor trip by storing THERMISTOR TRIP = ENABLE and THERMISTOR ALARM = DISABLE. With the thermistor resistance initially set to zero begin increasing resistance until a thermistor trip occurs. Note that the Alarm, Tripped and Stopped LEDs are lit, contactor A has opened, the Running LED is off and a THERMISTOR TRIP message is displayed. Verify that the thermistor resistance value agrees with the Thermistor Hot setpoint value using an ohm meter. Decrease the thermistor resistance below the Thermistor Hot value. Press the reset key verifying that the relay still indicates a trip. Reduce thermistor resistance just below the Thermistor Cold value. Press the keypad RESET key, noting that the Tripped LED turns off and the default display message returns. Momentarily short the Start A input terminals noting that Contactor A contacts now close and the Running LED becomes lit.

POWER FAIL TEST

To test the Power Fail circuit begin decreasing control voltage with a variac. When the control voltage drops below 85 for 120VAC input or 170 for 240VAC input, the fault light comes on and the Motor Manager ceases to operate. The Motor Manager 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 Motor Manager resumes its normal operation. Check the power fail memory circuit by verifying that setpoints, statistical data and thermal capacity have not been altered.

Overview

The 301 Motor Manager Relay implements a subset of the AEG Modicon Modbus serial communications standard. Modbus protocol is hardware-independent. That is, the physical layer can be any of a variety of standard hardware configurations. This includes RS232, RS422, RS485, fibre optics, etc. Modbus is a single master/multiple slave type of protocol suitable for a multi-drop configuration as provided by RS485 hardware. The 301 Relay Modbus implementation employs two-wire RS485 hardware. Using RS485, up to 32 slaves can be daisy-chained together on a single communication channel.

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

Modbus protocol exists in two versions: Remote Terminal Unit (RTU), binary) and ASCII. Only the RTU version is supported by the 301 Relay.

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

Electrical Interface

The hardware or electrical interface in the 301 Relay is two-wire RS485. In a two-wire link data flow is bidirectional. That is, data is transmitted and received over the same two wires. This means that the data flow is half duplex. That is, data is never transmitted and received at the same time.

RS485 lines should be connected in a daisy chain configuration with terminating resistors installed at each end of the link (ie. at the master end and at the slave farthest from the master). The value of the terminating resistors should be approximately equal to the characteristic impedance of the line. Belden 9841, 24 AWG stranded, shielded twisted pair wire, or equivalent, with a characteristic impedance of 120 Ω should be used to minimize noise.

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

Data Frame Format and Rate

One data frame of an asynchronous transmission to or from a 301 Relay consists of 1 start bit, 8 data bits, and 1 stop bit. This produces a 10 bit data frame. This is important for transmission through modems at high bit rates (11 bit data frames are not supported by Hayes modems at bit rates of greater than 300 bps).

Modbus protocol can be implemented at any standard communication speed. The 301 Relay supports operation at 1200, 2400, 4800 and 9600 baud.

Data Packet Format

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

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

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

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

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

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

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

FUNCTION CODE - This is the second byte of every transmission. Modbus defines function codes of 1 to 127. The 301 Relay implements some of these functions.

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

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

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

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

Error Checking

The RTU version of Modbus includes a two byte CRC-16 (16 bit cyclic redundancy check) with every transmission. The CRC-16 algorithm essentially treats the entire data stream (data bits only; start, stop and parity are ignored) as one continuous binary number. This number is first shifted left 16 bits and then divided by a characteristic polynomial (11000000000000101B). The 16 bit remainder of the division is appended to the end of the transmission, MS byte first. The resulting message including CRC, when divided by the same polynomial at the receiver will give a zero remainder if no transmission errors have occurred.

If a 301 Relay Modbus slave device receives a transmission in which an error is indicated by the CRC-16 calculation, the slave device will not respond to the transmission. A CRC-16 error indicates that one or more bytes of the transmission were received incorrectly and thus the entire transmission should be ignored in order to avoid the slave device performing any incorrect operation.

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

CRC-16 Algorithm
Once the following algorithm is complete, the working register "A" will contain the CRC value to be transmitted. Note that this algorithm requires the characteristic polynomial to be reverse bit ordered. The MS bit of the characteristic polynomial is dropped since it does not affect the value of the remainder. The following symbols are used in the algorithm:

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

algorithm:

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

Timing

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

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

will cause the communication link to be reset.

The following Modbus commands are supported:

Number	Modbus Definition	301 Definition
03,04	Read holding and input registers	Read setpoints/read actual values
05	Force single coil	Execute operation
06	Preset single register	Store single setpoint
07	Read exception status	Read device status
16	Preset multiple registers	Store multiple setpoints

These functions are described in detail as follows:

FUNCTION 03, 04, READ SETPOINTS, READ ACTUAL VALUES.

Modbus "Read Holding Registers" and "Read Input Registers" are used by the Master computer to read the relaying parameters or to read the measured or calculated circuit values from the 301. Modbus allows up to 125 consecutive registers (250 bytes) to be read with one command. Broadcast command is not allowed with these functions. The 301 Setpoint and Actual Values register map is given in Appendix A. This appendix represents the registers as inserted in the packet to be communicated. They are 16-bit words. The format of the packets communicated is given, with the following examples:

The Master computer, in order to read the 3 consecutive setpoint registers starting from register address 1000h from slave number 02h, sends the command:

		HI LO	HI LO	HI LO
02h	03h	10h 00h	00h 03h	B4h 27h
ADDRESS	FUNCTION	START REG	COUNT	CRC

slave number 02h replies with:

			HI LO	HI LO	HI LO	HI LO
02h	03h	06h	00h 01h	00h 64h	00h 64h	69h A1h
ADDRESS	FUNCTION	BYTE COUNT	REG COUNT	REG COUNT	REG COUNT	CRC

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

The Master computer, in order to read the 1 actual value registers starting from register address 0200h from slave number 02h, sends the command:

		HI LO	HI LO	HI LO
02h	04h	02h 00h	00h 01h	51h E1h
ADDRESS	FUNCTION	START REG	COUNT	CRC

slave number 02h replies with:

			HI LO	LO HI
02h	04h	02h	00h 00h	32h E4h
ADDRESS	FUNCTION	BYTE COUNT	REG DATA	CRC

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

FUNCTION 05, EXECUTE OPERATION .

Modbus "Force Single Coil" is used by the Master computer to request that the 301 perform a specific operation. Broadcast command is not allowed with this function. The operations that can be performed by the 301 are as follows:

00 - Reset
01 - Lockout Reset
02 - Stop
03 - Start A
04 - Start B
05 - Energize Programmable Relay #1
06 - De-energize Programmable Relay #1
(Must be set to off in setpoints)
07 - Reset Statistics to 0
08 - Local Control Disable
09 - Local Control Enable

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

The Master computer, in order to perform a stop on slave number 02h, sends the command:

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

slave number 02h replies with:

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

FUNCTION 06, STORE SINGLE SETPOINT.

Modbus "Preset Single Register" is used by the Master computer to store a single setpoint into the memory of the 301. Broadcast command is not allowed with this function. The response from the 301 will be the echo of the entire master transmission. The format of the packets communicated is given, with the following example:

The Master computer, in order to store one setpoint at address 1001h to slave number 02h, sends the command:

		HI LO	HI LO	LO HI
02h	06h	10h 01h	00h 64h	09h CEh
ADDRESS	FUNCTION	SETPOINT ADDRESS	DATA	CRC

slave number 02h replies with:

		HI LO	HI LO	LO HI
02h	06h	10h 01h	00h 64h	09h CEh
ADDRESS	FUNCTION	SETPOINT ADDRESS	DATA	CRC

FUNCTION 07, READ DEVICE STATUS .

Modbus "Read Exception Status" is used by the Master computer to quickly read the status of the 301. A short message allows for rapid reading of the status. The status byte returned will have individual bits set to 1 or 0 depending on the status of the 301. Broadcast command is not allowed with this function.
The status byte contains the following information:

Bit 0 - set if alarms are present
Bit 1 - set if trips are present
Bit 2 - set if internal fault present
Bit 3 - not used.
Bit 4 - set if contactor A N/O contacts are closed
Bit 5 - set if contactor A N/C contacts are closed
Bit 6 - set if contactor B N/O contacts are closed

Bit 7 - set if contactor B N/C contacts are closed

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

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

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

slave number 02h replies with:

			LO HI
02h	07h	A0h	13h F0h
ADDRESS	FUNCTION	DEVICE STATUS	CRC

FUNCTION 16 (10h), STORE MULTIPLE SETPOINTS.

Modbus "Preset multiple Registers" is used by the Master computer to remotely program the 301 setpoint registers. The maximum number of registers that may be written in a single command is 60. Care must be taken when using this command to ensure new setpoints are stored correctly. Broadcast command is not allowed with this function. The format of the packets communicated is given, with the following example:

The Master computer, in order to store two setpoints starting at address 0068h to slave number 02h, sends the command:

		HI LO	HI LO		HI LO	HI LO	LO HI
02h	10h	00h 68h	00h 02h	04h	00h 14h	00h 64h	BAh 85h
ADDR.	FUNC.	START REG	REG COUNT	BYTE COUNT	DATA	DATA	CRC

slave number 02h replies with:

		HI LO	HI LO	LO HI
02h	10h	00h 68h	00h 02h	C0h 27h
ADDRESS	FUNCTION	START REG	REG COUNT	CRC

Error Responses

When the master command received by the 301 cannot be performed, the 301 replies with an error code. This is different from detecting communications related errors such as parity or CRC errors for which the 301 ignores the command.

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

The error codes supported by the 301 relay are:

01 - illegal function ⇦ The function code transmitted is not one of the functions supported by the 301.

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

03 - illegal data value ⇦ The master has requested that the 301 store a setpoint which is out of range.

An example involving an error reply is:

Master sending a setpoint which is out of range:

		HI LO	HI LO	LO HI
02h	06h	00h 68h	64h 64h	23h 0Eh
ADDRESS	FUNCTION	SETPOINT ADDRESS	DATA	CRC

slave number 02h replies with:

			LO HI
02h	06h	03h	00h 61h
ADDRESS	FUNCTION	ERROR CODE	CRC

The value 6464h exceeds the range of the setpoint that is located at address 0068h.

Address Space

```
REGISTER ADDRESS CONTENTS                        UNITS          RANGE
DEFAULT
(hex)    (dec)                                                (decimal)

 0000     0      MULTILIN PRODUCT CODE           ----          54                        ----
 0001     1      301 HARDWARE REV CODE           ----          0000H-FFFFH               ----
                     00 01H = A
                     00 02H = B
                     00 03H = C
                     00 04H = D
 0002     2      301 FIRMWARE REV CODE           ----          0000H-FFFFH               ----
                     01 00H = 1.0
                     01 10H = 1.1
                     02 50H = 2.5
                     ETC.
 0003     3      MULTILIN MOD FILE NUMBER        ----          0000H-FFFFH               ----
                     00 00H = NO MODIFICATION
                     00 F8H = MOD #248
                     01 0AH = MOD #266
                     ETC.
```

NOTE: NEGATIVE NUMBERS ARE EXPRESSED USING 2'S COMPLIMENT

ACTUAL VALUES

```
 0100     256    OPERATION STATUS                ----          0-9                       ----
  BIT  0 - XXXX XXXX XXXX XXX1 - ALARM  (1=CONDITION PRESENT)
  BIT  1 - XXXX XXXX XXXX XX1X - TRIP
  BIT  2 - XXXX XXXX XXXX X1XX - INTERNAL FAULT
  BIT  3 - XXXX XXXX XXXX 1XXX - NOT USED
  BIT  4 - XXXX XXXX XXX1 XXXX - CONTACTOR A
  BIT  5 - XXXX XXXX XX1X XXXX - CONTACTOR B
  BIT  6 - XXXX XXXX X1XX XXXX - PROGRAMMABLE RELAY #1
  BIT  7 - XXXX XXXX 1XXX XXXX - NOT USED
  BIT  8 - XXXX XXX1 XXXX XXXX - RUNNING
  BIT  9 - XXXX XX1X XXXX XXXX - STARTING
 0101     257    SWITCH INPUT STATUS             ----          0-15                      ----
  BIT  0 - XXXX XXXX XXXX XXX1 - STATUS INPUT 1  (1=SWITCH CLOSED)
  BIT  1 - XXXX XXXX XXXX XX1X - STATUS INPUT 2
  BIT  2 - XXXX XXXX XXXX X1XX - SETPOINT ACCESS
  BIT  3 - XXXX XXXX XXXX 1XXX - STOP
  BIT  4 - XXXX XXXX XXX1 XXXX - START B
  BIT  5 - XXXX XXXX XX1X XXXX - START A
  BIT  6 - XXXX XXXX X1XX XXXX - PLANT INTERLOCK
  BIT  7 - XXXX XXXX 1XXX XXXX - TEST
  BIT  8 - XXXX XXX1 XXXX XXXX - CONTACTOR A STATUS, NC
  BIT  9 - XXXX XX1X XXXX XXXX - CONTACTOR A STATUS, NO
  BIT 10 - XXXX X1XX XXXX XXXX - CONTACTOR B STATUS, NC
  BIT 11 - XXXX 1XXX XXXX XXXX - CONTACTOR B STATUS, NO
  BIT 12 - XXX1 XXXX XXXX XXXX - LOCAL ISOLATOR, NC
  BIT 13 - XX1X XXXX XXXX XXXX - LOCAL ISOLATOR, NO
  BIT 14 - X1XX XXXX XXXX XXXX - LOCKOUT RESET
  BIT 15 - 1XXX XXXX XXXX XXXX - THERMISTOR  1=HOT, 0=COLD
 0102     258    ALARM STATUS                    ----          0-11                      ----
  BIT  0 - XXXX XXXX XXXX XXX1 - LOAD INCREASE ALARM  (1=ALARM PRESENT)
  BIT  1 - XXXX XXXX XXXX XX1X - GROUND FAULT ALARM
  BIT  2 - XXXX XXXX XXXX X1XX - UNBALANCE ALARM
  BIT  3 - XXXX XXXX XXXX 1XXX - THERMISTOR ALARM
  BIT  4 - XXXX XXXX XXX1 XXXX - INTERNAL FAULT ALARM
  BIT  5 - XXXX XXXX XX1X XXXX - OPEN CONTROL CIRCUIT ALARM
  BIT  6 - XXXX XXXX X1XX XXXX - WELDED CONTACTOR ALARM
  BIT  7 - XXXX XXXX 1XXX XXXX - UNDERCURRENT ALARM
  BIT  8 - XXXX XXX1 XXXX XXXX - EXTERNAL STOP ALARM
  BIT  9 - XXXX XX1X XXXX XXXX - EXTERNAL START ALARM
  BIT 10 - XXXX X1XX XXXX XXXX - RESERVED
  BIT 11 - XXXX 1XXX XXXX XXXX - THERMISTOR ALARM 2ND CHECK
 0103     259    LED STATUS                      ----          0-6
  BIT  0 - XXXX XXXX XXXX XXX1 - RUNNING LED STATUS
  BIT  1 - XXXX XXXX XXXX XX1X - STOPPED LED STATUS
  BIT  2 - XXXX XXXX XXXX X1XX - TRIPPED LED STATUS
  BIT  3 - XXXX XXXX XXXX 1XXX - ALARM LED STATUS
  BIT  4 - XXXX XXXX XXX1 XXXX - FAULT LED STATUS
  BIT  5 - XXXX XXXX XX1X XXXX - PRE-TRIP (1=HIGH SPEED; 0=LOW SPEED)
  BIT  6 - XXXX XXXX X1XX XXXX - INRUSH   (1=HIGH SPEED; 0=LOW SPEED)

 0200     512    PHASE A CURRENT                 AMPS          0-11000                   ----
 0201     513    PHASE B CURRENT                 AMPS          0-11000                   ----
```

REGISTER (hex)	ADDRESS (dec)	CONTENTS	UNITS	RANGE (decimal)	DEFAULT
0202	514	PHASE C CURRENT	AMPS	0-11000	----
0203	515	GROUND FAULT CURRENT	x0.1 AMPS	0-20000	----
0204	516	MOTOR LOAD	%	0-1100	----
0205	517	PEAK INRUSH CURRENT	AMPS	0-11000	----
0206	518	THERMAL CAPACITY	%	0-100	----
0207	519	TIME TO TRIP	SEC,MIN,HRS	0-7200	----
0208	520	PHASE UNBALANCE	%	0-100	----
0209	521	ACCELERATION TIME	X0.1 SEC	0-32767	----
0300	768	RUNNING HOURS	HOURS	0-32767	----
0301	769	NUMBER OF STARTS	----	0-32767	----
0302	770	TOTAL NUMBER OF TRIPS	----	0-32767	----
0303	771	NUMBER OF OVERLOAD TRIPS	----	0-32767	----
0304	772	NUMBER OF THERMISTOR TRIPS	----	0-32767	----
0305	773	NUMBER OF GROUND FAULT TRIPS	----	0-32767	----
0306	774	NUMBER OF SINGLE PHASE TRIPS	----	0-32767	----
0307	775	NUMBER OF ACCELERATION TRIPS	----	0-32767	----
0308	776	NUMBER OF UNDERCURRENT TRIPS	----	0-32767	----
0309	777	NUMBER OF STALLED ROTOR TRIPS	----	0-32767	----
030A	778	NUMBER OF CONTROL COMMAND TRIPS	----	0-32767	----
030B	779	PRETRIP PHASE A CURRENT	AMPS	0-11000	----
030C	780	PRETRIP PHASE B CURRENT	AMPS	0-11000	----
030D	781	PRETRIP PHASE C CURRENT	AMPS	0-11000	----
030E	782	PRETRIP GROUND FAULT CURRENT	x0.1 AMPS	0-20000	----
030F	783	CAUSE OF TRIP	----	0-21	----
		00 00H - NOT TRIPPED			
		00 0BH - PHASE OVERLOAD			
		00 0CH - SINGLE PHASE			
		00 0DH - THERMISTOR			
		00 0EH - ACCELERATION TIME			
		00 0FH - GROUND FAULT			
		00 10H - STALLED ROTOR			
		00 11H - PLANT INTERLOCK			
		00 12H - LOCAL ISOLATOR			
		00 13H - SERIAL LINK FAIL			
		00 14H - INTERNAL FAULT			
		00 15H - UNDERCURRENT			
0310	784	PROGRAMMABLE RELAY #1 DELAY	SEC	0-125	----
SETPOINTS					
1000	4096	OVERLOAD CURVE NUMBER	----	1-8	1
1001	4097	FULL LOAD CURRENT	AMPS	10-1000	100
1002	4098	HIGH SPEED FULL LOAD CURRENT	AMPS	10-1000	100
1003	4099	ACCELERATION TIME (FFFFH=OFF)	x0.1 SEC	5-1250/OFF	OFF
1004	4100	GROUND FAULT TRIP LEVEL (x:5)	% of FLC	10-100/OFF	OFF
1005	4101	GRND FAULT TRIP LEVEL (2000:1)	AMPS	1-10/OFF	OFF
1006	4102	GROUND FAULT TRIP DELAY	x0.1 SEC	0-20	10
1007	4103	GROUND FAULT ALARM LEVEL (x:5)	% of FLC	10-100/OFF	OFF
1008	4104	GRND FAULT ALARM LEVEL (2000:1)	AMPS	1-10/OFF	OFF
1009	4105	GROUND FAULT ALARM DELAY	SEC	1-60	5
100A	4106	STALLED ROTOR LEVEL	x0.1 xFLC	15-45/OFF	OFF
100B	4107	STALLED ROTOR DELAY	x0.1 SEC	5-50	20
100C	4108	UNDERCURRENT TRIP LEVEL	AMPS	10-100/OFF	OFF
100D	4109	UNDERCURRENT TRIP DELAY	SEC	1-60	10
100E	4110	UNDERCURRENT ALARM LEVEL	AMPS	10-100/OFF	OFF
100F	4111	UNDERCURRENT ALARM DELAY	SEC	1-60	10
1010	4112	LOAD INCREASE ALARM LEVEL	% of FLC	60-110/OFF	OFF
1011	4113	UNDERVOLTAGE RESTART	----	0-1	0
		00 00H - DISABLE			
		00 01H - ENABLE			
1012	4114	PULSE START	----	0-1	0
		00 00H - TIME UNLIMITED			
		00 01H - UV 4.5 SEC. MAX			
1013	4115	RESTART TIME DELAY	x0.1 SEC	2-3000	20
1100	4352	PHASE CT PRIMARY AMPS	AMPS	5-1000	100
1101	4353	HIGH SPEED CT PRIMARY AMPS	AMPS	5-1000	100
1102	4354	HIGH SENSITIVITY G/F CT	----	0-1	0
		00 00H - DISABLE			
		00 01H - ENABLE			
1103	4355	GROUND FAULT CT RATIO	----	5-1000	50
1104	4356	HIGH SPEED G/F CT RATIO	----	5-1000	50
1105	4357	THERMISTOR HOT	x0.1 KOHMS	1-300	200
1106	4358	THERMISTOR COLD	x0.1 KOHMS	1-300	1
1107	4359	THERMISTOR ALARM	----	0-1	0

REGISTER (hex)	ADDRESS (dec)	CONTENTS	UNITS	RANGE (decimal)	DEFAULT
		00 00H - DISABLE			
		00 01H - ENABLE			
1108	4360	THERMISTOR TRIP	----	0-1	0
		00 00H - DISABLE			
		00 01H - ENABLE			
1109	4361	UNBALANCE ALARM	----	0-1	0
		00 00H - DISABLE			
		00 01H - ENABLE			
110A	4362	OVERLOAD RESET	----	0-1	0
		00 00H - MANUAL			
		00 01H - AUTO			
110B	4363	STARTER TYPE	----	00H-03H	00H
		00 00H - DIRECT ON LINE			
		00 01H - REVERSING			
		00 02H - STAR-DELTA			
		00 03H - TWO SPEED			
110C	4364	STAR-DELTA CHANGE	SEC	2-100	30
110D	4365	RESERVED			
110E	4366	TRANSITION TIME	SEC	0-125	0
110F	4367	SERIAL COM FAIL TRIP	SEC	5-25/OFF	OFF
1110	4368	INTERNAL FAULT TRIP	----	0-1	0
		00 00H - DISABLE			
		00 01H - ENABLE			
1111	4369	PROGRAMMABLE RELAY #1	----	00H-08H	01H
		00 00H - TRIPS			
		00 01H - ALARMS			
		00 02H - POST CONTACTOR A			
		00 03H - POST CONTACTOR B			
		00 04H - OFF			
		00 05H - PRE CONTACTOR A			
		00 06H - LOAD INCREASE			
		00 07H - CONTACTOR C			
		00 08H - STATUS INPUT 2			
1112	4370	PROGRAMMABLE RELAY #1 DELAY	SEC	0-125	0
1113	4371	STATUS INPUT 2	----	00H-02H	02H
		00 00H - PLANT INTERLOCK			
		00 01H - 2 WIRE CONTROL			
		00 02H - OFF			
1200	4608	HOT/COLD CURVE RATIO	%	20-100	75
1201	4609	MOTOR COOLING TIME	SEC	10-120	30
1202	4610	MINIMIZE LOCKOUT TIME	----	0-1	0
		00 00H - DISABLE			
		00 01H - ENABLE			

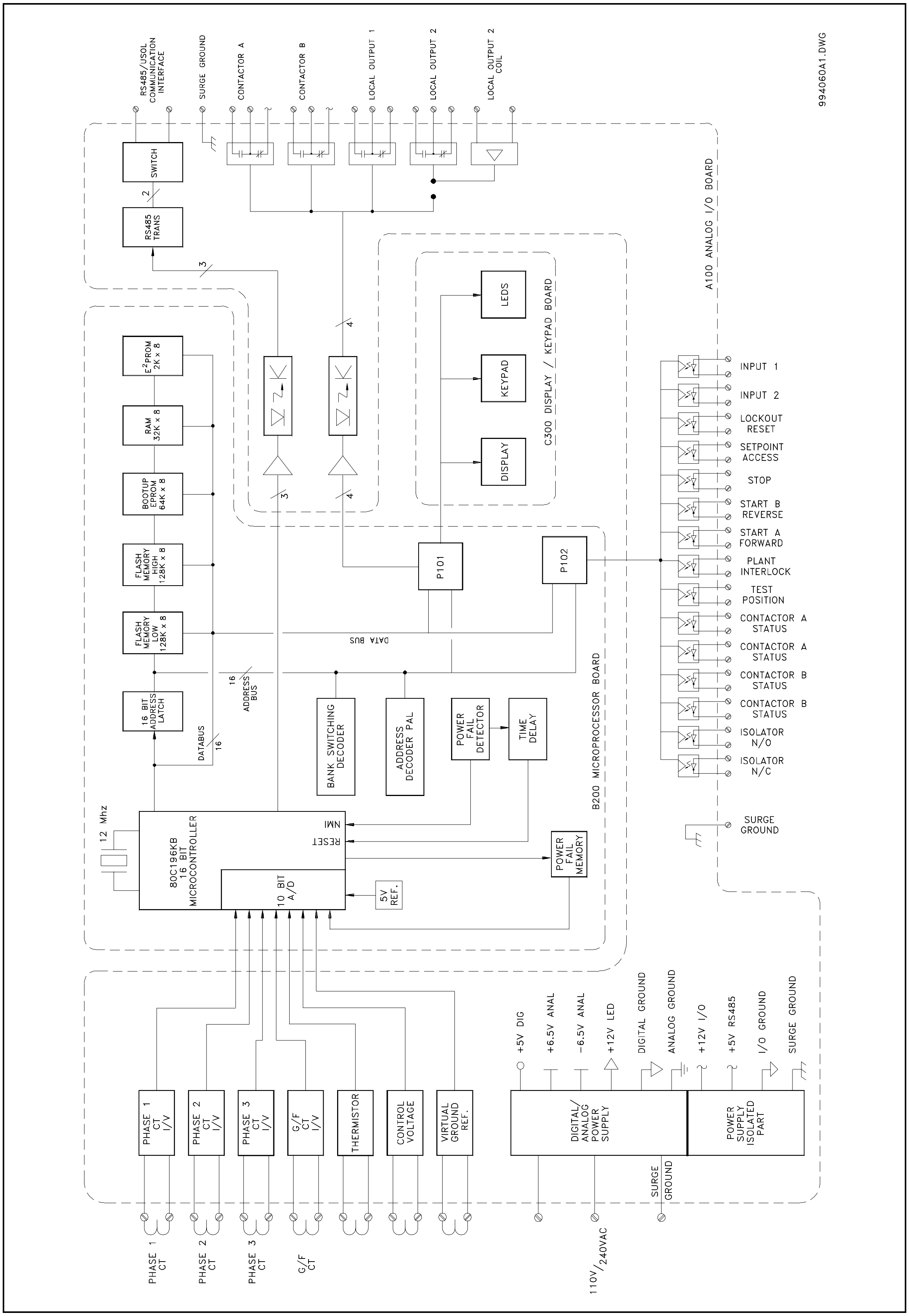

Figure B-1 301 Block Diagram

HARDWARE DESCRIPTION

A 16 bit 80196 microcontroller IC performs program execution and control logic for the Motor Manager. Refer to the block diagram for a complete overview of the Motor Manager 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 12Mhz. Instructions are stored in a 128K x 8 bit flash memory, data is stored in an 8K x 8 RAM while setpoints and accumulated data are stored in a 2K x 8 EEPROM.

Instructions are accessed as 16 bit words for higher throughput. Bus wait states, width control and address decoding are performed by an address decoder and bank switching is accomplished using a PAL decoding device.

Although the 80196 has some on-board I/O pins, external programmable I/O ports are used to expand the output capabilities of the system. These are treated as external RAM locations by the processor. An intelligent display module with its own microprocessor, memory and command set is accessed as an I/O device. It is driven from an I/O port instead of the bus. A 3x3 keypad is read as a multiplexed array of switches. LED outputs are latched and treated as an I/O location.

External RAM and I/O is accessed as a contiguous 64K space with I/O devices being read or written as if they were RAM locations.

External switch inputs are driven with 110VAC 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 80196 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 approximately a 2ms 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. DC voltages of thermistor equivalent resistance, control supply voltage (for determining motor voltage) and internal reference voltage are also monitored. An external precision 5V DC reference is used as the input reference for the A/D convertor.

When power to the unit is lost a precision capacitor which has been previously charged to a value representative of the thermal capacity value is isolated and begins to discharge through a known load. On power-on the capacitor voltage is read and used to determine the remaining thermal capacity.

Serial communications at 9600 baud is implemented with UART circuitry internal to the 80196 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 Motor Manager can be selected as 120 or 240 VAC using a switch and dual wound primary transformer. An LC pi 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. A separate watchdog timer and power fail monitoring circuits ensure that the CPU starts and operates under any input voltage conditions. Should normal program execution fail, the watchdog timeout resets the CPU.•

MULTILIN RELAY WARRANTY

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

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

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

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