

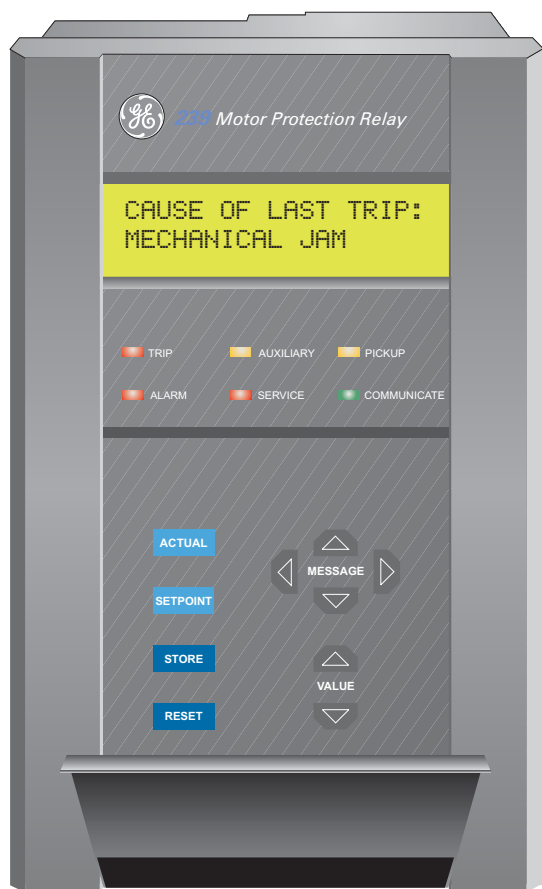


GE Consumer & Industrial  
Multilin

# 239

## MOTOR PROTECTION RELAY

### Instruction Manual



Firmware Revision: 2.7x

239PC Software: 2.7x or newer

Manual P/N: 1601-0067-DC (GEK-106613C)

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GE Multilin's Quality  
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QMI # 005094

UL # A3775

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GE Multilin 239 Motor Protection Relay instruction manual for revision 2.7x.

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Part number: 1601-0067-DC (October 2007)

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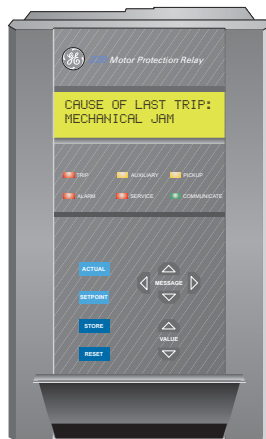
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# 239 Motor Protection Relay

## Chapter 1: Overview

---

### 1.1 Overview

#### 1.1.1 239 Relay Features

The GE Multilin 239 relay is designed to fully protect three phase AC motors against conditions which can cause damage. In addition to motor protection, the relay has features that can protect associated mechanical equipment, give an alarm before damage results from a process malfunction, diagnose problems after a fault and allow verification of correct relay operation during routine maintenance. Using the ModBus serial communications interface, motor starters throughout a plant can be connected to a central control/monitoring system for continuous monitoring and fast fault diagnosis of a complete process.

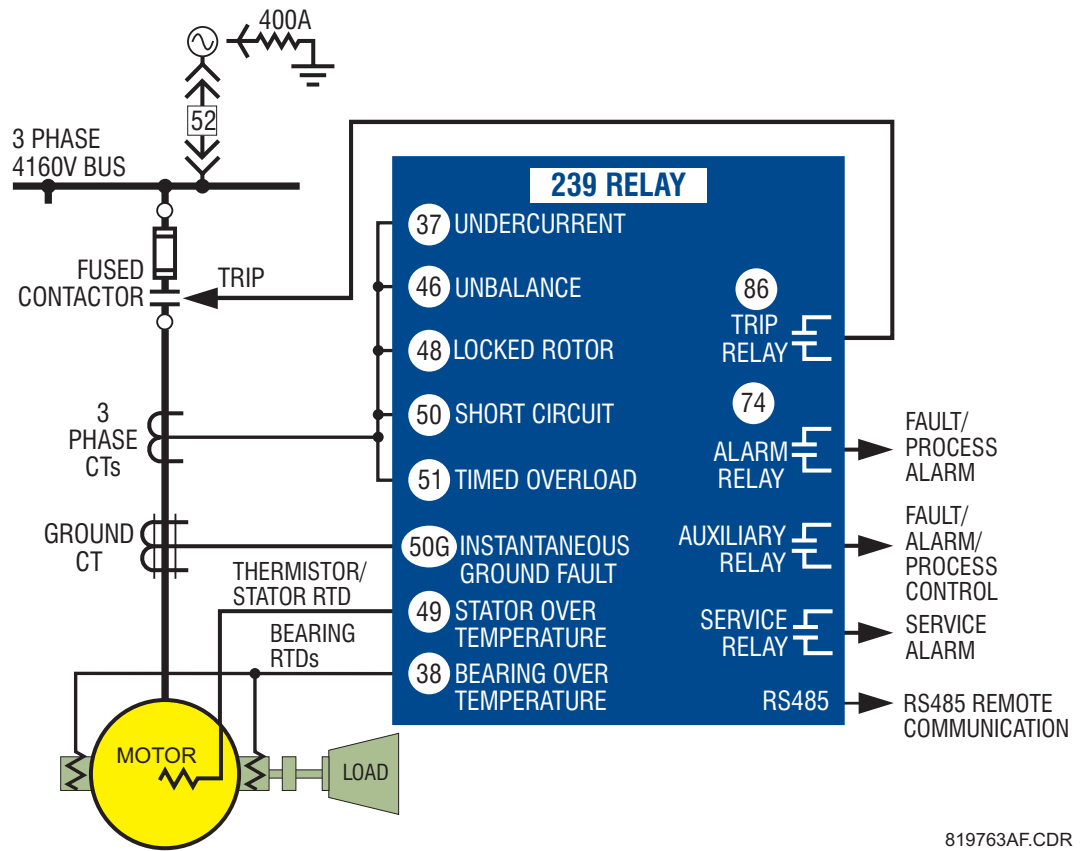
One relay is required per motor. Since phase current is monitored through current transformers, motors of any line voltage can be protected. The relay is used as a pilot device to cause a contactor or breaker to open under fault conditions; that is, it does not carry the primary motor current. When the over temperature option is ordered, up to 3

RTDs can be monitored. These can all be in the stator or 1 in the stator and 2 in the bearings. Installing a 239 in a motor starter for protection and monitoring of motors will minimize downtime due to process problems.

**Table 1-1:**

| PROTECTION  | FEATURES  |
|---|---|
| <ul style="list-style-type: none"> <li>• Overload (15 selectable curves)</li> <li>• Short circuit</li> <li>• Locked rotor</li> <li>• Stall / mechanical jam</li> <li>• Repeated starts (Mod 505)</li> <li>• Single phase / unbalance</li> <li>• Ground fault</li> <li>• Overtemperature (Thermistor &amp; 3 RTDs)</li> <li>• Undercurrent</li> <li>• Overload warning</li> <li>• Breaker failure</li> </ul> | <ul style="list-style-type: none"> <li>• Status/current/temperature display</li> <li>• Fault diagnosis</li> <li>• Trip record</li> <li>• Memory lockout</li> <li>• Thermal capacity / load% / RTD analog output</li> <li>• Trip / alarm / auxiliary / service relay outputs</li> <li>• Motor Running Hours</li> <li>• Motor maximum current on last start</li> <li>• Simulation mode for field testing</li> <li>• Clear LCD display</li> <li>• RS485 Modbus communications interface</li> <li>• AC/DC control power</li> <li>• Compact size, fits most starters</li> <li>• Update options and/or MODs in field</li> <li>• CSA/UL Approved</li> <li>• Conformal coating for harsh environment</li> </ul> |





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FIGURE 1-1: Continuous Protection Features

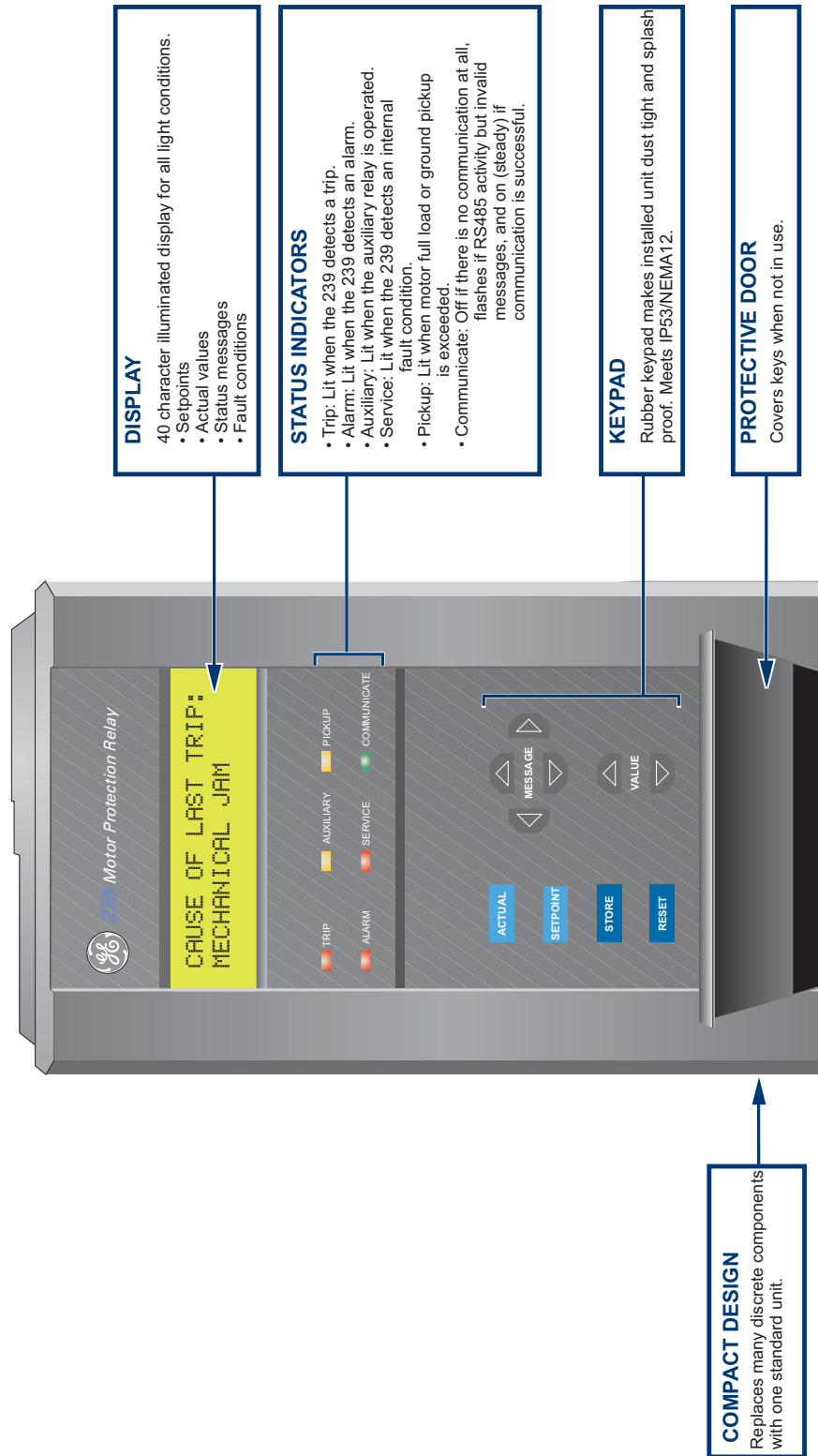


FIGURE 1-2: Feature Highlights – Front

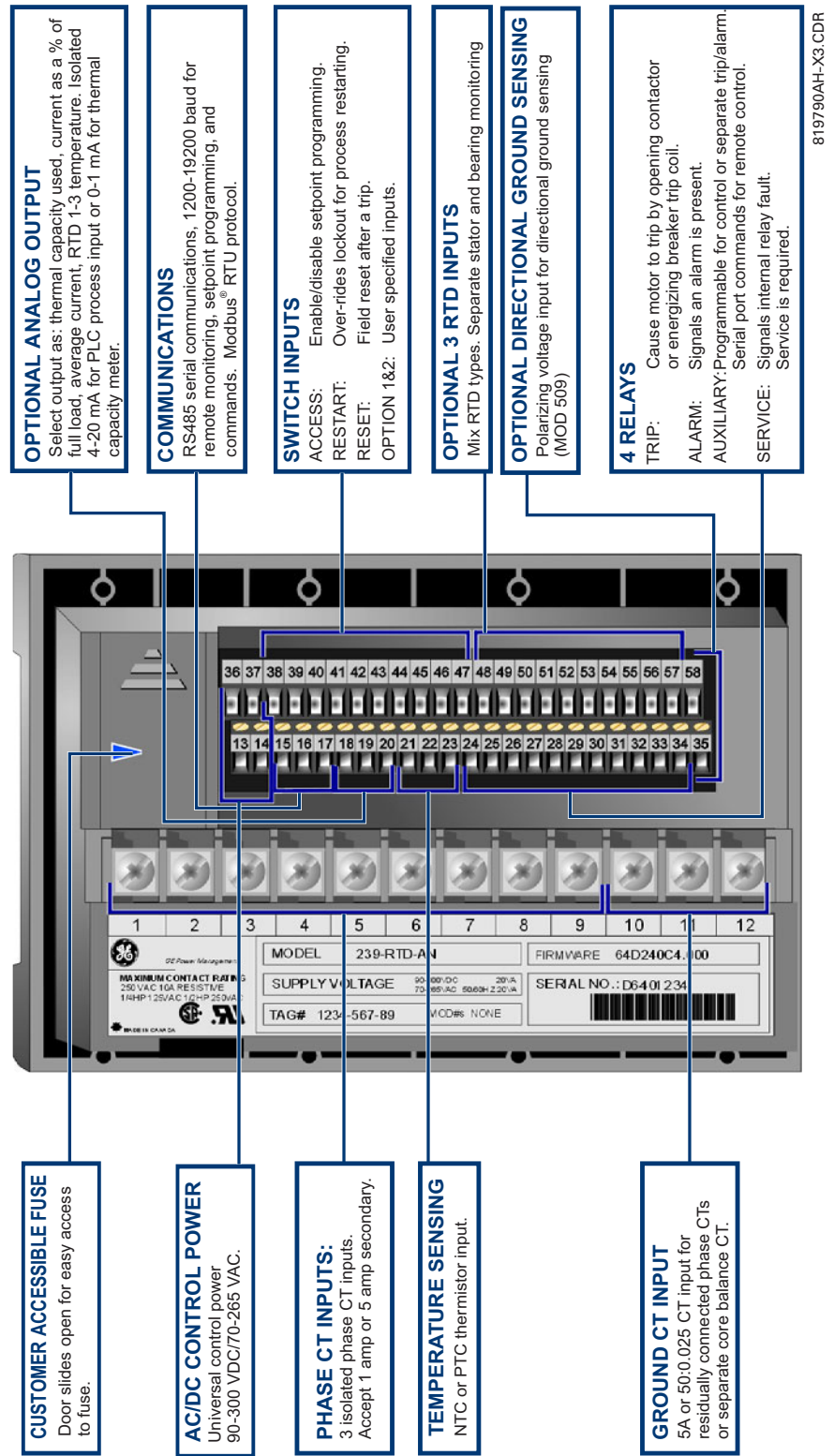


FIGURE 1-3: Feature Highlights – Rear

### 1.1.2 Typical Applications

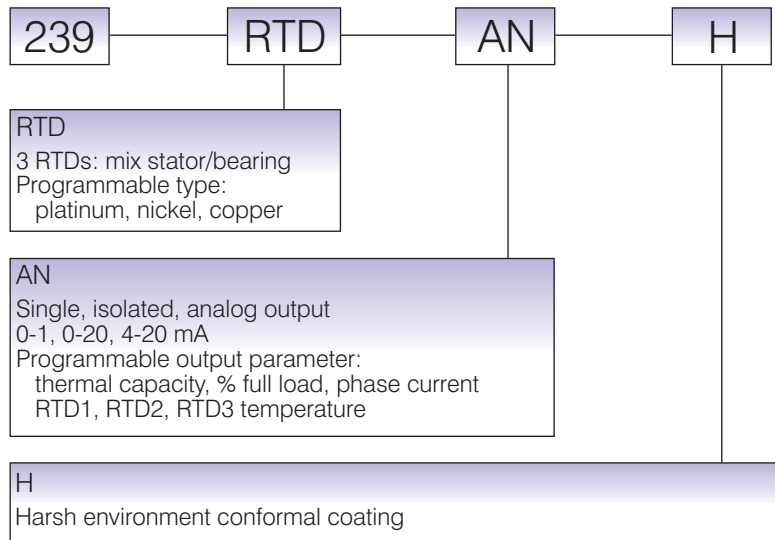
Versatile features and simple programming controls make the 239 an ideal choice for motor and equipment protection in a wide range of applications. In addition to basic electrical protection for motors, the 239 can protect against common faults due to process problems, such as:

1. Mechanical protection of pumps using the undercurrent feature to detect loss of suction or a closed discharge valve.
2. Personnel safety and mechanical protection of fans against loss of air flow in mines or flow in steam generating boilers using the undercurrent feature.
3. Electrical protection of compressor motors from excessive run up time caused by an open outlet using the start timer.
4. Mechanical protection of gears, pumps, fans, saw mill cutters, and compressors against mechanical jam using the mechanical jam trip feature.
5. Safety to personnel from shock hazard using the ground fault feature to detect winding shorts or leakage currents from moisture in mines.
6. Protection of motors and equipment from operator abuse using the thermal memory lockout

Cost savings are provided using versatile features such as:

1. Diagnostic information after a trip to identify problems and bring the process back on line quickly.
2. Fault indication of ground fault without shutdown to warn that corrective maintenance is required.
3. Simplified spare parts stocking and initial specification design using one universal model for many motor sizes, applications and settings.
4. Serial communication using the popular Modbus protocol to remotely monitor all values, program setpoints, issue commands and diagnose faults to minimize process disruptions.
5. Output of motor current suitable for programmable controller interface (4 to 20 mA).

### 1.1.3 Order Code



#### MODIFICATIONS

- MOD 500: Portable test/carrying case
- MOD 501: 20 to 60 V DC / 20 to 48 V AC control power
- MOD 504: Removable terminal blocks
- MOD 505: Enhanced start protection
- MOD 506: Custom programmable overload curve
- MOD 509: Directional ground sensing with 120 V AC polarizing voltage
- MOD 512: 1 AMP Ground CT input
- MOD 513: Class 1 Division 2 operation
- MOD 517: Australian Mines approval

#### ACCESSORIES

- 239PC Windows software (supplied free)
- Phase and ground CTs
- RS232 to RS485 converter (required to connect a computer to the 239 relay(s) to run 239PC)
- RS485 Terminating Network
- 2.25" collar for limited depth mounting (1009-0068)
- Large size (8.5 x 11") instruction manual (free upon request)

#### CONTROL POWER

- 90 to 300 V DC / 70 to 265 V AC standard
- 20 to 60 V DC / 20 to 48 V AC (MOD 501)

Thermal:.....separate start & run protection  
Activation:.....inrush 3 phase current increases from <5% to >101% FLC  
in 1 s  
Deactivation: .....current drops to <100% FLC motor running if current >5%  
FLC  
Locked Rotor:.....0.5 to 11.0 x FLC

Safe Stall Time:.....1.0 to 600.0 sec

### THERMAL MODELING

Thermal Capacity:.....separate start/run,  
exponential cool down

Cool Rate:.....

Stop:.....1 to 5000 minutes programmable

Run:.....50% of stopped cool time

Hot/cold:.....50 to 100%, hot after 15 min running

Lockout:.....1 to 5000 min programmable  $\pm 20\%$  power on / off

### UNBALANCE

Range:.....5 to 100% / OFF

Accuracy:..... $\pm 2\%$

Delay:.....0 - 60 sec

Calculation:

$$\text{If } I_{AV} \geq I_{FLC}, \text{ UB\%} = \frac{|I_M - I_{AV}|}{I_{AV}} \times 100$$

$$\text{If } I_{AV} < I_{FLC}, \text{ UB\%} = \frac{|I_M - I_{AV}|}{I_{FLC}} \times 100$$

where:  $I_{AV}$  = average phase current

$I_M$  = current in phase with max dev. from  $I_{AV}$

$I_{FLC}$  = full load current setting

### THERMISTOR

Type:.....PTC or NTC programmable

Hot Resistance:.....100 to 30 000  $\Omega$

Cold Resistance:.....100 to 30 000  $\Omega$

Delay:.....2 sec

Accuracy:..... $\pm 5\%$  or 100  $\Omega$ , whichever is greatest

### UNDERCURRENT

Range:.....5 to 100% FLC / OFF

Delay:.....0 to 250 sec

### RTDS (OPTIONAL)

Inputs:.....3 RTDs, stator/bearing prog.

Type:.....100 Pt (DIN 43760), 100 Ni, 120 Ni, 10 Cu programmable

Range:..... $-40$  to  $200$   $^{\circ}\text{C}$  /  $-40$  to  $400$   $^{\circ}\text{F}$

Trip/Alm Range:.....0 to  $200$   $^{\circ}\text{C}$  / 0 to  $400$   $^{\circ}\text{F}$

Dead Band:.....2  $^{\circ}\text{C}$  / 4  $^{\circ}\text{F}$

Accuracy:..... $\pm 2$   $^{\circ}\text{C}$  /  $\pm 4$   $^{\circ}\text{F}$

Lead Resistance:

Pt or Ni RTD:.....25  $\Omega$  max

Cu RTD:.....3  $\Omega$  max

3 wire lead resistance compensation

### COMMUNICATIONS

Type:.....RS485 2 wire, half duplex, isolated

Baud Rate:.....1200 to 19.2k bps

Protocol:.....Modbus<sup>®</sup> RTU

Functions:.....Read/write setpoints, read actual values, execute commands

**ANALOG OUTPUT (OPTIONAL)**

| OUTPUT     | PROGRAMMABLE  |              |              |
|------------|---------------|--------------|--------------|
|            | 0-1 mA        | 0-20 mA      | 4-20 mA      |
| MAX LOAD   | 2400 $\Omega$ | 600 $\Omega$ | 600 $\Omega$ |
| MAX OUTPUT | 1.1 mA        | 21 mA        | 21 mA        |

Accuracy:..... $\pm 2\%$  of full scale reading

Isolation: .....36 V DC isolated, active source

**OUTPUT RELAYS**

| VOLTAGE                 |         | MAKE/ CARRY<br>CONTINUOUS | MAKE/<br>CARRY<br>0.2 s | BREAK |
|-------------------------|---------|---------------------------|-------------------------|-------|
| RESISTIVE               | 30 VDC  | 10                        | 30                      | 10    |
|                         | 125 VDC | 10                        | 30                      | 0.5   |
|                         | 250 VDC | 10                        | 30                      | 0.3   |
| INDUCTIVE<br>(L/R=7 ms) | 30 VDC  | 10                        | 30                      | 5     |
|                         | 125 VDC | 10                        | 30                      | 0.25  |
|                         | 250 VDC | 10                        | 30                      | 0.15  |
| RESISTIVE               | 120 VAC | 10                        | 30                      | 10    |
|                         | 250 VAC | 10                        | 30                      | 10    |
| INDUCTIVE<br>PF=0.4     | 120 VAC | 10                        | 30                      | 10    |
|                         | 250 VAC | 10                        | 30                      | 10    |

Configuration: .....Form C NO/NC

Contact Material: .....Silver Alloy

**CT INPUTS**

|                         | CT INPUT<br>(A) | BURDEN |          |
|-------------------------|-----------------|--------|----------|
|                         |                 | VA     | $\Omega$ |
| PHASE CT (1A)           | 1               | 0.009  | 0.01     |
|                         | 5               | 0.2    | 0.01     |
|                         | 20              | 3.5    | 0.01     |
| PHASE CT (5A)           | 5               | 0.04   | 0.002    |
|                         | 25              | 0.9    | 0.002    |
|                         | 100             | 16     | 0.002    |
| GROUND CT<br>(5A)       | 5               | 0.04   | 0.002    |
|                         | 25              | 1.1    | 0.002    |
|                         | 100             | 17     | 0.002    |
| GROUND CT<br>(50:0.025) | 0.025           | 0.07   | 116      |
|                         | 0.1             | 1.19   | 119      |
|                         | 0.5             | 30.5   | 122      |



|                | BURDEN |        |                |
|----------------|--------|--------|----------------|
|                | 1s xCT | 5s xCT | continuous xCT |
| PHASE CT (1A)  | 100    | 40     | 3              |
| PHASE CT (5A)  | 100    | 40     | 3              |
| GROUND CT (5A) | 100    | 40     | 3              |

**50:0.025 GROUND INPUT WITHSTAND:**

Continuous:.....150 mA

Maximum: .....12 A for 3 cycles

50:0.025 input can be driven by a 50:0.025 CT.

**SWITCH INPUTS**

Type: .....dry contacts

Output: .....29 V DC, 10 mA (pulsed)

Duration:.....100 ms minimum

**CONTROL POWER**

Input: .....90 to 300 VDC or

70 to 265 VAC, 50/60 Hz

Power:.....10 VA (nominal) 20 VA (max)

Holdup:.....non-failsafe trip: 200 ms

failsafe trip: 100 ms

both times at 120VAC / 125VDC



NOTE

It is recommended that all 239 relays be powered up at least once per year to avoid deterioration of electrolytic capacitors in the power supply.

**FUSE TYPE/RATING**

5 × 20mm, 2.5 A, 250V

Slow blow, High breaking capacity

**ENVIRONMENT/GENERAL INFO**

Pollution Degree: .....2

Overvoltage Category: .....2

Insulation Voltage: .....300 V

Operating Temperature Range: .....0°C to 60°C

Storage Temperature Range: .....-40°C to 70°C

IP Class: .....40

Conformal coating is designed for Harsh Environment as an option in the order code.

**INSTALLATION**

WARNING

**HAZARD** may result if the product is not used for its intended purpose.

Ventilation Requirements: .....None

Cleaning Requirements: .....None

**TYPE TESTS**Dielectric Strength: .....2.0 kV for 1 minute to  
relays, CTs, power supply

Insulation Resistance: .....IEC255-5, 500 V DC

|                          |  |
|--------------------------|--|
| Transients: .....        | ANSI C37.90.1 Oscillatory 2.5 kV / 1 MHz; ANSI C37.90.1<br>Fast Rise 5 kV / 10 ns; Ontario Hydro A-28M-82; IEC255-4<br>Impulse/High Frequency Disturbance<br>Class III Level |
| Impulse Test: .....      | IEC 255-5 0.5 Joule 5 kV   |
| Voltage Deviation: ..... | IEC 61000-4-11   |
| RFI: .....               | 50 MHz/15 W Transmitter  |
| EMI: .....               | C37.90.2 Electromagnetic Interference @ 150 MHz and<br>450 MHz, 10 V/m   |
| Static: .....            | IEC 801-2 Static Discharge   |
| Humidity: .....          | 95% non-condensing   |
| Temperature: .....       | -10°C to +60°C ambient   |
| Environment: .....       | IEC 68-2-38 Temp/Humidity Cycle  |
| Dust/Moisture: .....     | NEMA 12/IP53   |

**PACKAGING**

|                     |  |
|---------------------|--|
| Shipping Box: ..... | 8½" × 6" × 6" (L × H × D)<br>215 mm × 152 mm × 152 mm<br>(L × H × D) |
| Ship Weight: .....  | 5 lbs. / 2.3 kg  |

**CERTIFICATION/COMPLIANCE**

|            |  |
|------------|--|
| ISO: ..... | Manufactured under an ISO9001 recognized program |
| UL: .....  | E83849 UL listed for the USA and Canada          |

**NOTE****Specifications subject to change without notice.**



# 239 Motor Protection Relay

## Chapter 2: Installation

---

### 2.1 Installation

#### 2.1.1 Mounting

Physical dimensions for the 239 and the required cutout dimensions are shown below. Once the cutout and mounting holes are made in the panel, use the eight #6 self tapping screws supplied to secure the relay. Mount the relay on a panel or switchgear door to allow operator access to the front panel keys and indicators.

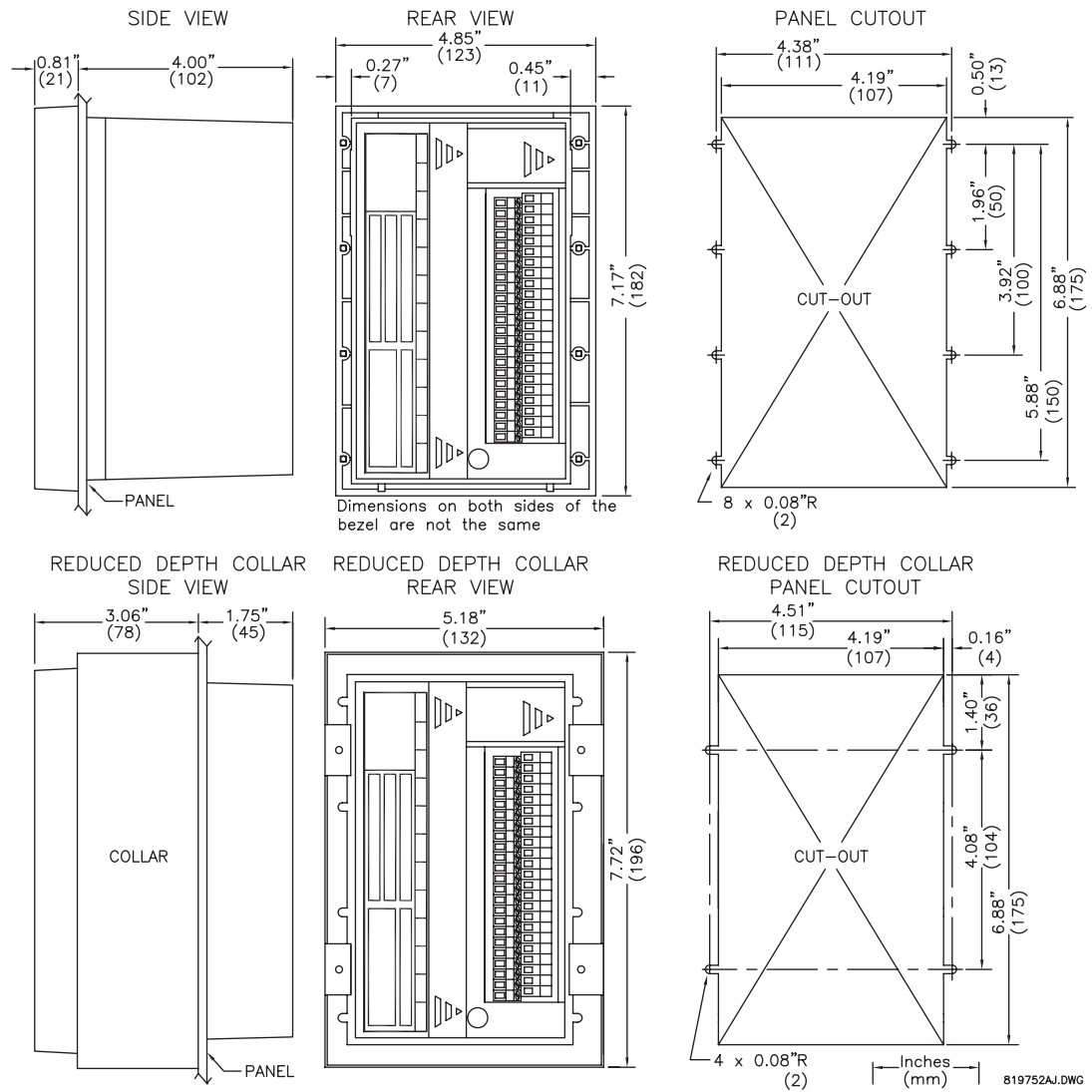






FIGURE 2-1: Physical Dimensions

### 2.1.2 Product Identification

Product attributes will vary according to the configuration and options installed based on the customer order. Before applying power to the relay, examine the label on the back of the 239 and check that the correct options are installed.

The information included on the product label is explained below:

| 1  | 2 | 3 | 4   | 5 | 6 | 7 | 8   | 9 | 10 | 11 | 12 |
|--|---|---|---|---|---|---|---|---|----|----|----|
| <br>GE Power Management   |   |   | MODEL 239-RTD-AN  |   |   |   | FIRMWARE 64D240C4.000   |   |    |    |    |
| <b>MAXIMUM CONTACT RATING</b><br>250 VAC 10A RESISTIVE<br>1/4HP 125VAC 1/2HP 250VAC<br> <br>MADE IN CANADA |   |   | SUPPLY VOLTAGE 90-300VDC 20VA<br>70-265VAC 50/60HZ 20VA |   |   |   | SERIAL NO.: D6401234<br> |   |    |    |    |
|  |   |   | TAG# 1234-567-89 MOD#s NONE                             |   |   |   |   |   |    |    |    |

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FIGURE 2-2: 239 Product Label (Example)

1. **MODEL NO:** The model number shows the configuration of the relay. The model number for a basic unit is 239. RTD and AN will appear in the model number only if the RTD option or Analog Output option is installed. H will appear in the model number if conformal coating is required.
2. **SUPPLY VOLTAGE:** Indicates the 239 power supply input configuration. The 239 shown above can accept any AC 50/60Hz voltage from 70 to 265 V AC or DC voltage from 90 to 300 V DC.
3. **TAG#:** This is an optional identification number specified by the customer.
4. **MOD#s:** These are used if unique features have been installed for special customer orders. These numbers should be available when contacting GE Multilin for technical support. Up to five MOD#s can be installed into the 239.
5. **SERIAL NO:** Indicates the serial number for the 239 in numeric and barcode format.

The following table shows the revision history of the 239. Each revision of the instruction manual corresponds to a particular firmware revision in the 239. The instruction manual revision is located on the first page of the manual as part of the manual P/N (1601-00XX-Revision). The 239 firmware revision is loaded in the relay and can be found by scrolling to the display message **A3: PRODUCT INFO\FIRMWARE VERSIONS\MAIN PROGRAM VER.**

When using the manual to determine relay features and settings, ensure that the revision corresponds to the 239 firmware revision using the table below. For a large instruction manual (8.5" × 11") the part number is 1601-0067; for a small instruction manual (5.5" × 7.25") it is 1601-0060.

Table 2-1: Firmware/manual Revisions Table

| MANUAL PART NO. | FIRMWARE VERSION | MANUAL PART NO. | FIRMWARE VERSION |
|-----------------|------------------|-----------------|------------------|
| 1601-00XX-C6    | 2.10             | 1601-00XX-D5    | 2.40             |
| 1601-00XX-C7    | 2.11             | 1601-00XX-D6    | 2.50             |
| 1601-00XX-C8    | 2.12             | 1601-00XX-D7    | 2.51             |
| 1601-00XX-D1    | 2.20             | 1601-00XX-D8    | 2.51             |
| 1601-00XX-D2    | 2.30             | 1601-00XX-D9    | 2.6x             |
| 1601-00XX-D3    | 2.3x             | 1601-00XX-DA    | 2.6x             |

Table 2-1: Firmware/manual Revisions Table

| MANUAL PART NO. | FIRMWARE VERSION | MANUAL PART NO. | FIRMWARE VERSION |
|-----------------|------------------|-----------------|------------------|
| 1601-00XX-D4    | 2.3x             | 1601-00XX-DB    | 2.7x             |

### 2.1.3 External Connections

Signal wiring is to box terminals that can accommodate wire as large as 12 gauge. CT connections are made using #8 screw ring terminals that can accept wire as large as 8 gauge (see FIGURE 2-3: *Typical Wiring Diagram* on page 2-18). A minimal configuration will include connections for control power, phase CTs and the trip relay. Other features can be wired as required. Considerations for wiring each feature are given in the sections that follow.

Table 2-2: External Connections

| CT ROW |                    | SIGNAL LOWER ROW |                   | SIGNAL UPPER ROW |                     |
|--------|--------------------|------------------|-------------------|------------------|---------------------|
| 1      | Phase A CT 5A      | 13               | Safety ground     | 36               | Control live (+)    |
| 2      | Phase A CT 1A      | 14               | Filter ground     | 37               | Control neutral (-) |
| 3      | Phase A CT COM     | 15               | RS485 A+          | 38               | Sw com              |
| 4      | Phase B CT 5A      | 16               | RS485 B-          | 39               | Sw com              |
| 5      | Phase B CT 1A      | 17               | RS485 ground      | 40               | Sw com              |
| 6      | Phase B CT COM     | 18               | Analog out +      | 41               | Sw com              |
| 7      | Phase C CT 5A      | 19               | Analog out -      | 42               | Sw com              |
| 8      | Phase C CT 1A      | 20               | Analog out shield | 43               | Access sw +         |
| 9      | Phase C CT COM     | 21               | Thermistor in +   | 44               | Restart sw +        |
| 10     | Ground CT 5A       | 22               | Thermistor com    | 45               | Reset sw +          |
| 11     | Ground CT 50:0.025 | 23               | Trip NO           | 46               | Option 1 sw +       |
| 12     | Ground CT COM      | 24               | Trip COM          | 47               | Option 2 sw +       |
|        |                    | 25               | Trip NC           | 48               | RTD shield          |
|        |                    | 26               | Alarm NO          | 49               | RTD1 hot            |
|        |                    | 27               | Alarm COM         | 50               | RTD1 comp           |
|        |                    | 28               | Alarm NC          | 51               | RTD1 ret            |
|        |                    | 29               | Auxiliary NO      | 52               | RTD2 hot            |
|        |                    | 30               | Auxiliary COM     | 53               | RTD2 comp           |
|        |                    | 31               | Auxiliary NC      | 54               | RTD2 ret            |
|        |                    | 32               | Service NO        | 55               | RTD3 hot            |
|        |                    | 33               | Service COM       | 56               | RTD3 comp           |

Table 2–2: External Connections

| CT ROW |  | SIGNAL LOWER ROW |                                 | SIGNAL UPPER ROW |                                   |
|--------|--|------------------|---------------------------------|------------------|-----------------------------------|
|        |  | 34               | Service NC                      | 57               | RTD3 ret                          |
|        |  | 35               | V1 polarizing<br>(Mod 509 only) | 58               | Vcom polarizing<br>(Mod 509 only) |

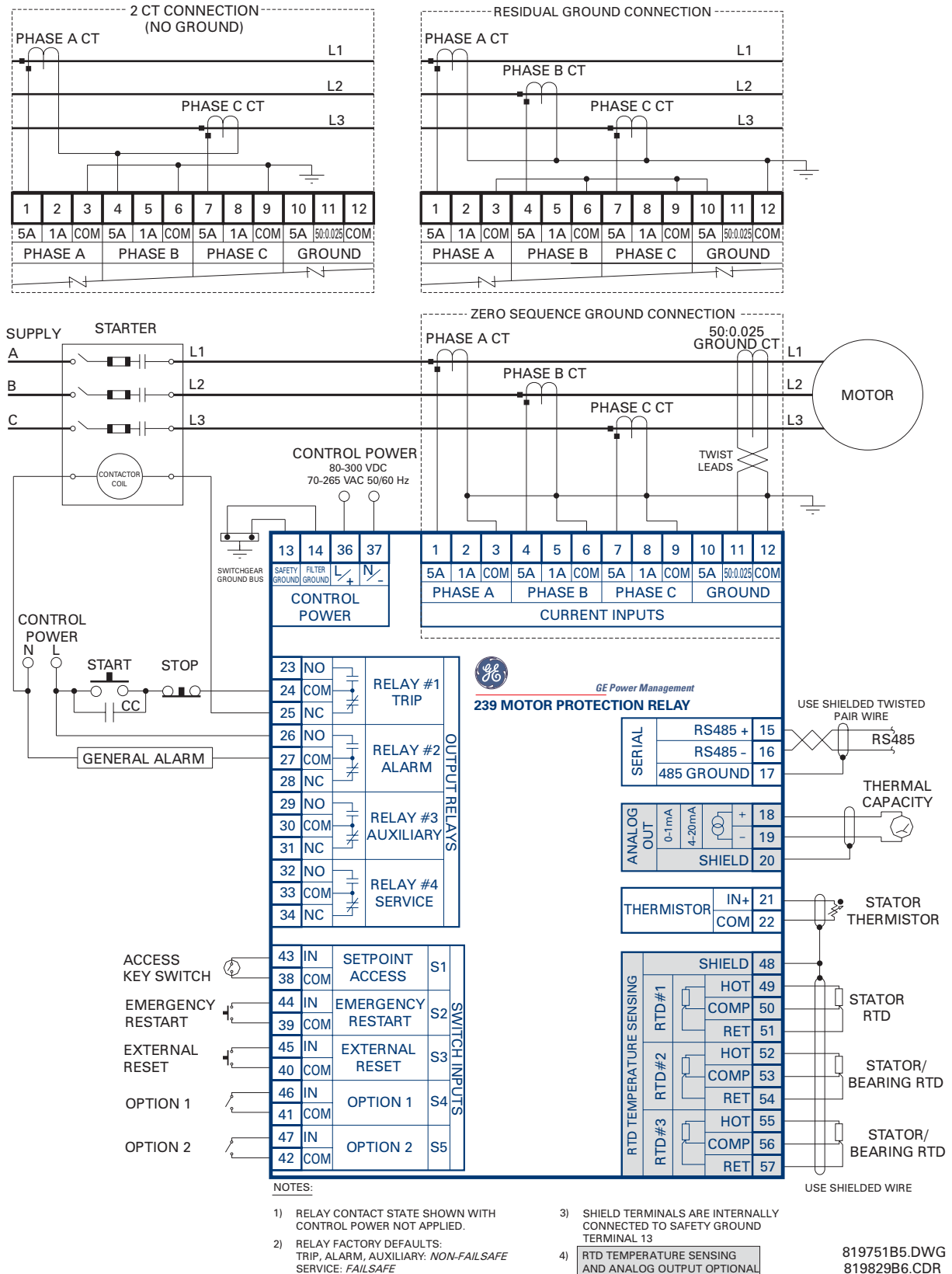


FIGURE 2-3: Typical Wiring Diagram



### CONTROL POWER (36/37)

A universal AC/DC power supply is standard. It covers the range 90 to 300 V DC and 70 to 265 V AC at 50/60 Hz. It is not necessary to make any adjustment to the relay as long as the control voltage falls within this range. A low voltage power supply is available upon a request of MOD# 501. It covers the range 20 to 60 V DC and 20 to 48 V AC at 50/60 Hz. Verify from the product identification label on the back of the relay that the control voltage matches the intended application. Connect the control voltage input to a stable source of supply for reliable operation. A 2.5 A fuse is accessible from the back of the unit without opening the relay by sliding back the fuse access door.

### PHASE CT INPUTS (1-9)

Current transformer secondaries of 5 or 1 A can be used for current sensing. Each phase current input has 3 terminals: 5 A input, 1 A input, and common. Select the 1 or 5 A terminal and common to match the phase CT secondary. Observe the polarity indicated in the TYPICAL WIRING DIAGRAM, otherwise current measures incorrectly for the 2-phase or residually connected CT configurations.

CTs should be selected to be capable of supplying the required current to the total secondary load which includes the 239 relay burden mentioned in Section 1.2: Specifications at rated secondary current and the connection wiring burden. The CT must not saturate under maximum current conditions which can be up to 8 times motor full load during starting or greater than 12 times during a short circuit. Only CTs rated for protective relaying should be used since metering CTs are usually not rated to provide enough current during faults. Examples of typical CT ratings are:

**Table 2-3: Typical CT Ratings**

| ORGANIZATION | CLASS TYPE               | 239 CT INPUT | DEFINITIONS  |
|--------------|--------------------------|--------------|--|
| CSA (Canada) | 10L4 B0.2                | 1 Amp        | L = Protection class<br>10 = 10% ratio error<br>4 = Voltage the CT can deliver to load burden at 20 × rated secondary current without exceeding the 10% ratio error<br>B0.2 = Maximum burden (0.2 Ω) that can be put on the transformer without exceeding the 10% ratio error  |
|              | 10L20 B0.2               | 5 Amp        | same as 1 Amp input  |
| ANSI (USA)   | 10T4 B0.2 or 10C4 B0.2   | 1 Amp        | T = Ratings determined by Tests<br>C = Ratings determined by Calculations<br>10 = 10% ratio error<br>4 = Voltage the CT can deliver to load burden at 20 × rated secondary current without exceeding the 10% ratio error<br>B0.2 = Maximum burden (0.2 Ω) that can be put on the transformer without exceeding the 10% ratio error |
|              | 10T20 B0.2 or 10C20 B0.2 | 5 Amp        | same as 1 Amp input  |

NOTE: The sizes shown above may not be standard CT ratings. The numbers are merely used to indicate what size CTs can be used with the 239.

Table 2-3: Typical CT Ratings

| ORGANIZATION | CLASS TYPE | 239 CT INPUT | DEFINITIONS  |
|--------------|------------|--------------|--|
| IEC (Europe) | 5P15 0.2VA | 1 Amp        | P = Protection class<br>5 = Maximum %voltage error at limiting factor<br>15 = Limit factor, determines max. voltage CT can deliver to load burden without exceeding the %voltage error<br>0.2 = Maximum amount of continuous burden allowed for rated CT secondary |
|              | 5P15 2.5VA | 5 Amp        | same as 1 Amp input  |

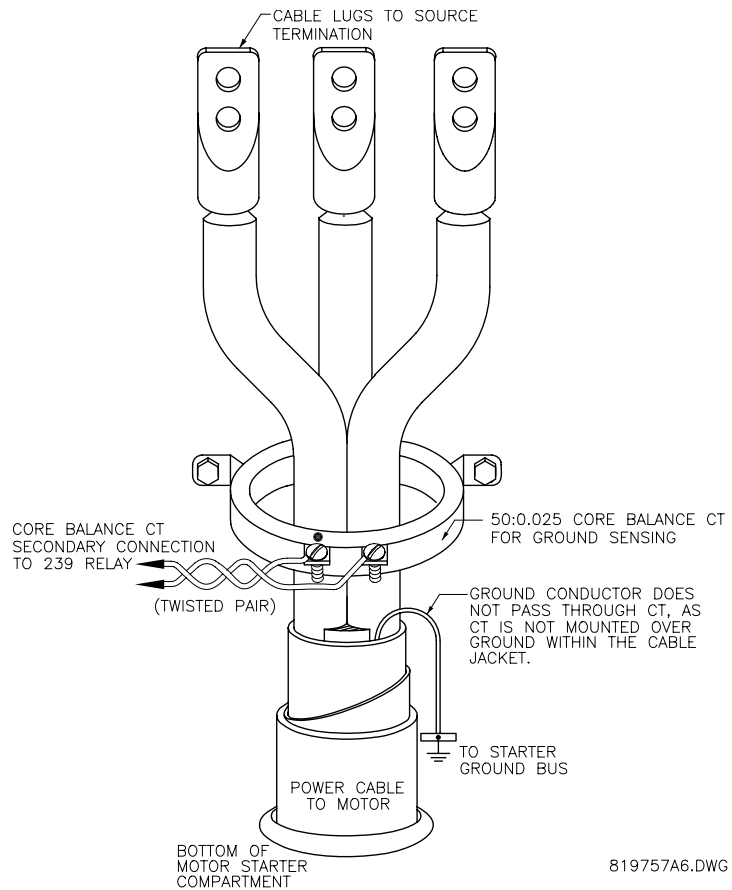
NOTE: The sizes shown above may not be standard CT ratings. The numbers are merely used to indicate what size CTs can be used with the 239.

### GROUND CT INPUT (10/11/12)

Ground sensing terminals are labeled 5A, 50:0.025, and COM. Connection depend on the grounding system and sensitivity required. For high resistance grounded systems that limit the ground current or in mines where low levels of ground leakage must be detected, use a separate CT to sense ground current. In this configuration, referred to as zero sequence or core balance detection, all three phase conductors must pass through the CT window. If the phase conductors are bundled in a cable with a ground, the ground wire must either pass outside the ground CT window or be routed back through the window if it passes through as part of the cable. Shielded and unshielded cable installations are illustrated in the TYPICAL WIRING DIAGRAM. A ground CT with a ratio of 50:0.025 for sensing primary ground currents from 0.05 to 15 A is available from GE. Connect this CT to terminals 50:0.025 and COM. If a conventional 5 A secondary CT is used for zero sequence ground sensing, connect it to the 5A and COM terminals. A 1 A secondary CT can also be used; however, to prevent readings from being off by a factor of 5, the ground CT primary setpoint must be adjusted. See Section 4.3.1 *CT Inputs* on page 4–21 under **GROUND CT PRIMARY** for suitable settings in this situation. Due to the low secondary currents, it is recommended that the ground CT secondary leads be twisted together and routed to the 239 away from high current carrying conductors. **NOTE: The 50:0.025 input is only recommended for resistance grounded systems. Where the system is solidly grounded or high levels of current are to be detected use the 5A ground input.**

For low resistance or solidly grounded systems where higher ground fault currents will flow, the phase CTs can be residually connected to provide ground sensing levels as low as 20% of the phase CT primary rating. For example, 100:5 CTs connected in the residual configuration can sense ground currents as low as 20 A (primary) without requiring a separate ground CT. This saves the expense of an extra CT however 3 phase CTs are required. If this connection is used on a high resistance grounded system verify that the

ground fault alarm and trip current setpoints are below the maximum ground current that can flow due to limiting by the system ground resistance. Sensing levels below 20% of the phase CT primary rating are not recommended for reliable operation.



**FIGURE 2-4: Core Balance Ground CT Installation (unshielded cable)**

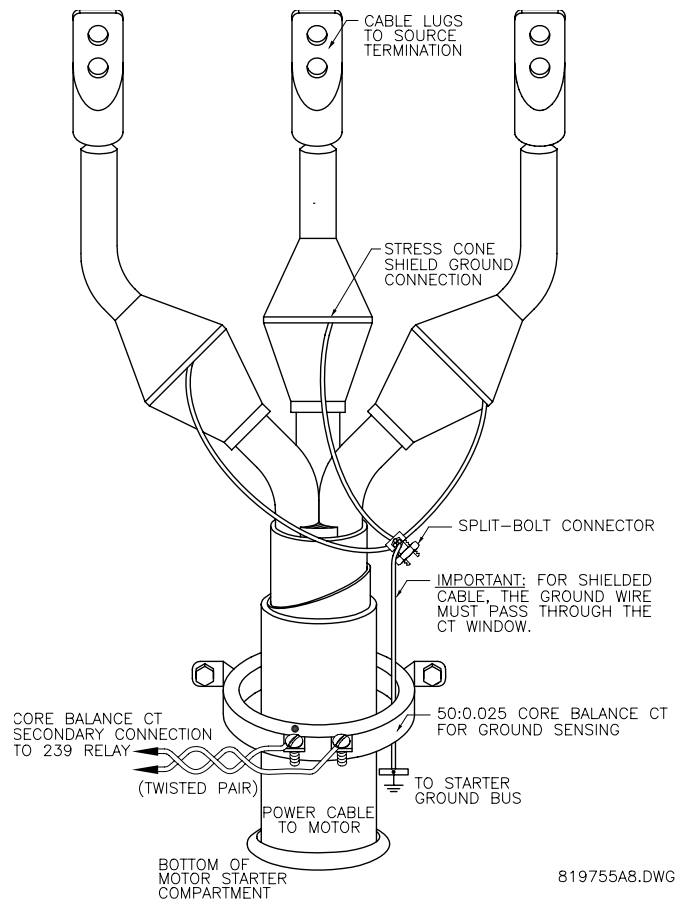


FIGURE 2-5: Core Balance Ground CT Installation (shielded cable)

## OUTPUT RELAYS

There are 4 output relays each with form C contacts (normally open (NO), normally closed (NC), and common (COM)). Contact ratings for each relay are identical and are listed in Section 1.2: Specifications. FIGURE 2-3: *Typical Wiring Diagram* on page 2-18 shows the state of the relay contacts with no control power applied; that is, the relays are not energized. Relay contact wiring will depend on how the relay operation is programmed in **S3:OUTPUT RELAYS** (see Section 4.4: S3: Output Relays on page -24).



**Relay contacts must be considered unsafe to touch when the system is energized. If the relay contacts are required for low voltage accessible applications, it is the customer's responsibility to ensure proper insulation levels.**

- **TRIP RELAY (23/24/25):** Wiring of the trip relay contacts will depend on whether a breaker or contactor is the motor tripping device and if failsafe or non-failsafe operation is desired. See programming considerations for the trip relay in Section 4.44.4.1 *Trip Relay* on page 4-25.

**Contactor:** For maximum motor protection, program the trip relay to be failsafe and wire the contactor to the NO/COM trip relay terminals. When control power is lost to the 239, the contactor will trip to ensure maximum protection. If process

considerations are more important than protection, program non-failsafe and wire the contactor to the NC/COM trip relay terminals. When control power to the 239 is lost, no protection is available and the motor will continue to run. This has the advantage that the process will not shut down, however the motor may be damaged if a fault develops under these conditions.

**Breaker:** Wire the breaker trip coil to the NO/COM trip relay terminals. The breaker auxiliary 52a contact (closed when the breaker is closed) should be wired in series with the trip relay to break the current to the trip coil as soon as the breaker opens. Program the trip relay as non-failsafe. Breaker close coil control is not provided by the 239 as it is a protection device. Control for closing the breaker must be provided externally.

- **ALARM RELAY (26/27/28):** A selected alarm condition will cause the alarm relay to activate. Alarms can be disabled for each feature so that only desired conditions cause an alarm. Alarm conditions that can be programmed to activate the alarm relay are: ground fault, undercurrent, phase unbalance, overload, RTD 1-3, thermistor, option switch 1, option switch 2, test and loss of control power (failsafe mode). If an alarm is required when control power is not present, indicating that protection is not available, select **FAILSAFE** operation for the alarm relay using **S3: OUTPUT RELAYS\ALARM RELAY\ALARM OPERATION**. Contacts NC/COM will be normally open going to a closed state on an alarm. Since the service relay gives a fault indication for loss of control power, it may be preferable to have no alarm on loss of control power and use the service relay for this indication to distinguish it from a process problem. In this case, wire the external alarm to the NO/COM terminals which will be normally open going to a closed state on an alarm condition. If **UNLATCHED** mode is selected using setpoint **S3: OUTPUT RELAYS\ALARM RELAY\ALARM ACTIVATION** the alarm relay automatically resets when the alarm condition disappears. For **LATCHED** mode, the **RESET** key must be pressed (or serial port reset command received) to reset the alarm relay.

- **AUXILIARY RELAY (29/30/31):** An additional output relay is provided which can be configured for:

**short circuit/ground trip:** Contactors are not rated to open under a short circuit. Use this output to trip the main feeder breaker in the event of a short circuit at the motor. See setpoint **S4: PROTECTION\PHASE CURRENT\PHASE S/C\PHASE S/C TRIP**.

**undercurrent:** Use as a process control output such as in a conveyor where an undercurrent condition controls flow of product onto the conveyor or in a pump situation to control a valve. Also can be used as an independent alarm. See setpoint **S4: PROTECTION\PHASE CURRENT\UNDERCURRENT\UNDERCURRENT FUNCTION**.

**serial port command:** For remote control via the RS485 communications link, a command can be issued to directly control this relay. This may be useful for control applications. See *239 Communications Guide*.

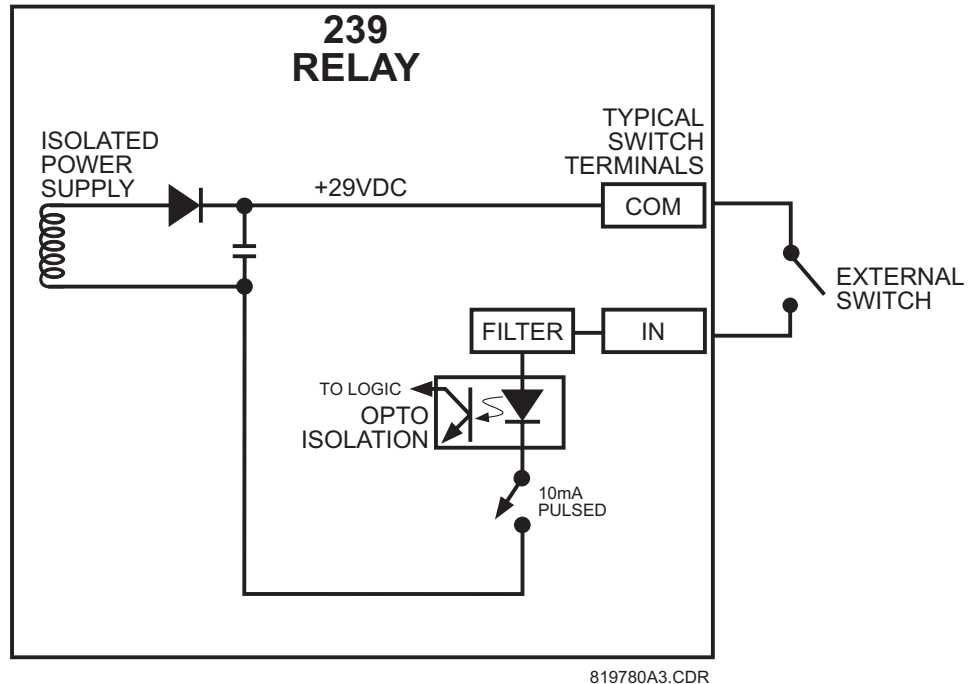
For further process control the auxiliary relay can be assigned to **option switch 1**, **option switch 2**, or **thermistor function**.

- **SERVICE RELAY (32/33/34):** If the 239 detects an internal failure during its self monitoring or if control power is not present, the NO/COM terminals of the service relay will be open to indicate that service is required. This relay is internally programmed to be failsafe so that in the normal condition, with control power applied,

the relay is energized and the NO/COM terminals shown in FIGURE 2-3: *Typical Wiring Diagram* on page 2-18 are closed. Connect these relay contacts to a suitable signaling input of a DCS system.

### SWITCH INPUTS

Each switch common terminal 38/39/40/41/42 is internally connected inside the 239. A single common wire can be connected between any of these terminals and a remote switch common terminal to reduce wiring if preferred.



819780A3.CDR

FIGURE 2-6: Switch Input Circuit

- SETPOINT ACCESS (38/43):** The access terminals 38 and 43 must be shorted together in order for the faceplate keypad to have the ability to store new setpoints. Typically the access terminals would be connected to a security keyswitch to allow authorized access only. Serial port commands to store a new setpoint will operate even if the access terminals are not shorted. When a jumper wire is connected between the access terminals all setpoints and configurations can be programmed using the keypad. Once programming is complete the jumper will normally be removed from these terminals or the connected keyswitch left open. When this is done all actual and setpoint values can still be accessed for viewing; however, if an attempt is made to store a new setpoint value the message *illegal access* will appear on the display and the previous setpoint will remain intact. In this way all of the programmed setpoints will remain secure and tamperproof.
- EMERGENCY RESTART (39/44):** When production or safety considerations become more important than motor protection requirements, it may be necessary to restart a tripped motor. If it is desired to override relay trips or lock-outs and restart the motor, a normally open keyswitch should be installed between the emergency restart terminals 39 and 44. Momentarily shorting these terminals together will cause the thermal

memory of the 239 to discharge to 0% used. The emergency restart terminals can be used to override a trip lockout caused by a running overload or locked rotor start. This option should be used only when an immediate restart after a lock-out trip is required for process continuity or personnel safety. Discharging the thermal memory of the 239 gives the relay an unrealistic value for the thermal capacity remaining in the motor and it is possible to thermally damage the motor by restarting it. Shorting the Emergency Restart terminals together will have no effect unless the motor is stopped (no phase or ground current present). Having these terminals permanently shorted together will cause the memory to be cleared whenever the motor stops. This will allow for an immediate restart after an overload trip. Caution is recommended in the use of Emergency Restart input since the thermal protective functions of the 239 will be over-ridden and it is possible to damage the motor.

- **EXTERNAL RESET (40/45):** An external reset switch which has the same effect as the front panel RESET key or a serial port reset command can be connected to terminals 40 and 45 for remote reset operation. The switch should have normally open contacts. Upon the momentary closure of these contacts the 239 will reset any latched alarm, latched auxiliary relay output, or trip providing it is not locked out. Installing a jumper wire permanently across the external reset terminals will cause the 239 to reset any latched alarm or trip whenever motor conditions allow for automatic reset.
- **OPTION SWITCH 1 (41/46) & 2 (42/47):** Two option inputs are provided. These switch inputs are considered active when closed. The state of these input switches can be monitored by the serial port for process signaling. They can also be programmed to provide an alarm, trip, alternate motor control setpoints or process control after a programmable time delay. Programming for these switch inputs, if used, is found in **S4: PROTECTION\SWITCH INPUTS** setpoints.

### THERMISTOR INPUT (21/22)

A motor can be equipped with a single thermistor in the end turns or three in the stator windings for overtemperature detection. Either positive thermal coefficient (PTC) or negative thermal coefficient (NTC) type thermistors may be directly connected to the 239. PTC thermistors are preferred because 3 thermistors can be connected in series to monitor each of the stator phases. This is not possible with NTC thermistors because all three thermistors must be hot to obtain an indication. Select thermistors that have a resistance between 100 to 30 000  $\Omega$  at the intended alarm/trip temperature. Either linear thermistors or those with a sharp change in resistance at the required temperature can be used. If no thermistor sensing is required, these terminals can be left disconnected and the thermistor feature programmed OFF.

### RTDS (OPTION) (48-57)

Up to 3 resistance temperature detectors (RTDs) must be supplied with the motor to use this option. Verify that the RTD option is installed by noting that the product identification label on back of the relay includes **-RTD** in the order code. When ordering a motor with RTDs, the 100  $\Omega$  platinum DIN 43730 type is the preferred choice for optimum sensitivity and linearity. Other RTDs that can be selected and used with the 239 are 100  $\Omega$  nickel, 120  $\Omega$  nickel and 10  $\Omega$  copper. RTDs do not have to be the same type, however the 239 must be programmed correctly so that each RTD input matches the installed type. The factory default is 100  $\Omega$  platinum. RTDs are placed in the stator slots and/or motor bearings to provide the required sensing signals to the 239 relay.

Up to 3 resistance temperature detectors (RTDs) may be used for motor stator and bearing temperature monitoring. Since an RTD indicates temperature by the value of its resistance, it is necessary to compensate for the resistance of the connecting wires, which is dependent on lead length and ambient temperature. The 239 uses a lead compensation circuit to cancel this lead resistance and read only the actual RTD resistance. Correct operation will occur providing all three wires are of the same length and the resistance of each lead is not greater than 25% of the RTD 0°C resistance (see Section 1.2: Specifications on page –8). This can be accomplished by using identical lengths of the same type of wire. Each RTD COM terminal is internally connected to the safety ground, terminal 13. Consequently, where code permits, the 3 RTD terminals should not be grounded at the motor end for the lead resistance compensation to work correctly. If 10  $\Omega$  copper RTDs are used, special care should be taken to keep the lead resistance as low as possible. If no RTD sensor is installed, the corresponding terminals may be left unconnected and the RTD programmed as OFF.

Shielded, three wire cable must be used in industrial environments to prevent noise pickup. Wherever possible, the RTD leads should be kept close to grounded metal casings and avoid areas of high electromagnetic or radio frequency fields. RTD leads should not run adjacent to, or in the same conduit as high current carrying wires. Use either multiconductor shielded cable for all 3 RTDs or separate three wire shielded cable of #18 AWG copper conductors for each RTD. The 239 shield terminal (48) and each RTD COM (51,54,57) are internally connected to safety ground, terminal 13. The shield connection of the RTD cable should not be grounded at both ends. This arrangement prevents noise pickup that could otherwise occur from circulating currents due to differences in ground potentials on a doubly grounded shield.

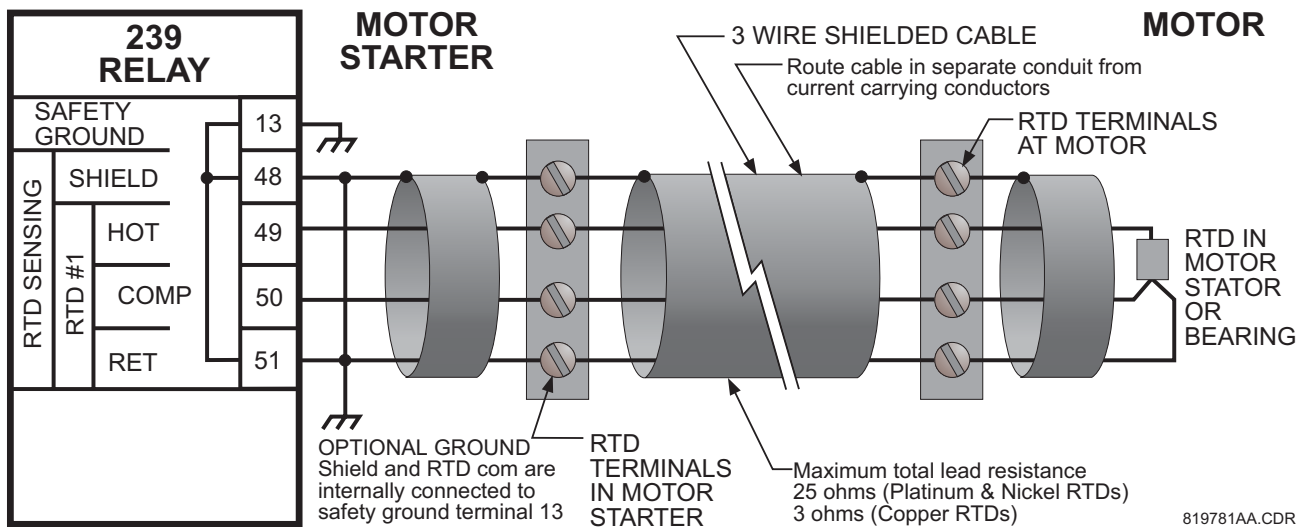


FIGURE 2-7: RTD Wiring

### ANALOG OUTPUT (OPTION) (18/19/20)

Terminals 18-20 of the 239 are available for a single analog current output of one parameter. Verify that the Analog Output option is installed by noting that the product identification label on back of the relay includes **-AN** in the order code. The choice of output and current range is selected in **51:239 SETUP\ANALOG OUTPUT\ANALOG OUTPUT**



**TYPE & RANGE.** Use the TYPE message to select one of the following for output: phase CT (secondary) amps, % motor full load current (FLC), thermal capacity used (100% = motor tripped), RTD1 temperature, RTD2 temperature, or RTD3 temperature. The RANGE message selects the output current as: 0-1 mA, 0-20 mA or 4-20 mA. Range assignment is shown below in Table 2-4: *Analog Output Range Assignment*.

**Table 2-4: Analog Output Range Assignment**

| SELECTED OUTPUT       | PROGRAMMED RANGE |        |         |        |         |        |
|-----------------------|------------------|--------|---------|--------|---------|--------|
|                       | 0-1 mA           |        | 0-20 mA |        | 4-20 mA |        |
|                       | 0 mA             | 1 mA   | 0 mA    | 20 mA  | 4 mA    | 20 mA  |
| Average Phase Current | 0 A              | 1A/5A* | 0 A     | 1A/5A* | 0A      | 1A/5A* |
| Motor Full Load %     | 0%               | 200%   | 0%      | 200%   | 0%      | 200%   |
| Thermal Capacity      | 0%               | 100%   | 0%      | 100%   | 0%      | 100%   |
| RTD 1-3 Temperature   | 0°C              | 180°C  | 0°C     | 180°C  | 0°C     | 180°C  |
| Forced Output         | 0%               | 100%   | 0%      | 100%   | 0%      | 100%   |

\* 1 Amp CT secondary = 1 A, 5 Amp CT secondary = 5 A

This output is a current source suitable for connection to a remote meter, chart recorder, programmable controller, or computer load. Use the 4-20 mA with a programmable controller that has a current input. If only a voltage input is available use a scaling resistor at the PLC terminals to scale the current to the equivalent voltage and select the 0 to 20 mA output. For example, install a 500  $\Omega$  resistor across the terminals of a 0 to 10 V input to make the 0 to 20 mA output correspond to 0 to 10V ( $R = V/I = 10 \text{ V} / 0.02 \text{ A} = 500 \Omega$ ). When the GE Multilin TCS2 thermal capacity meter is connected to the terminals, select the 0 to 1 mA range. Current levels are not affected by the total lead and load resistance which must not exceed 600  $\Omega$  for 0-20 mA and 4-20mA range and 2400  $\Omega$  for 0-1mA range. For readings greater than full scale the output will saturate at 21 mA (0-20/4-20 range) or 1.1 mA (0-1 range). This analog output is isolated. Since both output terminals 18 and 19 are floating, the connection of the analog output to a process input will not introduce a ground loop. Part of the system should be grounded for safety, typically at the programmable controller. For floating loads, such as a meter, ground terminal 19 externally. Terminal 20 is internally grounded and may be used as a shield ground if required. Ground the shield at one end only to prevent ground loop noise.

### SERIAL PORT (15/16/17)

A serial port provides communication capabilities between the 239 and a remote computer, PLC or distributed control system (DCS). Up to thirty-two 239 relays can be daisy chained together with 24 AWG stranded, shielded, twisted pair wire on a single communication channel. Suitable wire should have a characteristic impedance of 120  $\Omega$  such as Belden #9841. These wires should be routed away from high power AC lines and other sources of electrical noise. The total length of the communications wiring should not exceed 4000 feet for reliable operation. Correct polarity is essential for the communications port to operate. Terminal 15 (485 A+) of every 239 in a serial communication link must be connected together. Similarly, terminal 16 (485 B-) of every 239 must also be connected together. These polarities are specified for a 0 logic and

should match the polarity of the master device. When the communications link is active, the front panel **COMMUNICATE** light will be solid if valid data and relay address are being received. If the front panel **COMMUNICATE** light flashes to indicate invalid data, try reversing the wires to terminals 15 and 16. Each relay must be daisy chained to the next one as shown in FIGURE 2-8: *RS485 Communication Wiring* on page 2-28. Avoid star or stub connected configurations. If a large difference in ground potentials exists, communication on the serial communication link will not be possible. Therefore, it is imperative that the serial master and 239 are both at the same ground potential. This is accomplished by joining 485 ground terminal 17 of every unit together and grounding it at the master only.

The last 239 in the chain and the master computer need a terminating resistor and terminating capacitor to prevent communication errors by ensuring proper electrical matching of the loads. Using terminating resistors on all the 239s would load down the communication network while omitting them at the ends could cause reflections resulting in garbled data. Install the 120  $\Omega$  / ¼ watt terminating resistors and 1 nF capacitor externally. Although any standard resistor or capacitor of these values are suitable, these components can also be ordered from GE Multilin as a combined terminating network.

Each communication link must have only one computer (PLC or DCS) issuing commands called the master. The master should be centrally located and can be used to view actual values and setpoints from each 239 relay called the slave device. Other GE Multilin relays or devices that use the Modbus RTU protocol can be connected to the communication link. Setpoints in each slave can also be changed from the master. Each 239 in the communication link must be programmed with a different slave address prior to running communications using **S1: 239 SETUP\RS485 SERIAL PORT\SLAVE ADDRESS**. 239PC, a communications software package developed by GE Multilin, may be used on a PC to view motor status, actual values, and view and alter setpoints.

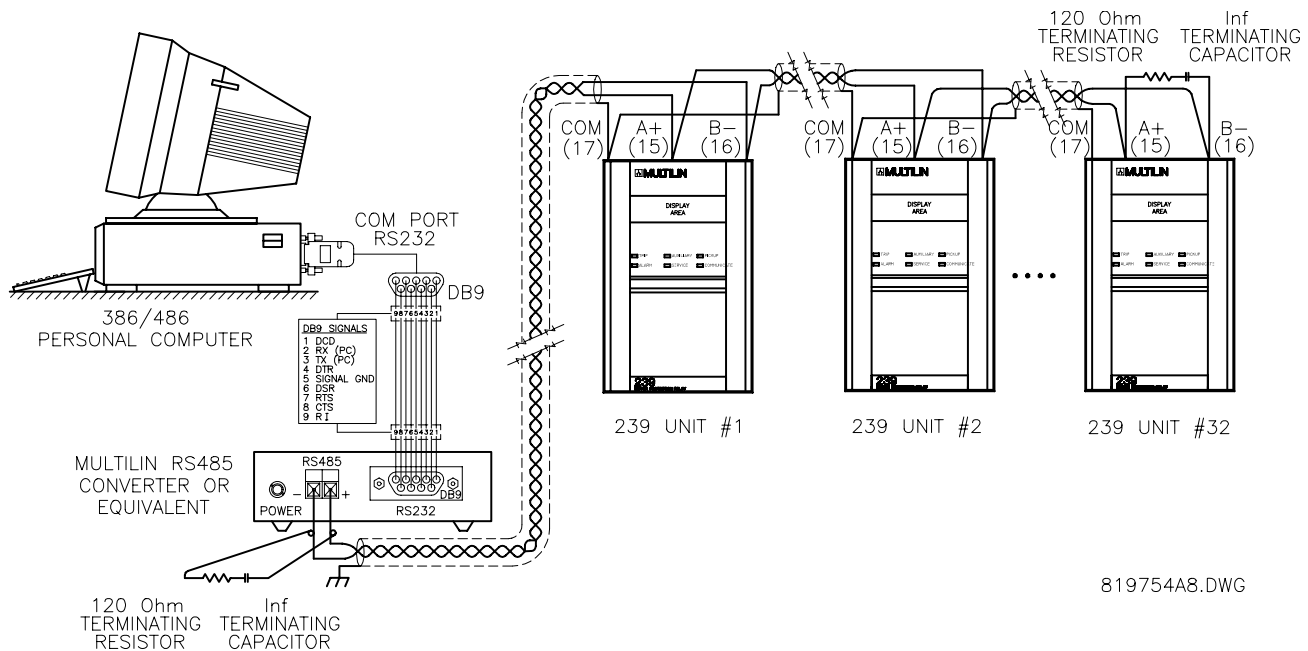


FIGURE 2-8: RS485 Communication Wiring

## GROUNDING

- **SAFETY GROUND (13):** Connect the safety ground terminal 13 to a reliable system ground within the starter using heavy gauge wire. For safety, all metal parts within the 239 are connected to this ground terminal. Shield terminals 20/48 and RTD COM terminals 51/54/57 are internally connected to the safety ground, terminal 13.
- **FILTER GROUND (14):** Using #12 gauge wire or ground braid, connect this terminal to a solid system ground, typically a copper bus in the starter. Extensive filtering and transient protection is built into the 239 to ensure reliable operation under harsh industrial operating environments. Transient energy must be conducted back to the source through filter ground terminal 14. The filter ground terminal is separated from the safety ground terminal to allow dielectric testing of a starter with a 239 wired up.

When properly installed, the 239 will meet the interference immunity requirements of IEC 801 and ANSI C37.90.

### 2.1.4 Dielectric Strength Testing

It may be required to test a complete motor starter for dielectric strength with the 239 installed. This is also known as “flash” or “hipot” testing. The 239 is rated for 1530 V AC isolation for 1 minute (or 1836 V AC for 1 second) between relay contacts, CT inputs, control power inputs and safety ground terminal 13. Some precautions are necessary to prevent damage to the 239 during these tests.

Filter networks and transient protection clamps are used between the control power, serial port, switch inputs, analog output, thermistor, RTDs inputs and the filter ground terminal 14 to filter out high voltage transients, radio frequency interference (RFI) and electromagnetic interference (EMI). The filter capacitors and transient absorbers could be damaged by the continuous high voltages relative to ground that are applied during dielectric strength testing. Disconnect the filter ground terminal 14 during testing of the control power inputs. Relay contact and CT terminals do not require any special precautions. **Do not dielectric strength test the serial port, thermistor, RTD or analog output terminals else the 239 internal circuitry will be damaged.**

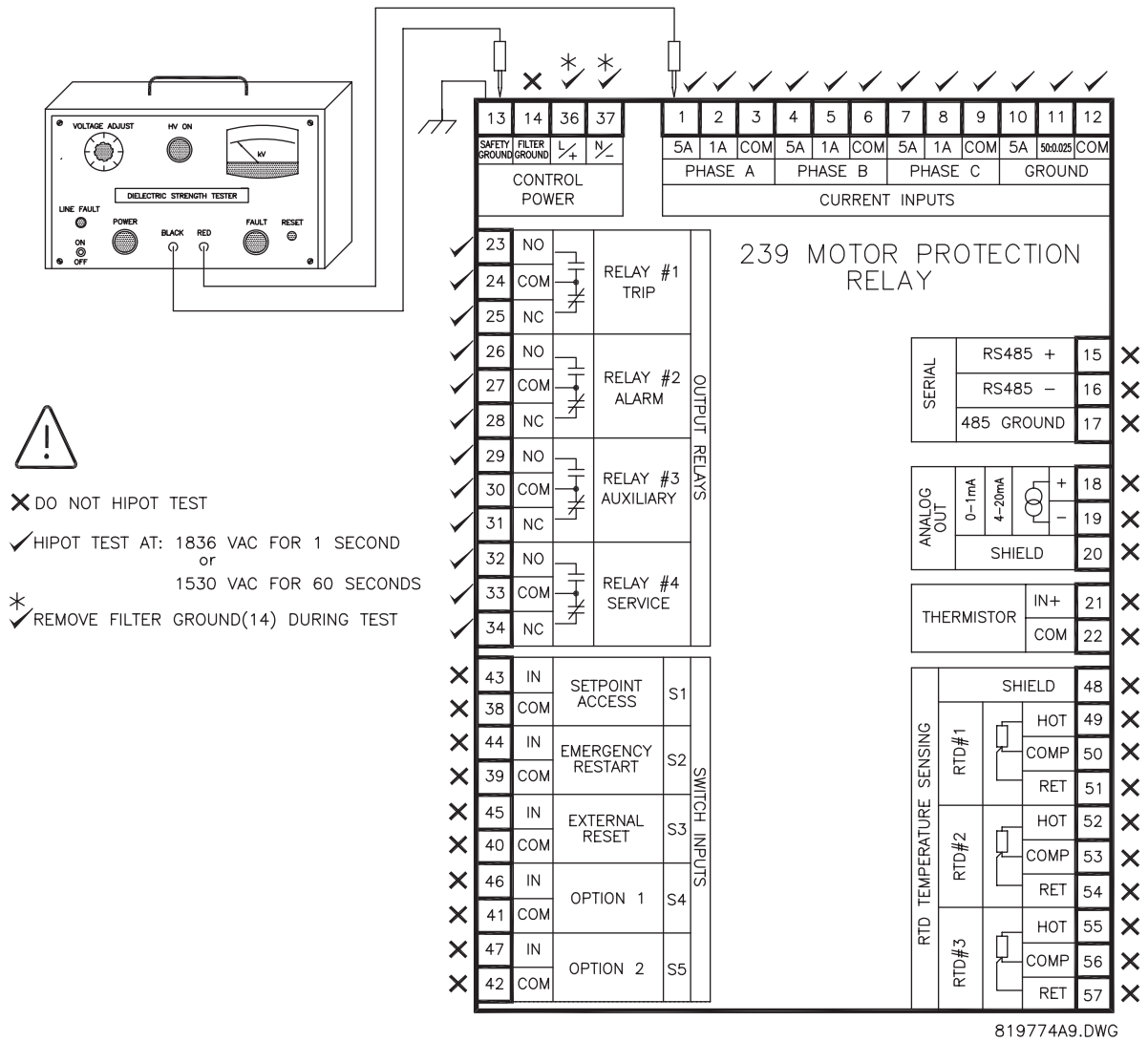
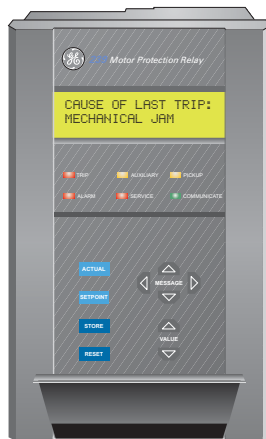


FIGURE 2-9: Dielectric Strength Testing



## 239 Motor Protection Relay

### Chapter 3: Operation

---

#### 3.1 Operation

##### 3.1.1 Front Panel

The local operator interface for setpoint entry and monitoring of measured values is from the front panel, as shown in the figure below. Control keys are used to select the appropriate message for entering setpoints or displaying measured values. Alarm and status messages are automatically displayed when required. Indicator LEDs provide important status information at all times.

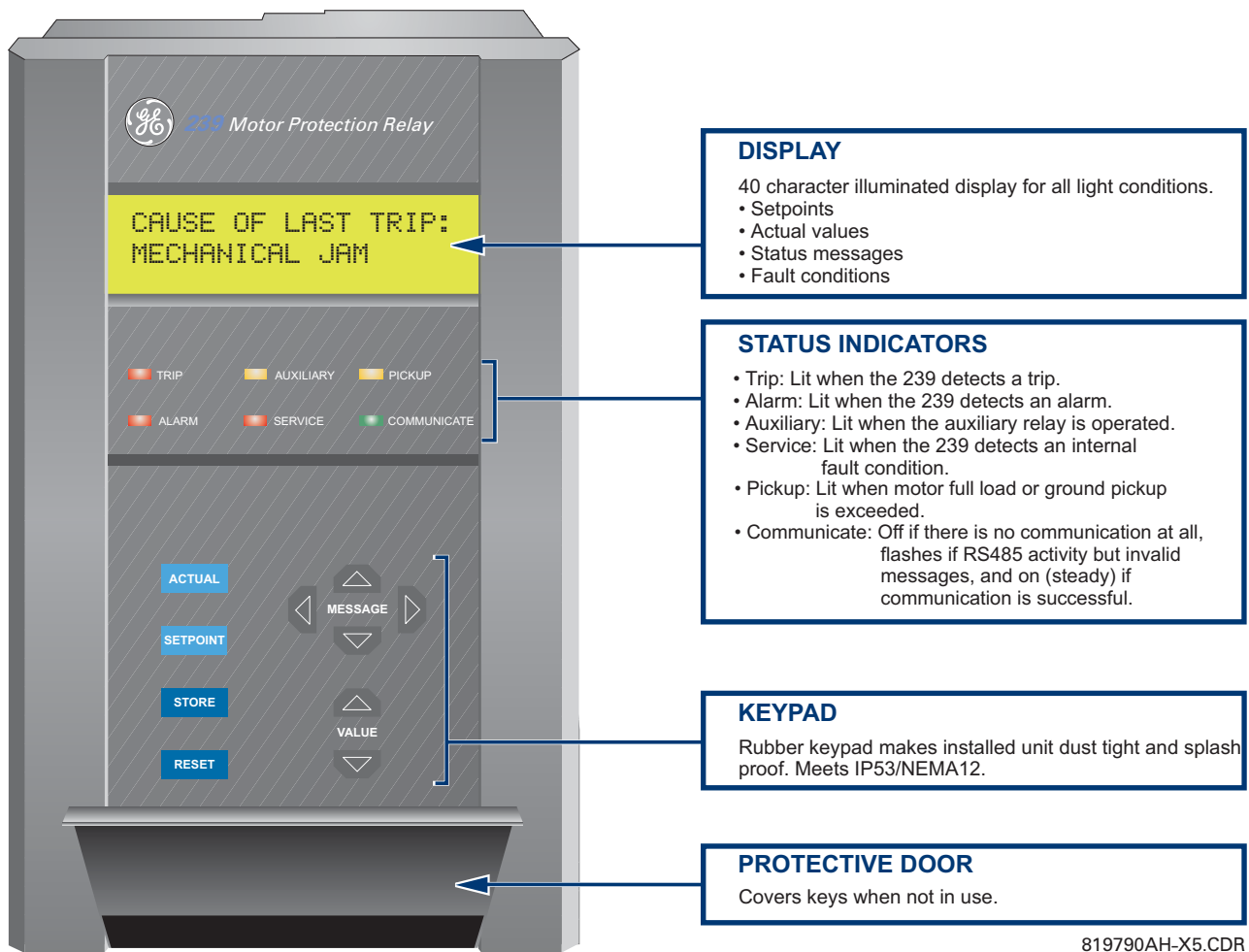


FIGURE 3-1: Front Panel

### 3.1.2 Display

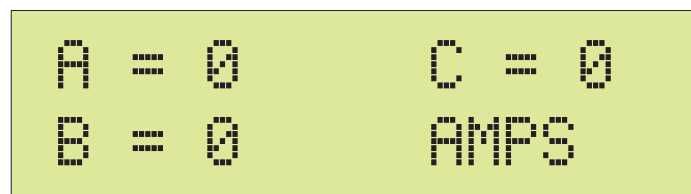


FIGURE 3-2: 239 Display

All messages are displayed in English on the 40-character LCD display, which is visible under varied lighting conditions. While the keypad and display are not actively being used, the screen will display the default status message. This message will appear if no key has been pressed for the time programmed in **S1:239 SETUP\PREFERENCES\DEFAULT MESSAGE TIME**. Trip and alarm condition messages will automatically override default messages.

To maximize the lifetime of the display, its brightness can be varied using the setpoint **S1: 239 SETUP\PREFERENCES\DEFAULT MESSAGE BRIGHTNESS**. The display will adjust to set brightness level when the default messages are being displayed. If any one of keys on the 239 keypad is pressed or an alarm/trip is present the display brightness will automatically become 100%. If the default messages time is set to OFF, the 239 display will dim to the set brightness level after 5 minutes have elapsed since one of the keys on the keypad was last pressed.

NOTE: Message brightness control is available only on units with the VFD display.

### 3.1.3 Status Indicators



819762A7.CDR

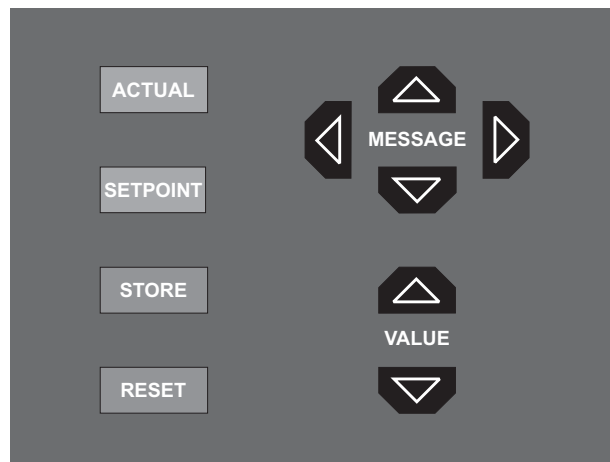
FIGURE 3-3: 239 Status Indicators

- **TRIP:** The **TRIP** indicator flashes when the 239 has tripped. This will be caused by any trip condition (overload, short circuit etc.) or a serial trip command issued via the communication port. The indicator and the trip relay are reset manually by pressing the **RESET** key, remotely using a computer reset command, or by closing the external reset input.
- **ALARM:** The **ALARM** relay is intended for general purpose alarm outputs. The **ALARM** indicator will be on while the **ALARM** relay is operating. If the **ALARM** is programmed as unlatched, this indicator will flash as long as the alarm condition persists. When the condition clears, the **ALARM** indicator will turn off. If the alarm relay has been programmed as latched, the alarm condition can only be cleared by pressing the **RESET** key, by issuing a computer reset command, or by closing the external reset input.
- **AUXILIARY:** The **AUXILIARY** relay is intended for customer specific requirements. The **AUXILIARY** indicator will turn on while the **AUXILIARY** relay is operating.
- **SERVICE:** Any abnormal condition detected during 239 self-monitoring, such as a hardware failure, will cause the **SERVICE** relay to operate. This relay is programmed to be failsafe (i.e. non-operated state is "Energized," operated state is "De-energized"). The **SERVICE** indicator will turn on while the **SERVICE** relay is operating (i.e. de-energized). Loss of control power to the 239 also causes the **SERVICE** relay to be de-energized, indicating that no protection is present.
- **PICKUP:** During testing, for calibration verification, it is useful to have an indication of when the motor full load or ground trip pickup setting has been exceeded. Eventually an alarm or a trip will occur if these conditions persist. The indicator will remain flashing as long as the motor full load setting remains exceeded while the motor is running or ground current is above the ground trip pickup level. The indicator will automatically turn off when the phase current

drops below the full load threshold and the ground current is below the trip pickup setting.

- **COMMUNICATE:** Status of the RS485 communication port is monitored with this indicator. If there is no serial data being received via the rear serial port terminals the **COMMUNICATE** indicator will be off. This situation will occur if there is no connection, the serial wires have become disconnected or the master computer is inactive. If there is activity on the serial port but the 239 is not receiving valid messages for its internally programmed address the indicator will flash. This could be caused by incorrect message format such as baud rate or framing, reversed polarity of the two RS485 twisted pair connections or the master not sending the currently programmed 239 address. If the 239 is being periodically addressed with a valid message, the **COMMUNICATE** indicator will be on continuously. If no valid message has been received for 10 seconds, the indicator will either flash (serial data present) or go off (no serial data).

### 3.1.4 Keys



819764A4.CDR

FIGURE 3-4: FRONT PANEL KEYS

- **SETPOINT:** Setpoints are arranged into groups of related messages called setpoint pages. Each time the **SETPOINT** key is pressed, the display advances to the first message of the next page of setpoints. Pressing the **SETPOINT** key while in the middle of a page of setpoints advances the display to the beginning of the next page. The **MESSAGE** ⬇ and **MESSAGE** ⬆ keys are used to move between messages within a page.
- **ACTUAL:** Measured values and collected data messages are arranged into groups of related messages called actual values pages. Each time the **ACTUAL** key is pressed, the display advances to the first message of the next page of actual values. Pressing the **ACTUAL** key while in the middle of a page of actual values advances the display to the beginning of the next page. The **MESSAGE** ⬆ and **MESSAGE** ⬇ keys are used to move between messages within a page.



- **STORE:** When programming setpoints, enter the new value using the **VALUE ▾** / **VALUE ▸** keys, followed by the **STORE** key. Setpoint programming must be enabled for the **STORE** key to store the edited value. An acknowledgment message will flash if the new setpoint is successfully saved in non-volatile memory. The **STORE** key is also used to add and remove user defined default messages. Refer to Section 3.1.6: Default Messages on page –8 for further details.
- **RESET:** After a trip the **TRIP** indicator will be flashing. Press the **RESET** key to clear the trip indicator. The **RESET** key will clear the trip indicator and the active trip message if the cause of the trip is no longer present. If the trip condition is still present, one of following two messages will flash to indicate that reset is not possible.

**RESET NOT POSSIBLE  
OVERLOAD LOCKOUT**

*Displayed when overload trip lockout condition is present.*

**RESET NOT POSSIBLE  
FAULT STILL PRESENT**

*Displayed when a trip condition other than an overload trip lockout is present.*

The **RESET** key, along with the **STORE** key, is also used to remove user defined default messages. Refer to Section 3.1.6: Default Messages on page –8 for further details.

- **MESSAGE UP/DOWN/LEFT/RIGHT:** To move between message groups within a page use the **MESSAGE ▸** / **MESSAGE ▾** keys. The **MESSAGE ▾** key moves toward the end of the page and the **MESSAGE ▸** key moves toward the beginning of the page. A page header message will appear at the beginning of each page and a page footer message will appear at the end of each page. To select messages within a subgroup press **MESSAGE ▸**. To back out of the subgroup or access the previous message, press **MESSAGE ▸**.

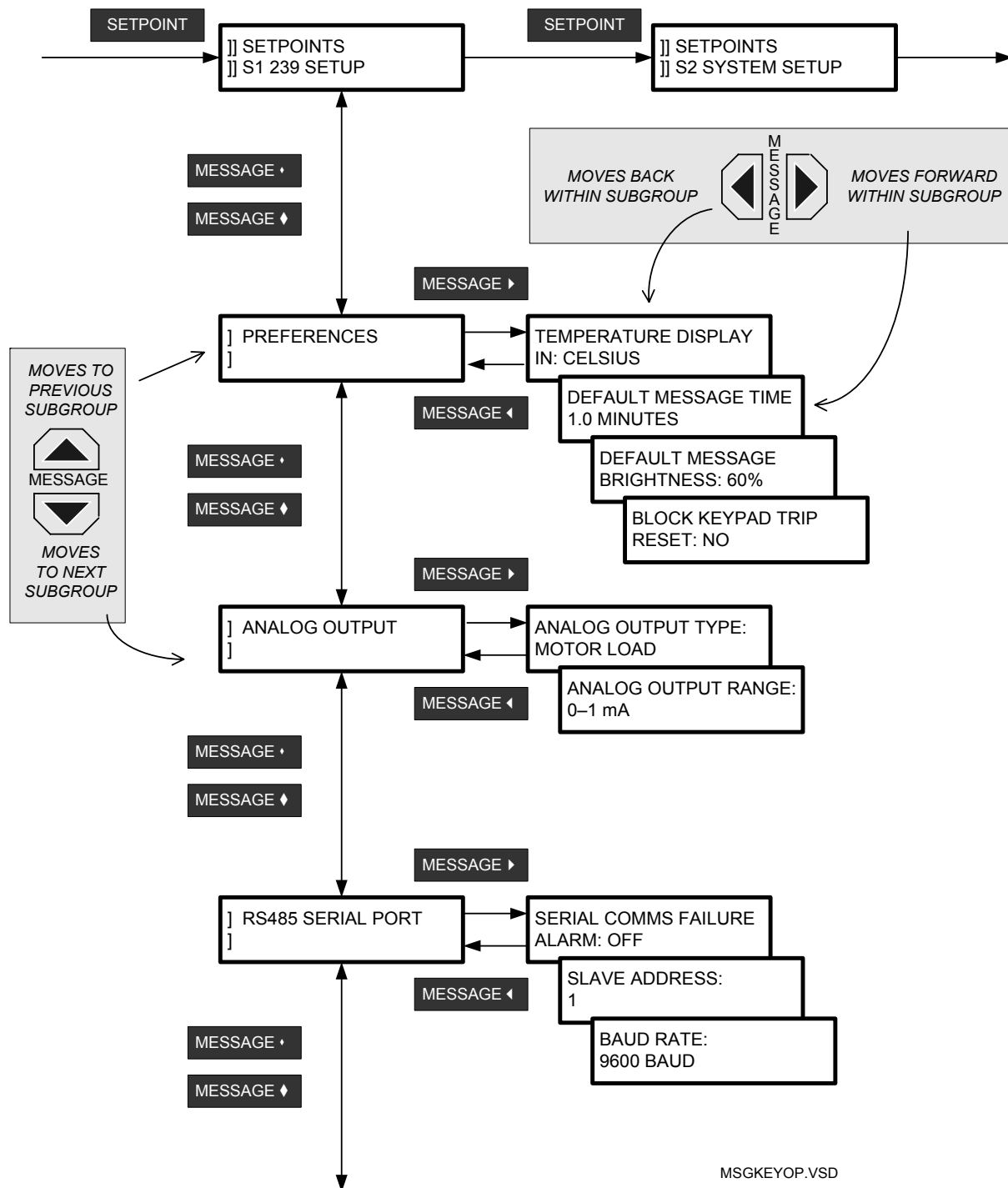
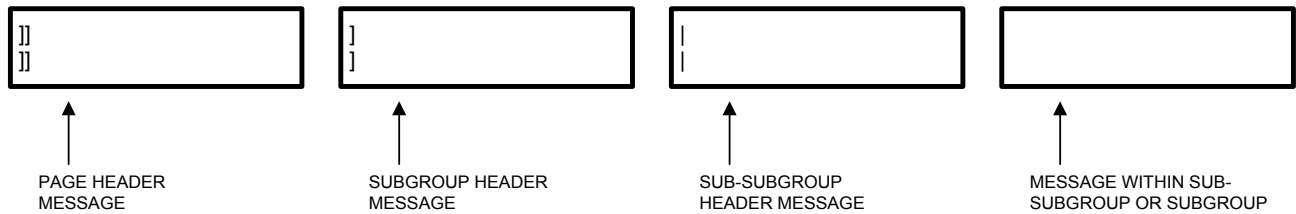


FIGURE 3-5: Message Key Operation

- VALUE UP/DOWN:** Setpoint values are entered using the **VALUE ◀** / **VALUE ▸** keys. When a setpoint is displayed calling for a yes/no response, each time **VALUE ◀** or **VALUE ▸** is pressed, the “Yes” becomes a “No” or the “No” becomes a “Yes.” Similarly, for multiple choice selections, each time **VALUE ◀** or **VALUE ▸** is

pressed the next choice is displayed. When numeric values are displayed, each time **VALUE ▸** is pressed, the value increases by the step increment, up to the maximum. Hold the key down to rapidly change the value.

- **KEYPAD ENTRY:** Press the **SETPOINT** key once and the first page of setpoints is displayed. Press the **SETPOINT** key several times to move to the top of successive pages. A header message with two bars in the first two character positions is the start of a new page. The page number and page title appear on the second line. All setpoint page headers are numbered with an 'S' prefix. Actual value page headers are numbered with an 'A' prefix.



The messages are organized into logical subgroups within each Setpoints and Actual Values page as shown above.

Press the **MESSAGE ◀** / **MESSAGE ▶** key when displaying a subgroup to access messages within that subgroup. Otherwise select the **MESSAGE ▸** / **MESSAGE ◀** keys to display the next subgroup.

- **COMPUTER ENTRY:** When using a computer running 239PC software, setpoint values are grouped together on a screen. The data is organized in a system of menus. See Chapter 6.1: EnerVista 239 Setup Interface for further details.
- **SCADA ENTRY:** Details of the complete communication protocol for reading and writing setpoints are given in *239 Communications Guide*. A SCADA system connected to the RS485 terminals can be customer programmed to make use of any of the communication commands for remote setpoint programming, monitoring and control.

### 3.1.5 Setpoint Access

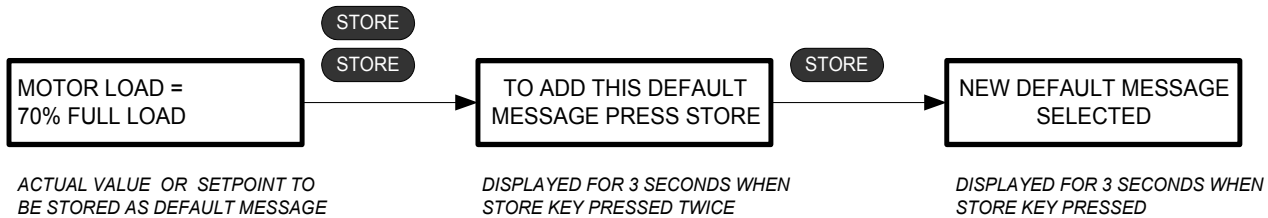
Hardware security is designed into the relay to provide protection against unauthorized setpoint changes. To program new setpoints using the front panel keys a hardware jumper must be installed across the setpoint access terminals on the back of the relay. These terminals can be permanently wired to a panel mounted keyswitch if this is more convenient. Attempts to enter a new setpoint without the electrical connection across the setpoint access terminals will result in an 'ILLEGAL ACCESS' error message. When setpoint programming is via a computer connected to the rear RS485 communication port, no setpoint access jumper is required. If a SCADA system is used for relay programming, it is up to the programmer to design in appropriate passcode security.

### 3.1.6 Default Messages

Up to 5 default messages can be selected to automatically scan sequentially when the 239 is left unattended. If no keys are pressed for the default message time set with **S1:239 SETUP\PREFERENCES\DEFAULT MESSAGE TIME**, then the currently displayed message will automatically be overwritten by the first default message. After 5 seconds, the next default message in the sequence will display if more than one is selected. Trip, Alarm and flash messages will override the default message display. Any setpoint or measured value can be selected as a default message.

Messages are displayed in the order they are selected.

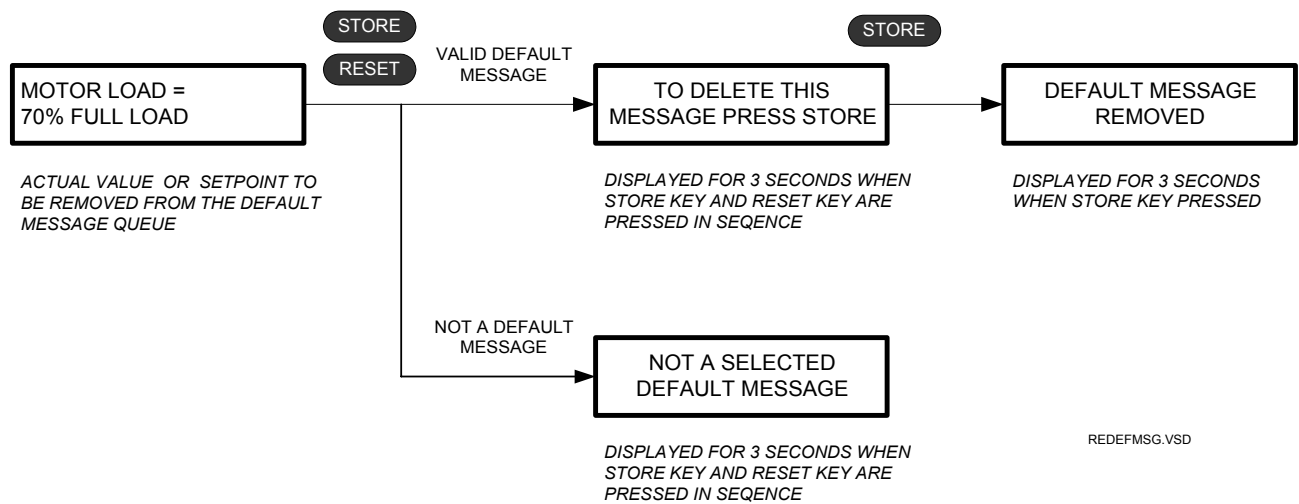
- ADDING NEW DEFAULT MESSAGE:** use the **MESSAGE ▸** / **MESSAGE ▾** keys to display any setpoint or actual value message to be added to the default message queue and follow the steps shown below. When selecting a setpoint message for display as a default, **do not** modify the value using the **VALUE ▾** / **VALUE ▸** keys or the 239 will recognize the **STORE** key as storing a setpoint instead of selecting a default message



ADEFMSG.VSD

If 5 default messages are already selected the first message is erased and the new message is added to the end of the queue.

- DELETING A DEFAULT MESSAGE:** Use the **MESSAGE ▸** / **MESSAGE ▾** keys to display the default message to be erased. If default messages are not known, wait until the 239 starts to display them and then write them down. If no default messages have been programmed, the 239 will remain on the current message and the display will dim to the level assigned in setpoint **S1: 239 SETUP\PREFERENCES\DEFAULT MESSAGE BRIGHTNESS** after the delay assigned in **S1: 239 SETUP\PREFERENCES\DEFAULT MESSAGE TIME** has expired. Use the **MESSAGE ▸** / **MESSAGE ▾** keys to display the setpoint or actual value message to be deleted from the default message queue and follow the steps shown below.



Each 239 is pre-programmed with five default messages as shown below. Note, each time the factory setpoints are reloaded the user programmed default messages are overwritten with these messages.

The 239 will scroll through the default messages in the sequence shown.

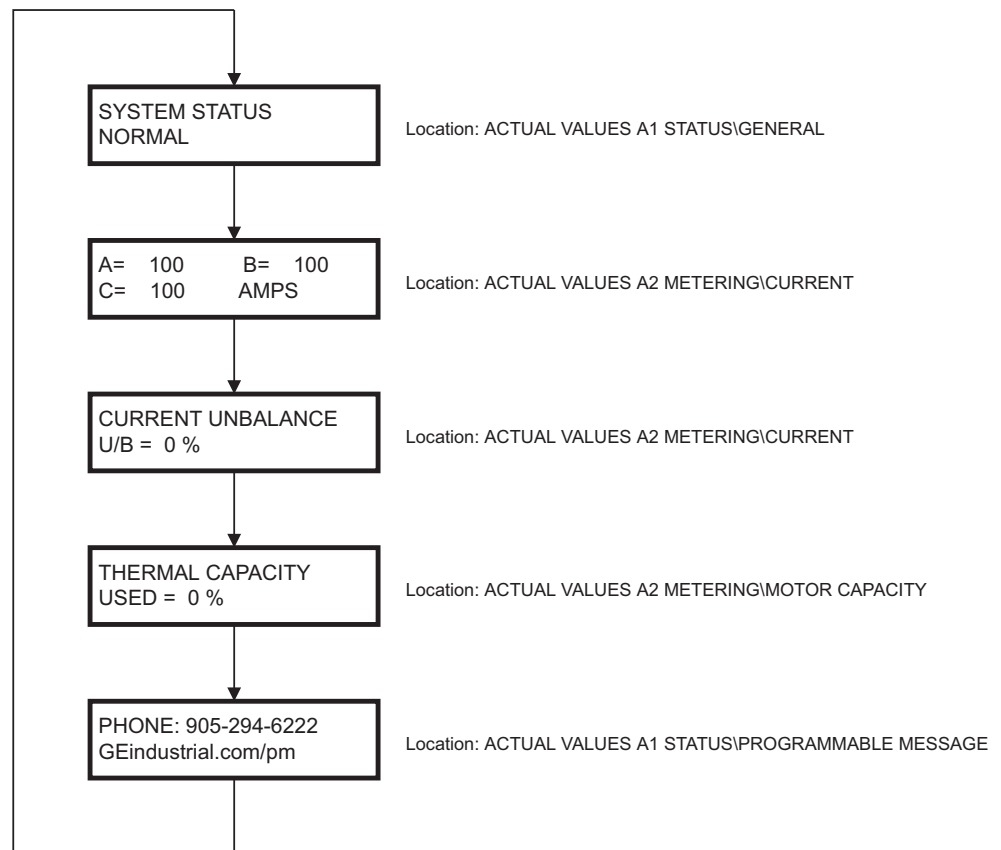
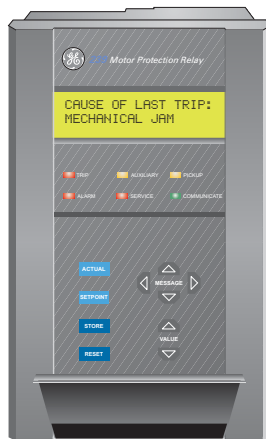


FIGURE 3-6: Default Message Sequence





## 239 Motor Protection Relay

### Chapter 4: Programming

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#### 4.1 Programming

##### 4.1.1 Setpoint Entry Methods

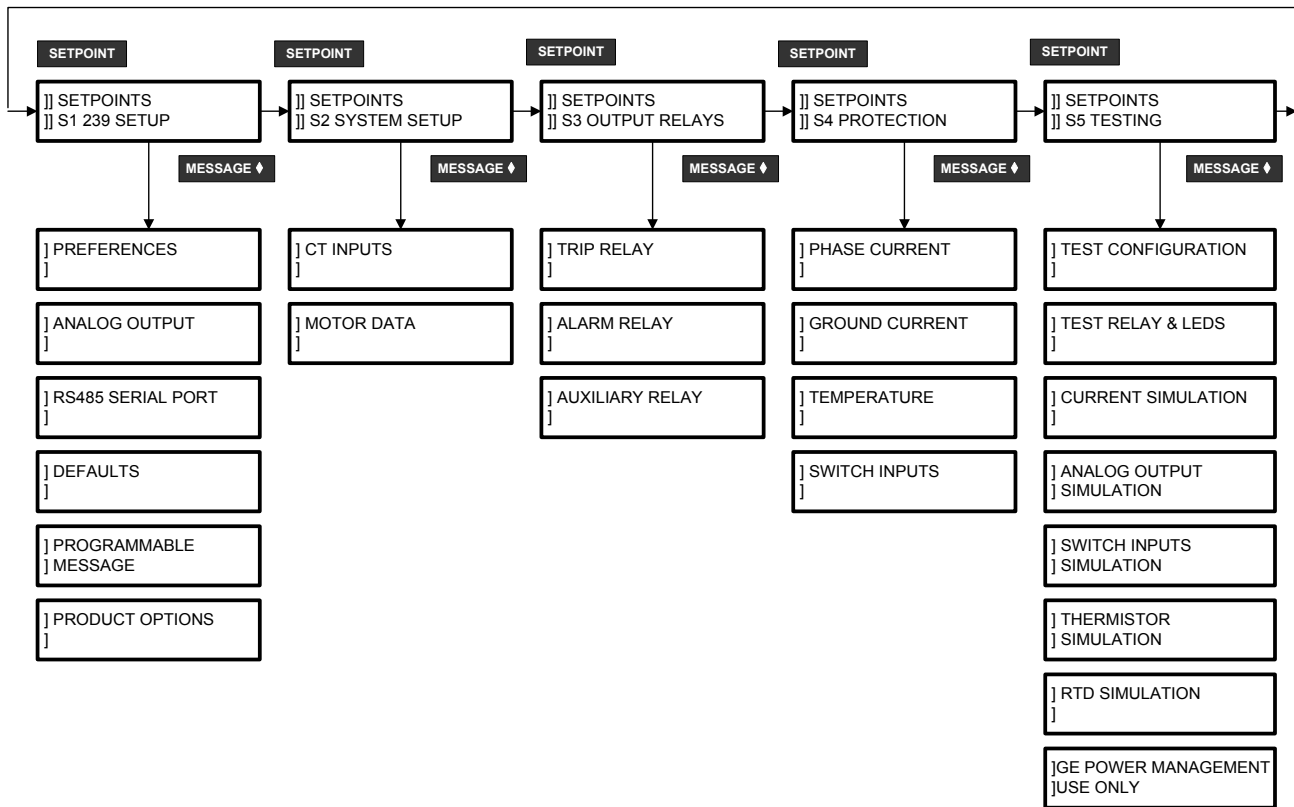
Prior to operating the 239 relay, setpoints defining system characteristics and protection settings must be entered, via one of the following methods:

1. Front panel, using the keys and display.
2. Rear terminal RS485 port and a computer running the 239PC communication program available from GE Multilin.
3. Rear terminal RS485 port and a SCADA system running user-written software.

Any of these methods can be used to enter the same information. However, a computer makes entry easier and files can be stored and downloaded for fast, error free entry. To facilitate this process, the 239PC programming software is available from GE Multilin. With this program installed on a portable computer, all setpoints can be downloaded to the 239.

Setpoint messages are organized into logical groups or pages for easy reference. Setpoint messages are described individually and a reference of all messages is also provided at the end of the chapter. Messages may vary somewhat from those illustrated because of installed options. Also, some messages associated with disabled features are hidden. This context sensitive operation eliminates confusing detail. Before attempting to start the protected motor, setpoints on each page should be worked through, entering values either by local keypad or computer.

The 239 relay leaves the factory with setpoints programmed to default values. These values are shown in all the setpoint message illustrations. Many of these factory default values can be left unchanged. At a minimum however, setpoints that are shown shaded on FIGURE 4-3: *Setpoints Page 2 – System Setup* on page 4-20 must be entered for the system to function correctly. In order to safeguard against the installation of a relay whose setpoints have not been entered, the 239 will trip and lock out until the values have been entered for these setpoints. A warning message “CAUSE OF LAST TRIP: PARAMETERS NOT SET” along with a trip condition is present until the 239 is programmed with these critical setpoints.

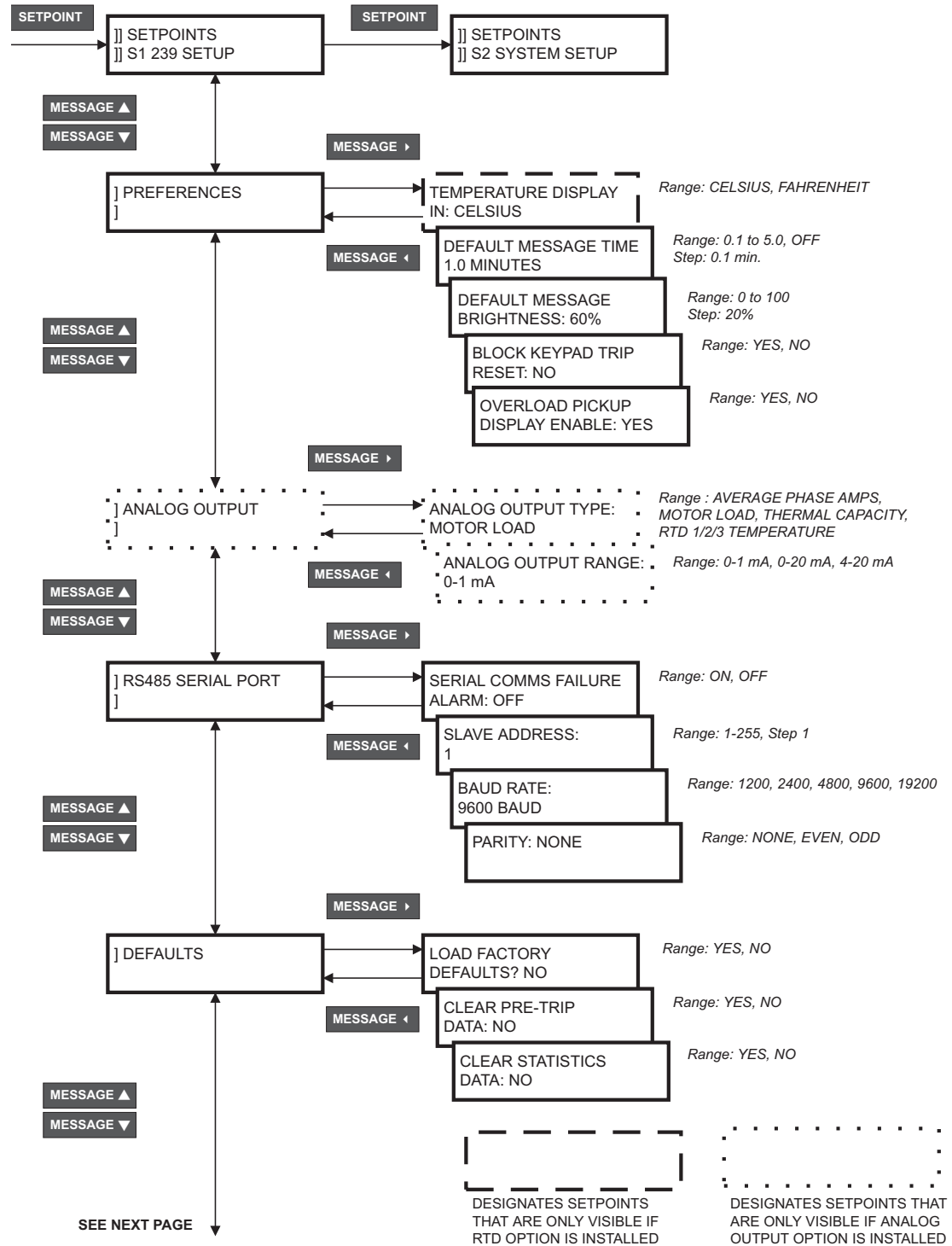


### FIGURE 4-1: Setpoint Message Organization



## 4.2 S1: 239 Setup

Settings to configure the 239 are entered here. This includes user preferences, RS485 communication port, loading of factory defaults, and user programmable messages.



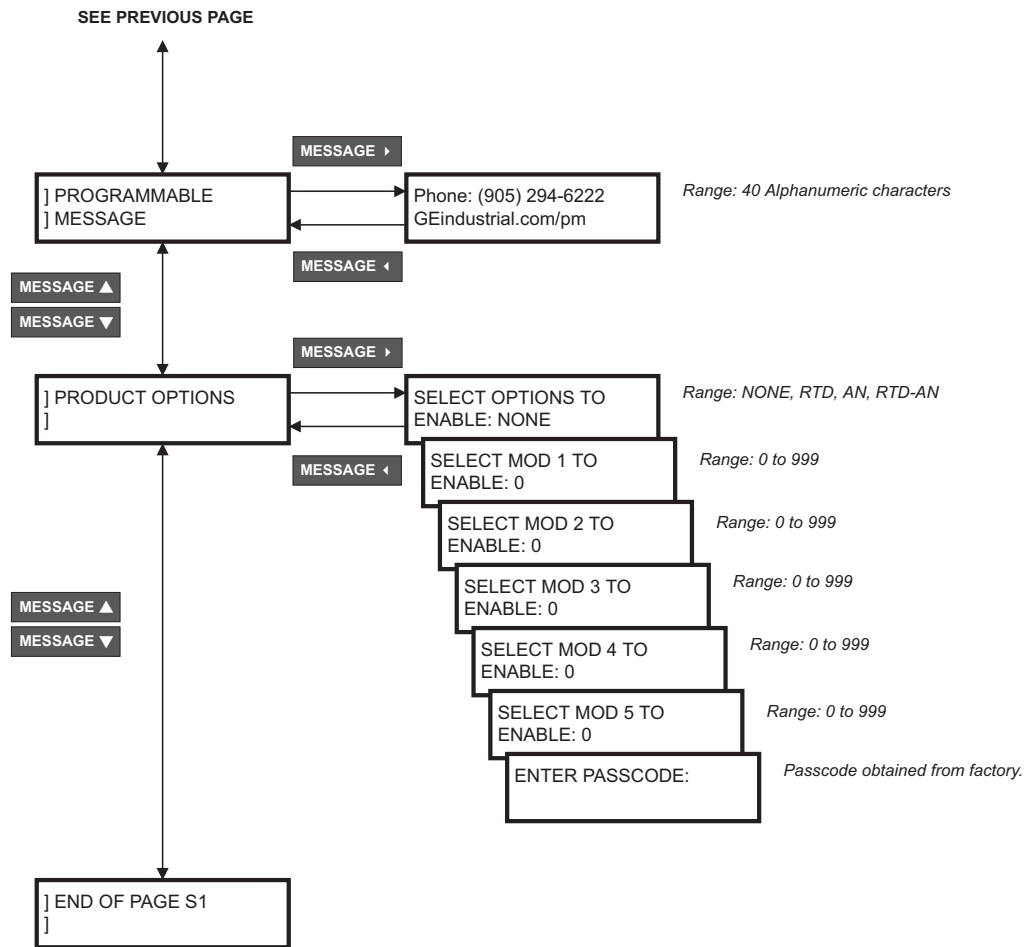


FIGURE 4-2: Setpoints Page 1 – 239 Setup

### 4.2.1 Preferences

- **TEMPERATURE DISPLAY:** Select whether temperatures should be displayed in degrees Celsius or Fahrenheit. Temperature units can be changed at any time.
- **DEFAULT MESSAGE TIME:** Up to 5 default messages can be selected to automatically scan sequentially when the 239 is left unattended. If no keys are pressed for the default message time set with this setpoint, then the currently displayed message will automatically be overwritten by the first default message. After 5 seconds, the next default message in the sequence will display if more than one is selected. Alarm and trip messages will over-ride default message display. Any setpoint or measured value can be selected as a default message. Refer to Section 3.1.6: Default Messages on page –8 for information on removing and adding new default messages.

Default messages can be disabled by setting this setpoint to **OFF**. When this setpoint is turned off, the currently displayed message will remain displayed until a condition such as a trip alarm, or key press forces the 239 to display a different message.

- **DEFAULT MESSAGE BRIGHTNESS:** The brightness of the displayed messages can be varied with this setpoint. The brightness set by this setpoint will be used when the default messages are being displayed. The brightness defaults back to 100% when:
  - trip is present
  - alarm is present
  - any one of the keys on the 239 keypad is pressed
  - the 239 is turned off and on

When **S1: 239 SETUP\PREFERENCES\DEFAULT MESSAGE TIME** is set to **OFF**, the brightness will adjust to set level after 5 minutes have elapsed since the 239 keys were last pressed. The 239 status must also be NORMAL to display the set brightness. If no default message is programmed, the display brightness will adjust to the set level after the programmed time in message **S1: 239 SETUP\PREFERENCES\DEFAULT MESSAGE TIME** has elapsed.

**NOTE: Message brightness control is available only with the VFD display option.**

- **BLOCK KEYPAD TRIP RESETS:** This feature blocks any attempts made to reset the present trip using the *RESET* key on the 239 keypad. When this feature is enabled and a trip is present, pressing the *RESET* key will display the following flash message for 3 seconds.

**RESET NOT POSSIBLE  
KEYPAD RESET BLOCKED**

This feature is applicable to trips only. The function of the **RESET** key in other areas (i.e. reset alarms, remove default messages, etc.) is not affected.

- **OVERLOAD PICKUP DISPLAY ENABLE:** When an overload pickup has occurred, this setpoint determines whether the 239 front display is automatically updated with the time to overload trip. When this setpoint is programmed to **NO**, an overload pickup will have no effect on the display. The pickup LED indicator and overload protection are not affected by this setpoint.

## 4.2.2 Analog Output

- **ANALOG OUTPUT TYPE:** If the relay is to be used in conjunction with programmable controllers, automated equipment, or a chart recorder the analog output can be used for continuous monitoring. Choose from one of the following parameters for output: **THERMAL CAPACITY**, **AVERAGE PHASE AMPS**, **MOTOR LOAD** (phase current as a percentage of full load), or **RTD1/2/3 TEMPERATURE**. Although a single parameter can be selected for continuous analog output, all values are available digitally through the communications interface. See Section 2.1.3 *ANALOG OUTPUT (OPTION) (18/19/20)* on page 2–26 for a description of current output scaling. Applications include using a computer to automatically shed loads as the motor current increases by monitoring current as a percentage of full load current or a chart recorder to plot the loading of a motor in a particular process.
- **ANALOG OUTPUT RANGE:** In processes where the motor loads are varied and operated at near the motor full load such as in grinding or in conveyor systems it is useful to know how close the relay is to tripping so the load may be adjusted

accordingly. The analog output can be connected to a remote meter, which is available and calibrated from 0 to 100% of motor capacity used. Select thermal capacity **0-1 MA** (0 mA = 0%, 1 mA = 100% i.e. motor tripped) for use with the 0-1 mA range meter model TCS2 scaled in units of thermal capacity used and available from GE Multilin. This meter would be situated near the operator and connected to the relay. The meter indicates how much the memory has charged corresponding to heat buildup in the motor. When the relay is about to trip, the meter will approach 100% capacity used. After a trip, the meter will indicate how much charge is left in the memory to give a rough idea of the lockout time remaining. Alternately, this output can be programmed as thermal capacity **4-20 MA** (4 mA = 0%, 20 mA = 100% i.e. motor tripped) and connected to a programmable controller or DCS as a signal for process control. It might typically be used to reduce the feed on to a conveyor as the conveyor motor thermal capacity approached 100%.

### 4.2.3 RS485 Serial Port

- **SERIAL COMMS FAILURE ALARM:** If loss of communications to the external master is required to activate the alarm relay, select ON. In this case an absence of communication polling on the RS485 communication port for 60 seconds will generate the alarm condition. Disable this alarm output if communications is not used or is not considered critical.
- **SLAVE ADDRESS:** Enter a unique address from 1 to 255 for this particular relay on the RS485 communication link. This setpoint cannot be changed via the RS485 port. A message sent with address 0 is a broadcast message to which all relays will listen but not respond. Although addresses do not have to be sequential, no two relays can have the same address or there will be conflicts resulting in errors. Generally, each relay added to the link will use the next higher address, starting from address 1.
- **BAUD RATE:** Enter the baud rate for the terminal RS485 communication port, which may be selected to one of **1200, 2400, 4800, 9600**, or **19200** baud. All relays on the RS485 communication link and the computer connecting them must run at the same baud rate. The fastest response will be obtained at 19200 baud. Slower baud rates should be used if noise becomes a problem. The data frame consists of 1 start bit, 8 data bits, 1 stop bit and a programmable parity bit, see **S1: 239 SETUP\RS485 SERIAL PORT\PARITY**. The baud rate default setting is 9600 baud.
- **PARITY:** Enter the parity for the terminal RS485 communication port, which may be selected to one of **EVEN, ODD**, or **NONE**. All relays on the RS485 communication link and the computer connecting them must have the same parity.

### 4.2.4 Defaults

- **LOAD FACTORY DEFAULTS:** When the 239 is shipped from the factory all setpoints will be set to factory default values. These settings are shown in the setpoint message reference figures. To return a relay to these known setpoints select **YES** and press the **STORE** key while this message is displayed and then momentarily remove power to the 239. It is a good idea to first load factory defaults when replacing a 239 to ensure all the settings are defaulted to reasonable values.

- **CLEAR PRE-TRIP DATA:** When **YES** is selected in this setpoint and the **STORE** key is pressed, all of the pre-trip data in **A1: STATUS\LAST TRIP DATA** will be cleared and the following flash message will be displayed for 3 seconds.

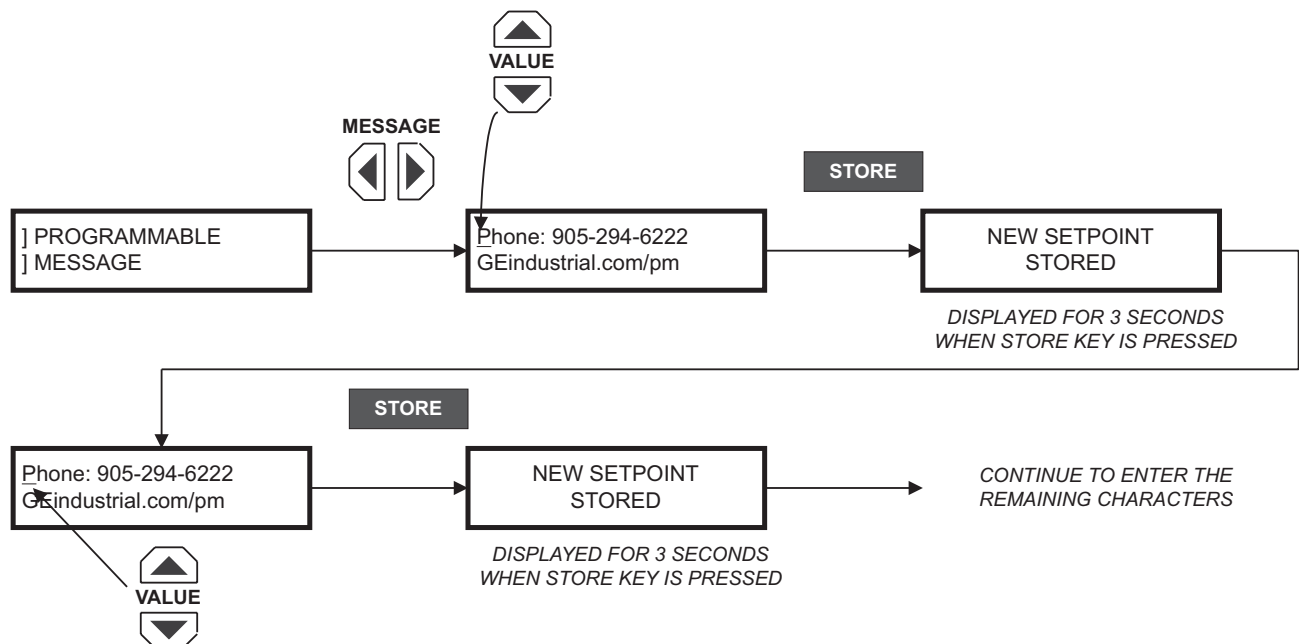
**PRE-TRIP DATA  
CLEARED**

If the pre-data is cleared while a trip is still present, all pre-data except for “CAUSE OF LAST TRIP” will be cleared.

- **CLEAR STATISTICS DATA:** Select **YES** and press the **STORE** key to clear all motor statistics, motor maximum starting current, and running time.

#### 4.2.5 Programmable Message

- **PROGRAMMABLE MESSAGE:** A 40-character message can be programmed using the keypad, or via the serial port using the 239PC software. Using the 239 keypad, a new message can be written over the existing message as shown below.



#### TIPS:

- The setpoint access jumper must be installed in order to alter the characters.
- To skip over a character press the **STORE** key.
- If a character is entered incorrectly, press the **STORE** key repeatedly until the cursor returns to the position of the error, and re-enter the character.
- To select this message as a default message, see Section 3.1.6: Default Messages on page –8.

- A copy of this message is also displayed in Actual Values page A1 under **PROGRAMMABLE MESSAGE**.

#### 4.2.6 Product Options

- **SELECT OPTIONS TO ENABLE:** The 239 factory options can be updated in the field. Enter the new desired options for the 239.
- **SELECT MOD 1 TO ENABLE:** Enter the desired mod. If no MOD is to be enabled enter zero (0).
- **SELECT MOD 2 TO ENABLE:** Enter the desired mod. If no MOD is to be enabled enter zero (0).
- **SELECT MOD 3 TO ENABLE:** Enter the desired mod. If no MOD is to be enabled enter zero (0).
- **SELECT MOD 4 TO ENABLE:** Enter the desired mod. If no MOD is to be enabled enter zero (0).
- **SELECT MOD 5 TO ENABLE:** Enter the desired mod. If no MOD is to be enabled enter zero (0).
- **ENTER PASSCODE:** To enter a passcode through the keypad use the value up and/or value down keys. When the appropriate character is reached press the message right key to move to the next character to be entered. If a character was entered incorrectly use the message left or right keys to the position the cursor at the error location. Use the value up or down keys to select the correct character.

When the entire passcode has been entered correctly press the store key. The 239 will then wait 2 seconds before resetting. See flow diagram below.

**NOTE:** Passcodes are obtained by contacting the factory. There will be a charge which is dependant on the options/Mods to be installed. Desired Mods are limited to firmware Mods, no hardware Mods are supported with this feature. The firmware version of the 239 defines what firmware Mods can be enabled.

**EXAMPLE:** The original 239 was ordered with the AN option. After receiving the unit, requirements have changed for the 239, and the RTD option is now required.

- Step 1: To add the RTD option to the 239 while keeping the AN option enter **RTD-AN** in the **SELECT OPTIONS TO ENABLE** setpoint.
- Step 2: If no Mods are to be enabled, leave zeros in the **SELECT MOD X TO ENABLE** setpoints.
- Step 3: With the unit serial number and the unit options required call the factory to obtain the passcode. Enter the passcode and press **STORE**. After a 2 second delay the 239 will reset and the desired options will now be present.
- Step 4: Verify correct options were installed:

|   |
|---|
| <b>ORDER CODE:</b><br><b>239-RTD-AN</b> |
|---|

*Located in ACTUAL VALUES page A3 under  
the sub-heading MODEL INFORMATION*

Step 5: Verify correct MODs were installed:

|                         |
|-------------------------|
| <b>MOD NUMBER(S): 0</b> |
|-------------------------|

*Located in ACTUAL VALUES page A3 under  
the sub-heading MODEL INFORMATION*

Step 6: Proceed with 239 setup.

### 4.3 S2: System Setup

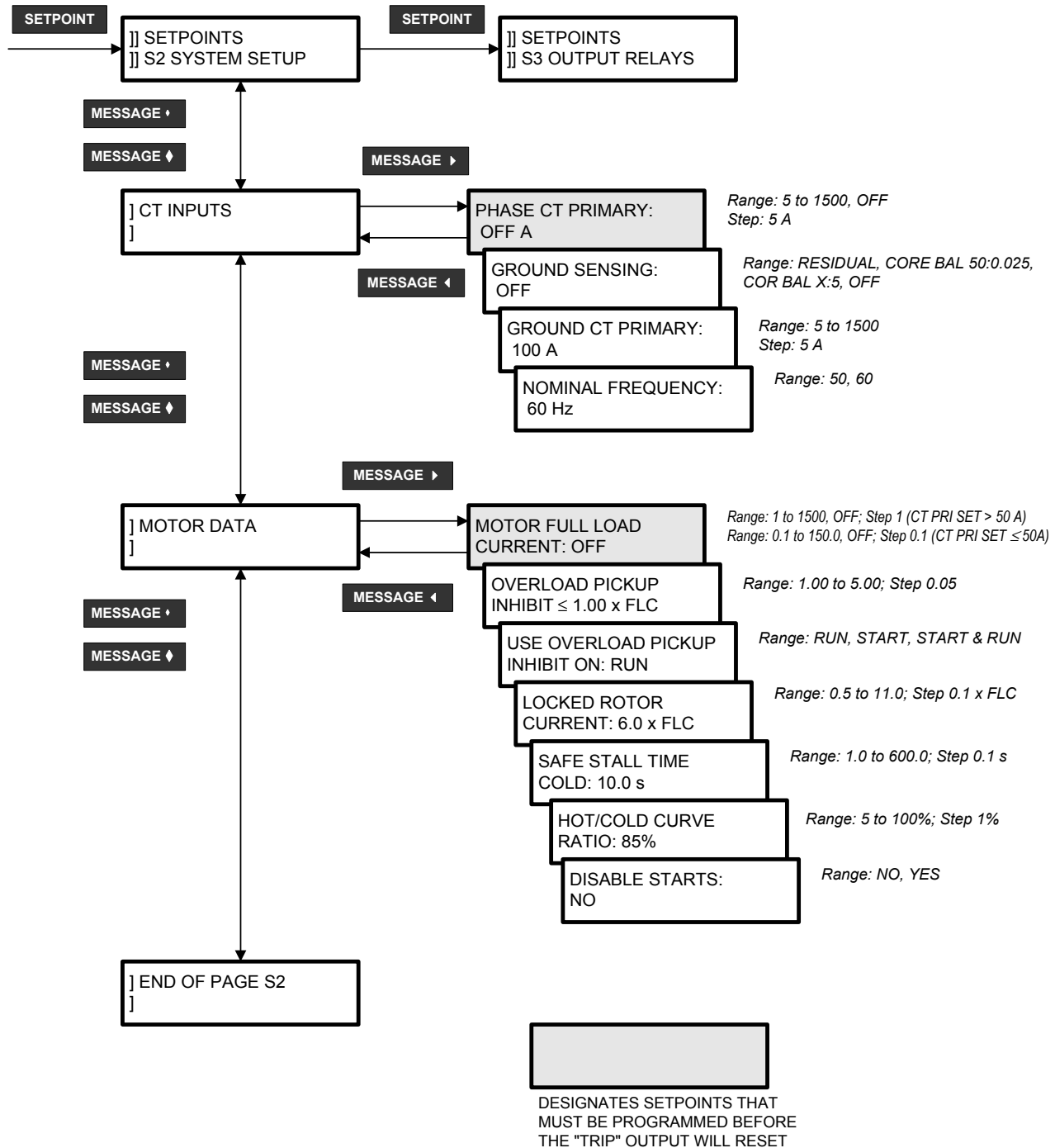


FIGURE 4-3: Setpoints Page 2 – System Setup



### 4.3.1 CT Inputs



At **PHASE CT PRIMARY > 50 A**, the 239 shifts the **MOTOR FULL LOAD CURRENT** settings by a factor of 10 to remove the extra decimal place (see FIGURE 4–3: *Setpoints Page 2 – System Setup* above). If changing the **PHASE CT PRIMARY** setting causes it to cross the 50 A value, the **MOTOR FULL LOAD CURRENT** is reset to 0 A, forcing the operator to restore the correct value. In previous firmware versions, crossing the 50 A value by changing the **PHASE CT PRIMARY** setting changed the **MOTOR FULL LOAD CURRENT** setting by a factor of 10 automatically, often without the operator's knowledge.

- **PHASE CT PRIMARY:** Enter the primary current rating of the phase current transformers. All three phase CTs must be of the same rating. For example if 500:5 CTs are used, the phase CT primary value entered should be 500. When the relay is shipped with factory defaults loaded, the phase CT ratio is set off. When off is the CT value, the 239 is forced to a trip state as a safety precaution until a valid CT value is entered. Ensure that the CT is connected to the correct 1 A or 5 A terminals to match the CT secondary.
- **GROUND SENSING:** Ground sensing on solid or low resistance grounded systems is possible with residually connected phase CTs as shown in FIGURE 2–3: *Typical Wiring Diagram* on page 2–18. If this connection is used enter residual. The ground CT primary will automatically be the same as the phase CTs. For more sensitive ground current detection a separate core balance (zero sequence) CT which encircles all three phase conductors can be used. In this case select core balance 50:0.025. A GE Multilin 50:0.025 CT is available. If a conventional 5 A secondary CT is used to encircle the 3 phase conductors, enter core balance x:5. It is then necessary to specify the CT primary using the next message **GROUND CT PRIMARY**.
- **GROUND CT PRIMARY:** This message will only be visible if the ground sensing in the previous message is selected as core balance x:5. Enter the CT primary current. For example, if a 50:5 CT is installed for ground sensing enter 50. One amp CTs can also be used for ground sensing. In this case enter the CT primary value multiplied by 5. For example, if a 100:1 ground CT is installed and the ground sensing is selected as core balance x:5 enter 500 for the primary value.
- **NOMINAL FREQUENCY:** Enter the nominal system frequency as either 50 or 60 Hz. The 239 uses this information in the detection of Phase Short Circuit and Ground Fault Trips.

### 4.3.2 Motor Data

- **MOTOR FULL LOAD CURRENT (FLC):** Enter the full load amps from the motor nameplate. This is the maximum rated current at which the motor can operate without overheating. It is the 1.0x pickup point on the timed overcurrent characteristic. When the current exceeds this value, the timed overcurrent feature begins to time, eventually leading to a trip. Immediate overload warning and undercurrent setpoints are multiples of this value. Timed overcurrent is not active during motor starting.
- **OVERLOAD PICKUP INHIBIT:** Enter the overload pickup (service factor) specified on the motor nameplate if shown. Otherwise enter an overload pickup of 1.00. The pickup inhibit will operate during start and/or run depending upon the value programmed in

the setpoint **USE OVERLOAD PICKUP INHIBIT ON** described below. During a running condition this value adjusts the pickup at which the overload curves begin timing. If the overload pickup is 1.15 for example, the overload curves will not begin to operate until the phase current reaches  $1.15 \times \text{FLC}$ . During a start, **SAFE STALL TIME** and **LOCKED ROTOR CURRENT** setpoints will not be used until the current reaches the overload pickup inhibit setting.

This setpoint acts as a lower cutoff for the overload pickup. The trip times are not shifted, but just cut-off below the value specified by the overload pickup inhibit setting.

- **USE OVERLOAD PICKUP INHIBIT ON:** This setpoint allows the overload pickup inhibit to be applied during a START, RUN, or START & RUN condition.
- **LOCKED ROTOR CURRENT AND SAFE STALL TIME COLD:** During starting the locked rotor current and safe stall time are used to determine how fast the thermal memory fills up. Timed overload curves are disabled. The start time allowed depends on the actual start current.

$$\text{Start Time Allowed} = \text{SAFE STALL TIME COLD} \times \frac{(\text{LOCKED ROTOR CURRENT})^2}{(\text{Actual Start Current})^2}$$

For example, assuming the normal inrush current is  $6 \times \text{FLC}$ . If the actual current inrush current was only  $5 \times \text{FLC}$  on a start and the **SAFE STALL TIME COLD** has been set to 20 seconds, the actual maximum start time allowed would be:

$$\begin{aligned} \text{Start Time Allowed} &= \text{SAFE STALL TIME COLD} \times \frac{(\text{LOCKED ROTOR CURRENT})^2}{(\text{Actual Start Current})^2} \\ &= 20 \times ((6)^2 / (5)^2) \\ &= 28.8 \text{ seconds} \end{aligned}$$

If the **SAFE STALL TIME** and **LOCKED ROTOR CURRENT** settings cannot be determined from the motor nameplate, then use the above formula to determine the allowed start time. A good rule of thumb is to set the **LOCKED ROTOR CURRENT** to  $6 \times \text{FLC}$  and **SAFE STALL TIME** to the trip time for the specified timed overload curve at  $6 \times \text{FLC}$ .

- **HOT/COLD CURVE RATIO:** This feature determines thermal capacity used when the motor is running at or below the full load current setpoint. The **HOT/COLD CURVE RATIO** setpoint is determined from the motor data using the Locked Rotor Time Hot and Locked Rotor Time Cold specifications as shown below.

$$\text{HOT/COLD CURVE RATIO} = \frac{\text{LRT Hot}}{\text{LRT Cold}} \times 100$$

where:

LRT Hot = *Locked Rotor Time Hot*, is defined as the locked rotor time when the motor has been running at FLC for a time sufficient for the motor temperature to reach a steady state value.

LRT Cold = *Locked Rotor Time Cold*, is defined as the locked rotor time when the motor has been stopped for a time sufficient for the motor temperature to reach ambient.

LRT Hot and LRT Cold are usually determined from the motor specifications. If this information is not known, enter a typical value of 85% for the **HOT/COLD CURVE RATIO**.

The **HOT/COLD CURVE RATIO** setpoint is used by the 239 to thermally model the motor when the average phase current is at or below the FLC setpoint. When the motor is cold (motor temperature at ambient) the thermal capacity used will be 0%. When the motor is hot (motor running at FLC for a time sufficient to reach a steady state temperature) the thermal capacity used will be calculated as 100% – **HOT/COLD CURVE RATIO**, or 100 – 85 = 15% using the example value given above. In between these two extremes there is a linear relationship; the 239 thermal model covers the entire range of motor temperatures: cold—cool—warm—hot. The steady state value of thermal capacity used for any phase current level can be calculated as:

$$\text{Thermal Capacity Used} = \frac{\text{Actual Current}}{\text{FLC Setpoint}} \times (100\% - \text{HOT/COLD CURVE RATIO})$$

For example, if LRT Hot = 7.0 s, LRT Cold = 10.0 s, FLC = 100 A, and the actual motor current is 80 A, then the steady state thermal capacity value will be:

$$\begin{aligned} \text{Thermal Capacity Used} &= \frac{\text{Actual Current}}{\text{FLC Setpoint}} \times (100\% - \text{HOT/COLD CURVE RATIO}) \\ &= \frac{80}{100} \times \left( 100\% - \left( \frac{7.0}{10.0} \times 100\% \right) \right) \\ &= 20\% \end{aligned}$$

- **DISABLE STARTS:** In some applications start protection may not be required. Therefore, by setting this setpoint to **YES**, the start protection on the 239 can be defeated. If the setpoint is set to **YES**, the 239 will go directly into run condition and overload curves will be employed to protect the connected load.

This setpoint can also be used in conjunction with a switch input. If the **DISABLE STARTS** setpoint is programmed to **YES** and **OPTION SWITCH 1-2 FUNCTION** setpoint described on page 46 is assigned to **DISABLE STARTS**, the 239 start protection will be defeated if the respective switch input is closed. The **DISABLE STARTS** setpoint must be programmed to **YES** for the feature to work via the switch inputs.

## 4.4 S3: Output Relays

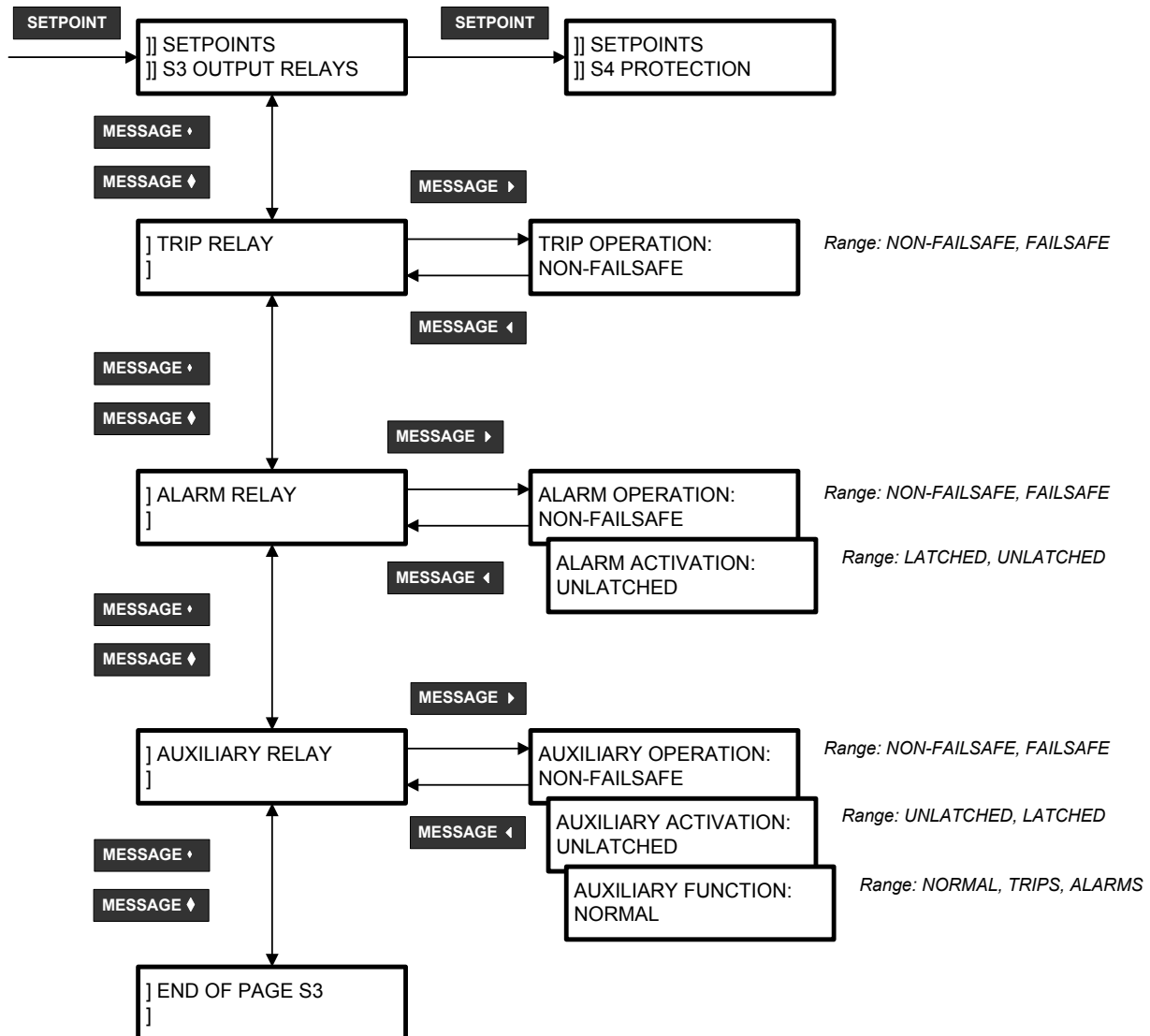


FIGURE 4-4: Setpoints Page 3 – Output Relays

|                      |  |
|----------------------|--|
| <b>NON-FAILSAFE:</b> | <i>The relay coil is not energized in its non-active state. Loss of control power will cause the relay to remain in the non-active state; i.e. a non-failsafe alarm or trip relay will not cause an alarm or trip on loss of control power. Contact configuration is shown in FIGURE 2-3: Typical Wiring Diagram on page 2-18 with relays programmed non-failsafe, control power not applied</i> |
| <b>FAILSAFE:</b>     | <i>The relay coil is energized in its non-active state. Loss of control power will cause the relay to go into its active state; i.e. a failsafe alarm or trip relay will cause an alarm or trip on loss of control power. Contact configuration is opposite to that shown in FIGURE 2-3: Typical Wiring Diagram on page 2-18 for relays programmed as failsafe when control power is applied</i> |

### 4.4.1 Trip Relay

- **TRIP OPERATION:** Any trip condition will activate the trip relay. This relay can be programmed to be **NON-FAILSAFE** or **FAILSAFE**. After a trip, the relay trip state will remain latched until reset by pressing the **RESET** key, momentarily closing the external reset switch input, or issuing a serial port reset command.

Where process continuity is more important than motor protection, the mode of operation can be chosen as **NON-FAILSAFE** so the trip relay is normally de-energized for a non-trip condition and energized for a trip. No trip occurs if control power to the 239 is lost but there will be no motor protection while this condition is present. Set the mode to **FAILSAFE** (the relay coil is normally energized for a non-trip condition going non-energized for a trip) to cause a trip when control power to the 239 is not present to ensure continuous motor protection.

When the motor interrupting device is a breaker, the trip relay is usually programmed **NON-FAILSAFE** and the trip contact wired in series with the breaker trip coil. Even though the trip contact is latched, the breaker 52 contact will normally be wired in series with the 239 trip contact so that the breaker 52 contact breaks the trip coil current as soon as the breaker opens. The 239 trip messages and records operate in the same way for contactors or breakers so the trip condition must still be cleared using the **RESET** key, momentarily closing the external reset terminals, or by sending the reset command via the computer.

### 4.4.2 Alarm Relay

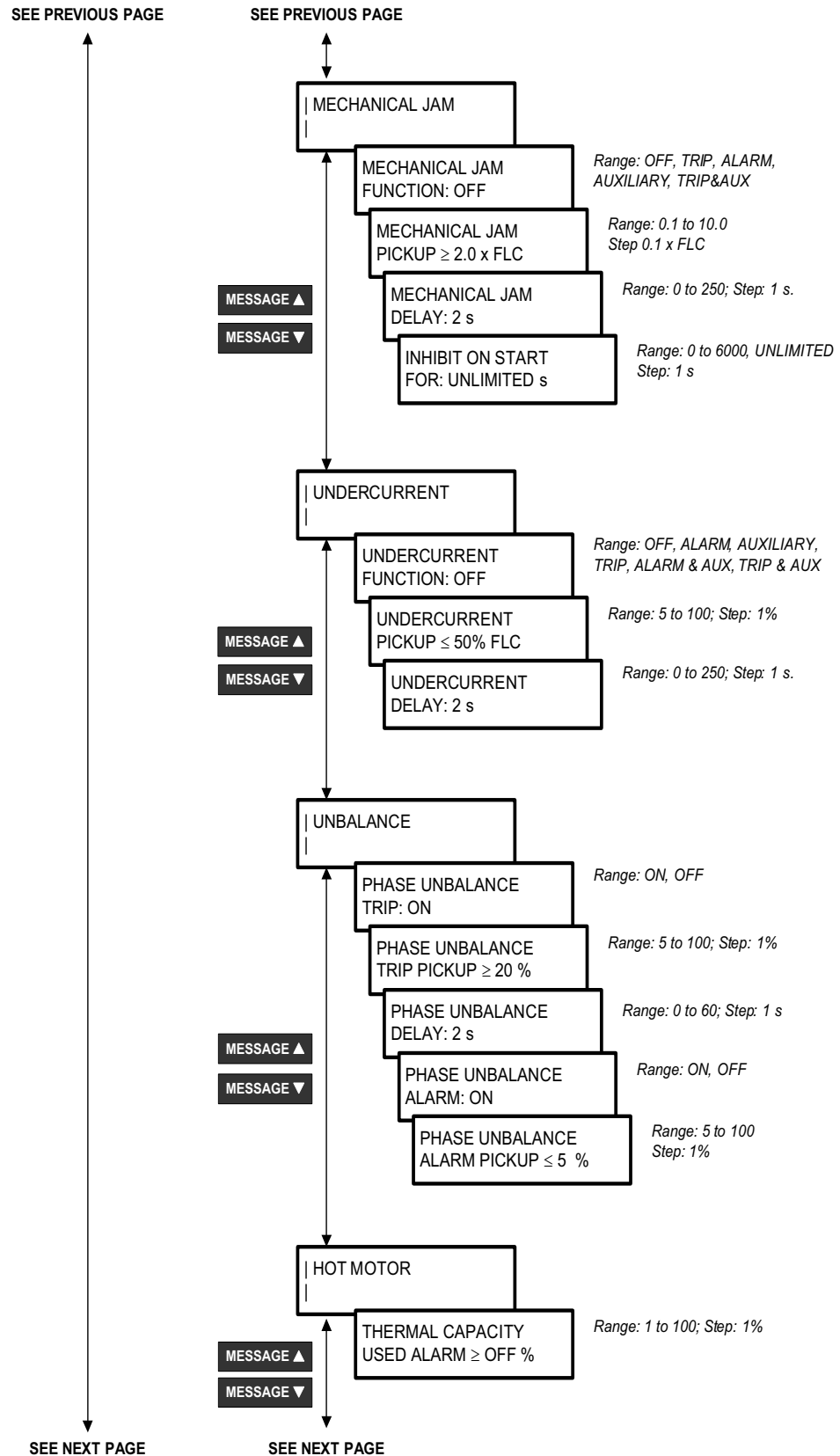
- **ALARM OPERATION:** Any alarm condition will activate the alarm relay. If an alarm is required when the 239 is not operational due to a loss of control power, select **FAILSAFE** operation. Otherwise, choose **NON-FAILSAFE**.
- **ALARM ACTIVATION:** If an alarm indication is only required while an alarm is present, select **UNLATCHED**. Once an alarm condition disappears, the alarm and associated message automatically clear. To ensure all alarms are acknowledged, select **LATCHED**. Even if an alarm condition is no longer present, the alarm relay and message can only be cleared by pressing the **RESET** key, momentarily closing the external reset terminals, or by sending the reset command via the computer.

### 4.4.3 Auxiliary Relay

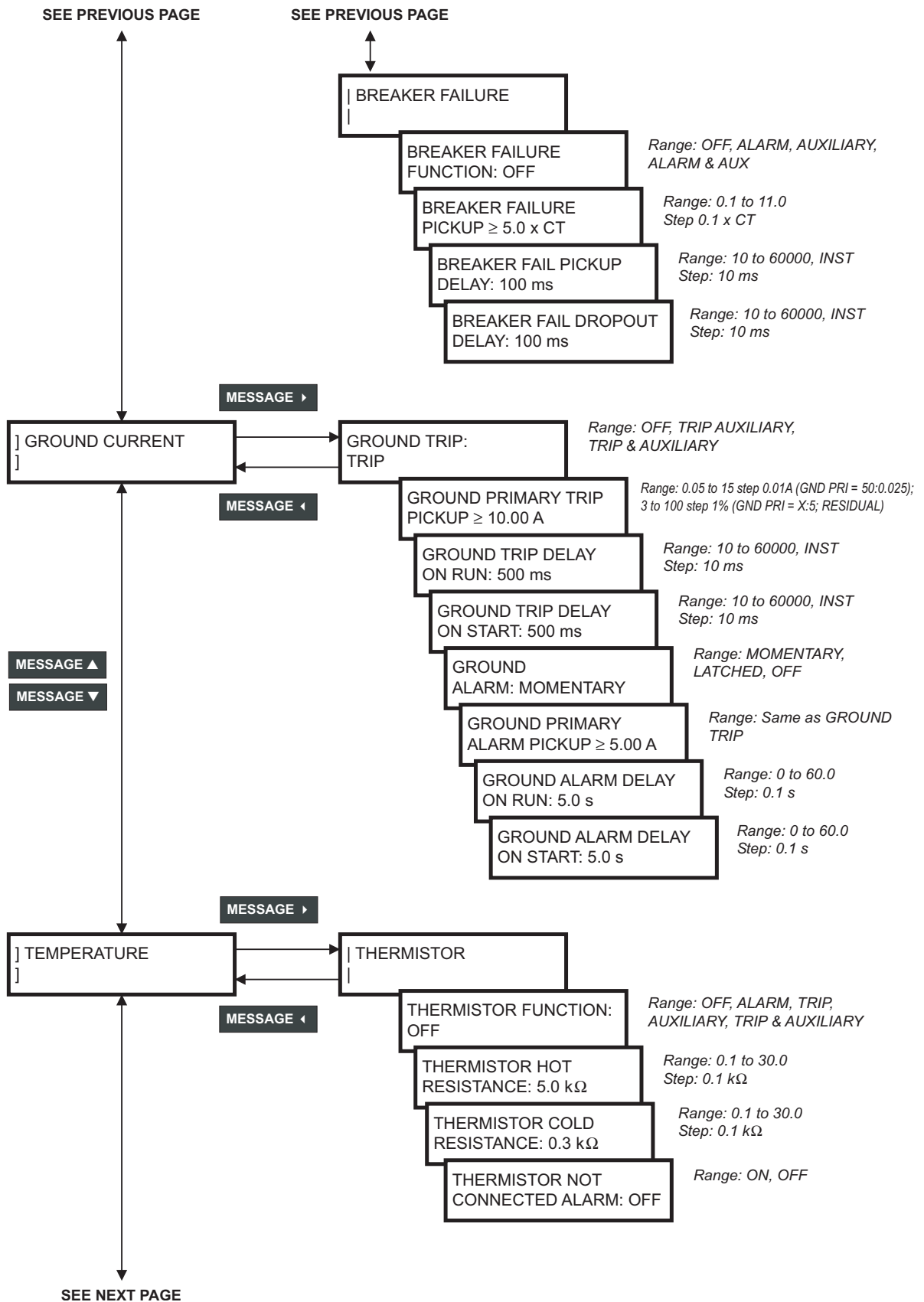
- **AUXILIARY OPERATION:** Any alarm, trip or auxiliary function can be programmed to activate the auxiliary relay. If an output is required when the 239 is not operational due to a loss of control power, select **FAILSAFE** auxiliary operation, otherwise, choose **NON-FAILSAFE**.
- **AUXILIARY ACTIVATION:** If an auxiliary relay output is only required while the alarm or auxiliary function is present, select **UNLATCHED**. Once an alarm or auxiliary function condition disappears, the auxiliary relay returns to the non-active state and the associated message automatically clears. To ensure all alarms or auxiliary function conditions are acknowledged, select **LATCHED**. Even if an alarm or auxiliary function condition is no longer present, the auxiliary relay and message can only be cleared by pressing the **RESET** key, momentarily closing the external reset terminals, or by sending the reset command via the computer.

- **AUXILIARY FUNCTION:** If the auxiliary relay is required to be controlled by the function it's assigned to then configure this setpoint to **NORMAL**. If the auxiliary relay is required to activate on an occurrence of an alarm or trip condition and remain energized while the alarm or trip condition is present then configure the setpoint to **ALARM** or **TRIP** depending on the requirement.



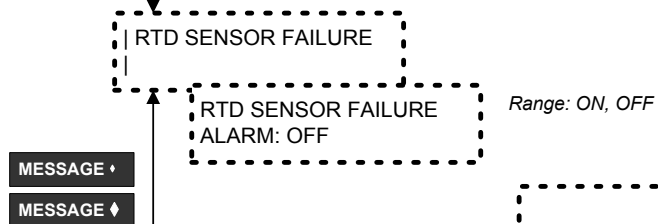
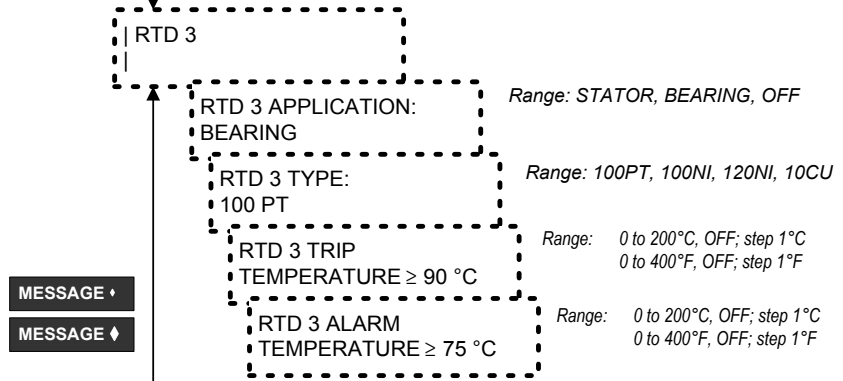
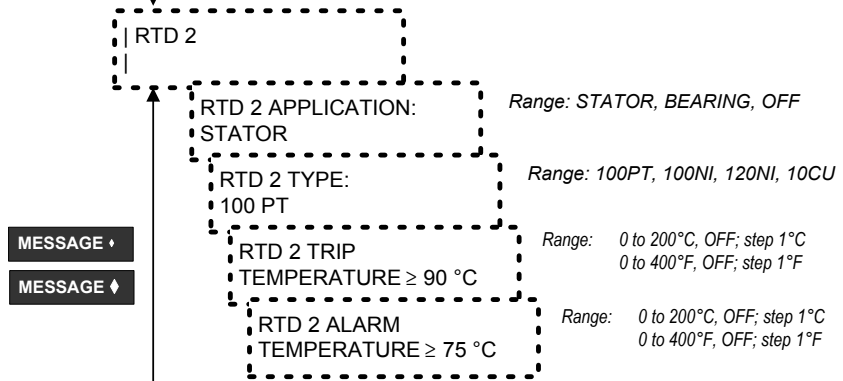
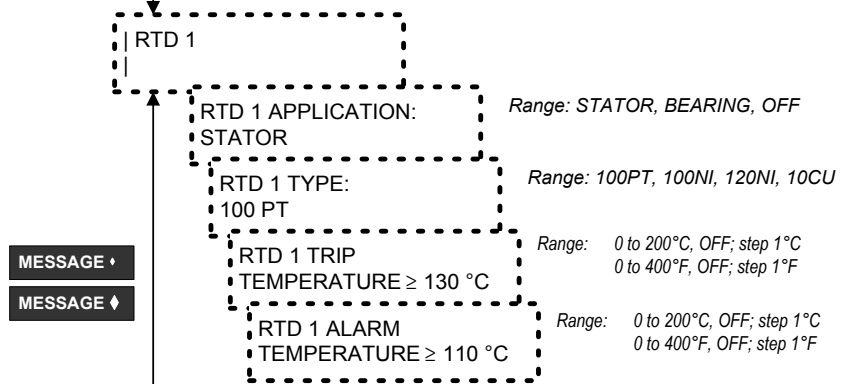






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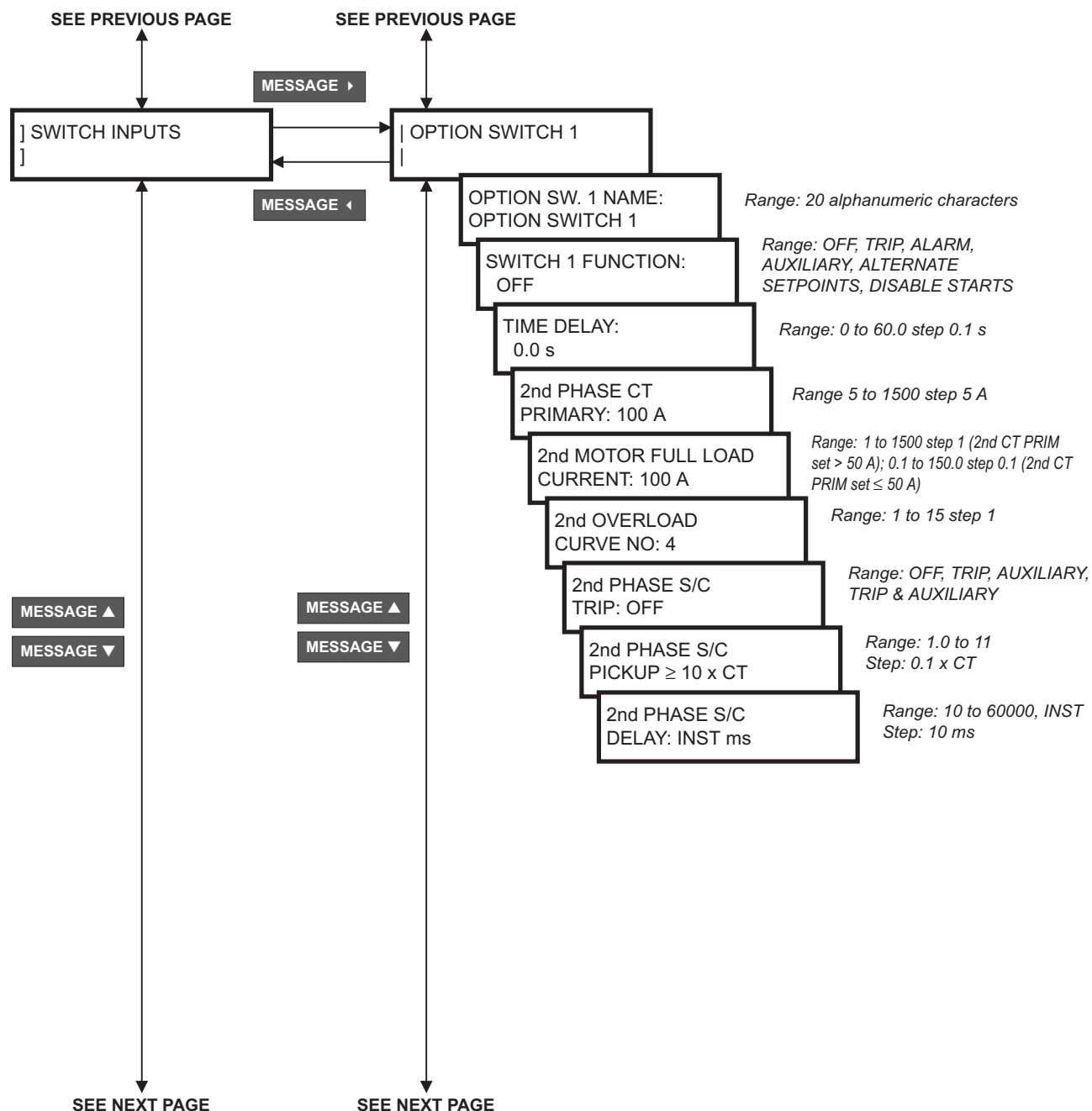
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DESIGNATES SETPOINTS  
THAT ARE ONLY VISIBLE IF  
RTD OPTION IS INSTALLED

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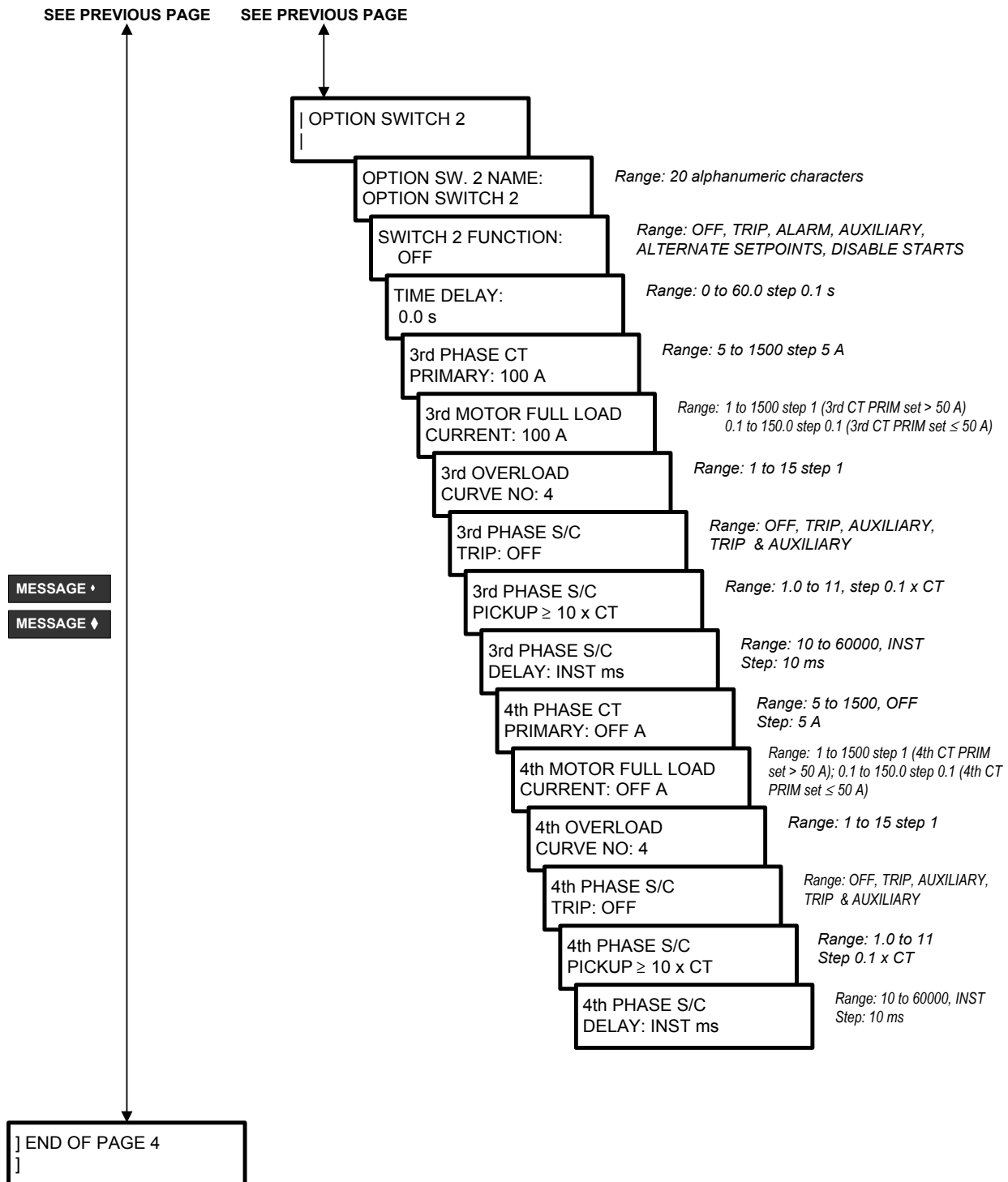


FIGURE 4-5: Setpoints Page 4 – Protection

### 4.5.1 Overload

- **OVERLOAD CURVE:** One of 15 different time/overload curves can be selected with the Phase Overload Curve number setpoint to closely match the thermal characteristics of the motor. Overlay motor curve data, if available, on the time overcurrent curves of FIGURE 4-6: *Phase Timed Overload Curves* on page 4-34 and choose the curve that falls just below the motor damage curve.

Each of the curves represents an  $I^2t$  characteristic of a motor. If no motor curve data is available, this setpoint can be set using the locked rotor time from the motor nameplate. Plot the point corresponding to the rated locked rotor or stall time (vertical axis) at the rated locked rotor current (horizontal axis). For example, choose the point at 9 seconds and  $6 \times \text{FLC}$  for a motor with a locked rotor time of 9 seconds and a locked rotor current of  $6 \times \text{FLC}$ . If the stall time is specified at some other inrush current, the point can be plotted on the time/overload curves of FIGURE 4-6: *Phase Timed Overload Curves* on page 4-34 and the next lowest curve selected. Curve points are also shown in tabular form in Table 4-2: *239 Phase Overload Trip Times (Seconds)* on page 4-34. Points for a selected curve can be plotted directly on curves for associated equipment to facilitate a coordination study. These points can also be entered into a computer co-ordination program to assist in curve selection.

The phase timed overload curve will come into effect when the motor current in any phase goes over the overload pickup  $\times \text{FLC}$  level. During overload motor thermal capacity will increase accordingly until the trip relay is activated when 100% of the available thermal capacity has been reached. After a trip, the thermal memory locks out a reset until the motor has cooled sufficiently ( $\text{TC} < 15\%$ ) to allow restarting.

- **OVERLOAD TRIP TIME CALCULATION:** This feature acts as a built-in calculator for a quick check of the expected trip time at all the selectable overload values. Using the **VALUE**  $\blacktriangledown$  / **VALUE**  $\blacktriangleright$  keys, scroll through the trip levels. As the trip level is being changed the trip time will automatically be updated to correspond with the currently displayed value. When the **STORE** key is pressed the currently displayed trip level is kept in the memory for future reference. The resolution of the displayed trip time is as shown in the table below.

**Table 4-1: Overload Trip Time Calculation**

| TRIP TIME RANGE                                 | DISPLAY RESOLUTION |
|---|--------------------|
| trip time < 100 seconds                         | 0.01 x seconds     |
| trip time $\geq$ 100 seconds and < 600 seconds  | 0.1 x seconds      |
| trip time $\geq$ 600 seconds and < 6000 seconds | 1.0 x seconds      |
| trip time $\geq$ 6000 seconds                   | 1.0 x minutes      |

- **OVERLOAD LOCKOUT TIME:** The motor cooling rate is controlled by this setpoint. Enter a typical time of 30 minutes to allow sufficient cooling. If process criteria requires shorter cooling periods, particularly for small motors, a different time can be entered. Care should be exercised in selecting short lockout times since operators may restart a hot motor resulting in damage if too short a lockout time is chosen. Timed overload is not active during motor start. The locked rotor current and safe stall time are used to model thermal capacity effect during starting.

- **AUTO RESET O/L TRIPS:** When enabled, this feature will automatically reset overload trips once the thermal capacity (TC) decreases to 15% or less. All other types of trips are not affected by this feature.

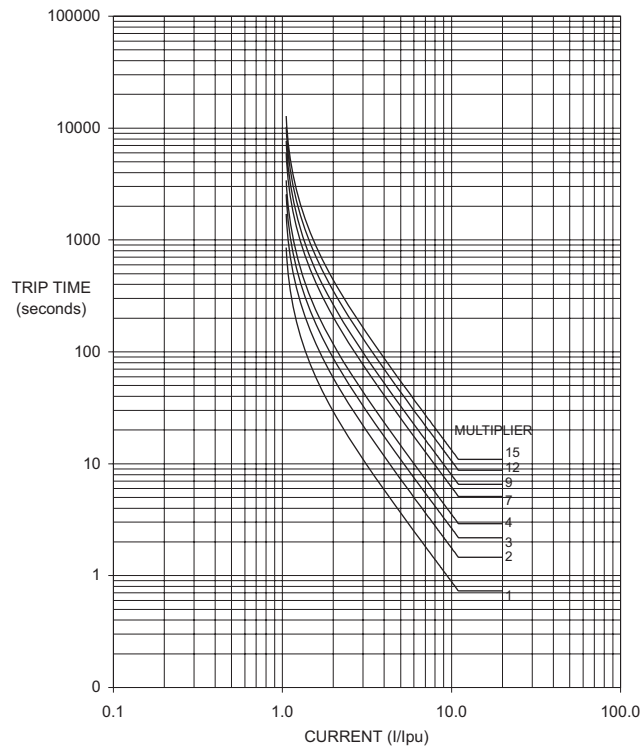


FIGURE 4-6: Phase Timed Overload Curves

Table 4-2: 239 Phase Overload Trip Times (Seconds)

| CURVE NUMBER | MULTIPLE OF MOTOR FULL LOAD CURRENT |      |        |       |       |       |      |      |       |       |       |      |      |
|--------------|-------------------------------------|------|--------|-------|-------|-------|------|------|-------|-------|-------|------|------|
|              | 1.03                                | 1.05 | 1.1    | 1.5   | 2     | 2.5   | 3    | 4    | 5     | 6     | 8     | 10   | 11   |
| 1            | 1437                                | 854  | 416.7  | 70.0  | 29.2  | 16.7  | 10.9 | 5.8  | 3.64  | 2.50  | 1.39  | 0.88 | 0.73 |
| 2            | 2874                                | 1707 | 833.4  | 140.0 | 58.3  | 33.3  | 21.9 | 11.7 | 7.29  | 5.00  | 2.78  | 1.77 | 1.46 |
| 3            | 4311                                | 2561 | 1250.0 | 210.0 | 87.5  | 50.0  | 32.8 | 17.5 | 10.93 | 7.49  | 4.16  | 2.65 | 2.19 |
| 4            | 5748                                | 3415 | 1666.7 | 280.0 | 116.6 | 66.6  | 43.7 | 23.3 | 14.57 | 9.99  | 5.55  | 3.53 | 2.91 |
| 5            | 7184                                | 4269 | 2083.4 | 349.9 | 145.8 | 83.3  | 54.7 | 29.1 | 18.22 | 12.49 | 6.94  | 4.42 | 3.64 |
| 6            | 8621                                | 5122 | 2500.1 | 419.9 | 174.9 | 100.0 | 65.6 | 35.0 | 21.86 | 14.99 | 8.33  | 5.30 | 4.37 |
| 7            | 10058                               | 5976 | 2916.8 | 489.9 | 204.1 | 116.6 | 76.5 | 40.8 | 25.50 | 17.49 | 9.71  | 6.18 | 5.10 |
| 8            | 11495                               | 6830 | 3333.5 | 559.9 | 233.3 | 133.3 | 87.5 | 46.6 | 29.15 | 19.98 | 11.10 | 7.06 | 5.83 |
| 9            | 12932                               | 7683 | 3750.1 | 629.9 | 262.4 | 149.9 | 98.4 | 52.5 | 32.79 | 22.48 | 12.49 | 7.95 | 6.56 |

Table 4-2: 239 Phase Overload Trip Times (Seconds)

| CURVE NUMBER | MULTIPLE OF MOTOR FULL LOAD CURRENT |       |        |        |       |       |       |      |       |       |       |       |       |
|--------------|-------------------------------------|-------|--------|--------|-------|-------|-------|------|-------|-------|-------|-------|-------|
|              | 1.03                                | 1.05  | 1.1    | 1.5    | 2     | 2.5   | 3     | 4    | 5     | 6     | 8     | 10    | 11    |
| 10           | 14369                               | 8537  | 4166.8 | 699.9  | 291.6 | 166.6 | 109.3 | 58.3 | 36.43 | 24.98 | 13.88 | 8.83  | 7.29  |
| 11           | 15806                               | 9391  | 4583.5 | 769.9  | 320.7 | 183.3 | 120.3 | 64.1 | 40.08 | 27.48 | 15.27 | 9.71  | 8.01  |
| 12           | 17243                               | 10245 | 5000.2 | 839.9  | 349.9 | 199.9 | 131.2 | 70.0 | 43.72 | 29.98 | 16.65 | 10.60 | 8.74  |
| 13           | 18680                               | 11098 | 5416.9 | 909.9  | 379.1 | 216.6 | 142.1 | 75.8 | 47.36 | 32.48 | 18.04 | 11.48 | 9.47  |
| 14           | 20116                               | 11952 | 5833.5 | 979.9  | 408.2 | 233.2 | 153.0 | 81.6 | 51.01 | 34.97 | 19.43 | 12.36 | 10.20 |
| 15           | 21553                               | 12806 | 6250.2 | 1049.8 | 437.4 | 249.9 | 164.0 | 87.4 | 54.65 | 37.47 | 20.82 | 13.25 | 10.93 |

#### 4.5.2 Phase S/C

- PHASE S/C TRIP:** In any application where the available short circuit current is above the interrupting capability of the contactor, short circuit currents must cause a fuse or circuit breaker to operate. This prevents damage to the contactor which is not designed to interrupt normal levels of short circuit current. In an application with fuses, program the setpoint **S4: PROTECTION\PHASE CURRENT\PHASE S/C\PHASE S/C TRIP: OFF** to prevent the contactor from attempting to trip during a short circuit.

If a circuit breaker which can be tripped by an external contact closure is available upstream from the contactor, it is possible to program the setpoint **S4:**

**PROTECTION\PHASE CURRENT\PHASE S/C\PHASE S/C TRIP: AUXILIARY** to cause a short circuit to activate the auxiliary relay instead of the trip relay. Though, it is also possible to activate both the trip & auxiliary relays simultaneously. The auxiliary relay could then be connected to the upstream breaker to cause it to open for a short circuit. Ensure that the auxiliary relay is only programmed to activate under short circuit when used in this manner.

**SPECIAL NOTE:** The AUXILIARY and TRIP status indicators will both operate for these trips even if the TRIP relay is not selected for use (i.e. AUXILIARY). If the breaker cannot be externally tripped, program the setpoint **S4: PROTECTION\PHASE CURRENT\PHASE S/C\PHASE S/C TRIP: OFF** to prevent the contactor from attempting to trip during a short circuit. If a breaker is used as the motor starter interrupting device, short circuit protection would generally be enabled as it will normally be capable of handling the fault current. Short circuit protection causes the breaker to open quickly to prevent excessive mechanical damage or fire due to any large phase current. Complete protection from phase-to-phase and phase-to-ground faults is provided with this feature. When enabled, by programming setpoint **S4: PROTECTION\PHASE CURRENT\PHASE S/C\PHASE S/C TRIP: TRIP**, short circuit protection is active at all times, including during motor starts. It can be disabled by setting the setpoint **S4: PROTECTION\PHASE CURRENT\PHASE S/C\PHASE S/C TRIP: OFF**.

- PHASE S/C PICKUP:** The phase current short circuit trip level can be set from 1 to 11 times the phase CT primary. When any phase current meets or exceeds this setpoint value during start or run conditions and is maintained for the **PHASE S/C DELAY** setpoint, the selected relay(s) will activate.

- **PHASE S/C DELAY:** The trip can be instantaneous (no intentional delay) or can be delayed by up to 60000 ms to prevent nuisance tripping or allow co-ordination with associated system switchgear. The **S4: PROTECTION\PHASE CURRENT\PHASE S/C\PHASE S/C DELAY** setpoint represents the intentional delay added to the detection and output relay activation delays of the 239. When this setpoint is set to **INST** the 239 will trip within 45 ms of the onset of the short circuit. Both the short circuit trip level and time delay should be set to co-ordinate with other system protective relays to minimize equipment shutdown during a high current fault.

### 4.5.3 Immediate Overload

- **IMMEDIATE OVERLOAD ALARM:** When the average phase current exceeds the full load current (FLC) setpoint the phase timed overload protection begins timing. This will eventually lead to a trip unless the overload disappears. Immediate overload warning can be used to alert an operator or to produce an alarm output using this setpoint. This feature should be set to off for systems that experience overloads as part of normal operation such as crushers.
- **IMMEDIATE OVERLOAD PICKUP:** The immediate overload pickup setpoint is adjustable from  $0.5 \times \text{FLC}$  to  $11.0 \times \text{FLC}$ . The alarm relay will activate immediately when the average three phase current exceeds this setpoint value when the motor is running. This feature can also operate during start condition using the **INHIBIT ON START FOR** setpoint described below.
- **INHIBIT ON START FOR:** If all other conditions are met for an immediate overload alarm to occur and the motor is starting, the alarm will occur when the delay set in this setpoint has elapsed. If this setpoint is set to **UNLIMITED**, the immediate overload alarm will never occur during a start.

### 4.5.4 Mechanical Jam

- **MECHANICAL JAM FUNCTION:** In protecting driven equipment such as pumps, gearboxes, compressors and saws, it is often desirable to have an immediate trip in the event of a locked rotor during running. During startup the mechanical jam can be disabled using the **INHIBIT ON START FOR** setpoint described below, since a typical inrush of 600% is normal. Use of this feature with loads that experience overloads as part of normal operation such as crushers is not recommended.
- **MECHANICAL JAM PICKUP:** If a fast trip for mechanical jam is required, enable the feature and enter the average current pickup value above the normal maximum expected operating average phase current.
- **MECHANICAL JAM DELAY:** If the average phase current exceeds the **MECHANICAL JAM PICKUP** setpoint value when the motor is running, and remains this way for the time delay programmed, one of the assigned relay(s) will activate. Since the mechanical jam function can be assigned to any relay, if **TRIP, AUXILIARY, or TRIP & AUX RELAYS** are assigned, the function is considered to be a trip and the "CAUSE OF LAST TRIP: MECHANICAL JAM" message will be displayed. Conversely, if the function is assigned to ALARM, and the above conditions are met, the fault is considered to be an ALARM, and the 239 will display "MECHANICAL JAM ALARM".



- **INHIBIT ON START FOR:** If all other conditions are met for a mechanical jam feature to activate and the motor is starting, the function will operate when the delay set in this setpoint has elapsed. If this setpoint is set to **UNLIMITED**, the mechanical jam function will never operate during a start.

#### 4.5.5 Undercurrent

- **UNDERCURRENT FUNCTION:** Typical uses for undercurrent include protection of pumps from loss of suction, fans from loss of airflow due to a closed damper or conveyor systems from a broken belt. Undercurrent can either be disabled, used as an alarm, a trip or as a process control. Set this setpoint to off if the feature is not required. Selecting alarm relay will cause the alarm relay to activate and display an alarm message whenever an undercurrent condition exists. Selecting trip relay will cause the trip relay to activate and display a cause of trip message whenever an undercurrent condition occurs. Selecting auxiliary relay will cause the auxiliary relay to activate for an undercurrent condition but no message will be displayed. This is intended for process control.

For example, if the motor full load current (FLC) is set to 100 A for a pump motor, setting the undercurrent pickup to 60% and selecting the alarm relay will cause the relay to activate and create an alarm message when the average phase current drops below 60 A while running which might represent loss of suction.

- **UNDERCURRENT PICKUP:** A further use of this feature is as a pre-overload warning. This is accomplished by setting the **UNDERCURRENT PICKUP** to be above the normal operating current of the motor but below the rated full load current. Suppose a fan normally draws 90 A and the full load current (FLC) was set to 100 A, which was the maximum rating for the fan motor. If the undercurrent pickup was set at 95% and the auxiliary relay was selected with the **UNDERCURRENT FUNCTION** setpoint, the 239 would always sense an undercurrent condition with the auxiliary relay energized. Bearing wear could cause the current to increase above 95 A causing the undercurrent condition to disappear. If an external alarm was wired across the normally closed auxiliary relay contacts, the alarm would sound above the normal current but before an overload occurred signaling an abnormal condition prior to actual shut down. Alternatively, the output could be wired to a process controller input to take automatic corrective action. The undercurrent feature works as long as the average phase current is  $\geq 5\%$  of full load current.
- **UNDERCURRENT DELAY:** If the average phase current drops below the **UNDERCURRENT PICKUP** setpoint value and remains this way for the time delay programmed in this setpoint, the alarm relay will activate and the "UNDERCURRENT ALARM" message will be displayed if the setpoint **S4: PROTECTION\PHASE CURRENT\UNDERCURRENT\UNDERCURRENT FUNCTION** is set to **ALARM**. If the setpoint **S4: PROTECTION\PHASE CURRENT\UNDERCURRENT\UNDERCURRENT FUNCTION** is set to **AUXILIARY**, the auxiliary relay will activate and no message will be displayed after the delay expires.

#### 4.5.6 Unbalance

- **UNBALANCE TRIP:** Unbalanced three phase supply voltages are a major cause of induction motor thermal damage. Unbalance can be caused by a variety of factors

and is common in industrial environments. Causes can include increased resistance in one phase due to a pitted or faulty contactor, loose connections, unequal tap settings in a transformer or non-uniformly distributed three phase loads. The incoming supply to a plant may be balanced but varying single phase loads within the plant can cause a voltage unbalance at the motor terminals. The most serious case of unbalance is single phasing which is the complete loss of one phase of the incoming supply. This can be caused by a utility supply problem or by a blown fuse in one phase and can seriously damage a three phase motor.

Under normal balanced conditions the stator current in each of the three motor phases is equal and the rotor current is just sufficient to provide the turning torque. When the stator currents are unbalanced, a much higher current is induced in the rotor because it has a lower impedance to the negative sequence current component present under unbalanced conditions. This current is normally at about twice the power supply frequency and produces a torque in the opposite direction to the desired motor output. Usually the increase in stator current is small (125 to 200%) so that timed overcurrent protection takes a long time to trip. However the much higher induced rotor current can cause extensive rotor damage in a short period of time. Motors can tolerate different levels of current unbalance depending on the rotor design and heat dissipation characteristics.

- **UNBALANCE TRIP PICKUP:** Unbalance protection is recommended at all times. Motor data is rarely provided and direct measurement of rotor temperature is impractical so setting the unbalance level is empirical. For a known balanced situation, a pickup level of 10% and time delay of 5 seconds is recommended as a starting point. The pickup level can be decreased until nuisance tripping occurs. Similarly the time delay may be increased if necessary.

To prevent nuisance trips/alarms on lightly loaded motors when a much larger unbalance level will not damage the rotor, the single phase detection will automatically be defeated if the average motor current is less than 30% of the full load current ( $I_{FLC}$ ) setting. Unbalance is calculated as:

$$I_{av} \geq I_{FLC}: \quad \frac{|I_m - I_{av}|}{I_{av}} \times 100\%$$

$$I_{av} < I_{FLC}: \quad \frac{|I_m - I_{av}|}{I_{FLC}} \times 100\%$$

where:  $I_{av}$  = average phase current  
 $I_m$  = current in a phase with maximum deviation from  $I_{av}$   
 $I_{FLC}$  = motor full load current setting

- **UNBALANCE ALARM:** The operation of this feature is identical to the operation of the unbalance trip feature.
- **UNBALANCE ALARM PICKUP:** The operation of this feature is identical to the operation of the unbalance trip pickup feature.
- **UNBALANCE DELAY:** If phase current unbalance increases above **UNBALANCE ALARM PICKUP** or **UNBALANCE TRIP PICKUP** setpoint value and remains this way for the time delay programmed in this setpoint, the respective relay will activate and the respective warning message will be displayed.

#### 4.5.7 Hot Motor

- **THERMAL CAPACITY USED:** This feature is used to signal a warning when the thermal capacity has exceeded a level set in this setpoint. Once the set level is exceeded the alarm relay will activate immediately and the “THERMAL CAPACITY USED ALARM” message will be displayed.

#### 4.5.8 Breaker Failure

- **BREAKER FAILURE FUNCTION:** This feature is used to activate the selected relay, if the current continues to flow after a trip has occurred. If the feature is assigned to **ALARM** or **ALARM & AUX**, the “BREAKER FAILURE ALARM” message will be displayed and the assigned output relay will be active. If the function is assigned to **AUXILIARY**, the auxiliary output relay will be active but, no message will be displayed.
- **BREAKER FAILURE PICKUP:** If a trip is present and the current is still flowing (breaker failed to open) and the level of the average three phase current is equal to or greater than the setting in the **BREAKER FAILURE PICKUP** setpoint, the breaker failure feature will operate.
- **BREAKER FAIL PICKUP DELAY:** If all other conditions are met, the breaker failure feature will operate after the delay programmed in this setpoint has elapsed. See Section 1.2: Specifications on page –8 for BREAKER FAILURE timing specifications.
- **BREAKER FAIL DROPOUT DELAY:** If the breaker opens or if the average three phase current falls below the **BREAKER FAILURE PICKUP** setpoint, the breaker failure feature will not clear until the delay programmed in this setpoint has elapsed. See Section 1.2: Specifications on page –8 for BREAKER FAILURE timing specifications.

#### 4.5.9 Ground Current

- **GROUND TRIP:** Aging and thermal cycling can eventually cause a lowering of the dielectric strength of the winding insulation in the stator winding. This can produce a low impedance path from the supply to ground resulting in ground currents which can be quite high in solidly grounded systems. These could quickly cause severe structural damage to the motor stator slots. In resistance grounded systems there is a resistance in series with the supply ground connection to limit ground current and allow the system to continue operating for a short time under fault conditions. The fault should be located and corrected as soon as possible, however, since a second fault on another phase would result in a very high current flow between the phases through the two ground fault paths. In addition to damaging the motor, a ground fault can place the motor casing above ground potential thus presenting a safety hazard to personnel.

On the occurrence of a ground fault caused by insulation breakdown, a motor will usually have to be taken out of service and rewound. However an unprotected motor could suffer mechanical damage to the stator slots making repair impossible. The fault could also cause the power supply bus to which the faulty motor is connected to trip in order to clear the fault resulting in unnecessary process shutdowns. Ground faults can occur in otherwise good motors because of environmental conditions. Moisture or conductive dust, which are often present in mines, can provide an

electrical path to ground thus allowing ground current to flow. In this case, ground fault protection should shut down the motor immediately so that it can be dried or cleaned before being restarted.

On low resistance or solidly grounded systems, sensing of the ground current is done using the phase CTs wired in a residual connection. For more sensitive ground current detection, a separate CT, referred to as a core balance or zero sequence CT, encircles the three motor conductors. Ground fault detection is only suitable for systems that have a path from the supply to ground either through a resistance or by direct connection. Ungrounded systems require an artificial ground to be created through use of a device like a zig-zag transformer if ground fault protection is to be used.

In systems with several levels of ground fault detection, time co-ordination is required for satisfactory operation. If ground fault protection is used on a bus, each motor must have a shorter ground fault trip time delay than the bus ground fault detector or a fault in any motor will shut down the whole bus. In a solidly grounded system, time delays as short as possible should be used to prevent system damage unless the contactor is not capable of breaking the fault current in which case a backup detection system of sufficient interrupting capacity should be allowed to operate first. When contactors are used in solidly grounded systems, the ground fault trip time should be longer than the fuse interrupt time.

On resistance grounded systems, where the ground current is limited to safe levels longer time delays can be used subject to co-ordination constraints. Too short time delays may cause nuisance tripping due to transients or capacitive charging currents and should be avoided if possible. Time delays of several hundred milliseconds are suitable for applications where the relay has to be coordinated with other protective devices or a long delay is desired because of transients. Time delays of several seconds are suitable for use on high resistance grounded systems where nuisance tripping may be a problem from capacitive or induced currents during the starting inrush. Ground currents limited by the supply ground resistance can flow for longer periods without causing any damage.

The relay(s) selected in this setpoint along with the respective status indicator(s) on the front panel of the 239 will be active upon a ground fault trip.

- **GROUND PRIMARY TRIP PICKUP:** Ground fault trip when enabled in **S4: PROTECTION\GROUND CURRENT\GROUND TRIP**, will signal a trip condition when the ground current becomes equal to or exceeds the value set in this setpoint. The amount of current that will flow due to a ground fault depends on where the fault occurs in the motor winding. High current flows if a short to ground occurs near the end of the stator winding nearest to the terminal voltage. Low ground fault currents flow if a fault occurs at the neutral end of the winding since this end should be a virtual ground. Thus a low level of ground fault pickup is desirable to protect as much of the stator winding as possible and to prevent the motor casing from becoming a shock hazard. In resistance grounded systems the ground fault trip level must be set below the maximum current limited by the ground resistor or else the relay will not see a large enough ground fault current to cause a trip.
- **GROUND TRIP DELAY ON RUN:** This delay is used when the motor is in a RUNNING condition. If the ground current is equal to or above the **GROUND PRIMARY TRIP PICKUP** setpoint value and remains this way for the time delay programmed in this

setpoint while the motor is running, the assigned relay(s) will activate and the “CAUSE OF TRIP: GROUND FAULT” message will be displayed.

**NOTE:** When the phase current increases from 0, the **GROUND TRIP DELAY ON START** setpoint described below is used until the 239 determines whether the motor is **RUNNING** or **STARTING**.

Refer to Section 5.2: A1: Status on page –59 for details on how the 239 detects a start condition.

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



NOTE

**When the phase current increases from 0, this delay is used until the 239 determines whether the motor is **RUNNING** or **STARTING**.**

Refer to Section 5.2: A1: Status on page –59 for details on how the 239 detects a start condition.

- **GROUND ALARM:** For detecting momentary ground faults due to initial insulation breakdown and arcing, this setpoint can be set to latched. This is especially useful in mines where moisture buildup in the windings may start to cause excessive leakage. Any short duration ground fault will then cause a latched alarm condition. Set to momentary if a ground fault alarm is required only while the ground current is actually present. Ground fault alarm when enabled, will signal an alarm condition when the ground current is greater than or equal to the value set by the **GROUND PRIMARY ALARM PICKUP** setpoint.
- **GROUND PRIMARY ALARM PICKUP:** This feature functions in a similar manner to the ground primary trip pickup feature.
- **GROUND ALARM DELAY ON RUN:** This delay is used when the motor is in a **RUNNING** condition. If the ground current is equal to or above the **GROUND PRIMARY ALARM PICKUP** setpoint value and remains this way for the time delay programmed in this setpoint while the motor is running, the alarm relay will activate and the “GROUND ALARM” message will be displayed.



NOTE

**When the phase current increases from 0, **GROUND ALARM DELAY ON START** described below is used until the 239 determines whether the motor is **RUNNING** or **STARTING**.**

Refer to Section 5.2: A1: Status on page –59 for details on how the 239 detects a start condition.

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

**NOTE:** When the phase current increases from 0, this delay is used until the 239 determines whether the motor is **RUNNING** or **STARTING**.

Refer to Section 5.2: A1: Status on page –59 for details on how the 239 detects a start condition.

#### 4.5.10 Temperature

##### Thermistor

Insulation breakdown of the stator windings due to overheating is the main cause of motor failure under overload conditions. Heat buildup in the rotor can be very rapid but the large thermal mass of the motor prevents direct detection by temperature sensors embedded in the stator slots soon enough to prevent damage. It may take several minutes for the temperature sensor to reach its trip temperature. Consequently, a predictive model is required to accurately determine heat buildup within the motor. The 239 relay uses an accurate electronic memory method based on motor currents and time based integration algorithms. Thermal overloads rely on using motor current to heat an element with a much smaller time constant than the motor itself to predict overheating within the motor but these devices, although inexpensive, are subject to many limitations.

Overheating from causes other than resistive heating due to current cannot be detected by modeling methods that only sense current. To detect the effects of motor overheating due to blocked ventilation, high ambient temperature or other unforeseen causes, direct temperature sensing is necessary. Since temperature rise under these conditions is much slower, the temperature detector will accurately sense the actual temperature within the motor which would not be true under a rapid heat buildup situation such as locked rotor for example.

- **THERMISTOR FUNCTION:** Linear sensing elements such as RTDs can give an output of actual temperature but these are expensive and unnecessary for basic protection of small motors. Thermistors are available which give a rapid change of resistance at a specific temperature. The 239 accepts a thermistor input and will provide a trip/ alarm/auxiliary control within 2 seconds of the thermistor threshold temperature being matched or exceeded. Either negative temperature coefficient (NTC) or positive temperature coefficient (PTC) thermistors can be used. The 239 assumes a PTC thermistor connection when the **HOT RESISTANCE** is programmed > **COLD RESISTANCE**. The 239 assumes a NTC thermistor connection when the **COLD RESISTANCE** is programmed  $\geq$  **HOT RESISTANCE**. PTC thermistors are preferred because three PTC thermistors can be connected in series to monitor each of the stator phases. This is not possible with NTC thermistors because all three thermistors must be hot to obtain a fault indication. Select OFF if no thermistor is installed. If the motor is still overheated after a trip, the thermistor signal will prevent restarting of the motor by tripping the 239 immediately after reset. Thermistor temperature will be displayed as either hot or cold because the thermistor is nonlinear. If the thermistor function is to be used for process control, assign it to the auxiliary relay in which case the auxiliary relay will activate but no message will be displayed.
- **THERMISTOR HOT RESISTANCE:** Consult manufacturer's data for the thermistor(s) installed in the motor and enter the hot resistance value here. If three PTC thermistors are connected in series, enter the hot resistance of 1 thermistor.
- **THERMISTOR COLD RESISTANCE:** Consult manufacturer's data for the thermistor(s) installed in the motor and enter the cold resistance value here. If three PTC thermistors are connected in series, enter 3 times the cold resistance value of a single thermistor.

*EXAMPLE 1: PTC THERMISTOR*

**S4:PROTECTION\TEMPERATURE\THERMISTOR\THERMISTOR HOT RESISTANCE:**  
**10.0 K $\Omega$**

**S4:PROTECTION\TEMPERATURE\THERMISTOR\THERMISTOR COLD RESISTANCE:**  
**0.5 K $\Omega$**

**S4:PROTECTION\TEMPERATURE\THERMISTOR\THERMISTOR FUNCTION: TRIP**

The thermistor trip will occur when the thermistor input resistance is greater than or equal to the **S4:\PROTECTION\TEMPERATURE\THERMISTOR\THERMISTOR HOT RESISTANCE** setting of **10.0 K $\Omega$** .

The thermistor trip can be reset when the thermistor input resistance becomes less than the **S4:PROTECTION\TEMPERATURE\THERMISTOR\THERMISTOR COLD RESISTANCE** setting of **0.5 K $\Omega$** .

*EXAMPLE 2: NTC THERMISTOR*

**S4:PROTECTION\TEMPERATURE\THERMISTOR\THERMISTOR HOT RESISTANCE:**  
**0.7 K $\Omega$**

**S4:PROTECTION\TEMPERATURE\THERMISTOR\THERMISTOR COLD RESISTANCE:**  
**12.0 K $\Omega$**

**S4:PROTECTION\TEMPERATURE\THERMISTOR\THERMISTOR FUNCTION: TRIP**

The thermistor trip will occur when the thermistor input resistance is less than or equal to the **S4:\PROTECTION\TEMPERATURE\THERMISTOR\THERMISTOR HOT RESISTANCE** setting of **0.7 K $\Omega$** .

The thermistor trip can be reset when the thermistor input resistance becomes greater than the **S4:PROTECTION\TEMPERATURE\THERMISTOR\THERMISTOR COLD RESISTANCE** setting of **12.0 K $\Omega$** .

- **THERMISTOR NOT CONNECTED ALARM:** If the thermistor becomes open circuited during use, the ACTUAL VALUES display for the thermistor will be "NOT CONNECTED". The 239 relay will generate an alarm to warn of the fault if this setpoint is enabled.

**RTD 1-3 (option)**

Protection against excessive motor temperature due to loss of ventilation or high ambient temperatures is provided by the RTD option which must be ordered with the relay if required. Up to 3 resistance temperature detectors (RTDs) must be supplied with the motor to use this option. When ordering a motor with RTDs, the 100  $\Omega$  platinum DIN 43730 type is the preferred choice for optimum sensitivity and linearity. Other RTDs that can be selected are 100  $\Omega$  nickel, 120  $\Omega$  nickel and 10  $\Omega$  copper.

- **RTD 1-3 APPLICATION:** RTDs can be located in the stator windings or the bearings. Specify the location of each RTD in this setpoint. The application name selected here will be displayed as part of the alarm and trip message. If a particular RTD input is not used, this setpoint should be set to off.
- **RTD 1-3 TYPE:** This setpoint must be programmed to the type of RTD for each of the RTDs connected. The factory default is 100  $\Omega$  platinum but 100  $\Omega$  nickel, 120  $\Omega$  nickel, or 10  $\Omega$  copper can also be connected to each input.

- **RTD 1-3 TRIP and RTD 1-3 ALARM:** Alarm and trip settings for stator RTDs depend on the motor stator insulation type. Class B insulation rating is the factory default with alarm and trip levels of 110°C and 130°C respectively. Higher temperatures can be selected for other insulation classes. Consult the motor manufacturer for suitable settings if higher temperature insulation is installed in the motor. Bearing temperature settings are empirically set. Default settings are 75°C alarm and 90°C trip. The alarm/trip will occur immediately after the input becomes equal to or exceeds the temperature setting. Once a motor is running for several hours the actual temperature can be monitored and the settings reduced. Over time a bearing problem such as a loss of lubricant will show up as an increased temperature. Consequently, a setting close to the actual operating temperature is desirable providing it does not generate nuisance alarms from ambient temperature changes or load variations.

Temperature display units are set as either Celsius or Fahrenheit depending on the selection of the setpoint **S1:239 SETUP\PREFERENCES\TEMPERATURE DISPLAY**. RTD temperature readings from all of the RTDs may be displayed. If RTD application is set to **OFF**, the display for that RTD will be "no RTD". When the setpoint **S1: 239 SETUP\PREFERENCES\TEMPERATURE DISPLAY** is changed from Celsius to Fahrenheit or *vice versa*, setpoints **S4: PROTECTION\TEMPERATURE\RTD 1-3\RTD 1-3 TRIP** and **S4: PROTECTION\TEMPERATURE\RTD 1-3\RTD 1-3 ALARM** will automatically be scaled to the proper setting.

### RTD Sensor Failure

- **RTD SENSOR FAILURE ALARM:** If an RTD becomes open circuited during use, the ACTUAL VALUES display for that RTD will be "no RTD". Readings from the disconnected RTD will then be ignored for overtemperature protection. The 239 relay will generate an alarm to warn of the faulty RTD if this setpoint is enabled. Setpoints **S4: PROTECTION\TEMPERATURE\RTD 1-3\RTD 1-3 TRIP** and **S4: PROTECTION\TEMPERATURE\RTD 1-3\RTD 1-3 ALARM** should be set to off for any unused RTD terminals.

Table 4–3: RTD Resistance VS. Temperature (Sheet 1 of 2)

| TEMPERATURE |     | 100 Ω<br>PLATINUM | 100 Ω<br>NICKEL | 120 Ω NICKEL | 10 Ω<br>COPPER |
|-------------|-----|-------------------|-----------------|--------------|----------------|
| °C          | °F  |                   |                 |              |                |
| -40         | -40 | 84.27 Ω           | 79.13 Ω         | 92.76 Ω      | 7.490 Ω        |
| -30         | -22 | 88.22 Ω           | 84.15 Ω         | 99.41 Ω      | 7.876 Ω        |
| -20         | -4  | 92.16 Ω           | 89.23 Ω         | 106.41 Ω     | 8.263 Ω        |
| -10         | 14  | 96.09 Ω           | 94.58 Ω         | 113.0 Ω      | 8.649 Ω        |
| 0           | 32  | 100.0 Ω           | 100.0 Ω         | 120.0 Ω      | 9.035 Ω        |
| 10          | 50  | 103.9 Ω           | 105.6 Ω         | 127.2 Ω      | 9.421 Ω        |
| 20          | 68  | 107.8 Ω           | 111.2 Ω         | 134.5 Ω      | 9.807 Ω        |
| 30          | 86  | 111.7 Ω           | 117.1 Ω         | 142.1 Ω      | 10.19 Ω        |
| 40          | 104 | 115.5 Ω           | 123.0 Ω         | 149.8 Ω      | 10.58 Ω        |



Table 4–3: RTD Resistance VS. Temperature (Sheet 2 of 2)

| TEMPERATURE        |                    | 100 $\Omega$<br>PLATINUM | 100 $\Omega$<br>NICKEL | 120 $\Omega$ NICKEL | 10 $\Omega$<br>COPPER |
|--------------------|--------------------|--------------------------|------------------------|---------------------|-----------------------|
| $^{\circ}\text{C}$ | $^{\circ}\text{F}$ |                          |                        |                     |                       |
| 50                 | 122                | 119.4 $\Omega$           | 129.1 $\Omega$         | 157.7 $\Omega$      | 10.97 $\Omega$        |
| 60                 | 140                | 123.2 $\Omega$           | 135.3 $\Omega$         | 165.9 $\Omega$      | 11.35 $\Omega$        |
| 70                 | 158                | 127.1 $\Omega$           | 141.7 $\Omega$         | 174.3 $\Omega$      | 11.74 $\Omega$        |
| 80                 | 176                | 130.9 $\Omega$           | 148.3 $\Omega$         | 182.8 $\Omega$      | 12.12 $\Omega$        |
| 90                 | 194                | 134.7 $\Omega$           | 154.9 $\Omega$         | 191.6 $\Omega$      | 12.51 $\Omega$        |
| 100                | 212                | 138.5 $\Omega$           | 161.8 $\Omega$         | 200.6 $\Omega$      | 12.90 $\Omega$        |
| 110                | 230                | 142.3 $\Omega$           | 168.8 $\Omega$         | 209.9 $\Omega$      | 13.28 $\Omega$        |
| 120                | 248                | 146.1 $\Omega$           | 176.0 $\Omega$         | 219.3 $\Omega$      | 13.67 $\Omega$        |
| 130                | 266                | 149.8 $\Omega$           | 183.3 $\Omega$         | 228.9 $\Omega$      | 14.06 $\Omega$        |
| 140                | 284                | 153.6 $\Omega$           | 190.9 $\Omega$         | 238.8 $\Omega$      | 14.44 $\Omega$        |
| 150                | 302                | 157.3 $\Omega$           | 198.7 $\Omega$         | 249.0 $\Omega$      | 14.83 $\Omega$        |
| 160                | 320                | 161.0 $\Omega$           | 206.6 $\Omega$         | 259.3 $\Omega$      | 15.22 $\Omega$        |
| 170                | 338                | 164.8 $\Omega$           | 214.8 $\Omega$         | 269.9 $\Omega$      | 15.61 $\Omega$        |
| 180                | 356                | 168.5 $\Omega$           | 223.2 $\Omega$         | 280.8 $\Omega$      | 16.00 $\Omega$        |
| 190                | 374                | 172.2 $\Omega$           | 231.6 $\Omega$         | 291.9 $\Omega$      | 16.38 $\Omega$        |
| 200                | 392                | 175.8 $\Omega$           | 240.0 $\Omega$         | 303.5 $\Omega$      | 16.78 $\Omega$        |

## 4.6 Switch Inputs

### 4.6.1 Option Switch 1-2

- **OPTION SWITCH 1-2 NAME:** A 20 character name can be assigned to the option switch inputs. See Section 4.24.2.5 *Programmable Message* on page 4–17 to learn how to enter the switch names. This name will appear in the following messages.
- **OPTION SWITCH 1-2 FUNCTION:** The two option switch inputs are identical in operation. These can be programmed to alarm, trip, energize the auxiliary relay for process control, select alternate setpoints upon detection of closure, or disable starts upon detection of closure in conjunction with the **DISABLE STARTS** setpoint described in Section 4.34.3.2 *Motor Data* on page 4–21. In some applications start protection may not be required. Therefore, by setting this setpoint to **YES**, the start protection on the 239 can be defeated. If the setpoint is set to **YES**, the 239 will go directly into run condition and overload curves will be employed to protect the connected load.
- **OPTION SWITCH 1-2 DELAY:** A delay of 0.0 to 60.0 seconds is programmed here. The switch must remain closed for the programmed length of time in order for the 239 to detect the condition. If the switches are not used then they should be set to off in **S4: PROTECTION\ SWITCH INPUTS\OPTION SWITCH 1-2\OPTION SWITCH 1-2 FUNCTION**.
- **OPTION SWITCH 1-2 ALTERNATE SETPOINTS:** see Section 4.7: Multi-speed Motor below.

## 4.7 Multi-speed Motor

The 239 has a multi-speed motor feature. This feature is intended to provide proper protection for a two, three, or four-speed motor where there will be different full motor characteristics (based upon speed settings). The algorithm integrates the heating at each speed into one thermal model using a common, thermal capacity used register for all speeds.

If the two-speed motor feature is used, OPTION SWITCH 1 and/or OPTION SWITCH 2 will be dedicated as the two-speed motor. Terminals 41 and 46 (and/or 42 and 47) will be monitored for a contact closure – closure of the contact will signify that the motor is in Speed 2. If the input is open, it signifies that the motor is in Speed 1. This allows the 239 to determine which setpoints should be active at any given point in time.

- **OPTION SWITCH 1-2 ALTERNATE SETPOINTS:** The alternate setpoints only appear if the **OPTION SWITCH FUNCTION** is set to **ALTERNATE SETPOINTS**. As shown in the table below, there are six alternate setpoints that are divided into 3 sets. The following table shows the conditions required to select the appropriate set of alternate setpoints.

**Table 4-4: Selecting Alternate Setpoints**

| OPTION SWITCH 1 STATUS | OPTION SWITCH 1 FUNCTION         | OPTION SWITCH 2 STATUS | OPTION SWITCH 2 FUNCTION         | SELECTED SETPOINTS SET |
|------------------------|----------------------------------|------------------------|----------------------------------|------------------------|
| X                      | anything but ALTERNATE SETPOINTS | X                      | anything but ALTERNATE SETPOINTS | MAIN                   |
| OPEN                   | ALTERNATE SETPOINTS              | X                      | anything but ALTERNATE SETPOINTS | MAIN                   |
| CLOSED                 | ALTERNATE SETPOINTS              | X                      | anything but ALTERNATE SETPOINTS | 2 <sup>nd</sup>        |
| X                      | anything but ALTERNATE SETPOINTS | OPEN                   | ALTERNATE SETPOINTS              | MAIN                   |
| X                      | anything but ALTERNATE SETPOINTS | CLOSED                 | ALTERNATE SETPOINTS              | 3 <sup>rd</sup>        |
| OPEN                   | ALTERNATE SETPOINTS              | OPEN                   | ALTERNATE SETPOINTS              | MAIN                   |
| CLOSED                 | ALTERNATE SETPOINTS              | OPEN                   | ALTERNATE SETPOINTS              | 2 <sup>nd</sup>        |
| OPEN                   | ALTERNATE SETPOINTS              | CLOSED                 | ALTERNATE SETPOINTS              | 3 <sup>rd</sup>        |
| CLOSED                 | ALTERNATE SETPOINTS              | CLOSED                 | ALTERNATE SETPOINTS              | 4 <sup>th</sup>        |

X = don't care

MAIN = main setpoints

The message shown below is available on the 239, to indicate which is the currently selected group. The 239 will also indicate the setpoints group that was in use at the time of the last trip.

**xxxx SETPOINTS GROUP  
CURRENTLY IN USE**

xxxx = MAIN, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>

Located in ACTUAL VALUES pages A1 under  
the sub-heading SWITCH STATUS

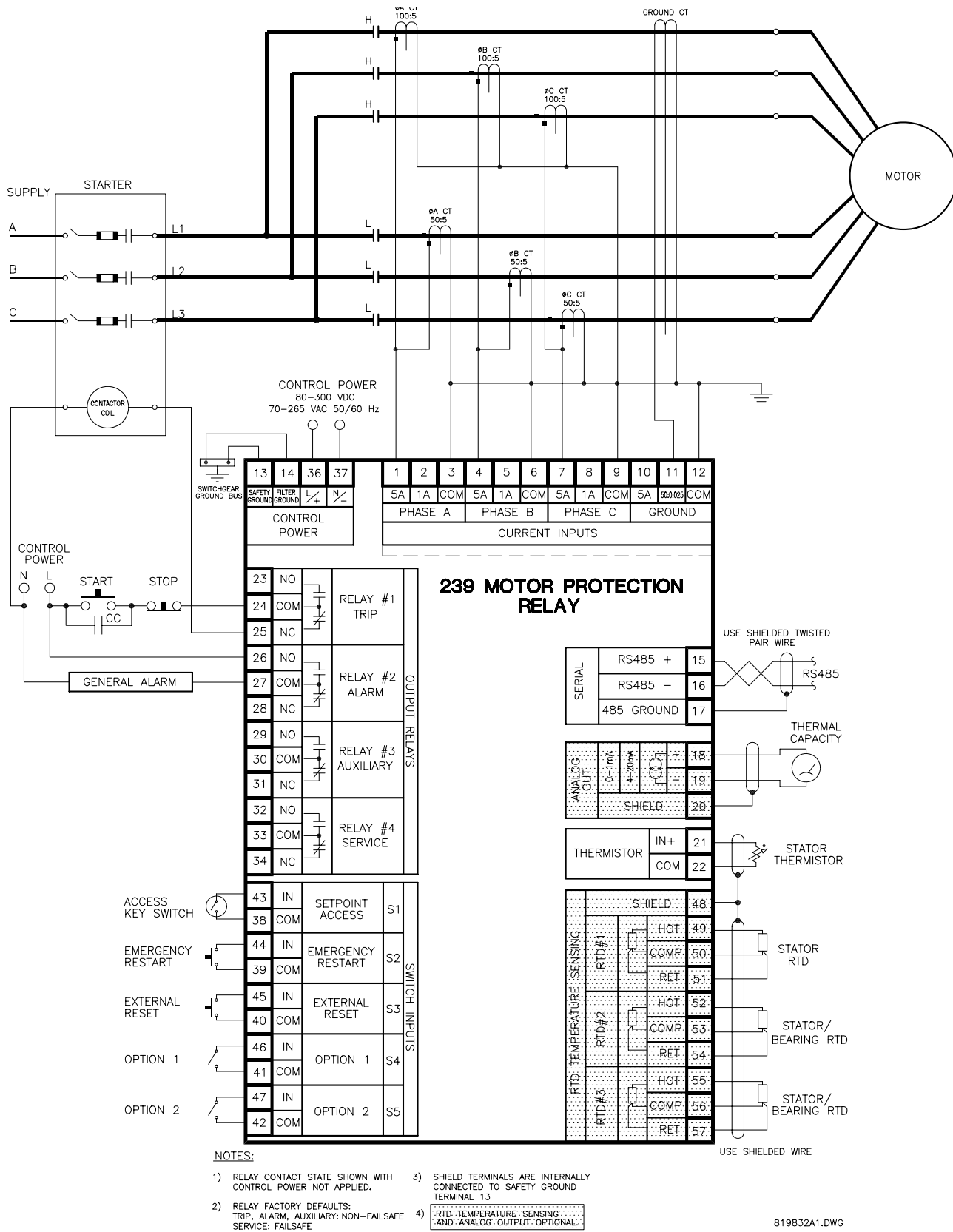
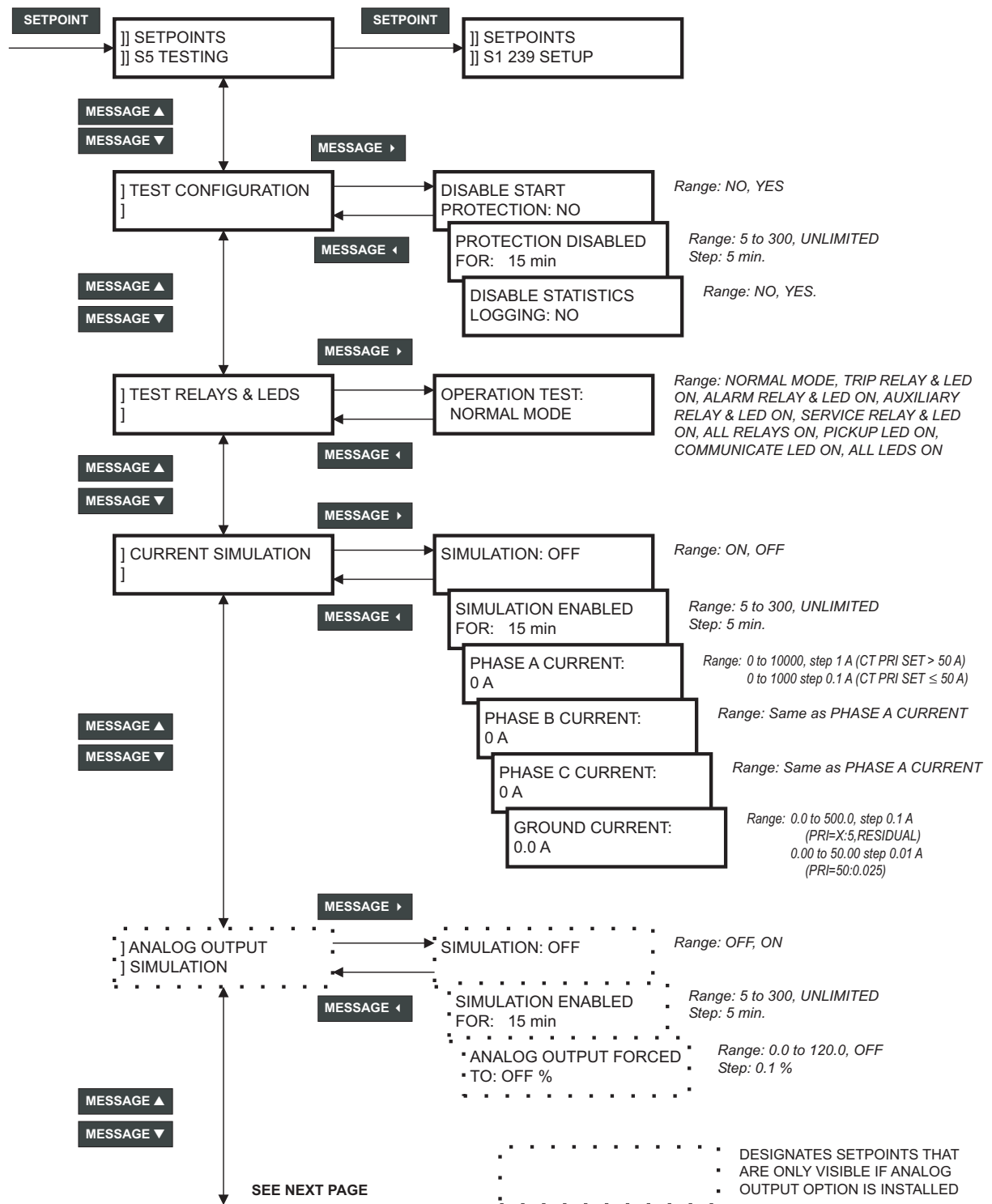


FIGURE 4-7: Two Speed Motor Wiring Diagram

## 4.8 S5: Testing



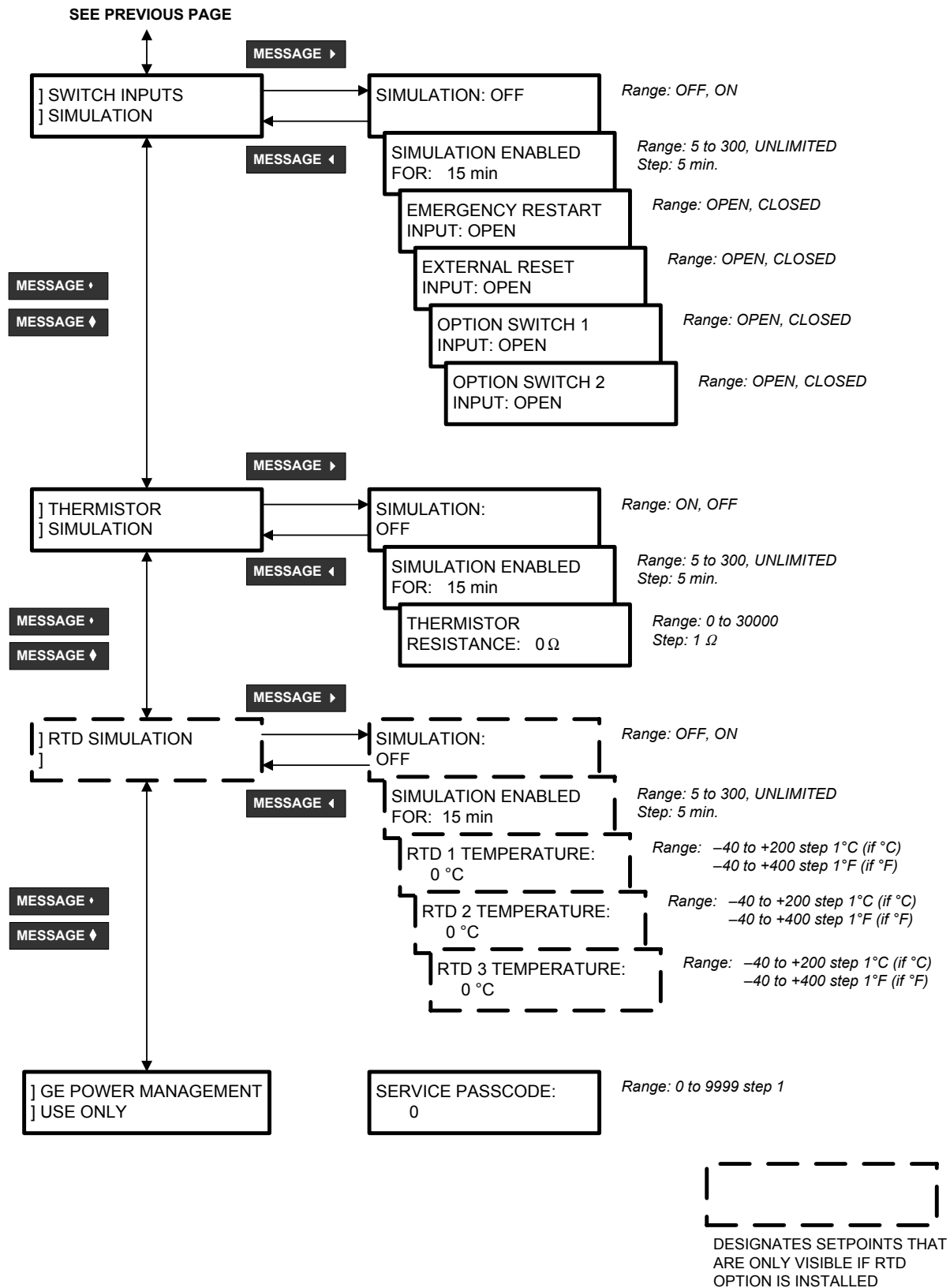


FIGURE 4-8: Setpoints Page 5 – Testing

### 4.8.1 Test Configuration

- **DISABLE START PROTECTION:** To verify correct operation of overload curves it may be necessary to disable the start protection. When this feature is turned on and current is injected above the full load setting, the overload curves will be used to build up the thermal capacity instead of the **LOCKED ROTOR CURRENT** and **SAFE STALL TIME** setpoints. When this feature is enabled the 239 assumes the motor is in RUN condition any time current is present even on initial startup inrush current.

EXAMPLE:

**S2: SYSTEM SETUP\MOTOR DATA\MOTOR FULL LOAD CURRENT: 100 A**

**S2: SYSTEM SETUP\MOTOR DATA\SAFE STALL TIME COLD: 20.0 S**

**S2: SYSTEM SETUP\MOTOR DATA\LOCKED ROTOR CURRENT: 6.0 X FLC**

**S2: PROTECTION\PHASE CURRENT\OVERLOAD\OVERLOAD CURVE NO: 4**

**S5: TESTING\TEST CONFIGURATION\DISABLE START PROTECTION: YES**

Inject phase current that  $5.0 \times \text{FLC}$ . The OVERLOAD TRIP will occur in 14.57 seconds instead of 28.8 seconds. This is because the overload curves is being used to buildup the thermal capacity instead if the **SAFE STALL TIME** and **LOCKED ROTOR CURRENT** settings.

As a safeguard, start protection will automatically be re-enabled if:

- power to the 239 is turned off and on
- time programmed in the **S5: TESTING\TEST CONFIGURATION\DISABLE PROTECTION FOR:** setpoint has elapsed since the start protection was first disabled

When start protection is disabled the following flash message will be displayed for 3 seconds.

**START PROTECTION  
HAS BEEN DISABLED**

When start protection is re-enabled the following flash message will be displayed for 3 seconds.

**START PROTECTION  
HAS BEEN ENABLED**

- **DISABLE PROTECTION FOR:** Select the desired length of time that start protection will be disabled. When the programmed time has elapsed, start protection will be re-enabled. If **UNLIMITED** is selected, start protection will be disabled until the feature is turned off via the **DISABLE START PROTECTION** setpoint or via the serial port or until control power is removed from the 239.
- **DISABLE STATISTICS LOGGING:** Setting this setpoint to NO disables the logging of the **MOTOR MAX STARTING CURRENT** and **MOTOR RUNNING TIME** actual values. See Section 5.25.2.3 *Motor Statistics* on page 5–61 for further details.

### 4.8.2 Test Output Relays & Leds

- **OPERATION TEST:** To verify correct operation of output relay wiring, each output relay and status indicator can be manually forced on or off via the keypad or serial port.

Testing is only allowed if there is no phase and ground current present and current simulation is turned off.

If the test is attempted while current is present, the setpoint will be forced to NORMAL MODE and the following flash message will be displayed for 3 seconds.

**RELAY TEST BLOCKED  
CURRENT PRESENT**

If **S5: TESTING\ CURRENT SIMULATION\SIMULATION** is **ON**, the setpoint will be forced to NORMAL MODE and the following flash message will be displayed for 3 seconds.

**RELAY TEST BLOCKED  
AMPS SIMULATION ON**

If testing is attempted via the serial port while phase or ground current is present or simulation mode is on, an error code will be returned.

While the **OPERATION TEST** setpoint is displayed, use the **VALUE** or **VALUE** key to scroll to the desired output relay and/or status indicator to be tested. As long as the test message remains displayed the respective output relay and/or status indicator will be forced to remain energized. As soon as a new message is selected, the respective output relay and/or status indicator return to normal operation.

As a safeguard, relay and LED test will turn off automatically if:

- power to the 239 is turned off and on
- phase or ground current is detected by the 239
- current simulation is turned on
- new message is displayed

### 4.8.3 Current Simulation

Simulated currents can be forced instead of the actual currents sensed by the external CTs connected to the 239. This allows verification of all current related relay functions such as timed overload trip. It also allows verification that external trip and alarm wiring is responding correctly.

- **SIMULATION:** Enter the required simulation phase and ground currents in the following messages. Enter ON to switch from actual currents to the programmed simulated values. This command will be ignored if real phase or ground current is present. Set this setpoint **OFF** after simulation is complete. As a safeguard, simulation will automatically turn off if:
  - real phase or ground current is detected while in simulation mode
  - power to the 239 is turned off and on
  - time programmed in the **S5: TESTING\CURRENT SIMULATION\SIMULATION ENABLED FOR** setpoint has elapsed since simulation was first enabled
  - 239 is tripped



When current simulation is turned on the following flash message will be displayed for 3 seconds.

**SIMULATION  
HAS BEEN ENABLED**

When current simulation is turned off the following flash message will be displayed for 3 seconds.

**CURRENT SIMULATION  
HAS BEEN DISABLED**

- **PHASE A/B/C CURRENT:** Enter the desired phase current for simulation. For example, to verify operation of the unbalance function, turn the unbalance function trip on, set **S4: PROTECTION\PHASE CURRENT\UNBALANCE\PHASE UNBALANCE TRIP PICKUP** to **20%**, and set **S4: PROTECTION\PHASE CURRENT\ UNBALANCE\PHASE UNBALANCE ALARM** to **OFF**. Enter the following simulation values, assuming **S2: SYSTEM SETUP\MOTOR DATA\MOTOR FULL LOAD** is set to **100A**, to create an unbalance of 27%:

$$I_a = 100 \text{ A}$$

$$I_b = 52 \text{ A}$$

$$I_c = 85 \text{ A}$$

Now set **S5: TESTING\CURRENT SIMULATION\SIMULATION: ON**. The relay will see this simulated current in all 3 phases instead of the actual input current. The 239 should trip after a time determined by **S4: PROTECTION\PHASE CURRENT\UNBALANCE\PHASE UNBALANCE DELAY**: setpoint. Set **S5: TESTING\CURRENT SIMULATION\SIMULATION: OFF** after testing is complete.

- **GROUND CURRENT:** Enter the ground current for simulation of a ground fault. Then set **S5: TESTING\CURRENT SIMULATION\SIMULATION: ON** to see the effect of this current.
- **SIMULATION ENABLED FOR:** Select the desired length of time that simulation will be enabled. When the programmed time has elapsed, current simulation will turn off. If **UNLIMITED** is selected, simulated current will be used until one of the above mentioned conditions is met.

#### 4.8.4 Analog Output Simulation

- **SIMULATION:** Enter ON to switch from actual analog output to the programmed simulation value. Set this setpoint to OFF after simulation is complete. As a safeguard, simulation will automatically turn off if:
  - power to the 239 is turned off and on
  - time programmed in the **S5: TESTING\ANALOG OUTPUT SIMULATION\SIMULATION ENABLED FOR** setpoint has elapsed since simulation was first enabled

When analog output simulation is turned on the following flash message will be displayed for 3 seconds.

**SIMULATION  
HAS BEEN ENABLED**

When analog output simulation is turned off the following flash message will be displayed for 3 seconds.

**ANALOG OUT SIMULATION  
HAS BEEN DISABLED**

- **ANALOG OUTPUT FORCED TO:** Enter in percent the analog output value to be simulated. Whether the output is 0-1mA, 0-20mA or 4-20mA is dependent upon the selection in **S1: 239 SETUP/ANALOG OUTPUT/ANALOG OUTPUT RANGE**.

*EXAMPLE:*

Alter the setpoints below as shown:

**S1:239 SETUP/ANALOG OUTPUT/ANALOG OUTPUT RANGE: 4-20 MA**

**S5:TESTING/ANALOG OUTPUT SIMULATION/ANALOG OUTPUT FORCED TO:  
50.0%**

**S5:TESTING/ANALOG OUTPUT SIMULATION/SIMULATION: ON**

The output current level will be 12mA.

- **SIMULATION ENABLED FOR:** Select the desired length of time that simulation will be enabled. When the programmed time has elapsed, analog output simulation will turn off. If **UNLIMITED** is selected, simulated analog output will be used until simulation is turned off via the **SIMULATION ON/OFF** setpoint or via the serial port or until control power is removed from the 239.

#### 4.8.5 Switch Inputs Simulation

- **SIMULATION:** Enter **ON** to switch from actual switch inputs to the programmed simulation status of each switch input. While simulation is on the actual switch input status will be overridden by the simulated status of each input. Set this setpoint to **OFF** after simulation is complete. As a safeguard, simulation will automatically turn off if:
  - power to the 239 is turned off and on
  - time programmed in the **S5: TESTING\SWITCH INPUTS  
SIMULATION\SIMULATION ENABLED FOR** setpoint has elapsed since simulation was first enabled

When switch inputs simulation is turned on the following flash message will be displayed for 3 seconds.

**SIMULATION  
HAS BEEN ENABLED**

When switch inputs simulation is turned off the following flash message will be displayed for 3 seconds.

**SIMULATION  
HAS BEEN DISABLED**

- **EMERGENCY RESTART INPUT:** Enter the status of this switch input as **OPEN** or **CLOSED**. The functionality of this input remains as is with actual input connected.
- **EXTERNAL RESET INPUT:** Enter the status of this switch input as **OPEN** or **CLOSED**. The functionality of this input remains as is with actual input connected.
- **OPTION 1 INPUT:** Enter the status of this switch input as **OPEN** or **CLOSED**. The functionality of this input remains as is with actual input connected.
- **OPTION 2 INPUT:** Enter the status of this switch input as **OPEN** or **CLOSED**. The functionality of this input remains as is with actual input connected.
- **SIMULATION ENABLED FOR:** Select the desired length of time that simulation will be enabled. When the programmed time has elapsed, switch inputs simulation will turn off. If **UNLIMITED** is selected, simulated switch input status will be used until simulation is turned off via the **SIMULATION ON/OFF** setpoint or via the serial port or until control power is removed from the 239.

#### 4.8.6 Thermistor Simulation

- **SIMULATION:** Enter **ON** to switch from actual thermistor input to the programmed simulation thermistor resistance value. While simulation is on the actual thermistor input will be overridden by the simulated resistance value. Set this setpoint to **OFF** after simulation is complete. As a safeguard, simulation will automatically turn off if:
  - power to the 239 is turned off and on
  - the time programmed in **S5: TESTING\THERMISTOR SIMULATION\SIMULATION ENABLED FOR** setpoint has elapsed since simulation was first enabled

When thermistor simulation is turned on the following flash message will be displayed for 3 seconds.

**SIMULATION  
HAS BEEN ENABLED**

When thermistor simulation is turned off the following flash message will be displayed for 3 seconds.

**THERMISTOR SIMULATION  
HAS BEEN DISABLED**

- **THERMISTOR RESISTANCE:** Enter the value of the thermistor resistance to be simulated. The functionality of the thermistor remains as is with an actual input connected to the 239.
- **SIMULATION ENABLED FOR:** Select the desired length of time that simulation will be enabled. When the programmed time has elapsed, thermistor simulation will turn off. If **UNLIMITED** is selected, simulated thermistor input will be used until simulation is

turned off via the **SIMULATION ON/OFF** setpoint or via the serial port or until control power is removed from the 239.

#### 4.8.7 RTD Simulation

- **SIMULATION:** Enter ON to switch from actual input to the programmed simulation temperature value of each RTD input value. While simulation is on all three RTD r inputs will be overridden by the simulated temperature values. Set this setpoint to **OFF** after simulation is complete. As a safeguard, simulation will automatically turn off if:
  - power to the 239 is turned off and on
  - time programmed in **S5: TESTING\RTD SIMULATION\SIMULATION ENABLED FOR** setpoint has elapsed since simulation was first enabled

When RTD simulation is turned on the following flash message will be displayed for 3 seconds.

**SIMULATION  
HAS BEEN ENABLED**

When RTD simulation is turned off the following flash message will be displayed for 3 seconds.

**RTD SIMULATION  
HAS BEEN DISABLED**

- **RTD 1/2/3 TEMPERATURE:** Enter the value of the each RTD temperature to be simulated. The functionality of the RTDs remains as is with actual inputs connected to the 239.
- **SIMULATION ENABLED FOR:** Select the desired length of time that simulation will be enabled. When the programmed time has elapsed, RTD simulation will turn off. If **UNLIMITED** is selected, simulated RTD input will be used until simulation is turned off via the **SIMULATION ON/OFF** setpoint or via the serial port or until control power is removed from the 239.

#### 4.8.8 GE Multilin Use Only

- **SERVICE PASSCODE CODE:** These messages are accessed by GE Multilin personnel only for testing and service.



## 239 Motor Protection Relay

### Chapter 5: Monitoring

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#### 5.1 Monitoring

##### 5.1.1 Actual Values Viewing

Any measured value can be displayed on demand using the **ACTUAL** key. Each time the **ACTUAL** key is pressed, the beginning of a new page of monitored values is displayed. These are grouped as: A1: STATUS, A2: METERING, A3: PRODUCT INFO. Use the **MESSAGE** / **MESSAGE** keys in the same fashion as for setpoints to move between actual value messages. A detailed description of each displayed message in these groups is given in the sections that follow.

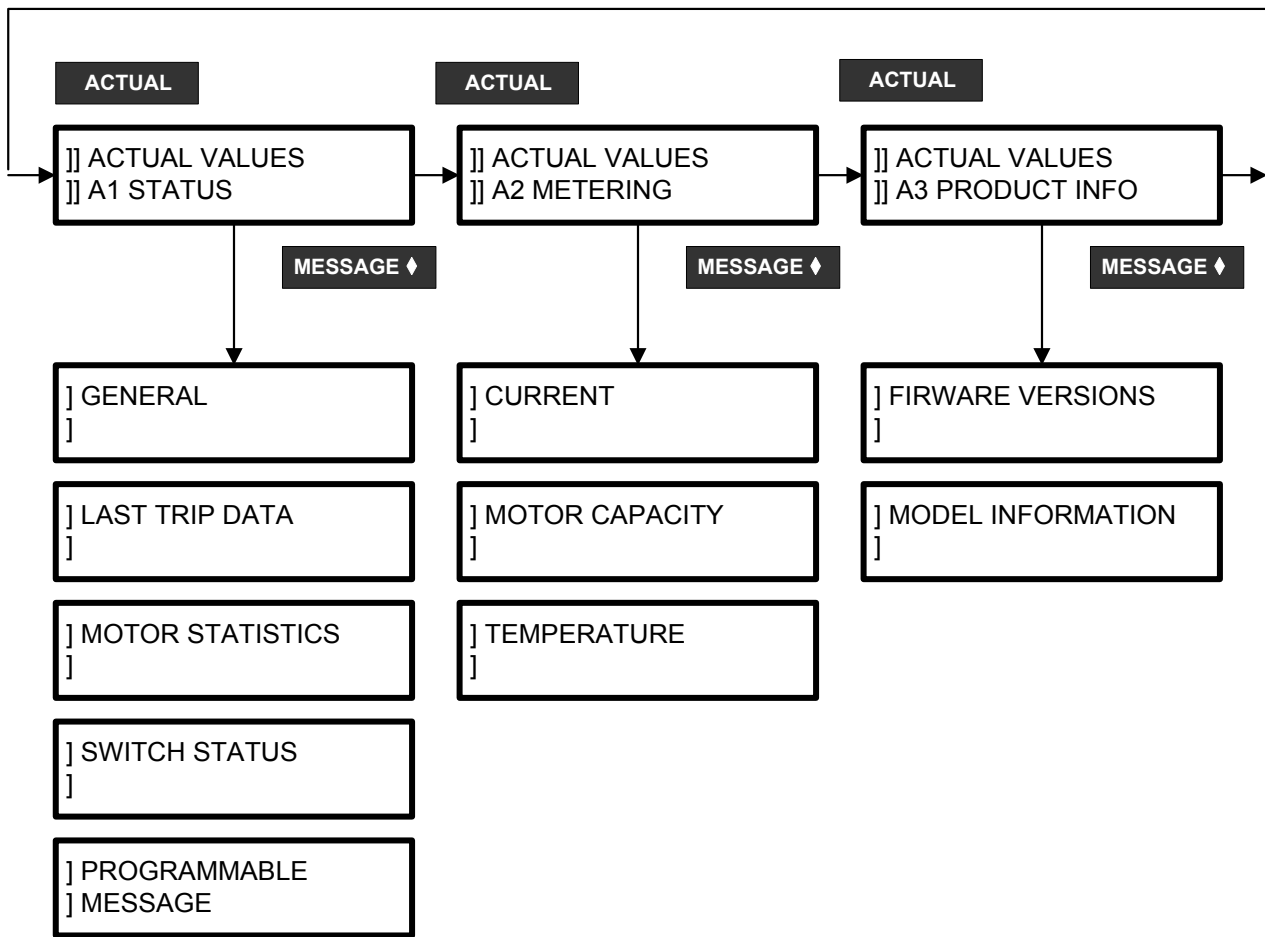
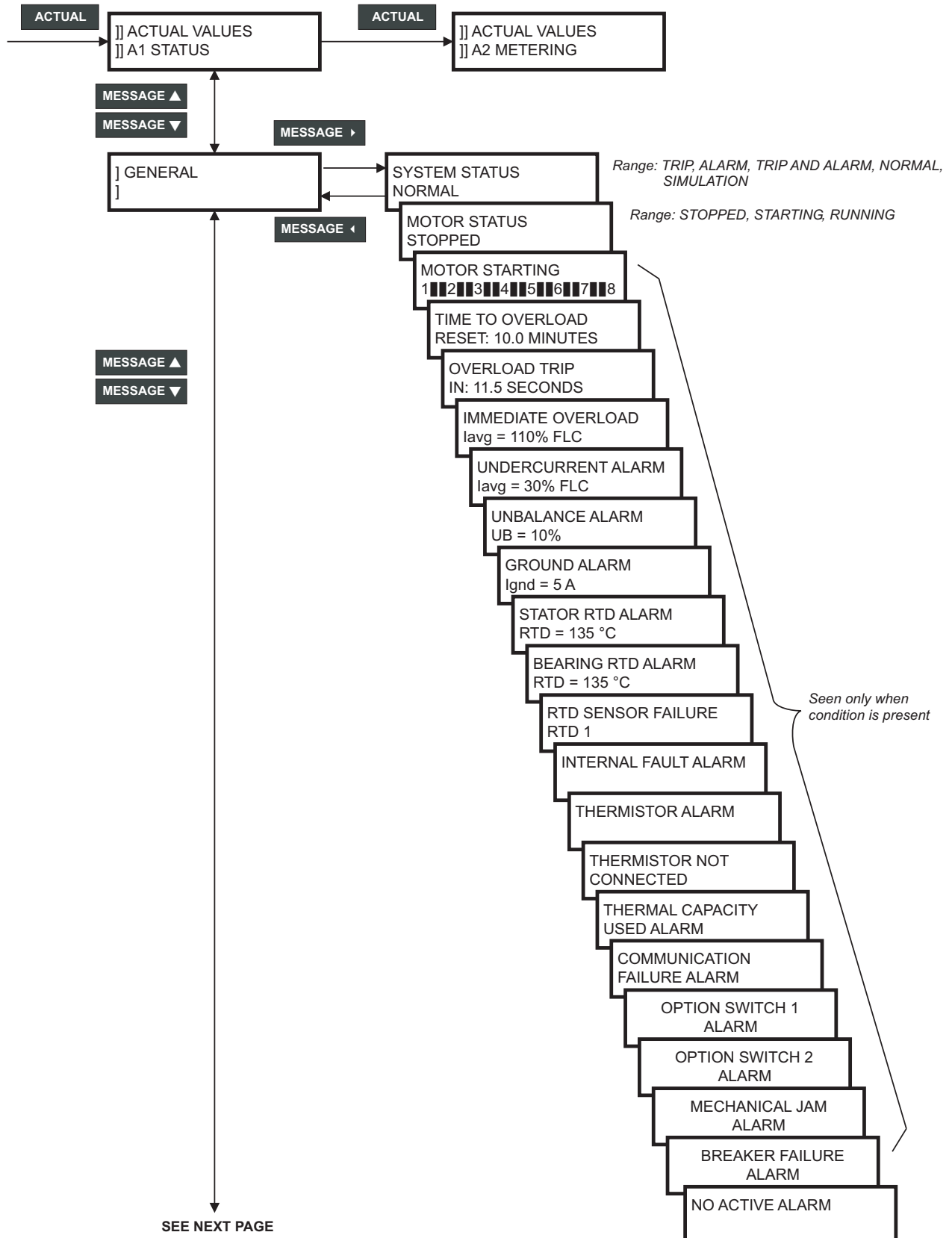


FIGURE 5-1: Actual Values Message Organization

## 5.2 A1: Status



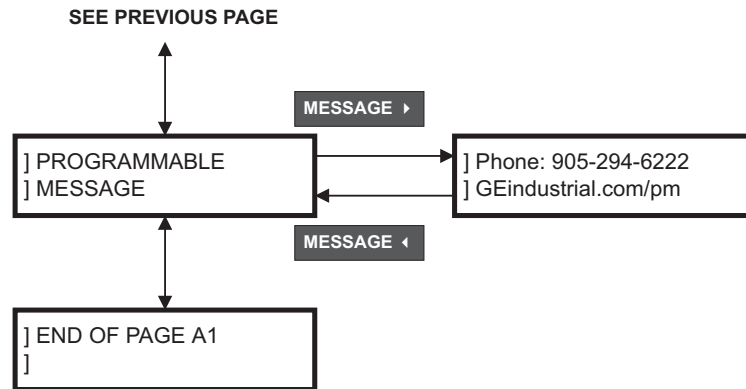


FIGURE 5–2: Actual Values Page 1 – Status

### 5.2.1 General

- **SYSTEM STATUS:** This message gives an indication if operation is normal or whether a trip and/or alarm has occurred. Only one condition can cause a trip at a time and this will be displayed after a trip. When alarms are present the system status will be alarm. Press **MESSAGE** to view all active alarm conditions and the corresponding actual value that is causing the alarm. Select the corresponding setpoint to determine by how much the actual value exceeds the alarm setting.
- **MOTOR STATUS:** This message displays the current status of the motor.
- **MOTOR STARTING:** This message is displayed when the motor is in a START mode. The START condition occurs if the average of the three phase currents rises above the full load current setting in **S2 SYSTEM SETUP\MOTOR DATA\MOTOR FULL LOAD CURRENT** within 300 ms (worst case) of initial detection of current by the 239.
- **TIME TO TRIP:** This message is displayed when a trip condition is in progress. The message display time is scaled as follows:
 

if the trip time is  $> 10.0$  minutes, the display will be 'xxx.x MINUTES'  
 $\leq 10.0$  minutes, the display will be 'xxx.x SECONDS'
- **TIME TO OVERLOAD RESET:** This message displays the amount of time remaining before an OVERLOAD TRIP is allowed to be reset. The time will become 0 when the thermal capacity decreases to 15%.
- **CAUSE OF ALARM:** The appropriate alarm message is displayed when the respective alarm condition is present. More than one alarm message can be present at once.

### 5.2.2 Last Trip Data

After a trip, all conditions present at the time of trip and the cause of trip are saved in non-volatile memory. In addition, a trip record of the last 5 causes of trip is also retained for diagnosing persistent problems.

- **CAUSE OF LAST TRIP:** Only one condition at a time will cause a trip. The most recent cause of trip is displayed.



- **A: B: C: CURRENT:** Actual current flowing in each of the three phases at the moment of trip is displayed. By comparing these values to the motor full load current after an overload trip, it should be easy to determine in which phase the fault has occurred. A high current in one phase and ground indicates a phase to ground fault. A high current in 2 phases suggests a phase to phase fault. High current in all three phases indicates a running overload or possible short circuit. The current resolution is 0.1 A if the **CT PRIMARY** setting is  $\leq 50$  A. The resolution is 1A if the **CT PRIMARY** setting is  $> 50$ A.
- **GROUND CURRENT:** If excessive ground current was present at the time of trip, an insulation failure is likely. With the motor off-line, check the insulation resistance in all three phases and cable wiring.
- **CURRENT UNBALANCE:** Excessive unbalance can be caused by loose terminal connections, faulty utility supply, a blown fuse, or faulty contactor. Check for these before restarting the motor.
- **STATOR (BEARING) RTD 1-3 (OPTION):** If any stator RTDs shows a high temperature, check that the ventilation to the motor is clear. Repeated starting using the Emergency Restart feature will cause the motor to overheat and should be avoided. After an overload trip, the RTD temperature may be elevated. Verify that the motor has cooled before restarting by checking each RTD temperature using the messages **A2: METERING\TEMPERATURE**. If the RTD is installed on a bearing, an excessive bearing temperature usually indicates a need for lubrication or a fault with the bearing itself. Lubricate the bearing then monitor its temperature closely after starting the motor.
- **SETPOINTS GROUP IN USE:** Alternate setpoints (i.e. **PHASE CT PRIMARY**, **FULL LOAD CURRENT**, etc.) can be selected using the Option Switch 1 and Option Switch 2 inputs as explained in Section 4.6: Switch Inputs on page –46. One of four possible groups of setpoints can be selected at once. This message displays the selected group at the time of the last trip.
- **2nd (3-5) LAST TRIP:** A trip record of the last 5 causes of trip is retained for diagnosing persistent problems. Each new trip is added to the trip record and the oldest (fifth) cause of trip is erased. No trip data is saved in this trip record. However, by observing repeated trips of the same type, an indication of an inherent fault is obtained for maintenance purposes.

### 5.2.3 Motor Statistics

The total motor running time (including start conditions) and the maximum average current present during the last successful start are monitored here.

### 5.2.4 Switch Status

To assist in troubleshooting, the state of each switch can be verified using these messages. A separate message displays the status of each input identified by the corresponding name as shown in FIGURE 2–3: *Typical Wiring Diagram* on page 2–18. For a dry contact closure across the corresponding switch terminals the message will read closed.

NOTE: If the switch simulation is turned on in

**S5:TESTING\SWITCH SIMULATION\SIMULATION**, the status shown in these messages will be of the simulated inputs.

- **SETPOINTS GROUP CURRENTLY IN USE:** Alternate setpoints (i.e. **PHASE CT PRIMARY**, **FULL LOAD CURRENT**, etc.) can be selected using the Option Switch 1 and Option Switch 2 inputs as explained in Section 4.6: Switch Inputs on page –46. One of four possible groups of setpoints can be selected at once. This message displays the currently selected group.

### 5.2.5 Programmable Message

A 40 character message can be programmed using the keypad or via the serial port using the 239PC software. See 4.2: S1: 239 Setup on page –13 for an example of programming this message using the keypad.

This message can be used for identification purposes such as company name, site name, station name, relay identification number, etc. It can be chosen as the default message so it is displayed when the unit is left alone.

### 5.3 A2: Metering

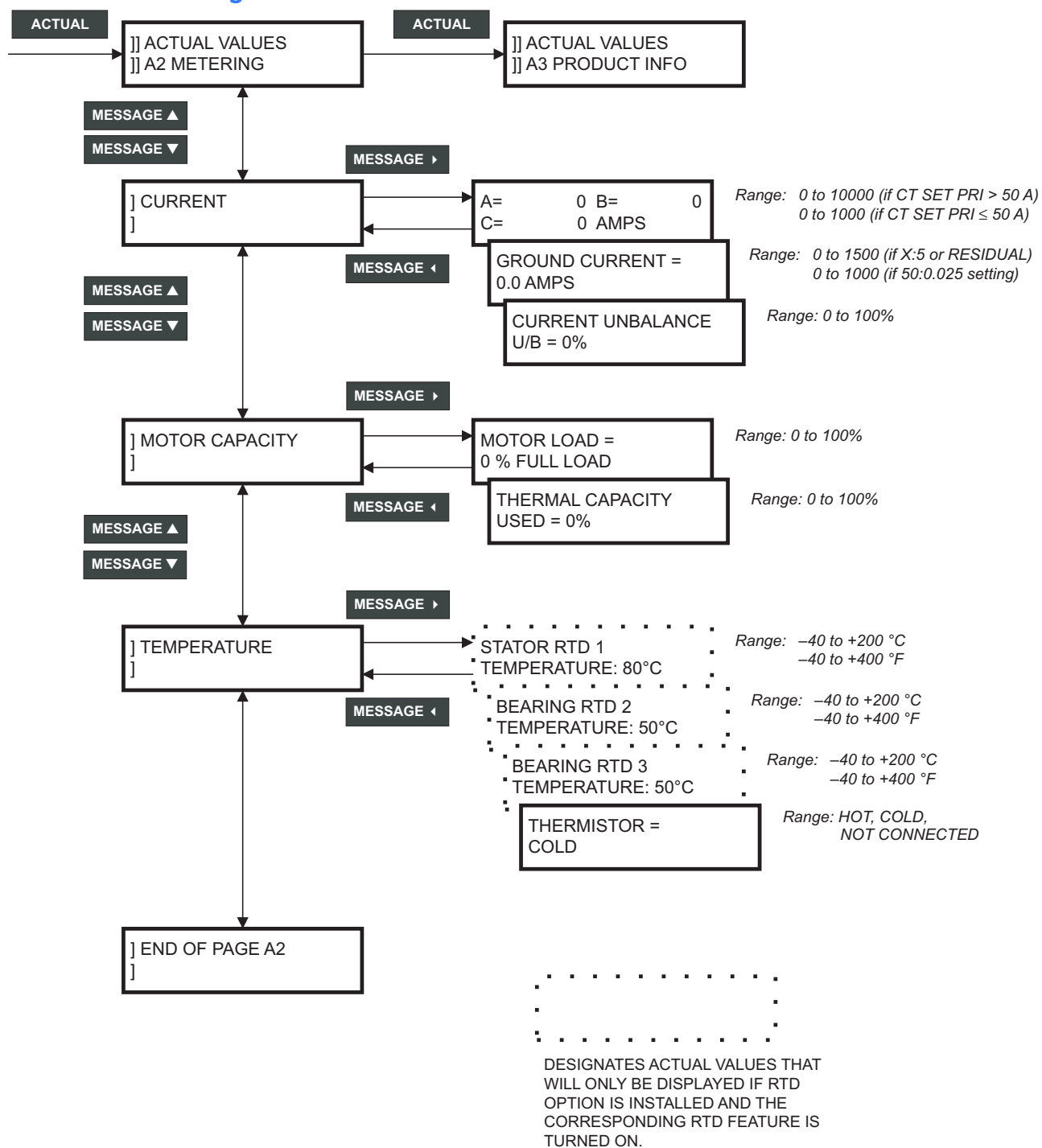


FIGURE 5-3: Actual Values Page 2 – Metering

### 5.3.1 Current

- **A: B: C: CURRENT:** Current in each phase corresponding to the A, B and C phase inputs is displayed. Current will only be measured correctly if **CT PRIMARY** is entered to match the installed CT primary and the CT secondary is wired to match the 1 or 5 A input. If the displayed current does not match the actual current, check this setpoint and wiring. During starting, the display will automatically switch to a bar graph showing multiples of full load current. Once the current drops below the motor full load setting, the display will revert to the three phase currents. The current resolution is 0.1 A if **CT PRIMARY** ≤ 50A. The resolution is 1 A if **CT PRIMARY** > 50A.
- **GROUND CURRENT:** Presence of ground current indicates some undesirable current to ground leakage. The ground current reading will only be correct if the CT is wired correctly and the correct **CT PRIMARY** value is entered. Verify ground current by connecting a clamp-on ammeter around all 3 phases. If the ground current appears incorrect, check the ground CT settings in **S2: SYSTEM SETUP\CT INPUTS** and verify the CT wiring.
- **CURRENT UNBALANCE:** Current unbalance causes rotor heating. It is calculated as:

$$I_{av} \geq I_{FLC}: \quad \frac{|I_m - I_{av}|}{I_{av}} \times 100\%$$

$$I_{av} < I_{FLC}: \quad \frac{|I_m - I_{av}|}{I_{FLC}} \times 100\%$$

where:  $I_{av}$  = average phase current  
 $I_m$  = current in a phase with maximum deviation from  $I_{av}$   
 $I_{FLC}$  = motor full load current setting

These formulas allow larger levels of unbalance to be tolerated by lightly loaded motors. Excessive unbalance can be caused by loose terminal connections, faulty utility supply, a blown fuse or a faulty contactor.

### 5.3.2 Motor Capacity

- **MOTOR LOAD:** In order to gauge how closely the motor is running to its maximum capacity, the motor load is calculated and displayed as: Motor Load =  $I_{av} / I_{FLC}$ .  $I_{av}$  is the average 3 phase current.  $I_{FLC}$  is the rated motor full load current entered in setpoint **S2: SYSTEM SETUP\MOTOR DATA**. A value greater than 100% indicates an overloaded motor that will eventually trip on timed overload. Values less than 100% indicate that the motor is operating normally.
- **THERMAL CAPACITY USED:** The heating effect of starts and overloads is integrated and stored in a thermal memory that models the heat buildup within the motor. When the thermal capacity used equals 100%, the 239 trips the motor since the motor is considered to be running at its maximum temperature. With no overloads present, the thermal capacity used will gradually decrease to a steady state value, determined as described in **S2: SYSTEM SETUP\MOTOR DATA\HOT/COLD CURVE RATIO**, to simulate motor cooling. When thermal capacity used is close to 100%, attempting to restart a stopped motor may result in a trip due to the rapid increase in the thermal memory used under a start condition.

### 5.3.3 Temperature

- STATOR (BEARING) RTD1 (2-3) TEMPERATURE (OPTION):** When enabled by **S4: TEMPERATURE\RTD1-3\RTD1-3 APPLICATION**, the actual temperature measured by each RTD will be displayed. For RTDs installed in the stator, interpretation of the temperature is more meaningful if the insulation class of the stator windings is known. This value indicates how close the stator is operating to its maximum allowable temperature. Consult the motor manufacturer's data for stator insulation class and maximum operating temperature. Insulation life typically is reduced by half for every 10°C rise in temperature. Bearing temperatures vary with ambient conditions, greasing, wear and loading. A significant increase in bearing temperature may indicate a problem that needs investigation. Temperatures can be viewed in °C or °F by selecting the appropriate setpoint in **S1: 239SETUP\PREFERENCES\TEMPERATURE DISPLAY IN**.
- THERMISTOR:** Thermistors typically installed in motors for temperature detection are nonlinear devices. When enabled, the thermistor readout will indicate hot or cold depending on whether the thermistor resistance exceeds its alarm/trip threshold setpoint. If the terminals are left unconnected while the thermistor function is set to trip or alarm or the thermistor resistance increases above 31.5 kΩ, **THERMISTOR NOT CONNECTED** alarm message will be displayed. Therefore, if the thermistor is not being used, the function must be set to off.

## 5.4 A3: Product Info

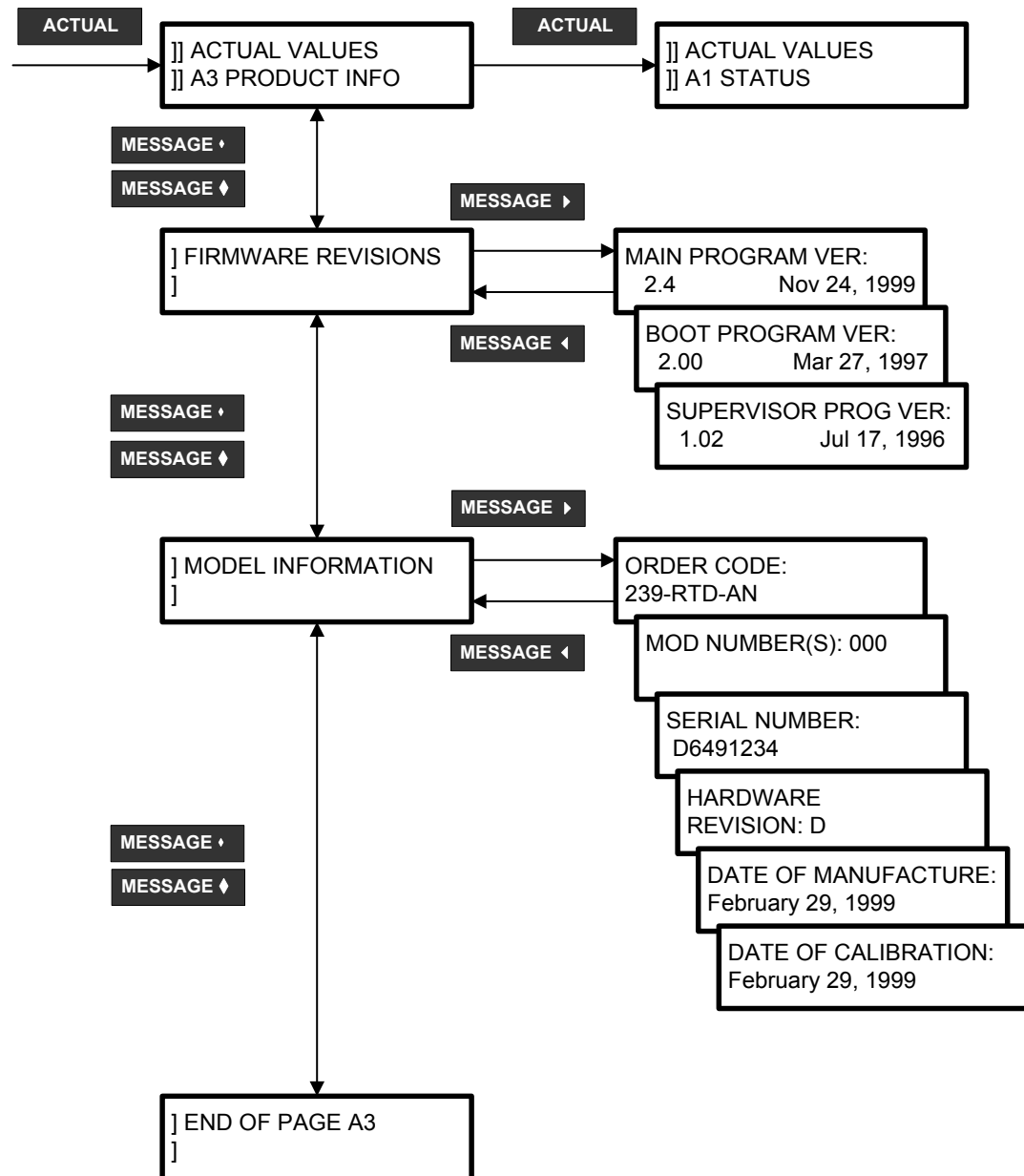


FIGURE 5-4: Actual Values Page 3 – Product Info

### 5.4.1 Software Versions

Product software revision information is contained in these messages.

- MAIN PROGRAM VERSION:** When referring to documentation or requesting technical assistance from the factory, record the **MAIN PROGRAM VERSION** and **MODIFICATION FILE NUMBER**. The **MAIN PROGRAM VERSION** identifies the firmware installed internally in the flash memory. The title page of this instruction manual states the

main program revision code for which the manual is written. There may be differences in the product and manual if the revision codes do not match.

- **BOOT PROGRAM VERSION:** This identifies the firmware installed internally in the PROM memory of the 239. This does not affect the functionality of the 239.
- **SUPERVISOR PROGRAM VERSION:** This identifies the firmware installed internally in the Supervisor (power fail) processor of the 239. This does not affect the functionality of the 239.

## 5.4.2 Identification

Product identification information is contained in these messages.

- **ORDER CODE:** The order code shows the configuration of the relay and will appear as shown below depending upon the options installed.

|              |   |   |
|--------------|---|---|
| '239'        | ➔ | no options are installed, basic unit                            |
| '239-RTD'    | ➔ | RTDs option are installed                                       |
| '239-AN'     | ➔ | Analog Output option are installed                              |
| '239-RTD-AN' | ➔ | RTDs and Analog Output options are installed                    |
| '239-H'      | ➔ | Conformal coating option is installed                           |
| '239-RTD-H'  | ➔ | RTD and conformal coating options are installed                 |
| '239-AN-H'   | ➔ | Analog output and conformal coating options are installed       |
| '239-RTD-AN' | ➔ | Analog output, RTD, and conformal coating options are installed |

- **MOD NUMBER:** If unique features have been installed for special customer orders, the **MOD NUMBER** will be used by factory personnel to identify the matching product records. If an exact replacement model is required, the **MAIN PROGRAM VERSION**, **MOD NUMBER**, and product order code found on the label located on the back of the 239 should be specified with the order.

It is possible for the 239 to have more than one **MOD NUMBER** installed (maximum of 5). In this case the message will display all the **MOD NUMBERS** separated by a comma (i.e. 501, 502, 503).

- **SERIAL NUMBER:** Each 239 shipped from the factory has a unique serial number for identification purposes. The serial number displayed in this message will match the serial number found on the product label located on the back of the 239.
- **HARDWARE REVISION:** This message identifies the internal hardware revision of the 239. The first letter of the 239 serial number must match the hardware revision identified in this message.
- **DATE OF CALIBRATION:** Each 239 is calibrated to exceed the specifications listed in Section 1.2: Specifications on page –8 using custom made test equipment. When all parameters have been calibrated and tested for proper operation the unit is stamped with the calibration date displayed in this message.
- **DATE OF MANUFACTURE:** This is the date the 239 was final tested at GE Multilin.







## 239 Motor Protection Relay

## Chapter 6: User Interface

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### 6.1 EnerVista 239 Setup Interface

#### 6.1.1 Hardware and Software Requirements

The following minimum requirements must be met for the EnerVista 239 Setup software to operate on your computer.

- Pentium class or higher processor (Pentium II 300 MHz or better recommended)
- Microsoft Windows 95, 98, 98SE, ME, NT 4.0 (SP4 or higher), 2000, XP
- 64 MB of RAM (256 MB recommended)
- Minimum of 50 MB hard disk space (200 MB recommended)

If EnerVista 239 Setup is currently installed, note the path and directory name. It may be required during upgrading.

The EnerVista 239 Setup software is included on the GE enerVista CD that accompanied the 239. The software may also be downloaded from the GE Multilin website at <http://www.GEindustrial.com/multilin>.

#### 6.1.2 Installing EnerVista 239 Setup

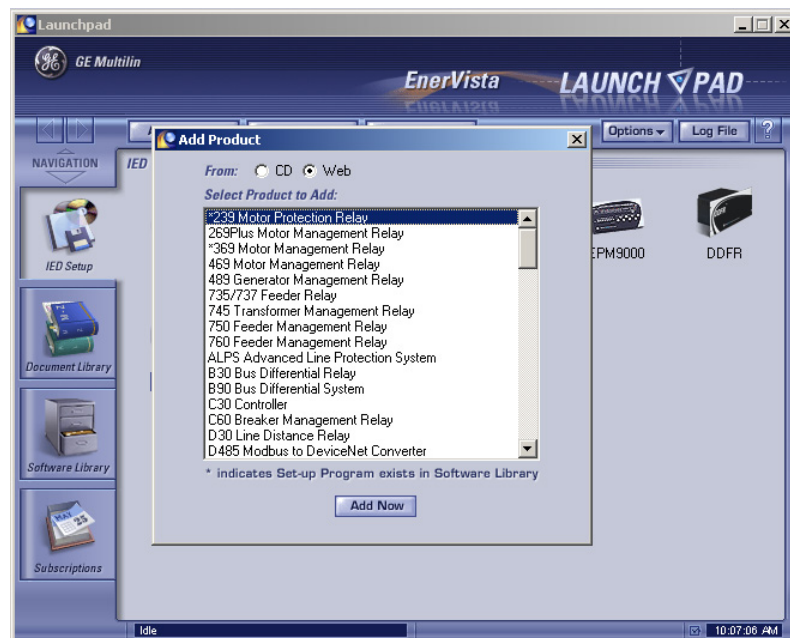
After ensuring these minimum requirements, use the following procedure to install the EnerVista 239 Setup software from the enclosed GE enerVista CD.

- ▷ Insert the GE enerVista CD into your CD-ROM drive.
- ▷ Click the **Install Now** button and follow the installation instructions to install the no-charge enerVista software on the local PC.
- ▷ When installation is complete, start the enerVista Launchpad application.

- ▷ Click the **IED Setup** section of the **Launch Pad** window.



- ▷ In the enerVista LaunchPad window, click the **Add Product** button and select the “239 Motor Protection Relay” as shown below. Select the “Web” option to ensure the most recent software release, or select “CD” if you do not have a web connection, then click the **Add Now** button to list software items for the 239.



EnerVista Launchpad will obtain the installation program from the Web or CD.

- ▷ Once the download is complete, double-click the installation program to install the EnerVista 239 Setup software.

The program will request the user to create a backup 3.5" floppy-disk set.

- ▷ If this is desired, click on the **Start Copying** button; otherwise, click on the **CONTINUE WITH 239 INSTALLATION** button.
- ▷ Select the complete path, including the new directory name, where the EnerVista 239 Setup software will be installed.
- ▷ Click on **Next** to begin the installation.  
The files will be installed in the directory indicated and the installation program will automatically create icons and add EnerVista 239 Setup software to the Windows start menu.

- ▷ Click **Finish** to end the installation.  
The 239 device will be added to the list of installed IEDs in the enerVista Launchpad window, as shown below.



## 6.2 Connecting EnerVista 239 Setup to the Relay

### 6.2.1 Configuring Serial Communications

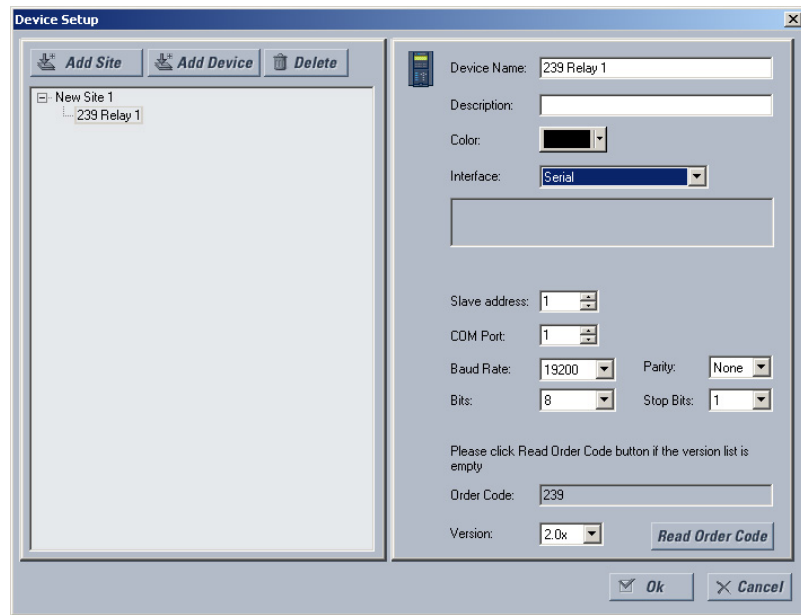
Before starting, verify that the serial cable is properly connected to either the RS232 port on the front panel of the device (for RS232 communications) or to the RS485 terminals on the back of the device (for RS485 communications).

This example demonstrates an RS232 connection. For RS485 communications, the GE Multilin F485 converter will be required. Refer to the F485 manual for additional details. To configure the relay for Ethernet communications, see *Configuring Ethernet Communications* on page 6–73.

- ▷ Install and start the latest version of the EnerVista 239 Setup software (available from the GE enerVista CD).  
See the previous section for the installation procedure.
- ▷ Click on the **Device Setup** button to open the Device Setup window.
- ▷ Click the **Add Site** button to define a new site.
- ▷ Enter the desired site name in the **Site Name** field.  
If desired, a short description of site can also be entered along with the display order of devices defined for the site.
- ▷ Click the **OK** button when complete.

The new site will appear in the upper-left list in the EnerVista 239 Setup window.

- ▷ Click the **Add Device** button to define the new device.
- ▷ Enter the desired name in the **Device Name** field and a description (optional) of the site.
- ▷ Select “Serial” from the Interface drop-down list.  
This will display a number of interface parameters that must be entered for proper RS232 functionality.



- Enter the slave address and COM port values (from the **S1 239 SETUP** ➡ **239 COMMUNICATIONS** menu) in the Slave Address and COM Port fields.
- Enter the physical communications parameters (baud rate and parity settings) in their respective fields.
- Click the **Read Order Code** button to connect to the 239 device and upload the order code.  
If an communications error occurs, ensure that the 239 serial communications values entered in the previous step correspond to the relay setting values.
- Click **OK** when the relay order code has been received.  
The new device will be added to the Site List window (or Online window) located in the top left corner of the main EnerVista 239 Setup window.

The 239 Site Device has now been configured for serial communications. Proceed to *Connecting to the Relay* on page 6-75 to begin communications.

### 6.2.2 Configuring Ethernet Communications

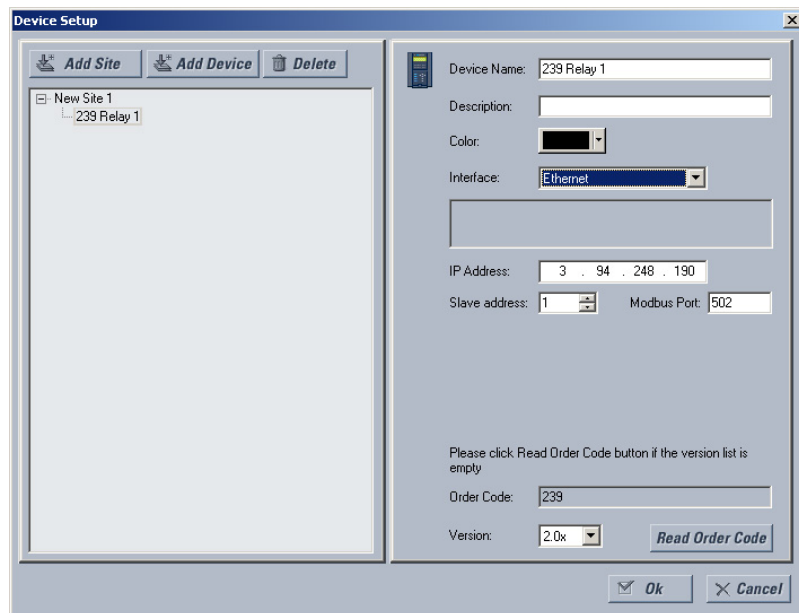
Before starting, verify that the Ethernet cable is properly connected to the MultiNET device, and that the MultiNET has been configured and properly connected to the relay. Refer to the MultiNET manual for additional details on configuring the MultiNET to work with the 239.

- Install and start the latest version of the EnerVista 239 Setup software (available from the GE enerVista CD).  
See the previous section for the installation procedure.
- Click on the **Device Setup** button to open the Device Setup window.

- ▷ Click the **Add Site** button to define a new site.
- ▷ Enter the desired site name in the **Site Name** field.  
If desired, a short description of site can also be entered along with the display order of devices defined for the site. In this example, we will use “Substation 2” as the site name.
- ▷ Click the **OK** button when complete.

The new site will appear in the upper-left list in the EnerVista 239 Setup window.

- ▷ Click the **Add Device** button to define the new device.
- ▷ Enter the desired name in the **Device Name** field and a description (optional) of the site.
- ▷ Select **Ethernet** from the Interface drop-down list.  
This will display a number of interface parameters that must be entered for proper Ethernet functionality.



- ▷ Enter the IP address assigned to the MultiNET adapter.
- ▷ Enter the slave address and Modbus port values (from the **S1 239 SETUP** ⇒ **239 COMMUNICATIONS** menu) in the Slave Address and Modbus Port fields.
- ▷ Click the **Read Order Code** button to connect to the 239 device and upload the order code.  
If an communications error occurs, ensure that the 239 Ethernet communications values entered in the previous step correspond to the relay and MultiNET setting values.
- ▷ Click **OK** when the relay order code has been received.  
The new device will be added to the Site List window (or Online window) located in the top left corner of the main EnerVista 239 Setup window.

The 239 Site Device has now been configured for Ethernet communications. Proceed to the following section to begin communications.

### 6.2.3 Connecting to the Relay

Now that the communications parameters have been properly configured, the user can easily connect to the relay.

- ▷ Expand the Site list by double clicking on the site name or clicking on the «+» box to list the available devices for the given site (for example, in the “Substation 1” site shown below).
- ▷ Desired device trees can be expanded by clicking the «+» box. The following list of headers is shown for each device:
  - Device Definitions
  - Settings
  - Actual Values
  - Communications
- ▷ Expand the **Settings > Relay Setup** list item and double click on Front Panel to open the Front Panel settings window as shown below:

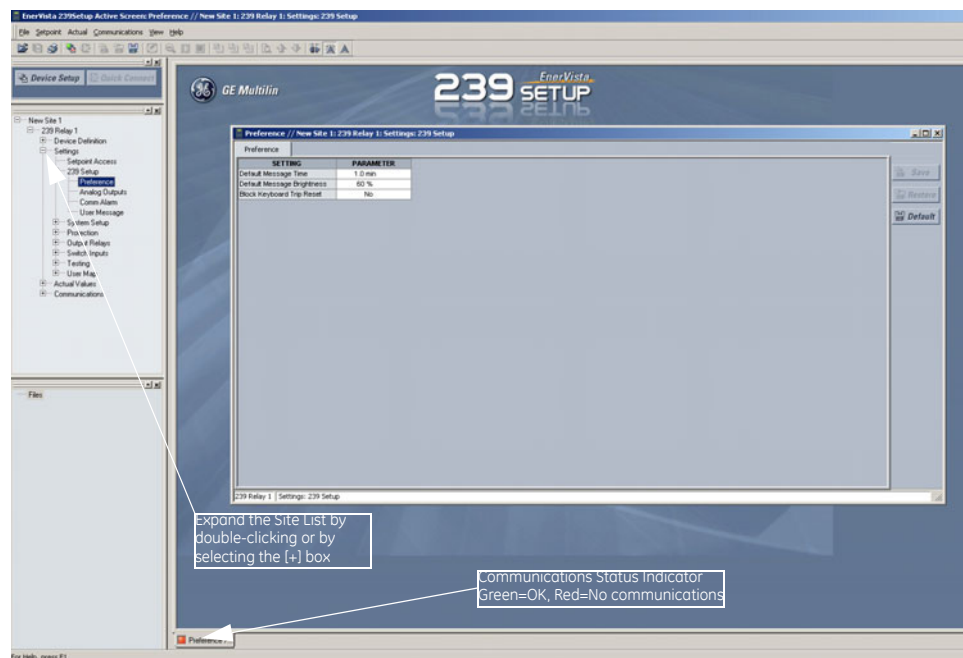


FIGURE 6–1: Main Window After Connection

The Front Panel settings window will open with a corresponding status indicator on the lower left of the EnerVista 239 Setup window.

- ▷ If the status indicator is red, verify that the serial or Ethernet cable is properly connected to the relay, and that the relay has been properly configured for communications (steps described earlier).

The Front Panel settings can now be edited, printed, or changed according to user specifications. Other setpoint and commands windows can be displayed and edited in a similar manner. Actual values windows are also available for display. These windows can be locked, arranged, and resized at will.



**Refer to the EnerVista 239 Setup Help File for additional information about the using the software.**



## 6.3 Working with Setpoints and Setpoint Files

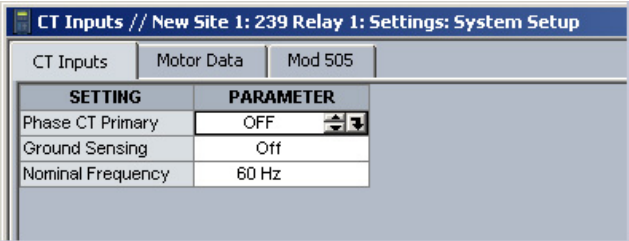
### 6.3.1 Engaging a Device

The EnerVista 239 Setup software may be used in on-line mode (relay connected) to directly communicate with a 239 relay. Communicating relays are organized and grouped by communication interfaces and into sites. Sites may contain any number of relays selected from the SR or UR product series.

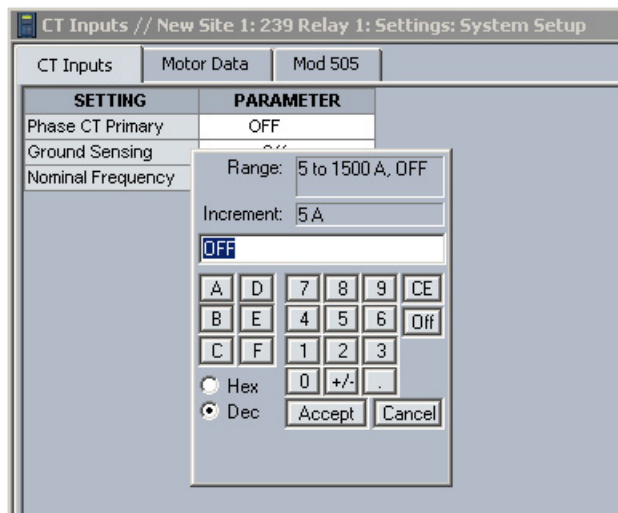
### 6.3.2 Entering Setpoints

The System Setup page will be used as an example to illustrate the entering of setpoints. In this example, we will be changing the current sensing setpoints.

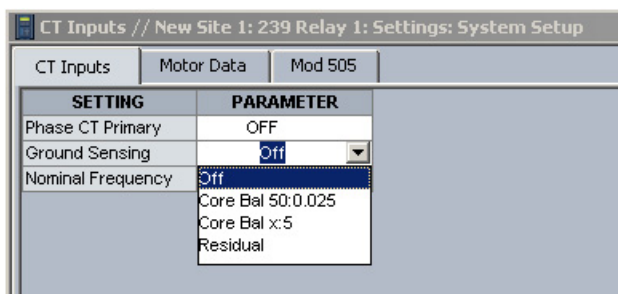
- ▷ Establish communications with the relay.
- ▷ Select the **Setpoint > S2 System Setup > CT/VT Setup** menu item. This can be selected from the device setpoint tree or the main window menu bar.
- ▷ Select the **PHASE CT PRIMARY** setpoint by clicking anywhere in the parameter box. This will display three arrows: two to increment/decrement the value and another to launch the numerical calculator.



- Clicking the arrow at the end of the box displays a numerical keypad interface that allows the user to enter a value within the setpoint range displayed near the top of the keypad:



- Click **Accept** to exit from the keypad and keep the new value.
- Click on **Cancel** to exit from the keypad and retain the old value.
- For setpoints requiring non-numerical pre-set values (e.g. **GROUND CT TYPE** above), clicking anywhere within the setpoint value box displays a drop-down selection menu arrow. Select the desired value from this list.



- For setpoints requiring an alphanumeric text string (e.g. message scratchpad messages), the value may be entered directly within the setpoint value box.
- Click on **Save** to save the values into the 239.
- Click **OK** to accept any changes and exit the window.
- Otherwise, click **Restore** to retain previous values and exit.

### 6.3.3 File Support

Opening any EnerVista 239 Setup file will automatically launch the application or provide focus to the already opened application. If the file is a settings file (has a '239' extension) which had been removed from the Settings List tree menu, it will be added back to the Settings List tree.

New files will be automatically added to the tree, which is sorted alphabetically with respect to settings file names.

### 6.3.4 Using Setpoints Files

#### Overview

The EnerVista 239 Setup software interface supports three ways of handling changes to relay settings:

- In *off-line* mode (relay disconnected) to create or edit relay settings files for later download to communicating relays.
- Directly modifying relay settings while *connected* to a communicating relay, then saving the settings when complete.
- Creating/editing settings files while *connected* to a communicating relay, then saving them to the relay when complete.

Settings files are organized on the basis of file names assigned by the user. A settings file contains data pertaining to the following categories of relay settings:

- Device Definition
- Product Setup
- System Setup
- Grouped Elements
- Control Elements
- Inputs/Outputs
- Testing

Factory default values are supplied and can be restored after any changes.

The EnerVista 239 Setup software displays relay setpoints with the same hierarchy as the front panel display. For specific details on setpoints, refer to Chapter 5.

#### Downloading and Saving Setpoints Files

Setpoints must be saved to a file on the local PC before performing any firmware upgrades. Saving setpoints is also highly recommended before making any setpoint changes or creating new setpoint files.

The EnerVista 239 Setup window, setpoint files are accessed in the Settings List control bar window or the Files Window. Use the following procedure to download and save setpoint files to a local PC.

- ▷ Ensure that the site and corresponding device(s) have been properly defined and configured as shown in *Connecting EnerVista 239 Setup to the Relay* on page 6–72.

- ▷ Select the desired device from the site list.
- ▷ Select the **File > Read Settings from Device** menu item to obtain settings information from the device.

After a few seconds of data retrieval, the software will request the name and destination path of the setpoint file. The corresponding file extension will be automatically assigned.

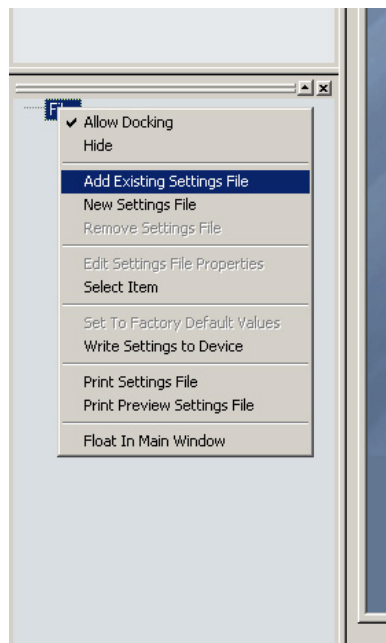
- ▷ Press **Save** to complete the process.  
A new entry will be added to the tree, in the File pane, showing path and file name for the setpoint file.

### Adding Setpoints Files to the Environment

The EnerVista 239 Setup software provides the capability to review and manage a large group of setpoint files. Use the following procedure to add a new or existing file to the list.

- ▷ In the files pane, right-click on 'Files'.
- ▷ Select the **Add Existing Setting File** item as shown

:



The Open dialog box will appear, prompting the user to select a previously saved setpoint file.

- ▷ As for any other Microsoft Windows<sup>®</sup> application, browse for the file to be added then
- ▷ Click **Open**.  
The new file and complete path will be added to the file list.

## Creating a New Settings File

The EnerVista 239 Setup software allows the user to create new Settings files independent of a connected device. These can be uploaded to a relay at a later date. The following manual procedure illustrates how to create new Settings Files.

- ▷ In the File pane, right click on **File**.
- ▷ Select the **New Settings File** item.  
The EnerVista 239 Setup software displays the following window, allowing the configuration of the Settings File as shown below.



NOTE

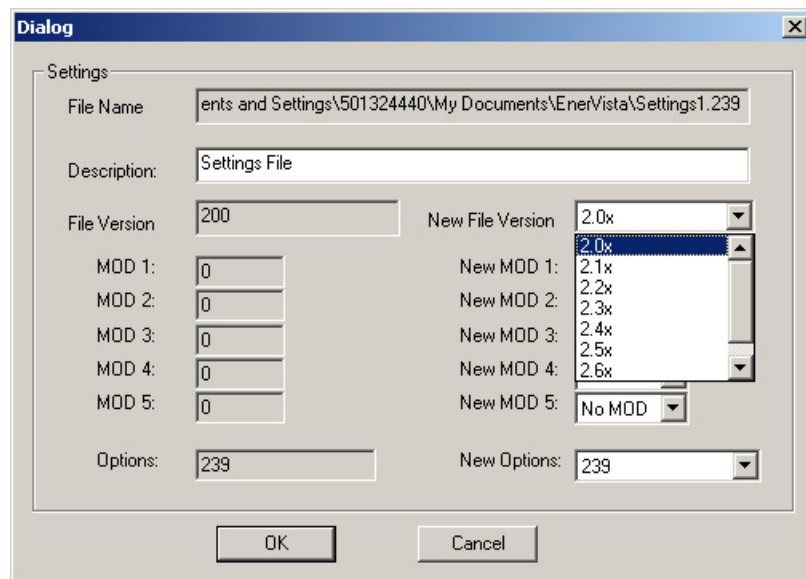
It is important to define the correct firmware version to ensure that settings not available in a particular version are not downloaded into the relay

- ▷ Select the file name and path to store the file, or select any displayed file name to update an existing file.  
To select the file name and path for the new file, click the button beside the **File Name** box [...].  
All 239 Settings Files should have the extension '239' (for example, 'motor1.239').
- ▷ Select the Firmware **Version** for the new Settings File.
- ▷ For future reference, enter some useful information in the **Description** box to facilitate the identification of the device and the purpose of the file.
- ▷ Select the appropriate **Options** for your new Settings File.
- ▷ Select the appropriate **MOD(s)** for your new Settings File.
- ▷ Click **OK** to complete the process.  
Once this step is completed, the new file, with a complete path, will be added to the EnerVista 239 Setup software environment.

## Upgrading Setpoint Files to a New Revision

It is often necessary to upgrade the revision code for a previously saved setpoint file after the 239 firmware has been upgraded (for example, this is required for firmware upgrades). This is illustrated in the following procedure.

- ▷ Establish communications with the 239.
- ▷ Select the **Actual Values > Product Information > Product Information** menu item and record the Software Revision identifier of the relay firmware.
- ▷ Load the setpoint file to be upgraded into the EnerVista 239 Setup environment as described in *Adding Setpoints Files to the Environment* on page 6–80.
- ▷ In the **Files** pane, select the saved setpoint file.
- ▷ From the main window menu bar, select the **File > Properties** menu item.
- ▷ Note the **File Version** of the setpoint file.  
If this version is different from the Software Revision code noted in step 2, select a **New File Version** that matches the Software Revision code from the pull-down menu.

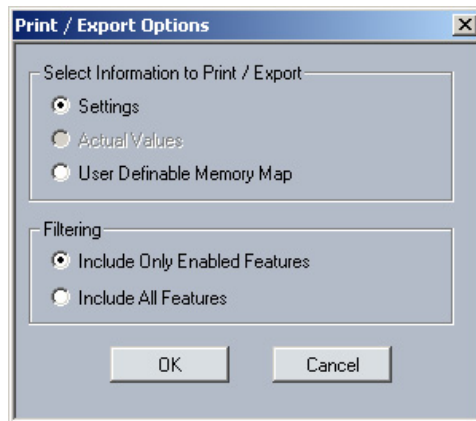


- ▷ When complete, click **Convert** (which will appear) to convert the setpoint file to the desired revision.  
A dialog box will request confirmation. See *Loading Setpoints from a File* on page 6–84 for instructions on loading this setpoint file into the 239.

## Printing Setpoints and Actual Values

The EnerVista 239 Setup software allows the user to print partial or complete lists of setpoints and actual values. Use the following procedure to print a list of setpoints:

- ▷ Select a previously saved setpoints file in the File pane or establish communications with a 239 device.
- ▷ From the main window, select the **File > Print Settings** menu item. The Print/Export Options dialog box will appear.
- ▷ Select **Settings** in the upper section.
- ▷ Select either **Include All Features** (for a complete list) or **Include Only Enabled Features** (for a list of only those features which are currently used) in the filtering section.
- ▷ Click **OK**.



The process for **File > Print Preview Settings** is identical to the steps above.

Setpoints lists can be printed in the same manner by right clicking on the desired file (in the file list) or device (in the device list) and selecting the **Print Device Information** or **Print Settings File** options.

A complete list of actual values can also be printed from a connected device with the following procedure:

- ▷ Establish communications with the desired 239 device.
- ▷ From the main window, select the **File > Print Settings** menu item. The **Print/Export Options** dialog box will appear.
- ▷ Select **Actual Values** in the upper section.
- ▷ Select either **Include All Features** (for a complete list) or **Include Only Enabled Features** (for a list of only those features which are currently used) in the filtering section.
- ▷ Click **OK**.
- ▷ Actual values lists can be printed in the same manner by right clicking on the desired device (in the device list) and selecting the **Print Device Information** option.

## Loading Setpoints from a File



An error message will occur when attempting to download a setpoint file with a revision number that does not match the relay firmware. If the firmware has been upgraded since saving the setpoint file, see *Upgrading Setpoint Files to a New Revision* on page 6–82 for instructions on changing the revision number of a setpoint file.

The following procedure illustrates how to load setpoints from a file. Before loading a setpoints file, it must first be added to the EnerVista 239 Setup environment as described in *Adding Setpoints Files to the Environment* on page 6–80.

- ▷ Select the previously saved setpoints file from the File pane of the EnerVista 239 Setup software main window.
- ▷ Select the **File > Properties** menu item and verify that the corresponding file is fully compatible with the hardware and firmware version of the target relay.  
If the versions are not identical, see *Upgrading Setpoint Files to a New Revision* on page 6–82 for details on changing the setpoints file version.
- ▷ Right-click on the selected file.
- ▷ Select the **Write Settings to Device** item.
- ▷ Select the target relay from the list of devices shown.
- ▷ Click **Send**.  
If there is an incompatibility, an error will occur: If there are no incompatibilities between the target device and the settings file, the data will be transferred to the relay. An indication of the percentage completed will be shown in the bottom of the main window.



## 6.4 Upgrading Relay Firmware

### 6.4.1 Description

To upgrade the 239 firmware, follow the procedures listed in this section. Upon successful completion of this procedure, the 239 will have new firmware installed with the original setpoints.

The latest firmware files are available from the GE Multilin website at <http://www.GEindustrial.com/multilin>.

### 6.4.2 Saving Setpoints to a File

Before upgrading firmware, it is very important to save the current 239 settings to a file on your PC. After the firmware has been upgraded, it will be necessary to load this file back into the 239.

Refer to *Downloading and Saving Setpoints Files* on page 6–79 for details on saving relay setpoints to a file.

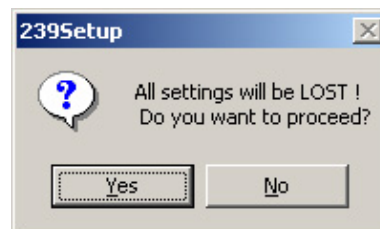
### 6.4.3 Loading New Firmware

Loading new firmware into the 239 flash memory is accomplished as follows:

- ▷ Connect the relay to the local PC and save the setpoints to a file as shown in *Downloading and Saving Setpoints Files* on page 6–79.
- ▷ Select the **Communications > Update Firmware** menu item. The following warning message will appear: Select **Yes** to proceed or **No** to cancel the process.

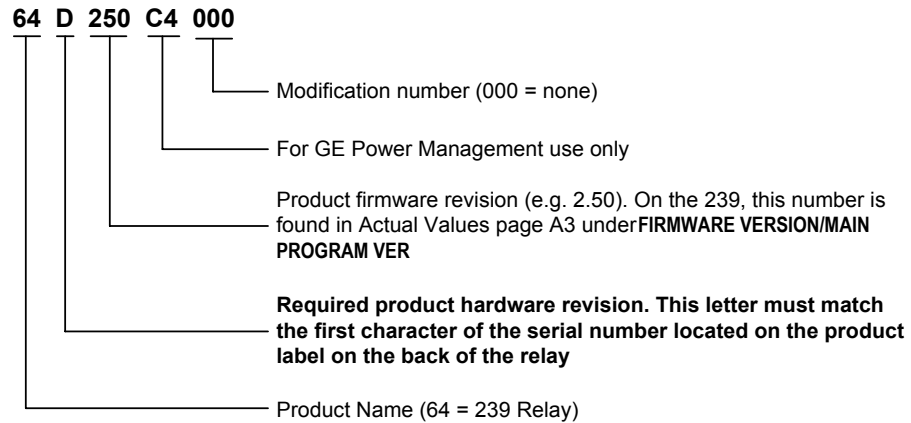


***Do NOT proceed unless you have saved the current setpoints***



The EnerVista 239 Setup software will request the new firmware file.

- ▷ Locate the firmware file to load into the 239.  
The firmware filename has the following format:



The EnerVista 239 Setup software automatically lists all filenames beginning with '64'.

- ▷ Select the appropriate file.
- ▷ Click **OK** to continue.

The software will prompt with another Upload Firmware Warning window. This will be the final chance to cancel the firmware upgrade before the flash memory is erased.

- ▷ Click **Yes** to continue or **No** to cancel the upgrade.

The EnerVista 239 Setup software now prepares the 239 to receive the new firmware file. The 239 will display a message indicating that it is in Upload Mode. While the file is being loaded into the 239, a status box appears indicating how much of the new firmware file has been transferred and how much is remaining, as well as the upgrade status. The entire transfer process takes approximately five minutes.

The EnerVista 239 Setup software will notify the user when the 239 has finished loading the file.

- ▷ Carefully read any displayed messages.
- ▷ Click **OK** to return the main screen.



Cycling power to the relay is highly recommended after a firmware upgrade.

#### 6.4.4 Upgrading and Loading Settings Files



If the relay is not communicating with the EnerVista 239 Setup program, check your communication settings by (a) checking the slave address and baud rate on the relay, or (b) clicking on the **Device Setup** button on the main Enervista 239 screen and viewing the communications parameters. Make sure that the Device Setup screen shows the new firmware level. If not, click the **Read Order Code** button.

- ▷ Convert your settings file(s) to the new firmware version.  
To view the procedure to convert (upgrade) a settings file to the new firmware version, refer to the section: *Upgrading Setpoint Files to a New Revision*, shown above.
- ▷ Load the converted settings file(s) into the relay.  
To view the procedure to load setpoints from a settings file to the relay, refer to the section: *Loading Setpoints from a File*, shown above.

## 6.5 Advanced EnerVista 239 Setup Features

### 6.5.1 Trending

Trending from the 239 is accomplished via EnerVista 239 Setup. Many different parameters can be trended and graphed at sampling periods from 1 second up to 1 hour. The parameters which can be trended by EnerVista 239 Setup are:

- Currents: phase currents A/B/C; motor load (% FLC); current unbalance (%); ground current
- Thermal capacity used (%).

To use the Trending function,

- ▷ Run the EnerVista 239 Setup software and establish communications with a connected 239 unit.
- ▷ Select the **Actual Values > Trending > Trending** menu item to open the Trending window.

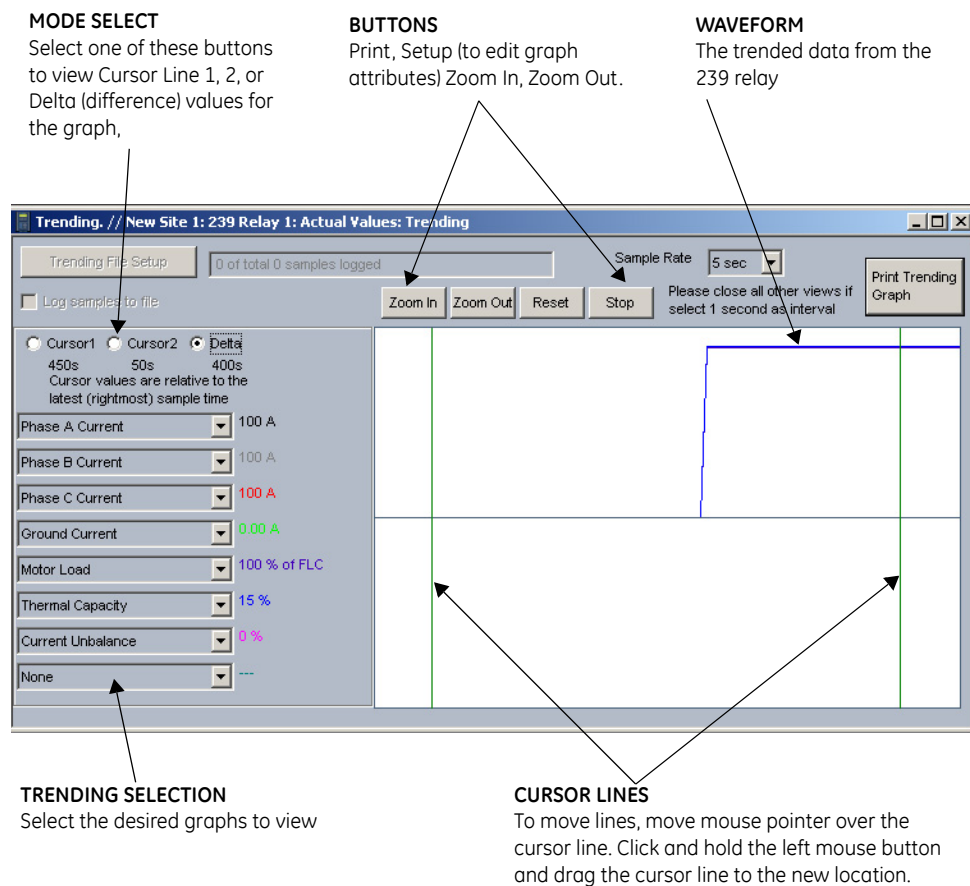


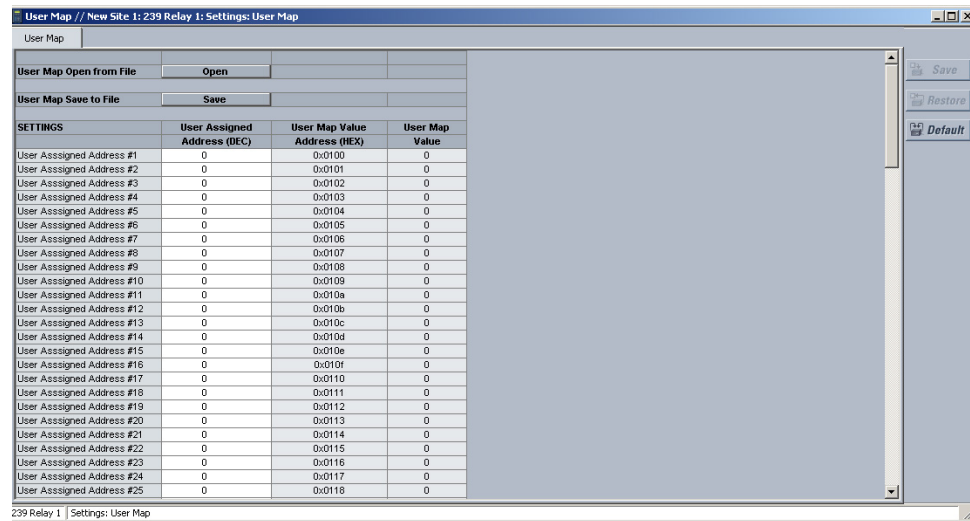
FIGURE 6–2: Trending View

- ▷ Program the parameters to display by selecting them from the pull down menus.
- ▷ Select the **Sample Rate**.
- ▷ Select **RUN** to begin the trending sampling.  
The trended values can be printed using **Print Trending Graph** button.  
The Trending File Setup button can be used to write the graph data to a file in a standard spreadsheet format.
- ▷ Ensure that the **Write Trended Data to File** box is checked, and that the **Sample Rate** is at a minimum of 5 seconds.
- ▷ Set the file capacity limit to the amount of memory available for trended data.

### 6.5.2 Modbus User Map

The EnerVista 239 Setup software provides a means to program the 239 User Map (Modbus addresses 0180h to 01F7h). Refer to *User Definable Memory Map Area* on page 9–293 for additional information on the User Map.

- ▷ Select a connected device in EnerVista 239 Setup.
- ▷ Select the **Setpoint > User Map > User Map** menu item to open the following window.



The above window allows the desired addresses to be written to User Map locations. The User Map values that correspond to these addresses are then displayed.

### 6.5.3 Viewing Actual Values

You can view real-time relay data such as input/output status and measured parameters. From the main window menu bar, selecting Actual Values opens a window with tabs, each tab containing data in accordance to the following list:

- **Motor Status:** Motor Statistics, Last Trip, Alarm Status
- **Metering Data:** Currents, Motor Capacity, Temperature
- **Trending** (see section 6.5.1 above)
- **Product Information:** Revision Codes and Calibration Dates
- **Front Panel:** HMI Display

Selecting an actual values window also opens the actual values tree from the corresponding device in the site list and highlights the current location in the hierarchy.

For complete details on actual values, refer to Chapter 6.

- ▷ To view a separate window for each group of actual values, select the desired item from the tree.

- ▷ Double click with the left mouse button.  
Each group will be opened on a separate tab. The windows can be rearranged to maximize data viewing as shown in the following figure (showing actual current, voltage, and power values tiled in the same window):

## 6.6 Using EnerVista Viewpoint with the 239

### 6.6.1 Plug and Play Example

EnerVista Viewpoint is an optional software package that puts critical 239 information onto any PC with plug-and-play simplicity. EnerVista Viewpoint connects instantly to the 239 via serial, ethernet or modem and automatically generates detailed overview, metering, power, demand, energy and analysis screens. Installing EnerVista Launchpad (see previous section) allows the user to install a fifteen-day trial version of enerVista Viewpoint. After the fifteen day trial period you will need to purchase a license to continue using enerVista Viewpoint. Information on license pricing can be found at <http://www.enerVista.com>.

- ▷ Install the EnerVista Viewpoint software from the GE enerVista CD.
- ▷ Ensure that the 239 device has been properly configured for either serial or Ethernet communications (see previous sections for details).
- ▷ Click the **Viewpoint** window in EnerVista to log into EnerVista Viewpoint.  
At this point, you will be required to provide a login and password if you have not already done so.



FIGURE 6-3: enerVista Viewpoint Main Window

- ▷ Click the **Device Setup** button to open the Device Setup window.
- ▷ Click the **Add Site** button to define a new site.
- ▷ Enter the desired site name in the **Site Name** field.  
If desired, a short description of site can also be entered along with the display order of devices defined for the site.



- ▷ Click the **OK** button when complete.  
The new site will appear in the upper-left list in the EnerVista 239 Setup window.
- ▷ Click the **Add Device** button to define the new device.
- ▷ Enter the desired name in the **Device Name** field and a description (optional) of the site.
- ▷ Select the appropriate communications interface (Ethernet or Serial) and fill in the required information for the 239.  
See *Connecting EnerVista 239 Setup to the Relay* on page 6–72 for details.

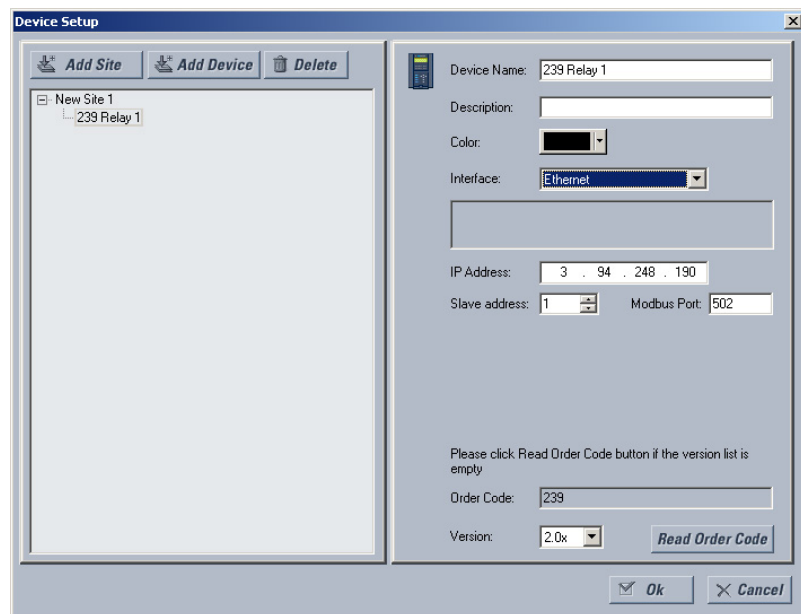


FIGURE 6–4: Device Setup Screen (Example)

- ▷ Click the **Read Order Code** button to connect to the 239 device and upload the order code.  
If a communications error occurs, ensure that communications values entered in the previous step correspond to the relay setting values.
- ▷ Click **OK** when complete.
- ▷ From the EnerVista main window, select the **IED Dashboard** item to open the Plug and Play IED dashboard.  
An icon for the 239 will be shown.

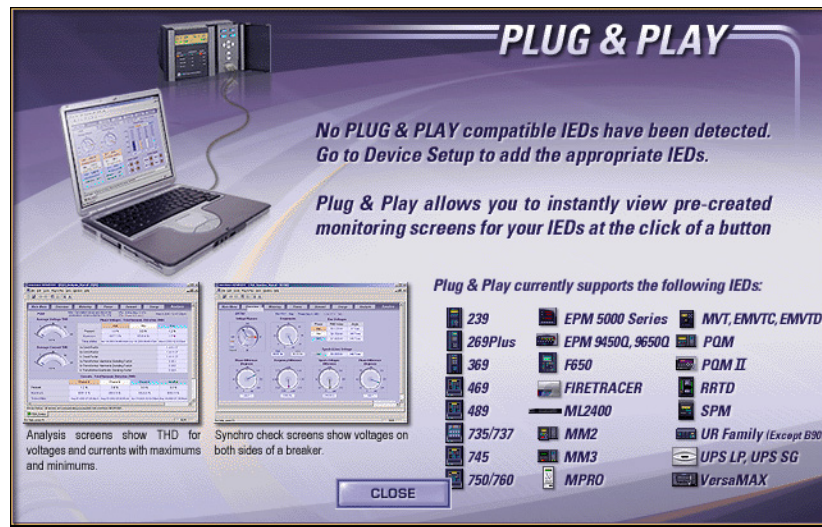


FIGURE 6-5: 'Plug and Play' Dashboard

- Click the **Dashboard** button below the 239 icon to view the device information.

We have now successfully accessed our 239 through EnerVista Viewpoint.



FIGURE 6-6: EnerVista 239 Plug and Play Screen (Example)

For additional information on EnerVista viewpoint, please visit the EnerVista website at <http://www.EnerVista.com>.



## 239 Motor Protection Relay

### Chapter 7: Testing

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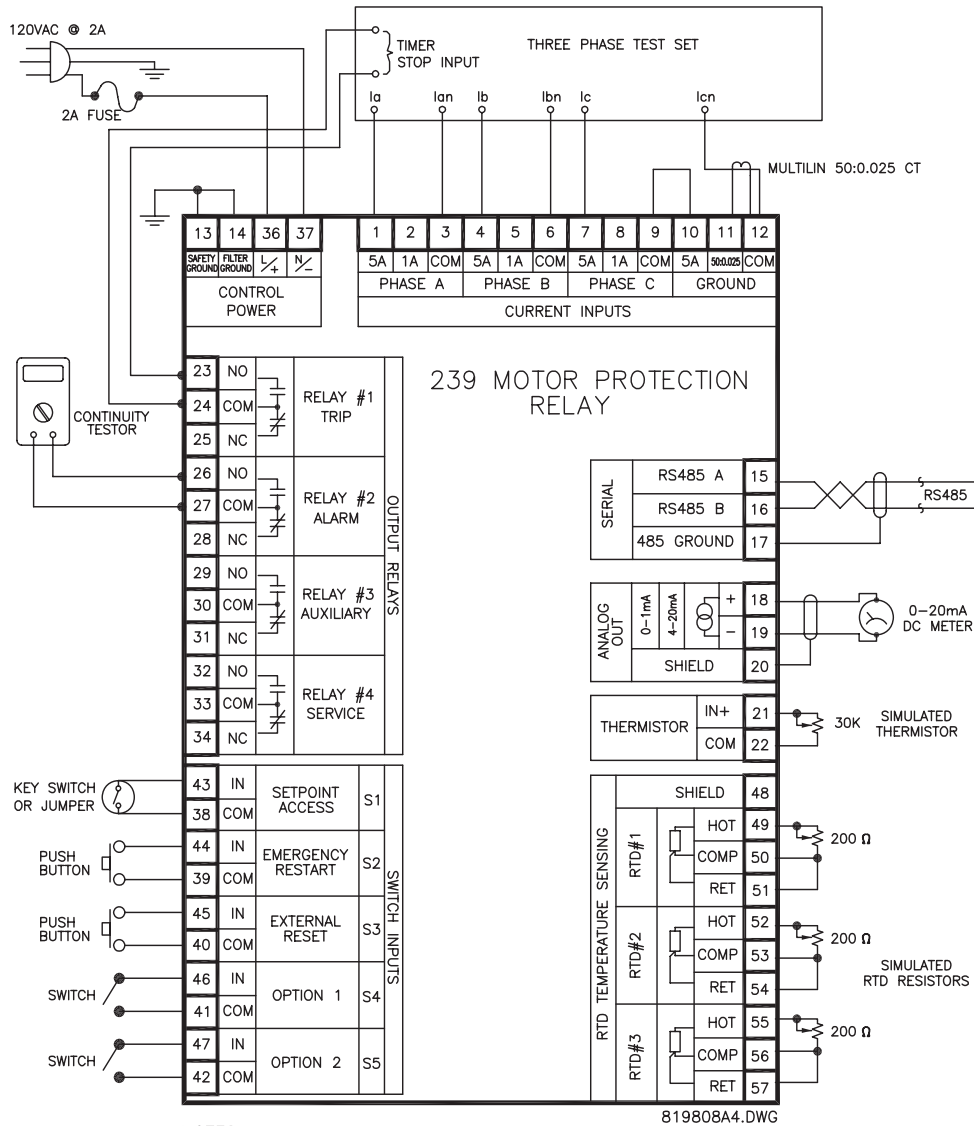
#### 7.1 Testing

##### 7.1.1 Primary Injection Testing

Prior to relay commissioning at installation, complete system operation can be verified by injecting current through the phase and ground CTs. To accomplish this, a primary high current injection test set is required. Operation of the entire relay system, except the phase and ground CTs, can be checked by applying input signals to the 239 from a secondary injection test set as described in the following sections.

## 7.2 Secondary Injection Testing

Setup the secondary injection test as shown in the figure below to perform the 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 will verify correct firmware/hardware interaction.



### NOTES:

- 1) RELAY CONTACT STATE SHOWN WITH CONTROL POWER NOT APPLIED
- 2) RTD TEMPERATURE SENSING AND ANALOG OUTPUT ARE OPTIONAL

**FIGURE 7-1: SECONDARY INJECTION TEST SETUP**

## 7.3 Phase Current Accuracy

Any phase current protection is based on the ability of the 239 to read phase input currents accurately to  $\pm 2\%$  of full scale. Perform the steps below to test the phase current accuracy.

1. Alter the following setpoint.

**S2: SYSTEM SETUP\CT INPUTS\PHASE CT PRIMARY: 100A**

2. To determine if the relay is reading the proper input current values, inject phase currents shown in the table below, view the readings in **A2: METERING\CURRENT**, and verify with the expected readings stated in the table.

**Table 7-1: Phase Current Accuracy Test, 5 A Input**

| INJECTED CURRENT | EXPECTED READING IN EACH PHASE † | ACTUAL PHASE A READING (A) | ACTUAL PHASE B READING (A) | ACTUAL PHASE C READING (A) |
|------------------|----------------------------------|----------------------------|----------------------------|----------------------------|
| 0.5 A            | 10 A                             |                            |                            |                            |
| 1.0 A            | 20 A                             |                            |                            |                            |
| 3.5 A            | 70 A                             |                            |                            |                            |
| 5.0 A            | 100 A                            |                            |                            |                            |
| 10.0 A           | 200 A                            |                            |                            |                            |

$$\dagger \text{ displayed current} = \text{injected current} \times \left( \frac{\text{PHASE CT PRIMARY}}{5 \text{ A}} \right)$$

3. Alter the setup to inject current into the 1 A input of each phase and repeat the above step with current settings shown in the table below.

**Table 7-2: Phase Current Accuracy Test, 1 A Input**

| INJECTED CURRENT | EXPECTED READING IN EACH PHASE † | ACTUAL PHASE A READING (A) | ACTUAL PHASE B READING (A) | ACTUAL PHASE C READING (A) |
|------------------|----------------------------------|----------------------------|----------------------------|----------------------------|
| 0.1 A            | 10 A                             |                            |                            |                            |
| 0.3 A            | 30 A                             |                            |                            |                            |
| 0.6 A            | 60 A                             |                            |                            |                            |
| 1.0 A            | 100 A                            |                            |                            |                            |
| 2.0 A            | 200 A                            |                            |                            |                            |

$$\dagger \text{ displayed current} = \text{injected current} \times \text{PHASE CT PRIMARY}$$

## 7.4 Phase Current Overload

1. Alter the following setpoints:  
**S4: PROTECTION\PHASE CURRENT\OVERLOAD\OVERLOAD CURVE NUMBER: 4**  
**S2: SYSTEM SETUP\CT INPUTS\PHASE CT PRIMARY: 100A**  
**S2: SYSTEM SETUP\MOTOR DATA\MOTOR FULL LOAD CURRENT: 50A**  
**S5: TESTING\TEST CONFIGURATION\DISABLE START PROTECTION: YES**
2. Before beginning this test it is necessary to ensure that the thermal capacity value in **A2: METERING\MOTOR CAPACITY** is 0% to obtain a proper trip time. If required reset this value to 0% by shorting together the Emergency Restart switch terminals (39, 44) momentarily. The Emergency Restart input will not function if any phase or ground current is injected.
3. Inject a current of 10 A into all three phases. The relay will display a current value of:

$$\text{Displayed current} = \text{actual injected current} \times \frac{\text{PHASE CT PRIMARY}}{5 \text{ A}} = 10 \text{ A} \times \frac{100 \text{ A}}{5 \text{ A}} = 200 \text{ A}$$

This represents four times **S2: SYSTEM SETUP\MOTOR DATA\MOTOR FULL LOAD CURRENT** setpoint. Therefore, based on a 400% overload and curve #4, the trip relay should activate after a time of 23.3 seconds after the overload is first applied.

4. After the overload trip has occurred, verify by viewing **A2: METERING\MOTOR CAPACITY** that the thermal capacity used is 98% to 100%. The thermal capacity value will start decreasing as soon as the overload condition is removed and therefore may vary depending upon how quickly after the overload trip the **A2: METERING\MOTOR CAPACITY** message is viewed. After viewing **A2: METERING\MOTOR CAPACITY**, momentarily short the Emergency Restart terminals and press the reset key to reset the unit.

## 7.5 Phase Unbalance Alarm

- Alter the following setpoints:  
**S4: PROTECTION\PHASE CURRENT\UNBALANCE\PHASE UNBALANCE ALARM: ON**  
**S4: PROTECTION\PHASE CURRENT\UNBALANCE\PHASE UNBALANCE TRIP: OFF**  
**S4: PROTECTION\PHASE CURRENT\UNBALANCE\PHASE UNBALANCE ALARM PICKUP: 20%**  
**S4: PROTECTION\PHASE CURRENT\UNBALANCE\PHASE UNBALANCE DELAY: 0 SEC**
- Inject three-phase current at the FLA level into all three phases. While viewing **A2: METERING\CURRENT\CURRENT UNBALANCE U/B**, slowly decrease the current in one of the phases until the UNBALANCE ALARM message comes on. Please note that the unbalance feature will not operate if the load is  $\leq 30\%$  FLC. In the table below, record the injected current level at the point when the unbalance alarm occurred. Use the formulae shown below to calculate percent unbalance using the currents recorded in the table. Compare the calculated value to the displayed value on **A2: METERING\CURRENT\CURRENT UNBALANCE U/B** and ensure they are match.

Table 7-3: Phase Unbalance Alarm Test

| ACTUAL DISPLAY READING (A) |         |         | PHASE UNBALANCE |           |
|----------------------------|---------|---------|-----------------|-----------|
| PHASE A                    | PHASE B | PHASE C | CALCULATED      | DISPLAYED |
|                            |         |         |                 |           |

- Unbalance is calculated as follows:

For average currents ( $I_{av}$ ) greater than or equal to the motor full load current ( $I_{FLC}$ ):

$$\%UB = \left( \frac{|I_m - I_{av}|}{I_{av}} \right) \times 100\% \quad \text{for } I_{av} \geq I_{FLC}$$

For average currents less than motor full load current:

$$\%UB = \left( \frac{|I_m - I_{av}|}{I_{FLC}} \right) \times 100\% \quad \text{for } I_{av} < I_{FLC}$$

where:

$$I_{av} = \frac{I_a + I_b + I_c}{3} = \text{average of three phase currents}$$

$I_m$  = RMS current in any phase with maximum deviation from the average current ( $I_{av}$ )

$I_{FLC}$  = motor full load current

$I_a$  = phase A current

$I_b$  = phase B current

$I_c$  = phase C current

**EXAMPLE: CALCULATING THE PERCENT OF UNBALANCE**

Find the percent unbalance given the following information:

| PRIMARY               | SECONDARY (5A) |
|-----------------------|----------------|
| $I_a = 73 \text{ A}$  | 3.65 A         |
| $I_b = 100 \text{ A}$ | 5 A            |
| $I_c = 100 \text{ A}$ | 5 A            |

The average of the three phase currents is:

$$I_{av} = \frac{I_a + I_b + I_c}{3} = \frac{73 + 100 + 100}{3} \text{ A} = \frac{273}{3} \text{ A} = 91 \text{ A}$$

Now, since  $I_{av} < I_{FLC}$ , we have percent unbalance given by:

$$\%UB = \left( \frac{|I_m - I_{av}|}{I_{FLC}} \right) \times 100\% = \left( \frac{|73 - 91|}{100} \right) \times 100\% = 18\%$$

Therefore, the percent unbalance in this case is 18%.



## 7.6 Ground Current Accuracy

- Alter the following setpoints:  
**S2: SYSTEM SETUP\CT INPUTS\GROUND SENSING: X:5**  
**S2: SYSTEM SETUP\CT INPUTS\GROUND CT PRIMARY: 100**  
**S4: PROTECTION\GROUND CURRENT\GROUND TRIP: OFF**  
**S4: PROTECTION\GROUND CURRENT\GROUND ALARM: OFF**
- To determine if the relay is reading the proper ground current, inject various ground currents shown in the table below into the 5A ground input and view the readings in **A2: METERING\CURRENT\GROUND CURRENT** and verify with the expected readings stated in the table.

Table 7–4: Ground Current Accuracy Test

| INJECTED CURRENT | EXPECTED GROUND CURRENT READING † | ACTUAL GROUND CURRENT READING |
|------------------|-----------------------------------|-------------------------------|
| 0.5              | 10                                |                               |
| 1.0              | 20                                |                               |
| 3.5              | 70                                |                               |
| 5.0              | 100                               |                               |
| 6.0              | 120                               |                               |

$$\dagger \text{ displayed current} = \text{injected current} \times \left( \frac{\text{PHASE CT PRIMARY}}{5 \text{ A}} \right)$$

### 7.6.1 50:0.025 Ground Accuracy Test

- Alter the following setpoint:  
**S2: SYSTEM SETUP\CT INPUTS\GROUND SENSING: CORE BAL 50:0.025**
- Inject the values shown below as primary values into a GE Multilin 50:0.025 Core Balance CT. View the readings in **A2: METERING\CURRENT\GROUND CURRENT** and verify with the expected readings shown in the following table.

Table 7–5: 50:0.025 Ground Current Accuracy Test

| INJECTED PRIMARY CURRENT | EXPECTED GROUND CURRENT READING | ACTUAL GROUND CURRENT READING |
|--------------------------|---------------------------------|-------------------------------|
| 0.25 A                   | 0.25 A                          |                               |
| 1 A                      | 1.00 A                          |                               |
| 10 A                     | 10.00 A                         |                               |
| 25 A                     | 25.00 A                         |                               |

### 7.6.2 Ground Alarm And Trip

1. Alter the following setpoints:  
**S2: SYSTEM SETUP\CT INPUTS\GROUND SENSING: *RESIDUAL***  
**S2: SYSTEM SETUP\CT INPUTS\PHASE CT PRIMARY: *100***  
**S4: PROTECTION\GROUND CURRENT\GROUND TRIP: *TRIP***  
**S4: PROTECTION\GROUND CURRENT\GROUND PRIMARY TRIP PICKUP: *80%***  
**S4: PROTECTION\GROUND CURRENT\GROUND ALARM: *MOMENTARY***  
**S4: PROTECTION\GROUND CURRENT\GROUND PRIMARY ALARM PICKUP: *40%***
2. While viewing **A2: METERING\CURRENT\GROUND CURRENT**, begin injecting current into the 5A ground input. The ALARM LED will become lit and the alarm relay will change state at one half the trip setting; i.e. at a displayed Ground Fault current of 40 A (40% of **PHASE CT PRIMARY** setting).
3. With the display showing GROUND ALARM message, change the display to **A2: METERING\CURRENT\GROUND CURRENT** and continue increasing the input current. When the display current of 80 A (80% of **PHASE CT PRIMARY**) is reached, the 239 trip relay will activate and the TRIP LED will become lit. The 239 will display CAUSE OF LAST TRIP: GROUND FAULT message.
4. Turn the ground current off and press the reset key to reset the trip relay.

## 7.7 Switch Input

- To verify the operation of each 239 switch input, go to **A1: STATUS\SWITCH STATUS** and with the **MESSAGE ◀** and **MESSAGE ▶** keys, view the status of each switch input one at a time. Open and close each switch input and note that the display reflects the present status of the input terminals. Verify the results with the table below.

**Table 7–6: Switch Input Test**

| SWITCH NAME         | INPUT TERMINAL STATUS | EXPECTED DISPLAY READING |
|---------------------|-----------------------|--------------------------|
| SW.1 ACCESS         | OPEN                  | OPEN                     |
|                     | SHORTED               | CLOSED                   |
| SW2. EMERG RESTART  | OPEN                  | OPEN                     |
|                     | SHORTED               | CLOSED                   |
| SW3. EXTERNAL RESET | OPEN                  | OPEN                     |
|                     | SHORTED               | CLOSED                   |
| SW4. OPTION 1       | OPEN                  | OPEN                     |
|                     | SHORTED               | CLOSED                   |
| SW5. OPTION 2       | OPEN                  | OPEN                     |
|                     | SHORTED               | CLOSED                   |

## 7.8 Analog Output

- Alter the following setpoints:  
**S1: 239 SETUP\ANALOG OUTPUT\ANALOG OUTPUT RANGE: 4-20 MA**  
**S5: TESTING\ANALOG OUTPUT SIMULATION\SIMULATION: ON**
- As shown in FIGURE 7-1: *SECONDARY INJECTION TEST SETUP* on page 7-96, connect a DC ammeter between terminals 18 and 19.
- Using the setpoint **S5: TESTING\ANALOG OUTPUT SIMULATION\ANALOG OUTPUT FORCED TO** force the output to various levels shown in the table below and view the results on the DC ammeter. Verify the meter results with expected results shown in the table below. If the 239 is turned off or 15 minutes have expired since **S5: TESTING\ANALOG OUTPUT\SIMULATION\SIMULATION** was turned on this setpoint will automatically turn off to disable analog output simulation. This setpoint must be turned on to continue further testing if needed.

| OUTPUT FORCED TO | EXPECTED OUTPUT | ACTUAL OUTPUT (mA) |
|------------------|-----------------|--------------------|
| OFF              | 4               |                    |
| 0                | 4               |                    |
| 40               | 10.4            |                    |
| 70               | 15.6            |                    |
| 100              | 20              |                    |
| 110              | 21.6            |                    |

---

## 7.9 Thermistor Alarm

1. Alter the following setpoints:  
**S4: PROTECTION\TEMPERATURE\THERMISTOR\THERMISTOR FUNCTION: ALARM**  
**S4: PROTECTION\TEMPERATURE\THERMISTOR\THERMISTOR HOT RESISTANCE: 20KW**  
**S4: PROTECTION\TEMPERATURE\THERMISTOR\THERMISTOR COLD RESISTANCE: 0.1KW**
2. As shown in FIGURE 7-1: *SECONDARY INJECTION TEST SETUP* on page 7-96, place a variable 30 k $\Omega$  resistor across thermistor terminals 21/22.
3. With the variable resistor 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 239.
4. Remove the variable resistor and measure its resistance with an ohmmeter to verify that it agrees with the **S4: PROTECTION\TEMPERATURE\THERMISTOR\HOT RESISTANCE** setpoint.
5. Place the variable resistor back on terminals 21 and 22 and start decreasing its resistance until the thermistor alarm disappears. This will occur when the input resistance has decreased below the **S4: PROTECTION\TEMPERATURE\THERMISTOR\COLD RESISTANCE** setpoint.
6. Once again, check by removing the variable resistor and measuring its resistance by putting an ohmmeter across its terminals to verify that it agrees with the **S4: PROTECTION\TEMPERATURE\THERMISTOR\COLD RESISTANCE** setpoint.

---

## 7.10 RTD Measurement

1. Alter the following setpoints:  
**S4: PROTECTION\TEMPERATURE\RTD 1\RTD 1 TYPE: 100PT**  
**S4: PROTECTION\TEMPERATURE\RTD 1\RTD 1 APPLICATION: BEARING**  
**S4: PROTECTION\TEMPERATURE\RTD 1\RTD 1 TRIP TEMPERATURE: OFF**  
**S4: PROTECTION\TEMPERATURE\RTD 1\RTD 1 ALARM TEMPERATURE: OFF**
2. To verify RTD 1 readings ensure a 10 turn 200  $\Omega$  variable resistor is connected to terminals 49, 50 and 51 as shown in FIGURE 7-1: *SECONDARY INJECTION TEST SETUP* on page 7-96.
3. Using Table 4-3: *RTD Resistance VS. Temperature* on page 4-44 as a reference, input various resistances and verify that displayed temperatures in **A2:**  
**METERING\TEMPERATURE\BEARING RTD 1 TEMPERATURE:** match the results shown in the Resistance vs. Temperature table.
4. Repeat the above steps with RTD 2 and RTD 3 inputs.

---

## 7.11 Power Failure / Non-volatile Memory

1. Slowly decrease the AC voltage applied to a 239 relay until the UNDERVOLTAGE message appears on the 239 display. At this instant all output relays will go to their de-energized state and the SERVICE LED turns on. This phenomenon should occur after the voltage has decreased below 70 V.
2. To test the memory circuitry of the relay, remove and then re-apply control power. All stored setpoints and statistical data should be unchanged. The displayed thermal capacity in **A2: METERING\MOTOR CAPACITY** will continue to decrease even when control power is removed. An accurate value of thermal capacity is guaranteed if the power off time is less than 60 minutes.

## 7.12 Routine Maintenance Verification

1. Once a relay has been properly installed, periodic tests can be performed to check correct operation of the protection system. Many conditions can be simulated without creating the actual trip/alarm conditions themselves. This is done by changing relay setpoints to values which will initiate trips and alarms during normal motor operation. Changed setpoints should be returned to their proper values when tests have been completed. The Setpoint Access terminals must be shorted together to allow setpoint changes.
2. To test relay functions using phase current data, with the motor running, change **S2: SYSTEM SETUP\MOTOR DATA\MOTOR FULL LOAD CURRENT** setpoint to a value under the actual motor current. The trip relay will activate after thermal capacity builds up to 100%. The time to trip at a given overload level should never be greater than the time on the overload curve. However, the trip time could be less depending upon how much thermal capacity was already accumulated. Larger overloads, representing short circuits or mechanical jams, can be simulated by changing the **S2: SYSTEM SETUP\MOTOR DATA\MOTOR FULL LOAD CURRENT** setpoint to a value much lower than the actual motor phase current.
3. Unbalance trip or alarm conditions can be simulated by changing the Unbalance Trip or Alarm Level setpoints to values below the actual unbalance present at the motor terminals. The unbalance feature will not work if the motor load is  $\leq 30\%$  FLC.
4. Other trip or alarm conditions using ground current data and RTD temperature data can be simulated using the procedures outlined in the previous sections.
5. To test the operation of the 239 output relays and the switchgear connected to them setpoint **S5: TESTING\TEST RELAYS & LEDS\OPERATION TEST** is used. The motor must be stopped in order for this function to operate. While this setpoint is displayed, use the **VALUE ▾** or **VALUE ▸** key to scroll through each message. The currently selected relay will be energized and all other relays will be de-energized. As soon as another setpoint or actual value is displayed the 239 returns to normal operation.
6. To test the analog output hardware repeat the test in Section 7.8: Analog Output on page –104. This test can be performed while current is present.



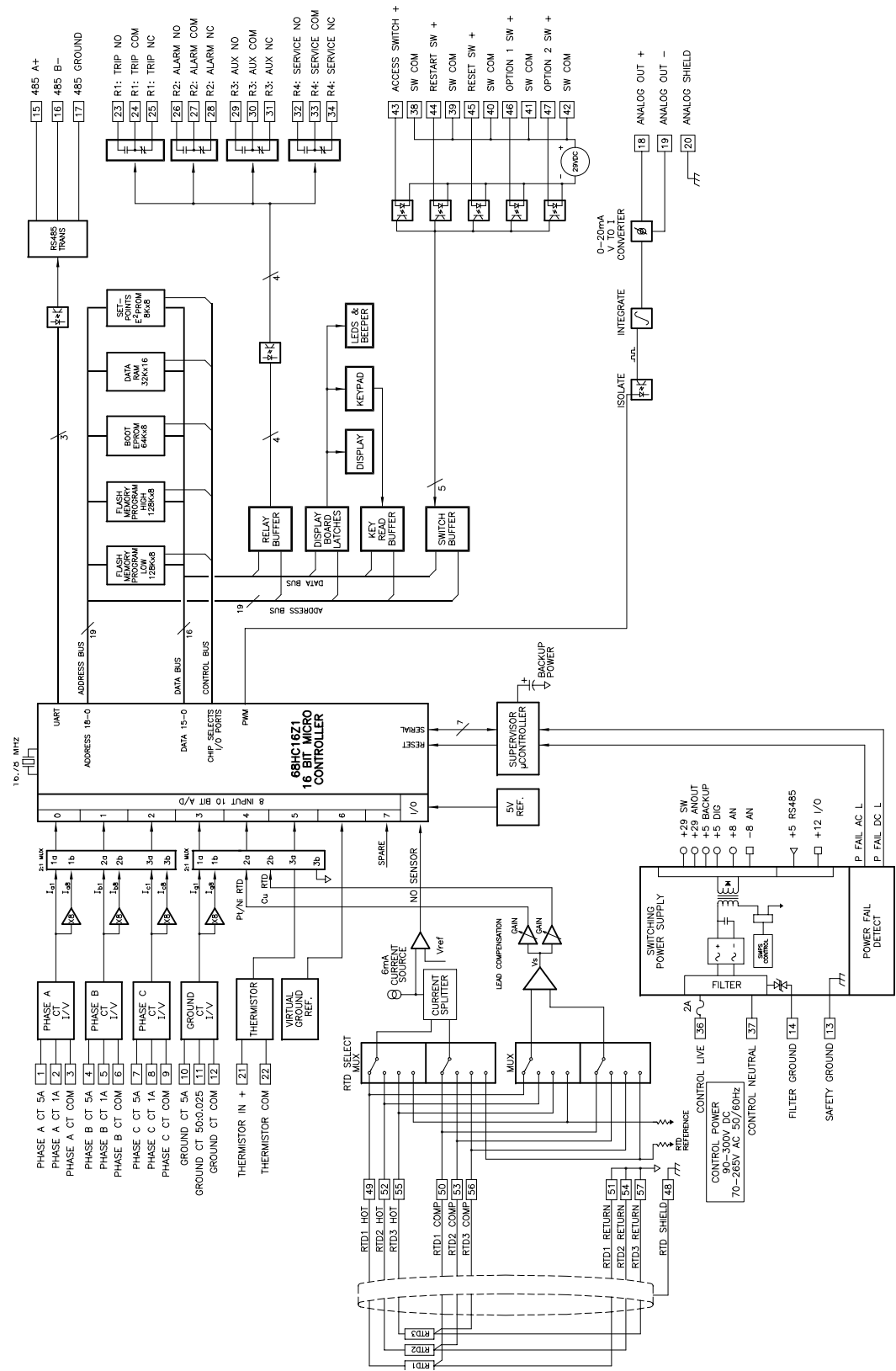


FIGURE 7-2: 239 Hardware Block Diagram





## 239 Motor Protection Relay

### Chapter A: Appendix

#### A.1 239 Warranty

##### **GE MULTILIN RELAY WARRANTY**

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

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

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

GE Multilin is not liable for special, indirect or consequential damages or for loss of profit or for expenses sustained as a result of a relay malfunction, incorrect application or adjustment.

For complete text of Warranty (including limitations and disclaimers), refer to GE Multilin Standard Conditions of Sale.



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