

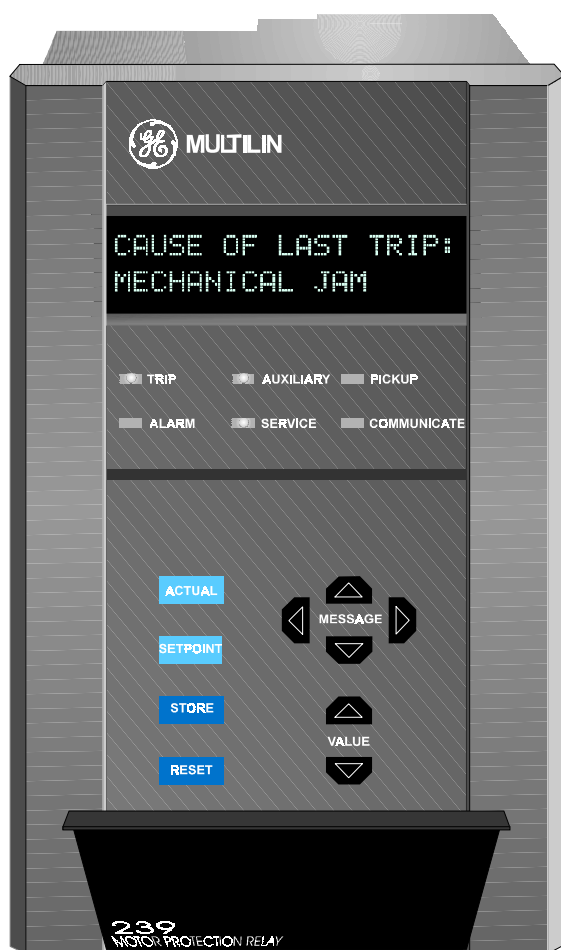


GE Power Management

239

MOTOR PROTECTION RELAY

Instruction Manual



Firmware Revision: 2.50
239PC Software: 2.50 or newer
Manual P/N: 1601-0060-D6
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Manufactured under an
ISO9002 Registered system.

These instructions do not purport to cover all details or variations in equipment nor provide for every possible contingency to be met in connection with installation, operation, or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purpose, the matter should be referred to the General Electric Company.

To the extent required the products described herein meet applicable ANSI, IEEE, and NEMA standards; but no such assurance is given with respect to local codes and ordinances because they vary greatly.

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1.1 239 RELAY FEATURES

1

The GE Power Management 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.

PROTECTION

- Overload (15 selectable curves)
- Short circuit
- Locked rotor
- Stall / mechanical jam
- Repeated starts
- Single phase / unbalance
- Ground fault
- Overtemperature (Thermistor & 3 RTDs)
- Undercurrent
- Overload warning
- Breaker failure

FEATURES

- Status/current/temperature display
- Fault diagnosis
- Trip record
- Memory lockout
- Thermal capacity / load% / RTD analog output
- Trip / alarm / auxiliary / service relay outputs
- Motor Running Hours
- Motor maximum current on last start
- Simulation mode for field testing
- Clear LCD display
- RS485 Modbus communications interface
- AC/DC control power
- Compact size, fits most starters
- Update options and/or MODs in field
- CSA/UL Approved

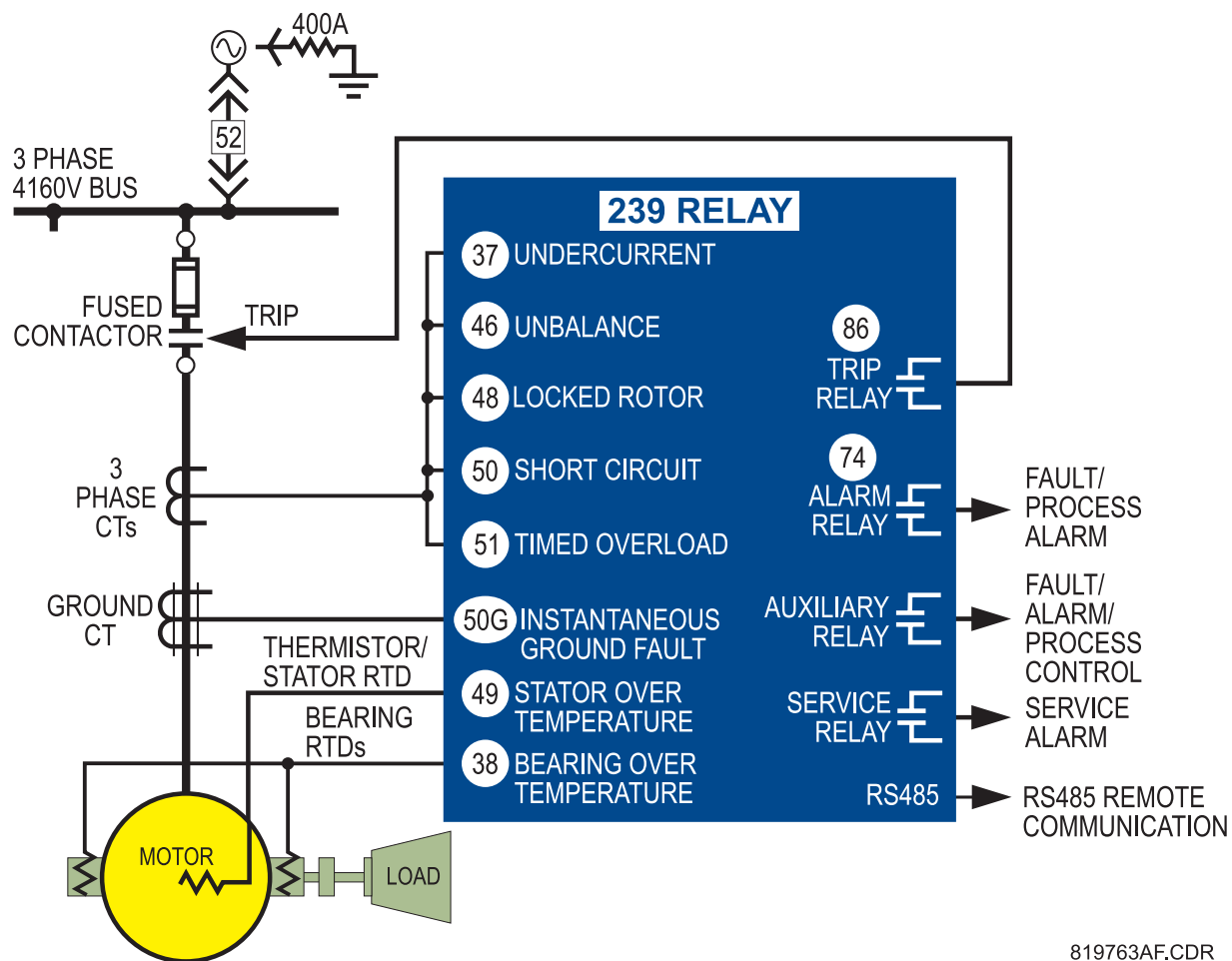


Figure 1-1: CONTINUOUS PROTECTION FEATURES

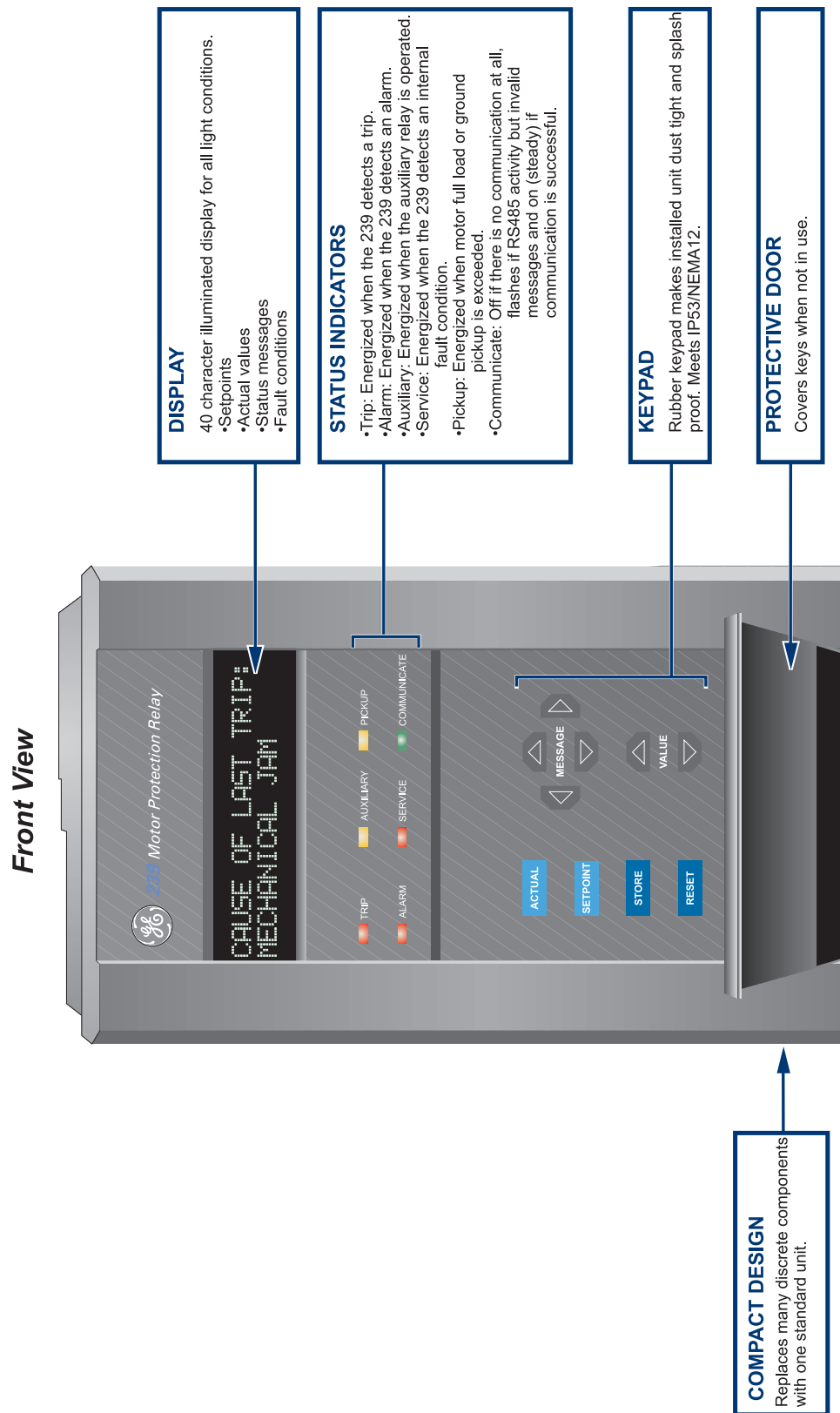


Figure 1–2: FEATURE HIGHLIGHTS – FRONT

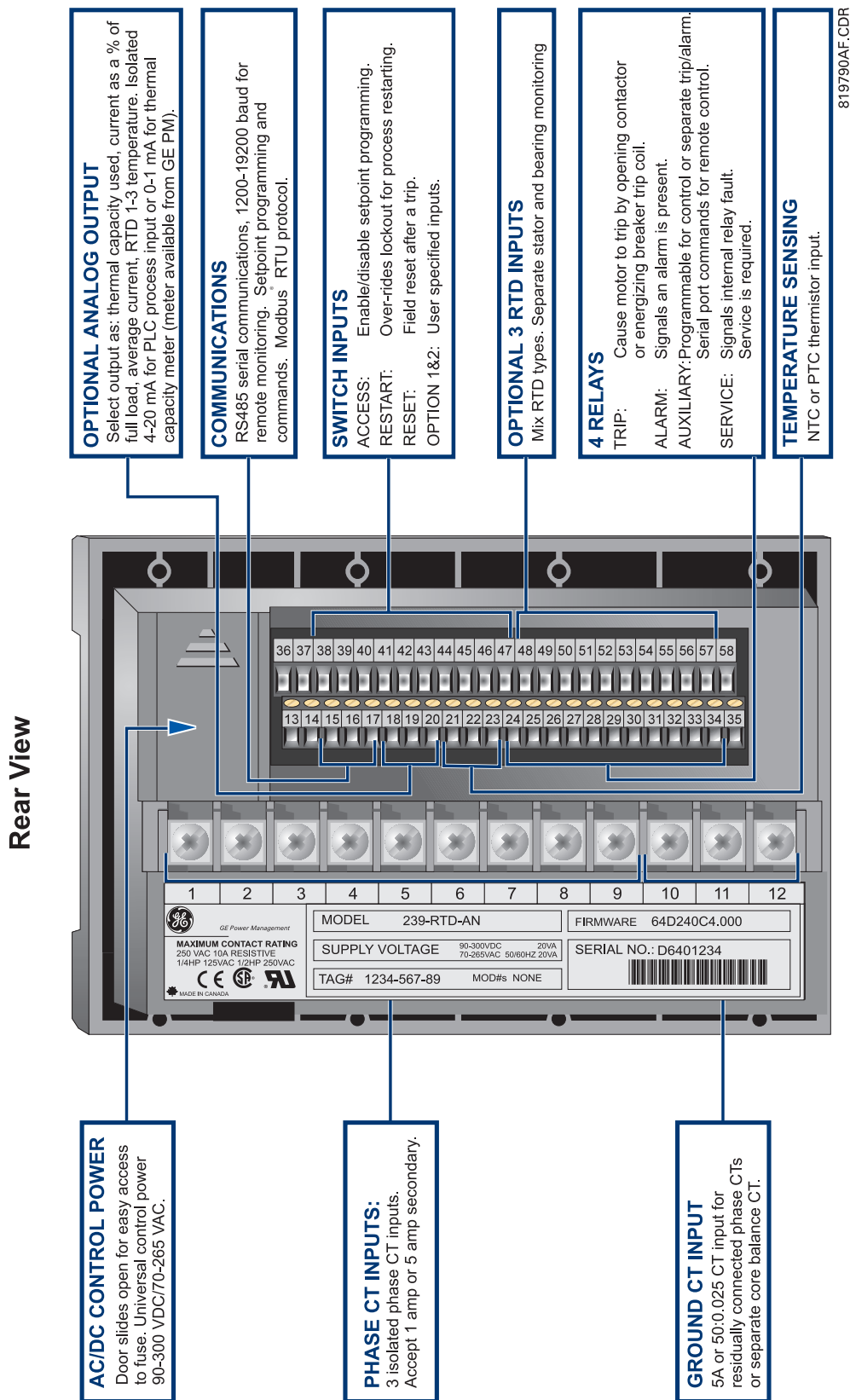


Figure 1-3: FEATURE HIGHLIGHTS – REAR

1.2 TYPICAL APPLICATIONS

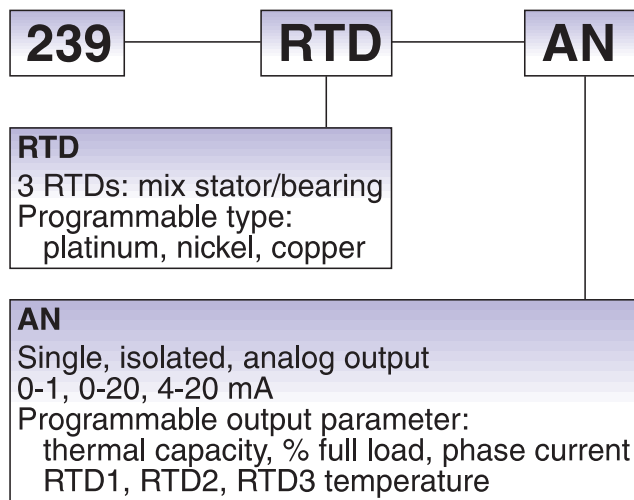
1

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 set-points, issue commands and diagnose faults to minimize process disruptions.
5. Output of motor current suitable for programmable controller interface (4-20mA).

**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 (free upon request)
- Phase and ground CTs
- Thermal Capacity Meter TCS2
- Emergency Restart keyswitch
- 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)

1.4 SPECIFICATIONS

1

PHASE CURRENT INPUTS

CONVERSION: true rms, 16 samples/cycle
 CT INPUT: 1 A and 5 A secondary
 RANGE: 0.1 - 11 x phase CT primary
 FREQUENCY: 20 to 300 Hz
 ACCURACY: $\pm 2\%$ of full scale

GROUND CURRENT INPUTS

CONVERSION: true rms, 16 samples/cycle
 CT INPUT: 5 A secondary and 50:0.025
 RANGE: 0.03 to 1.4 x CT primary (5A CT)
 0.05 to 16.0 amps (50:0.025 CT)
 FREQUENCY: 20 to 300 Hz
 ACCURACY:
 5A CT: $\pm 2\%$ of full scale (5A CT)
 50:0.025 CT: ± 0.03 A (0 to 0.49 A)
 ± 0.07 A (0.50 to 3.99 A)
 ± 0.20 A (4.00 to 16.00 A)

OVERLOAD CURVES TRIP TIME

CURVES: 15 curves, fixed shape
 OVERLOAD PICKUP
 INHIBIT: 1.00 to 5.00 x FLC
 PICKUP LEVEL: 1 to 1500 amps
 ACCURACY:
 PICKUP: $\pm 1\%$ of Displayed Value
 TIME: $\pm 2\%$ of trip time or ± 1 sec which
 ever is greater

SHORT CIRCUIT & GROUND TRIP

GROUND TRIP
 LEVEL: 0.05 to 15A (50:0.025 CT)
 3 to 100% (5A CT)
 S/C TRIP LEVEL: 1 to 11 x CT PRI / OFF
 INTENTIONAL
 DELAY: INST. or 10ms to 60000 ms pro-
 grammable
 INST: 20 to 45ms
 * TOTAL DELAY: INST + INTENTIONAL
 * trip time accuracy guaranteed if current > 1.4x trip
 level setting

BREAKER FAILURE TIMING

DELAY: INST. or 10ms to 60000 ms pro-
 grammable
 INST: 20 to 45ms
 * TOTAL DELAY: INST + INTENTIONAL
 * trip time accuracy guaranteed if current > 1.4x trip
 level setting

START PROTECTION

THERMAL: separate start & run protection
 ACTIVATION: inrush 3 phase current increases
 from <5% to >101% FLC in 1 sec
 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 run-
 ning
 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 a phase with maximum deviation
 from I_{AV}
 I_{FLC} = full load current setting

THERMISTOR

TYPE: PTC or NTC programmable
 HOT RESISTANCE: 100 to 30 000 Ω
 COLD RESISTANCE: 100 to 30 000 Ω
 DELAY: 2 sec
 ACCURACY: $\pm 5\%$ or 100 Ω , whichever is great-
 est

UNDERCURRENT

RANGE: 5 to 100% FLC / OFF
 DELAY: 0 to 250 sec

RTDs (OPTIONAL)

INPUTS: 3 RTDs, stator/bearing programmable

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

RANGE: -40 to 200 °C/ -40 to 400 °F

TRIP/ALM RANGE: 0 to 200 °C / 0 to 400 °F

DEAD BAND: 2 °C / 4 °F

ACCURACY: ± 2 °C / ± 4 °F

LEAD RESISTANCE:

- Pt or Ni RTD: 25 Ω max
- Cu RTD: 3 Ω max
- 3 wire lead resistance compensation

COMMUNICATIONS

TYPE: RS485 2 wire, half duplex, isolated

BAUD RATE: 1200 to 19.2k bps

PROTOCOL: Modbus[®] RTU

FUNCTIONS: Read/write setpoints, read actual values, execute commands

ANALOG OUTPUT (OPTIONAL)

OUTPUT	PROGRAMMABLE		
	0-1 mA	0-20 mA	4-20 mA
OUTPUT	0-1 mA	0-20 mA	4-20 mA
MAX LOAD	2400 Ω	600 Ω	600 Ω
MAX OUTPUT	1.1 mA	21 mA	21 mA

ACCURACY: $\pm 2\%$ of full scale reading

ISOLATION: 50V isolated, active source

OUTPUT RELAYS

VOLTAGE		MAKE/ CARRY CONTINUOUS	MAKE/ CARRY 0.2 s	BREAK
RESISTIVE	30 VDC	10	30	10
	125 VDC	10	30	0.5
	250 VDC	10	30	0.3
INDUCTIVE (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 PF=0.4	120 VAC	10	30	10
	250 VAC	10	30	10

CONFIGURATION FORM C NO/NC

CONTACT MATERIALSILVER ALLOY

SWITCH INPUTS

TYPE: dry contacts

OUTPUT: 29 V DC, 10 mA (pulsed)

DURATION: 100 ms minimum

CT INPUTS

	CT INPUT (A)	BURDEN	
		VA	Ω
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 (5A)	5	0.04	0.002
	25	1.1	0.002
	100	17	0.002
GROUND CT (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 GE Power Management 50:0.025 CT.

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 120 VAC / 125 VDC

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 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

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 Fast Rise 5 kV /
10 ns
Ontario Hydro A-28M-82
IEC255-4 Impulse/High
Frequency Disturbance
Class III Level

IMPULSE TEST: IEC 255-5 0.5 Joule 5 kV

RFI: 50 MHz/15 W Transmitter

EMI:C37.90.2 Electromagnetic Inter-
ference @ 150 MHz and 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

INSTALLATION**WARNING:****HAZARD may result if the prod-
uct is not used for its intended
purpose.**

VENTILATION REQUIREMENTS: None

CLEANING REQUIREMENTS: None

PACKAGINGSHIPPING BOX: 8½" × 6" × 6" (L × H × D)
215 mm × 152 mm × 152 mm
(L × H × D)

SHIP WEIGHT: 5 lbs. / 2.3 kg

CERTIFICATION/COMPLIANCEISO: Manufactured under an ISO9001
recognized program

UL: Recognized under E83849

CSA: Approved under LR41286

CE: IEC 947-1, IEC 1010-1

NOTE: Specifications subject to change without notice.

2.1 MOUNTING

Physical dimensions for the 239 and the required cutout dimensions are shown below in Figure 2-1: PHYSICAL DIMENSIONS. 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.

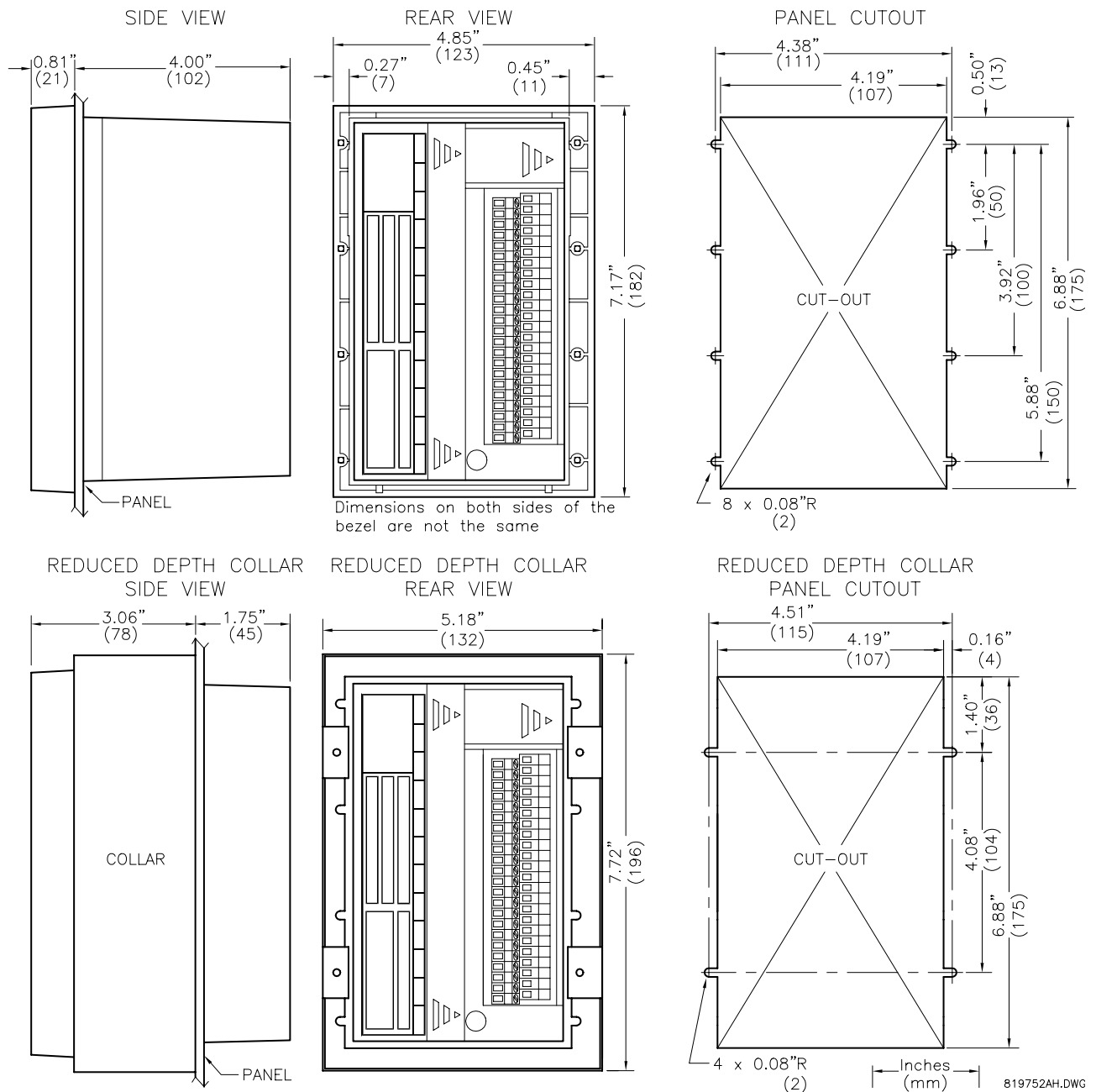


Figure 2-1: PHYSICAL DIMENSIONS

2.2 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
 GE Power Management			MODEL 239-RTD-AN				FIRMWARE 64D250C4.000				
MAXIMUM CONTACT RATING 250 VAC 10A RESISTIVE 1/4HP 125VAC 1/2HP 250VAC   MADE IN CANADA			SUPPLY VOLTAGE 90-300VDC 20VA 70-265VAC 50/60HZ 20VA				SERIAL NO.: D6441234				
			TAG# 1234-567-89 MOD#s NONE								

Figure 2–2: 239 PRODUCT LABEL

- 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.
- SUPPLY VOLTAGE:** This 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.
- TAG#:** This is an optional identification number specified by the customer.
- MOD#s:** These are used if unique features have been installed for special customer orders. These numbers should be available when contacting GE Power Management for technical support. Up to five MOD#s can be installed into the 239.
- SERIAL NO:** This number 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 instruction manual to determine relay features and settings, ensure that the manual 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-C4	2.00	1601-00XX-D1	2.20
1601-00XX-C5	2.01	1601-00XX-D2	2.30
1601-00XX-C6	2.10	1601-00XX-D3 or D4	2.3x
1601-00XX-C7	2.11	1601-00XX-D5	2.40
1601-00XX-C8	2.12	1601-00XX-D6	2.50

2.3 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 2–4). 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
		34	Service NC	57	RTD3 ret
		35	Unused	58	Unused

2

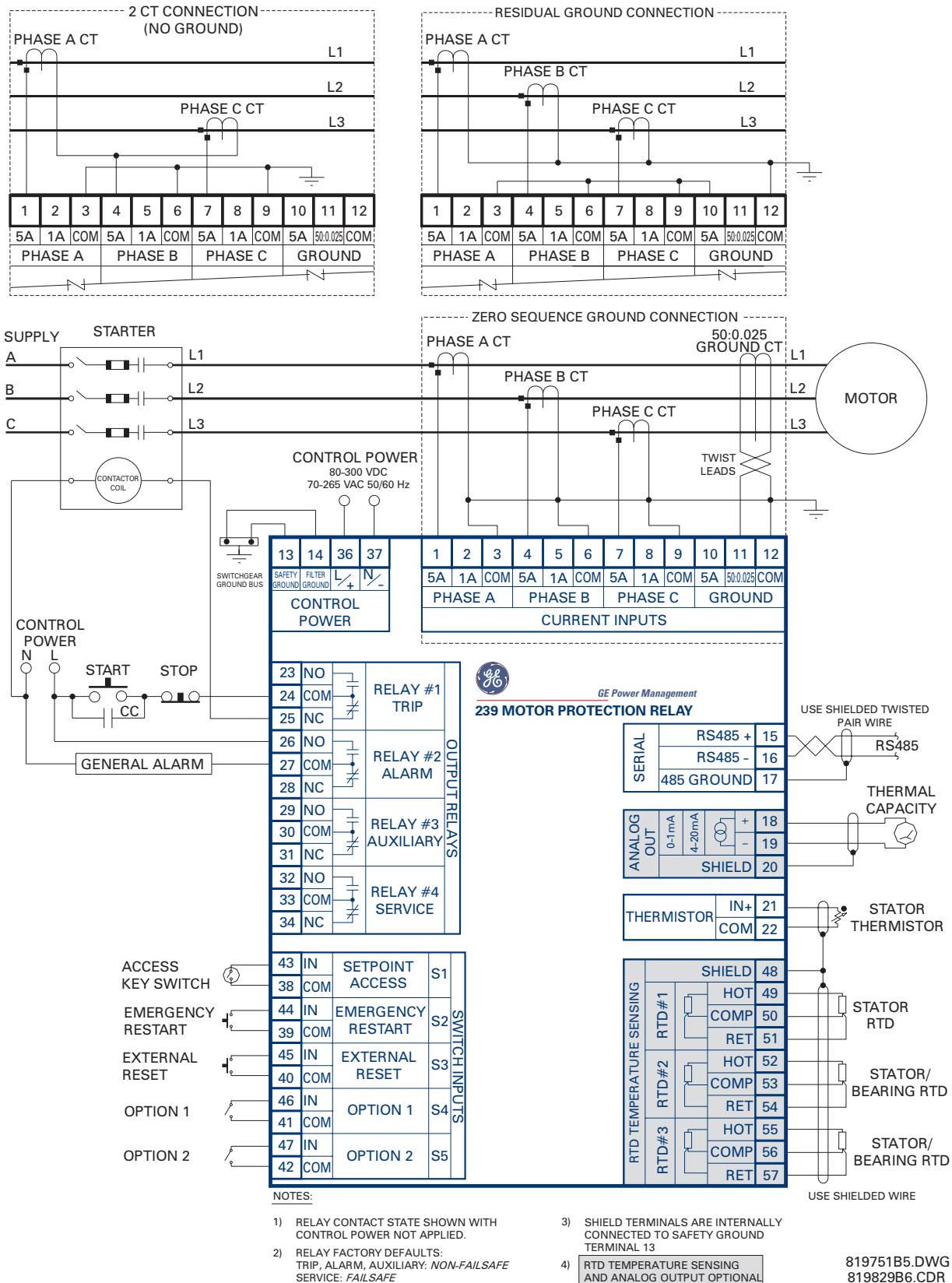


Figure 2-3: TYPICAL WIRING DIAGRAM

a) 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 A fuse is accessible from the back of the unit without opening the relay by sliding back the fuse access door.

b) PHASE CT INPUTS (1-9)

Current transformer secondaries of 5 or 1 A can be used with the 239 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 polarity as indicated in the TYPICAL WIRING DIAGRAM, otherwise current measureS incorrectly for the 2-phase CT 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 1.4: SPECIFICATIONS on page 1–7 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 10 = 10% ratio error 4 = Voltage the CT can deliver to load burden at 20x the rated secondary current without exceeding the 10% ratio error 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 C = Ratings determined by Calculations 10 = 10% ratio error 4 = Voltage the CT can deliver to load burden at 20x the rated secondary current without exceeding the 10% ratio error 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
IEC (Europe)	5P15 0.2VA	1 Amp	P = Protection class 5 = Maximum %voltage error at limiting factor 15 = Limit factor, determines maximum voltage CT can deliver to load burden without exceeding the %voltage error 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.

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

Ground sensing terminals are labeled 5A, 50:0.025, and COM. Connection will depend on the type of 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 Figure 2–3: TYPICAL WIRING DIAGRAM on page 2–4. 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 Power Management. 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 all the readings from being off by a factor of 5, the ground CT primary setpoint must be adjusted. See Section 4.3a) CT INPUTS on page 4–9 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 to be used on 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.

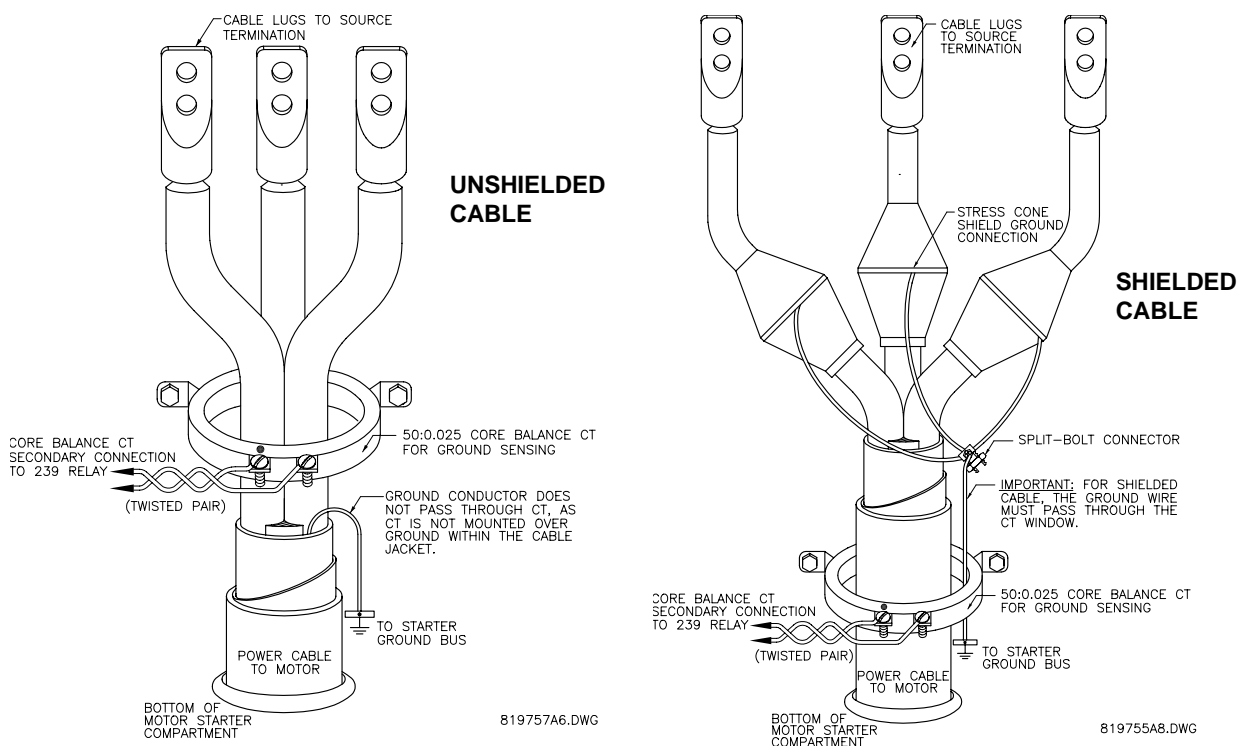


Figure 2–4: CORE BALANCE GROUND CT INSTALLATION

d) 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 1.4: SPECIFICATIONS on page 1–7. Figure 2–3: TYPICAL WIRING DIAGRAM on page 2–4 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 4–12).

- **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 4.4a) TRIP RELAY on page 4–13.

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 Chapter 7: COMMUNICATIONS.

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 2–4 are closed. Connect these relay contacts to a suitable signaling input of a DCS system.

e) 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.

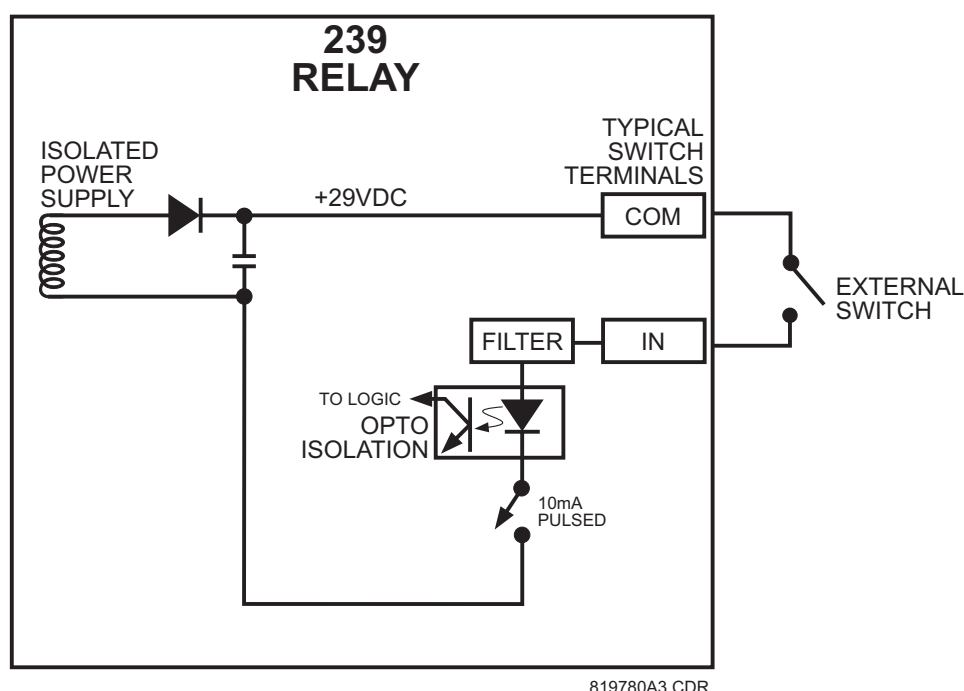


Figure 2–5: SWITCH INPUT CIRCUIT

- **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.

f) THERMISTOR INPUT (21/22)

A motor can be equipped with a single thermistor in the end turns or three in the stator windings for over-temperature 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 Ω 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.

g) 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 Ω 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 Ω nickel, 120 Ω nickel and 10 Ω 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 Ω 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 1.4: SPECIFICATIONS on page 1–7). 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 Ω 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.

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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 electro-magnetic 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.

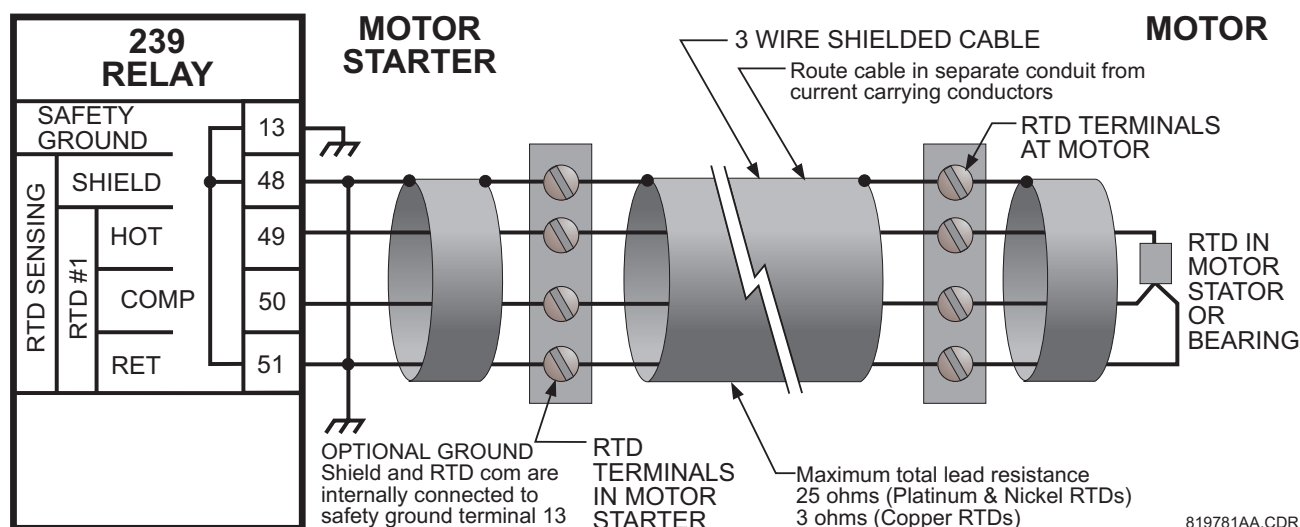


Figure 2-6: RTD WIRING

h) 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 **S1:239 SETUPANALOG OUTPUTANALOG 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 Ω 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 Power Management 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 Ω for 0-20 mA and 4-20mA range and 2400 Ω 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.

i) 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 Ω 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 2–7: RS485 COMMUNICATION WIRING on page 2–12. 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.

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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 Ω / 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 Power Management 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 Power Management 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 Power Management, may be used on a PC to view motor status, actual values, and view and alter setpoints.

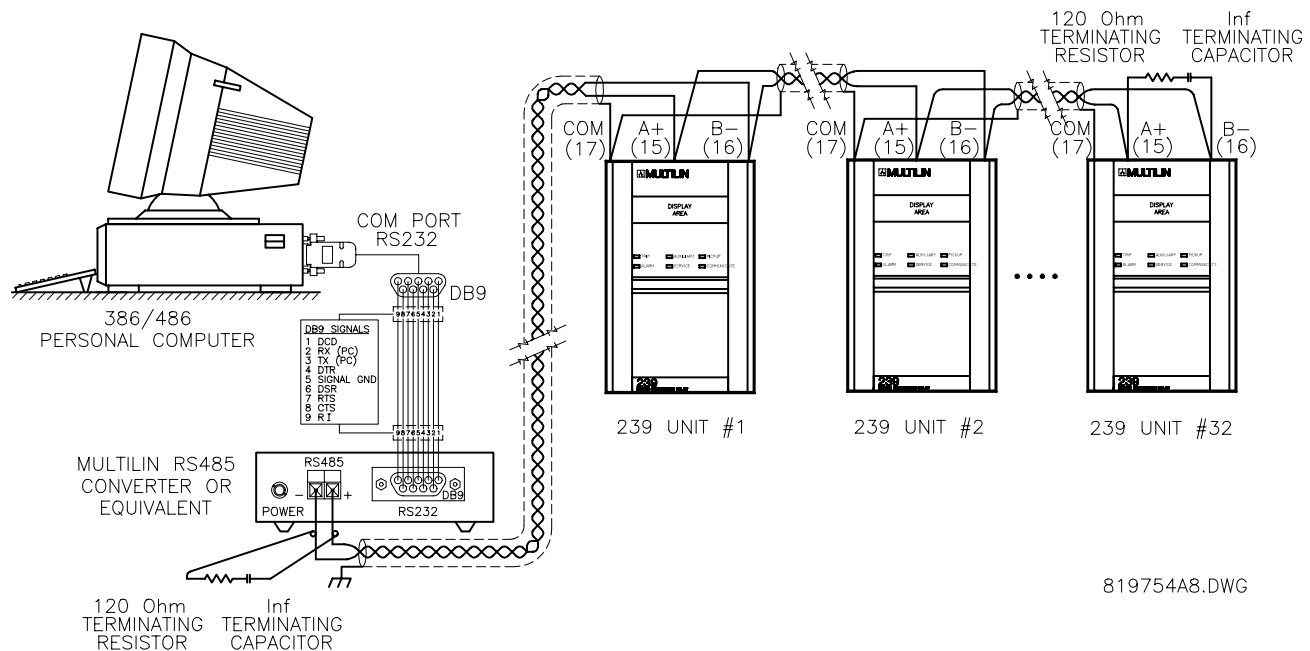


Figure 2-7: RS485 COMMUNICATION WIRING

j) 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.

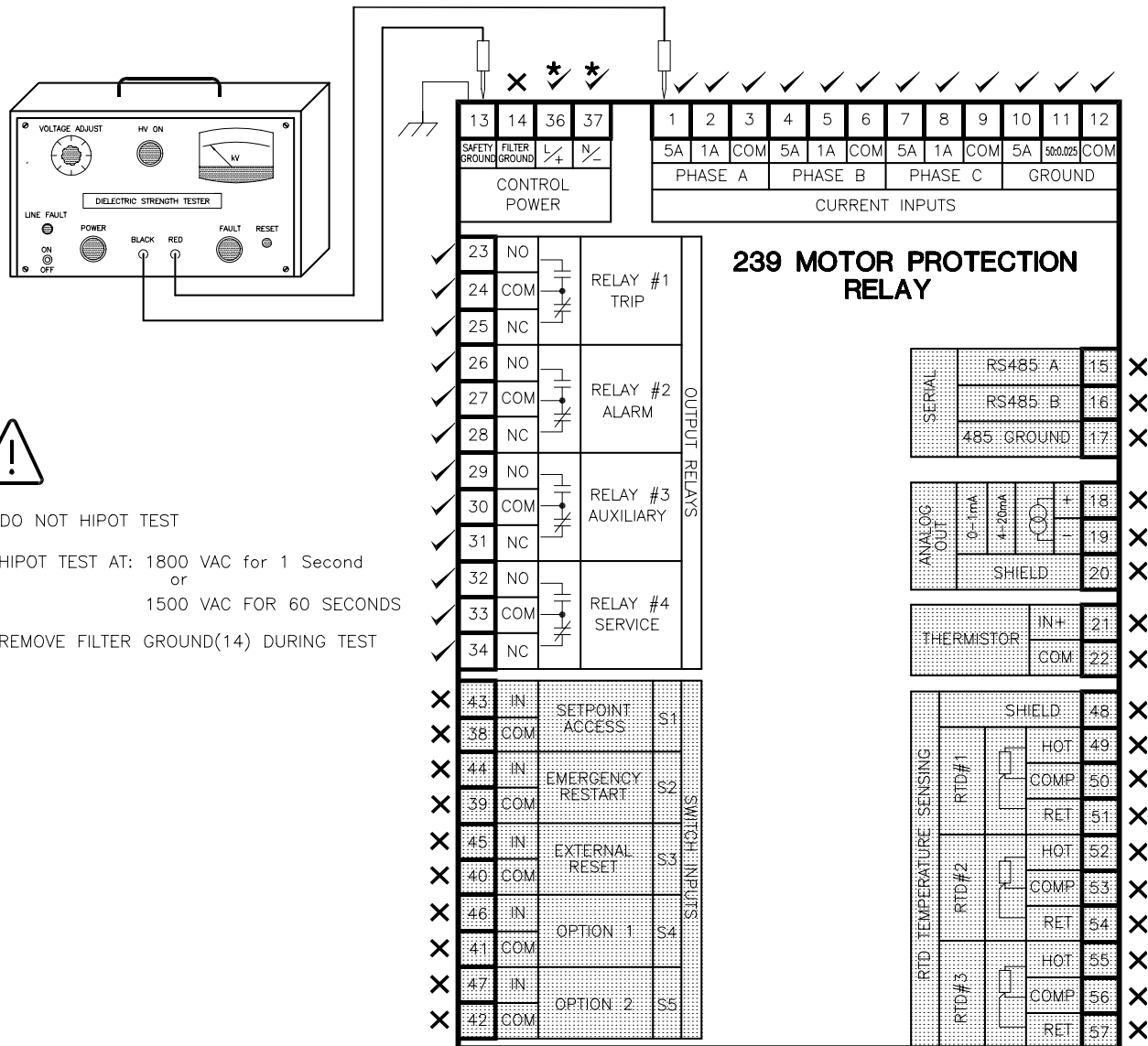
2.4 DIELECTRIC STRENGTH TESTING

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 1500 V AC isolation 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.**

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Figure 2-8: DIELECTRIC STRENGTH TESTING

3.1 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.

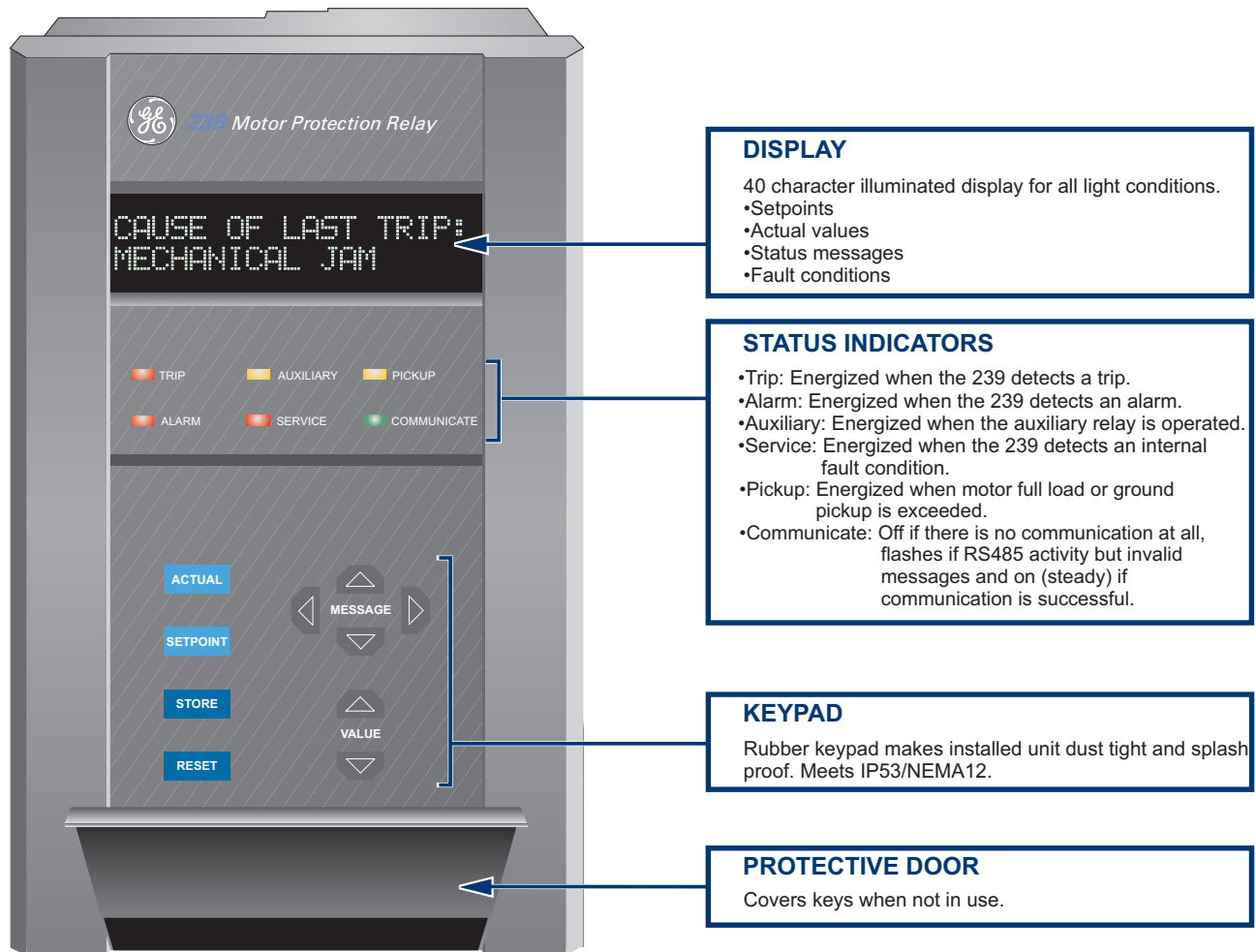


Figure 3–1: FRONT PANEL

3.2 DISPLAY



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Figure 3-2: 239 DISPLAY

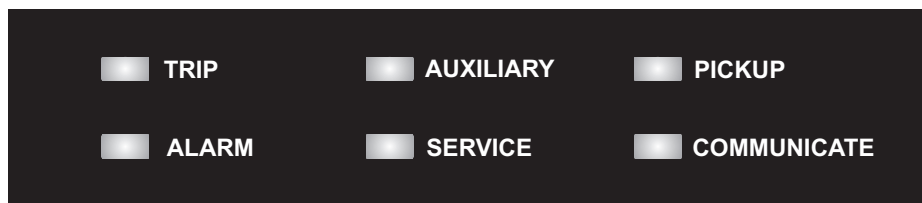
3

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 with the VFD display option.

3.3 STATUS INDICATORS



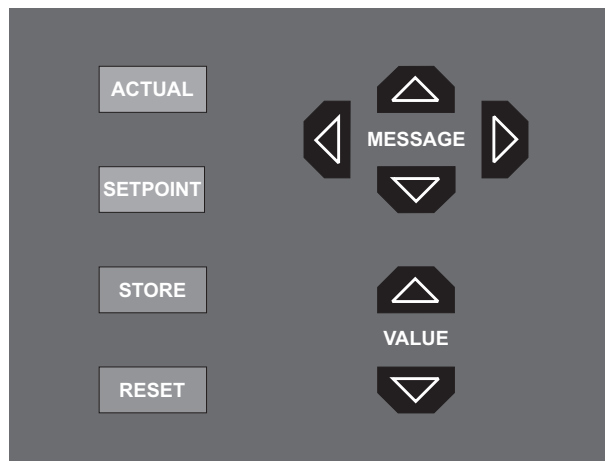
819762A7.CDR

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).

3.4 KEYS



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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 3.6: DEFAULT MESSAGES on page 3–6 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 3.6: DEFAULT MESSAGES on page 3–6 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 ◀**.

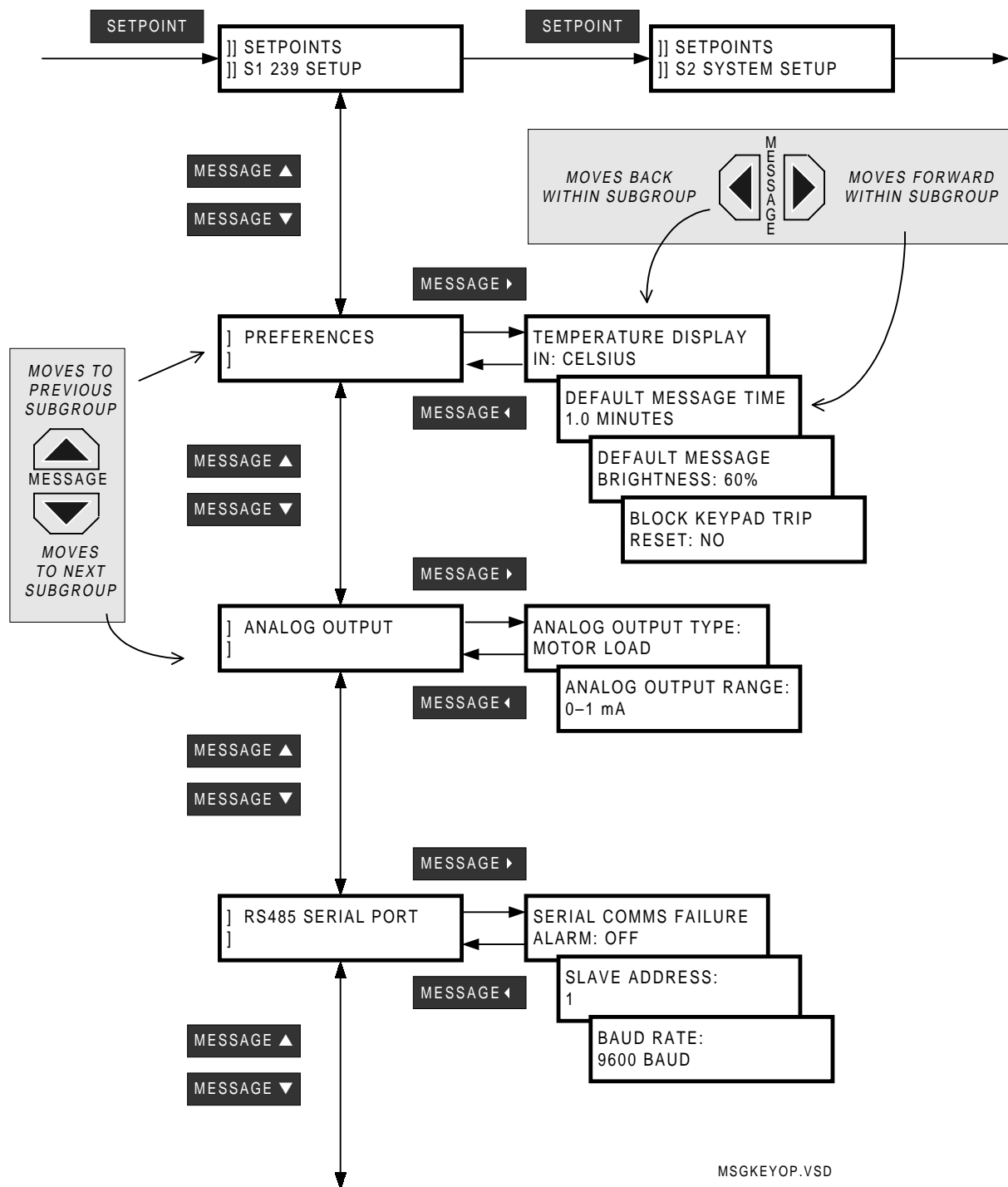
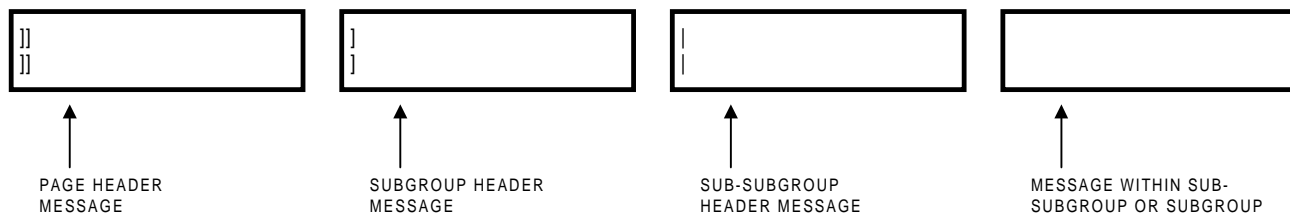


Figure 3-5: MESSAGE KEY OPERATION

- 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 dis-

played, 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: 239PC SOFTWARE for further details.
- **SCADA ENTRY:** Details of the complete communication protocol for reading and writing setpoints are given in Chapter 7: COMMUNICATIONS. 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.

3.5 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.

3.6 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.

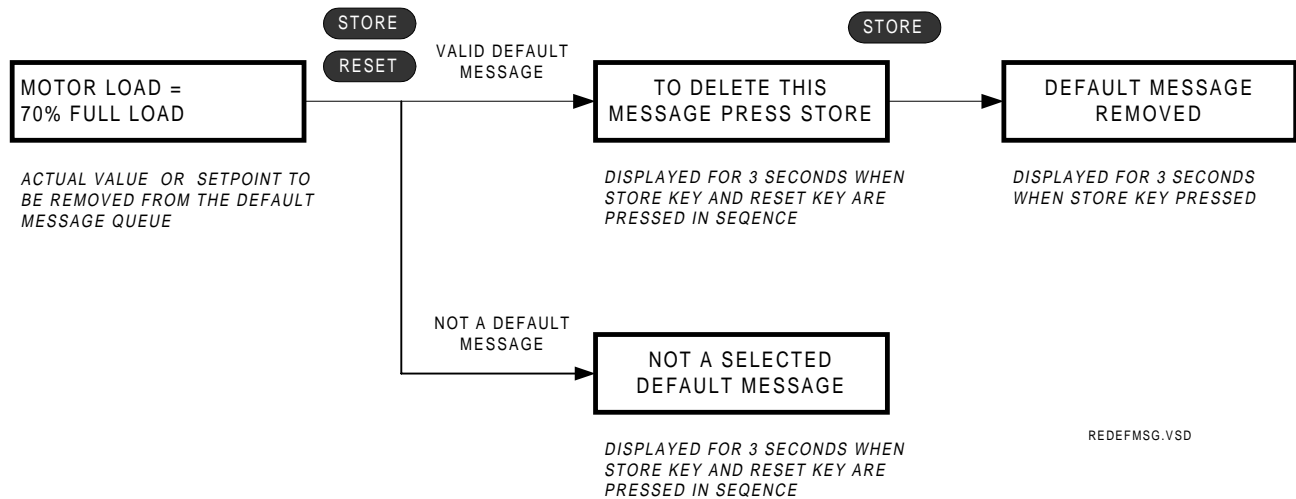
Messages are displayed in the order they are selected.

- 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



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|PREFERENCE|DEFAULT MESSAGE BRIGHTNESS after the delay assigned in S1: 239 SETUP|PREFERENCE|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.

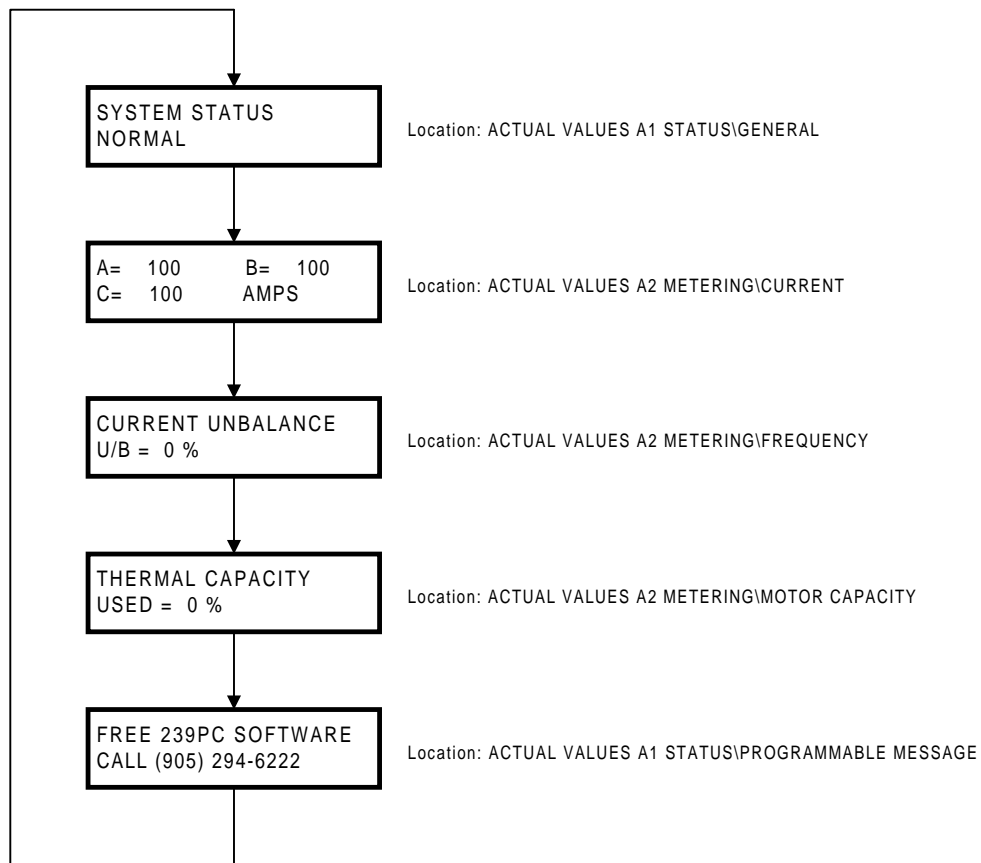


Figure 3–6: DEFAULT MESSAGE SEQUENCE

4.1 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 Power Management.
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. A computer, however, makes entry easier. In addition, files can be stored and downloaded for fast, error free entry when a computer is used. To facilitate this process, the 239PC programming software is available from GE Power Management. 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 4–8 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.

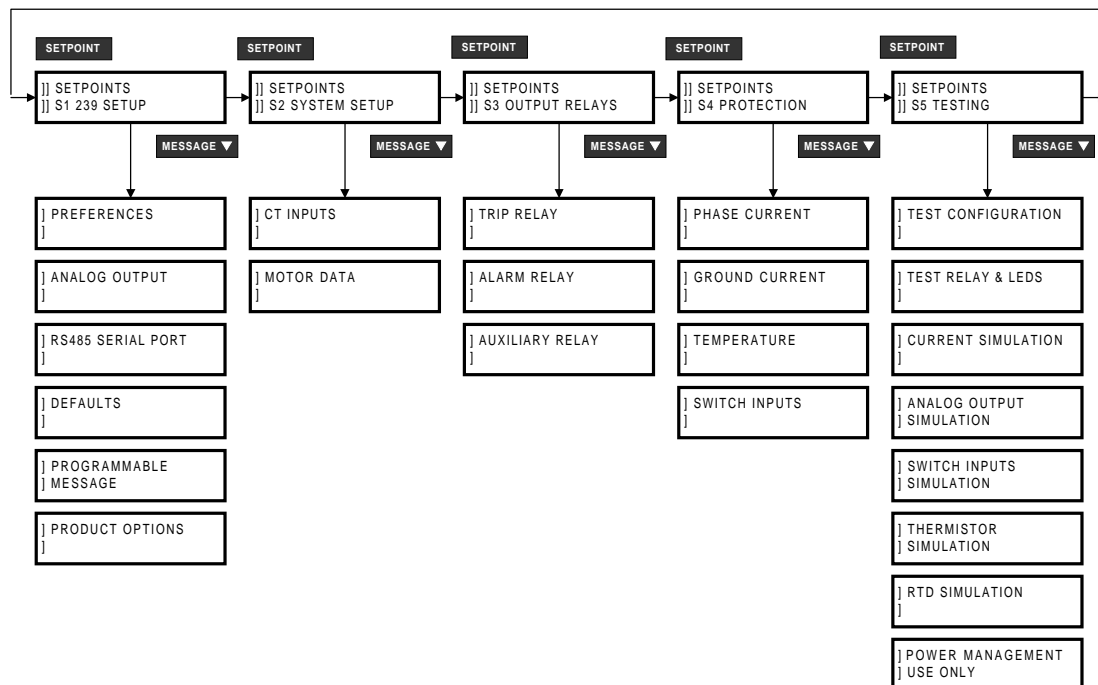
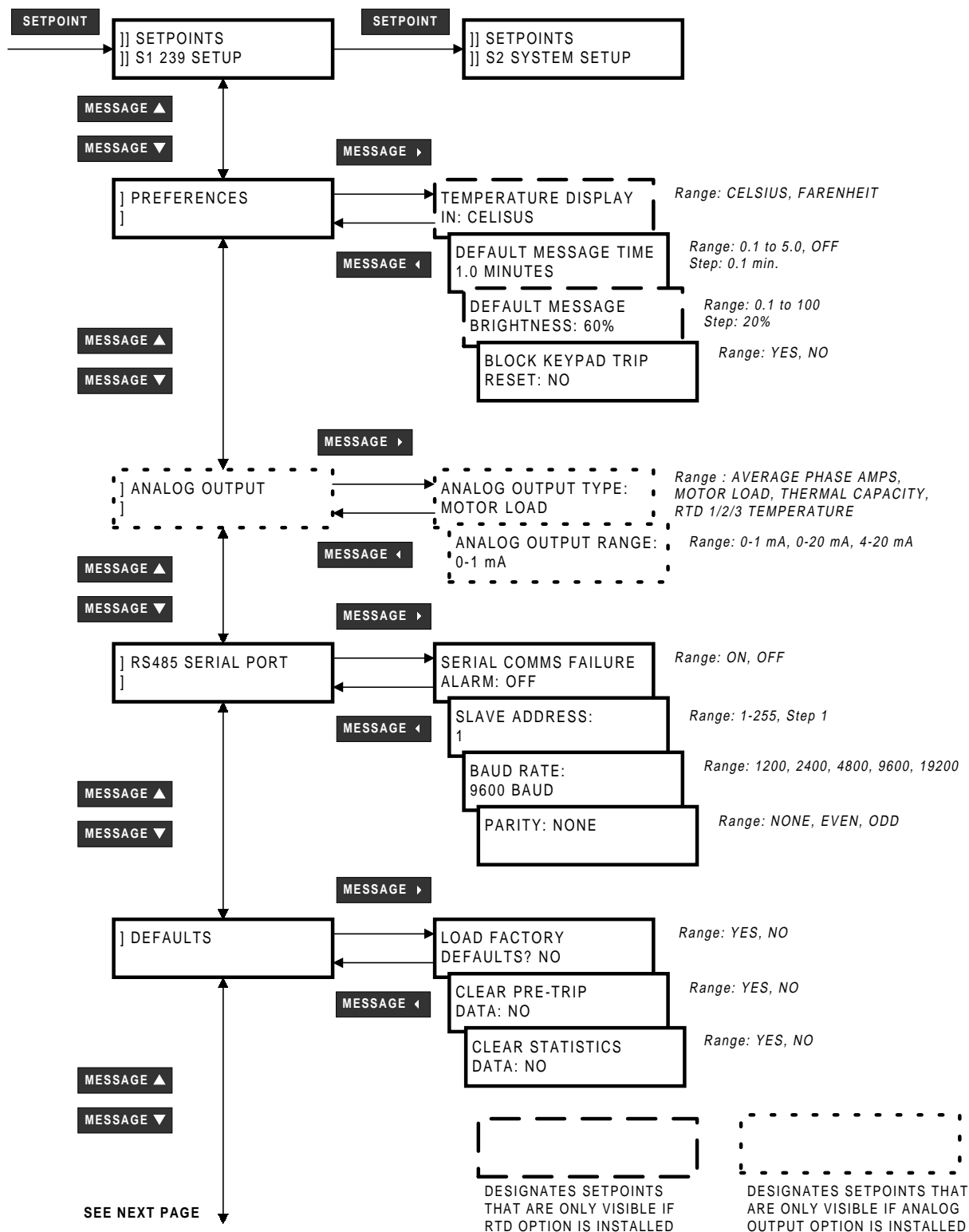


Figure 4–1: SETPOINT MESSAGE ORGANIZATION

4.2 S1: 239 SETUP

Settings to configure the 239 relay itself are entered on this page. This includes user preferences, the RS485 communication port, loading of factory defaults, and user programmable message.



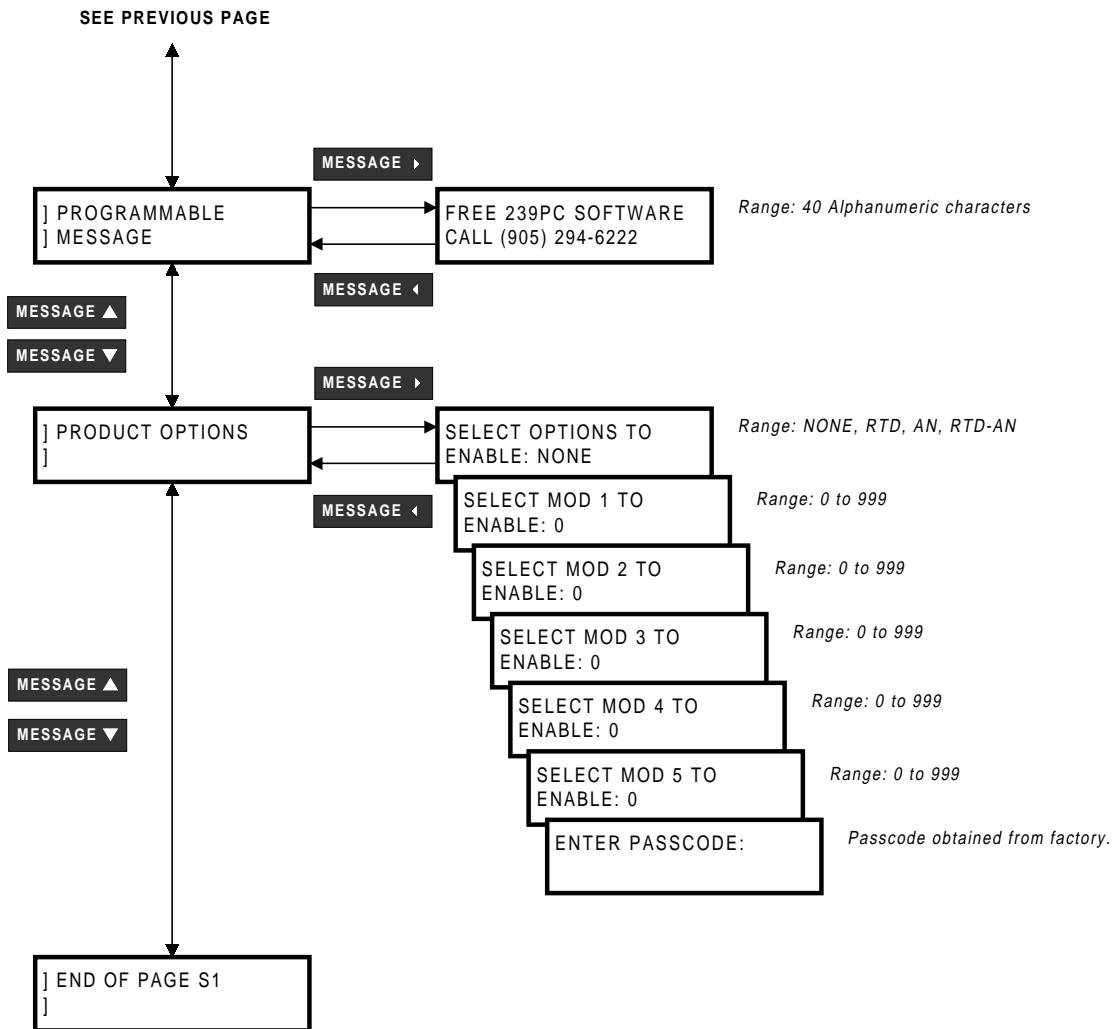


Figure 4–2: SETPOINTS PAGE 1 – 239 SETUP

a) 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 3.6: DEFAULT MESSAGES on page 3–6 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  key in other areas (i.e. reset alarms, remove default messages, etc.) is not affected.

b) 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 2.3h) **ANALOG OUTPUT (OPTION)** (18/19/20) on page 2–10 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 Power Management. 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%.

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

d) DEFAULTS

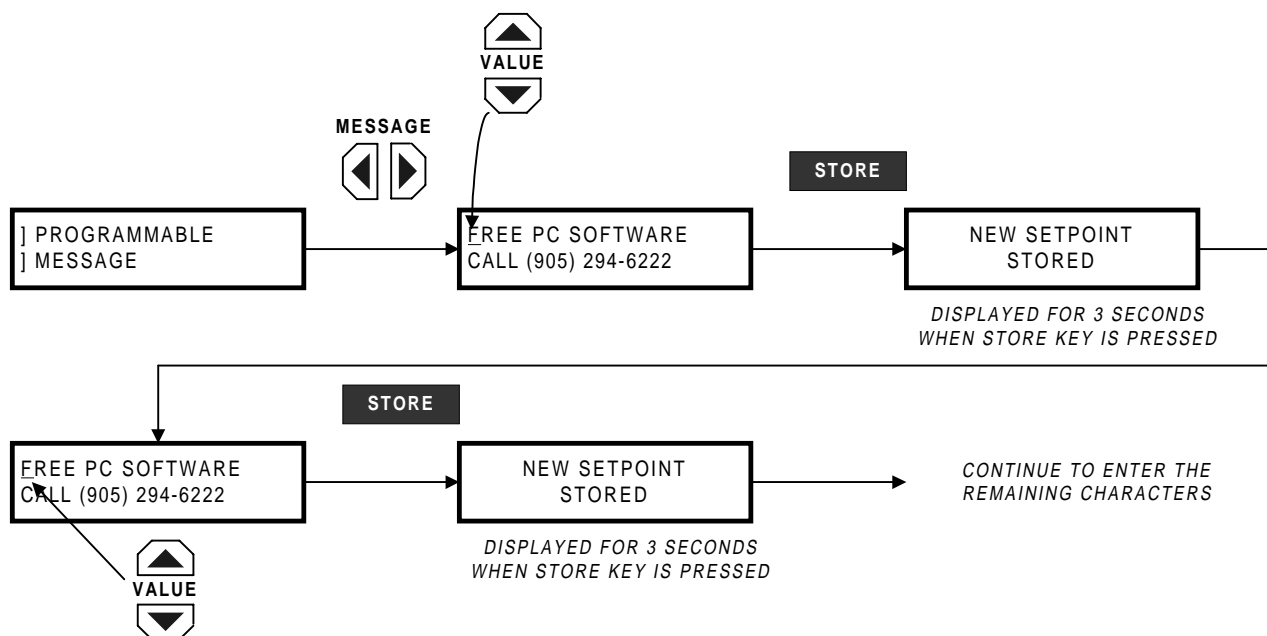
- **LOAD FACTORY DEFAULTS:** When the 239 is shipped from the factory all setpoints will be set to factory default values. These settings are shown in the setpoint message reference figures. To return a relay to these known setpoints select **YES** and press the **STORE** key while this message is displayed 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.

e) 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 3.6: DEFAULT MESSAGES on page 3–6.
- A copy of this message is also displayed in Actual Values page A1 under **PROGRAMMABLE MESSAGE**.

f) 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:

ORDER CODE:
239-RTD-AN

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

Step 5: Verify correct MODs were installed:

MOD NUMBER(S): 0

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

Step 6: Proceed with 239 setup.

4.3 S2: SYSTEM SETUP

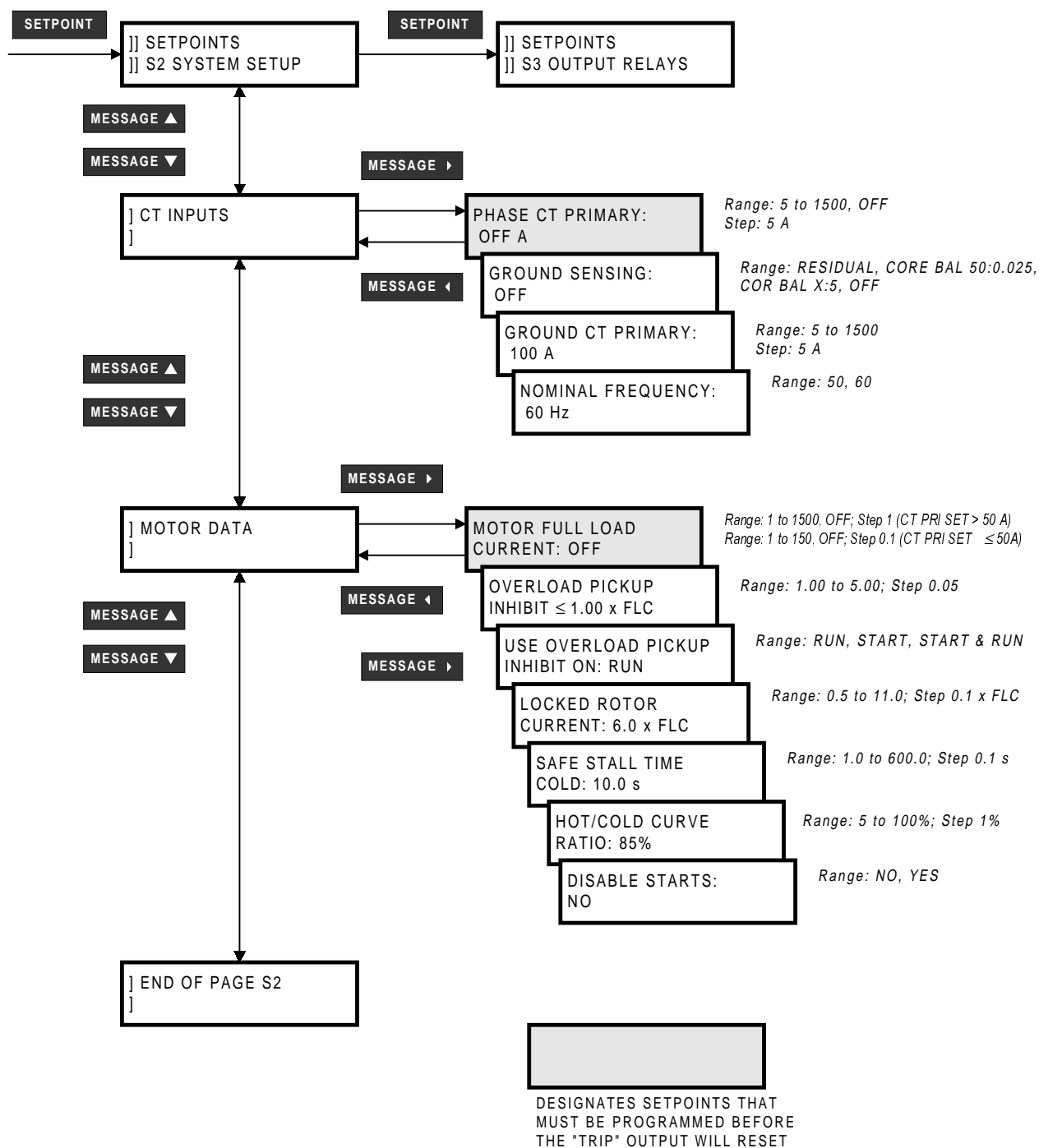


Figure 4-3: SETPOINTS PAGE 2 – SYSTEM SETUP

a) CT INPUTS



NOTE

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 2–4. 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 Power Management 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.

b) 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 1.0× 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 setting programmed in the setpoint 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.

- **OVERLOAD PICKUP INHIBIT ON:** This setpoint allows the overload pickup Inhibit to be applied be during a START, RUN or START and 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:

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

4

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 $100\% - \text{HOT/COLD CURVE RATIO}$, 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 4-31 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

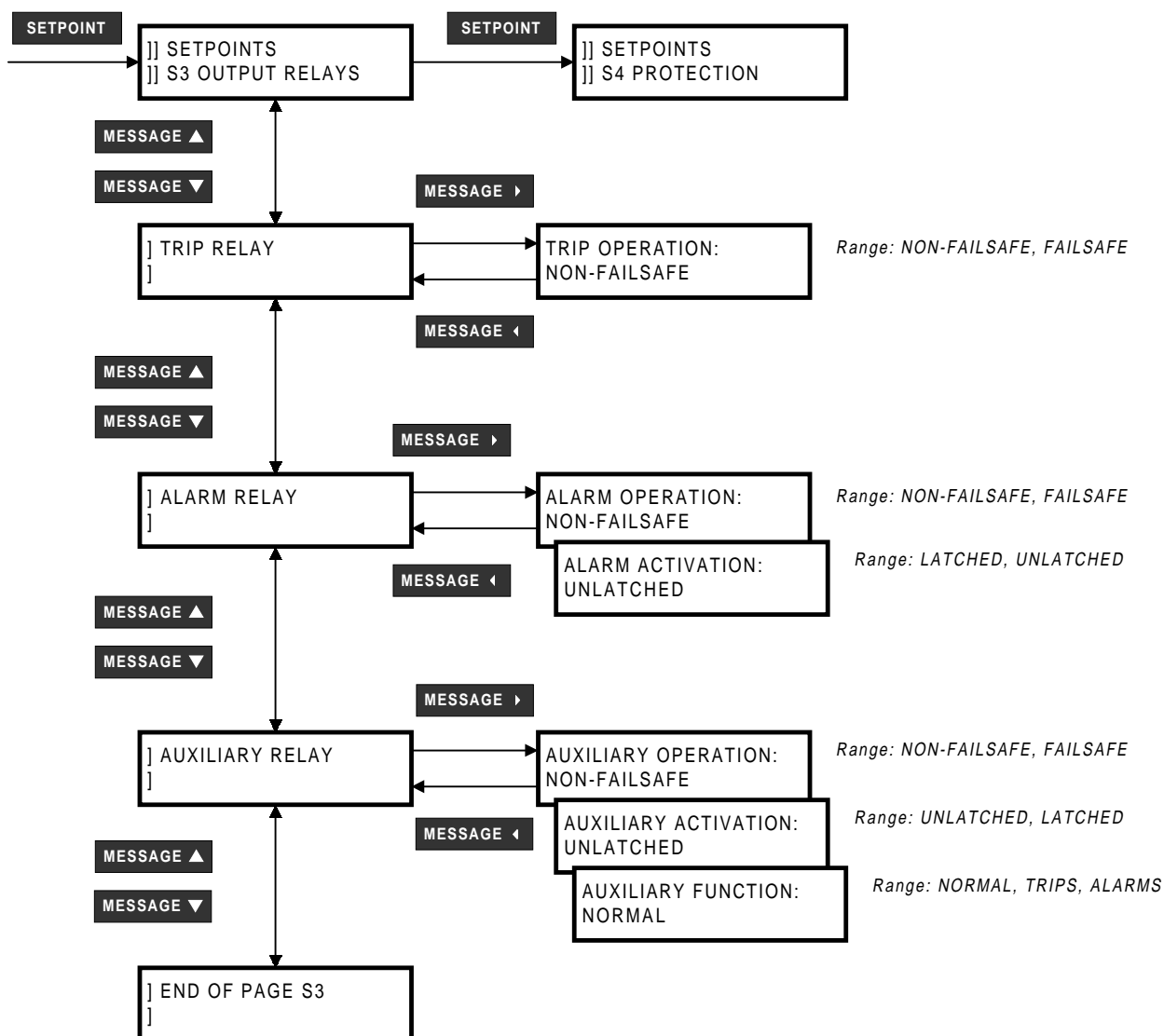


Figure 4-4: SETPOINTS PAGE 3 – OUTPUT RELAYS

NON-FAILSAFE: 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 2-4 with relays programmed non-failsafe, control power not applied

FAILSAFE: 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 2-4 for relays programmed as failsafe when control power is applied

a) 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.

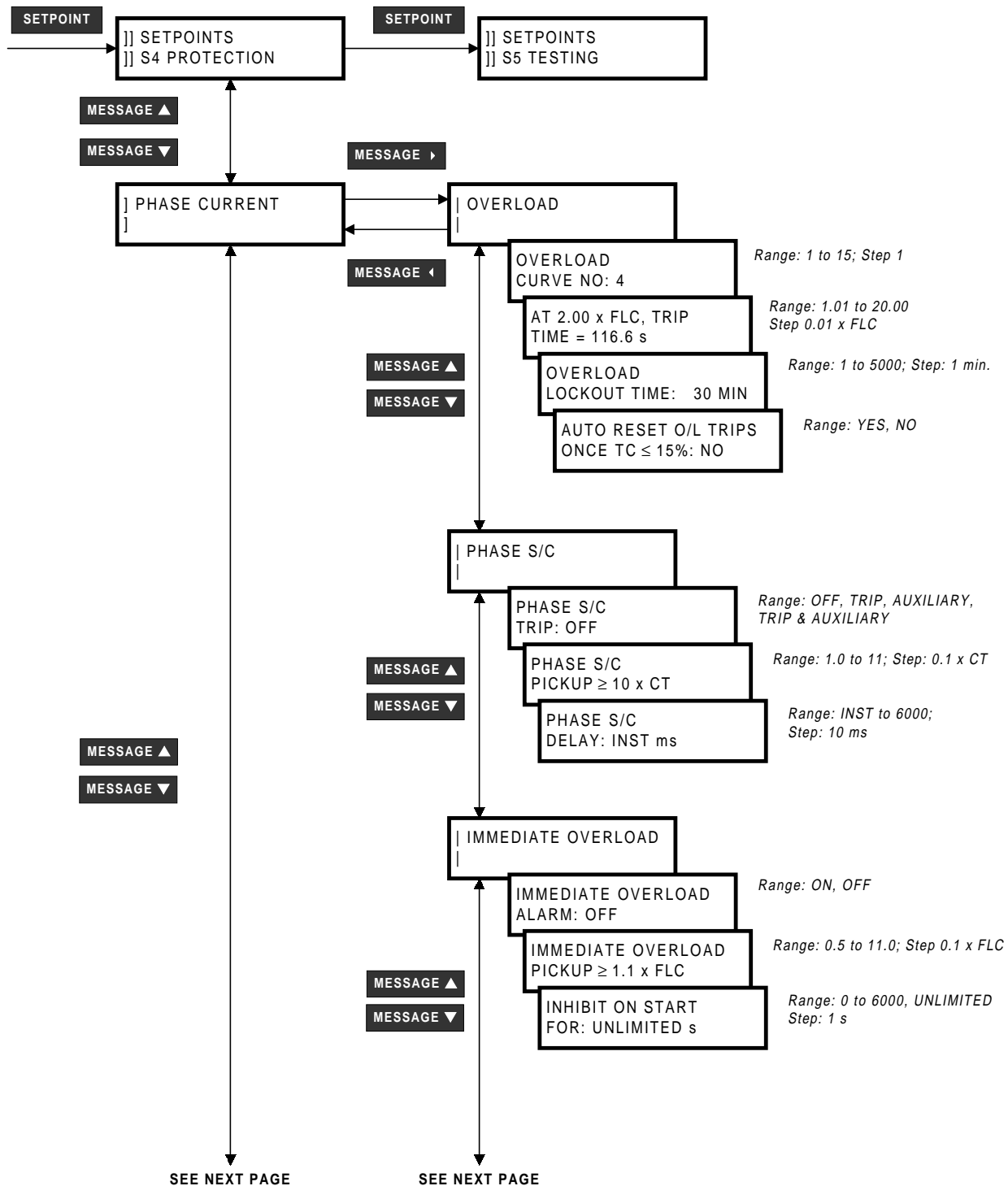
b) ALARM RELAY

- **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.

c) AUXILIARY RELAY

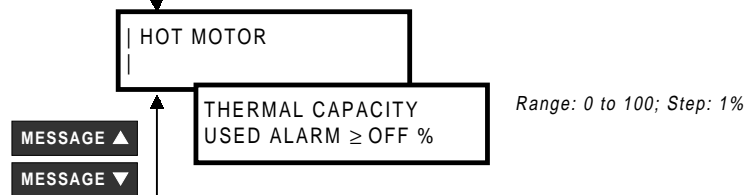
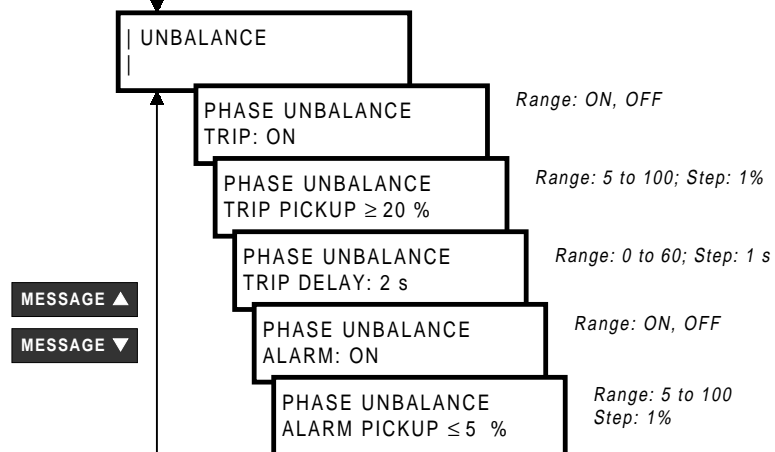
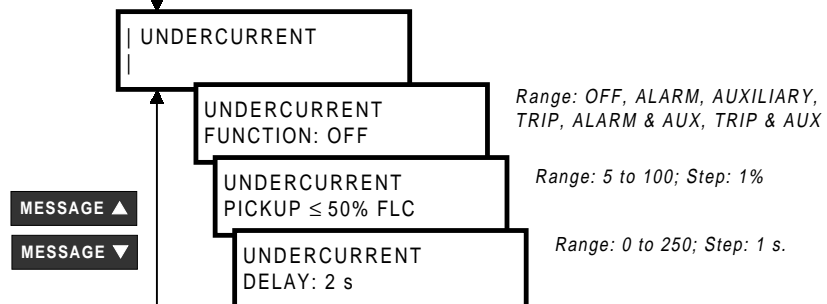
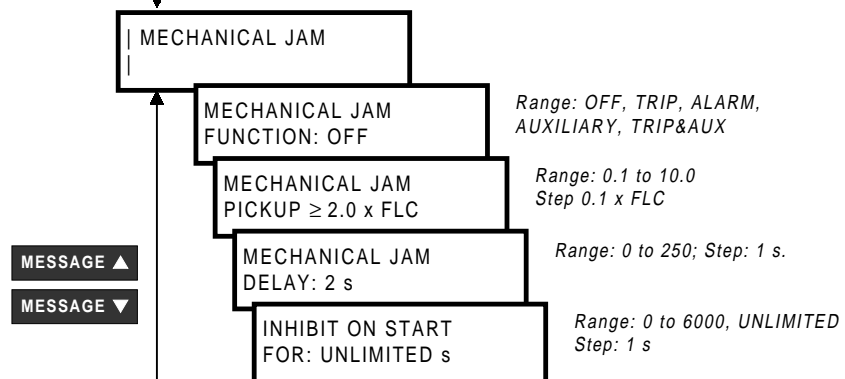
- **AUXILIARY OPERATION:** Any alarm, trip or auxiliary function can be programmed to activate the auxiliary relay. If an output is required when the 239 is not operational due to a loss of control power, select *FAILSAFE* auxiliary operation, otherwise, choose *NON-FAILSAFE*.
- **AUXILIARY ACTIVATION:** 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.

4.5 S4: PROTECTION



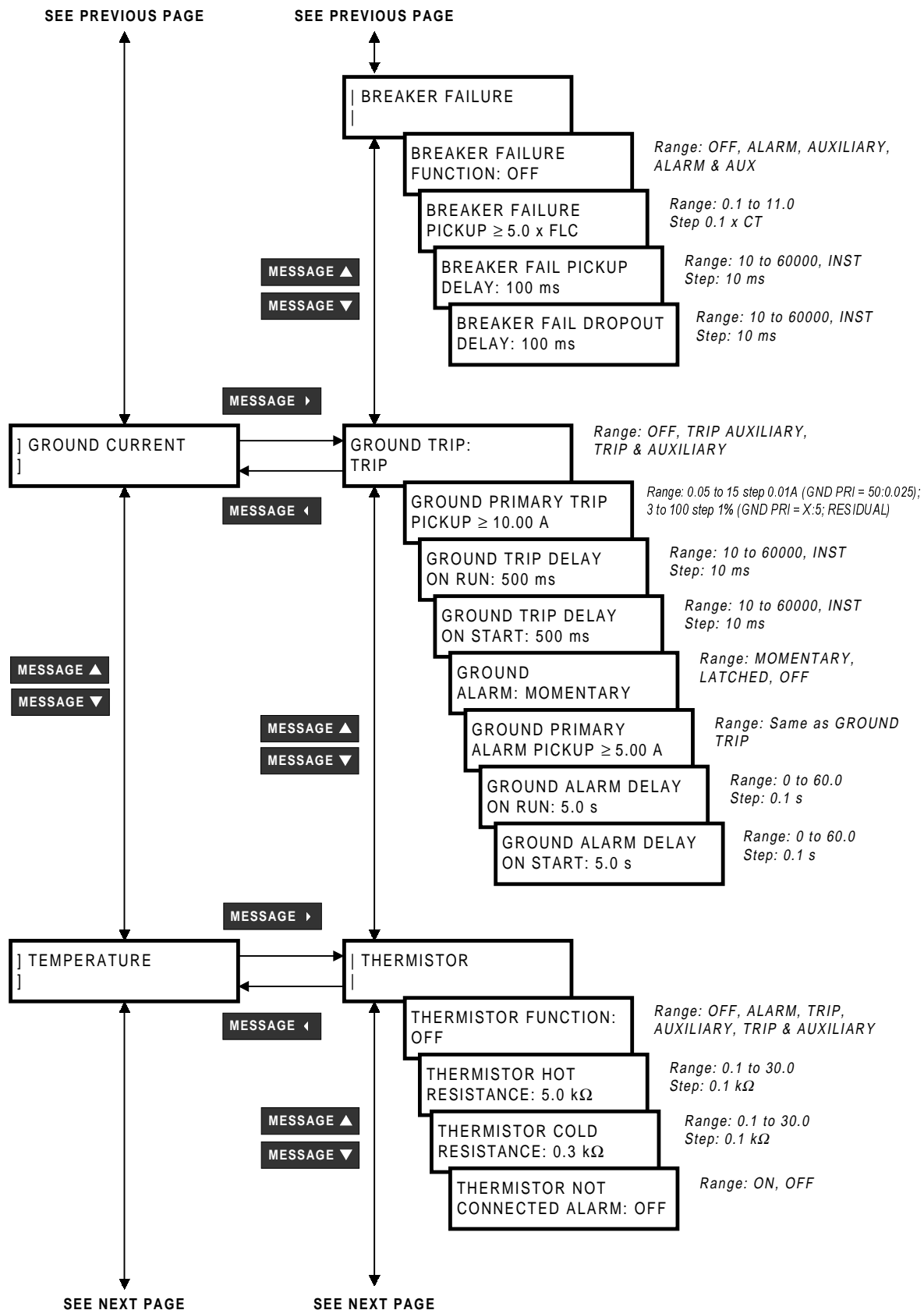
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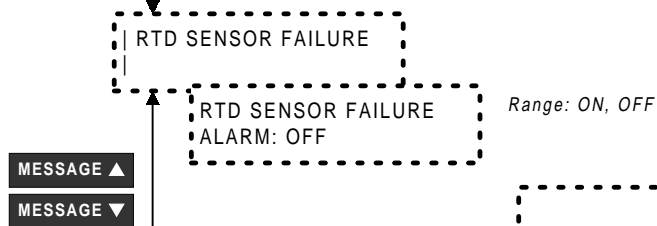
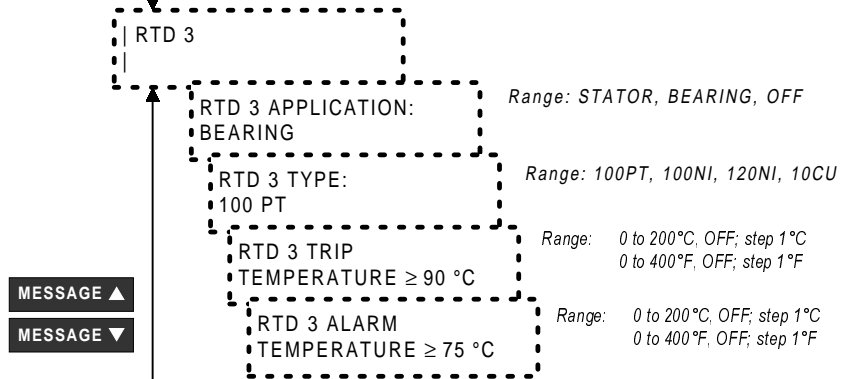
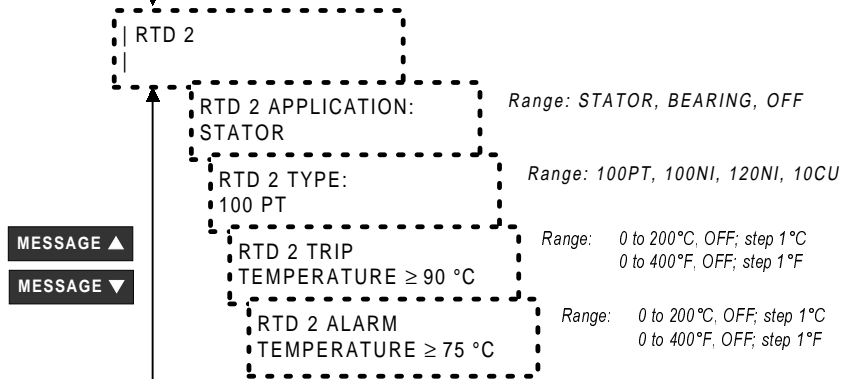
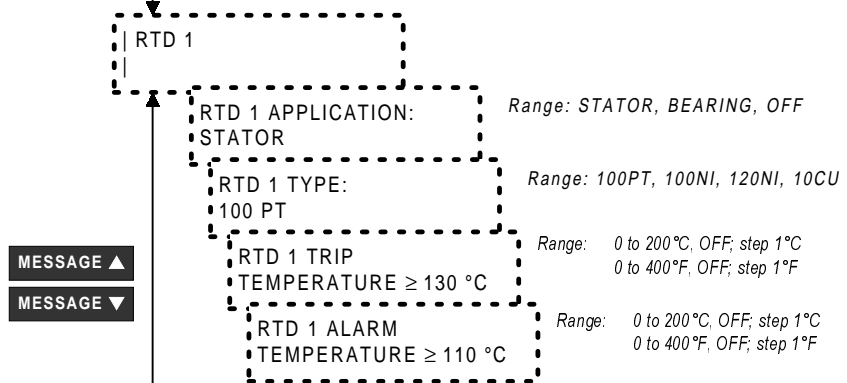
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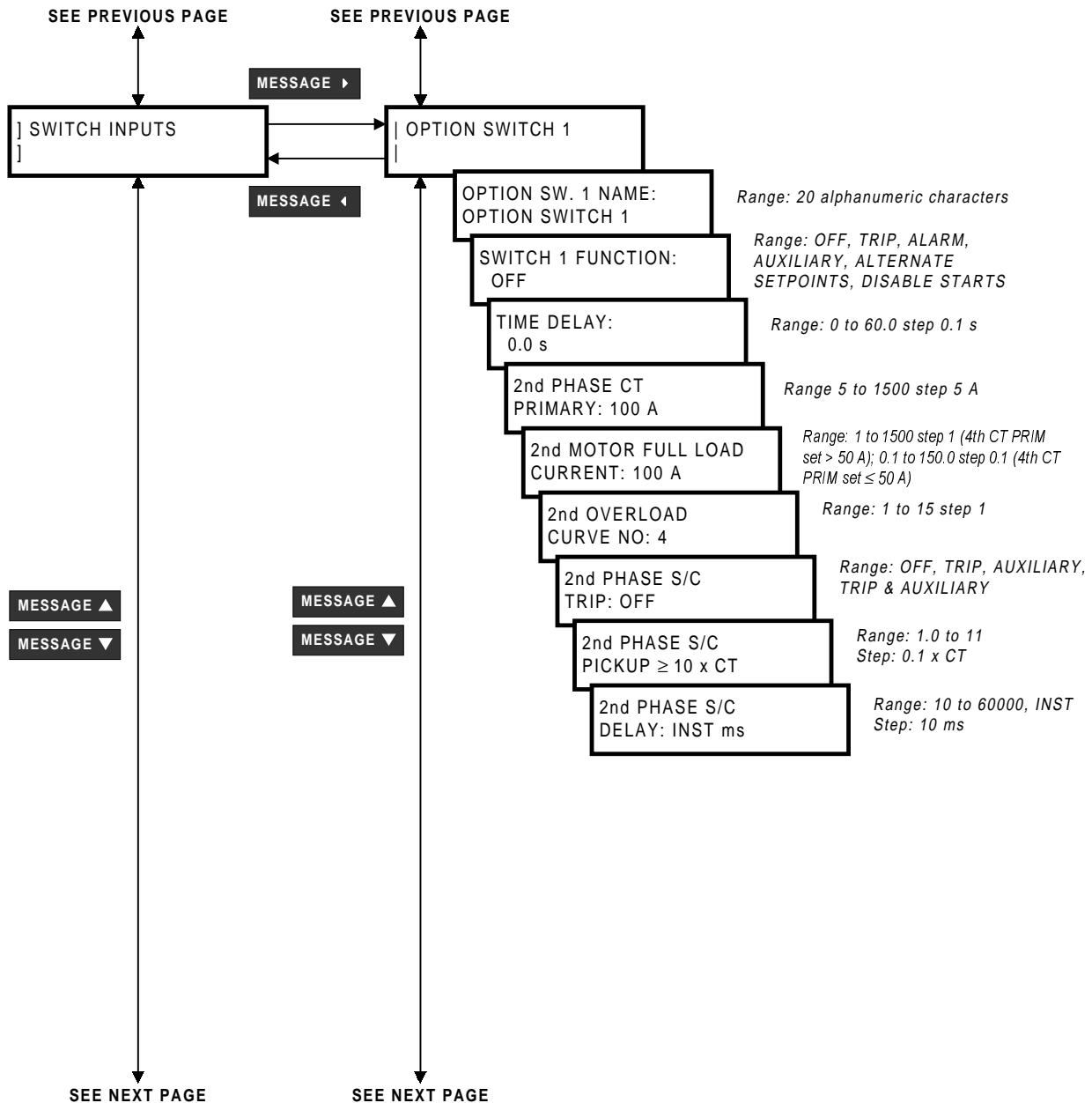
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DESIGNATES SETPOINTS
THAT ARE ONLY VISIBLE IF
RTD OPTION IS INSTALLED



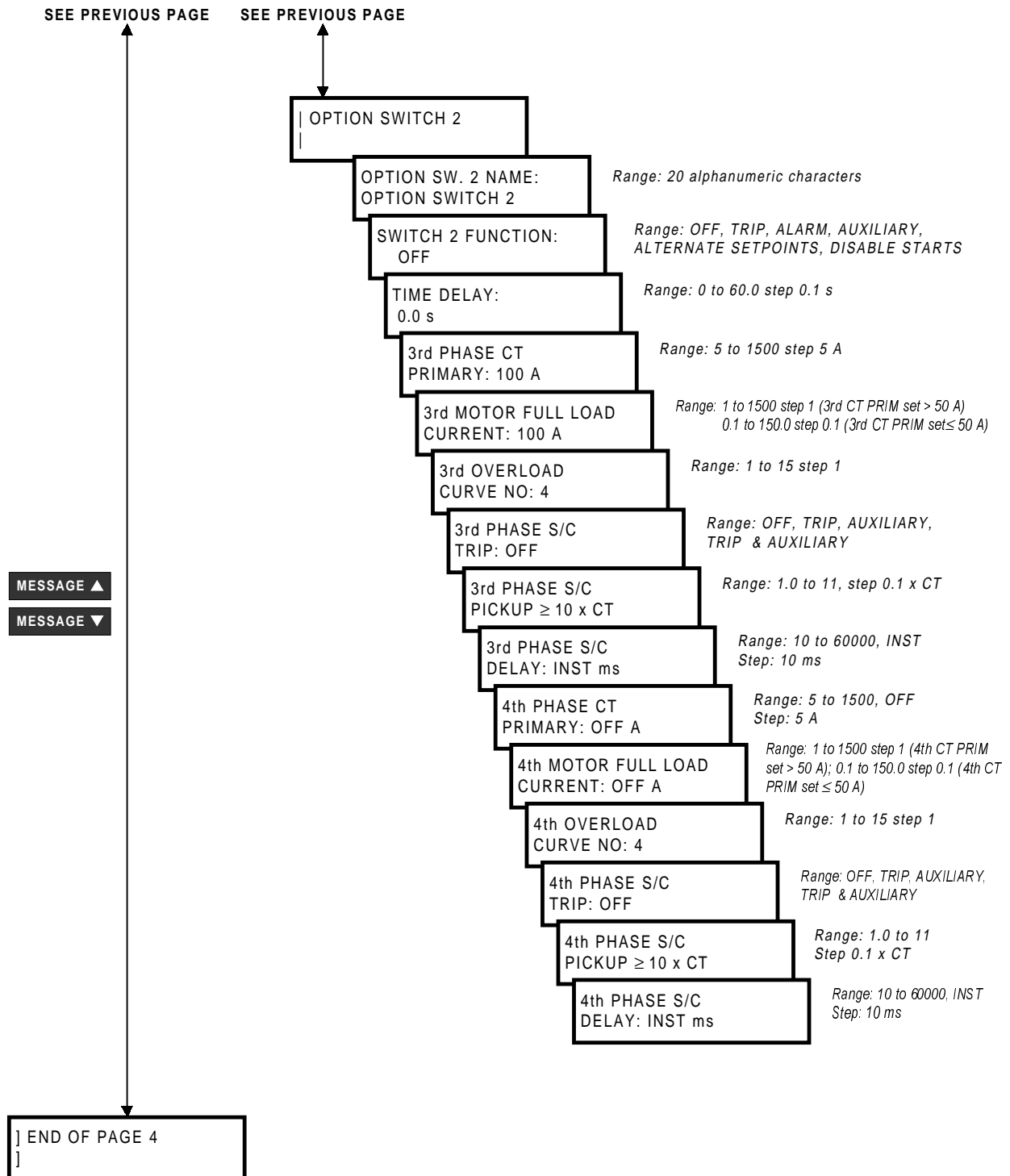


Figure 4-5: SETPOINTS PAGE 4 – PROTECTION

a) 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 4–21 and choose the curve that falls just below the motor damage curve.

Each of the curves represents an \hat{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 4–21 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 4–22. 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 ▼** / **VALUE ▲** 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.

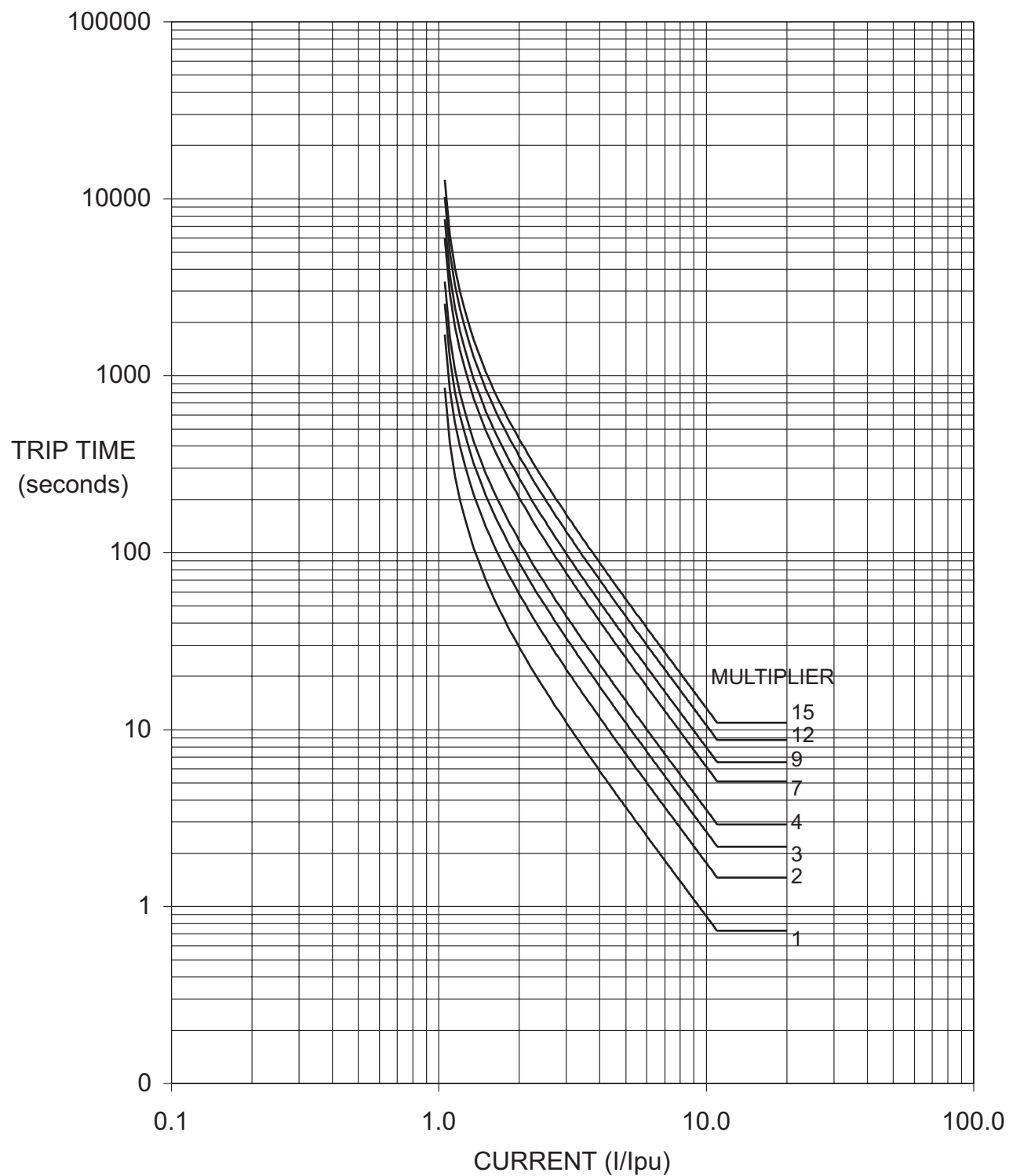
**Figure 4-6: PHASE TIMED OVERLOAD CURVES**

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
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

b) 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 SIC 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 shut-down during a high current fault.

c) 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 ALARM 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.

d) 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.

e) 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.

f) 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.

g) 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.

h) 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 1.4: SPECIFICATIONS on page 1–7 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 1.4: SPECIFICATIONS on page 1–7 for BREAKER FAILURE timing specifications.

i) 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: PROTECTIONIGROUND CURRENTIGROUND 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 5–2 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 5–2 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 5–2 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 5–2 for details on how the 239 detects a start condition.

4.6 TEMPERATURE

a) 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:PROTECTIONTEMPERATUREITHERMISTORITHERMISTOR HOT RESISTANCE: 10.0 kW

S4:PROTECTIONTEMPERATUREITHERMISTORITHERMISTOR COLD RESISTANCE: 0.5 kW

S4:PROTECTIONTEMPERATUREITHERMISTORITHERMISTOR 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 kW.

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 kW.

EXAMPLE 2: NTC THERMISTOR

S4: \PROTECTION\TEMPERATURE\THERMISTOR\THERMISTOR HOT RESISTANCE: 0.7 kW

S4: \PROTECTION\TEMPERATURE\THERMISTOR\THERMISTOR COLD RESISTANCE: 12.0 kW

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 kW.

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 kW.

- **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.

b) 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 Ω platinum DIN 43730 type is the preferred choice for optimum sensitivity and linearity. Other RTDs that can be selected are 100 Ω nickel, 120 Ω nickel and 10 Ω 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 Ω platinum but 100 Ω nickel, 120 Ω nickel, or 10 Ω 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.

c) 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: PROTECTIONTEMPERATURE\RTD 1-3\RTD 1-3 TRIP** and **S4: PROTECTIONTEMPERATURE\RTD 1-3\RTD 1-3 ALARM** should be set to off for any unused RTD terminals.

Table 4–3: RTD RESISTANCE VS. TEMPERATURE

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

4.7 SWITCH INPUTS

a) OPTION SWITCH 1-2

- **OPTION SWITCH 1-2 NAME:** A 20 character name can be assigned to the option switch inputs. See Section 4.2e) PROGRAMMABLE MESSAGE on page 4–5 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 4.3b) MOTOR DATA on page 4–9. 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 4.8: MULTI-SPEED MOTOR below.

4.8 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 nd
X	anything but ALTERNATE SETPOINTS	OPEN	ALTERNATE SETPOINTS	MAIN
X	anything but ALTERNATE SETPOINTS	CLOSED	ALTERNATE SETPOINTS	3 rd
OPEN	ALTERNATE SETPOINTS	OPEN	ALTERNATE SETPOINTS	MAIN
CLOSED	ALTERNATE SETPOINTS	OPEN	ALTERNATE SETPOINTS	2 nd
OPEN	ALTERNATE SETPOINTS	CLOSED	ALTERNATE SETPOINTS	3 rd
CLOSED	ALTERNATE SETPOINTS	CLOSED	ALTERNATE SETPOINTS	4 th

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, 2nd, 3rd, 4th

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

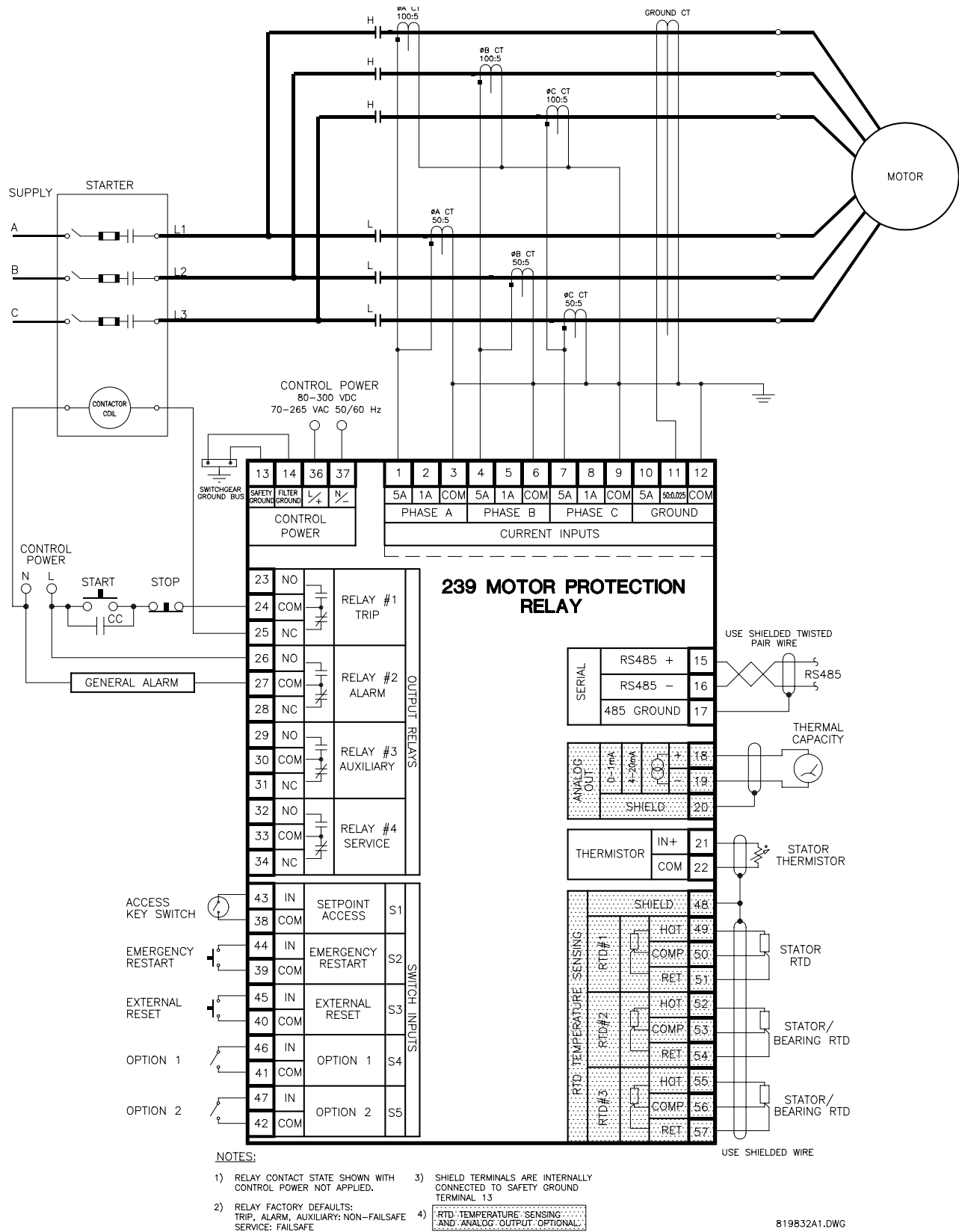
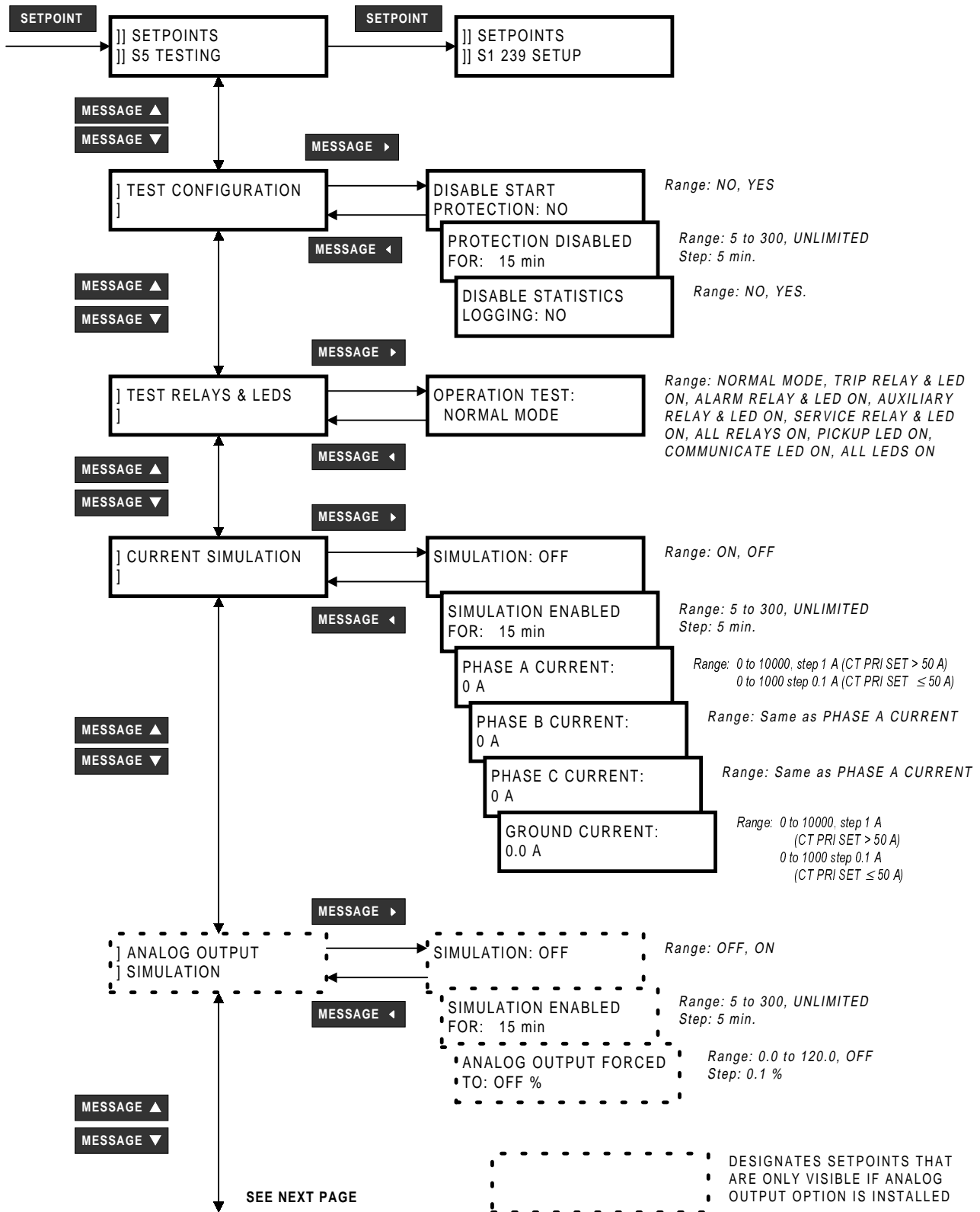


Figure 4-7: TWO SPEED MOTOR WIRING DIAGRAM

4.9 S5: TESTING



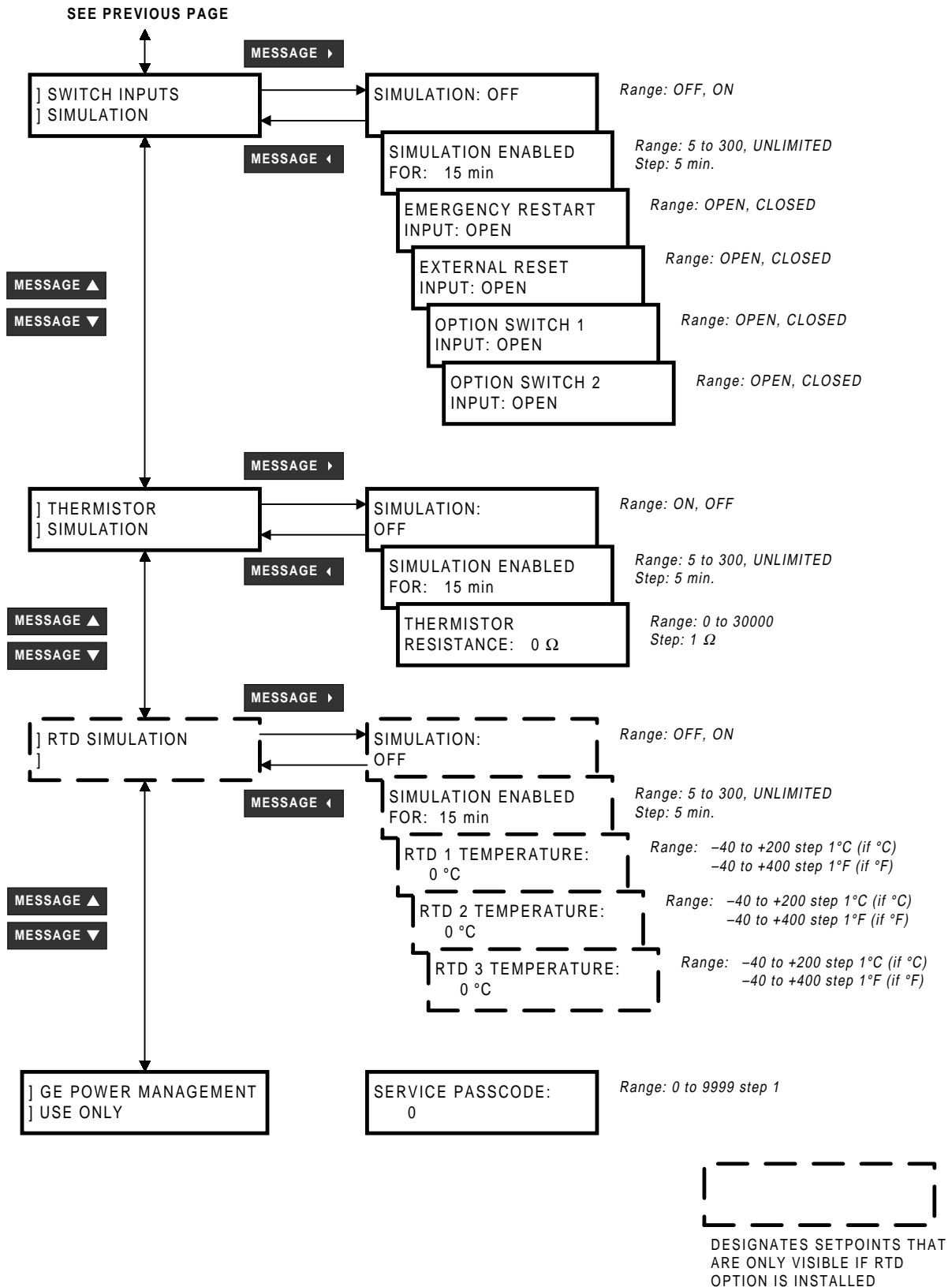


Figure 4-8: SETPOINTS PAGE 5 – TESTING

a) 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 5.2c) **MOTOR STATISTICS** on page 5–5 for further details.

b) 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

c) 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.

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d) 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.

e) 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.

f) 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.

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g) 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.

h) GE POWER MANAGEMENT USE ONLY

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

5.1 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.

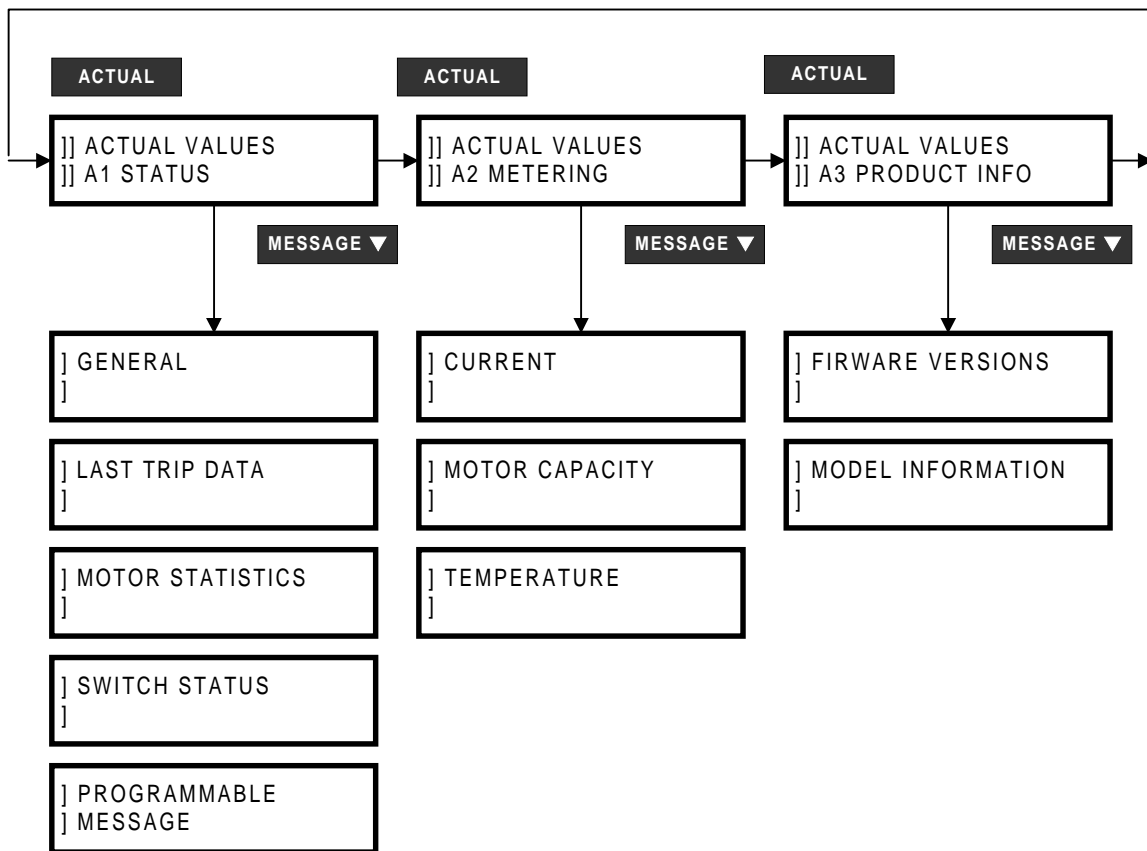
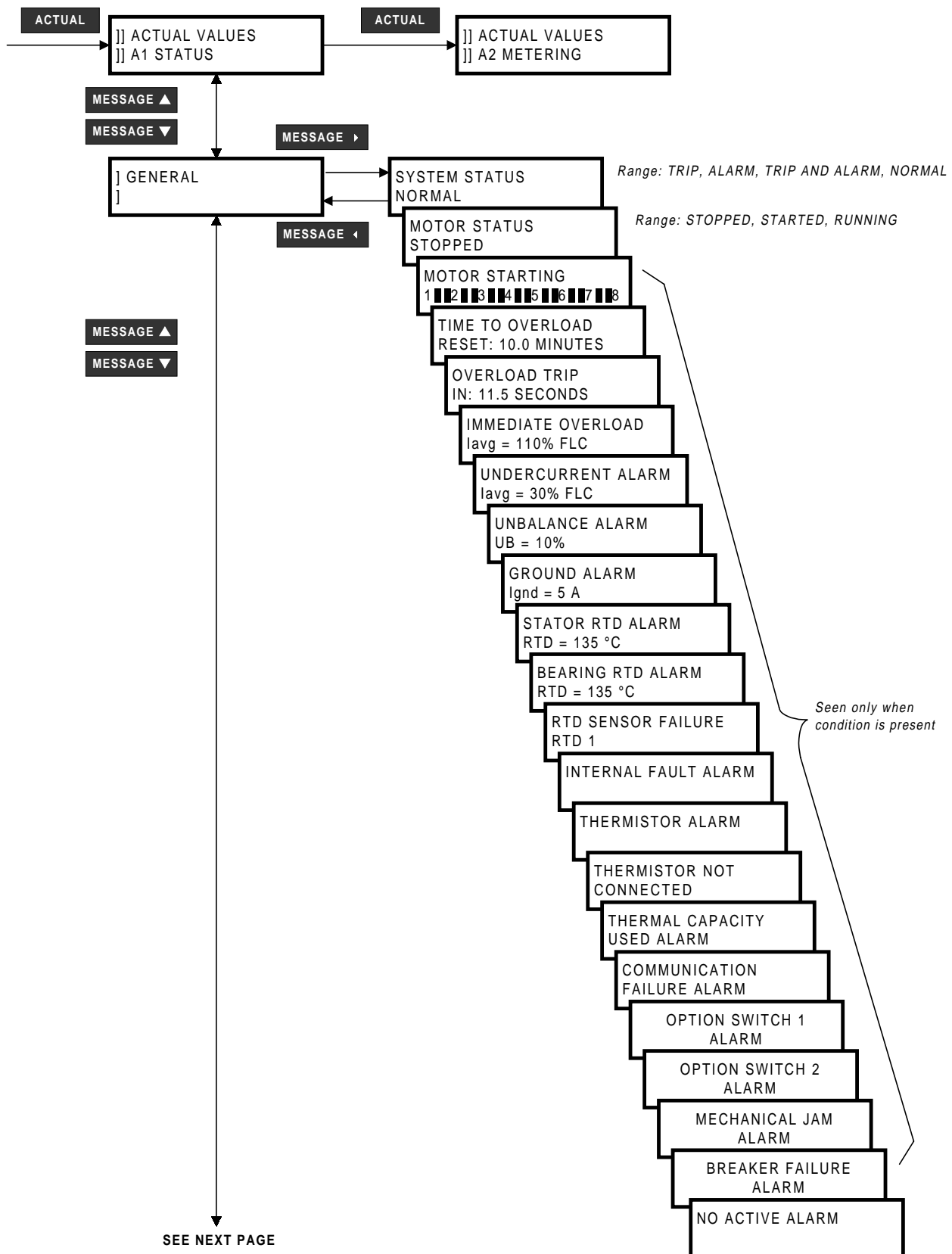
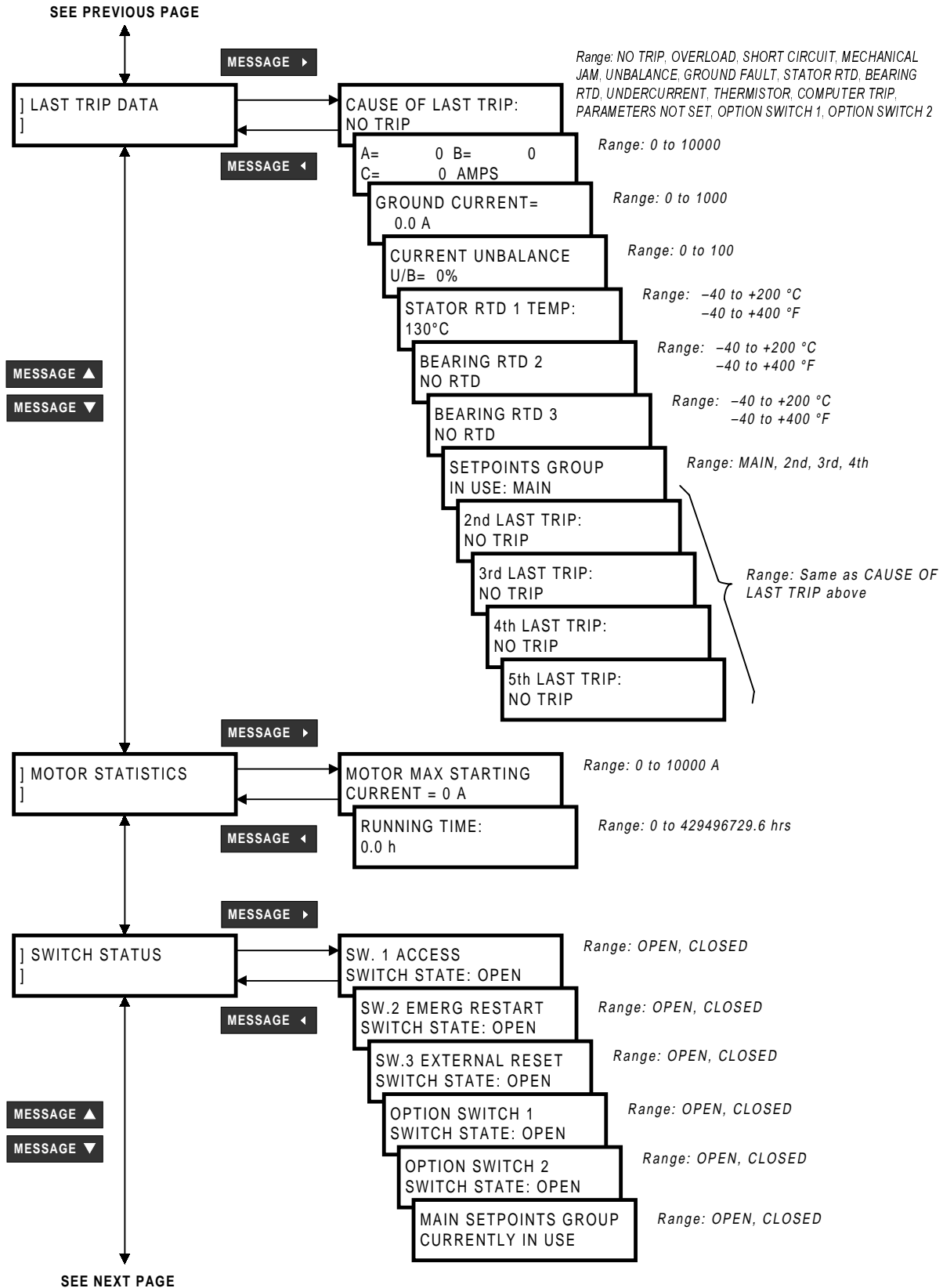


Figure 5–1: ACTUAL VALUES MESSAGE ORGANIZATION

5.2 A1: STATUS





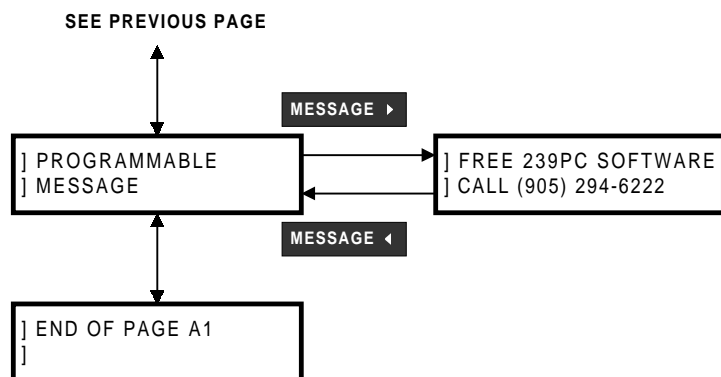


Figure 5–2: ACTUAL VALUES PAGE 1 – STATUS

a) 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'
 ≤ 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.

b) 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 ≤ 50 A. The resolution is 1A if the CT PRIMARY setting is > 50A.

- **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 conditions before restarting the motor.
- **STATOR (BEARING) RTD 1-3 (OPTION):** If any of the 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: METERINGTEMPERATURE. 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 4.7: SWITCH INPUTS on page 4–31. 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.

c) MOTOR STATISTICS

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

d) 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 2–4. 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 4.7: SWITCH INPUTS on page 4–31. One of four possible groups of setpoints can be selected at once. This message displays the currently selected group.

e) 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 4–2 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

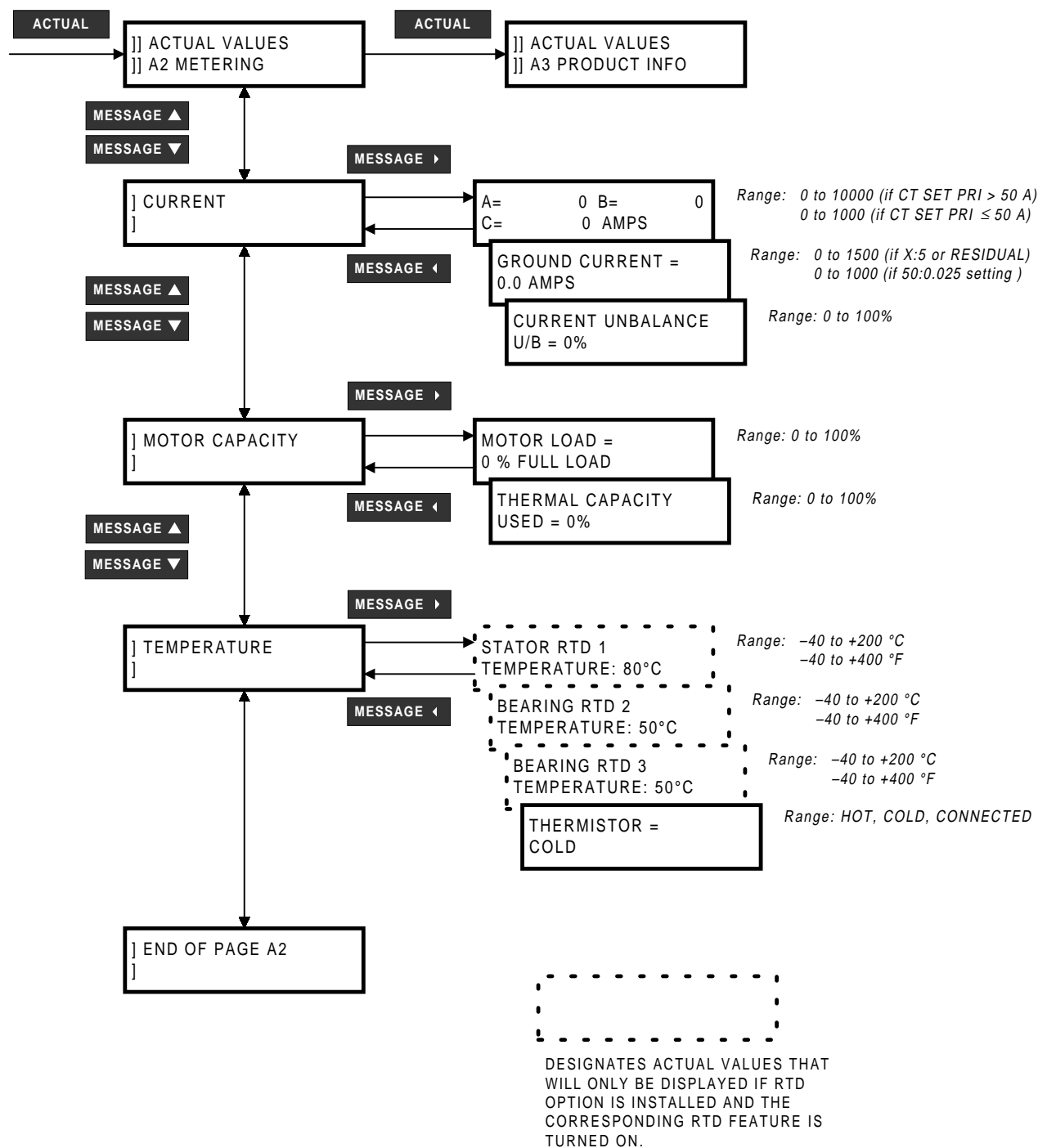


Figure 5-3: ACTUAL VALUES PAGE 2 – METERING

a) 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.

b) 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.

c) 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 k Ω , **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

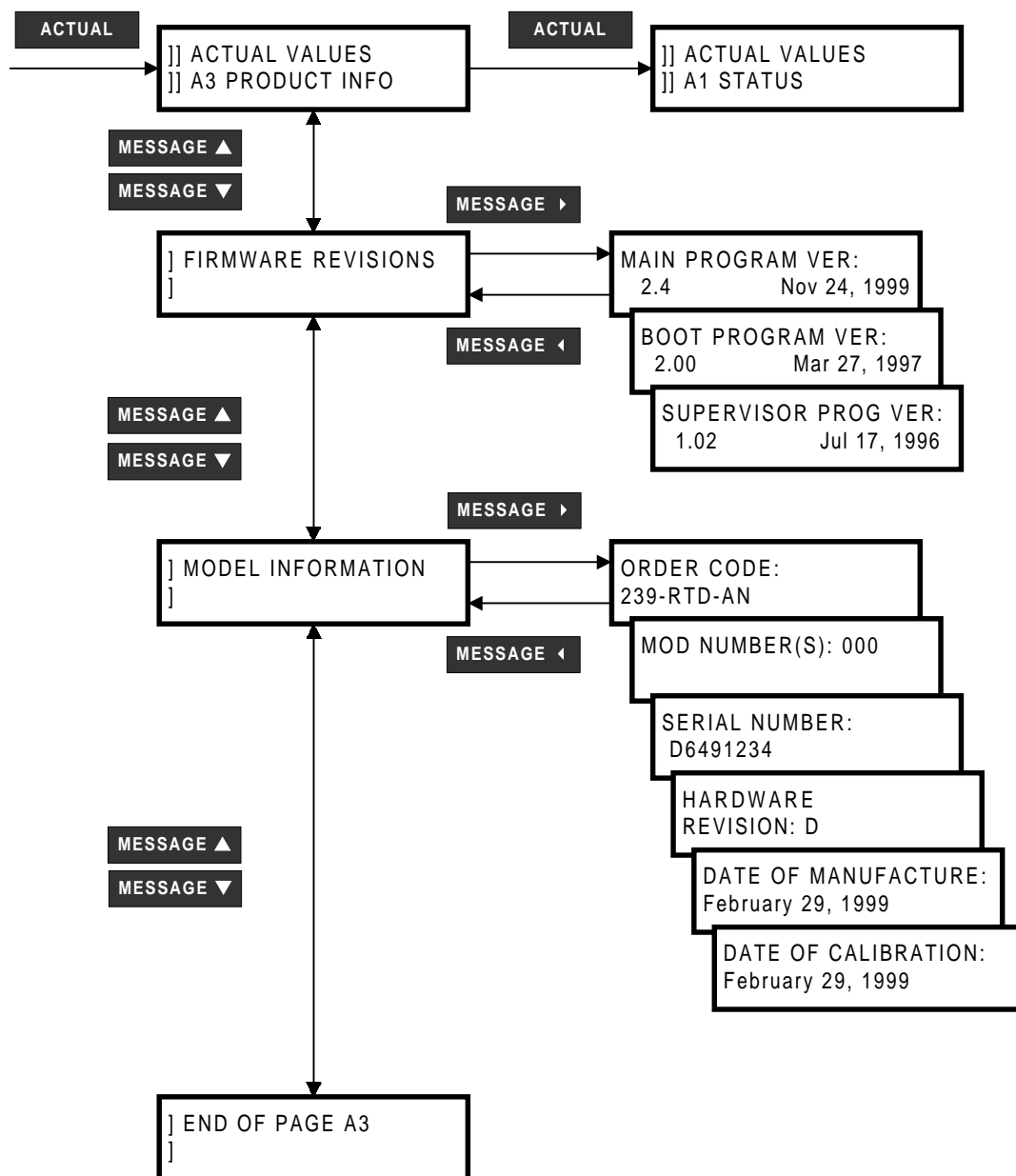


Figure 5–4: ACTUAL VALUES PAGE 3 – PRODUCT INFO

a) 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.

b) 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 have been installed, basic unit

‘239-RTD’ → RTDs option has been installed

‘239-AN’ → Analog Output option has been installed

‘239-RTD-AN’ → RTDs and Analog Output options have been 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 1.4: SPECIFICATIONS on page 1–7 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 Power Management.

6.1 OVERVIEW

Although setpoints can be entered manually using the front panel keys, it is much easier to use a computer to download values through the communications port. A free program called 239PC is available from Multilin to make this as convenient as possible. With 239PC running on your personal computer under Windows it is possible to:

- Program/modify setpoints
- Load/save setpoint files from/to disk
- Read actual values
- Monitor status
- Plot/print trends
- Read pre-trip data and trip record
- Get help on any topic
- Print the instruction manual from disk

The 239PC software allows immediate access to all the features of the 239 with easy to use pull down menus in the familiar Windows environment.

The 239PC software can run without a 239 connected to a computer and save settings to a file. If a 239 is connected to a serial port on a computer and communications is enabled, the 239 can be programmed from the *Setpoint* screens. In addition, measured values, status and trip messages can be displayed with the *Actual* screens.

6.2 HARDWARE CONFIGURATION

The 239 communications is setup as shown in the figure below.

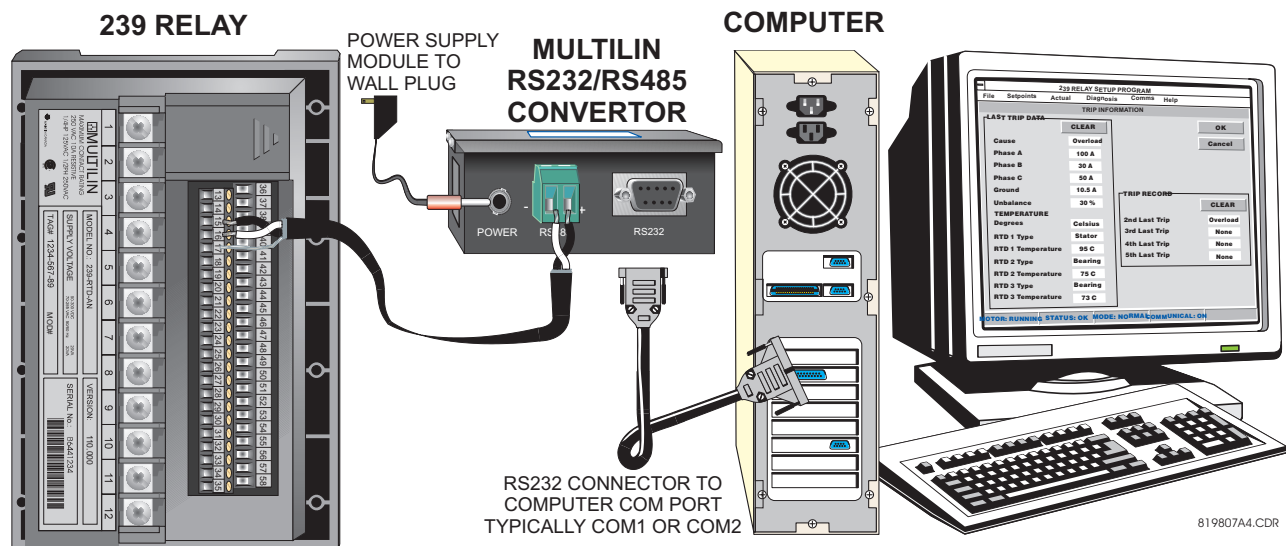
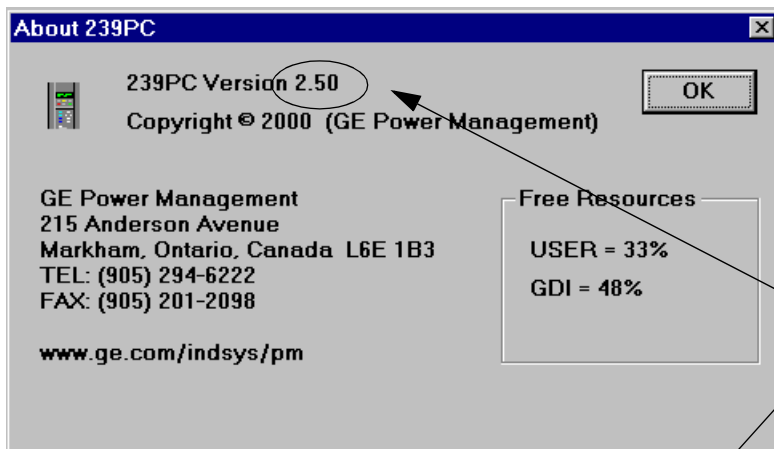
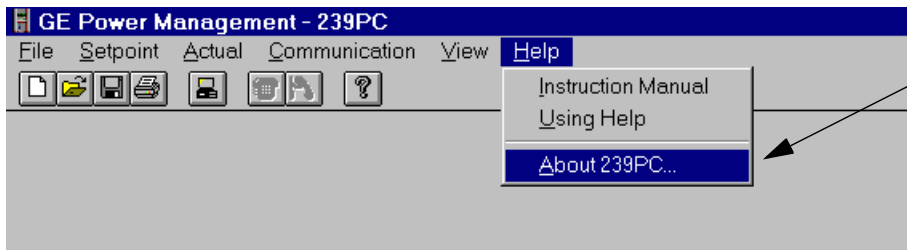


Figure 6–1: TYPICAL COMMUNICATIONS SETUP

6.3 239PC VERSION

If the 239PC software is already installed, check if it needs to be upgraded as shown below. If the 239PC software is installed and is up-to-date then skip to 6.4: INSTALLING/UPGRADING 239PC on page 6-3.



6



GE Power Management

239 MOTOR PROTECTION RELAY Instruction Manual

Firmware Revision: 2.50
239PC Software: 2.50 (no newer)
Manual P/N: 1601-0060-D6
Copyright © 2001 GE Power Management

Front page of manual.



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Tel: (905) 294-6222 Fax: (905) 294-8512
Internet: <http://www.GEindustrial.com/pm/>



6.4 INSTALLING/UPGRADING 239PC

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

- Windows® 3.1 / Windows 95 or higher is installed and running
- 10MB free hard disk space

If the 239PC software already exists and is being upgraded, then please note down exact path and the directory name of the current installation because it will be required during the new installation process.

1. Start Windows.
2. Insert the GE Power Management Product CD into the appropriate drive (alternately, you can go the the GE Power Management website at www.GEindustrial.com/pm to continue the installation—the steps are roughly the same).
3. The following window will be displayed by your default web browser once the CD drawer, with the Product CD, is closed:



4. Use the mouse to click on **Software**. If 3.5" floppy disks are required, they may be created from the installation program on this CD, created from the GE Power Management webpage at www.GEindustrial.com/pm, or ordered directly from the factory.

6

5. The browser will display the GE Power Management product list in alphabetical order. Choose the **239 Motor Protection Relay** from this list.

6. Select the 239PC program from the list of software and firmware items.

239 Software

PC Program:

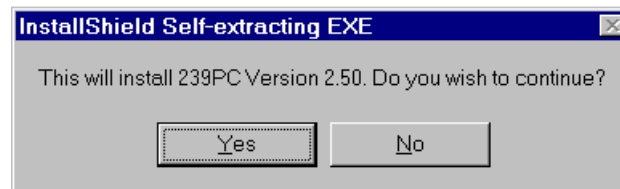
- [239PC Version 2.50 \(.exe\)](#) [4M]



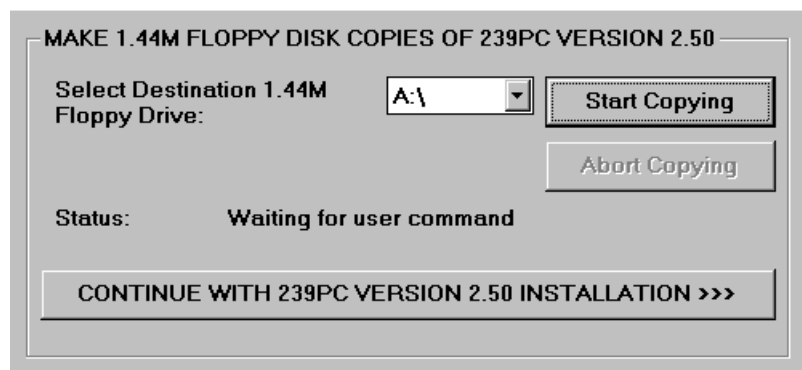
Relay Firmware:

- [2.50 Firmware serial# beginning with B or C \(.zip\)](#) [58k]
- [2.50 Firmware for serial# beginning with D \(.zip\)](#) [59k]

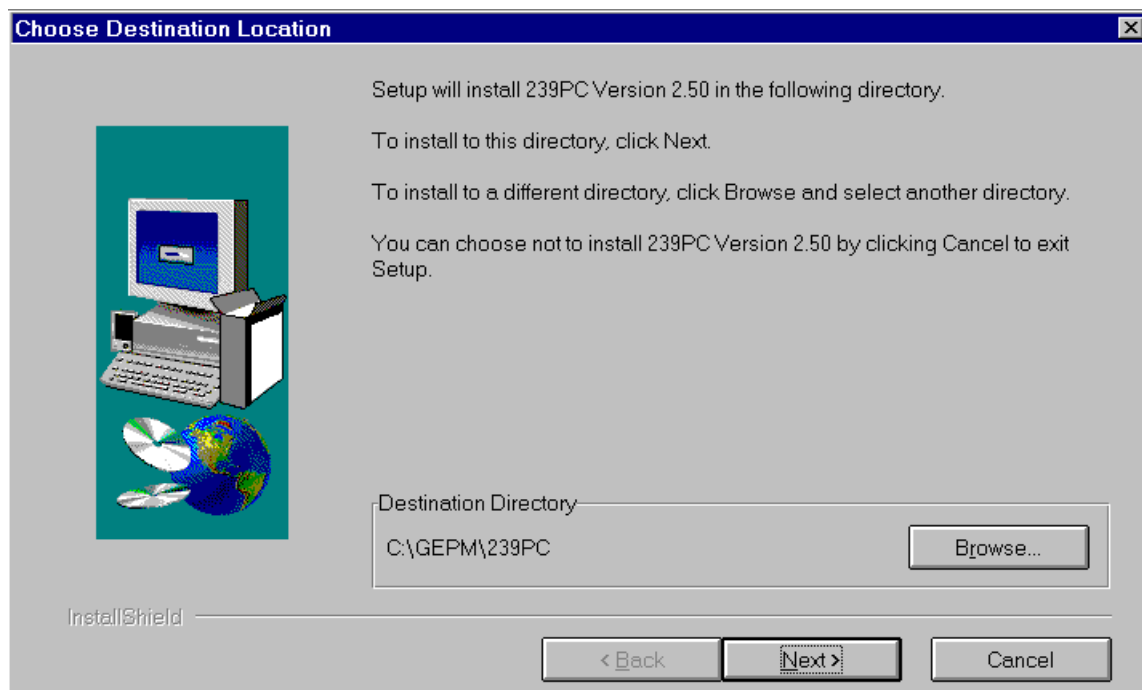
7. The browser will launch the **File Download** window. Select the **Run this program from its current location** option and click **OK**. The following window will appear.



8. Verify that you wish to install 239PC by clicking **Yes**.
9. Click on **CONTINUE WITH 239 PC VERSION 2.50 INSTALLATION** to continue installing the PC software directly to your hard drive. If you wish to make a 1.44MB floppy disk containing the 239PC software, click on **Start Copying**.



10. The install program will prompt for a destination folder.



11. If the program is not to be installed in the default directory, or 239PC is already installed in a different location, click on **Browse** and enter the complete path for 239PC. If 239PC is already installed, the old files will be replaced with new ones. Click **Next** to continue with the installation process once the destination directory is correct.
12. The 239PC install program will ask you to choose between **Typical**, **Compact**, and **Custom** setup (**Typical** is fine for almost all cases). Choose the desired type of setup preferred and click **Next** to continue the installation process.
13. You will be prompted to choose a folder name to place the 239PC icon. Select a folder and click **Next** to continue.
14. Click on **Finish** to complet the installation of 239PC. It is recommended that you restart Windows before using the program.



NOTE

The 239PC program may also be installed from the GE Power Management Website at www.GEindustrial.com/pm. Follow the instructions above for installation.

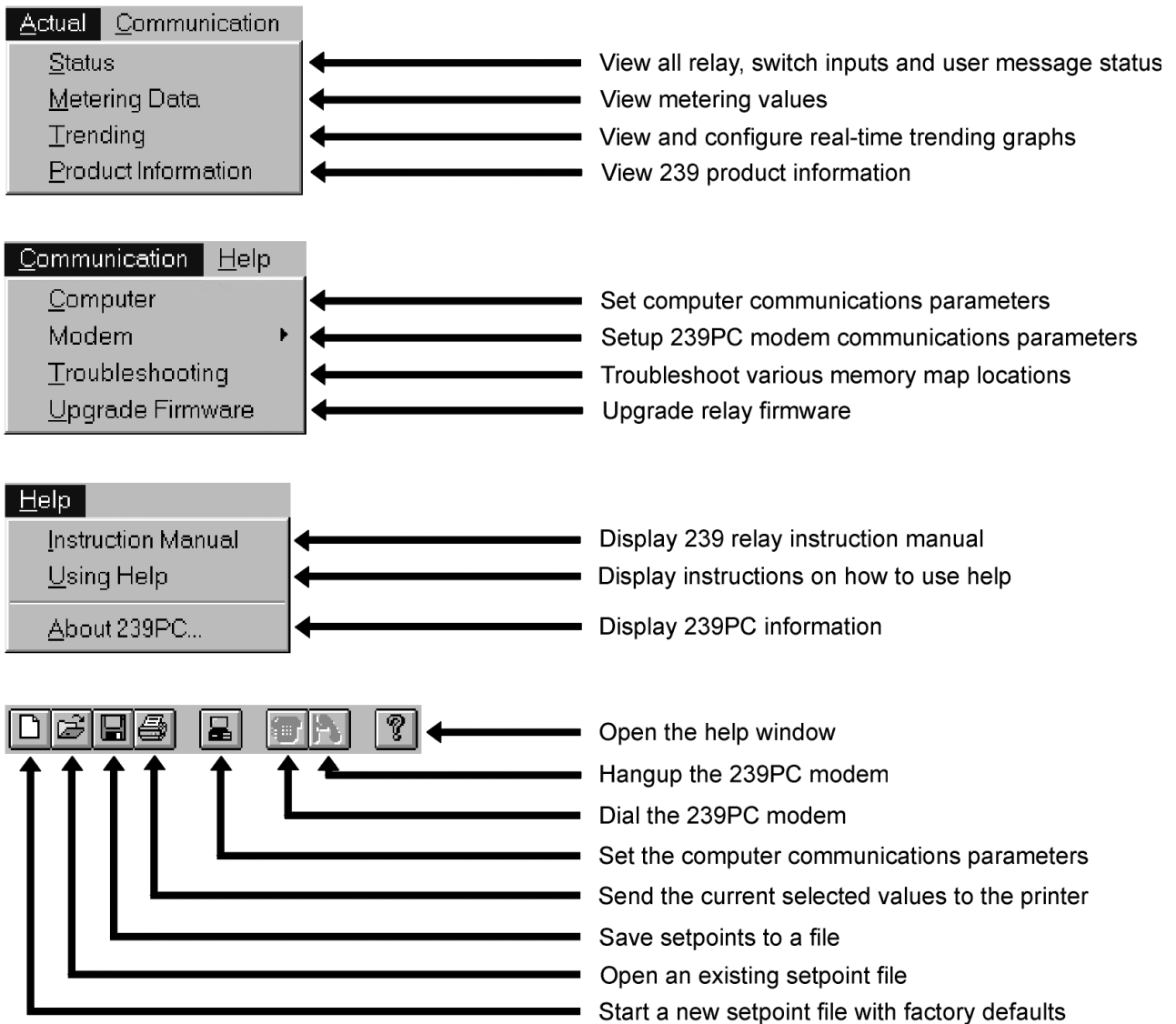
6.5 239PC MENU STRUCTURE

File	Setpoint	Actual	Comm
New		Ctrl+N	← Create a new setpoints file with factory defaults
Open...		Ctrl+O	← Open an existing file
Save As		Ctrl+S	← Save the file to an existing or new name
Properties			← Set setpoint file version and options
Send Info to Relay			← Send setpoint file information to the relay
Print Setup			← Select which values to be printed/Setup printer
Print Preview			← Preview selected values to be printed
Print...			← Print selected values
Exit			← Exit the 239 setup program

Setpoint	Actual	Communication	Help
Setpoint Access			← Disable/Enable write access to the relay
239 Setup			← Change 239 setup setpoints
System Setup			← Change system setup setpoints
Protection			← Change phase current protection setpoints
Output Relays			← Change ground current protection setpoints
Switch Inputs			← Change temperature protection setpoints
Testing			
User Map			

6

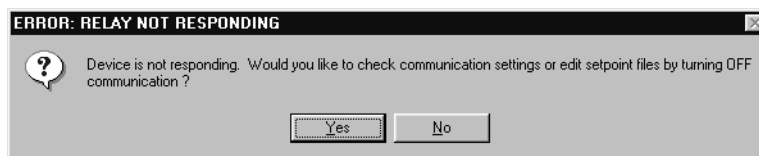
Setpoint	Actual	Com
Setpoint Access		
239 Setup		
System Setup		
Protection		
Output Relays		← Change output relays setpoints
Switch Inputs		← Change switch inputs setpoints
Testing		← Test/Simulate various 239 inputs & outputs
User Map		← User can remap all actual values and setpoint registers



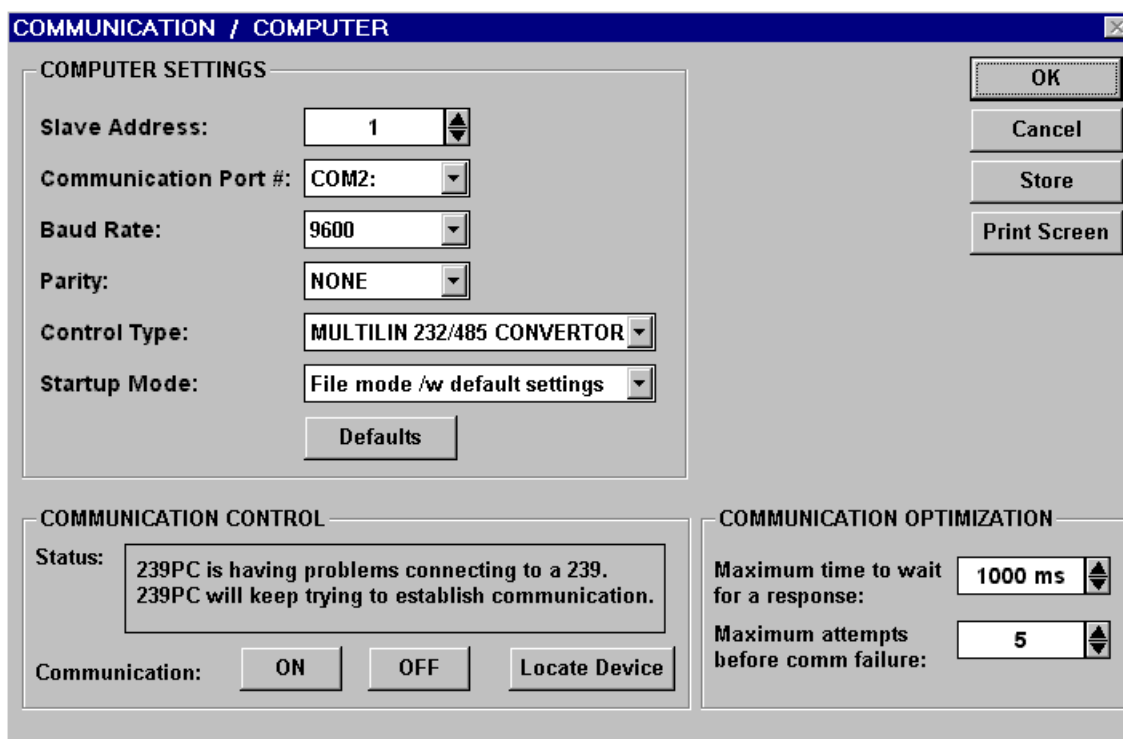
6.6 CONFIGURING 239PC

1. Start 239PC by double-clicking the **239PC** icon in the GE Power Management folder (or alternate folder containing the 239PC icon) or from the Start menu.
2. Once 239PC starts to execute, it will attempt to communicate with the relay. If communication is established successfully, the screen and LEDs on the relay graphic shown in the 239PC window will display the same information as the actual relay.

3. If 239PC cannot establish communication with the relay, the following message will be displayed.



4. Click on **Yes** to edit the 239PC communication settings. This will display the **COMMUNICATION/COMPUTER** window shown below.

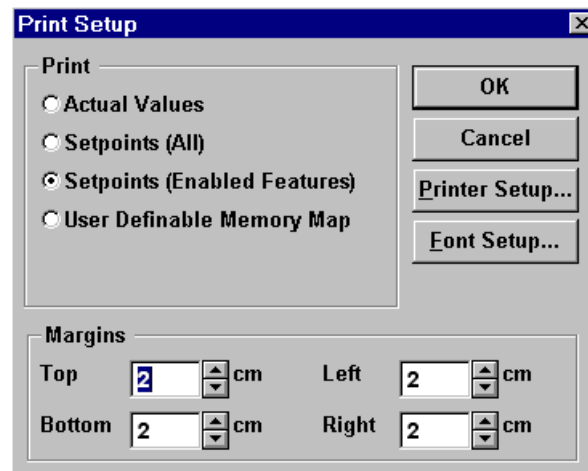


5. Set **Slave Address** to match the relay address setpoint.
6. Set **Communication Port #** to the COM port where the relay is connected.
7. Set **Baud Rate** to match the relay baud rate setpoint.
8. Set **Parity** to match the relay parity setpoint.
9. If using the GE Power Management F485 converter, leave the **Control Type** setting as is.
10. Set **Startup Mode** to "Communicate with relay".
11. Click the **ON** button to communicate with the relay and 239PC will notify when communications have been established with the relay. If it fails to communicate, check the following:
- Ensure that the settings above match the relay settings.
 - Ensure the COM port setting matches the COM port being used.
 - Ensure the hardware is connected correctly as shown in Figure 6–1: TYPICAL COMMUNICATIONS SETUP on page 6–1.
 - Ensure the RS485 cable polarity is correct and connected to the correct relay terminals.

6.7 239 FIRMWARE UPGRADE

a) STEP 1—SAVING AND PRINTING SETPOINTS

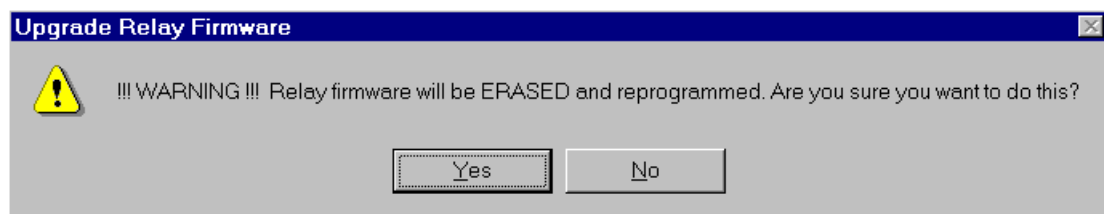
1. Save the 239 setpoints to a file by selecting **Save As** from the **File** menu.
2. 239PC will prompt for a file name and location. Choose an appropriate file name and directory then click **OK** to continue saving the setpoints.
3. Select **Print Setup** from the **File** menu.
4. The **Print Setup** dialog box (shown below) will appear. Select the desired information to be printed, in this case **Setpoints (All)**, and then click **OK**.



5. Select **Print** from the **File** menu.
6. Ensure the printer selected is setup and on-line and click **OK** to print setpoints.

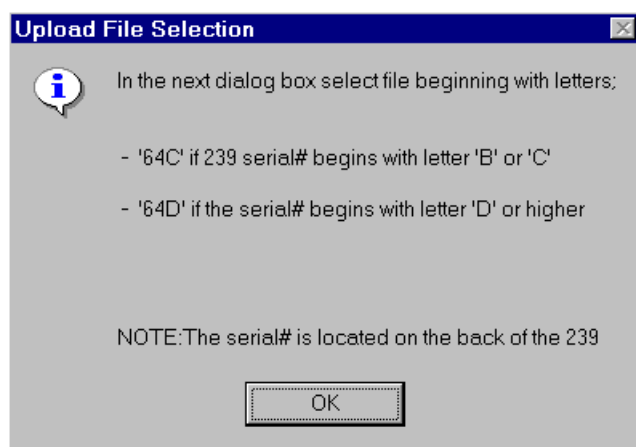
b) STEP 2—LOADING NEW FIRMWARE INTO THE 239

1. Select **Upgrade Firmware** from the **Communication** menu.
2. The following window will appear. Select **Yes** to proceed or **No** to abort the process.

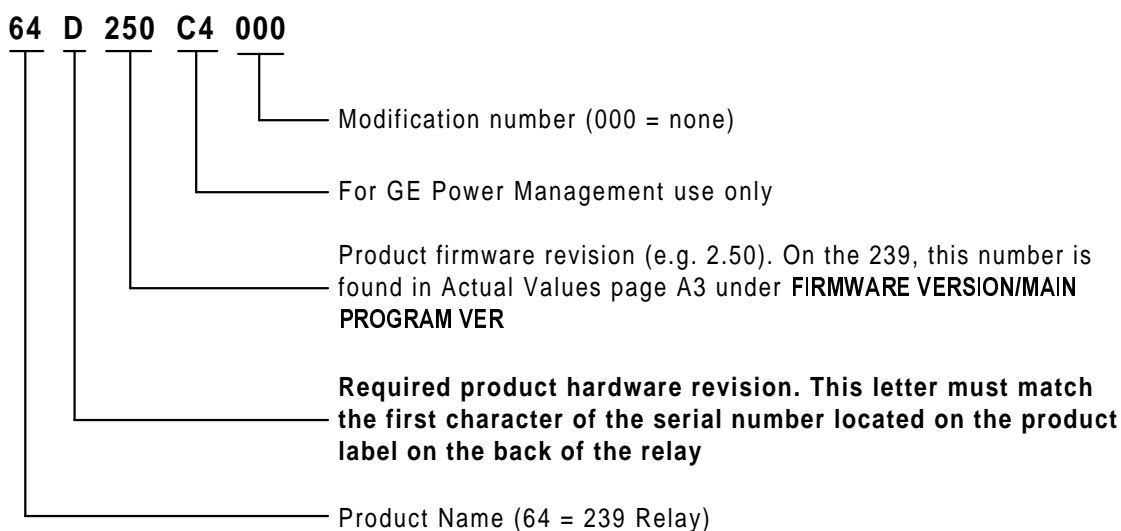


3. The file to be loaded into the 239 **must** match the hardware inside the 239.
 - If the 239 serial number begins with B or C, select the file beginning with the characters 64C.
 - If the 239 serial number begins with D, select the file beginning with the characters 64D.

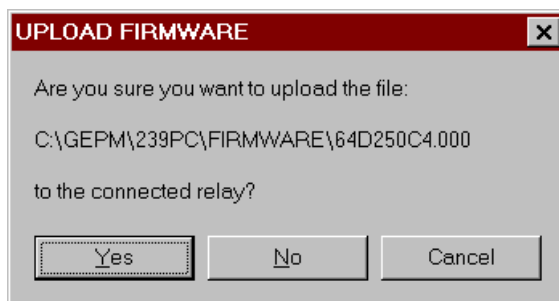
This is indicated in the following dialog box. Click **OK** to continue.



4. The Load Firmware dialog box appears. The firmware file name has the following format:



5. Locate the firmware file to be loaded into the relay and click **OK** to proceed.
6. The following dialog box will appear; select
- **Yes** to proceed
 - **No** to load a different firmware file
 - **Cancel** to abort the process



The program will now prepare the relay to receive the new firmware file. The 239 will display the UPLOAD MODE message.

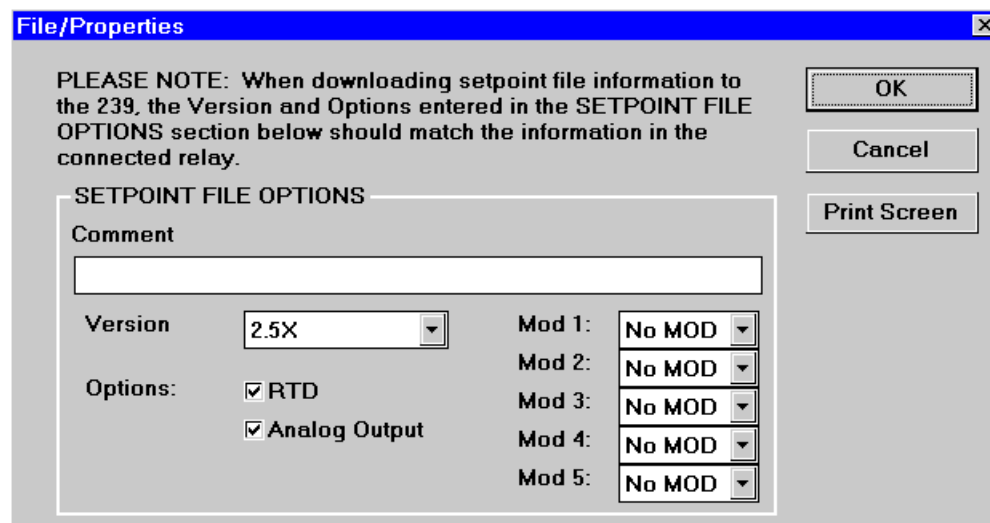
7. A dialog box will appear indicating the file transfer progress and time elapsed. The entire download process takes approximately three minutes.
8. The following dialog box will appear when the firmware has been successfully loaded into the relay.



9. Carefully read any notes indicated in the box and click on **OK** to return to the main screen. If the relay does not communicate with the 239PC program, ensure the following setpoints agree with the 239PC SE settings shown in the **COMMUNICATION/COMPUTER** window.

c) STEP 3—LOADING SAVED SETPOINTS

1. Select **Open** from the **File** menu.
2. Select the file containing the setpoints to be loaded into the relay (saved in Step 1).
3. Select **Properties** from the **File** menu. The following dialog box will appear:



4. Change the **Version** and **Options** to match the firmware version and options of the 239 relay. The relay firmware and options can be in A3: **PRODUCT INFO/FIRMWARE VERSIONS** and A3: **PRODUCT INFO/MODEL INFORMATION**, respectively. Also, select any MODs included with the relay. Click **OK** when finished.
5. Select **Send Info to Relay** from the **File** menu to load the setpoints file into the 239 relay. If new setpoints were added to the upgrade software, they will be set to the factory defaults.

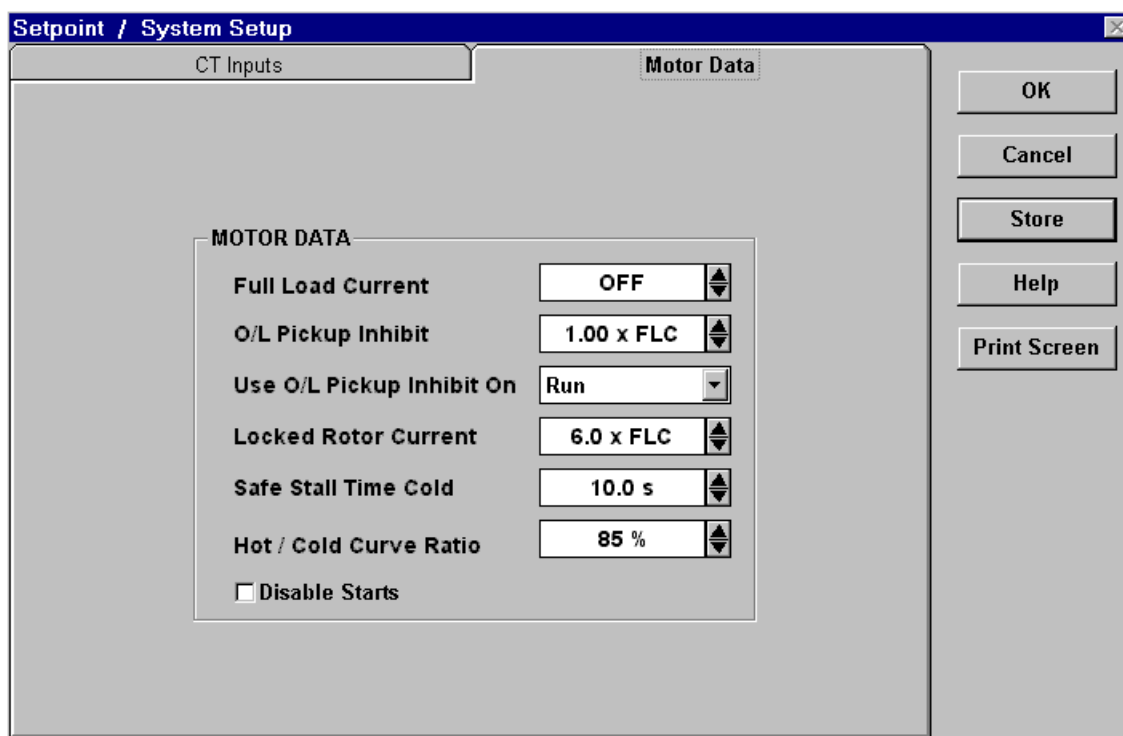
6. Upon successful completion of this procedure, the relay will have new firmware installed with the original setpoints.

6.8 USING 239PC

a) ENTERING SETPOINTS

All the 239 setpoints can be modified with 239PC. Setpoints pages S1 through S6 are available through the **Setpoints** menu.

For example, to change the value for setpoint **S2: SYSTEM SETUP/MOTOR DATA/OVERLOAD PICKUP INHIBIT**, choose the System Setup item from the Setpoints menu. This launches the **Setpoint / System Setup** dialog box. Each subgroup (in this case, CT Inputs and Motor Data) are represented by folder tabs. Click the **Motor Data** tab to list the **S2: SYSTEM SETUP/MOTOR DATA** setpoints.



To change the OVERLOAD INHIBIT PICKUP setpoint, use the ▲ and ▼ buttons to choose an appropriate value and click **Store** to load into the relay.

All 239 setpoints can be changed in a similar manner.

b) ACTUAL VALUES

If a 239 is connected to a PC via the serial port, any measured value, status and last trip data can be displayed. Use the **Actual** pulldown menu to select various measured value screens. Monitored values will be displayed and continuously updated.

To plot a measured parameter, choose the **Trending** item from the **Actual** menu.

c) SAVING/PRINTING SETPOINT FILES

- To print and save all the setpoints to a file, follow the steps outlined in Section 6.7c) SAVING/PRINTING SETPOINT FILES on page 6–12.

d) LOADING SETPOINT FILES

- To load an existing setpoints file to a 239 and/or send the setpoints to the 239, follow the steps outlined in Section 6.7d) LOADING SETPOINT FILES on page 6–13.

e) GETTING HELP

The complete instruction manual, including diagrams such as wiring, is available through on-line Help.

- Click on the **Help** menu and select the desired topic. Consult Help for an explanation of any feature, specifications, wiring, installation, etc.
- Context sensitive help can be activated by clicking on the desired function.
- For easy reference, any topic can be printed by selecting **File > Print Topic** while in Help. A laser printer is recommended for printing illustrations. Screen colours will appear in the printout if a colour ink jet printer is used.

7.1 MODBUS PROTOCOL

The GE Power Management 239 implements a subset of the AEG Modicon Modbus RTU serial communication standard. Many popular programmable controllers support this protocol directly with a suitable interface card allowing direct connection of relays. Although the Modbus protocol is hardware independent, the 239 interface uses a 2 wire RS485 hardware interface. Modbus is a single master multiple slave protocol suitable for a multi-drop configuration as provided by RS485 hardware. In this configuration up to 32 slaves can be daisy-chained together on a single communication channel.

The GE Power Management 239 is always a Modbus slave. It cannot be programmed as a Modbus master. Computers or PLCs are commonly programmed as masters. The Modbus protocol exists in two versions: Remote Terminal Unit (RTU, binary) and ASCII. Only the RTU version is supported by the 239. Monitoring, programming and control functions are possible using read and write register commands.

7.2 ELECTRICAL INTERFACE

The hardware or electrical interface is two-wire RS485. In a two-wire RS485 link data flow is bi-directional and half duplex. That is, data is never transmitted and received at the same time. RS485 lines should be connected in a daisy chain configuration (avoid star connections) with a terminating network installed at each end of the link, i.e. at the master end and at the slave farthest from the master. The terminating network should consist of a 120 Ω resistor in series with a 1 nF ceramic capacitor when used with Belden 9841 RS485 wire. The value of the terminating resistors should be equal to the characteristic impedance of the line. This is approximately 120 Ω for standard #22 AWG twisted pair wire. Shielded wire should always be used to minimize noise. Polarity is important in RS485 communications. Each '+' terminal of every device must be connected together for the system to operate. See Section 2.3: EXTERNAL CONNECTIONS on page 2–3 for details on correct serial port wiring.

7.3 DATA FRAME FORMAT AND DATA RATE

One data frame of an asynchronous transmission to or from a 239 consists of 1 start bit, 8 data bits, and 1 stop bit. This produces a 10 bit data frame. This is important for transmission through modems at high bit rates (11 bit data frames are not supported by Hayes modems at bit rates of greater than 300 bps).

Modbus protocol can be implemented at any standard communication speed. The 239 supports operation at 1200, 2400, 4800, 9600, and 19200 baud.

7.4 DATA PACKET FORMAT

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

Master Request Transmission:

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

Slave Response Transmission:

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

- **SLAVE ADDRESS:** This is the first byte of every transmission. This byte represents the user-assigned address of the slave device that is to receive the message sent by the master. Each slave device must be assigned a unique address and only the addressed slave will respond to a transmission that starts with its address. In a master request transmission the SLAVE ADDRESS represents the address of the slave to which the request is being sent. In a slave response transmission the SLAVE ADDRESS represents the address of the slave that is sending the response. Note: A master transmission with a SLAVE ADDRESS of 0 indicates a broadcast command. Broadcast commands can be used only in certain situations; see APPLICATIONS for details.
- **FUNCTION CODE:** This is the second byte of every transmission. Modbus defines function codes of 1 to 127. The 239 implements some of these functions. See section 3 for details of the supported function codes. In a master request transmission the FUNCTION CODE tells the slave what action to perform. In a slave response transmission if the FUNCTION CODE sent from the slave is the same as the FUNCTION CODE sent from the master then the slave performed the function as requested. If the high order bit of the FUNCTION CODE sent from the slave is a 1 (i.e. if the FUNCTION CODE is > 127) then the slave did not perform the function as requested and is sending an error or exception response.
- **DATA:** This will be a variable number of bytes depending on the FUNCTION CODE. This may be Actual Values, Setpoints, or addresses sent by the master to the slave or by the slave to the master. See section 3 for a description of the supported functions and the data required for each.
- **CRC:** This is a two byte error checking code.

7.5 ERROR CHECKING

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

If a 239 Modbus slave device receives a transmission in which an error is indicated by the CRC-16 calculation, the slave device will not respond to the transmission. A CRC-16 error indicates that one or more bytes of the transmission were received incorrectly and thus the entire transmission should be ignored in order to avoid the 239 performing any incorrect operation.

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

CRC-16 ALGORITHM:

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

```
-->      data transfer
A16      bit working register
AL       low order byte of A
AH       high order byte of A
CRC      16 bit CRC-16 value
i,j      loop counters
(+)      logical exclusive-or operator
Di       i-th data byte (i = 0 to N-1)
G        16 bit characteristic polynomial = 1010000000000001 with MSbit
         dropped and bit order reversed
shr(x)   shift right (the LSbit of the low order byte of x shifts into a carry
         flag, a '0' is shifted into the MSbit of the high order byte of x, all
         other bits shift right one location
```

The algorithm:

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

7.6 TIMING

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

7.7 239 SUPPORTED MODBUS FUNCTIONS

The following functions are supported by the 239:

- 03 - Read Setpoints and Actual Values
- 04 - Read Setpoints and Actual Values
- 05 - Execute Operation
- 06 - Store Single Setpoint
- 07 - Read Device Status
- 08 - Loopback Test
- 16 - Store Multiple Setpoints

7.8 FUNCTION CODES 03 AND 04 – READ SETPOINTS AND ACTUAL VALUES

- Modbus implementation: Read Input and Holding Registers
- 239 Implementation: Read Setpoints and Actual Values

For the 239 implementation of Modbus, these commands can be used to read any Setpoint ("holding registers") or Actual Value ("input registers"). Holding and input registers are 16-bit (two byte) values transmitted low order byte first. Thus all 239 Setpoints and Actual Values are sent as two bytes. The maximum number of registers that can be read in one transmission is 125. Function codes 03 and 04 are configured to read setpoints or actual values interchangeably because some PLCs do not support both of them.

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

7

a) MESSAGE FORMAT AND EXAMPLE

Request slave 11 to respond with 3 registers starting at address 006B.

For this example the register data in these addresses is:

Address	Data
006B	0000
006C	0000
006D	0000

Master Transmission	Bytes	Example (hex)	
SLAVE ADDRESS	- 1 byte	11	message for slave 11
FUNCTION CODE	- 1 byte	03	read registers
DATA STARTING ADDRESS	- 2 bytes	00 6B	data starting at 006B
NUMBER OF SETPOINTS	- 2 bytes	00 03	3 registers – 6 bytes total
CRC	- 2 bytes	76 87	CRC calculated by the master

Slave Response	Bytes	Example (hex)	
SLAVE ADDRESS	- 1 byte	11	message from slave 11
FUNCTION CODE	- 1 byte	03	read registers
BYTE COUNT	- 1 byte	06	3 registers = 6 bytes
DATA 1	- 2 byte	00 00	bit set corresponding to command 13
DATA 2	- 2 bytes	00 00	value in address 006C
DATA 3	- 2 bytes	00 00	value in address 006D
CRC	- 2 bytes	EC B5	CRC calculated by slave

7.9 FUNCTION CODE 05 – EXECUTE OPERATION

- Modbus Implementation: Force Single Coil
- 239 Implementation: Execute Operation

This function code allows the master to request a 239 to perform specific command operations. The command numbers listed in the Commands area of the memory map correspond to operation code for function code 05.

The operation commands can also be initiated by writing to the Commands area of the memory map using function code 16. Refer to Section 7.14: FUNCTION CODE 16 – PERFORMING COMMANDS on page 7–10 for complete details.

a) MESSAGE FORMAT AND EXAMPLE

Reset 239 (operation code 1).

Master Transmission	Bytes	Example (hex)	
SLAVE ADDRESS	- 1 byte	11	message for slave 11
FUNCTION CODE	- 1 byte	05	execute operation
OPERATION CODE	- 2 bytes	00 01	reset command (operation code 1)
CODE VALUE	- 2 bytes	FF 00	perform function
CRC	- 2 bytes	DF 6A	CRC calculated by the master

Slave Response	Bytes	Example (hex)	
SLAVE ADDRESS	- 1 byte	11	message from slave 11
FUNCTION CODE	- 1 byte	05	execute operation
OPERATION CODE	- 2 bytes	00 01	reset command (operation code 1)
CODE VALUE	- 2 bytes	FF 00	perform function
CRC	- 2 bytes	DF 6A	CRC calculated by slave

7.10 FUNCTION CODE 06 – STORE SINGLE SETPOINT

- Modbus Implementation: Preset Single Register
- 239 Implementation: Store Single Setpoint

This command allows the master to store a single setpoint into the memory of a 239. The slave response to this function code is to echo the entire master transmission.

a) MESSAGE FORMAT AND EXAMPLE

Request slave 11 to store the value 0064 in Setpoint address 1020.

After the transmission in this example is complete, Setpoints address 1020 will contain the value 0064.

Master Transmission	Bytes	Example (hex)	
SLAVE ADDRESS	- 1 byte	11	message for slave 11
FUNCTION CODE	- 1 byte	06	store single setpoint
DATA STARTING ADDRESS	- 2 bytes	10 20	Setpoint address 1020
DATA	- 2 bytes	00 64	data for address 1020
CRC	- 2 bytes	8F BB	CRC calculated by the master
Slave Response	Bytes	Example (hex)	
SLAVE ADDRESS	- 1 byte	11	message from slave 11
FUNCTION CODE	- 1 byte	06	store single Setpoint
DATA STARTING ADDRESS	- 2 bytes	10 20	Setpoint address 1020
DATA	- 2 bytes	00 64	data stored in address 1020
CRC	- 2 bytes	8F BB	CRC calculated by slave

7.11 FUNCTION CODE 07 - READ DEVICE STATUS

- Modbus Implementation: Read Exception Status
- 239 Implementation: Read Device Status

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

239 General Status Byte:

LSBit B0: Alarm condition = 1
 B1: Trip condition = 1
 B2: Internal fault = 1
 B3: Not used
 B4: Not used
 B5: Not used
 B6: Not used

MSBit B7: Not used

a) MESSAGE FORMAT AND EXAMPLE

Request status from slave 11.

Master Transmission	Bytes	Example (hex)	
SLAVE ADDRESS	- 1 byte	11	message for slave 11
FUNCTION CODE	- 1 byte	07	read device status
CRC	- 2 bytes	8F BB	CRC calculated by the master
Slave Response	Bytes	Example (hex)	
SLAVE ADDRESS	- 1 byte	11	message from slave 11
FUNCTION CODE	- 1 byte	07	execute operation
DEVICE STATUS	- 1 byte	00	status = 00000000 in binary
CRC	- 2 bytes	23 F5	CRC calculated by slave

7.12 FUNCTION CODE 08 – LOOPBACK TEST

- Modbus Implementation: Loopback Test
- 239 Implementation: Loopback Test

This function is used to test the integrity of the communication link. The 239 will echo the request.

a) MESSAGE FORMAT AND EXAMPLE

Loopback test from slave 11.

Master Transmission	Bytes	Example (hex)	
SLAVE ADDRESS	- 1 byte	11	message for slave 11
FUNCTION CODE	- 1 byte	08	loopback test
DIAG CODE	- 2 bytes	00 00	must be 00 00
DATA	- 2 bytes	00 00	must be 00 00
CRC	- 2 bytes	E0 0B	CRC calculated by the master
Slave Response	Bytes	Example (hex)	
SLAVE ADDRESS	- 1 byte	11	message from slave 11
FUNCTION CODE	- 1 byte	08	loopback test
DIAG CODE	- 2 bytes	00 00	must be 00 00
DATA	- 2 bytes	00 00	must be 00 00
CRC	- 2 bytes	E0 0B	CRC calculated by slave

7.13 FUNCTION CODE 16 – STORE MULTIPLE SETPOINTS

- Modbus Implementation: Preset Multiple Registers
- 239 Implementation: Store Multiple Setpoints

This function code allows multiple Setpoints to be stored into the 239 memory. Modbus "registers" are 16 bit (two byte) values transmitted low order byte first. Thus all 239 setpoints are sent as two bytes. The maximum number of Setpoints that can be stored in one transmission is dependent on the slave device. Modbus allows up to a maximum of 60 holding registers to be stored. The 239 response to this function code is to echo the slave address, function code, starting address, the number of Setpoints stored, and the CRC.

a) MESSAGE FORMAT AND EXAMPLE

Request slave 11 to store the value 0096 to Setpoint addresses 1028 and 1029. After the transmission in this example is complete, 239 slave 11 will have the following Setpoints information stored:

Address	Data
1028	0096
1029	0096

Master Transmission		Bytes	Example (hex)	
SLAVE ADDRESS		- 1 byte	11	message for slave 11
FUNCTION CODE		- 1 byte	10	store Setpoints
DATA STARTING ADDRESS		- 2 bytes	10 28	Setpoint address 1028
NUMBER OF SETPOINTS		- 2 bytes	00 02	2 Setpoints (4 bytes total)
BYTE COUNT		- 1 byte	04	4 bytes of data
DATA 1		- 2 bytes	00 96	data for address 1028
DATA 2		- 2 bytes	00 96	data for address 1029
CRC		- 2 bytes	09 53	CRC calculated by the master
Slave Response				
SLAVE ADDRESS		- 1 byte	11	message from slave 11
FUNCTION CODE		- 1 byte	10	store Setpoints
DATA STARTING ADDRESS		- 2 bytes	10 28	Setpoint address 1028
NUMBER OF SETPOINTS		- 2 bytes	00 02	2 Setpoints
CRC		- 2 bytes	C7 90	CRC calculated by slave

7.14 FUNCTION CODE 16 – PERFORMING COMMANDS

Some PLCs may not support execution of commands using function code 5 but do support storing multiple setpoints using function code 16. To perform this operation using function code 16 (10H), a certain sequence of commands must be written at the same time to the 239. The sequence consists of: Command Function register, Command operation register and Command Data (if required). The Command Function register must be written with the value of 5 indicating an execute operation is requested. The Command Operation register must then be written with a valid command operation number from the list of commands shown in the memory map. The Command Data registers must be written with valid data if the command operation requires data. The selected command will execute immediately upon receipt of a valid transmission.

a) MESSAGE FORMAT AND EXAMPLE

Master Transmission	Bytes	Example (hex)	
SLAVE ADDRESS	- 1 byte	11	message for slave 11
FUNCTION CODE	- 1 byte	10	store Setpoints
DATA STARTING ADDRESS	- 2 bytes	00 80	Setpoint address 0080
NUMBER OF SETPOINTS	- 2 bytes	00 02	2 Setpoints (4 bytes total)
BYTE COUNT	- 1 byte	04	4 bytes of data
DATA 1	- 2 bytes	00 05	data for address 0080
DATA 2	- 2 bytes	00 01	data for address 0081
CRC	- 2 bytes	7E CE	CRC calculated by the master
Slave Response			
SLAVE ADDRESS	- 1 byte	11	message from slave 11
FUNCTION CODE	- 1 byte	10	store Setpoints
DATA STARTING ADDRESS	- 2 bytes	00 80	Setpoint address 0080
NUMBER OF SETPOINTS	- 2 bytes	00 02	2 Setpoints
CRC	- 2 bytes	42 B0	CRC calculated by slave

7.15 ERROR RESPONSES

When a 239 detects an error other than a CRC error, a response will be sent to the master. The MSbit of the FUNCTION CODE byte will be set to 1 (i.e. the function code sent from the slave will be equal to the function code sent from the master plus 128). The following byte will be an exception code indicating the type of error that occurred.

Transmissions received from the master with CRC errors will be ignored by the 239.

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

SLAVE ADDRESS	- 1 byte
FUNCTION CODE	- 1 byte (with MSbit set to 1)
EXCEPTION CODE	- 1 byte
CRC	- 2 bytes

The 239 implements the following exception response codes.

01 - ILLEGAL FUNCTION

The function code transmitted is not one of the functions supported by the 239.

02 - ILLEGAL DATA ADDRESS

The address referenced in the data field transmitted by the master is not an allowable address for the 239.

03 - ILLEGAL DATA VALUE

The value referenced in the data field transmitted by the master is not within range for the selected data address.

7.16 MEMORY MAP INFORMATION

The data stored in the 239 is grouped as Setpoints and Actual Values. Setpoints can be read and written by a master computer. Actual Values can be read only. All Setpoints and Actual Values are stored as two byte values. That is, each register address is the address of a two byte value. Addresses are listed in hexadecimal. Data values (Setpoint ranges, increments, factory values) are in decimal.

7.17 USER DEFINABLE MEMORY MAP AREA

The 239 contains a User Definable area in the memory map. This area allows remapping of the addresses of all Actual Values and Setpoints registers. The User Definable area has two sections:

1. A Register Index area (memory map addresses 0180H-01F7H) that contains 120 Actual Values or Setpoints register addresses.
2. A Register area (memory map addresses 0100H-0177H) that contains the data at the addresses in the Register Index.

Register data that is separated in the rest of the memory map may be remapped to adjacent register addresses in the User Definable Registers area. This is accomplished by writing to register addresses in the User Definable Register Index area. This allows for improved throughput of data and can eliminate the need for multiple read command sequences.

For example, if the values of Phase A Current (register address 0229H) and RTD 1 Celsius Temperature (register address 0240H) are required to be read from a 239, their addresses may be remapped as follows:

1. Write 0229H to address 0180H (User Definable Register Index 0000) using function code 06 or 16.
2. Write 0240H to address 0181H (User Definable Register Index 0001) using function code 06 or 16.

A read (function code 03 or 04) of registers 0100H (User Definable Register 0000) and 0101H (User Definable Register 0001) will return the Phase A Current and RTD 1 Celsius Temperature.

7.18 239 MEMORY MAP

Table 7–1: 239 MEMORY MAP (Sheet 1 of 18)

REG ADDR (HEX)	GROUP	DESCRIPTION	REGISTER VALUE RANGE	STEP VALUE	UNITS & SCALE	FOR-MAT	FACTORY DEFAULT VALUE (CONVERTED)
<i>Product Information (Input Registers) Addresses – 0000 to 007F</i>							
0000	PRODUCT ID	GE Power Management Product Device Code	---	---	---	F1	64
0001		Hardware Version Code	---	---	---	F3	current version
0002		Main Software Version Code	---	---	---	F1	current version
0003		Modification File Number 1	---	---	---	F1	mod. file number 1
0004		Boot Software Version Code	---	---	---	F1	current version
0005		Supervisor Processor Version Code	---	---	---	F1	current version
0006		GE Power Management product options	---	---	---	F104	from order code
0007		Modification File Number 2	---	---	---	F1	mod. file number 2
0008		Modification File Number 3	---	---	---	F1	mod. file number 3
0009		Modification File Number 4	---	---	---	F1	mod. file number 4
000A		Modification File Number 5	---	---	---	F1	mod. file number 5
000B		Main Version Month, Day	---	---	---	F40	
000C		Main Version Year	---	---	---	F41	
000D		Supervisor Revision Month, Day	---	---	---	F40	
000E		Supervisor Revision Year	---	---	---	F41	
000F		Boot Revision Month, Day	---	---	---	F40	
0010		Boot Revision Year	---	---	---	F41	
0011		Reserved					
to		↓					
001F		Reserved					
0020		Serial Number characters 1 and 2	---	---	ASCII	F8	1st, 2nd char.
0021		Serial Number characters 3 and 4	---	---	ASCII	F8	3rd, 4th char.
0022		Serial Number characters 5 and 6	---	---	ASCII	F8	5th, 6th char.
0023		Serial Number characters 7 and 8	---	---	ASCII	F8	7th, 8th char.
0024		Reserved					
to		↓					
002F		Reserved					
0030		Calibration Day	---	---	---	F1	day of calibration
0031		Calibration Month	---	---	---	F109	month of calibration
0032		Calibration Year	---	---	---	F1	year of calibration
0033		Reserved					
to		↓					
003F		Reserved					

1, 2, 3, *, **, ***, ****, †, ‡ See page 7–30 for explanation of Table notes.

Table 7–1: 239 MEMORY MAP (Sheet 2 of 18)

REG ADDR (HEX)	GROUP	DESCRIPTION	REGISTER VALUE RANGE	STEP VALUE	UNITS & SCALE	FOR- MAT	FACTORY DEFAULT VALUE (CONVERTED)
0040		Manufacture Day	---	---	---	F1	day of manufacture
0041		Manufacture Month	---	---	---	F109	month of manufacture
0042		Manufacture Year	---	---	---	F1	year of manufacture
0043		Reserved					
to		↓					
007F		Reserved					
Commands (Holding Registers) Addresses – 0080 to 00FF							
0080	COMMANDS	Command Function Code	5	---	---	F1	5
0081		Command Operation Code	1-13	1	---	F27	0
0082		Command Data 1	0-65535	1	---	F8, F28 F30	0
0083		Command Data 2	0-65535	1	---	F31	0
0084		Command Data 3	0-65535	1	---	F8	0
0085		Command Data 4	0-65535	1	---	F8	0
0086		Command Data 5	0-65535	1	---	F8	0
0087		Command Data 6	0-65535	1	---	F8	0
0088		Command Data 7	0-65535	1	---	F8	0
0089		Command Data 8	0-65535	1	---	F8	0
008A		Command Data 9	0-65535	1	---	F8	0
008B		Command Data 10	0-65535	1	---	F8	0
008C		Command Data 11	0-65535	1	---	F8	0
008D		Reserved					
008E		Reserved					
008F		Reserved					
0090		Reserved					
to		↓					
00FF		Reserved					
User Definable Register (Input Registers) Addresses – 0100 to 017F							
0100	USER DEFINABLE REGISTERS	User Definable Data 0000	---	---	---	---	---
0101		User Definable Data 0001	---	---	---	---	---
0102		User Definable Data 0002	---	---	---	---	---
0103		User Definable Data 0003	---	---	---	---	---
0104		User Definable Data 0004	---	---	---	---	---
0105		User Definable Data 0005	---	---	---	---	---
0106		User Definable Data 0006	---	---	---	---	---
0107		User Definable Data 0007	---	---	---	---	---

1, 2, 3, *, **, ***, ****, †, ‡ See page 7–30 for explanation of Table notes.

Table 7–1: 239 MEMORY MAP (Sheet 3 of 18)

REG ADDR (HEX)	GROUP	DESCRIPTION	REGISTER VALUE RANGE	STEP VALUE	UNITS & SCALE	FOR-MAT	FACTORY DEFAULT VALUE (CONVERTED)
0108		User Definable Data 0008	---	---	---	---	---
0109		User Definable Data 0009	---	---	---	---	---
010A		User Definable Data 000A	---	---	---	---	---
010B		User Definable Data 000B	---	---	---	---	---
to		↓	↓	↓	↓	↓	↓
0177		User Definable Data 0077	---	---	---	---	---
0178		Reserved					
to		↓					
017F		Reserved					
User Definable Register Index (Holding Registers) Addresses – 0180 to 01FF							
0180	USER DEFINABLE REGISTER INDEX	Register address for User Definable Data 0000	†	1	---	F1	0
0181		Register address for User Definable Data 0001	†	1	---	F1	0
0182		Register address for User Definable Data 0002	†	1	---	F1	0
0183		Register address for User Definable Data 0003	†	1	---	F1	0
0184		Register address for User Definable Data 0004	†	1	---	F1	0
0185		Register address for User Definable Data 0005	†	1	---	F1	0
0186		Register address for User Definable Data 0006	†	1	---	F1	0
0187		Register address for User Definable Data 0007	†	1	---	F1	0
0188		Register address for User Definable Data 0008	†	1	---	F1	0
0189		Register address for User Definable Data 0009	†	1	---	F1	0
018A		Register address for User Definable Data 000A	†	1	---	F1	0
to		↓	↓	↓	↓	↓	↓
01F7		Register address for User Definable Data 0077	†	1	---	F1	0
01F8		Reserved					
to		↓					
01FF		Reserved					
Actual Values (Input Registers) Addresses – 0200 to 027F							
0200	STATUS	Switch Input Status	---	---	---	F100	N/A
0201		LED Status Flags	---	---	---	F101	N/A
0202		LED Attribute Flags	---	---	---	F108	N/A
0203		Output Relay Status Flags	---	---	---	F107	N/A
0204		Auxiliary Active Status Flags	---	---	---	F106	N/A
0205		Auxiliary Pickup Status Flags	---	---	---	F106	N/A
0206		Alarm Active Status Flags	---	---	---	F102	N/A
0207		Alarm Pickup Status Flags	---	---	---	F102	N/A
0208		Trip Active Status Flags	---	---	---	F103	N/A

1, 2, 3, *, **, ***, ****, †, ‡ See page 7–30 for explanation of Table notes.

Table 7–1: 239 MEMORY MAP (Sheet 4 of 18)

REG ADDR (HEX)	GROUP	DESCRIPTION	REGISTER VALUE RANGE	STEP VALUE	UNITS & SCALE	FOR-MAT	FACTORY DEFAULT VALUE (CONVERTED)
0209		Trip Pickup Status Flags	---	---	---	F103	N/A
020A		Motor Mode	---	---	---	F4	N/A
020B		Cause of Trip	---	---	---	F5	N/A
020C	GENERAL	System Status	---	---	---	F29	N/A
020D		Time To Trip	---	---	0.1xsec 0.1xmin	F1 ²	N/A
020E		Time To Trip Units	---	---	---	F110	N/A
020F		Trip Type for Time To Trip	---	---	---	F5	N/A
0210	LAST TRIP DATA	Cause of Last Trip	---	---	---	F5	N/A
0211		Pre-Trip Phase A Current	---	---	***	F1	N/A
0212		Pre-Trip Phase B Current	---	---	***	F1	N/A
0213		Pre-Trip Phase C Current	---	---	***	F1	N/A
0214		Pre-Trip Ground Current	---	---	0.1 x A	F1	N/A
0215		Pre-Trip Current Unbalance	---	---	%	F1	N/A
0216		Pre-Trip RTD 1 Temp. (RTD Option)	---	---	°C	F2****	N/A
0217		Pre-Trip RTD 1 Temp. (RTD Option)	---	---	°F	F2****	N/A
0218		Pre-Trip RTD 2 Temp. (RTD Option)	---	---	°C	F2****	N/A
0219		Pre-Trip RTD 2 Temp. (RTD Option)	---	---	°F	F2****	N/A
021A		Pre-Trip RTD 3 Temp. (RTD Option)	---	---	°C	F2****	N/A
021B		Pre-Trip RTD 3 Temp. (RTD Option)	---	---	°F	F2****	N/A
021C		Cause of 2nd Last Trip	---	---	---	F5	N/A
021D		Cause of 3rd Last Trip	---	---	---	F5	N/A
021E		Cause of 4th Last Trip	---	---	---	F5	N/A
021F		Cause of 5th Last Trip	---	---	---	F5	N/A
0220		Setpoints Group In Use	0-3	---	---	F113	N/A
0221		Reserved					
0222	SWITCH	Currently Selected Setpoints Group	---	---	---	F113	N/A
0223	STATUS	Reserved					
0224		Reserved					
0225		Reserved					
0226		Reserved					
0227		Reserved					
0228	CURRENT	Main Phase Current Scale Factor	---	---	---	F1	N/A
0229		Phase A Current	---	---	***	F1	N/A
022A		Phase B Current	---	---	***	F1	N/A
022B		Phase C Current	---	---	***	F1	N/A

1, 2, 3, *, **, ***, ****, †, ‡ See page 7–30 for explanation of Table notes.

Table 7–1: 239 MEMORY MAP (Sheet 5 of 18)

REG ADDR (HEX)	GROUP	DESCRIPTION	REGISTER VALUE RANGE	STEP VALUE	UNITS & SCALE	FOR-MAT	FACTORY DEFAULT VALUE (CONVERTED)
022C		Ground Current	---	---	0.1 x A	F1	N/A
022D		Current Unbalance	---	---	%	F1	N/A
022E		Ground Current Scale Factor	---	---	---	F114	N/A
022F		2 nd Phase Current Scale Factor	---	---	---	F1	N/A
0230		3 rd Phase Current Scale Factor	---	---	---	F1	N/A
0231		4 th Phase Current Scale Factor	---	---	---	F1	N/A
0232		Reserved					
0233		Reserved					
0234		Reserved					
0235		Reserved					
0236		Reserved					
0237		Reserved					
0238	MOTOR CAPACITY	Motor Load	---	---	% FLC	F1	N/A
0239		Thermal Capacity	---	---	%	F1	N/A
023A		Calculated Time To O/L Trip	---	---	F39	F1	---
023B		Time To O/L Trip Units and Scale	---	---	---	F39	---
023C		Time To Overload Reset	---	---	0.1xmin	F1	---
023D		Reserved					
023E		Reserved					
023F		Reserved					
0240	TEMPERATURE	RTD 1 Temperature (RTD Option)	---	---	°C	F2****	N/A
0241		RTD 1 Temperature (RTD Option)	---	---	°F	F2****	N/A
0242		RTD 2 Temperature (RTD Option)	---	---	°C	F2****	N/A
0243		RTD 2 Temperature (RTD Option)	---	---	°F	F2****	N/A
0244		RTD 3 Temperature (RTD Option)	---	---	°C	F2****	N/A
0245		RTD 3 Temperature (RTD Option)	---	---	°F	F2****	N/A
0246		Thermistor	---	---	---	F6	N/A
0247		RTD Sensor Failure Cause (RTD Option)	---	---	---	F33	N/A
0248		Hottest Stator RTD Number (RTD Option)	---	---	---	F1	N/A
0249		Hottest Bearing RTD Number (RTD Option)	---	---	---	F1	N/A
024A		Reserved					
024B		Reserved					
024C		Reserved					
024D		Reserved					
024E		Reserved					
024F		Reserved					

1, 2, 3, *, **, ***, ****, †, ‡ See page 7–30 for explanation of Table notes.

Table 7–1: 239 MEMORY MAP (Sheet 6 of 18)

REG ADDR (HEX)	GROUP	DESCRIPTION	REGISTER VALUE RANGE	STEP VALUE	UNITS & SCALE	FOR-MAT	FACTORY DEFAULT VALUE (CONVERTED)
0250	DEBUG	ADC Reference	---	---	---	F1	N/A
0251	DATA	Thermistor Reading	---	---	Ω	F1	N/A
0252		Power Loss Fine Time	---	---	10 ms	F1	N/A
0253		Power Loss Coarse Time	---	---	0.1 min.	F1	N/A
0254		Current key press	---	---	---	F7	N/A
0255		Internal Fault Error Code	---	---	---	F105	N/A
0256		Phase A Current (fast update)	---	---	***	F1	N/A
0257		Phase B Current (fast update)	---	---	***	F1	N/A
0258		Phase C Current (fast update)	---	---	***	F1	N/A
0259		Ground Current (fast update)	---	---	0.1 x A	F1	N/A
025A		Calibrated Unscaled RTD 1 value	---	---	ADC counts	F1	N/A
025B		RTD Reference	---	---	---	F1	N/A
025C		Upload Mode Count	---	---	---	F1	N/A
025D		Reserved					
025E		Reserved					
025F		Reserved					
0260		Message Buffer characters 1 and 2	---	---	ASCII	F8	N/A
0261		Message Buffer characters 3 and 4	---	---	ASCII	F8	N/A
0262		Message Buffer characters 5 and 6	---	---	ASCII	F8	N/A
0263		Message Buffer characters 7 and 8	---	---	ASCII	F8	N/A
0264		Message Buffer characters 9 and 10	---	---	ASCII	F8	N/A
0265		Message Buffer characters 11 and 12	---	---	ASCII	F8	N/A
0266		Message Buffer characters 13 and 14	---	---	ASCII	F8	N/A
0267		Message Buffer characters 15 and 16	---	---	ASCII	F8	N/A
0268		Message Buffer characters 17 and 18	---	---	ASCII	F8	N/A
0269		Message Buffer characters 19 and 20	---	---	ASCII	F8	N/A
026A		Message Buffer characters 21 and 22	---	---	ASCII	F8	N/A
026B		Message Buffer characters 23 and 24	---	---	ASCII	F8	N/A
026C		Message Buffer characters 25 and 26	---	---	ASCII	F8	N/A
026D		Message Buffer characters 27 and 28	---	---	ASCII	F8	N/A
026E		Message Buffer characters 29 and 30	---	---	ASCII	F8	N/A
026F		Message Buffer characters 31 and 32	---	---	ASCII	F8	N/A
0270		Message Buffer characters 33 and 34	---	---	ASCII	F8	N/A
0271		Message Buffer characters 35 and 36	---	---	ASCII	F8	N/A
0272		Message Buffer characters 37 and 38	---	---	ASCII	F8	N/A

1, 2, 3, *, **, ***, ****, †, ‡ See page 7–30 for explanation of Table notes.

Table 7–1: 239 MEMORY MAP (Sheet 7 of 18)

REG ADDR (HEX)	GROUP	DESCRIPTION	REGISTER VALUE RANGE	STEP VALUE	UNITS & SCALE	FOR-MAT	FACTORY DEFAULT VALUE (CONVERTED)
0273		Message Buffer characters 39 and 40	---	---	ASCII	F8	N/A
0274		Reserved					
0275		Reserved					
0276		Reserved					
0277		Reserved					
0278		Reserved					
0279		Reserved					
027A		Reserved					
027B		Reserved					
027C		Reserved					
027D		Reserved					
to		↓					
02AF		Reserved					
02B0	MOTOR STATISTICS	Motor Max Starting Current	0 to 10000	1	A	F1	---
02B1		Reserved					
02B2		Reserved					
02B3		Reserved					
02B4		Motor Running Time (high)			0.1 x hr	F45	
02B5		Motor Running Time (low)			0.1 x hr	F45	
02B6		Reserved					
to		↓					
0FFF		Reserved					
Setpoint Values (Holding Registers) Addresses – 1000 to 11EF							
1000	PREFERENCES	Temp. Display Units (<i>RTD Option</i>)		1	---	F9	0 = CELSIUS
1001		Default Message Time	1-51	1	min x 0.1	F1 **	10 = 1.0 min
1002		Default Message Brightness	0-100	20	%	F1	60%
1003		Block Keypad Trip Reset	0-1	1	---	F14	0 = NO
1004		Reserved					
1005		Reserved					
1006		Reserved					
1007		Reserved					
1008	ANALOG OUTPUT	Analog Output Type (<i>AN Option</i>)		1	---	F10	0 = MOTOR LOAD
1009		Analog Output Range (<i>AN Option</i>)	0-2	1	---	F11	0 = 0-1 mA
100A		Reserved					
100B		Reserved					
100C		Reserved					

1, 2, 3, *, **, ***, ****, †, ‡ See page 7–30 for explanation of Table notes.

Table 7–1: 239 MEMORY MAP (Sheet 8 of 18)

REG ADDR (HEX)	GROUP	DESCRIPTION	REGISTER VALUE RANGE	STEP VALUE	UNITS & SCALE	FOR-MAT	FACTORY DEFAULT VALUE (CONVERTED)
100D		Reserved					
100E		Reserved					
100F		Reserved					
1010	RS485 SERIAL PORT	Serial Communication Failure Alarm	0-1	1	---	F20	0 = OFF
1011		Modbus Baud Rate	0-4	1	---	F13	3 = 9600
1012		Parity	0-2	1	---	F35	0 = NONE
1013		Reserved					
1014		Reserved					
1015		Reserved					
1016		Reserved					
1017		Reserved					
1018	DEFAULTS	Load Factory Defaults	0-1	1	---	F14	0 = NO
1019		Clear Pre-trip Data	0-1	1	---	F14	0 = NO
101A		Clear Statistics Data	0-1	1		F14	0 = NO
101B		Reserved					
101C		Reserved					
101D		Reserved					
101E		Reserved					
101F		Reserved					
1020	CT INPUTS	Phase CT Primary	0-1500	5	A	F1 *	0 = OFF
1021		Ground Sensing	0-3	1	---	F15	0 = OFF
1022		Ground CT Primary	5-1500	5	A	F1	100
1023		Nominal Frequency	50-60	10	Hz	F1	60
1024		Reserved					
1025		Reserved					
1026		Reserved					
1027		Reserved					
1028	MOTOR DATA	Motor Full Load Current	0-1500	1	***	F1 *	0 = OFF
1029		Overload Pickup Inhibit	100-500	5	0.01xFLC	F1	100 = 1.00
102A		Locked Rotor Current	5-110	1	0.1 xFLC	F1	60 = 6.0 xFLC
102B		Safe Stall Time Cold	10-6000	1	0.1 x s	F1	100 = 10.0 s
102C		Hot / Cold Curve Ratio	5-100	1	%	F1	85%
102D		Disable Starts	0-1	1	---	F14	0 = NO
102E		Use Overload Pickup Inhibit On	0-2	1	---	F43	0 = RUN
102F		Reserved					
1030		Reserved					

1, 2, 3, *, **, ***, ****, †, ‡ See page 7–30 for explanation of Table notes.

Table 7–1: 239 MEMORY MAP (Sheet 9 of 18)

REG ADDR (HEX)	GROUP	DESCRIPTION	REGISTER VALUE RANGE	STEP VALUE	UNITS & SCALE	FOR-MAT	FACTORY DEFAULT VALUE (CONVERTED)
1031		Reserved					
1032		Reserved					
1033		Reserved					
1034		Reserved					
1035		Reserved					
1036		Reserved					
1037		Reserved					
1038	TRIP RELAY	Trip Operation	0-1	1	---	F16	0 = NON-FAILSAFE
1039		Reserved					
103A		Reserved					
103B		Reserved					
103C		Reserved					
103D		Reserved					
103E		Reserved					
103F		Reserved					
1040	ALARM RELAY	Alarm Operation	0-1	1	---	F16	0 = NON-FAILSAFE
1041		Alarm Activation	0-1	1	---	F17	0 = UNLATCHED
1042		Reserved					
1043		Reserved					
1044		Reserved					
1045		Reserved					
1046		Reserved					
1047		Reserved					
1048	AUXILIARY RELAY	Auxiliary Operation	0-1	1	---	F16	0 = NON-FAILSAFE
1049		Auxiliary Activation	0-1	1	---	F17	0 = UNLATCHED
104A		Auxiliary Function	0-2	1	---	F18	0 = NORMAL
104B		Reserved					
104C		Reserved					
104D		Reserved					
104E		Reserved					
104F		Reserved					
1050	PHASE TIMED O/L	Phase Timed O/L Curve No	1-15	1	---	F1	4
1051		Phase Timed O/L Lockout Time	1-5000	1	min	F1	30 min
1052		Overload Level to Calculate Trip Time	101-2000	1	0.01xFLC	F1	200 = 2.00 xFLC
1053		Auto Reset Overload Trips	0-1	1	---	F14	0 = NO
1054		Reserved					

1, 2, 3, *, **, ***, ****, †, ‡ See page 7–30 for explanation of Table notes.

Table 7–1: 239 MEMORY MAP (Sheet 10 of 18)

REG ADDR (HEX)	GROUP	DESCRIPTION	REGISTER VALUE RANGE	STEP VALUE	UNITS & SCALE	FOR- MAT	FACTORY DEFAULT VALUE (CONVERTED)
1055		Reserved					
1056		Reserved					
1057		Reserved					
1058	PHASE S/C	Phase S/C Trip	0-3	1	---	F19	0 = OFF
1059		Phase S/C Pickup	10-110	1	0.1 xCT	F1	100 = 10.0 xCT
105A		Phase S/C Delay	0-60000	10	ms	F1 ‡	0 ms
105B		Reserved					
105C		Reserved					
105D		Reserved					
105E		Reserved					
105F		Reserved					
1060	IMMEDIATE OVERLOAD	Immediate Overload Alarm	0-1	1	---	F20	0 = OFF
1061		Immediate Overload Pickup	5-110	1	0.1 xFLC	F1	10 = 1.0 xFLC
1062		Inhibit Sensing On Start For	0-6001	1	s	F1	6001 = UNLIMITED
1063		Reserved					
1064		Reserved					
1065		Reserved					
1066		Reserved					
1067		Reserved					
1068	MECHANICAL JAM	Mechanical Jam Function	0-4	1	---	F23	0 = OFF
1069		Mechanical Jam Pickup	1-100	1	0.1 xFLC	F1	2.0 x FLC
106A		Mechanical Jam Delay	0-250	1	s	F1	2 s
106B		Inhibit Sensing On Start For	0-6001	1	s	F1	6001 = UNLIMITED
106C		Reserved					
106D		Reserved					
106E		Reserved					
106F		Reserved					
1070	UNDER-CURRENT	Undercurrent Function	0-5	1	---	F21	0 = OFF
1071		Undercurrent Pickup	5-100	1	0.01xFLC	F1	0.50 xFLC
1072		Undercurrent Delay	0-250	1	s	F1	2 s
1073		Reserved					
1074		Reserved					
1075		Reserved					
1076		Reserved					
1077		Reserved					
1078	UNBALANCE	Phase Unbalance Trip	0-1	1	---	F20	1 = ON

1, 2, 3, *, **, ***, ****, †, ‡ See page 7–30 for explanation of Table notes.

Table 7–1: 239 MEMORY MAP (Sheet 11 of 18)

REG ADDR (HEX)	GROUP	DESCRIPTION	REGISTER VALUE RANGE	STEP VALUE	UNITS & SCALE	FOR-MAT	FACTORY DEFAULT VALUE (CONVERTED)
1079		Phase Unbalance Trip Pickup	5-100	1	%	F1	20%
107A		Phase Unbalance Delay	0-60	1	s	F1	2 s
107B		Phase Unbalance Alarm	0-1	1	---	F20	1 = ON
107C		Phase Unbalance Alarm Pickup	5-100	1	%	F1	5%
107D		Reserved					
107E		Reserved					
107F		Reserved					
1080	HOT MOTOR	% Thermal Capacity Used Alarm	1-101	1	%	F1 **	101 = OFF
1081		Reserved					
1082		Reserved					
1083	BREAKER FAILURE	Breaker Failure Function	0-3	1	---	F44	0 = OFF
1084		Breaker Failure Pickup	1-110	1	0.1 xCT	F1	5 = 0.5xCT
1085		Breaker Fail Pickup Delay	10-60000,INST	10	ms	F1	INST
1086		Breaker Fail Dropout Delay	10-60000,INST	10	ms	F1	INST
1087		Reserved					
1088	GROUND CURRENT	Ground Trip	0-3	1	---	F38	1 = TRIP
1089		Ground Primary Trip Pickup (5A CT)	3-100	1	% of CT	F1	10%
108A		Ground Primary Trip Pickup (50:0.025 CT)	5-1500	1	0.01 x A	F1	1000 = 10.00 A
108B		Ground Trip Delay On Run	0-60000	10	ms	F1 †	500 ms
108C		Ground Alarm	0-2	1	---	F22	1 = MOMENTARY
108D		Ground Primary Alarm Level (5A CT)	3-100	1	% of CT	F1	10%
108E		Ground Primary Alarm Level (50:0.025 CT)	5-1500	1	0.01 x A	F1	500 = 5.00 A
108F		Ground Alarm Delay On Run	0-600	1	0.1 x s	F1	50 = 5.0 s
1090		Ground Trip Delay On Start	0-60000	10	ms	F1 †	500 ms
1091		Ground Alarm Delay On Start	0-600	1	0.1 x s	F1	50 = 5.0 s
1092		Reserved					
1093		Reserved					
1094		Reserved					
1095		Reserved					
1096		Reserved					
1097		Reserved					
1098	THERMISTOR	Thermistor Function	0-4	1	---	F23	0 = OFF
1099		Thermistor Hot Resistance	1-300	1	0.1 kΩ	F1	50 = 5.0 kΩ
109A		Thermistor Cold Resistance	1-300	1	0.1 kΩ	F1	3 = 0.3 kΩ
109B		Thermistor Failure Alarm	0-1	1	---	F20	0 = OFF
109C		Reserved					

1, 2, 3, *, **, ***, ****, †, ‡ See page 7–30 for explanation of Table notes.

Table 7–1: 239 MEMORY MAP (Sheet 12 of 18)

REG ADDR (HEX)	GROUP	DESCRIPTION	REGISTER VALUE RANGE	STEP VALUE	UNITS & SCALE	FOR-MAT	FACTORY DEFAULT VALUE (CONVERTED)
109D		Reserved					
109E		Reserved					
109F		Reserved					
10A0	RTD 1	RTD 1 Application (<i>RTD Option</i>)	0-2	1	---	F24	1 = STATOR
10A1		RTD 1 Type (<i>RTD Option</i>)	0-3	1	---	F25	0 = 100 PT
10A2		RTD 1 Trip Temp. (<i>RTD Option</i>)	0 - 201	1	°C	F1 **	130 °C
10A3		RTD 1 Trip Temp. (<i>RTD Option</i>)	0 - 401	1	°F	F1 **	266 °F
10A4		RTD 1 Alarm Temp. (<i>RTD Option</i>)	0 - 201	1	°C	F1 **	110 °C
10A5		RTD 1 Alarm Temp. (<i>RTD Option</i>)	0 - 401	1	°F	F1 **	230 °F
10A6		Reserved					
10A7		Reserved					
10A8	RTD 2	RTD 2 Application (<i>RTD Option</i>)	0-2	1	---	F24	2 = BEARING
10A9		RTD 2 Type (<i>RTD Option</i>)	0-3	1	---	F25	0 = 100 PT
10AA		RTD 2 Trip Temp. (<i>RTD Option</i>)	0 - 201	1	°C	F1 **	90 °C
10AB		RTD 2 Trip Temp. (<i>RTD Option</i>)	0 - 401	1	°F	F1 **	194 °F
10AC		RTD 2 Alarm Temp. (<i>RTD Option</i>)	0 - 201	1	°C	F1 **	75 °C
10AD		RTD 2 Alarm Temp. (<i>RTD Option</i>)	0 - 401	1	°F	F1 **	167 °F
10AE		Reserved					
10AF		Reserved					
10B0	RTD 3	RTD 3 Application (<i>RTD Option</i>)	0-2	1	---	F24	2 = BEARING
10B1		RTD 3 Type (<i>RTD Option</i>)	0-3	1	---	F25	0 = 100 PT
10B2		RTD 3 Trip Temp. (<i>RTD Option</i>)	0 - 201	1	°C	F1 **	90 °C
10B3		RTD 3 Trip Temp. (<i>RTD Option</i>)	0 - 401	1	°F	F1 **	194 °F
10B4		RTD 3 Alarm Temp. (<i>RTD Option</i>)	0 - 201	1	°C	F1 **	75 °C
10B5		RTD 3 Alarm Temp. (<i>RTD Option</i>)	0 - 401	1	°F	F1 **	167 °F
10B6		Reserved					
10B7		Reserved					
10B8	RTD SENSOR	RTD Sensor Fail Alarm (<i>RTD Option</i>)	0-1	1	---	F20	0 = OFF
10B9		Reserved					
10BA		Reserved					
10BB		Reserved					
10BC		Reserved					
10BD		Reserved					
10BE		Reserved					
10BF		Reserved					

1, 2, 3, *, **, ***, ****, †, ‡ See page 7–30 for explanation of Table notes.

Table 7–1: 239 MEMORY MAP (Sheet 13 of 18)

REG ADDR (HEX)	GROUP	DESCRIPTION	REGISTER VALUE RANGE	STEP VALUE	UNITS & SCALE	FOR-MAT	FACTORY DEFAULT VALUE (CONVERTED)
10C0	OPTION SWITCH 1	Option Switch 1 Function	0-5	1	---	F26	0 = OFF
10C1		Option Switch 1 Time Delay	0-600	1	0.1 x s	F1	0 = 0.0
10C2		Reserved					
10C3		Reserved					
10C4		Reserved					
10C5		Reserved					
10C6		Reserved					
10C7		Reserved					
10C8	OPTION SWITCH 2	Option Switch 2 Function	0-5	1	---	F26	0 = OFF
10C9		Option Switch 2 Time Delay	0-600	1	0.1 x s	F1	0 = 0.0
10CA		Reserved					
10CB		Reserved					
10CC		Reserved					
10CD		Reserved					
10CE		Reserved					
10CF		Reserved					
10D0	CURRENT SIMULATION	Simulation	0-1	1	---	F20	0 = OFF
10D1		Phase A Current	0-10000	1	***	F1	0
10D2		Phase B Current	0-10000	1	***	F1	0
10D3		Phase C Current	0-10000	1	***	F1	0
10D4		Ground Current	0-5000	1	0.1 x A	F1	0
10D5		Current Simulation Period	5-305	5	min	F1 ³	15 min
10D6		Reserved					
10D7		Reserved					
10D8	ANALOG SIMULATION	Simulation (<i>AN Option</i>)	0-1	1	---	F20	0 = OFF
10D9		Force Analog Output (<i>AN Option</i>)	0-1201	1	0.1%	F1**	1201 = OFF
10DA		Analog Output Simulation Period (<i>AN Option</i>)	5-305	5	min	F1 ³	15 min
10DB		Reserved					
10DC		Reserved					
10DD		Reserved					
10DE		Reserved					
10DF		Reserved					
10E0		Reserved					
10E1		Reserved					
10E2		Reserved					
10E3		Reserved					

1, 2, 3, *, **, ***, ****, †, ‡ See page 7–30 for explanation of Table notes.

Table 7–1: 239 MEMORY MAP (Sheet 14 of 18)

REG ADDR (HEX)	GROUP	DESCRIPTION	REGISTER VALUE RANGE	STEP VALUE	UNITS & SCALE	FOR-MAT	FACTORY DEFAULT VALUE (CONVERTED)
10E4		Reserved					
10E5		Reserved					
10E6		Reserved					
10E7		Reserved					
10E8		Reserved					
10E9		Reserved					
10EA		Reserved					
10EB		Reserved					
10EC		Reserved					
10ED		Reserved					
10EE		Reserved					
10EF		Reserved					
10F0		Reserved					
10F1		Reserved					
10F2		Reserved					
10F3		Reserved					
10F4		Reserved					
10F5		Reserved					
10F6		Reserved					
10F7		Reserved					
10F8	FLASH MESSAGE	Flash message characters 1 and 2	32-127	1	ASCII	F8	" "
10F9		Flash message characters 3 and 4	32-127	1	ASCII	F8	" "
10FA		Flash message characters 5 and 6	32-127	1	ASCII	F8	" "
10FB		Flash message characters 7 and 8	32-127	1	ASCII	F8	" "
10FC		Flash message characters 9 and 10	32-127	1	ASCII	F8	" "
10FD		Flash message characters 11 and 12	32-127	1	ASCII	F8	" "
10FE		Flash message characters 13 and 14	32-127	1	ASCII	F8	" "
10FF		Flash message characters 15 and 16	32-127	1	ASCII	F8	" "
1100		Flash message characters 17 and 18	32-127	1	ASCII	F8	" "
1101		Flash message characters 19 and 20	32-127	1	ASCII	F8	" "
1102		Flash message characters 21 and 22	32-127	1	ASCII	F8	" "
1103		Flash message characters 23 and 24	32-127	1	ASCII	F8	" "
1104		Flash message characters 25 and 26	32-127	1	ASCII	F8	" "
1105		Flash message characters 27 and 28	32-127	1	ASCII	F8	" "
1106		Flash message characters 29 and 30	32-127	1	ASCII	F8	" "
1107		Flash message characters 31 and 32	32-127	1	ASCII	F8	" "

1, 2, 3, *, **, ***, ****, †, ‡ See page 7–30 for explanation of Table notes.

Table 7–1: 239 MEMORY MAP (Sheet 15 of 18)

REG ADDR (HEX)	GROUP	DESCRIPTION	REGISTER VALUE RANGE	STEP VALUE	UNITS & SCALE	FOR-MAT	FACTORY DEFAULT VALUE (CONVERTED)
1108		Flash message characters 33 and 34	32-127	1	ASCII	F8	" "
1109		Flash message characters 35 and 36	32-127	1	ASCII	F8	" "
110A		Flash message characters 37 and 38	32-127	1	ASCII	F8	" "
110B		Flash message characters 39 and 40	32-127	1	ASCII	F8	" "
110C		Reserved					
110D		Reserved					
110E		Reserved					
110F		Reserved					
1110	PROGRAMMABLE MESSAGE	Programmable message characters 1 & 2	32-127	1	ASCII	F8	"FO"
1111		Programmable message characters 3 & 4	32-127	1	ASCII	F8	"R "
1112		Programmable message characters 5 & 6	32-127	1	ASCII	F8	"FR"
1113		Programmable message characters 7 & 8	32-127	1	ASCII	F8	"EE"
1114		Programmable message characters 9 & 10	32-127	1	ASCII	F8	" S"
1115		Programmable message characters 11 & 12	32-127	1	ASCII	F8	"ET"
1116		Programmable message characters 13 & 14	32-127	1	ASCII	F8	"UP"
1117		Programmable message characters 15 & 16	32-127	1	ASCII	F8	" D"
1118		Programmable message characters 17 & 18	32-127	1	ASCII	F8	"IS"
1119		Programmable message characters 19 & 20	32-127	1	ASCII	F8	"K "
111A		Programmable message characters 21 & 22	32-127	1	ASCII	F8	"CA"
111B		Programmable message characters 23 & 24	32-127	1	ASCII	F8	"LL"
111C		Programmable message characters 25 & 26	32-127	1	ASCII	F8	" ("
111D		Programmable message characters 27 & 28	32-127	1	ASCII	F8	"90"
111E		Programmable message characters 29 & 30	32-127	1	ASCII	F8	"5)"
111F		Programmable message characters 31 & 32	32-127	1	ASCII	F8	" 2"
1120		Programmable message characters 33 & 34	32-127	1	ASCII	F8	"94"
1121		Programmable message characters 35 & 36	32-127	1	ASCII	F8	"-6"
1122		Programmable message characters 37 & 38	32-127	1	ASCII	F8	"22"
1123		Programmable message characters 39 & 40	32-127	1	ASCII	F8	"2 "
1124		Reserved					
1125		Reserved					
1126		Reserved					
1127		Reserved					
1128	SWITCH SIMULATION	Simulation	0-1	1	---	F20	0 = OFF
1129		Emergency Restart Input	0-1	1	---	F36	0 = OPEN
112A		External Reset Input	0-1	1	---	F36	0 = OPEN
112B		Option 1 Input	0-1	1	---	F36	0 = OPEN

1, 2, 3, *, **, ***, ****, †, ‡ See page 7–30 for explanation of Table notes.

Table 7–1: 239 MEMORY MAP (Sheet 16 of 18)

REG ADDR (HEX)	GROUP	DESCRIPTION	REGISTER VALUE RANGE	STEP VALUE	UNITS & SCALE	FOR- MAT	FACTORY DEFAULT VALUE (CONVERTED)
112C		Option 2 Input	0-1	1	---	F36	0 = OPEN
112D		Switch Simulation Period	5-305	5	min	F1 ³	15 min
112E		Reserved					
112F		Reserved					
1130	THERMISTOR SIMULATION	Simulation	0-1	1	---	F20	0 = OFF
1131		Thermistor Resistance	0-30000	1	W	F1	0 Ω
1132		Thermistor Simulation Period	5-305	5	min	F1 ³	15 min
1133		Reserved					
1134		Reserved					
1135	RTD SIMULATION	Simulation (<i>RTD Option</i>)	0-1	1	---	F20	0 = OFF
1136		RTD 1 Temperature (<i>RTD Option</i>)	0-240	1	°C	F1 [†]	0 = -40 °C
1137		RTD 1 Temperature (<i>RTD Option</i>)	0-440	1	°F	F1 [†]	0 = -40 °F
1138		RTD 2 Temperature (<i>RTD Option</i>)	0-240	1	°C	F1 [†]	0 = -40 °C
1139		RTD 2 Temperature (<i>RTD Option</i>)	0-440	1	°F	F1 [†]	0 = -40 °F
113A		RTD 3 T-1	0-240	1	°C	F1 [†]	0 = -40 °C
113B		RTD 3 Temperature (<i>RTD Option</i>)	0-440	1	°F	F1 [†]	0 = -40 °F
113C		RTD Simulation Period (<i>RTD Option</i>)	5-305	5	min	F1 ³	15 min
113D		Reserved					
113E		Reserved					
113F	TEST CONFIG.	Disable Start Protection	0-1	1	---	F14	0 = NO
1140		Start Protection Disable Period	5-305	5	min	F1 ³	15 min
1141		Disable Statistics Logging	0-1	1	---	F14	0 = NO
1142		Reserved					
to		↓					
118F		Reserved					
1190	OPTION SWITCH 1	Option Switch 1 characters 1 and 2	32-127	1	ASCII	F8	"OP"
1191		Option Switch 1 characters 3 and 4	32-127	1	ASCII	F8	"TI "
1192		Option Switch 1 characters 5 and 6	32-127	1	ASCII	F8	"ON"
1193		Option Switch 1 characters 7 and 8	32-127	1	ASCII	F8	" S"
1194		Option Switch 1 characters 9 and 10	32-127	1	ASCII	F8	"WI"
1195		Option Switch 1 characters 11 and 12	32-127	1	ASCII	F8	"TC"
1196		Option Switch 1 characters 13 and 14	32-127	1	ASCII	F8	"H "
1197		Option Switch 1 characters 15 and 16	32-127	1	ASCII	F8	"1 "
1198		Option Switch 1 characters 17 and 18	32-127	1	ASCII	F8	" "
1199		Option Switch 1 characters 19 and 20	32-127	1	ASCII	F8	" "
119A		2 nd Phase CT Primary	5-1500	5	A	F1	100 A

1, 2, 3, *, **, ***, ****, †, ‡ See page 7–30 for explanation of Table notes.

Table 7–1: 239 MEMORY MAP (Sheet 17 of 18)

REG ADDR (HEX)	GROUP	DESCRIPTION	REGISTER VALUE RANGE	STEP VALUE	UNITS & SCALE	FOR-MAT	FACTORY DEFAULT VALUE (CONVERTED)
119B		2 nd Motor Full Load Current	1-1500	1	***	F1	100 A
119C		2 nd Phase Timed O/L Curve No	1-15	1	---	F1	4
119D		2 nd Phase S/C Trip	0-3	1	---	F19	0 = OFF
119E		2 nd Phase S/C Pickup	10-110	1	0.1 xCT	F1	100 = 10.0 xCT
119F		2 nd Phase S/C Delay	0-60000	10	ms	F1 ‡	0 ms
11A0		Reserved					
to		↓					
11AF		Reserved					
11B0	OPTION SWITCH 2	Option Switch 2 characters 1 and 2	32-127	1	ASCII	F8	"OP"
11B1		Option Switch 2 characters 3 and 4	32-127	1	ASCII	F8	"TI "
11B2		Option Switch 2 characters 5 and 6	32-127	1	ASCII	F8	"ON"
11B3		Option Switch 2 characters 7 and 8	32-127	1	ASCII	F8	" S"
11B4		Option Switch 2 characters 9 and 10	32-127	1	ASCII	F8	"WI"
11B5		Option Switch 2 characters 11 and 12	32-127	1	ASCII	F8	"TC"
11B6		Option Switch 2 characters 13 and 14	32-127	1	ASCII	F8	"H "
11B7		Option Switch 2 characters 15 and 16	32-127	1	ASCII	F8	"2 "
11B8		Option Switch 2 characters 17 and 18	32-127	1	ASCII	F8	" "
11B9		Option Switch 2 characters 19 and 20	32-127	1	ASCII	F8	" "
11BA		3 rd Phase CT Primary	5-1500	5	A	F1	100 A
11BB		3 rd Motor Full Load Current	1-1500	1	***	F1	100 A
11BC		3 rd Phase Timed O/L Curve No	1-15	1	---	F1	4
11BD		3 rd Phase S/C Trip	0-3	1	---	F19	0 = OFF
11BE		3 rd Phase S/C Pickup	10-110	1	0.1 xCT	F1	100 = 10.0 xCT
11BF		3 rd Phase S/C Delay	0-60000	10	ms	F1 ‡	0 ms
11C0		4 th Phase CT Primary	5-1500	5	A	F1	100 A
11C1		4 th Motor Full Load Current	1-1500	1	***	F1	100 A
11C2		4 th Phase Timed O/L Curve No	1-15	1	---	F1	4
11C3		4 th Phase S/C Trip	0-3	1	---	F19	0 = OFF
11C4		4 th Phase S/C Pickup	10-110	1	0.1 xCT	F1	100 = 10.0 xCT
11C5		4 th Phase S/C Delay	0-60000	10	ms	F1 ‡	0 ms
11C6		Reserved					
11C7		Reserved					
11C8		Reserved					
11C9		Reserved					
11CA		Reserved					
11CB		Reserved					

1, 2, 3, *, **, ***, ****, †, ‡ See page 7–30 for explanation of Table notes.

Table 7–1: 239 MEMORY MAP (Sheet 18 of 18)

REG ADDR (HEX)	GROUP	DESCRIPTION	REGISTER VALUE RANGE	STEP VALUE	UNITS & SCALE	FOR-MAT	FACTORY DEFAULT VALUE (CONVERTED)
11CC		Reserved					
11CD		Reserved					
11CE		Reserved					
11CF		Reserved					
to		↓					
11EF		Reserved					

1, 2, 3, *, **, ***, ***, †, ‡ See page 7–30 for explanation of Table notes.

a) MEMORY MAP TABLE NOTES

Notes: * = Minimum Setpoint value represents “OFF”
 ** = Maximum Setpoint value and FFFFH represent “OFF”
 *** = 1/Phase Current Scale Factor x A
 **** = 32767 represents “NO RTD”
 † = Any valid Actual Values or Setpoints address
 ‡ = Minimum Setpoint value represents “INST”
 1 = Display value = (Modbus Register Value – 40)
 2 = Display value = 0.0 - 600.0 sec, 10.0 - 6553.5 min
 3 = Maximum Setpoint value represents “UNLIMITED”

7.19 MEMORY MAP DATA FORMATS

Table 7-2: DATA FORMATS (Sheet 1 of 11)

CODE	DESCRIPTION	BITMASK
F1	UNSIGNED INTEGER - NUMERICAL DATA	FFFF
F2	SIGNED INTEGER - NUMERICAL DATA	FFFF
F3	HARDWARE VERSION CODE	---
	1 = A	---
	2 = B	---
	.	---
	.	---
	26 = Z	---
F4	UNSIGNED INTEGER - MOTOR MODE	FFFF
	0 = Starting	---
	1 = Stopped	---
	2 = Running	---
F5	UNSIGNED INTEGER - CAUSE OF TRIP	FFFF
	0 = No Trip	---
	1 = Overload	---
	2 = Short Circuit	---
	3 = Mechanical Jam	---
	4 = Unbalance	---
	5 = Ground	---
	6 = Stator RTD	---
	7 = Bearing RTD	---
	8 = Thermistor	---
	9 = Parameters Not Set	---
	10 = Option Switch 1 Trip	---
	11 = Option Switch 2 Trip	---
	12 = Computer Trip	---
	13 = Undercurrent Trip	---
F6	UNSIGNED INTEGER - THERMISTOR STATE	FFFF
	0 = Not Connected	---
	1 = Cold	---
	2 = Hot	---
F7	UNSIGNED INTEGER - CURRENT KEY PRESS	FFFF
	0000 = no key	---
	FE02 = RESET	---
	FE01 = STORE	---
	FE08 = SETPOINT	---

Table 7-2: DATA FORMATS (Sheet 2 of 11)

CODE	DESCRIPTION	BITMASK
	FE04 = ACTUAL	---
	FD08 = MESSAGE UP	---
	FD02 = MESSAGE DOWN	---
	FD01 = MESSAGE LEFT	---
	FD04 = MESSAGE RIGHT	---
	FB01 = VALUE UP	---
	FB02 = VALUE DOWN	---
F8	TWO ASCII CHARACTERS	FFFF
	32-127 = ASCII Character	7F00
	32-127 = ASCII Character	007F
F9	UNSIGNED INTEGER-TEMP. UNIT (RTD Option)	FFFF
	0 = Celsius	---
	1 = Fahrenheit	---
F10	ANALOG OUTPUT TYPE (AN Option)	FFFF
	0 = Motor Full Load (FLC)	---
	1 = Average Phase Amps	---
	2 = Thermal Capacity	---
	3 = RTD 1 Temperature	---
	4 = RTD 2 Temperature	---
	5 = RTD 3 Temperature	---
F11	ANALOG OUTPUT RANGE(AN Option)	FFFF
	0 = 0-1 mA	---
	1 = 0-20 mA	---
	2 = 4-20 mA	---
F12	UNSIGNED INTEGER - ENABLE / DISABLE	FFFF
	0 = Disable	---
	1 = Enable	---
F13	UNSIGNED INTEGER - MODBUS BAUD RATE	FFFF
	0 = 1200	---
	1 = 2400	---
	2 = 4800	---
	3 = 9600	---
	4 = 19200	---
F14	UNSIGNED INTEGER - YES / NO	FFFF
	0 = No	---
	1 = Yes	---

Table 7–2: DATA FORMATS (Sheet 3 of 11)

CODE	DESCRIPTION	BITMASK
F15	UNSIGNED INTEGER - GROUND SENSING TYPE	FFFF
	0 = Off	---
	1 = Core Bal. 50:0.025	---
	2 = Core Bal. x:5	---
	3 = Residual	---
F16	UNSIGNED INTEGER - FAILSAFE/NONFAILSAFE	FFFF
	0 = Non-failsafe	---
	1 = Failsafe	---
F17	UNSIGNED INTEGER - UNLATCHED / LATCHED	FFFF
	0 = Unlatched	---
	1 = Latched	---
F18	UNSIGNED INTEGER - AUX RELAY FUNCTION	FFFF
	0 = Normal	---
	1 = Trips	---
	2 = Alarms	---
F19	PHASE S/C TRIP	FFFF
	0 = Off	---
	1 = Trip	---
	2 = Auxiliary	---
	3 = Trip & Auxiliary	---
F20	UNSIGNED INTEGER - ON / OFF	FFFF
	0 = Off	---
	1 = On	---
F21	UNDERCURRENT	FFFF
	0 = Off	---
	1 = Alarm	---
	2 = Auxiliary	---
	3 = Trip	---
	4 = Alarm & Auxiliary	---
	5 = Trip & Auxiliary	---
F22	GROUND ALARM	FFFF
	0 = Off	---
	1 = Momentary	---
	2 = Latched	---
F23	THERMISTOR/MECHANICAL JAM	FFFF
	0 = Off	---

Table 7–2: DATA FORMATS (Sheet 4 of 11)

CODE	DESCRIPTION	BITMASK
	1 = Trip	---
	2 = Alarm	---
	3 = Auxiliary	---
	4 = Trip & Auxiliary	---
F24	RTD APPLICATION(RTD Option)	FFFF
	0 = Off	---
	1 = Stator	---
	2 = Bearing	---
F25	RTD TYPE (RTD Option)	FFFF
	0 = 100 PT	---
	1 = 100 NI	---
	2 = 120 NI	---
	3 = 10 CU	---
F26	OPTION SWITCH FUNCTION	FFFF
	0 = Off	---
	1 = Trip	---
	2 = Alarm	---
	3 = Auxiliary	---
	4 = Alternate Setpoints	---
	5 = Disable Starts	---
F27	COMMAND	FFFF
	1 = Reset	---
	2 = Emergency Restart	---
	3 = Computer Trip	---
	4 = Auxiliary Relay On	---
	5 = Auxiliary Relay Off	---
	6 = Display Message	---
	7 = Simulate Keypress	---
	8 = Upload Mode Entry 2	---
	9 = Upload Mode Entry 1	---
	10 = Factory Setpoints Reload 2	---
	11 = Factory Setpoints Reload 1	---
	12 = Test Relays and LEDs	---
	13 = Clear Pre-trip Data	---
F28	UNSIGNED INTEGER - KEYPRESS SIMULATION	FFFF
	49 = '1' = SETPOINT	---
	50 = '2' = ACTUAL	---
	51 = '3' = RESET	---

Table 7–2: DATA FORMATS (Sheet 5 of 11)

CODE	DESCRIPTION	BITMASK
	52 = '4' = STORE	---
	53 = '5' = MESSAGE UP	---
	54 = '6' = MESSAGE DOWN	---
	55 = '7' = MESSAGE LEFT	---
	56 = '8' = MESSAGE RIGHT	---
	57 = '9' = VALUE UP	---
	97 = 'a' = VALUE DOWN	---
F29	UNSIGNED INTEGER - SYSTEM STATUS	FFFF
	0 = Normal	---
	1 = Trip	---
	2 = Alarm	---
	3 = Trip and Alarm	---
	4 = Relays & LEDs Test or Simulation On	---
F30	UNSIGNED INTEGER - RELAY/LED TEST DATA	FFFF
	0 = Relay/LED Test Off	---
	1 = Relay/LED Test On	---
F31	RELAY/LED TEST DATA	FFFF
	Trip Relay	0001
	Alarm Relay	0002
	Auxiliary Relay	0004
	Service Relay	0008
	Trip LED	0010
	Alarm LED	0020
	Auxiliary LED	0040
	Service LED	0080
	Pickup LED	0100
	Communicate LED	0200
F33	RTD SENSOR FAILURE CAUSE (RTD Option)	FFFF
	No Sensor Failure Alarm	0000
	RTD 1	0001
	RTD 2	0002
	RTD 3	0004
F35	PARITY TYPE	FFFF
	NONE	0000
	EVEN	0001
	ODD	0002

Table 7–2: DATA FORMATS (Sheet 6 of 11)

CODE	DESCRIPTION	BITMASK
F36	SIMULATED SWITCH STATE	FFFF
	0 = OPEN	---
	1 = CLOSED	---
F38	GROUND TRIP	FFFF
	0 = OFF	---
	1 = TRIP	---
	2 = AUXILIARY	---
	3 = TRIP & AUXILIARY	---
F39	TIME TO OVERLOAD TRIP UNITS AND SCALE	FFFF
	0 = 0.01 x seconds	---
	1 = 0.1 x seconds	---
	2 = seconds	---
	3 = minutes	---
F40	DATE - MONTH/DAY	FFFF
	Month: 1=January, 2=February, 3=March, etc.	FF00
	Day: 1-31 in steps of 1	00FF
F41	DATE - YEAR	FFFF
	Year: 1995, 1996, 1997, etc.	FFFF
F43	OVERLOAD PICKUP INHIBIT ON	FFFF
	0 = Run	---
	1 = Start	---
	2 = Start & Run	---
F44	BREAKER FAILURE RELAY ASSIGNMENT	FFFF
	0 = Off	---
	1 = Alarm	---
	2 = Auxiliary	---
	3 = Alarm & Auxiliary	---
F45	UNSIGNED LONG INTEGER (NUMERICAL DATA)	FFFFFFFF
F100	SWITCH INPUT STATUS (0=OPEN, 1=CLOSED)	FFFF
	Not Used	0001
	Not Used	0002
	Not Used	0004
	Not Used	0008
	Not Used	0010
	Not Used	0020
	Not Used	0040
	Not Used	0080

Table 7–2: DATA FORMATS (Sheet 7 of 11)

CODE	DESCRIPTION	BITMASK
	Access	0100
	Emergency Restart	0200
	External Reset	0400
	Option 1	0800
	Option 2	1000
	Not Used	2000
	Not Used	4000
	Not Used	8000
F101	LED STATUS FLAGS: (0 = OFF, 1 = ON)	FFFF
	Trip	0001
	Auxiliary	0002
	Pickup	0004
	Alarm	0008
	Service	0010
	Communicate	0020
	Not Used	0040
	Not Used	0080
	Not Used	0100
	Not Used	0200
	Not Used	0400
	Not Used	0800
	Not Used	1000
	Not Used	2000
	Not Used	4000
	Not Used	8000
F102	ALARM STATUS FLAGS:	FFFF
	Immediate Overload Alarm	0001
	Undercurrent Alarm	0002
	Unbalance Alarm	0004
	Ground Alarm	0008
	Thermistor Alarm	0010
	Thermistor Open Alarm	0020
	Stator RTD Alarm (<i>RTD Option</i>)	0040
	Bearing RTD Alarm (<i>RTD Option</i>)	0080
	RTD Failure Alarm (<i>RTD Option</i>)	0100
	Communication Failure	0200
	Internal Fault Alarm	0400
	Thermal Capacity Alarm	0800
	Option Switch 1 Alarm	1000

Table 7–2: DATA FORMATS (Sheet 8 of 11)

CODE	DESCRIPTION	BITMASK
	Option Switch 2 Alarm	2000
	Breaker Failure Alarm	4000
	Mechanical Jam Alarm	8000
F103	TRIP FLAGS:	FFFF
	Ground	0001
	Overload	0002
	Unbalance	0004
	Thermistor	0008
	Mechanical Jam	0010
	Short Circuit	0020
	Stator RTD (<i>RTD Option</i>)	0040
	Bearing RTD (<i>RTD Option</i>)	0080
	Parameters Not Set	0100
	Option Switch 1	0200
	Option Switch 2	0400
	Computer Command	0800
	Undercurrent	1000
	Not Used	2000
	Not Used	4000
	Not Used	8000
F104	GE POWER MANAGEMENT OPTIONS	FFFF
	No Options Installed	0000
	RTD Option (<i>RTD Option</i>)	0001
	Analog Output Option (<i>AN Option</i>)	0002
	Not Used	0004
	Not Used	0008
	Not Used	0010
	Not Used	0020
	Not Used	0040
	Not Used	0080
	Not Used	0100
	Not Used	0200
	Not Used	0400
	Not Used	0800
	Not Used	1000
	Not Used	2000
	Not Used	4000
	Not Used	8000

Table 7–2: DATA FORMATS (Sheet 9 of 11)

CODE	DESCRIPTION	BITMASK
F105	INTERNAL FAULT ERROR CODE	FFFF
	ADC Reference Out of Range	0001
	HC705 Processor not Responding	0002
	Switch Input Circuit Fault	0004
	RTD Reference Out of Range (<i>RTD Option</i>)	0008
	HC705 MOR Byte Not Programmed	0010
	Not Used	0020
	Not Used	0040
	Not Used	0080
	Not Used	0100
	Not Used	0200
	Not Used	0400
	Not Used	0800
	Not Used	1000
	Not Used	2000
	Not Used	4000
	Not Used	8000
F106	AUXILIARY STATUS FLAGS:	FFFF
	Undercurrent	0001
	Option Switch 1	0002
	Option Switch 2	0004
	Alarms	0008
	Trips	0010
	Short Circuit	0020
	Ground	0040
	Thermistor	0080
	Breaker Failure	0100
	Mechanical Jam	0200
	Not Used	0400
	Not Used	0800
	Not Used	1000
	Not Used	2000
	Not Used	4000
	Not Used	8000
F107	RELAYS (0 = DE-ENERGIZED, 1 = ENERGIZED)	FFFF
	Trip Relay	0001
	Alarm Relay	0002
	Auxiliary Relay	0004

Table 7–2: DATA FORMATS (Sheet 10 of 11)

CODE	DESCRIPTION	BITMASK
	Service Relay	0008
	Reserved	0010
	Not Used	0020
	Not Used	0040
	Not Used	0080
	Not Used	0100
	Not Used	0200
	Not Used	0400
	Not Used	0800
	Not Used	1000
	Not Used	2000
	Not Used	4000
	Not Used	8000
F108	LED Attribute Flags (0=flash, 1=solid; when active)	FFFF
	Trip	0001
	Auxiliary	0002
	Pickup	0004
	Alarm	0008
	Service	0010
	Communicate	0020
	Not Used	0040
	Not Used	0080
	Not Used	0100
	Not Used	0200
	Not Used	0400
	Not Used	0800
	Not Used	1000
	Not Used	2000
	Not Used	4000
	Not Used	8000
F109	Names of the Months	FFFF
	1 = January	---
	2 = February	---
	3 = March	---
	4 = April	---
	5 = May	---
	6 = June	---
	7 = July	---

Table 7–2: DATA FORMATS (Sheet 11 of 11)

CODE	DESCRIPTION	BITMASK
	8 = August	---
	9 = September	---
	10 = October	---
	11 = November	---
	12 = December	---
F110	Display Units	FFFF
	0 = Seconds	---
	1 = Minutes	---
F113	Currently Selected Setpoints Group	FFFF
	0 = Main Group	---
	1 = 2 nd Group	---
	2 = 3 rd Group	---
	3 = 4 th Group	---
F114	Ground Current Scale Factor	FFFF
	10 = RESIDUAL or X:5 GROUND SENSING	---
	100 = OFF or 50:0.025 GROUND SENSING	---

8.1 PRIMARY INJECTION TESTING

Prior to relay commissioning at installation, complete system operation can be verified by injecting current through the phase & 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.

8.2 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.

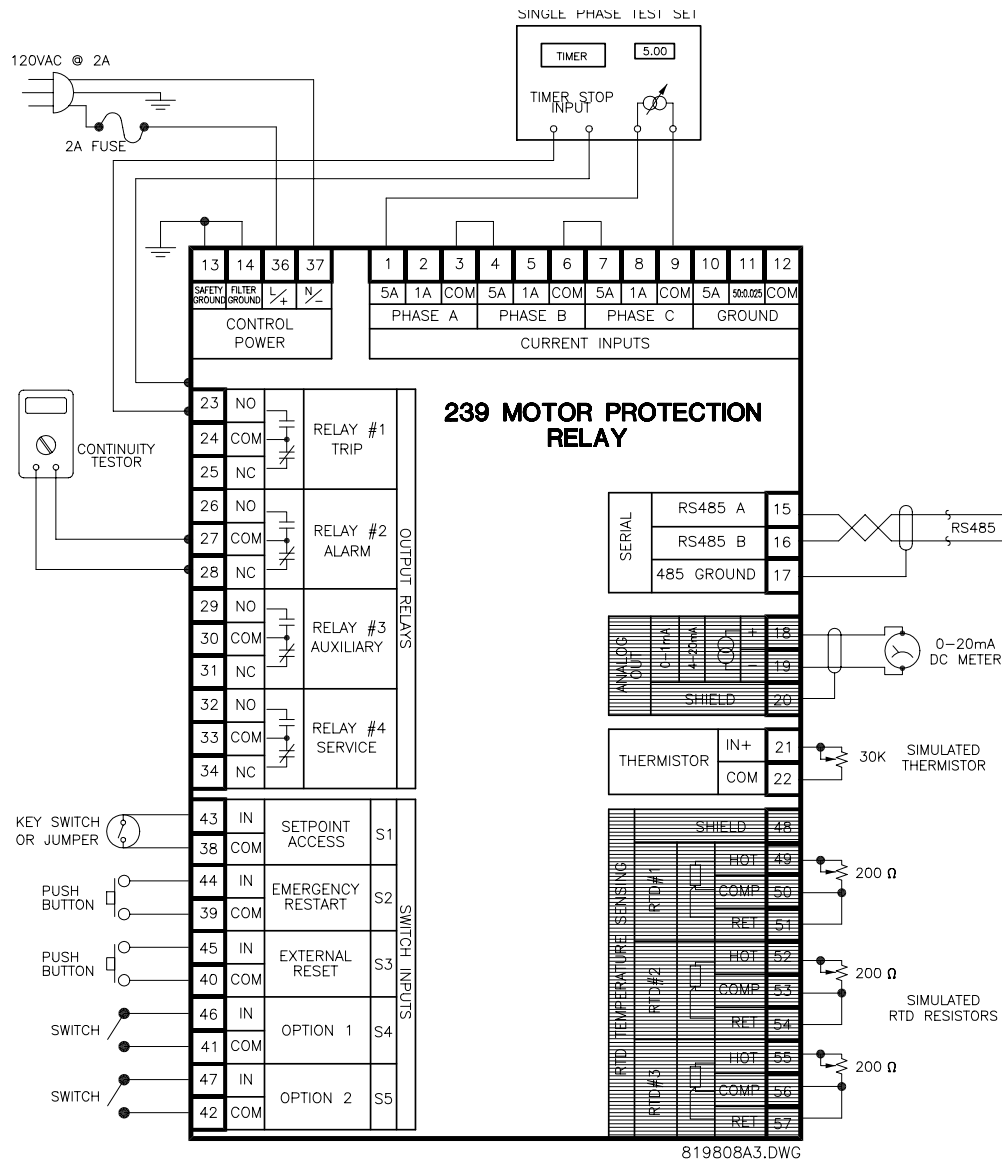


Figure 8-1: SECONDARY INJECTION TEST SETUP

8.3 PHASE CURRENT ACCURACY TEST

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 ICT 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 8–1: 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 8–2: 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			

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

8.4 PHASE CURRENT OVERLOAD TEST

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 each phase in series. 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.

8.5 PHASE UNBALANCE ALARM TEST

1. 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

2. Connect the test set to inject current into phase A and phase C only. While viewing A2: METERING\CURRENT\CURRENT UNBALANCE U/B, slowly increase the current 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 8–3: PHASE UNBALANCE ALARM TEST

INJECTED CURRENT (A)	ACTUAL DISPLAY READING (A)		
	PHASE A	PHASE B	PHASE C

3. 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

a) EXAMPLE: CALCULATING THE PERCENT OF UNBALANCE

Find % 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 % 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 % unbalance in this case is 18%.

8.6 GROUND CURRENT ACCURACY TEST

- 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 8–4: 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	

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

8.7 GROUND ALARM AND TRIP TEST

- 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%*
- 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).
- 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.
- Turn the ground current off and press the reset key to reset the trip relay.

8.8 SWITCH INPUT TEST

- 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 8–5: 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

8.9 ANALOG OUTPUT TEST

- Alter the following setpoints:
S1: 239 SETUPANALOG OUTPUTANALOG OUTPUT RANGE: 4-20 mA
S5: TESTINGANALOG OUTPUT SIMULATIONISIMULATION: ON
- As shown in Figure 8–1: SECONDARY INJECTION TEST SETUP on page 8–1, connect a DC ammeter between terminals 18 and 19.
- Using the setpoint **S5: TESTINGANALOG OUTPUT SIMULATIONISIMULATION** **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: TESTINGANALOG OUTPUTISIMULATIONISIMULATION** 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.

Table 8–6: ANALOG OUTPUT TEST

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

8.10 THERMISTOR ALARM TEST

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 8–1: SECONDARY INJECTION TEST SETUP on page 8–1, place a variable 30 kΩ 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. 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\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.

8.11 RTD MEASUREMENT TESTS

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 Ω variable resistor is connected to terminals 49, 50 and 51 as shown in Figure 8–1: SECONDARY INJECTION TEST SETUP on page 8–1.
3. Use Table 4–3: RTD RESISTANCE VS. TEMPERATURE on page 4–30 as a reference guide. Input various resistance values and verify that displayed temperature 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.

8.12 POWER FAILURE AND NON-VOLATILE MEMORY TEST

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.

8.13 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 SETUPIMOTOR DATAIMOTOR 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 SETUPIMOTOR DATAIMOTOR 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: TESTINGTEST RELAYS & LEDSIOPERATION 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 8.9: ANALOG OUTPUT TEST on page 8–6. This test can be performed while current is present.

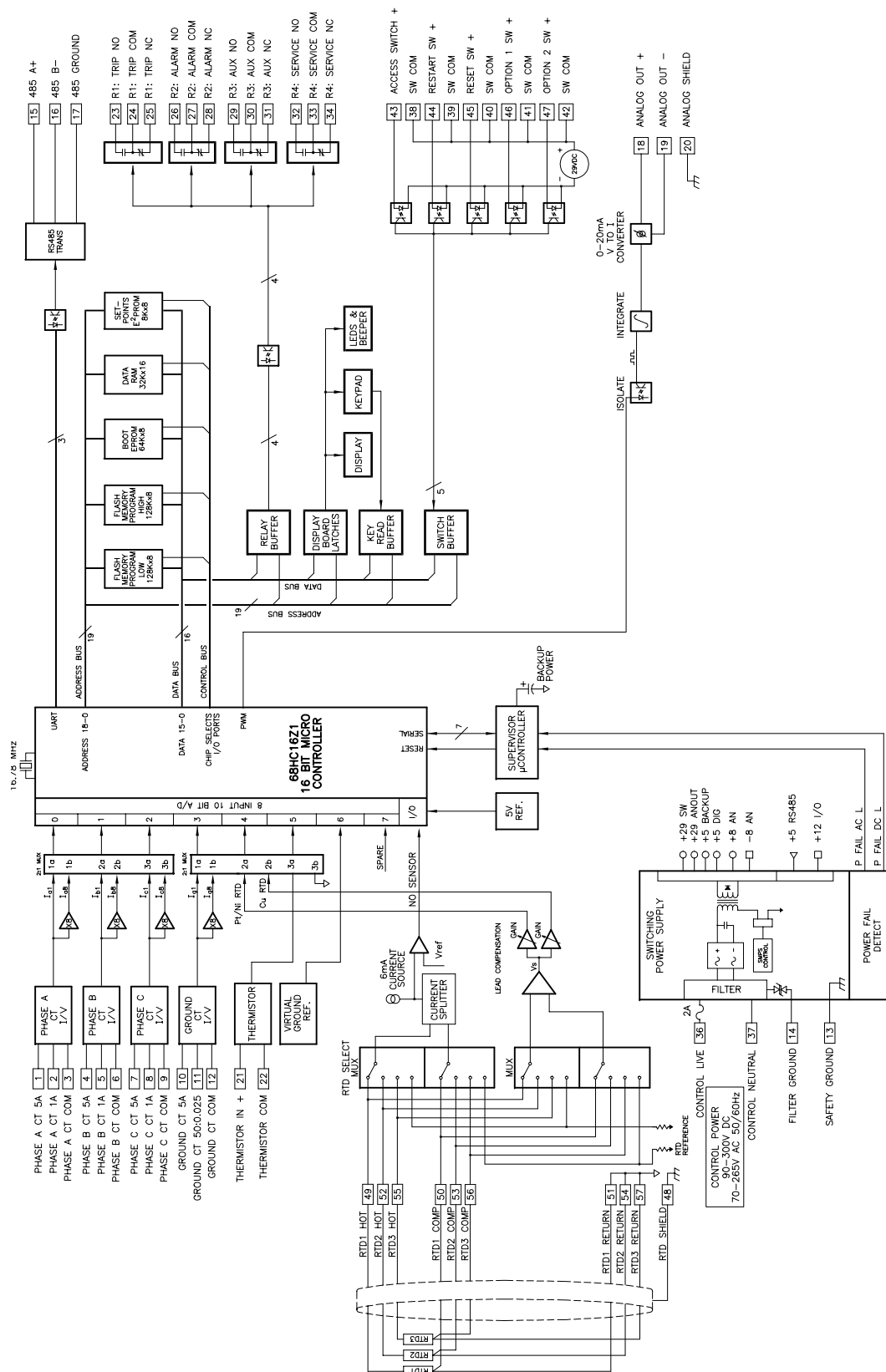


Figure 8-2: 239 HARDWARE BLOCK DIAGRAM

9.1 COMMISSIONING SUMMARY

Table 9–1: SETPOINTS TABLE (Sheet 1 of 6)

PAGE S1: 239 SETUP	
PREFERENCES	
TEMPERATURE DISPLAY IN:	
DEFAULT MESSAGE TIME:	min
DEFAULT MESSAGE BRIGHTNESS:	%
BLOCK KEYPAD TRIP RESET:	
ANALOG OUTPUT	
ANALOG OUTPUT TYPE:	
ANALOG OUTPUT RANGE:	mA
RS485 SERIAL PORT	
SERIAL COMMS FAILURE ALARM:	
SLAVE ADDRESS:	
BAUD RATE:	baud
PARITY:	
DEFAULTS	
RELOAD SETPOINTS:	
CLEAR PRE-TRIP DATA:	
CLEAR STATISTICS DATA:	
PROGRAMMABLE MESSAGE	
PROGRAMMABLE MESSAGE NAME:	
PRODUCT OPTIONS	
SELECT OPTIONS TO ENABLE:	
SELECT MOD 1 TO ENABLE:	
SELECT MOD 2 TO ENABLE:	
SELECT MOD 3 TO ENABLE:	
SELECT MOD 4 TO ENABLE:	
SELECT MOD 5 TO ENABLE:	
ENTER PASSCODE:	
SETPOINTS PAGE S2: SYSTEM SETUP	
CT INPUTS	
PHASE CT PRIMARY:	A

Table 9–1: SETPOINTS TABLE (Sheet 2 of 6)

GROUND SENSING:	
GROUND CT PRIMARY:	A
NOMINAL FREQUENCY	Hz
MOTOR DATA	
MOTOR FULL LOAD CURRENT:	A
OVERLOAD PICKUP INHIBIT ≤	x FLC
USE OVERLOAD PICKUP INHIBIT ON:	
LOCKED ROTOR CURRENT	x FLC
SAFE STALL TIME COLD:	s
HOT/COLD CURVE RATIO:	%
DISABLE STARTS:	
SETPOINTS PAGE S3: OUTPUT RELAYS	
TRIP RELAY	
TRIP OPERATION:	
ALARM RELAY	
ALARM OPERATION:	
ALARM ACTIVATION:	
AUXILIARY RELAY	
AUXILIARY OPERATION:	
AUXILIARY ACTIVATION:	
AUXILIARY FUNCTION:	
SETPOINTS PAGE S4: PROTECTION	
PHASE CURRENT	
OVERLOAD	
OVERLOAD CURVE NO:	
AT ____ x FLC, TRIP TIME:	s
OVERLOAD LOCKOUT TIME:	min
AUTO RESET O/L TRIPS:	
PHASE S/C	
PHASE S/C TRIP:	
PHASE S/C PICKUP ≥	x CT

Table 9–1: SETPOINTS TABLE (Sheet 3 of 6)

PHASE S/C DELAY:	ms
IMMEDIATE OVERLOAD	
IMMEDIATE OVERLOAD ALARM:	
IMMEDIATE OVERLOAD PICKUP \geq	x FLC
INHIBIT ON START FOR:	s
MECHANICAL JAM	
MECHANICAL JAM TRIP:	
MECHANICAL JAM PICKUP \geq	x FLC
MECHANICAL JAM DELAY:	s
INHIBIT ON START FOR:	s
UNDERCURRENT	
UNDERCURRENT FUNCTION:	
UNDERCURRENT PICKUP \leq	% FLC
UNDERCURRENT DELAY:	s
UNBALANCE	
PHASE UNBLANCE TRIP:	
UNBALANCE TRIP PICKUP \geq	% FLC
PHASE UNBALANCE DELAY:	s
PHASE UNBLANCE ALARM:	
UNBALANCE ALARM PICKUP \geq	% FLC
HOT MOTOR	
THERMAL CAPACITY ALARM:	%
BREAKER FAILURE	
BREAKER FAILURE FUNCTION:	
BREAKER FAILURE PICKUP:	x CT
BREAKER FAIL PICKUP DELAY:	ms
BREAKER FAIL DROPOUT DELAY:	ms
GROUND CURRENT	
GROUND TRIP:	
GROUND PRIMARY TRIP PICKUP \geq	—
GROUND TRIP DELAY ON RUN:	ms
GROUND TRIP DELAY ON START:	ms

Table 9–1: SETPOINTS TABLE (Sheet 4 of 6)

GROUND ALARM:	
GROUND ALARM PICKUP \geq	—
GROUND ALARM DELAY ON RUN:	s
GROUND ALARM DELAY ON START	s
TEMPERATURE	
THERMISTOR	
THERMISTOR FUNCTION	
THERMISTOR HOT RESISTANCE:	k Ω
THERMISTOR COLD RESISTANCE:	k Ω
NOT CONNECTED ALARM:	
RTD 1	
RTD 1 APPLICATION:	
RTD 1 TYPE:	
RTD 1 TRIP TEMPERATURE \geq	° —
RTD 1 ALARM TEMPERATURE \geq	° —
RTD 2	
RTD 2 APPLICATION:	
RTD 2 TYPE:	
RTD 2 TRIP TEMPERATURE \geq	° —
RTD 2 ALARM TEMPERATURE \geq	° —
RTD 3	
RTD 3 APPLICATION:	
RTD 3 TYPE:	
RTD 3 TRIP TEMPERATURE \geq	° —
RTD 3 ALARM TEMPERATURE \geq	° —
RTD SENSOR FAILURE	
RTD SENSOR FAILURE ALARM:	
SWITCH INPUTS	
OPTION SWITCH 1	
OPTION SW. 1 NAME:	
SWITCH 1 FUNCTION:	
TIME DELAY:	s

Table 9–1: SETPOINTS TABLE (Sheet 5 of 6)

2 nd PHASE CT PRIMARY:	A
2 nd FULL LOAD CURRENT:	A
2 nd OVERLOAD CURVE NUMBER:	
2 nd PHASE S/C TRIP:	
2 nd PHASE S/C PICKUP \geq	x CT
2 nd PHASE S/C DELAY:	ms
OPTION SWITCH 2	
OPTION SW. 2 NAME:	
SWITCH 2 FUNCTION:	
TIME DELAY:	
3 rd PHASE CT PRIMARY:	A
3 rd FULL LOAD CURRENT:	A
3 rd OVERLOAD CURVE NUMBER:	
3 rd PHASE S/C TRIP:	
3 rd PHASE S/C PICKUP \geq	x CT
3 rd PHASE S/C DELAY:	ms
4 th PHASE CT PRIMARY:	A
4 th FULL LOAD CURRENT:	A
4 th OVERLOAD CURVE NUMBER	
4 th PHASE S/C TRIP:	
4 th PHASE S/C PICKUP \geq	x CT
4 th PHASE S/C DELAY:	ms
SETPOINTS PAGE S5: TESTING	
TEST CONFIGURATION	
DISABLE START PROTECTION:	
PROTECTION DISABLED FOR:	min
TEST RELAYS & LEDS	
OPERATION TEST:	
CURRENT SIMULATION	
SIMULATION:	
SIMULATION ENABLED FOR:	min
PHASE A CURRENT:	A

Table 9–1: SETPOINTS TABLE (Sheet 6 of 6)

PHASE B CURRENT:	A
PHASE C CURRENT:	A
GROUND CURRENT:	A
ANALOG OUTPUT SIMULATION	
SIMULATION:	
SIMULATION ENABLED FOR:	min
ANALOG OUTPUT FORCED TO:	%
SWITCH INPUTS SIMULATION	
SIMULATION:	
SIMULATION ENABLED FOR:	min
EMERGENCY RESTART INPUT:	
EXTERNAL RESET INPUT:	
OPTION SWITCH 1 INPUT:	
OPTION SWITCH 2 INPUT:	
THERMISTOR SIMULATION	
SIMULATION:	
SIMULATION ENABLED FOR:	min
THERMISTOR RESISTANCE:	Ω
RTD SIMULATION	
SIMULATION:	
SIMULATION ENABLED FOR:	min
RTD 1 TEMPERATURE:	$^{\circ}$ —
RTD 2 TEMPERATURE:	$^{\circ}$ —
RTD 3 TEMPERATURE:	$^{\circ}$ —
GE POWER MANAGEMENT USE ONLY	
SERVICE PASSCODE:	

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NOTES

The latest product information for the 239 relay is available on the Internet via the GE Power Management home page:

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