

469

Motor Management Relay



Instruction Manual

GE Digital Energy
650 Markland Street
Markham, Ontario
Canada L6C 0M1

TELEPHONE: Worldwide +1 905 927 7070
Europe/Middle East Africa +34 94 485 88 54
North America toll-free 1 800 547 8629

FAX: +1 905 927 5098

E-MAIL: Worldwide multilin.tech@ge.com
Europe multilin.tech.euro@ge.com

HOME PAGE: Internet: <http://www.gedigitalenergy.com/multilin>

Software Revision: 5.20

Manual P/N: 1601-0122-AG

Manual Order Code: GEK-106474Q



GE Digital Energy's Quality Management System is registered to ISO9001:2008

QMI # 005094



© 2013 GE Multilin Incorporated. All rights reserved.

GE Multilin 469 Motor Management Relay instruction manual for revision 5.20.

469 Motor Management Relay, is a registered trademark of GE Multilin Inc.

The contents of this manual are the property of GE Multilin Inc. This documentation is furnished on license and may not be reproduced in whole or in part without the permission of GE Multilin. The content of this manual is for informational use only and is subject to change without notice.

Part numbers contained in this manual are subject to change without notice, and should therefore be verified by GE Multilin before ordering.

Part number: 1601-0122-AG (November 2013)

Safety words and definitions

The following symbols used in this document indicate the following conditions:



Indicates a hazardous situation which, if not avoided, will result in death or serious injury.



Indicates a hazardous situation which, if not avoided, could result in death or serious injury.



Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.



Indicates practices not related to personal injury.



Indicates general information and practices, including operational information and practices, that are not related to personal injury.

Table of Contents

1: GETTING STARTED	IMPORTANT PROCEDURES	1-1
	CAUTIONS AND WARNINGS	1-1
	INSPECTION CHECKLIST	1-1
	MANUAL ORGANIZATION	1-2
	USING THE RELAY	1-3
	MENU NAVIGATION	1-3
	PANEL KEYING EXAMPLE	1-7
	CHANGING SETTINGS	1-9
	INTRODUCTION	1-9
	THE HELP KEY	1-10
	NUMERICAL SETTINGS	1-10
	ENUMERATION SETTINGS	1-11
	OUTPUT RELAY SETTINGS	1-15
	TEXT SETTINGS	1-15
	APPLICATION EXAMPLE	1-17
	DESCRIPTION	1-17
	INSTRUMENT TRANSFORMER DATA	1-25
	MOTOR PROTECTION	1-25
	S2 SYSTEM SETTINGS	1-30
	S3 DIGITAL INPUTS SETTINGS	1-32
	S5 THERMAL MODEL	1-33
	S6 CURRENT ELEMENTS	1-33
	S7 MOTOR STARTING	1-35
	S8 RTD TEMPERATURE	1-35
	OTHER SETTINGS	1-36
	INSTALLATION	1-38
	TESTING	1-38

2: INTRODUCTION	OVERVIEW	2-1
	DESCRIPTION	2-1
	ORDERING INFORMATION	2-4
	ORDER CODES	2-5
	EXAMPLE ORDER CODES	2-5
	ACCESSORIES	2-5
	SPECIFICATIONS	2-6
	INPUTS	2-6
	OUTPUTS	2-7
	PROTECTION	2-8
	DIGITAL INPUTS	2-11
	MONITORING	2-12
	POWER SUPPLY	2-13
	CPU	2-14
	WAVEFORM CAPTURE (TRACE MEMORY)	2-14
	TESTING	2-14
	CERTIFICATION	2-15
	PHYSICAL	2-16
	ENVIRONMENTAL	2-16
	LONG-TERM STORAGE	2-16

3: INSTALLATION	MECHANICAL INSTALLATION	3-1
	DESCRIPTION	3-1
	PRODUCT IDENTIFICATION	3-2
	INSTALLATION	3-3
	UNIT WITHDRAWAL AND INSERTION	3-5
	ETHERNET CONNECTION	3-7
	DEVICENET CONNECTION	3-8
	TERMINAL LOCATIONS	3-9
	TERMINAL LIST	3-9
	ELECTRICAL INSTALLATION	3-11
	TYPICAL WIRING	3-11
	DESCRIPTION	3-12
	CONTROL POWER	3-12
	CURRENT INPUTS	3-13
	VOLTAGE INPUTS	3-17
	DIGITAL INPUTS	3-18
	ANALOG INPUTS	3-19
	ANALOG OUTPUTS	3-19
	RTD SENSOR CONNECTIONS	3-20
	OUTPUT RELAYS	3-22
	DRAWOUT INDICATOR	3-24
	RS485 COMMUNICATIONS PORTS	3-24
	DIELECTRIC STRENGTH	3-25
	2-SPEED MOTOR WIRING	3-27

4: INTERFACES	FACEPLATE INTERFACE	4-1
	DESCRIPTION	4-1
	DISPLAY	4-1
	LED INDICATORS	4-2
	RS232 PORT	4-3
	KEYPAD	4-4
	SETTINGS ENTRY	4-6
	DIAGNOSTIC MESSAGES	4-7
	SELF-TEST WARNINGS	4-8
	FLASH MESSAGES	4-9
	ENERVISTA 469 SETUP SOFTWARE INTERFACE	4-10
	OVERVIEW	4-10
	HARDWARE	4-11
	INSTALLING THE ENERVISTA 469 SETUP SOFTWARE	4-13
	CONNECTING ENERVISTA 469 SETUP TO THE RELAY	4-16
	CONFIGURING SERIAL COMMUNICATIONS	4-16
	USING THE QUICK CONNECT FEATURE	4-17
	CONFIGURING ETHERNET COMMUNICATIONS	4-18
	CONNECTING TO THE RELAY	4-19
	WORKING WITH SETTINGS AND SETTINGS FILES	4-22
	ENGAGING A DEVICE	4-22
	ENTERING SETTINGS	4-22
	FILE SUPPORT	4-23
	USING SETTINGS FILES	4-23
	UPGRADING RELAY FIRMWARE	4-35
	DESCRIPTION	4-35
	SAVING SETTINGS TO A FILE	4-35

LOADING NEW FIRMWARE 4-35

ADVANCED ENERVISTA 469 SETUP FEATURES 4-38

TRIGGERED EVENTS 4-38

WAVEFORM CAPTURE (TRACE MEMORY) 4-38

PHASORS 4-40

TRENDING (DATA LOGGER) 4-42

EVENT RECORDER 4-44

MODBUS USER MAP 4-45

VIEWING ACTUAL VALUES 4-46

USING ENERVISTA VIEWPOINT WITH THE 469 4-49

PLUG AND PLAY EXAMPLE 4-49

5: SETTINGS

OVERVIEW 5-1

SETTINGS MESSAGE MAP 5-1

TRIPS, ALARMS, AND BLOCKS 5-6

RELAY ASSIGNMENT PRACTICES 5-7

S1 469 SETUP 5-8

PASSCODE 5-8

PREFERENCES 5-9

COMMUNICATIONS 5-11

REAL TIME CLOCK 5-13

DEFAULT MESSAGES 5-14

MESSAGE SCRATCHPAD 5-15

CLEAR DATA 5-16

INSTALLATION 5-16

S2 SYSTEM SETUP 5-18

CURRENT SENSING 5-18

VOLTAGE SENSING 5-20

POWER SYSTEM 5-20

COMMUNICATIONS CONTROL 5-21

REDUCED VOLTAGE 5-22

PRESET MOTOR VALUES 5-24

S3 DIGITAL INPUTS 5-26

DESCRIPTION 5-26

STARTER STATUS 5-27

ASSIGNABLE INPUTS 1(4) 5-27

S4 OUTPUT RELAYS 5-36

DESCRIPTION 5-36

RELAY RESET MODE 5-36

FORCE OUTPUT RELAY 5-37

S5 THERMAL MODEL 5-38

MOTOR THERMAL LIMITS 5-38

THERMAL MODEL 5-40

OVERLOAD CURVE SETUP 5-41

S6 CURRENT ELEMENTS 5-60

SHORT CIRCUIT TRIP 5-60

OVERLOAD ALARM 5-61

MECHANICAL JAM 5-61

UNDERCURRENT 5-62

CURRENT UNBALANCE 5-63

GROUND FAULT 5-64

PHASE DIFFERENTIAL 5-65

S7 MOTOR STARTING 5-67

ACCELERATION TIMER	5-67
START INHIBIT	5-67
JOGGING BLOCK	5-68
RESTART BLOCK	5-70
S8 RTD TEMPERATURE	5-71
RTD TYPES	5-71
RTDs 1 to 6	5-72
RTDs 7 to 10	5-73
RTD 11	5-74
RTD 12	5-75
OPEN RTD SENSOR	5-76
RTD SHORT/LOW TEMP	5-76
S9 VOLTAGE ELEMENTS	5-77
UNDERVOLTAGE	5-77
OVERVOLTAGE	5-79
PHASE REVERSAL	5-79
FREQUENCY	5-80
S10 POWER ELEMENTS	5-81
POWER MEASUREMENT CONVENTIONS	5-81
POWER FACTOR	5-82
REACTIVE POWER	5-83
UNDERPOWER	5-84
REVERSE POWER	5-85
TORQUE SETUP	5-85
OVERTORQUE	5-86
S11 MONITORING	5-87
TRIP COUNTER	5-87
STARTER FAILURE	5-87
DEMAND	5-88
PULSE OUTPUT	5-90
LOSS OF COMMUNICATIONS	5-91
S12 ANALOG INPUTS/OUTPUTS	5-93
ANALOG OUTPUTS 1 TO 4	5-93
ANALOG INPUTS 1 TO 4	5-95
ANALOG INPUT DIFF 1-2	5-97
ANALOG INPUT DIFF 3-4	5-98
S13 469 TESTING	5-100
SIMULATION MODE	5-100
PRE-FAULT SETUP	5-101
FAULT SETUP	5-102
TEST OUTPUT RELAYS	5-103
TEST ANALOG OUTPUTS	5-103
COMM PORT MONITOR	5-104
GR DIGITAL ENERGY USE ONLY	5-104
S14 TWO-SPEED MOTOR	5-105
DESCRIPTION	5-105
SPEED2 UNDERCURRENT	5-109
SPEED2 ACCELERATION	5-109

6: ACTUAL VALUES

OVERVIEW	6-1
ACTUAL VALUES MAP	6-1
DESCRIPTION	6-3
A1 STATUS	6-4

NETWORK STATUS 6-4
 MOTOR STATUS 6-5
 LAST TRIP DATA 6-5
 ALARM STATUS 6-7
 START BLOCKS 6-9
 DIGITAL INPUTS 6-9
 REAL TIME CLOCK 6-10
 LOSS OF COMMUNICATIONS 6-10
A2 METERING DATA 6-11
 CURRENT METERING 6-11
 TEMPERATURE 6-12
 VOLTAGE METERING 6-13
 SPEED 6-13
 POWER METERING 6-14
 DEMAND METERING 6-15
 ANALOG INPUTS 6-15
 PHASORS 6-16
A3 LEARNED DATA 6-27
 MOTOR STARTING 6-27
 AVERAGE MOTOR LOAD 6-27
 RTD MAXIMUMS 6-28
 ANALOG INPUT MIN/MAX 6-29
A4 MAINTENANCE 6-30
 TRIP COUNTERS 6-30
 GENERAL COUNTERS 6-31
 TIMERS 6-32
A5 EVENT RECORDER 6-33
 EVENT 01 TO EVENT 256 6-33
A6 PRODUCT INFO 6-36
 469 MODEL INFORMATION 6-36
 CALIBRATION INFORMATION 6-36
DIAGNOSTICS 6-37
 DIAGNOSTIC MESSAGES 6-37
 FLASH MESSAGES 6-38

7: TESTING

OVERVIEW 7-1
 TEST SETUP 7-1
HARDWARE FUNCTIONAL TESTING 7-3
 PHASE CURRENT ACCURACY TEST 7-3
 VOLTAGE INPUT ACCURACY TEST 7-3
 GROUND AND DIFFERENTIAL ACCURACY TEST 7-4
 GE DIGITAL ENERGY 50:0.025 GROUND ACCURACY TEST 7-5
 RTD ACCURACY TEST 7-5
 DIGITAL INPUTS AND TRIP COIL SUPERVISION 7-7
 ANALOG INPUTS AND OUTPUTS 7-8
 OUTPUT RELAYS 7-10
ADDITIONAL FUNCTIONAL TESTING 7-11
 OVERLOAD CURVE TEST 7-11
 POWER MEASUREMENT TEST 7-11
 UNBALANCE TEST 7-12
 VOLTAGE PHASE REVERSAL TEST 7-13
 SHORT CIRCUIT TEST 7-14

A: APPENDIX	TWO-PHASE CT CONFIGURATION	A-1
	DESCRIPTION	A-1
	COOL TIME CONSTANTS	A-4
	SELECTION OF COOL TIME CONSTANTS	A-4
	CURRENT TRANSFORMERS	A-6
	GROUND FAULT CTs FOR 50:0.025 A CT	A-6
	GROUND FAULT CTs FOR 5 A SECONDARY CT	A-8
	PHASE CTs	A-8
	EU DECLARATION OF CONFORMITY	A-10
	EU DECLARATION OF CONFORMITY	A-10
	CHANGE NOTES	A-11
	REVISION HISTORY	A-11
	CHANGES TO THE 469 MANUAL	A-11
	GE DIGITAL ENERGY WARRANTY	A-15
	WARRANTY STATEMENT	A-15



469 Motor Management Relay

Chapter 1: Getting Started

1.1 Important Procedures

1.1.1 Cautions and Warnings

Please read this chapter to guide you through the initial setup of your new relay.



WARNING

Before attempting to install or use the relay, it is imperative that all **WARNINGS** and **CAUTIONS** in this manual are reviewed to help prevent personal injury, equipment damage, and/or downtime.



CAUTION

1.1.2 Inspection Checklist

- Open the relay packaging and inspect the unit for physical damage.
- View the rear nameplate and verify that the correct model has been ordered.
- Ensure that the following items are included:
 - Instruction Manual
 - GE EnerVista CD (includes software and relay documentation)
 - mounting screws
- For product information, instruction manual updates, and the latest software updates, please visit the GE Digital Energy website at <http://www.gedigitalenergy.com>.



NOTE

If there is any noticeable physical damage, or any of the contents listed are missing, please contact GE Digital Energy immediately.

1.1.3 Manual Organization

Reading a lengthy instruction manual on a new product is not a task most people enjoy. To speed things up, this introductory chapter provides a step-by-step tutorial for a simple motor application. Important wiring considerations and precautions discussed in *Electrical Installation* on page 3–11 should be observed for reliable operation. Detailed information regarding accuracy, output relay contact ratings, and so forth are detailed in *Specifications* on page 2–6. The remainder of this manual should be read and kept for reference to ensure maximum benefit from the 469 Motor Management Relay. For further information, please consult your local sales representative or the factory. Comments about new features or modifications for your specific requirements are welcome and encouraged.

settings and actual values are indicated as follows in the manual:

A3 LEARNED DATA ▸ ▾ AVERAGE MOTOR LOAD ▸ AVERAGE MOTOR LOAD LEARNED

This 'path representation' illustrates the location of an specific actual value or settings with regards to its previous menus and sub-menus. In the example above, the **AVERAGE MOTOR LOAD LEARNED** actual value is shown to be an item in the **AVERAGE MOTOR LOAD** sub-menu, which itself is an item in the **A3 LEARNED DATA** menu, which is an item of **ACTUAL VALUES**.

Sub-menu levels are entered by pressing the MESSAGE ► or ENTER key. When inside a submenu, the ◀ MESSAGE or ESCAPE key returns to the previous sub-menu. The MESSAGE ▼ and MESSAGE ▲ keys are used to scroll through the settings in a sub-menu. The display indicates which keys can be used at any given point.

1.2 Using the Relay

1.2.1 Menu Navigation

The relay has three types of display messages: actual value, settings, and target messages. A summary of the menu structure for settings and actual values can be found at the beginning of chapters 5 and 6, respectively.

Settings are programmable settings entered by the user. These types of messages are located within a menu structure that groups the information into categories. Navigating the menu structure is described below.

Actual values include the following information:

1. Motor and System Status:
 - a. Motor status either stopped, starting, or running. It includes values such as motor load, thermal capacity used, motor speed, and instantaneous values of power system quantities.
 - b. The status of digital inputs.
 - c. Last trip information, including values such as cause of last trip, time and date of trip, motor speed and load at the time of trip, pre-trip temperature measurements, pre-trip analog inputs values, and pre-trip instantaneous values of power system quantities.
 - d. Active alarms.
 - e. Relay date and time.
 - f. Present blocking conditions.
 - g. General system status indication including the status of output relays, active pickup, alarm and trip conditions.
2. Metering Data:
 - a. Instantaneous current measurements including phase, differential, unbalance, ground, average, and motor load.
 - b. RTD Temperatures including hottest RTDs.
 - c. Instantaneous phase to phase and phase to ground voltages (depending on the VT connections), average voltage, and system frequency.
 - d. Motor Speed
 - e. Power Quantities including apparent, real and reactive power.
 - f. Current and power demand including peak values.
 - g. Analog inputs
 - h. Vector information.
3. Motor Learned Data:
 - a. Learned and last acceleration time.
 - b. Learned and last starting current.

- c. Learned and last starting capacity.
 - d. Average motor load.
4. Maintenance data. This is useful statistical information that may be used for preventive maintenance. It includes:
 - a. Trip counters
 - b. General counter such as number of motor starts, number of emergency restarts, number of starter operations, digital counter for other purposes not listed above.
 - c. Timers such as motor running hours, time between starts timer, and five start timers used to calculate the average start time of the motor.
 5. RTD Learned Data, which includes the maximum temperature measured by each of the 12 RTDs.
 6. Event recorder downloading tool.
 7. Product information including model number, firmware version, additional product information, and calibration dates.
 8. Oscillography downloading tool.

Alarm, trip conditions, diagnostics, and system flash messages are grouped under *Target Messages*.

- ▷ Press the MENU key to access the header of each menu, which will be displayed in the following sequence:

```
1. SETPOINTS
Press [▷] for more
```

```
2. ACTUAL VALUES
Press [▷] for more
```

```
3. TARGET MESSAGES
Press [▷] for more
```

To access settings,

- ▷ Press the MENU key until the display shows the header of the Settings menu.
- ▷ Press the MESSAGE ► or ENTER key to display the header for the first Settings page.
The Settings pages are numbered, have an 'S' prefix for easy identification and have a name which provides a general idea of the settings available in that page.
Pressing the MESSAGE ▼ and MESSAGE ▲ keys will scroll through all the available Settings page headers. Settings page headers look as follows:

```
■ SETPOINTS [▷]
S1 469 SETUP
```

To enter a given Settings page,

- ▷ Press the MESSAGE ► or ENTER key.
- ▷ Press the MESSAGE ▼ or MESSAGE ▲ keys to scroll through sub-page headers until the required message is reached.
The end of a page is indicated by the message **END OF PAGE**. The beginning of a page is indicated by the message **TOP OF PAGE**.

To access actual values,

- ▷ Press the MENU key until the display shows the header of the actual values menu.
- ▷ Press the MESSAGE ► or ENTER key to display the header for the first actual values page.
The actual values pages are numbered, have an 'A' prefix for easy identification and have a name, which gives a general idea of the information available in that page.
Pressing the MESSAGE ▼ or MESSAGE ▲ keys will scroll through all the available actual values page headers. Actual values page headers look as follows:

■ ACTUAL VALUES [▷] A1 STATUS

To enter a given actual values page,

- ▷ Press the MESSAGE ► or ENTER key.
- ▷ Press the MESSAGE ▼ or MESSAGE ▲ keys to scroll through sub-page headers until the required message is reached.
The end of a page is indicated by the message **END OF PAGE**. The beginning of a page is indicated by the message **TOP OF PAGE**.

Similarly, to access additional sub-pages,

- ▷ Press the MESSAGE ► or ENTER key to enter the first sub-page,
- ▷ Press the MESSAGE ▼ or MESSAGE ▲ keys to scroll through the available sub-pages, until the desired message is reached.
The process is identical for both settings and actual values.

The following procedure illustrates the key sequence to access the Current Demand actual values.

- ▷ Press the MENU key until you reach the actual values main menu.
- ▷ Press MESSAGE ► or ENTER key to enter the first actual values page.
- ▷ Press the MESSAGE ▼ or MESSAGE ▲ key to scroll through pages, until the **A2 METERING DATA** page appears.

■ ACTUAL VALUES [▷] A2 METERING DATA

- ▷ Press the MESSAGE ► or ENTER key to display the first sub-page heading for the Metering Data actual values page:

■ CURRENT	[▷]
METERING	

Pressing the MESSAGE ▼ or MESSAGE ▲ keys will scroll the display up and down through the sub-page headers.

Pressing the ◀ MESSAGE or ESCAPE key at any sub-page heading will return the display to the heading of the corresponding settings or actual value page.

Pressing it again, will return the display to the main menu header.

- ▷ Press the MESSAGE ▼ key until the **DEMAND METERING** sub-page heading appears.

■ DEMAND	[▷]
METERING	

At this point, pressing MESSAGE ► or ENTER key will display the messages under this sub-page. If instead you press the MESSAGE ▲ key, it will return to the previous sub-page heading. In this case,

■ POWER	[▷]
METERING	

When the symbols ■ and [▷] appear on the top line, it indicates that additional sub-pages are available and can be accessed by pressing the MESSAGE ► or ENTER key.

- ▷ Press MESSAGE ► or ENTER while at the Demand Metering sub-page heading to display the following:

CURRENT	
DEMAND :	0 Amps

- ▷ Press ◀ MESSAGE key to return to the Demand Metering sub-page heading.
- ▷ Press the MESSAGE ▼ key to display the next actual value of this sub-page.
Actual values and settings messages always have a colon separating the name of the value and the actual value or settings. This particular message displays the current demand as measured by the relay.

The menu path to this value is shown as **A2 METERING DATA** ▷ ▽ **DEMAND METERING** ▷ **CURRENT DEMAND**. Settings and actual values messages are referred to in this manner throughout the manual.

For example, the **A3 LEARNED DATA** ▷ **MOTOR STARTING** ▷ **LEARNED ACCELERATION TIME** path representation describes the following key-press sequence:

- ▷ Press the MENU key until the actual value header appears on the display, MESSAGE ► or ENTER key,

- ▷ Press the MESSAGE ▼ key until the **A3 LEARNED DATA** message is displayed.
- ▷ Press the MESSAGE ► or ENTER key to display **MOTOR STARTING** message.
- ▷ Press the MESSAGE ► or ENTER key to reach the **LEARNED ACCELERATION TIME** message and the corresponding actual value.
- ▷ Press the MESSAGE ▼ key to display the next actual value message as shown below:

LEARNED STARTING
CURRENT: 0 A

- ▷ Press the MESSAGE ▼ or MESSAGE ▲ keys to scroll the display up and down through all the actual value displays in this corresponding sub-page.
- ▷ Press the ◀ MESSAGE key to reverse the process described above and return the display to the previous level.

■ MOTOR [▷]
STARTING

- ▷ Press the ◀ MESSAGE key twice to return to the **A3 LEARNED DATA** page header.

■ ACTUAL VALUES [▷]
A3 LEARNED DATA

1.2.2 Panel Keying Example

The following figure gives a specific example of how the keypad is used to navigate through the menu structure. Specific locations are referred to throughout this manual by using a 'path representation'. The example shown in the figure gives the key presses required to read the learned starting current denoted by the path **A3 LEARNED DATA ▷ ▽ MOTOR STARTING ▷ ▽ LEARNED STARTING CURRENT**.

- ▷ Press the menu key until the relay displays the actual values page.

■ ACTUAL VALUES [▷]

Press the MESSAGE  or ENTER key

■ ACTUAL VALUES [▷]
A1 STATUS

Press the MESSAGE  key

■ ACTUAL VALUES [▷]
A2 METERING DATA

Press the MESSAGE  key

■ ACTUAL VALUES [▷]
A3 LEARNED DATA

MESSAGE 

■ MOTOR STARTING [▷]

MESSAGE 

LEARNED ACCELERATION
TIME: 0.0 s

MESSAGE 

LEARNED STARTING
CURRENT: 0 A

1.3 Changing Settings

1.3.1 Introduction

There are several classes of settings, each distinguished by the way their values are displayed and edited.

The relay's menu is arranged in a tree structure. Each setting in the menu is referred to as a settings, and each settings in the menu may be accessed as described in the previous section.

The settings are arranged in pages with each page containing related settings; for example, all the Short Circuit Trip settings are contained within the same page. As previously explained, the top menu page of each setting group describes the settings contained within that page. Pressing the MESSAGE keys allows the user to move between these top menus.

All of the 469 settings fall into one of following categories: device settings, system settings, digital input settings, output relay settings, thermal model settings, current element settings, motor starting settings, RTD temperatures settings, voltage element settings, power element settings, monitoring settings, analog input/output settings, two speed motor settings, and testing settings.



IMPORTANT: Settings are stored and used by the relay immediately after they are entered. As such, caution must be exercised when entering settings while the relay is in service. Modifying or storing protection settings is not recommended when the relay is in service since any incompatibility or lack of coordination with other previously saved settings may cause unwanted operations.

Now that we have become more familiar with maneuvering through messages, we can learn how to edit the values used by all settings classes.

Hardware and passcode security features are designed to provide protection against unauthorized settings changes. Since we will be programming new settings using the front panel keys, a hardware jumper must be installed across the settings access terminals (C1 and C2) on the back of the relay case. Attempts to enter a new settings without this electrical connection will result in an error message.

The jumper does not restrict settings access via serial communications. The relay has a programmable passcode settings, which may be used to disallow settings changes from both the front panel and the serial communications ports. This passcode consists of up to eight (8) numeric characters.

The factory default passcode is "0". When this specific value is programmed into the relay it has the effect of removing all settings modification restrictions. Therefore, only the settings access jumper can be used to restrict settings access via the front panel and there are no restrictions via the communications ports.

When the passcode is programmed to any other value, settings access is restricted for the front panel and all communications ports. Write Access via keypad is not permitted until the passcode is entered via the keypad. Write access via communication port is not permitted until the passcode is entered via that port. That is, the passcode must be entered via the port from which access is desired.

Entering the passcode on any communication port automatically restricts the other ports, but does not restrict the keypad. For example, entering the passcode on computer RS485 permits settings write access on computer RS485, and restricts write access on computer RS232, auxiliary RS485, and ethernet.

A front panel command can disable settings access once all modifications are complete. For the communications ports, writing an invalid passcode disables access. In addition, settings access is automatically disabled on an interface if no activity is detected for thirty minutes.

The EnerVista 469 Setup software incorporates a facility for programming the relay's passcode as well as enabling and disabling settings access. For example, when an attempt is made to modify a settings but access is restricted, the software will prompt the user to enter the passcode and send it to the relay before the settings is actually written to the relay. If a SCADA system is used for relay programming, it is the programmer's responsibility to incorporate appropriate security for the application.

1.3.2 The HELP Key

Pressing the **HELP** key displays context-sensitive information about settings such as the range of values and the method of changing the settings. Help messages will automatically scroll through all messages currently appropriate.

1.3.3 Numerical Settings

Each numerical settings has its own minimum, maximum, and step value. These parameters define the acceptable settings value range. Two methods of editing and storing a numerical settings value are available.

The first method uses the 469 numeric keypad in the same way as any electronic calculator. A number is entered one digit at a time with the 0 to 9 and decimal keys. The left-most digit is entered first and the right-most digit is entered last. Pressing **ESCAPE** before the **ENTER** key returns the original value to the display.

The second method uses the **VALUE ▲** key to increment the displayed value by the step value, up to a maximum allowed value. Likewise, the **VALUE ▼** key decrements the displayed value by the step value, down to a minimum value. For example:

- ▷ Select the **S2 SYSTEM SETUP ▷ VOLTAGE SENSING ▷ MOTOR NAMEPLATE VOLTAGE** settings message.

```
MOTOR NAMEPLATE
VOLTAGE: 4000 V
```

- ▷ Press the 1, 3, 8, 0, and 0 keys. The display message will change as shown.

```
MOTOR NAMEPLATE
VOLTAGE: 13800 V
```

Until the **ENTER** key is pressed, editing changes are not registered by the relay.

- ▷ Therefore, press the ENTER key to store the new value in memory. This flash message will momentarily appear as confirmation of the storing process.

**NEW SETPOINT HAS
BEEN STORED**

1.3.4 Enumeration Settings

The example shown in the following figures illustrates the keypress sequences required to enter system parameters such as the phase CT primary rating, ground CT primary rating, bus VT connection type, secondary voltage, and VT ratio.

The following values will be entered:

Phase CT primary rating: 600 A
 Motor Full Load Current: 318 A
 Ground CT ratings: 50/5 A
 Phase Differential CT: None
 Voltage Transformer Connection Type: Open Delta
 Motor Nameplate Voltage: 13800 V
 VT Ratio: 115:1

To set the phase CT primary rating, modify the **S2 SYSTEM SETUP** ▷ **CURRENT SENSING** ▷ **PHASE CT PRIMARY** settings as shown below.

- ▷ Press the MENU key until the relay displays the Sepoints menu header.

1. SETPOINTS
Press [▷] for more

Press MESSAGE ► or ENTER

■ **SETPOINTS** [▷]
S1 469 SETUP

Press MESSAGE ▼

■ **SETPOINTS** [▷]
S2 SYSTEM SETUP

Press MESSAGE ► or ENTER

■ **CURRENT SENSING** [▷]

Press MESSAGE ► or ENTER

PHASE CT PRIMARY:
OFF

Press the VALUE keys until 600 A is displayed, or enter the value directly via the numeric keypad.

PHASE CT PRIMARY:
600 A

Press the ENTER key to store the settings.

**NEW SETPOINT HAS
BEEN STORED**

To set the phase Motor Full Load Amps FLA, modify the **S2 SYSTEM SETUP** ▷ **CURRENT SENSING** ▷ **MOTOR FULL LOAD AMPS FLA** settings as shown below.

- ▷ Press the MENU key until the relay displays the Setpoints menu header.

1. SETPOINTS
 Press [▷] for more

Press MESSAGE ► or ENTER

■ **SETPOINTS** [▷]
 S1 469 SETUP

Press MESSAGE ▼

■ **SETPOINTS** [▷]
 S2 SYSTEM SETUP

Press
 MESSAGE ►
 or ENTER

■ **CURRENT** [▷]
 SENSING

Press
 MESSAGE ►
 or ENTER

PHASE CT PRIMARY:
 600 A

Press
 MESSAGE ▼

MOTOR FULL LOAD AMPS
FLA: OFF

Press the VALUE keys until 318 A is displayed,
 or enter the value directly via the numeric
 keypad.

MOTOR FULL LOAD AMPS
FLA: 318 A

Press the ENTER key to store the settings.

NEW SETPOINT HAS
BEEN STORED

To set the ground CT ratings, modify the **S2 SYSTEM SETUP** > **CURRENT SENSING** > **GROUND CT** and the **S2 SYSTEM SETUP** > **CURRENT SENSING** > **GROUND CT PRIMARY** settings as shown below.

- ▷ Press the MENU key until the relay displays the Setpoints menu header.

1. SETPOINTS
Press [▷] for more

Press MESSAGE ▶ or ENTER

■ **SETPOINTS** [▷]
S1 469 SETUP

Press MESSAGE ▼

■ **SETPOINTS** [▷]
S2 SYSTEM SETUP

Press MESSAGE ▶ or ENTER

■ **CURRENT SENSING** [▷]

Press MESSAGE ▶ or ENTER

PHASE CT PRIMARY:
600 A

Press MESSAGE ▼

MOTOR FULL LOAD AMPS
FLA: 318 A

Press MESSAGE ▼

GROUND CT:
50:0.025

Press the VALUE keys until "5 A Secondary" is displayed.

GROUND CT:
5 A Secondary

Press the ENTER key to store the settings.

NEW SETPOINT HAS BEEN STORED

Press MESSAGE ▼

GROUND CT PRIMARY:
100 A

Press the VALUE keys until 50 A is displayed, or enter the value directly via the numeric keypad.

GROUND CT PRIMARY:
50 A

Press the ENTER key to store the settings.

NEW SETPOINT HAS BEEN STORED

To set the VT connection type and ratings, modify the **S2 SYSTEM SETUP ▾ ▾ VOLTAGE SENSING ▾ ▾ VT CONNECTION TYPE** and the **S2 SYSTEM SETUP ▾ ▾ VOLTAGE SENSING ▾ ▾ VOLTAGE TRANSFORMER RATIO**, and **S2 SYSTEM SETUP ▾ ▾ VOLTAGE SENSING ▾ ▾ MOTOR NAMEPLATE VOLTAGE** settings as shown below.

▷ Press the MENU key until the relay displays the Setpoints menu header.

1. SETPOINTS
Press [▷] for more

Press MESSAGE ▷ or ENTER

■ **SETPOINTS** [▷]
S1 469 SETUP

Press MESSAGE ▼

■ **SETPOINTS** [▷]
S2 SYSTEM SETUP

Press MESSAGE ▶ or ENTER

■ **CURRENT SENSING** [▷]

Press MESSAGE ▼

■ **VOLTAGE SENSING** [▷]

Press MESSAGE ▶ or ENTER

VT CONNECTION TYPE:
None

Press the VALUE keys until "Open Delta" is displayed.

VT CONNECTION TYPE:
Open Delta

Press the ENTER key to store the settings.

NEW SETPOINT HAS BEEN STORED

Press MESSAGE ▼

ENABLE SINGLE VT:
OPERATION: OFF

Press MESSAGE ▼

VOLTAGE TRANSFORMER RATIO: 35.00 : 1

Press the VALUE keys until 115.00 : 1 is displayed, or enter the value directly via the numeric keypad.

VOLTAGE TRANSFORMER RATIO: 115.00 : 1

Press the ENTER key to store the settings.

NEW SETPOINT HAS BEEN STORED

Press MESSAGE ▼

MOTOR NAMEPLATE VOLTAGE: 4000 V

Press the VALUE keys until 13800 V is displayed, or enter the value directly via the numeric keypad.

MOTOR NAMEPLATE VOLTAGE: 13800 V

Press the ENTER key to store the settings.

NEW SETPOINT HAS BEEN STORED

If an entered settings value is out of range, the relay displays the following message:

OUT-OF-RANGE! ENTER:
100-36000 by 1

"100-36000" indicates the range and "1" indicates the step value

where 100 is the minimum settings value, 36000 is the maximum, and 1 is the step value. To have access to information on maximum, minimum, and step value, press the HELP key.

1.3.5 Output Relay Settings

Output relays (Trip or Alarm) can be associated to the Auxiliary Relays 2 and 3. Each can be selected individually, or in combination, in response to customer specific requirements, which can be initiated by any protection element or function, whose **ASSIGN RELAYS** settings has them selected.

- ▷ Select the **S6 CURRENT ELEM. ▷ SHORT CIRCUIT TRIP ▷ ▾ ASSIGN TRIP RELAYS** settings message.

```
ASSIGN TRIP RELAYS:
Trip
```

If an application requires the short circuit protection element to operate the Auxiliary Output 3 relay,

- ▷ Select this output relay by pressing the value key until the desired combination appear in the display.

```
ASSIGN TRIP RELAYS:
Trip & Auxiliary3
```

- ▷ Press the ENTER key to store this change into memory. As before, confirmation of this action will momentarily flash on the display.

```
NEW SETPOINT HAS
BEEN STORED
```

1.3.6 Text Settings

Text settings have data values which are fixed in length but user-defined in character. They may be composed of uppercase letters, lowercase letters, numerals, and a selection of special characters. The editing and storing of a text value is accomplished using the decimal [.] , VALUE, and ENTER keys.

For **example**:

- ▷ Move to message **S3 DIGITAL INPUTS ▷ ▾ ASSIGNABLE INPUT 1 ▷ INPUT 1 FUNCTION**, and scrolling with the VALUE keys, select "General Sw. A".

The relay will display the following message:

```
INPUT 1 FUNCTION:
General Sw. A
```

- ▷ Press the MESSAGE ▼ key to view the next settings, **SWITCH NAME**. The name of this user-defined input will be changed in this example from the generic "General Sw. A" to something more descriptive.

If an application is to be using the relay as a station monitor, it is more informative to rename this input "Station Monitor".

- ▷ Press the decimal [.] key to enter the text editing mode. The first character will appear underlined as follows:

```
SWITCH NAME:  
General Sw. A
```

- ▷ Press the VALUE keys until the character “S” is displayed in the first position.
- ▷ Press the decimal [.] key to store the character and advance the cursor to the next position.
- ▷ Change the second character to a “t” in the same manner.
- ▷ Continue entering characters in this way until all characters of the text “Stn. Monitor” are entered.
Note that a space is selected like a character. If a character is entered incorrectly, press the decimal [.] key repeatedly until the cursor returns to the position of the error. Re-enter the character as required.
- ▷ Once complete, press the ENTER key to remove the solid cursor and view the result. Once a character is entered, by pressing the ENTER key, it is automatically saved in flash memory, as a new settings.

```
SWITCH NAME:  
Stn. Monitor
```


- VT primary and secondary ratings
- System frequency
- System phase sequence
- Define the protection elements that will be enabled. Prepare a list of protection functions including the following information. By default, all the protection functions must be assumed “Disabled”:
 - Pickup parameter
 - Operating curve, if applicable
 - Time dial or multiplier
 - Any additional intentional time delay
 - Directionality, if applicable
- Define how many output contacts will be energized in response to a given protection function. Note that the 469 relay can be programmed to Trip or Alarm and, at the same time, to energize one, a combination, or all the 2 auxiliary relays during the process.
- Define if the output relays will be set as failsafe type.
- Define if the 469 relay will be used to start the motor. If so, gather information on the required conditions to execute the command.
- Define if the 469 will be involved in the motor starting process, particularly on reduced voltage start applications.
- Define if the 469 will be applied a multi speed applications.
- Define if the relay will be used to monitor the status of the starter or breaker. It is strongly recommended that the 469 be always programmed to monitor the status of the disconnecting device, by means of a dry contact connected to one of the digital inputs of the relay. Use an auxiliary contact from the breaker or starter either a normally open contact, 52a, which is normally in open position when the disconnecting device is open, or a normally closed contact, 52b, which is in close position when the breaker or starter is open.
- If the 469 will be used to respond to digital inputs, record the following information:
 - Digital Input name
 - Condition by which the digital input would be considered asserted
 - Function that the digital input will initiate within the 469
- If the 469 will be used to perform monitoring functions and act upon certain conditions, record information such as:
 - minimum and maximum values
 - alarm and trip values
 - time delays
- It is important to familiarize yourself with the relay protection and control functions before setting up the relay.

To begin, simply power on the unit and follow the instructions in this tutorial. Assume the following system characteristics and that the 469 settings are unaltered from their factory default values.

Refer to the following figures for schematics related to this application example.

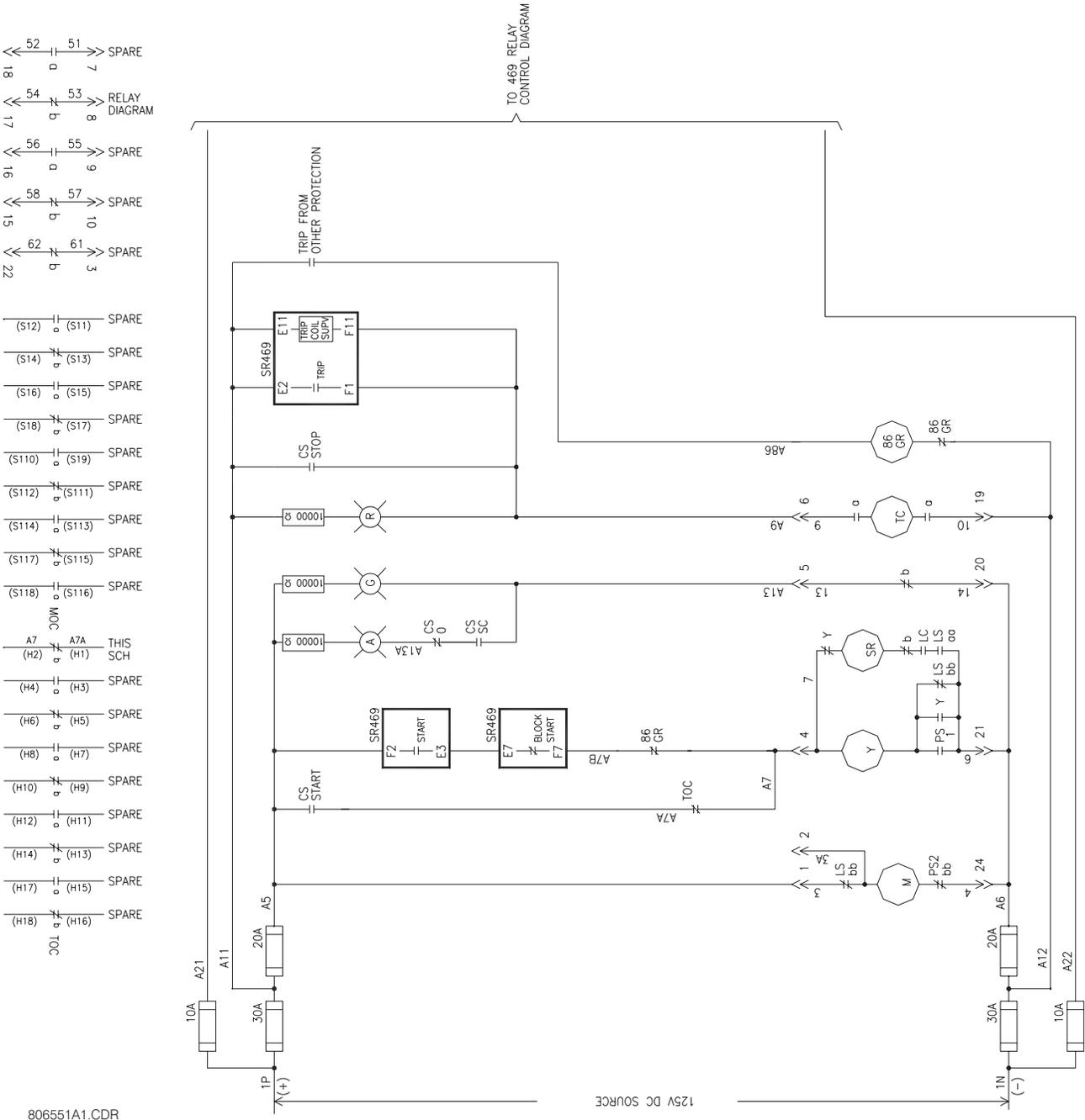


FIGURE 1-4: Typical Breaker Control Diagram

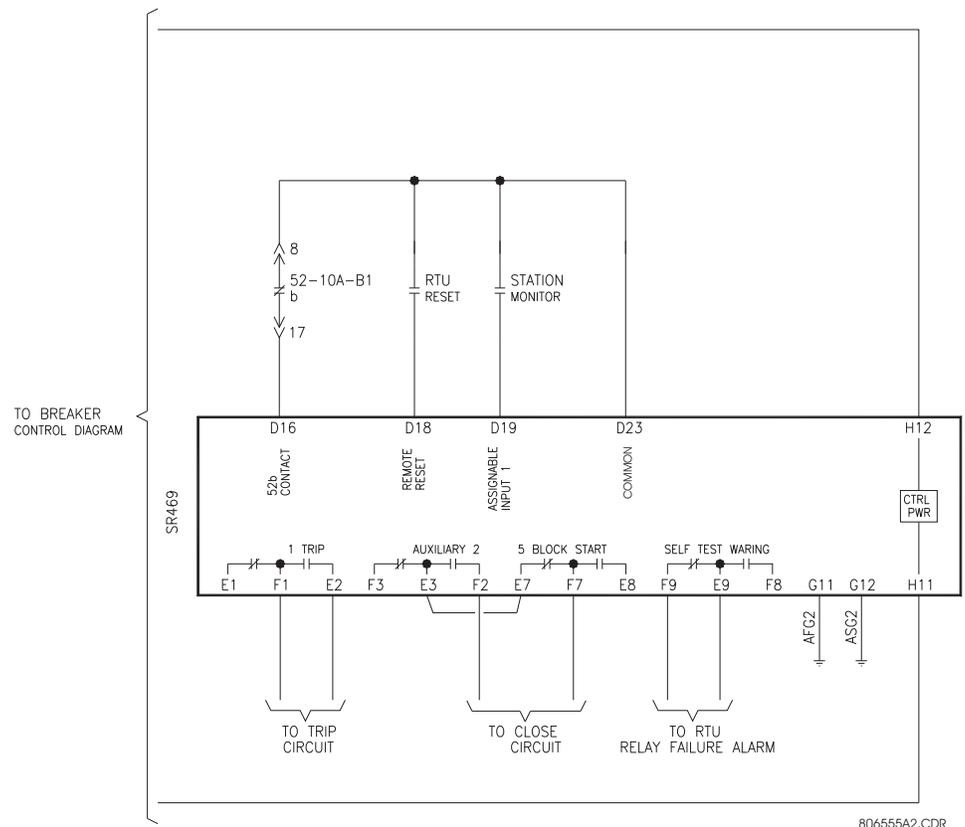


FIGURE 1-5: Typical Relay Control Diagram

- **Power System Data**

- a) System: 3 ϕ , 4 wire
- b) Frequency: 60 Hz
- c) Line voltage: 600 V

- **Motor Data**

As per the following motor data sheet information:

```

400HP,3/60/ 575V,1800RPM,TYPE hsa SCIM,d509, TEFC,80/40C BY RES @FL
Insulation Class      f      Service Factor      1.15
Full Load Speed      1788  RPM      Design      b      LKVA-code      . F
Full Load Torque      .1179 LB-FT      Load (% FL)      100%      75%      .50%
Locked Rotor Torque    88 % FLT      Nom.Eff(CSA)      95.7      95.4      94.5
Breakdown Torque      225 % FLT      Power Factor      90.2      90.1      87.7
Locked Rotor Amps      631 % FLA      Current(A)      347.5      261.7      181.0
Safe Stall Time H/C    16/ 18 SEC      Max PF Correct.    50 KVAR to 97.0 %
Load Torque Curve      VTFL      Load Inertia (EEMAC) LB-FT2      1545
Application:           NOT SPEC'D      Rotor Inertia LB-FT2      196
FOR: WESTINGHOUSE      Data sheet Number      WC26277-B
RANDOM WOUND STATOR. FABRICATED COPPER BAR ROTOR. /5S7/02
Note: Eff'y per CSA C390 M1985      Date Jan- 8,1993
CAUTION: ACCELERATION TIMES BASED ON ASSUMED LOAD CONDITIONS
PROVIDE WMCC WITH LOAD TORQUE CURVE, LOAD WK2 AT MOTOR SHAFT
AND TERMINAL VOLTAGE FOR ANALYSIS
    
```

FIGURE 1-6: Motor Data Sheet Information

- **Motor Operating Curves**

Motor operating curves as shown below:

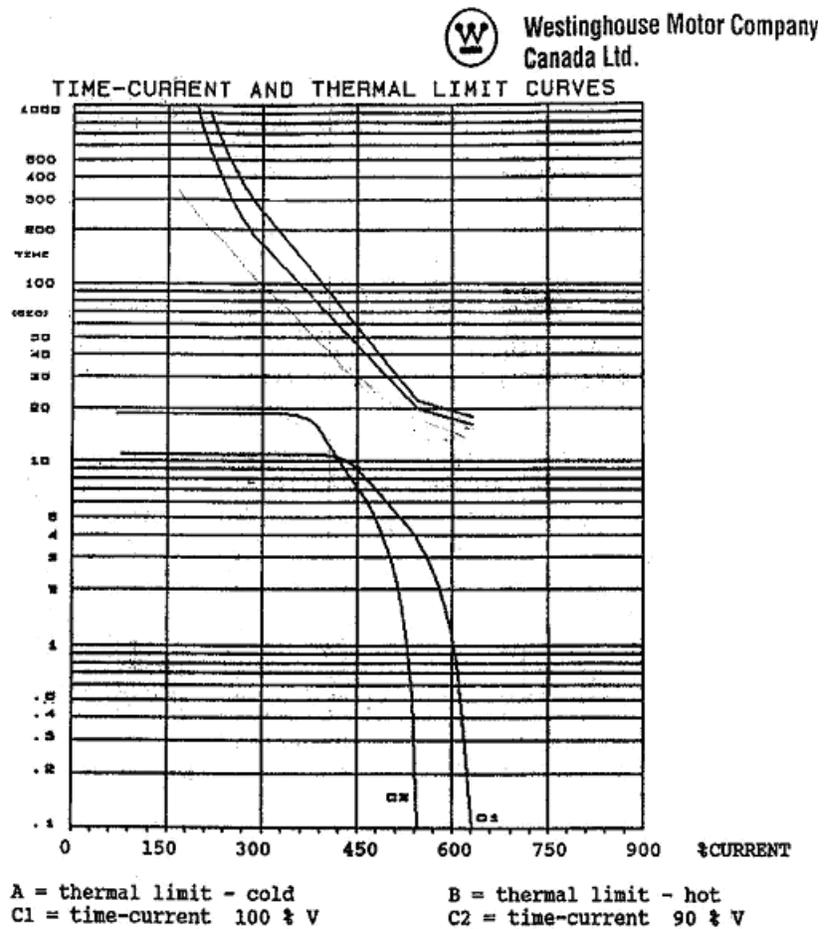


FIGURE 1-7: Motor Operating Curves for Application Example

- **Control System Requirements**

- All protection elements trip the breaker
- Breaker position monitoring via 52b contact only
- Only current metering is required
- Serial communication remote start from RTU
- Alarm after 100 s delay from station monitor. This is normally used to signal the remote center when someone has gained access to the substation.

- **Contact Outputs**

- Trip and close to breaker control circuit (Trip and Auxiliary2 relays)
- Relay failure alarm to RTU (self-test warning relay, no programming required)
- Alarm contact (setup in General Sw. A for "Station Monitor")
- No data communications to other equipment.

- **RTDs**

The motor is fitted with the following RTDs:

- RTD type: 100 Ω Platinum
- 6 Stator RTDs, 2 per phase
- 2 Bearing RTDs
- 1 Ambient RTD

Use the above data to set the output relays to achieve breaker control; to set digital inputs for breaker status, remote operations, remote status, and alarm indication. Assume that the communications between the station and the master control center will be done by the RTU. Alarms, status indication, and breaker commands will be hard-wired from the relay to the RTU. Similar information could be exchanged between the RTU and the relay via an RS485 or RS422 Serial Link using the Modbus RTU protocol. Refer to GE Publication GEK-106491C: *469 Communications Guide* for additional information.

1.4.2 Instrument Transformer Data

- **Voltage Transformers**

- 2 \times Open Delta connected, ratio = 600:120 V
- Motor System Voltage = 575 V

- **Phase CTs**

The phase CTs should be chosen such that the FLC is 50% to 100% of CT primary. Since the FLC is 347.5A a 350:5, or 400:5 CT may be chosen; 400:5 is a standard available size and so would probably be selected.

- **Ground CT**

For high resistive grounded systems, sensitive ground detection is possible with the 50:0.025 CT. Use a 1 A or 5 A secondary CT on solidly grounded or low resistive grounded systems where the fault current is much higher. If a residual connection is chosen, pickup levels and timers must be set with respect to the acceleration time. The chosen zero-sequence CT must be able to handle all potential fault levels without saturating. In this example, 50:5A CT is selected.

- **Motor FLC**

Set the motor full load current to 348 A, as specified by the data sheets.

Use the above data to set the relay system parameters, such as CT and VT connections, VT secondary voltage, and CT and VT primary to secondary ratios.

1.4.3 Motor Protection

- **Overload Pickup**

The overload pickup is set to the maximum allowed by the service factor of the motor. Since this motor has RTDs and the relay will be using the RTD bias feature for enhanced protection, set the overload pickup to the highest setting of $1.25 \times \text{FLC}$ for the motor service factor of 1.15. If service factor is unknown, assume 1.0.

- **Overload Curve**

Select the standard overload curve to be just below the cold thermal limit to give maximum process uptime, without compromising protection.

The best fitting curve is curve 7 (see figure below)

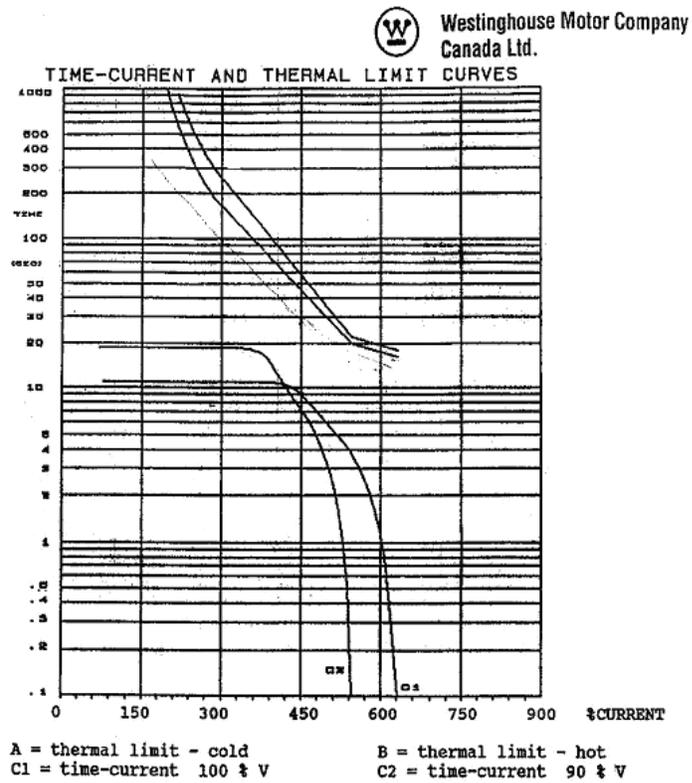
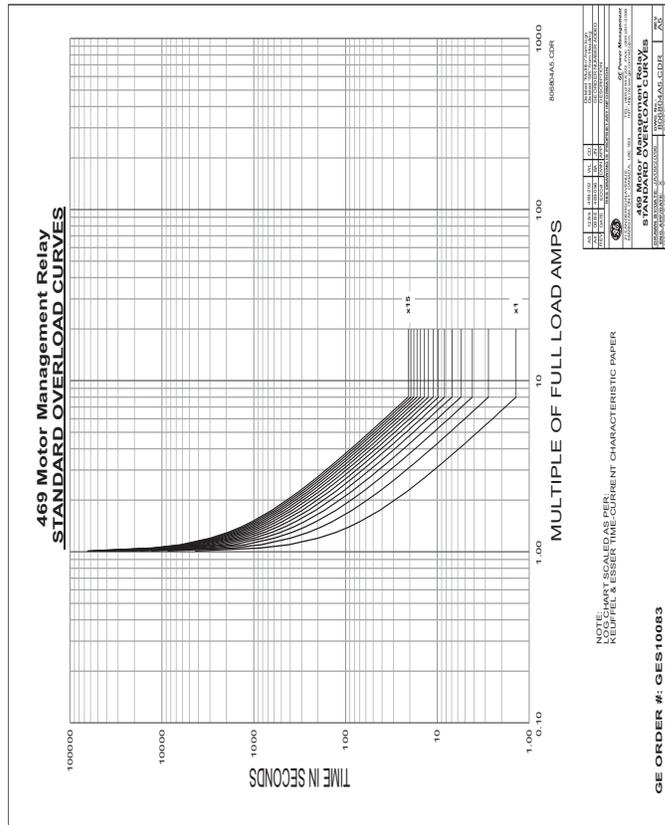


FIGURE 1-8: Overload Curve Matching (Example)

- **Short Circuit Trip**

The short circuit trip should be set above the maximum locked rotor current but below the short circuit current of the fuses. The data sheets indicate a maximum locked rotor current of 630% FLC or $6.3 \times \text{FLC}$. A setting of $7 \times \text{FLC}$ with a instantaneous time delay will be ideal but nuisance tripping may result due to the asymmetrical starting currents and DC offset. If asymmetrical starting currents limits the starting capability, set the S/C level higher to a maximum of $11 \times \text{FLC}$ to override this condition ($1.7 \times 6.3 = 11.7$ where 1.7 is the maximum DC offset for an asymmetrical current).

- **Ground Fault**

Unfortunately, there is not enough information to determine a ground fault setting. These settings depend on the following information:

1. The ground fault current available.
2. System grounding; for example, high resistive grounding or solidly grounded
3. Ground fault CT used.
4. Ground fault connection; for example, zero-sequence or residual connection

For the purpose of this example, assume a fault current of 10 Amps or $10/50 = 0.2 \times \text{CT}$, no intentional time delay.

- **Unbalance Alarm and Trip**

The unbalance settings are determined by examining the motor application and motor design. The heating effect of unbalance will be protected by enabling unbalance input to thermal memory; described in details in Chapter 5, Thermal Model. A setting of 10% for the unbalance alarm with a delay of 10 seconds would be appropriate and the trip can be set to 25% with a delay of 5 seconds.

- **Stopped and Running Cool Times**

The motor manufacturer usually supplies this information as either cooling times, or cooling time constants not provided in the data sheet issued with this motor. Since RTDs are present and wired to the relay, biasing of the thermal model will be used so it is not critical to have these cooling times from the manufacturer. The default values of motor cooling time constants are 15 and 30 minutes, and can be used for the running and stopped cool times respectively. If the manufacturer provides cooling times instead, the approximate values of the cooling time constants is 1/5th the cooling times provided by the manufacturer.

- **Acceleration Trip**

This settings should be set higher than the maximum starting time to avoid nuisance tripping when the voltage is lower or for varying loads during acceleration. If reduced voltage starting is used, according to the acceleration curves, a setting of 18 seconds would be appropriate, or if across the line starting is used, a setting of 13 seconds would be appropriate.

- **Enable Start Inhibit**

This function will limit starts when the motor is already hot. The relay learns the amount of thermal capacity used at start. If the motor is hot, thus having some thermal capacity used, the relay will not allow a start if the available thermal capacity is less than the required thermal capacity for a start.

- **Starts/Hour**

When available, set starts/Hour to the number of cold starts as per the data sheet.

- **Time Between Starts**

In some cases, the motor manufacturer will specify the time between motor starts. This information is not given so this feature can be left disabled. If the information is available, the time provided on the motor data sheets should be programmed.

- **Stator RTDs**

Set the RTD trip level at or below the maximum temperature rating of the insulation. The data available shows class F insulation (temperature rating of 155°C), therefore the Stator RTD Trip level should be set to between 140°C to 155°C, with 155°C being maximum. The RTD alarm level should be set to provide a warning that the motor temperature is rising. For this example, 135°C would be appropriate since this motor is designed for class B rise, 130°C is its normal hot operating temperature.

- **Bearing RTDs**

The Bearing RTD alarm and trip settings will be determined by evaluating the temperature specification from the bearing manufacturer.

- **Unbalance bias of thermal capacity**

Enable the Unbalance Bias of Thermal Capacity so that the heating effect of unbalance currents is added to the Thermal Capacity Used.

- **Unbalance bias K factor**

The K value is used to calculate the contribution of the negative-sequence current flowing in the rotor due to unbalance. It is defined as:

$$K = \frac{R_{r2}}{R_{r1}} \quad (\text{EQ 1.1})$$

where: R_{r2} = rotor negative-sequence resistance

R_{r1} = rotor positive-sequence resistance.

A formula based on empirical data states that K is equal to 230 divided by the per-unit locked rotor current squared.

From the data sheet, the locked rotor amps = 631% FLA or $6.31 \times \text{FLA}$. Therefore,

$$K = \frac{230}{(\text{per-unit locked rotor amps})^2} = \frac{230}{6.31^2} \approx 6 \quad (\text{EQ 1.2})$$

- **Hot/cold curve ratio**

The hot/cold curve ratio is calculated by simply dividing the hot safe stall time by the cold safe stall time or use the motor thermal limits curve. For this example, both are available. Using the data sheets the, safe stall time H/C or hot/cold curve ratio is given as $16/18 = 0.89$

- **Enable RTD Biasing**

This will enable the temperature from the Stator RTD sensors, to be included in the calculations of thermal capacity. This model determines the thermal capacity used based on the temperature of the Stator and is separate from the overload model for calculating thermal capacity used.

RTD biasing is a back up protection element, which accounts for such things as loss of cooling or unusually high ambient temperature. This measured temperature is used to bias or modify the thermal capacity value stored in the relay.

RTD BIAS MINIMUM: Set to 40°C, which is the ambient temperature, obtained from the data sheets.

RTD BIAS MID POINT: The center point temperature is set to the motor's hot running temperature and is calculated as follows:

Temperature Rise of Stator + Ambient Temperature

The temperature rise of the stator is 80°C (class F rise by resistance) + 10% hot spot allowance, obtained from the data sheets. Therefore, the RTD Center point temperature is set to 90°C + 40°C or 130°C.

RTD BIAS MAXIMUM: This settings is set to the rating of the insulation or slightly less. A class F insulation is used in this motor which is rated at 155°C, so the setting should be "155".

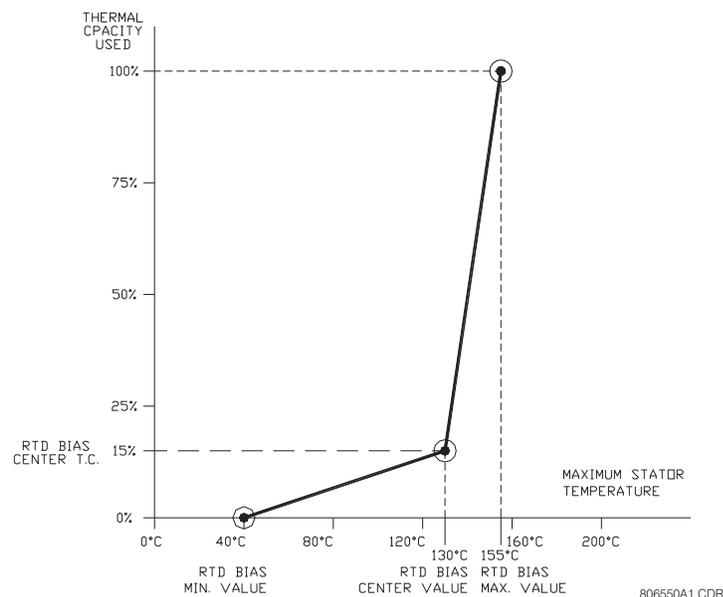


FIGURE 1-9: RTD Bias Example 1

You should now be familiar with maneuvering through and editing settings messages. As such, we will now limit our discussion to just the values that must be programmed to meet the requirements of the example application. Any settings not explicitly mentioned should be left at the factory default value.

1.4.4 S2 System Settings

The S2 settings page contains settings for entering the characteristics of the equipment on the motor electrical system. In our example, these characteristics are specified under the Power System Data and Instrument Transformer Data headings in the previous subsection. From this information and the resulting calculations, program the page S2 settings as indicated.

For current transformers, make the following change in the **S2 SYSTEM SETUP ▷ CURRENT SENSING** settings page:

PHASE CT PRIMARY: "400 A"
MOTOR FULL LOAD AMPS FLA: "348 A"
GROUND CT: "5 A Secondary"
GROUND CT PRIMARY: "50 A"
PHASE DIFFERENTIAL CT: "None"
ENABLE 2-SPEED MOTOR PROTECTION: "No"

For current transformers, make the following change in the **S2 SYSTEM SETUP ▷ VOLTAGE SENSING** settings page:

VT CONNECTION TYPE: "Open Delta"
ENABLE SINGLE VT OPERATION: "Off"
VOLTAGE TRANSFORMER RATIO: "5 : 1"
 (for a 600 V system, $600/120\text{ V} = 5$, where 5 is the VT ratio)
MOTOR NAMEPLATE VOLTAGE: "575 V"

The 469 Motor Management Relay was designed with the ability to display primary system values. Current and voltage measurements are performed at secondary levels, which the relay transforms to primary values using CT and VT ratios, system voltage, as well as the nominal secondary values.

In the case of the phase CTs, configuring the relay for current measurements is simple and it only requires inputting the CT primary current. Phase CT inputs can be 1 A or 5 A, and they must be specified when the relay is purchased.

There is more flexibility with regards to Ground CT inputs, as well as VT inputs, where nominal values are not required ahead of time, before the relay is ordered; therefore more settings are needed to set the relay for measurements.

Make the following change in the **S2 SYSTEM SETUP ▷ POWER SYSTEM** settings page to reflect the power system:

NOMINAL SYSTEM FREQUENCY: "60 Hz"
SYSTEM PHASE SEQUENCE: "ABC"

The example calls for remote control via serial communications, received from the master station, through the RTU. Motor starting and stopping is possible via any of the three 469 communication ports.

When a start command is issued, the auxiliary relay assigned for starting control is activated for 1 second to complete the close coil circuit for a breaker application, or complete the start control circuit for a contactor application. A contactor sealing contact would be used to maintain the circuit. For details on issuing a start or stop command via communications, refer to the GE Publication GEK-106491: *469 Communications Guide*.

Make the following changes to the communications settings in the **S2 SYSTEM SETUP ▷ SERIAL COMM. CONTROL** page.

SERIAL COMMUNICATION CONTROL: "On"
ASSIGN START CONTROL RELAYS: "Auxiliary2"

The Auxiliary 2 relay will be used to start the motor. Note that this auxiliary relay can not be used for any other application.

Once the signal is received the motor will be started across the line. Therefore, the following settings are left with their default values. In the **S2 SYSTEM SETUP ▷ ▾ REDUCE VOLTAGE STARTING** settings page:

REDUCE VOLTAGE STARTING: "Off"
ASSIGN CONTROL RELAYS: "Auxiliary3" (available for other use)
TRANSITION ON: "Current Only"
ASSIGN TRIP RELAYS: "Trip"
REDUCE VOLTAGE START LEVEL: "100% FLA"
REDUCE VOLTAGE START TIMER: "200 s"

1.4.5 S3 Digital Inputs Settings

The S3 settings page is for entering the characteristics of the digital inputs. In our example, these characteristics are specified under the Control System Requirements heading. Program the S3 settings as indicated.

Some of the functions assigned to the digital inputs of the 469 Motor Management Relay are pre-defined functions, which can be selected from a list. There are four user-defined functions, called General Switch A to D, associated to the assignable inputs. Set these inputs to operate output relays, with or without delay, responding to the status change of dry contacts connected to the digital input terminals. Use the following procedure to set these functions:

- ▷ Change the default names to meaningful values so they can be easily identified, either via the LCD or when reviewing event reports.
- ▷ Identify their asserted logic.
- ▷ Define the functionality of the digital inputs.

All the other assignable input functions are pre-defined, and when selected, they can be set to generate Trip or Alarms, as well as energize auxiliary outputs as needed.

For breaker position monitoring, set the following pre-defined Digital Input called "Starter Status". As per the information provided above, a 52b contact will be used, and must be connected between terminals D16 to D23:

S3 DIGITAL INPUTS ▷ ▾ STARTER STATUS ▷ STARTER STATUS SW: "Starter Auxiliary b"

To set the relay to monitor access to the station, use Assignable Input 1 as "General Switch A", as follows. To define the digital input, enter the following data in the **S3 DIGITAL INPUTS ▷ ▾ ASSIGNABLE INPUT 1** settings page.

To identify the digital input:

INPUT 1 FUNCTION: "General Sw. A"
SWITCH NAME: "Stn. Monitor"

To define the asserted logic:

GENERAL SWITCH A: "Normally Open"

To define the functionality:

BLOCK INPUT FROM START: "0 s"
GENERAL SWITCH A ALARM: "Latched"
ASSIGN ALARM RELAYS: "Alarm"

GENERAL SWITCH A ALARM DELAY: "5.0 s"

GENERAL SWITCH A EVENTS: "On" so this event is registered.

GENERAL SWITCH A TRIP: "Off"

If the relay will not be used to trip the motor when someone gains unauthorized access to the station, the next settings should be left at their default values:

GENERAL SWITCH A TRIP: "Off"

ASSIGN TRIP RELAYS: "Trip"

GENERAL SWITCH A TRIM DELAY: "5.0 s"

1.4.6 S5 Thermal Model

The S5 Thermal Model settings page contains settings for entering settings related to protection of the motor during the starting process as well as during normal operation.

As per the information provided above, the settings for the Thermal Model are entered as follows in the

SELECT CURVE STYLE: "Standard"

OVERLOAD PICKUP: "1.25 x FLA"

ASSIGN TRIP RELAYS: "Trip"

UNBALANCE BIAS K FACTOR: "6"

COOL TIME CONSTANT RUNNING: "15 min."

COOL TIME CONSTANT STOPPED: "30 min."

HOT/COLD SAFE STALL RATIO: "0.89"

ENABLE RTD BIASING: "Yes"

RTD BIAS MINIMUM: "40°C" – ambient temperature

RTD BIAS CENTER POINT: "130°C" – center value

RTD BIAS MAXIMUM: "155°C" – maximum value

THERMAL CAPACITY ALARM: "Unlatched" – recommended for early warning to take corrective actions and prevent the interruption of the process.

ASSIGN ALARM RELAYS: "Alarm" – the Alarm contact could be use for local indication, or to send a local signal to reduce load, before a trip is issued.

THERMAL CAP. ALARM LEVEL: "80%"

THERMAL CAPACITY ALARM EVENT: "Yes" – captures event in the event report.

As well, select the overload curve for the Thermal model with the following settings in the **S5 THERMAL MODEL ▷ ▾ OVERLOAD CURVE SETUP** menu:

STANDARD OVERLOAD CURVE NUMBER: "7"

1.4.7 S6 Current Elements

The S6 Current Elements settings page contains settings for entering protection element characteristics. In our example, these characteristics are specified under Motor Protection heading.

From this data and the resulting calculations, program the S6 settings page as indicated. When setting the relay for the first time, other settings not listed in this example should be left disabled.

For the Short Circuit element, enter the following values in the **S6 CURRENT ELEMENTS** ▷ **SHORT CIRCUIT TRIP** page. Press the MESSAGE ▼ key after each settings is entered to move to the next message.

SHORT CIRCUIT TRIP: "Latched"

SHORT CIRCUIT TRIP OVERREACH FILTER: "Off" - no filtering of DC component is required (refer to *Short Circuit Trip* on page 5-60 for additional information)

ASSIGN TRIP RELAYS: "Trip"

SHORT CIRCUIT TRIP PICKUP: "11.7"

INTENTIONAL S/C TRIP DELAY: "0 ms" - Instantaneous trip is required.

SHORT CIRCUIT TRIP BACKUP: "On" - if the main disconnect device does not respond to the trip command, a second signal will be initiated via an auxiliary relay to generate a bus shot down; in most cases, the second trip command energizes a lock out relay (86) which is used to trip the upstream breakers

ASSIGN BACKUP RELAYS: "Auxiliary3"

SHORT CIRCUIT TRIP BACKUP DELAY: "200 ms" - this time must be greater than the total time required to trip the main breaker plus a margin

Since the specifications do not indicate values for the following features, they must be left "Off":

OVERLOAD ALARM: "Off"

MECHANICAL JAM: "Off"

UNDERCURRENT: "Off"

PHASE DIFFERENTIAL: "Off"

For the Ground Fault element, enter the following values in the **S6 CURRENT ELEMENTS** ▷▽ **GROUND FAULT** page. Press the MESSAGE ▼ key after each settings is entered to move to the next message.

GROUND FAULT OVERREACH FILTER: "Off" - no filtering of DC component is required (refer to *Ground Fault* on page 5-64 for additional information)

GROUND FAULT ALARM: "Off" - default setting, no Alarm is required

ASSIGN ALARM RELAYS: "Alarm" - default setting

GROUND FAULT ALARM PICKUP: "0.10 x CT" - default setting

INTENTIONAL GF ALARM DELAY: "0 ms" - default setting

GROUND FAULT ALARM EVENTS: "Off" - default setting

GROUND FAULT TRIP: "Latched" - the output relay will remind energized until the Reset command executed

ASSIGN TRIP RELAYS: "Trip"

GROUND FAULT TRIP PICKUP: "0.20 x CT"

INTENTIONAL GF TRIP DELAY: "0 ms"

GROUND FAULT TRIP BACKUP: "On"

ASSIGN BACKUP RELAYS: "Auxiliary3" - same relay assigned for the Short Circuit Trip Backup

GROUND FAULT TRIP BACKUP DELAY: "200 ms" - same time delay assigned to the Short Circuit Trip Backup

For the Current Unbalance element, enter the following values in the **S6 CURRENT ELEMENTS** ▷▽ **CURRENT UNBALANCE** page. Press the MESSAGE ▼ key after each settings is entered to move to the next message.

CURRENT UNBALANCE ALARM: "Unlatched"
ASSIGN ALARM RELAYS: "Alarm"
CURRENT UNBALANCE ALARM PICKUP: "10%"
CURRENT UNBALANCE ALARM DELAY: "10 s"
CURRENT UNBALANCE ALARM EVENTS: "On"
CURRENT UNBALANCE TRIP: "Latched" – the output relay will remind energized until the Reset command executed
ASSIGN TRIP RELAYS: "Trip"
CURRENT UNBALANCE TRIP PICKUP: "20%"
CURRENT UNBALANCE TRIP DELAY: "5 s"

1.4.8 S7 Motor Starting

The S7 Motor Starting settings page contains additional settings used to complement the Thermal Model. In our example, these characteristics are specified under Motor Protection heading.

For the Acceleration Timer element, enter the following values in the **S7 MOTOR STARTING ▷ ACCELERATION TIMER** page. Press the MESSAGE ▼ key after each settings is completed to move to the next message.

ACCELERATION TIMER TRIP: "Latched"
ASSIGN TRIP RELAYS: "Trip"
ACCELERATION TIMER FROM START: "13 s" – as shown in the acceleration curves at 100% voltage

For the Start Inhibit element, enter the following values in the **S7 MOTOR STARTING ▷ START INHIBIT** page. Press the MESSAGE ▼ key after each settings is completed to move to the next message.

START INHIBIT BLOCK: "On"
TC USED MARGIN: "25%"

With these settings, the 469 relay prevents motor starting if there is insufficient thermal capacity for a successful motor start. Refer to *Start Inhibit* on page 5–67 for additional information.

There is not information available to set Starts/Hour, Time Between Starts, or the Restart Block features. Therefore, the following settings must be disabled:

JOGGING BLOCK: "Off"
RESTART BLOCK: "Off"

1.4.9 S8 RTD Temperature

The S8 RTD Temperature page contains the settings for the twelve (12) field programmable RTDs that are normally used for temperature monitoring. The temperature measured by each RTD can be compared to pickup values, and set to energize Trip or Alarm outputs.

For proper temperature monitoring, enter the RTD types in the **S8 RTD TEMPERTURE ▷ RTD TYPES** page. Press the MESSAGE ▼ key after each settings is completed to move to the next message.

STATOR RTD TYPE: "100 Ohm Platinum"
BEARING RTD TYPE: "100 Ohm Platinum"
AMBIENT RTD TYPE: "100 Ohm Platinum"
OTHER RTD TYPE: "100 Ohm Platinum" – default value

As per the information provided above, there will be six RTDs, two per phase located in the Stator, and two Bearing RTDs, one to monitor the ambient temperature.

For Stator Overtemperature protection, enter the following settings in the **S8 RTD TEMPERATURE** ▷▽ **RTD 1** to **RTD6** menus:

RTD #1 APPLICATION: "Stator"
RTD #1 NAME: "ST Ph A1"
RTD #1 ALARM: "Unlatched"
ASSIGN ALARM RELAYS: "Alarm"
RTD #1 ALARM TEMPERATURE: "135°C"
RTD #1 HIGH ALARM: "Off"
HIGH ALARM RELAYS: "Alarm" - default value
RTD #1 HIGH ALARM TEMPERATURE: "135°C" - default value
RTD #1 ALARM EVENTS: "On"
RTD #1 TRIP: "Latched"
RTD #1 TRIP VOTING: "RTD #5"
ASSIGN TRIP RELAYS: "Trip"
RTD #1 TRIP TEMPERATURE: "155°C"

The settings for the other RTDs are entered in similar fashion. Refer to *S8 RTD Temperature* on page 5–71 for additional settings and additional information on RTD monitoring.

1.4.10 Other Settings

Undervoltage Protection

In addition to the settings illustrated above, there will be cases in motor applications where additional settings will be required, to monitor other system parameters such as voltage levels.

The following sub-section will illustrate the procedures to set the 469 Motor Management Relay to meet those requirements.

Description

Using the same system information, the following example illustrates the steps to set the 469 for Undervoltage protection.

The following settings are provided:

Pickup: 70% of nominal voltage – starting
 80% of nominal voltage – running
 Time Delay: 13.0 s

Other Considerations

- The function will be active only if there is voltage in the line feeding the motor, to avoid nuisance trips due to the lack of voltage. The 469 will consider the bus energized only

if the measured voltage is greater than 20% of nominal voltage. A trip condition will be initiated only if undervoltage is detected in all the phases.

- In order to monitor for VT Fuse Failure or to monitor for undervoltage in one phase only, set an Alarm when the voltage is 90% of nominal voltage both during start and running.

For the Undervoltage element, enter the following values in the **S9 VOLTAGE ELEMENTS** ▾ ▽ **UNDERVOLTAGE** settings page. Press the ENTER key to save, and then the MESSAGE ▼ key, after each settings is completed, to move to the next message:

U/V ACTIVE ONLY IF BUS ENERGIZED: "Yes"
UNDERVOLTAGE ALARM: "Unlatched"
ASSIGN ALARM RELAYS: "Alarm"
UNDERVOLTAGE ALARM PICKUP: "0.9 x RATED"
STARTING U/V ALARM PICKUP: "0.9 x RATED"
UNDERVOLTAGE ALARM DELAY: "0.0 s"
UNDERVOLTAGE ALARM EVENTS: "Yes"
UNDERVOLTAGE TRIP: "Latched"
UNDERVOLTAGE TRIP MODE: "3-Phase"
ASSIGN TRIP RELAYS: "Trip"
UNDERVOLTAGE TRIP PICKUP: "0.8 x RATED"
STARTING U/V TRIP PICKUP: "0.7 x RATED"
UNDERVOLTAGE TRIP DELAY: "13.0 s"

1.5 Installation

1.5.1 Testing

Extensive commissioning tests are available in Chapter 7. Tables for recording required settings are available in Microsoft Excel format from the GE Digital Energy website at <http://www.gedigitalenergy.com/>. The website also contains additional technical papers and FAQs relevant to the 469 Motor Management Relay.



469 Motor Management Relay

Chapter 2: Introduction

2.1 Overview

2.1.1 Description

The 469 Motor Management Relay is a microprocessor based relay designed for the protection and management of medium and large horsepower motors and driven equipment. The 469 is equipped with six (6) output relays for trips, alarms, and start blocks. Motor protection, fault diagnostics, power metering, and RTU functions are integrated into one economical drawout package. The single-line diagram below illustrates the 469 functionality using ANSI (American National Standards Institute) device numbers

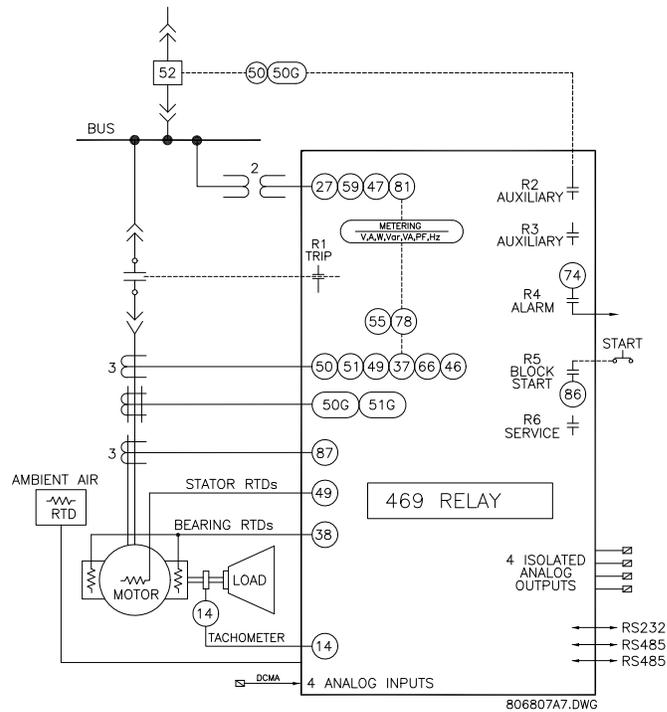


FIGURE 2-1: Single Line Diagram

Typical applications include: pumps, fans, compressors, mills, shredders, extruders, debarkers, refiners, cranes, conveyors, chillers, crushers, and blowers.

Some of the protection highlights are detailed here; a complete list is shown below. Four assignable digital inputs may be configured for a number of different features including tachometer or generic trip and alarm with a programmable name. The thermal model incorporates unbalance biasing, RTD feedback, and exponential cooling. In addition to the 15 standard overload curves, there is a custom curve feature and a curve specifically designed for the starting of high inertia loads, when the acceleration time exceeds the safe stall time. A second overload curve is provided for two-speed motors. Ground faults or earth leakage as low as 0.25 A may be detected using the GE Digital Energy 50:0.025 Ground CT. CT inputs for phase differential protection are also provided. The 12 RTD inputs provided may be individually field programmed for different RTD types. Voltage transformer inputs allow for numerous protection features based on voltage and power quantities. Four 4 to 20 mA analog inputs may be used for tripping and alarming on any transducer input such as vibration, pressure, flow, etc.

ANSI		Trip	Alarm	Block Start	Control
51	Overload	●	●	●	●
86	Overload Lockout			●	
66	Starts/Hour & Time Between Starts			●	
	Restart Block (Anti-Backspin Timer)			●	
50	Short Circuit & Short Circuit Backup	●		●	
	Mechanical Jam	●		●	●
32	Reverse Power	●	●	●	
37	Undercurrent/Underpower	●	●	●	
46	Current Unbalance	●	●	●	
50G/51G	Ground Fault & Ground Fault Backup	●	●	●	
87	Differential	●		●	
	Acceleration	●		●	
49	Stator RTD	●	●	●	
38	Bearing RTD	●	●	●	
	Other RTD & Ambient RTD	●	●	●	
	Open RTD Alarm		●		
	Short/Low RTD		●		
27/59	Undervoltage/Overvoltage	●	●	●	
47	Phase Reversal	●		●	
81	Frequency	●	●	●	
	Reactive Power	●	●	●	●
55/78	Power Factor	●	●	●	●
	Analog Input	●	●	●	
	Demand Alarm: A kW kvar kVA		●		●
	SR469 Self-Test, Service		●		
	Trip Coil Supervision		●		
	Welded Contactor		●		
	Breaker Failure		●		
	Remote Switch	●	●	●	
14	Speed Switch & Tachometer Trip	●	●	●	
	Load Shed Switch	●		●	
	Pressure Switch	●	●	●	
	Vibration Switch	●	●	●	
19	Reduced Voltage Start				●
48	Incomplete Sequence (Reduced Voltage Start)	●		●	●
	Remote Start/Stop				●
	Over Torque		●		
	Forced Relay Operation				●

PROCTLA5.CDR

FIGURE 2-2: Protection Features

Fault diagnostics are provided through pretrip data, event record, trace memory, and statistics. Prior to issuing a trip, the 469 takes a snapshot of the measured parameters and stores them with the cause of the trip. This pre-trip data may be viewed using the MENU key, viewing the **TARGET MESSAGES** before the trip is reset, or by accessing the **A1 STATUS** ▸ ▽ **LAST TRIP DATA** actual values. The 469 event recorder stores up to 256 time and date stamped events including the pre-trip data. Each time a trip occurs, the 469 stores a trace of 8 cycles pre-trip and 8 cycles post-trip for all measured AC quantities. Trip counters record the number of occurrences of each type of trip. Minimum and maximum values for analog inputs, along with maximum values for RTDs, are also recorded. These features enable the operator to pinpoint a problem quickly and with certainty.

Power metering included with the 469 as a standard feature. The table below outlines the metered parameters available either through the front panel or communications ports.

The 469 is equipped with 3 fully functional and independent communications ports. The front panel RS232 port may be used for 469 settings programming, local interrogation or control, and upgrading of 469 firmware. The Computer RS485 port may be connected to a PLC, DCS, or PC based user interface program. The Auxiliary RS485 port may be used for redundancy or simultaneous interrogation and/or control from a second PLC, DCS, or PC software.

There are also four 4 to 20 mA or 0 to 1 mA (as specified with order) transducer outputs that may be assigned to any measured parameter. The range of these outputs is scalable. Additional features are outlined below.

METERING:

- Voltage
- Current and amps demand
- Real power, kW demand, kW power consumption
- Apparent power and kVA demand
- Reactive power, kvar demand, kvar consumption/generation
- Frequency
- Power factor
- RTD
- Speed in RPM with a key phasor input
- User-programmable analog inputs.

ADDITIONAL FEATURES:

- Drawout case (for ease of maintenance/testing)
- Reduced voltage starting control for single transition
- Trip coil supervision
- Flash memory for easy firmware updates

2.1.2 Ordering Information

All 469 features are standard; there are no options. The phase CT secondaries, control power, and analog output range must be specified at the time of order. The 469 differential CT inputs are field programmable for CTs with 1 A or 5 A secondaries. There are two ground CT inputs, one for the GE Digital Energy 50:0.025 core balance CT and one for a ground CT with a 1 A or 5 A secondary, also field programmable. The VT inputs will accommodate VTs in either a delta or wye configuration. The output relays are always non-failsafe with the exception of the service relay. The EnerVista 469 Setup software is provided with each unit. A metal demo case may be ordered for demonstration or testing purposes.

2.1.3 Order Codes

Table 2-1: 469 Order Codes

	4	6	9	-	*	-	*	-	*	-	*
Base Unit	469										469 Motor Management Relay
Phase Current Inputs	P1										1 A phase CT secondaries
	P5										5 A phase CT secondaries
Control Power											20 to 60 V DC;
	LO										20 to 48 V AC at 48 to 62 Hz
Control Power											90 to 300 V DC;
	HI										70 to 265 V AC at 48 to 62 Hz
Analog Outputs											Four (4) 0 to 1 mA analog outputs
	A1										Four (4) 4 to 20 mA analog outputs
Display											Discontinued: Basic display
										E	Enhanced display, larger LCD
										T	Enhanced with Ethernet (10Base-T)
Harsh Environment											Enhanced display with DeviceNet
										H	Harsh (chemical) environment conformal coating

2.1.4 Example Order Codes

1. The 469-P1-LO-A20-E code specifies a 469 Motor Management Relay with 1 A CT inputs, 20 to 60 V DC or 20 to 48 V AC control voltage, 4 to 20 mA analog outputs, and enhanced display option with larger LCD.
2. The 469-P5-HI-A1-T-H code specifies a 469 Motor Management Relay with 5 A CT inputs, 90 to 300 V DC or 70 to 265 V AC control voltage, 0 to 1 mA analog outputs, enhanced display with Ethernet (10Base-T) communications, and a harsh environment conformal coating.

2.1.5 Accessories

The following accessories are available for the 469 Motor Management Relay:

- **EnerVista 469 Setup software:** No-charge software provided with each relay
- **Demo:** Metal Carry Case in which 469 unit may be mounted
- **SR 19-1 Panel:** Single cutout 19-inch panel
- **SR 19-2 Panel:** Dual cutout 19-inch panel
- **SCI Module:** RS232-to-RS485 converter box designed for harsh industrial environments
- **Phase CT:** 50, 75, 100, 150, 200, 250, 300, 350, 400, 500, 600, 750, 1000
- **HGF3, HGF5, HGF8:** For sensitive ground detection on high resistance grounded systems.
- **469 1-inch Collar:** For shallow switchgear, reduces the depth of the relay by 1 3/8 inches
- **469 3-inch Collar:** For shallow switchgear, reduces the depth of the relay by 3 inches
- **Optional Mounting Kit:** Additional mounting support 1819-0030

VOLTAGE PHASE REVERSAL

Configuration:ABC or ACB phase rotation
 Timing Accuracy:500 to 700 ms
 Elements:.....Trip

**NOTE 1**

For Timing accuracy specifications marked (Note 1), setpoint "Motor Load Filter Interval" may increase trip/alarm times. When setpoint is greater than 1 cycle, trip/alarm times increase 16.7 ms for each additional cycle in the filter interval.

2.2.4 Digital Inputs**DIGITAL COUNTER**

Configuration:assign to digital inputs 1 to 4
 Frequency:.....≤50 times a second
 Range:.....0 to 1 000 000 000
 Elements:.....Alarm

GENERAL PURPOSE SWITCH

Configuration:assign to digital inputs 1 to 4
 Time delay:.....0.1 to 5000.0 s in steps of 0.1
 Block from start:0 to 5000 s in steps of 1
 Timing accuracy:±250 ms or ±0.5% of total time
 Elements:.....Trip and Alarm

LOAD SHED

Configuration:assign to digital inputs 1 to 4
 Timing accuracy:100 ms maximum
 Elements:.....Trip

PRESSURE SWITCH

Configuration:assign to digital inputs 1 to 4
 Time delay:.....0.1 to 100.0 s in steps of 0.1
 Block from start:0 to 5000 s in steps of 1
 Timing accuracy:±250 ms or ±0.5% of total time
 Elements:.....Trip and Alarm

REMOTE SWITCH

Configuration:assign to digital inputs 1 to 4
 Timing accuracy:100 ms maximum
 Elements:.....Trip and Alarm

SPEED SWITCH

Configuration:assign to digital inputs 1 to 4
 Time delay:.....1.0 to 250.0 s in steps of 0.1
 Timing accuracy:250 ms maximum
 Elements:.....Trip

TACHOMETER

Configuration:assign to digital inputs 1 to 4
 Range:.....100 to 7200 RPM
 Pulse duty cycle:>10%
 Elements:.....Trip and Alarm

VIBRATION SWITCH

Standard	Test Name	Level
IEC 60068-2-38	Composite Temperature/Humidity	65/-10°C at 93% RH
IEC 60255-5	Dielectric Strength	2300 V AC
IEC 60255-5	Impulse Voltage	5 kV
IEC 60255-5	Insulation Resistance	>100 MΩ / 500 V AC / 10 s
IEC 60255-21-1	Sinusoidal Vibration	2 g
IEC 60255-22-1	Damped Oscillatory Burst, 1 MHz	2.5 kV / 1 kV
IEC 60255-22-2	Electrostatic Discharge: Direct	8 kV
IEC 60255-22-3	Radiated RF Immunity	10 V/m
IEC 60255-22-4	Electrical Fast Transient / Burst Immunity	4 kV
IEC 60255-22-5	Surge Immunity	4 kV / 2 kV
IEC 60255-22-6	Conducted RF Immunity, 150 kHz to 80 MHz	10 V/m
IEC 60255-25	Radiated RF Emission	Group 1 Class A
IEC 60255-25	Conducted RF Emission	Group 1 Class A
IEC 60529	Ingress of Solid Objects and Water (IP)	IP40 (front), IP20 (back)
IEC 61000-4-11	Voltage Dip; Voltage Interruption	0%, 40%, 100%
IEEE C37.90.1	Fast Transient SWC	±4 kV
IEEE C37.90.1	Oscillatory Transient SWC	±2.5 kV
IEEE C37.90.3	Electrostatic Discharge: Air and Direct	15 kV / 8 kV

PRODUCTION TESTS

Thermal cycling:operational test at ambient, reducing to -40°C and then increasing to 60°C

Dielectric strength:2000 VAC for 1 minute (as per UL & CE)



DO NOT CONNECT FILTER GROUND TO SAFETY GROUND DURING ANY PRODUCTION TESTS!

2.2.10 Certification

CERTIFICATION

ACA:.....conforms to RF emissions for Australia, tick mark

CE:.....conforms to EN 55011/CISPR 11, EN 50082-2

EN:.....EN50263 EMC - CE for Europe

FCC:.....conforms to RF emissions for North America, part 15

IEC:.....conforms to 1010-1, LVD - CE for Europe

ISO:.....Manufactured under an ISO9001 registered system.

UL:.....UL listed E83849 for the USA and Canada



469 Motor Management Relay

Chapter 3: Installation

3.1 Mechanical Installation

3.1.1 Description

The 469 is packaged in the standard GE Digital Energy SR-series arrangement, which consists of a drawout unit and a companion fixed case. The case provides mechanical protection to the unit and is used to make permanent connections to all external equipment. The only electrical components mounted in the case are those required to connect the unit to the external wiring. Connections in the case are fitted with mechanisms required to allow the safe removal of the relay unit from an energized panel (for example, automatic CT shorting). The unit is mechanically held in the case by pins on the locking handle that cannot be fully lowered to the locked position until the electrical connections are completely mated. Any 469 can be installed in any 469 case, except for custom manufactured units that are clearly identified as such on both case and unit, and are equipped with an index pin keying mechanism to prevent incorrect pairings.

No special ventilation requirements need to be observed during the installation of the unit. The 469 can be cleaned with a damp cloth.

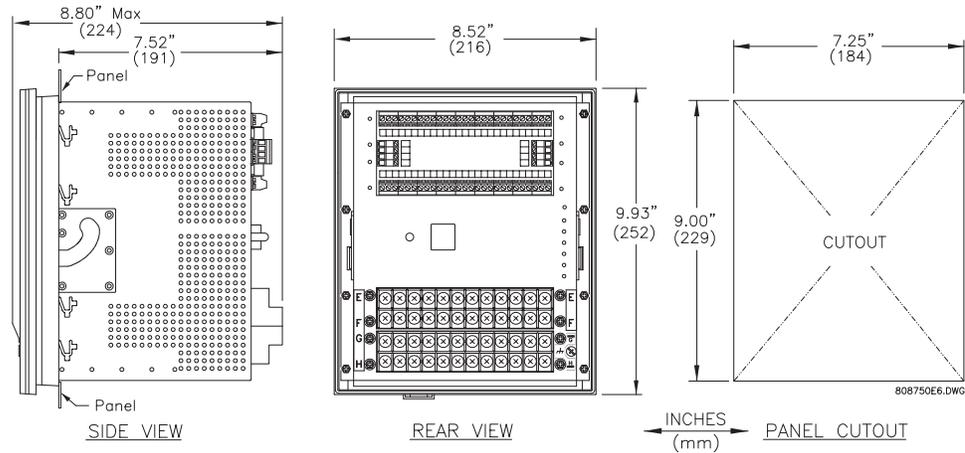


FIGURE 3-1: Dimensions

To prevent unauthorized removal of the drawout unit, a wire lead seal can be installed in the slot provided on the handle. With this seal in place, the drawout unit cannot be removed. A passcode or settings access jumper can be used to prevent entry of settings but allow monitoring of actual values. If access to the front panel controls must be restricted, a separate seal can be installed on the cover to prevent it from being opened.



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



FIGURE 3-2: Seal on Drawout Unit

3.1.2 Product Identification

Each 469 unit and case are equipped with a permanent label. This label is installed on the left side (when facing the front of the relay) of both unit and case. The case label details which units can be installed.

The *case label* details the following information: model number, manufacture date, and special notes.

The *unit label* details the following information: model number, type, serial number, manufacture date, phase current inputs, special notes, overvoltage category, insulation voltage, pollution degree, control power, and output contact rating.



FIGURE 3–3: Case and Unit Identification Labels

3.1.3 Installation

The 469 case, alone or adjacent to another SR-series unit, can be installed in the panel of a standard 19-inch rack (see below for panel cutout dimensions). Provision must be made when mounting for the front door to swing open without interference to, or from, adjacent equipment. Normally the 469 unit is mounted in its case when shipped from the factory, and should be removed before mounting the case in the supporting panel. Unit withdrawal is described in the next section.

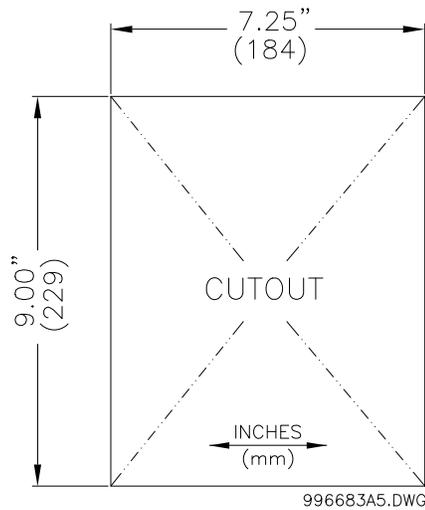


FIGURE 3-4: Single 469 Cutout Panel

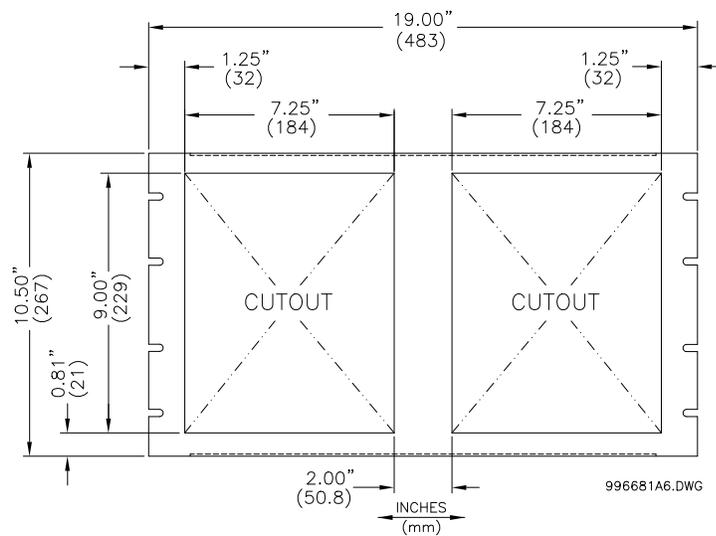


FIGURE 3-5: Double 469 Cutout Panel

After the mounting hole in the panel has been prepared, slide the 469 case into the panel from the front. Applying firm pressure on the front to ensure the front bezel fits snugly against the front of the panel, bend out the pair of retaining tabs (to a horizontal position) from each side of the case as shown below. The case is now securely mounted, ready for panel wiring. If additional support is desired, the SR optional mounting kit may be ordered.

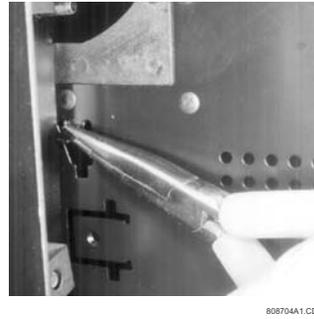


FIGURE 3-6: Bend Up Mounting Tabs

3.1.4 Unit Withdrawal and Insertion



TURN OFF CONTROL POWER BEFORE DRAWING OUT OR RE-INSERTING THE RELAY TO PREVENT MALOPERATION!



If an attempt is made to install a unit into a non-matching case, the mechanical key will prevent full insertion of the unit. Do not apply strong force in the following step or damage may result.

To remove the unit from the case:

- ▷ Open the cover by grasping the center of the right side and then pulling the cover, which will rotate about the hinges on the left.
- ▷ Release the locking latch, located below the locking handle, by pressing upward on the latch with the tip of a screwdriver.



FIGURE 3-7: Press Latch to Disengage Handle

- ▷ While holding the latch raised, grasp the locking handle in the center and pull firmly, rotating the handle up from the bottom of the unit until movement ceases.



FIGURE 3-8: Rotate Handle to Stop Position

Once the handle is released from the locking mechanism, the unit can freely slide out of the case when pulled by the handle. It may sometimes be necessary to adjust the handle position slightly to free the unit.



FIGURE 3-9: Slide Unit out of Case

To insert the unit into the case:

- ▷ Raise the locking handle to the highest position.
- ▷ Hold the unit immediately in front of the case and align the rolling guide pins (near the hinges of the locking handle) to the guide slots on either side of the case.
- ▷ Slide the unit into the case until the guide pins on the unit have engaged the guide slots on either side of the case.
- ▷ Grasp the locking handle from the center and press down firmly, rotating the handle from the raised position toward the bottom of the unit.

When the unit is fully inserted, the latch will be heard to click, locking the handle in the final position.

CAUTION

No special ventilation requirements need to be observed during the installation of the unit. The unit does not require cleaning.

3.1.5 Ethernet Connection

If using the 469 with the Ethernet 10Base-T option, ensure that the network cable is disconnected from the rear RJ45 connector before removing the unit from the case. This prevents any damage to the connector.

The unit may also be removed from the case with the network cable connector still attached to the rear RJ45 connector, provided that there is at least 16" of network cable available when removing the unit from the case. This extra length allows the network cable to be disconnected from the RJ45 connector from the front of the switchgear panel. Once disconnected, the cable can be left hanging safely outside the case for re-inserting the unit back into the case.

The unit may then be re-inserted by first connecting the network cable to the units' rear RJ45 connector (see step 3 of *Unit Withdrawal and Insertion* on page 3–5).

CAUTION

Ensure that the network cable does not get caught inside the case while sliding in the unit. This may interfere with proper insertion to the case terminal blocks and damage the cable.



FIGURE 3–10: Ethernet Cable Connection

To ensure optimal response from the relay, the typical connection timeout should be set as indicated in the following table:

TCP/IP sessions	Timeout setting
up to 2	2 seconds
up to 4	3 seconds

3.1.6 DeviceNet Connection

If using the 469 DeviceNet option (Refer to GEK-106491C: *469 Communications Guide*), ensure that the network cable is disconnected from the rear terminal block before removing the unit out of the case to prevent any damage to the connector.

The unit may also be removed from the case with the network cable connector still attached to the rear terminal block provided that there is at least 16" of network cable available when removing the unit out of the case. This extra length will allow the network cable to be disconnected from the terminal block from the front of the switchgear panel. Once disconnected, the cable can be left hanging safely outside the case for re-inserting the unit back into the case.

The unit may then be re-inserted by first connecting the network cable to the units' rear terminal block (see step 3 of *Unit Withdrawal and Insertion* on page 3-5).



Ensure that the network cable does not get caught inside the case while sliding in the unit. This may interfere with proper insertion to the case terminal blocks and damage the cable.

The DeviceNet port has the following characteristics:

- Connector type: 5-pin Phoenix connector
- Baud rate: 125K, 250K or 500K baud
- Protocol: DeviceNet

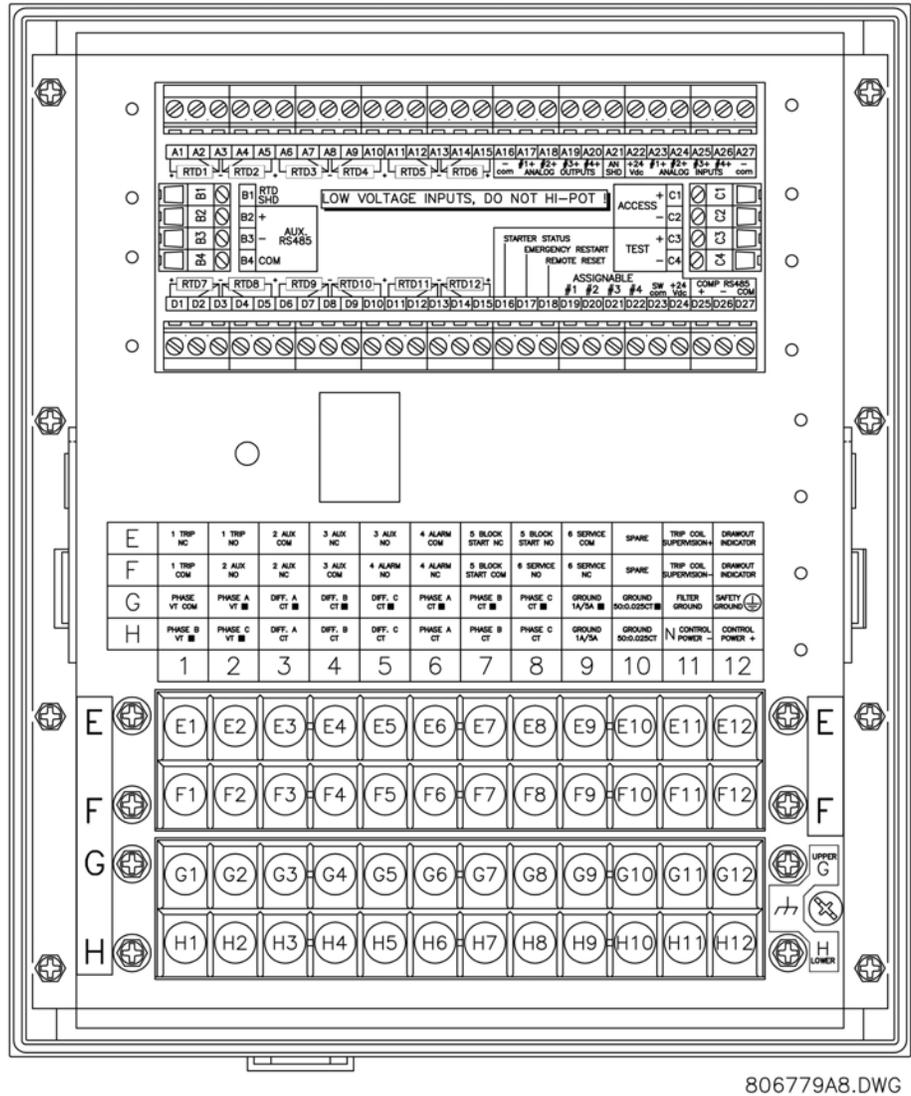
The following ports available simultaneously:

- RS232, 2 × RS485/422 with no DeviceNet option
- RS232, 1 × RS485/422 with DeviceNet option

The DeviceNet configuration is shown in the following table:

Pin	Signal	Description
1	V-	Negative supply voltage
2	CAN_L	CAN_L bus line
3	SHIELD	Cable shield
4	CAN_H	CAN_H bus line
5	V+	Positive supply voltage

3.1.7 Terminal Locations



806779A8.DWG

FIGURE 3-11: Terminal Layout

3.1.8 Terminal List

Table 3-1: 469 Terminal List

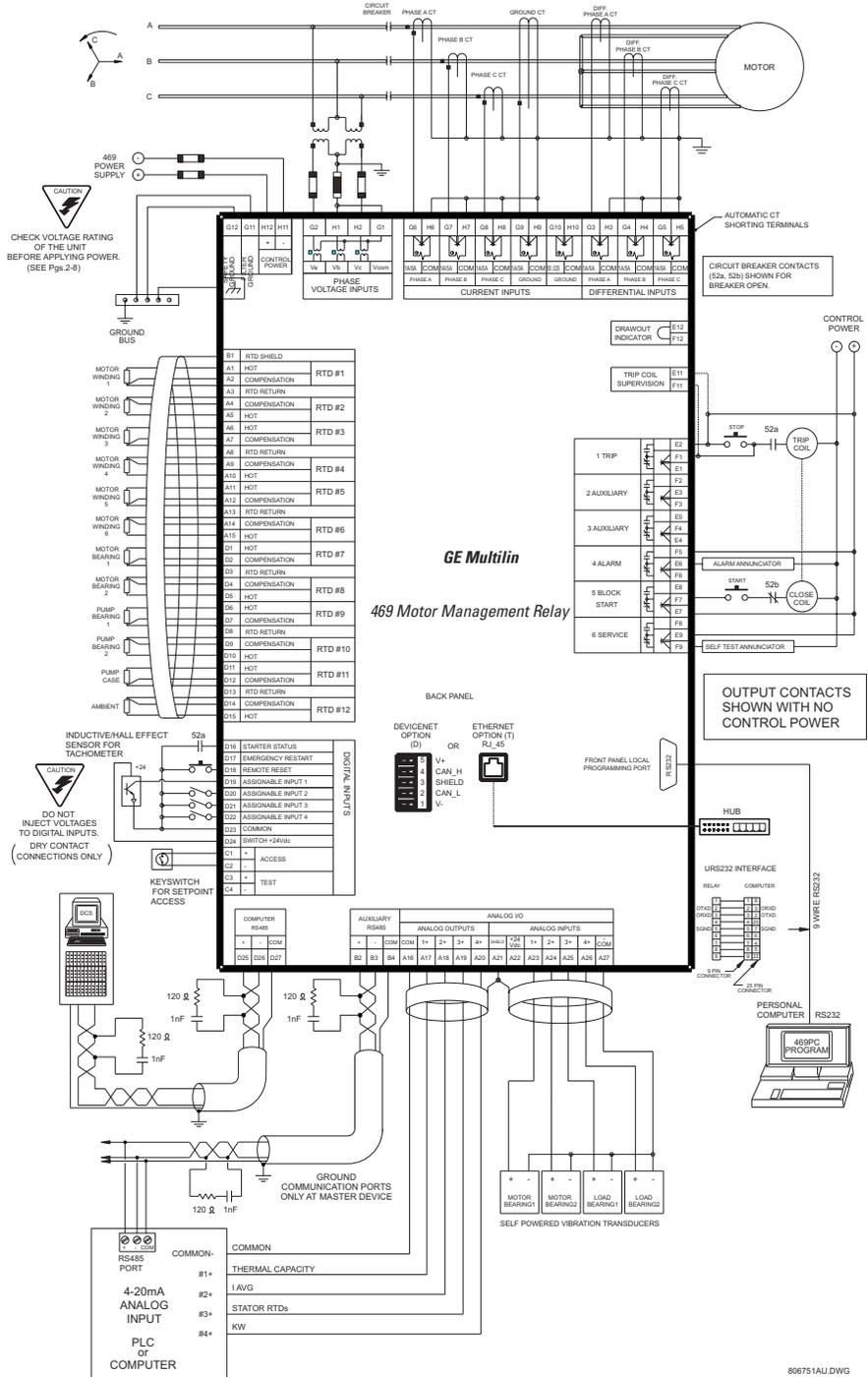
Terminal	Description	Terminal	Description
A01	RTD #1 Hot	D21	Assignable Switch 3
A02	RTD #1 Compensation	D22	Assignable Switch 4
A03	RTD Return	D23	Switch Common
A04	RTD #2 Compensation	D24	Switch +24 V DC
A05	RTD #2 Hot	D25	Computer RS485 +
A06	RTD #3 Hot	D26	Computer RS485 -
A07	RTD #3 Compensation	D27	Computer RS485 Common
A08	RTD Return	E01	1 Trip NC

Table 3-1: 469 Terminal List

Terminal	Description	Terminal	Description
A09	RTD #4 Compensation	E02	1 Trip NO
A10	RTD #4 Hot	E03	2 Auxiliary Common
A11	RTD #5 Hot	E04	3 Auxiliary NC
A12	RTD #5 Compensation	E05	3 Auxiliary NO
A13	RTD Return	E06	4 Alarm COMMON
A14	RTD #6 Compensation	E07	5 Block Start NC
A15	RTD #6 Hot	E08	5 Block Start NO
A16	Analog Output Common -	E09	6 Service Common
A17	Analog Output 1 +	E10	not used
A18	Analog Output 2 +	E11	Coil Supervision +
A19	Analog Output 3 +	E12	469 Drawout Indicator
A20	Analog Output 4 +	F01	1 Trip Common
A21	Analog Shield	F02	2 Auxiliary NO
A22	Analog In 24 V DC Power Supply +	F03	2 Auxiliary NC
A23	Analog Input 1 +	F04	3 Auxiliary COMMON
A24	Analog Input 2 +	F05	4 Alarm NO
A25	Analog Input 3 +	F06	4 Alarm NC
A26	Analog Input 4 +	F07	5 Block Start Common
A27	Analog Input Common -	F08	6 Service NO
B01	RTD Shield	F09	6 Service NC
B02	Auxiliary RS485 +	F10	not used
B03	Auxiliary RS485 -	F11	Coil Supervision -
B04	Auxiliary RS485 Common	F12	469 Drawout Indicator
C01	Access +	G01	Phase VT Neutral
C02	Access -	G02	Phase A VT •
C03	469 Under Test +	G03	Differential A CT •
C04	469 Under Test -	G04	Differential B CT •
D01	RTD #7 Hot	G05	Differential C CT •
D02	RTD #7 Compensation	G06	Phase A CT •
D03	RTD Return	G07	Phase B CT •
D04	RTD #8 Compensation	G08	Phase C CT •
D05	RTD #8 Hot	G09	1A/5A Ground CT •
D06	RTD #9 Hot	G10	50:0.025 Ground CT •
D07	RTD #9 Compensation	G11	Filter Ground
D08	RTD Return	G12	Safety Ground
D09	RTD #10 Compensation	H01	Phase B VT •
D10	RTD #10 Hot	H02	Phase C VT •
D11	RTD #11 Hot	H03	Differential A CT
D12	RTD #11 Compensation	H04	Differential B CT
D13	RTD Return	H05	Differential C CT
D14	RTD #12 Compensation	H06	Phase A CT
D15	RTD #12 Hot	H07	Phase B CT
D16	Starter Status	H08	Phase C CT
D17	Emergency Restart	H09	1A/5A Ground CT
D18	Remote Reset	H10	50:0.025 Ground CT
D19	Assignable Switch 1	H11	Control Power -
D20	Assignable Switch 2	H12	Control Power +

3.2 Electrical Installation

3.2.1 Typical Wiring



3.2.2 Description

A broad range of 469 applications are available. Although it is not possible to present typical connections for all possible schemes, this section will cover the interconnections of instrument transformer inputs, other inputs, outputs, communications, and grounding. See FIGURE 3-11: *Terminal Layout* on page 3-9 and Table 3-1: *469 Terminal List* on page 3-9 for terminal arrangement.

3.2.3 Control Power

The order code from the terminal label on the side of the drawout unit specifies the nominal control voltage as follows:

LO: 20 to 60 V DC; 20 to 48 V AC, or
 HI: 90 to 300 V DC; 70 to 265 V AC

Ensure applied control voltage and rated voltage on drawout case terminal label match. For example, the HI power supply will work with any DC voltage from 90 to 300 V, or AC voltage from 70 to 265 V. The internal fuse may blow if the applied voltage exceeds this range.



The 469 control power must match the installed switching power supply. If the applied voltage does not match, damage to the unit may occur!

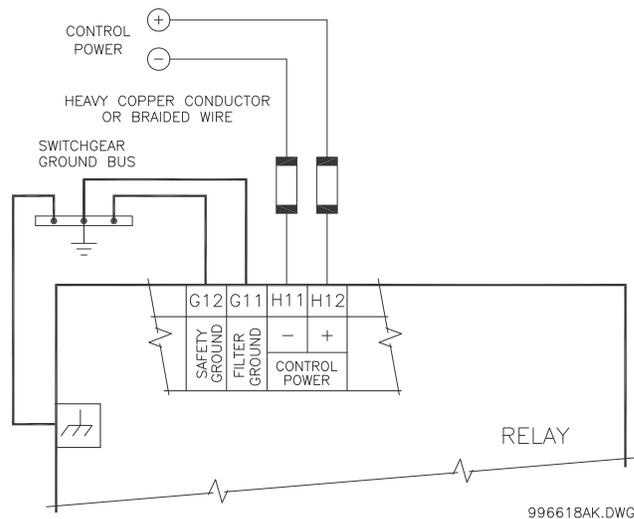


FIGURE 3-13: Control Power Connection

Extensive filtering and transient protection are built into the 469 to ensure proper operation in harsh industrial environments. Transient energy must be conducted back to the source through the filter ground terminal. A separate safety ground terminal is provided for hi-pot testing.



All grounds MUST be hooked up for normal operation regardless of control power supply type.

3.2.4 Current Inputs

Phase Current Inputs

The 469 has three channels for phase current inputs, each with an isolating transformer. There are no internal ground connections on the current inputs. If the unit is withdrawn, each phase CT circuit is shorted by automatic mechanisms on the 469 case. The phase CTs should be chosen so the FLA is no less than 50% of the rated phase CT primary. Ideally, the phase CT primary should be chosen such that the FLA is 100% of the phase CT primary or slightly less, never more. This will ensure maximum accuracy for the current measurements. The maximum phase CT primary current is 5000 A.

The 469 correctly measures up to 20 times the phase current nominal rating. Since the conversion range is large, 1 A or 5 A CT secondaries must be specified at the time of order to ensure the appropriate interposing CT is installed in the unit. The chosen CTs must be capable of driving the 469 phase CT burden (see *Specifications* on page 2–6 for ratings).



Verify that the 469 nominal phase current of 1 A or 5 A matches the secondary rating and connections of the connected CTs. Unmatched CTs may result in equipment damage or inadequate protection. Polarity of the phase CTs is critical for Negative Sequence Unbalance calculation, power measurement, and residual ground current detection (if used).

See *Two-Phase CT Configuration* on page A–1 for 2-phase CT information.

Ground Current Input

The 469 has a dual primary isolating transformer for ground CT connection. There are no internal ground connections on the ground current inputs. The ground CT circuits are shorted by automatic mechanisms on the 469 case if the unit is withdrawn. The 1 A / 5 A tap is used either for zero-sequence / core balance applications or residual ground connections where the summation of the three phase current CTs is passed through the ground current input (see the figure below). The maximum ground CT primary current is 5000 A for the 1 A / 5 A tap. Alternatively, the 50:0.025 ground CT input has been designed for sensitive ground current detection on high resistance grounded systems where the GE Digital Energy 50:0.025 core-balance CT is to be used. For example, in mining applications where earth leakage current must be measured for personnel safety, primary ground current as low as 0.25 A may be detected with the GE Digital Energy 50:0.025 CT. Only one ground CT input tap should be used on a given unit.

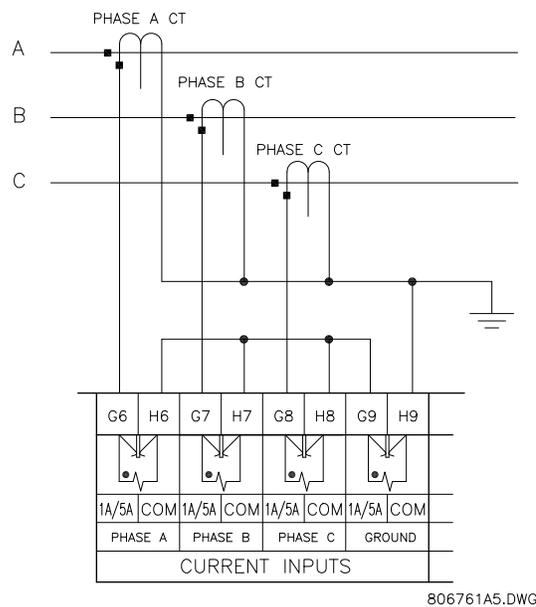


FIGURE 3-14: Residual Ground CT Connection

The 469 measures up to 5 A secondary current if the 1 A / 5 A tap is used. Since the conversion range is relatively small, the 1 A or 5 A option is field programmable. Proper selection of this settings ensures proper reading of primary ground current. The 1 A / 5 A ground CT chosen must be capable of driving the 469 ground CT burden (see *Specifications* on page 2-6). The 469 measures up to 25 A of primary ground current if this tap is used in conjunction with the GE Digital Energy core balance CT.



The zero-sequence connection is recommended. Unequal saturation of CTs, size and location of motor, resistance of power system and motor core saturation density, etc., may cause false readings in the residually connected GF circuit.



Only one ground input should be wired – the other input should be unconnected.

The exact placement of a zero-sequence CT to detect only ground fault current is shown below. If the core balance CT is placed over shielded cable, capacitive coupling of phase current into the cable shield during motor starts may be detected as ground current unless the shield wire is also passed through the CT window. Twisted pair cabling on the zero-sequence CT is recommended.

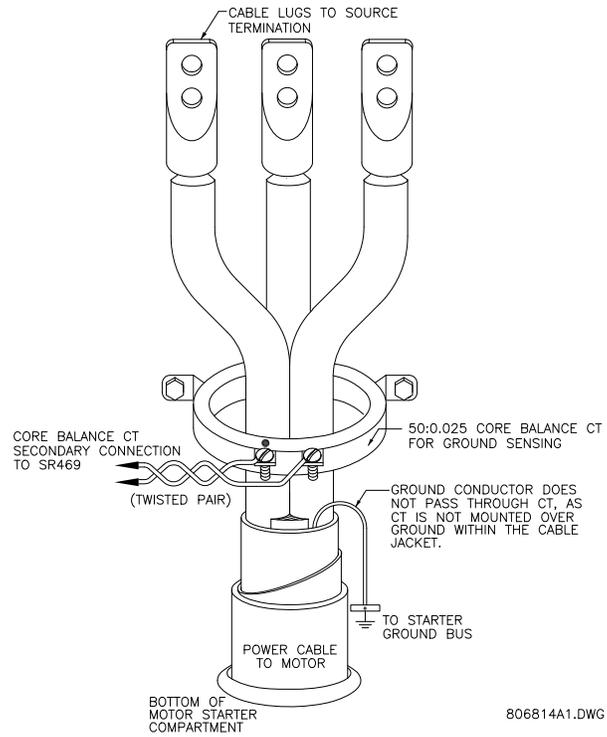


FIGURE 3-15: Core Balance Ground CT Installation – Unshielded Cable

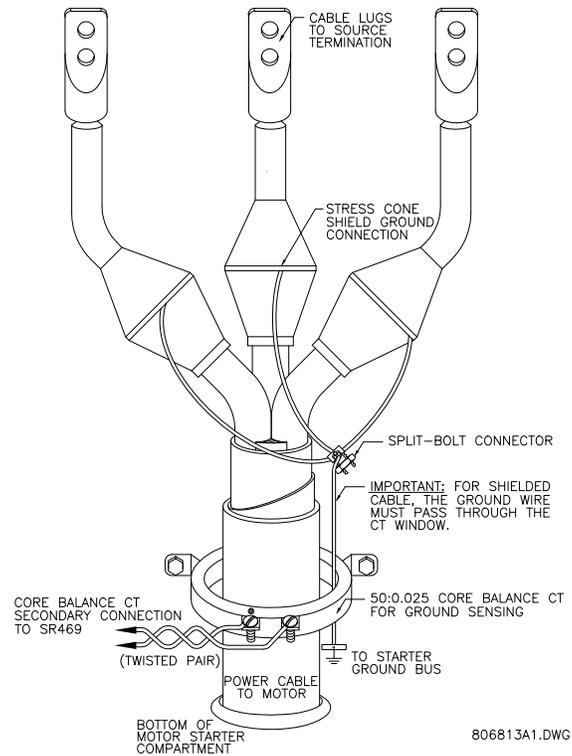


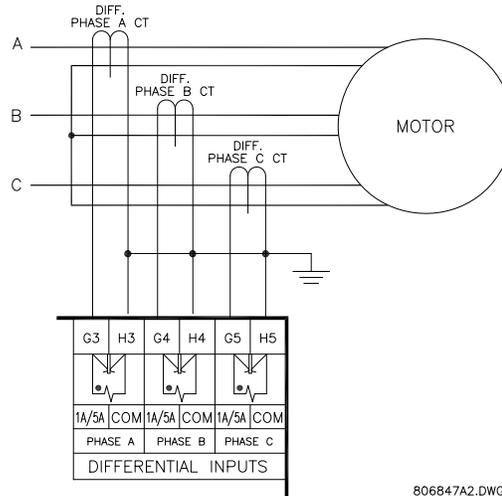
FIGURE 3-16: Core Balance Ground CT Installation – Shielded Cable

Differential Current Inputs

The 469 has three channels for differential current inputs, each with an isolating transformer. There are no internal ground connections on the current inputs. Each differential CT circuit is shorted by automatic mechanisms on the 469 case if the unit is withdrawn. The maximum differential CT primary current is 5000 A.

The 469 measures up to 5 A secondary current for the differential CT inputs. Since the conversion range is relatively small, the 1 A or 5 A option is field programmable. Proper selection of this settings ensures proper reading of primary phase differential current. The 1 A / 5 A differential CT chosen must be capable of driving the 469 differential CT burden (see *Specifications* on page 2-6 for ratings).

The differential CTs may be core balance as shown in the first figure below. Alternatively, the summation of two CTs per phase into the differential input will provide a larger zone of protection. If the summation of two CTs is used, observation of CT polarity is important. The summation method may also be implemented using the phase CTs as shown below. They will have to have the same CT ratio.



806847A2.DWG

FIGURE 3-17: Core Balance Method

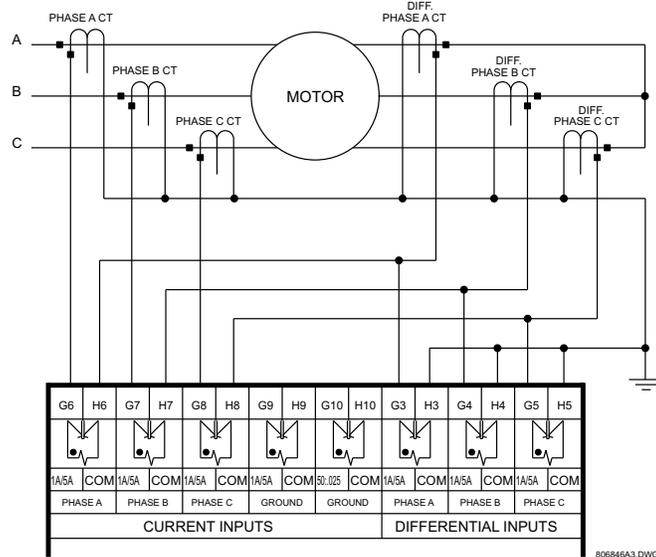


FIGURE 3-18: Summation Method with Phase CTs

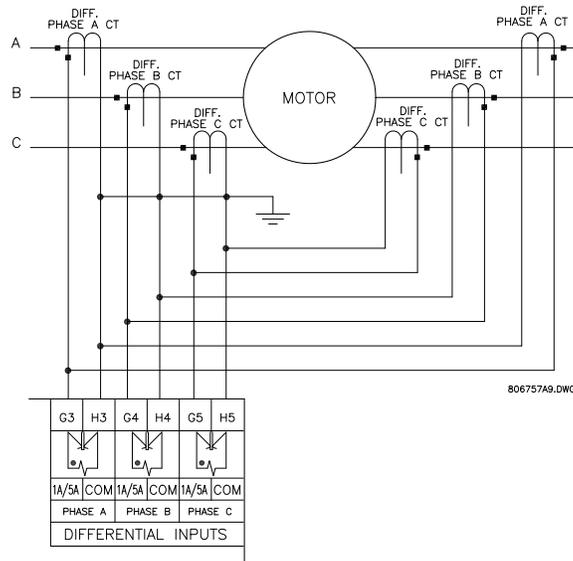


FIGURE 3-19: Summation Method without Phase CTs (Phase CTs wiring is shown in Figure 3-12)

3.2.5 Voltage Inputs

The 469 has three channels for AC voltage inputs, each with an isolating transformer. There are no internal fuses or ground connections on the voltage inputs. The maximum VT ratio is 300.00:1. The two VT connections are open delta (see FIGURE 3-12: *Typical Wiring Diagram* on page 3-11) or wye (see below). The voltage channels are connected in wye internally, which means that the jumper shown on the delta-source connection of the typical wiring diagram, between the phase B input and the 469 neutral terminal, must be installed for open delta VTs.

Polarity of the VTs is critical for correct power measurement and voltage phase reversal operation.

A 1 A fuse is typically used to protect the inputs.

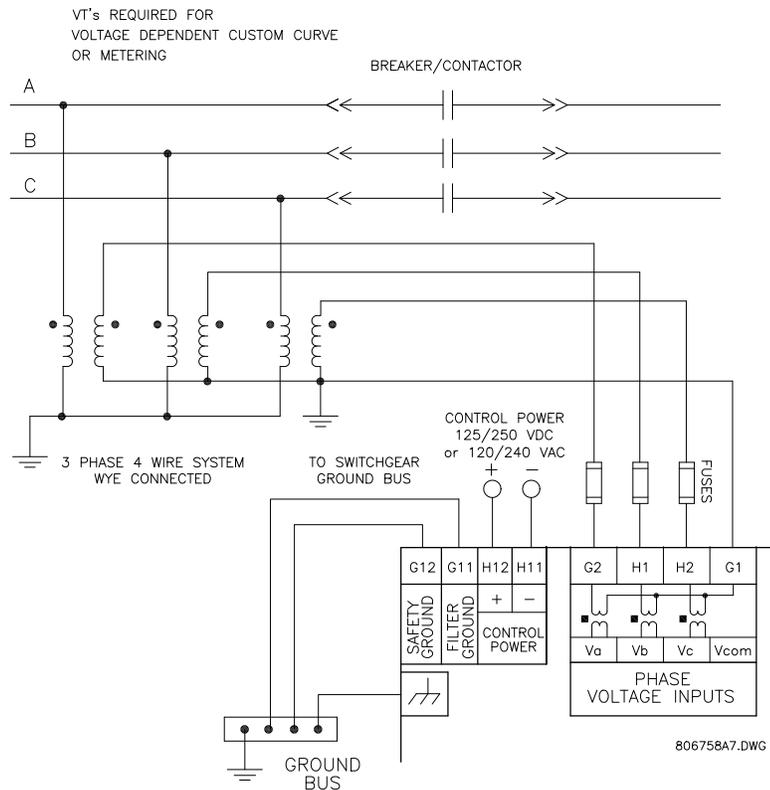


FIGURE 3–20: Wye Voltage Transformer Connection

3.2.6 Digital Inputs



The digital inputs of the 469 relay are designed for dry contact connection. In an application where the contact inputs need to be connected to the 469 relay digital inputs using long cable, it is recommended that you use interposing auxiliary contacts to interface between the 469 relay and the long digital input cable. This will help prevent the relay falsely sensing the digital input as "closed" due to induced voltage on the cables as a result of the capacitive effect. It is recommended that you use shielded twisted pair wires grounded at one end only, for digital inputs and avoid locating these wires in close to current carrying cables, contactors or other sources of high EMI.



DO NOT INJECT VOLTAGES TO DIGITAL INPUTS. DRY CONTACT CONNECTIONS ONLY.

There are 9 digital inputs designed for dry contact connections only. Two of the digital inputs (Access and Test) have their own common terminal; the balance of the digital inputs share one common terminal (see FIGURE 3–12: *Typical Wiring Diagram* on page 3–11).

In addition, the +24 V DC switch supply is brought out for control power of an inductive or capacitive proximity probe. The NPN transistor output could be taken to one of the assignable digital inputs configured as a counter or tachometer. Refer to *Specifications* on page 2–6 for maximum current draw from the +24 V DC switch supply.

3.2.7 Analog Inputs

The 469 provides terminals for four 0 to 1mA, 0 to 20mA, or 4 to 20mA current input signals (field programmable). This current signal can be used to monitor external quantities such as vibration, pressure, or flow. The four inputs share one common return. Polarity of these inputs must be observed for proper operation. The analog input circuitry is isolated as a group with the analog output circuitry and the RTD circuitry. Only one ground reference should be used for the three circuits. Transorbs limit this isolation to ± 36 V with respect to the 469 safety ground.

In addition, the +24 V DC analog input supply is brought out for control power of loop powered transducers. Refer to *Specifications* on page 2–6 for maximum current draw from this supply.

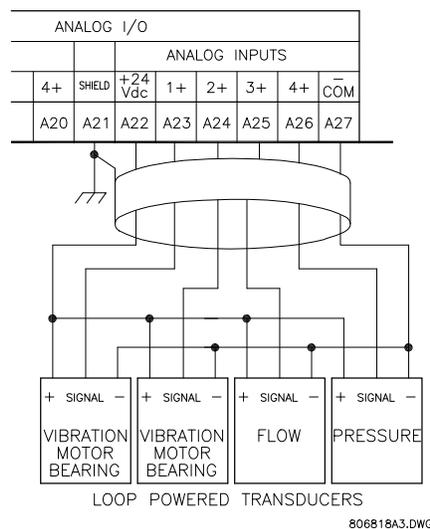


FIGURE 3–21: Loop Powered Transducer Connection

3.2.8 Analog Outputs

The 469 provides 4 analog output channels which may be ordered to provide a full-scale range of either 0 to 1 mA (into a maximum 10 k Ω impedance) or 4 to 20 mA (into a maximum 1200 Ω impedance). Each channel can be configured to provide full-scale output sensitivity for any range of any measured parameter.

As shown in FIGURE 3–12: *Typical Wiring Diagram* on page 3–11, these outputs share one common return. Polarity of these outputs must be observed for proper operation. Shielded cable should be used, with only one end of the shield grounded, to minimize noise effects.

The analog output circuitry is isolated as a group with the Analog Input circuitry and the RTD circuitry. Only one ground reference should be used for the three circuits. Transorbs limit this isolation to ± 36 V with respect to the 469 safety ground.

If a voltage output is required, a burden resistor must be connected at the input of the SCADA measuring device. Ignoring the input impedance of the input, $R_{load} = V_{full\ scale} / I_{max}$. For 0 to 1 mA, for example, if 5 V full scale is required to correspond to 1 mA, $R_{load} = 5\ V / 0.001\ A = 5000\ \Omega$. For 4 to 20 mA, this resistor would be $R_{load} = 5\ V / 0.020\ A = 250\ \Omega$.

3.2.9 RTD Sensor Connections

Description

The 469 monitors up to 12 RTD inputs for Stator, Bearing, Ambient, or Other temperature monitoring. The type of each RTD is field programmable as 100 Ω Platinum (DIN 43760), 100 Ω Nickel, 120 Ω Nickel, or 10 Ω Copper. RTDs must be three wire type. Every two RTDs shares a common return.

The RTD circuitry compensates for lead resistance, provided that each of the three leads is the same length. Lead resistance should not exceed 25 Ω per lead for platinum/nickel RTDs or 3 Ω per lead for copper RTDs. Shielded cable should be used to prevent noise pickup in the industrial environment. RTD cables should be kept close to grounded metal casings and away from areas of high electromagnetic or radio interference. RTD leads should not be run adjacent to or in the same conduit as high current carrying wires.

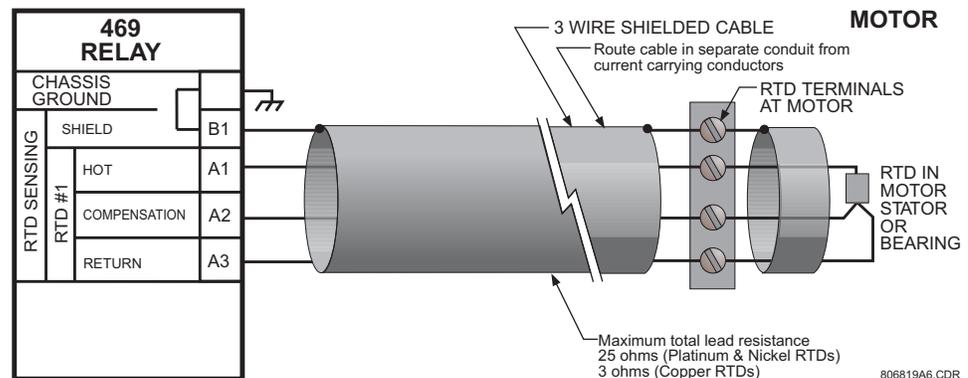


FIGURE 3–22: RTD Wiring



IMPORTANT: The RTD circuitry is isolated as a group with the Analog Input circuitry and the Analog Output circuitry. Only one ground reference should be used for the three circuits. Transorbs limit this isolation to $\pm 36\ V$ with respect to the 469 safety ground.

Reduced RTD Lead Number Application

The 469 requires three leads to be brought back from each RTD: Hot, Return and Compensation. This can be quite expensive. It is however possible to reduce the number of leads required to 3 for the first RTD and 1 for each successive RTD. Refer to the figure below for wiring configuration for this application.

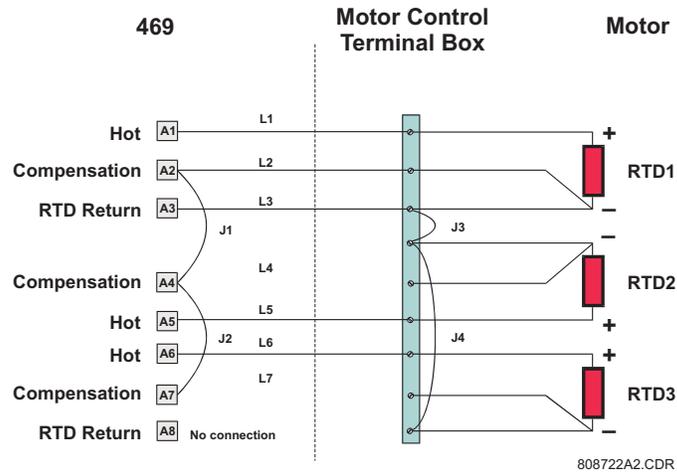


FIGURE 3–23: Reduced Wiring RTDs

The Hot line would have to be run as usual for each RTD. The Compensation and Return leads, however, need only be run for the first RTD. At the motor RTD terminal box, the RTD Return leads must be jumpered together with as short as possible jumpers. The Compensation leads must be jumpered together at the 469.

Note that an error is produced on each RTD equal to the voltage drop across the jumper on the RTD return. This error increases with each successive RTD added.

$$V_{RTD1} = V_{RTD1}$$

$$V_{RTD2} = V_{RTD2} + V_{J3}$$

$$V_{RTD3} = V_{RTD3} + V_{J3} + V_{J4}, \text{ etc.}$$

This error is directly dependent on the length and gauge of the wire used for the jumpers and any error introduced by a poor connection. For RTD types other than 10 Ω Copper, the error introduced by the jumpers is negligible. Although this RTD wiring technique reduces the cost of wiring, the following disadvantages must be noted:

1. There will be an error in temperature readings due to lead and connection resistances. This technique is **NOT** recommended for 10 Ω Copper RTDs.
2. If the RTD Return lead to the 469 or any of the jumpers break, all RTDs from the point of the break will read open.
3. If the Compensation lead or any of the jumpers break, all RTDs from the point of the break will function without any lead compensation.

Two-Wire RTD Lead Compensation

An example of how to add lead compensation to a two wire RTD may be shown in the figure below.

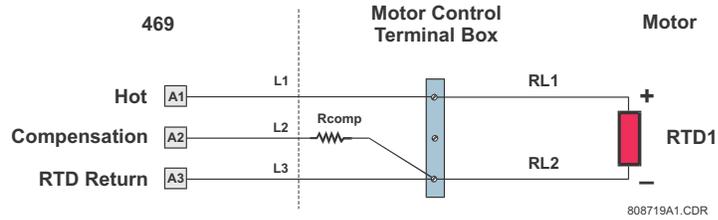


FIGURE 3–24: 2-Wire RTD Lead Compensation

The compensation lead L2 is added to compensate for Hot (L1) and Return (L3), assuming they are all of equal length and gauge. To compensate for leads RL1 and RL2, a resistor equal to the resistance of RL1 or RL2 could be added to the compensation lead, though in many cases this is unnecessary.

RTD Grounding

Grounding of one lead of the RTDs is done at either the 469 or at the motor. Grounding should **not** be done in both places as it could cause a circulating current. Only RTD Return leads may be grounded. When grounding at the 469, only one Return lead need be grounded as they are hard-wired together internally. No error is introduced into the RTD reading by grounding in this manner.

If the RTD Return leads are tied together and grounded at the motor, only one RTD Return lead can be run back to the 469. See the figure below for a wiring example. Running more than one RTD Return lead to the 469 causes significant errors as two or more parallel paths for the return current have been created. Use of this wiring scheme causes errors in readings equivalent to that in the Reduced RTD Lead Number application described earlier.

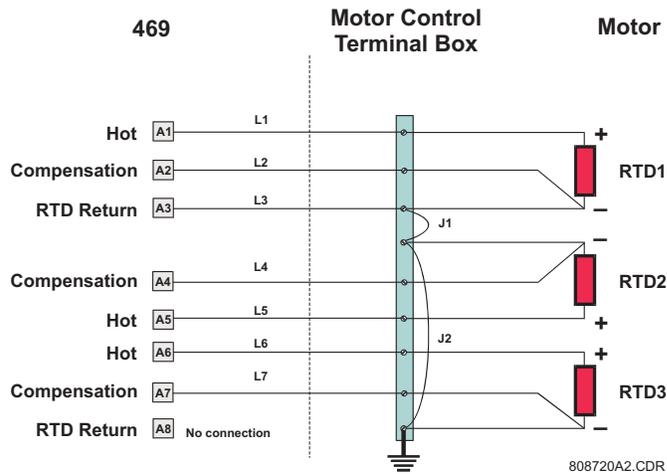


FIGURE 3–25: RTD Alternate Grounding

3.2.10 Output Relays

There are six (6) Form-C output relays (see *Specifications* on page 2–6 for details). Five of the six relays are always non-failsafe; 6 SERVICE is always failsafe. As failsafe, the 6 SERVICE relay is normally energized and de-energizes when called upon to operate. It also de-energizes when 469 control power is lost and will be in its operated state. All other

relays, being non-failsafe, will normally be de-energized and energize when called upon to operate. When the 469 control power is lost, these relays are de-energized and in their non-operated state. Shorting bars in the drawout case ensure that no trip or alarm occurs when the 469 is drawn out. However, the 6 SERVICE output will indicate that the 469 has been drawn out. Each output relay has an LED indicator on the front panel that turns on when the associated relay is in the operated state.



Relay contacts must be considered unsafe to touch when the 469 is energized! If the output relay contacts are required for low voltage accessible applications, it is the customer's responsibility to ensure proper insulation levels.

- **1 TRIP:** The trip relay should be wired to take the motor off line when conditions warrant. For a breaker application, the normally-open 1 TRIP contact should be wired in series with the Breaker trip coil. For contactor applications, the normally-closed 1 TRIP contact should be wired in series with the contactor coil.

Supervision of a breaker trip coil requires that the supervision circuit be in parallel with the 1 TRIP relay output contacts. With this connection made, the supervision input circuits place an impedance across the contacts that draws a 2 mA current (for an external supply voltage from 30 to 250 V DC) through the breaker trip coil. The supervision circuits respond to a loss of this trickle current as a failure condition. Circuit breakers equipped with standard control circuits have a breaker auxiliary contact permitting the trip coil to be energized only when the breaker is closed. When these contacts are open, as detected by the Starter Status Digital Input monitoring breaker auxiliary contacts, trip coil supervision circuit is automatically disabled. This logic allows the trip circuit to be monitored only when the breaker is closed.

- **2 AUXILIARY, 3 AUXILIARY:** The auxiliary relays may be programmed for trip echo, alarm echo, trip backup, alarm differentiation, control circuitry, and numerous other functions. They should be wired as configuration warrants.
- **4 ALARM:** The alarm relay should connect to the appropriate annunciator or monitoring device.
- **5 BLOCK START:** This relay should be wired in series with the start pushbutton in either a breaker or contactor configuration to prevent motor starting. When a trip has not been reset on a breaker, the block start relay prevents a start attempt that would result in an immediate trip. Any lockout functions are also directed to the block start relay.
- **6 SERVICE:** The service relay operates if any of the 469 diagnostics detect an internal failure or on loss of control power. This output may be monitored with an annunciator, PLC or DCS. If it is deemed that a motor is more important than a process, the service relay normally-closed contact may also be wired in parallel with the trip relay on a breaker application or the normally-open contact may be wired in series with the trip relay on a contactor application. This will provide failsafe operation of the motor; that is, the motor will be tripped off line in the event that the 469 is not protecting it. If however, the process is critical, annunciation of such a failure will allow the operator or the operation computer to either continue, or do a sequenced shutdown. See the following figure for details.

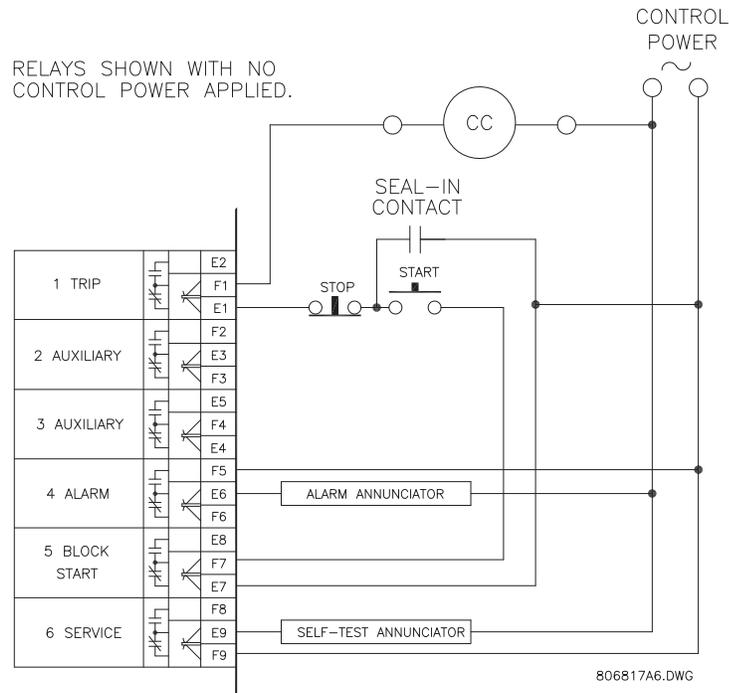


FIGURE 3-26: Alternate Wiring for Contactors

3.2.11 Drawout Indicator

The Drawout Indicator is simply a jumper from terminals E12 to F12. When the 469 is withdrawn from the case, terminals E12 and F12 are open. This may be useful for differentiating between loss of control power as indicated by the 6 SERVICE relay and withdrawal of the unit.

3.2.12 RS485 Communications Ports

Two independent two-wire RS485 ports are provided. Up to 32 469s can be daisy-chained together on a communication channel without exceeding the driver capability. For larger systems, additional serial channels must be added. Commercially available repeaters can also be used to add more than 32 relays on a single channel. Suitable cable should have a characteristic impedance of 120 Ω (e.g. Belden #9841) and total wire length should not exceed 4000 ft. Commercially available repeaters will allow for transmission distances greater than 4000 ft.

Voltage differences between remote ends of the communication link are not uncommon. For this reason, surge protection devices are internally installed across all RS485 terminals. Internally, an isolated power supply with an optocoupled data interface is used to prevent noise coupling.



To ensure that all devices in a daisy-chain are at the same potential, it is imperative that the common terminals of each RS485 port are tied together and grounded only once, at the master. Failure to do so may result in intermittent or failed communications.

The source computer/PLC/SCADA system should have similar transient protection devices installed, either internally or externally, to ensure maximum reliability. Ground the shield at one point only, as shown in the figure below, to avoid ground loops.

Correct polarity is also essential. The 469s must be wired with all the '+' terminals connected together and all the '-' terminals connected together. Each relay must be daisy-chained to the next one. Avoid star or stub connected configurations. The last device at each end of the daisy chain should be terminated with a 120 Ω ¼-watt resistor in series with a 1 nF capacitor across the '+' and '-' terminals. Observing these guidelines provides a reliable communication system immune to system transients.

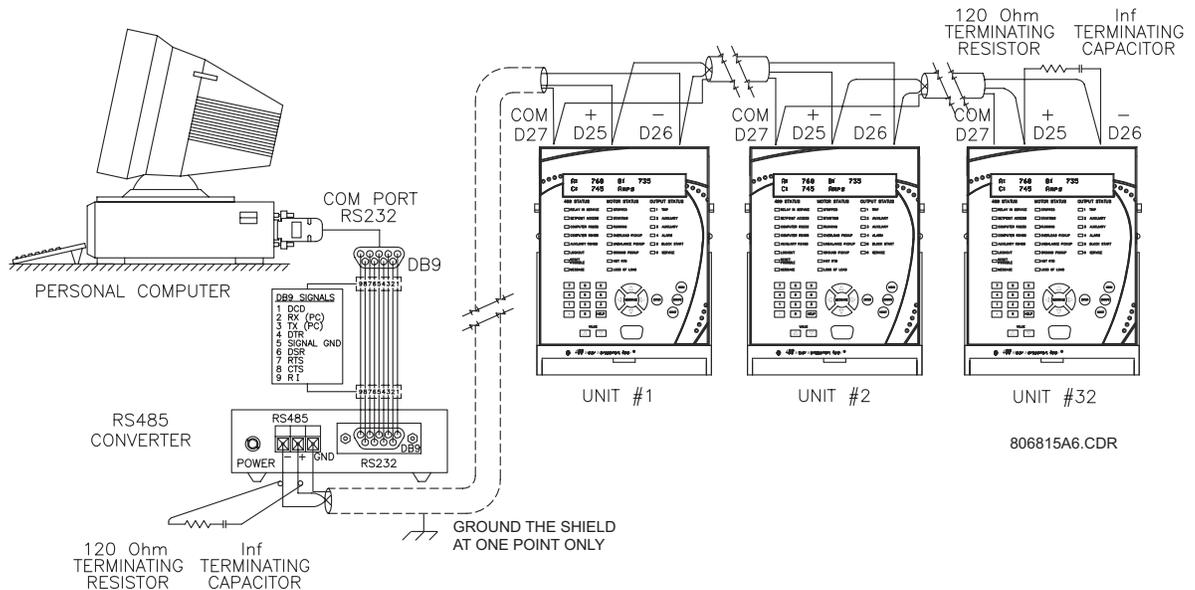


FIGURE 3-27: RS485 Communications Wiring

3.2.13 Dielectric Strength

It may be required to test a complete motor starter for dielectric strength (“flash” or “hipot”) with the 469 installed. The 469 is rated for 1.9 kV AC for 1 second, or 1.6 kV AC for 1 minute (per UL 508) isolation between relay contacts, CT inputs, VT inputs, trip coil supervision, and the safety ground terminal G12. Some precautions are required to prevent damage to the 469 during these tests.

Filter networks and transient protection clamps are used between control power, trip coil supervision, and the filter ground terminal G11. This is intended to filter out high voltage transients, radio frequency interference (RFI), and electromagnetic interference (EMI). The filter capacitors and transient suppressors may be damaged by continuous high voltage. Disconnect the filter ground terminal G11 during testing of control power and trip coil supervision. The CT inputs, VT inputs, and output relays do not require any special precautions. Low voltage inputs (less than 30 V), RTDs, analog inputs, analog outputs, digital inputs, and RS485 communication ports are not to be tested for dielectric strength under any circumstance (see below).

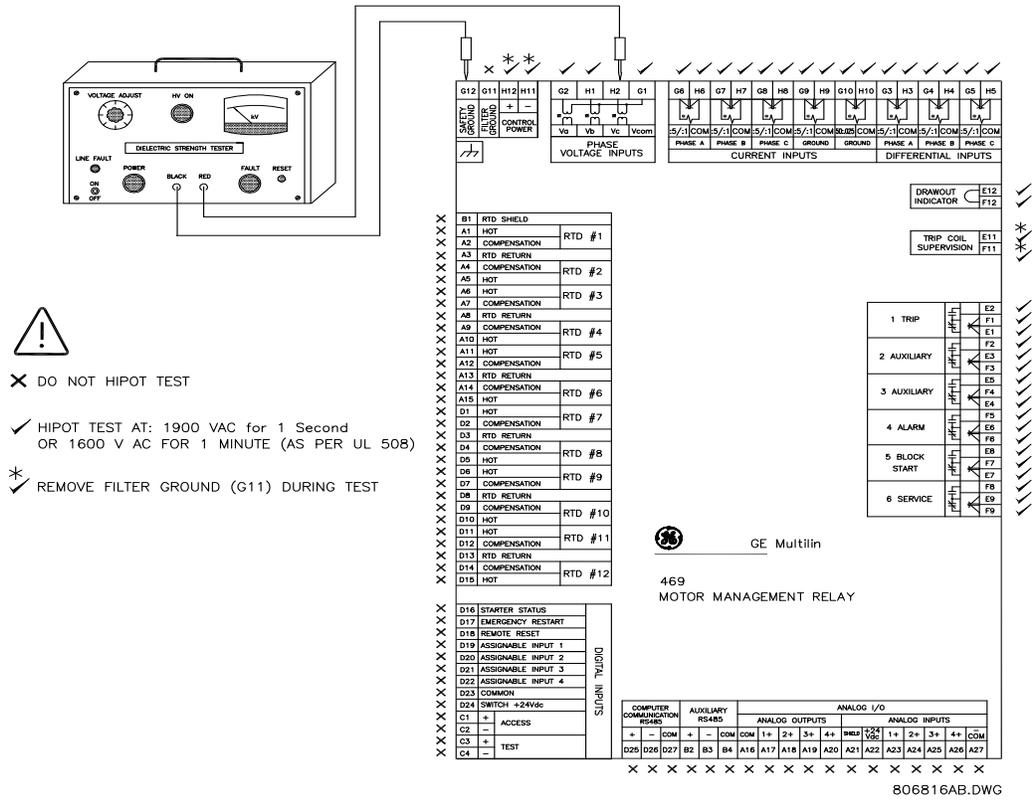
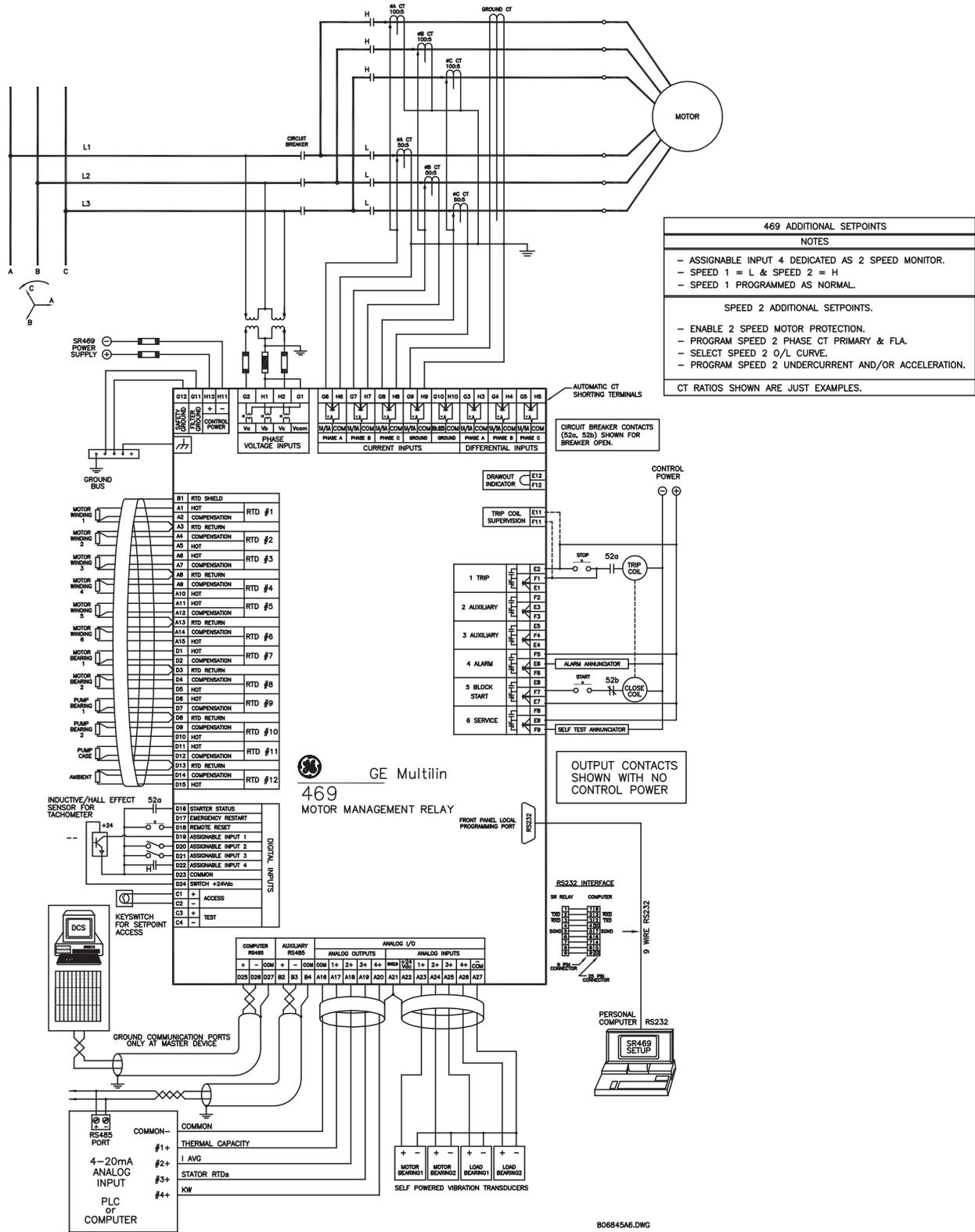


FIGURE 3-28: Testing for Dielectric Strength

3.2.14 2-Speed Motor Wiring





469 Motor Management Relay

Chapter 4: Interfaces

4.1 Faceplate Interface

4.1.1 Description

The front panel provides local operator interface with a liquid crystal display, LED status indicators, control keys, and program port. The display and status indicators update alarm and status information automatically. The control keys are used to select the appropriate message for entering settings or displaying measured values. The RS232 program port is also provided for connection with a computer running the EnerVista 469 Setup software.

4.1.2 Display

The 40-character liquid crystal display allows visibility under varied lighting conditions. While the keypad and display are not being used, the screen will display system information by scrolling through a maximum of 20 user-selected default messages. These default messages will only appear after a user programmed period of inactivity. Pressing any key during default message scrolling will return the display to the last message shown before the default messages appeared. Any trip, alarm, or start block is displayed immediately, automatically overriding the default messages.

4.1.3 LED Indicators

There are three groups of LED indicators. They are 469 Status, Motor Status, and Output Relays.



806977A1.CDR

FIGURE 4-1: 469 LED INDICATORS

469 Status LED Indicators

- **469 IN SERVICE:** This LED indicates that control power is applied, all monitored inputs/outputs and internal systems are OK, the 469 has been programmed, and the 469 is in protection mode, not simulation mode. This LED flashes when the 469 is in simulation or testing mode.
- **SETPOINT ACCESS:** This LED indicates that the access jumper is installed and passcode protection has been satisfied; settings may be altered and stored.
- **COMPUTER RS232:** This LED flashes when there is any activity on the communication port. The LED remains on solid if incoming data is valid.
- **COMPUTER RS485:** Flashes when there is any activity on the communication port. Remains on solid if incoming data is valid and intended for the slave address programmed in the relay.
- **AUXILIARY RS485:** Flashes when there is any activity on the communication port. Remains on solid if incoming data is valid and intended for the slave address programmed in the relay.
- **LOCKOUT:** Indicates start attempts will be blocked either by a programmed lockout time or a condition that is still present.
- **RESET POSSIBLE:** A trip or latched alarm may be reset. Press the RESET key to clear the trip or alarm.
- **MESSAGE:** Flashes when a trip, alarm, or start block occurs. Pressing the MESSAGE keys scroll through diagnostic messages. This LED remains solid when settings and actual value messages are being viewed. Pressing the RESET key returns the display to the default messages. Under normal conditions, the default messages selected during settings programming are displayed. If any alarm or trip condition is generated, a diagnostic message overrides the displayed message and this indicator flashes. If there is more than one condition present, MESSAGE ▼ can be used to scroll through the messages. Pressing any other key return to the normally displayed messages. While viewing normally displayed messages, the Message LED continues to flash if any diagnostic message is active. To return to the

diagnostic messages from the normally displayed messages, press the MENU key until the following message is displayed.

3. TARGET MESSAGES
Press [▶] for more

Now, press the MESSAGE ▶ key followed by the MESSAGE ▼ key to scroll through the messages. Note that diagnostic messages for alarms disappear with the condition while diagnostic messages for trips remain until cleared by a reset.

Motor Status LED Indicators

- **STOPPED:** The motor is stopped based on zero phase current and starter status auxiliary contact feedback.
- **STARTING:** Motor is starting.
- **RUNNING:** Motor is running normally below overload pickup level.
- **OVERLOAD:** Motor is running above overload pickup.
- **UNBALANCE PICKUP:** Level of current unbalance has exceeded the unbalance alarm or trip level.
- **GROUND PICKUP:** Level of ground current has exceeded the ground fault alarm or trip level.
- **HOT RTD:** One of the RTD measurements has exceeded its RTD alarm or trip level.
- **LOSS OF LOAD:** Average motor current has fallen below the undercurrent alarm or trip level; or power consumption has fallen below the underpower alarm or trip level.

Output Relay LED Indicators

- **1 TRIP:** The 1 TRIP relay has operated (energized).
- **2 AUXILIARY:** The 2 AUXILIARY relay has operated (energized).
- **3 AUXILIARY:** The 3 AUXILIARY relay has operated (energized).
- **4 ALARM:** The 4 ALARM relay has operated (energized).
- **5 BLOCK START:** The 5 BLOCK START relay has operated (energized).
- **6 SERVICE:** The 6 SERVICE relay has operated (de-energized, 6 SERVICE is failsafe, normally energized).

4.1.4 RS232 Port

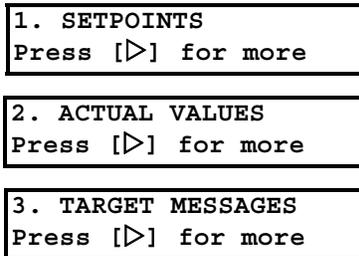
This port is intended for connection to a portable PC. Settings files may be created at any location and downloaded through this port with the EnerVista 469 Setup software. Local interrogation of settings and actual values is also possible. New firmware may also be downloaded to the 469 flash memory through this port. Upgrading of the relay firmware does not require a hardware EPROM change.

4.1.5 Keypad

Description

The 469 display messages are organized into main menus, pages, and sub-pages. There are three main menus labeled settings, Actual Values, and Target Messages.

Pressing the MENU key followed by the MESSAGE ▼ key scrolls through the three main menu headers, which appear in sequence as follows:



Pressing the MESSAGE ► key or the ENTER key from these main menu pages will display the corresponding menu page. Use the MESSAGE ▼ and MESSAGE ▲ keys to scroll through the page headers.

When the display shows **SETTINGS**, pressing the MESSAGE ► key or the ENTER key will display the page headers of programmable parameters (referred to as settings in the manual). When the display shows **ACTUAL VALUES**, pressing the MESSAGE ► key or the ENTER key displays the page headers of measured parameters (referred to as actual values in the manual). When the display shows **TARGET MESSAGES**, pressing the MESSAGE ► key or the ENTER key displays the page headers of event messages or alarm conditions.

Each page is broken down further into logical sub-pages. The MESSAGE ▼ and MESSAGE ▲ keys are used to navigate through the sub-pages. A summary of the settings and actual values can be found in the chapters 5 and 6, respectively.

The ENTER key is dual purpose. It is used to enter the sub-pages and to store altered settings values into memory to complete the change. The MESSAGE ► key can also be used to enter sub-pages but not to store altered settings.

The ESCAPE key is also dual purpose. It is used to exit the sub-pages and to cancel a settings change. The MESSAGE ◀ key can also be used to exit sub-pages and to cancel settings changes.

The VALUE keys are used to scroll through the possible choices of an enumerated settings. They also decrement and increment numerical settings. Numerical settings may also be entered through the numeric keypad.

Pressing the HELP key displays context-sensitive information about settings such as the range of values and the method of changing the settings. Help messages will automatically scroll through all messages currently appropriate.

The RESET key resets any latched conditions that are not presently active. This includes resetting latched output relays, latched Trip LEDs, breaker operation failure, and trip coil failure.

The MESSAGE ▼ and MESSAGE ▲ keys scroll through any active conditions in the relay. Diagnostic messages are displayed indicating the state of protection and monitoring elements that are picked up, operating, or latched. When the Message LED is on, there are messages to be viewed with the MENU key by selecting target messages as described earlier.

Entering Alphanumeric Text

Text settings have data values that are fixed in length but user-defined in character. They may be comprised of upper case letters, lower case letters, numerals, and a selection of special characters. The editing and storing of a text value is accomplished with the use of the decimal [.] , VALUE, and ENTER keys.

- ▷ Move to message **S3 DIGITAL INPUTS** ▷ ▾ **ASSIGNABLE INPUT 1** ▷ **INPUT 1 FUNCTION**, and scrolling with the VALUE keys, select “General Sw. A”.

The relay will display the following message:

```
INPUT 1 FUNCTION:
General Sw. A
```

- ▷ Press the MESSAGE ▼ key to view the SWITCH NAME settings. The name of this user-defined input will be changed in this example from the generic “General Sw. A” to something more descriptive.

If an application is to be using the relay as a station monitor, it is more informative to rename this input “Station Monitor”.

- ▷ Press the decimal [.] to enter the text editing mode. The first character will appear underlined as follows:

```
SWITCH NAME:
General Sw. A
```

- ▷ Press the VALUE keys until the character “S” is displayed in the first position.
- ▷ Press the decimal [.] key to store the character and advance the cursor to the next position.
- ▷ Change the second character to a “t” in the same manner.
- ▷ Continue entering characters in this way until all characters of the text “Stn. Monitor” are entered. Note that a space is selected like a character.
 - If a character is entered incorrectly, press the decimal [.] key repeatedly until the cursor returns to the position of the error. Re-enter the character as required.
- ▷ Once complete, press the ENTER key to remove the solid cursor and view the result.
 - Once a character is entered, by pressing the ENTER key, it is automatically saved in Flash Memory, as a new setting.

```
SWITCH NAME:
Stn. Monitor
```

The 469 does not have '+' or '-' keys. Negative numbers may be entered in one of two manners.

- ▷ Immediately pressing one of the VALUE keys causes the settings to scroll through its range including any negative numbers.
- ▷ After entering at least one digit of a numeric settings value, pressing the VALUE keys changes the sign of the value where applicable.

4.1.6 Settings Entry

To store any settings, terminals C1 and C2 (access terminals) must be shorted (a keyswitch may be used for security). There is also a settings passcode feature that restricts access to settings. The passcode must be entered to allow the changing of settings values. A passcode of "0" effectively turns off the passcode feature - in this case only the access jumper is required for changing settings. If no key is pressed for 5 minutes, access to settings values will be restricted until the passcode is entered again. To prevent settings access before the 5 minutes expires, the unit may be turned off and back on, the access jumper may be removed, or the **SETTINGS ACCESS** settings may be changed to "Restricted". The passcode cannot be entered until terminals C1 and C2 (access terminals) are shorted. When settings access is allowed, the settings Access LED indicator on the front of the 469 will be lit.

Settings changes take effect immediately, even when motor is running. However, changing settings while the motor is running is not recommended as any mistake may cause a nuisance trip.

The following procedure may be used to access and alter settings. This specific example refers to entering a valid passcode to allow access to settings if the passcode was "469".

- ▷ Press the MENU key to access the header of each menu, which will be displayed in the following sequence:

```
1. SETPOINTS
Press [▷] for more
```

```
2. ACTUAL VALUES
Press [▷] for more
```

```
3. TARGET MESSAGES
Press [▷] for more
```

- ▷ Press the MENU key until the display shows the header of the Settings menu.
- ▷ Press the MESSAGE ► or ENTER key to display the header for the first settings page.

The set point pages are numbered, have an 'S' prefix for easy identification and have a name which gives a general idea of the settings available in that page. Pressing the MESSAGE ▼ or MESSAGE ▲ keys will scroll through all the available settings page headers. Settings page headers look as follows:

```
■ SETPOINTS [▷]
S1 469 SETUP
```

- ▷ To enter a given Setpoints page, press the MESSAGE ► or ENTER key.
- ▷ Press the MESSAGE ▼ or MESSAGE ▲ keys to scroll through sub-page headers until the required message is reached. The end of a page is indicated by the message **END OF PAGE**. The beginning of a page is indicated by **TOP OF PAGE**.

Each page is broken further into subgroups.

- ▷ Press MESSAGE ▼ or MESSAGE ▲ to cycle through subgroups until the desired subgroup appears on the screen.
- ▷ Press the MESSAGE ► or ENTER key to enter a subgroup.

■ PASSCODE [►]

Each sub-group has one or more associated settings messages.

- ▷ Press the MESSAGE ► or ENTER key to enter the setting message.

ENTER PASSCODE FOR
ACCESS:

- ▷ Press the MESSAGE ▼ or MESSAGE ▲ keys to scroll through more settings messages, if applicable.

The majority of settings are changed by pressing the VALUE keys until the desired value appears, and then pressing ENTER. Numeric settings may also be entered through the numeric keys (including decimals). If the entered settings is out of range, the original settings value reappears. If the entered settings is out of step, an adjusted value will be stored (e.g. 101 for a settings that steps 95, 100, 105 is stored as 100). If a mistake is made entering the new value, pressing ESCAPE returns the settings to its original value. Text editing is a special case described in detail in *Entering Alphanumeric Text* on page 4-5. Each time a new settings is successfully stored, a message will flash on the display stating **NEW SETPOINT HAS BEEN STORED**.

- ▷ Press the 4, 6, 9 keys, then press ENTER. The following flash message is displayed:

NEW SETPOINT HAS
BEEN STORED

and the display returns to:

SETPOINT ACCESS:
Permitted

1. Press ESCAPE or MESSAGE ◀ to exit the subgroup. Pressing ESCAPE or MESSAGE ◀ numerous times will always return the cursor to the top of the page.

4.1.7 Diagnostic Messages

Diagnostic messages are automatically displayed for any active conditions in the relay such as trips, alarms, or asserted logic inputs. These messages provide a summary of the present state of the relay. The Message LED flashes when there are diagnostic messages available; press the MENU key until the relay displays **TARGET MESSAGES**, then press the

MESSAGE ► key, followed by the MESSAGE ▼ key, to scroll through the messages. For additional information and a complete list of diagnostic messages, refer to *Diagnostic Messages* on page 6–37.

4.1.8 Self-Test Warnings

The 469 relay performs self test diagnostics at initialization (after power up) and continuously as a background task to ensure the hardware and software is functioning correctly. Self-test warnings indicate either a minor or major problem. Minor problems are problems that does not compromise motor protection. Major problems are very serious problems that compromise all aspects of relay operation. Upon detection of either a minor or a major problem the relay will:

- De-energize the self-test warning relay
- Light the self-test warning LED
- Flash a diagnostic message periodically on the display screen

Table 4–1: Self-Test Warnings

Message	Severity	Failure description
Self-Test Warning 1 Replace Immediately	Major	Caused by detection of a corrupted location in the program memory as determined by a CRC error check. Any function of the relay is susceptible to malfunction from this failure.
Self-Test Warning 2 Replace Immediately	Major	Caused by a failure of the analog to digital converter A/D1. The integrity of system input measurements is affected by this failure.
Self-Test Warning 3 Replace Immediately	Major	Caused by a failure of the analog to digital converter A/D2. The integrity of system input measurements is affected by this failure.
Self-Test Warning 5 Replace Immediately	Major	Caused by out of range reading of self-test RTD 13. The integrity of system input measurements is affected by this failure.
Self-Test Warning 6 Replace Immediately	Major	Caused by out of range reading of self-test RTD 14. The integrity of system input measurements is affected by this failure.
Self-Test Warning 7 Replace Immediately	Major	Caused by out of range reading of self-test RTD 15. The integrity of system input measurements is affected by this failure.
Self-Test Warning 8 Replace Immediately	Major	Caused by out of range reading of self-test RTD 16. The integrity of system input measurements is affected by this failure.
Clock Not Set Program Date/Time	Minor	Occurs if the clock has not been set.
Unit Temp. Exceeded Service/CheckAmbient	Minor	Caused by the detection of unacceptably low (less than -40°C) or high (greater than +85°C) temperatures detected inside the unit.
Unit Not Calibrated Replace Immediately	Minor	This warning occurs when the relay has not been factory calibrated.

Table 4-1: Self-Test Warnings

Message	Severity	Failure description
Relay Not Configured Consult User Manual	Minor	This warning occurs when the 469 CT Primary or FLA is set to "None".
Service Required Schedule Maintenance	Minor	Caused by a failure of the real time clock circuit. The ability of the relay to maintain the current date and time is lost.

4.1.9 Flash Messages

Flash messages are warning, error, or general information messages displayed in response to certain key presses. The length of time these messages remain displayed can be programmed in **SI RELAY SETUP** ▷ ▽ **PREFERENCES** ▷ ▽ **DEFAULT MESSAGE CYCLE TIME**. The factory default flash message time is 4 seconds. For additional information and a complete list of flash messages, refer to *Flash Messages* on page 6-38.

4.2 EnerVista 469 Setup Software Interface

4.2.1 Overview

The front panel provides local operator interface with a liquid crystal display. The EnerVista 469 Setup software provides a graphical user interface (GUI) as one of two human interfaces to a 469 device. The alternate human interface is implemented via the device's faceplate keypad and display (see the first section in this chapter).

The EnerVista 469 Setup software provides a single facility to configure, monitor, maintain, and trouble-shoot the operation of relay functions, connected over serial communication networks. It can be used while disconnected (i.e. off-line) or connected (i.e. on-line) to a 469 device. In off-line mode, Settings files can be created for eventual downloading to the device. In on-line mode, you can communicate with the device in real-time.

This no-charge software, provided with every 469 relay, can be run from any computer supporting Microsoft Windows[®] 95 or higher. This chapter provides a summary of the basic EnerVista 469 Setup software interface features. The EnerVista 469 Setup help file provides details for getting started and using the software interface.

With the EnerVista 469 Setup running on your PC, it is possible to

- Program and modify settings
- Load/save Settings files from/to disk
- Read actual values and monitor status
- Perform waveform capture and log data
- Plot, print, and view trending graphs of selected actual values
- Download and playback waveforms
- Get help on any topic

4.2.2 Hardware

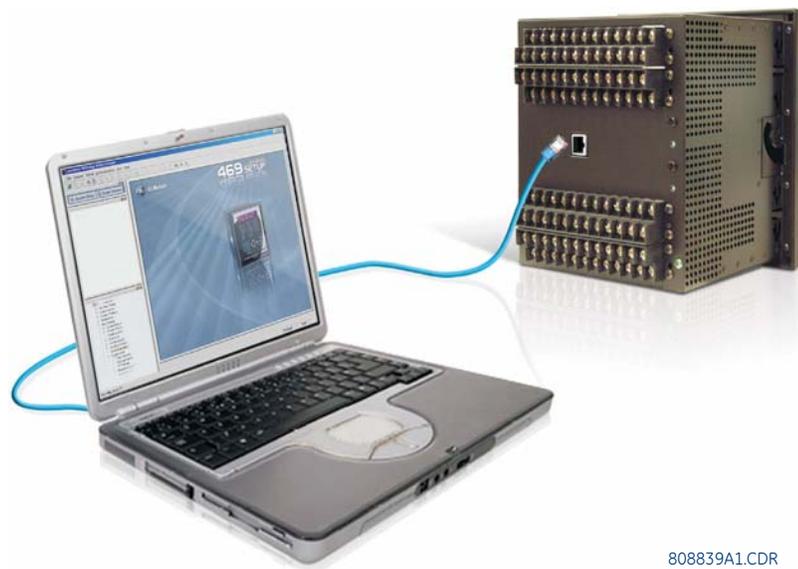
Communications from the EnerVista 469 Setup to the 469 can be accomplished three ways: RS232, RS485, and Ethernet communications. The following figures illustrate typical connections for RS232 and RS485 communications.



FIGURE 4-2: Communications using The Front RS232 Port



FIGURE 4-3: Communications using Rear RS485 Port



808839A1.CDR

FIGURE 4-4: Communications using Rear Ethernet Port

4.2.3 Installing the EnerVista 469 Setup Software

The following minimum requirements must be met for the EnerVista 469 Setup software to operate on your computer.

- Pentium class or higher processor (Pentium II 400 MHz or better recommended)
- Microsoft Windows 95, 98, 98SE, NT 4.0 (SP4 or higher), 2000, XP
- 128 MB of RAM (256 MB recommended)
- Minimum of 200 MB hard disk space

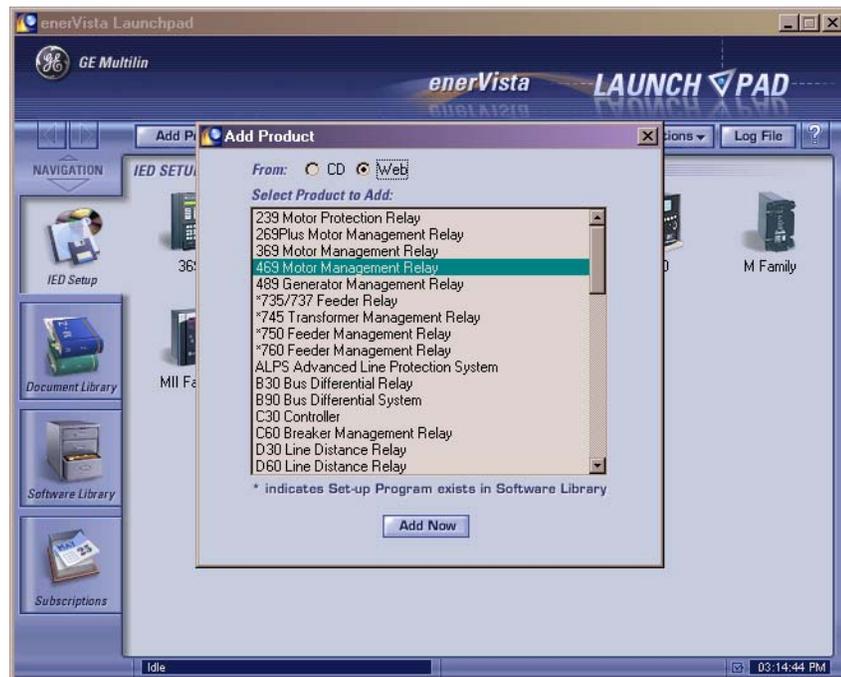
After ensuring these minimum requirements, use the following procedure to install the EnerVista 469 Setup software from the enclosed GE EnerVista CD.

- ▷ Insert the GE EnerVista CD into your CD-ROM drive.
- ▷ Click the **Install Now** button and follow the installation instructions to install the no-charge EnerVista software on the local PC.
- ▷ When installation is complete, start the EnerVista Launchpad application.
- ▷ Click the **IED Setup** section of the **Launch Pad** window.

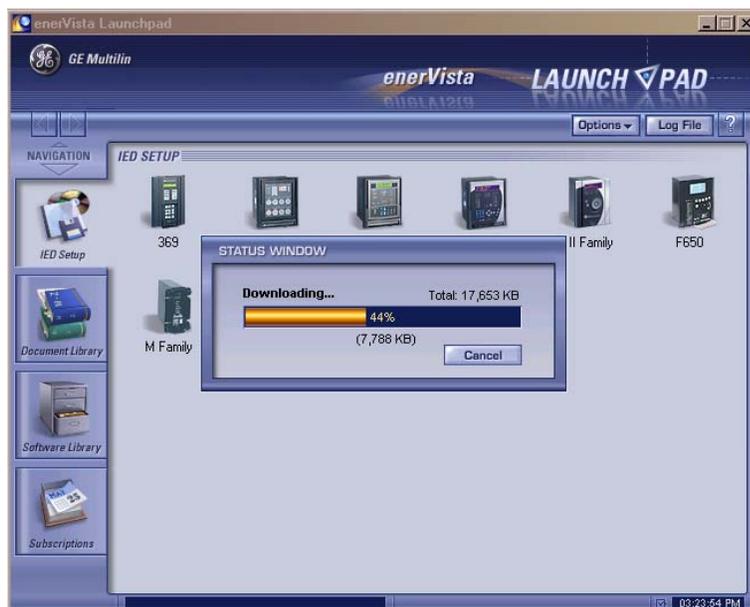


- ▷ In the EnerVista Launch Pad window, click the **Add Product** button and select the “469 Motor Management Relay” from the Install Software window as shown below.
- ▷ Select the “Web” option to ensure the most recent software release, or select “CD” if you do not have a web connection.

- ▷ Click the **Add Now** button to list software items for the 469.



EnerVista Launchpad will obtain the latest installation software from the Web or CD and automatically start the installation process. A status window with a progress bar will be shown during the downloading process.



- ▷ Select the complete path, including the new directory name, where the EnerVista 469 Setup software will be installed.

- ▷ Click on Next to begin the installation.
The files will be installed in the directory indicated and the installation program will automatically create icons and add EnerVista 469 Setup software to the Windows start menu.
- ▷ Click Finish to end the installation.
The 469 device will be added to the list of installed IEDs in the EnerVista Launchpad window, as shown below.



4.3 Connecting EnerVista 469 Setup to the Relay

4.3.1 Configuring Serial Communications

Before starting, verify that the serial cable is properly connected to either the RS232 port on the front panel of the device (for RS232 communications) or to the RS485 terminals on the back of the device (for RS485 communications). See *Hardware* on page 4–11 for connection details.

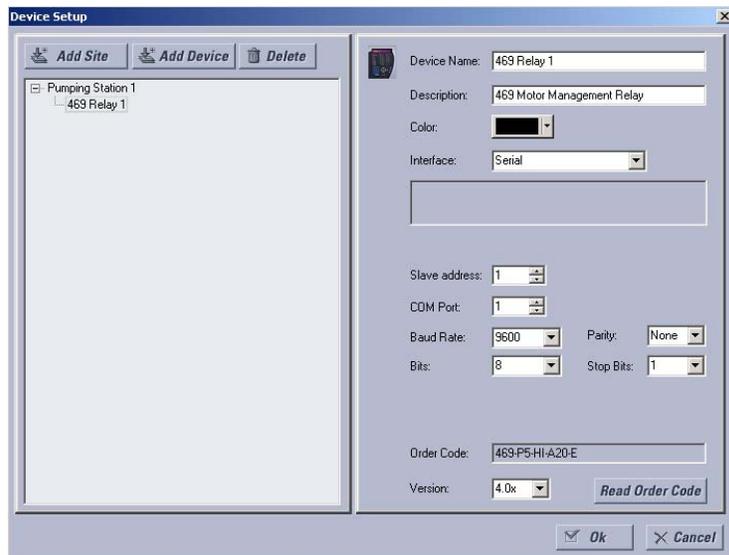
This example demonstrates an RS232 connection. For RS485 communications, the GE Digital Energy F485 converter will be required. Refer to the F485 manual for additional details. To configure the relay for Ethernet communications, see *Configuring Ethernet Communications* on page 4–18.

- ▷ Install and start the latest version of the EnerVista 469 Setup software (available from the GE EnerVista CD). See the previous section for the installation procedure.
- ▷ Click on the **Device Setup** button to open the Device Setup window.
- ▷ Click the **Add Site** button to define a new site.
- ▷ Enter the desired site name in the **Site Name** field. If desired, a short description of site can also be entered along with the display order of devices defined for the site. In this example, we will use “Pumping Station 1” as the site name.
- ▷ Click the **OK** button when complete.

The new site will appear in the upper-left list in the EnerVista 469 Setup window.

- ▷ Click the **Add Device** button to define the new device.
- ▷ Enter the desired name in the **Device Name** field and a description (optional) of the site.

- ▷ Select “Serial” from the Interface drop-down list. This will display a number of interface parameters that must be entered for proper RS232 functionality.

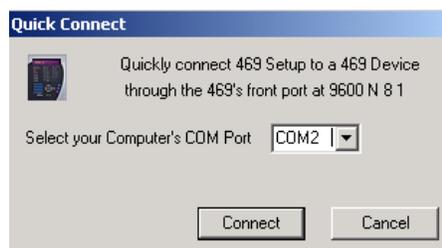


- Enter the slave address and COM port values (from the **S1 469 SETUP ▷ ▾ SERIAL PORTS** menu) in the Slave Address and COM Port fields.
 - Enter the physical communications parameters (baud rate and parity settings) in their respective fields. Note that when communicating to the relay from the front port, the default communications settings are a baud rate of 9600, with slave address of 1, no parity, 8 bits, and 1 stop bit. **These values cannot be changed.**
2. Click the **Read Order Code** button to connect to the 469 device and upload the order code. If an communications error occurs, ensure that the 469 serial communications values entered in the previous step correspond to the relay setting values.
 3. Click **OK** when the relay order code has been received. The new device will be added to the Site List window (or Online window) located in the top left corner of the main EnerVista 469 Setup window.

The 469 Site Device has now been configured for serial communications. Proceed to *Connecting to the Relay* on page 4-19 to begin communications.

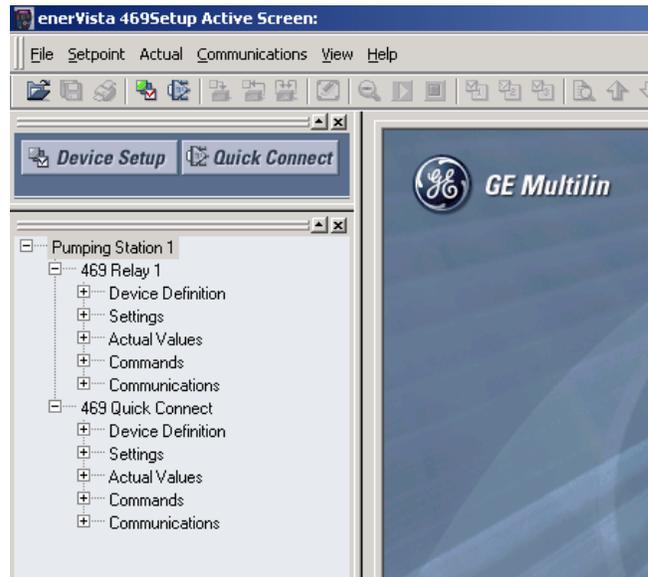
4.3.2 Using the Quick Connect Feature

The Quick Connect button can be used to establish a fast connection through the front panel RS232 port of a 469 relay. The following window will appear when the Quick Connect button is pressed:



As indicated by the window, the Quick Connect feature quickly connects the EnerVista 469 Setup software to a 469 front port with the following settings: 9600 baud, no parity, 8 bits, 1 stop bit. Select the PC communications port connected to the relay and press the **Connect** button.

The EnerVista 469 Setup software will display a window indicating the status of communications with the relay. When connected, a new Site called “Quick Connect” will appear in the Site List window. *The properties of this new site cannot be changed.*



The 469 Site Device has now been configured via the Quick Connect feature for serial communications. Proceed to *Connecting to the Relay* on page 4–19 to begin communications.

4.3.3 Configuring Ethernet Communications

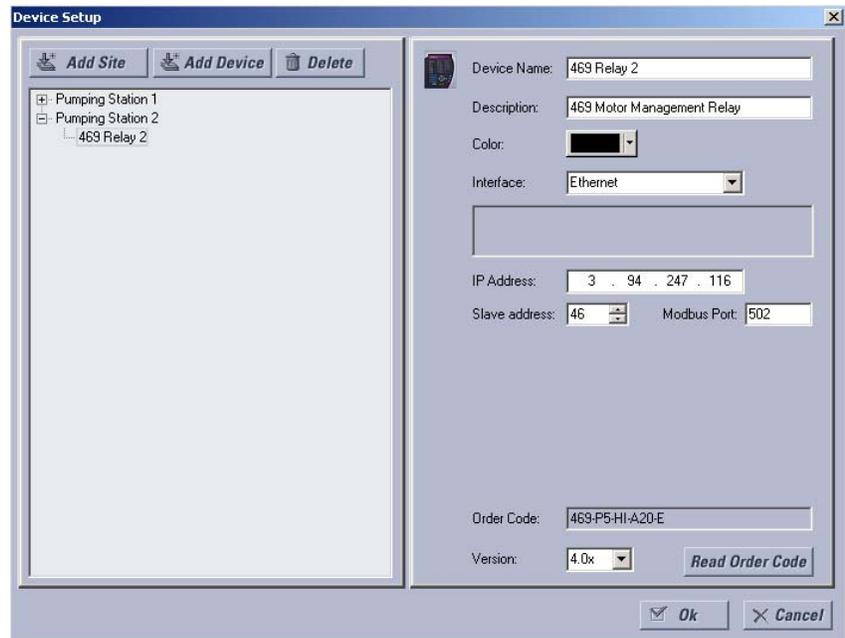
Before starting, verify that the Ethernet cable is properly connected to the RJ-45 Ethernet port.

- ▷ Install and start the latest version of the EnerVista 469 Setup software (available from the GE enerVista CD). See the previous section for the installation procedure.
- ▷ Click on the **Device Setup** button to open the Device Setup window and click the **Add Site** button to define a new site.
- ▷ Enter the desired site name in the **Site Name** field. If desired, a short description of site can also be entered along with the display order of devices defined for the site. In this example, we will use “Pumping Station 2” as the site name. Click the **OK** button when complete.

The new site will appear in the upper-left list.

- ▷ Click the **Add Device** button to define the new device.
- ▷ Enter the desired name in the **Device Name** field and a description (optional).

- ▷ Select “Ethernet” from the Interface drop-down list.
This will display a number of interface parameters that must be entered for proper Ethernet functionality.



- ▷ Enter the IP address assigned to the relay.
- ▷ Enter the slave address and Modbus port values (from the **S1 469 SETUP** ▷ **SERIAL PORTS** menu) in the **Slave Address** and **Modbus Port** fields. Refer to GEK-106491C: *469 Communications Guide*.
- ▷ Click the **Read Order Code** button to connect to the 469 device and upload the order code.
If a communications error occurs, ensure that the 469 Ethernet communications values entered in the previous step correspond to the relay setting values.
- ▷ Click **OK** when the relay order code has been received.
The new device will be added to the Site List window (or Online window) located in the top left corner of the main EnerVista 469 Setup window.

The 469 Site Device has now been configured for Ethernet communications. Proceed to the following section to begin communications.

4.3.4 Connecting to the Relay

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

- ▷ Expand the Site list by double clicking on the site name or clicking on the «+» box to list the available devices for the given site (for example, in the “Pumping Station 1” site shown below).

- ▷ Click the «+» box to expand the desired device trees.
The following list of headers is shown for each device:
 - Device Definitions
 - Settings
 - Actual Values
 - Commands
 - Communications
- ▷ Expand the **Settings > Relay Setup** list item
- ▷ Double click on Front Panel to open the Front Panel Settings window as shown below:

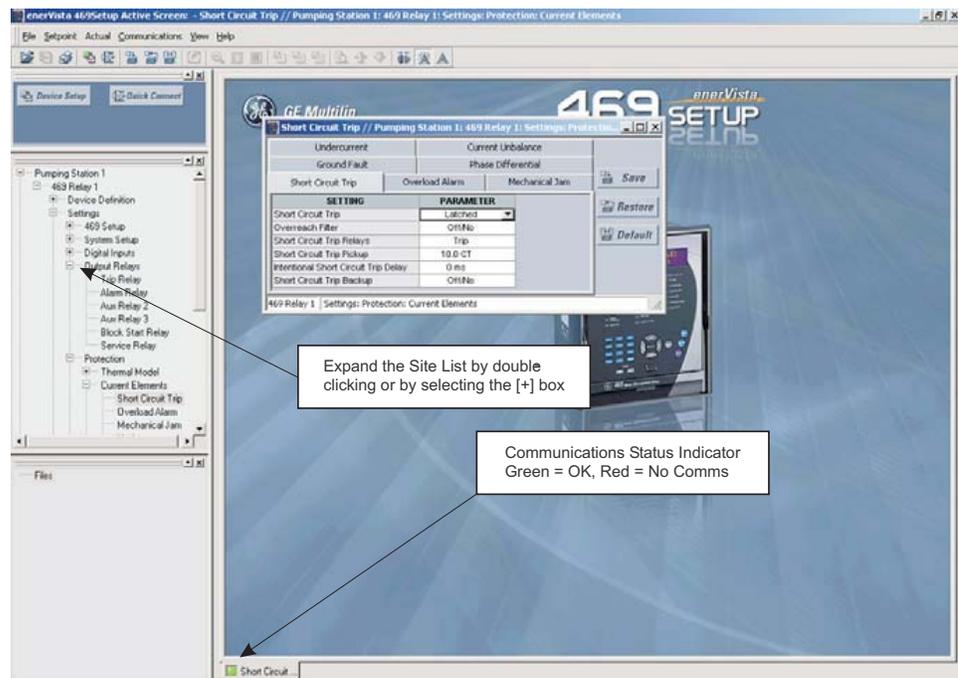


FIGURE 4-5: Main Window after Connection

The Front Panel Settings window will open with a corresponding status indicator on the lower left of the EnerVista 469 Setup window.

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

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



Refer to the EnerVista 469 Setup Help File for additional information about the using the software.

4.4 Working with Settings and Settings Files

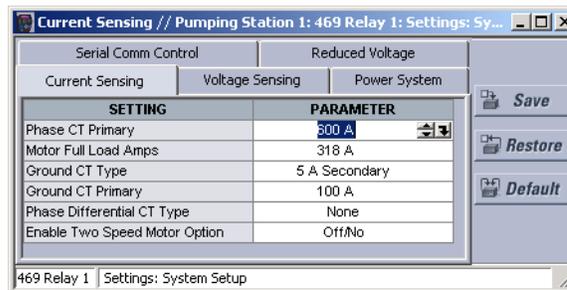
4.4.1 Engaging a Device

The EnerVista 469 Setup software may be used in on-line mode (relay connected) to directly communicate with a 469 relay. Communicating relays are organized and grouped by communication interfaces and into sites. Sites may contain any number of relays selected from the SR or UR product series.

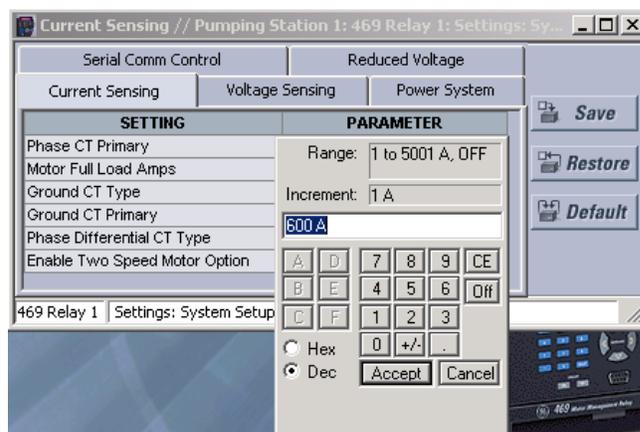
4.4.2 Entering Settings

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

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

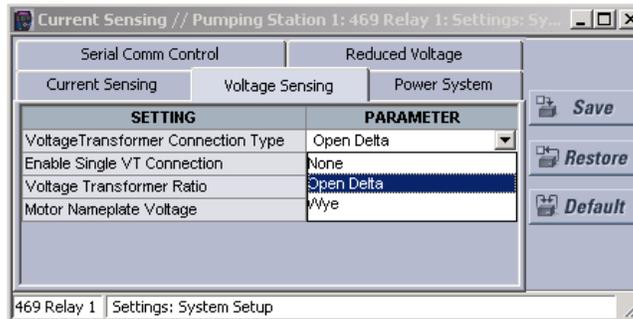


- ▷ Click on the arrow at the end of the box to display a numerical keypad interface that allows you to enter a value within the settings range displayed near the top of the keypad:



- ▷ Click **Accept** to exit from the keypad and keep the new value.

- ▷ Click on **Cancel** to exit from the keypad and retain the old value.
- ▷ For settings requiring non-numerical pre-set values (e.g. **VT CONNECTION TYPE** above, in the Voltage Sensing tab), click anywhere within the settings value box to display a drop-down selection menu arrow.
- ▷ Click on the arrow to select the desired settings.



For settings requiring an alphanumeric text string (e.g. message scratchpad messages), the value may be entered directly within the settings value box.

- ▷ In the Settings / System Setup dialog box, click on **Save** to save the values into the 469.
- ▷ Click **Yes** to accept any changes.
- ▷ Click **No**, and then **Restore** to retain previous values and exit.

4.4.3 File Support

Opening any EnerVista 469 Setup file will automatically launch the application or provide focus to the already opened application. If the file is a Settings file (has a '469' extension) which had been removed from the Settings List tree menu, it will be added back to the Settings List tree.

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

4.4.4 Using Settings Files

Overview

The EnerVista 469 Setup software interface supports three ways of handling changes to relay settings:

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

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

- Device Definition
- Product Setup
- System Setup
- Digital Inputs
- Output Relays
- Protection Elements
- Monitoring Functions
- Analog Inputs and Outputs
- Relay Testing
- Settings for Two-Speed Motors
- User Memory Map Setting Tool

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

The EnerVista 469 Setup display relay settings with the same hierarchy as the front panel display. For specific details on settings, refer to Chapter 5.

Downloading and Saving Settings Files

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

The EnerVista 469 Setup window, Settings files are accessed in the Settings List control bar window or the Files Window. Use the following procedure to download and save Settings files to a local PC.

- ▷ Ensure that the site and corresponding device(s) have been properly defined and configured as shown in *Connecting EnerVista 469 Setup to the Relay* on page 4–16.
- ▷ Select the desired device from the site list.
- ▷ Select the **File > Read Settings from Device** menu item to obtain settings information from the device.

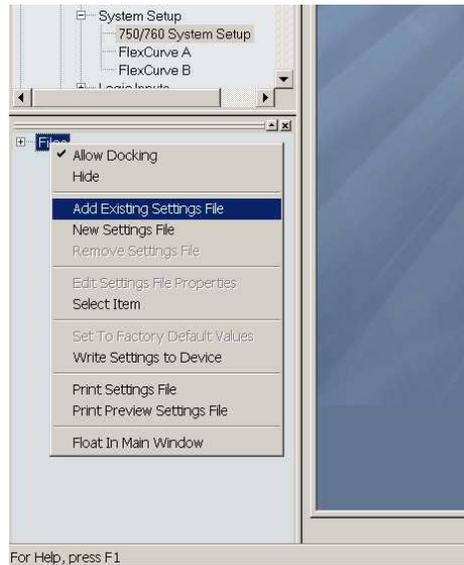
After a few seconds of data retrieval, the software will request the name and destination path of the Settings file. The corresponding file extension will be automatically assigned.

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

Adding Settings Files to the Environment

The EnerVista 469 Setup software provides the capability to review and manage a large group of Settings files. Use the following procedure to add a new or existing file to the list.

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



The Open dialog box will appear, prompting for a previously saved Settings file.

- ▷ As for any other Windows® application, browse for the file to add then click **Open**. The new file and complete path will be added to the file list.

Creating a New Settings File using Motor Settings Auto-Config

The EnerVista 469 Setup software allows the user to create new Settings files independent of a connected device. These can be uploaded to a relay at a later date.

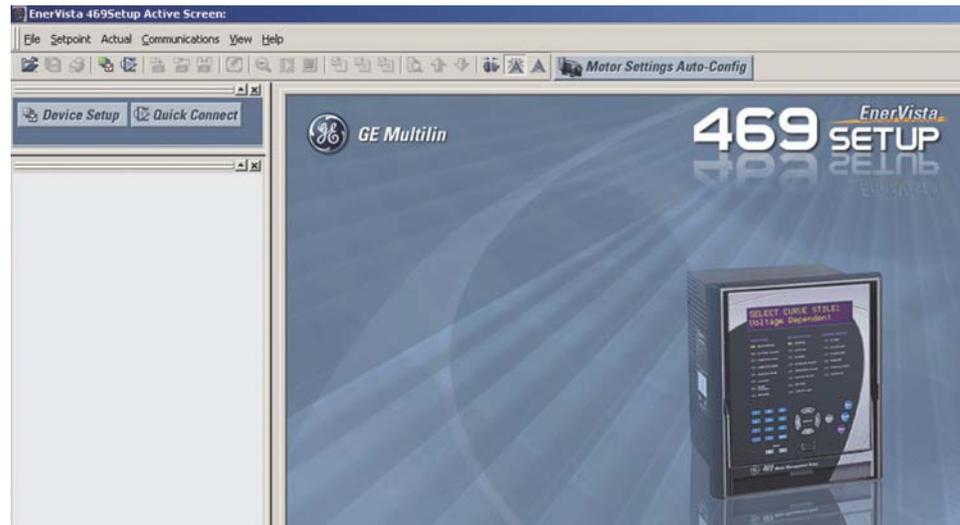
One method of doing this - the **EnerVista Motor Settings Auto-Config** option - allows the user to easily create new Settings Files automatically, using a guided step-by-step process as outlined below.



The Motor Settings Auto-Config option does NOT allow the user to configure existing Settings Files.

The following procedure illustrates how to create new Settings Files using the Motor Settings Auto-Config option:

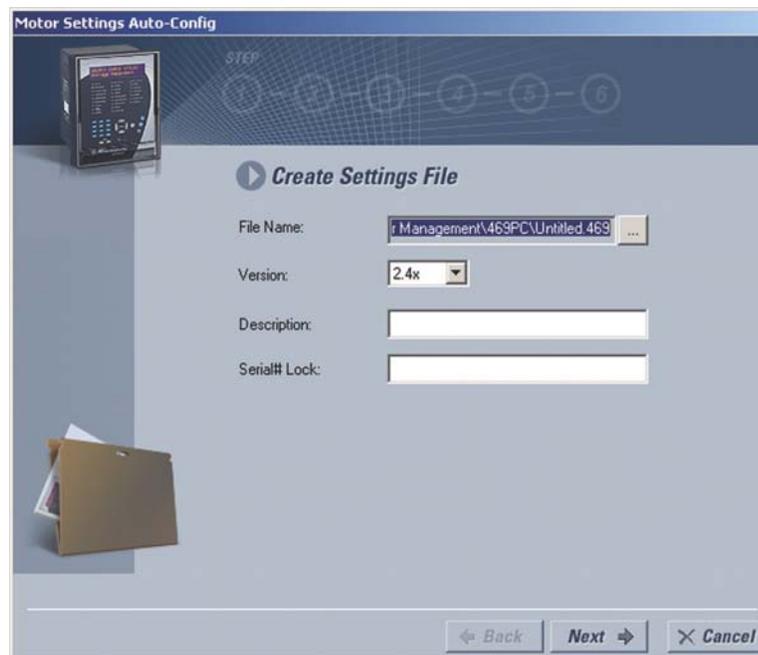
- ▷ At the top of the screen, click on the **Motor Settings Auto-Config** button.



OR

- ▷ On the main menu, select **File > Motor Settings Auto-Config**

The EnerVista 469 Setup software displays the following box, allowing the configuration of the Settings File as shown. .



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

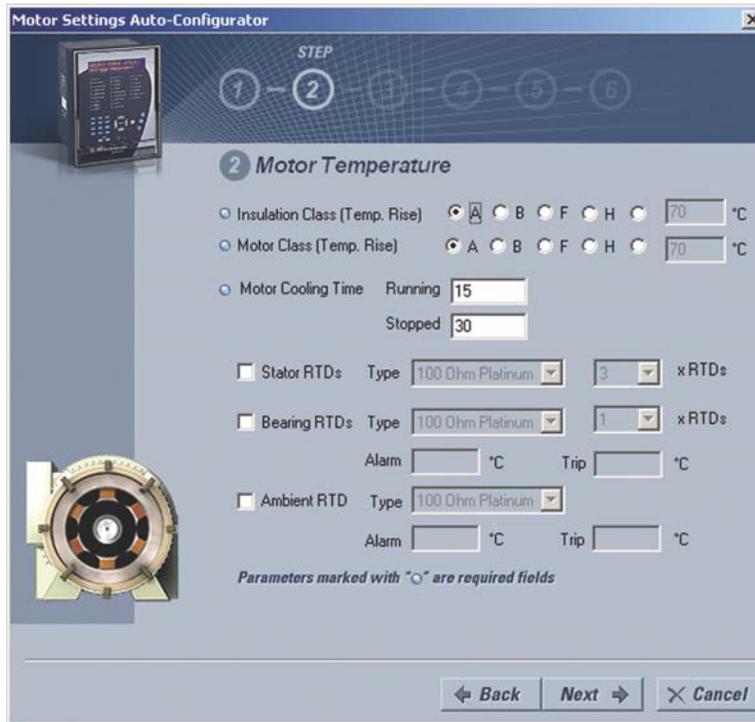
- ▷ Select the Firmware **Version** for the new Settings File.

- ▷ For future reference, enter some useful information in the **Description** box to facilitate the identification of the device and the purpose of the file.
- ▷ To select a file name and path for the new file, click the button [...] beside the **File Name** box.
- ▷ Select the file name and path to store the file, or select any displayed file name to update an existing file.
All 469 Settings Files should have the extension '469' (for example, 'motor1.469').
- ▷ Click **Next** and **OK** to continue the process.
A new window - **Step 1** - will appear:

- ▷ Fill in the fields as indicated.
- ▷ When complete, **press** Next.
The next window - **Step 2** - will appear as follows:

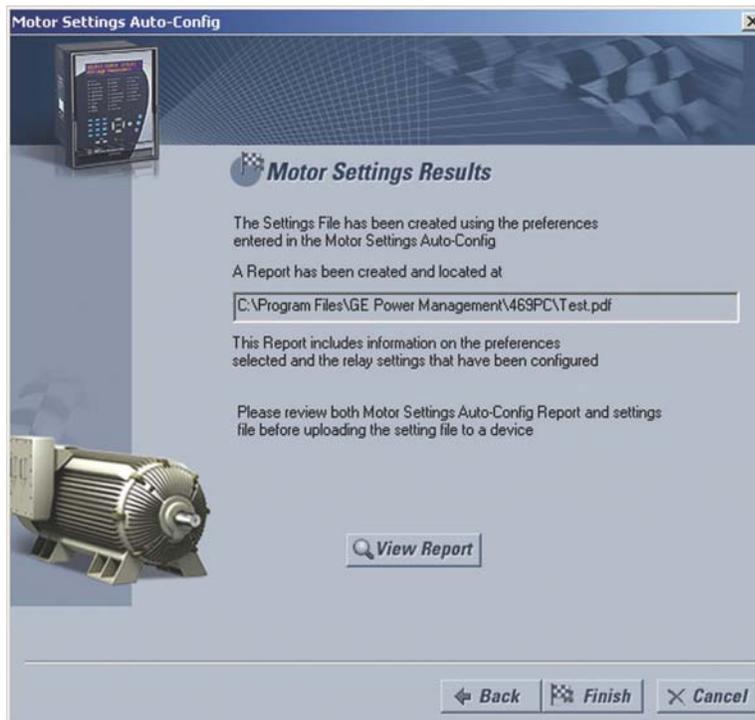


As each Step is completed, the user will be prompted to make appropriate changes to what has been entered, if the Auto-Config determines that the parameter entered is incorrect or inappropriate for the situation.



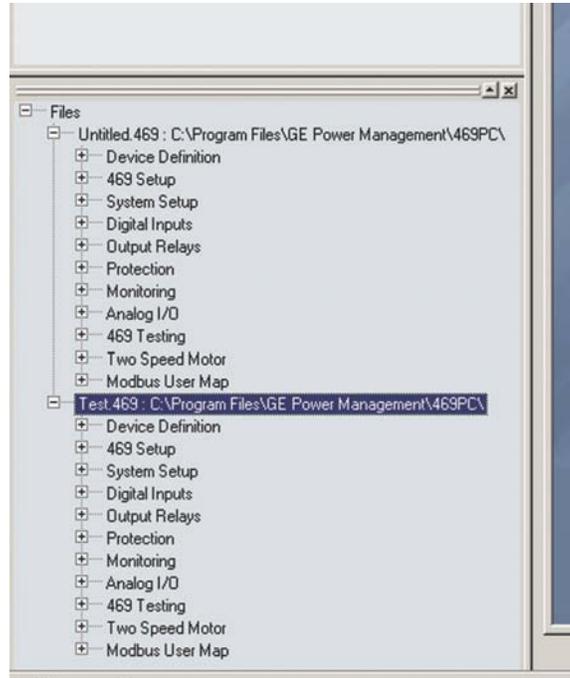
▷ Continue filling in the fields as indicated.

Once you have completed all 6 Steps, the final window will show as follows:



- ▷ Click **Finish** to complete the Auto-Config procedure.
The Motor Settings Auto-Config window will disappear.

A new Settings File containing the parameters you have just input will appear in the Files pane as shown:



Creating a New Settings File *without* using Motor Settings Auto-Config

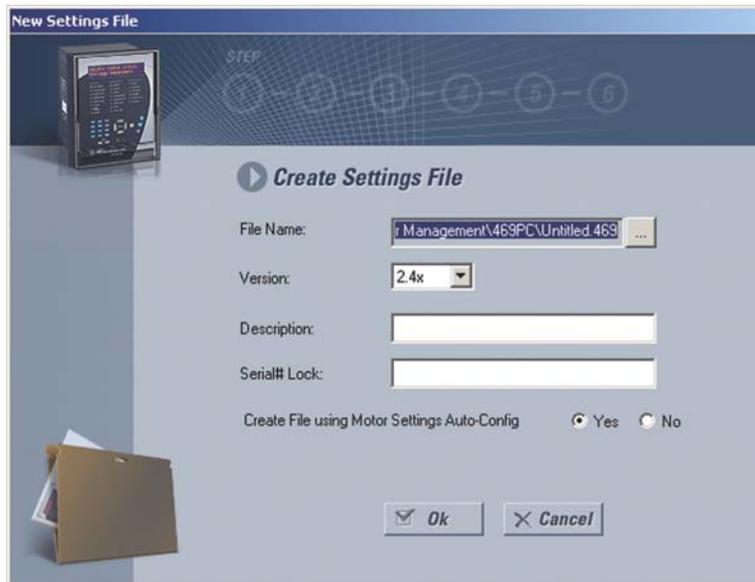
The EnerVista 469 Setup software allows the user to create new Settings files independent of a connected device. These can be uploaded to a relay at a later date. The following manual procedure - as distinct from the Motor Settings Auto-Config option described above - illustrates how to create new Settings Files.

- ▷ In the File pane, right click on **File**.
- ▷ Select the **New Settings File** item.
The EnerVista 469 Setup software displays the following window, allowing the configuration of the Settings File as shown below.



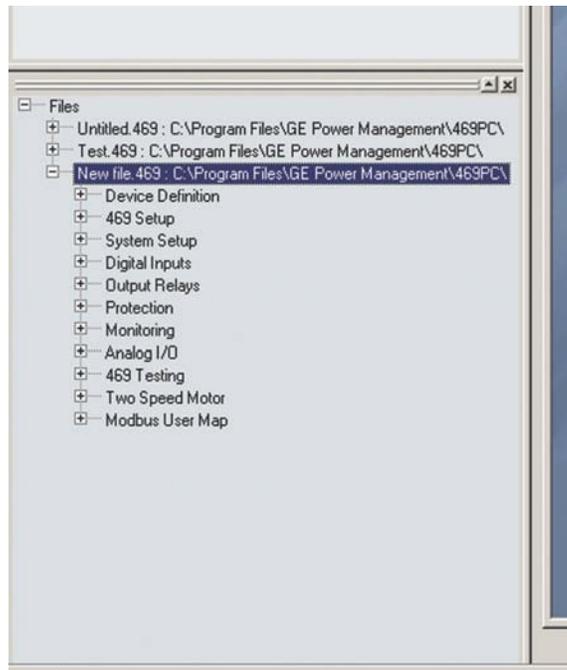
NOTE

Note that this window allows you to choose between creating your Settings File manually or using the Motor Settings Auto-Config as detailed above.



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

- ▷ Select the Firmware **Version** for the new Settings File.
- ▷ For future reference, enter some useful information in the **Description** box to facilitate the identification of the device and the purpose of the file.
- ▷ To select a file name and path for the new file, click the button beside the **File Name** box [...].
- ▷ Select the file name and path to store the file, or select any displayed file name to update an existing file.
All 469 Settings Files should have the extension '469' (for example, 'motor1.469').
- ▷ Click the appropriate radio button (**yes** or **no**) to choose between Auto-Config or manual creation of the Settings File.
- ▷ Click **OK** to complete the process.
Once this step is completed, the new file, with a complete path, will be added to the EnerVista 469 Setup software environment.

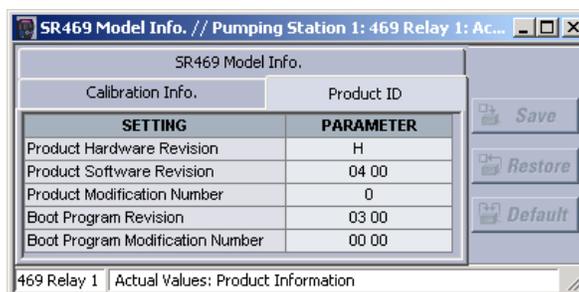


- ▷ Enter the appropriate settings manually to complete the new Settings File.

Upgrading Settings Files to a New Revision

It is often necessary to upgrade the revision code for a previously saved Settings file after the 469 firmware has been upgraded (for example, this is required for firmware upgrades). This is illustrated in the following procedure.

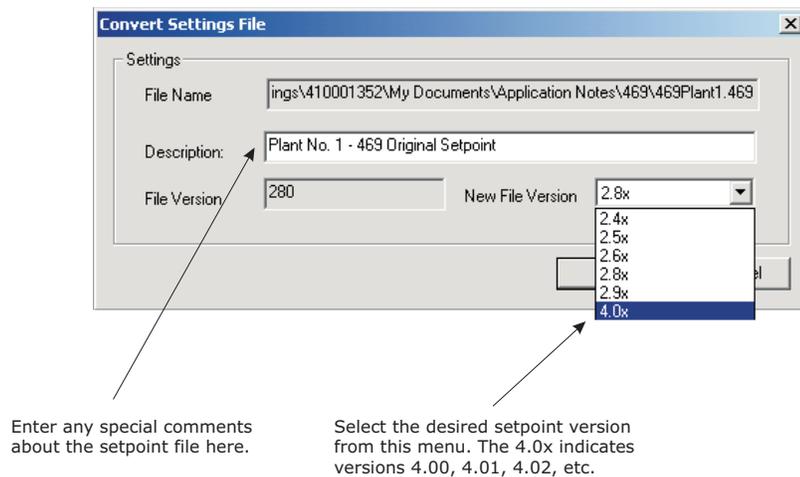
- ▷ Establish communications with the 469 relay.
- ▷ Select the **Actual > Product Information** menu item.
- ▷ Record the Software Revision identifier of the relay firmware as shown below.



- ▷ Load the Settings file to be upgraded into the EnerVista 469 Setup environment as described in *Adding Settings Files to the Environment* on page 4–24.
- ▷ In the File pane, select the saved Settings file.

- ▷ From the main window menu bar, select the **File > Properties** menu item and note the version code of the Settings file.
If this version (e.g. 4.0X shown below) is different than the **Software Revision** code noted in step 2, select a **New File Version** that matches the Software Revision code from the pull-down menu.

For example, if the software revision is 2.80 and the current Settings file revision is 4.00, change the Settings file revision to "4.0X", as shown below:



- ▷ When complete, click Convert to convert the Settings file to the desired revision.
A dialog box will request confirmation. See *Loading Settings from a File* on page 4-33 for instructions on loading this Settings file into the 469.

Printing Settings and Actual Values

The EnerVista 469 Setup software allows the user to print partial or complete lists of settings and actual values. Use the following procedure to print a list of settings:

- ▷ Select a previously saved Settings file in the File pane or establish communications with a 469 device.
- ▷ From the main window, select the **File > Print Settings** menu item. The Print/Export Options dialog box will appear.
- ▷ Select **Settings** in the upper section and select either **Include All Features** (for a complete list) or **Include Only Enabled Features** (for a list of only those features which are currently used) in the filtering section.

- ▷ Click **OK**.



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

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

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

- ▷ Establish communications with the desired 469 device.
- ▷ From the main window, select the **File > Print Settings** menu item. The Print/Export Options dialog box will appear.
- ▷ Select **Actual Values** in the upper section.
- ▷ Select either **Include All Features** (for a complete list) or **Include Only Enabled Features** (for a list of only those features which are currently used) in the filtering section.
- ▷ Click **OK**.

Actual values lists can be printed in the same manner by right clicking on the desired device (in the device list) and selecting the **Print Device Information** option.

Loading Settings from a File



An error message will occur when attempting to download a Settings file with a revision number that does not match the relay firmware. If the firmware has been upgraded since saving the Settings file, see *Upgrading Settings Files to a New Revision* on page 4–31 for instructions on changing the revision number of a Settings file.

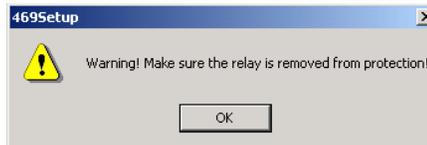
The following procedure illustrates how to load settings from a file. Before loading a Settings file, it must first be added to the EnerVista 469 Setup environment as described in *Adding Settings Files to the Environment* on page 4–24.

- ▷ Select the previously saved Settings file from the File pane of the EnerVista 469 Setup software main window.
- ▷ Select the **File > Properties** menu item and verify that the corresponding file is fully compatible with the hardware and firmware version of the target relay. If the versions are not identical, see *Upgrading Settings Files to a New*

Revision on page 4–31 for details on changing the Settings file version.

- ▷ Right-click on the selected file.
- ▷ Select the **Write Settings to Device** item.

The EnerVista 469 Setup software will generate the following warning message, to remind the user to remove the relay from service, before attempting to load settings into an in-service relay.:



- ▷ Select the target relay from the list of devices shown.
 - ▷ Click Send.
- If there is an incompatibility, an error of the following type will occur.



If there are no incompatibilities between the target device and the Settings file, the data will be transferred to the relay. An indication of the percentage completed will be shown in the bottom of the main menu.

4.5 Upgrading Relay Firmware

4.5.1 Description

To upgrade the 469 firmware, follow the procedures listed in this section. Upon successful completion of this procedure, the 469 will have new firmware installed with the original settings.

The latest firmware files are available from the GE Digital Energy website at <http://www.gedigitalenergy.com>.

4.5.2 Saving Settings to a File

Before upgrading firmware, it is very important to save the current 469 settings to a file on your PC. After the firmware has been upgraded, it will be necessary to load this file back into the 469.

Refer to *Downloading and Saving Settings Files* on page 4–24 for details on saving relay settings to a file.

4.5.3 Loading New Firmware

Loading new firmware into the 469 flash memory is accomplished as follows:

- ▷ Connect the relay to the local PC and save the settings to a file as shown in *Downloading and Saving Settings Files* on page 4–24.
- ▷ Select the **Communications > Update Firmware** menu item.
- ▷ The warning message shown below will appear.
- ▷ Select **Yes** to proceed or **No** to cancel the process.
Do not proceed unless you have saved the current settings.



An additional message will be displayed to ensure the PC is connected to the relay front port, as the 469 cannot be upgraded via the rear RS485 ports.

The EnerVista 469 Setup software will request the new firmware file.

- ▷ Locate the firmware file to load into the 469.
The firmware filename has the following format:

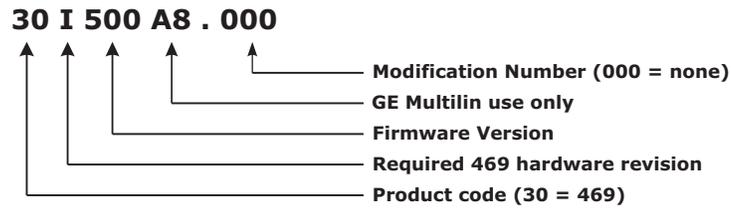


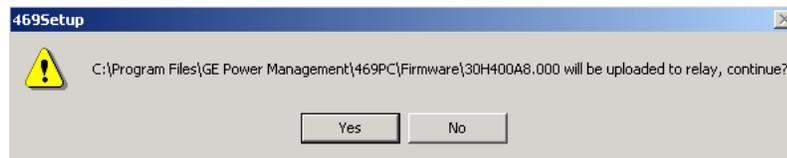
FIGURE 4-6: Firmware File Format

The EnerVista 469 Setup software automatically lists all filenames beginning with '30'.

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

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

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



The EnerVista 469 Setup software now prepares the 469 to receive the new firmware file. The 469 will display a message indicating that it is in Upload Mode. While the file is being loaded into the 469, a status box appears showing how much of the new firmware file has been transferred and how much is remaining, as well as the upgrade status. The entire transfer process takes approximately five minutes.



The EnerVista 469 Setup software will notify the user when the 469 has finished loading the file.

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



NOTE

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

After successfully updating the 469 firmware, the relay will not be in service and will require settings programming. To communicate with the relay, the following settings will have to be manually programmed.

MODBUS COMMUNICATION ADDRESS

BAUD RATE

PARITY (if applicable)

When communications is established, the saved settings must be reloaded back into the relay. See *Loading Settings from a File* on page 4–33 for details.

Modbus addresses assigned to firmware modules, features, settings, and corresponding data items (i.e. default values, min/max values, data type, and item size) may change slightly from version to version of firmware. Refer to GEK-106491C: *469 Communications Guide*.

The addresses are rearranged when new features are added or existing features are enhanced or modified. The **EEPROM DATA ERROR** message displayed after upgrading/downgrading the firmware is a resettable, self-test message intended to inform users that the Modbus addresses have changed with the upgraded firmware. This message does not signal any problems when appearing after firmware upgrades.

4.6 Advanced EnerVista 469 Setup Features

4.6.1 Triggered Events

While the interface is in either on-line or off-line mode, data generated by triggered specified parameters can be viewed and analyzed via one of the following:

- **Event Recorder:** The event recorder captures contextual data associated with the last 256 events, listed in chronological order from most recent to the oldest.
- **Oscillography:** The oscillography waveform traces provide a visual display of power system data captured during specific triggered events.

4.6.2 Waveform Capture (Trace Memory)

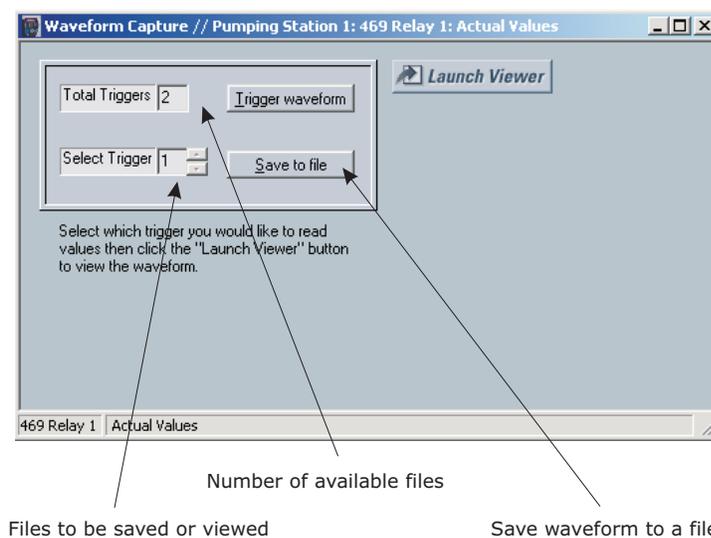
The EnerVista 469 Setup software can be used to capture waveforms (or view trace memory) from the 469 relay at the instance of a trip. A maximum of 128 cycles can be captured and the trigger point can be adjusted to anywhere within the set cycles. A maximum of 16 traces can be buffered (stored) with the buffer/cycle trade-off.

The following waveforms can be captured:

- Phase A, B, and C currents (I_a , I_b , and I_c)
- Differential A, B, and C currents (I_{diffa} , I_{diffb} , and I_{diffc})
- Ground currents (I_g)
- Phase A-N, B-N, and C-N voltages (V_{an} , V_{bn} , and V_{cn}) for wye connections
- Phase A-B and B-C (V_{ab} and V_{bc}) for open-delta connections
- Relay output status.

With EnerVista 469 Setup running and communications established,

- ▷ Select the **Actual > Waveform Capture** menu item to open the waveform capture setup window:



- ▷ Click on **Trigger Waveform** to trigger a waveform capture.

The waveform file numbering starts with the number zero in the 469; therefore, the maximum trigger number will always be one less than the total number triggers available.

- ▶ Click on the **Save to File** button to save the selected waveform to the local PC.

A new window will appear requesting for file name and path.

The file is saved as a CSV (comma delimited values) file, which can be viewed and manipulated with compatible third-party software.

- ▶ To view a previously saved file, click the **Open** button and select the corresponding CSV file.
- ▶ To view the captured waveforms, click the **Launch Viewer** button. A detailed Waveform Capture window will appear as shown below:

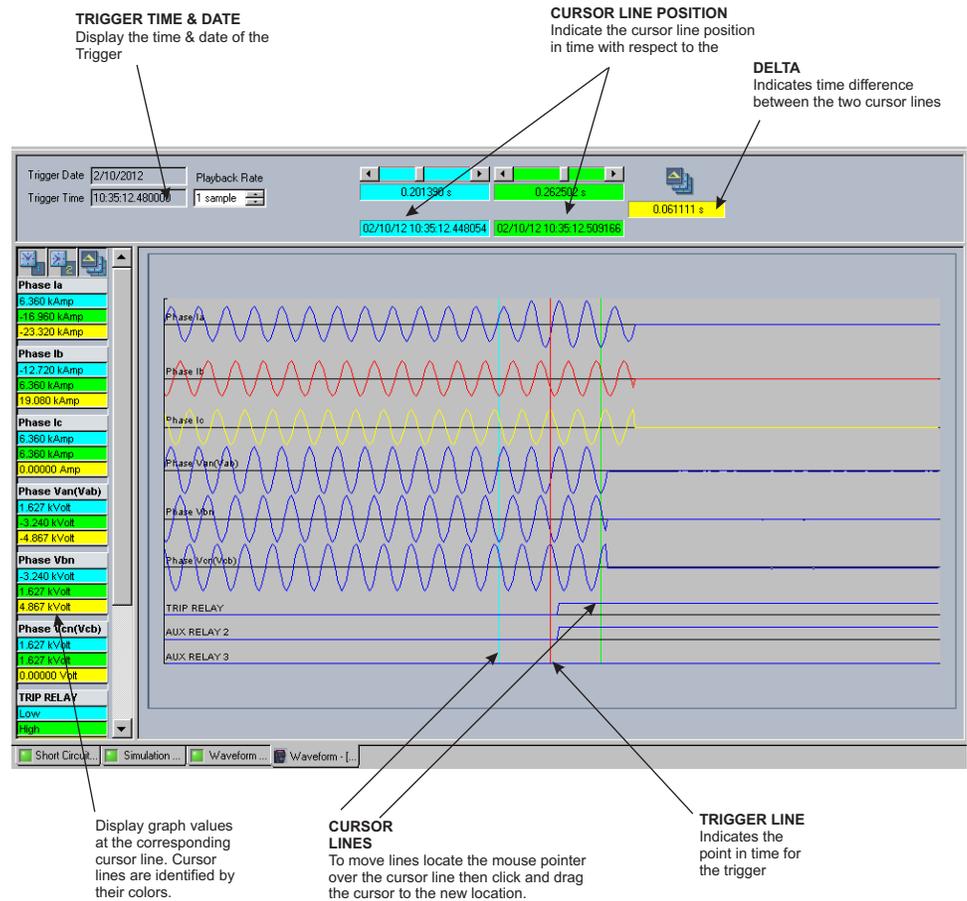


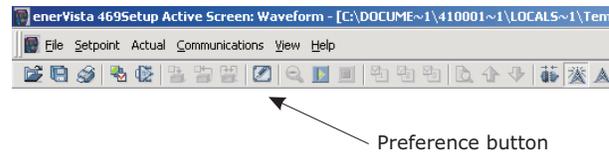
FIGURE 4-7: Waveform Capture Window Attributes

The red vertical line indicates the trigger point of the relay.

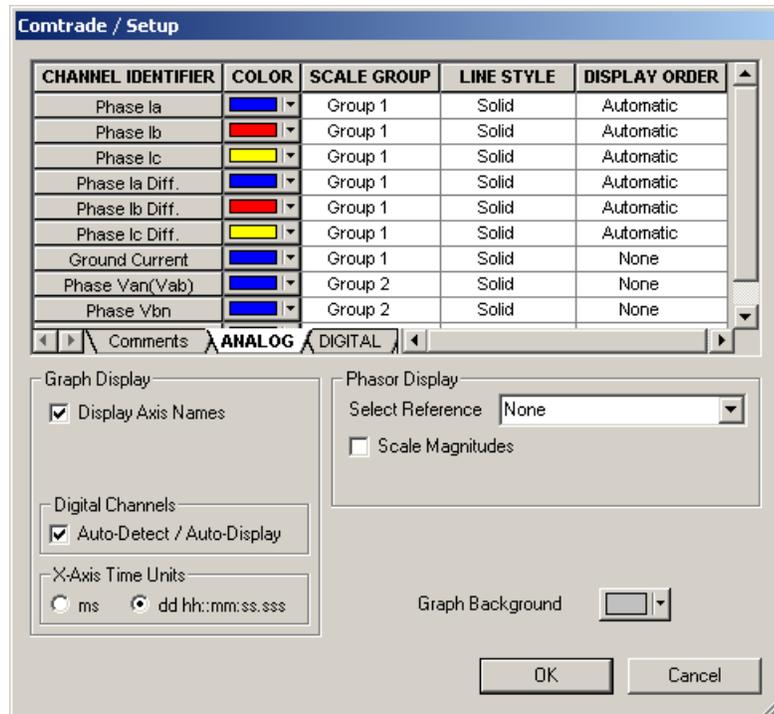
The date and time of the trigger is displayed at the top left corner of the window. To match the captured waveform with the event that triggered it, make note of the time and date shown in the graph. Then, find the event that matches the same time and date in the event recorder. The event record will provide additional information on the cause and the system conditions at the time of the event. Additional information on how to download and save

events is shown in *Event Recorder* on page 4-44.

- ▷ From the window main menu bar, press the Preference button to change the graph attributes.



The following window will appear:



- ▷ Change the color of each graph as desired.
- ▷ Select other options as required, by checking the appropriate boxes.
- ▷ Click **OK** to store these graph attributes, and to close the window.

The Waveform Capture window will reappear with the selected graph attributes available for use.

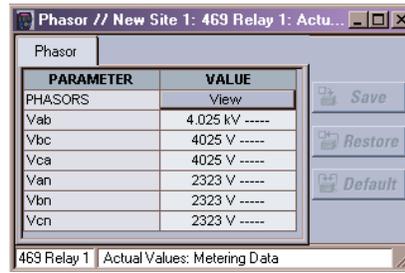
4.6.3 Phasors

The EnerVista 469 Setup software can be used to view the phasor diagram of three-phase currents and voltages. The phasors are for: phase voltages V_a , V_b , and V_c ; phase currents I_a , I_b , and I_c .

With the EnerVista 469 Setup software running and communications established,

- ▷ Open the **Actual Values > Metering Data** window.
- ▷ Click on the Phasors tab.

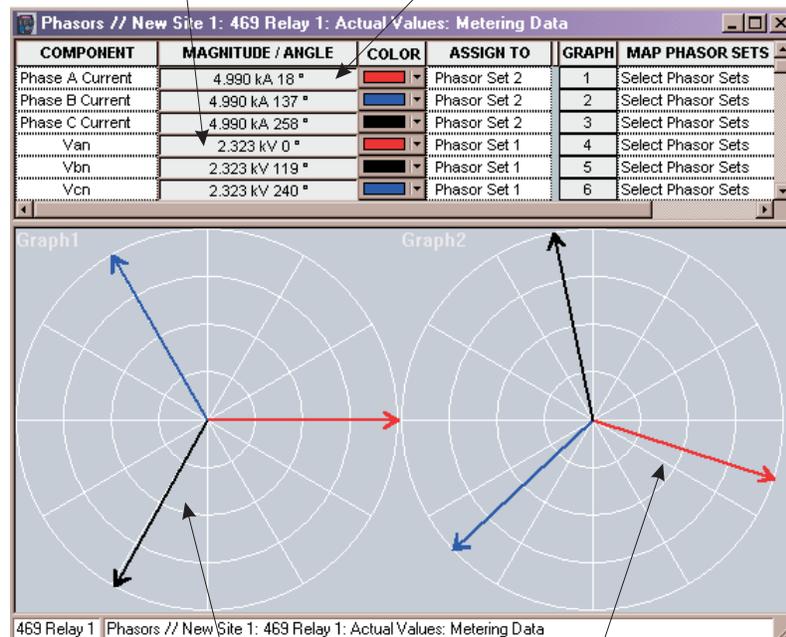
The EnerVista 469 Setup software will display the following window:



▷ Press the "View" button to display the following window:

VOLTAGE LEVEL
Displays the value and the angle of the voltage phasors

CURRENT LEVEL
Displays the value and angle of the current phasor



VOLTAGE VECTORS
Assigned to Phasor Set 1, Graph 1

CURRENT VECTORS
Assigned to Phasor Set 2, Graph 2

The 469 Motor Management Relay was designed to display lagging angles. Therefore, if a system condition would cause the current to lead the voltage by 45°, the 469 relay will display such angle as 315° Lag instead of 45° Lead.



WARNING When the currents and voltages measured by the relay are zero, the angles displayed by the relay and those shown by the EnerVista 469 Setup software are not fixed values.

4.6.4 Trending (Data Logger)

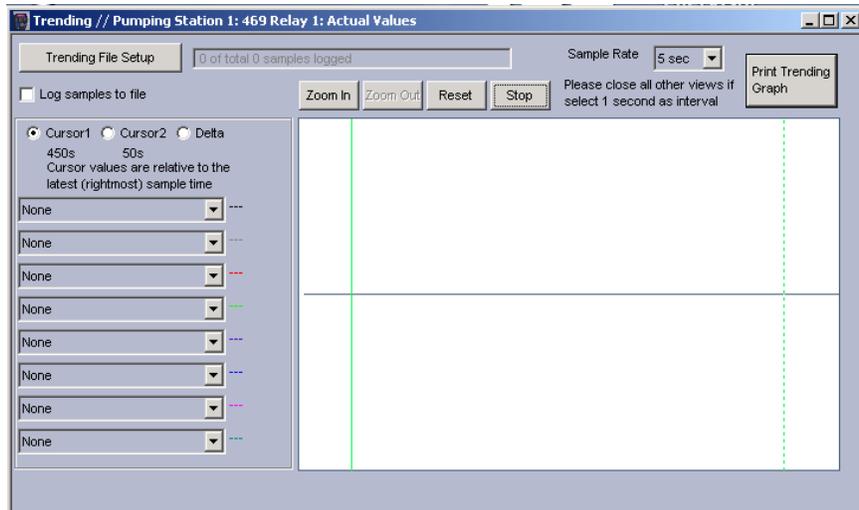
The trending or data logger feature is used to sample and record up to eight actual values at an interval defined by the user. Several parameters can be trended and graphed at sampling periods ranging from 1 second up to 1 hour. The parameters which can be trended by the EnerVista 469 Setup software are:

- **Currents/Voltages:**
 - Phase Currents A, B, and C, and Average Phase Current
 - Motor Load
 - Current Unbalance
 - Ground Current
 - Differential Currents A, B, and C
 - System Frequency
 - Voltages Vab, Vbc, Vca Van, Vbn & Vcn
- **Power:**
 - Power Factor
 - Real (kW or hp) Reactive (kvar), and Apparent (kVA) Power
 - Positive Watthours
 - Positive and Negative Varhours
 - Torque
- **Temperature:**
 - Hottest Stator RTD
 - Thermal Capacity Used
 - RTDs 1 through 12
- **Demand:**
 - Current
 - Peak Current
 - Reactive Power
 - Peak Reactive Power
 - Apparent Power
 - Peak Apparent Power
- **Others:**
 - Analog Inputs 1, 2, 3, and 4
 - Tachometer

With EnerVista 469 Setup running and communications established,

- ▷ Select the **Actual Values > Trending** menu item to open the trending window.

The following window will appear.

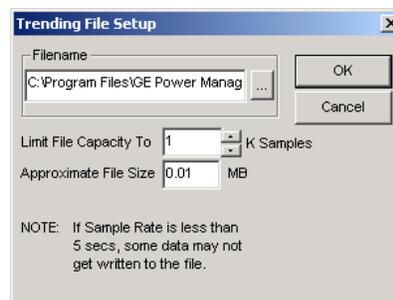


To prepare for new trending,

- ▷ Select **Stop** to stop the data logger and **Reset** to clear the screen.
- ▷ Select the graphs to be displayed through the pull-down menu beside each channel description.
- ▷ Select the Sample Rate through the pull-down menu.

If you want to save the information captured by trending,

- ▷ Check the box besides **Log Samples to File**.
The following dialog box will appear requesting for file name and path. The file is saved as 'csv' (comma delimited values) file, which can be viewed and manipulated with compatible third-party software. Ensure that the sample rate not less than 5 seconds, otherwise some data may not get written to the file.



To limit the size of the saved file,

- ▷ Enter a number in the **Limit File Capacity To** box.
The minimum number of samples is 1000. At a sampling rate of 5 seconds (or 1 sample every 5 seconds), the file will contain data

collected during the past 5000 seconds. The EnerVista 469 Setup software will automatically estimate the size of the trending file.

- ▷ Press “Run” to start the data logger.

If the **Log Samples to File** item is selected, the EnerVista 469 Setup software will begin collecting data at the selected sampling rate and will display it on the screen. The data log will continue until the **Stop** button is pressed or until the selected number of samples is reached, whichever occurs first.

During the process of data logging, the trending screen appears as shown below.

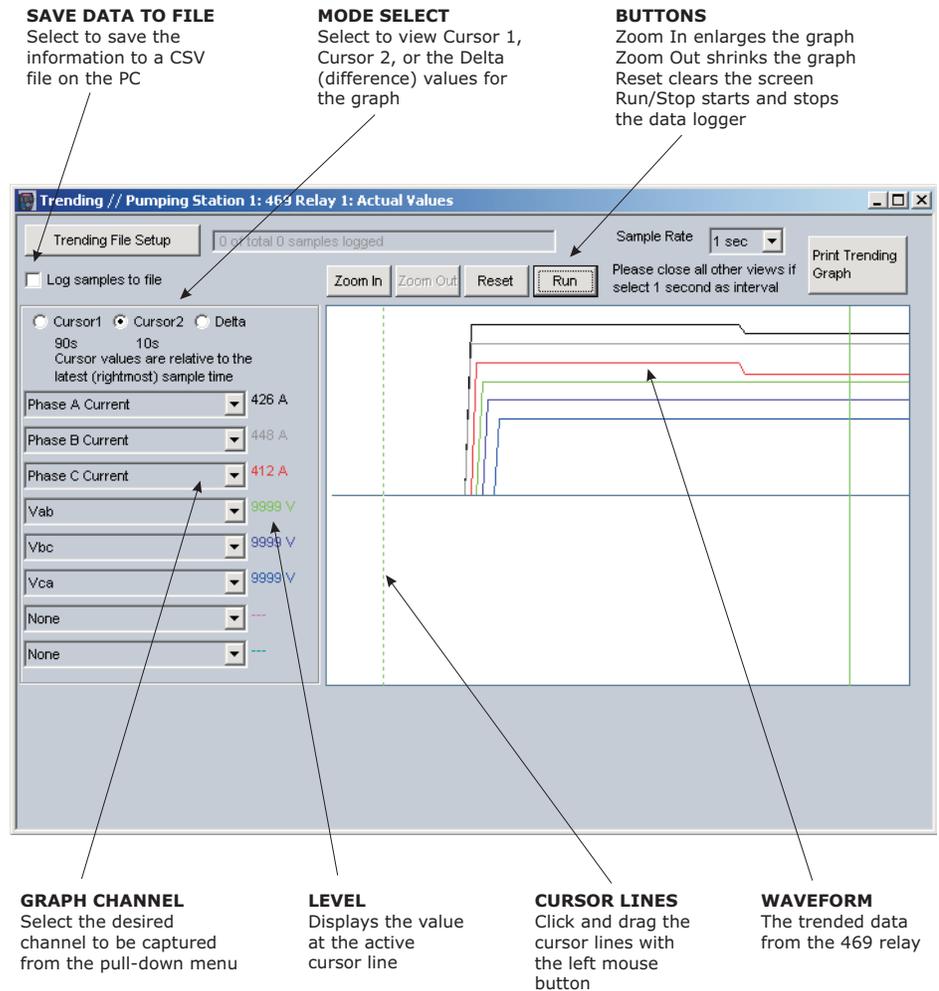
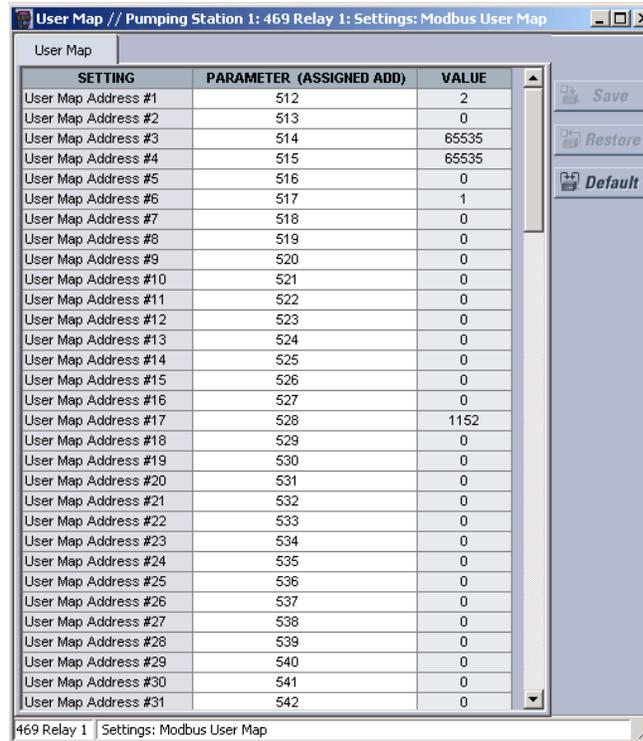


FIGURE 4-8: Trending Screen

4.6.5 Event Recorder

The 469 event recorder can be viewed through the EnerVista 469 Setup software. The event recorder stores generator and system information each time an event occurs (e.g. breaker failure). A maximum of 256 events can be stored, where E256 is the most recent event and E01 is the oldest event. E01 is overwritten whenever a new event occurs. Refer to *Event 01 to Event 256* on page 6–33 for additional information on the event recorder.

- ▷ Select the **Settings > User Map** menu item to open the following window.



SETTING	PARAMETER (ASSIGNED ADD)	VALUE
User Map Address #1	512	2
User Map Address #2	513	0
User Map Address #3	514	65535
User Map Address #4	515	65535
User Map Address #5	516	0
User Map Address #6	517	1
User Map Address #7	518	0
User Map Address #8	519	0
User Map Address #9	520	0
User Map Address #10	521	0
User Map Address #11	522	0
User Map Address #12	523	0
User Map Address #13	524	0
User Map Address #14	525	0
User Map Address #15	526	0
User Map Address #16	527	0
User Map Address #17	528	1152
User Map Address #18	529	0
User Map Address #19	530	0
User Map Address #20	531	0
User Map Address #21	532	0
User Map Address #22	533	0
User Map Address #23	534	0
User Map Address #24	535	0
User Map Address #25	536	0
User Map Address #26	537	0
User Map Address #27	538	0
User Map Address #28	539	0
User Map Address #29	540	0
User Map Address #30	541	0
User Map Address #31	542	0

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

4.6.7 Viewing Actual Values

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

1. **Motor and System Status:**
 - Motor status either stopped, starting, or running. It includes values such as motor load, thermal capacity used, motor speed, and instantaneous values of power system quantities.
 - The status of digital inputs.
 - Last trip information, including values such as cause of last trip, time and date of trip, motor speed and load at the time of trip, pre-trip temperature measurements, pre-trip analog inputs values, and pre-trip instantaneous values of power system quantities.
 - Active alarms.
 - Relay date and time.
 - Present blocking conditions.
 - General system status indication including the status of output relays, active pickup, alarm and trip conditions.

2. Metering Data:

- Instantaneous current measurements including phase, differential, unbalance, ground, average, motor load, and differential currents.
- RTD Temperatures including hottest stator RTD.
- Instantaneous phase to phase and phase to ground voltages (depending on the VT connections), average voltage, and system frequency.
- Motor Speed
- Power Quantities including Apparent, Real and Reactive Power.
- Current and power demand including peak values.
- Analog inputs
- Vector information.

3. Motor Learned Data:

- Learned Acceleration Time
- Learned Starting Current
- Learned Starting Capacity
- Last Acceleration Time
- Last Starting Current
- Last Starting Capacity
- Average Motor Load Learned

4. Maintenance data

This is useful statistical information that may be used for preventive maintenance. It includes:

- Trip counters
- General counter such as Number of Motor Starts, Number of Emergency Restarts, Number of Starter Operations, Digital Counter for other purposes not listed above.
- Timers such as Motor Running Hours, Time Between Starts Timer, and five Start Timers used to calculate the average start time of the motor.

5. RTD Learned Data

This includes the maximum temperature measured by each of the 12 RTDs.

6. Event recorder downloading tool

7. Product information

This includes model number, firmware version, additional product information, and calibration dates.

8. Oscillography and data logger downloading tool

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

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

To view a separate window for each group of actual values, select the desired item from the tree, and double click with the left mouse button. Each group will be opened on a separate tab. The windows can be re-arranged to maximize data viewing as shown in the following figure (showing actual current, voltage, and motor status values tiled in the same window):

The screenshot displays three tiled windows showing actual values for Pumping Station 1: 469 Relay 1. Each window has a 'Current' tab and a 'PARAMETER' column.

Current // Pumping Station 1: 469 Relay 1: Actual V...

SETTING	PARAMETER
Phase A Current	426 A
Phase B Current	448 A
Phase C Current	412 A
Average Phase Current	429 A
Motor Load	0.95 FLA
Current Unbalance	2 %
Equivalent Motor Current	0.95 FLA
Ground Current	0.00 A

469 Relay 1 | Actual Values: Metering Data

Voltage // Pumping Station 1: 469 Relay 1: Actua...

SETTING	PARAMETER
Vab	13204 V
Vbc	13204 V
Vca	13204 V
Average Line Voltage	13204 V
System Frequency	60.00 Hz

469 Relay 1 | Actual Values: Metering Data

Motor Status // Pumping Station 1: 469 Relay 1: Actual Values: St...

SETTING	PARAMETER
Motor Status	Running
Motor Load	0.95 FLA
Motor Thermal Capacity Used	0 %
Estimated Time to Trip on Overload	-1 s
Motor Speed	Low Speed (Speed 1)
Phase A Current	426 A
Phase B Current	448 A
Phase C Current	412 A
Average Phase Current	429 A
Current Unbalance	2 %
Vab	13204 V
Vbc	13204 V
Vca	13204 V
Average Line Voltage	13204 V
System Frequency	60.00 Hz
Power Factor	0.86
Real Power	8267 kW
Real Power (HP)	11086 hp
Reactive Power	4840 kvar
Apparent Power	9580 kVA

469 Relay 1 | Actual Values: Status

FIGURE 4–10: Actual Values Display

4.7 Using EnerVista Viewpoint with the 469

4.7.1 Plug and Play Example

EnerVista Viewpoint is an optional software package that puts critical 469 information onto any PC with plug-and-play simplicity. EnerVista Viewpoint connects instantly to the 469 via serial, ethernet or modem and automatically generates detailed overview, metering, power, demand, energy and analysis screens. Installing EnerVista Launchpad (see previous section) allows the user to install a fifteen-day trial version of EnerVista Viewpoint. After the fifteen day trial period you will need to purchase a license to continue using EnerVista Viewpoint. Information on license pricing can be found at <http://www.enervista.com>.

- ▷ Install the EnerVista Viewpoint software from the GE EnerVista CD.
- ▷ Ensure that the 469 device has been properly configured for either serial or Ethernet communications (see previous sections for details).
- ▷ Click the **Viewpoint** window in EnerVista to log into EnerVista Viewpoint.
At this point, you will be required to provide a login and password if you have not already done so.



FIGURE 4–11: EnerVista Viewpoint Main Window

- ▷ Click the **Device Setup** button to open the Device Setup window.
- ▷ Click the **Add Site** button to define a new site.
- ▷ Enter the desired site name in the **Site Name** field.
If desired, a short description of site can also be entered along with the display order of devices defined for the site.
- ▷ Click the **OK** button when complete.
The new site will appear in the upper-left list in the EnerVista 469 Setup window.
- ▷ Click the **Add Device** button to define the new device.

- ▷ Enter the desired name in the **Device Name** field and a description (optional) of the site.
- ▷ Select the appropriate communications interface (Ethernet or Serial) and fill in the required information for the 469. See *Connecting EnerVista 469 Setup to the Relay* on page 4–16 for details.

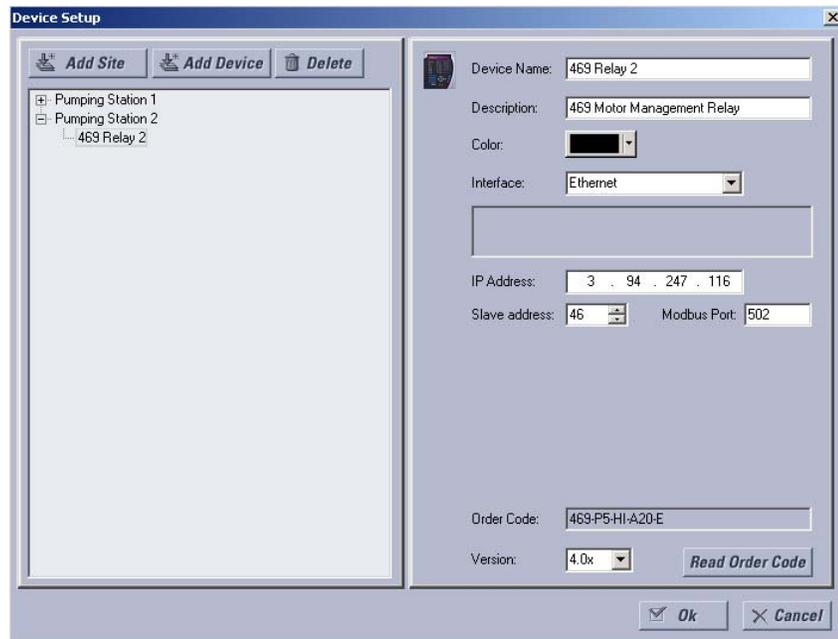


FIGURE 4–12: Device Setup Screen (Example)

- ▷ Click the **Read Order Code** button to connect to the 469 device and upload the order code.
If a communications error occurs, ensure that communications values entered in the previous step correspond to the relay setting values.
- ▷ Click **OK** when complete.
- ▷ From the EnerVista main window, select the **IED Dashboard** item to open the Plug and Play IED dashboard.
An icon for the 469 will be shown.

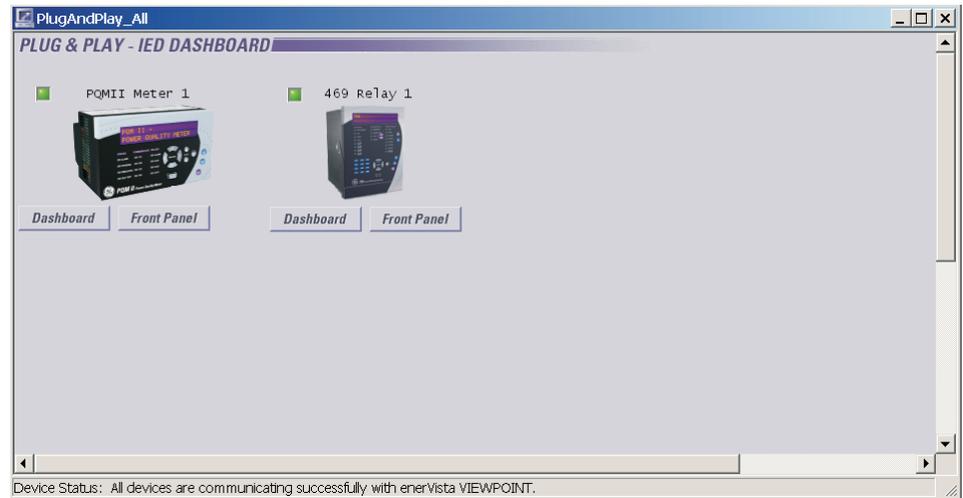


FIGURE 4-13: 'Plug and Play' Dashboard

- ▶ Click the **Dashboard** button below the 469 icon to view the device information.
We have now successfully accessed our 469 through EnerVista Viewpoint.

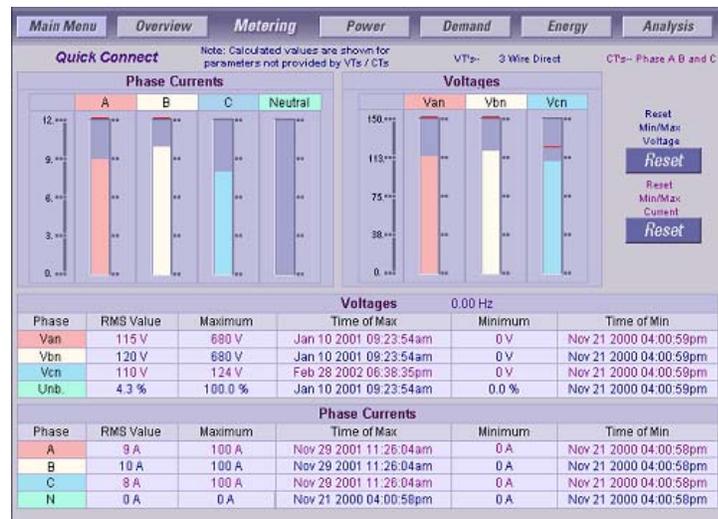
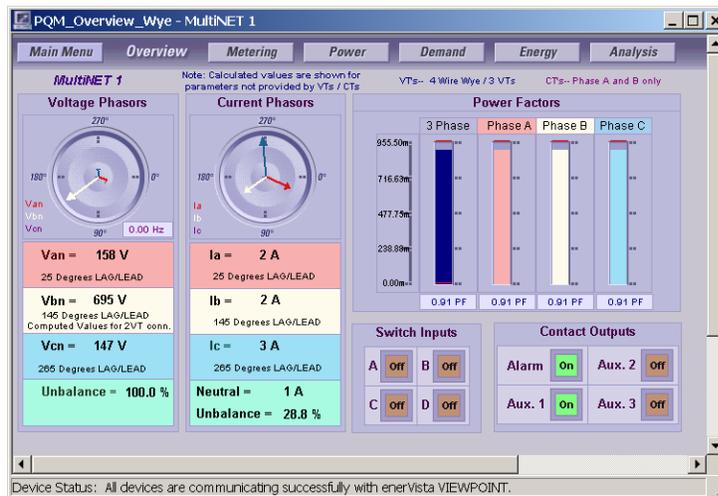


FIGURE 4-14: EnerVista Plug and Play Screens

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



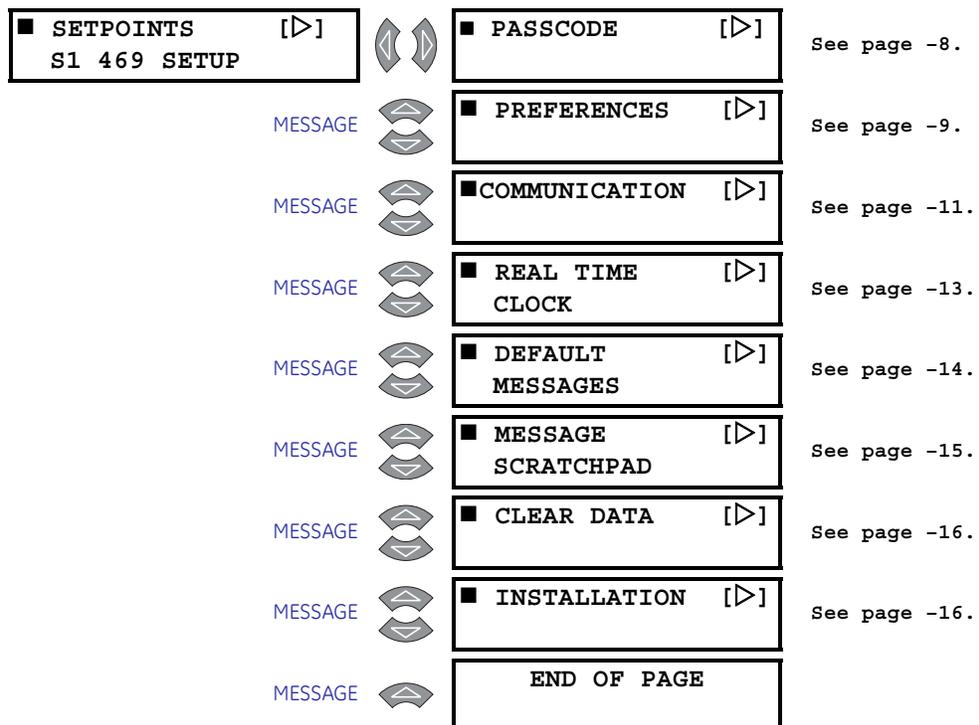
469 Motor Management Relay

Chapter 5: Settings

5.1 Overview

5.1.1 Settings Message Map

The 469 has a considerable number of programmable settings which makes it extremely flexible. The settings have been grouped into a number of pages and sub-pages as shown below. Each page of settings (e.g. **S2 SYSTEM SETUP**) has a section which describes in detail all the settings found on that page.



				
■ SETPOINTS [▷] S2 SYSTEM SETUP		■ CURRENT SENSING [▷]		See page -18.
MESSAGE		■ VOLTAGE SENSING [▷]		See page -20.
MESSAGE		■ POWER SYSTEM [▷]		See page -20.
MESSAGE		■ SERIAL COMM. CONTROL [▷]		See page -21.
MESSAGE		■ REDUCED VOLTAGE STARTING [▷]		See page -22.
MESSAGE		END OF PAGE		

				
■ SETPOINTS [▷] S3 DIGITAL INPUTS		■ STARTER STATUS [▷]		See page -27.
MESSAGE		■ ASSIGNABLE INPUT 1 [▷]		See page -27.
MESSAGE		■ ASSIGNABLE INPUT 2 [▷]		See page -27.
MESSAGE		■ ASSIGNABLE INPUT 3 [▷]		See page -27.
MESSAGE		■ ASSIGNABLE INPUT 4 [▷]		See page -27.
MESSAGE		END OF PAGE		

				
■ SETPOINTS [▷] S4 OUTPUT RELAYS		■ RELAY RESET MODE [▷]		See page -36.
MESSAGE		■ FORCE OUTPUT RELAYS [▷]		See page -37.
MESSAGE		END OF PAGE		

				
■ SETPOINTS [▷] S5 THERMAL MODEL		■ THERMAL MODEL [▷]		See page -40.
MESSAGE		■ OVERLOAD CURVE SETUP [▷]		See page -41.
MESSAGE		END OF PAGE		

				
■ SETPOINTS [▷] S6 CURRENT ELEM.		■ SHORT CIRCUIT TRIP [▷]	See page -60.	
MESSAGE		■ OVERLOAD ALARM [▷]	See page -61.	
MESSAGE		■ MECHANICAL JAM [▷]	See page -61.	
MESSAGE		■ UNDERCURRENT [▷]	See page -62.	
MESSAGE		■ CURRENT UNBALANCE [▷]	See page -63.	
MESSAGE		■ GROUND FAULT [▷]	See page -64.	
MESSAGE		■ PHASE DIFFERENTIAL [▷]	See page -65.	
MESSAGE		END OF PAGE		
				
■ SETPOINTS [▷] S7 MOTOR STARTING		■ ACCELERATION TIMER [▷]	See page -67.	
MESSAGE		■ START INHIBIT [▷]	See page -67.	
MESSAGE		■ JOGGING BLOCK [▷]	See page -68.	
MESSAGE		■ RESTART BLOCK [▷]	See page -70.	
MESSAGE		END OF PAGE		
				
■ SETPOINTS [▷] S8 RTD TEMPERATURE		■ RTD TYPES [▷]	See page -71.	
MESSAGE		■ RTD #1 [▷]	See page -72.	
MESSAGE		■ RTD #2 [▷]	See page -72.	
MESSAGE		■ RTD #3 [▷]	See page -72.	
	↓			
MESSAGE		■ RTD #12 [▷]		

MESSAGE  ■ OPEN [▷] RTD SENSOR See page -76.

MESSAGE  ■ RTD SHORT/LOW TEMP [▷] See page -76.

MESSAGE  END OF PAGE



■ SETPOINTS [▷] S9 VOLTAGE ELEM.



■ UNDERVOLTAGE [▷]

See page -77.

MESSAGE  ■ OVERVOLTAGE [▷]

See page -79.

MESSAGE  ■ PHASE REVERSAL [▷]

See page -79.

MESSAGE  ■ FREQUENCY [▷]

See page -80.

MESSAGE  END OF PAGE



■ SETPOINTS [▷] S10 POWER ELEMENTS



■ POWER FACTOR [▷]

See page -82.

MESSAGE  ■ REACTIVE POWER [▷]

See page -83.

MESSAGE  ■ UNDERPOWER [▷]

See page -84.

MESSAGE  ■ REVERSE POWER [▷]

See page -85.

MESSAGE  ■ TORQUE SETUP [▷]

See page -85.

MESSAGE  ■ OVERTORQUE [▷]

See page -86.

MESSAGE  END OF PAGE



■ SETPOINTS [▷] S11 MONITORING



■ TRIP COUNTER [▷]

See page -87.

MESSAGE  ■ STARTER FAILURE [▷]

See page -87.

MESSAGE  ■ CURRENT DEMAND [▷]

See page -88.

MESSAGE  ■ kW DEMAND [▷]

See page -88.

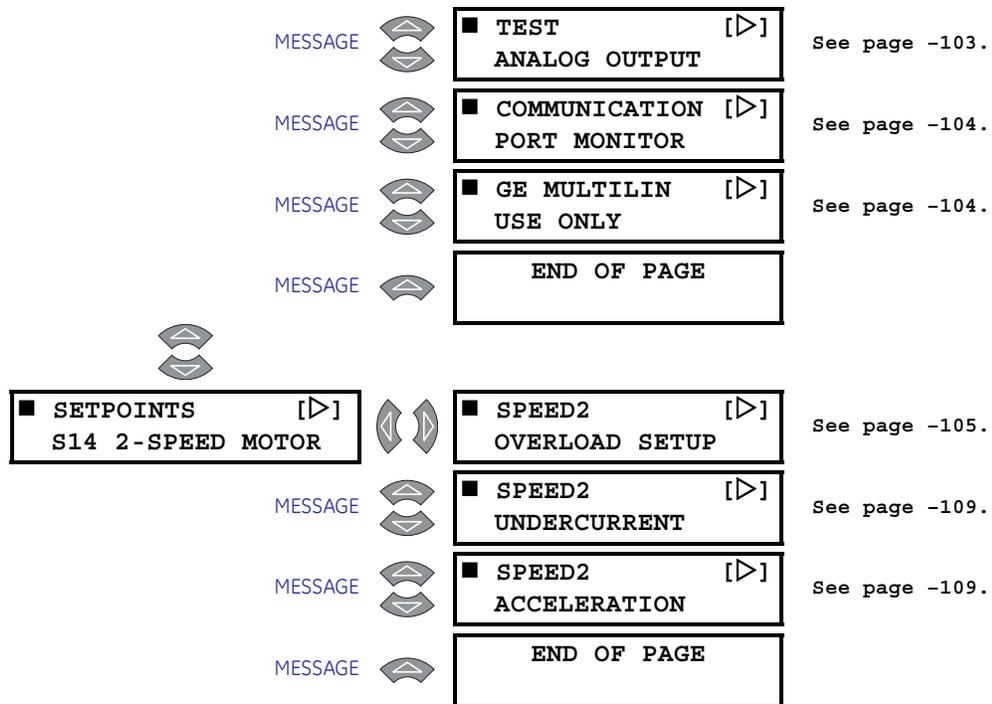
MESSAGE		■ kvar DEMAND [▷]	See page -88.
MESSAGE		■ kVA DEMAND [▷]	See page -88.
MESSAGE		■ PULSE OUTPUT [▷]	See page -90.
MESSAGE		END OF PAGE	



■ SETPOINTS S12 ANALOG I/O [▷]		■ ANALOG OUTPUT 1 [▷]	See page -93.
MESSAGE		■ ANALOG OUTPUT 2 [▷]	See page -93.
MESSAGE		■ ANALOG OUTPUT 3 [▷]	See page -93.
MESSAGE		■ ANALOG OUTPUT 4 [▷]	See page -93.
MESSAGE		■ ANALOG INPUT 1 [▷]	See page -95.
MESSAGE		■ ANALOG INPUT 2 [▷]	See page -95.
MESSAGE		■ ANALOG INPUT 3 [▷]	See page -95.
MESSAGE		■ ANALOG INPUT 4 [▷]	See page -95.
MESSAGE		■ ANALOG INPUT DIFF 1-2 [▷]	See page -97.
MESSAGE		■ ANALOG INPUT DIFF 3-4 [▷]	See page -98.
MESSAGE		END OF PAGE	



■ SETPOINTS S13 469 TESTING [▷]		■ SIMULATION MODE [▷]	See page -100.
MESSAGE		■ PRE-FAULT SETUP [▷]	See page -101.
MESSAGE		■ FAULT SETUP [▷]	See page -102.
MESSAGE		■ TEST OUTPUT RELAYS [▷]	See page -103.



5.1.2 Trips, Alarms, and Blocks

The 469 has three basic categories of protection elements. They are *trips*, *alarms*, and *blocks*.

- TRIPS:** A 469 trip feature may be assigned to any combination of the two Auxiliary relays, 2 AUXILIARY and 3 AUXILIARY, in addition to the 1 TRIP Relay. If a Trip becomes active, the appropriate LED (indicator) on the 469 faceplate will illuminate to show which of the output relays has operated. In addition to the Trip relay(s), a trip will always operate the Block Start relay. Trip features are may be programmed as latched or unlatched. Once a relay has been operated by a latched trip, a reset must be performed to clear the trip when the condition is no longer present. If there is a lockout time, the Block Start relay will not reset until the lockout time has expired. If an unlatched trip feature becomes active, that trip will reset itself (and associated output relays) as soon as the condition that caused the trip ceases. Immediately prior to issuing a trip, the 469 takes a snapshot of motor parameters and stores them as pre-trip values which will allow for troubleshooting after the trip occurs. The cause of last trip message is updated with the current trip and the 469 display defaults to that message. All trip features are automatically logged and date and time stamped as they occur. In addition, all trips are counted and logged as statistics such that any long term trends may be identified.
- ALARMS:** A 469 alarm feature may be assigned to operate any combination of three output relays, 4 ALARM, 3 AUXILIARY, and 2 AUXILIARY. Also an alarm may be assigned to NONE. When set to 'NONE', an alarm may record an event without operating one of the alarm or auxiliary relays. When an Alarm becomes active, the appropriate LED (indicator) on the 469 faceplate will illuminate when an output relay(s) has operated. Each alarm feature may be programmed as latched or unlatched. Once a latched alarm feature becomes active, the reset key must be pressed to reset that alarm. If the

condition that has caused the alarm is still present (e.g. hot RTD) the Alarm relay(s) will not reset until the condition is no longer present. If on the other hand, an unlatched alarm feature becomes active, that alarm will reset itself (and associated output relay(s)) as soon as the condition that caused the alarm ceases. As soon as an alarm occurs, the alarms messages are updated to reflect the alarm and the 469 display defaults to that message. Since it may not be desirable to log all alarms as events, each alarm feature may be programmed to log as an event or not. If an alarm is programmed to log as an event, when it becomes active, it is automatically logged as a date and time stamped event.

- BLOCK START:** A 469 Block Start prevents or inhibits the start of the motor based on some logic or algorithm. The Block Start feature is always assigned to the Block Start relay. In addition to the Trip relay(s), a trip always operates the Block Start relay. If the condition that has caused the trip is still present (e.g. hot RTD), or there is a lockout time when the RESET key is pressed, the Block Start relay will not reset until the condition is no longer present or the lockout time has expired. Blocking features are always unlatched and reset immediately when conditions that caused the block cease. In addition to becoming active in conjunction with trips, a block may become active once the motor stops. There are several features that operate as such: Starts/Hour, Time Between Starts, Start Inhibit, Restart Block, and 469 Not Programmed. Block messages are updated to reflect the block when it becomes active (complete with lockout time if required) and the screen defaults to that message. Blocks are normally not logged as events. If however, a motor start or start attempt is detected when a block is active, it is automatically logged as a date and time stamped event. This scenario might occur if someone shorts across the block terminals and overrides the 469 protection to start the motor.

5.1.3 Relay Assignment Practices

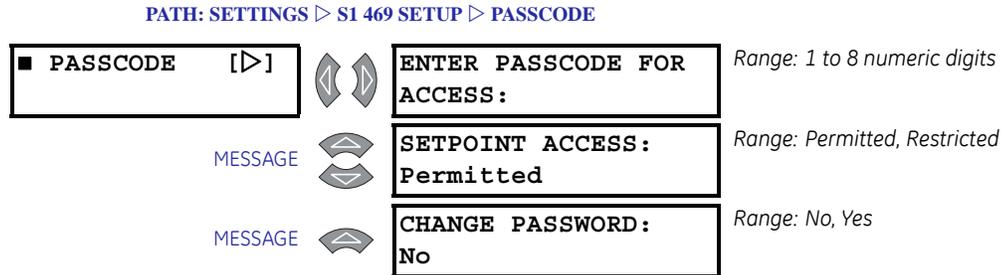
There are six output relays. Five of the relays are always non-failsafe, the other (Service) is failsafe and dedicated to enunciate internal 469 faults (these faults include settings Corruption, failed hardware components, loss of control power, etc.). One of the output relays is dedicated as the Block Start relay; it is dedicated to features that are intended to block motor starting. The four remaining relays may be programmed for different types of features depending on what is required. One of the relays, 1 TRIP, is intended to be used as the main trip relay. Another relay, 4 ALARM, is intended to be used as the main alarm relay. The two relays that are left, 2 AUXILIARY and 3 AUXILIARY, are intended for special requirements.

When assigning features to Auxiliary Relays 2 and 3, it is a good idea to decide early on what is required since features that may be assigned may conflict. For example, if 2 AUXILIARY is to be used for upstream trips, it cannot also be used for the control of a Reduced Voltage Start. Similarly, if 3 AUXILIARY is to be dedicated as a relay to echo all alarm conditions to a PLC, it cannot also be used strictly to enunciate a specific alarm such as Undercurrent.

In order to ensure that conflicts in relay assignment do not occur, several precautions have been taken. All trips with the exception of the Short Circuit Backup Trip default to the 1 TRIP output relay. All alarms default to the 4 ALARM relay. Only special control functions are defaulted to Auxiliary Relays 2 and 3. It is recommended that these assignments be reviewed once all the settings have been programmed.

5.2 S1 469 Setup

5.2.1 Passcode



A passcode access security feature is provided in addition to the settings access jumper. When shipped from the factory, the passcode is '0'. Settings write access is permitted when the passcode is 0. The settings access jumper is required for changing settings from the front panel keypad.

The **ENTER PASSCODE FOR ACCESS** settings is seen only if the passcode is not 0 and **SETPOINT ACCESS** is "Restricted". The **SETPOINT ACCESS** and **CHANGE PASSWORD** settings are seen only if the passcode is 0 and the **SETPOINT ACCESS** is "Permitted".

To enable passcode protection on a new relay, follow the procedure below:

1. Press MESSAGE ► then MESSAGE ▼ until **CHANGE PASSCODE?** is displayed.
2. Select "Yes" and follow the directions to enter a new passcode 1 to 8 digits in length.
3. Once a passcode (other than "0") is programmed, it must be entered each time settings access is restricted. If a non-zero passcode has been programmed and settings access is restricted, then the **ENTER PASSCODE FOR ACCESS** message appears when entering the **S1 469 SETUP ▷ PASSCODE** subgroup.
4. Enter the correct passcode. A flash message will advise if the code is incorrect and allows a retry. If the passcode is correct and the settings access jumper is installed, the **SETPOINT ACCESS: Permitted** message appears.
5. settings can now be entered. Press ESCAPE to exit the **S1 469 SETUP ▷ PASSCODE** group and program the appropriate settings. If no keys are pressed for 5 minutes, programming access will no longer be allowed and the passcode must be re-entered. Removing the settings access jumper or setting the **SETPOINTS ACCESS** settings to "Restricted" will also immediately disable settings access.

If a new passcode is required, gain settings access by entering the valid passcode as described above, then press MESSAGE ▼ to display the **CHANGE PASSCODE** message and follow directions. If an invalid passcode is entered, an encrypted passcode may be viewed by pressing the HELP key. Consult the factory service department with this number if the currently programmed passcode is unknown. Using a deciphering program, the passcode can be determined.

5.2.2 Preferences

PATH: SETTINGS > S1 469 SETUP > ▾ PREFERENCES

■ PREFERENCES [▷]			DEFAULT MESSAGE CYCLE TIME: 2.0 s	Range: 0.5 to 10.0 s in steps of 1
MESSAGE			DEFAULT MESSAGE TIMEOUT: 300 s	Range: 10 to 900 s in steps of 1
MESSAGE			AVERAGE MOTOR LOAD CALC. PERIOD: 15 min.	Range: 1 to 90 min. in steps of 1
MESSAGE			TEMPERATURE DISPLAY: Celsius	Range: Celsius, Fahrenheit
MESSAGE			TRACE MEMORY TRIGGER POSITION: 25%	Range: 1 to 100% in steps of 1
MESSAGE			TRACE MEMORY BUFFERS 8x14 cycles	Range: 1x64, 2x42, 3x32, 4x35, 5x21, 6x18, 7x16, 8x14, 9x12, 10x11, 11x10, 12x9, 13x9, 14x8, 15x8, 16x7 cycles.
MESSAGE			DISPLAY UPDATE INTERVAL: 0.4 s	Range: 0.1 to 6.0 s in steps of 0.1
MESSAGE			MOTOR LOAD FILTER INTERVAL: 0 cycles	Range: 0 to 32 cycles (0 = OFF) in steps of 1

Some characteristics can be modified for different situations. Normally this subgroup will not require changes.

- **DEFAULT MESSAGE CYCLE TIME:** If multiple default messages are chosen, the display automatically cycles through those messages. The display time can be changed to accommodate different user preferences.
- **DEFAULT MESSAGE TIMEOUT:** If no keys are pressed for a period of time, the relay automatically scans a programmed set of default messages. This time can be user-defined to ensure messages remain on the screen for a suitable time while entering settings or actual values. Once default scanning starts, pressing any key returns the last message viewed.
- **AVERAGE MOTOR LOAD CALCULATION PERIOD:** This settings adjusts the period of time over which the average motor load is calculated. The calculation is a sliding window and is ignored during motor starting.
- **TEMPERATURE DISPLAY:** Temperature measurements may be displayed in either Celsius or Fahrenheit. Each temperature value is displayed as °C or °F. RTD settings are always displayed in degrees Celsius.
- **TRACE MEMORY TRIGGER POSITION:** Sets the trigger position for waveform capture. This value represents the percentage of cycles captured and recorded in the trace memory buffer prior to the trigger (trip).
- **TRACE MEMORY BUFFERS:** Sets the number of traces to capture and the number of cycles captured for each of the waveforms and outputs. Note: 10 analog waveforms and 6 digital outputs are captured for each trace, showing all currents and voltages, and all relay output states

- **DISPLAY UPDATE INTERVAL:** Sets the duration for which the metered current and voltage readings are averaged before being displayed. It does not affect relay protection or function timing in any way. It can be used to steady the display when readings are bouncing.
- **MOTOR LOAD FILTER INTERVAL:** This value (when non-zero) averages current and power factor for the programmed number of cycles using a running average technique. This settings is intended for use on synchronous motors running at low RPM and driving reciprocating loads. The number of cycles to average can be determined by using current waveform capture. The number of cycles to complete one stroke can be determined from this waveform. This value can be used as the starting point for the motor load filter interval. Additional fine tuning may be required. This settings is not seen if **NOMINAL SYSTEM FREQUENCY** is "Variable".


WARNING

When set greater than one cycle, Motor Load Filter Interval may increase trip/alarm times for the following protection elements. No other elements are affected. Trip/ alarm times increase 16.7 ms for each additional cycle in the filter interval.

- Acceleration Timer
- Current Unbalance
- Mechanical Jam
- Overload
- Stall
- Thermal Model
- Reduced Voltage Start
- Undercurrent
- Demand
- Power Factor
- Three-Phase Apparent Power
- Three-Phase Reactive Power
- Three-Phase Real Power
- Under Power
- Reverse Power

5.2.3 Communications

Serial Communications

The following settings appear when the relay is ordered with the regular enhanced (E) option.

PATH: SETTINGS ▷ S1 469 SETUP ▷ COMMUNICATIONS

■ COMMUNICATIONS [▷]		SLAVE ADDRESS: 254	Range: 1 to 254 in steps of 1
MESSAGE		COMPUTER RS485 BAUD RATE: 9600	Range: 300, 1200, 2400, 4800, 9600, 19200
MESSAGE		COMPUTER RS485 PARITY: None	Range: None, Odd, Even
MESSAGE		AUXILIARY RS485 BAUD RATE: 9600	Range: 300, 1200, 2400, 4800, 9600, 19200
MESSAGE		AUXILIARY RS485 PARITY: None	Range: None, Odd, Even

The 469 has three (3) serial communications ports supporting a subset of the Modbus protocol (Refer to GEK-106491C: *469 Communications Guide*). The front panel RS232 has a fixed baud rate of 9600, a fixed data frame of 1 start, 8 data, and 1 stop bits with no parity. The front port is for local use only and responds regardless of the slave address programmed. This port may be connected to a personal computer running EnerVista 469 Setup. The software can download and upload settings files as well as upgrade the 469 firmware.

For RS485 communications, each 469 must have a unique address from 1 to 254. Address 0 is the broadcast address detected by all relays. Addresses do not have to be sequential but no two units can have the same address or errors will occur. Generally, each unit added to the link uses the next higher address starting at 1. Baud rates can be selected as 300, 1200, 2400, 4800, 9600, or 19200. The data frame is fixed at 1 start, 8 data, and 1 stop bits, while parity is optional. The computer RS485 port is a general purpose port for connection to a DCS, PLC, or PC. The auxiliary RS485 port may be used for redundancy or, it may be used to talk to auxiliary GE Digital Energy devices. The RS485 COM2 port is disabled if the Ethernet or DeviceNet option is ordered.

Ethernet Communications

The following settings appear when the relay is ordered with the Ethernet (T) option.

PATH: SETTINGS > S1 469 SETUP > COMMUNICATIONS

COMMUNICATIONS [▶]		SLAVE ADDRESS: 254	Range: 1 to 254 in steps of 1
MESSAGE		COMPUTER RS485 BAUD RATE: 9600	Range: 300, 1200, 2400, 4800, 9600, 19200
MESSAGE		COMPUTER RS485 PARITY: None	Range: None, Odd, Even
MESSAGE		FRONT PORT RS232 BAUD RATE: 19200	Range: 300, 1200, 2400, 4800, 9600, 19200
MESSAGE		IP ADDRESS: 0.0.0.0	Range: standard IP address format
MESSAGE		SUBNET IP MASK: 255.255.255.000	Range: standard IP address format
MESSAGE		GATEWAY IP ADDRESS: 0.0.0.0	Range: standard IP address format

The IP addresses are used with the Modbus protocol (Refer to GEK-106491C: 469 Communications Guide). Enter the dedicated IP, subnet IP, and gateway IP addresses provided by the network administrator.

To ensure optimal response from the relay, the typical connection timeout should be set as indicated in the following table:

TCP/IP sessions	Timeout setting
up to 2	2 seconds
up to 4	3 seconds

DeviceNet Communications

(Refer to GEK-106491C: 469 Communications Guide)

The following settings appear when the relay is ordered with the DeviceNet (D) option.

PATH: SETTINGS > S1 469 SETUP > COMMUNICATIONS

COMMUNICATIONS [▶]		SLAVE ADDRESS: 254	Range: 1 to 254 in steps of 1
MESSAGE		COMPUTER RS485 BAUD RATE: 9600	Range: 300, 1200, 2400, 4800, 9600, 19200
MESSAGE		COMPUTER RS485 PARITY: None	Range: None, Odd, Even
MESSAGE		FRONT PORT RS232 BAUD RATE: 19200	Range: 300, 1200, 2400, 4800, 9600, 19200
MESSAGE		DEVICENET MAC ID: 1	Range: 0 to 63
MESSAGE		DEVICENET BAUD RATE: 125K	Range: 125K, 250K, 500K

Enter the dedicated MAC ID and baud rate as per the DeviceNet design (Refer to GEK-106491C: *469 Communications Guide*). The DeviceNet option is implemented by the 469 relay using the AnyBus-S DeviceNet (HMS) module as a communication adapter. The module is ODVA certified and acts as a server between the relay and the DeviceNet network.

The following master/slave connection objects are supported by the 469 DeviceNet implementation:

- Explicit Messaging Connection
- Poll I/O Connection
- Change of State or Cyclic I/O Connection

The following objects have been implemented:

Object	Class
DeviceNet objects	
Identity object	01h
Message Router object	02h
DeviceNet object	03h
Assembly object	04h
Connection object	05h
Acknowledge Handler object	2Bh
469 specific objects	
I/O Data Input Mapping object	A0h
Parameter Data Input Mapping object	B0h

Refer to publication GEK-106491C: *469 Communications Guide* for additional details on the DeviceNet implementation.

5.2.4 Real Time Clock

PATH: SETTINGS > S1 469 SETUP > REAL TIME CLOCK

■ REAL TIME [▷]
CLOCK



DATE (MM.DD.YYYY)
01/01/1994



TIME (HH.MM.SS) :
12:00:00

Range: 01 to 12 / 01 to 31 / 1995 to 2094

Range: 00 to 23 hrs / 00 to 59 min. / 00 to 59 sec.

The correct time and date must be entered for event recorder events to be correctly time/date stamped. A supercap backed internal clock runs for 45 days even when power is off. It has an accuracy of approximately ±5 minutes per month. It must be periodically corrected manually through the front panel or via the RS485 serial link clock update command. If the approximate time an event occurred without synchronization to other relays is sufficient, then entry of time/date from the front panel keys is adequate.

If the RS485 serial communication link is used, then all the relays can keep synchronized time. A new clock time is pre-loaded into the 469 memory via the RS485 port by a remote computer to each relay connected on the communications channel. After the computer broadcasts (address 0) a “set clock” command, all relays in the system begin timing at the same instant. There can be up to 100 ms of delay in receiving serial commands so the

clock time in each relay is ± 100 ms, \pm the absolute clock accuracy in the PLC or PC. Refer to GE publication GEK-106491: *469 Communications Guide* for information on programming the time preload and synchronizing commands.

5.2.5 Default Messages

PATH: SETTINGS \triangleright S1 469 SETUP \triangleright ∇ DEFAULT MESSAGES

■	DEFAULT MESSAGES	[▷]		DEFAULT MESSAGES 6 OF 20 ASSIGNED	Range: N/A
MESSAGE				MOTOR STATUS: Stopped	Range: N/A
MESSAGE				A: 0 B: 0 C: 0 Amps	Range: N/A
MESSAGE				MOTOR LOAD: 0.00 x FLA	Range: N/A
MESSAGE				CURRENT UNBALANCE: 0%	Range: N/A
MESSAGE				DATE: 01/01/1995 TIME: 12:00:00	Range: N/A
MESSAGE				MULTILIN 469 Motor Management Relay	Range: N/A

After a period of inactivity, the 469 displays default messages. Between 1 and 20 default messages can be selected. Multiple default messages sequentially scan at a rate determined by the **S1 469 SETUP \triangleright PREFERENCES \triangleright DEFAULT MESSAGE CYCLE TIME** settings. Any actual value can be selected for default display. In addition, up to five user programmable messages can be created and displayed (message scratchpad). For example, the relay can alternately scan a motor identification message, the current in each phase, and the hottest stator RTD. Default messages are shown in this subgroup.

Use the following procedure to add default messages:

1. Enter the correct passcode for the **S1 469 SETUP \triangleright PASSCODE \triangleright ENTER PASSCODE FOR ACCESS** settings (unless the passcode has already been entered or the passcode is "0", defeating the passcode security feature).
2. Move to the message to be added to the default message list using the MESSAGE \blacktriangledown and MESSAGE \blacktriangle keys. The selected message can be any actual value or Message Scratchpad message.
3. Press ENTER. The message **PRESS [ENTER] TO ADD DEFAULT MESSAGES** will be displayed for 5 seconds.
4. Press ENTER again while displayed to add the current message to the default message list.
5. If the procedure was followed correctly, the **DEFAULT MESSAGE HAS BEEN ADDED** flash message will be displayed:
6. To verify that the message was added, view the last message in the **S1 469 SETUP \triangleright ∇ DEFAULT MESSAGES** subgroup.

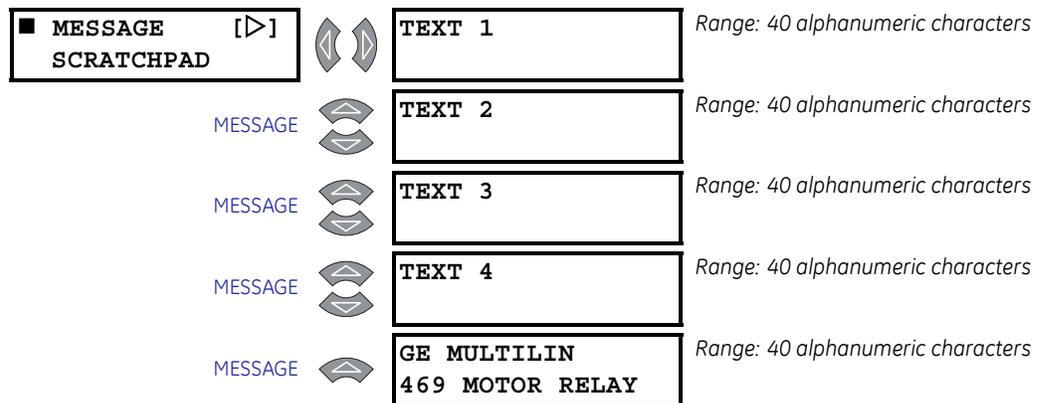
Use the following procedure to remove default messages:

1. Enter the correct passcode for the **S1 469 SETUP** > **PASSCODE** > **ENTER PASSCODE FOR ACCESS** settings (unless the passcode has already been entered or unless the passcode is "0", defeating the passcode security feature).
2. Select the message to remove under the **S1 469 SETUP** > **DEFAULT MESSAGES** sub-group.
3. When the default message to be removed is shown, press ENTER. The relay displays the **PRESS [ENTER] TO REMOVE DEFAULT MESSAGE** message.
4. Press ENTER to remove the current message from the default message list.
5. If the procedure was followed correctly, the following flash message will be displayed:

**DEFAULT MESSAGE
HAS BEEN REMOVED**

5.2.6 Message Scratchpad

PATH: **SETTINGS** > **S1 469 SETUP** > **MESSAGE SCRATCHPAD**



Up to five (5) message screens can be programmed under the message scratchpad area. These messages may be notes that pertain to the installation or the motor or any other information deemed pertinent by the user. In addition, these messages may be selected for scanning during default message display. This might be useful for reminding operators to perform certain tasks. The messages may be entered from the communications ports or through the keypad. The following procedure demonstrates the use of the message scratchpad:

1. Select the user message to be changed.
2. Press the decimal [.] key to enter text mode. An underline cursor will appear under the first character.
3. Use the VALUE keys to display the desired character. A space is selected like a character.
4. Press the decimal [.] key to advance to the next character. To skip over a character press the decimal key. If an incorrect character is accidentally stored, press the decimal key enough times to scroll the cursor around to the character.
5. When the desired message is displayed press ENTER to store or ESCAPE to quit. The message is now permanently stored. Press ESCAPE to cancel the altered message.

5.2.7 Clear Data

PATH: SETTINGS > S1 469 SETUP > ▾ CLEAR DATA

■ CLEAR DATA [▷]		CLEAR LAST TRIP DATA: No	Range: No, Yes
MESSAGE		RESET MWh and Mvarh METERS: No	Range: No, Yes
MESSAGE		CLEAR PEAK DEMAND DATA: No	Range: No, Yes
MESSAGE		CLEAR RTD MAXIMUMS: No	Range: No, Yes
MESSAGE		CLEAR ANALOG I/P MIN/MAX: No	Range: No, Yes
MESSAGE		CLEAR TRIP COUNTERS: No	Range: No, Yes
MESSAGE		PRESET DIGITAL COUNTER: No	Range: No, Yes
MESSAGE		CLEAR EVENT RECORDER: No	Range: No, Yes

These commands may be used to clear various historical data.

- **CLEAR LAST TRIP DATA:** Clears the last trip data.
- **RESET MWh and Mvarh METERS:** Resets the MWh and Mvarh metering to zero.
- **CLEAR PEAK DEMAND DATA:** Clears the peak demand values.
- **CLEAR RTD MAXIMUMS:** All maximum RTD temperature measurements are stored and updated each time a new maximum temperature is established. This command clears the maximum values.
- **CLEAR ANALOG I/P MIN/MAX:** The minimum and maximum analog input values are stored for each analog input. These minimum and maximum values may be cleared at any time.
- **CLEAR TRIP COUNTERS:** There are counters for each possible type of trip. This command clears these counters.
- **PRESET DIGITAL COUNTER:** When one of the assignable Digital Inputs is configured as “Counter”, this command presets the counter. If the counter is an incrementing type, setting the preset value to “0” effectively resets the counter.
- **CLEAR EVENT RECORDER:** The event recorder saves the last 256 events, automatically overwriting the oldest event. If desired, this command can clear all events to prevent confusion with old information.

5.2.8 Installation

PATH: SETTINGS > S1 469 SETUP > ▾ INSTALLATION

■ INSTALLATION [▷]		RESET MOTOR INFORMATION: No	Range: No, Yes
--------------------	--	--------------------------------	----------------

MESSAGE

**RESET STARTER
INFORMATION: No***Range: No, Yes*

These commands clear various informative and historical data when the 469 is first applied on a new installation.

- **RESET MOTOR INFORMATION:** Counters for number of motor starts and emergency restarts can be viewed in actual values. The 469 also learns various motor characteristics through motor operation. These learned parameters include acceleration time, starting current, and starting thermal capacity. Total motor running hours may also be viewed in actual values. On a new installation or if new equipment is installed, all this information can be reset with this settings.
- **RESET STARTER INFORMATION:** The total number of starter operations can be viewed in actual values. Use this settings to clear this counter on a new installation or if maintenance work is done on the breaker or contactor.

5.3 S2 System Setup

5.3.1 Current Sensing

PATH: SETTINGS ▷ ▾ S2 SYSTEM SETUP ▷ CURRENT SENSING

■ CURRENT SENSING [▷]		PHASE CT PRIMARY: Not Programmed	Range: 1 to 5000 A in steps of 1. Values ≥5001 denote not
MESSAGE		MOTOR FULL LOAD AMPS FLA: Not Programmed	Range: 1 to 5000 A in steps of 1. Values ≥5001 denote not
MESSAGE		GROUND CT: 50:0.025	Range: None, 1A Secondary, 5A Secondary, 50:0.025
MESSAGE		GROUND CT PRIMARY: 100 A	Range: 1 to 5000 A in steps of 1
MESSAGE		PHASE DIFFERENTIAL CT: None	Range: None, 1A Secondary, 5A Secondary
MESSAGE		PHASE DIFFERENTIAL CT PRIMARY: 100 A	Range: 1 to 5000 in steps of 1
MESSAGE		ENABLE 2-SPEED MOTOR PROTECTION: No	Range: No, Yes
MESSAGE		SPEED2 PHASE CT PRIMARY: 100 A	Range: 1 to 5000 A in steps of 1
MESSAGE		SPEED2 MOTOR FLA: 1 A	Range: 1 to 5000 A in steps of 1



NOTE

The **GROUND CT PRIMARY** setting is not seen if the **GROUND CT** is set to “1A Secondary” or “5A Secondary”. The **PHASE DIFFERENTIAL CT PRIMARY** is not seen if the **PHASE DIFFERENTIAL CT** is set to “1A Secondary” or “5A Secondary”.



NOTE

The **SPEED2 PHASE CT PRIMARY** and **SPEED2 MOTOR FLA** settings are seen only if two-speed motor protection is enabled.

As a safeguard, **PHASE CT PRIMARY** and **MOTOR FULL LOAD AMPS** are defaulted to “Not Programmed” when shipped. A block start indicates the 469 was never programmed. Once **PHASE CT PRIMARY** and **MOTOR FULL LOAD AMPS** are entered, the alarm resets itself. The phase CT should be chosen so the FLA is no less than 50% of the rated phase CT primary. Ideally, the phase CT primary should be chosen so the FLA is 100% of the phase CT primary or slightly less, never more. The secondary value of 1 or 5 A *must* be specified at the time of order so that the proper hardware is installed. A value for **MOTOR FULL LOAD AMPS** (FLA) must also be entered. The value may be taken from the motor nameplate data sheets. The service factor may be entered as overload pickup (see *S5 Thermal Model* on page 5–38).

For high resistance grounded systems, sensitive ground current detection is possible if the 50:0.025 ground CT input is used. To use the 50:0.025 input, select “50:0.025” for the **GROUND CT** settings. No additional ground CT messages will appear. On solidly grounded

systems where fault currents may be quite large, the 469 1A or 5A secondary ground CT input should be used for either zero-sequence or residual ground sensing. If the connection is residual, the Ground CT secondary and primary values should be the same as the phase CT. If however, the connection is zero-sequence, the Ground CT secondary and primary values must be entered. The Ground CT primary should be selected such that potential fault current does not exceed 20 times the primary rating. When relaying class CTs are purchased, this precaution will ensure that the Ground CT does not saturate under fault conditions.

The **PHASE DIFFERENTIAL CT PRIMARY** must be entered if the differential feature is to be used. If two CTs are used per phase in a vectorial summation configuration, the CTs should be chosen to ensure there is no saturation during motor starting. If however, a core balance CT is used for the differential protection in each phase, a low CT rating of 50 or 100 A allows for very sensitive differential protection.

When the two-speed motor feature is used, a value for a second set of Phase CTs and motor FLA must be entered here for Speed 2. If the Phase CTs are the same as the speed 1 phase CTs, simply enter the same value here as well.

Example 1:

Consider a 469 with a 5 A Phase CT secondary and Ground Fault Detection set to Residual and a motor with the following specifications:

Motor Nameplate FLA: 87 A; Low Resistance Grounded; Maximum Fault: 400 A

The following settings are required:

PHASE CT PRIMARY: "100"

MOTOR FULL LOAD AMPS: "87"

GROUND CT: "5 A Secondary"

GROUND CT PRIMARY: "100"

Example 2:

Consider a 469 with a 5 A Phase CT secondary and Ground Fault Detection set to Residual and a motor with the following specifications:

Motor Nameplate FLA: 255 A; Solidly Grounded; Maximum Fault: 10000 A;
Zero Sequence Ground CT: (10000/20) 500:1

The following settings are required:

PHASE CT PRIMARY: "300"

MOTOR FULL LOAD AMPS: "255"

GROUND CT: "5 A Secondary"

GROUND CT PRIMARY: "500"

Example 3:

Again, consider a 469 with a 5 A Phase CT secondary and Ground Fault Detection set to Residual and a motor with the following specifications:

Motor Nameplate FLA: 330 A; High Resistance Grounded; Maximum Fault: 5 A

The following settings are required:

PHASE CT PRIMARY: “350”
MOTOR FULL LOAD AMPS: “330”
GROUND CT: “50:0.025”

5.3.2 Voltage Sensing

PATH: SETTINGS ▾ ▾ S2 SYSTEM SETUP ▾ ▾ VOLTAGE SENSING

<div style="border: 1px solid black; padding: 2px;"> VOLTAGE SENSING [▷] </div>		VT CONNECTION TYPE: None	<i>Range: Open Delta, Wye, None</i>	
	MESSAGE		ENABLE SINGLE VT OPERATION: OFF	<i>Range: AN, BN, CN, OFF or AB, BC, OFF</i>
	MESSAGE		VOLTAGE TRANSFORMER RATIO: 35.00:1	<i>Range: 1.00:1 to 300.00:1 in steps of 0.01</i>
	MESSAGE		MOTOR NAMEPLATE VOLTAGE: 4000 V	<i>Range: 100 to 36000 V in steps of 1</i>

The manner in which the voltage transformers are connected must be entered here. A value of “None” for **VT CONNECTION TYPE** indicates that no voltage measurement is required. Note that phase reversal is disabled for single VT operation. All voltages are assumed balanced. Also, frequency is only available for AN or AB connections.

The **ENABLE SINGLE VT OPERATION** settings is seen only if the **VT CONNECTION TYPE** is “Open Delta” or “Wye”.

If voltage measurements are to be made, the turns ratio of the voltage transformers must be entered. The **VOLTAGE TRANSFORMER RATIO** must be chosen such that the secondary voltage of the VTs is between 40 and 240 V when the primary is at **MOTOR NAMEPLATE VOLTAGE**. All voltage protection features that require a level settings are programmed as a percent of the **MOTOR NAMEPLATE VOLTAGE** or rated voltage, where **MOTOR NAMEPLATE VOLTAGE** represents the rated design voltage line to line.

For example, given the motor nameplate voltage as 4160 V and the VTs are 4160/120 Open Delta, set the voltage sensing settings as follows:

VT CONNECTION TYPE: “Open Delta”
VT RATIO: “34.67:1”
MOTOR NAMEPLATE VOLTAGE: “4160”

5.3.3 Power System

PATH: SETTINGS ▾ ▾ S2 SYSTEM SETUP ▾ ▾ POWER SYSTEM

<div style="border: 1px solid black; padding: 2px;"> POWER SYSTEM [▷] </div>		NOMINAL SYSTEM FREQUENCY: 60 Hz	<i>Range: 50 Hz, 60 Hz, Variable</i>	
	MESSAGE		SYSTEM PHASE SEQUENCE: ABC	<i>Range: ABC, ACB</i>
	MESSAGE		SPEED2 PHASE SEQUENCE: ABC	<i>Range: ABC, ACB</i>

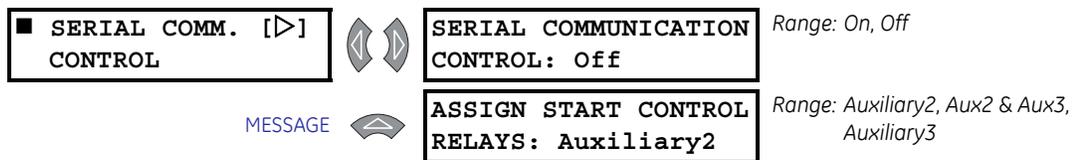
Enter the nominal system frequency here. These settings allow the 469 to determine the internal sampling rate for maximum accuracy.

The 469 may be used on variable frequency drives when the **NOMINAL SYSTEM FREQUENCY** is set to "Variable". All of the elements function in the same manner with the following exceptions: the ratio of negative to positive-sequence current is calculated from 0 to 30%, not 40%, and the voltage and power elements work properly if the voltage waveform is approximately sinusoidal. An unfiltered voltage waveform from a pulse width modulated drive cannot be measured accurately; however, the current waveform is approximately sinusoidal and can be measured accurately. All current elements will function properly. Note, however, that undervoltage and underfrequency elements will not work instantaneously using variable frequency. If "Variable" is chosen, the filtering algorithm increases the trip and alarm times by up to 270 ms when the level is close to the threshold. If the level exceeds the threshold by a significant amount, trip and alarm times will decrease until they match the programmed delay. The exceptions to this increased time are the short circuit, ground fault, and differential elements which will trip as per specification.

If the sequence of phase rotation for a given plant is ACB rather than the standard ABC, the **SYSTEM PHASE SEQUENCE** settings may be used to accommodate this. This settings allows the 469 to properly calculate phase reversal, negative sequence, and power quantities. The **SPEED2 PHASE SEQUENCE** can be programmed to accommodate the reversed motor rotation at Speed2 and is seen only if two-speed motor protection is enabled.

5.3.4 Communications Control

PATH: SETTINGS ▾ ▾ S2 SYSTEM SETUP ▾ ▾ SERIAL COMM. CONTROL



If enabled, motor starting and stopping is possible via any of the three 469 communication ports. Refer to GE publication GEK-106491: *469 Communications Guide* for command formats. When a stop command is issued, the 1 TRIP relay is activated for 1 second to complete the trip coil circuit for a breaker application or break the contact coil circuit for a contactor application. When a start command is issued, the auxiliary relay assigned for starting control is activated for 1 second to complete the close coil circuit for a breaker application or complete the start control circuit for a contactor application. A contactor sealing contact would be used to maintain the circuit.

For details on issuing a start or stop command via communications, refer to GE publication GEK-106491: *469 Communications Guide*.

5.3.5 Reduced Voltage

PATH: SETTINGS ▾ ▾ S2 SYSTEM SETUP ▾ ▾ REDUCED VOLTAGE STARTING

<div style="border: 1px solid black; padding: 2px;"> REDUCED VOLTAGE STARTING [▷] </div>		REDUCED VOLTAGE STARTING: Off	Range: On, Off
MESSAGE		ASSIGN CONTROL RELAYS: Auxiliary3	Range: Auxiliary2, Aux2 & Aux3, Auxiliary3
MESSAGE		TRANSITION ON: Current Only	Range: Current Only, Current or Timer, Current and Timer
MESSAGE		ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Aux2, Trip & Aux2 & Aux3, Trip & Aux3
MESSAGE		REDUCED VOLTAGE START LEVEL: 100% FLA	Range: 25 to 300% in steps of 1
MESSAGE		REDUCED VOLTAGE START TIMER: 200 s	Range: 1 to 600 s in steps of 1

The 469 can control the transition of a reduced voltage starter from reduced to full voltage. That transition may be based on “Current Only”, “Current and Timer”, or “Current or Timer” (whichever comes first). When the 469 measures the transition of no motor current to some value of motor current, a 'Start' is assumed to be occurring (typically current will rise quickly to a value in excess of FLA, e.g. $3 \times \text{FLA}$). At this point, the **REDUCED VOLTAGE START TIMER** is initialized with the programmed value in seconds.

- If “Current Only” is selected, when the motor current falls below the user's programmed Transition Level, transition will be initiated by activating the assigned output relay for 1 second. If the timer expires before that transition is initiated, an Incomplete Sequence Trip will occur activating the assigned trip relay(s).
- If “Current or Timer” is selected, when the motor current falls below the user's programmed Transition Level, transition will be initiated by activating the assigned output relay for 1 second. If the timer expires before that transition is initiated, the transition will be initiated regardless.
- If “Current and Timer” is selected, when the motor current falls below the user's programmed Transition Level and the timer expires, transition will be initiated by activating the assigned output relay for 1 second. If the timer expires before current falls below the Transition Level, an Incomplete Sequence Trip will occur activating the assigned trip relay(s).

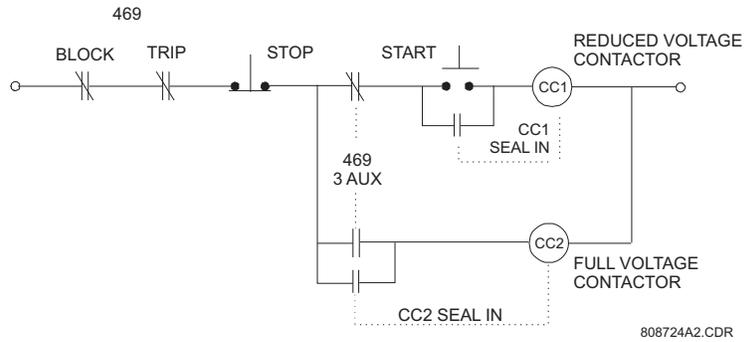


FIGURE 5-1: Reduced Voltage Start Contactor Control Circuit

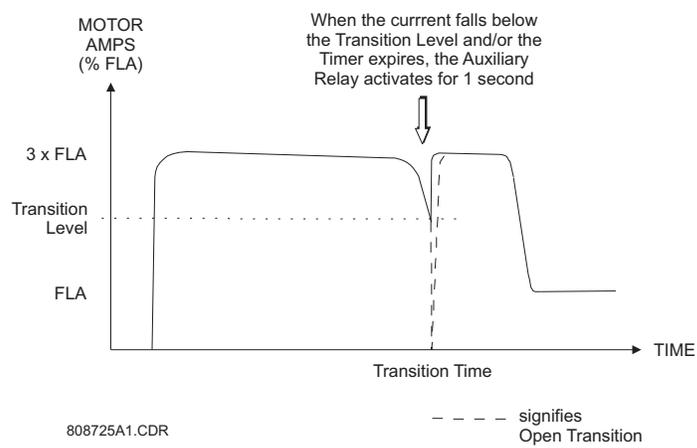
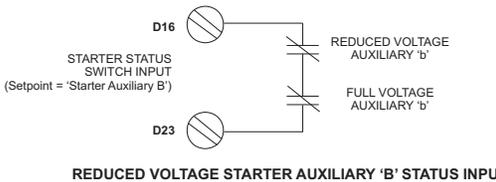
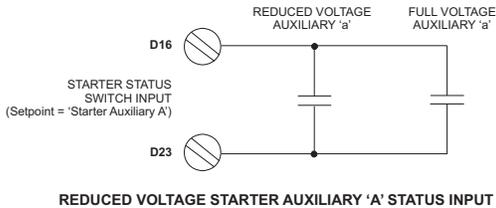


FIGURE 5-2: Reduced Voltage Starting Current Characteristic



If this feature is used, the Starter Status Switch input must be either from a common control contact or a parallel combination of Auxiliary 'a' contacts or a series combination of Auxiliary 'b' contacts from the reduced voltage contactor and the full voltage contactor. Once transition is initiated, the 469 assumes the motor is still running for at least 2 seconds. This prevents the 469 from recognizing an additional start if motor current goes to zero during an open transition.



808723A1.CDR

FIGURE 5-3: Reduced Voltage Starter Inputs

5.3.6 Preset Motor Values

PATH: SETTINGS > S2 SYSTEM SETUP > PRESET MOTOR VALUES

<p>■ PRESET MOTOR VALUES [▶]</p> <p>MESSAGE</p> <p>MESSAGE</p> <p>MESSAGE</p>	<p>MOTOR RUNNING HOURS PRESET: 0</p>	<p>Range: 0 to 99999 in steps of 1</p>
	<p>POS WATTHOURS PRESET: 0.000 MWh</p>	<p>Range: 0 to 999999.999 in steps of .001</p>
	<p>POS varHOURS PRESET: 0.000 Mvarh</p>	<p>Range: 0 to 999999.999 in steps of .001</p>
	<p>NEG varHOURS PRESET: 0.000 Mvarh</p>	<p>Range: 0 to 999999.999 in steps of .001</p>

The 469 can preset the following actual value accumulators. When an accumulator is preset, 469 discards the previous value and continues to accumulate starting from the new value.

- Motor running hours

Display and set actual value shown in

ACTUAL VALUES > A4 MAINTENANCE > TIMERS > MOTOR RUNNING HOURS

- Positive watt hours

Display and set actual value shown in

ACTUAL VALUES > A2 METERING DATA > POWER METERING > POSITIVE WATTHOURS

- Positive var hours

Display and set actual value shown in

ACTUAL VALUES > A2 METERING DATA > POWER METERING > POSITIVE VARHOURS

- Negative var hours

Display and set actual value shown in

ACTUAL VALUES > A2 METERING DATA > POWER METERING > NEGATIVE VARHOURS

5.4 S3 Digital Inputs

5.4.1 Description

Overview

The 469 relay has nine (9) digital inputs. Five of the digital inputs have been pre-assigned as switches having a specific function. Four of the five pre-assigned digital inputs are always functional and do not have any settings messages associated with them. The fifth, Starter Status, may be configured for either an 'a' or 'b' auxiliary contact. The remaining four digital inputs are assignable; that is to say, the function that the input is used for may be chosen from one of a number of different functions. Some of those functions are very specific, others may be programmed to adapt to the user requirements. If the Two-Speed Motor feature is enabled, Assignable Input 4 will be dedicated as the Two-Speed Motor Monitor.

Access Switch

Terminals C1 and C2 **must** be shorted to allow changing of any settings values. This safeguard is in addition to the settings passcode feature, which functions independently (see *Passcode* on page 5–8).

Test Switch

Once the 469 is in service, it may be tested from time to time as part of a regular maintenance schedule. The relay will have accumulated statistical information relating historically to starter and motor operation. This information includes: last trip data, demand data (if the metering features are in use), MWh and Mvarh metering, RTD maximums, the event record, analog input minimums and maximums, number of motor trips, number of trips by type, total motor running hours, learned parameters, number of starter operations, number of motor starts, number of emergency restarts, and the digital counter. Shorting the 469 Test input (terminals C3 and C4) prevents all of this data from being corrupted or updated when the relay is under test. The In Service LED will flash while the test terminals are shorted.

Emergency Restart

Shorting terminals D17 and D23 discharges the thermal capacity used to zero, sets any Starts/Hour Block lockout to zero, sets any Time Between Starts Block lockout to zero, and reset all Trips and Alarms so that a hot motor may be restarted. However, a Restart Block lockout will remain active (it may be used as a backspin timer) and any trip condition that remains (such as a hot RTD) will still cause a trip. Therefore, while the terminals are shorted, the Trip and Block output relays will remain in their normal non-operated state. In the event of a real emergency, the Emergency Restart terminals should remain shorted until the emergency is over. Also, while the Emergency Restart terminals are shorted, a Service Alarm message indicates any trips or blocks that are active. As the name implies, this feature should only be used in an emergency – using it otherwise defeats the purpose of the relay, namely, protecting the motor. Any Emergency Restart input transition from open to closed or closed to open is logged as an event.

Remote Reset

Shorting terminals D18 and D23 resets any trips or latched alarms provided that the condition that caused the alarm or trip is no longer present. If there is a lockout time the Block Start relay will not reset until the lockout time has expired.

5.4.2 Starter Status

PATH: SETTINGS > S3 DIGITAL INPUTS > STARTER STATUS

STARTER STATUS [▷]		STARTER STATUS SW: Starter Auxiliary A	Range: Starter Auxiliary A, Starter Auxiliary B	
---------------------------	---	---	--	---

This input is *necessary* for all motors. The 469 determines that a motor has stopped when the phase current falls below the level that the relay can measure (5% of CT primary). Monitoring an auxiliary contact from the breaker or contactor prevents the relay from detecting additional starts when an unloaded motor is loaded, or issuing a block start after an unloaded motor is started and running at less than 5% CT rated primary current.

If “Starter Auxiliary A” is chosen, terminals D16 and D23 are monitored to detect the breaker or contactor state, open signifying the breaker or contactor is open and shorted signifying closed. The 469 will then determine that a motor has made the transition from ‘running’ to ‘stopped’ only when the measured current is less than 5% CT ratio **and** the ‘a’ contact is open.

If “Starter Auxiliary B” is chosen, terminals D16 and D23 are monitored to detect the breaker or contactor state, open signifying the breaker or contactor is closed and shorted signifying open. The 469 then determines that a motor has made the transition from ‘running’ to ‘stopped’ only when the measured current is less than 5% CT ratio **and** the ‘b’ contact is closed.

5.4.3 Assignable Inputs 1(4)

Main Menu

PATH: SETTINGS > S3 DIGITAL INPUTS > ASSIGNABLE INPUT 1(4)

ASSIGNABLE INPUT 1 [▷]		INPUT 1 FUNCTION: Off	Range: see below
ASSIGNABLE INPUT 2 [▷]		INPUT 2 FUNCTION: Off	Range: see below
ASSIGNABLE INPUT 3 [▷]		INPUT 3 FUNCTION: Off	Range: see below
ASSIGNABLE INPUT 4 [▷]		INPUT 4 FUNCTION: Off	Range: see below

There are four (4) user-assignable digital inputs configurable to a number of different functions (see below), or turned Off. Once a function is chosen, any messages that follow may be used to set pertinent parameters for operation. Each function may only be chosen once. Assignable Inputs 1 to 4 are activated by shorting D19 to D22 (respectively) with D23.

The range for the **INPUT 1(4) FUNCTION** settings is: Off, Remote Alarm, Remote Trip, Speed Switch Trip, Load Shed Trip, Pressure Sw Alarm, Pressure Switch Trip, Vibration Sw Alarm, Vibration Sw Trip, Digital Counter, Tachometer, General Sw A, General Sw B, General Sw C, General Sw D, Capture Trace, Simulate Pre-Fault, Simulate Fault, Simulate Pre Fault... Fault.

Two-speed motor protection is enabled with the **S2 SYSTEM SETUP > CURRENT SENSING > ENABLE 2-SPEED MOTOR PROTECTION** settings. If the two-speed motor feature is enabled, Assignable Input 4 is dedicated as the two-speed motor monitor and terminals D22 and D23 are monitored for a contact closure. Closure of the contact signifies that the motor is in Speed 2 or High Speed. If the input is open, it signifies that the motor is in Speed 1. This allows the 469 to determine which settings should be active at any given point in time.

Remote Alarm

PATH: SETTINGS > S3 DIGITAL INPUTS > ASSIGNABLE INPUT 1(4)

■ ASSIGNABLE [▷] INPUT 1		INPUT 1 FUNCTION: Remote Alarm	Range: See above
	MESSAGE 	REMOTE ALARM NAME: Remote Alarm	Range: 20 alphanumeric characters
	MESSAGE 	REMOTE ALARM: Unlatched	Range: Latched, Unlatched
	MESSAGE 	ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Aux2, Alarm & Aux2 & Aux3, Alarm & Aux3, Auxiliary2, None
	MESSAGE 	REMOTE ALARM EVENTS: Off	Range: On, Off

These settings apply only if the **INPUT 1(4) FUNCTION** is “Remote Alarm”.

Once the Remote Alarm function is chosen for one of the assignable digital inputs, the settings messages shown here will follow the assignment message. An alarm relay may be selected and the name of the alarm may be altered. A contact closure on the digital input assigned as Remote Alarm will cause an alarm within 100 ms with the name that has been chosen. Multiple sources may be used to trigger a remote alarm by paralleling inputs (see FIGURE 5-4: Remote Alarm/Trip from Multiple Sources on page 5-29).

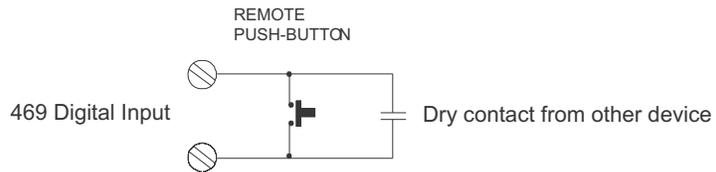
Remote Trip

PATH: SETTINGS > S3 DIGITAL INPUTS > ASSIGNABLE INPUT 1(4)

■ ASSIGNABLE [▷] INPUT 1		INPUT 1 FUNCTION: Remote Trip	Range: See above
	MESSAGE 	REMOTE TRIP NAME: Remote Trip	Range: 20 character alphanumeric
	MESSAGE 	ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3

These settings apply only if the **INPUT 1(4) FUNCTION** is “Remote Trip”.

Once the Remote Trip function is chosen for one of the assignable digital inputs, the settings messages shown here will follow the assignment message. A trip relay may be selected and the name of the trip may be altered. A contact closure on the digital input assigned as Remote Trip will cause a trip within 100 ms with the name that has been chosen. Multiple sources may be used to trigger a remote trip by paralleling inputs.



808716A1.CDR

FIGURE 5-4: Remote Alarm/Trip from Multiple Sources

Speed Switch Trip

PATH: SETTINGS ▷ ▾ S3 DIGITAL INPUTS ▷ ▾ ASSIGNABLE INPUT 1(4)

■ ASSIGNABLE [▷] INPUT 1		INPUT 1 FUNCTION: Speed Switch Trip	Range: See above.
		ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3
		SPEED SWITCH TRIP TIME DELAY: 5.0 s	Range: 1.0 to 250.0 s in steps of 0.1

These settings apply only if the **INPUT 1(4) FUNCTION** is “Speed Switch Trip”.

When this function is assigned to a digital input, the following will occur. When a transition from stopped to start is detected a timer will be loaded with the delay programmed. If that delay expires before a contact closure is detected, a trip will occur. Once the motor is stopped, the scheme is reset.

Load Shed Trip

PATH: SETTINGS ▷ ▾ S3 DIGITAL INPUTS ▷ ▾ ASSIGNABLE INPUT 1(4)

■ ASSIGNABLE [▷] INPUT 1		INPUT 1 FUNCTION: Load Shed Trip	Range: See above
		ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3

These settings apply only if the **INPUT 1(4) FUNCTION** is “Load Shed Trip”.

Once the load shed trip function is chosen for one of the assignable digital inputs, the settings messages shown here will follow the assignment message. A trip relay may be selected. A contact closure on the switch input assigned as load shed trip will cause a trip within 100 ms.

Pressure Switch Alarm

PATH: SETTINGS ▷ ▾ S3 DIGITAL INPUTS ▷ ▾ ASSIGNABLE INPUT 1(4)

■ ASSIGNABLE [▷]		INPUT 1 FUNCTION: Pressure Sw Alarm	Range: See above
MESSAGE		BLOCK PRES. SW. ALARM FROM START: 0 s	Range: 0 to 5000 s in steps of 1
MESSAGE		PRESSURE SWITCH ALARM: Unlatched	Range: Latched, Unlatched
MESSAGE		ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Auxiliary2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE		PRESSURE SW. ALARM DELAY: 5.0 s	Range: 0.1 to 100.0 sec., step: 0.1
MESSAGE		PRESSURE SW. ALARM EVENTS: Off	Range: On, Off

These settings apply only if the **INPUT 1(4) FUNCTION** is “Pressure Sw. Alarm”.

Once the pressure switch alarm function is chosen for one of the assignable digital inputs, the settings messages shown here will follow the assignment message. The Pressure Switch alarm feature may be blocked for a specified period of time from a motor start. A value of zero for the block time indicates that the feature is always active, when the motor is stopped or running. After the block delay has expired, the digital input will be monitored. If a closure occurs, after the specified delay, an alarm will occur.

Pressure Switch Trip

PATH: SETTINGS ▷ ▾ S3 DIGITAL INPUTS ▷ ▾ ASSIGNABLE INPUT 1(4)

■ ASSIGNABLE [▷]		INPUT 1 FUNCTION: Pressure Switch Trip	Range: See above
MESSAGE		BLOCK PRES. SW. TRIP FROM START: 0 s	Range: 0 to 5000 sec.; step: 1
MESSAGE		ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3
MESSAGE		PRESSURE SW. TRIP DELAY: 5.0 s	Range: 0.1 to 100.0 s in steps of 0.1

These settings apply only if the **INPUT 1(4) FUNCTION** is “Pressure Switch Trip”.

Once the Pressure Switch Trip function is chosen for one of the digital inputs, the settings messages shown here will follow the assignment message. The Pressure Switch Trip feature may be blocked for a specified period of time from a motor start. A value of zero for the Block time indicates that the feature is always active, when the motor is stopped or running. After the block delay has expired, the digital input will be monitored. If a closure occurs, after the specified delay, a trip will occur.

Vibration Switch Alarm

PATH: SETTINGS ▾ ▾ S3 DIGITAL INPUTS ▾ ▾ ASSIGNABLE INPUT 1(4)

<div style="border: 1px solid black; padding: 2px;"> <p>■ ASSIGNABLE [▷] INPUT 1</p> </div>		<div style="border: 1px solid black; padding: 2px;"> <p>INPUT 1 FUNCTION: Vibration Sw Alarm</p> </div>	Range: See above
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> <p>VIBRATION SWITCH ALARM: Unlatched</p> </div>	Range: Latched, Unlatched
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> <p>ASSIGN ALARM RELAYS: Alarm</p> </div>	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> <p>VIBRATION SW. ALARM DELAY: 5.0 s</p> </div>	Range: 0.1 to 100.0 s in steps of 0.1
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> <p>VIBRATION SW. ALARM EVENTS: Off</p> </div>	Range: On, Off

These settings apply only if the **INPUT 1(4) FUNCTION** is “Vibration Sw. Alarm”.

Once the Vibration Switch Alarm function is chosen for one of the digital inputs, the settings messages shown follow the assignment message. When the motor is stopped or running, the digital input will be monitored. If a closure occurs, an alarm will occur after the specified delay.

Vibration Switch Trip

PATH: SETTINGS ▾ ▾ S3 DIGITAL INPUTS ▾ ▾ ASSIGNABLE INPUT 1(4)

<div style="border: 1px solid black; padding: 2px;"> <p>■ ASSIGNABLE [▷] INPUT 1</p> </div>		<div style="border: 1px solid black; padding: 2px;"> <p>INPUT 1 FUNCTION: Vibration Sw Trip</p> </div>	Range: See above
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> <p>ASSIGN TRIP RELAYS: Trip</p> </div>	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> <p>VIBRATION SW. TRIP DELAY: 5.0 s</p> </div>	Range: 0.1 to 100.0 s in steps of 0.1

These settings apply only if the **INPUT 1(4) FUNCTION** is “Pressure Sw. Trip”.

Once Vibration Switch Trip is chosen for a digital input, the settings shown follow the assignment message. When the motor is stopped or running, the digital input will be monitored. If a closure occurs, a trip will occur after the specified delay.

Digital Counter

PATH: SETTINGS ▷ S3 DIGITAL INPUTS ▷ ASSIGNABLE INPUT 1(4)

■ ASSIGNABLE [▷] INPUT 1		INPUT 1 FUNCTION: Digital Counter	Range: See above
MESSAGE		COUNTER UNITS: Units	Range: 6 alphanumeric characters
MESSAGE		COUNTER PRESET VALUE: 0	Range: 0 to 1000000000 in steps of 1
MESSAGE		COUNTER TYPE: Increment	Range: Increment, Decrement
MESSAGE		COUNTER ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE		COUNTER ALARM LEVEL: 100	Range: 0 to 1000000000 in steps of 1
MESSAGE		COUNTER ALARM PICKUP: Over	Range: Over, Under
MESSAGE		COUNTER ALARM EVENTS: Off	Range: On, Off

These settings apply only if the **INPUT 1(4) FUNCTION** is “Digital Counter”.

Once the Digital Counter function is chosen for one of the assignable digital inputs, the settings messages shown here will follow the assignment message. Each closure of the switch will be counted, by either incrementing or decrementing the counter value. An alarm may be configured when a certain count is reached. The counter value may be viewed in the **A4 MAINTENANCE ▷ GENERAL COUNTERS ▷ DIGITAL COUNTER** actual value.

To initialize the counter, program the counter value here and then change the **S1 469 SETUP ▷ CLEAR DATA ▷ PRESET DIGITAL COUNTER** settings to “Yes”.

For example, a capacitive proximity probe may be used to sense non-magnetic units that are passing by on a conveyor, glass bottles for instance. The probe could be powered from the +24 V from the input switch power supply. The NPN transistor output could be taken to one of the assignable digital inputs configured as a counter.

Tachometer

PATH: SETTINGS ▷ S3 DIGITAL INPUTS ▷ ASSIGNABLE INPUT 1(4)

■ ASSIGNABLE [▷] INPUT 1		INPUT 1 FUNCTION: Tachometer	Range: See above
MESSAGE		RATED SPEED: 3600 RPM	Range: 100 to 7200 RPM in steps of 1

MESSAGE		TACHOMETER ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE		TACHOMETER ALARM SPEED: 10% Rated	Range: 5 to 100% in steps of 1
MESSAGE		TACHOMETER ALARM DELAY: 1 s	Range: 1 to 250 s in steps of 1
MESSAGE		TACHOMETER ALARM EVENTS: Off	Range: On, Off
MESSAGE		TACHOMETER TRIP: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3
MESSAGE		TACHOMETER TRIP SPEED: 10% Rated	Range: 5 to 95% in steps of 1
MESSAGE		TACHOMETER TRIP DELAY: 1 s	Range: 1 to 250 s in steps of 1

These settings apply only if the **INPUT 1(4) FUNCTION** is “Tachometer”.

Once the tachometer is chosen for a digital input, the settings shown here follow the assignment message. The period of time between each switch closure is measured and converted to an RPM value based on one closure per revolution.

A trip and alarm may be configured such that the motor or load must be at a certain speed within a set period of time from the motor starting. The tachometer trip and alarm features are configured such that the specified speed (**TACHOMETER TRIP SPEED** or **TACHOMETER ALARM SPEED**) must be reached in the specified time (**TACHOMETER TRIP DELAY** or **TACHOMETER ALARM DELAY**), otherwise the element operates. Initially, the time delay begins when the motor is started and resets when the desired speed is reached. Once the motor is running and the speed drops below the set threshold, the time delay restarts and the designated output contact will operate if the motor fails to reach the set speed in the allotted time. This element is active when motor is running and ignored while the motor is stopped. The RPM value may be viewed with the **A2 METERING** ▾ ▽ **SPEED** ▾ **TACHOMETER** actual value.

For example, an inductive proximity probe or hall effect gear tooth sensor may be used to sense the key on the motor. The probe could be powered from the +24 V from the input switch power supply. The NPN transistor output could be taken to one of the assignable switch inputs configured as a tachometer.

General Switch A to D

PATH: SETTINGS ▷ ▾ S3 DIGITAL INPUTS ▷ ▾ ASSIGNABLE INPUT 1(4)

<div style="border: 1px solid black; padding: 2px;"> ■ ASSIGNABLE [▷] </div> <div style="border: 1px solid black; padding: 2px;"> INPUT 1 </div>		<div style="border: 1px solid black; padding: 2px;"> INPUT 1 FUNCTION: General Sw. A </div>	<i>Range: See above</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> SWITCH NAME: General Sw. A </div>	<i>Range: 12 alphanumeric characters</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> GENERAL SWITCH A: Normally Open </div>	<i>Range: Normally Open, Normally Closed.</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> BLOCK INPUT FROM START: 0 s </div>	<i>Range: 0 to 5000 s in steps of 1</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> GENERAL SWITCH A ALARM: Off </div>	<i>Range: Off, Latched, Unlatched</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> ASSIGN ALARM RELAYS: Alarm </div>	<i>Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> GENERAL SWITCH A ALARM DELAY: 5.0 s </div>	<i>Range: 0.1 to 5000.0 s in steps of 0.1</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> GENERAL SWITCH A EVENTS: Off </div>	<i>Range: On, Off</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> GENERAL SWITCH A TRIP: Off </div>	<i>Range: Off, Latched, Unlatched</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> ASSIGN TRIP RELAYS: Trip </div>	<i>Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> GENERAL SWITCH A TRIP DELAY: 5.0 s </div>	<i>Range: 0.1 to 5000.0 s in steps of 0.1</i>

These settings apply only if the **INPUT 1(4) FUNCTION** is “General Switch A”. Similar messages appear for General Switches B, C, and D.

There are four general switch functions assignable to the four digital inputs. Once a general switch function is chosen for one of the digital inputs, the settings messages shown here follow the assignment message. An alarm and/or trip may then be configured for that input. The alarm and/or trip may be assigned a common name and a common block time from motor start if required (if the alarm is to be disabled until some period of time after the motor has been started). A value of “0” for the **BLOCK TIME** settings indicates that the feature is always active, when the motor is stopped or running. The switch may also be defined as normally open or normally closed. After the block delay has expired, the digital input will be monitored. If the switch is not in its normal state after the specified delay, an alarm or trip will occur.

Capture Trace

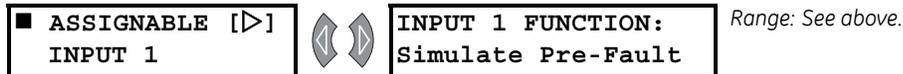
PATH: SETTINGS ▷ ▾ S3 DIGITAL INPUTS ▷ ▾ ASSIGNABLE INPUT 1(4)

<div style="border: 1px solid black; padding: 2px;"> ■ ASSIGNABLE [▷] </div> <div style="border: 1px solid black; padding: 2px;"> INPUT 1 </div>		<div style="border: 1px solid black; padding: 2px;"> INPUT 1 FUNCTION: Capture Trace </div>	<i>Range: See above.</i>
--	---	--	--------------------------

Setting the **INPUT 1(4) FUNCTION** to “Capture Trace” allows for trace capture upon command via a switch input. The captured waveforms can be displayed with the relay software. There are no additional settings associated with this value.

Simulate Pre-Fault

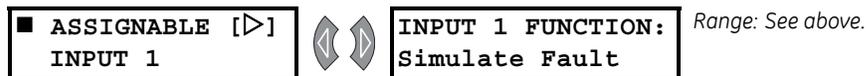
PATH: [SETTINGS](#) ▾ ▾ [S3 DIGITAL INPUTS](#) ▾ ▾ [ASSIGNABLE INPUT 1\(4\)](#)



Setting the **INPUT 1(4) FUNCTION** to “Simulate Pre-Fault” allows the user to start the Simulate Pre-Fault mode as per the [S13 469 TESTING](#) ▾ [SIMULATION MODE](#) ▾ [SIMULATION MODE](#) setting via a switch input. This is typically used for relay or system testing. There are no additional Digital Input settings associated with this value.

Simulate Fault

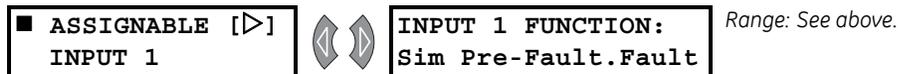
PATH: [SETTINGS](#) ▾ ▾ [S3 DIGITAL INPUTS](#) ▾ ▾ [ASSIGNABLE INPUT 1\(4\)](#)



Setting the **INPUT 1(4) FUNCTION** to “Simulate Fault” allows the user to start the Simulate Fault mode as per the [S13 469 TESTING](#) ▾ [SIMULATION MODE](#) ▾ [SIMULATION MODE](#) setting via a switch input. This is typically used for relay or system testing. There are no additional Digital Input settings associated with this value.

Simulate Pre-Fault ...Fault

PATH: [SETTINGS](#) ▾ ▾ [S3 DIGITAL INPUTS](#) ▾ ▾ [ASSIGNABLE INPUT 1\(4\)](#)



Setting the **INPUT 1(4) FUNCTION** to “Sim Pre-Fault.Fault” allows the user to start the Simulate Pre-Fault to Fault mode as per the [S13 469 TESTING](#) ▾ [SIMULATION MODE](#) ▾ [SIMULATION MODE](#) setting via a switch input. This is typically used for relay or system testing. There are no additional Digital Input settings associated with this value.

5.5 S4 Output Relays

5.5.1 Description

Five of the six output relays are always non-failsafe; the 6 SERVICE relay is always failsafe. As failsafe, the 6 SERVICE relay will be energized normally and de-energize when called upon to operate. It will also de-energize when control power to the 469 is lost and therefore, be in its operated state. All other relays, being non-failsafe, will be de-energized normally and energize when called upon to operate. Obviously, when control power is lost to the 469, the output relays must be de-energized and therefore, they will be in their non-operated state. Shorting bars in the drawout case ensure that when the 469 is drawn out, no trip or alarm occurs. The the 6 SERVICE relay will however indicate that the 469 has been drawn out.

5.5.2 Relay Reset Mode

PATH: SETTINGS > ▾ S4 OUTPUT RELAYS > RELAY RESET MODE

<div style="border: 1px solid black; padding: 2px;"> RELAY [▷] </div>		<div style="border: 1px solid black; padding: 2px;"> 1 TRIP: All Resets </div>	Range: All Resets, Remote Reset Only, Keypad Reset Only
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> 2 AUXILIARY: All Resets </div>	Range: All Resets, Remote Reset Only, Keypad Reset Only
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> 3 AUXILIARY: All Resets </div>	Range: All Resets, Remote Reset Only, Keypad Reset Only
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> 4 ALARM: All Resets </div>	Range: All Resets, Remote Reset Only, Keypad Reset Only
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> 5 BLOCK START: Auto-Reset </div>	Range: N/A
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> 6 SERVICE: All Resets </div>	Range: All Resets, Remote Reset Only, Keypad Reset Only

A latched trip or alarm may be reset at any time, providing that the condition that caused the trip or alarm is no longer present. Unlatched trips and alarms will reset automatically once the condition is no longer present. If any condition may be reset, the Reset Possible LED will be lit. All Block Start features reset automatically when the lockout time has expired and the trip has been reset.

The other relays may be programmed to All Resets which allows reset from the front keypad or the remote reset switch input or the communications port. Optionally, relays 1 through 6 may be programmed to reset by the “Remote Reset Only” (by the remote reset switch input or the communications port) or “Keypad Reset Only” (reset only by relay keypad).



NO trip or alarm element must *EVER* be assigned to two output relays where one is Remote Reset Only and the other is Keypad Reset Only. The trip or alarm will not be resettable if this occurs.

For example, serious trips such as Short Circuit and Ground Fault may be assigned to the 2 AUXILIARY relay so that they can only be reset via the remote reset terminals (D18 and D23) or the communication port. The remote reset terminals should be connected to a keyswitch so that only authorized personnel could reset such a critical trip.

- Assign only Short Circuit and Ground Fault to the 2 AUXILIARY relay
- Program **2 AUXILIARY** to “Remote Reset Only”

5.5.3 Force Output Relay

PATH: SETTINGS > S4 OUTPUT RELAYS > FORCE OUTPUT RELAYS

<div style="border: 1px solid black; padding: 2px;"> FORCE OUTPUT RELAYS [▶] </div>		<div style="border: 1px solid black; padding: 2px;"> FORCE 1 TRIP RELAY: Disabled </div>	<i>Range: Disabled, Enabled</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> FORCE TRIP RELAY DURATION: Static </div>	<i>Range: Static, 1 to 300 s in steps of 1</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> FORCE 2 AUXILIARY RELAY: Disabled </div>	<i>Range: Disabled, Enabled</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> FORCE 2 AUX RELAY DURATION: Static </div>	<i>Range: Static, 1 to 300 s in steps of 1</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> FORCE 3 AUXILIARY RELAY: Disabled </div>	<i>Range: Disabled, Enabled</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> FORCE 3 AUX RELAY DURATION: Static </div>	<i>Range: Static, 1 to 300 s in steps of 1</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> FORCE 4 ALARM RELAY: Disabled </div>	<i>Range: Disabled, Enabled</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> FORCE ALARM RELAY DURATION: Static </div>	<i>Range: Static, 1 to 300 s in steps of 1</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> FORCE 5 BLOCK START RELAY: Disabled </div>	<i>Range: Disabled, Enabled</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> FORCE BLOCK RELAY DURATION: Static </div>	<i>Range: Static, 1 to 300 s in steps of 1</i>

The output relays can be independently forced in static or dynamic mode. In static mode the selected relay will operate as long as it is in the “Enabled” state. Only when the user enters “Disabled” will the selected relay reset. In dynamic mode the user specifies the operate time (1 to 300 seconds) and the selected relay will operate for the specified duration.

The **FORCE OUTPUT RELAY** option is NOT allowed when the selected relay output is already active due to trip or alarm condition, when the 469 is in start block condition, or when the 469 is not in service.



IMPORTANT NOTE: The forced relay will override any trip or alarm conditions. (i.e. when the relay is forced and trip occurs, the relay will still be enabled when the trip condition is reset).

Control power loss in the 469 will **reset** all forced relays.

5.6 S5 Thermal Model

5.6.1 Motor Thermal Limits

One of the principle enemies of motor life is heat. When a motor is specified, the purchaser communicates to the manufacturer what the loading conditions and duty cycle will be, as well as, environment and other pertinent information about the driven load such as starting torque, etc. The manufacturer then provides a stock motor or builds a motor that should have a reasonable life under those conditions.

Motor thermal limits are dictated by the design of both the stator and the rotor. Motors have three modes of operation: locked rotor or stall (when the rotor is not turning), acceleration (when the rotor is coming up to speed), and running (when the rotor turns at near synchronous speed). Heating occurs in the motor during each of these conditions in very distinct ways. Typically, during motor starting, locked rotor and acceleration conditions, the motor is rotor limited. That is to say that the rotor will approach its thermal limit before the stator. Under locked rotor conditions, voltage is induced in the rotor at line frequency, 50 or 60 Hz. This voltage causes a current to flow in the rotor, also at line frequency, and the heat generated (I^2R) is a function of the effective rotor resistance. At 50 or 60 Hz, the reactance of the rotor cage causes the current to flow at the outer edges of the rotor bars. The effective resistance of the rotor is therefore at a maximum during a locked rotor condition as is rotor heating. When the motor is running at rated speed, the voltage induced in the rotor is at a low frequency (approximately 1 Hz) and therefore, the effective resistance of the rotor is reduced quite dramatically. During running overloads, the motor thermal limit is typically dictated by stator parameters. Some special motors might be all stator or all rotor limited. During acceleration, the dynamic nature of the motor slip dictates that rotor impedance is also dynamic, and a third overload thermal limit characteristic is necessary.

The figure below illustrates typical thermal limit curves. The motor starting characteristic is shown for a high inertia load at 80% voltage. If the motor started quicker, the distinct characteristics of the thermal limit curves would not be required and the running overload curve would be joined with locked rotor safe stall times to produce a single overload curve.

The motor manufacturer should provide a safe stall time or thermal limit curves for any motor they sell. To program the 469 for maximum protection, it is necessary to ask for these items when the motor is out for bid. These thermal limits are intended to be used as guidelines and their definition is not always precise. When operation of the motor exceeds the thermal limit, the motor insulation does not immediately melt. Rather, the rate of insulation degradation has reached a point that motor life will be significantly reduced if it is run any longer in that condition.

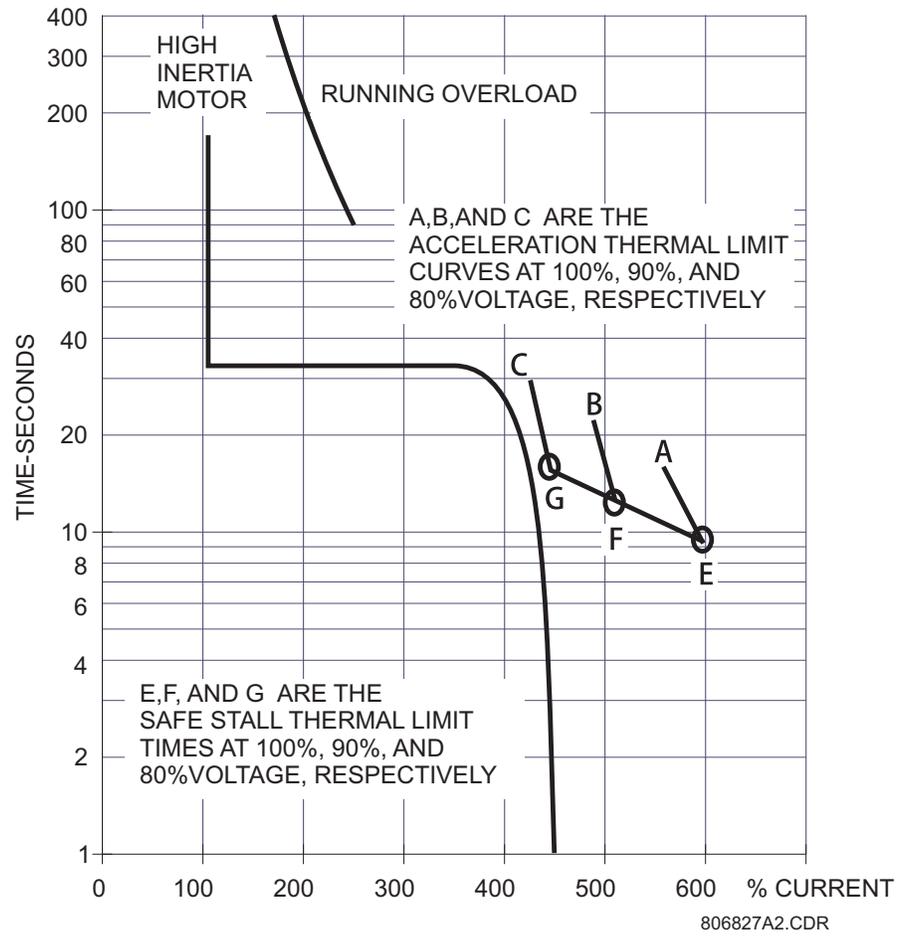


FIGURE 5-5: Typical Time-Current and Thermal Limit Curves (ANSI/IEEE C37.96)

5.6.2 Thermal Model

PATH: SETTINGS ▷ ▾ S5 THERMAL MODEL ▷ THERMAL MODEL

■ THERMAL MODEL [▷]		SELECT CURVE STYLE: Standard	Range: Standard, Custom, Voltage Dependent
MESSAGE		OVERLOAD PICKUP LEVEL: 1.01 x FLA	Range: 1.01 to 1.25 in steps of 0.01
MESSAGE		ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Aux2, Trip & Aux2 & Aux3, Trip & Aux3
MESSAGE		UNBALANCE BIAS K FACTOR: 0	Range: 0 to 19 in steps of 1. (0 defeats this feature)
MESSAGE		COOL TIME CONSTANT RUNNING: 15 min.	Range: 1 to 1000 min. in steps of 1
MESSAGE		COOL TIME CONSTANT STOPPED: 30 min.	Range: 1 to 1000 min. in steps of 1
MESSAGE		HOT/COLD SAFE STALL RATIO: 1.00	Range: 0.01 to 1.00 in steps of 0.01
MESSAGE		ENABLE RTD BIASING: No	Range: Yes, No
MESSAGE		RTD BIAS MINIMUM: 40 °C	Range: 0°C to RTD BIAS CENTER value in steps of 1
MESSAGE		RTD BIAS CENTER POINT: 130 °C	Range: RTD BIAS MINIMUM value to RTD BIAS MAXIMUM value in steps of 1
MESSAGE		RTD BIAS MAXIMUM: 155 °C	Range: RTD BIAS CENTER value to 250°C in steps of 1
MESSAGE		THERMAL CAPACITY ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE		THERMAL CAP. ALARM LEVEL: 75% USED	Range: 10 to 100% in steps of 1
MESSAGE		THERMAL CAPACITY ALARM EVENTS: Off	Range: On, Off

The primary protective function of the 469 is the thermal model. It consists of five key elements: the overload curve and overload pickup level, the unbalance biasing of the motor current while the motor is running, the motor cooling time constants, and the biasing of the thermal model based on Hot/Cold motor information and measured stator temperature. Each of these elements are described in detail in the sections that follow.

The 469 integrates stator and rotor heating into one model. Motor heating is reflected in the **AI STATUS ▷ MOTOR STATUS ▷ ▾ MOTOR THERMAL CAPACITY USED** actual value register. If the motor has been stopped for a long period of time, it will be at ambient temperature

and the **MOTOR THERMAL CAPACITY USED** should be zero. If the motor is in overload, once the thermal capacity used reaches 100%, a trip will occur. The **THERMAL CAPACITY ALARM** may be used as a warning indication of an impending overload trip.

5.6.3 Overload Curve Setup

Overview

The overload curve accounts for motor heating during stall, acceleration, and running in both the stator and the rotor. The **OVERLOAD PICKUP LEVEL** settings dictates where the running overload curve begins as the motor enters an overload condition. This is useful for service factor motors as it allows the pickup level to be defined. The curve is effectively cut off at current values below this pickup.

Motor thermal limits consist of three distinct parts based on the three conditions of operation: locked rotor or stall, acceleration, and running overload. Each of these curves may be provided for a hot and a cold motor. A hot motor is defined as one that has been running for a period of time at full load such that the stator and rotor temperatures have settled at their rated temperature. A cold motor is a motor that has been stopped for a period of time such that the stator and rotor temperatures have settled at ambient temperature. For most motors, the distinct characteristics of the motor thermal limits are formed into a smooth homogeneous curve. Sometimes only a safe stall time is provided. This is acceptable if the motor has been designed conservatively and can easily perform its required duty without infringing on the thermal limit. In this case, the protection can be conservative and process integrity is not compromised. If a motor has been designed very close to its thermal limits when operated as required, then the distinct characteristics of the thermal limits become important.

The 469 overload curve can take one of three formats: Standard, Custom Curve, or Voltage Dependent. Regardless of the selected curve style, thermal memory is retained in the **A1 STATUS ▷ MOTOR STATUS ▷ ▽ MOTOR THERMAL CAPACITY USED** register. This register is updated every 100 ms using the following equation:

$$TC_{\text{used at } t} = TC_{\text{used at } t-100\text{ms}} + \frac{100 \text{ ms}}{\text{time to trip}} \times 100\% \quad (\text{EQ 5.1})$$

where: time_to_trip = time taken from the overload curve at I_{eq} as a function of FLA. The overload protection curve should always be set slightly lower than the thermal limits provided by the manufacturer. this will ensure that the motor is tripped before the thermal limit is reached.

Standard Overload Curves

If the **SELECT CURVE STYLE** is set to "Standard" in the Thermal Model, only the following settings will appear:

PATH: SETTINGS ▷ ▽ S5 THERMAL MODEL ▷ ▽ OVERLOAD CURVE SETUP

■ **OVERLOAD** [▷]
CURVE SETUP



STANDARD OVERLOAD
CURVE NUMBER: 4

Range: 1 to 15 in steps of 1. Seen only if Standard curve is selected.

If the motor starting times are well within the safe stall times, it is recommended that the 469 Standard Overload Curve be used. The standard overload curves are a series of 15 curves with a common curve shape based on typical motor thermal limit curves (see the figure and table below).

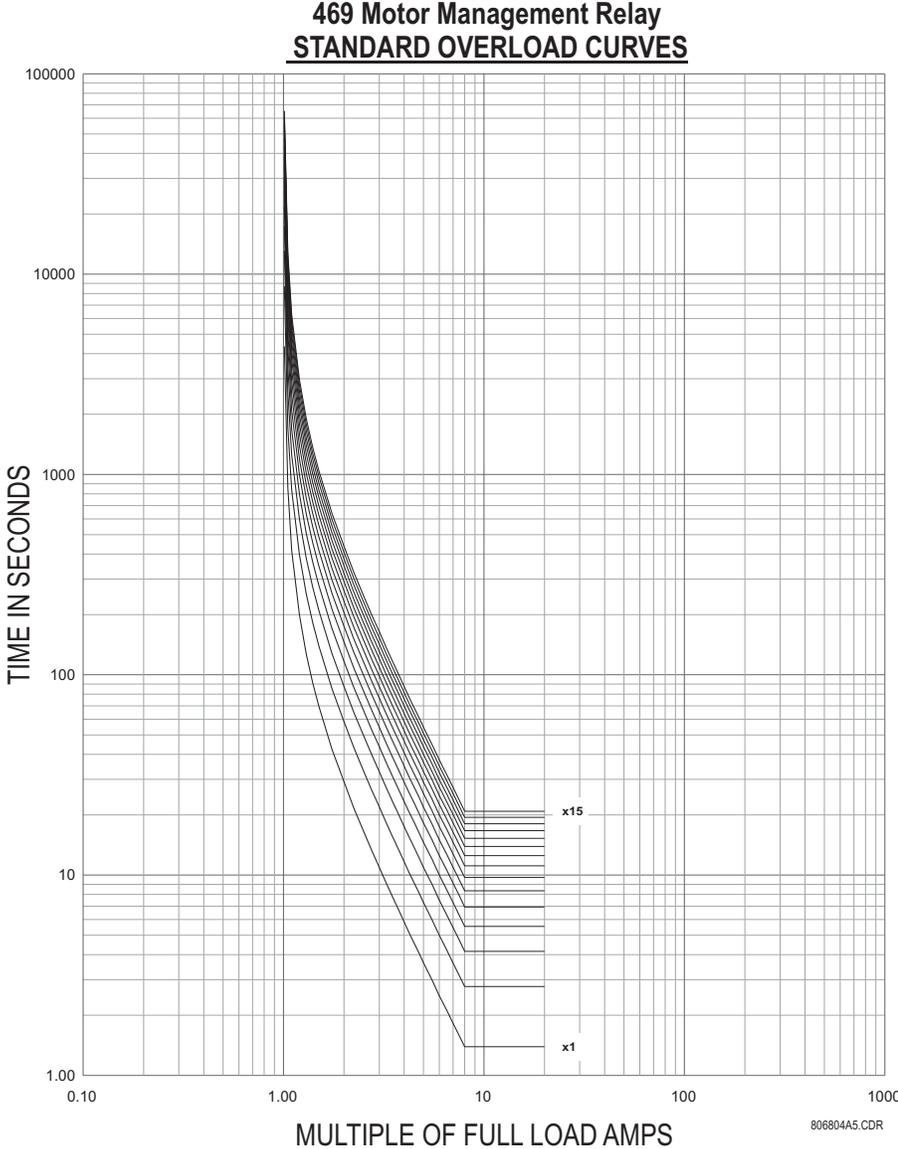


FIGURE 5-6: 469 Standard Overload Curves

Table 5-1: 469 Standard Overload Curve Multipliers

PICKUP (× FLA)	STANDARD CURVE MULTIPLIERS														
	× 1	× 2	× 3	× 4	× 5	× 6	× 7	× 8	× 9	× 10	× 11	× 12	× 13	× 14	× 15
1.01	4353.6	8707.2	13061	17414	21768	26122	30475	34829	39183	43536	47890	52243	56597	60951	65304
1.05	853.71	1707.4	2561.1	3414.9	4268.6	5122.3	5976.0	6829.7	7683.4	8537.1	9390.8	10245	11098	11952	12806

Table 5-1: 469 Standard Overload Curve Multipliers

PICKUP (× FLA)	STANDARD CURVE MULTIPLIERS														
	× 1	× 2	× 3	× 4	× 5	× 6	× 7	× 8	× 9	× 10	× 11	× 12	× 13	× 14	× 15
1.10	416.68	833.36	1250.0	1666.7	2083.4	2500.1	2916.8	3333.5	3750.1	4166.8	4583.5	5000.2	5416.9	5833.6	6250.2
1.20	198.86	397.72	596.58	795.44	994.30	1193.2	1392.0	1590.9	1789.7	1988.6	2187.5	2386.3	2585.2	2784.1	2982.9
1.30	126.80	253.61	380.41	507.22	634.02	760.82	887.63	1014.4	1141.2	1268.0	1394.8	1521.6	1648.5	1775.3	1902.1
1.40	91.14	182.27	273.41	364.55	455.68	546.82	637.96	729.09	820.23	911.37	1002.5	1093.6	1184.8	1275.9	1367.0
1.50	69.99	139.98	209.97	279.96	349.95	419.94	489.93	559.92	629.91	699.90	769.89	839.88	909.87	979.86	1049.9
1.75	42.41	84.83	127.24	169.66	212.07	254.49	296.90	339.32	381.73	424.15	466.56	508.98	551.39	593.81	636.22
2.00	29.16	58.32	87.47	116.63	145.79	174.95	204.11	233.26	262.42	291.58	320.74	349.90	379.05	408.21	437.37
2.25	21.53	43.06	64.59	86.12	107.65	129.18	150.72	172.25	193.78	215.31	236.84	258.37	279.90	301.43	322.96
2.50	16.66	33.32	49.98	66.64	83.30	99.96	116.62	133.28	149.94	166.60	183.26	199.92	216.58	233.24	249.90
2.75	13.33	26.65	39.98	53.31	66.64	79.96	93.29	106.62	119.95	133.27	146.60	159.93	173.25	186.58	199.91
3.00	10.93	21.86	32.80	43.73	54.66	65.59	76.52	87.46	98.39	109.32	120.25	131.19	142.12	153.05	163.98
3.25	9.15	18.29	27.44	36.58	45.73	54.87	64.02	73.16	82.31	91.46	100.60	109.75	118.89	128.04	137.18
3.50	7.77	15.55	23.32	31.09	38.87	46.64	54.41	62.19	69.96	77.73	85.51	93.28	101.05	108.83	116.60
3.75	6.69	13.39	20.08	26.78	33.47	40.17	46.86	53.56	60.25	66.95	73.64	80.34	87.03	93.73	100.42
4.00	5.83	11.66	17.49	23.32	29.15	34.98	40.81	46.64	52.47	58.30	64.13	69.96	75.79	81.62	87.45
4.25	5.12	10.25	15.37	20.50	25.62	30.75	35.87	41.00	46.12	51.25	56.37	61.50	66.62	71.75	76.87
4.50	4.54	9.08	13.63	18.17	22.71	27.25	31.80	36.34	40.88	45.42	49.97	54.51	59.05	63.59	68.14
4.75	4.06	8.11	12.17	16.22	20.28	24.33	28.39	32.44	36.50	40.55	44.61	48.66	52.72	56.77	60.83
5.00	3.64	7.29	10.93	14.57	18.22	21.86	25.50	29.15	32.79	36.43	40.08	43.72	47.36	51.01	54.65
5.50	2.99	5.98	8.97	11.96	14.95	17.94	20.93	23.91	26.90	29.89	32.88	35.87	38.86	41.85	44.84
6.00	2.50	5.00	7.49	9.99	12.49	14.99	17.49	19.99	22.48	24.98	27.48	29.98	32.48	34.97	37.47
6.50	2.12	4.24	6.36	8.48	10.60	12.72	14.84	16.96	19.08	21.20	23.32	25.44	27.55	29.67	31.79
7.00	1.82	3.64	5.46	7.29	9.11	10.93	12.75	14.57	16.39	18.21	20.04	21.86	23.68	25.50	27.32
7.50	1.58	3.16	4.75	6.33	7.91	9.49	11.08	12.66	14.24	15.82	17.41	18.99	20.57	22.15	23.74
8.00	1.39	2.78	4.16	5.55	6.94	8.33	9.71	11.10	12.49	13.88	15.27	16.65	18.04	19.43	20.82
10.00	1.39	2.78	4.16	5.55	6.94	8.33	9.71	11.10	12.49	13.88	15.27	16.65	18.04	19.43	20.82
15.00	1.39	2.78	4.16	5.55	6.94	8.33	9.71	11.10	12.49	13.88	15.27	16.65	18.04	19.43	20.82
20.00	1.39	2.78	4.16	5.55	6.94	8.33	9.71	11.10	12.49	13.88	15.27	16.65	18.04	19.43	20.82



Above 8.0 × Pickup, the trip time for 8.0 is used. This prevents the overload curve from acting as an instantaneous element.

The standard overload curves equation is:

$$\text{Time to Trip} = \frac{\text{Curve_Multiplier} \times 2.2116623}{0.02530337 \times (\text{Pickup} - 1)^2 + 0.05054758 \times (\text{Pickup} - 1)} \quad \text{(EQ 5.2)}$$

Custom Overload Curve

If the **SELECT CURVE STYLE** is set to “Custom” in the Thermal Model, the following settings will appear:

PATH: SETTINGS > S5 THERMAL MODEL > OVERLOAD CURVE SETUP

<div style="border: 1px solid black; padding: 2px;"> ■ OVERLOAD [▷] CURVE SETUP </div>		TIME TO TRIP AT 1.01 x FLA: 17414.5 s	<i>Range: 0.5 to 99999.9 s in steps of 0.1</i>
MESSAGE		TIME TO TRIP AT 1.05 x FLA: 3414.9 s	<i>Range: 0.5 to 99999.9 s in steps of 0.1</i>
MESSAGE		TIME TO TRIP AT 1.10 x FLA: 1666.7 s	<i>Range: 0.5 to 99999.9 s in steps of 0.1</i>
MESSAGE		TIME TO TRIP AT 1.20 x FLA: 795.4 s	<i>Range: 0.5 to 99999.9 s in steps of 0.1</i>
MESSAGE		TIME TO TRIP AT 1.30 x FLA: 507.2 s	<i>Range: 0.5 to 99999.9 s in steps of 0.1</i>
MESSAGE		TIME TO TRIP AT 1.40 x FLA: 364.6 s	<i>Range: 0.5 to 99999.9 s in steps of 0.1</i>
MESSAGE		TIME TO TRIP AT 1.50 x FLA: 280.0 s	<i>Range: 0.5 to 99999.9 s in steps of 0.1</i>
MESSAGE		TIME TO TRIP AT 1.75 x FLA: 169.7 s	<i>Range: 0.5 to 99999.9 s in steps of 0.1</i>
MESSAGE		TIME TO TRIP AT 2.00 x FLA: 116.6 s	<i>Range: 0.5 to 99999.9 s in steps of 0.1</i>
MESSAGE		TIME TO TRIP AT 2.25 x FLA: 86.1 s	<i>Range: 0.5 to 99999.9 s in steps of 0.1</i>
MESSAGE		TIME TO TRIP AT 2.50 x FLA: 66.6 s	<i>Range: 0.5 to 99999.9 s in steps of 0.1</i>
MESSAGE		TIME TO TRIP AT 2.75 x FLA: 53.3 s	<i>Range: 0.5 to 99999.9 s in steps of 0.1</i>
MESSAGE		TIME TO TRIP AT 3.00 x FLA: 43.7 s	<i>Range: 0.5 to 99999.9 s in steps of 0.1</i>
MESSAGE		TIME TO TRIP AT 3.25 x FLA: 36.6 s	<i>Range: 0.5 to 99999.9 s in steps of 0.1</i>
MESSAGE		TIME TO TRIP AT 3.50 x FLA: 31.1 s	<i>Range: 0.5 to 99999.9 s in steps of 0.1</i>
MESSAGE		TIME TO TRIP AT 3.75 x FLA: 26.8 s	<i>Range: 0.5 to 99999.9 s in steps of 0.1</i>
MESSAGE		TIME TO TRIP AT 4.00 x FLA: 23.3 s	<i>Range: 0.5 to 99999.9 s in steps of 0.1</i>
MESSAGE		TIME TO TRIP AT 4.25 x FLA: 20.5 s	<i>Range: 0.5 to 99999.9 s in steps of 0.1</i>
MESSAGE		TIME TO TRIP AT 4.50 x FLA: 18.2 s	<i>Range: 0.5 to 99999.9 s in steps of 0.1</i>

MESSAGE		TIME TO TRIP AT 4.75 x FLA: 16.2 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 5.00 x FLA: 14.6 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 5.50 x FLA: 12.0 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 6.00 x FLA: 10.0 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 6.50 x FLA: 8.5 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 7.00 x FLA: 7.3 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 7.50 x FLA: 6.3 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 8.00 x FLA: 5.6 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 10.0 x FLA: 5.6 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 15.0 x FLA: 5.6 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 20.0 x FLA: 5.6 s	Range: 0.5 to 99999.9 s in steps of 0.1

If the motor starting current begins to infringe on the thermal damage curves, it may become necessary to use a custom curve to tailor the motor protection so that successful starting may occur without compromising protection. Furthermore, the characteristics of the starting thermal damage curve (locked rotor and acceleration) and the running thermal damage curves may not fit together very smoothly. In this instance, a custom curve may be necessary to tailor motor protection to the motor thermal limits so it may be started successfully and be utilized to its full potential without compromising protection. The distinct parts of the thermal limit curves now become more critical. For these conditions, it is recommended that the 469 custom curve thermal model be used. The custom overload curve feature allows the user to program their own curve by entering trip times for 30 pre-determined current levels.

As seen in the figure below, if the running overload thermal limit curve were smoothed into one curve with the locked rotor overload curve, the motor could not start at 80% line voltage. A custom curve is required.



TYPICAL CUSTOM CURVE
6500 HP, 13800 VOLT INDUCED DRAFT FAN MOTOR

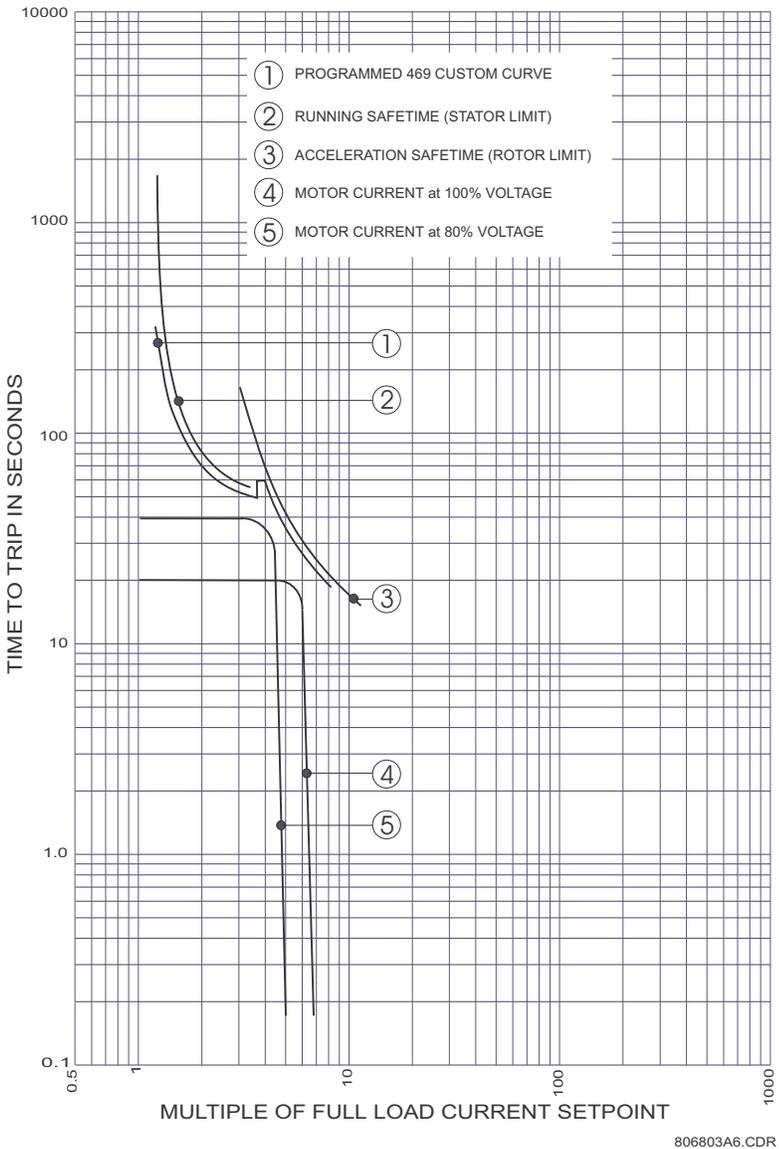


FIGURE 5-7: Custom Curve Example



During the interval of discontinuity, the longer of the two trip times is used to reduce the chance of nuisance tripping during motor starts.

Voltage Dependent Overload Curves

If the **SELECT CURVE STYLE** is set to "Voltage Dependent" in the Thermal Model, the following settings will appear:

PATH: SETTINGS ▾ ▾ S5 THERMAL MODEL ▾ ▾ OVERLOAD CURVE SETUP

OVERLOAD CURVE SETUP [▷]		TIME TO TRIP AT 1.01 x FLA: 17414.5 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 1.05 x FLA: 3414.9 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 1.10 x FLA: 1666.7 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 1.20 x FLA: 795.4 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 1.30 x FLA: 507.2 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 1.40 x FLA: 364.6 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 1.50 x FLA: 280.0 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 1.75 x FLA: 169.7 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 2.00 x FLA: 116.6 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 2.25 x FLA: 86.1 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 2.50 x FLA: 66.6 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 2.75 x FLA: 53.3 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 3.00 x FLA: 43.7 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 3.25 x FLA: 36.6 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 3.50 x FLA: 31.1 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 3.75 x FLA: 26.8 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 4.00 x FLA: 23.3 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 4.25 x FLA: 20.5 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 4.50 x FLA: 18.2 s	Range: 0.5 to 99999.9 s in steps of 0.1

MESSAGE		TIME TO TRIP AT 4.75 x FLA: 16.2 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 5.00 x FLA: 14.6 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 5.50 x FLA: 12.0 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 6.00 x FLA: 10.0 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 6.50 x FLA: 8.5 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 7.00 x FLA: 7.3 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 7.50 x FLA: 6.3 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 8.00 x FLA: 5.6 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 10.0 x FLA: 5.6 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 15.0 x FLA: 5.6 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		TIME TO TRIP AT 20.0 x FLA: 5.6 s	Range: 0.5 to 99999.9 s in steps of 0.1
MESSAGE		MINIMUM ALLOWABLE LINE VOLTAGE: 80%	Range: 70 to 95% in steps of 1
MESSAGE		STALL CURRENT @ MIN Vline: 4.80 x FLA	Range: 2.00 to 15.00 x FLA in steps of 0.01
MESSAGE		SAFE STALL TIME @ MIN Vline: 20.0 s	Range: 0.5 to 999.9 s in steps of 0.1
MESSAGE		ACCEL. INTERSECT @ MIN Vline: 3.80 x FLA	Range: 2.00 to STALL CURRENT @ MIN VLINE - 0.01 in steps of 0.01
MESSAGE		STALL CURRENT @ 100% Vline: 6.00 x FLA	Range: 2.00 to 15.00 x FLA in steps of 0.01
MESSAGE		SAFE STALL TIME @ 100% Vline: 10.0 s	Range: 0.5 to 999.9 s in steps of 0.1
MESSAGE		ACCEL. INTERSECT @ 100% Vline: 5.00 x FLA	Range: 2.00 to STALL CURRENT @ MIN VLINE - 0.01 in steps of 0.01

If the motor is called upon to drive a high inertia load, it is quite possible and acceptable for the acceleration time to exceed the safe stall time (keeping in mind that a locked rotor condition is different than an acceleration condition). In this instance, each distinct portion of the thermal limit curve must be known and protection must be coordinated against that curve. The relay protecting the motor must be able to distinguish between a locked rotor condition, an accelerating condition, and a running condition. The Voltage Dependent

Overload Curve feature is tailored to protect these types of motors. Voltage is continually monitored during motor starting and the acceleration thermal limit curve is adjusted accordingly.

The Voltage Dependent Overload Curve is comprised of the three characteristic shapes of thermal limit curves as determined by the stall or locked rotor condition, acceleration, and running overload. The curve is constructed by entering a custom curve shape for the running overload protection curve. Next, a point must be entered for the acceleration protection curve at the point of intersection with the custom curve, based on the minimum allowable starting voltage as defined by the minimum allowable line voltage. The locked rotor current and safe stall time must also be entered for that voltage. A second point of intersection must be entered for 100% line voltage. Once again, the locked rotor current and the safe stall time must be entered, this time for 100% line voltage. The protection curve created from the safe stall time and intersection point will be dynamic based on the measured line voltage between the minimum allowable line voltage and the 100% line voltage. This method of protection inherently accounts for the change in motor speed as an impedance relay would. The change in impedance is reflected by motor terminal voltage and line current. For any given speed at any given line voltage, there is only one value of line current.

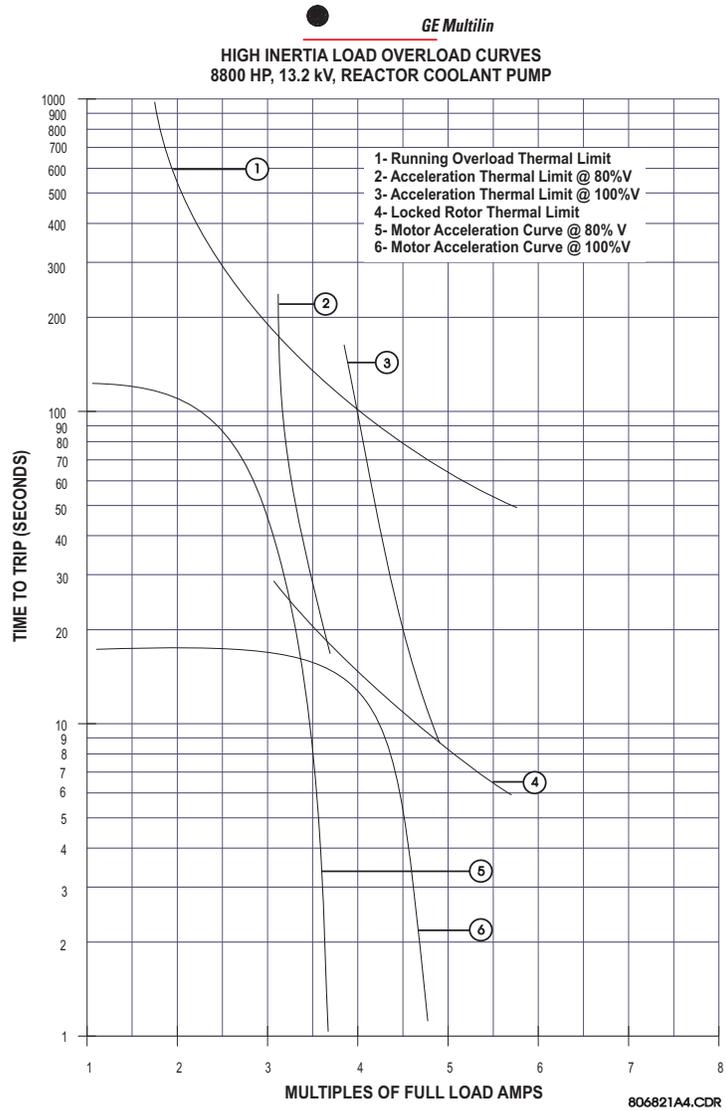


FIGURE 5-8: Thermal Limits for High Inertial Load

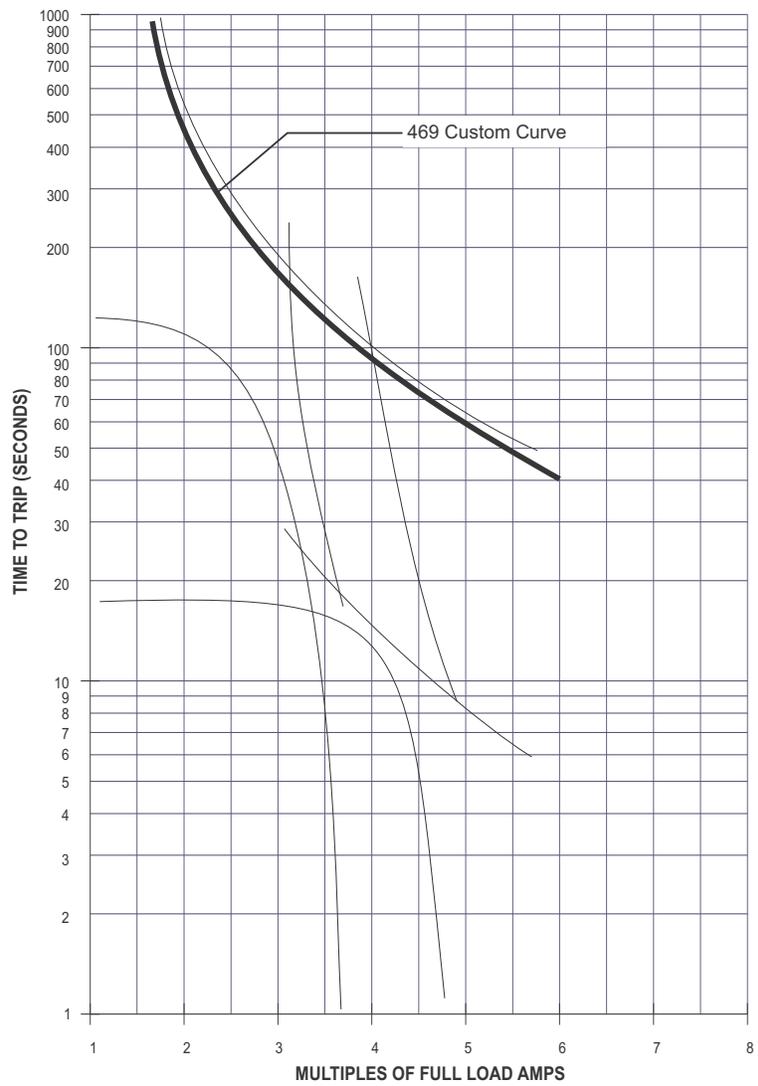
To illustrate the Voltage Dependent Overload Curve feature, the thermal limits of FIGURE 5-8: *Thermal Limits for High Inertial Load* will be used.

1. Construct a custom curve for the running overload thermal limit. If the curve does not extend to the acceleration thermal limits, extend it such that the curve intersects the acceleration thermal limit curves (see the Custom Curve below).
2. Enter the per unit current value for the acceleration overload curve intersect with the custom curve for 80% line voltage. Also enter the per unit current and safe stall protection time for 80% line voltage (see the Acceleration Curves below).
3. Enter the per unit current value for the acceleration overload curve intersect with the custom curve for 100% line voltage. Also enter the per unit current and safe stall protection time for 100% line voltage (see the Acceleration Curves below).



GE Multiin

**HIGH INERTIA LOAD OVERLOAD CURVES
8800 HP, 13.2 kV, REACTOR COOLANT PUMP**



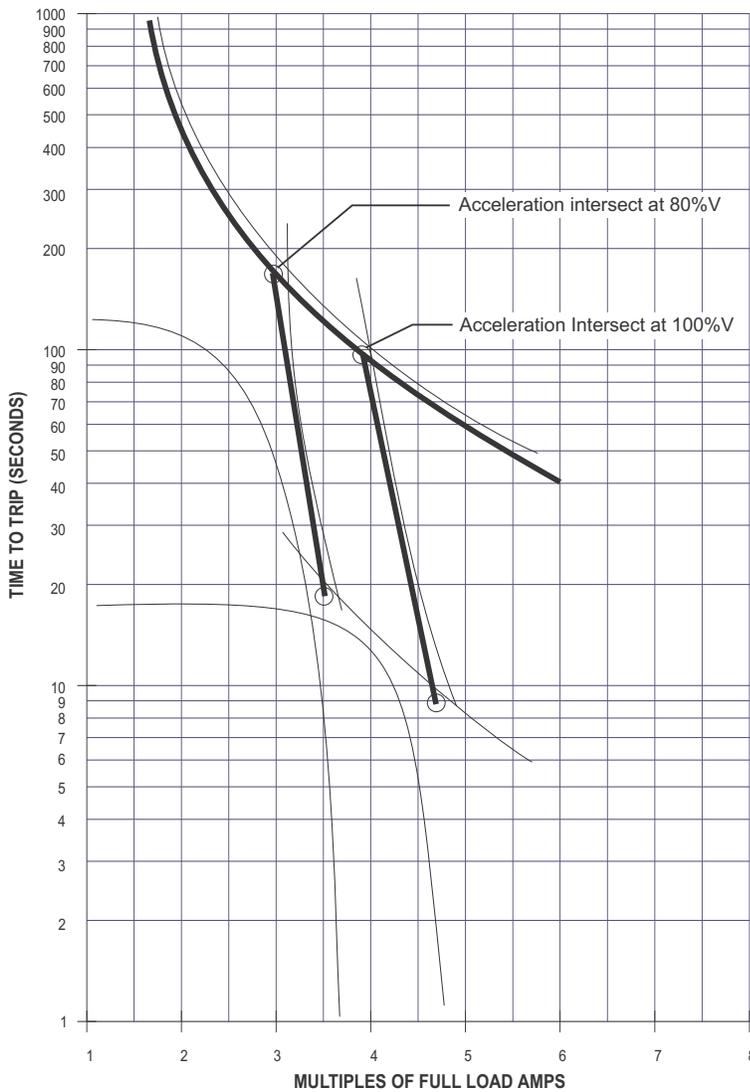
806822A4.CDR

FIGURE 5-9: Voltage Dependent Overload Curve (Custom Curve)



GE Multilin

**HIGH INERTIA LOAD OVERLOAD CURVES
8800 HP, 13.2 kV, REACTOR COOLANT PUMP**



806823A4.CDR

FIGURE 5-10: Voltage Dependent Overload Curves (Acceleration Curves)

The 469 takes the information provided and create protection curves for any voltage between the minimum and 100%. For values above the voltage in question, the 469 extrapolates the safe stall protection curve to 110% voltage. This current level is calculated by taking the locked rotor current at 100% voltage and multiplying by 1.10. For trip times above the 110% voltage level, the trip time of 110% will be used (see figure below).

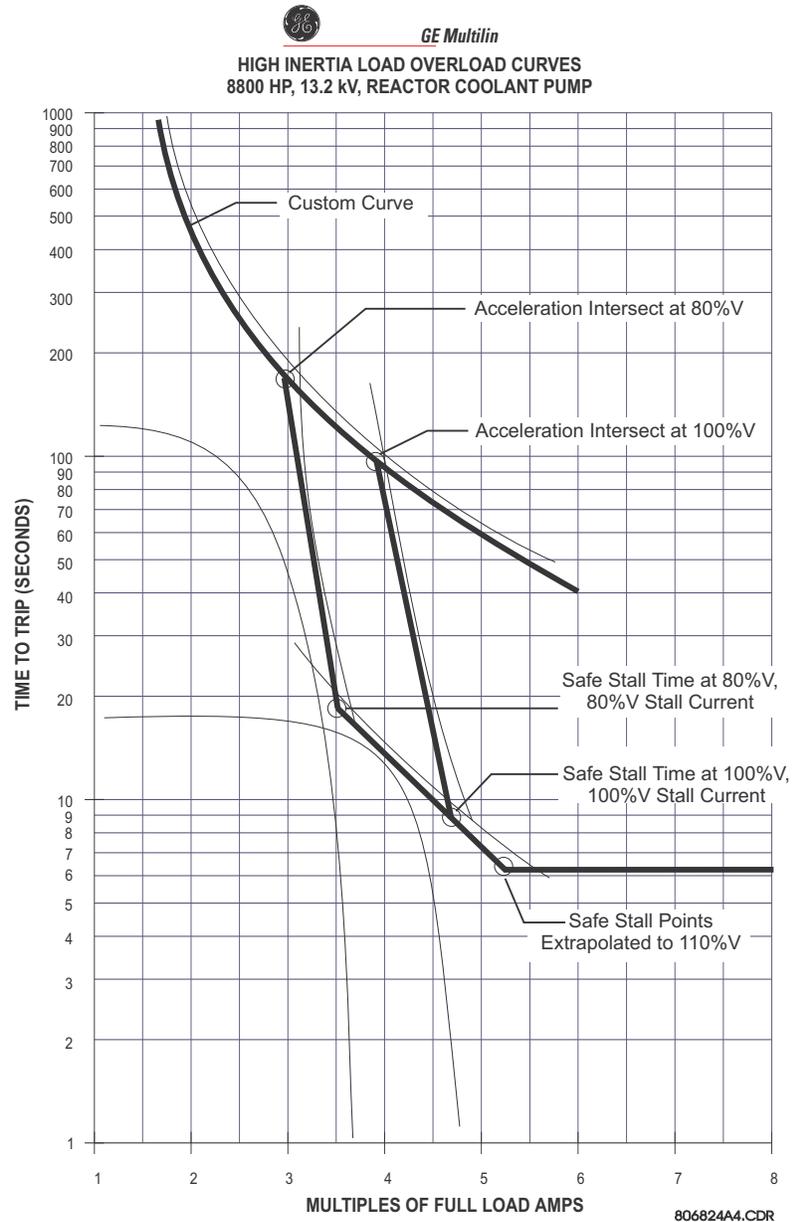


FIGURE 5-11: Voltage Dependent Overload Protection Curves



The safe stall curve is in reality a series of safe stall points for different voltages. For a given voltage, there can only be one value of stall current and therefore, only one safe stall time.

The following two figures illustrate the resultant overload protection curves for 80% and 100% line voltage, respectively. For voltages in between, the 469 will shift the acceleration curve linearly and constantly based on measured line voltage during a motor start.

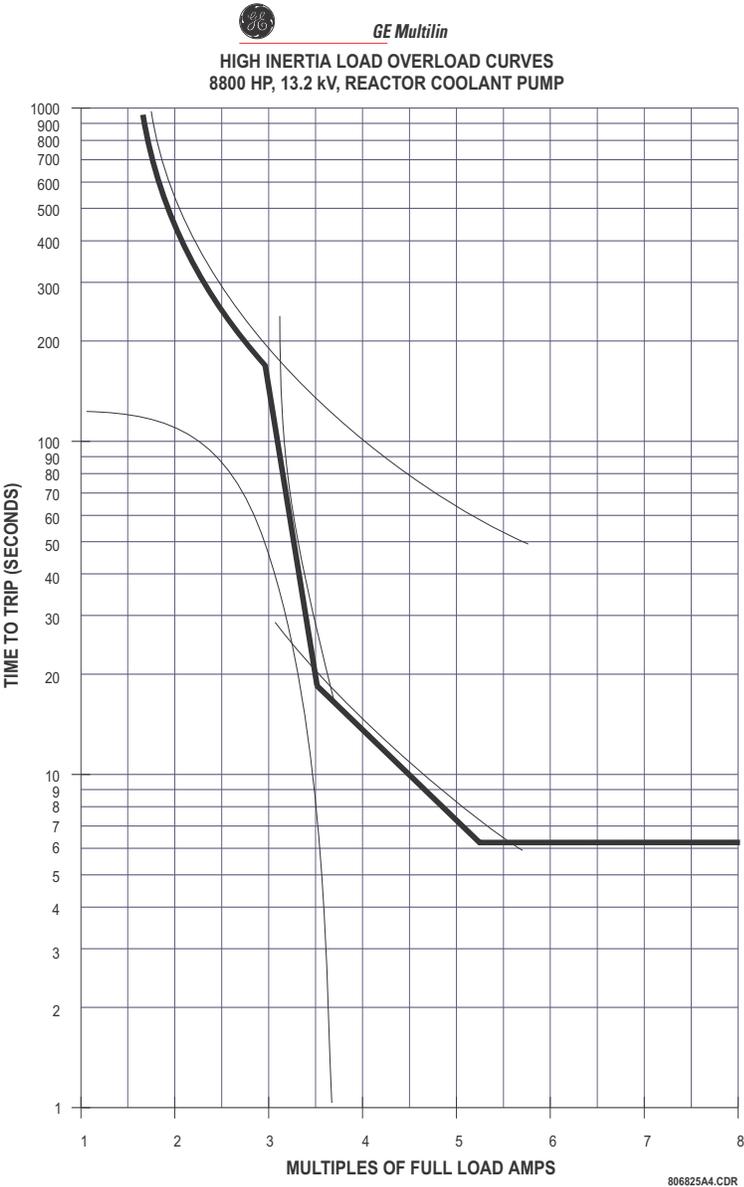


FIGURE 5-12: Voltage Dependent Overload Protection at 80% Voltage

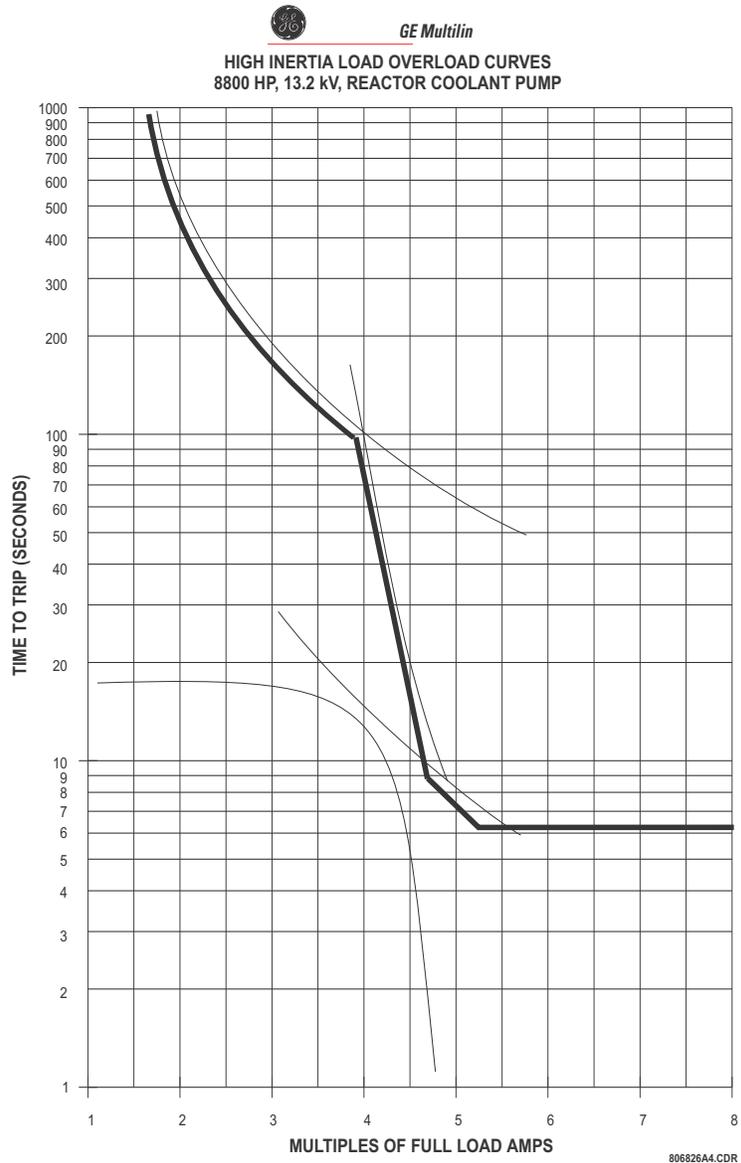


FIGURE 5-13: Voltage Dependent Overload Protection at 100% Voltage

Unbalance Bias

Unbalanced phase currents also cause additional rotor heating not accounted for by electromechanical relays and also not accounted for in some electronic protective relays. When the motor is running, the rotor rotates in the direction of the positive-sequence current at near synchronous speed. Negative-sequence current, with a phase rotation opposite to positive-sequence current (and hence, opposite to the rotor rotation), generates a rotor voltage that produces a substantial rotor current. This induced current has a frequency approximately 2 times the line frequency: 100 Hz for a 50 Hz system or 120 Hz for a 60 Hz system. The skin effect in the rotor bars at this frequency causes a significant increase in rotor resistance and therefore a significant increase in rotor heating.

This extra heating is not accounted for in the thermal limit curves supplied by the motor manufacturer, as these curves assume only positive-sequence currents from a perfectly balanced supply and motor design.

The 469 measures the ratio of negative to positive-sequence current. The thermal model may be biased to reflect the additional heating that is caused by negative sequence current when the motor is running. This biasing is accomplished by creating an equivalent motor heating current rather than simply using average current (I_{per_unit}). This equivalent current is calculated as shown below.

$$I_{eq} = \sqrt{I_{per_unit}^2 \cdot \left(1 + k \cdot \left(\frac{I_2}{I_1}\right)^2\right)} \tag{EQ 5.3}$$

- where: I_{eq} = equivalent motor heating current
- I_{per_unit} = per unit current based on FLA
- I_2 = negative sequence current, I_1 = positive sequence current
- k = constant

The figure below shows recommended motor derating as a function of voltage unbalance recommended by NEMA (the National Electrical Manufacturers Association). Assuming a typical induction motor with an inrush of 6 × FLA and a negative sequence impedance of 0.167, voltage unbalances of 1, 2, 3, 4, and 5% equal current unbalances of 6, 12, 18, 24, and 30% respectively. Based on this assumption, the GE Digital Energy curve illustrates the motor derating for different values of k entered for the **UNBALANCE BIAS K FACTOR** settings. Note that the curve created when $k = 8$ is almost identical to the NEMA derating curve.

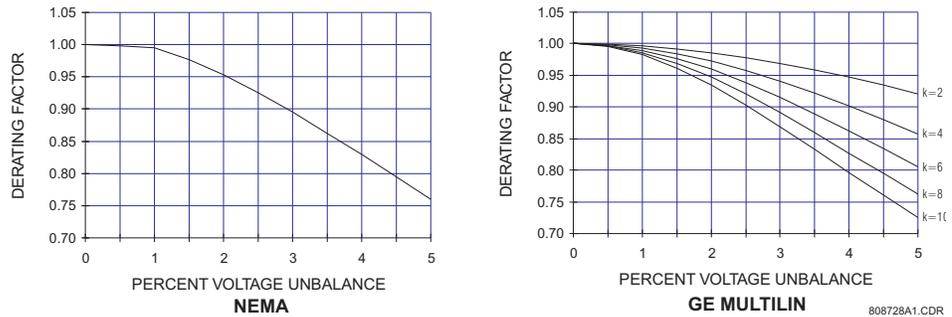


FIGURE 5-14: Medium Motor Derating Factor due to Unbalanced Voltage

If a k value of 0 is entered, the unbalance biasing is defeated and the overload curve will time out against the measured per unit motor current. k may be calculated as:

$$k = \frac{175}{I_{LR}^2} \text{ (typical estimate); } k = \frac{230}{I_{LR}^2} \text{ (conservative estimate)} \tag{EQ 5.4}$$

where I_{LR} is the per-unit locked rotor current.

Motor Cooling

The thermal capacity used value decreases exponentially when the motor current is less than the **OVERLOAD PICKUP** settings. This reduction simulates motor cooling. The motor cooling time constants should be entered for both stopped and running cases. Since cooling is exponential, the time constants are one-fifth of the total time from 100% thermal capacity used to 0%. A stopped motor normally cools significantly slower than a running motor. Motor cooling is calculated as:

$$TC_{used} = (TC_{used_start} - TC_{used_end})(e^{-t/\tau}) + TC_{used_end} \tag{EQ 5.5}$$

$$TC_{used_end} = \left(\frac{I_{eq}}{ol_pkp}\right)\left(1 - \frac{hot}{cold}\right) \times 100\% \tag{EQ 5.6}$$

where: TC_{used} = thermal capacity used
 TC_{used_start} = TC_{used} value caused by overload condition
 TC_{used_end} = TC_{used} value dictated by the hot/cold safe stall ratio when the motor is running (= 0 when the motor is stopped)
 t = time in minutes
 τ = Cool Time Constant (running or stopped)
 I_{eq} = equivalent motor heating current
 ol_pkp = overload pickup settings as a multiple of FLA
 $hot / cold$ = hot/cold safe stall ratio

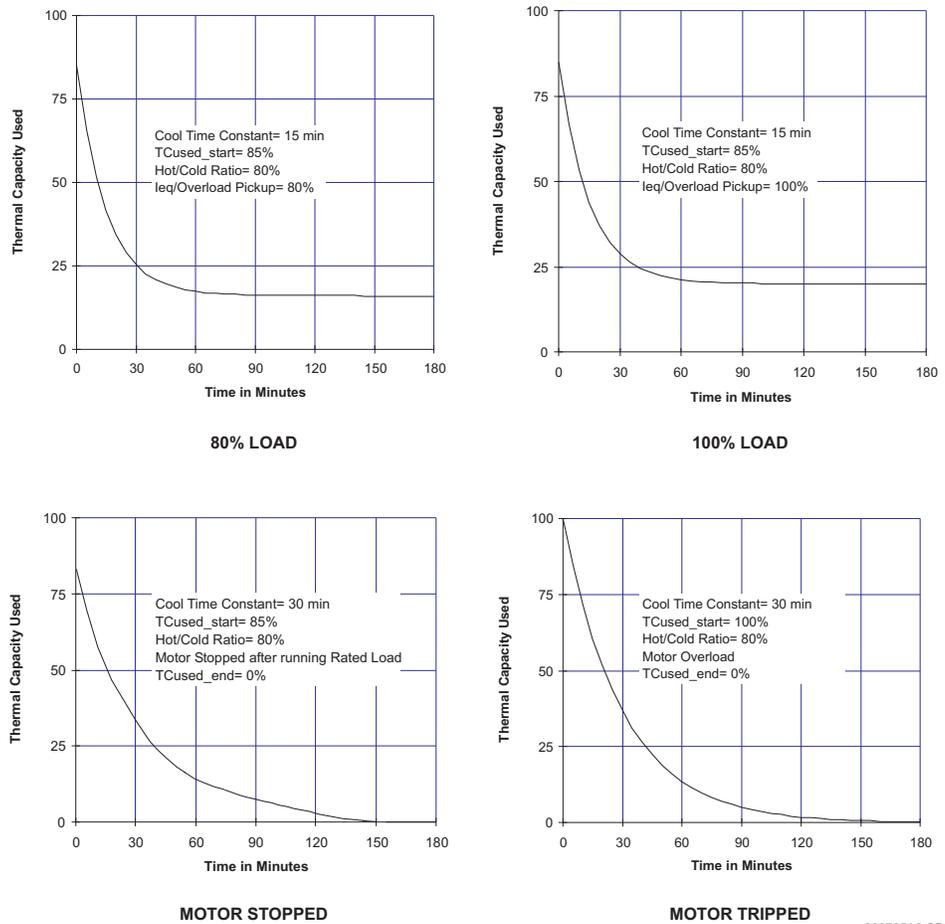


FIGURE 5-15: Thermal Model Cooling

808705A2.CDR

Hot/Cold Safe Stall Ratio

The motor manufacturer may provide thermal limit information for a hot/cold motor. The 469 thermal model adapts for these conditions if the **HOT/COLD SAFE STALL RATIO** settings is programmed. This settings value dictates the level of thermal capacity used the relay will settle at for current levels below the **OVERLOAD PICKUP LEVEL**. When the motor is running

at a level that is below the **OVERLOAD PICKUP LEVEL**, the **THERMAL CAPACITY USED** register will rise or fall to a value based on the average phase current and the **HOT/COLD SAFE STALL RATIO** settings. The **THERMAL CAPACITY USED** will either rise at a fixed rate of 5% per minute or fall as dictated by the running cool time constant.

$$TC_{used_end} = I_{eq} \times \left(1 - \frac{hot}{cold}\right) \times 100\% \quad (\text{EQ 5.7})$$

where: TC_{used_end} = **THERMAL CAPACITY USED** if I_{per_unit} remains steady state
 I_{eq} = equivalent motor heating current
 hot / cold = **HOT/COLD SAFE STALL RATIO** settings

The **HOT/COLD SAFE STALL RATIO** may be determined from the thermal limit curves if provided or the hot and cold safe stall times. Simply divide the hot safe stall time by the cold safe stall time. If hot and cold times are not provided, there can be no differentiation and the **HOT/COLD SAFE STALL RATIO** should be entered as "1.00".

RTD Bias

The 469 thermal replica operates as a complete and independent model. However, the thermal overload curves are based solely on measured current, assuming normal 40°C ambient and normal motor cooling. If the ambient temperature is unusually high, or motor cooling is blocked, the motor temperature will increase. If the motor stator has embedded RTDs, the RTD bias feature should be used to correct the thermal model.

The RTD bias feature is a two-part curve, constructed using 3 points. If the maximum stator RTD temperature is below the **RTD BIAS MINIMUM** settings (typically 40°C), no biasing occurs. If the maximum stator RTD temperature is above the **RTD BIAS MAXIMUM** (typically at the stator insulation rating or slightly higher), then the thermal memory is fully biased and **THERMAL CAPACITY USED** is forced to "100%". At values between the maximum and minimum, the **THERMAL CAPACITY USED** created by the overload curve and the thermal model is compared to the RTD Bias thermal capacity used from the RTD Bias curve. If the RTD Bias thermal capacity used value is higher, then that value is used from that point onward. The **RTD BIAS CENTER POINT** should be set at the rated motor running temperature. The 469 automatically determines the **THERMAL CAPACITY USED** value for the center point using the **HOT/COLD SAFE STALL RATIO** settings.

$$TC_{used\ at\ RBC} = (1 - hot/cold) \times 100\% \quad (\text{EQ 5.8})$$

At < RTD_Bias_Center temperature,

$$RTD_Bias_TC_{used} = \frac{T_{actual} - T_{min}}{T_{center} - T_{min}} \times TC_{used\ at\ RBC} \quad (\text{EQ 5.9})$$

At > RTD_Bias_Center temperature,

$$RTD_Bias_TC_{used} = \frac{T_{actual} - T_{center}}{T_{max} - T_{center}} \times (100 - TC_{used\ at\ RBC}) + TC_{used\ at\ RBC} \quad (\text{EQ 5.10})$$

where: $RTD_Bias_TC_{used}$ = TC used due to hottest stator RTD
 T_{actual} = current temperature of the hottest stator RTD
 T_{min} = RTD Bias minimum settings, T_{center} = RTD Bias center settings
 T_{max} = RTD Bias maximum settings
 $TC_{used\ at\ RBC}$ = TC used defined by the **HOT/COLD SAFE STALL RATIO** settings

In simple terms, the RTD bias feature is real feedback of the measured stator temperature. This feedback acts as correction of the thermal model for unforeseen situations. Since RTDs are relatively slow to respond, RTD biasing is good for correction and slow motor heating. The rest of the thermal model is required during starting and heavy overload conditions when motor heating is relatively fast.

Note that the RTD bias feature alone cannot create a trip. If the RTD bias forces thermal capacity used to 100%, the motor current must be above the overload pickup before an overload trip occurs. Presumably, the motor would trip on stator RTD temperature at that time.

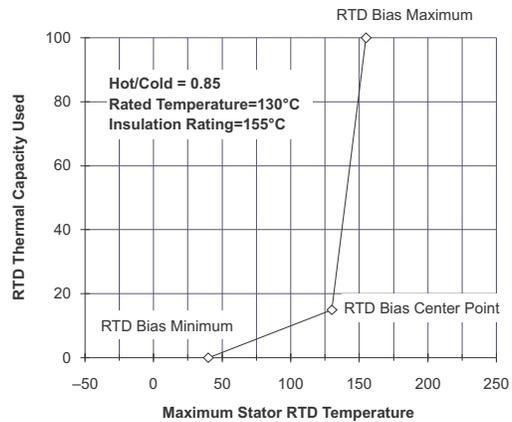


FIGURE 5-16: RTD Bias Curve

5.7 S6 Current Elements

5.7.1 Short Circuit Trip

PATH: SETTINGS ▾ ▾ S6 CURRENT ELEM. ▾ SHORT CIRCUIT TRIP

■ SHORT CIRCUIT TRIP [▷]		SHORT CIRCUIT TRIP: Off	Range: Off, Latched, Unlatched
MESSAGE		SHORT CIRCUIT TRIP OVERREACH FILTER: Off	Range: On, Off
MESSAGE		ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Aux 2, Trip & Aux2 & Aux3, Trip & Aux3, Aux2, Aux2 & Aux3, Aux3
MESSAGE		SHORT CIRCUIT TRIP PICKUP: 10.0 x CT	Range: 2.0 to 20.0 x CT in steps of 0.1
MESSAGE		INTENTIONAL S/C TRIP DELAY: 0 ms	Range: 0 to 1000 ms in steps of 10
MESSAGE		SHORT CIRCUIT TRIP BACKUP: Off	Range: On, Off
MESSAGE		ASSIGN BACKUP RELAYS: Auxiliary2	Range: Auxiliary2, Aux2 & Aux3, Auxiliary3
MESSAGE		SHORT CIRCUIT TRIP BACKUP DELAY: 200 ms	Range: 10 to 2000 ms in steps of 10

WARNING

Care must be taken when turning On this feature. If the interrupting device (contactor or circuit breaker) is not rated to break the fault current, this feature should be disabled. Alternatively, this feature may be assigned to an auxiliary relay and connected such that it trips an upstream device that is capable of breaking the fault current.

If turned on, the Short Circuit element functions as follows.

A trip occurs once the magnitude of either I_a , I_b , or I_c exceeds the Pickup Level \times Phase CT Primary for the time specified by **INTENTIONAL S/C TRIP DELAY**. A backup trip feature may also be enabled. The **SHORT CIRCUIT TRIP BACKUP DELAY** should be greater than the **INTENTIONAL S/C TRIP DELAY** plus the breaker clearing time. If the **SHORT CIRCUIT TRIP BACKUP** is "On" and a Short Circuit trip has initiated, a second trip occurs if the motor phase current persists for a time exceeding the **SHORT CIRCUIT TRIP BACKUP DELAY**. It is intended that this second trip be assigned to 2 Auxiliary or 3 Auxiliary which would be dedicated as an upstream breaker trip relay. Whenever the output relay assigned to backup trip operates, it will remain latched regardless of how the trip relay is configured for the Short Circuit Trip element.

Various situations (e.g. charging a long line to the motor or power factor correction capacitors) may cause transient inrush currents during motor starting that may exceed the **SHORT CIRCUIT TRIP PICKUP** level for a very short period of time. The **INTENTIONAL S/C TRIP DELAY** is adjustable in 10 ms increments. This delay can be fine tuned to an application so it still responds very fast but rides through normal operational disturbances. Normally, the **INTENTIONAL S/C TRIP DELAY** is set as quick as possible, 0 ms. This time may

be increased if nuisance tripping occurs.

When a motor starts, the starting current (typically $6 \times \text{FLA}$ for an induction motor) has an asymmetrical component. This asymmetrical current may cause one phase to see as much as 1.6 times the normal RMS starting current. If the **SHORT CIRCUIT TRIP PICKUP** was set at 1.25 times the symmetrical starting current, it is probable that there would be nuisance trips during motor starting. A rule of thumb has been developed over time that short circuit protection at least 1.6 times the symmetrical starting current value. This allows the motor to start without nuisance tripping.

The overreach filter removes the DC component from the asymmetrical current present at the moment of fault. This eliminates overreach; however, the response time slows slightly (10 to 15 ms) but remains within specification.

5.7.2 Overload Alarm

PATH: SETTINGS ▾ ▾ S6 CURRENT ELEM. ▾ ▾ OVERLOAD ALARM

<input checked="" type="checkbox"/> OVERLOAD ALARM [▷]		OVERLOAD ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Auxiliary2, Auxiliary3, Alarm & Aux2, Alarm & Aux3, Aux2 & Aux3, Alarm & Aux2 & Aux3, None
MESSAGE		OVERLOAD ALARM DELAY: 0.1 s	Range: 0.1 to 60 s in steps of 0.1
MESSAGE		OVERLOAD ALARM EVENTS: Off	Range: On, Off

If enabled as “Latched” or “Unlatched”, the Overload Alarm functions as follows. After a motor start, when the equivalent motor heating current exceeds the **OVERLOAD PICKUP LEVEL**, an alarm will occur. If programmed as “Unlatched”, the overload alarm resets itself when the motor is no longer in overload. If programmed as “Latched”, the RESET key must be pressed to reset the alarm once the overload condition is gone. Event recording for all alarm features is optional.

For example, it may be desirable to have an unlatched alarm connected to a PLC that is controlling the load on a motor.

5.7.3 Mechanical Jam

PATH: SETTINGS ▾ ▾ S6 CURRENT ELEM. ▾ ▾ MECHANICAL JAM

<input checked="" type="checkbox"/> MECHANICAL JAM [▷]		MECHANICAL JAM TRIP: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3
MESSAGE		MECHANICAL JAM PICKUP: 1.50 x FLA	Range: 1.01 to 3.00 x FLA in steps of 0.01
MESSAGE		MECHANICAL JAM DELAY: 1 s	Range: 1 to 30 s in steps of 1

If turned On, the Mechanical Jam element function as follows. After a motor start, a Trip occurs once the magnitude of Ia, Ib, or Ic exceeds the Pickup Level \times FLA for a period of time specified by the **MECHANICAL JAM DELAY** settings. This feature may be used to indicate a stall condition when running. Not only does it protect the motor by taking it off-line quicker than the thermal model (overload curve), it may also prevent or limit damage to the driven equipment if motor starting torque persists on jammed or broken equipment.

The **MECHANICAL JAM PICKUP** level should be set higher than motor loading during normal operation, but lower than the motor stall level. Normally the delay is set to the minimum time delay or set so that no nuisance trips occur due to momentary load fluctuations.

5.7.4 Undercurrent

PATH: SETTINGS \triangleright S6 CURRENT ELEM. \triangleright UNDERCURRENT

<input checked="" type="checkbox"/> UNDERCURRENT [\triangleright]		BLOCK UNDERCURRENT FROM START: 0 s	Range: 0 to 15000 s in steps of 1
MESSAGE		UNDERCURRENT ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE		UNDERCURRENT ALARM PICKUP: 0.70 \times FLA	Range: 0.10 to 0.95 \times FLA in steps of 0.01
MESSAGE		UNDERCURRENT ALARM DELAY: 1 s	Range: 1 to 60 s in steps of 1
MESSAGE		UNDERCURRENT ALARM EVENTS: Off	Range: On, Off
MESSAGE		UNDERCURRENT TRIP: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3
MESSAGE		UNDERCURRENT TRIP PICKUP: 0.70 \times FLA	Range: 0.10 to 0.99 \times FLA in steps of 0.01
MESSAGE		UNDERCURRENT TRIP DELAY: 1 s	Range: 1 to 60 s in steps of 1

A trip or alarm will occur once the magnitude Ia, Ib, or Ic falls below the pickup level \times FLA for the time specified by the **UNDERCURRENT ALARM DELAY**. The Undercurrent element is active only when the motor is running. It is blocked upon the initiation of a motor start for the time defined by the **U/C BLOCK FROM START** settings (e.g. this block may be used to allow pumps to build up head before the undercurrent element trips). A value of "0" means the feature is not blocked from start. If a value other than "0" is entered, the feature is disabled when the motor is stopped and also from the time a start is detected until the time entered expires. The **UNDERCURRENT ALARM PICKUP** level should be set lower than motor loading during normal operations.

For example, if a pump is cooled by the liquid it pumps, loss of load may mean that the pump overheats. In this case, enable the undercurrent feature. If the motor loading should never fall below $0.75 \times \text{FLA}$, even for short durations, the **UNDERCURRENT TRIP PICKUP** could be set to “0.70” and the **UNDERCURRENT ALARM PICKUP** to “0.75”. If the pump is always started loaded, the **BLOCK UNDERCURRENT FROM START** settings should be disabled (programmed as “0”).

The **UNDERCURRENT ALARM DELAY** or **UNDERCURRENT TRIP DELAY** is typically set as quick as possible, i.e. 1 second.

5.7.5 Current Unbalance

PATH: SETTINGS ▾ ▾ S6 CURRENT ELEM. ▾ ▾ CURRENT UNBALANCE

■ CURRENT UNBALANCE [▷]		CURRENT UNBALANCE ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE		CURRENT UNBALANCE ALARM PICKUP: 15%	Range: 4 to 40% in steps of 1
MESSAGE		CURRENT UNBALANCE ALARM DELAY: 1 s	Range: 1 to 60 s in steps of 1
MESSAGE		CURRENT UNBALANCE ALARM EVENTS: Off	Range: On, Off
MESSAGE		CURRENT UNBALANCE TRIP: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3
MESSAGE		CURRENT UNBALANCE TRIP PICKUP: 20%	Range: 4 to 40% in steps of 1
MESSAGE		CURRENT UNBALANCE TRIP DELAY: 1 s	Range: 1 to 60 s in steps of 1

For the 469 relay, unbalance is defined as the ratio of negative-sequence to positive-sequence current, I_2 / I_1 , if the motor is operating at a load (I_{avg}) greater than FLA. If the motor I_{avg} is less than FLA, unbalance is defined as $I_2 / I_1 \times I_{avg} / \text{FLA}$. This derating is necessary to prevent nuisance alarms when a motor is lightly loaded. If enabled, a trip and/or alarm occurs once the unbalance magnitude equals or exceeds the **CURRENT UNBALANCE ALARM(TRIP) PICKUP** for a period of time specified by the **CURRENT UNBALANCE ALARM(TRIP) DELAY**. If the unbalance level equals or exceeds 40%, or when $I_{avg} \geq 25\% \text{ FLA}$ and current in any one phase is zero, the motor is considered single phasing and a trip occurs within 2 seconds. Single phasing protection is disabled if the unbalance trip feature is turned “Off”.

When setting the **CURRENT UNBALANCE ALARM(TRIP) PICKUP** level, note that a 1% voltage unbalance typically translates into a 6% current unbalance. Therefore, to prevent nuisance trips or alarms, the pickup level should not be set too low. Also, since short term

unbalances are common, a reasonable delay should be set to avoid nuisance trips or alarms. The unbalance bias feature is recommended to bias the thermal model for motor heating caused by cyclic short term unbalances (see page –55 for details).



Unusually high unbalance levels may be caused by incorrect phase CT wiring.

For example, fluctuations of current unbalance levels are typically caused by the supply voltage. It may be desirable to have a latched alarm to capture any such fluctuations that go beyond the Unbalance Alarm parameters. Also, a trip is recommended.

If the supply voltage is normally unbalanced up to 2%, the current unbalance seen by a typical motor is $2 \times 6 = 12\%$. In this case, set the **CURRENT UNBALANCE ALARM PICKUP** to “15” and the **CURRENT UNBALANCE TRIP PICKUP** to “20” to prevent nuisance tripping; 5 or 10 seconds is a reasonable delay.

5.7.6 Ground Fault

PATH: SETTINGS ▷ ▾ S6 CURRENT ELEM. ▷ ▾ GROUND FAULT

■	GROUND FAULT [▷]		GROUND FAULT OVERREACH FILTER: Off	Range: On, Off
MESSAGE			GROUND FAULT ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE			ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE			GROUND FAULT ALARM PICKUP: 0.10 x CT	Range: 0.1 to 1.00 x CT in steps of 0.01 or 0.25 to 25 A in steps of 0.01
MESSAGE			INTENTIONAL GF ALARM DELAY: 0 ms	Range: 0 to 1000 ms in steps of 1
MESSAGE			GROUND FAULT ALARM EVENTS: Off	Range: On, Off
MESSAGE			GROUND FAULT TRIP: Off	Range: Off, Latched, Unlatched
MESSAGE			ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3
MESSAGE			GROUND FAULT TRIP PICKUP: 0.20 x CT	Range: 0.1 to 1.00 x CT in steps of 0.01 or 0.25 to 25 A in steps of 0.01
MESSAGE			INTENTIONAL GF TRIP DELAY: 0 ms	Range: 0 to 1000 ms in steps of 1
MESSAGE			GROUND FAULT TRIP BACKUP: Off	Range: On, Off
MESSAGE			ASSIGN BACKUP RELAYS: Auxiliary2	Range: Auxiliary2, Aux2 & Aux3, Auxiliary3

MESSAGE  **GROUND FAULT TRIP**
BACKUP DELAY: 200 ms *Range: 10 to 2000 ms in steps of 10*



The **GROUND FAULT ALARM PICKUP** and **GROUND FAULT TRIP PICKUP** settings are entered in units of '× CT' if the Ground CT is programmed as 1 A or 5 A Secondary or in units of 'A' if the Ground CT is programmed as "50:0.025".

The Ground Fault element functions as follows. Once the ground current magnitude exceeds the Pickup Level × **GROUND CT PRIMARY** (see 5.3.1: Current Sensing on page –18) for the time specified by the delay, a trip and/or alarm will occur. There is also a backup trip feature that can be enabled. If the **GROUND FAULT TRIP BACKUP** is "On", and a Ground Fault trip has initiated, a second trip will occur if the ground current persists longer than the **GROUND FAULT TRIP BACKUP DELAY**. It is intended that this second trip be assigned to 2 Auxiliary or 3 Auxiliary, which would be dedicated as an upstream breaker trip relay. The **GROUND FAULT TRIP BACKUP DELAY** must be set to a time longer than the breaker clearing time. Whenever the output relay assigned to the backup trip operates, it will stay latched regardless of how the trip relay is configured for the Ground Fault element.



Care must be taken when turning On this feature. If the interrupting device (contactor or circuit breaker) is not rated to break ground fault current (low resistance or solidly grounded systems), the feature should be disabled. Alternately, the feature may be assigned to an auxiliary relay and connected such that it trips an upstream device that is capable of breaking the fault current.

Various situations (e.g. contactor bounce) may cause transient ground currents during motor starting that may exceed the Ground Fault pickup levels for a very short period of time. The Ground Fault time delays are adjustable in 10 ms increments. The delay can be fine tuned to an application such that it still responds very fast, but rides through normal operational disturbances. Normally, the Ground Fault time delays are set as quick as possible, that is, 0 ms. Time may have to be increased if nuisance tripping occurs.

Special care must be taken when the ground input is wired to the phase CTs in a residual connection. When a motor starts, the starting current (typically 6 × FLA for an induction motor) has an asymmetrical component. This asymmetrical current may cause one phase to see as much as 1.6 times the normal RMS starting current. This momentary DC component will cause each of the phase CTs to react differently and the net current into the ground input of the 469 will not be negligible. A 20 ms block of the ground fault elements when the motor starts enables the 469 to ride through this momentary ground current signal.

The overreach filter removed the DC component from the asymmetrical current present at the moment a fault occurs. This results in no overreach whatsoever, however, the response time slows slightly (10 to 15 ms) but times still remain within specifications.

5.7.7 Phase Differential

PATH: SETTINGS ▷ ▾ S6 CURRENT ELEM. ▷ ▾ PHASE DIFFERENTIAL

■ PHASE DIFFERENTIAL [**▷**]  **PHASE DIFFERENTIAL**
TRIP: Off *Range: Off, Latched, Unlatched*

MESSAGE		ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Auxiliary2, Aux2 & Aux3, Auxiliary3
MESSAGE		STARTING DIFF. TRIP PICKUP: 0.10 x CT	Range: 0.05 to 1.00 x CT in steps of 0.01
MESSAGE		STARTING DIFF. TRIP DELAY: 0 ms	Range: 0 to 60000 ms in steps of 10
MESSAGE		RUNNING DIFF. TRIP PICKUP: 0.10 x CT	Range: 0.05 to 1.00 x CT in steps of 0.01
MESSAGE		RUNNING DIFF. TRIP DELAY: 0 ms	Range: 0 to 1000 ms in steps of 10

These settings program the differential element when the differential feature is in use. This feature consists of three instantaneous overcurrent elements for phase differential protection. Differential protection may be considered first line protection for phase to phase or phase to ground faults. In the event of such a fault, differential protection may limit the damage that may occur.



NOTE

Care must be taken when enabling this feature. If the interrupting device (contactor or circuit breaker) is not rated to break potential faults, the feature should be disabled. Alternately, the feature may be assigned to an auxiliary relay and connected such that it trips an upstream device that is capable of breaking the fault current. A low level differential fault can develop into a short circuit in an instant.

A trip occurs once the magnitude of either $I_{aIN} - I_{aOUT}$, $I_{bIN} - I_{bOUT}$, or $I_{cIN} - I_{cOUT}$ (phase differential) exceeds the Pickup Level \times Differential CT Primary for a period of time specified by the delay. Separate pickup levels and delays are provided for motor starting and running conditions.

The Differential trip element is programmable as a fraction of the rated CT. The level may be set more sensitive if the Differential CTs are connected in a flux balancing configuration (3 CTs). If 6 CTs are used in a summing configuration, the values from the two CTs on each phase during motor starting may not be equal since the CTs are not perfectly identical (asymmetrical currents may cause the CTs on each phase to have different outputs). To prevent nuisance tripping in this configuration, the **STARTING DIFF. TRIP PICKUP** level may have to be set less sensitive, or the **STARTING DIFF. TRIP DELAY** may have to be extended to ride through the problem period during start. The running differential delay can then be fine tuned to an application such that it responds very fast to sensitive (low) differential current levels.

5.8 S7 Motor Starting

5.8.1 Acceleration Timer

PATH: SETTINGS ▷ ▾ S7 MOTOR STARTING ▷ ACCELERATION TIMER

<div style="border: 1px solid black; padding: 5px; display: inline-block;"> ■ ACCELERATION TIMER [▷] </div>		ACCELERATION TIMER TRIP: Off	Range: Off, Latched, Unlatched	
	MESSAGE		ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3
	MESSAGE		ACCELERATION TIMER FROM START: 10.0 s	Range: 1.0 to 250.0 s in steps of 0.1

The thermal model protects the motor under both starting and overload conditions. The acceleration timer trip may be used to complement this protection. For example, if the motor always starts in 2 seconds, but the safe stall time is 8 seconds, there is no point letting the motor remain in a stall condition for 7 or 8 seconds when the thermal model would take it off line. Furthermore, the starting torque applied to the driven equipment for that period of time could cause severe damage.

If enabled, the Acceleration Timer functions as follows. A motor start is assumed to be occurring when the 469 measures the transition of no motor current to some value of motor current. Typically current rises quickly to a value in excess of FLA (e.g. 6 x FLA). At this point, the acceleration timer will be initialized with the **ACCELERATION TIMER FROM START** value in seconds. If the current does not fall below the overload curve pickup level before the timer expires, an acceleration trip will occur. If the acceleration time of the motor is variable, this feature should be set just beyond the longest acceleration time.

Some motor soft-starters allow current to ramp up slowly while others limit current to less than FLA throughout the start. Since the 469 is a generic motor relay, it cannot differentiate between a motor with a slow ramp up time and one that has completed a start and gone into overload. Therefore, if the motor current does not rise to greater than full load within 1 second on start, the acceleration timer feature is ignored. In any case, the motor is still protected by the overload curve.

5.8.2 Start Inhibit

PATH: SETTINGS ▷ ▾ S7 MOTOR STARTING ▷ ▾ START INHIBIT

<div style="border: 1px solid black; padding: 5px; display: inline-block;"> ■ START INHIBIT [▷] </div>		START INHIBIT BLOCK: Off	Range: On, Off
	MESSAGE		TC USED MARGIN: 25%

The Start Inhibit feature prevents motor starting if there is insufficient thermal capacity. The largest **THERMAL CAPACITY USED** value from the last five successful starts is multiplied by (1 + **TC USED MARGIN**) and stored as the **LEARNED STARTING CAPACITY**. This thermal capacity margin ensures a successful motor start. If the number is greater than 100%, 100% is stored as **LEARNED STARTING CAPACITY**. A successful motor start is one in which

phase current rises from 0 to greater than overload pickup and then, after acceleration, falls below the overload curve pickup level. If the Start Inhibit feature is enabled, the amount of thermal capacity available (100% - **THERMAL CAPACITY USED**) is compared to the **LEARNED STARTING CAPACITY** each time the motor is stopped. If the thermal capacity available does not exceed the **LEARNED STARTING CAPACITY**, or is not equal to 100%, the Start Inhibit Block is activated until there is sufficient thermal capacity. When a block occurs, the lockout time will be equal to the time required for the motor to cool to an acceptable start temperature. This time is a function of the **S5 THERMAL MODEL** ⇒ **THERMAL MODEL** ⇒ **COOL TIME CONSTANT STOPPED** settings.

If this feature is turned “Off”, the **THERMAL CAPACITY USED** must reduce to 15% before an overload lockout resets. This feature should be turned off if the load varies for different starts.

For example, if the **THERMAL CAPACITY USED** for the last 5 starts is 24, 23, 27, 25, and 21% respectively, the **LEARNED STARTING CAPACITY** is $27\% \times 1.25 = 33.75\%$ used. If the motor stops with 90% thermal capacity used, a start block will be issued. When the motor has cooled and the level of thermal capacity used has fallen to 66%, a start will be permitted. If the **COOL TIME CONSTANT STOPPED** settings is programmed for 30 minutes, the lockout time will be equal to:

$$\begin{aligned} TC_{\text{used}} &= TC_{\text{used_start}} \times e^{-t/\tau} \Rightarrow 66\% = 90\% \times e^{-t/30} \\ &\Rightarrow t = \ln \frac{66}{90} \times -30 = 9.3 \text{ minutes} \end{aligned} \quad (\text{EQ 5.11})$$

5.8.3 Jogging Block

PATH: SETTINGS ▷ ▾ S7 MOTOR STARTING ▷ ▾ JOGGING BLOCK

<div style="border: 1px solid black; padding: 5px; display: inline-block;"> JOGGING BLOCK [▷] </div>		JOGGING BLOCK: Off	Range: On, Off
	MESSAGE 	MAX. STARTS/HOUR PERMISSIBLE: 3	Range: 1 to 5 in steps of 1
	MESSAGE 	TIME BETWEEN STARTS PERMISSIBLE: 10 min.	Range: 0 to 500 min. in steps of 1

The Jogging Block feature may be used to prevent operators from jogging the motor (multiple starts and stops performed in rapid succession). It consists of two distinct elements: Starts/Hour and Time Between Starts.

The Starts/Hour feature does not guarantee that a certain number of starts or start attempts will be allowed within an hour; rather, it ensures that a certain number of start attempts will not be exceeded within an hour. Similarly, the Time Between Starts feature does not guarantee another start will be permitted if the **TIME BETWEEN STARTS PERMISSIBLE** elapses after the most recent start. Rather, it ensures a minimum time between starts. If however, the first start attempt from cold is unsuccessful due to a jam or it takes long because the process is overloaded, the Thermal Model might reduce the number of starts that can be attempted within an hour. It may also cause a lockout time that exceeds a Time Between Starts lockout that may have been active. Such a thermal lockout will remain until the motor has cooled to an acceptable temperature for a start.

- **Max. Starts/Hour Permissible:** A motor start is assumed to be occurring when the 469 measures the transition of no motor current to some value of motor current. At this point, one of the Starts/Hour timers is loaded with 60 minutes. Even unsuccessful start attempts will be logged as starts for this feature. Once the motor is stopped, the number of starts within the past hour is compared to the number of starts allowable. If the two numbers are the same, a block will occur. If a block occurs, the lockout time will be equal to the longest time elapsed since a start within the past hour, subtracted from one hour.

For example, if **MAX. STARTS/HOUR PERMISSIBLE** is programmed at "2",

- one start occurs at $T = 0$ minutes,
- a second start occurs at $T = 17$ minutes,
- the motor is stopped at $T = 33$ minutes,
- a block occurs,
- the lockout time would be $1 \text{ hour} - 33 \text{ minutes} = 27 \text{ minutes}$.

- **Time Between Starts Permissible:** A motor start is assumed to be occurring when the 469 measures the transition of no motor current to some value of motor current. At this point, the Time Between Starts timer is loaded with the entered time. Even unsuccessful start attempts will be logged as starts for this feature. Once the motor is stopped, if the time elapsed since the most recent start is less than the **TIME BETWEEN STARTS PERMISSIBLE** settings, a block will occur. If a block occurs, the lockout time will be equal to the time elapsed since the most recent start subtracted from the **TIME BETWEEN STARTS PERMISSIBLE**. A value of "0" effectively disables this element.

For example, if **TIME BETWEEN STARTS PERMISSIBLE** is programmed = 25 min.

- a start occurs at $T = 0$ minutes,
- the motor is stopped at $T = 12$ minutes,
- a block occurs,
- the lockout time would be $25 \text{ minutes} - 12 \text{ minutes} = 13 \text{ minutes}$

5.8.4 Restart Block

PATH: SETTINGS ▾ ▾ S7 MOTOR STARTING ▾ ▾ RESTART BLOCK

■ RESTART BLOCK [▷]		RESTART BLOCK: Off	Range: On, Off
MESSAGE 		RESTART BLOCK TIME: 1 s	Range: 1 to 50000 s in steps of 1

The Restart Block feature may be used to ensure that a certain amount of time passes between stopping a motor and restarting that motor. This timer feature may be very useful for some process applications or motor considerations. If a motor is on a down-hole pump, after the motor stops, the liquid may fall back down the pipe and spin the rotor backwards. It would be very undesirable to start the motor at this time. In another scenario, a motor may be driving a very high inertia load. Once the supply to the motor is disconnected, the rotor may continue to turn for a long period of time as it decelerates. The motor has now become a generator and applying supply voltage out of phase may result in catastrophic failure.



The Restart Block feature is strictly a timer. The 469 does not sense rotor rotation.

5.9 S8 RTD Temperature

5.9.1 RTD Types

PATH: SETTINGS ▾ ▾ S8 RTD TEMPERATURE ▾ RTD TYPES

■ RTD TYPES [▷]		STATOR RTD TYPE: 100 Ohm Platinum	Range: see below
MESSAGE		BEARING RTD TYPE: 100 Ohm Platinum	Range: see below
MESSAGE		AMBIENT RTD TYPE: 100 Ohm Platinum	Range: see below
MESSAGE		OTHER RTD TYPE: 100 Ohm Platinum	Range: see below

Each of the twelve RTDs may be configured as “None” or any one of four application types: “Stator”, “Bearing”, “Ambient”, or “Other”. Each of these types may in turn be any one of four different RTD types: “100 Ohm Platinum”, “120 Ohm Nickel”, “100 Ohm Nickel”, or “10 Ohm Copper”. The table below lists RTD resistance versus temperature.

Table 5–2: RTD Temperature vs. Resistance

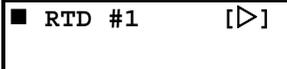
Temperature		100 Ω Pt (DIN 43760)	120 Ω Ni	100 Ω Ni	10 Ω Cu
° C	° F				
-50	-58	80.31	86.17	71.81	7.10
-40	-40	84.27	92.76	77.30	7.49
-30	-22	88.22	99.41	82.84	7.88
-20	-4	92.16	106.15	88.45	8.26
-10	14	96.09	113.00	94.17	8.65
0	32	100.00	120.00	100.00	9.04
10	50	103.90	127.17	105.97	9.42
20	68	107.79	134.52	112.10	9.81
30	86	111.67	142.06	118.38	10.19
40	104	115.54	149.79	124.82	10.58
50	122	119.39	157.74	131.45	10.97
60	140	123.24	165.90	138.25	11.35
70	158	127.07	174.25	145.20	11.74
80	176	130.89	182.84	152.37	12.12
90	194	134.70	191.64	159.70	12.51
100	212	138.50	200.64	167.20	12.90
110	230	142.29	209.85	174.87	13.28
120	248	146.06	219.29	182.75	13.67
130	266	149.82	228.96	190.80	14.06
140	284	153.58	238.85	199.04	14.44
150	302	157.32	248.95	207.45	14.83
160	320	161.04	259.30	216.08	15.22

Table 5–2: RTD Temperature vs. Resistance

Temperature		100 Ω Pt (DIN 43760)	120 Ω Ni	100 Ω Ni	10 Ω Cu
$^{\circ}$ C	$^{\circ}$ F				
170	338	164.76	269.91	224.92	15.61
180	356	168.47	280.77	233.97	16.00
190	374	172.46	291.96	243.30	16.39
200	392	175.84	303.46	252.88	16.78
210	410	179.51	315.31	262.76	17.17
220	428	183.17	327.54	272.94	17.56
230	446	186.82	340.14	283.45	17.95
240	464	190.45	353.14	294.28	18.34
250	482	194.08	366.53	305.44	18.73

5.9.2 RTDs 1 to 6

PATH: SETTINGS \triangleright ∇ S8 RTD TEMPERATURE \triangleright ∇ RTD #1(6)

		RTD #1 APPLICATION: Stator	Range: Stator, Bearing, Ambient, Other, None
MESSAGE		RTD #1 NAME:	Range: 8 alphanumeric characters
MESSAGE		RTD #1 ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE		RTD #1 ALARM TEMPERATURE: 130 $^{\circ}$ C	Range: 1 to 250 $^{\circ}$ C in steps of 1
MESSAGE		RTD #1 HIGH ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE		HIGH ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE		RTD #1 HIGH ALARM TEMPERATURE: 130 $^{\circ}$ C	Range: 1 to 250 in steps of 1
MESSAGE		RTD #1 ALARM EVENTS: Off	Range: On, Off
MESSAGE		RTD #1 TRIP: Off	Range: Off, Latched, Unlatched
MESSAGE		RTD #1 TRIP VOTING: RTD #1	Range: RTD #1 to RTD #12
MESSAGE		ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3

MESSAGE  **RTD #1 TRIP**
TEMPERATURE: 155 °C *Range: 1 to 250°C in steps of 1*

RTDs 1 through 6 default to “Stator” RTD type. There are individual alarm and trip configurations for each RTD. This allows one of the RTDs to be turned off if it malfunctions. The alarm level is normally set slightly above the normal running temperature. The high alarm is usually set as a warning of a trip or to initiate an orderly shutdown before tripping occurs. The trip level is normally set at the insulation rating. Trip voting has been added for extra reliability in the event of RTD malfunction. If enabled, a second RTD must also exceed the trip temperature of the RTD being checked before a trip will be issued. If the RTD is chosen to vote with itself, the voting feature is disabled. Each RTD name may be changed if desired.

5.9.3 RTDs 7 to 10

PATH: SETTINGS ▷ ▾ S8 RTD TEMPERATURE ▷ ▾ RTD #7(10)

■ RTD #7	[▷]		RTD #7 APPLICATION: Bearing	<i>Range: Stator, Bearing, Ambient, Other, None</i>
MESSAGE			RTD #7 NAME:	<i>Range: 8 alphanumeric characters</i>
MESSAGE			RTD #7 ALARM: Off	<i>Range: Off, Latched, Unlatched</i>
MESSAGE			ASSIGN ALARM RELAYS: Alarm	<i>Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None</i>
MESSAGE			RTD #7 ALARM TEMPERATURE: 80 °C	<i>Range: 1 to 250°C in steps of 1</i>
MESSAGE			RTD #7 HIGH ALARM: Off	<i>Range: Off, Latched, Unlatched</i>
MESSAGE			HIGH ALARM RELAYS: Alarm	<i>Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None</i>
MESSAGE			RTD #7 HIGH ALARM TEMPERATURE: 80 °C	<i>Range: 1 to 250°C in steps of 1</i>
MESSAGE			RTD #7 ALARM EVENTS: Off	<i>Range: On, Off</i>
MESSAGE			RTD #7 TRIP: Off	<i>Range: Off, Latched, Unlatched</i>
MESSAGE			RTD #7 TRIP VOTING: RTD #7	<i>Range: RTD #1 to RTD #12</i>
MESSAGE			ASSIGN TRIP RELAYS: Trip	<i>Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3</i>
MESSAGE			RTD #7 TRIP TEMPERATURE: 90 °C	<i>Range: 1 to 250°C in steps of 1</i>

RTDs 7 through 10 default to “Bearing” RTD type. There are individual alarm and trip configurations for each RTD. This allows one of the RTDs to be turned off if it malfunctions. The alarm level, high alarm level and the trip level are normally set slightly above the normal running temperature, but below the bearing temperature rating. Trip voting has been added for extra reliability in the event of RTD malfunction. If enabled, a second RTD must also exceed the trip temperature of the RTD being checked before a trip will be issued. If the RTD is chosen to vote with itself, the voting feature is disabled. Each RTD name may be changed if desired.

5.9.4 RTD 11

PATH: SETTINGS ▾ ▾ S8 RTD TEMPERATURE ▾ ▾ RTD #11

■ RTD #11 [▶]		RTD #11 APPLICATION: Other	Range: Stator, Bearing, Ambient, Other, None
MESSAGE		RTD #11 NAME:	Range: 8 alphanumeric characters
MESSAGE		RTD #11 ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE		RTD #11 ALARM TEMPERATURE: 80 °C	Range: 1 to 250°C in steps of 1
MESSAGE		RTD #7 HIGH ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE		HIGH ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE		RTD #11 HIGH ALARM TEMPERATURE: 80 °C	Range: 1 to 250°C in steps of 1
MESSAGE		RTD #11 ALARM EVENTS: Off	Range: On, Off
MESSAGE		RTD #11 TRIP: Off	Range: Off, Latched, Unlatched
MESSAGE		RTD #11 TRIP VOTING: RTD #11	Range: RTD #1 to RTD #12
MESSAGE		ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3
MESSAGE		RTD #11 TRIP TEMPERATURE: 90 °C	Range: 1 to 250°C in steps of 1

RTD 11 defaults to “Other” RTD type. The Other selection allows the RTD to be used to monitor any temperature that might be required, either for a process or additional bearings or other. There are individual alarm, high alarm and trip configurations for this

RTD. Trip voting has been added for extra reliability in the event of RTD malfunction. If enabled, a second RTD must also exceed the trip temperature of the RTD being checked before a trip will be issued. If the RTD is chosen to vote with itself, the voting feature is disabled. The RTD name may be changed if desired.

5.9.5 RTD 12

PATH: SETTINGS > S8 RTD TEMPERATURE > RTD 12

■ RTD #12 [▷]		RTD #12 APPLICATION: Ambient	Range: Stator, Bearing, Ambient, Other, None
MESSAGE		RTD #12 NAME:	Range: 8 alphanumeric characters
MESSAGE		RTD #12 ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE		RTD #12 ALARM TEMPERATURE: 60 °C	Range: 1 to 250°C in steps of 1
MESSAGE		RTD #12 HIGH ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE		HIGH ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE		RTD #12 HIGH ALARM TEMPERATURE: 60 °C	Range: 1 to 250°C in steps of 1
MESSAGE		RTD #12 ALARM EVENTS: Off	Range: On, Off
MESSAGE		RTD #12 TRIP: Off	Range: Off, Latched, Unlatched
MESSAGE		RTD #12 TRIP VOTING: RTD #12	Range: RTD #1 to RTD #12
MESSAGE		ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3
MESSAGE		RTD #12 TRIP TEMPERATURE: 80 °C	Range: 1 to 250°C in steps of 1

RTDs 12 defaults to “Ambient” RTD type. There are individual alarm, high alarm and trip configurations for this RTD. Trip voting has been added for extra reliability in the event of RTD malfunction. If enabled, a second RTD must also exceed the trip temperature of the RTD being checked before a trip will be issued. If the RTD is chosen to vote with itself, the voting feature is disabled. The RTD name may be changed if desired.

5.9.6 Open RTD Sensor

PATH: SETTINGS ▷ ▾ S8 RTD TEMPERATURE ▷ ▾ OPEN RTD SENSOR

<input checked="" type="checkbox"/> OPEN RTD SENSOR	[▷]		OPEN RTD SENSOR ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE			ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE			OPEN RTD SENSOR ALARM EVENTS: Off	Range: On, Off

The 469 has an Open RTD Sensor alarm. This alarm will look at all RTDs that have either an alarm or trip programmed and determine if an RTD connection has been broken. Any RTDs that do not have a trip or alarm associated with them will be ignored for this feature. When a broken sensor is detected, the assigned output relay will operate and a message will appear on the display identifying the RTD that is broken. It is recommended that if this feature is used, the alarm be programmed as latched so that intermittent RTDs are detected and corrective action may be taken.

5.9.7 RTD Short/Low Temp

PATH: SETTINGS ▷ ▾ S8 RTD TEMPERATURE ▷ ▾ RTD SHORT/LOW TEMP

<input checked="" type="checkbox"/> RTD SHORT/LOW TEMP	[▷]		RTD SHORT/LOW TEMP ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE			ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE			RTD SHORT/LOW TEMP ALARM EVENTS: Off	Range: On, Off

The 469 has an RTD Short/Low Temperature alarm. This alarm will look at all RTDs that have either an alarm or trip programmed and determine if an RTD has either a short or a very low temperature (less than -50°C). Any RTDs that do not have a trip or alarm associated with them will be ignored for this feature. When a short/low temperature is detected, the assigned output relay will operate and a message will appear on the display identifying the RTD that caused the alarm. It is recommended that if this feature is used, the alarm be programmed as latched so that intermittent RTDs are detected and corrective action may be taken.

5.10 S9 Voltage Elements

5.10.1 Undervoltage

PATH: SETTINGS ▾ ▾ S9 VOLTAGE ELEM. ▾ UNDERVOLTAGE

■ UNDERVOLTAGE [▷]		U/V ACTIVE ONLY IF BUS ENERGIZED: No	Range: No, Yes
MESSAGE		UNDERVOLTAGE ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE		UNDERVOLTAGE ALARM PICKUP: 0.85 x RATED	Range: 0.60 to 0.99 x RATED in steps of 0.01
MESSAGE		STARTING U/V ALARM PICKUP: 0.85 x RATED	Range: 0.60 to 1.00 x RATED in steps of 0.01. Enter "1.00" to turn this function off.
MESSAGE		UNDERVOLTAGE ALARM DELAY: 3.0 s	Range: 0.0 to 60.0 s in steps of 0.1
MESSAGE		UNDERVOLTAGE ALARM EVENTS: Off	Range: On, Off
MESSAGE		UNDERVOLTAGE TRIP: Off	Range: Off, Latched, Unlatched
MESSAGE		UNDERVOLTAGE TRIP MODE: 1-Phase	Range: 1-Phase, 3-Phase
MESSAGE		ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3
MESSAGE		UNDERVOLTAGE TRIP PICKUP: 0.80 x RATED	Range: 0.60 to 0.99 x RATED in steps of 0.01
MESSAGE		STARTING U/V TRIP PICKUP: 0.80 x RATED	Range: 0.60 to 1.00 x RATED in steps of 0.01. Enter "1.00" to turn this function off.
MESSAGE		UNDERVOLTAGE TRIP DELAY: 3.0 s	Range: 0.0 to 60.0 s in steps of 0.1

The **U/V ACTIVE ONLY IF BUS ENERGIZED** settings may be used to prevent nuisance alarms or trips when the bus is not energized. If this settings is programmed to "Yes", at least one voltage must be greater than 20% of the nominal nameplate voltage rating for any alarm/trip. If the load is high inertia, it may be desirable to trip the motor off-line or prevent it from starting in the event of a total loss of line voltage. Programming "No" for this settings ensures that the motor is tripped and may be restarted only after the bus is re-energized.

If the undervoltage alarm feature is enabled, an alarm will occur once the magnitude of either V_{ab} , V_{bc} , or V_{ca} falls below the pickup level while running or starting for a period of time specified by the delay (note that pickup levels are multiples of motor nameplate voltage). The running pickup level also applies when the motor is stopped and the **U/V ACTIVE ONLY IF BUS ENERGIZED** settings is programmed to “No”.

Undervoltage trips can be set for single-phase or three-phase conditions. If undervoltage tripping is enabled, and the **UNDervOLTAGE TRIP MODE** is set for “3-Phase”, a trip will occur only when the magnitude of all three phases falls below the pickup level while running or starting for a period of time specified by the time delay. On the other hand, if undervoltage trip is enabled, and the **UNDervOLTAGE TRIP MODE** is set for “1-Phase”, a trip will occur once the magnitude of either V_{ab} , V_{bc} , or V_{ca} falls below the pickup level while running or starting for a period of time specified by the time delay. Note that pickup levels are multiples of motor nameplate voltage. The running pickup level also applies when the motor is stopped, and the **U/V ACTIVE ONLY IF BUS ENERGIZED** settings is programmed to “No”.

An undervoltage on a running motor with a constant load results in increased current. The relay thermal model typically picks up this condition and provides adequate protection. However, this settings may be used in conjunction with the time delay to provide additional protection that may be programmed for advance warning by tripping.

Attempting to start a large motor when the supply voltage is down may also be undesirable. An undervoltage of significant proportion that persists while starting a motor may prevent the motor from reaching rated speed. This may be especially critical for a synchronous motor. As such, this feature may be used in with a time delay to provide protection for undervoltage conditions before and during starting.

In the event of system problems causing asymmetrical voltage conditions where at least one voltage remains above pickup, an Alarm condition will occur, indicating that the voltage on at least one phase is below acceptable levels. The trip relay will not be energized unless the **UNDervOLTAGE TRIP MODE** is set to “1-Phase”. The factory default setting for **UNDervOLTAGE TRIP MODE** is “1-Phase”.

To prevent for nuisance undervoltage trips due to VT Fuse Failure, set the **UNDervOLTAGE TRIP MODE** to “3-Phase”. The alarm relay will be energized in the event of a single-phase undervoltage, which can also be an indication of a potential VT fuse failure. Typically a fuse failure is detected when there are significant levels of negative-sequence voltage, indicating voltage unbalance due to the loss of one phase, without correspondingly significant levels of negative-sequence current, indicating current unbalance, measured at the output CTs.

If the conditions for Fuse Failure exist, an alarm will occur after a time delay due to an undervoltage condition in at least one phase. If the motor is running, the voltage in the faulted phase will be zero, and the measured load current should not indicate a significant amount of negative or unbalance currents. Therefore the motor can be kept in service until the opportunity to replace the faulty fuse is available.

If the alarm is caused by an abnormal system conditions, a significant amount of unbalance current will be present. If the condition is not detected on time, the unbalance function or the underpower element will trip the motor.



Set **UNDervoltage TRIP MODE** to “3-Phase”, when the settings **S2 SYSTEM SETUP** > **VOLTAGE SENSING** > **ENABLE SINGLE VT OPERATION** is set to “On”. The relay assumes a balanced three phase system when fed from a single VT.

5.10.2 Overvoltage

PATH: SETTINGS > S9 VOLTAGE ELEM. > OVERVOLTAGE

<input checked="" type="checkbox"/> OVERVOLTAGE [>]		OVERVOLTAGE ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE		OVERVOLTAGE ALARM PICKUP: 1.05 x RATED	Range: 1.01 to 1.20 x RATED in steps of 0.01
MESSAGE		OVERVOLTAGE ALARM DELAY: 3.0 s	Range: 0.5 to 60.0 s in steps of 0.1
MESSAGE		OVERVOLTAGE ALARM EVENTS: Off	Range: On, Off
MESSAGE		OVERVOLTAGE TRIP: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3
MESSAGE		OVERVOLTAGE TRIP PICKUP: 1.10 x RATED	Range: 1.01 to 1.20 x RATED in steps of 0.01
MESSAGE		OVERVOLTAGE TRIP DELAY: 3.0 s	Range: 0.5 to 60.0 s in steps of 0.1

If enabled, once the magnitude of either V_{ab} , V_{bc} , or V_{ca} rises above the pickup level for a period of time specified by the delay, a trip or alarm will occur (pickup levels are multiples of motor nameplate voltage).

An overvoltage on running motor with a constant load results in decreased current. However, iron and copper losses increase, causing an increase in motor temperature. The current overload relay will not pickup this condition and provide adequate protection. Therefore, the overvoltage element may be useful for protecting the motor in the event of a sustained overvoltage condition.

5.10.3 Phase Reversal

PATH: SETTINGS > S9 VOLTAGE ELEM. > PHASE REVERSAL

<input checked="" type="checkbox"/> PHASE REVERSAL [>]		PHASE REVERSAL TRIP: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3

The 469 can detect the phase rotation of the three phase voltage. If the Phase Reversal feature is turned on when all 3 phase voltages are greater than 50% motor nameplate voltage, and the phase rotation of the three phase voltages is not the same as the settings, a trip and block start will occur in 500 to 700 ms.



This feature does not work when single VT operation is enabled.

5.10.4 Frequency

PATH: SETTINGS ▾ ▾ S9 VOLTAGE ELEM. ▾ ▾ FREQUENCY

FREQUENCY [▷]		FREQUENCY ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE		OVER FREQUENCY ALARM LEVEL: 60.50	Range: 25.01 to 70.00 Hz in steps of 0.01
MESSAGE		UNDER FREQUENCY ALARM LEVEL: 59.50	Range: 20.00 to 60.00 Hz in steps of 0.01
MESSAGE		FREQUENCY ALARM DELAY: 1.0 s	Range: 0.0 to 60.0 s in steps of 0.1
MESSAGE		FREQUENCY ALARM EVENTS: Off	Range: On, Off
MESSAGE		FREQUENCY TRIP: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3
MESSAGE		OVER FREQUENCY TRIP LEVEL: 60.50 Hz	Range: 25.01 to 70.00 Hz in steps of 0.01
MESSAGE		UNDER FREQUENCY TRIP LEVEL: 59.50 Hz	Range: 20.00 to 60.00 Hz in steps of 0.01
MESSAGE		FREQUENCY TRIP DELAY: 1.0 s	Range: 0.0 to 60.0 s in steps of 0.1

Once the frequency of the phase AN or AB voltage (depending on wye or delta connection) is out of range of the overfrequency and underfrequency settings, a trip or alarm will occur.

This feature may be useful for load shedding applications on large motors. It could also be used to load shed an entire feeder if the trip was assigned to an upstream breaker.

5.11 S10 Power Elements

5.11.1 Power Measurement Conventions

By convention, an induction motor consumes Watts and vars. This condition is displayed on the 469 as +Watts and +vars. A synchronous motor can consume Watts and vars or consume Watts and generate vars. These conditions are displayed on the 469 as +Watts, +vars, and +Watts, -vars respectively (see the figure below).

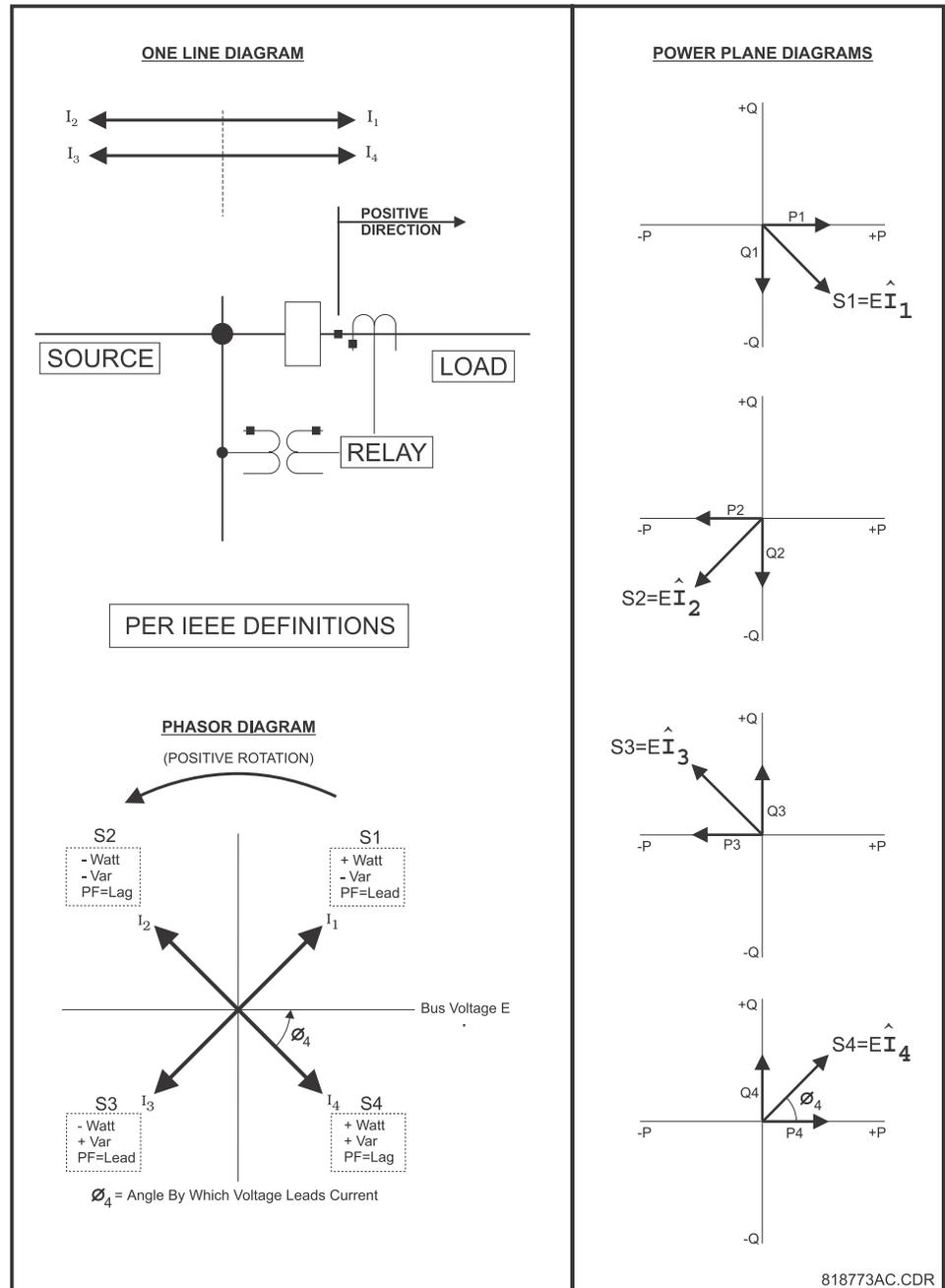


FIGURE 5-17: Power Measurement Conventions

5.11.2 Power Factor

PATH: SETTINGS ▾ ▾ S10 POWER ELEMENTS ▾ POWER FACTOR

■ POWER FACTOR	[▷]		BLOCK PF ELEMENT FROM START: 1 s	Range: 0 to 5000 s in steps of 1
MESSAGE			POWER FACTOR ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE			ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE			POWER FACTOR LEAD ALARM LEVEL: Off	Range: 0.05 to 1.00 in steps of 0.01. Enter 1.00 to turn feature off.
MESSAGE			POWER FACTOR LAG ALARM LEVEL: Off	Range: 0.05 to 1.00 in steps of 0.01. Enter 1.00 to turn feature off.
MESSAGE			POWER FACTOR ALARM DELAY: 1.0 s	Range: 0.2 to 30.0 s in steps of 0.1
MESSAGE			POWER FACTOR ALARM EVENTS: Off	Range: On, Off
MESSAGE			POWER FACTOR TRIP: Off	Range: Off, Latched, Unlatched
MESSAGE			ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3
MESSAGE			POWER FACTOR LEAD TRIP LEVEL: Off	Range: 0.05 to 1.00 in steps of 0.01. Enter 1.00 to turn feature off.
MESSAGE			POWER FACTOR LAG TRIP LEVEL: Off	Range: 0.05 to 1.00 in steps of 0.01. Enter 1.00 to turn feature off.
MESSAGE			POWER FACTOR TRIP DELAY: 1.0 s	Range: 0.2 to 30.0 s in steps of 0.1

If the 469 is applied on a synchronous motor, it is desirable not to trip or alarm on power factor until the field has been applied. Therefore, this feature can be blocked until the motor comes up to speed and the field is applied. From that point forward, the power factor trip and alarm elements will be active. Once the power factor is less than either the Lead or Lag level, for the specified delay, a trip or alarm will occur indicating a Lead or Lag condition. The power factor alarm can be used to detect loss of excitation and out of step.

The 469 is not designed to estimate power factor when both of the following conditions are true:

- setpoint System Nominal Frequency is "Variable"
- Input Voltage is not at frequency 60 Hz.

5.11.3 Reactive Power

PATH: SETTINGS ▾ ▾ S10 POWER ELEMENTS ▾ ▾ REACTIVE POWER

■ REACTIVE POWER [▷]		BLOCK kvar ELEMENT FROM START: 1 s	Range: 0 to 5000 s in steps of 1
MESSAGE		REACTIVE POWER ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE		POSITIVE kvar ALARM LEVEL: 10 kvar	Range: 1 to 25000 kvar in steps of 1
MESSAGE		NEGATIVE kvar ALARM LEVEL: 10 kvar	Range: 1 to 25000 kvar in steps of 1
MESSAGE		REACTIVE POWER ALARM DELAY: 1.0 s	Range: 0.2 to 30.0 s in steps of 0.1
MESSAGE		REACTIVE POWER ALARM EVENTS: Off	Range: On, Off
MESSAGE		REACTIVE POWER TRIP: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3
MESSAGE		POSITIVE kvar TRIP LEVEL: 25 kvar	Range: 1 to 25000 kvar in steps of 1
MESSAGE		NEGATIVE kvar TRIP LEVEL: 25 kvar	Range: 1 to 25000 kvar in steps of 1
MESSAGE		REACTIVE POWER TRIP DELAY: 1.0 s	Range: 0.2 to 30.0 s in steps of 0.1

If the 469 is applied on a synchronous motor, it is desirable not to trip or alarm on kvar until the field has been applied. Therefore, this feature can be blocked until the motor comes up to speed and the field is applied. From that point forward, the kvar trip and alarm elements will be active. Once the kvar level exceeds either the positive or negative level, for the specified delay, a trip or alarm will occur indicating a positive or negative kvar condition. The reactive power alarm can be used to detect loss of excitation and out of step.

5.11.4 Underpower

PATH: SETTINGS ▷ ▾ S10 POWER ELEMENTS ▷ ▾ UNDERPOWER

■ UNDERPOWER [▷]		BLOCK UNDERPOWER FROM START: 0 s	Range: 0 to 15000 s in steps of 1
MESSAGE		UNDERPOWER ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE		UNDERPOWER ALARM LEVEL: 2 kW	Range: 1 to 25000 kW in steps of 1
MESSAGE		UNDERPOWER ALARM DELAY: 1 s	Range: 1 to 30 s in steps of 1
MESSAGE		UNDERPOWER ALARM EVENTS: Off	Range: On, Off
MESSAGE		UNDERPOWER TRIP: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3
MESSAGE		UNDERPOWER TRIP LEVEL: 1 kW	Range: 1 to 25000 kW in steps of 1
MESSAGE		UNDERPOWER TRIP DELAY: 1 s	Range: 1 to 30 s in steps of 1

If enabled, once the magnitude of 3Φ total power falls below the Pickup Level for a period of time specified by the Delay, a trip or alarm will occur. The Underpower element is active only when the motor is running and will be blocked upon the initiation of a motor start for a period of time defined by the **BLOCK ELEMENT FROM START** settings (e.g. this block may be used to allow pumps to build up head before the underpower element trips or alarms). A value of 0 means the feature is not blocked from start. If a value other than 0 is entered, the feature will be disabled when the motor is stopped and also from the time a start is detected until the time entered expires. The pickup level should be set lower than motor loading during normal operations.

For example, underpower may be used to detect loss of load conditions. Loss of load conditions will not always cause a significant loss of current. Power is a more accurate representation of loading and may be used for more sensitive detection of load loss or pump cavitation. This may be especially useful for detecting process related problems.

5.11.5 Reverse Power

PATH: SETTINGS > S10 POWER ELEMENTS > REVERSE POWER

REVERSE POWER [▷]		BLOCK REVERSE POWER FROM START: 0 s	Range: 0 to 50000 s in steps of 1
MESSAGE		REVERSE POWER ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE		REVERSE POWER ALARM LEVEL: 2 kW	Range: 1 to 25000 kW in steps of 1
MESSAGE		REVERSE POWER ALARM DELAY: 1 s	Range: 0.2 to 30.0 s in steps of 0.1
MESSAGE		REVERSE POWER ALARM EVENTS: Off	Range: On, Off
MESSAGE		REVERSE POWER TRIP: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3
MESSAGE		REVERSE POWER TRIP LEVEL: 1 kW	Range: 1 to 25000 kW in steps of 1
MESSAGE		REVERSE POWER TRIP DELAY: 1 s	Range: 0.2 to 30.0 s in steps of 1

If enabled, once the magnitude of 3-phase total power exceeds the Pickup Level in the reverse direction (negative kW) for a period of time specified by the Delay, a trip or alarm will occur.



The minimum magnitude of power measurement is determined by the phase CT minimum of 5% rated CT primary. If the level for reverse power is set below that level, a trip or alarm will only occur once the phase current exceeds the 5% cutoff.

5.11.6 Torque Setup

PATH: SETTINGS > S10 POWER ELEMENTS > TORQUE SETUP

TORQUE SETUP [▷]		TORQUE METERING Disabled	Range: Disabled, Enabled
MESSAGE		STATOR RESISTANCE: 0.004 mΩ	Range: 0.001 to 50.000 mΩ in steps of 0.001
MESSAGE		POLE PAIRS: 2	Range: 2 to 128 in steps of 1
MESSAGE		TORQUE UNIT: Newton-meter	Range: Newton-meter, Foot-pound

Before torque can be determined, the motor stator resistance and number of pole pairs must be entered here. The base stator resistance can be determined from the motor's rated voltage and current. Torque metering is intended for induction motors only, and only positive torque is calculated. Please consult the motor specifications for the stator resistance and the pole pairs.

The default unit for torque is the SI unit of Newton-meter (Nm). The torque unit is selectable to either Newton-meter or foot-pound.



1 Nm = 0.738 ft-lb.

5.11.7 Overtorque

PATH: SETTINGS ▾ ▾ S10 POWER ELEMENTS ▾ ▾ OVERTORQUE

<div style="display: flex; align-items: center;"> <div style="margin-right: 10px;">■</div> <div>OVERTORQUE [▷]</div> </div>		OVERTORQUE ALARM: Off	<i>Range: Off, Latched, Unlatched</i>
MESSAGE		ASSIGN ALARM RELAYS: Alarm	<i>Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None</i>
MESSAGE		TORQUE ALARM LEVEL: 4000.0 Nm	<i>Range: 0.1 to 999999.9 Nm (or ft-lb) in steps of 0.1</i>
MESSAGE		TORQUE ALARM DELAY: 1.0 s	<i>Range: 0.2 to 30 s in steps of 0.1</i>
MESSAGE		TORQUE ALARM EVENTS: Off	<i>Range: On, Off</i>

Detection of a motor overtorque condition, usually done to protect devices driven by the motor, can be set up here. The assigned relay activates when the torque measured exceeds the specified level for the specified time duration.

5.12 S11 Monitoring

5.12.1 Trip Counter

PATH: SETTINGS ▷ ▾ S11 MONITORING ▷ TRIP COUNTER

<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ■ TRIP COUNTER [▷] </div>		<div style="border: 1px solid black; padding: 2px;"> TRIP COUNTER ALARM: Off </div>	<i>Range: Off, Latched, Unlatched</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> ASSIGN ALARM RELAYS: Alarm </div>	<i>Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> TRIP COUNTER ALARM LEVEL: 25 Trips </div>	<i>Range: 1 to 50000 Trips in steps of 1</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> TRIP COUNTER ALARM EVENTS: Off </div>	<i>Range: On, Off</i>

When the Trip Counter Limit is reached, an alarm will occur. The trip counter must be cleared or the alarm level raised and the reset key must be pressed (if the alarm was latched) to reset the alarm.

For example, it might be useful to set a Trip Counter alarm at 100 so that if 100 trips occur, the resulting alarm prompts the operator or supervisor to investigate the type of trips that occurred. A breakdown of trips by type may be found on [A3 MAINTENANCE/TRIP COUNTERS](#). If a trend is detected, it would warrant further investigation.

5.12.2 Starter Failure

PATH: SETTINGS ▷ ▾ S11 MONITORING ELEMENTS ▷ ▾ STARTER FAILURE

<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ■ STARTER FAILURE [▷] </div>		<div style="border: 1px solid black; padding: 2px;"> STARTER FAILURE ALARM: Off </div>	<i>Range: Off, Latched, Unlatched</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> STARTER TYPE: Breaker </div>	<i>Range: Breaker, Contactor</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> ASSIGN ALARM RELAYS: Alarm </div>	<i>Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> STARTER FAILURE DELAY: 100 ms </div>	<i>Range: 10 to 1000 ms in steps of 10</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> SUPERVISION OF TRIP COIL: Disabled </div>	<i>Range: Disabled, 52 Closed, 52 Open/Closed</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> STARTER FAILURE ALARM EVENTS: Off </div>	<i>Range: On, Off</i>

If the **STARTER FAILURE ALARM** is set to “Latched” or “Unlatched”, then the Starter Status input and motor current are monitored when the 469 initiates a trip. If the starter status contacts do not change state or motor current does not drop to zero after the programmed time delay, an alarm occurs. The time delay should be slightly longer than

the breaker or contactor operating time. If an alarm occurs and "Breaker" was chosen as the starter type, the alarm will be Breaker Failure. If "Contactor" was chosen for starter type, the alarm will be Welded Contactor. Also, if the starter type chosen is "Breaker", Trip Coil Supervision may be enabled. The **SUPERVISION OF TRIP COIL** settings is seen only if the **STARTER TYPE** is "Breaker".

- If "52 Closed" is selected, the trip coil supervision circuitry monitors the trip coil circuit for continuity any time the starter status input indicates that the breaker is closed or motor current is detected. If that continuity is broken, a Starter Failure alarm will indicate Trip Coil Supervision.
- If "52 Open/Closed" is selected, the trip coil supervision circuitry monitors the trip coil circuit for continuity at all times, regardless of breaker state. This requires an alternate path around the 52a contacts in series with the trip coil when the breaker is open. See the following figure for modifications to the wiring and proper resistor selection. If that continuity is broken, a Starter Failure alarm will indicate Trip Coil Supervision.

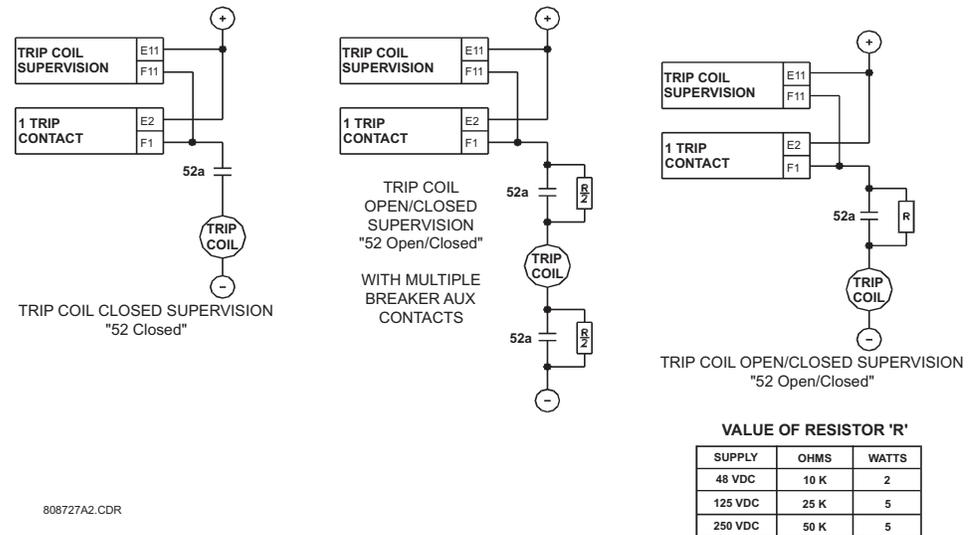


FIGURE 5-18: Trip Coil Supervision

5.12.3 Demand

PATH: SETTINGS > S11 MONITORING > CURRENT DEMAND

<div style="border: 1px solid black; padding: 5px; display: inline-block;"> CURRENT DEMAND </div>		CURRENT DEMAND PERIOD: 15 min.	Range: 5 to 90 min. in steps of 1
MESSAGE		CURRENT DEMAND ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE		CURRENT DEMAND LIMIT: 100 A	Range: 10 to 100000 A in steps of 1

	MESSAGE		CURRENT DEMAND ALARM EVENTS: Off	Range: On, Off
<div style="border: 1px solid black; padding: 2px;"> ■ kW DEMAND </div>			kW DEMAND PERIOD: 15 min.	Range: 5 to 90 min. in steps of 1
	MESSAGE		kW DEMAND ALARM: Off	Range: Off, Latched, Unlatched
	MESSAGE		ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
	MESSAGE		kW DEMAND LIMIT: 100 kW	Range: 1 to 50000 kW in steps of 1
	MESSAGE		kW DEMAND ALARM EVENTS: Off	Range: On, Off
<div style="border: 1px solid black; padding: 2px;"> ■ kvar DEMAND </div>			kvar DEMAND PERIOD: 15 min.	Range: 5 to 90 min. in steps of 1
	MESSAGE		kvar DEMAND ALARM: Off	Range: Off, Latched, Unlatched
	MESSAGE		ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
	MESSAGE		kvar DEMAND LIMIT: 100 kvar	Range: 1 to 50000 kvar, step 1
	MESSAGE		kvar DEMAND ALARM EVENTS: Off	Range: On, Off
<div style="border: 1px solid black; padding: 2px;"> ■ kVA DEMAND </div>			kVA DEMAND PERIOD: 15 min.	Range: 5 to 90 min. in steps of 1
	MESSAGE		kVA DEMAND ALARM: Off	Range: Off, Latched, Unlatched
	MESSAGE		ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
	MESSAGE		kVA DEMAND LIMIT: 100 kVA	Range: 1 to 50000 kVA, step: 1
	MESSAGE		kVA DEMAND ALARM EVENTS: Off	Range: On, Off

The 469 measures motor demand for several parameters (current, kW, kvar, and kVA). These values may be of interest for energy management programs where processes may be altered or scheduled to reduce overall demand on a feeder.

Demand is calculated as follows. Every minute, an average magnitude is calculated for current, +kW, +kvar, and kVA based on samples taken every 5 seconds. These values are stored in a FIFO (first in, first out) buffer. The buffer size is dictated by the settings demand

period. The average value of the buffer is calculated and stored as the new demand value every minute. Demand for real and reactive power is only positive quantities (+kW and +kvar).

$$\text{Demand} = \frac{1}{N} \sum_{n=1}^N |\text{Average}_N| \tag{EQ 5.12}$$

where: N = programmed demand period in minutes
 n = time in minutes.

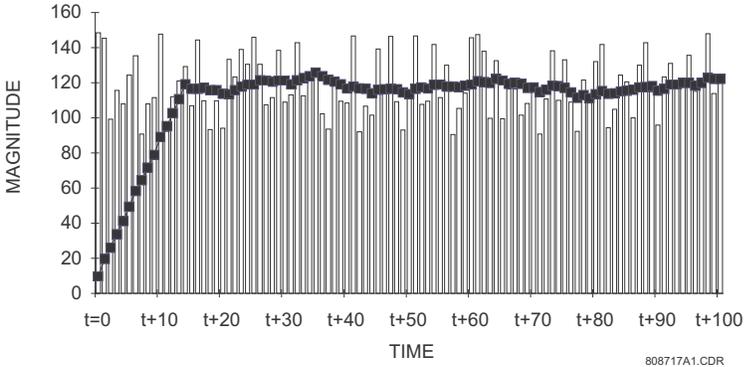


FIGURE 5-19: Rolling Demand (15 Minute Window)

5.12.4 Pulse Output

PATH: SETTINGS > S11 MONITORING > PULSE OUTPUT

<input checked="" type="checkbox"/> PULSE OUTPUT [▷]		POS kWh PULSE OUTPUT RELAY: Off	Range: Off, Alarm, Auxiliary2, Auxiliary3
MESSAGE		POS kWh PULSE OUTPUT INTERVAL: 1 kWh	Range: 1 to 50000 kWh in steps of 1
MESSAGE		POS kvarh PULSE OUT RELAY: Off	Range: Off, Alarm, Auxiliary2, Auxiliary3
MESSAGE		POS kvarh PULSE OUT INTERVAL: 1 kvarh	Range: 1 to 50000 kvarh in steps of 1
MESSAGE		NEG kvarh PULSE OUT RELAY: Off	Range: Off, Alarm, Auxiliary2, Auxiliary3
MESSAGE		NEG kvarh PULSE OUT INTERVAL: 1 kvarh	Range: 1 to 50000 kvarh in steps of 1
MESSAGE		RUNNING TIME PULSE RELAY: Off	Range: Off, Alarm, Auxiliary2, Auxiliary3
MESSAGE		RUNNING TIME PULSE INTERVAL: 0 s	Range: 1 to 50000 s in steps of 1

This feature configures one or more of the output relays as a pulsed output. When the programmed interval has transpired the assigned relay will be activated for 1 second.



This feature should be programmed such that no more than one pulse per second will be required or the pulsing will lag behind the interval activation.

5.12.5 Loss of Communications

PATH: SETTINGS > S11 MONITORING > LOSS OF COMMS

<div style="border: 1px solid black; padding: 2px;"> ■ LOSS OF COMMS ▷] </div>		LOSS OF COMMS FUNCTION: Off	Range: Off, Latched, Unlatched
MESSAGE		*LOSS OF COMMS FUNCTION TYPE: Alarm	Range: Alarm, Trip
MESSAGE		*LOSS OF COMMS PORT: COMP_RS485	Range: COMP_RS485, **AUX_RS485, **Ethernet-T, **DeviceNet
MESSAGE		+ASSIGN LOSS OF COMMS RELAY: Alarm	Range: Alarm, Alarm & Aux2, Alarm & Aux2 & Aux3, Alarm & Aux3, Aux2, Aux2 & Aux3, Aux3, None
MESSAGE		++ASSIGN LOSS OF COMMS RELAY: Trip	Range: Trip, Trip & Aux2, Trip & Aux2 & Aux3, Trip & Aux3
MESSAGE		*LOSS OF COMMS DELAY: 1 s	Range: 1 to 30 s in steps of 1 s
MESSAGE		+LOSS OF COMMS ALARM EVENTS: Off	Range: On, Off

* Only shown if "LOSS OF COMMS: FUNCTION" selection is not 'Off'.

** Only shown if the Option Code is present.

+ Only shown if "LOSS OF COMMS: FUNCTION" selection is not 'Off' and function type is "Alarm"

+ +Only shown if "LOSS OF COMMS: FUNCTION" selection is not 'Off' and function type is "Trip"

When the SR469 relay detects inactivity in communicating with the master, the enabled port will issue a "Loss of Comms Alarm/Trip" event and operate a combination of output relays.

The communication inactivity detection shown in "Not Communicating" applies to all four of the SR469 communication ports.

The detailed causes for "Not Communicating" are displayed in section S13 469 TESTING - Communication Port Monitor.

The Loss of Communication Alarm/Trip function can be programmed for Latched or Unlatched:

- Latched: The programmed output relays and target remain latched until communications with the master are re-established. The latched alarm/trip can be manually reset or remotely reset via a Modbus command.

- Unlatched: The programmed output relays are activated until communication is re-established. Once communication is active, the alarm/trip condition will be cleared and the assigned output relays will deactivate.

5.13 S12 Analog Inputs/Outputs

5.13.1 Analog Outputs 1 to 4

PATH: SETTINGS ▾ ▾ S12 ANALOG I/O ▾ ANALOG OUTPUT 1

ANALOG OUTPUT 1 [▷]		ANALOG OUTPUT 1: Therm. Capacity Used	<i>Range: See Analog Output Parameter Selection Table on page 5-94</i>	
		MESSAGE	THERM. CAPACITY USED MIN: 0%	<i>Range: 0 to 100% in steps of 1</i>
		MESSAGE	THERM. CAPACITY USED MAX: 100%	<i>Range: 0 to 100% in steps of 1</i>
ANALOG OUTPUT 2 [▷]		ANALOG OUTPUT 2: Motor Load	<i>Range: See Analog Output Parameter Selection Table on page 5-94</i>	
		MESSAGE	MOTOR LOAD MIN: 0.00 x FLA	<i>Range: 0.00 to 20.00 x FLA in steps of 0.01</i>
		MESSAGE	MOTOR LOAD MAX: 1.50 x FLA	<i>Range: 0.00 to 20.00 x FLA in steps of 0.01</i>
ANALOG OUTPUT 3 [▷]		ANALOG OUTPUT 3: Hottest Stator RTD	<i>Range: See Analog Output Parameter Selection Table on page 5-94</i>	
		MESSAGE	HOTTEST STATOR RTD MIN: 0°C	<i>Range: -50 to 250°C (or -58 to 482°F) in steps of 1</i>
		MESSAGE	HOTTEST STATOR RTD MAX: 250°C	<i>Range: -50 to 250°C (or -58 to 482°F) in steps of 1</i>
ANALOG OUTPUT 4 [▷]		ANALOG OUTPUT 4: Real Power (kW)	<i>Range: See Analog Output Parameter Selection Table on page 5-94</i>	
		MESSAGE	REAL POWER (kW) MIN: 0 kW	<i>Range: -50000 to 50000 kW in steps of 1</i>
		MESSAGE	REAL POWER (kW) MAX: 1000 kW	<i>Range: -50000 to 50000 kW in steps of 1</i>

The 469 has four analog output channels (4 to 20 mA or 0 to 1 mA as ordered). Each channel may be individually configured to represent a number of different measured parameters as shown in the table below. The minimum value programmed represents the 4 mA output. The maximum value programmed represents the 20 mA output. If the maximum is programmed lower than the minimum, the output will function in reverse. All four of the outputs are updated once every 50 ms. Each parameter may only be used once.

For example, the analog output parameter may be chosen as “Hottest Stator RTD” for a 4 to 20 mA output. If the minimum is set for “0°C” and the maximum is set for “250°C”, the analog output channel will output 4 mA when the Hottest Stator RTD temperature is at 0°C, 12 mA when it is 125°C, and 20 mA when it is 250°C.

Table 5-3: Analog Output Parameter Selection Table

PARAMETER NAME	RANGE / UNITS	STEP	DEFAULT	
			MIN.	MAX
Phase A Current	0 to 100000 A	1	0	100
Phase B Current	0 to 100000 A	1	0	100
Phase C Current	0 to 100000 A	1	0	100
Avg. Phase Current	0 to 100000 A	1	0	100
AB Line Voltage	50 to 20000 V	1	3200	4500
BC Line Voltage	50 to 20000 V	1	3200	4500
CA Line Voltage	50 to 20000 V	1	3200	4500
Avg. Line Voltage	50 to 20000 V	1	3200	4500
Phase AN Voltage	50 to 20000 V	1	1900	2500
Phase BN Voltage	50 to 20000 V	1	1900	2500
Phase CN Voltage	50 to 20000 V	1	1900	2500
Avg. Phase Voltage	50 to 20000 V	1	1900	2500
Hottest Stator RTD	-50 to +250°C or -58 to +482°F	1	0	200
Hottest Bearing RTD	-50 to +250°C or -58 to +482°F	1	0	200
Ambient RTD	-50 to +250°C or -58 to +482°F	1	-50	60
RTD #1 to 12	-50 to +250°C or -58 to +482°F	1	-50	250
Power Factor	0.01 to 1.00 lead/lag	0.01	0.8 lag	0.8 lead
Reactive Power	-50000 to 50000 kvar	1	0	750
Real Power	-50000 to 50000 kW	1	0	1000
Apparent Power	0 to 50000 kVA	1	0	1250
Thermal Capacity Used	0 to 100%	1	0	100
Relay Lockout Time	0 to 500 min.	1	0	150
Current Demand	0 to 100000 A	1	0	700
kvar Demand	0 to 50000 kvar	1	0	1000
kW Demand	0 to 50000 kW	1	0	1250
kVA Demand	0 to 50000 kVA	1	0	1500
Motor Load	0.00 to 20.00 x FLA	0.01	0.00	1.25
Analog Inputs 1-4	-50000 to +50000	1	0	+50000
Tachometer	100 to 7200 RPM	1	3500	3700

Table 5-3: Analog Output Parameter Selection Table

PARAMETER NAME	RANGE / UNITS	STEP	DEFAULT	
			MIN.	MAX
MWhrs	0.000 to 999999.999 MWhrs	0.001	50.000	100.000
Analog In Diff 1-2	-50000 to +50000	1	0	100
Analog In Diff 3-4	-50000 to +50000	1	0	100
Torque	0 to 999999.9	0.1	0	100

5.13.2 Analog Inputs 1 to 4

PATH: SETTINGS ▾ ▾ S12 ANALOG I/O ▾ ANALOG INPUT 1(4)

<div style="display: flex; align-items: center;"> <div style="margin-right: 5px;">■</div> <div style="margin-right: 5px;">ANALOG</div> <div style="margin-left: 20px;">[▷]</div> </div>		ANALOG INPUT 1: Disabled	<i>Range: Disabled, 4-20 mA, 0-20 mA, 0-1 mA</i>
MESSAGE	 	ANALOG INPUT 1 NAME: Analog I/P 1	<i>Range: 12 alphanumeric characters</i>
MESSAGE	 	ANALOG INPUT 1 UNITS: Units	<i>Range: 6 alphanumeric characters</i>
MESSAGE	 	ANALOG INPUT 1 MINIMUM: 0	<i>Range: -50000 to 50000 in steps of 1</i>
MESSAGE	 	ANALOG INPUT 1 MAXIMUM: 100	<i>Range: -50000 to 50000 in steps of 1</i>
MESSAGE	 	BLOCK ANALOG INPUT 1 FROM START: 0 s	<i>Range: 0 to 5000 s in steps of 1</i>
MESSAGE	 	ANALOG INPUT 1 ALARM: Off	<i>Range: Off, Latched, Unlatched</i>
MESSAGE	 	ASSIGN ALARM RELAYS: Alarm	<i>Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None</i>
MESSAGE	 	ANALOG INPUT 1 ALARM LEVEL: 10 Units	<i>Range: -50000 to 50000 in steps of 1 Units reflect ANALOG INPUT 1 UNITS above</i>
MESSAGE	 	ANALOG INPUT 1 ALARM PICKUP: Over	<i>Range: Over, Under</i>
MESSAGE	 	ANALOG INPUT 1 ALARM DELAY: 0.1 s	<i>Range: 0.1 to 300.0 s in steps of 0.1</i>
MESSAGE	 	ANALOG INPUT 1 ALARM EVENTS: Off	<i>Range: On, Off</i>
MESSAGE	 	ANALOG INPUT 1 TRIP: Off	<i>Range: Off, Latched, Unlatched</i>
MESSAGE	 	ASSIGN TRIP RELAYS: Trip	<i>Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3 Trip & Auxiliary3</i>

MESSAGE		ANALOG INPUT 1 TRIP LEVEL: 20 Units	Range: -50000 to 50000 in steps of 1 Units reflect ANALOG INPUT 1 UNITS above
MESSAGE		ANALOG INPUT 1 TRIP PICKUP: Over	Range: Over, Under
MESSAGE		ANALOG INPUT 1 TRIP DELAY: 0.1 s	Range: 0.1 to 300.0 s in steps of 0.1

There are 4 analog inputs, 4 to 20 mA, 0 to 20 mA, or 0 to 1 mA as selected. These inputs may be used to monitor transducers such as vibration monitors, tachometers, pressure transducers, etc. These inputs may be used for alarm and tripping purposes. The inputs are sampled every 50 ms. The level of the analog input is also available over the communications port.

Before the input may be used, it must be configured. A name may be assigned for the input, units may be assigned, and a minimum and maximum value may be assigned. Also, the trip and alarm features may be blocked from start for a specified time delay. If the block time is 0, there is no block and the trip and alarm features will be active when the motor is stopped or running. If a time is programmed other than 0, the feature will be disabled when the motor is stopped and also from the time a start is detected until the time entered expires. Once the input is setup, both the trip and alarm features may be configured. In addition to programming a level and time delay, the pickup settings may be used to dictate whether the feature picks up when the measured value is over or under the level.

For example, if a pressure transducer is to be used for a pump application, program the following settings:

ANALOG INPUT 1(4) NAME: "Pressure"
ANALOG INPUT 1(4) UNITS: "PSI"
ANALOG INPUT 1(4) MINIMUM: "0"
ANALOG INPUT 1(4) MAXIMUM: "500"

If there is no pressure until the pump is up and running for 5 minutes and pressure builds up, program the **ANALOG INPUT 1 BLOCK FROM START** as 6 minutes ("360 s"). The alarm may be fed back to a PLC for when pressure is under 300 PSI. Program a reasonable delay (e.g **ANALOG INPUT ALARM 1 DELAY** = "3 s") and **ANALOG INPUT ALARM 1 PICKUP** as "Under".

If a vibration transducer is to be used for a pump application, program the following settings:

ANALOG INPUT 1(4) NAME: "Vibration"
ANALOG INPUT 1(4) UNITS: "mm/s"
ANALOG INPUT 1(4) MINIMUM: "0"
ANALOG INPUT 1(4) MAXIMUM: "25"

Program **BLOCK ANALOG INPUT 1(4) FROM START** as "0" minutes. Set the alarm for a reasonable level slightly higher than the normal vibration level. Program a delay of "3 s" and a pickup value of "Over".

5.13.3 Analog Input Diff 1-2

PATH: SETTINGS ▾ ▾ S12 ANALOG I/O ▾ ▾ ANALOG INPUT DIFF 1-2

<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ANALOG INPUT DIFF 1-2 [▷] </div>			<div style="border: 1px solid black; padding: 2px;"> ANALOG IN DIFF 1-2: Disabled </div>	Range: Disabled, Enabled
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> ANALOG IN DIFF 1-2 NAME: Analog 1-2 </div>	Range: 12 alphanumeric characters	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> ANALOG IN DIFF 1-2 COMPARISON: % Diff </div>	Range: % Diff, Abs. Diff	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> ANALOG IN DIFF 1-2 LOGIC: 1<>2 </div>	Range: 1<>2, 1>2, 2>1	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> ANALOG IN DIFF 1-2 ACTIVE: Always </div>	Range: Always, Start/Run	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> A/I DIFF 1-2 BLOCK FROM START: 0 s </div>	Range: 0 to 5000 s in steps of 1	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> ANALOG IN DIFF 1-2 ALARM: Off </div>	Range: Off, Latched, Unlatched	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> ASSIGN ALARM RELAYS: Alarm </div>	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> ANALOG IN DIFF 1-2 ALARM LEVEL: 10% </div>	Range: 0 to 500% in steps of 1 or 0 to 50000 Units in steps of 1	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> ANALOG IN DIFF 1-2 ALARM DELAY: 0.1 s </div>	Range: 0.1 to 300.0 s in steps of 0.1	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> ANALOG IN DIFF 1-2 EVENTS: Off </div>	Range: On, Off	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> ANALOG IN DIFF 1-2 TRIP: Off </div>	Range: Off, Latched, Unlatched	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> ASSIGN TRIP RELAYS: Trip </div>	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3 Trip & Auxiliary3	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> ANALOG IN DIFF 1-2 TRIP LEVEL: 10% </div>	Range: 0 to 500% in steps of 1 or 0 to 50000 Units in steps of 1	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> ANALOG IN DIFF 1-2 TRIP DELAY: 0.1 s </div>	Range: 0.1 to 300.0 s in steps of 0.1	



NOTE

This settings menu is seen only if Analog Inputs 1 and 2 are enabled. The **ANALOG IN DIFF 1-2 TRIP LEVEL** and **ANALOG IN DIFF 1-2 ALARM LEVEL** settings are shown units of “%” if the **ANALOG IN DIFF 1-2 COMPARISON** is “%Diff” or in units defined by the **ANALOG INPUT 1 UNITS** settings if **ANALOG IN DIFF 1-2 COMPARISON** is “Abs Diff”.

This feature compares two analog inputs and activate alarms or trips based on their difference, which can be an absolute difference in units or a percentage difference. The second analog input (2 for 1-2) is used as the reference value for percentage calculations. The comparison logic can also be selected as one input greater than the other (“1>2”) or vice versa (“2>1”) or as absolute difference (“1<>2”). The compared analog inputs must be programmed with the same units type prior to programming this feature.

For example, two motors on a dual motor drive are each protected a 469. The motors should be at the same power level (kW). Connect the analog outputs (programmed for kW) from both relays to the analog inputs of one relay. Program the analog input differential to monitor the two motors kW and trip at a predetermined level.

5.13.4 Analog Input Diff 3-4

PATH: SETTINGS ▷ ▾ S12 ANALOG I/O ▷ ▾ ANALOG INPUT DIFF 3-4

■ ANALOG INPUT DIFF 3-4 [▷]		ANALOG IN DIFF 3-4: Disabled	Range: Disabled, Enabled
MESSAGE		ANALOG IN DIFF 3-4 NAME: Analog 3-4	Range: 12 alphanumeric characters
MESSAGE		ANALOG IN DIFF 3-4 COMPARISON: % Diff	Range: % Diff, Abs. Diff
MESSAGE		ANALOG IN DIFF 3-4 LOGIC: 3<>4	Range: 3<>4, 3>4, 4>3
MESSAGE		ANALOG IN DIFF 3-4 ACTIVE: Always	Range: Always, Start/Run
MESSAGE		A/I DIFF 3-4 BLOCK FROM START: 0 s	Range: 0 to 5000 s in steps of 1
MESSAGE		ANALOG IN DIFF 3-4 ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN ALARM RELAYS: Alarm	Range: Alarm, Alarm & Auxiliary2, Alarm & Aux2 & Aux3, Alarm & Auxiliary3, Auxiliary2, Aux2 & Aux3, Auxiliary3, None
MESSAGE		ANALOG IN DIFF 3-4 ALARM LEVEL: 10%	Range: 0 to 500% in steps of 1 or 0 to 50000 Units in steps of 1
MESSAGE		ANALOG IN DIFF 3-4 ALARM DELAY: 0.1 s	Range: 0.1 to 300.0 s in steps of 0.1
MESSAGE		ANALOG IN DIFF 3-4 EVENTS: Off	Range: On, Off
MESSAGE		ANALOG IN DIFF 3-4 TRIP: Off	Range: Off, Latched, Unlatched
MESSAGE		ASSIGN TRIP RELAYS: Trip	Range: Trip, Trip & Auxiliary2, Trip & Aux2 & Aux3, Trip & Auxiliary3
MESSAGE		ANALOG IN DIFF 3-4 TRIP LEVEL: 10%	Range: 0 to 500% in steps of 1 or 0 to 50000 Units in steps of 1
MESSAGE		ANALOG IN DIFF 3-4 TRIP DELAY: 0.1 s	Range: 0.1 to 300.0 s in steps of 0.1



This settings menu is seen only if Analog Inputs 3 and 4 are enabled. The **ANALOG IN DIFF 3-4 TRIP LEVEL** and **ANALOG IN DIFF 3-4 ALARM LEVEL** settings are shown units of “%” if the **ANALOG IN DIFF 3-4 COMPARISON** is “%Diff” or in units defined by the **ANALOG INPUT 3 UNITS** settings if **ANALOG IN DIFF 3-4 COMPARISON** is “Abs Diff”.

This feature compares two of the analog inputs and activate alarms or trips based on the difference between them. The difference can be of an absolute difference in units or a percentage difference. The second analog input (4 for 3-4) is used as the reference value for percentage calculations. The comparison logic can also be selected as one input greater than the other ("3>4") or vice versa ("4>3") or as absolute difference ("3<>4"). Note that the compared analog inputs must be programmed with the same unit type prior to using this feature.

5.14 S13 469 Testing

5.14.1 Simulation Mode

PATH: SETTINGS ▾ ▾ S13 469 TESTING ▾ SIMULATION MODE

<div style="border: 1px solid black; padding: 2px;"> <p>■ SIMULATION MODE [▷]</p> </div>	<div style="border: 1px solid black; padding: 2px;"> <p>SIMULATION MODE Off</p> </div>	<p>Range: Off, Simulate Pre-Fault, Simulate Fault, Pre-Fault to Fault</p>
<p>MESSAGE</p>	<div style="border: 1px solid black; padding: 2px;"> <p>PRE-FAULT TO FAULT TIME DELAY: 15 s</p> </div>	<p>Range: 0 to 300 s in steps of 1</p>

The 469 may be placed in several simulation modes. This simulation may be useful for several purposes.

- First, it may be used to understand the operation of the 469 for learning or training purposes.
- Second, simulation may be used during startup to verify that control circuitry operates as it should in the event of a trip, alarm, or block start.
- In addition, simulation may be used to verify that settings had been set properly in the event of fault conditions.

Simulation mode may be entered only if the motor is stopped and there are no trips, alarms, or block starts active. The values entered as Pre-Fault Values will be substituted for the measured values in the 469 when the simulation mode is “Simulate Pre-Fault”. The values entered as Fault Values will be substituted for the measured values in the 469 when the simulation mode is “Simulate Fault”. If the simulation mode: Pre-Fault to Fault is selected, the Pre-Fault values will be substituted for the period of time specified by the delay, followed by the Fault values. If a trip occurs, simulation mode will revert to Off. Selecting “Off” for the simulation mode will place the 469 back in service. If the 469 measures phase current or control power is cycled, simulation mode will automatically revert to Off.

If the 469 is to be used for training, it might be desirable to allow all learned parameters, statistical information, and event recording to update when operating in simulation mode. If however, the 469 has been installed and will remain installed on a specific motor, it might be desirable to short the 469 Test input (C3 and C4) to prevent all of this data from being corrupted or updated. In any case, when in simulation mode, the 469 In Service LED (indicator) will flash, indicating that the 469 is not in protection mode.

5.14.2 Pre-Fault Setup

PATH: SETTINGS ▾ ▾ S13 469 TESTING ▾ ▾ PRE-FAULT SETUP

<div style="border: 1px solid black; padding: 2px; display: inline-block;"> ■ PRE-FAULT SETUP [>] </div>			<div style="border: 1px solid black; padding: 2px;"> PRE-FAULT CURRENT PHASE A: 0.00 x CT </div>	<i>Range: 0.00 to 20.00 x CT in steps of 0.01</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> PRE-FAULT CURRENT PHASE B: 0.00 x CT </div>	<i>Range: 0.00 to 20.00 x CT in steps of 0.01</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> PRE-FAULT CURRENT PHASE C: 0.00 x CT </div>	<i>Range: 0.00 to 20.00 x CT in steps of 0.01</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> PRE-FAULT GROUND CURRENT: 0.0 A </div>	<i>Range: 0.0 to 5000.0 A in steps of 0.1</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> PRE-FAULT VOLTAGES VLINE: 1.00 x RATED </div>	<i>Range: 0.00 to 1.10 x RATED in steps of 0.01</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> PRE-FAULT CURRENT LAGS VOLTAGE: 0° </div>	<i>Range: 0 to 359° in steps of 1</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> PRE-FAULT DIFF AMPS IDIFF: 0.00 x CT </div>	<i>Range: 0.00 to 1.10 x RATED in steps of 0.01</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> PRE-FAULT STATOR RTD TEMP: 40°C </div>	<i>Range: -50 to 250°C in steps of 1</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> PRE-FAULT BEARING RTD TEMP: 40°C </div>	<i>Range: -50 to 250°C in steps of 1</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> PRE-FAULT OTHER RTD TEMP: 40°C </div>	<i>Range: -50 to 250°C in steps of 1</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> PRE-FAULT AMBIENT RTD TEMP: 40°C </div>	<i>Range: -50 to 250°C in steps of 1</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> PRE-FAULT SYSTEM FREQUENCY: 60.0 Hz </div>	<i>Range: 45.0 to 70.0 Hz in steps of 0.1</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> PRE-FAULT ANALOG INPUT 1: 0% </div>	<i>Range: 0 to 100% in steps of 1</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> PRE-FAULT ANALOG INPUT 2: 0% </div>	<i>Range: 0 to 100% in steps of 1</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> PRE-FAULT ANALOG INPUT 3: 0% </div>	<i>Range: 0 to 100% in steps of 1</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> PRE-FAULT ANALOG INPUT 4: 0% </div>	<i>Range: 0 to 100% in steps of 1</i>	

The values entered under Pre-Fault Values will be substituted for the measured values in the 469 when the simulation mode is "Simulate Pre-Fault".

5.14.3 Fault Setup

PATH: SETTINGS >> S13 469 TESTING >> FAULT SETUP

■ FAULT SETUP	[>]		FAULT CURRENT PHASE A: 0.00 x CT	Range: 0.00 to 20.00 x CT in steps of 0.01
MESSAGE			FAULT CURRENT PHASE B: 0.00 x CT	Range: 0.00 to 20.00 x CT in steps of 0.01
MESSAGE			FAULT CURRENT PHASE C: 0.00 x CT	Range: 0.00 to 20.00 x CT in steps of 0.01
MESSAGE			FAULT GROUND CURRENT: 0.0 A	Range: 0.0 to 5000.0 A in steps of 0.1
MESSAGE			FAULT VOLTAGES VLINE: 1.00 x RATED	Range: 0.00 to 1.10 x RATED in steps of 0.01
MESSAGE			FAULT CURRENT LAGS VOLTAGE: 0°	Range: 0 to 359° in steps of 1
MESSAGE			FAULT DIFF AMPS IDIFF: 0.00 x CT	Range: 0.00 to 1.10 x RATED in steps of 0.01
MESSAGE			FAULT STATOR RTD TEMP: 40°C	Range: -50 to 250°C in steps of 1
MESSAGE			FAULT BEARING RTD TEMP: 40°C	Range: -50 to 250°C in steps of 1
MESSAGE			FAULT OTHER RTD TEMP: 40°C	Range: -50 to 250°C in steps of 1
MESSAGE			FAULT AMBIENT RTD TEMP: 40°C	Range: -50 to 250°C in steps of 1
MESSAGE			FAULT SYSTEM FREQUENCY: 60.0 Hz	Range: 45.0 to 70.0 Hz in steps of 0.1
MESSAGE			FAULT ANALOG INPUT 1: 0%	Range: 0 to 100% in steps of 1
MESSAGE			FAULT ANALOG INPUT 2: 0%	Range: 0 to 100% in steps of 1
MESSAGE			FAULT ANALOG INPUT 3: 0%	Range: 0 to 100% in steps of 1
MESSAGE			FAULT ANALOG INPUT 4: 0%	Range: 0 to 100% in steps of 1

The values entered under Fault Values will be substituted for the measured values in the 469 when the simulation mode is "Simulate Fault".

5.14.4 Test Output Relays

PATH: SETTINGS ▾ ▾ S13 469 TESTING ▾ ▾ TEST OUTPUT RELAYS

<div style="display: flex; justify-content: space-between; align-items: center;"> ■ TEST [>] </div> <div style="text-align: center; margin-top: 5px;"> </div>	<div style="display: flex; justify-content: space-between; align-items: center;"> FORCE OPERATION OF RELAYS: Disabled </div>	<i>Range: Disabled, 1 Trip, 2 Auxiliary, 3 Auxiliary, 4 Alarm, 5 Block, 6 Service, All Relays, No Relays</i>
--	---	--

In addition to the simulation modes, the **TEST OUTPUT RELAYS** settings group may be used during startup or testing to verify that the output relays are functioning correctly.

The output relays can only be forced to operate only if the motor is stopped and there are no trips, alarms, or start blocks active. If any relay is forced to operate, the relay will toggle from its normal state when there are no trips, alarms, or blocks to its active state. The appropriate relay indicator will illuminate at that time. Selecting “Disabled” places the output relays back in service. If the 469 measures phase current or control power is cycled, the **FORCE OPERATION OF RELAYS** settings will automatically become disabled and the output relays will revert back to their normal states.

If any relay is forced, the 469 In Service LED will flash, indicating that the 469 is not in protection mode.

5.14.5 Test Analog Outputs

PATH: SETTINGS ▾ ▾ S13 469 TESTING ▾ ▾ TEST ANALOG OUTPUT

<div style="display: flex; justify-content: space-between; align-items: center;"> ■ TEST [>] </div> <div style="text-align: center; margin-top: 5px;"> </div>	<div style="display: flex; justify-content: space-between; align-items: center;"> FORCE ANALOG OUTPUTS FUNCTION: Disabled </div>	<i>Range: Enabled, Disabled</i>
MESSAGE	<div style="display: flex; justify-content: space-between; align-items: center;"> ANALOG OUTPUT 1 </div> <div style="text-align: center; margin-top: 5px;"> </div> <div style="display: flex; justify-content: space-between; align-items: center;"> FORCED VALUE: 0% </div>	<i>Range: 0 to 100%, step 1</i>
MESSAGE	<div style="display: flex; justify-content: space-between; align-items: center;"> ANALOG OUTPUT 2 </div> <div style="text-align: center; margin-top: 5px;"> </div> <div style="display: flex; justify-content: space-between; align-items: center;"> FORCED VALUE: 0% </div>	<i>Range: 0 to 100%, step 1</i>
MESSAGE	<div style="display: flex; justify-content: space-between; align-items: center;"> ANALOG OUTPUT 3 </div> <div style="text-align: center; margin-top: 5px;"> </div> <div style="display: flex; justify-content: space-between; align-items: center;"> FORCED VALUE: 0% </div>	<i>Range: 0 to 100%, step 1</i>
MESSAGE	<div style="display: flex; justify-content: space-between; align-items: center;"> ANALOG OUTPUT 4 </div> <div style="text-align: center; margin-top: 5px;"> </div> <div style="display: flex; justify-content: space-between; align-items: center;"> FORCED VALUE: 0% </div>	<i>Range: 0 to 100%, step 1</i>

In addition to the simulation modes, the **TEST ANALOG OUTPUT** settings group may be used during startup or testing to verify that the analog outputs are functioning correctly.

The analog outputs can only be forced if the motor is stopped and there are no trips, alarms, or start blocks active. When the **FORCE ANALOG OUTPUTS FUNCTION** is “Enabled”, the output reflects the forced value as a percentage of the 4 to 20 mA or 0 to 1 mA range. Selecting “Disabled” places all four analog output channels back in service, reflecting the parameters programmed to each. If the 469 measures phase current or control power is cycled, the **FORCE ANALOG OUTPUTS FUNCTION** is automatically disabled and all analog outputs revert back to their normal state.

Any time the analog outputs are forced, the 469 In Service LED will flash, indicating that the 469 is not in protection mode.

5.14.6 Comm Port Monitor

PATH: SETTINGS > S13 469 TESTING > COMMUNICATION PORT MONITOR

COMMUNICATION PORT MONITOR [>]		MONITOR COMM. PORT: Computer RS485	Range: Computer RS485, Auxiliary RS485, Front Panel RS232
MESSAGE		CLEAR COMM. BUFFERS: No	Range: No, Yes
MESSAGE		LAST Rx BUFFER: Received OK	Range: Buffer Cleared, Received OK, Wrong Slave Addr., Illegal Function, Illegal Count, Illegal Reg. Addr., CRC Error, Illegal Data
MESSAGE		Rx1: 02,03,00,67,00,03,B4,27,/-	Range: received data in HEX
MESSAGE		Rx2: -----	Range: received data in HEX
MESSAGE		Tx1: 02,03,06,00,64,00,0A,00,0F,/-	Range: transmitted data in HEX
MESSAGE		Tx2: -----	Range: transmitted data in HEX

During the course of troubleshooting communications problems, it can be very useful to see the data that is first being transmitted to the 469 from some master device, and then see the data that the 469 transmits back to that master device. The messages shown here should make it possible to view that data. Any of the three communications ports may be monitored. After the communication buffers have been cleared, any data received from the communications port being monitored will be stored in the Rx1 and Rx2 buffers with '/' acting as a character break between messages. If the 469 transmits a message, it will appear in the Tx1 and Tx2 buffers. In addition to these buffers, there is a message that will indicate the status of the last received message.

5.14.7 GR Digital Energy Use Only

PATH: SETTINGS > S13 469 TESTING > GE MULTILIN USE ONLY

GE MULTILIN USE ONLY [>]		GE MULTILIN USE ONLY CODE: 0	Range: N/A
---	--	-------------------------------------	------------

This section is for use by GE Digital Energy personnel for testing and calibration purposes.

5.15 S14 Two-Speed Motor

5.15.1 Description

The two-speed motor feature provides proper protection for a two-speed motor where there will be two different full load values. The algorithm integrates the heating at each speed into one thermal model using a common thermal capacity used register value for both speeds.

If the two-speed motor feature is used, Assignable Input 4 is dedicated as the two-speed motor monitor and terminals D22 and D23 are monitored for a contact closure. Contact closure signifies that the motor is in Speed 2; if the input is open, it signifies that the motor is in Speed 1. This allows the 469 to determine which settings should be active at any given point in time. Two-speed motor protection is enabled with the **S2 SYSTEM SETUP** > **CURRENT SENSING** > **ENABLE 2-SPEED MOTOR PROTECTION** settings.

Speed2 Overload Setup

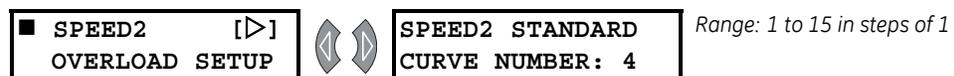
- **Overview**

The settings corresponding to the Speed2 Overload Curve are closely related to the Thermal Model curve style and overload curve settings. Refer to 5.6.2 *Thermal Model* on page 5–40 and 5.6.3 *Overload Curve Setup* on page 5–41 for details. When setting the Speed2 Overload Curve characteristics, only the relevant settings corresponding to the overload curve style will be shown, as described below.

- **Standard Overload Curves**

If the **SELECT CURVE STYLE** is set to “Standard” in the Thermal Model, the following settings will appear:

PATH: SETTINGS > **S14 2-SPEED MOTOR** > **SPEED2 OVERLOAD SETUP**

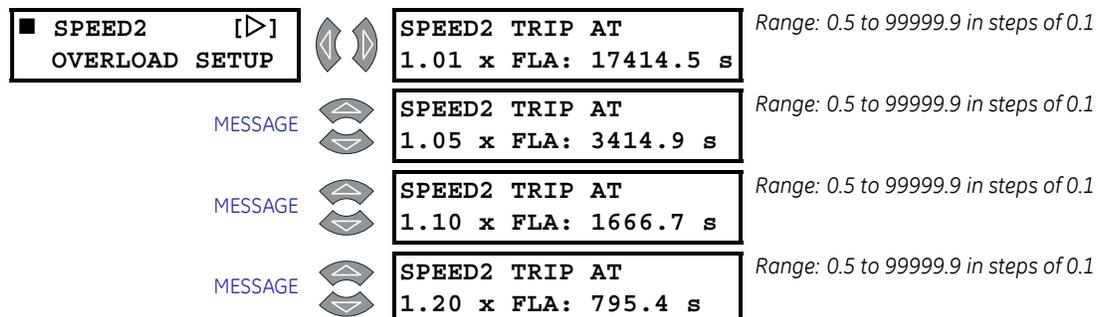


Refer to *Standard Overload Curves* on page 5–41 for additional details on the standard overload curves available for Speed2.

- **Custom Overload Curves**

If the **SELECT CURVE STYLE** is set to “Custom” in the Thermal Model, the following settings will appear:

PATH: SETTINGS > **S14 2-SPEED MOTOR** > **SPEED2 OVERLOAD SETUP**



MESSAGE		SPEED2 TRIP AT 1.30 x FLA: 507.2 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 1.40 x FLA: 364.6 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 1.50 x FLA: 280.0 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 1.75 x FLA: 169.7 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 2.00 x FLA: 116.6 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 2.25 x FLA: 86.1 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 2.50 x FLA: 66.6 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 2.75 x FLA: 53.3 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 3.00 x FLA: 43.7 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 3.25 x FLA: 36.6 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 3.50 x FLA: 31.1 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 3.75 x FLA: 26.8 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 4.00 x FLA: 23.2 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 4.25 x FLA: 20.5 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 4.50 x FLA: 18.2 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 4.75 x FLA: 16.2 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 5.00 x FLA: 14.6 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 5.50 x FLA: 12.0 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 6.00 x FLA: 10.0 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 6.50 x FLA: 8.5 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 7.00 x FLA: 7.3 s	Range: 0.5 to 99999.9 in steps of 0.1

MESSAGE		SPEED2 TRIP AT 7.50 x FLA: 6.3 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 8.00 x FLA: 5.6 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 10.0 x FLA: 5.6 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 15.0 x FLA: 5.6 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 20.0 x FLA: 5.6 s	Range: 0.5 to 99999.9 in steps of 0.1

Refer to *Custom Overload Curve* on page 5–44 for additional details on the custom overload curves available for Speed2.

- **Voltage Dependent Overload Curves**

If the **SELECT CURVE STYLE** is set to “Voltage Dependent” in the Thermal Model, the following settings will appear:

PATH: SETTINGS ▾ ▾ **S14 2-SPEED MOTOR** ▾ **SPEED2 OVERLOAD SETUP**

■ SPEED2 OVERLOAD SETUP [>]		SPEED2 TRIP AT 1.01 x FLA: 17414.5 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 1.05 x FLA: 3414.9 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 1.10 x FLA: 1666.7 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 1.20 x FLA: 795.4 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 1.30 x FLA: 507.2 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 1.40 x FLA: 364.6 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 1.50 x FLA: 280.0 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 1.75 x FLA: 169.7 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 2.00 x FLA: 116.6 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 2.25 x FLA: 86.1 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 2.50 x FLA: 66.6 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 2.75 x FLA: 53.3 s	Range: 0.5 to 99999.9 in steps of 0.1

MESSAGE		SPEED2 TRIP AT 3.00 x FLA: 43.7 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 3.25 x FLA: 36.6 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 3.50 x FLA: 31.1 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 3.75 x FLA: 26.8 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 4.00 x FLA: 23.2 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 4.25 x FLA: 20.5 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 4.50 x FLA: 18.2 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 4.75 x FLA: 16.2 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 5.00 x FLA: 14.6 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 5.50 x FLA: 12.0 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 6.00 x FLA: 10.0 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 6.50 x FLA: 8.5 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 7.00 x FLA: 7.3 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 7.50 x FLA: 6.3 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 8.00 x FLA: 5.6 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 10.0 x FLA: 5.6 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 15.0 x FLA: 5.6 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 TRIP AT 20.0 x FLA: 5.6 s	Range: 0.5 to 99999.9 in steps of 0.1
MESSAGE		SPEED2 MIN ALLOWABLE LINE VOLTAGE: 80%	Range: 70 to 95% in steps of 1
MESSAGE		SPEED2 ISTALL @ MIN Vline: 4.80 x FLA	Range: 2.00 to 15.00 x FLA in steps of 0.01
MESSAGE		SPEED2 SAFE STALL @ MIN Vline: 20.0 s	Range: 0.5 to 999.9 s in steps of 0.1

MESSAGE		SPEED2 ACL INTERSECT @MIN Vline: 3.80 x FLA	Range: 2.00 to SPEED2 ISTALL @ MIN VLINE - 0.01 in steps of 0.01
MESSAGE		SPEED2 ISTALL @ 100% Vline: 6.00 x FLA	Range: 2.00 to 15.00 x FLA in steps of 0.01
MESSAGE		SPEED2 SAFE STALL @ 100% Vline: 10.0 s	Range: 0.5 to 999.9 s in steps of 0.1
MESSAGE		SPEED2 ACL INTERSECT @100% Vline: 5.00 x FLA	Range: 2.00 to SPEED2 ISTALL @ 100% VLINE - 0.01 in steps of 0.01

Refer to *Voltage Dependent Overload Curves* on page 5–47 for additional details on the custom overload curves available for Speed2.

5.15.2 Speed2 Undercurrent

PATH: SETTINGS >> S14 2-SPEED MOTOR >> SPEED2 UNDERCURRENT

<input checked="" type="checkbox"/> SPEED2 UNDERCURRENT [>]		BLOCK SPEED2 U/C FROM START: 0 s	Range: 0 to 15000 s in steps of 1
MESSAGE		SPEED2 U/C ALARM: Off	Range: Off, Latched, Unlatched
MESSAGE		SPEED2 U/C ALARM PICKUP: 0.70 x FLA	Range: 0.10 to 0.95 x FLA in steps of 0.01
MESSAGE		SPEED2 U/C ALARM DELAY: 1 s	Range: 1 to 60 s in steps of 1
MESSAGE		SPEED2 U/C ALARM EVENTS: Off	Range: On, Off
MESSAGE		SPEED2 U/C TRIP: Off	Range: Off, Latched, Unlatched
MESSAGE		SPEED2 U/C TRIP PICKUP: 0.70 x FLA	Range: 0.10 to 0.99 x FLA in steps of 0.01
MESSAGE		SPEED2 U/C TRIP DELAY: 1 s	Range: 1 to 60 s in steps of 1

The addition of a second Undercurrent trip or alarm level may be useful as it will indicate if the wrong settings are being used for the wrong speed i.e. normal running current for Speed 2 may be undercurrent for Speed 1.

5.15.3 Speed2 Acceleration

PATH: SETTINGS >> S14 2-SPEED MOTOR >> SPEED2 ACCELERATION

<input checked="" type="checkbox"/> SPEED2 ACCELERATION [>]		SPEED2 ACCEL. TIMER FROM START: 10.0 s	Range: 1.0 to 250.0 s in steps of 0.1
MESSAGE		ACCEL. TIMER FROM SPEED1-2: 10.0 s	Range: 1.0 to 250.0 s in steps of 0.1

MESSAGE		SPEED SWITCH TRIP SPEED2 DELAY: 5.0 s	Range: 1.0 to 250.0 s in steps of 0.1. Seen only if one of the digital inputs is assigned as Speed Switch
MESSAGE		SPEED2 RATED SPEED: 3600 RPM	Range: 100 to 7200 RPM in steps of 1. Seen only if one of the digital inputs is assigned as Tachometer.

Two additional acceleration timers are provided for the two speed motor feature. One timer is for a start in Speed 2 from a stopped condition. The other is an acceleration timer for the transition from Speed 1 to Speed 2. Also, while the motor is running, the 469 will ignore Mechanical Jam protection during the acceleration from Speed 1 to Speed 2 until the motor current has dropped below Speed 2 FLA \times Overload Pickup value, or the Speed 1-2 acceleration time has expired. At that point in time, the Mechanical Jam feature will be enabled with the Speed 2 FLA.



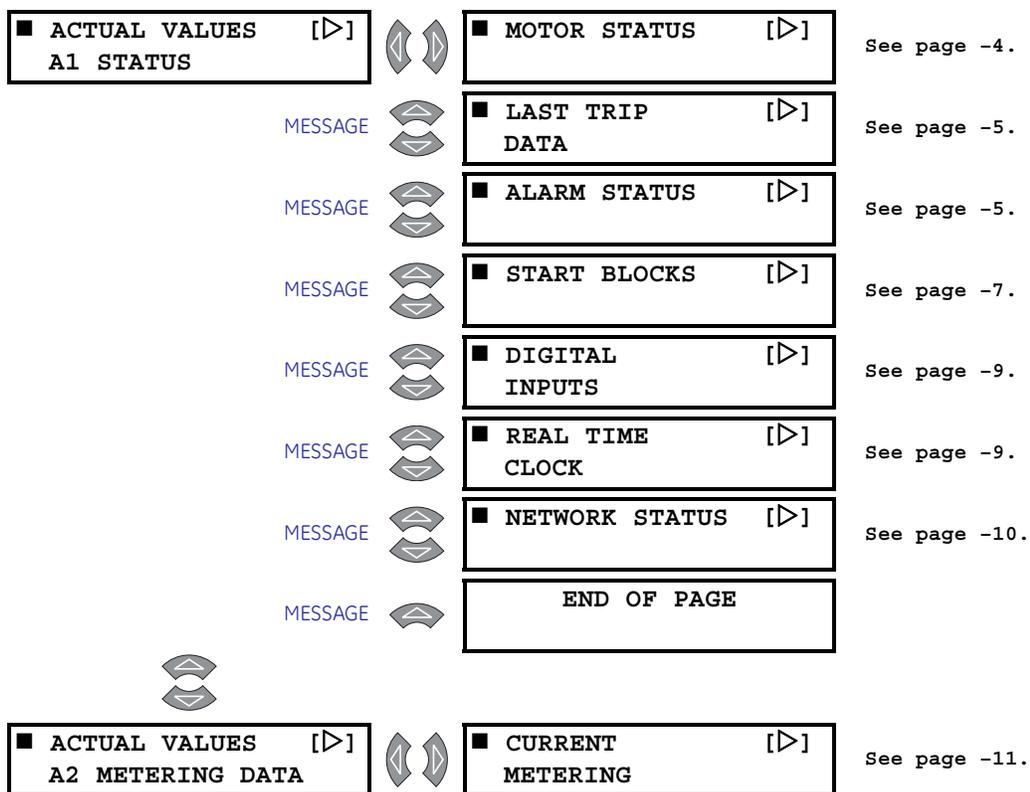
469 Motor Management Relay

Chapter 6: Actual Values

6.1 Overview

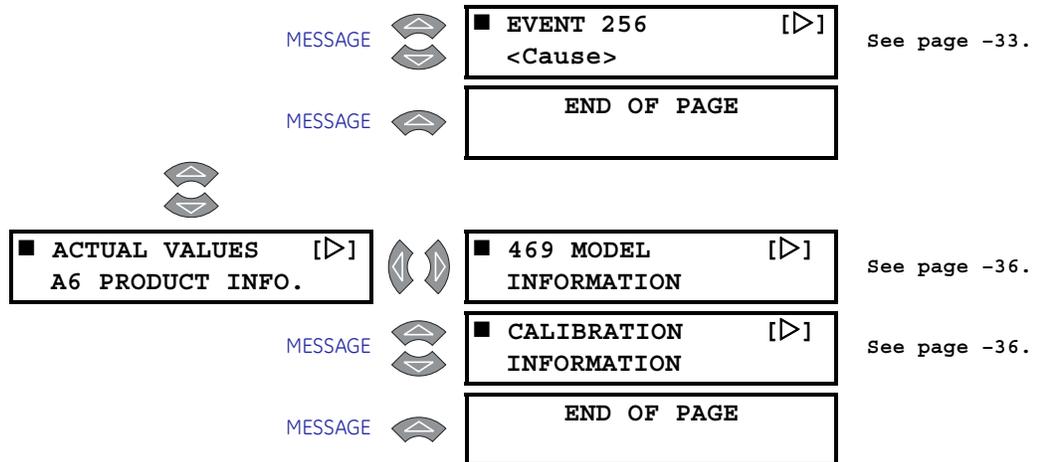
6.1.1 Actual Values Map

The actual values message map is shown below.



MESSAGE		■ TEMPERATURE [▷]	See page -12.
MESSAGE		■ VOLTAGE METERING [▷]	See page -13.
MESSAGE		■ SPEED [▷]	See page -13.
MESSAGE		■ POWER METERING [▷]	See page -14.
MESSAGE		■ DEMAND METERING [▷]	See page -15.
MESSAGE		■ ANALOG INPUTS [▷]	See page -15.
MESSAGE		■ PHASORS [▷]	See page -16.
MESSAGE		END OF PAGE	
			
		■ ACTUAL VALUES A3 LEARNED DATA [▷]	
		■ MOTOR STARTING [▷]	See page -27.
MESSAGE		■ AVERAGE MOTOR LOAD [▷]	See page -27.
MESSAGE		■ RTD MAXIMUMS [▷]	See page -28.
MESSAGE		■ ANALOG INPUT MIN/MAX [▷]	See page -29.
MESSAGE		END OF PAGE	
			
		■ ACTUAL VALUES A4 MAINTENANCE [▷]	
		■ TRIP COUNTERS [▷]	See page -30.
MESSAGE		■ GENERAL COUNTERS [▷]	See page -31.
MESSAGE		■ TIMERS [▷]	See page -32.
MESSAGE		END OF PAGE	
			
		■ ACTUAL VALUES A5 EVENT RECORD [▷]	
		■ EVENT 01 <Cause> [▷]	See page -33.





6.1.2 Description

Measured values, maintenance and fault analysis information are accessed in Actual Value mode. Actual values may be accessed via one of the following methods:

1. The front panel, using the keys and display.
2. The front program port and a portable computer running the EnerVista 469 Setup software supplied with the relay.
3. The rear RS485 port and a PLC/SCADA system running user-written software.

Any of these methods can be used to view the same information. A computer makes viewing much more convenient, since many variables may be viewed at the same time. Actual value messages are organized into logical groups, or pages, for easy reference. All actual value messages are illustrated and described in blocks throughout this chapter. All values shown in these message illustrations assume that no inputs (besides control power) are connected to the 469.

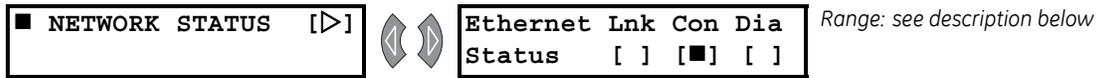
In addition to the actual value messages, there are also diagnostic messages and flash messages that appear when certain conditions occur. Diagnostic messages are described on page -37. Flash messages are described on page -38.

6.2 A1 Status

6.2.1 Network Status

Ethernet Connection

PATH: ACTUAL VALUES ▷ A1 STATUS ▷ ▾ NETWORK STATUS



This actual value appears when the relay is ordered with the Ethernet (T) option.

The **ETHERNET STATUS** actual value message indicates the status of the Ethernet link, connection, and diagnostic via three indicators. The [■] symbol indicates on, and the [] symbol indicates off. There is also a blinking indication.

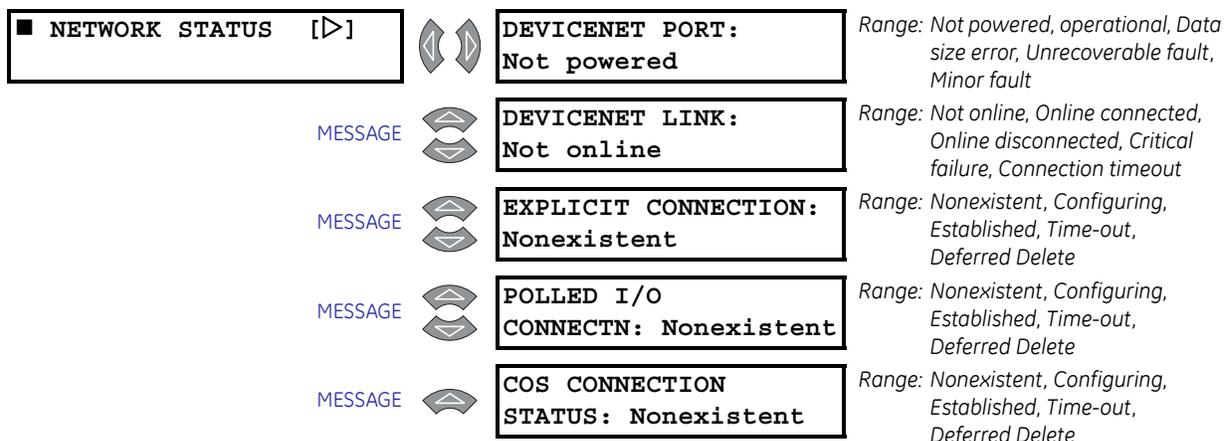
The box under **LNK** column indicates the Ethernet link status. If it is on, the Ethernet port is connected to the network; if it is off, the port is disconnected. This indicator is normally on.

The box under the **CON** column indicates the connection status. If on, the Ethernet port is configured and ready to transmit and receive data. If blinking, the Ethernet port is either active (transmitting or receiving data) or indicating an error if the diagnostic status is also on or blinking.

The box under the **DIA** column indicates the diagnostic status. If it is on, then either a fatal Ethernet port error has occurred or there is a duplicate IP address on the network. If blinking, then there is a non-fatal network error. Off indicates no errors.

DeviceNet Connection (Refer to GEK-106491C: 469 Communications Guide)

PATH: ACTUAL VALUES ▷ A1 STATUS ▷ ▾ NETWORK STATUS



These values appear when the relay is ordered with the DeviceNet (D) option.

6.2.2 Motor Status

PATH: ACTUAL VALUES > A1 STATUS > ▾ MOTOR STATUS

<div style="border: 1px solid black; padding: 2px;"> ■ MOTOR STATUS [▷] </div>		MOTOR STATUS: Stopped	<i>Range: Tripped, Stopped, Starting, Running, Overload</i>
MESSAGE		MOTOR THERMAL CAPACITY USED: 0%	<i>Range: 0 to 100%</i>
MESSAGE		ESTIMATED TRIP TIME ON OVERLOAD: Never	<i>Range: 0 to 10000 sec., Never</i>
MESSAGE		MOTOR SPEED: Low Speed	<i>Range: High Speed, Low Speed. Seen if two speed motor is enabled</i>

These messages describe the motor status at any given point in time. If the motor has been tripped and the 469 has not yet been reset, the **MOTOR STATUS** value will be “Tripped”. The **MOTOR THERMAL CAPACITY USED** reflects an integrated value of both the Stator and Rotor Thermal Capacity Used. The values for **ESTIMATED TRIP TIME ON OVERLOAD** appear whenever the 469 picks up on the overload curve.

6.2.3 Last Trip Data

PATH: ACTUAL VALUES > A1 STATUS > ▾ LAST TRIP DATA

<div style="border: 1px solid black; padding: 2px;"> ■ LAST TRIP DATA [▷] </div>		CAUSE OF LAST TRIP: No Trip to Date	<i>Range: see below</i>
MESSAGE		TIME OF LAST TRIP: 09:00:00.00	<i>Range: hour:min:sec</i>
MESSAGE		DATE OF LAST TRIP: Jan 01 1995	<i>Range: Month Day Year</i>
MESSAGE		MOTOR SPEED DURING TRIP: Low Speed	<i>Range: High Speed, Low Speed. Seen if two-speed motor is enabled</i>
MESSAGE		TACHOMETER PreTrip: 3600 RPM	<i>Range: 0 to 3600 RPM. Seen if a Digital Input set as Tachometer.</i>
MESSAGE		A: 0 B: 0 C: 0 A PreTrip	<i>Range: 0 to 100000 A</i>
MESSAGE		MOTOR LOAD: 0.00 x FLA PreTrip	<i>Range: 0.00 to 20.00 x FLA</i>
MESSAGE		CURRENT UNBALANCE PreTrip: 0%	<i>Range: 0 to 100%</i>
MESSAGE		GROUND CURRENT PreTrip: 0.00 Amps	<i>Range: 0.0 to 5000.0 A. Not seen if Ground CT is set to “None”.</i>
MESSAGE		A: 0 B: 0 C: 0 A Diff.PreTrip	<i>Range: 0 to 5000 A. Not seen if Differential CT is set as None</i>
MESSAGE		HOTTEST STATOR RTD RTD #1: 0°C PreTrip	<i>Range: -50 to 250°C or -58 to 482°F. Seen only if at least 1 RTD is set as Stator</i>

MESSAGE		HOTTEST BEARING RTD RTD #7: 0°C PreTrip	Range: -50 to 250°C or -58 to 482°F. Seen only if at least 1 RTD is set as Bearing
MESSAGE		HOTTEST OTHER RTD RTD #11: 0°C PreTrip	Range: -50 to 250°C or -58 to 482°F. Seen only if at least 1 RTD is set as Other
MESSAGE		AMBIENT RTD RTD#12: 0°C PreTrip	Range: -50 to 250°C or -58 to 482°F. Seen only if at least 1 RTD is set as Ambient
MESSAGE		Vab: 0 Vbc: 0 Vca: 0 V PreTrip	Range: 0 to 20000 V. Not seen if VT Connection is set as None
MESSAGE		Van: 0 Vbn: 0 Vcn: 0 V PreTrip	Range: 0 to 20000 V. Seen only if VT Connection is set as Wye
MESSAGE		PRETRIP SYSTEM FREQUENCY: 0.00 Hz	Range: Not seen if VT Connect. set as None
MESSAGE		0 kW 0 kVA 0 kvar PreTrip	Range: -50000 to 50000 kVA. Not seen if VT Connection set as None
MESSAGE		POWER FACTOR PreTrip: 0.00	Range: 0.01 to 0.99 Lead or Lag, 0.00, 1.00. Not seen if VT Connection is set as "None"
MESSAGE		Analog I/P 1 PreTrip: 0 Units	Range: -50000 to 50000. Not seen if Analog Input 1 is "Disabled".
MESSAGE		Analog I/P 2 PreTrip: 0 Units	Range: -50000 to 50000. Not seen if Analog Input 2 is "Disabled".
MESSAGE		Analog I/P 3 PreTrip: 0 Units	Range: -50000 to 50000. Not seen if Analog Input 3 is "Disabled".
MESSAGE		Analog I/P 4 PreTrip: 0 Units	Range: -50000 to 50000. Not seen if Analog Input 4 is "Disabled".

Immediately prior to issuing a trip, the 469 takes a snapshot of motor parameters and stores them as pre-trip values that allow for troubleshooting after the trip occurs. The **CAUSE OF LAST TRIP** message is updated with the current trip and the screen defaults to that message. All trip features are automatically logged as date and time stamped events as they occur. This information may include motor speed (2-Speed feature or Assignable Digital Input), phase and ground currents, RTD temperatures, voltages, frequency, power quantities, and analog inputs. This information can be cleared using the **S1 469 SETUP** ▾ ▽ **CLEAR DATA** ▾ ▽ **CLEAR LAST TRIP DATA** settings.

The **CAUSE OF LAST TRIP** actual value has the following range: No Trip to Date, Incomplete Sequence, Remote Trip, Speed Switch, Load Shed, Pressure Switch, Vibration Switch, General Sw, Overload, Short Circuit, Mechanical Jam, Undercurrent, Current Unbalance, Ground Fault, Phase Differential, Acceleration, Tachometer, RTDs #1 to #12, Undervoltage, Overvoltage, Phase Reversal, Frequency, Reactive Power, Power Factor, Underpower, Analog Inputs 1 to 4, Single Phasing, Reverse Power, Analog Diff 1-2, Analog Diff 3-4, and Loss of Comms Trip.



Phase, differential, and ground currents are recorded 1 cycle prior to the trip. All other pre-trip data is recorded 50 ms prior to the trip. Thus some values will not be recorded upon instantaneous trips during a start if the trip is less than 50 ms.

6.2.4 Alarm Status

PATH: ACTUAL VALUES > A1 STATUS > ▾ ALARM STATUS

<div style="border: 1px solid black; padding: 2px;"> ■ ALARM STATUS [>] </div>			<div style="border: 1px solid black; padding: 2px;">NO ALARMS</div>	<i>Range: N/A. Message seen when no alarms are active</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> REMOTE ALARM STATUS: Active </div>	<i>Range: Active, Latched</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> PRESSURE SWITCH ALARM STATUS: Active </div>	<i>Range: Active, Latched</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> VIBRATION SWITCH ALARM STATUS: Active </div>	<i>Range: Active, Latched</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> DIG. COUNTER ALARM: 1 000 000 000 Units </div>	<i>Range: 1 to 999999999. Displays current value of digital counter</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> TACHOMETER ALARM: 3000 RPM </div>	<i>Range: 0 to 3600 RPM. Displays current Tachometer Digital Input value</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> GENERAL SW. A ALARM STATUS: Active </div>	<i>Range: Active, Latched</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> THERMAL CAPACITY ALARM: 100% USED </div>	<i>Range: 1 to 100. Thermal Capacity Used value is shown here</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> XX.XX x FLA OVERLOAD TIME TO TRIP: XXXXX s </div>	<i>Range: 0 to 99999 s. Shows overload level and estimated time to trip.</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> UNDERCURRENT ALARM Ia = 85 A 85% FLA </div>	<i>Range: 1 to 5000 A; 5 to 99% FLA. Lowest phase current shown.</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> CURRENT UNBALANCE ALARM: 15% </div>	<i>Range: 0 to 100%. Reflects the present unbalance level</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> GROUND FAULT ALARM: 25.3 A </div>	<i>Range: 0.1 to 5000 A. Reflects the present ground current level</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> STATOR RTD #1 ALARM: 135°C </div>	<i>Range: -50 to 250°C</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> OPEN SENSOR ALARM: RTD # 1 2 3 4 5 6... </div>	<i>Range: RTD with the open sensor as programmed for RTDs 1 to 12</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> SHORT/LOW TEMP ALARM RTD # 7 8 9 10 11... </div>	<i>Range: 1 to 12. Shows RTD with the short/low temperature alarm</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> UNDERVOLTAGE ALARM Vab= 3245 V 78% </div>	<i>Range: 0 to 20000 V; 50 to 99% of Rated</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> OVERVOLTAGE ALARM Vab= 4992 V 120% </div>	<i>Range: 0 to 20000 V; 101 to 150% of Rated</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> SYSTEM FREQUENCY ALARM: 59.4 Hz </div>	<i>Range: 0.00, 20.00 to 120.00 Hz</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> POWER FACTOR ALARM PF: 0.00 </div>	<i>Range: 0.00 to 0.99 Lead or Lag, 0.00, 1.00</i>	
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> REACTIVE POWER ALARM: +2000 kvar </div>	<i>Range: -50000 to +50000 kvar</i>	

MESSAGE		UNDERPOWER ALARM: 200 kW	Range: -50000 to +50000 kW
MESSAGE		TRIP COUNTER ALARM: 25 Trips	Range: 1 to 10000 Trips
MESSAGE		STARTER FAILURE: Trip Coil Super	Range: Trip Coil Super, Welded Contactor, Breaker Failure
MESSAGE		CURRENT DEMAND ALARM: 1053 A	Range: 1 to 10000 A
MESSAGE		kW DEMAND ALARM: 505 kW	Range: -50000 to +50000 kW
MESSAGE		kvar DEMAND ALARM: -2000 kvar	Range: -50000 to +50000 kvar
MESSAGE		kVA DEMAND ALARM: 2062 kVA	Range: 0 to 50000 kVA
MESSAGE		ANALOG I/P 1 ALARM: 201 Units	Range: -50000 to +50000
MESSAGE		EMERGENCY RESTART: Trip Still Present	Range: Trip Still Present, Block Still Present, No Trips & No Blocks
MESSAGE		ALARM, 469 NOT INSERTED PROPERLY	Range: N/A
MESSAGE		469 NOT IN SERVICE Not Programmed	Range: Not Programmed, Output Relays Forced, Analog Output Forced, Test Switch Shorted
MESSAGE		RTD #1 HI ALARM: 135 °C	Range: 1 to 250°C
MESSAGE		ANALOG 1-2 ALARM: 50%	Range: 0 to 999 (% Diff) or 0 to 99999 (Abs Diff)
MESSAGE		ANALOG 3-4 ALARM: 50%	Range: 0 to 999 (% Diff) or 0 to 99999 (Abs Diff)
MESSAGE		OVERTORQUE ALARM: 0.00	Range: 0.00 to 999999.9 Nm
MESSAGE		*LOSS OF COMMS ALARM STATUS: Latched	Range: OFF, Not Active, Timing Out, Active, Latched

*Only shown if " LOSS OF COMMS: FUNCTION " selection is not 'Off'

Any active alarms may be viewed here.

The various alarm and alarm status actual values reflect the Alarm Name as programmed in the first line of the message. The status is "Active" if the condition that caused the alarm is still present.

If the 469 chassis is only partially engaged with the case, the **ALARM, 469 NOT INSERTED PROPERLY** service alarm appears after 1 second. Secure the chassis handle to ensure that all contacts mate properly.

6.2.5 Start Blocks

PATH: ACTUAL VALUES > A1 STATUS > START BLOCKS

<div style="border: 1px solid black; padding: 5px; display: inline-block;"> START BLOCKS [▷] </div>			<div style="border: 1px solid black; padding: 5px;"> NO START BLOCKS ACTIVE </div>	Range: N/A. Message seen when no start blocks are active
	MESSAGE		<div style="border: 1px solid black; padding: 5px;"> OVERLOAD LOCKOUT BLOCK: 25 min. </div>	Note: Message seen only after an overload trip
	MESSAGE		<div style="border: 1px solid black; padding: 5px;"> START INHIBIT BLOCK LOCKOUT TIME: 20 min. </div>	Range: 0 to 500 min.
	MESSAGE		<div style="border: 1px solid black; padding: 5px;"> STARTS/HOUR BLOCK LOCKOUT TIME: 20 min. </div>	Range: 0 to 60 min.
	MESSAGE		<div style="border: 1px solid black; padding: 5px;"> TIME BETWEEN STARTS LOCKOUT TIME: 20 min. </div>	Range: 0 to 500 min.
	MESSAGE		<div style="border: 1px solid black; padding: 5px;"> RESTART BLOCK LOCKOUT: 1200 s </div>	Range: 0 to 50000 sec.
	MESSAGE		<div style="border: 1px solid black; padding: 5px;"> WARNING 469 NOT PROGRAMMED </div>	Note: Seen only if Phase CT Primary or Motor FLA not programmed

Any active blocking functions may be viewed here. The **WARNING 469 NOT PROGRAMMED** message is seen only if the Phase CT Primary or Motor FLA settings have not been programmed.

6.2.6 Digital Inputs

PATH: ACTUAL VALUES > A1 STATUS > DIGITAL INPUTS

<div style="border: 1px solid black; padding: 5px; display: inline-block;"> DIGITAL INPUTS [▷] </div>			<div style="border: 1px solid black; padding: 5px;"> ACCESS SWITCH STATE: Open </div>	Range: Open, Shorted
	MESSAGE		<div style="border: 1px solid black; padding: 5px;"> TEST SWITCH STATE: Open </div>	Range: Open, Shorted
	MESSAGE		<div style="border: 1px solid black; padding: 5px;"> STARTER STATUS SWITCH STATE: Open </div>	Range: Open, Shorted
	MESSAGE		<div style="border: 1px solid black; padding: 5px;"> EMERGENCY RESTART SWITCH STATE: Open </div>	Range: Open, Shorted
	MESSAGE		<div style="border: 1px solid black; padding: 5px;"> REMOTE RESET SWITCH STATE: Open </div>	Range: Open, Shorted
	MESSAGE		<div style="border: 1px solid black; padding: 5px;"> ASSIGNABLE DIGITAL INPUT1 STATE: Open </div>	Range: Open, Shorted
	MESSAGE		<div style="border: 1px solid black; padding: 5px;"> ASSIGNABLE DIGITAL INPUT2 STATE: Open </div>	Range: Open, Shorted
	MESSAGE		<div style="border: 1px solid black; padding: 5px;"> ASSIGNABLE DIGITAL INPUT3 STATE: Open </div>	Range: Open, Shorted
	MESSAGE		<div style="border: 1px solid black; padding: 5px;"> ASSIGNABLE DIGITAL INPUT4 STATE: Open </div>	Range: Open, Shorted

MESSAGE  **TRIP COIL**
SUPERVISION: No Coil *Range: Coil, No Coil*

The messages shown here may be used to monitor Digital Input status. This may be useful during relay testing or during installation.



Digital Input states will read as shorted if assigned as a tachometer.

6.2.7 Real Time Clock

PATH: ACTUAL VALUES ▷ A1 STATUS ▷ ▾ REAL TIME CLOCK

■ **REAL TIME** [▷]   **DATE: 01/01/1994** *Range: 01 to 12 / 01 to 31 / 1995 to 2094*
CLOCK **TIME: 12:00:00**

The time and date from the 469 real time clock may be viewed here.

6.2.8 Loss of Communications

PATH: ACTUAL VALUES ▷ A1 STATUS ▷ ▾ LOSS OF COMMS

■ **LOSS OF COMMS** [▷]   ***LOSS OF COMMS PORT:** *Range: Not Communicating, Communicating*
Not Communicating

*Only shown if " LOSS OF COMMS: FUNCTION " selection is not 'Off'.

6.3 A2 Metering Data

6.3.1 Current Metering

PATH: ACTUAL VALUES > ▾ A2 METERING DATA > CURRENT METERING

<div style="display: flex; justify-content: space-between; align-items: center;"> ■ CURRENT METERING [▷] </div>		<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%;">A:</td> <td style="width: 33%;">0</td> <td style="width: 33%;">B:</td> <td style="width: 33%;">0</td> </tr> <tr> <td>C:</td> <td>0</td> <td>Amps</td> <td></td> </tr> </table>	A:	0	B:	0	C:	0	Amps		<i>Range: 0 to 100000 A</i>
A:	0	B:	0								
C:	0	Amps									
MESSAGE		AVERAGE PHASE CURRENT: 0 Amps	<i>Range: 0 to 100000 A</i>								
MESSAGE		MOTOR LOAD: 0.00 x FLA	<i>Range: 0.00 to 20.00 x FLA</i>								
MESSAGE		CURRENT UNBALANCE: 0%									
MESSAGE		U/B BIASED MOTOR LOAD: 0.00 x FLA	<i>Range: 0.00 to 20.00 x FLA</i>								
MESSAGE		GROUND CURRENT: 0.00 Amps	<i>Range: 0.00 to 5000.00 A. Not seen if Ground CT is set as "None".</i>								
MESSAGE		<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%;">A:</td> <td style="width: 33%;">0</td> <td style="width: 33%;">B:</td> <td style="width: 33%;">0</td> </tr> <tr> <td>C:</td> <td>0</td> <td>Amps Diff.</td> <td></td> </tr> </table>	A:	0	B:	0	C:	0	Amps Diff.		<i>Range: 0 to 5000 A. Seen if Phase Differential CT has 1A/5A Secondary</i>
A:	0	B:	0								
C:	0	Amps Diff.									

All measured current values are displayed here. The **CURRENT UNBALANCE** is defined as the ratio of negative-sequence to positive-sequence current, I_2 / I_1 when the motor is operating at a load (I_{avg}) greater than FLA. If the motor I_{avg} is less than FLA, unbalance is defined as $I_2 / I_1 \times I_{avg} / FLA$. This derating is necessary to prevent nuisance alarms and trips when a motor is lightly loaded. The **U/B BIASED MOTOR LOAD** value shows the equivalent motor heating current caused by the unbalance k factor.

6.3.2 Temperature

PATH: ACTUAL VALUES ▾ ▾ A2 METERING DATA ▾ ▾ TEMPERATURE

■ TEMPERATURE	[▷]		HOTTEST STATOR RTD RTD#1: 40 °C	Range: -50 to 250°C, No RTD (open), --- - (shorted)
MESSAGE			RTD #1 TEMPERATURE: 40 °C	Range: -50 to 250°C, No RTD (open), --- - (shorted)
MESSAGE			RTD #2 TEMPERATURE: 40 °C	Range: -50 to 250°C, No RTD (open), --- - (shorted)
MESSAGE			RTD #3 TEMPERATURE: 40 °C	Range: -50 to 250°C, No RTD (open), --- - (shorted)
MESSAGE			RTD #4 TEMPERATURE: 40 °C	Range: -50 to 250°C, No RTD (open), --- - (shorted).
MESSAGE			RTD #5 TEMPERATURE: 40 °C	Range: -50 to 250°C, No RTD (open), --- - (shorted).
MESSAGE			RTD #6 TEMPERATURE: 40 °C	Range: -50 to 250°C, No RTD (open), --- - (shorted)
MESSAGE			RTD #7 TEMPERATURE: 40 °C	Range: -50 to 250°C, No RTD (open), --- - (shorted).
MESSAGE			RTD #8 TEMPERATURE: 40 °C	Range: -50 to 250°C, No RTD (open), --- - (shorted)
MESSAGE			RTD #9 TEMPERATURE: 40 °C	Range: -50 to 250°C, No RTD (open), --- - (shorted)
MESSAGE			RTD #10 TEMPERATURE: 40 °C	Range: -50 to 250°C, No RTD (open), --- - (shorted)
MESSAGE			RTD #11 TEMPERATURE: 40 °C	Range: -50 to 250°C, No RTD (open), --- - (shorted)
MESSAGE			RTD #12 TEMPERATURE: 40 °C	Range: -50 to 250°C, No RTD (open), --- - (shorted)

The current level of the 12 RTDs is displayed here. If the RTD is not connected, the value will be “No RTD”. The values will reflect the RTD names as programmed. The **HOTTEST STATOR RTD** value is shown only if at least one RTD is set as “Stator”.

If no RTDs are programmed in **S8 RTD TEMPERATURE**, the **THIS FEATURE NOT PROGRAMMED** flash message will appear when an attempt is made to enter this group of messages.

6.3.3 Voltage Metering

PATH: ACTUAL VALUES ▾ ▾ A2 METERING DATA ▾ ▾ VOLTAGE METERING

<div style="border: 1px solid black; padding: 2px;"> VOLTAGE METERING [>] </div>		Vab: 0 Vbc: 0 Vca: 0 Volts	<i>Range: 0 to 20000 V. Not seen if VT Connection is set as None</i>
		AVERAGE LINE VOLTAGE: 0 Volts	<i>Range: 0 to 20000 V. Not seen if VT Connection is set as None</i>
		Van: 0 Vbn: 0 Vcn: 0 Volts	<i>Range: 0 to 20000 V. Seen only if VT Connection is set as Wye</i>
		AVERAGE PHASE VOLTAGE: 0 Volts	<i>Range: 0 to 20000 V. Seen only if VT Connection is set as Wye</i>
		SYSTEM FREQUENCY: 0.00 Hz	<i>Range: 0.00, 20.00 to 120.00 Hz</i>

Measured voltage parameters will be displayed here.

If no VT connection type is programmed for the **S2 SYSTEM SETUP ▾ ▾ VOLTAGE SENSING ▾ ▾ VT CONNECTION TYPE** settings, the **THIS FEATURE NOT PROGRAMMED** flash message will appear when an attempt is made to enter this group of messages.

6.3.4 Speed

PATH: ACTUAL VALUES ▾ ▾ A2 METERING DATA ▾ ▾ SPEED

 SPEED [>]		TACHOMETER 0 RPM	<i>Range: 0 to 7200 RPM</i>
--	---	-----------------------------------	-----------------------------

If the Tachometer function is assigned to one of the digital inputs, the tachometer readout may be viewed here.

If no digital input is configured as tachometer in **S3 DIGITAL INPUTS ▾ ▾ ASSIGNABLE INPUT1(4)**, the **THIS FEATURE NOT PROGRAMMED** flash message will appear when an attempt is made to enter this group of messages.

6.3.5 Power Metering

PATH: ACTUAL VALUES ▾ ▾ A2 METERING DATA ▾ ▾ POWER METERING

■ POWER METERING	[>]		POWER FACTOR: 0.00	Range: 0.01 to 0.99 Lead or Lag, 0.00, 1.00
MESSAGE			REAL POWER: 0 kW	Range: 0 to ±99999 kW
MESSAGE			REAL POWER: 0 hp	Range: 0 to 65535 hp
MESSAGE			REACTIVE POWER: 0 kvar	Range: 0 to ±99999 kvar
MESSAGE			APPARENT POWER: 0 kVA	Range: 0 to 65535 kVA
MESSAGE			POSITIVE WATTHOURS: 0.000 MWh	Range: 0.000 to 999999.999 MWh
MESSAGE			POSITIVE VARHOURS: 0.000 Mvarh	Range: 0.000 to 999999.999 Mvarh
MESSAGE			NEGATIVE VARHOURS: 0.000 Mvarh	Range: 0.000 to 999999.999 Mvarh
MESSAGE			TORQUE: 000.0 Nm	Range: 0.00 to 999999.9 Nm. Seen only if torque metering is enabled

The values for power metering and 3-phase total power quantities are displayed here. Watthours and varhours can also be seen here.



NOTE

An induction motor by convention consumes Watts and vars (+Watts and +vars). A synchronous motor can generate vars (-vars) and feed them back to the power system.

If the **S2 SYSTEM SETUP ▾ ▾ VOLTAGE SENSING ▾ ▾ VOLTAGE TRANSFORMER RATIO** settings is not programmed, the **THIS FEATURE NOT PROGRAMMED** flash message appears when an attempt is made to enter this group of messages.



NOTE

Real Power (hp) is converted directly from Real Power (kW). This display-only value is not used for protection functions. This message will not display more than 65535 hp regardless of the actual kW that are being metered.

6.3.6 Demand Metering

PATH: ACTUAL VALUES ▾ ▾ A2 METERING DATA ▾ ▾ DEMAND METERING

<div style="border: 1px solid black; padding: 2px;"> DEMAND METERING [▷] </div>			CURRENT DEMAND: 0 Amps	Range: 0 to 100000 A
MESSAGE		REAL POWER DEMAND: 0 kW	Range: 0 to 99999 kW	
MESSAGE		REACTIVE POWER DEMAND: 0 kvar	Range: 0 to 99999 kvar	
MESSAGE		APPARENT POWER DEMAND: 0 kVA	Range: 0 to 65535 kVA	
MESSAGE		PEAK CURRENT DEMAND: 0 Amps	Range: 0 to 100000 A	
MESSAGE		PEAK REAL POWER DEMAND: 0 kW	Range: 0 to 99999 kW	
MESSAGE		PEAK REACTIVE POWER DEMAND: 0 kvar	Range: 0 to 99999 kvar	
MESSAGE		PEAK APPARENT POWER DEMAND: 0 kVA	Range: 0 to 65535 kVA	

The values for current and power demand are shown. The power demand values are not shown if the **VT RATIO** is programmed as "None". Peak Demand information is cleared with the **S1 469 SETUP ▾ ▾ CLEAR DATA ▾ ▾ CLEAR PEAK DEMAND DATA** settings. Demand is shown only for positive real and positive reactive power.

6.3.7 Analog Inputs

PATH: ACTUAL VALUES ▾ ▾ A2 METERING DATA ▾ ▾ ANALOG INPUTS

<div style="border: 1px solid black; padding: 2px;"> ANALOG INPUTS [▷] </div>			ANALOG I/P 1 0 Units	Range: -50000 to 50000. Seen only if Analog Input is programmed.
MESSAGE		ANALOG I/P 2 0 Units	Range: -50000 to 50000. Seen only if Analog Input is programmed.	
MESSAGE		ANALOG I/P 3 0 Units	Range: -50000 to 50000. Seen only if Analog Input is programmed.	
MESSAGE		ANALOG I/P 4 0 Units	Range: -50000 to 50000. Seen only if Analog Input is programmed.	
MESSAGE		ANALOG 1-2 0 Percent	Range: -5100 to 4900%. Seen only if Analog In Diff 1-2 set to %Diff	
MESSAGE		ANALOG 1-2 0 Units	Range: -100000 to 100000. Seen only if Analog In Diff 1-2 is Abs Diff	
MESSAGE		ANALOG 3-4 0 Percent	Range: -5100 to 4900%. Seen only if Analog In Diff 3-4 set to %Diff	
MESSAGE		ANALOG 3-4 0 Units	Range: -100000 to 100000. Seen only if Analog In Diff 3-4 is Abs Diff	

The values for analog inputs are shown here. The name of the input and the units will reflect those programmed for each input. If no analog inputs are programmed in **S12 ANALOG I/O > ANALOG INPUT 1(4)**, the **THIS FEATURE NOT PROGRAMMED** flash message will appear when an attempt is made to enter this group of messages.

6.3.8 Phasors

PATH: ACTUAL VALUES > A2 METERING DATA > PHASORS

■ PHASORS	[>]		Va PHASOR 0.0% AT 0°Lag
MESSAGE			Vb PHASOR 0.0% AT 0°Lag
MESSAGE			Vc PHASOR 0.0% AT 0°Lag
MESSAGE			Ia PHASOR 0.0% AT 0°Lag
MESSAGE			Ib PHASOR 0.0% AT 0°Lag
MESSAGE			Ic PHASOR 0.0% AT 0°Lag

The 469 Motor Management Relay was designed to display lagging angles. Therefore, if a system condition would cause the current to lead the voltage by 45°, the 469 relay will display such angle as 315° Lag instead of 45° Lead.



When the currents and voltages measured by the relay are zero, the angles displayed by the relay and those shown by the EnerVista 469 Setup software are not fixed values.

The EnerVista 469 Setup software is a useful tool to view the vectors seen by the relay in graphical format. The same information described above is displayed by the EnerVista 469 Setup software as follows:

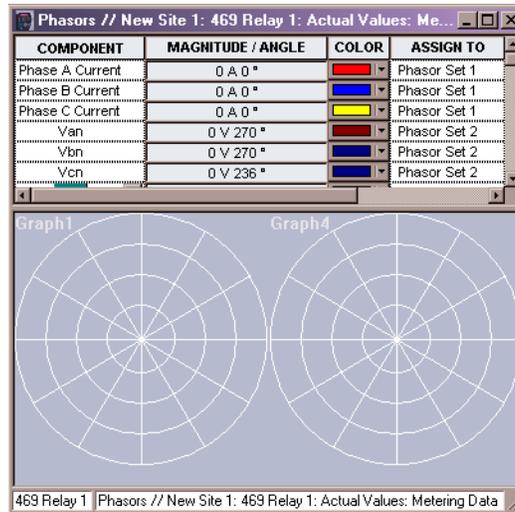


FIGURE 6-1: Vector display in EnerVista 469 Setup

IEEE conventions define vectors in terms of relative angles as shown below:

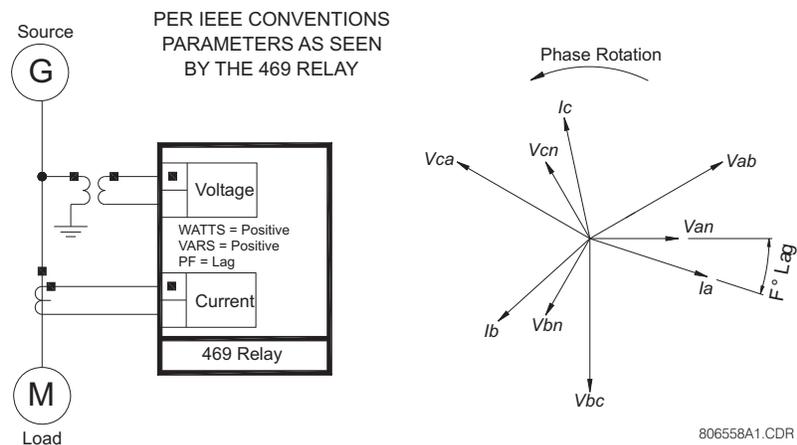


FIGURE 6-2: Flow Direction of Signed Values for Watts and Vars

All phasors calculated by 469 relays are rotating phasors that maintain the correct phase angle relationships with each other at all times.

For display purposes, all phasor angles in a given relay are referred to phase V_{an} or V_{ab}, depending on the **S2 SYSTEM SETUP** > **VOLTAGE SENSING** > **VT CONNECTION TYPE** settings. If set to “Wye”, the reference quantity is V_{an}; if set to “Open Delta”, the reference quantity is V_{ab}. If neither voltage is available, the relay uses the current in Phase A as reference.

The phase angles are assigned and displayed as positive angles. However, by design, the relay will always work with angles in the lagging direction. This is illustrated below.

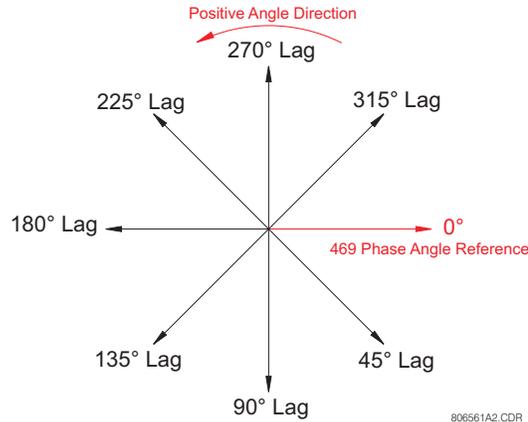


FIGURE 6-3: Phase Angle Measurement Convention

The EnerVista 469 Setup software follows this convention and displays vectors accordingly.



The 469 Motor Management Relay works with lagging angles only.

The following is a typical presentation of a three-phase system where current lags the voltage by 30 degrees.

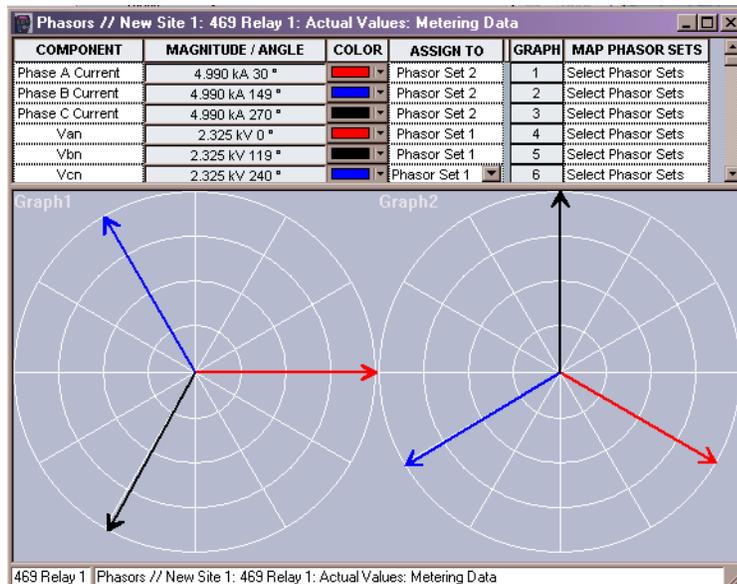


FIGURE 6-4: Current Lagging Voltage by 30° Display

The phasors shown by the relay and the EnerVista 469 Setup software are a clear representation of the relationship between the system quantities as seen by the relay.

The **ACTUAL VALUES ▷▽ PHASORS** page is a useful troubleshooting tool to identify wiring errors. Use the phasors displayed by the relay and the tables on pages –22 and –25 to determine if VTs and CTs are on the correct phases and their polarity is correct. Problems arising from incorrect wiring include:

- Extremely high unbalance levels (CTs),
- Erroneous power readings (CTs and VTs),
- Phase reversal trips (VTs).

To correct wiring, simply start the motor and record the phasors. The correct phasors can be determined using the tables along with recorded phasors, system rotation, VT connection type, and motor power factor. Note that the phase angle for V_a (V_{ab} if delta) is always assumed to be 0° and is the reference for all angle measurements.

Common problems include:

- Phase currents 180° from proper location (CT polarity reversed)
- Phase currents or voltages 120° or 240° out (CT/VT on wrong phase)

An explanation of how the relay identifies and displays system quantities follows. Assume that the relay is connected to a balanced three-phase system and that V_A , V_B , V_C , and V_{COM} are the relay ID names for terminals G2, H1, H2, and G1, respectively.

When the relay is set for the “Open Delta” VT connection type, voltages are measured at terminals G2 (V_A) and H2 (V_C). The voltage at terminal H1 (V_B) is not measured; however, the corresponding system quantity is calculated, assuming a balanced three phase system, where $V_A + V_B + V_C = 0$, leading to $V_B = -(V_A + V_C)$. In the **ACTUAL VALUES ▷▽ VOLTAGE METERING** page, the 469 displays only phase-to-phase voltages. The relationship between the displayed and measured quantities is as follows:

$$\begin{aligned} V_{ab} &= V_A \\ V_{bc} &= -V_C \\ V_{ca} &= -(V_A + V_C) \text{ as calculated} \end{aligned}$$

In the **ACTUAL VALUES ▷▽ PHASORS** page, the relay displays the relationship between measured quantities. Refer to the figure below for wiring connections.

- The measured voltage phasor between terminals G2 (V_A) and G1 (V_{COM}) is displayed by the relay as “ V_a Phasor” and “ V_{ab} ” by the EnerVista 469 Setup software. In this case, V_a Phasor is equal to the system quantity V_{ab} .
- The voltage measured between terminals H1 (V_C) and G1 (V_{COM}) is displayed by the relay as “ V_c Phasor” and “ V_{cb} ” by the EnerVista 469 Setup software. In this case, V_c Phasor is equal to the system quantity V_{cb} or $-V_{bc}$.
- The voltage between H2 (V_B) and G1 (V_{COM}) is zero. Hence, the relay displays a vector with no magnitude.

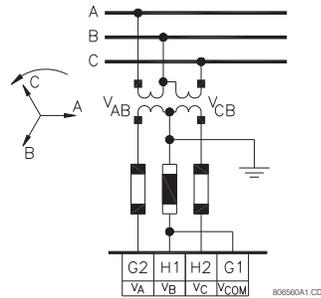


FIGURE 6-5: Open Delta VT Connection

The following phasor diagram presents, in graphic form, the relationship between system quantities and how they are measured, calculated, and displayed. Note that all angles shown are negative or lagging angles.

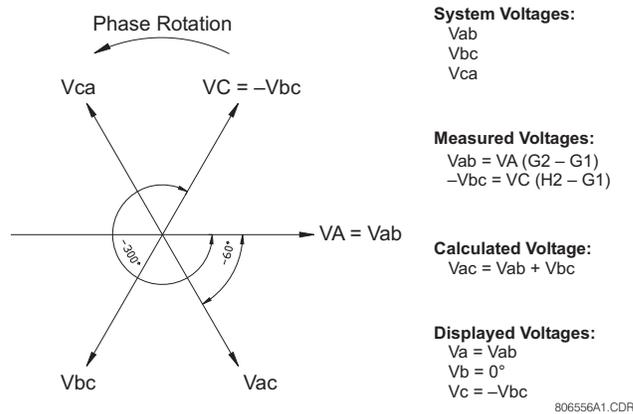


FIGURE 6-6: Typical Phasor Diagram for Open Delta Connection

For example, assume a balanced three phase system with a VT Turn Ratio of 35:1, VT ratings 4200/120 V, and motor running at full load with a power factor of 0.95 (18.2° angle). When the measured phase to phase voltage is 115 V, the following quantities are displayed by the relay and EnerVista 469 Setup software:

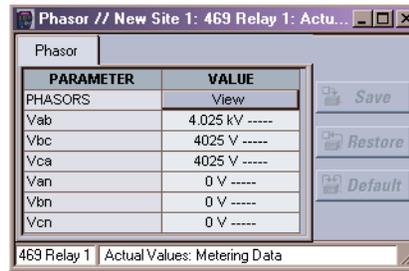
In the **A2 METERING DATA** ▾ ▽ **VOLTAGE METERING** menu:

VAB: "4025 Volts"
VBC: "4025 Volts"
VCA: "4025 Volts"
AVERAGE LINE VOLTAGE: "4025 Volts"
SYSTEM FREQUENCY: "60.00 Hz"

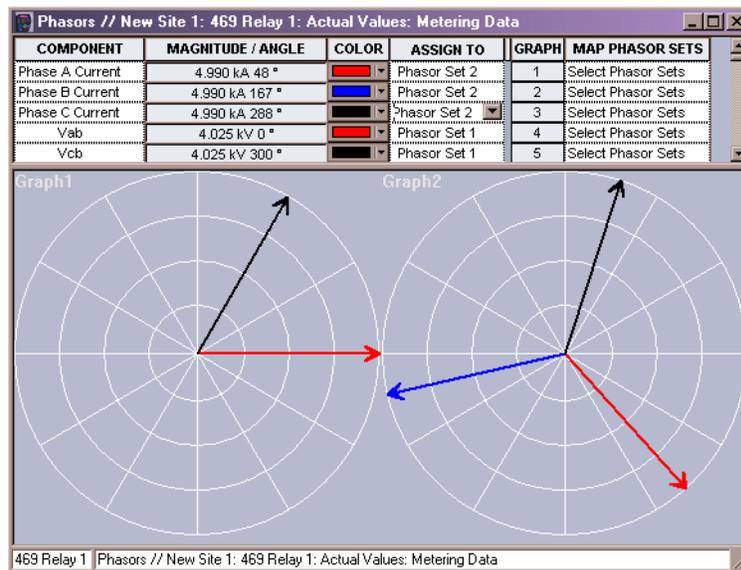
In the **A2 METERING DATA** ▾ ▽ **PHASORS** menu:

VA PHASOR: "95.8% at 0° Lag"
VB PHASOR: "0.0% at 48° Lag"
VC PHASOR: "95.8% at 300° Lag"
IA PHASOR: "100.0% at 48° Lag"
IB PHASOR: "100.0% at 168° Lag"
IC PHASOR: "100.0% at 288° Lag"

The EnerVista 469 Setup software displays the following screen for **A2 METERING DATA** ▾ ▾ **PHASORS** values:



Pressing the “View” button displays the following screen:



The following phasor diagram illustrates the vector diagram of our example. By definition, power factor is the cosine of the angle between the phase to neutral voltages and the corresponding phase current. In this example, 18.2° is the angle between Van and Ia, Vbn and Ib, and Vcn and Ic. Since the relay is measuring phase-phase quantities, and Vab is the reference phasor, the angle displayed by the relay takes into consideration the 30° angle between phase-phase and phase-neutral voltages.

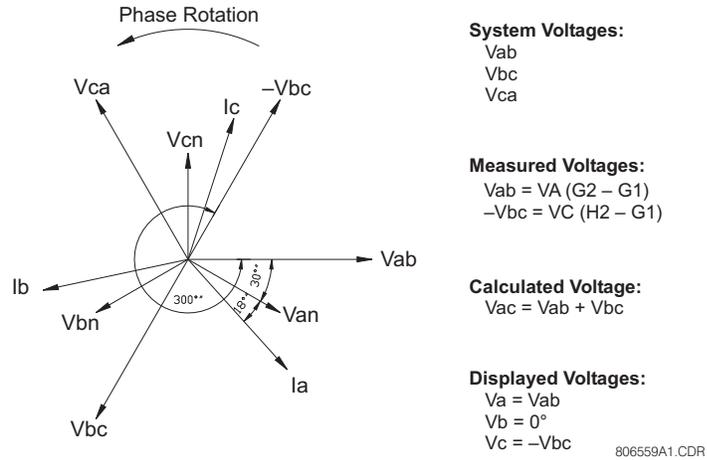


FIGURE 6-7: Phasor Diagram for Open Delta Example

Table 6-1: Three-phase Open Delta VT Connection

ABC Rotation	0.3 pf (72.5°) lag	0.7 pf (45°) lag	1.00 pf (0°) lag	0.7 pf (45°) lead	0.3 pf (72.5°) lead
Va	0	0°	0°	0°	0
Vb	----	----	----	----	----
Vc	300	300	300	300	300
Ia	100	75	30	345	320
Ib	220	195	150	105	80
Ic	340	315	270	225	200
kW	+	+	+	+	+
kVAR	+	+	0	-	-
kVA	+	+	+(=kW)	+	+

ACB Rotation	0.3 pf (72.5°) lag	0.7 pf (45°) lag	1.00 pf (0°) lag	0.7 pf (45°) lead	0.3 pf (72.5°) lead
Va	0	0°	0°	0°	0
Vb	----	----	----	----	----
Vc	60	60	60	60	60
Ia	45	15	330	285	260
Ib	285	255	210	165	140
Ic	165	135	90	45	20
kW	+	+	+	+	+
kVAR	+	+	0	-	-
kVA	+	+	+(=kW)	+	+

When the relay set for the “Wye” VT connection type, voltages are measured at terminals G2 (V_A), H1 (V_B), and H2 (V_C) with respect to G1 (V_{COM}). Refer to the figure below for details. The phase-to-phase voltages are calculated using the following relationships:

$$V_{ab} = \sqrt{3} \times V_A$$

$$V_{bc} = \sqrt{3} \times V_B$$

$$V_{ca} = \sqrt{3} \times V_C$$

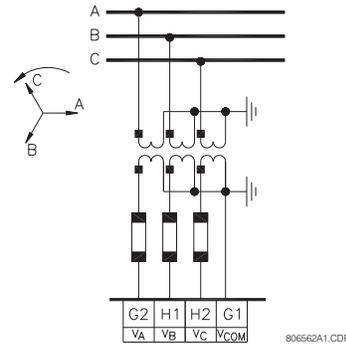


FIGURE 6–8: Wye VT Connection

The quantities displayed by the relay and the EnerVista 469 Setup software are straightforward and follow the phasor diagram shown below. Note that all the angles shown are negative or lagging angles.

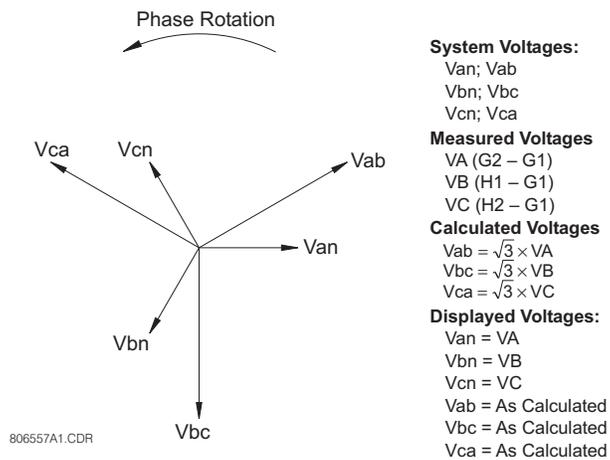


FIGURE 6–9: Typical Phasor Diagram for Wye Connection

Using the same example as for the open delta connection, except for the **VT CONNECTION TYPE** setting to “Wye”, the following quantities are displayed by the relay and EnerVista 469 Setup software:

In the **A2 METERING DATA** ▾ ▹ **VOLTAGE METERING** menu:

- VAB:** “4025 Volts”
- VBC:** “4025 Volts”
- VCA:** “4025 Volts”
- AVERAGE LINE VOLTAGE:** “4025 Volts”
- VAN:** “2323 Volts”

VBN: "2323 Volts"
VCN: "2323 Volts"
AVERAGE PHASE VOLTAGE: "2323 Volts"
SYSTEM FREQUENCY: "60.00 Hz"

In the **A2 METERING DATA ▾ ▽ PHASORS** menu:

VA PHASOR: "95.8% at 0° Lag"
VB PHASOR: "95.8% at 120° Lag"
VC PHASOR: "95.8% at 240° Lag"
IA PHASOR: "100.0% at 18° Lag"
IB PHASOR: "100.0% at 138° Lag"
IC PHASOR: "100.0% at 258° Lag"

The following phasor diagram illustrates the system vector diagram where the **VT CONNECTION TYPE** setting is selected as "Wye". By definition, power factor is the cosine of the angle between the phase to neutral voltages and the corresponding phase current. In this example, 18.2° is the angle between Van and Ia, Vbn and Ib, and Vcn and Ic. The phase-to-phase quantities are not shown in the **A2 METERING DATA ▾ ▽ PHASORS** menu and the EnerVista 469 Setup software. However, they are shown on the following figure.

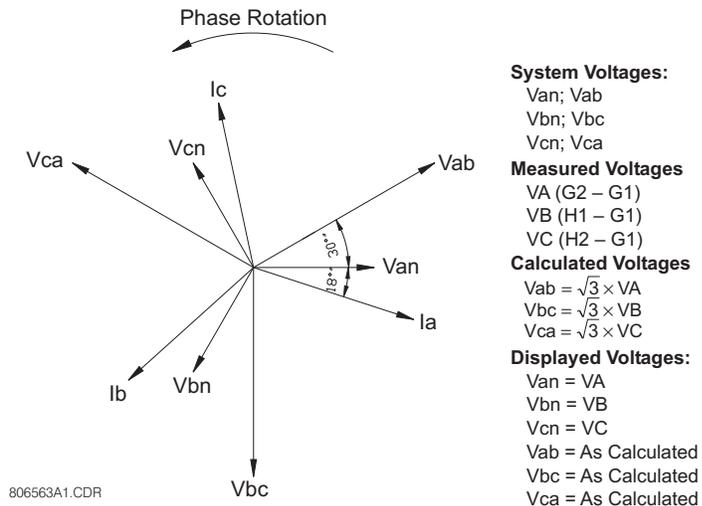
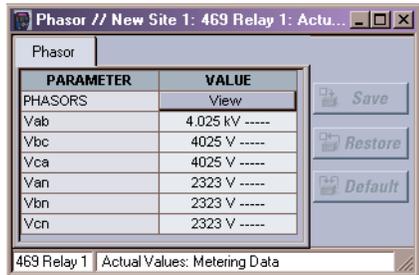


FIGURE 6–10: Typical Phasor Diagram for Wye Connection

The EnerVista 469 Setup software displays the following screen:



Pressing the “View” button displays the following screen:

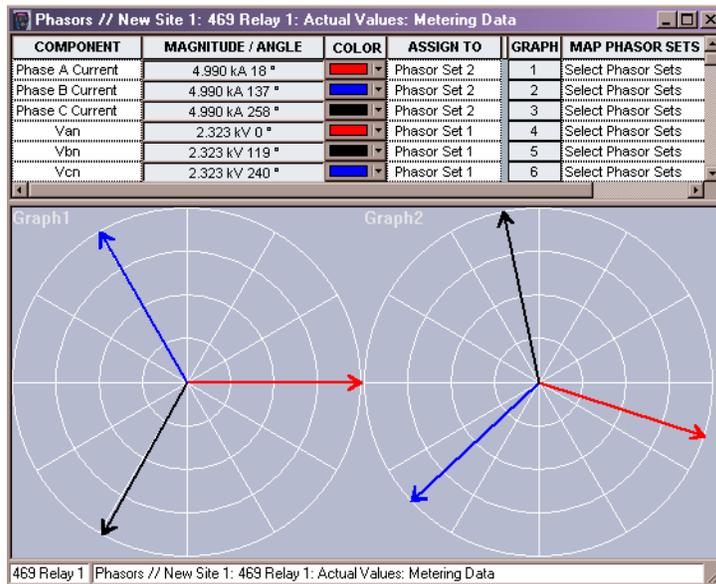


Table 6-2: Three-phase Wye VT Connection

ABC rotation	0.3 pf (72.5°) lag	0.7 pf (45°) lag	1.00 pf (0°) lag	0.7 pf (45°) lead	0.3 pf (72.5°) lead
V _a	0	0° lag	0° lag	0° lag	0
V _b	120	120	120	120	120
V _c	240	240	240	240	240
I _a	75	45	0	315	285
I _b	195	165	120	75	45
I _c	315	285	240	195	165
kW	+	+	+	+	+
kVAR	+	+	0	-	-
kVA	+	+	+= kW	+	+

ACB rotation	0.3 pf (72.5°) lag	0.7 pf (45°) lag	1.00 pf (0°) lag	0.7 pf (45°) lead	0.3 pf (72.5°) lead
V _a	0	0° lag	0° lag	0° lag	0
V _b	240	240	240	240	240
V _c	120	120	120	120	120
I _a	75	45	0	315	285
I _b	315	285	240	195	165
I _c	195	165	120	75	45

Table 6-2: Three-phase Wye VT Connection

ABC rotation	0.3 pf (72.5°) lag	0.7 pf (45°) lag	1.00 pf (0°) lag	0.7 pf (45°) lead	0.3 pf (72.5°) lead
kW	+	+	+	+	+
kVAR	+	+	0	-	-
kVA	+	+	+(=kW)	+	+

6.4 A3 Learned Data

6.4.1 Motor Starting

PATH: ACTUAL VALUES ▷ ▾ A3 LEARNED DATA ▷ MOTOR STARTING

<div style="border: 1px solid black; padding: 2px;"> MOTOR STARTING </div>	[▷]		LEARNED ACCELERATION TIME: 0.0 s	Range: 0.0 to 200.0 sec.	
		MESSAGE		LEARNED STARTING CURRENT: 0 A	Range: 0 to 50000 A
		MESSAGE		LEARNED STARTING CAPACITY: 0% used	Range: 0 to 100%
		MESSAGE		LAST ACCELERATION TIME: 0.0 s	Range: 0.0 to 200.0 sec.
		MESSAGE		LAST STARTING CURRENT: 0 A	Range: 0 to 50000 A
		MESSAGE		LAST STARTING CAPACITY: 0% used	Range: 0 to 100%

The 469 learns the acceleration time, the starting current, as well as, the thermal capacity required during motor starts. This data is accumulated based on the last five starts. The 469 also keeps statistics for last acceleration time, last starting current, and last starting capacity. This information can be reset to default using the **S1 469 SETUP ▷ ▾ INSTALLATION ▷ ▾ RESET MOTOR INFORMATION** settings.

If motor load during starting is relatively consistent, the **LEARNED ACCELERATION TIME** may be used to fine tune the acceleration protection. Learned acceleration time will be the longest time of the last five successful starts. The time is measured from the transition of motor current from zero to greater than overload pickup, until line current falls below the overload pickup level.

LEARNED STARTING CURRENT is measured 200 ms after the transition of motor current from zero to greater than overload pickup. This should ensure that the measured current is symmetrical. The value displayed is the average of the last 5 successful starts. If there are less than 5 starts, 0s will be averaged in for the full 5 starts.

The **LEARNED STARTING CAPACITY** is used to determine if there is enough thermal capacity to permit a start (refer to *Start Inhibit* on page 5–67 for more information on start inhibit). If there is not enough thermal capacity for a start, a start inhibit will be issued. Starting will be blocked until there is sufficient thermal capacity.

6.4.2 Average Motor Load

PATH: ACTUAL VALUES ▷ ▾ A3 LEARNED DATA ▷ ▾ AVERAGE MOTOR LOAD

<div style="border: 1px solid black; padding: 2px;"> AVERAGE MOTOR LOAD </div>	[▷]		AVERAGE MOTOR LOAD LEARNED: 0.00 x FLA	Range: 0.00 to 20.00

The 469 can learn the average motor load over a period of time. This time is specified by the **S1 469 SETUP** ▾ ▾ **PREFERENCES** ▾ ▾ **AVERAGE MOTOR LOAD CALC. PERIOD** settings (default 15 minutes). The calculation is a sliding window and is ignored during motor starting.

6.4.3 RTD Maximums

PATH: ACTUAL VALUES ▾ ▾ A3 LEARNED DATA ▾ ▾ RTD MAXIMUMS

■ RTD MAXIMUMS [▷]			RTD #1 MAX. TEMP.: 40 °C	Range: -50 to 250°C
MESSAGE			RTD #2 MAX. TEMP.: 40 °C	Range: -50 to 250°C
MESSAGE			RTD #3 MAX. TEMP.: 40 °C	Range: -50 to 250°C
MESSAGE			RTD #4 MAX. TEMP.: 40 °C	Range: -50 to 250°C
MESSAGE			RTD #5 MAX. TEMP.: 40 °C	Range: -50 to 250°C
MESSAGE			RTD #6 MAX. TEMP.: 40 °C	Range: -50 to 250°C
MESSAGE			RTD #7 MAX. TEMP.: 40 °C	Range: -50 to 250°C
MESSAGE			RTD #8 MAX. TEMP.: 40 °C	Range: -50 to 250°C
MESSAGE			RTD #9 MAX. TEMP.: 40 °C	Range: -50 to 250°C
MESSAGE			RTD #10 MAX. TEMP.: 40 °C	Range: -50 to 250°C
MESSAGE			RTD #11 MAX. TEMP.: 40 °C	Range: -50 to 250°C
MESSAGE			RTD #12 MAX. TEMP.: 40 °C	Range: -50 to 250°C

The 469 will learn the maximum temperature for each RTD. This information can be cleared using the **S1 469 SETUP** ▾ ▾ **CLEAR DATA** ▾ ▾ **CLEAR RTD MAXIMUMS** settings.

The values in this menu reflect the RTD names as programmed. If no RTDs are programmed in **S8 RTD TEMPERATURE**, the **THIS FEATURE NOT PROGRAMMED** flash message will appear when an attempt is made to enter this group of messages.

6.4.4 Analog Input Min/Max

PATH: ACTUAL VALUES ▾ ▾ A3 LEARNED DATA ▾ ▾ ANALOG IN MIN/MAX

■	ANALOG INPUT MIN/MAX	[>]		ANALOG I/P 1 MIN: 0 Units	Range: -50000 to 50000
	MESSAGE			ANALOG I/P 1 MAX: 0 Units	Range: -50000 to 50000
	MESSAGE			ANALOG I/P 2 MIN: 0 Units	Range: -50000 to 50000
	MESSAGE			ANALOG I/P 2 MAX: 0 Units	Range: -50000 to 50000
	MESSAGE			ANALOG I/P 3 MIN: 0 Units	Range: -50000 to 50000
	MESSAGE			ANALOG I/P 3 MAX: 0 Units	Range: -50000 to 50000
	MESSAGE			ANALOG I/P 4 MIN: 0 Units	Range: -50000 to 50000
	MESSAGE			ANALOG I/P 4 MAX: 0 Units	Range: -50000 to 50000

The 469 will learn the minimum and maximum values of the analog inputs since they were last cleared. This information can be cleared with the **S1 469 SETUP ▾ ▾ CLEAR DATA ▾ ▾ CLEAR ANALOG I/P MIN/MAX** settings. When the data is cleared, the present value of each analog input will be loaded as a starting point for both minimum and maximum. The name of the input and the units will reflect those programmed for each input.

The values shown here reflect the programmed analog input names. If no Analog Inputs are programmed in **S12 ANALOG I/O**, the **THIS FEATURE NOT PROGRAMMED** flash message appears when an attempt is made to enter this group of messages.

6.5 A4 Maintenance

6.5.1 Trip Counters

PATH: ACTUAL VALUES ▾ ▾ A4 MAINTENANCE ▾ TRIP COUNTERS

<div style="border: 1px solid black; padding: 2px;"> TRIP COUNTERS [▷] </div>		<div style="border: 1px solid black; padding: 2px;"> TOTAL NUMBER OF TRIPS: 0 </div>	Range: 0 to 50000
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> INCOMPLETE SEQUENCE TRIPS: 0 </div>	Range: 0 to 50000. Caused by the Reduced Voltage Start feature
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> INPUT SWITCH TRIPS: 0 </div>	Range: 0 to 50000 Caused by Remote, Speed, Load Shed, Pressure, Vibration, or General Purpose Switch Trip features
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> TACHOMETER TRIPS: 0 </div>	Range: 0 to 50000. Caused by Digital Input set as Tachometer
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> OVERLOAD TRIPS: 0 </div>	Range: 0 to 50000
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> SHORT CIRCUIT TRIPS: 0 </div>	Range: 0 to 50000
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> MECHANICAL JAM TRIPS: 0 </div>	Range: 0 to 50000
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> UNDERCURRENT TRIPS: 0 </div>	Range: 0 to 50000
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> CURRENT UNBALANCE TRIPS: 0 </div>	Range: 0 to 50000
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> GROUND FAULT TRIPS: 0 </div>	Range: 0 to 50000
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> PHASE DIFFERENTIAL TRIPS: 0 </div>	Range: 0 to 50000
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> ACCELERATION TIMER TRIPS: 0 </div>	Range: 0 to 50000
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> STATOR RTD TRIPS: 0 </div>	Range: 0 to 50000
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> BEARING RTD TRIPS: 0 </div>	Range: 0 to 50000
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> OTHER RTD TRIPS: 0 </div>	Range: 0 to 50000
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> AMBIENT RTD TRIPS: 0 </div>	Range: 0 to 50000
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> UNDERVOLTAGE TRIPS: 0 </div>	Range: 0 to 50000
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> OVERVOLTAGE TRIPS: 0 </div>	Range: 0 to 50000

MESSAGE		PHASE REVERSAL TRIPS: 0	Range: 0 to 50000
MESSAGE		VOLTAGE FREQUENCY TRIPS: 0	Range: 0 to 50000
MESSAGE		POWER FACTOR TRIPS: 0	Range: 0 to 50000
MESSAGE		REACTIVE POWER TRIPS: 0	Range: 0 to 50000
MESSAGE		REVERSE POWER TRIPS: 0	Range: 0 to 50000
MESSAGE		UNDERPOWER TRIPS: 0	Range: 0 to 50000
MESSAGE		ANALOG I/P 1 TRIPS: 0	Range: 0 to 50000
MESSAGE		ANALOG I/P 2 TRIPS: 0	Range: 0 to 50000
MESSAGE		ANALOG I/P 3 TRIPS: 0	Range: 0 to 50000
MESSAGE		ANALOG I/P 4 TRIPS: 0	Range: 0 to 50000
MESSAGE		ANALOG 1-2 TRIPS: 0	Range: 0 to 50000
MESSAGE		ANALOG 3-4 TRIPS: 0	Range: 0 to 50000
MESSAGE		LOSS OF COMMS TRIPS: 0	Range: 0 to 50000

A breakdown of number of trips by type is displayed here. When the total exceeds 50000, all counters reset to 0. This information can be cleared using the **S1 469 SETUP ▾ ▾ CLEAR DATA ▾ ▾ CLEAR TRIP COUNTERS** settings. Messages relating to analog inputs reflect the programmed analog input name.

6.5.2 General Counters

PATH: ACTUAL VALUES ▾ ▾ A4 MAINTENANCE ▾ ▾ GENERAL COUNTERS

GENERAL COUNTERS	[▷]		NUMBER OF MOTOR STARTS: 0	Range: 0 to 50000
MESSAGE			NUMBER OF EMERGENCY RESTARTS: 0	Range: 0 to 50000
MESSAGE			NUMBER OF STARTER OPERATIONS: 0	Range: 0 to 50000
MESSAGE			DIGITAL COUNTER 0 Units	Range: 0 to 1 000 000 000. Seen if a Digital Input is Digital Counter.

Two of the 469 general counters count the number of motor starts or start attempts and the number of Emergency Restarts performed to start a given motor over time. This may be useful information when troubleshooting a motor failure. When either of these counters exceeds 50000, that counter will reset to 0. This information can be cleared with the **S1 469 SETUP ▷ ▾ INSTALLATION ▷ ▾ RESET MOTOR INFORMATION** settings. Another of the 469 General counters will count the number of starter operations performed over time. This counter is incremented any time the motor is stopped, either by a trip or normal stop. This may be useful information for starter maintenance. When the counter exceeds 50000, that counter will reset to 0. This information may be cleared with the **S1 469 SETUP ▷ ▾ INSTALLATION ▷ ▾ RESET STARTER INFORMATION** settings. If one of the assignable digital inputs is programmed as Digital Counter, that counter measurement will appear here. The counter can be reset to zero if the counter is of the incrementing type or pre-set to a predetermined value using the **S1 469 SETUP ▷ ▾ CLEAR DATA ▷ ▾ PRESET DIGITAL COUNTER** settings.

6.5.3 Timers

PATH: ACTUAL VALUES ▷ ▾ A4 MAINTENANCE ▷ ▾ TIMERS

■ TIMERS [▷]		MOTOR RUNNING HOURS: 0 hr	<i>Range: 0 to 100000 hrs.</i>
	MESSAGE 	TIME BETWEEN STARTS TIMER: 0 min	<i>Range: 0 to 500 min.</i>
	MESSAGE 	STARTS/HOUR TIMERS 0 0 0 0 0 min	<i>Range: 0 to 60 min.</i>

One of the 469 timers accumulates the total running time for the Motor. This may be useful for scheduling routine maintenance. When this timer exceeds 100000, it will reset to 0. This timer can be cleared using the **S1 469 SETUP ▷ ▾ INSTALLATION ▷ ▾ RESET MOTOR INFORMATION** settings.

The **TIME BETWEEN STARTS TIMER** value may be viewed here. This value might be useful for planning a motor shutdown. The **STARTS/HOUR TIMER** value is also viewable here.

6.6 A5 Event Recorder

6.6.1 Event 01 to Event 256

PATH: ACTUAL VALUES ▾ ▾ A5 EVENT RECORDER ▾ ▾ EVENT 01(256)

<div style="border: 1px solid black; padding: 2px;"> ■ EVENT 01 [▷] </div>		<div style="border: 1px solid black; padding: 2px;"> TIME OF EVENT 01: 00:00:00.0 </div>	<i>Range: hour:minutes:seconds</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> DATE OF EVENT 01: Jan. 01, 1992 </div>	<i>Range: month day, year</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> MOTOR SPEED DURING EVENT01: Low Speed </div>	<i>Range: High Speed, Low Speed. Seen if two-speed feature is enabled.</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> TACHOMETER DURING EVENT01: 0 RPM </div>	<i>Range: 0 to 3600 RPM. Seen only if a Digital Input is Tachometer.</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> A: 0 B: 0 C: 0 A EVENT01 </div>	<i>Range: 0 to 100000 A</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> MOTOR LOAD EVENT01: 0.00 x FLA </div>	<i>Range: 0.00 to 20.00 x FLA</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> CURRENT UNBALANCE EVENT01: 0% </div>	<i>Range: 0 to 100%</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> GROUND CURRENT EVENT01: 0.00 A </div>	<i>Range: 0.00 to 5000.0 A. Not seen if Ground CT is set as None.</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> A: 0 B: 0 C: 0 A Diff. EV01 </div>	<i>Range: 0 to 5000 A. Seen only if Phase Differential CT is set.</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> HOTTEST STATOR RTD: 0 °C EVENT01 </div>	<i>Range: -50 to 250°C, --- (no RTD). Seen if at least 1 RTD is set as Stator.</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> HOTTEST BEARING RTD: 0 °C EVENT01 </div>	<i>Range: -50 to 250°C, --- (no RTD). Seen if at least 1 RTD is Bearing.</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> HOTTEST OTHER RTD: 0 °C EVENT01 </div>	<i>Range: -50 to 250°C, --- (no RTD). Seen if at least 1 RTD is set as Other.</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> AMBIENT RTD: 0 °C EVENT01 </div>	<i>Range: -50 to 250°C, --- (no RTD). Seen if at least 1 RTD is Ambient.</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> Vab: 0 Vbc: 0 Vca: 0 A EVENT01 </div>	<i>Range: 0 to 20000 A. Not seen if VT Connection set as None</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> Van: 0 Vbn: 0 Vcn: 0 A EVENT01 </div>	<i>Range: 0 to 20000 A. Seen only if VT Connection set as Wye.</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> SYSTEM FREQUENCY EVENT01: 0.00 Hz </div>	<i>Range: 0.00, 20.00 to 120.00 Hz. Not seen if VT Connection is None.</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> 0 kW 0 kVA 0 kvar EVENT01 </div>	<i>Range: -50000 to 50000 kVA. Not seen if VT Connection is set as None</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> POWER FACTOR EVENT01: 0.00 </div>	<i>Range: 0.01 to 0.99 Lead or Lag, 0.00, 1.00 Not seen if VT Connection is set as None.</i>

MESSAGE		TORQUE EVENT01: 0.0 Nm	Range: 0 to 999999.9. Seen only if Torque Metering is Enabled
MESSAGE		ANALOG I/P 1 EVENT01: 0 Units	Range: -50000 to 50000. Not seen if Analog Input 1 is Disabled.
MESSAGE		ANALOG I/P 2 EVENT01: 0 Units	Range: -50000 to 50000. Not seen if Analog Input 2 is Disabled.
MESSAGE		ANALOG I/P 3 EVENT01: 0 Units	Range: -50000 to 50000. Not seen if Analog Input 3 is Disabled.
MESSAGE		ANALOG I/P 4 EVENT01: 0 Units	Range: -50000 to 50000. Not seen if Analog Input 4 is Disabled.

The event recorder stores motor and system information each time an event occurs. An event description is stored along with a time and date stamp for troubleshooting purposes. Events include all trips, any alarm optionally (except Service Alarm, and 469 Not Inserted Alarm, which always records as events), loss of control power, application of control power, emergency restarts, and motor starts when a blocking function is active. The latter event could occur if the block start contacts were shorted out to bypass the 469 and start the motor.

EVENT 01 is the most recent event and **EVENT 256** is the oldest event. Each new event bumps the other event records up one until **EVENT 256** is reached. The event record in **EVENT 256** is lost when a new event occurs. This information can be cleared using the **S1 469 SETUP** ▾ ▽ **CLEAR DATA** ▾ ▽ **CLEAR EVENT RECORD** settings.

Table 6-3: Cause of Events (Sheet 1 of 2)

TRIPS			
Acceleration Trip	Analog Diff 1-2 Trip	Analog Diff 3-4 Trip	Analog I/P 1 Trip
Analog I/P 2 Trip	Analog I/P 3 Trip	Analog I/P 4 Trip	Current U/B Trip
Differential Trip	General Sw.A Trip	General Sw.B Trip	General Sw.C Trip
General Sw.D Trip	Ground Fault Backup	Ground Fault Trip	Incomplete Seq Trip
Load Shed Trip	Mechanical Jam Trip	Overload Trip	Overvoltage Trip
Phase Reversal Trip	Power Factor Trip	Pressure Sw. Trip	Reactive Power Trip
Remote Trip	Reverse Power Trip	RTD 1 Trip	RTD 2 Trip
RTD 3 Trip	RTD 4 Trip	RTD 5 Trip	RTD 6 Trip
RTD 7 Trip	RTD 8 Trip	RTD 9 Trip	RTD 10 Trip
RTD 11 Trip	RTD 12 Trip	Short Circuit Backup	Short Circuit Trip
Single Phasing (Unbalanced)	Speed Switch Trip	Tachometer Trip	Undercurrent Trip
Underpower Trip	Undervoltage Trip	Vibration Sw.Trip	Volt. Frequency Trip
Loss of Comms Trip			

Table 6-3: Cause of Events (Sheet 2 of 2)

ALARMS (OPTIONAL EVENTS)			
Analog Diff 1-2 Alarm	Analog Diff 3-4 Alarm	Analog I/P 1 Alarm	Analog I/P 2 Alarm
Analog I/P 3 Alarm	Analog I/P 4 Alarm	Breaker Failure	Control Alarm
Counter Alarm	Current Demand Alarm	Current U/B Alarm	General Sw.A Alarm
General Sw.B Alarm	General Sw.C Alarm	General Sw.D Alarm	Ground Fault Alarm
kVA Demand Alarm	kvar Demand Alarm	kW Demand Alarm	Open RTD Alarm
Overload Alarm	Overtorque Alarm	Overvoltage Alarm	Power Factor Alarm
Pressure Sw. Alarm	Reactive Power Alarm	Remote Alarm	Reverse Power Alarm
RTD 1 Alarm	RTD 2 Alarm	RTD 3 Alarm	RTD 4 Alarm
RTD 5 Alarm	RTD 6 Alarm	RTD 7 Alarm	RTD 8 Alarm
RTD 9 Alarm	RTD 10 Alarm	RTD 11 Alarm	RTD 12 Alarm
RTD 1 High Alarm	RTD 2 High Alarm	RTD 3 High Alarm	RTD 4 High Alarm
RTD 5 High Alarm	RTD 6 High Alarm	RTD 7 High Alarm	RTD 8 High Alarm
RTD 9 High Alarm	RTD 10 High Alarm	RTD 11 High Alarm	RTD 12 High Alarm
Service Alarm	Short/Low RTD Alarm	Starter Failed Alarm	Tachometer Alarm
Thermal Model Alarm	Trip Coil Super.	Trip Counter Alarm	Undercurrent Alarm
Underpower Alarm	Undervoltage Alarm	Vibration Sw. Alarm	Volt. Frequency Alarm
Welded Contactor	Loss of Comms Alarm		
OTHER			
1 TRIP Relay Forced	2 AUX Relay Forced	3 AUX Relay Forced	4 ALARM Relay Forced
469 Not Inserted	5 BLOCK Relay Forced		Control Power Applied
Control Power Lost	Digital Trace Trigger	Emergency Rst. Close	Emergency Rst. Open
Force 1 TRIP Disabled	Force 2 AUX Disabled	Force 3 AUX Disabled	Force 4 ALARM Disabled
Force 5 BLOCK Disabled	Forced Relay	Motor Started	No Event/Trip to Date
Relay Not Inserted	Serial Trace Trigger	Service Alarm	Simulation Started
Simulation Stopped	Start While Blocked	Self-test Warning 9*	

* The event "Self-test warning 9" is caused by unexpected microprocessor reset. System input measurements were interrupted for at least 2 seconds.

6.7 A6 Product Info

6.7.1 469 Model Information

PATH: ACTUAL VALUES ▾ ▾ A6 PRODUCT INFO ▾ ▾ 469 MODEL INFORMATION

<div style="border: 1px solid black; padding: 2px;"> 469 MODEL INFORMATION [▷] </div>		<div style="border: 1px solid black; padding: 2px;"> ORDER CODE: 469-P5-HI-A20-E </div>	<i>Range: Displays the relay order code and installed options.</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> 469 SERIAL NO: A3050001 </div>	<i>Range: Displays the serial number of the relay.</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> FIRMWARE REVISION: 4.00 </div>	<i>Range: Displays the firmware revision of the relay.</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> BOOT REVISION: 3.00 </div>	<i>Range: Displays the boot software revision of the relay.</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> HARDWARE REVISION: H </div>	<i>Range: Displays the hardware revision of the relay.</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> MOD NUMBER: 004 </div>	<i>Range: Displays the relay modification number.</i>

All of the 469 model information may be viewed here when the unit is powered up. In the event of a product software upgrade or service question, the information shown here should be jotted down prior to any inquiry.

6.7.2 Calibration Information

PATH: ACTUAL VALUES ▾ ▾ A6 PRODUCT INFO ▾ ▾ CALIBRATION INFORMATION

<div style="border: 1px solid black; padding: 2px;"> CALIBRATION INFORMATION [▷] </div>		<div style="border: 1px solid black; padding: 2px;"> ORIGINAL CALIBRATION DATE: Jan 01 1995 </div>	<i>Range: month day year</i>
MESSAGE		<div style="border: 1px solid black; padding: 2px;"> LAST CALIBRATION DATE: Jan 01 1995 </div>	<i>Range: month day year</i>

The date of the original calibration and last calibration may be viewed here.

6.8 Diagnostics

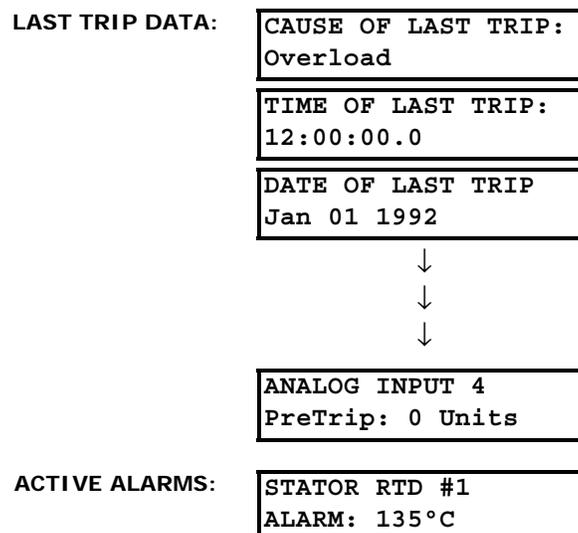
6.8.1 Diagnostic Messages

Some actual value messages are helpful in diagnosing the cause of Trips, Alarms, or Start Blocks. The 469 automatically defaults to the most important message. The hierarchy is Trip and PreTrip messages, Alarm, and lastly, Start Block Lockout. To simplify things, the Message LED (indicator) will flash, prompting the operator to press the NEXT key. When NEXT is pressed, the next relevant message is automatically displayed. The 469 cycles through the messages with each keypress. When all of these conditions have cleared, the 469 reverts back to the normal default messages.

Any time the 469 is not displaying the default messages because other Actual Value or settings messages are being viewed and there are no trips, alarms, or blocks, the Message LED (indicator) will be on solid. From any point in the message structure, pressing the NEXT key will cause the 469 to revert back to the normal default messages. When normal default messages are being displayed, pressing NEXT displays the next default message immediately.

Example:

When an overload trip occurs, an RTD alarm may also occur as a result of the overload and a lockout time associated with the trip. The 469 automatically defaults to the **A1 STATUS** ▸ ▾ **LAST TRIP DATA** ▸ **CAUSE OF LAST TRIP** actual value message and the Message LED flashes. Pressing the NEXT key cycles through the time and date stamp information as well as all of the pre-trip data. When the bottom of this queue is reached, pressing NEXT again normally returns to the top of the queue. However, because an alarm is active, the display skips to the alarm message at the top of the **A1 STATUS** ▸ ▾ **ALARM STATUS** queue. Similarly, pressing NEXT again skips to the **A1 STATUS** ▸ ▾ **START BLOCK** ▸ ▾ **RESTART BLOCK LOCKOUT** message. Pressing NEXT once final time returns to the original **CAUSE OF LAST TRIP** message, and the cycle could be repeated.



**START BLOCK
LOCKOUTS:**

OVERLOAD LOCKOUT BLOCK: 25 min

When the RESET has been pressed, the hot RTD condition is no longer present, and the lockout time has expired, the display will revert back to the normal Default Messages.

6.8.2 Flash Messages

Flash messages are warning, error, or general information messages that are temporarily displayed in response to certain key presses. These messages are intended to assist with navigation of the 469 messages by explaining what has happened or by prompting the user to perform certain actions.

[.] KEY IS USED TO ADVANCE THE CURSOR	ACCESS DENIED, ENTER PASSCODE	ACCESS DENIED, SHORT ACCESS SWITCH	ALL POSSIBLE RESETS HAVE BEEN PERFORMED
ARE YOU SURE? PRESS [ENTER] TO VERIFY	DATA CLEARED SUCCESSFULLY	DATE ENTRY OUT OF RANGE	DATE ENTRY WAS NOT COMPLETE
DEFAULT MESSAGE HAS BEEN ADDED	DEFAULT MESSAGE HAS BEEN REMOVED	DEFAULT MESSAGE LIST IS FULL	DEFAULT MESSAGES 6 TO 20 ARE ASSIGNED
END OF LIST	END OF PAGE	ENTER NEW PASSCODE FOR ACCESS	INPUT FUNCTION ALREADY ASSIGNED
INVALID PASSCODE ENTERED!	INVALID SERVICE CODE ENTERED	KEY PRESSED IS INVALID HERE	NEW PASSCODE HAS BEEN ACCEPTED
NEW settings HAS BEEN STORED	NO ALARMS	NO START BLOCKS ACTIVE	NO TRIPS OR ALARMS TO RESET
OUT OF RANGE! ENTER: ####-#### by #	PRESS [ENTER] TO ADD DEFAULT MESSAGE	PRESS [ENTER] TO REMOVE MESSAGE	RESET PERFORMED SUCCESSFULLY
ROUNDED settings HAS BEEN STORED	settings ACCESS IS NOW PERMITTED	settings ACCESS IS NOW RESTRICTED	THIS FEATURE NOT PROGRAMMED
TIME ENTRY OUT OF RANGE	TIME ENTRY WAS NOT COMPLETE	TOP OF LIST	TOP OF PAGE

- **[.] KEY IS USED TO ADVANCE THE CURSOR:** Any time a settings that requires text editing is viewed, this message will appear immediately to prompt the user to use the decimal key for cursor control. If the settings is not altered for one (1) minute, the message will flash again.
- **ACCESS DENIED, ENTER PASSCODE:** The 469 has a passcode security feature. If that feature has been enabled, not only do the access switch terminals have to be shorted, but the passcode must also be entered. If the correct passcode has been lost or

forgotten, contact the factory with the encrypted access code. See *Passcode* on page 5–8 for passcode features.

- **ACCESS DENIED, SHORT ACCESS SWITCH:** In order to store any settings values, the access switch must be shorted. If this message appears and it is necessary to change a settings, short access terminals C1 and C2.
- **ALL POSSIBLE RESETS HAVE BEEN PERFORMED:** If only some of the trip and alarm features that are active can be cleared (i.e. the conditions that caused some of these trips and/or alarms are still present), then this message will appear when a RESET is performed, indicating that only trips and alarms that could be reset have been reset.
- **ARE YOU SURE? PRESS [ENTER] TO VERIFY:** If the RESET key is pressed and resetting of any trip or alarm feature is possible, this message will appear to ask for verification of the operation. If RESET is pressed again while the message is still on the display, the reset will be performed.
- **DATA CLEARED SUCCESSFULLY:** This message confirms that data has been cleared or reset in the **S1 469 SETUP** ▾ ▽ **CLEAR DATA** or **S1 469 SETUP** ▾ ▽ **INSTALLATION** settings groups.
- **DATE ENTRY WAS NOT COMPLETE:** Since the **DATE** settings has a special format (MM/DD/YYYY), if ENTER is pressed before the complete value is entered, this message appears and the new value is not stored. Another attempt will have to be made with the complete information.
- **DATE ENTRY WAS OUT OF RANGE:** This message appears if an invalid entry is made for the **DATE** (e.g. 15 entered for month).
- **DEFAULT MESSAGE HAS BEEN ADDED:** Any time a new default message is added to the default message list, this message will appear as verification.
- **DEFAULT MESSAGE HAS BEEN REMOVED:** Any time a default message is removed from the default message list, this message will appear as verification.
- **DEFAULT MESSAGE LIST IS FULL:** If an attempt is made to add a new default message to the default message list when 20 messages are already assigned, this message will appear. In order to add a message, one of the existing messages must be removed.
- **DEFAULT MESSAGES 6 of 20 ARE ASSIGNED:** This message appears each time the **S1 469 SETUP** ▾ ▽ **DEFAULT MESSAGES** settings group is entered. It notifies the user of the number of assigned default messages.
- **END OF LIST:** This message will indicate when the bottom of a subgroup has been reached.
- **END OF PAGE:** This message will indicate when the bottom of a page has been reached.
- **ENTER NEW PASSCODE FOR ACCESS:** If the passcode is zero, the passcode security feature is disabled. If the Change Passcode settings is entered as yes, this flash message will appear prompting the user to enter a non-zero passcode which in turn will enable the feature.
- **INPUT FUNCTION IS ALREADY ASSIGNED:** The Assignable Digital Input functions may only be used once. If an attempt is made to assign the same function to two different switches, this message will appear.

- **INVALID PASSCODE ENTERED:** If an invalid passcode is entered for passcode security feature, this message will flash on the display.
- **INVALID SERVICE CODE ENTERED:** This message appears if an invalid code is entered in [S13 469 TESTING ▷▽ GE MULTILIN USE ONLY](#).
- **KEY PRESSED HERE IS INVALID:** Under certain situations, certain keys have no function (e.g. any number key while viewing Actual Values). If a key is pressed where it should have no function, this message will appear.
- **NEW PASSCODE HAS BEEN ACCEPTED:** This message will appear as an acknowledge that the new passcode has been accepted when changing the passcode for the passcode security feature.
- **NEW settings HAS BEEN STORED:** This message appear each time a settings has been altered and stored as shown on the display.
- **NO ALARMS:** This message appears if an attempt is made to enter the [A1 STATUS ⇒ ALARM STATUS](#) subgroup when there are no active alarms.
- **NO START BLOCKS ACTIVE:** This message appears if an attempt is made to enter the [A1 STATUS ⇒ ↓ START BLOCKS](#) subgroup when there are no active Start Blocks.
- **NO TRIPS OR ALARMS TO RESET:** If RESET is pressed when there are no trips or alarms present, this message will appear.
- **OUT OF RANGE! ENTER: #### - ##### by #:** If an entered settings value that is outside of the acceptable range of values, the 469 displays this message, substituting the proper values for that settings. An appropriate value may then be entered.
- **PRESS [ENTER] TO ADD DEFAULT MESSAGE:** If the ENTER key is pressed anywhere in the 469 actual value messages, this message prompts the user to press ENTER again to add a new default message. To add a new default message, ENTER must be pressed while this message is being displayed.
- **PRESS [ENTER] TO REMOVE MESSAGE:** If the decimal key is pressed in the [S1 469 SETUP ▷▽ DEFAULT MESSAGES](#) settings group, immediately followed by the ENTER key, this message prompts the user to press enter to remove a default message. To remove the default message, ENTER must be pressed while this message is being displayed.
- **RESET PERFORMED SUCCESSFULLY:** If all trip and alarm features that are active can be cleared (i.e. the conditions that caused these trips and/or alarms are no longer present), then this message will appear when a reset is performed, indicating that all trips and alarms have been cleared.
- **ROUNDED settings HAS BEEN STORED:** A settings value entered with the numeric keypad may be between valid settings values. The 469 detects this condition and stores a value that has been rounded to the nearest valid settings value. To find the valid range and step for a given settings, simply press HELP while the settings is being displayed.
- **settings ACCESS IS NOW PERMITTED:** This flash message notifies the user that settings may now be altered and stored any time the passcode security feature is enabled and a valid passcode is entered.
- **settings ACCESS IS NOW RESTRICTED:** This message appears if the passcode security feature is enabled, a valid passcode has been entered, and the [S1 469 SETUP ▷](#)

PASSCODE > **SETTINGS ACCESS** settings value is Restricted. This message also appears anytime that settings access is permitted and the access jumper is removed.

- **THIS FEATURE NOT PROGRAMMED:** If an attempt is made to enter an actual value message subgroup, when the settings are not configured for that feature, this message will appear.
- **TIME ENTRY WAS NOT COMPLETE:** Since the **TIME** settings has a special format (HH/MM/SS.S), if **ENTER** is pressed before the complete value entered, this message appears and the new value is not stored. Another attempt will have to be made with the complete information.
- **TIME ENTRY WAS OUT OF RANGE:** If an invalid entry is made for the time (e.g. 35 entered for hour), this message will appear.
- **TOP OF LIST:** This message will indicate when the top of subgroup has been reached.
- **TOP OF PAGE:** This message will indicate when the top of a page has been reached.



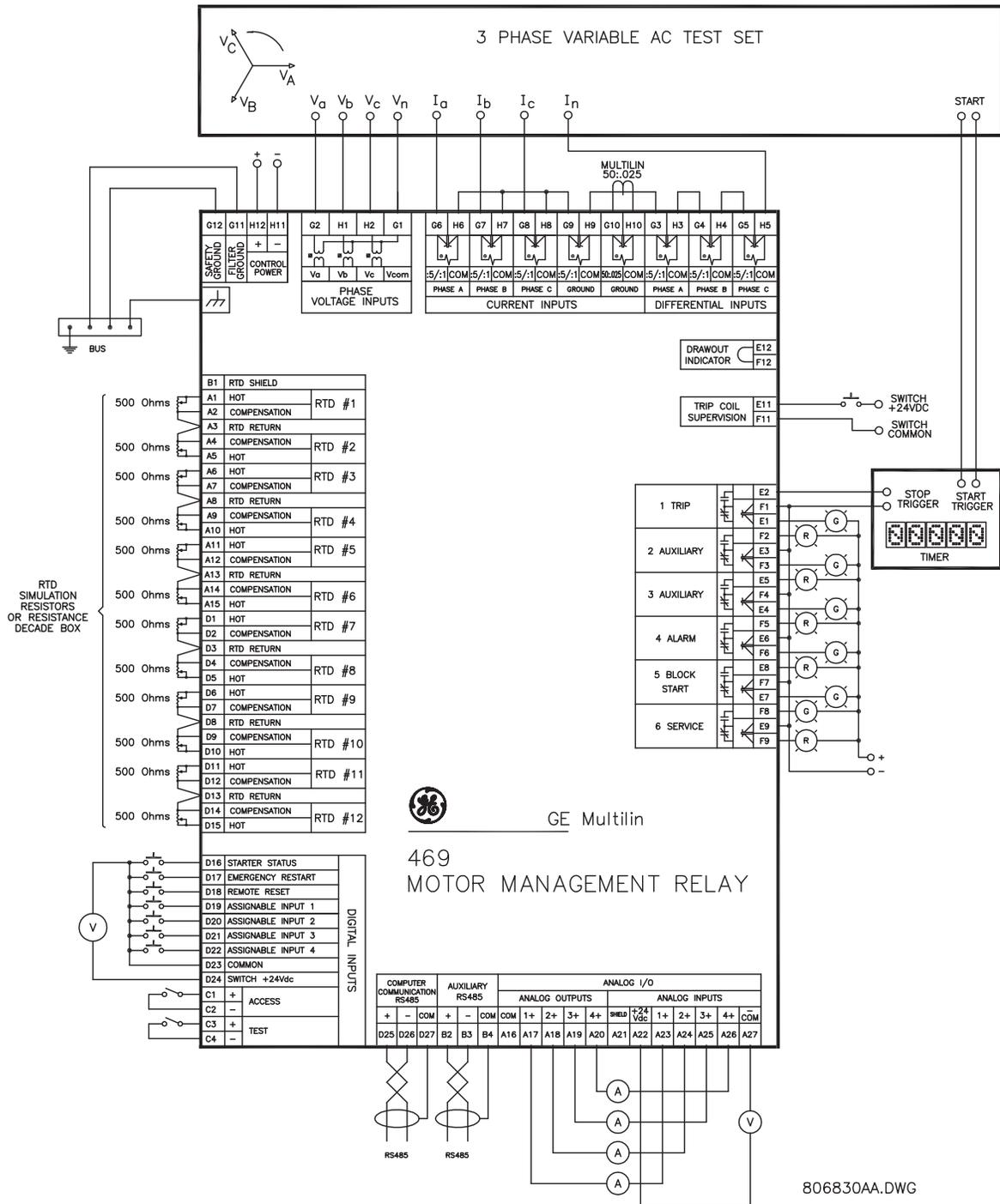
469 Motor Management Relay

Chapter 7: Testing

7.1 Overview

7.1.1 Test Setup

The purpose of this testing description is to demonstrate the procedures necessary to perform a complete functional test of all the 469 hardware while also testing firmware/hardware interaction in the process. Since the 469 is packaged in a drawout case, a demo case (metal carry case in which an 469 may be mounted) may be useful for creating a portable test set. Testing of the relay during commissioning using a primary injection test set will ensure that CTs and wiring are correct and complete.



806830AA.DWG

FIGURE 7-1: Secondary Injection Test Setup

7.2 Hardware Functional Testing

7.2.1 Phase Current Accuracy Test

The 469 specification for phase current accuracy is $\pm 0.5\%$ of $2 \times \text{CT}$ when the injected current is less than $2 \times \text{CT}$. Perform the steps below to verify accuracy.

- ▷ Alter the following settings:

S2 SYSTEM SETUP ▷ CURRENT SENSING ▷ PHASE CT PRIMARY: “1000 A”

Measured values should be ± 10 A.

- ▷ Inject the values shown in the table below.
- ▷ Verify accuracy of the measured values.
- ▷ View the measured values in:

A2 METERING DATA ▷ CURRENT METERING

INJECTED CURRENT 1 A UNIT	INJECTED CURRENT 5 A UNIT	EXPECTED CURRENT READING	MEASURED CURRENT PHASE A	MEASURED CURRENT PHASE B	MEASURED CURRENT PHASE C
0.1 A	0.5 A	100 A			
0.2 A	1.0 A	200 A			
0.5 A	2.5 A	500 A			
1.0 A	5.0 A	1000 A			
1.5 A	7.5 A	1500 A			
2.0 A	10 A	2000 A			

7.2.2 Voltage Input Accuracy Test

The 469 specification for voltage input accuracy is $\pm 0.5\%$ of full scale (273 V). Perform the steps below to verify accuracy.

- ▷ Alter the following settings:

S2 SYSTEM SETUP ▷ VOLTAGE SENSING ▷ VT CONNECTION TYPE: “Wye”

S2 SYSTEM SETUP ▷ VOLTAGE SENSING ▷ VOLTAGE TRANSFORMER RATIO: “10.00:1”

Measured values should be ± 13.65 V.

- ▷ Apply the voltage values shown in the table.
- ▷ Verify accuracy of the measured values.
- ▷ View the measured values in:

A2 METERING DATA ▷ VOLTAGE METERING

APPLIED LINE-NEUTRAL VOLTAGE	EXPECTED VOLTAGE READING	MEASURED VOLTAGE A-N	MEASURED VOLTAGE B-N	MEASURED VOLTAGE C-N
30 V	300 V			
50 V	500 V			
100 V	1000 V			
150 V	1500 V			

APPLIED LINE-NEUTRAL VOLTAGE	EXPECTED VOLTAGE READING	MEASURED VOLTAGE A-N	MEASURED VOLTAGE B-N	MEASURED VOLTAGE C-N
200 V	2000 V			
270 V	2700 V			

7.2.3 Ground and Differential Accuracy Test

The 469 specification for differential current and 1 A/5 A ground current input accuracy is $\pm 0.5\%$ of $1 \times CT$ for the 5 A input and 0.5% of $5 \times CT$ for the 1 A input. Perform the steps below to verify accuracy.

5 A Input

▷ Alter the following settings:

S2 SYSTEM SETUP ▷ CURRENT SENSING ▷ ▾ GROUND CT: "5A Secondary"

S2 SYSTEM SETUP ▷ CURRENT SENSING ▷ ▾ GROUND CT PRIMARY: "1000 A"

S2 SYSTEM SETUP ▷ CURRENT SENSING ▷ ▾ PHASE DIFFERENTIAL CT: "5A Secondary"

S2 SYSTEM SETUP ▷ CURRENT SENSING ▷ ▾ PHASE DIFFERENTIAL CT PRIMARY: "1000 A"

Measured values should be ± 5 A.

▷ Inject the values shown in the table below into one phase only.

▷ Verify accuracy of the measured values.

▷ View the measured values in:

A2 METERING DATA ▷ CURRENT METERING

INJECTED CURRENT 5 A UNIT	EXPECTED CURRENT READING	MEASURED GROUND CURRENT	MEASURED DIFFERENTIAL CURRENT		
			PHASE A	PHASE B	PHASE C
0.5 A	100 A				
1.0 A	200 A				
2.5 A	500 A				
5.0 A	1000 A				

1 A Input

▷ Alter the following settings:

S2 SYSTEM SETUP ▷ CURRENT SENSING ▷ ▾ GROUND CT: "1A Secondary"

S2 SYSTEM SETUP ▷ CURRENT SENSING ▷ ▾ GROUND CT PRIMARY: "1000 A"

S2 SYSTEM SETUP ▷ CURRENT SENSING ▷ ▾ PHASE DIFFERENTIAL CT: "1A Secondary"

S2 SYSTEM SETUP ▷ CURRENT SENSING ▷ ▾ PHASE DIFFERENTIAL CT PRIMARY: "1000 A"

Measured values should be ± 25 A.

▷ Inject the values shown below into one phase only.

▷ Verify accuracy of the measured values.

▷ View the measured values in:

A2 METERING DATA ▷ CURRENT METERING:

INJECTED CURRENT 1 A UNIT	EXPECTED CURRENT READING	MEASURED GROUND CURRENT	MEASURED DIFFERENTIAL CURRENT		
			PHASE A	PHASE B	PHASE C
0.1 A	100 A				
0.2 A	200 A				
0.5 A	500 A				
1.0 A	1000 A				

7.2.4 GE Digital Energy 50:0.025 Ground Accuracy Test

The 469 specification for GE Digital Energy 50:0.025 ground current input accuracy is $\pm 0.5\%$ of CT rated primary (25 A). Perform the steps below to verify accuracy.

- ▷ Alter the following settings:

S2 SYSTEM SETUP ▷ CURRENT SENSING ▷ ▾ GROUND CT: "50:0.025"

Measured values should be ± 0.125 A.

- ▷ Inject the values shown in the table below either as primary values into a GE Digital Energy 50:0.025 Core Balance CT or as secondary values that simulate the core balance CT.
- ▷ Verify accuracy of the measured values.
- ▷ View the measured values in:

A2 METERING DATA ▷ CURRENT METERING

PRIMARY INJECTED CURRENT	SECONDARY INJECTED CURRENT	EXPECTED CURRENT READING	MEASURED GROUND CURRENT
0.25 A	0.125 mA	0.25 A	
1 A	0.5 mA	1.00 A	
10 A	5 mA	10.00 A	
25 A	12.5 mA	25.00 A	

7.2.5 RTD Accuracy Test

The 469 specification for RTD input accuracy is $\pm 2^\circ$. Perform the steps below.

- ▷ Alter the following settings:

S8 RTD TEMPERATURE ▷ RTD TYPES ▷ STATOR RTD TYPE: "100 Ohm Platinum" (select desired type)

S8 RTD TEMPERATURE ▷ ▾ RTD #1 ▷ RTD #1 APPLICATION: "Stator" (repeat for RTDs 2 to 12)

Measured values should be $\pm 2^\circ\text{C}$ or $\pm 4^\circ\text{F}$.

- ▷ Alter the resistances applied to the RTD inputs as per the table below to simulate RTDs.
- ▷ Verify accuracy of the measured values.
- ▷ View measured values in:

A2 METERING DATA ▷▽ TEMPERATURE:

Table 7-1: 100 Ω PLATINUM TEST

APPLIED RESISTANCE 100 Ω PLATINUM	EXPECTED RTD TEMPERATURE READING		MEASURED RTD TEMPERATURE SELECT ONE: ____ (°C) ____ (°F)											
	°Celsius	°Fahrenheit	1	2	3	4	5	6	7	8	9	10	11	12
80.31 Ω	-50°C	-58°F												
100.00 Ω	0°C	32°F												
119.39 Ω	50°C	122°F												
138.50 Ω	100°C	212°F												
157.32 Ω	150°C	302°F												
175.84 Ω	200°C	392°F												
194.08 Ω	250°C	482°F												

Table 7-2: 120 Ω NICKEL TEST

APPLIED RESISTANCE 120 Ω NICKEL	EXPECTED RTD TEMPERATURE READING		MEASURED RTD TEMPERATURE SELECT ONE: ____ (°C) ____ (°F)											
	°Celsius	°Fahrenheit	1	2	3	4	5	6	7	8	9	10	11	12
86.17 Ω	-50°C	-58°F												
120.00 Ω	0°C	32°F												
157.74 Ω	50°C	122°F												
200.64 Ω	100°C	212°F												
248.95 Ω	150°C	302°F												
303.46 Ω	200°C	392°F												
366.53 Ω	250°C	482°F												

Table 7-3: 100 Ω NICKEL TEST

APPLIED RESISTANCE 100 Ω NICKEL	EXPECTED RTD TEMPERATURE READING		MEASURED RTD TEMPERATURE SELECT ONE: ____ (°C) ____ (°F)											
	°Celsius	°Fahrenheit	1	2	3	4	5	6	7	8	9	10	11	12
71.81 Ω	-50°C	-58°F												
100.00 Ω	0°C	32°F												
131.45 Ω	50°C	122°F												

Table 7-3: 100 Ω NICKEL TEST

APPLIED RESISTANCE 100 Ω NICKEL	EXPECTED RTD TEMPERATURE READING		MEASURED RTD TEMPERATURE SELECT ONE: ____ (°C) ____ (°F)											
	°Celsius	°Fahrenheit	1	2	3	4	5	6	7	8	9	10	11	12
167.20 Ω	100°C	212°F												
207.45 Ω	150°C	302°F												
252.88 Ω	200°C	392°F												
305.44 Ω	250°C	482°F												

Table 7-4: 10 Ω COPPER TEST

APPLIED RESISTANCE 10 Ω COPPER	EXPECTED RTD TEMPERATURE READING		MEASURED RTD TEMPERATURE SELECT ONE: ____ (°C) ____ (°F)											
	°Celsius	°Fahrenheit	1	2	3	4	5	6	7	8	9	10	11	12
7.10 Ω	-50°C	-58°F												
9.04 Ω	0°C	32°F												
10.97 Ω	50°C	122°F												
12.90 Ω	100°C	212°F												
14.83 Ω	150°C	302°F												
16.78 Ω	200°C	392°F												
18.73 Ω	250°C	482°F												

7.2.6 Digital Inputs and Trip Coil Supervision

The digital inputs and trip coil supervision can be verified easily with a simple switch or pushbutton. Verify the SWITCH +24 V DC with a voltmeter. Perform the steps below to verify functionality of the digital inputs.

- ▷ Open switches of all of the digital inputs and the trip coil supervision circuit.
- ▷ View the status of the digital inputs and trip coil supervision in:
 - ACTUAL VALUES ▷ A1 STATUS ▷ ▾ DIGITAL INPUTS**
- ▷ Close switches of all of the digital inputs and the trip coil supervision circuit.
- ▷ View the status of the digital inputs and trip coil supervision in:

A1 STATUS ▷ ▾ DIGITAL INPUTS

INPUT	EXPECTED STATUS (SWITCH OPEN)	PASS / FAIL	EXPECTED STATUS (SWITCH CLOSED)	PASS / FAIL
ACCESS	Open		Shorted	
TEST	Open		Shorted	
STARTER STATUS	Open		Shorted	
EMERGENCY RESTART	Open		Shorted	
REMOTE RESET	Open		Shorted	
ASSIGNABLE INPUT 1	Open		Shorted	
ASSIGNABLE INPUT 2	Open		Shorted	
ASSIGNABLE INPUT 3	Open		Shorted	
ASSIGNABLE INPUT 4	Open		Shorted	
TRIP COIL SUPERVISION	No Coil		Coil	

7.2.7 Analog Inputs and Outputs

The 469 specification for analog input and analog output accuracy is $\pm 1\%$ of full scale. Perform the steps below to verify accuracy. Verify the Analog Input +24 V DC with a voltmeter.

4 to 20 mA Analog Input

▷ Alter the following settings:

S12 ANALOG I/O ▷ ▾ ANALOG INPUT1 ▷ ANALOG INPUT1: "4-20 mA"

S12 ANALOG I/O ▷ ▾ ANALOG INPUT1 ▷ ▾ ANALOG INPUT1 MINIMUM: "0"

S12 ANALOG I/O ▷ ▾ ANALOG INPUT1 ▷ ▾ ANALOG INPUT1 MAXIMUM: "1000" (repeat this value for Analog Inputs 2 to 4)

Analog output values should be ± 0.2 mA on the ammeter. Measured analog input values should be ± 10 units.

▷ Force the analog outputs using the following settings:

S13 TESTING ▷ ▾ TEST ANALOG OUTPUT ▷ FORCE ANALOG OUTPUTS FUNCTION: "Enabled"

S13 TESTING ▷ ▾ TEST ANALOG OUTPUT ▷ ▾ ANALOG OUTPUT 1 FORCED VALUE: "0%" (enter desired value in percent; repeat for Analog Outputs 2 through 4)

▷ Verify the ammeter readings as well as the measured analog input readings.

For the purposes of testing, the analog input is fed in from the analog output (see FIGURE 7-1: *Secondary Injection Test Setup* on page 7-2).

▷ View the measured values in:

A2 METERING DATA ▾ ▾ ANALOG INPUTS:

ANALOG OUTPUT FORCE VALUE	EXPECTED AMMETER READING	MEASURED AMMETER READING (mA)				EXPECTED ANALOG INPUT READING	MEASURED ANALOG INPUT READING (units)			
		1	2	3	4		1	2	3	4
0%	4 mA					0 mA				
25%	8 mA					250 mA				
50%	12 mA					500 mA				
75%	16 mA					750 mA				
100%	20 mA					1000 mA				

0 to 1 mA Analog Input

- ▷ Alter the following settings:

S12 ANALOG I/O ▾ ▾ ANALOG INPUT1 ▾ ANALOG INPUT1: "0-1 mA"

S12 ANALOG I/O ▾ ▾ ANALOG INPUT1 ▾ ▾ ANALOG INPUT1 MINIMUM: "0"

S12 ANALOG I/O ▾ ▾ ANALOG INPUT1 ▾ ▾ ANALOG INPUT1 MAXIMUM: "1000" (repeat for Analog Inputs 2 to 4)

Analog output values should be ± 0.01 mA on the ammeter. Measured analog input values should be ± 10 units.

- ▷ Force the analog outputs using the following settings:

S13 TESTING ▾ ▾ TEST ANALOG OUTPUT ▾ FORCE ANALOG OUTPUTS FUNCTION: "Enabled"

S13 TESTING ▾ ▾ TEST ANALOG OUTPUT ▾ ▾ ANALOG OUTPUT 1 FORCED VALUE: "0%" (enter desired percent, repeats for analog output 2-4)

- ▷ Verify the ammeter readings as well as the measured analog input readings.
- ▷ View the measured values in:

A2 METERING DATA ▾ ▾ ANALOG INPUTS:

ANALOG OUTPUT FORCE VALUE	EXPECTED AMMETER READING	MEASURED AMMETER READING (mA)				EXPECTED ANALOG INPUT READING	MEASURED ANALOG INPUT READING (units)			
		1	2	3	4		1	2	3	4
0%	0 mA					0 mA				
25%	0.25 mA					250 mA				
50%	0.50 mA					500 mA				
75%	0.75 mA					750 mA				
100%	1.00 mA					1000 mA				

7.2.8 Output Relays

To verify the functionality of the output relays, perform the following steps:

Using the settings:

S13 TESTING ▷ ▽ **TEST OUTPUT RELAYS** ⇒ **FORCE OPERATION OF RELAYS: "1 Trip"**

▷ Select and store values as per the table below, verifying operation

FORCE OPERATION SETTINGS	EXPECTED MEASUREMENT 4 FOR SHORT												ACTUAL MEASUREMENT 4 FOR SHORT											
	1		2		3		4		5		6		1		2		3		4		5		6	
	no	nc	no	nc	no	nc	no	nc	no	nc	no	nc	no	nc	no	nc	no	nc	no	nc	no	nc	no	nc
1 TRIP	4			4		4		4		4	4													
2 AUXILIARY		4	4			4		4		4	4													
3 AUXILIARY		4		4	4			4		4	4													
4 ALARM		4		4		4	4			4	4													
5 BLOCK START		4		4		4		4	4		4													
6 SERVICE		4		4		4		4		4		4												
All Relays	4		4		4		4		4		4													
No Relays		4		4		4		4		4	4													



The 6 SERVICE relay is failsafe or energized normally. Operating the 6 SERVICE relay causes it to de-energize.

7.3 Additional Functional Testing

7.3.1 Overload Curve Test

The 469 specification for overload curve timing accuracy is ± 100 ms or $\pm 2\%$ of time to trip. Pickup accuracy is as per the current inputs ($\pm 0.5\%$ of $2 \times CT$ when the injected current is less than $2 \times CT$ and $\pm 1\%$ of $20 \times CT$ when the injected current is $\geq 2 \times CT$). Perform the steps below to verify accuracy.

- ▷ Alter the following settings:

S2 SYSTEM SETUP ▷ CURRENT SENSING ▷ PHASE CT PRIMARY: "1000"

S2 SYSTEM SETUP ▷ CURRENT SENSING ▷ MOTOR FULL LOAD AMPS FLA: "1000"

S5 THERMAL MODEL ▷ THERMAL MODEL ▷ SELECT CURVE STYLE: "Standard"

S5 THERMAL MODEL ▷ THERMAL MODEL ▷ OVERLOAD PICKUP LEVEL: "1.10"

S5 THERMAL MODEL ▷ THERMAL MODEL ▷ UNBALANCE BIAS K FACTOR: "0"

S5 THERMAL MODEL ▷ THERMAL MODEL ▷ HOT/COLD SAFE STALL RATIO: "1.00"

S5 THERMAL MODEL ▷ THERMAL MODEL ▷ ENABLE RTD BIASING: "No"

S5 THERMAL MODEL ▷ O/L CURVE SETUP ▷ STANDARD OVERLOAD CURVE NUMBER: "4"

Any trip must be reset prior to each test.

- ▷ Short the emergency restart terminals momentarily immediately prior to each overload curve test to ensure that the thermal capacity used is zero.
Failure to do so will result in shorter trip times.
- ▷ Inject the current of the proper amplitude to obtain the values as shown.
- ▷ Verify the trip times.
Motor load may be viewed in:

A2 METERING DATA ▷ CURRENT METERING.

Thermal capacity used and estimated time to trip may be viewed in

A1 STATUS ▷ MOTOR STATUS.

AVERAGE PHASE CURRENT DISPLAYED	PICKUP LEVEL	EXPECTED TIME TO TRIP	TOLERANCE RANGE	MEASURED TIME TO TRIP
1050 A	1.05	never	n/a	
1200 A	1.20	795.44 sec.	779.53 to 811.35 sec.	
1750 A	1.75	169.66 sec.	166.27 to 173.05 sec.	
3000 A	3.00	43.73 sec.	42.86 to 44.60 sec.	
6000 A	6.00	9.99 sec.	9.79 to 10.19 sec.	
10000 A	10.00	5.55 sec.	5.44 to 5.66 sec.	

7.3.2 Power Measurement Test

The specification for reactive and apparent power is $\pm 1\%$ of $\sqrt{3} \times 2 \times CT \times VT \times VT$ full scale at $I_{avg} < 2 \times CT$. Perform the steps below to verify accuracy.

▷ Alter the following settings:

S2 SYSTEM SETUP ▷ CURRENT SENSING ▷ PHASE CT PRIMARY: "1000"

S2 SYSTEM SETUP ▷ VOLTAGE SENSING ▷ VT CONNECTION TYPE: "Wye"

S2 SYSTEM SETUP ▷ VOLTAGE SENSING ▷ VOLTAGE TRANSFORMER RATIO: "10.00:1"

▷ Inject current and apply voltage as per the table below.

▷ Verify accuracy of the measured values.

▷ View the measured values in:

A2 METERING DATA ▷ POWER METERING.

INJECTED CURRENT 1A UNIT, APPLIED VOLTAGE (Ia is the reference vector)	INJECTED CURRENT 5A UNIT, APPLIED VOLTAGE (Ia is the reference vector)	EXPECTED LEVEL OF POWER QUANTITY	TOLERANCE RANGE OF POWER QUANTITY	MEASURED POWER QUANTITY	EXPECTED POWER FACTOR	MEASURED POWER FACTOR
Ia = 1 A ∠0° Ib = 1 A ∠120° Ic = 1 A ∠240° Va = 120 V ∠342° Vb = 120 V ∠102° Vc = 120 V ∠222°	Ia = 5 A ∠0° Ib = 5 A ∠120° Ic = 5 A ∠240° Va = 120 V ∠342° Vb = 120 V ∠102° Vc = 120 V ∠222°	+ 3424 kW	3329 to 3519 kW		0.95 lag	
Ia = 1 A ∠0° Ib = 1 A ∠120° Ic = 1 A ∠240° Va = 120 V ∠288° Vb = 120 V ∠48° Vc = 120 V ∠168°	Ia = 5 A ∠0° Ib = 5 A ∠120° Ic = 5 A ∠240° Va = 120 V ∠288° Vb = 120 V ∠48° Vc = 120 V ∠168°	+ 3424 kvar	3329 to 3519 kvar		0.31 lag	

7.3.3 Unbalance Test

The 469 measures the ratio of negative sequence current (I_2) to positive sequence current (I_1). This value as a percent is used as the unbalance level when motor load exceeds FLA. When the average phase current is below FLA, the unbalance value is de-rated to prevent nuisance tripping as positive sequence current is much smaller and negative sequence current remains relatively constant. The derating formula is:

$$\left| \frac{I_2}{I_1} \right| \times \frac{I_{avg}}{FLA} \times 100\% \tag{EQ 7.1}$$

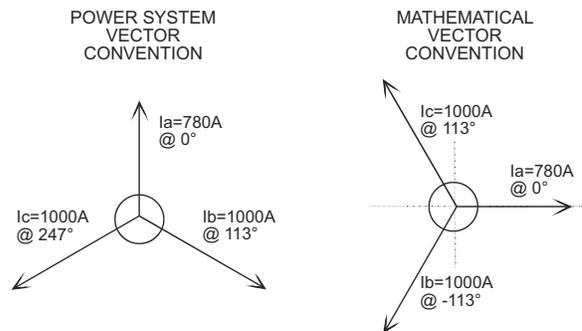


FIGURE 7-2: Three Phase Example for Unbalance Calculation

Symmetrical component analysis of vectors using the mathematical vector convention yields a ratio of negative sequence current to positive sequence current as shown:

$$\frac{I_2}{I_1} = \frac{\frac{1}{3}(I_a + a^2 I_b + a I_c)}{\frac{1}{3}(I_a + a I_b + a^2 I_c)} \quad \text{where } a = 1 \angle 120^\circ = -0.5 + j0.886 \quad (\text{EQ 7.2})$$

Given the values in the figure above, we have:

$$\begin{aligned} \frac{I_2}{I_1} &= \frac{780 \angle 0^\circ + (1 \angle 120^\circ)^2 (1000 \angle -113^\circ) + (1 \angle 120^\circ) (1000 \angle 113^\circ)}{780 \angle 0^\circ + (1 \angle 120^\circ) (1000 \angle -113^\circ) + (1 \angle 120^\circ)^2 (1000 \angle 113^\circ)} \\ &= \frac{780 \angle 0^\circ + 1000 \angle 127^\circ + 1000 \angle 233^\circ}{780 \angle 0^\circ + 1000 \angle 7^\circ + 1000 \angle 353^\circ} \\ &= \frac{780 - 601.8 + j798.6 - 601.8 - j798.6}{780 + 992.5 + j121.9 + 992.5 - j121.9} = \frac{-423.6}{2765} = 0.1532 \end{aligned} \quad (\text{EQ 7.3})$$

If FLA = 1000, then:

$$I_{avg} = \frac{780 + 1000 + 1000}{3} \text{ A} = 926.7 \text{ A} \quad (\text{EQ 7.4})$$

and since $I_{avg} = 926.7 \text{ A} < 1000 = \text{FLA}$, the 469 unbalance is:

$$469 \text{ Unbalance} = |-0.1532| \times \frac{926.7}{1000} \times 100\% = 14.2\% \quad (\text{EQ 7.5})$$

The 469 specification for unbalance accuracy is $\pm 2\%$. Perform the steps below to verify accuracy.

▷ Alter the following settings:

S2 SYSTEM SETUP ▷ CURRENT SENSING ▷ PHASE CT PRIMARY: "1000 A"

S2 SYSTEM SETUP ▷ CURRENT SENSING ▷ ▾ MOTOR FULL LOAD AMPS FLA: "1000 A"

▷ Inject the values shown in the table below.

▷ Verify accuracy of the measured values.

▷ View the measured values in:

A2 METERING DATA ▷ CURRENT METERING

INJECTED CURRENT		EXPECTED UNBALANCE LEVEL	MEASURED UNBALANCE LEVEL
1 A UNIT	5 A UNIT		
I _a = 0.78 A ∠0° I _b = 1 A ∠113° I _c = 1 A ∠247°	I _a = 3.9 A ∠0° I _b = 5 A ∠113° I _c = 5 A ∠247°	14%	
I _a = 1.56 A ∠0° I _b = 2 A ∠247° I _c = 2 A ∠113°	I _a = 7.8 A ∠0° I _b = 10 A ∠247° I _c = 10 A ∠113°	15%	
I _a = 0.39 A ∠0° I _b = 0.5 A ∠247° I _c = 0.5 A ∠113°	I _a = 1.95 A ∠0° I _b = 2.5 A ∠247° I _c = 2.5 A ∠113°	7%	

7.3.4 Voltage Phase Reversal Test

The 469 can detect voltage phase rotation and protect against phase reversal. To test the phase reversal element, perform the following steps:

▷ Alter the following settings:

S2 SYSTEM SETUP ▷ **VOLTAGE SENSING** ▷ **VT CONNECTION TYPE**: “Wye” or “Delta”

S2 SYSTEM SETUP ▷ **POWER SYSTEM** ▷ **SYSTEM PHASE SEQUENCE**: “ABC”

S9 VOLTAGE ELEMENTS ▷ **PHASE REVERSAL** ▷ **PHASE REVERSAL TRIP**: “Latched”

S9 VOLTAGE ELEMENTS ▷ **PHASE REVERSAL** ▷ **ASSIGN TRIP RELAYS**: “Trip”

▷ Apply voltages as per the table below.

▷ Verify the 469 operation on voltage phase reversal.

APPLIED VOLTAGE	EXPECTED RESULT 8 NO TRIP 4 PHASE REVERSAL TRIP	OBSERVED RESULT 8 NO TRIP 4 PHASE REVERSAL TRIP
Va = 120 V ∠0° Vb = 120 V ∠120° Vc = 120 V ∠240°	8	
Va = 120 V ∠0° Vb = 120 V ∠240° Vc = 120 V ∠120°	4	

7.3.5 Short Circuit Test

The 469 specification for short circuit timing is +50 ms. The pickup accuracy is as per the phase current inputs. Perform the steps below to verify the performance of the short circuit element.

▷ Alter the following settings:

S2 SYSTEM SETUP ▷ **CURRENT SENSING** ▷ **PHASE CT PRIMARY**: “1000”

S6 CURRENT ELEMENTS ▷ **SHORT CIRCUIT TRIP** ▷ **SHORT CIRCUIT TRIP**: “On”

S6 CURRENT ELEMENTS ▷ **SHORT CIRCUIT TRIP** ▷ **ASSIGN TRIP RELAYS**: “Trip”

S6 CURRENT ELEMENTS ▷ **SHORT CIRCUIT TRIP** ▷ **SHORT CIRCUIT TRIP PICKUP**: “5.0 × CT”

S6 CURRENT ELEMENTS ▷ **SHORT CIRCUIT TRIP** ▷ **INTENTIONAL S/C DELAY**: “0”

▷ Inject current as per the table below, resetting the unit after each trip by pressing the RESET key, and verify timing accuracy.

▷ Pre-trip values may be viewed by pressing NEXT after each trip.

INJECTED CURRENT		EXPECTED TIME TO TRIP	MEASURED TIME TO TRIP
5 A UNIT	1 A UNIT		
30 A	6 A	< 50 ms	
40 A	8 A	< 50 ms	
50 A	10 A	< 50 ms	



469 Motor Management Relay

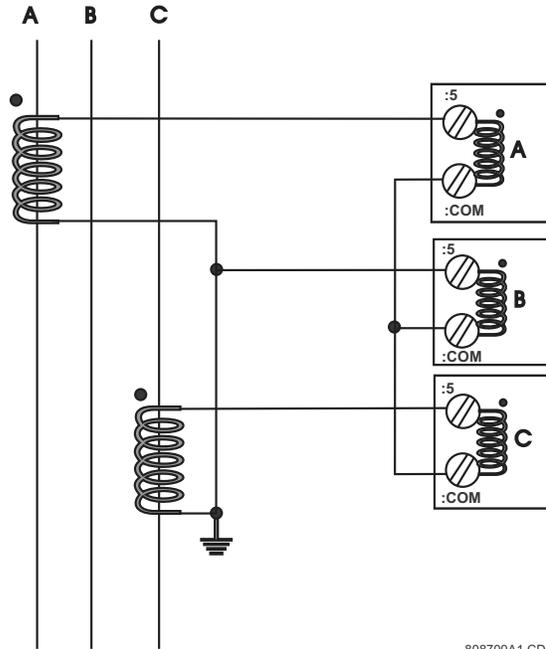
Chapter A: Appendix

A.1 Two-Phase CT Configuration

A.1.1 Description

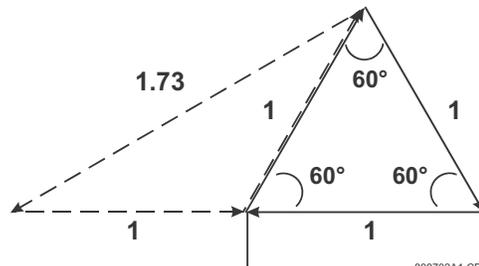
This appendix illustrates how two CTs may be used to sense three phase currents.

The proper configuration for the use of two CTs rather than three to detect phase current is shown. Each of the two CTs acts as a current source. The current that comes out of the CT on phase A flows into the interposing CT on the relay marked A. From there, the current sums with the current that is flowing from the CT on phase C which has just passed through the interposing CT on the relay marked C. This 'summed' current flows through the interposing CT marked B and from there, the current splits up to return to its respective source (CT). **Polarity is very important since the value of phase B must be the negative equivalent of A + C in order for the sum of all the vectors to equate to zero.** Note that there is only one ground connection as shown. If two ground connections are made, a parallel path for current has been created.



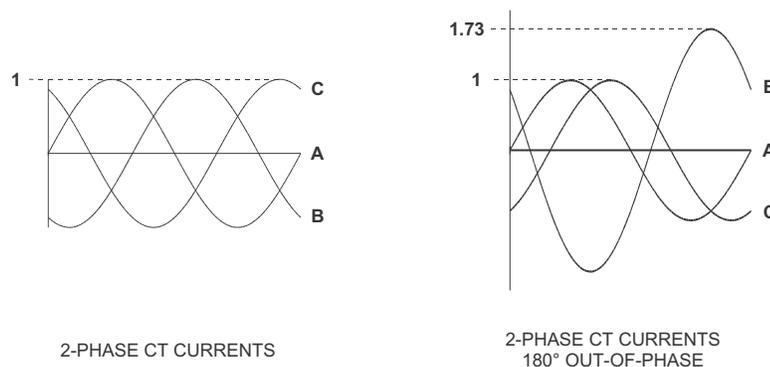
808700A1.CDR

In the two CT configuration, the currents will sum vectorially at the common point of the two CTs. The diagram illustrates the two possible configurations. If one phase is reading high by a factor of 1.73 on a system that is known to be balanced, simply reverse the polarity of the leads at one of the two phase CTs (taking care that the CTs are still tied to ground at some point). **Polarity is important.**



808702A1.CDR

To illustrate the point further, the following diagram shows how the current in phases A and C sum up to create phase 'B'.



2-PHASE CT CURRENTS

2-PHASE CT CURRENTS
180° OUT-OF-PHASE

808701A1.CDR

Once again, if the polarity of one of the phases is out by 180° , the magnitude of the resulting vector on a balanced system will be out by a factor of 1.73.

On a three wire supply, this configuration will always work and unbalance will be detected properly. In the event of a single phase, there will always be a large unbalance present at the interposing CTs of the relay. If for example Phase A was lost, Phase A would read zero while Phase B and C would both read the magnitude of Phase C. If on the other hand, phase B was lost, at the supply, Phase A would be 180° out-of-phase with Phase C and the vector addition would equal zero at Phase B.

A.2 Cool Time Constants

A.2.1 Selection of Cool Time Constants

Thermal limits are not a black and white science and there is some art to setting a protective relay thermal model. The definition of thermal limits mean different things to different manufacturers, and information is often not available. Therefore, it is important to remember the goal of the motor protection thermal modeling: to thermally protect the motor (rotor and stator) without impeding the normal and expected operating conditions of the motor.

The 469 thermal model provides integrated rotor and stator heating protection. If supplied with the motor, the cooling time constants recommended by the manufacturer should be used. Since rotor and stator heating and cooling is integrated into a single model, use of the longest cooling time constants (rotor or stator) is recommended.

If no cooling time constants are provided by the motor manufacturer, settings will have to be determined. Before determining the cool time constant settings, the motor duty cycle must be considered. If the motor is typically started up and run continuously for very long periods of time with no overload duty requirements, the cooling time constants can be large, making the thermal model conservative. If the normal duty cycle of the motor involves frequent starts and stops with a periodic overload duty requirement, the cooling time constants will be shorter and closer to the actual *thermal limit* of the motor.

Normally, motors are rotor limited during starting. Thus RTDs in the stator do not provide the best method of determining cool times. Determination of reasonable settings for the running and stopped cool time constants can be accomplished in one of the following manners listed in order of preference.

1. The motor running and stopped cool times or constants may be provided on the motor data sheets or requested from the manufacturer. Remember that the cooling is exponential and the time constants are one fifth of the total time interval from 100% to 0% thermal capacity used.
2. Attempt to determine a conservative value from the available motor data. See the following example for details.
3. If no motor data is available, an educated guess must be made. Perhaps the motor data could be estimated from other motors of a similar size or use. Note that conservative protection is the best first choice until a better understanding of the motor requirements is developed. Remember that the goal is to protect the motor without impeding the operating duty that is desired.

Example

Motor data sheets state that the starting sequence allowed is two (2) cold or one (1) hot, after which you must wait five (5) hours before attempting another start.

- This implies that under a normal start condition the motor is using between 34 and 50% thermal capacity. Hence, two consecutive starts are allowed, but not three.
- If the hot and cold curves or a hot/cold safe stall ratio are not available, program "0.5" (1 hot / 2 cold starts) as the **HOT/COLD SAFE STALL RATIO**.

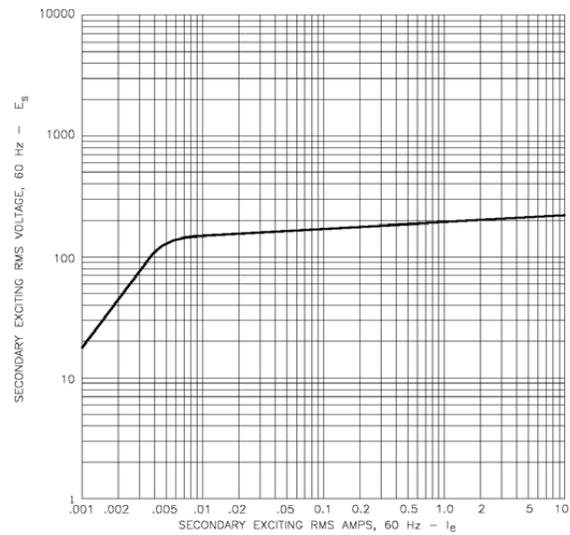
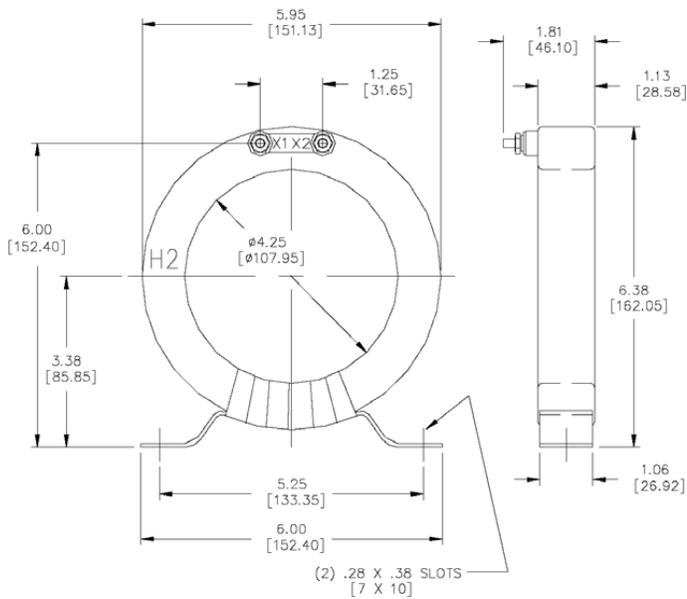
- Programming the **START INHIBIT** settings to “On” makes a restart possible as soon as 62.5% (50×1.25) thermal capacity is available.
- After two (2) cold or one (1) hot start, the thermal capacity used will approach 100%. The thermal capacity used decays exponentially (see *Motor Cooling* on page 5–56 for details). As such, the thermal capacity used after 1 time constant will be 37%, meaning there is enough thermal capacity available for another start. Program 300 minutes (5 hours) as the **COOL TIME CONSTANT STOPPED** settings. Thus, after two (2) cold or one (1) hot start, a stopped motor will be blocked from starting for 5 hours.
- Since the rotor cools faster when the motor is running, a reasonable setting for the running cool time constant might be half the stopped cool time constant or 150 minutes.

A.3 Current Transformers

A.3.1 Ground Fault CTs for 50:0.025 A CT

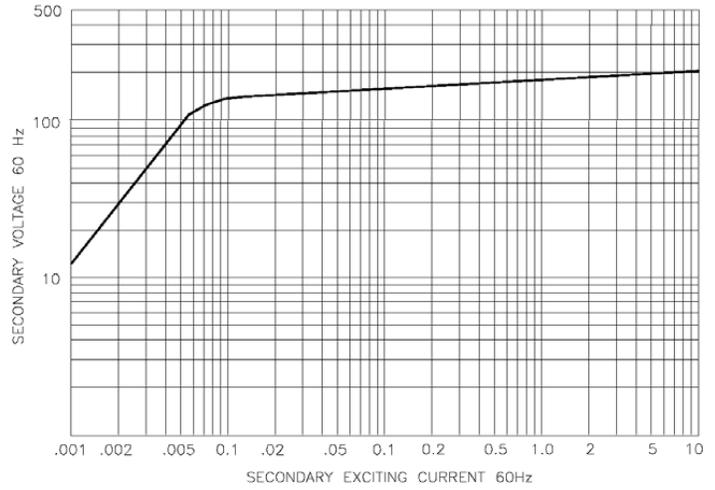
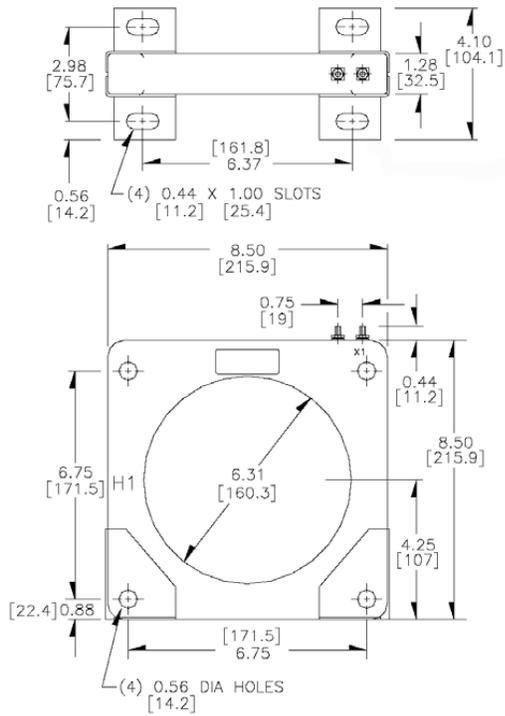
CTs that are specially designed to match the ground fault input of GE Digital Energy motor protection relays should be used to ensure correct performance. These CTs have a 50:0.025A (2000:1 ratio) and can sense low leakage currents over the relay setting range with minimum error. Three sizes are available with 3½-inch, 5½-inch, or 8-inch diameter windows.

HGF3C



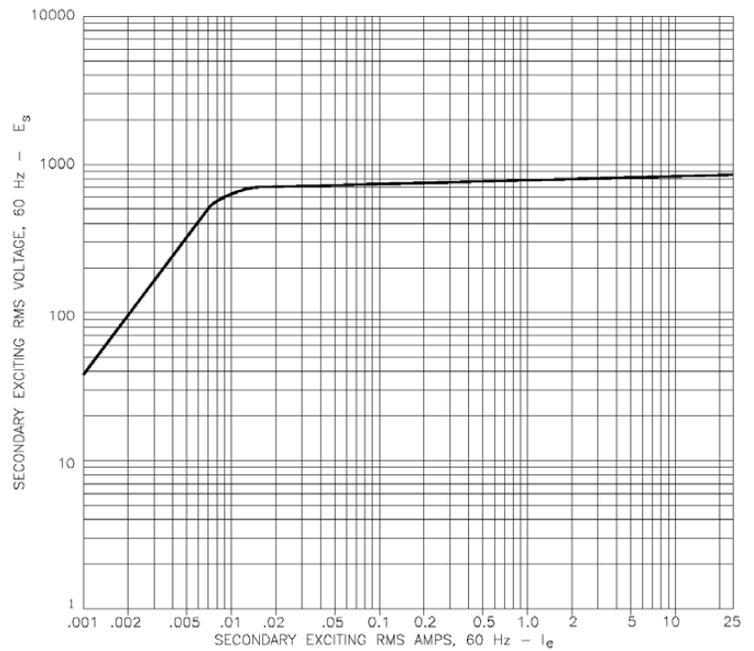
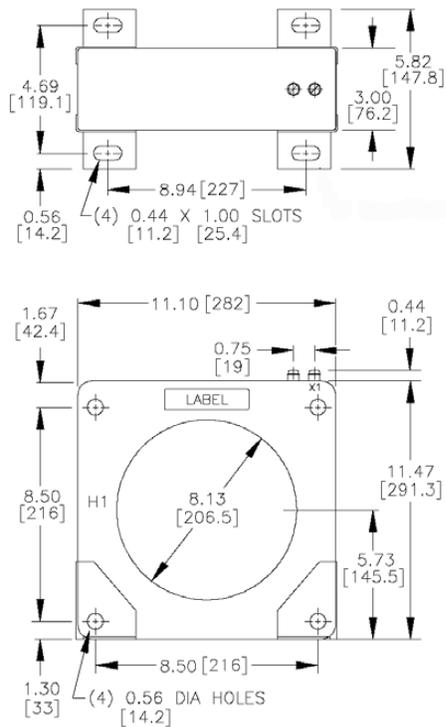
808840A1

HGF5C



808841A1

HGF8

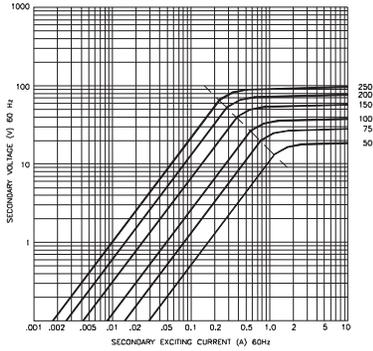


808842A1

A.3.2 Ground Fault CTs for 5 A Secondary CT

For low resistance or solidly grounded systems, a 5 A secondary CT should be used. Two sizes are available with 5½" or 13" x 16" windows. Various Primary amp CTs can be chosen (50 to 250).

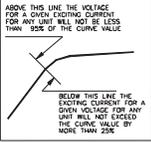
GCT5



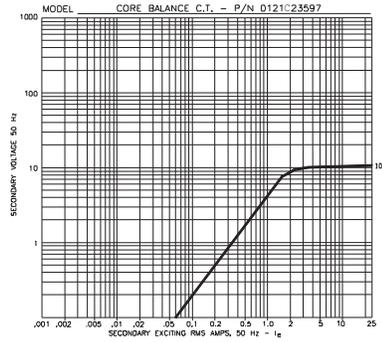
MULTIPL. NO.	CURRENT RATIO	TURNS RATIO	SEC. RES. *
X021-0251	250:5	50:1	0.097
X021-0201	200:5	40:1	0.076
X021-0151	150:5	30:1	0.058
X021-0101	100:5	20:1	0.039
X021-0076	75:5	15:1	0.029
X021-0051	50:5	10:1	0.019

* OHMS AT 75° C.

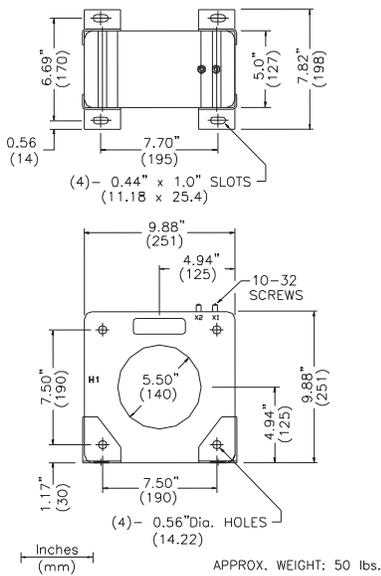
This test report is in accordance with ANSI/IEEE C57.13 1993



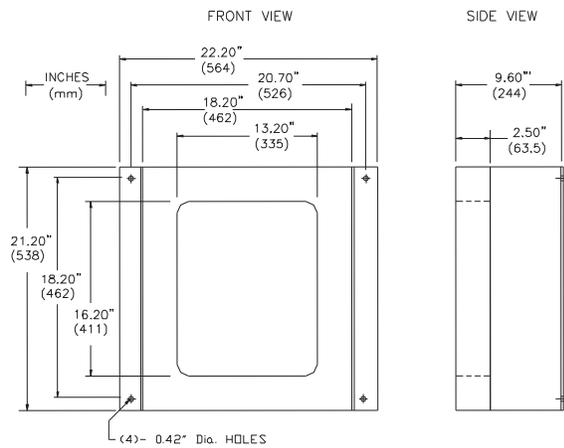
GCT16



DIMENSIONS



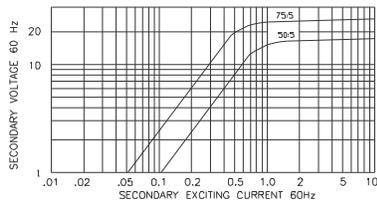
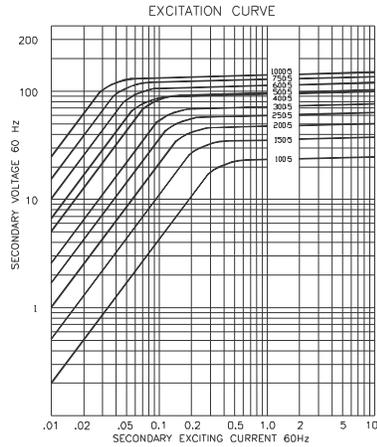
DIMENSIONS



808709A1.CDR

A.3.3 Phase CTs

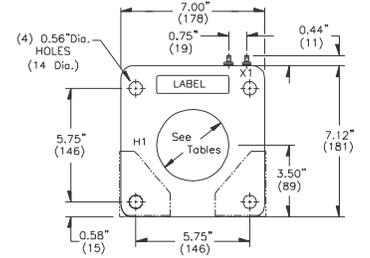
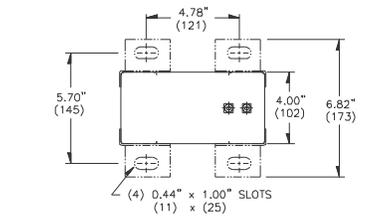
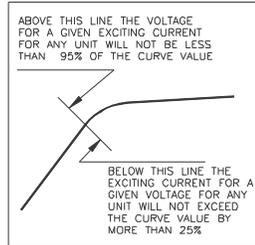
Current transformers in most common ratios from 50:5 to 1000:5 are available for use as phase current inputs with motor protection relays. These come with mounting hardware and are also available with 1 A secondaries. Voltage class: 600 V BIL 10 kV.



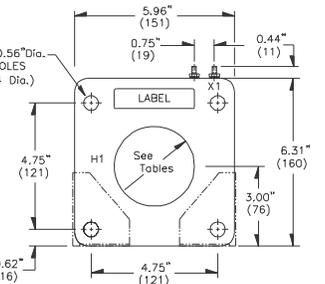
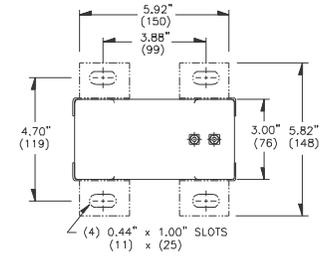
CURRENT TRANSFORMER SPECIFICATIONS				
CURRENT RATIO	WINDOW SIZE	CT CLASS	MULTILIN No.	CT Dirms.
50:5	2.75"	C10	X911-0010	A
75:5	2.75"	C10	X911-0011	A
100:5	3.00"	C10	X911-0012	B
150:5	3.00"	C10	X911-0013	B
200:5	3.00"	C20	X911-0014	B
250:5	3.00"	C20	X911-0015	B
300:5	3.00"	C20	X911-0016	B
400:5	3.00"	C20	X911-0017	B
500:5	3.00"	C50	X911-0018	B
600:5	3.00"	C50	X911-0019	B
750:5	3.00"	C50	X911-0020	B
1000:5	3.75"	C50	X911-0021	B

909068A1.DWG

This test report is in accordance with ANSI/IEEE C57.13 1993



CT DIMENSIONS "A"



CT DIMENSIONS "B"

808712A1.CDR

A.4 EU Declaration of Conformity

A.4.1 EU Declaration of Conformity

EU DECLARATION OF CONFORMITY

Applicable Council Directive(s): 73/23/EEC The Low Voltage Directive
89/336/EEC The EMC Directive

Standards to Which Conformity is Declared:

IEC 1010-1:1990+ A 1:1992+ A 2:1995 Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use
EN 50263: EMC Product Standard for Measuring Relays and protective Equipment

Manufacturer's Name: General Electric Multilin

Manufacturer's Address: 215 Anderson Ave.
Markham, Ontario, Canada
L6E 1B3

Manufacturer's Representative in the EU: Jokin Galletero
GE Multilin
Avenida Pinoa 10
48170 Zamudio, Spain
Tel.: 34-94-4858817 Fax: 34-94-4858838

Type of Equipment: Motor Protection Relay

Model Number: SR469

First Year of Manufacture: 1995

I the undersigned, hereby declare that the equipment specified above conforms to the above Directives and Standards.

Full Name: Jeff Mazereeuw

Position: Technology Manager

Signature:



Place: 215 Anderson Ave.
Markham, Ontario, Canada
L6E 1B3

Date: June. 11. 2004

A.5 Change Notes

A.5.1 Revision History

MANUAL P/N	REVISION	RELEASE DATE
1601-0122-A1	4.0x	February 09, 2004
1601-0122-A2	4.0x	May 21, 2004
1601-0122-A3	4.0x	May 27, 2005
1601-0122-A4	5.0x	July 12, 2006
1601-0122-A5	5.0x	February 9, 2007
1601-0122-A6	5.0x	March 24, 2008
1601-0122-A7	5.0x	October 7, 2008
1601-0122-A8	5.0x	September 15, 2009
1601-0122-A9	5.1x	April 15, 2010
1601-0122-AA	5.1x	July 13, 2011
1601-0122-AB	5.1x	February 8, 2012
1601-0122-AC	5.1x	March 30, 2012
1601-0122-AD	5.2x	October 19, 2012
1601-0122-AE	5.2x	February 1, 2013
1601-0122-AF	5.2x	July 16, 2013
1601-0122-AG	5.2x	November 6, 2013

A.5.2 Changes to the 469 Manual

Table A-1: Major Updates for 469 Manual Revision AG

SECT (AF)	SECT (AG)	CHANGE	DESCRIPTION
Title	Title	Update	Manual part number to 1601-0122-AG
2.1.3	2.1.3	Update	Updated order code. Discontinued: Basic Display
3.2.1	3.2.1	Update	Typical Wiring Diagram updated
3.2.12	3.2.12	Update	RS485 Communications Wiring updated

Table A-2: Major Updates for 469 Manual Revision AF

SECT (AE)	SECT (AF)	CHANGE	DESCRIPTION
Title	Title	Update	Manual part number to 1601-0122-AF
3.2.4	3.2.4	Update	Revised Wiring diagram shown in Figure 3-18
3.2.4	3.2.4	Update	Changed caption for Figure 3-19
3.2.9	3.2.9	Update	Removed RTD motor terminals in Figure 3-22

Table A-3: Major Updates for 469 Manual Revision AE

SECT (AD)	SECT (AE)	CHANGE	DESCRIPTION
Title	Title	Update	Manual part number to 1601-0122-AE
2.2.3	2.2.3	Update	Add Note 1 to section and to some specifications
2.2.5	2.2.5	Update	Add Note 1 to section and to some specifications
5.2.2	5.2.2	Update	Warning message

Table A-4: Major Updates for 469 Manual Revision AD

SECT	SECT (AD)	CHANGE	DESCRIPTION
Title	Title	Update	Manual part number to 1601-0122-AD
	Gen	Update	Information on "Loss of Comms Trip/Alarm"

Table A-5: Major Updates for 469 Manual Revision AB

SECT (AA)	SECT (AB)	CHANGE	DESCRIPTION
Title	Title	Update	Manual part number to 1601-0122-AB
5, 6	5, 6	Update	Expand "Display Tables" to show full readout
5	5	Correction	Typographical errors (2)
2.2.5	2.2.5	Update	Add "Motor Status" specification

Table A-6: Major Updates for 469 Manual Revision AA

SECT (A9)	SECT (AA)	CHANGE	DESCRIPTION
Title	Title	Update	Manual part number to 1601-0122-AA
1.3.1	1.3.1	Update	Introduction changes: Passcode
5.2.1	5.2.1	Update	Passcode changes
2.2.7	2.2.7	Update	Supercap-backed clock information
5.2.4	5.2.4	Update	Supercap-backed clock information

Table A-7: Major Updates for 469 Manual Revision A9

SECT (A8)	SECT (A9)	CHANGE	DESCRIPTION
Title	Title	Update	Manual part number to 1601-0122-A9
2.2.3	2.2.3	Update	Ground Inst O/C, Phase S/C Timing Accuracy changes
5.11.2	5.11.2	Update	Power Factor changes

Table A-8: Major Updates for 469 Manual Revision A8

SECT (A7)	SECT (A8)	CHANGE	DESCRIPTION
Title	Title	Update	Manual part number to 1601-0122-A8
3.1.7	3.1.7	Revision	Figure 3-11 revised
3.2.1	3.2.1	Revision	Figure 3-12 revised
A.3.1	A.3.1	Revision	CT drawings revised

Table A-9: Major Updates for 469 Manual Revision A7

SECT (A6)	SECT (A7)	CHANGE	DESCRIPTION
Title	Title	Update	Manual part number to 1601-0122-A7
5.11.6	5.11.6	Update	Change Pole Pairs to step 1

Table A-10: Major Updates for 469 Manual Revision A6

SECT (A5)	SECT (A6)	CHANGE	DESCRIPTION
Title	Title	Update	Manual part number to 1601-0122-A6
2.1.3	2.1.3	Update	Change DC power supply range

Table A-11: Major Updates for 469 Manual Revision A5

PAGE (A4)	PAGE (A5)	CHANGE	DESCRIPTION
Title	Title	Update	Manual part number to 1601-0122-A5.
2-14	2-14	Update	Changes to ELECTROSTATIC DISCHARGE value

Table A-12: Major Updates for 469 Manual Revision A4

PAGE (A3)	PAGE (A4)	CHANGE	DESCRIPTION
Title	Title	Update	Manual part number to 1601-0122-A4.
3-22	3-22	Update	Updated DIELECTRIC STRENGTH section

Table A-13: Major Updates for 469 Manual Revision A3

PAGE (A2)	PAGE (A3)	CHANGE	DESCRIPTION
Title	Title	Update	Manual part number to 1601-0122-A3.
5-47	5-47	Update	Updated THERMAL MODEL COOLING diagram to 808705A2

Table A-14: Major Updates for 469 Manual Revision A2

PAGE (A1)	PAGE (A2)	CHANGE	DESCRIPTION
Title	Title	Update	Manual part number to 1601-0122-A2.
Additional changes for revision A2 were cosmetic. There was no change to content.			

A.6 GE Digital Energy Warranty

A.6.1 Warranty Statement

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

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

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

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

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

Index

Numerics

0 to 1mA ANALOG INPUT	3-19, 5-93, 5-96
0 to 20mA ANALOG INPUT	5-96
1 TRIP RELAY	
description	3-23
operating	5-37
reset mode	5-36
2 AUXILIARY RELAY	
description	3-23
operating	5-37
reset mode	5-36
3 AUXILIARY RELAY	
description	3-23
operating	5-37
reset mode	5-36
3-PHASE OPEN DELTA VTs	6-22
3-PHASE WYE VTs	6-25
4 ALARM RELAY	
description	3-23
operating	5-37
reset mode	5-36
4 to 20mA ANALOG INPUT	3-19, 5-93, 5-96
5 START BLOCK RELAY	
description	3-23
operating	5-37
reset mode	5-36
50:0.025 CT	3-13, 5-18
6 SERVICE RELAY	
description	3-23
reset mode	5-36

A

A1 STATUS	6-4
A2 METERING DATA	6-11
A3 LEARNED DATA	6-27
A4 MAINTENANCE	6-30
A5 EVENT RECORDER	6-33
A6 PRODUCT INFO	6-36
ACCELERATION TIMER	
actual values	6-27
setpoints	5-67
setpoints for 2-speed motor	5-109
specifications	2-8
trip counter	6-30
ACCESS SWITCH	5-26, 6-9
ACCESSORIES	2-5
ACTUAL VALUES	
A1 STATUS	6-5

A2 METERED DATA.....	6-11
A3 LEARNED DATA.....	6-27
A4 MAINTENANCE.....	6-30
A5 EVENT RECORDER.....	6-33
A6 PRODUCT INFO.....	6-36
ALARM RELAY	
<i>see 4 ALARM RELAY</i>	
ALARM STATUS	6-7, 6-8
ALARMS	5-6
ALIGN START CONTROL RELAYS	5-21
ALTERNATE WIRING FOR CONTACTORS	3-24
AMBIENT RTD.....	5-71, 5-75
AMBIENT RTD TRIPS	6-30
ANALOG I/O TESTING	7-8
ANALOG IN DIFF 1-2.....	5-97
ANALOG IN DIFF 3-4.....	5-98
ANALOG IN MIN/MAX	6-29
ANALOG INPUTS	
actual values.....	6-15
analog in diff 1-4	5-97
analog in diff 3-4	5-98
analog in min/max	6-29
analog input minimums/maximums	5-26
clearing analog input data.....	5-16
description.....	3-19, 5-96
difference setpoints	5-97, 5-98
maximums	6-29
minimums	6-29
setpoints.....	5-95
specifications.....	2-6
testing.....	7-8, 7-9
trip counters.....	6-31
ANALOG OUTPUTS	
description.....	3-19
operating.....	5-103
setpoints.....	5-93
specifications.....	2-7
testing.....	5-103, 7-8, 7-9
ANSI DEVICE NUMBERS	2-1
APPARENT POWER	
actual values.....	6-14
specifications.....	2-13
APPARENT POWER DEMAND	6-15
APPLICATION EXAMPLE	1-17
APPLICATION NOTES	
current transformers	A-6
APPLICATIONS.....	2-2
ASSIGNABLE DIGITAL INPUTS	5-27
ASYMMETRICAL CURRENT	5-61
AUXILIARY RELAY	
<i>see 2 AUXILIARY RELAY and 3 AUXILIARY RELAY</i>	
AVERAGE MOTOR LOAD	5-9, 6-27
AVERAGE PHASE CURRENT	6-11

B

BAUD RATE	
setpoints	5-11, 5-12
specifications	2-14
BEARING RTD	5-71, 5-74
BEARING RTD TRIPS	6-30
BLOCK START	5-7

C

CALIBRATION DATE	6-36
CAPTURE TRACE	5-34
CASE	2-16
CAUSE OF EVENTS TABLE	6-34
CERTIFICATIONS	2-15
CHANGING PASSCODE	5-8
CHANGING SETPOINTS	1-9
CLEAR DATA	5-16
CLOCK	5-13, 6-10
COMM PORT MONITOR	5-104
COMMUNICATIONS	
clear buffers	5-104
control	5-21
monitoring	5-104
RS232	4-11, 4-16, 4-18
RS485	3-24, 4-12, 4-16, 4-18
setpoints	5-11, 5-21, 5-104
specifications	2-14
wiring	4-11, 4-12
CONTACTOR, ALTERNATE WIRING	3-24
CONTROL POWER	
connection diagram	3-12
description	3-12
COOL TIME CONSTANTS	5-40, 5-56, 5-58, 5-68
CORE BALANCE	5-19
CORE BALANCE GROUND CT	
connection	3-15
method	3-16
CTs	
differential	3-16
ground	3-13, 3-14, 5-18
ground fault	A-8
phase	3-13, 5-18, A-8
phasors	6-19
see CURRENT TRANSFORMER	
CURRENT DEMAND	5-88, 6-15
CURRENT METERING	6-11
CURRENT SENSING	5-18
CURRENT TRANSFORMERS	
see CTs	A-6
CURRENT UNBALANCE	
actual value	6-11
event record	6-33
pre-trip value	6-5

setpoints.....	5-63
specifications.....	2-8
trip counter.....	6-30
CUSTOM OVERLOAD CURVES	
description.....	5-44
example.....	5-46
voltage dependent overload.....	5-51, 5-52
CUTOUT PANELS	3-4

D

DATE	5-13, 6-10, 6-39
DEFAULT MESSAGES	
adding.....	5-14
cycle time.....	5-9
description.....	5-14
flash messages.....	6-39
removing.....	5-14
setpoints.....	5-14
timeout.....	5-9
DEMAND	
calculating demand.....	5-90
current.....	5-88, 6-15
kVA.....	5-89, 6-15
kvar.....	5-89, 6-15
kW.....	5-89, 6-15
metering.....	6-15
period.....	5-90
power.....	5-88, 6-15
specifications.....	2-12
DEMAND DATA, CLEARING	5-16
DEMAND PERIOD	5-90
DERATING FACTOR	5-56
DESCRIPTION	2-1
DEVICE NUMBERS	2-2
DEVICENET	
actual values.....	6-4
setpoints.....	5-12
DIAGNOSTIC MESSAGES	6-37
DIELECTRIC STRENGTH	3-25, 3-26
DIFFERENTIAL	5-66
DIFFERENTIAL CT PRIMARY	5-19
DIFFERENTIAL CTs	3-16
DIFFERENTIAL CURRENT INPUTS	3-16
DIFFERENTIAL CURRENT TESTING	7-4
DIFFERENTIAL PHASE CURRENT INPUTS	2-6
DIGITAL COUNTER	
actual values.....	6-31
preset.....	5-16
setpoints.....	5-32
specifications.....	2-11
DIGITAL INPUT FUNCTION	
capture trace.....	5-34
digital counter.....	5-32
general switch a-d.....	5-34
load shed trip.....	5-29

pressure switch alarm	5-30
pressure switch trip	5-30
remote alarm	5-28
remote trip	5-28
simulate fault	5-35
simulate pre-fault	5-35
simulate pre-fault..fault	5-35
speed switch trip	5-29
tachometer	5-32
vibration switch alarm	5-31
vibration switch trip	5-31
DIGITAL INPUTS	
actual values	6-9
assignable	5-27
description	3-18, 5-26
specifications	2-6
testing	7-7
DIMENSIONS	3-2
DISPLAY	4-1
DISPLAY UPDATE INTERVAL	5-10
DRAWOUT INDICATOR	3-24

E

ELECTRICAL INSTALLATION	3-11
EMERGENCY RESTART	5-17, 5-26, 6-31
ENERVISTA VIEWPOINT WITH THE 469	4-49
ENTERING TEXT	4-5
ENVIRONMENTAL SPECIFICATIONS	2-16
ESTIMATED TRIP TIME ON OVERLOAD	6-5
ETHERNET	
actual values	6-4
setpoints	5-11
EU DECLARATION OF CONFORMITY	A-10
EVENT RECORD	
actual values	6-33, 6-34
cause of events	6-34
clearing	5-16
date	6-33
motor speed	6-33
tachometer	6-33

F

FACEPLATE	4-1
FAULT SETUP	5-102
FAULT SIMULATION	5-35
FEATURES	2-3
FIRMWARE	
upgrading via EnerVista 469 setup software	4-35
FLA	5-18, 5-19
FLASH MESSAGES	6-38, 6-39, 6-41
FLOW	3-19
FORCE ANALOG OUTPUTS	5-103
FORCE OUTPUT RELAY	5-37

FORCE RELAY OPERATION	5-103
FREQUENCY	
event record	6-33
pre-trip system frequency	6-6
setpoints	5-80
specifications	2-8
system frequency	5-20
trip counter	6-31
FRONT PANEL	
using	1-3
FUNCTIONAL TESTING	7-3, 7-11
FUSE	2-13

G

GCT CTs	A-8
GENERAL COUNTERS	6-31
GENERAL SWITCH	
setpoints	5-34
specifications	2-11
GETTING STARTED	1-1
GROUND CT	
core balance	3-15
primary	5-18
setpoints	5-18
GROUND CTs	3-14
GROUND CURRENT INPUT	2-6, 3-13
GROUND CURRENT TESTING	7-4
GROUND FAULT	
setpoints	5-64, 5-65
trip counter	6-30
GROUND FAULT CTs	A-8
GROUND FAULT CTs FOR 50:0.025 A	A-6
GROUND FAULT CTs FOR 5A SECONDARY	A-8
GROUND INSTANTANEOUS OVERCURRENT	
setpoints	5-64
specifications	2-9

H

HELP KEY	1-10
HGF CTs	A-6
HIGH INERTIAL LOAD	5-38, 5-50
HI-POT	3-25
HOT/COLD CURVE RATIO	5-57
HOT/COLD SAFE STALL RATIO	5-40
HOTTEST STATOR RTD	6-5

I

IED SETUP	4-13
INCOMPLETE SEQUENCE TRIPS	6-30
INPUT SWITCH TRIPS	6-30
INPUTS	

analog current	2-6
differential current	3-16
differential phase current	2-6
digital	2-6, 3-18
ground current	2-6, 3-13
phase current	2-6, 3-13
voltage	2-7, 3-17
INSERTION	3-5
INSPECTION CHECKLIST	1-1
INSTALLATION	3-3
description	1-38
electrical	3-11, 3-12
mechanical	3-1, 3-3
putting the relay in Ready state	1-38
setpoints	5-16
INTENTIONAL S/C TRIP DELAY	5-60

J

JOGGING BLOCK	
setpoints	5-68
specifications	2-9

K

K FACTOR	5-56
KEYPAD	4-4
help	1-10
kVA DEMAND	5-89
kvar DEMAND	5-89
kW DEMAND	5-89

L

LAST TRIP DATA	
actual values	6-5, 6-6
clearing	5-16
test switch	5-26
LATCH	3-5
LEARNED ACCLERATION TIME	6-27
LEARNED DATA	6-27
LEARNED PARAMETERS	5-26, 6-27
LEARNED STARTING CAPACITY	6-27
LEARNED STARTING CURRENT	6-27
LED INDICATORS	4-2
LINE VOLTAGE, MINIMUM	5-48, 5-108
LOAD SHED	
frequency setpoints	5-80
specifications	2-11
trip	5-29
LOAD SHED TRIP	5-29
LOCKOUT TIME	5-68
LONG-TERM STORAGE	2-16
LOOP POWERED TRANSDUCER CONNECTION	3-19

LOSS OF LOAD	4-3
--------------------	-----

M

MAXIMUM RTD TEMPERATURE	5-16, 5-26
MECHANICAL INSTALLATION	3-1
MECHANICAL JAM	
setpoints	5-61
specifications	2-9
trip counter	6-30
MECHANICAL JAM TRIPS	6-30
MESSAGE SCRATCHPAD	5-15
METERING	
actual values	6-11
apparent power	6-14
current	6-11
demand	6-15
torque	5-85
MINIMUM ALLOWABLE LINE VOLTAGE	5-48, 5-108
MODEL INFORMATION	6-36
MONITOR COMM PORT	5-104
MOTOR COOLING	5-56
MOTOR DERATING FACTOR	5-56
MOTOR FLA	5-18
MOTOR INFORMATION, RESETTING	5-16
MOTOR LOAD	
actual values	6-5, 6-11, 6-28
average	6-28
calculation period	5-9
filter interval	5-10
last trip data	6-5
setpoint	5-14
MOTOR LOAD FILTER INTERVAL	5-9
MOTOR LOAD, AVERAGE	6-27
MOTOR NAMEPLATE VOLTAGE	5-20
MOTOR RUNNING HOURS	6-32
MOTOR SPEED	
actual value	6-5
event recorder	6-33
MOTOR SPEED DURING TRIP	6-5
MOTOR STARTING	6-27
MOTOR STARTS	5-17, 5-26, 6-31
MOTOR STATUS	5-14, 6-5
MOTOR STATUS LEDs	4-3
MOTOR THERMAL LIMITS	5-38
MOTOR TRIPS	5-26
MOUNTING TABS	3-5
MULTILIN USE ONLY	5-104
Mvarh METERING	5-16, 5-26
MWh METERING	5-16, 5-26

N

NAMEPLATE	1-1
-----------------	-----

NAMEPLATE VOLTAGE	5-20
NEGATIVE-SEQUENCE CURRENT	5-55, 5-63, 6-11
NEMA DERATING CURVE	5-56
NOMINAL SYSTEM FREQUENCY	5-20
NUMBER OF EMERGENCY RESTARTS	6-31
NUMBER OF MOTOR STARTS	6-31
NUMERICAL SETPOINTS	1-10

O

OPEN DELTA VTs	3-17, 6-22
OPEN RTD SENSOR	5-76
OPERATE OUTPUT RELAYS	5-37
ORDER CODE	
actual values	6-36
ORDER INFORMATION	2-4
OTHER RTD	5-71, 5-74
OUTPUT RELAY LEDs	4-3
OUTPUT RELAY TESTING	7-10
OUTPUT RELAYS	
1 TRIP	3-23
2 AUXILIARY	3-23
3 AUXILIARY	3-23
4 ALARM	3-23
5 START BLOCK	3-23
6 SERVICE	3-23
alarm	3-23
assignment practices	5-7
auxiliary	3-23
description	3-23, 5-36
forcing	5-37
operating	5-37, 5-103
restart mode	5-36
setpoints	5-36
specifications	2-8
testing	5-103
OUTPUTS, ANALOG	2-7
OVERCURRENT	
ground instantaneous	2-9
phase differential	2-10
specifications	2-9
OVERFREQUENCY	
setpoints	5-80
specifications	2-8
OVERLOAD ALARM	5-61
OVERLOAD CURVE MULTIPLIERS	5-42
OVERLOAD CURVE SETUP	5-41
OVERLOAD CURVE TESTING	7-11
OVERLOAD CURVES	
custom	5-44, 5-46
description	5-41
graph	5-42
safe stall curve	5-53
selection	5-40
setpoints	5-41
standard	5-41, 5-42

standard multipliers	5-42
voltage dependent	5-47, 5-51, 5-52, 5-53, 5-54, 5-55
OVERLOAD PICKUP	5-40
OVERLOAD TRIPS	6-30
OVERREACH FILTER	5-61
OVERTORQUE	5-86
OVERTORQUE SETUP	5-86
OVERVIEW	2-1, 6-1
OVERVOLTAGE	
setpoints	5-79
specifications	2-9
trip counter	6-30

P

PACKAGING	2-16
PARITY	5-11, 5-12
PASSCODE	6-1
flash messages	6-39
setpoints	5-8
PEAK DEMAND	5-16, 6-15
PHASE CT PRIMARY	5-18
PHASE CTs	3-13, A-8
PHASE CURRENT ACCURACY TEST	7-3
PHASE CURRENT INPUTS	
description	3-13
specifications	2-6
PHASE CURRENT, AVERAGE	6-11
PHASE DIFFERENTIAL	
setpoints	5-65
trip counter	6-30
PHASE DIFFERENTIAL CT	5-18
PHASE DIFFERENTIAL CT PRIMARY	5-18
PHASE DIFFERENTIAL OVERCURRENT	2-10
PHASE REVERSAL	
setpoints	5-79
specifications	2-11
trip counter	6-31
PHASE ROTATION SETTINGS	5-21
PHASE SEQUENCE	5-20
PHASE SHORT CIRCUIT	
specifications	2-10
PHASORS	
3-phase open delta	6-22
3-phase wye VTs	6-25
actual values	6-16
POLE PAIRS	5-85
POSITIVE-SEQUENCE CURRENT	5-56, 5-63, 6-11
POWER	
apparent	6-14
reactive	5-83, 6-14
real	6-14
reverse	5-85
underpower	5-84
POWER DEMAND	6-15

POWER FACTOR	
setpoints	5-82
specifications	2-12
trip counter	6-31
POWER MEASUREMENT CONVENTIONS	5-81
POWER MEASUREMENT TEST	7-11
POWER METERING	6-14
POWER SYSTEM	5-20
PRE-FAULT SETUP	5-101
PRE-FAULT SIMULATION	5-35
PRE-FAULT TO FAULT SIMULATION	5-35
PREFERENCES	5-9
PRESET DIGITAL COUNTER	5-16
PRESSURE	3-19
PRESSURE SWITCH	2-11
PRESSURE SWITCH ALARM	5-30
PRESSURE SWITCH TRIP	5-30
PRESSURE TRANSDUCER	5-96
PRODUCT IDENTIFICATION	3-2
PRODUCTION TESTS	2-15
PROTECTION FEATURES	2-3
PROXIMITY PROBE	3-19
PULSE OUTPUT	5-90

R

REACTIVE POWER	
consumption specifications	2-12
metering	6-14
setpoints	5-83
specifications	2-13
REACTIVE POWER DEMAND	6-15
REACTIVE POWER TRIPS	6-31
REAL POWER	
consumption specifications	2-12
metering	6-14
specifications	2-13
REAL POWER DEMAND	6-15
REAL TIME CLOCK	5-13, 6-10
REDUCED RTD LEAD NUMBER	3-20
REDUCED VOLTAGE START	
auxiliary A status input	5-24
auxiliary B status input	5-24
contactor control circuit	5-23
current characteristics	5-23
setpoints	5-22
specifications	2-10
REDUCED WIRING RTDs	3-21
RELAY ASSIGNMENT PRACTICES	5-7
RELAY RESET MODE	5-36, 5-37
REMOTE ALARM	5-28, 5-29
REMOTE ALARM STATUS	6-7
REMOTE RESET	5-27
REMOTE SWITCH	2-11
REMOTE TRIP	5-28, 5-29

REMOVING THE 469 FROM THE CASE	3-6
RESET	5-6
RESET MOTOR INFORMATION	5-16
RESET STARTER INFORMATION	5-17
RESET, REMOTE	5-27
RESETTING THE 469	5-36
RESIDUAL	5-19
RESIDUAL GROUND CONNECTION	3-13, 3-14
RESTART BLOCK	
emergency restart	5-26
setpoints	5-70
specifications	2-10
RESTART, EMERGENCY	5-26
REVERSE POWER	5-85
REVERSE POWER TRIPS	6-31
ROLLING DEMAND	5-90
RS232	
program port	4-3
RS232 COMMUNICATIONS	
configuring with EnerVista 469 setup	4-16, 4-18
configuring with EnerVista 750/760 Setup	4-18
connections	4-11
setpoints	5-11
RS485 COMMUNICATIONS	
<i>see also COMMUNICATIONS and SERIAL PORTS</i>	
configuring with EnerVista 469 setup	4-16, 4-18
configuring with EnerVista 750/760 Setup	4-18
connections	4-12
description	3-24
wiring diagram	3-25
RTD	
actual values	6-12, 6-28
alternate grounding	3-22
ambient	5-71, 5-75
bearing	5-71, 5-74
bias	5-58, 5-59
clearing RTD data	5-16
description	3-20
grounding	3-22
maximums	5-16, 5-26, 6-28
open RTD sensor	5-76
other	5-71, 5-74
reduced lead number	3-20
reduced wiring	3-21
sensor connections	3-20
setpoints	5-71
short/low temp	5-76
specifications	2-10
stator	5-73
temperatures	6-12
types	5-71
wiring	3-20
RTD 11	5-74
RTD 12	5-75
RTD 1-6	5-72
RTD 7-10	5-73
RTD ACCURACY TEST	7-5

RTD BIAS	
curve	5-59
description	5-58
enabling	5-40
setpoints	5-40
RTD LEAD COMPENSATION	3-21, 3-22
RTD MAXIMUMS	6-28
RTD SHORT/LOW TEMP	5-76
RTD TYPES	5-71
RTDs 1 to 6	5-72
RTDs 7 to 10	5-73
RUNNING HOURS	5-26

S

S1 469 SETUP	5-8
S10 POWER ELEMENTS	5-81
S11 MONITORING	5-87
S12 ANALOG I/O	5-93
S13 469 TESTING	5-100
S14 TWO-SPEED MOTOR	5-105
S2 SYSTEM SETUP	
setpoints	5-18
settings example	1-30
S3 DIGITAL INPUTS	
setpoints	5-26
settings example	1-32
S4 OUTPUT RELAYS	5-36
S5 THERMAL MODEL	
setpoints	5-38
settings example	1-33
S6 CURRENT ELEMENTS	
setpoints	5-60
settings example	1-33
S7 MOTOR STARTING	
setpoints	5-67
settings example	1-35
S8 RTD TEMPERATURE	
setpoints	5-71
settings example	1-35
S9 VOLTAGE ELEMENTS	5-77
SAFE STALL CURVES	5-53
SAFE STALL TIME	5-48, 5-108
SAMPLE APPLICATION	1-17
SECONDARY INJECTION TEST SETUP	7-2
SERIAL COMMUNICATIONS CONTROL	5-21
SERIAL COMMUNICATIONS	
<i>see COMMUNICATIONS</i>	
SERIAL NUMBER	6-36
SERIAL PORTS	
description	3-24
setpoints	5-21
wiring diagram	3-24
SERVICE RELAY	
<i>see 6 SERVICE RELAY</i>	

SETPOINT ACCESS	
flash messages	6-40
setpoints	5-8
SETPOINT ACCESS SWITCH	5-26
SETPOINT ENTRY	4-6
SETPOINT GROUPS	
<i>see individual groups S1 through S12</i>	
SETPOINT MESSAGE MAP	5-1
SETPOINTS	
changing	1-9
entering with EnerVista 469 setup software	4-22
loading from a file	4-33
messages	5-1
numerical	1-10
saving to a file	4-35
text	1-15
SHORT CIRCUIT	
actual values	6-30
setpoints	5-60
specifications	2-10
test	7-14
trip	5-60
SHORT CIRCUIT TRIP	
setpoints	5-60
SIMULATE FAULT	5-35
SIMULATE FAULT-FAULT	5-35
SIMULATE PRE-FAULT	5-35
SIMULATION MODE	5-100
SINGLE LINE DIAGRAM	2-1
SINGLE PHASING	5-63
SINGLE VT OPERATION	5-20
SLAVE ADDRESS	5-11, 5-12
SOFTWARE	
entering setpoints	4-22
hardware requirements	4-11
installation	4-13
loading setpoints	4-33
overview	4-10
saving setpoints	4-35
serial communications	4-16, 4-18
SPECIFICATIONS	2-6, 2-13
SPEED	6-13
SPEED SWITCH	2-11
SPEED SWITCH TRIP	5-29
SPEED2 ACCELERATION	5-109
SPEED2 O/L SETUP	5-105
SPEED2 PHASE SEQUENCE	5-20
SPEED2 UNDERCURRENT	5-109
STALL TIME, SAFE	5-48, 5-108
STANDARD OVERLOAD CURVES	
description	5-41
equation	5-43
graph	5-42
multipliers	5-42
selection	5-41
START BLOCK RELAY	

<i>see 5 START BLOCK RELAY</i>	
START BLOCKS	6-9
START INHIBIT	5-67
STARTER	
failure.....	5-87
information	5-17
operations.....	5-26, 6-31
status	5-27
status switch.....	5-23
STARTING CURRENT	5-17, 6-27
STARTING THERMAL CAPACITY	5-17
STARTS/HOUR	5-69, 6-32
STARTS/HOUR BLOCK	5-26
STATOR RESISTANCE	5-85
STATOR RTD	5-73
STATOR RTD TRIPS	6-30
STATUS LED	4-2
SUMMATION METHOD.....	3-17
SYSTEM FREQUENCY	5-20
SYSTEM PHASE SEQUENCE	5-20

T

TACHOMETER	
actual value.....	6-13
event record	6-33
pre-trip value	6-5
setpoints	5-32
specifications.....	2-11
TACHOMETER TRIPS	6-30
TC USED MARGIN	5-67
TEMPERATURE	6-12
TEMPERATURE DISPLAY	5-9
TERMINALS	
locations	3-9
specifications	2-16
terminal list	3-9
TEST ANALOG OUTPUT	5-103
TEST OUTPUT RELAYS	5-103
TEST SWITCH	5-26
TESTS	
analog input/output.....	7-8
differential current	7-4
digital inputs	7-7
functional.....	7-11
ground CT accuracy	7-5
ground current	7-4
output relays.....	7-10
overload curves.....	7-11
phase current accuracy	7-3
phase reversal.....	7-13
power measurement.....	7-11
RTD accuracy	7-5
short circuit	7-14
simulation mode	5-100
unbalance	7-12

voltage input accuracy.....	7-3
voltage phase reversal	7-13
TEXT SETPOINTS	1-15
THERMAL CAPACITY ALARM	5-40, 6-7
THERMAL CAPACITY USED	5-67, 6-5
actual value.....	6-5
algorithm.....	5-41
learned.....	6-27
margin (for Start Inhibit)	5-67
setpoint.....	5-40
with RTD Bias	5-58
THERMAL LIMITS	
curves	5-39
description	5-38
high inertial load	5-50
THERMAL MODEL	
cooling	5-57
curve selection	5-40
description	5-40
setpoints.....	5-40
specifications	2-9
TIME	5-13, 6-10, 6-39
TIME BETWEEN STARTS	5-26, 5-68, 5-69, 6-32
TIME OF EVENT	6-33
TIME SYNCHRONIZATION.....	5-13
TIME-CURRENT CURVES	5-39
TIMERS.....	6-32
TORQUE	
event record.....	6-34
metering.....	5-85
overtorque	5-86
setup	5-85
specifications	2-12
TORQUE ALARM MESSAGE	6-8
TORQUE SETUP	5-85
TRACE MEMORY	5-9
TRIP COIL SUPERVISION	2-7, 5-87, 5-88, 6-10, 7-7
TRIP COUNTER	
actual values.....	6-30, 6-31
clearing.....	5-16
setpoints.....	5-87
TRIP RELAY	
<i>see 1 TRIP RELAY</i>	
TRIP TIME ON OVERLOAD	6-5
TRIPS	5-6
TWO-PHASE CT CONFIGURATION	A-1
TWO-SPEED MOTOR	
acceleration	5-109
assignable input 4	5-28
description	5-105
enabling.....	5-18
setup	5-105
undercurrent	5-109
wiring diagram	3-27
TYPICAL APPLICATIONS	2-2
TYPICAL WIRING	

description	3-12
wiring diagram	3-11

U

UNBALANCE	
actual values	6-11
event record	6-33
pre-trip value	6-5
setpoints	5-63
specifications	2-8
testing	7-12
three-phase example	7-12
trip counter	6-30
UNBALANCE BIAS	5-40, 5-55
UNDERCURRENT	
setpoints	5-62
setpoints for 2-speed motor	5-109
specifications	2-10
trip counter	6-30
UNDERFREQUENCY	
setpoints	5-80
specifications	2-8
UNDERPOWER	
	5-84
UNDERPOWER TRIPS	
	6-31
UNDERVOLTAGE	
setpoints	5-77
specifications	2-10
trip counter	6-30
UNPACKING THE RELAY	
	1-1
UPGRADING FIRMWARE	
	4-35

V

VARIABLE FREQUENCY DRIVES	5-21
VIBRATION	3-19
VIBRATION SWITCH	2-11
VIBRATION SWITCH ALARM	5-31
VIBRATION SWITCH TRIP	5-31
VOLTAGE DEPENDENT OVERLOAD	
acceleration curves	5-51, 5-52
curves	5-47
custom curves	5-51, 5-52
description	5-41, 5-47, 5-53
protection curves	5-53, 5-54, 5-55
safe stall curve	5-53
VOLTAGE INPUT ACCURACY TEST	7-3
VOLTAGE INPUTS	
description	3-17
specifications	2-7
wye VT connection	3-18
VOLTAGE METERING	6-13
VOLTAGE PHASE REVERSAL	
<i>see PHASE REVERSAL</i>	
VOLTAGE PHASE REVERSAL TEST	7-13

VOLTAGE SENSING	
setpoints.....	5-20
VOLTAGE TRANSFORMER	
<i>see VTs</i>	
VOLTAGE TRANSFORMER RATIO	5-20
VT CONNECTION TYPE	5-20
VT RATIO	5-20
VTs	
3-phase open delta	6-22
3-phase wye	6-25
connection type.....	5-20
open delta.....	3-17
phasors.....	6-19
<i>see VOLTAGE TRANSFORMER</i>	
single VT operation.....	5-20
wye	3-17

W

WARRANTY	A-15
WAVEFORM CAPTURE	
capture trace	5-35
trace memory buffers	5-9
trace memory trigger.....	5-9
WITHDRAWAL.....	3-5
WYE VTs.....	3-17

Z

ZERO-SEQUENCE.....	3-14, 5-19
--------------------	------------