OFFICIAL MANUFACTURER DOCUMENT PACKAGE

Manufacturer's Manual

489-P5-HI-A20

GE Multilin official documentation applicable to this exact model

Source file: 489-P5-HI-A20.pdf

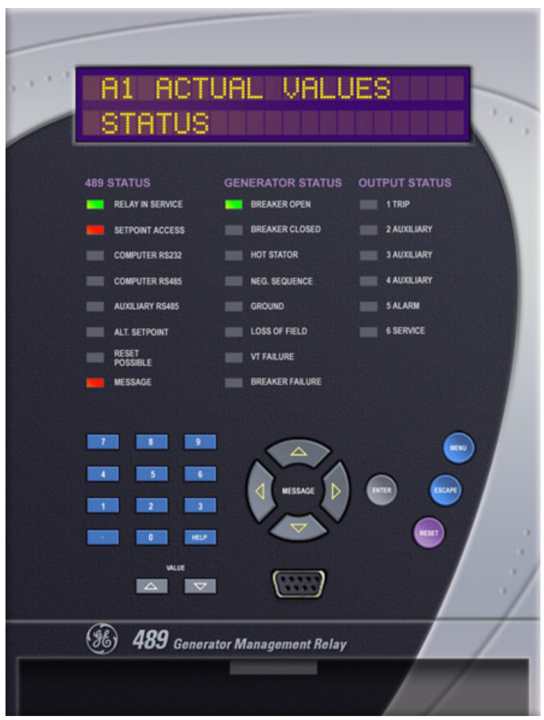
Applicable official manufacturer pages follow this Amikon cover without alteration.

Digital Energy
Multilin

489 Generator Management Relay
Instruction Manual

Firmware Revision: 4.0X

Manual Part Number: 1601-0150-AF
Manual Order Code: GEK-106494P



GE Multilin

215 Anderson Avenue, Markham, Ontario

Canada L6E 1B3

Tel: (905) 294-6222 Fax: (905) 201-2098

Internet: http://www.GEindustrial.com/multilin

REGISTERED ISO9001:2000 GE MULTILIN

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

QMI # 005094
UL # A3775

Digital Energy
Multilin

489 Generator Management Relay

Chapter 2: Introduction

2.1 Overview

2.1.1 Description

The 489 Generator Management Relay is a microprocessor-based relay designed for the protection and management of synchronous and induction generators. The 489 is equipped with 6 output relays for trips and alarms. Generator protection, fault diagnostics, power metering, and RTU functions are integrated into one economical drawout package. The single line diagram illustrates the 489 functionality using ANSI (American National Standards Institute) device numbers.

ANSI	PROTECTION	Synchronous	Induction
12	overspeed	●	●
21	distance	●	●
24	volts/hertz	●	
27	undervoltage	●	●
50/27	inadvertent generator energization	●	●
32	reverse power/low forward power	●	●
38	bearing overtemperature (RTD)	●	●
39	bearing vibration (analog inputs)	●	●
40	loss of excitation (impedance)	●	
40Q	loss of field (reactive power)	●	
46	negative sequence overcurrent (I^2_2t)	●	●
47	voltage phase reversal	●	●
49	stator thermal (RTD/thermal model)	●	●
50	high-set phase overcurrent	●	●
50BF	breaker failure detection	●	●
50	offline overcurrent	●	●
50/51GN	ground overcurrent	●	●
51V	voltage restrained phase overcurrent	●	●
59	overvoltage	●	●
59GN/27TN	100% stator ground	●	●
60FL	VT fuse failure	●	●
67	ground directional	●	●
76	overexcitation (analog input)	●	
81	overfrequency/underfrequency	●	●
86	electrical lockout	●	●
87G	percentage differential	●	●
	sequential tripping logic	●	●
	trip coil supervision	●	●
	generator running hours alarm	●	●

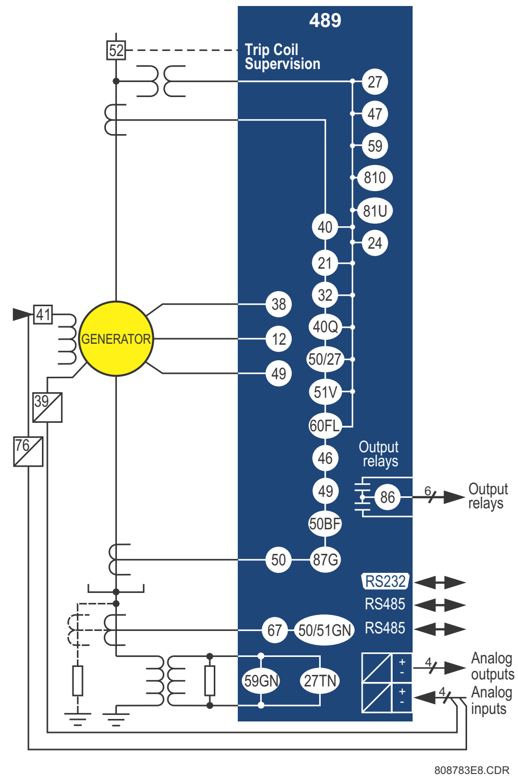


FIGURE 2–1: Single Line Diagram

Fault diagnostics are provided through pretrip data, event record, waveform capture, and statistics. Prior to issuing a trip, the 489 takes a snapshot of the measured parameters and stores them in a record with the cause of the trip. This pre-trip data may be viewed using the NEXT key before the trip is reset, or by accessing the last trip data in actual values page 1. The event recorder stores a maximum of 256 time and date stamped events including the pre-trip data. Every time a trip occurs, the 489 stores a 16 cycle trace for all measured AC quantities. Trip counters record the number of occurrences of each type of trip. Minimum and maximum values for RTDs and analog inputs are also recorded. These features allow the operator to pinpoint a problem quickly and with certainty.

A complete list protection features is shown below:

Table 2–1: Trip and Alarm Protection Features

Trip Protection	Alarm Protection
Seven (7) Assignable Digital Inputs: General Input, Sequential Trip (low forward power or reverse power), Field-Breaker discrepancy, and Tachometer	7 assignable digital inputs: general input and tachometer
	Overload
	Negative Sequence
Offline Overcurrent (protection during startup)	Ground Overcurrent
Inadvertent Energization	Ground Directional
Phase Overcurrent with Voltage Restraint	Undervoltage
Negative-Sequence Overcurrent	Overvoltage
Ground Overcurrent	Volts Per Hertz
Percentage Phase Differential	Underfrequency
Ground Directional	Overfrequency
High-Set Phase Overcurrent	Neutral Overvoltage (Fundamental)
Undervoltage	Neutral Undervoltage (3rd Harmonic)
Overvoltage	Reactive Power (kvar)
Volts Per Hertz	Reverse Power
Voltage Phase Reversal	Low Forward Power
Underfrequency (two step)	RTD: Stator, Bearing, Ambient, Other
Overfrequency (two step)	Short/Low RTD
Neutral Overvoltage (Fundamental)	Open RTD
Neutral Undervoltage (3rd Harmonic)	Thermal Overload
Loss of Excitation (2 impedance circles)	Trip Counter
Distance Element (2 zones of protection)	Breaker Failure
Reactive Power (kvar) for loss of field	Trip Coil Monitor
Reverse Power for anti-motoring	VT Fuse Failure
Low Forward Power	Demand: Current, MW, Mvar, MVA
RTDs: Stator, Bearing, Ambient, Other	Generator Running Hours
Thermal Overload	Analog Inputs 1 to 4
Analog Inputs 1 to 4	Service (Self-Test Failure)
Electrical Lockout	IRIG-B Failure

NOTE

The following protection elements require neutral-end current inputs.

- Distance Element
- Offline Overcurrent
- Phase Differential

Power metering is a standard feature in the 489. The table below outlines the metered parameters available to the operator through the front panel and communications ports. The 489 is equipped with three independent communications ports. The front panel RS232 port may be used for setpoint programming, local interrogation or control, and firmware upgrades. The computer RS485 port may be connected to a PLC, DCS, or PC based interface software. The auxiliary RS485 port may be used for redundancy or simultaneous interrogation and/or control from a second PLC, DCS, or PC program. There are also four 4 to 20 mA transducer outputs that may be assigned to any measured parameter. The range of these outputs is scalable. Additional features are outlined below.

Table 2–2: Metering and Additional Features

Metering
Voltage (phasors)
Current (phasors) and Amps Demand
Real Power, MW Demand, MWh
Apparent Power and MVA demand
MW, Mvar, and ±MVarh demand
Frequency
Power Factor
RTD
Speed in RPM with a Key Phasor Input
User-Programmable Analog Inputs

Additional Features
Drawout Case (maintenance and testing)
Breaker Failure
Trip Coil Supervision
VT Fuse Failure
Simulation
Flash Memory for easy firmware upgrades

2.1.2 Ordering

All features of the 489 are standard, there are no options. The phase CT secondaries, control power, and analog output range must be specified at the time of order. There are two ground CT inputs: one for a 50:0.025 CT and one for a ground CT with a 1 A secondary (may also accommodate a 5 A secondary). The VT inputs 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 489 Setup software is provided with each unit. A metal demo case may be ordered for demonstration or testing purposes.

Table 2–3: 489 Order Codes

	489 –	* –	* –	* –	* –	*	
Base unit	489	|	|	|	|	|	489 Generator Management Relay
Phase current inputs		P1	|	|	|	|	1 A phase CT secondaries
		P5	|	|	|	|	5 A phase CT secondaries
Control power			LO	|	|	|	20 to 60 V DC; 20 to 48 V AC at 48 to 62 Hz
			HI	|	|	|	90 to 300 V DC; 70 to 265 V AC at 48 to 62 Hz
Analog outputs				A1	|	|	0 to 1 mA analog outputs
				A20	|	|	4 to 20 mA analog outputs
Display					|	|	Basic display
					E	|	Enhanced display, larger LCD
					T	|	Enhanced with Ethernet (10Base-T)
Harsh environment						H	Harsh (chemical) environment conformal coating

For example, the 489-P1-LO-A20-E code specifies a 489 Generator 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 an enhanced display.

2.1.3 Other Accessories

Additional 489 accessories are listed below.

- **EnerVista 489 Setup software:** no-charge software provided with the 489
- **SR 19-1 PANEL:** single cutout for 19” panel
- **SR 19-2 PANEL:** double cutout for 19” 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 phase CT primaries
- **HGF3, HGF5, HGF8:** For sensitive ground detection on high resistance grounded systems
- **489 1 3/8-inch Collar:** For shallow switchgear, reduces the depth of the relay by 1 3/8 inches
- **489 3-inch Collar:** For shallow switchgear, reduces the depth of the relay by 3 inches

2.2 Specifications

2.2.1 Inputs

ANALOG CURRENT INPUTS

Inputs:	0 to 1 mA, 0 to 20 mA, 4 to 20mA (setpoint)
Input impedance:	226 Ω ±10%
Conversion range:	0 to 20 mA
Accuracy:	±1% of full scale
Type:	Passive
Analog input supply:	+24 V DC at 100 mA max.
Sampling Interval:	50 ms

ANALOG INPUTS FREQUENCY TRACKING

Frequency tracking:	Va for wye, Vab for open delta; 6 V minimum, 10 Hz/s

DIGITAL INPUTS

Inputs:	9 opto-isolated inputs
External switch:	dry contact < 400 Ω, or open collector NPN transistor from sensor. 6 mA sinking from internal 4K pull-up at 24 V DC with Vce < 4 V DC
489 sensor supply:	24 V DC at 20 mA max.

GROUND CURRENT INPUT

CT primary:	10 to 10000 A (1 A / 5 A CTs)
CT secondary:	1 A / 5 A or 50:0.025 (HGF CTs)
Conversion range:	0.02 to 20 × CT for 1A/5A CTs 0.0 to 100 A primary for 50:0.025 CTs (HGF)
50:0.025 CT accuracy:	±0.1 A at < 10 A ±1.0 A at ≥ 10 to 100 A
1 A / 5 A CT accuracy:	at < 2 × CT: ±0.5% of 2 × CT at ≥ 2 × CT: ±1% of 20 × CT

GROUND CT BURDEN

Ground CT	Input	Burden	
		VA	Ω
1 A / 5 A	1 A	0.024	0.024
	5 A	0.605	0.024
	20 A	9.809	0.024
50:0.025 HGF	0.025 A	0.057	90.7
	0.1 A	0.634	90.7
	0.5 A	18.9	75.6

GROUND CT CURRENT WITHSTAND (SECONDARY)

Ground CT	Withstand Time		
	1 sec.	2 sec.	continuous
1 A / 5 A	80 × CT	40 × CT	3 × CT
50:0.025 HGF	N/A	N/A	150 mA

NEUTRAL VOLTAGE INPUT

VT ratio:	1.00 to 240.00:1 in steps of 0.01
VT secondary:	100 V AC (full-scale)
Conversion range:	0.005 to 1.00 × Full Scale

Accuracy:	*Fundamental*:+/-0.5% of Full Scale *3rd Harmonic at >3V secondary*: +/-5% of reading *3rd Harmonic at < 3V secondary*: +/- 0.15% of full scale
Max. continuous:	280 V AC

OUTPUT AND NEUTRAL END CURRENT INPUTS

CT primary:	10 to 50000 A
CT secondary:	1 A or 5 A (specify with order)
Conversion range:	0.02 to 20 × CT
Accuracy:	at < 2 × CT: ±0.5% of 2 × CT at ≥ 2 × CT: ±1% of 20 × CT
Burden:	Less than 0.2 VA at rated load
CT withstand:	1 s at 80 × rated current 2 s at 40 × rated current continuous at 3 × rated current

PHASE VOLTAGE INPUTS

VT ratio:	1.00 to 300.00:1 in steps of 0.01
VT secondary:	200 V AC (full-scale)
Conversion range:	0.02 to 1.00 × full-scale
Accuracy:	±0.5% of full-scale
Max. continuous:	280 V AC
Burden:	> 500 KΩ

RTD INPUTS

RTDs (3-wire type):	100 Ω Platinum (DIN.43760) 100 Ω Nickel, 120 Ω Nickel, 10 Ω Copper
RTD sensing current:	5 mA
Isolation:	36 Vpk (isolated with analog inputs and outputs)
Range:	–50 to +250°C
Accuracy:	±2°C/±4°F for Pt and Ni ±5°C/±9°F for Cu
Lead resistance:	25 Ω max. per lead (Pt and Ni types); 3 Ω max. per lead (Cu type)
NO sensor:	>1 kΩ
Short/low alarm:	<–50°C

IRIG-B

Amplitude Modulated:	2.5 to 6.0 Vpk-pk at 3:1 signal ratio
DC shift:	TTL
Input impedance:	50 kΩ ±10%

2.2.2 Outputs

ANALOG CURRENT OUTPUT

Type:	Active
Range:	4 to 20mA, 0 to 1 mA (must be specified with order)
Accuracy:	±1% of full scale
4 to 20 mA max. load:	1.2 kΩ
0 to 1 mA max. load:	10 kΩ
Isolation:	36 Vpk (isolated with RTDs and analog inputs)
4 assignable outputs:	phase A, B, C output current, three-phase average current, negative sequence current, generator load, hottest stator RTD, hottest bearing RTD, RTDs 1 to 12, voltage (AB, BC, and CA),

	average phase-phase voltage, volts/hertz, frequency, third harmonic neutral voltage, power (3-phase Mvar, MW, and MVA), power factor, analog inputs 1 to 4, tachometer, thermal capacity used, demand (I, Mvar, MW, and MVA), torque

PULSE OUTPUT

Parameters:	+ kwh, +kvarh, –kvarh
Interval:	1 to 50000 in steps of 1
Pulse width:	200 to 1000 ms in steps of 1

RELAYS

WARNING

Relay contacts must be considered unsafe to touch when the relay 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.

Configuration:	6 electromechanical Form-C relays
Contact material:	silver alloy
Operate time:	10 ms
Make/carry:	30 A for 0.2 s, 10 A continuous (for 100000 operations)

Maximum ratings for 100000 operations:

Voltage		Break	Max. Load
DC Resistive	30 V	10 A	300 W
	125 V	0.5 A	62.5 W
	250 V	0.3 A	75 W
DC inductive L/R = 40 ms	30 V	5 A	150 W
	125 V	0.25 A	31.3 W
	250 V	0.15 A	37.5 W
AC Resistive	120 V	10 A	2770 VA
	250 V	10 A	2770 VA
AC Inductive PF = 0.4	120 V	4 A	480 VA
	250 V	3 A	750 VA

2.2.3 Protection

PHASE DISTANCE (IMPEDANCE)

Characteristics:	offset mho
Reach (secondary Ω):	0.1 to 500.0 Ω in steps of 0.1
Reach accuracy:	±5%
Characteristic angle:	50 to 85° in steps of 1
Time delay:	0.15 to 150.0 s in steps of 0.1
Timing accuracy:	±50 ms or ±0.5% of total time
Number of zones:	2

GROUND DIRECTIONAL

Pickup level:	0.05 to 20.00 × CT in steps of 0.01
Time delay:	0.1 to 120.0 s in steps of 0.1
Pickup accuracy:	as per phase current inputs
Timing accuracy:	±100 ms or ±0.5% of total time
Elements:	Trip and Alarm

GROUND OVERCURRENT

Pickup level:	0.05 to 20.00 × CT in steps of 0.01
Curve shapes:	ANSI, IEC, IAC, Flexcurve, Definite Time

Time delay:	0.00 to 100.00 s in steps of 0.01
Pickup accuracy:	as per ground current input
Timing accuracy:	+50 ms at 50/60 Hz or ±0.5% total time
Elements:	Trip

HIGH-SET PHASE OVERCURRENT

Pickup level:	0.15 to 20.00 × CT in steps of 0.01
Time delay:	0.00 to 100.00 s in steps of 0.01
Pickup accuracy:	as per phase current inputs
Timing accuracy:	±50 ms at 50/60 Hz or ±0.5% total time
Elements:	Trip

INADVERTENT ENERGIZATION

Arming signal:	undervoltage and/or offline from breaker status
Pickup level:	0.05 to 3.00 × CT in steps of 0.01 of any one phase
Time delay:	no intentional delay
Pickup accuracy:	as per phase current inputs
Timing accuracy:	+50 ms at 50/60 Hz
Elements:	Trip

LOSS OF EXCITATION (IMPEDANCE)

Pickup level:	2.5 to 300.0 Ω secondary in steps of 0.1 with adjustable impedance offset 1.0 to 300.0 Ω secondary in steps of 0.1
Time delay:	0.1 to 10.0 s in steps of 0.1
Pickup accuracy:	as per voltage and phase current inputs
Timing accuracy:	±100 ms or ±0.5% of total time
Elements:	Trip (2 zones using impedance circles)

NEGATIVE SEQUENCE OVERCURRENT

Pickup level:	3 to 100% FLA in steps of 1
Curve shapes:	I_2^2t trip defined by *k*, definite time alarm
Time delay:	0.1 to 100.0 s in steps of 0.1
Pickup accuracy:	as per phase current inputs
Timing accuracy:	±100ms or ± 0.5% of total time
Elements:	Trip and Alarm

NEUTRAL OVERVOLTAGE (FUNDAMENTAL)

Pickup level:	2.0 to 100.0 V secondary in steps of 0.01
Time delay:	0.1 to 120.0 s in steps of 0.1
Pickup accuracy:	as per neutral voltage input
Timing accuracy:	±100 ms or ±0.5% of total time
Elements:	Trip and Alarm

NEUTRAL UNDERVOLTAGE (3RD HARMONIC)

Blocking signals:	low power and low voltage if open delta
Pickup level:	0.5 to 20.0 V secondary in steps of 0.01 if open delta VT; adaptive if wye VT
Time delay:	5 to 120 s in steps of 1
Pickup accuracy:	as per Neutral Voltage Input
Timing accuracy:	±3.0 s
Elements:	Trip and Alarm

OFFLINE OVERCURRENT

Pickup level:	0.05 to 1.00 × CT in steps of 0.01 of any one phase
Time delay:	3 to 99 cycles in steps of 1
Pickup accuracy:	as per phase current inputs
Timing accuracy:	+50ms at 50/60 Hz

Elements:	Trip

OTHER FEATURES

Serial Start/Stop Initiation,	Remote Reset (configurable digital input), Test Input (configurable digital input), Thermal Reset (configurable digital input), Dual Setpoints, Pre-Trip Data, Event Recorder, Waveform Memory, Fault Simulation, VT Failure, Trip Counter, Breaker Failure, Trip Coil Monitor, Generator Running Hours Alarm, IRIG-B Failure Alarm

OVERCURRENT ALARM

Pickup level:	0.10 to 1.50 × FLA in steps of 0.01 (average phase current)
Time delay:	0.1 to 250.0 s in steps of 0.1
Pickup accuracy:	as per phase current inputs
Timing accuracy:	±100 ms or ±0.5% of total time
Elements:	Alarm

OVERFREQUENCY

Required voltage:	0.50 to 0.99 × rated voltage in Phase A
Block from online:	0 to 5 sec. in steps of 1
Pickup level:	25.01 to 70.00 in steps of 0.01
Curve shapes:	1 level alarm, 2 level trip definite time
Time delay:	0.1 to 5000.0 s in steps of 0.1
Pickup accuracy:	±0.02 Hz
Timing accuracy:	±150 ms or ±1% of total time at 50Hz and 60Hz; ±300 ms or 2% of total time at 25Hz
Elements:	Trip and Alarm

OVERLOAD / STALL PROTECTION / THERMAL MODEL

Overload curves:	15 Standard Overload Curves, Custom Curve, and Voltage Dependent Custom Curve (all curves time out against average phase current)
Curve biasing:	Phase Unbalance, Hot/Cold Curve Ratio, Stator RTD, Online Cooling Rate, Offline Cooling Rate, Line Voltage
Overload pickup:	1.01 to 1.25
Pickup accuracy:	as per phase current inputs
Timing accuracy:	±100 ms or ±2% of total time
Elements:	Trip and Alarm

OVERVOLTAGE

Pickup level:	1.01 to 1.50 × rated V in steps of 0.01
Curve shapes:	Inverse Time, definite time alarm
Time Delay:	0.2 to 120.0 s in steps of 0.1
Pickup accuracy:	as per Voltage Inputs
Timing accuracy:	±100 ms or ±0.5% of total time
Elements:	Trip and Alarm

PHASE DIFFERENTIAL

Pickup level:	0.05 to 1.00 × CT in steps of 0.01
Curve shape:	Dual Slope
Time delay:	0 to 100 cycles in steps of 1
Pickup accuracy:	as per phase current inputs
Timing accuracy:	+50 ms at 50/60 Hz or ±0.5% total time
Elements:	Trip

PHASE OVERCURRENT

Voltage restraint:	programmable fixed characteristic
Pickup level:	0.15 to 20.00 × CT in steps of 0.01 of any one phase

Curve shapes:	ANSI, IEC, IAC, FlexCurve, Definite Time
Time delay:	0.000 to 100.000 s in steps of 0.001
Pickup accuracy:	as per phase current inputs
Timing accuracy:	+50 ms at 50/60 Hz or ±0.5% total time
Elements:	Trip

RTDS 1 TO 12

Pickup:	1 to 250°C in steps of 1
Pickup hysteresis:	2°C
Time delay:	3 sec.
Elements:	Trip and Alarm

UNDERFREQUENCY

Required voltage:	0.50 to 0.99 × rated voltage in Phase A
Block from online:	0 to 5 sec. in steps of 1
Pickup level:	20.00 to 60.00 in steps of 0.01
Curve shapes:	1 level alarm, two level trip definite time
Time delay:	0.1 to 5000.0 sec. in steps of 0.1
Pickup accuracy:	±0.02 Hz
Timing accuracy:	±150 ms or ±1% of total time at 50Hz and 60Hz; ±300 ms or 2% of total time at 25Hz
Elements:	Trip and Alarm

UNDERVOLTAGE

Pickup level:	0.50 to 0.99 × rated V in steps of 0.01
Curve shapes:	Inverse Time, definite time alarm
Time Delay:	0.2 to 120.0 s in steps of 0.1
Pickup accuracy:	as per voltage inputs
Timing accuracy:	±100 ms or ±0.5% of total time
Elements:	Trip and Alarm

VOLTAGE PHASE REVERSAL

Configuration:	ABC or ACB phase rotation
Timing accuracy:	200 to 400 ms
Elements:	Trip

VOLTS PER HERTZ

Pickup level:	1.00 to 1.99 × nominal in steps of 0.01
Curve shapes:	Inverse Time, definite time alarm
Time delay:	0.1 to 120.0 s in steps of 0.1
Pickup accuracy:	as per voltage inputs
Timing accuracy:	±100 ms at ≥ 1.2 × Pickup ±300 ms at < 1.2 × Pickup
Elements:	Trip and Alarm

2.2.4 Digital Inputs

FIELD BREAKER DISCREPANCY

Configurable:	assignable to Digital Inputs 1 to 7
Time delay:	0.1 to 500.0 s in steps of 0.1
Timing accuracy:	±100 ms or ±0.5% of total time
Elements:	Trip

GENERAL INPUT A TO G

Configurable:	ssignable Digital Inputs 1 to 7
Time delay:	0.1 to 5000.0 s in steps of 0.1
Block from online:	0 to 5000 s in steps of 1
Timing accuracy:	±100 ms or ±0.5% of total time
Elements:	Trip, Alarm, and Control

SEQUENTIAL TRIP

Configurable:	assignable to Digital Inputs 1 to 7
Pickup level:	0.02 to 0.99 × rated MW in steps of 0.01, Low Forward Power / Reverse Power
Time delay:	0.2 to 120.0 s in steps of 0.1
Pickup accuracy:	see power metering
Timing accuracy:	±100 ms or ±0.5% of total time
Elements:	Trip

TACHOMETER

Configurable:	assignable to Digital Inputs 4 to 7
RPM measurement:	0 to 7200 RPM
Duty cycle of pulse:	>10%
Pickup level:	101 to 175 × rated speed in steps of 1
Time delay:	1 to 250 s in steps of 1
Timing accuracy:	±0.5 s or ±0.5% of total time
Elements:	Trip and Alarm

2.2.5 Monitoring

DEMAND METERING

Metered values:	maximum phase current, 3 phase real power, 3 phase apparent power, 3 phase reactive power
Measurement type:	rolling demand
Demand interval:	5 to 90 min. in steps of 1
Update rate:	1 minute
Elements:	Alarm

ENERGY METERING

Description:	continuous total of +watthours and ±varhours
Range:	0.000 to 4000000.000 Mvarh
Timing accuracy:	±0.5%
Update Rate:	50 ms

LOW FORWARD POWER

Block from online:	0 to 15000 s in steps of 1
Pickup level:	0.02 to 0.99 × rated MW
Time delay:	0.2 to 120.0 s in steps of 0.1
Pickup accuracy:	see power metering
Timing accuracy:	±100 ms or ±0.5% of total time
Elements:	Trip and Alarm

POWER METERING

Range:	-2000.000 to 2000.000 MW, –2000.000 to 2000.000 Mvar, 0 to 2000.000 MVA
Accuracy at $I_{avg} < 2 \times$ CT:	$\pm 1\%$ of $\sqrt{3} \times 2 \times CT \times VT_{ratio} \times VT_{full\text{-}scale}$
Accuracy at $I_{avg} > 2 \times$ CT:	$\pm 1.5\%$ of $\sqrt{3} \times 20 \times CT \times VT_{ratio} \times VT_{full\text{-}scale}$

REACTIVE POWER

Block from online:	0 to 5000 s in steps of 1
Pickup level:	0.02 to 1.50 × rated Mvar (positive and negative)
Time delay:	0.2 to 120.0 s in steps of 0.1
Pickup accuracy:	see power metering
Timing accuracy:	±100ms or ±0.5% of total time
Elements:	Trip and Alarm

REVERSE POWER

Block from online:	0 to 5000 s in steps of 1
Pickup level:	0.02 to 0.99 × rated MW
Time delay:	0.2 to 120.0 s in steps of 0.1
Pickup accuracy:	see power metering
Timing accuracy:	±100 ms or ±0.5% of total time
Elements:	Trip and Alarm

TRIP COIL SUPERVISION

Applicable voltage:	20 to 300 V DC/AC
Trickle current:	2 to 5 mA

2.2.6 Power Supply

CONTROL POWER

Options:	LO / HI (specify with order)
LO range:	20 to 60 V DC 20 to 48 V AC at 48 to 62 Hz
HI range:	90 to 300 V DC 70 to 265 V AC at 48 to 62 Hz
Power:	45 VA (max.), 25 VA typical

Total loss of voltage ride through time (0% control power): 16.7 ms

WARNING

It is recommended that the 489 be powered up at least once per year to prevent deterioration of electrolytic capacitors in the power supply.

FUSE

Current rating:	2.5 A
Type:	5x20mm HRC SLO-BLO Littelfuse
Model:	215-02.5

WARNING

An external fuse must be used if the supply voltage exceeds 250 V

2.2.7 Communications

COMMUNICATIONS PORTS

RS232 port:	1, front panel, non-isolated
RS485 ports:	2, isolated together at 36 Vpk
RS485 baud rates:	300, 1200, 2400, 4800, 9600, 19200
RS232 baud rate:	9600
Parity:	None, Odd, Even
Protocol:	Modbus® RTU / half duplex, DNP 3.0

2.2.8 Testing

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)

WARNING

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

TYPE TESTING

The table below lists the 489 type tests:

Test	Reference Standard	Test Level
Dielectric voltage withstand	EN60255-5	2.3KV
Impulse voltage withstand	EN60255-5	5KV
Insulation resistance	EN60255-5	500Vdc
Damped Oscillatory	IEC61000-4-18IEC60255-22-1	2.5KV CM, 1KV DM
Electrostatic Discharge	EN61000-4-2/IEC60255-22-2	Level 4
RF immunity	EN61000-4-3/IEC60255-22-3	Level 3
Fast Transient Disturbance	EN61000-4-4/IEC60255-22-4	Class A and B
Surge Immunity	EN61000-4-5/IEC60255-22-5	Level 3 & 4
Conducted RF Immunity	EN61000-4-6/IEC60255-22-6	Level 3
Radiated & Conducted Emissions	CISPR11 /CISPR22/ IEC60255-25	Class A
Sinusoidal Vibration	IEC60255-21-1	Class 1
Power magnetic Immunity	IEC61000-4-8	Level 4
Voltage Dip & interruption	IEC61000-4-11	0, 40, 70% dips, 250/ 300 cycle interrupts
Ingress Protection	IEC60529	IP40 front , IP10A Back
Environmental (Cold)	IEC60068-2-1	-40C 16 hrs
Environmental (Dry heat)	IEC60068-2-2	85C 16hrs
Relative Humidity Cyclic	IEC60068-2-30	6day variant 2
EFT	IEEE/ANSI C37.90.1	4KV, 2.5Khz

Test	Reference Standard	Test Level
Damped Oscillation	IEEE/ANSI C37.90.1	2.5KV, 1.0Mhz
ESD	IEEE/ANSIC37.90.3	8KV CD/ 15KV AD
Safety	UL508	e83849 NKCR
	UL C22.2-14	e83849 NKCR7
	UL1053	e83849 NKCR

2.2.9 Approvals

	Applicable Council Directive	According to
CE compliance	Low voltage directive	EN60255-5/EN60255-27
	EMC Directive	EN50263
North America	cULus	UL508
		UL1053
		C22.2.No 14
ISO	Manufactured under a registered quality program	ISO9001

2.2.10 Physical

CASE

Drawout:	Fully drawout (automatic CT shorts)
Seal:	Seal provision
Door:	Dust tight door
Mounting:	Panel or 19" rack mount
IP Class:	IP10A

PACKAGING

Shipping box:	12” × 11” × 10” (W × H × D) 30.5cm × 27.9cm × 25.4cm
Shipping weight:	17 lbs / 7.7 kg max.

TERMINALS

Low voltage (A, B, C, D terminals): 12 AWG max

High voltage (E, F, G, H terminals): #8 ring lug, 10 AWG wire standard

2.2.11 Environmental

Ambient temperatures:	
Storage/Shipping:	-40C to 85C
Operating:	-40C to 60C
Humidity:	Operating up to 95% (non condensing) @ 55C (As per IEC60068-2-30 Variant 2, 6days)
Altitude:	2000m (max)
Pollution Degree:	II
Overvoltage Category:	II
Ingress protection:	IP40 Front , IP10A back

NOTE

At temperatures less than –20°C, the LCD contrast may be impaired.

2.2.12 Long-term Storage

LONG-TERM STORAGE

Environment:	In addition to the above environmental considerations, the relay should be stored in an environment that is dry, corrosive-free, and not in direct sunlight.
Correct storage:	Prevents premature component failures caused by environmental factors such as moisture or corrosive gases. Exposure to high humidity or corrosive environments will prematurely degrade the electronic components in any electronic device regardless of its use or manufacturer, unless specific precautions, such as those mentioned in the Environmental section above, are taken.

NOTE

It is recommended that all relays be powered up once per year, for one hour continuously, to avoid deterioration of electrolytic capacitors and subsequent relay failure.

Digital Energy
Multilin

489 Generator Management Relay

Chapter 3: Installation

3.1 Mechanical Installation

3.1.1 Description

The 489 is packaged in the standard GE Multilin 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, such as automatic CT shorting. The unit is mechanically held in the case by pins on the locking handle, which cannot be fully lowered to the locked position until the electrical connections are completely mated. Any 489 can be installed in any 489 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, but the unit should be wiped clean with a damp cloth.

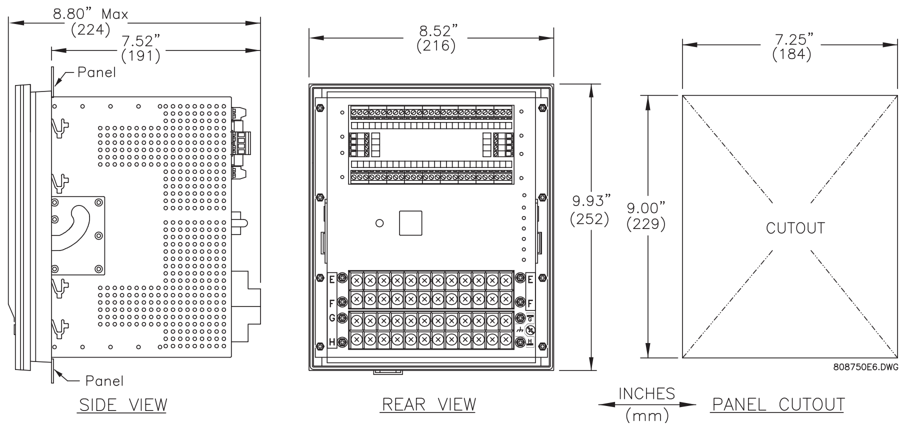


FIGURE 3–1: 489 Dimensions

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

FIGURE 3–2: Drawout Unit Seal

WARNING

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

3.1.2 Product Identification

Each 489 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 model number, manufacture date, and special notes.

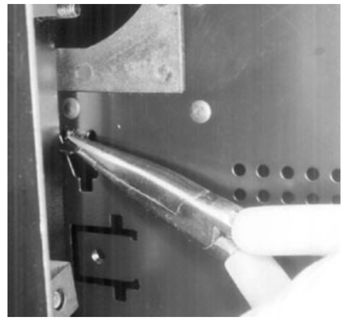
The unit label details the model number, type, serial number, file number, manufacture date, phase current inputs, special notes, overvoltage category, insulation voltage, pollution degree, control power, and output contact rating.

FIGURE 3–3: Product Case and Unit Labels

3.1.3 Installation

The 489 case, alone or adjacent to another SR-series unit, can be installed in a standard 19-inch rack panel (see *489 Dimensions* on page 3–2). Provision must be made for the front door to swing open without interference to, or from, adjacent equipment. The 489 unit is normally 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.

After the mounting hole in the panel has been prepared, slide the 489 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.



808704A1.CDR

FIGURE 3–4: Bend Up Mounting Tabs

3.1.4 Unit Withdrawal and Insertion

CAUTION

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

CAUTION

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 pulling the upper or lower corner of the right side, 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 3–5: Press Latch to Disengage Handle

▷ Grasp the locking handle in the center and pull firmly, rotating the handle up from the bottom of the unit until movement ceases.

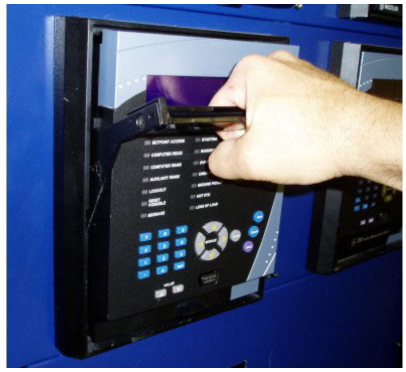


FIGURE 3–6: Rotate Handle to Stop Position

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 3–7: 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.

3.1.5 Ethernet Connection

If using the 489 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 inches 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 be re-inserted by first connecting the network cable to the rear RJ45 connector of the 489 (see step 3 of *Unit Withdrawal and Insertion* on page 3–4).

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 3–8: 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

The RS485 COM2 port is disabled if the Ethernet option is ordered.

3.1.6 Terminal Locations

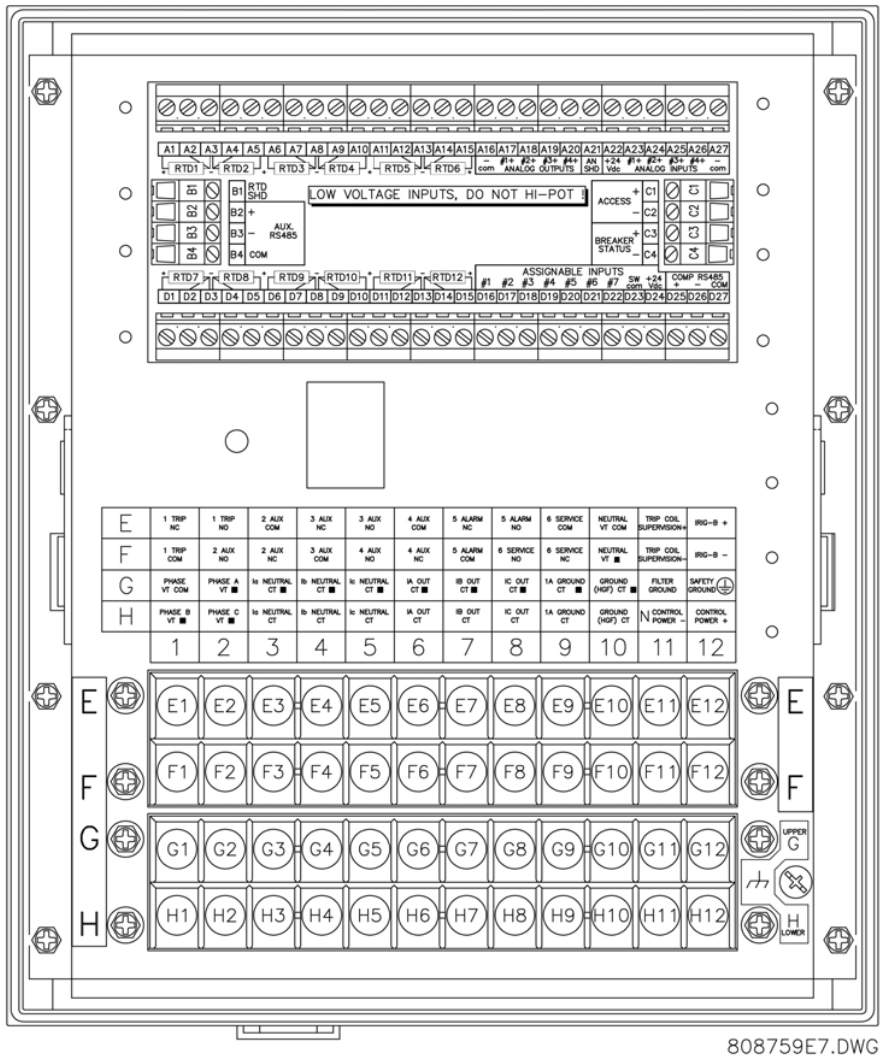


FIGURE 3–9: Terminal Layout

Table 3–1: 489 Terminal List

Terminal	Description	Terminal	Description
A01	RTD #1 Hot	D21	Assignable Switch 6
A02	RTD #1 Compensation	D22	Assignable Switch 7
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
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 Auxiliary Common
A14	RTD #6 Compensation	E07	5 Alarm NC
A15	RTD #6 Hot	E08	5 Alarm NO
A16	Analog Output Common –	E09	6 Service Common
A17	Analog Output 1 +	E10	Neutral VT Common
A18	Analog Output 2 +	E11	Coil Supervision +
A19	Analog Output 3 +	E12	IRIG-B +
A20	Analog Output 4 +	F01	1 Trip Common
A21	Analog Shield	F02	2 Auxiliary NO
A22	Analog Input 24 V DC Supply +	F03	2 Auxiliary NC
A23	Analog Input 1 +	F04	3 Auxiliary Common
A24	Analog Input 2 +	F05	4 Auxiliary NO
A25	Analog Input 3 +	F06	4 Auxiliary NC
A26	Analog Input 4 +	F07	5 Alarm Common
A27	Analog Input Common –	F08	6 Service NO
B01	RTD Shield	F09	6 Service NC
B02	Auxiliary RS485 +	F10	Neutral VT +
B03	Auxiliary RS485 –	F11	Coil Supervision –
B04	Auxiliary RS485 Common	F12	IRIG-B –
C01	Access +	G01	Phase VT Common
C02	Access –	G02	Phase A VT •
C03	Breaker Status +	G03	Neutral Phase A CT •
C04	Breaker Status –	G04	Neutral Phase B CT •
D01	RTD #7 Hot	G05	Neutral Phase C CT •
D02	RTD #7 Compensation	G06	Output Phase A CT •
D03	RTD Return	G07	Output Phase B CT •
D04	RTD #8 Compensation	G08	Output Phase C CT •
D05	RTD #8 Hot	G09	1A Ground CT •
D06	RTD #9 Hot	G10	HGF 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	Neutral Phase A CT
D12	RTD #11 Compensation	H04	Neutral Phase B CT
D13	RTD Return	H05	Neutral Phase C CT
D14	RTD #12 Compensation	H06	Output Phase A CT
D15	RTD #12 Hot	H07	Output Phase B CT
D16	Assignable Switch 1	H08	Output Phase C CT
D17	Assignable Switch 2	H09	1A Ground CT
D18	Assignable Switch 3	H10	HGF Ground CT
D19	Assignable Switch 4	H11	Control Power –
D20	Assignable Switch 5	H12	Control Power +

3.2 Electrical Installation

3.2.1 Typical Wiring

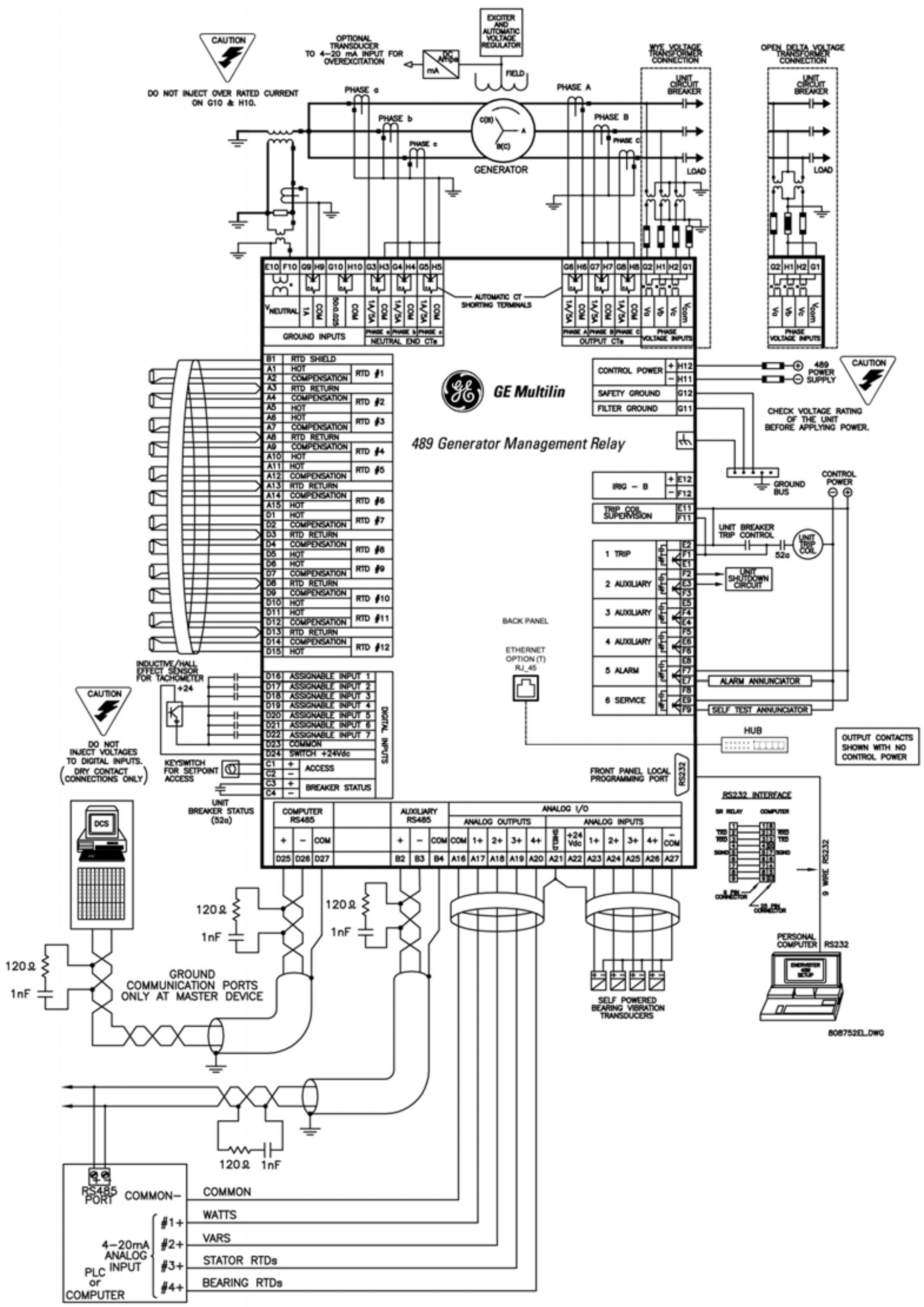


FIGURE 3–10: Typical Wiring Diagram

3.2.2 General Wiring Considerations

A broad range of applications are available to the user and it is not possible to present typical connections for all possible schemes. The information in this section will cover the important aspects of interconnections, in the general areas of instrument transformer inputs, other inputs, outputs, communications and grounding. See *Terminal Layout* on page 3–7 and *489 Terminal List* on page 3–8 for terminal arrangement, and *Typical Wiring Diagram* on page 3–9 for typical connections.

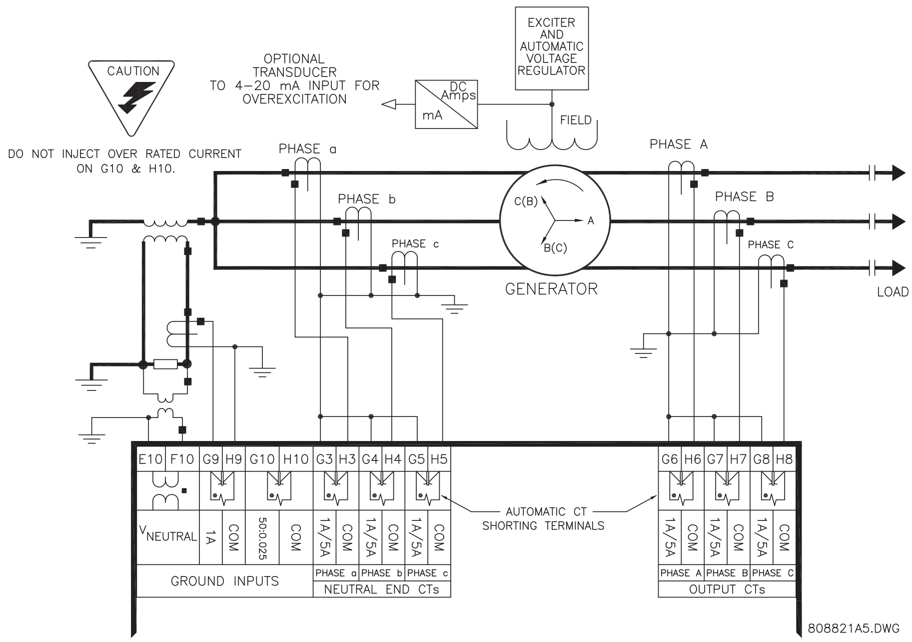


FIGURE 3–11: Typical Wiring (Detail)

3.2.3 Control Power

Control power supplied to the relay must match the installed power supply range. If the applied voltage does not match, damage to the unit may occur. All grounds MUST be connected for normal operation regardless of control power supply type.

The label found on the left side of the relay specifies its order code or model number. The installed power supply's operating range will be one of the following.

LO: 20 to 60 V DC or 20 to 48 V AC
HI: 88 to 300 V DC or 70 to 265 V AC

The relay should be connected directly to the ground bus, using the shortest practical path. A tinned copper, braided, shielding and bonding cable should be used. As a minimum, 96 strands of number 34 AWG should be used. Belden catalog number 8660 is suitable.

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.

Extensive filtering and transient protection are built into the 489 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.

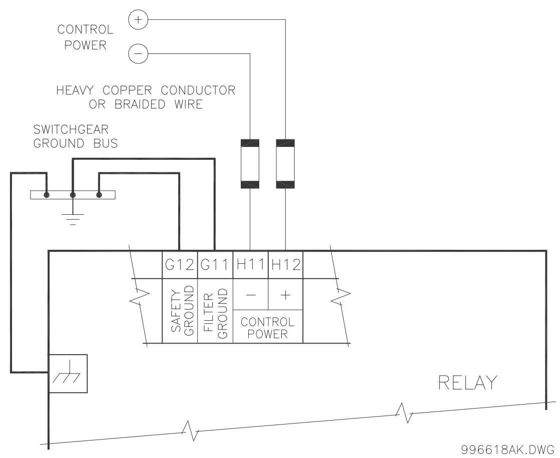


FIGURE 3–12: Control Power Connection

3.2.4 Current Inputs

Phase Current

The 489 has six phase current transformer inputs (three output side and three neutral end), each with an isolating transformer. There are no internal ground connections on the CT inputs. Each phase CT circuit is shorted by automatic mechanisms on the 489 case if the unit is withdrawn. The phase CTs should be chosen such that 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. This will ensure maximum accuracy for the current measurements. The maximum phase CT primary current is 50000 A.

The 489 will measure correctly 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 such that the appropriate interposing CT may be installed in the unit. CTs chosen must be capable of driving the 489 phase CT burden (see SPECIFICATIONS for ratings).

CAUTION

Verify that the 489 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 phase differential, negative sequence, power measurement, and residual ground current detection (if used).

Ground Current

The 489 has a dual primary isolating transformer for ground CT connections. There are no internal ground connections on the ground current inputs. The ground CT circuits are shorted by automatic mechanisms on the case if the unit is withdrawn. The 1 A tap is used for 1 A or 5 A secondary CTs in either core balance or residual ground configurations. If the 1 A tap is used, the 489 measures up to 20 A secondary with a maximum ground CT ratio of 10000:1. The ground CT must be capable of driving the ground CT burden.

The HGF ground CT input is designed for sensitive ground current detection on high resistance grounded systems where the GE Multilin HGF core balance CT (50:0.025) is used. In applications such as mines, 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 Multilin HGF CT. Only one ground CT input tap should be used on a given unit.

The HGF CT has a rating of 50:0.025. However if the HGF CT is used in conjunction with the 489, the relay assumes a fixed ratio of 5:0.0025. Therefore, the pickup level in primary amps will be Pickup × CT, where CT is equal to 5.

NOTE

Only one ground input should be wired. The other input should be unconnected.

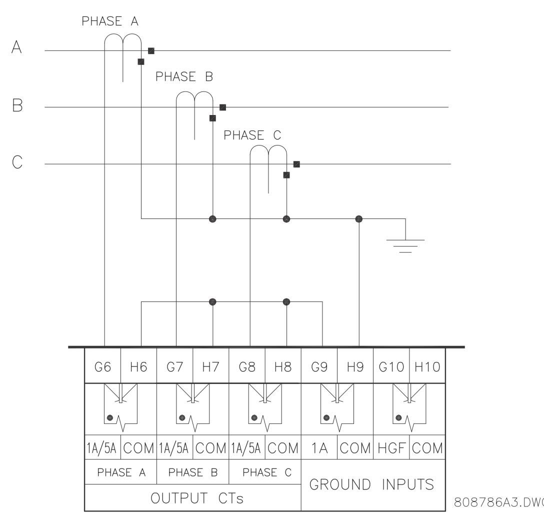


FIGURE 3–13: Residual Ground CT Connection

CAUTION

DO NOT INJECT OVER THE RATED CURRENT TO HGF TERMINAL (0.25 to 25 A PRIMARY).

The exact placement of a zero sequence CT to detect 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 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.

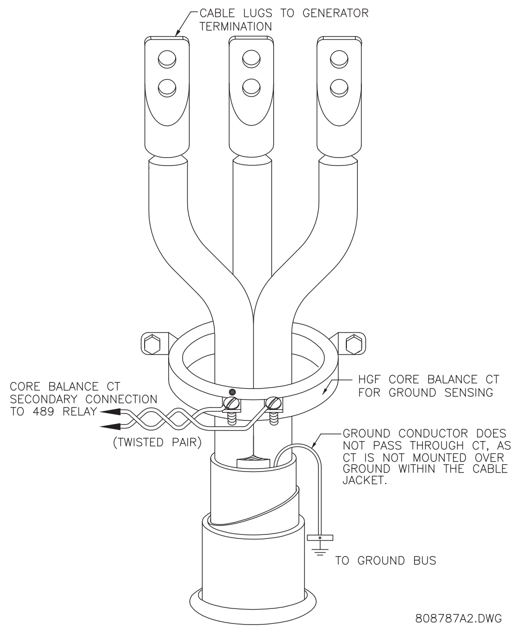


FIGURE 3–14: Core Balance Ground CT Installation – Unshielded Cable

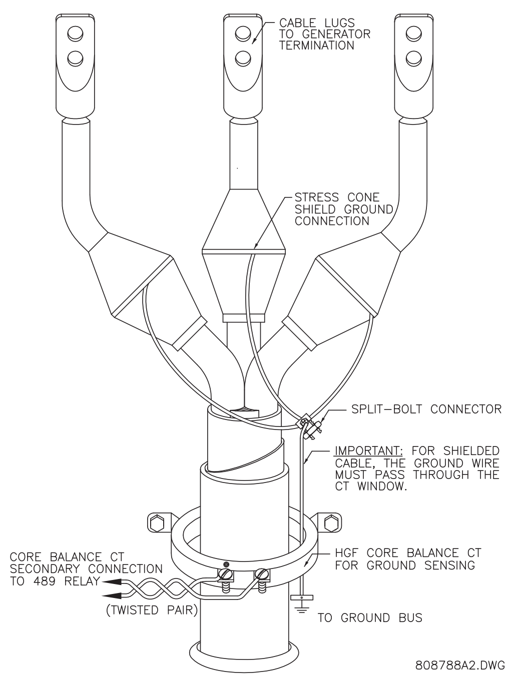


FIGURE 3–15: Core Balance Ground CT Installation – Shielded Cable

6.7 A6 Product Information

6.7.1 489 Model Info

PATH: ACTUAL VALUES ▷▽ A6 PRODUCT INFO ▷ 489 MODEL INFO

■ 489 MODEL [▷] INFORMATION		ORDER CODE: 489-P5-HI-A20	Range: N/A
	MESSAGE	489 SERIAL NO: A3260001	Range: N/A
	MESSAGE	489 REVISION: 32E100A4.000	Range: N/A
	MESSAGE	489 BOOT REVISION: 30K401A0.000	Range: N/A

All of the 489 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 Info

PATH: ACTUAL VALUES ▷▽ A6 PRODUCT INFO ▷▽ CALIBRATION INFO

■ CALIBRATION [▷] INFORMATION		ORIGINAL CALIBRATION DATE: Jan 01 1996	Range: month day year
	MESSAGE	LAST CALIBRATION DATE: Jan 01 1996	Range: month day year

The date of the original calibration and last calibration may be viewed here.