

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



NOTE

The following protection elements require neutral-end current inputs.

- Distance Element
- Offline Overcurrent
- Phase Differential

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 \pm 10%
Conversion range:	0 to 20 mA
Accuracy:	\pm 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
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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 \times CT for 1A/5A CTs 0.0 to 100 A primary for 50:0.025 CTs (HGF)
50:0.025 CT accuracy:	\pm 0.1 A at < 10 A \pm 1.0 A at \geq 10 to 100 A
1 A / 5 A CT accuracy:	at < 2 \times CT: \pm 0.5% of 2 \times CT at \geq 2 \times CT: \pm 1% of 20 \times 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 \times CT	40 \times CT	3 \times 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 \times Full Scale

Accuracy:	<i>Fundamental</i> : +/-0.5% of Full Scale <i>3rd Harmonic at >3V secondary</i> : +/-5% of reading <i>3rd Harmonic at < 3V secondary</i> : +/- 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



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: $\pm 5\%$
 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 $\pm 0.5\%$ of total time
 Number of zones: 2

GROUND DIRECTIONAL

Pickup level: 0.05 to 20.00 \times 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 $\pm 0.5\%$ of total time
 Elements: Trip and Alarm

GROUND OVERCURRENT

Pickup level: 0.05 to 20.00 \times 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 $\pm 0.5\%$ total time
Elements:	Trip

HIGH-SET PHASE OVERCURRENT

Pickup level:	0.15 to 20.00 \times 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 $\pm 0.5\%$ total time
Elements:	Trip

INADVERTENT ENERGIZATION

Arming signal:	undervoltage and/or offline from breaker status
Pickup level:	0.05 to 3.00 \times 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 $\pm 0.5\%$ 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:	$I_2^2 t$ 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:	± 100 ms or $\pm 0.5\%$ 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 $\pm 0.5\%$ 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 \times 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 $1.50 \times \text{FLA}$ 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 $\pm 0.5\%$ of total time
 Elements: Alarm

OVERFREQUENCY

Required voltage: 0.50 to $0.99 \times$ 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 $\pm 1\%$ 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 $\pm 2\%$ of total time
 Elements: Trip and Alarm

OVERVOLTAGE

Pickup level: 1.01 to $1.50 \times$ 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 $\pm 0.5\%$ of total time
 Elements: Trip and Alarm

PHASE DIFFERENTIAL

Pickup level: 0.05 to $1.00 \times \text{CT}$ 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 $\pm 0.5\%$ total time
 Elements: Trip

PHASE OVERCURRENT

Voltage restraint: programmable fixed characteristic
 Pickup level: 0.15 to $20.00 \times \text{CT}$ 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 $\pm 0.5\%$ 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 \times 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 $\pm 1\%$ 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 \times 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 $\pm 0.5\%$ 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 \times 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 $\geq 1.2 \times$ Pickup ± 300 ms at $< 1.2 \times$ 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 $\pm 0.5\%$ of total time
Elements:	Trip



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.

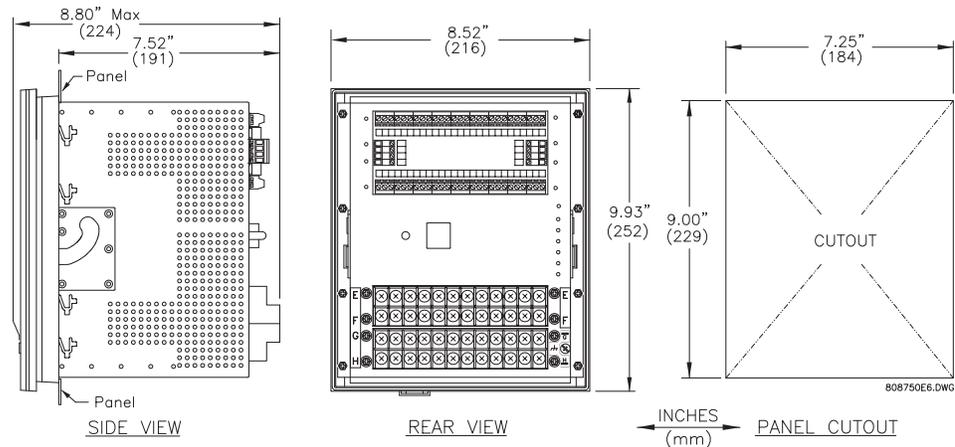


FIGURE 3-1: 489 Dimensions

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



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.

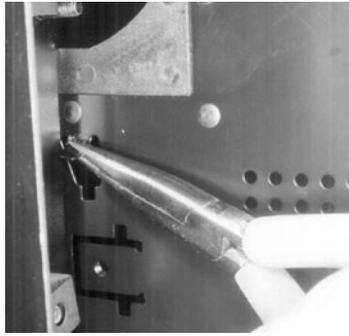


FIGURE 3-3: Product Case and Unit Labels

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.