



## GENERATOR PROTECTION SYSTEM

Economical protection, monitoring and metering for generators

### KEY BENEFITS

- Complete, secure protection of small to medium sized generators
- Easy to use generator protection system supported by and industry leading suite of software tools.
- Advanced protection and monitoring features including the use of RTDs for stator and bearing thermal protection and Analog Inputs for vibration monitoring
- Global acceptance as a member of the most renowned protection relay product family in the market.
- Draw-out construction allowing for minimized downtime and easy removal/installation of the 489 during maintenance routines
- Large, user-friendly front panel interface allowing for real-time power monitoring and setpoint access with a display that is easily readable in direct sunlight
- Enhanced generator troubleshooting through the use of IIRIG-B time synchronized event records, waveform capturing, and data loggers
- Simplified setpoint verification testing using built in waveform simulation functionality
- Cost effective access to information through industry standard communication hardware (RS232, RS485, 10BaseT Ethernet) and protocols (Modbus RTU, Modbus TCP/IP, DNP 3.0)
- Available for use in most extreme harsh locations with the available Harsh Chemical Environment Option
- GL Certification for below deck shipboard applications

### APPLICATIONS

- Synchronous or induction generators operating at 25Hz, 50Hz or 60Hz
- Primary or backup protection in cogeneration applications

### FEATURES

#### Protection and Control

- Generator stator differential
- 100% stator ground
- Loss of excitation
- Distance backup
- Reverse power (anti-motoring)
- Overexcitation
- Ground directional overcurrent
- Inadvertent energization
- Breaker failure
- Stator and bearing thermal monitoring
- Stator and bearing vibration monitoring
- Negative sequence overcurrent

#### Communications

- Networking interfaces - RS232, RS485, 10Mbps copper Ethernet
- Multiple protocols - ModBus™ RTU, ModBus™ TCP/IP, DNP 3.0 Level 2

#### Monitoring and Metering

- Metering – current, voltage, power, Energy, frequency, power factor
- Demand – current, watts, vars, VA
- Temperature – 12 RTD inputs
- Vibration and Speed – 4 analog transducer inputs
- Event Recorder – 256 time tagged events
- Oscillography – 12 samples/ cycle up to 128 cycles in length
- Trending – 8 parameters with up to a 5 second sample rate

#### EnerVista™ Software

- State of the art software for configuration and commissioning GE Multilin products
- Document and software archiving toolset to ensure reference material and device utilities are up-to-date
- Ease to use real time monitoring, control, and data archiving software available
- EnerVista™ Integrator providing easy integration of data in the 489 into new or existing monitoring and control systems



Digital Energy  
Multilin

## Protection and Control

The 489 Generator Protection System provides comprehensive protection, metering, and monitoring of small to medium sized synchronous or induction generators operating at 25, 50 or 60 Hz. The 489 is ideally suited for primary or backup generator protection as well as for use in cogeneration applications. Protection features found in the 489 include:

### Generator Stator Differential

The 489 utilizes high-speed dual slope differential protection for detecting and clearing of stator phase faults. Advanced CT saturation detection algorithms maintain immunity to saturation conditions that may be caused due to external disturbances through the use of a directional check that provides additional supervision and ensures the fault is internal to the generator before triggering it to trip.

### 100% Stator Ground

100% stator ground fault protection is provided through an overvoltage element and an adaptive voltage differential feature responding to the unbalance of the third harmonic at the machine terminals and at the neutral point. The 489 compares the machine neutral voltage and ground current to determine if ground directional faults are within or outside the generator.

### Backup Phase Distance

Two separate phase distance elements provide time-delayed backup protection for generator faults that have not otherwise been cleared by the primary system and generator protections. The distance characteristic can compensate for a unit delta/bye power transformer that is located between the generator and the end of the zone of protection.

### Sensitive Directional Power

The 489 provides low forward power and reverse power elements to prevent

generator motoring that can cause damage the prime mover. Independent settings for power pickup levels and operational delays are available for both alarming and tripping of each element.

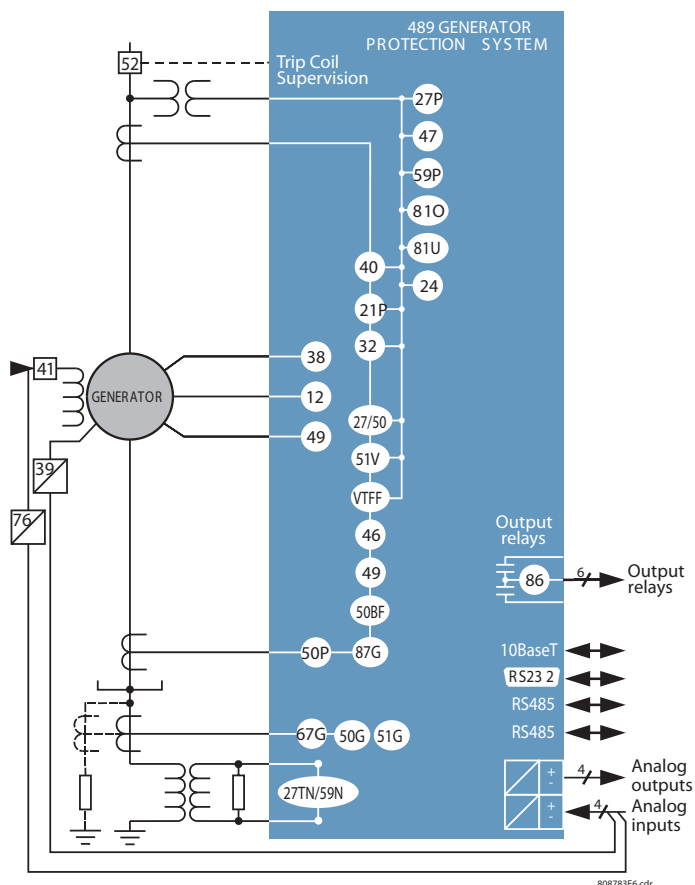
### Breaker Failure

The embedded breaker failure function in the 489 allows for improved system dependability without the additional cost of providing an independent breaker failure relay. Upon detection of a breaker failure condition, the 489 can be configured to operate one of its 4 available digital outputs to signal upstream devices to quickly isolate the fault.

### Loss of Excitation

Generator loss of excitation protection is provided through two negative offset mho characteristics as per IEEE C37.102 and has independent pickup delay setting for each characteristic. The loss of excitation element will be blocked from tripping if a VT fuse fail condition is detected or if the Voltage Supervision characteristic is

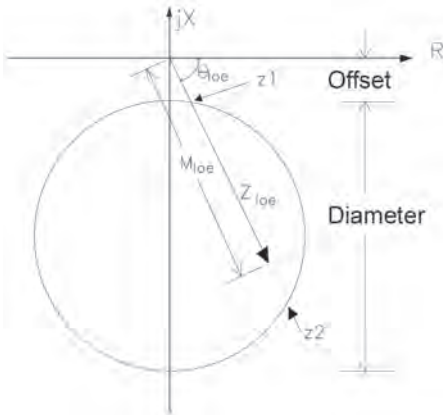
## Functional Block Diagram



### ANSI Device Numbers & Functions

Device Number	Function
12	Overspeed protection
21P	Phase distance
24	Volts/Hz
27P	Phase undervoltage
27/50	Accidental generator energization
27TN/59N	100% stator earth fault
32	Directional power
38	Bearing overtemperature (RTD)
39	Bearing vibration
40	Loss of excitation
46	Stator current unbalance
47	Phase reversal
49	Thermal overload
50BF	Breaker failure
50P	Phase instantaneous overcurrent
50G	Ground instantaneous overcurrent
51P	Phase time overcurrent
51G	Ground time overcurrent
51_2	Negative Sequence Time Overcurrent
51V	Voltage restrained time overcurrent
59P	Phase overvoltage
67G	Ground directional overcurrent
81O	Overfrequency
81U	Underfrequency
86	Lockout
87G	Generator differential
VTFF	VT fuse failure

enable and the voltage is measured to be above the user defined level.



A negative mho element can be used to detect a loss of excitation of the generator

### Stator Thermal Protection

The 489 provides thermal modeling overload protection to prevent generator damage caused by generator overheating. The thermal model algorithms incorporate current unbalance biasing and RTD biasing which provides accurate modeling of the actual generator temperature. The 489 can be configured to trip the generator offline when the generator's thermal limits are reached, or close an Alarm contact that signals operations personnel to take appropriate actions.

### Bearing Overtemperature

Twelve RTD inputs are provided that may be configured to monitor and protect against bearing overtemperature conditions. The 489 provides the option for using RTD voting which requires that two RTDs simultaneously indicate an overtemperature condition before it will trip the generator offline. RTD voting provides additional security against tripping of generators when an invalid overtemperature signal is received from a malfunctioning RTD.

### Negative Sequence Overcurrent

Rotor thermal protection is provided through monitoring of negative sequence current, which is a significant contributor to rotor heating, to ensure it does not increase above the generator's capability limits. The 489 provides a negative sequence definite time overcurrent alarm element and a negative sequence timed overcurrent curve tripping element to ensure the generator stays within its short

time and continuous negative sequence current rated limits.

### Abnormal Frequency Protection

Operation of generators at off-nominal frequencies can have extremely detrimental effects on both the generator itself and the associated prime mover, in particular with steam turbine generators operating below normal frequency. The 489 provides overfrequency and underfrequency elements needed to provide protection of generators from operation at off-nominal frequencies. The 489 has alarm level settings to alert operations of abnormal frequency conditions as well as multiple trip levels that have independent tripping delay settings for each magnitude of abnormal frequency detected.

### Overcurrent Backup

Three voltage restrained overcurrent elements provide backup protection for system faults. The pickup level for the inverse time curves of the overcurrent elements are adjusted in conjunction with the measured phase-to-phase voltage. This feature is provided to protect against prolonged generator contribution to a fault on the system.

## Monitoring and Metering

The 489 includes high accuracy metering and recording for all AC signals. Voltage, current, frequency, power, energy, and

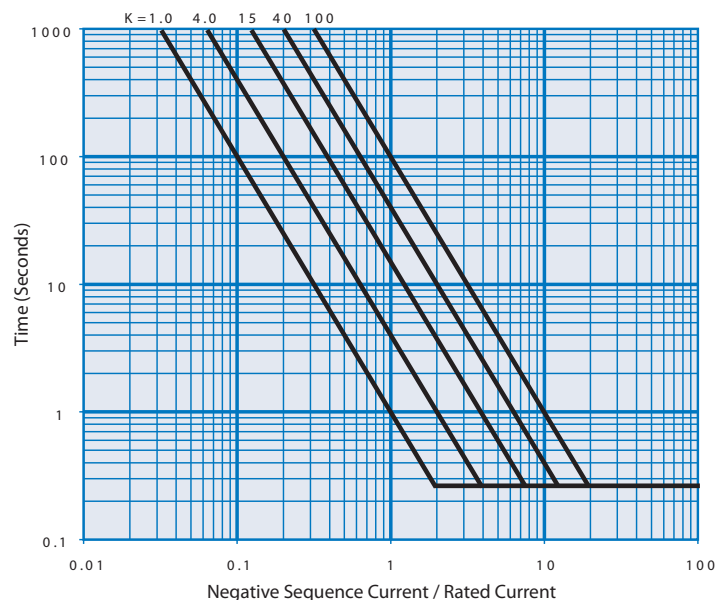
demand metering are built into the relay as a standard feature. Current and voltage parameters are available as total RMS magnitude, and as fundamental frequency magnitude and angle. Metered values can be read from the relay using one of the available communications ports or on the relay's front panel display.

### Event Recording

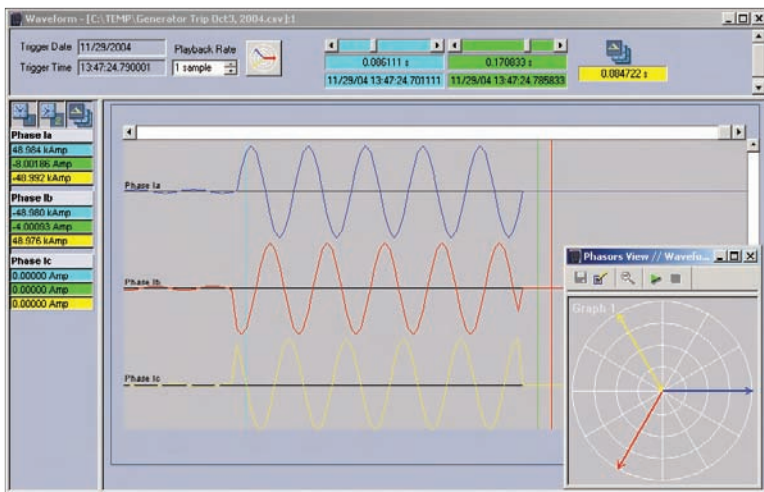
The 489 simplifies power generator troubleshooting by creating a sequence of events record that timestamps and logs events of internal relay operations and the operation of external devices connected to the relay's inputs. With each of the last 256 events the 489 stores, the relay will create a detailed event report that includes the time and date of the event, and the instantaneous value of all of the voltages, phase currents, and differential currents that were measured at the time the event occurred.

### Oscillography

Postmortem analysis of generator faults can be performed using the waveform capture feature in the 489. The 489 samples the currents and voltages inputs at a rate of 12 times per cycle and can record records up to 128 cycles in length. The recorded waveforms can be retrieved and viewed using the EnerVista 489 Setup Software and allows users to examine the magnitudes and relationships of the measured signals at the time of the fault.



The negative sequence overcurrent element is adaptable to ensure negative sequence currents stay within the specific capability limits of a given generator



Analyze generator faults using waveforms that are captured at the time of generator faults or system instabilities

### IRIG-B Time Synchronization

The 489 supports receiving an input from an IRIG-B time synchronization clock that will synchronize the 489 internal clock with other devices found in the substation or distributed across the power system. IRIG-B time synchronization will provide timestamping of events in the Event Record with 1ms accuracy thereby providing a means of accurately determining the sequence of operation of events that occurred across multiple devices in the power system.

### Simulation Mode

The 489 has a built in simulation feature that allows for testing the functionality and relay response to programmed conditions without the need for external inputs. When placed in simulation mode the 489 suspends reading of the actual inputs and substitutes them with the simulated values. Pre-trip, fault, and post fault states can be simulated, with currents, voltages, system frequency, RTD temperatures, and analog inputs configurable for each state.

## Automation

The 489 offers a multitude of different analog and digital inputs and outputs to allow the 489 to be seamlessly integrated into most generator automation schemes.

### Outputs Relays

The 489 provides six output contacts for the purpose of controlling or signaling other devices and operations personnel.

Protection elements can be configured to control the Trip contact, the Alarm contact, or the 3 Auxiliary contacts whenever the element operates. The status of each of these contact are also displayed on LEDs found on the relays front panel.

### Digital Inputs

Eight digital inputs are available for monitoring the status of external contacts, tachometers, or control switches. With these inputs, the relay can identify the status of the associated breakers and receive commands from operational staff such as controlling the output relays, resetting the thermal limits, or triggering a waveform capture.

### RTD Inputs

Twelve RTD inputs allow the 489 to monitor both the generator stator and bearing temperature. A built in voting feature adds additional security by ensuring that two RTDs monitoring the same device both detect the overtemperature condition before tripping the generator offline.

### Analog Inputs

Four analog inputs are available for providing protection and monitoring of generator bearing vibration. The analog inputs are field programmable to measure transducer signals that operator over a range of 0 to 1 mA, 0 to 20 mA, or 4 to 20 mA.

## Analog Outputs

Four analog outputs are available for signaling the value of measured analog quantities to external process control devices such as PLCs. The analog outputs can be ordered to operate over a 4 to 20mA range or a 0 to 1mA range and can be configured to signal a representation of most analog quantities measured by the 489 including currents, voltages, frequency, RTD temperature, power and demand.

## Communications

The 489 provides advanced communications technologies for remote data and engineering access, making it easy and flexible to use and integrate into new or existing monitoring and control systems. Multiple communication ports are available including a front panel RS232 serial port for easy local computer access, two RS485 serial ports and a 10Mbps copper Ethernet port that provide direct integration in most communications architectures.

The 489 supports the most popular industry standard protocols enabling easy, direct integration into most DCS and SCADA systems. Protocols supported include:

- Modbus RTU
- Modbus TCP/IP
- DNP 3.0 Level 2

## User Interfaces

### Keypad and Display

The 489 has a keypad and 40 character display for local monitoring and relay configuration without the need for a computer. Up to 20 user-selected default messages can be displayed when the relay is protecting the generator. In the event of a trip, or an alarm, the display will automatically default to the proper message indicating the cause of the operation.

### LED Indicators

The 489 front panel features 22 LED indicators that provide a quick indication of 489 status, generator status, and output relay status.

## EnerVista™ Software

The EnerVista™ Suite is an industry-leading set of software programs that simplify every aspect of using the 489 relay. The EnerVista™ suite provides all the tools to monitor the status of your protected asset, maintain the relay and integrate information measured by the 489 into DCS or SCADA monitoring systems. Convenient COMTRADE and Sequence of Events viewers are an integral part of the 489 Setup software included with every relay to carry out post-mortem event analysis.

## EnerVista™ Launchpad


EnerVista™ Launchpad is a powerful software package that provides users with all of the setup and support tools needed for configuring and maintaining GE Multilin products. The setup software within Launchpad allows configuring devices in real-time by communicating using serial, Ethernet, or modem connections, or offline by creating setting files to be sent to devices at a later time. Included in Launchpad is a document archiving and management system

that ensures critical documentation is up-to-date and available when needed. Documents made available include:

- Manuals
- Application Notes
- Guideform Specifications
- Brochures
- Wiring Diagrams
- FAQs
- Service Bulletins

## Features

### 489 FRONT



**489 STATUS INDICATORS**

- 489 status
- Generator status
- Output relays

**NUMERIC KEYPAD**

Numeric keys allow for simple entry of setpoint values. Control keys allow simple navigation through setpoint and actual value message structures. Help key provides context sensitive help messages

**VALUE KEYS**

Value Up, and Value Down keys to change setpoint values

**PROGRAM PORT INTERFACE**

RS232 for connection to a computer, 9600 baud

**LARGE DISPLAY**

Forty character display for viewing setpoints and actual value messages. Diagnostic messages are displayed when there is a trip or alarm condition. Default messages are displayed after a period of inactivity.

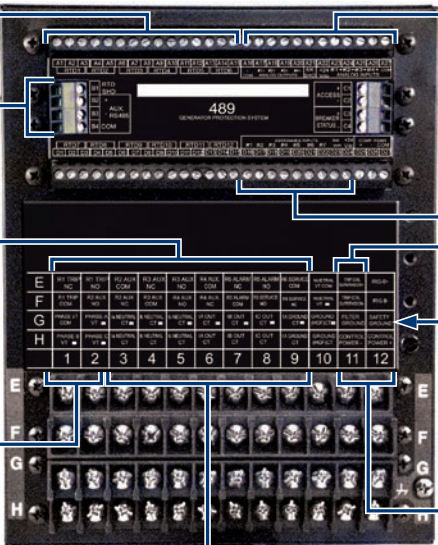
**CONTROL AND PROGRAMMING KEYS**

Menu, Escape, Reset, Enter, Menu Up, and Menu Down keys for complete access without a computer.

**DRAWOUT HANDLE**

With provision for a wire lead seal to prevent unauthorized removal

### 489 REAR



**RTD INPUTS**

Twelve RTD inputs are individually field programmable to measure platinum, nickel, or copper type RTDs.

**RS485 COMMUNICATIONS**

Two independent RS485 communication ports may be accessed simultaneously using ModbusRTU and DNP 3.0 protocol at baud rates up to 19200 bps.

**OUTPUT RELAYS**

Six, trip duty, form C output relays may be assigned to trip, alarm and control functions.

**VT INPUTS**

Four VT inputs provide wye or open delta system voltage sensing as well as neutral voltage sensing.

**ANALOG SIGNALS**

Four isolated 4-20 mA analog outputs may be used to replace costly transducers. They may be field programmed to reflect any measured parameter. Four 0-1 or 4-20 mA analog inputs may be used to monitor any transducer signal. Possible applications include vibration and field current monitoring.

**DIGITAL INPUTS**

Access jumper input provides setpoint programming security. Breaker status input tells 489 if the generator is online or offline. Seven assignable digital inputs may be field programmed for a variety of functions including tachometer.

**TRIP COIL SUPERVISION**

Monitors the trip circuit for continuity when the generator is online and alarms if that continuity is broken.

**GROUND**

Separate safety and filter ground. All inputs meet C37.90 EMI, SWC, RFI interference immunity.

**AC/DC CONTROL POWER**

Universal power supply  
90-300 VDC 70-265 VAC

**CT INPUTS**

Seven CT inputs provide three-phase output, three-phase neutral and ground current sensing.

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105



## Viewpoint Monitoring

Viewpoint Monitoring is a simple-to-use and full-featured monitoring and data recording software package for small systems. Viewpoint Monitoring provides a complete HMI package with the following functionality:

- Plug & Play Device Monitoring
- System Single-Line Monitoring & Control
- Annunciator Alarm Screens
- Trending Reports
- Automatic Event Retrieval
- Automatic Waveform Retrieval

## Viewpoint Maintenance

Viewpoint Maintenance provides tools that will create reports on the operating status of the relay, simplify the steps to download fault and event data, and reduce the work required for cyber-security compliance audits. Tools available in Viewpoint Maintenance include:

- Settings Security Audit Report
- Device Health Report
- Single Click Fault Data Retrieval

## EnerVista™ Integrator

EnerVista™ Integrator is a toolkit that allows seamless integration of GE Multilin devices into new or existing automation systems. Included in EnerVista Integrator is:

- OPC/DDE Server
- GE Multilin Drivers
- Automatic Event Retrieval
- Automatic Waveform Retrieval

## Technical Specifications

<b>PROTECTION</b> <b>OVERCURRENT ALARM</b> <b>Pick-up Level:</b> 0.10 to 1.50 x FLA in steps of 0.01 average phase current <b>Time Delay:</b> 0.1 to 250.0 s in steps of 0.1 <b>Pickup Accuracy:</b> as per Phase Current Inputs <b>Timing Accuracy:</b> ±100 ms or ±0.5% of total time <b>OFFLINE OVERCURRENT</b> <b>Pick-up Level:</b> 0.05 to 1.00 x CT in steps of 0.01 of any one phase <b>Time Delay:</b> 3 to 99 cycles in steps of 1 <b>Pickup Accuracy:</b> as per Phase Current Inputs <b>Timing Accuracy:</b> +50ms at 50/60 Hz <b>INADVERTENT ENERGIZATION</b> <b>Arming Signal:</b> undervoltage and/or offline from breaker status <b>Pick-up Level:</b> 0.05 to 3.00 x CT in steps of 0.01 of any one phase <b>Time Delay:</b> no intentional delay <b>Pickup Accuracy:</b> as per Phase Current Inputs <b>Timing Accuracy:</b> +50 ms at 50/60 Hz <b>PHASE OVERCURRENT</b> <b>Voltage Restraint:</b> Programmable fixed characteristic <b>Pick-up Level:</b> 0.15 to 20.00 x CT in steps of 0.01 of any one phase <b>Curve Shapes:</b> ANSI, IEC, IAC, Flexcurve, Definite Time <b>Time Delay:</b> 0.000 to 100.000 s in steps of 0.001 <b>Pickup Accuracy:</b> as per Phase Current Inputs <b>Timing Accuracy:</b> +50 ms at 50/60 Hz or ±0.5% total time <b>NEGATIVE SEQUENCE OVERCURRENT</b> <b>Pickup Level:</b> 3 to 100% FLA in steps of 1 <b>Curve Shapes:</b> I <sup>2</sup> t trip defined by k, definite time alarm <b>Time Delay:</b> 0.1 to 100.0 s in steps of 0.1 <b>Pickup Accuracy:</b> as per Phase Current Inputs <b>Timing Accuracy:</b> ±100ms or ±0.5% of total time <b>GROUND OVERCURRENT</b> <b>Pickup Level:</b> 0.05 to 20.00 x CT in steps of 0.01 <b>Curve Shapes:</b> ANSI, IEC, IAC, Flexcurve, Definite Time <b>Time Delay:</b> 0.00 to 100.00 s in steps of 0.01 <b>Pickup Accuracy:</b> as per Ground Current Input <b>Timing Accuracy:</b> +50 ms at 50/60 Hz or ±0.5% total time <b>PHASE DIFFERENTIAL</b> <b>Pickup Level:</b> 0.05 to 1.00 x CT in steps of 0.01 <b>Curve Shapes:</b> Dual Slope <b>Time Delay:</b> 0 to 100 cycles in steps of 1 <b>Pickup Accuracy:</b> as per Phase Current Inputs <b>Timing Accuracy:</b> +50 ms at 50/60 Hz or ±0.5% total time <b>GROUND DIRECTIONAL</b> <b>Pickup Level:</b> 0.05 to 20.00 x CT in steps of 0.01 <b>Time Delay:</b> 0.1 to 120.0 s in steps of 0.1 <b>Pickup Accuracy:</b> as per Phase Current Inputs <b>Timing Accuracy:</b> ±100 ms or ±0.5% of total time <b>HIGH-SET PHASE OVERCURRENT</b> <b>Pickup Level:</b> 0.15 to 20.00 x CT in steps of 0.01 <b>Time Delay:</b> 0.00 to 100.00 s in steps of 0.01 <b>Pickup Accuracy:</b> as per Phase Current Inputs <b>Timing Accuracy:</b> ±50 ms at 50/60 Hz or ±0.5% total time <b>UNDERVOLTAGE</b> <b>Pickup Level:</b> 0.50 to 0.99 x rated V in steps of 0.01 <b>Curve Shapes:</b> Inverse Time, definite time alarm 1 <b>Time Delay:</b> 0.2 to 120.0 s in steps of 0.1 <b>Pickup Accuracy:</b> as per Voltage Inputs <b>Timing Accuracy:</b> ±100 ms or ±0.5% of total time <b>Elements:</b> Trip and Alarm	<b>PROTECTION</b> <b>OVERVOLTAGE</b> <b>Pick-up Level:</b> 1.01 to 1.50 x rated V in steps of 0.01 <b>Curve Shapes:</b> Inverse Time, definite time alarm <b>Time Delay:</b> 0.2 to 120.0 s in steps of 0.1 <b>Pickup Accuracy:</b> as per Voltage Inputs <b>Timing Accuracy:</b> ±100 ms or ±0.5% of total time <b>VOLTS/HERTZ</b> <b>Pick-up Level:</b> 1.00 to 1.99 x nominal in steps of 0.01 <b>Curve Shapes:</b> Inverse Time, definite time alarm <b>Time Delay:</b> 0.1 to 120.0 s in steps of 0.1 <b>Pickup Accuracy:</b> as per voltage inputs <b>Timing Accuracy:</b> ±100 ms at <math>? 1.2 \times \text{Pickup}</math> ±300 ms at <math>< 1.2 \times \text{Pickup}</math> <b>VOLTAGE PHASE REVERSAL</b> <b>Configuration:</b> ABC or ACB phase rotation <b>Timing Accuracy:</b> 200 to 400 ms <b>Required Voltage:</b> 0.50 to 0.99 x rated voltage in Phase A <b>Block From Online:</b> 0 to 5 sec. in steps of 1 <b>Pickup Level:</b> 20.00 to 60.00 in steps of 0.01 <b>Curve Shapes:</b> 1 level alarm, two level trip definite time <b>Time Delay:</b> 0.1 to 5000.0 sec. in steps of 0.1 <b>Pickup Accuracy:</b> ±0.02 Hz <b>Timing Accuracy:</b> ±100 ms or ±0.5% of total time <b>Required Voltage:</b> 0.50 to 0.99 x rated voltage in Phase A <b>Block From Online:</b> 0 to 5 sec. in steps of 1 <b>Pickup Level:</b> 25.01 to 70.00 in steps of 0.01 <b>Curve Shapes:</b> 1 level alarm, 2 level trip definite time <b>Time Delay:</b> 0.1 to 5000.0 s in steps of 0.1 <b>Pickup Accuracy:</b> ±0.02 Hz <b>Timing Accuracy:</b> ±100 ms or ±0.5% of total time <b>NEUTRAL OVERVOLTAGE (FUNDAMENTAL)</b> <b>Pick-up Level:</b> 2.0 to 100.0 V secondary in steps of 0.01 <b>Time Delay:</b> 0.1 to 120.0 s in steps of 0.1 <b>Pickup Accuracy:</b> as per Neutral Voltage Input <b>Timing Accuracy:</b> ±100 ms or ±0.5% of total time <b>NEUTRAL UNDERVOLTAGE (3RD HARMONIC)</b> <b>Blocking Signals:</b> Low power and low voltage if open delta <b>Pickup Level:</b> 0.5 to 20.0 V secondary in steps of 0.01 <b>Time Delay:</b> 5 to 120 s in steps of 1 <b>Pickup Accuracy:</b> as per Neutral Voltage Input <b>Timing Accuracy:</b> ±3.0 s <b>LOSS OF EXCITATION (IMPEDANCE)</b> <b>Pickup Level:</b> 2.5 to 300.0 $\Omega$ secondary in steps of 0.1 with adjustable impedance offset <b>Time Delay:</b> 0.1 to 10.0 s in steps of 0.1 <b>Pickup Accuracy:</b> as per Voltage and Phase Current Inputs <b>Timing Accuracy:</b> ±100 ms or ±0.5% of total time <b>TIMING ACCURACY (IMPEDANCE)</b> <b>Pickup Levels:</b> 0.1 to 50.0 $\Omega$ secondary in steps of 0.1 <b>Time Delay:</b> 50 to 85° reach in steps of 1 <b>Pickup Accuracy:</b> 0.0 to 150.0 s in steps of 0.1 <b>Timing Accuracy:</b> as per Voltage and Phase Current Inputs <b>Timing Accuracy:</b> 150 ms ±50 ms or ±0.5% of total time	<b>PROTECTION</b> <b>REACTIVE POWER</b> <b>Block From Online:</b> 0 to 5000 s in steps of 1 <b>Pickup Level:</b> 0.02 to 1.50 x rated Mvar (positive and negative) <b>Time Delay:</b> 0.2 to 120.0 s in steps of 0.1 <b>Pickup Accuracy:</b> see power metering <b>Timing Accuracy:</b> ±100ms or ±0.5% of total time <b>REVERSE POWER</b> <b>Block From Online:</b> 0 to 5000 s in steps of 1 <b>Pickup Level:</b> 0.02 to 0.99 x rated MW <b>Time Delay:</b> 0.2 to 120.0 s in steps of 0.1 <b>Pickup Accuracy:</b> see power metering <b>Timing Accuracy:</b> ±100 ms or ±0.5% of total time <b>LOW FORWARD POWER</b> <b>Block From Online:</b> 0 to 15000 s in steps of 1 <b>Pickup Level:</b> 0.02 to 0.99 x rated MW <b>Time Delay:</b> 0.2 to 120.0 s in steps of 0.1 <b>Pickup Accuracy:</b> see power metering <b>Timing Accuracy:</b> ±100 ms or ±0.5% of total time <b>PULSE OUTPUT</b> <b>Parameters:</b> + kwh, +kvarh, -kvarh <b>Interval:</b> 1 to 50000 in steps of 1 <b>Pulse Width:</b> 200 to 1000 ms in steps of 1 ms <b>RTDS 1 TO 12</b> <b>Pickup:</b> 1 to 250°C in steps of 1 <b>Pickup Hysteresis:</b> 2°C <b>Time Delay:</b> 3 sec. <b>OVERLOAD / STALL PROTECTION / THERMAL MODEL</b> <b>Overload Curves:</b> 15 Standard Overload Curves Custom Curve Voltage Dependent Custom Curve Phase Unbalance Hot/Cold Curve Ratio Stator RTD Online Cooling Rate Offline Cooling Rate Line Voltage 1.01 to 1.25 <b>Overload Pickup:</b> as per Phase Current Inputs <b>Pickup Accuracy:</b> ±100 ms or ±2% of total time <b>Timing Accuracy:</b> ±100 ms or ±2% of total time <b>DIGITAL INPUT</b> <b>GENERAL INPUT A TO G (DIGITAL INPUT)</b> <b>Configurable:</b> Assignable Digital Inputs 1 to 7 <b>Time Delay:</b> 0.1 to 5000.0 s in steps of 0.1 <b>Block From Online:</b> 0 to 5000 s in steps of 1 <b>Timing Accuracy:</b> ±100 ms or ±0.5% of total time <b>SEQUENTIAL TRIP (DIGITAL INPUT)</b> <b>Configurable:</b> Assignable to Digital Inputs 1 to 7 <b>Pickup Level:</b> 0.02 to 0.99 x rated MW in steps of 0.01 Low Forward Power / Reverse Power 0.2 to 120.0 s in steps of 0.1 see power metering <b>Time Delay:</b> ±100 ms or ±0.5% of total time <b>FIELD BREAKER DISCREPANCY (DIGITAL INPUT)</b> <b>Configurable:</b> Assignable to Digital Inputs 1 to 7 <b>Time Delay:</b> 0.1 to 500.0 s in steps of 0.1 <b>Timing Accuracy:</b> ±100 ms or ±0.5% of total time <b>TACHOMETER (DIGITAL INPUT)</b> <b>Configurable:</b> Assignable to Digital Inputs 4 to 7 <b>RPM Measurement:</b> 100 to 7200 RPM <b>Duty Cycle of Pulse:</b> >10% <b>Pickup Level:</b> 101 to 175 x rated speed in steps 1 to 250 s in steps of 1 <b>Time Delay:</b> ±0.5 s or ±0.5% of total time <b>Timing Accuracy:</b> ±0.5 s or ±0.5% of total time
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## Technical Specifications (continued)

### ANALOG INPUTS

**PHASE CURRENT INPUTS**  
**CT Primary:** 10 to 50000 A  
**CT Secondary:** 1 A or 5 A (must be specified with order)  
**Conversion Range:** 0.02 to 20 x CT  
**Accuracy:** at < 2 x CT: ±0.5% of 2 x CT  
 at > 2 x CT: ±1% of 20 x CT  
 Less than 0.2 VA at rated load  
**Burden:** 1 second at 80 times rated current  
 2 seconds at 40 times rated current  
 continuous at 3 times rated current

**GROUND CURRENT INPUTS**  
**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 x CT for 1 A / 5 A CTs 0.0 to 100 A pri. for 50:0.025 CTs(HGF)  
 ± 0.1 A at < 10 A  
**50:0.025 CT**  
**Accuracy:** ± 0.1 A at 3 to 100 A  
**1A/5A CT**  
**Accuracy:** at < 2 x CT: ±0.5% of 2 x CTat > 2 x CT: ±1% of 20 x CT

GROUND CT	INPUT	BURDEN	
		VA	Ω
1A/5A	1 A	0.024	0.024
	5 A	0.605	0.024
50:0.025	0.025 A	0.057	90.7
	HGF	0.1 A	0.634
HGF	0.1 A	0.634	90.7
	0.5 A	18.9	75.6

GROUND CT	WITHSTAND TIME		
	1 SEC	2 SEC.	CONTINUOUS
CT			
1A/5A	80 x CT	40 x CT	3 x CT
50:0.025 HGF	N/A	N/A	150 mA

**PHASE VOLTAGE INPUTS**  
**VT Ratio:** 1.00 to 240.00:1 in steps of 0.01  
**VT Secondary:** 200 V AC (full-scale)  
**Conversion Range:** 0.02 to 1.00 x Full Scale  
**Accuracy:** ±0.5% of Full Scale  
**Max. Continuous:** 280 V AC  
**Burden:** > 500 K $\Omega$

**NEUTRAL VOLTAGE INPUTS**  
**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 x Full Scale  
**Accuracy:** ±0.5% of Full Scale  
**Max. Continuous:** 280 V AC  
**Burden:** > 500 K $\Omega$

**DIGITAL INPUTS**  
**Inputs:** 9 opto-isolated inputs  
 dry contact < 400 $\Omega$   
**External Switch:** +24 V DC at 20 mA maximum

**ANALOG TRANSDUCER INPUTS**  
**Current Inputs:** 0 to 1 mA, 0 to 20mA or 4 to 20 mA (setpoint)  
**Input Impedance:** 226 $\Omega$  ±10%  
**Conversion Range:** 0 to 21 mA  
**Accuracy:** ±1% of full scale  
**Type:** passive  
**Analog In Supply:** +24 V DC at 100 mA maximum  
**Sampling Interval** 50 ms

### INPUTS

**RTD INPUTS**  
**RTD (3 wire Types):** 100  $\Omega$  Platinum  
 100  $\Omega$  Nickel, 120 $\Omega$  Nickel  
 10  $\Omega$  Copper

**RTD Sensing**  
**Current:** 5mA  
**Isolation:** 36 Vpk (isolated with analog inputs and outputs)  
 -50 to +250°C

**Range:** ±2°C for Platinum and Nickel  
 ±5°C for Copper  
**Accuracy:** ±2 $\Omega$  Max per lead for Pt and Ni type 3 $\Omega$  Max per lead for Cu type  
**Lead Resistance:** >1000 $\Omega$   
 < -50°C

**No Sensor:** Short/Low Alarm:  
**TRIP COIL SUPERVISION**  
**Applicable Voltage:** 20 to 300 V DC / V AC  
**Trickle Current:** 2 to 5 mA

### OUTPUTS

**ANALOG OUTPUTS**  
**Type:** Active  
**Range:** 4 to 20 mA, 0 to 1 mA (must be specified with order)  
**Accuracy:** ±1% of full scale  
**Maximum** 4 to 20 mA input: 1200,  
 0 to 1 mA input: 10 k  
**Isolation:** 36 Vpk

**OUTPUT RELAYS**  
**Configuration:** 6 Electromechanical Form C  
**Contact Material:** Silver alloy  
**Operate Time:** 10 ms  
**Max ratings for 100000 operations**

VOLTAGE		M/C CONT.	M/C 0.2 SEC	BREAK	MAX LOAD
DC Resistive	30 VDC	10 A	30 A	10 A	300 W
	125 VDC	10 A	30 A	0.5 A	62.5 W
	250 VDC	10 A	30 A	0.3 A	75 W
DC Inductive L/R= 40 ms	30 VDC	10 A	30 A	5 A	150 W
	125 VDC	10 A	30 A	0.25 A	31.3 W
	250 VDC	10 A	30 A	0.15 A	37.5 W
AC Resistive	120 VAC	10 A	30 A	10 A	2770 VA
	250 VAC	10 A	30 A	10 A	2770 VA
	AC Inductive P.F. = 0.4	120 VAC	10 A	30 A	4 A
	250 VAC	10 A	30 A	3 A	750 VA

### POWER SUPPLY

**CONTROL POWER**  
**Options:** LO / HI (must be specified with order)  
 DC: 20 to 60 V DC  
 AC: 20 to 48 V AC at 48 to 62 Hz  
 DC: 90 to 300 V; AC: 70 - 265 V @ 48 - 62 Hz  
**Hi Range:** AC: 70 to 265 V AC at 48 to 62 Hz  
**Power:** 45 VA (max), 25 VA typical

### AC ANALOG INPUTS FREQUENCY TRACKING

**Frequency Tracking:** Va for wye, Vab for open delta  
 6 V minimum, 10 Hz/sec.

### COMMUNICATIONS

**RS232 Port:** 1, Front Panel, non-isolated  
**RS485 Ports:** 2, Isolated together at 36 Vpk  
**Baud Rates:** RS485: 300 - 19,200 Baud  
 RS232: 9600 Baud  
**Parity:** None, Odd, Even  
**Ethernet:** 10Mbps Copper RJ45  
**Protocol:** Modbus $\text{®}$  RTU / Modbus $\text{®}$  TCP/IP  
 DNP 3.0 Level 2

### ENVIRONMENTAL

**Temperature Range:**  
**Operating:** -40 °C to +60 °C  
**Ambient Storage:** -40 °C to +85 °C  
**Ambient Shipping:** -40 °C to +85 °C  
**Humidity:** Operating up to 95% (non condensing) @ 55C  
 Up to 2000 m  
**Altitude:** Up to 2000 m  
**Pollution degree:** 2

### PRODUCT TESTS

**Thermal Cycling:** Operational test at ambient, reducing to -40°C and then increasing to 60°C  
**Dielectric Strength:** 2.0 kV for 1 minute from relays, CTs, VTs, power supply to Safety Ground

### TYPE TESTS

**Dielectric voltage withstand:** EN60255-5  
**Impulse voltage withstand:** EN60255-5  
**Insulation resistance:** EN60255-5  
**Damped Oscillatory:** IEC61000-4-18, IEC60255-22-1  
**Electrostatic Discharge:** EN61000-4-2, IEC60255-22-2  
**RF immunity:** EN61000-4-3, IEC60255-22-3  
**Fast Transient Disturbance:** EN61000-4-4, IEC60255-22-4  
**Surge Immunity:** EN61000-4-5, IEC60255-22-5  
**Conducted RF Immunity:** EN61000-4-6, IEC60255-22-6  
**Radiated & Conducted Emissions:** CISPR11, CISPR22, IEC60255-25  
**Sinusoidal Vibration:** IEC60255-21-1  
**Power magnetic Immunity:** IEC61000-4-8  
**Voltage Dip & interruption:** IEC61000-4-11  
**IEC60529**  
**Environmental (Cold):** IEC60068-2-1  
**Environmental (Dry heat):** IEC60068-2-2  
**Relative Humidity Cyclic:** IEC60068-2-30  
**EFT:** IEE/ANSI C37.90.1  
**ESD:** IEE/ANSI C37.90.3

### CERTIFICATION

**ISO:** Manufactured under an ISO9001 registered system.  
**CSA/UL:** UL508, UL1053, C22.2.No 14  
**CE:** Conforms to EN60255-5, EN50263

Please refer to Multilin 489 Generator Protection System Instruction Manual for complete technical specifications

## Ordering

489	*	*	*	*	*	
Current Input Relays	P1					1 A phase CT secondaries
	P5					5 A phase CT secondaries
Power Supply Options	LO					DC: 24 - 60 V; AC: 20 - 48 V @ 48 - 62 Hz
	HI					DC: 90 - 300 V; AC: 70 - 265 V @ 48 - 62 Hz
Analogue Outputs		A1				0 - 1 mA analog outputs
		A20				4 - 20 mA analog outputs
Enhancements			E			Enhanced display, larger LCD, improved keypad
			T			Enhanced display, larger LCD, improved keypad plus 10BaseT Ethernet Port
Environmental Protection				H		Harsh (Chemical) Environment Conformal Coating

### Accessories for the 489

- 489 Generator Protection Learning CD TRCD-SR489-C-S-1
- Multilink Ethernet Switch ML1600-HI-A1-A1
- Multinet Multinet-FE
- Viewpoint Maintenance VPM-1
- Viewpoint Monitoring VP-1

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