GE
Grid Solutions

Multilin 889

Advanced Generator Protection and Management

The Multilin™ 889 Generator Protection System, a member of the Multilin 8 Series protection relay platform, has been designed for the protection, control, and management of generators and associated unit transformers in critical utility and industrial applications.

The 889 goes beyond asset protection providing power system engineers with the data, measurement accuracy, and visibility needed for comprehensive generator management. These advanced asset monitoring capabilities provides engineers with the ability to make informed, proactive decisions that enable planned maintenance activities reducing costs associated with pre- and post-fault analysis, equipment damage, and unplanned or extended downtime.

With a focus on connectivity and security, the 889 supports the latest in communications technologies and protocols including IEC 61850 Edition 2, OPC-UA, and IEC 62439/PRP, and provides advanced, industry standard, cybersecurity tools, ensuring simplified and secure device integration into new or existing SCADA or DCS systems.

Key Benefits

- Enhanced generator protection algorithms provide sub-cycle differential protection, ensuring faster fault clearing times for reduced generator damage
- Dedicated generator monitoring and control functions providing mission critical operational data to enable a pro-active maintenance approach
- Additional overall generator-transformer differential (87O) providing additional back-up protection
- Advanced generator diagnosis, comprehensive asset monitoring and high-end fault and disturbance recording, simplifies pre- and post-fault analysis
- Advanced cyber security features including AAA, Radius, RBAC and Syslog enabling NERC/CIP requirements
- Low insertion force, draw-out design simplifying testing, commissioning, and maintenance for increased process uptime
- Optional Wi-Fi connectivity minimizes system configuration and facilitates remote relay programming and diagnostic retrieval
- Patented environmental monitoring, providing visibility to changes in environmental conditions that can affect relay life

Applications

- Comprehensive protection from small to large generators
- Industrial or utility power generation
- Co-generation and renewable generation applications
- Unit Transformer Protection applications

Innovative Technology & Design

- Proven algorithms delivering sub-cycle and reliable differential protection
- Continuous monitoring and event driven diagnostics for a wide range of generator applications
- Patented environmental monitoring & diagnostics
- Advanced, flexible and embedded communications: IEC® 61850 Ed2, OPC-UA, IEC 62439/PRP, Modbus® RTU & TCP/IP, DNP3.0, IEC 60870-5-104
- Single setup and configuration across the 8 Series platform
- Field swappable power supply
- Enhanced relay draw-out construction
- Elimination of electrolytic capacitors

Exceptional Quality & Reliability

- IPC A-610-E Class 3 manufacturing standards
- Highest reliability standards for electronics testing
- 100% Environmental Stress Screening and full functional testing
- Rated for IP54 (front) applications
- Standard Harsh Environment Conformal Coating

Uncompromising Service & Support

- Covered under GE's 10 year warranty plan
- Designed, tested and assembled by GE

imagination at work

Protection & Control

The Multilin 8 Series provides comprehensive and field proven algorithms to ensure asset management and uninterrupted process and system availability. With a fast protection pass, the 8 Series relays provide fast operating current, voltage, power, and frequency protection elements. With highly configurable protection logic, system coordination with upstream and downstream disconnect devices is greatly simplified. Various forms of I/O are supported in the 8 Series to ensure protection, control, and management of critical substation and field assets.

Generator Stator Differential

The 889 provides fault clearing operation at up to sub-cycle speed, by utilizing a 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, additional supervision is provided to ensure the fault is internal to the generator before triggering it to trip. This sub-cycle operation translates to less burning, and hence low carbon dissipation and thermal stress on insulation. This also enables root cause analysis during diagnosis/maintenance of the winding (sever longer duration faults burns-out all the evidence and make root cause analysis extremely difficult or sometimes impossible).

Overall Generator & Transformer Differential Protection

The 889 provides overall generator and transformer differential protection (87O). It covers the protection zones from the generator neutral to the Generator Step-Up (GSU) Transformer's High Voltage (HV) winding. For mid to large-size machines, the typical protection philosophy and architecture is to implement a dedicated transformer protection device along with a single function differential relay to provide the overall differential protection between the transformer and the generator. With support for 3 sets of phase CT inputs, the 889 can replace the single function device, providing the necessary overall differential protection with the added benefit of protection redundancy for both the Transformer and the Generator, when there is no tapping between the generator and GSU or unit transformer.

100% Stator Ground Fault Protection

The 889 provides 100% Stator Ground Fault Protection for High Resistance Grounded System (HRG), Low Resistance Grounded (LRG) or Hybrid Grounded Systems. For HRG systems the 889 employes a unique combination of Auxiliary Overvoltage and 3rd Harmonic Neutral Undervoltage protection elements to provide secure, reliable protection of the stator winding. With this function the 3rd harmonic neutral voltage variations do not need to be considered, simplifying the settings and configuration process.

For LRG systems with parallel machines, the 889 provides ground fault coordination ensuring only the faulted generator is islanded. In Hybrid Grounded Systems, the 889 provides fast, dynamic switching from low-z to high-z when an internal generator fault is detected, reducing potential damage to the generator and eliminating the need for additional protection devices.

Sensitive Directional Power

The 889 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.

The 889 directional power element responds to three-phase directional power and is designed for reverse power (32REV) and low forward power (32FWD) applications for interconnections involving co-generation.

Loss of Excitation

Supporting application flexibility, the 889 offers two methodologies to support loss of excitation detection. This can be done through an impedance-based approach or a Reactive Power approach. Unlike the Impedance based function, the Reactive Power Function settings do not need machine parameters for setting and can be used in cases where machine parameters are not available.

Out of Step Protection

The out-of-step element provides out of step (loss-of-synchronism or pole slip) tripping function for generators. The element is simplified using a single blinder operating characteristic with an offset mho supervisory. It is easy to apply based on IEEE/ANSI C37.102 guidelines, and IEEE PES PSRC tutorial on generator protection. The purpose of the supervisory mho is to prevent operation on stable swings that pass through both blinders and outside the mho characteristic. In addition, the out-of-step tripping feature allows "MHO EXIT" trip mode to reduce stresses on the circuit breaker.

Stator Thermal Protection

The 889 provides thermal overload protection as per IEC 60255-8 to prevent generator damage caused by generator overheating. The 889 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.

Overcurrent Elements

The 889 can be used to provide backup protection for transformer and adjacent power system equipment. Instantaneous overcurrent (IOC) elements can be used for fast clearing of severe internal and external (through) faults. Up to six time overcurrent protection (TOC) elements per winding allow to coordinate with the adjacent protection zones and act as backup protection.

- IOC protection functions are provided for phase, neutral & ground currents
- TOC protection functions are provided for phase, neutral and ground currents. A variety of standard time curves including IEEE, IEC, GE IAC, I2t, definite time are provided
- FlexCurves to coordinate with adjacent protections (including fuses) as well as transformer damage curves and thermal/damage curves for downstream equipment Directional protection functions are provided for phase, neutral and ground currents. The voltage memory function enables a more reliable relay operation, especially for faults close to the VTs.

Negative Sequence Overcurrent

For Delta/Wye impedance grounded transformers, overcurrent protection is particularly difficult to set. A negative sequence based overcurrent element provides the required sensitivity phase during faults.

Breaker Failure Protection

The breaker failure protection element monitors for timely operation of the connected breaker. If a trip command is not successful in operating the breaker and clearing the fault, the breaker failure element can be used to send trip signals to upstream breakers to clear the fault.

Undervoltage and Overvoltage Protection

The 889 provides phase Over and Under voltage functions and in addition also includes Neutral Overvoltage, Negative Sequence Overvoltage.

Over/Under Frequency Protection

The 889 calculates and maintains a running average of the system frequency and the frequency rate-of-change (df/dt). Two underfrequency and four rate-of-change elements are provided to implement traditional and advanced load shedding schemes. Additionally, an overfrequency element can be used to trigger a generator rampdown.

Synchronism Check

The 889 provides synchrocheck elements that monitor voltage difference, phase angle difference and slip frequency to ensure proper breaker closure for parallel operation.

Volts/Hz

To take care of over excitation that may result in saturation of the magnetic core or over heating due to stray flux.

In the 889, the per-unit volts-per-hertz (V/Hz) value is calculated using the maximum of the three-phase voltage inputs or the auxiliary voltage

## User Definable Protection Functions

Eight user-definable protection functions (FlexElements) can be programmed to respond to quantities measured or computed by the relay (phase, ground and sequence current and voltage power, frequency, power factor, etc.) These elements respond to variations in its input signal. Applications could include: overvoltage, overpower, low power factor, temperature differential, and more.

CTs and VTs

Up to 12 analog current transformer (CT) and 8 voltage transformer (VT) signals can be configured to monitor power system equipment. Both 1A and 5A CTs are supported.

Functional Block Diagram

ANSI DEVICE	DESCRIPTION
24	Volts per Hertz
25	Synchrocheck
27P	Phase Undervoltage
27X	Auxiliary Undervoltage
27TN	Third Harmonic Neutral Undervoltage
32	Directional Power
38	Bearing Overtemperature (RTD)
39	Bearing Vibration (dcmA)
40	Loss of Excitation
40Q	Reactive Power
46	Generator Unbalance
47	Phase Reversal
49	Thermal (RTD)
49TOL	Thermal Overload
50/27	Inadvertent Energization
50BF	Breaker Failure
50G	Ground Instantaneous Overcurrent
50SG	Sensitive Ground Instantaneous Overcurrent
50N	Neutral Instantaneous Overcurrent
50P	Phase Instantaneous Overcurrent
50_2	Negative Sequence Instantaneous Overcurrent
50OFL	Offline Overcurrent
50OL	Overload
51G	Ground Time Overcurrent
51N	Neutral Time Overcurrent
51SG	Sensitive Ground Time Overcurrent
51V	Voltage Restrained Time Overcurrent
55	Power Factor
59N	Neutral Overvoltage
59P	Phase Overvoltage
59X	Auxiliary Overvoltage
59_2	Negative Sequence Overvoltage
64TN	100% Stator Ground using 3rd Harmonic Voltage Differential
67G	Ground Directional Element
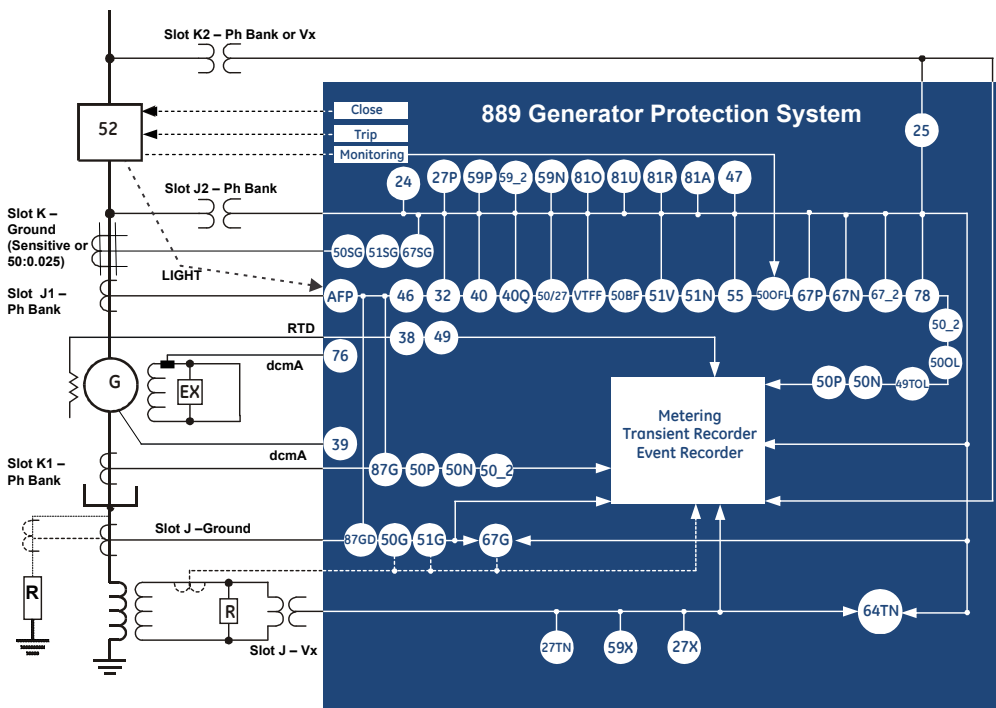
------- Alternatives for connection

ANSI DEVICE	DESCRIPTION
67N	Neutral Directional Element
67P	Phase Directional Element
67SG	Sensitive Ground Directional Element
67_2	Negative Sequence Directional Element
76	Excitation Current Protection (dcmA)

ANSI DEVICE	DESCRIPTION
78	Out-of-step Protection
81A	Frequency out-of-band
81O	Overfrequency
81U	Underfrequency
81R	Frequency Rate of Change
87G	Generator Stator Differential
87O	Overall Unit (Gen-Xfrm) Protection
87GD	Restricted Ground Fault (RGF)

Digital I/O

Up to 14 contact inputs and 10 contact outputs are available and can be used to monitor and control a wide range of auxiliary equipment found within a substation or other protection applications.

RTD

8 Series devices support up to 13 programmable RTD inputs that can be configured for an Alarm or Trip. The RTDs can be assigned to a group for monitoring winding and ambient temperatures. The RTD voting option gives additional reliability to ignore any RTD failures.

Analog Inputs, Analog Outputs

The 889 provides 7 Analog Outputs (dc mA), 4 Analog Inputs (dc mA). The configurable analog inputs can be used to measure quantities fed to the relay from standard transducers. Each input can be individually set to measure 4-20 mA, 0-20 mA or 0-1 mA transducer signals.

The 889 can also be set to issue trip or alarm commands based on signal thresholds. The configurable analog outputs can be used to provide standard transducer signals to local monitoring equipment. The analog outputs can be configured to provide outputs based on measured analog values, or calculated quantities. An optional general purpose transducer input allows a user-defined quantity to be monitored and used as part of the protection as defined by FlexLogic™.

Switchgear Control and Configurable SLD

The Multilin 889 provides a configurable, dynamic Single Line Display (SLD), up to six (6) pages for comprehensive switchgear control. Up to 15 digital and metering status elements can be configured per SLD page. These pages can be configured to show breakers, switches, metering, and status elements or measurements. Individual SLD pages can be selected as the default home screen pages. Automatic cycling through these pages can also be achieved through default screen settings.

The provision of such powerful control and display capability within the relay ("One Box" concept) eliminates the need for external controls, switches and annunciation on the panel reducing equipment and engineering cost.

Annunciator panel and virtual PBs

The Multilin 889 offers a configurable annunciator panel that can be constructed to show up to 36 alarms in either self-reset mode or latched mode per ISA 18.1 standard similar to a physical annunciator panel - eliminating the need for physical one. The alarms can be displayed on the front panel in a configurable grid layout of 2x2 or 3x3.

The Multilin 889 extends local control functionality with 20 virtual pushbuttons that can be assigned for various functions. Each programmable pushbutton has its own programmable LED which can be used to acknowledge the action taken by the tab pushbutton.

Integrated Arc Flash Protection

The Multilin 8 Series supports an integrated arc flash module providing constant monitoring of an arc flash condition within the switchgear, motor control centers, or panelboards. With a 2ms protection pass, the 8 Series is able to detect light and overcurrent using 4 arc sensors connected to the 8 Series relay. In situations where an arc flash/fault does occur, the relay is able to quickly identify the fault and issue a trip command to the associated breaker thereby reducing the total incident energy and minimizing resulting equipment damage.

Self-monitoring and diagnostics of the sensors ensures the health of the sensors as well as the full length fiber cables. LEDs on the front panel display of an 8 Series relay can be configured to indicate the health of the sensors and its connections to the relay.

WANT TO LEARN MORE?
**EXPLORE IN 3D**
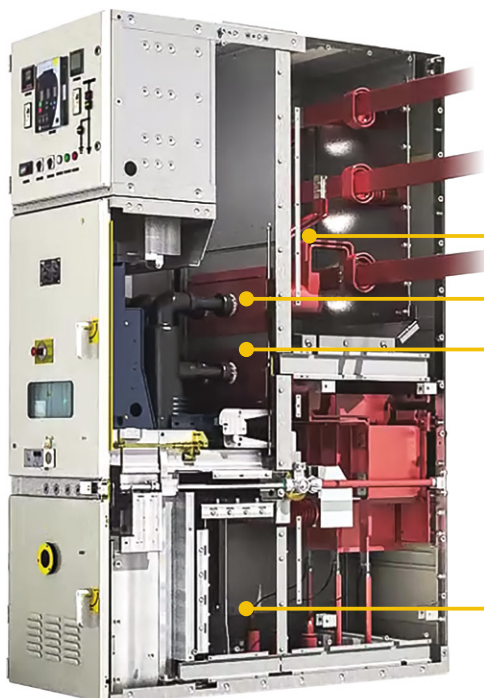
Multilin 8 Series

Fast, reliable arc flash protection with light-based arc flash sensors integrated within the Multilin 8 Series of protection & control devices. With arc flash detection in as fast as 2msec, the costs associated with equipment damage and unplanned downtime is significantly reduced.
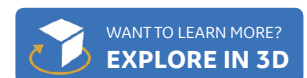
Advanced Automation

The Multilin 889 incorporates advanced automation capabilities that exceeds what is found in most generator protection relays. This reduces the need for additional programmable controllers or discrete control relays including programmable logic, communication, and SCADA devices. Advanced automation also facilitates the Multilin 889 to integrate seamlessly with other protection/process systems.
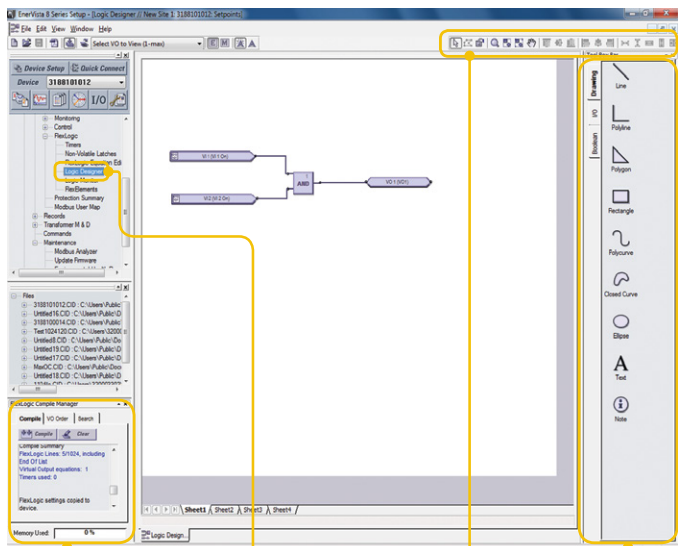
| Single Click Device Communications | Launch 'Logic Designer' | Flex Tokens Tool Box | 'Basic Actions' Tool Bar |

EnerVista Logic Designer provides a graphical, simplified way to define and create operational and control logic

FlexLogic™

FlexLogic is the powerful programming logic engine that provides the ability to create customized protection and control schemes, minimizing the need and associated costs of auxiliary components and wiring. Using FlexLogic, the 889 can be programmed to provide the required tripping logic along with custom scheme logic for breaker control (including external inputs for interlocking), interlocking schemes with adjacent protections (for example, preventing sympathetic tripping of healthy feeders), and dynamic setting group changes.

Monitoring & Diagnostics

Multilin 8 Series devices include high accuracy metering and recording for all AC signals. Voltage, current, and power 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.

Advanced Asset Health Monitoring

Focused on delivering situational awareness and actionable information Multilin 8 Series devices go beyond protection and control providing power system operators and engineers with advanced asset monitoring and diagnostic tools to help extend the life of critical power system assets.

Digital Fault Records

Integrated digital fault records capture data required to analyze fault conditions and identify possible failure modes in order to take the necessary preventative and maintenance actions.

Asset Health Reports

Multilin 8 Series devices provide pre-formatted, easy to read, asset health reports in PDF format. These reports capture key operational data of the asset, providing clear indication of asset condition at an instant of time. This helps operators and asset managers analyze the risks associated with the asset as well as condition based maintenance planning.

Multilin 8 Series Breaker Health Report available on the display or via the setup software

Dedicated Generator System Monitoring & Control

Turbine maintenance scheduling based on Frequency Out-of-band Accumulators (81A) along with other frequency elements which are useful for scheduling turbine maintenance. Distribution and industrial power system experience more variations in generation-load balances. This forces the turbine to function out-side the normal operating band.

• Generator Maintenance using Running hours
• Generator running hour accumulates duration of generator has been running since last maintenance
• Harmonic detection
• High speed harmonic detection function - allowing 2nd to 5th harmonic supervision for protection functions (i.e.: 87G blocking in-case of 2nd & 5th harmonic).

Over speed

Any of the input contacts can be used to read the pulses from the input source to determine the speed of the motor. The source of the pulses can be an inductive proximity probe or Hall Effect gear tooth sensor. Two modes of speed: under speed and over speed can be defined.

Advanced Generator Monitoring Diagnosis

- Bearing vibration (Analog Input)
- Excitation current (Analog Input)
- Any generator transducer (dcmA) input monitoring
- Breaker Health
- Data logger, Oscillography, Event Recorder.

The Multilin 889 offers a comprehensive generator health report that provides an easy-to-read snapshot of a generator's health and operating condition. Based on graphical representation and trend values of the generator historical data, the 889 enables operators and asset managers to identify process issues and maintenance requirements before damage occurs and costly repairs are required.
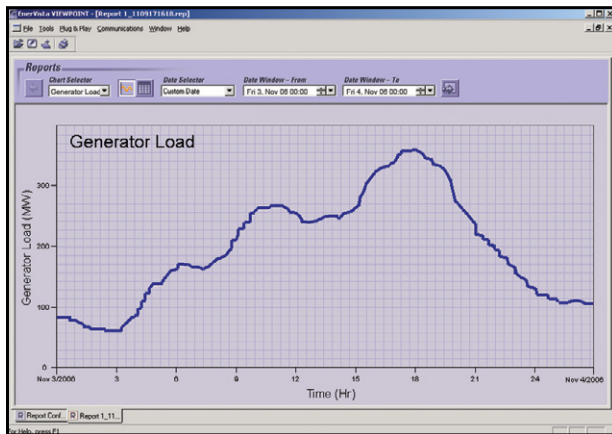
Log generator operating parameters to allow for analyzing generator loading and performance over weeks and months.

Breaker Health Monitoring

The breaker is monitored by the relay not only for detection of breaker failure, but also for the overall "breaker health" which includes:

- Breaker close and breaker open times
- Trip circuit monitoring
- Spring charging time
- Per-phase arcing current
- Trip counters

All algorithms provide the user with the flexibility to set up initial breaker trip counter conditions and define the criteria for breaker wear throughout a number of set points.

Environmental Monitoring

The Multilin 8 Series relay implements a patented environmental monitoring system that measures and provides operating condition information.
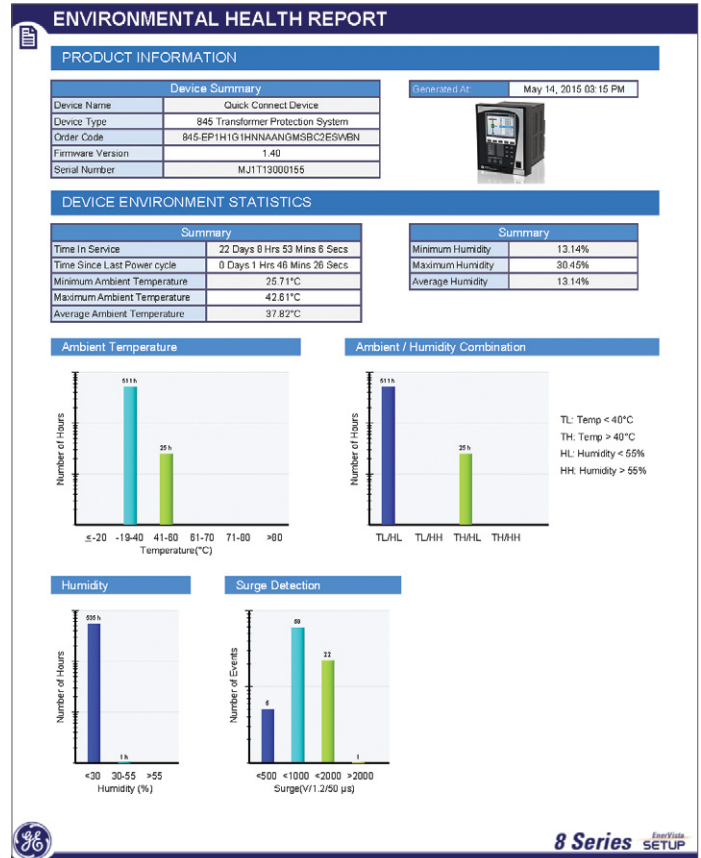
Environmental health report is available via Multilin PC Software

Metering

The Multilin 8 Series offers high accuracy power quality monitoring for fault and system disturbance analysis. The Multilin 8 Series delivers unmatched power system analytics through the following advanced features and monitoring and recording tools:

- Harmonics measurement up to 25th harmonic for both currents and voltages including THD.
- The length of the transient recorder record ranges from 31 cycles to 1549 cycles.
- 32 digital points and 16 analog values.
- Comprehensive data logger provides the recording of 16 analog values.
- Detailed Fault Report.
- 1024 Event Recorder.

Communications

The Multilin 8 Series provides advanced communications technologies for remote data and engineering access, making it easy and flexible to use and integrate into new and existing infrastructures. Direct support for fiber optic Ethernet provides high-bandwidth communications, allowing for low-latency controls and high-speed file transfers of relay fault and event record information. The 8 Series also supports two independent IP addresses, providing high flexibility for the most challenging of communication networks.

Providing several Ethernet and serial port options and supporting a wide range of industry standard protocols, the 8 Series enables easy, direct integration into DCS and SCADA systems. The 8 Series supports the following protocols:

- IEC 61850, IEC 62439 / PRP
- DNP 3.0 serial, DNP 3.0 TCP/IP, OPC-UA, IEC 60870-5-103, IEC 60870-5-104
- Modbus RTU, Modbus TCP/IP

The 8 Series has two interfaces a USB front port and optional Wi-Fi for ease of access to the relay.

Wi-Fi Connectivity:

- Simplify set-up and configuration
- Simplify diagnostic retrieval
- Eliminate personnel in front of switchgear
- WPA-2 security

Cyber Security

The 8 Series offers a comprehensive suite of industry standard cyber security tools, enabling operators to comply with NER/CIP and international cyber security guidelines and regulations.

- AAA Server Support (Radius/LDAP)
- Role Based Access Control (RBAC)
- Event Recorder (Syslog for SEM)

Cyber Security with Radius Authentication
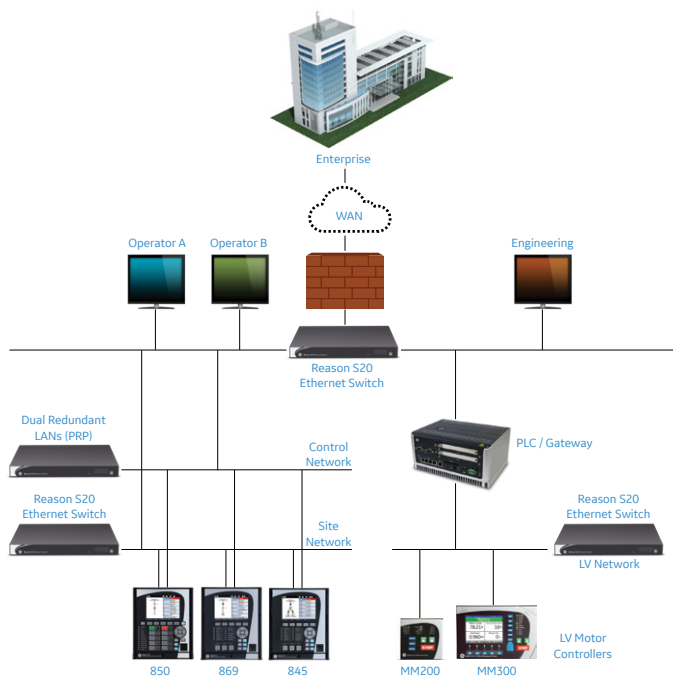
Retrofit Existing Multilin SR 489 Devices in Minutes

Traditionally, retrofitting or upgrading an existing relay has been a challenging and time consuming task often requiring re-engineering, panel modifications, and re-wiring. The Multilin 8 Series Retrofit Kit provides a quick, 3-step solution to upgrade previously installed Multilin SR 489 protection relays, reducing upgrade costs.

With the new 8 Series Retrofit Kit, users are able to install a new 889 Feeder Management System without modifying existing panel or switchgear cutouts, re-wiring, or need for drawing changes and re-engineering time and cost.

With this three-step process, operators are able to upgrade existing SR relays in as fast as 21 minutes, simplifying maintenance procedures and reducing system downtime.

1	**2**	**3**
Update **Settings File**	Replace **Relay**	Plug & Play **Reconnection**

EnerVista 8 Series Setup Software provides automated setting file conversion with graphical report to quickly and easily verify settings and identify any specific settings that may need attention.

Simply remove the upper, lower and low voltage terminal blocks and then remove the SR chassis from the panel. No need to disconnect any of the field wiring.
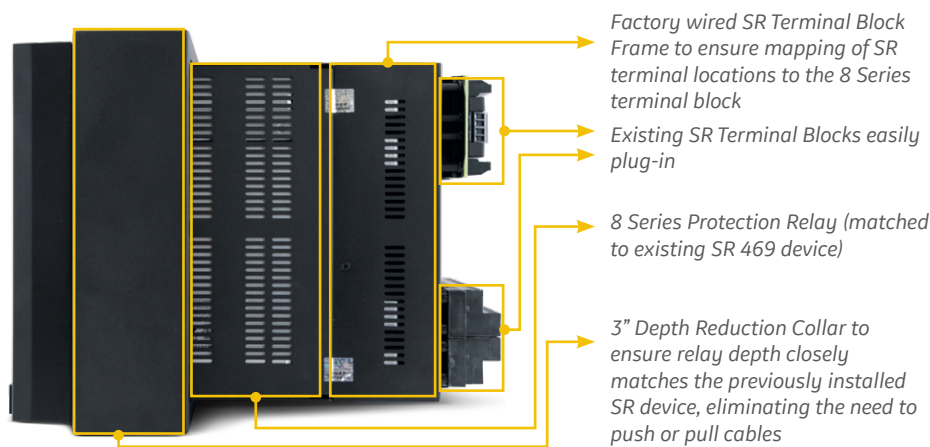
Insert the new 8 Series Retrofit chassis into the switchgear and simply plug-in the old terminal blocks - there is need to make any cut-out modifications or push and pull cables.

The 8 Series Retrofit Kit comes factory assembled and tested as a complete unit with the 8 Series protection device and includes replacement hardware (terminal blocks and screws) if the existing hardware is significantly aged or damaged.

Factory wired SR Terminal Block Frame to ensure mapping of SR terminal locations to the 8 Series terminal block

Existing SR Terminal Blocks easily plug-in

8 Series Protection Relay (matched to existing SR 469 device)

3" Depth Reduction Collar to ensure relay depth closely matches the previously installed SR device, eliminating the need to push or pull cables
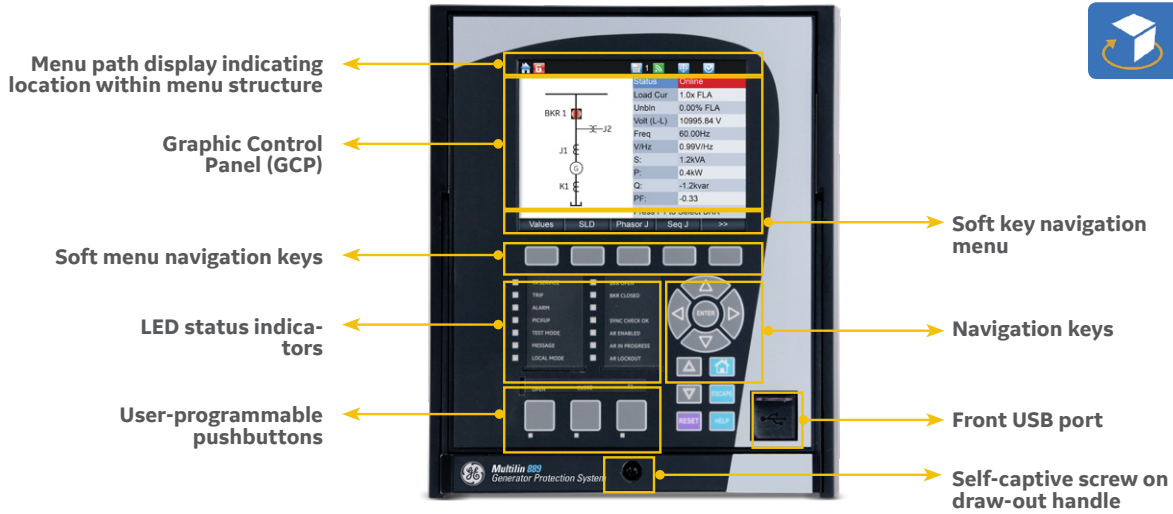
Explore in Detail

Visit us online to explore the SR to 8 Series retrofit kit in detail using our interactive app. **www.GEGridSolutions.com/8SeriesRetrofitKit**

Multilin 8 Series Retrofit: Solutions Explorer Application

Front View - Membrane Front Panel

Menu path display indicating location within menu structure

Graphic Control Panel (GCP)

Soft menu navigation keys

LED status indicators

User-programmable pushbuttons

WANT TO LEARN MORE?
EXPLORE IN 3D

Soft key navigation menu

Navigation keys

Front USB port

Self-captive screw on draw-out handle

Rear View

Grounding screw

Power supply

RTDs

Digital I/O, DCMA, Arc Flash sensors

Standard serial and RJ45 Ethernet module

Advanced communications module (fiber optic port)

CT, VT inputs

Optional IP20 cover available

Dimensions & Mounting

9.90"

8.84"

8.42"

1.55"

7.55"

imagination at work

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