GE
Digital Energy

Multilin™ 850

Innovative Feeder Protection System for Industrial & Distribution Utility Feeder Applications

The Multilin 850 relay is a member of the Multilin 8 Series protective relay platform and has been designed for the management, protection and control of distribution feeder applications. The Multilin 850 is used to provide primary or backup protection for underground and overhead medium voltage feeders from distribution and industrial power networks.

Designed with advanced communications options and detailed asset monitoring capabilities, the Multilin 850 provides advanced functionality, including high-performance protection, extensive programmable logic and flexible configuration capabilities.

Built from a rich history and legacy in providing advanced protection and control solutions and utilizing advanced design practices, superior technology, and state-of-the art test and manufacturing facilities, GE is raising the bar on system performance, quality and reliability.

Key Benefits

- Increase uptime with industry-leading quality, reliability and design processes ensuring long operational life
- Reduce downtime with relay environmental diagnostic information
- Simplify testing and increase process uptime withlow-insertion force, draw-out construction
- Designed with no electrolytic capacitors and manufactured to IPC-A 610 Class 3 industry standard
- Minimize system configuration time with optional point-to-point Wi-Fi connectivity, allowing secure, local relay programming and diagnostic retrieval

Key Applications

Oil & Gas / Petrochemical / Refineries
- Protection and control for feeders and incomers
- Reliable motor-bus auto transfer and high-speed interlocking schemes
- Distribution load-shedding schemes

Mining & Metals
- Primary or back-up protection for feeders and incomers
- Reliable, automatic bus transfer schemes
- High-speed fault detection for arc flash mitigation

Distribution Utility
- Protection and control for radial or looped distribution circuits
- Auto-reclosing control schemes
- Distribution generation interconnect protection

imagination at work

Exceptional Quality & Reliability

- IPC A-610-E Class 3 manufacturing standards
- Adheres to the highest reliability standards for electronics testing
- 100% Electrical Stress Screening and full functional testing
- Rated for IP54 applications
- Standard Harsh Conformal Coating

Innovative Technology & Design

- Elimination of electrolytic capacitors
- Advanced diagnostics with unique algorithms ensuring asset protection is not compromised
- Single setup and configuration across the platform
- Built-in field swappable power supply
- Enhanced relay draw-out construction
- Advanced and flexible communications offering simplifying system integration
- Embedded communications offering including: IEC® 61850, IEC 62439/PRP, Modbus® RTU & TCP/IP

Uncompromising Service & Support

- Covered under GE's 10 year warranty plan
- Fully designed, tested and manufactured in at GE facilities

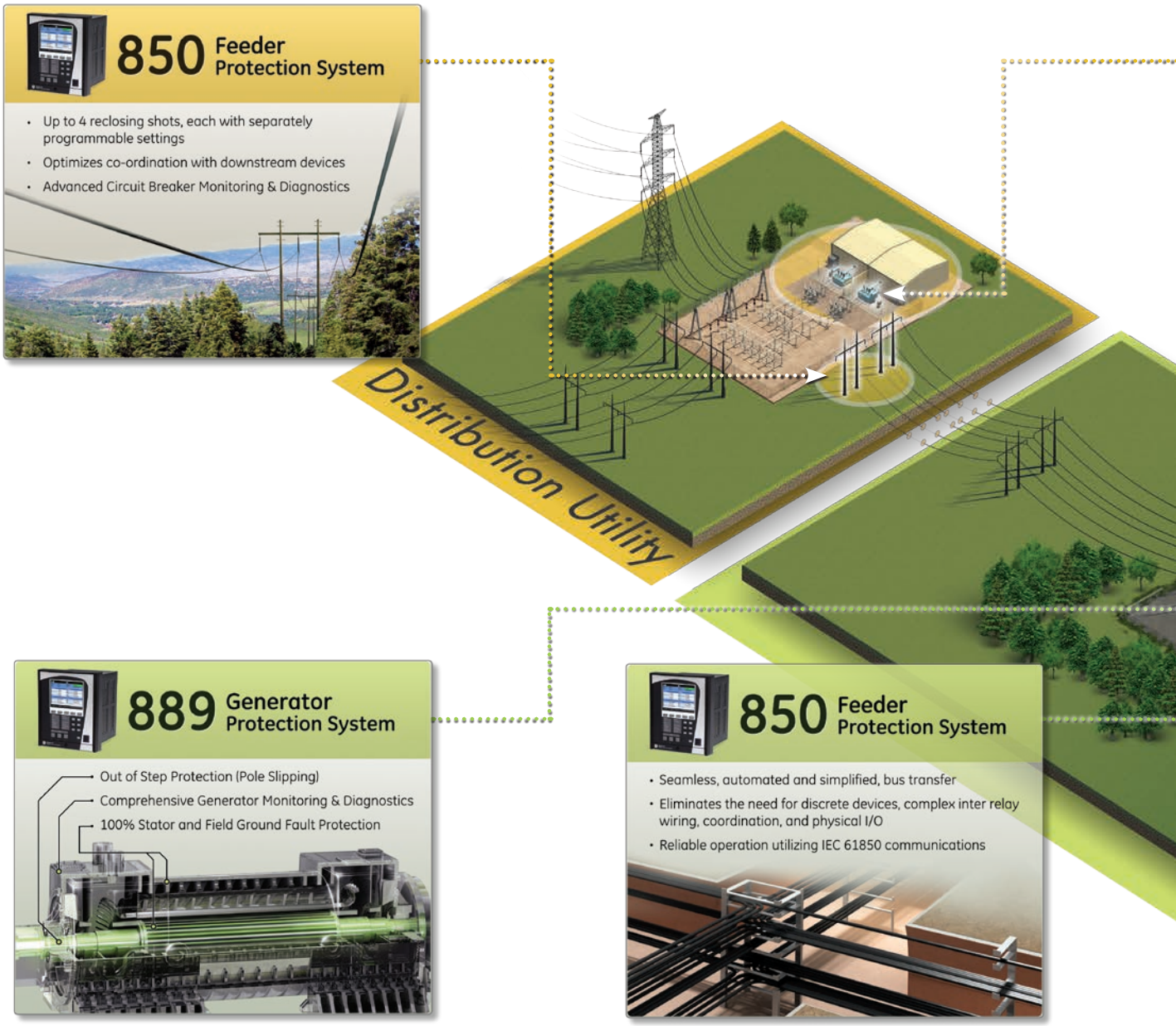
Multilin 850 Overview

The Multilin 850 Feeder Protection System is a protection device designed for the management, protection and control of distribution feeders. The 850 provides the necessary primary and back-up protection of underground and overhead medium voltage feeders used in industrial and distribution utility applications.

The 850 is an advanced feeder protection relay that provides high-performance protection, high-density I/O, extensive programmable logic and flexible configuration capabilities. With protection and control logic, the 850 allows for simplified coordination with upstream and downstream disconnect devices.

The control features, such as auto transfer schemes, cold load pickup and auto-reclose, available for the optimal protection and control of industrial and distribution networks. This advanced protection relay also offers enhanced features, such as diagnostics, preventative maintenance, condition monitoring, security, and advanced communications options.

The Multilin 850 is designed to solve the unique challenges that customers face in running their day-to-day operations, including maximizing system and process uptime, simplifying system integration and maintenance, and extending the life of critical assets.



Multilin 8 Series Platform - Application Example

From oil pumping and refining facilities, to open pit or underground mining and processing operations, companies demand solutions that ensure maximum process uptime, minimum operational and maintenance efforts, and have the durability to withstand harsh environmental conditions.

The Multilin 8 Series is GE's next-generation protection and control relay platform designed for industrial and distribution utilities. The platform provides comprehensive protection and asset monitoring for critical feeders, motors, generators, and transformers.

The 8 Series was designed to solve the challenges that customers face in running their day-to-day operations including maximizing system and process uptime, simplifying system integration and maintenance, and extending the life of critical assets. Utilizing advanced design practices (IPC A-610 design standards), superior technology (elimination of all electrolytic capacitors), and state-of-the art test and manufacturing facilities (every device endures 100% Environmental Stress Screening), GE is raising the bar on system performance and reliability.

With advanced communications the 8 Series integrates easily and seamlessly into your new or existing control system, along with your other Multilin protection devices, providing a comprehensive solution for the end-to-end electrical system within your operations.

Exceptional Quality & Reliability

Industry-leading quality, reliability and design processes are at the core of GE's next generation protective relay platform. With significant investments in state-of-the-art type test facilities that simulate a complete range of operating environments and designed to the IPC A-610 Class 3 standard, adhering to the highest reliability standards and ensuring rugged performance, each device completes one hundred percent Electrical Stress Screening prior to shipping from GE's facility.

The 850 Feeder Protection System is manufactured in an ISO® 9001:2008 certified manufacturing facility with a completely lead-free design.

Innovative Technology & Design

Available as part of the Multilin 8 Series platform, the Multilin 850 Feeder Protection System provides comprehensive, high-performance protection and control for distribution feeder applications.

For main-tie-main configurations, the Multilin 850 delivers a more economical and reliable solution, enabling customers to reduce hardware requirements and simplify device integration, including safe and secure Wi-Fi communications for system configuration and diagnostics.

Utilizing decades of experience, GE has implemented ease-of-use features, such as configurable scheme logic that eliminates the need for complex end-user programming, driving quicker setup times, decreased implementation costs and reduced points of failure.

The Multilin 850 has an integrated protection integrity engine that utilizes customized algorithms, providing advanced diagnostics to ensure asset protection is not compromised.

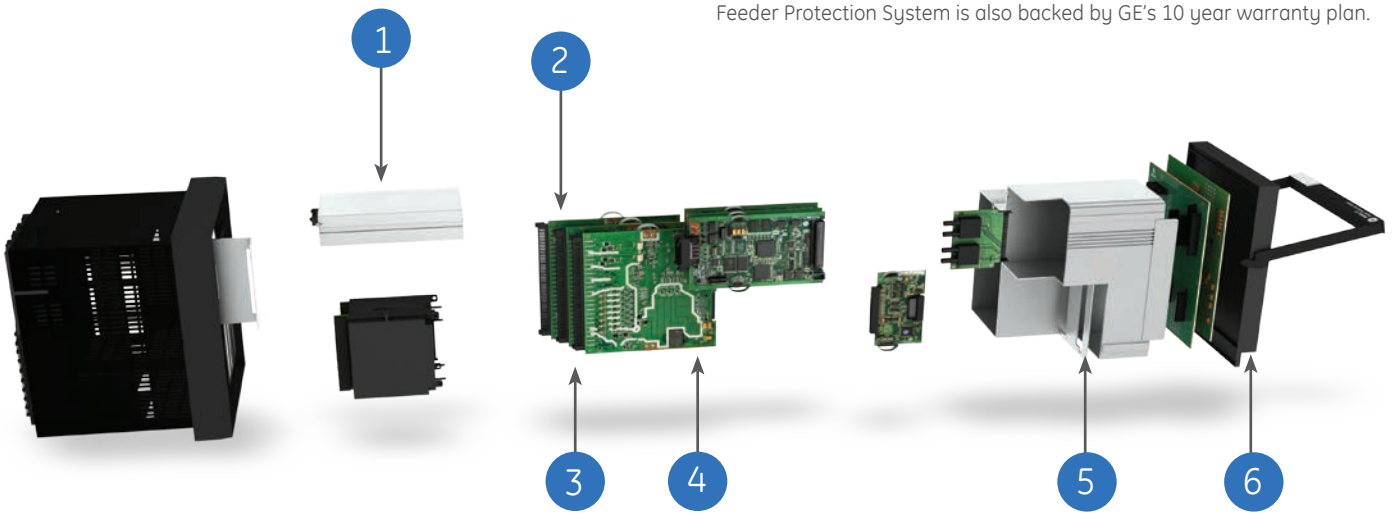
Maintaining and safeguarding the electrical supply of an operation is critical to ensuring maximum process availability and performance. The 850 incorporates the latest cyber security features, including password complexity, RADIUS authentication, role-based access control (RBAC), customers to comply with NERC CIP and NISTIR 7628 requirements.

Understanding that customers need protection and control devices that must reliably operate in extremely harsh and challenging environments, GE delivers the Multilin 850 with harsh conformal coating on all printed circuit boards and a patented environmental awareness module that provides real-time detection of environmental factors that affect product life, as part of its standard offering, delivering higher reliability and extended relay life.

Uncompromised Service and Support

Designed, manufactured and tested to the highest standards in the industry at our state-of-the-art facilities, the 850 Feeder Protection System delivers maximum performance for today's most demanding environments.

In addition to the unparalleled technology and design advancements, to deliver uncompromised performance and reliability, the Multilin 850 Feeder Protection System is also backed by GE's 10 year warranty plan.



1 Field Swappable Power Supply
Extends the usable life of the protection relay and minimizes costly, time consuming replacement and re-configuration.

2 Harsh Environment Conformal Coating
Standard (not optional) on all printed circuit boards delivering higher reliability and extended relay life

3 No Electrolytic Capacitors
Increasing quality and reliability for continuous plant operations by removing high failure components

4 IPC A-610 Class 3 Manufacturing
Drives to the highest level of reliability standards delivering rugged performance

5 Robust Extruded Aluminum Chassis
Custom-designed extruded aluminum chassis delivering optimal operating performance

6 Draw-Out
Providing simplified device fleet management

Full Color Graphical HMI Front Display

A large, full color Graphic Control Panel (GCP) ensures clear representation of critical status and measurements. When the keypad and display are not being used, the GCP will automatically revert to screen saver mode, which will turn off the display until one of the local pushbuttons is pushed.

The GCP can be used to view device and system status, alarms and event logs, and metering information. The GCP and navigation keys simplify relay configuration and setup, allowing users to make setting changes directly through the front panel.

LED Indicators for Quick Status Indication

The front panel includes user configurable LED's. Each LED can be completely configured and named based on the application and user requirements.

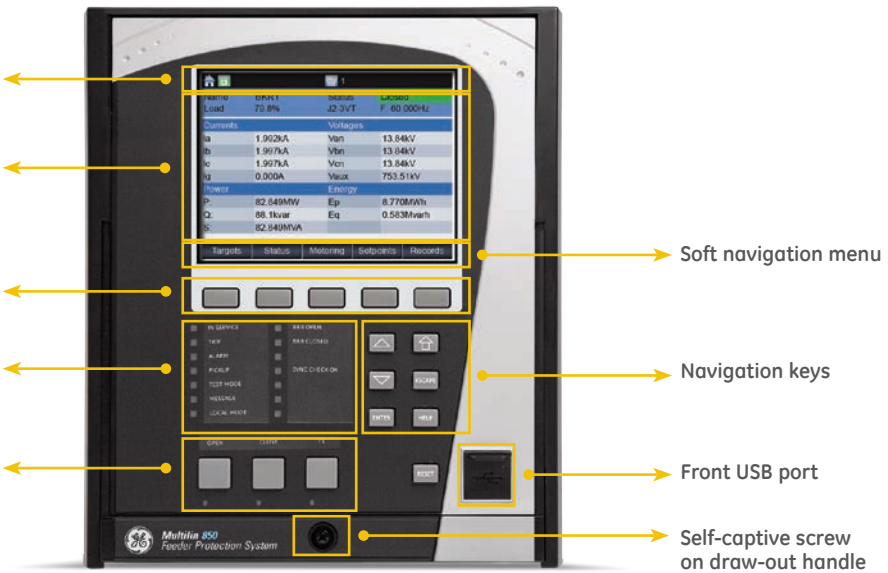
The color of each indicator conveys its importance.

G = Green: General Condition
A = Amber: Alert Condition
R = Red: Serious Alarm or Important Status. The phase OV detection

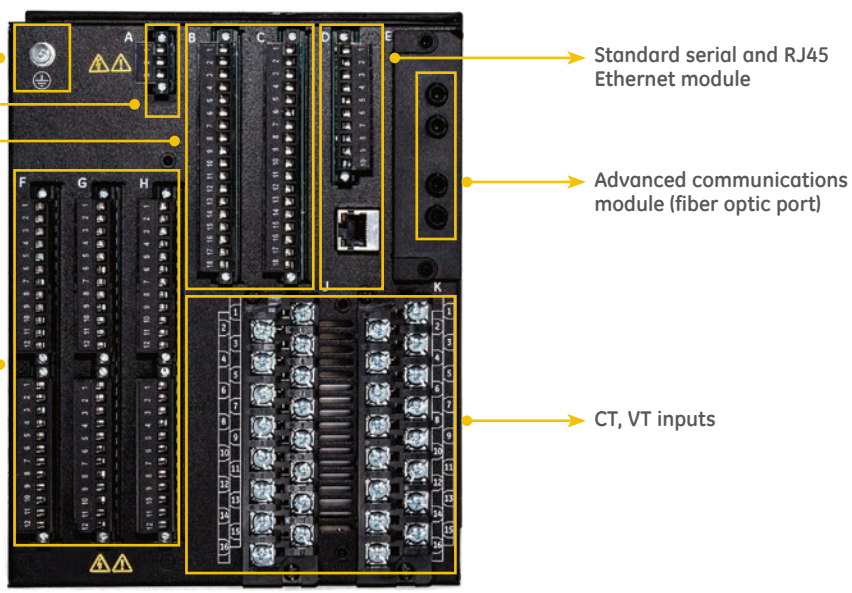
The 850 front panel provides 14 LED indicators and 3 LED pushbutton indicators. 10 LED's are user-programmable while "In service" and "Pickup" LED's are non-programmable. "Trip" and "Alarm" LED's are not color programmable but can be assigned with selected operands.

User-programmable LED's can be turned on by a selection of FlexLogic operands representing protection, control or monitoring elements. Each LED can be configured to be self-reset or latched and labeled based on the application and user requirements. User-programmable LED's can be selected to be either Red, Green or Orange to give the distinctive indication of selected operations.

Front View



Rear View



Robust Security Features

A suite of powerful system security features are designed into the 850, enabling a high level of cyber security protection, helping operators to comply with NERC®/CIP guidelines and regulations. This includes AAA server support (Radius/LDAP), permitting authentication and accounting of all user activities, and RBAC, which provides efficient administration of users and roles within devices.

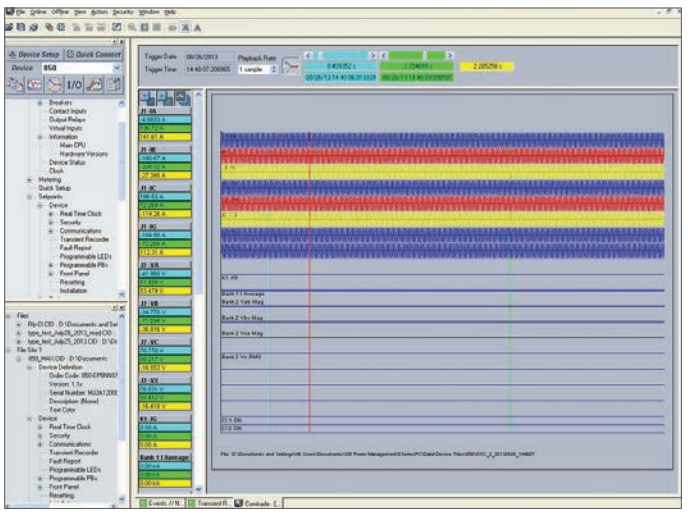
Advanced Asset Management

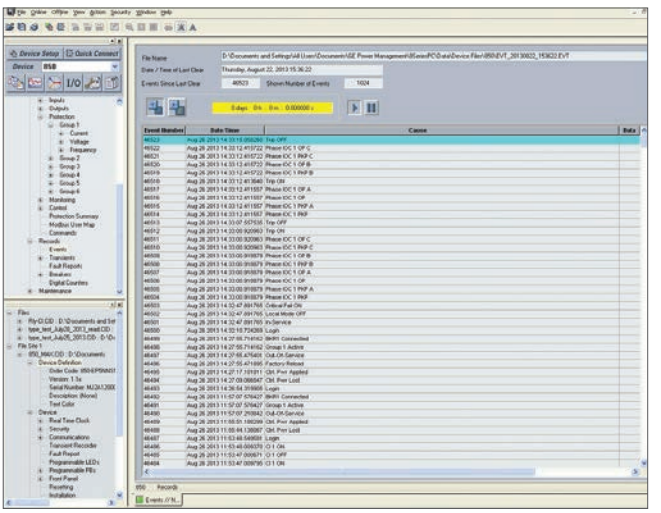
By leveraging GE's global research facilities located around the world, the 850 Feeder Protection Relay has integrated a number of advanced algorithms which allow for detailed diagnostic information to be provided as required. This allows users to make informed decisions based on real operational data.

Environmental Monitoring

The 850 Feeder Protection System implements a patented Environmental Monitoring system that measures and provides operating condition information. The 850 continuously monitors the temperature, humidity, voltage surges and vibration that the relay is exposed to and provides a user the necessary information to make decisions based on the operating environment, enabling proactive decisions prior to any system issues that may arise. In addition, the 850 performs comprehensive device health diagnostic tests at startup and continuously during run-time to test its own major functions and critical hardware.

Built into the relay as a standard feature, the 850 includes high-accuracy metering and recording for all AC permitting. current, voltage, and power metering. Current and voltage parameters are available as total RMS magnitude, and as fundamental frequency magnitude and angle. The 850 also measures up to the 25th harmonic and total harmonic distortion (THD) on voltage and current, suitable for power quality applications.





Monitoring system performance with oscillography and event records.

Designed for Ease-of-Use

Continuing its legacy in providing easy-to-use protective relay solutions, the 850 is designed to minimize product and system configurability requirements, for quicker physical installations, easier and simplified setup and configuration.

Simplified Setup and On-Going Maintenance

The robust 850 streamlines user workflow processes and simplifies engineering tasks, such as configuration, wiring, testing, commissioning, and maintenance. Building on the history of simplified setup and configuration, the 850 Feeder Protection Relay has implemented simplified setup screens to assist in minimizing relay setup time. In addition, for local programming, the 850 comes with a fully functional GCP, which allows users to locally monitor the asset.

1 Easy to Use - Draw-out case

2 Easy to Configure - 1 simple step

3 Detailed Diagnostics

Software and Configuration

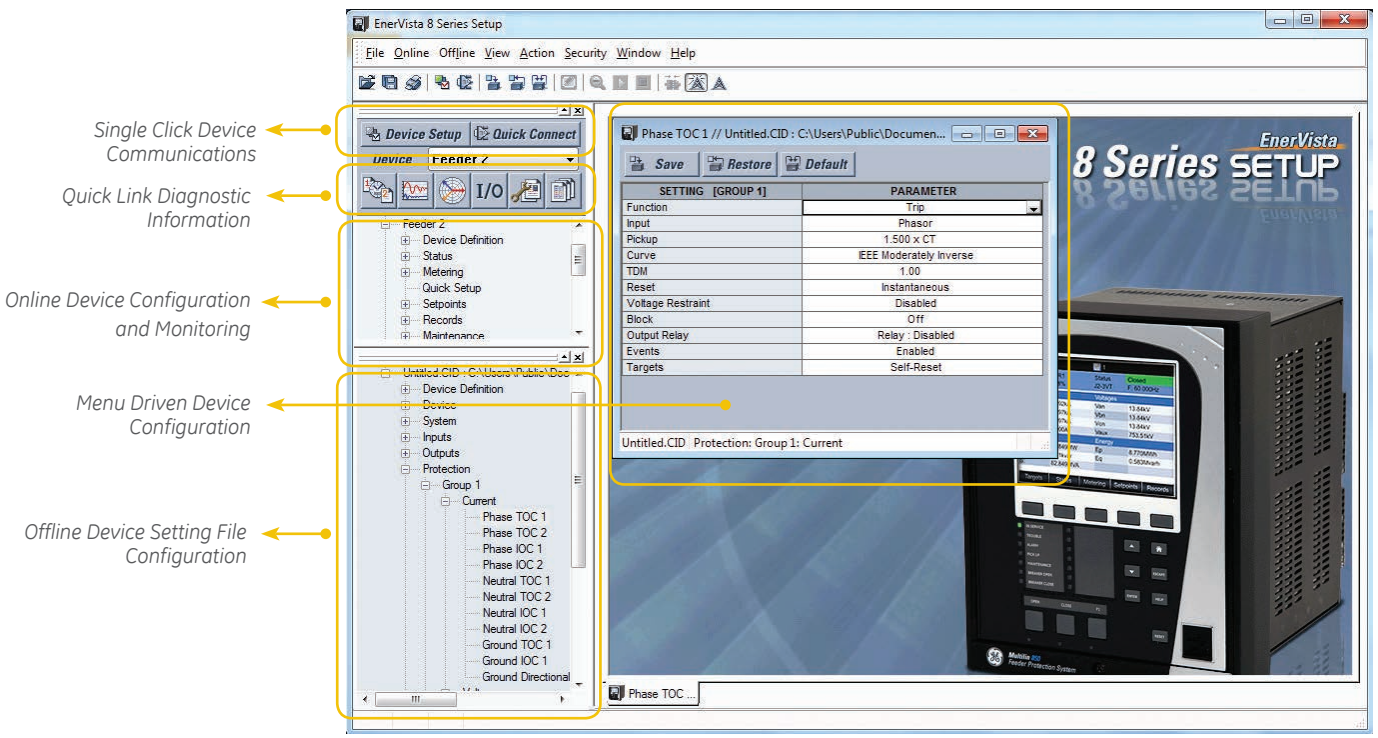
The EnerVista™ suite is an industry-leading set of software programs that simplifies every aspect of using the Multilin 850. EnerVista provides all the tools to monitor the status of the protected asset, maintain the device and integrate the information measured by the Multilin 8 Series, into SCADA or DCS process control systems. The ability to easily view sequence of events is an integral part of the setup software, as postmortem event analysis is critical to proper system management.

EnerVista Launchpad

The setup tools within Launchpad allow for the configuration of devices in real-time, by communicating via serial, Ethernet or modem connections, or offline, by creating device setting files to be sent to devices at a later time.

8 Series Setup Software

EnerVista setup software can reduce device setup and configuration time.

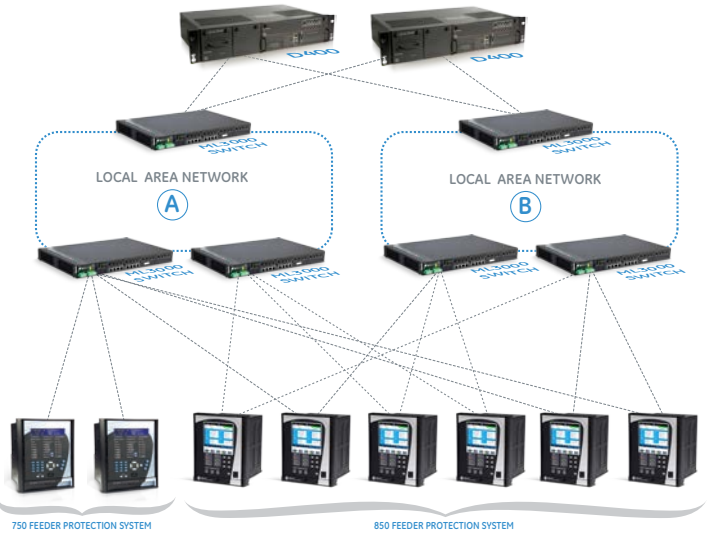


Extensive Communications Options

The 850 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 850 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 the widest range of industry standard protocols, the 850 enables easy, direct integration into DCS and SCADA systems. The 850 supports the following protocols:

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



Designed to Support Multiple Applications

Industrial and distribution utility electrical systems have become more complex, requiring protection relays to deliver faster detection and operation, while providing instantaneous, remote access to critical asset information. In addition, as conditions and power requirements change within the facility, the protection device must be able to seamlessly adapt to and integrate within the network. With a suite of intelligent devices that range from feeder to motor to transformer and generator protection, the Multilin 8 Series platform has been designed to solve the challenges industries face in running their day-to-day operations, including maximizing system and process uptime, simplifying system integration and ongoing maintenance, and extending the life of critical assets.

GE's 850 Feeder Protection Relay can be used to support numerous applications and functions, including feeder protection, bus blocking/interlocking schemes, auto transfer schemes, load shedding applications, auto-reclose applications, customer-utility interconnections, and distributed generation applications. The 850 incorporates advanced automation features, including powerful programmable logic, communications, and SCADA capabilities, that allow for advanced and flexible programming, and easy integration into new and existing communication architectures. In addition, the 850 integrates seamlessly with other GE Multilin relays for complete system protection.

Application Challenge: Intelligent Load Shedding

Challenge:

In a multiple power source network, it may happen that some power sources are lost utility circuit creating deficit of the power even with a presence of in-facility generator. In these partially islanding situations the deficit of active power may result in a sudden drop of system frequency resulting in power system instability, bring the processes and operations to a halt.

Solution:

Being able to dynamically balance and maintain loads in this type of separation scenario requires an intelligent device that has advanced communications, automation and control logic capabilities. The Multilin 850 provides distribution networks and industrial facilities with the system stability functionality and cost saving options, required to maintain power system availability and process continuity. With and advanced protection features including underfrequency, overfrequency, frequency rate of change, sensitive reverse power, underfrequency restoration and other elements plus superior communications enabling sharing data with other IEDs, distribution utilities and industrial facilities rely on GE 850 to deliver power system reliability, efficiency and security required.

Application Challenge: Modern Feeder Protection

Challenge:

Industrial facilities depend on reliable and secure electricity services to keep their operations running. Regardless if the facility is supplied directly from a utility source and/or supported by on-site generation (co-generation), a fully integrated protection & control scheme is critical to maintaining uninterrupted power to the entire facility.

Solution:

The Multilin 8 Series offers the ideal solution for protecting, monitoring and controlling electrical cables and overhead lines from disturbances or faults. With a fast protection pass, running every 2 msec, the 8 Series provides unmatched overcurrent, overvoltage, undervoltage, and frequency protection. Supporting the latest in industry standard communication protocols, including IEC 62439/PRP and IEC 61850, the Multilin 8 Series easily integrates into new or existing networks.

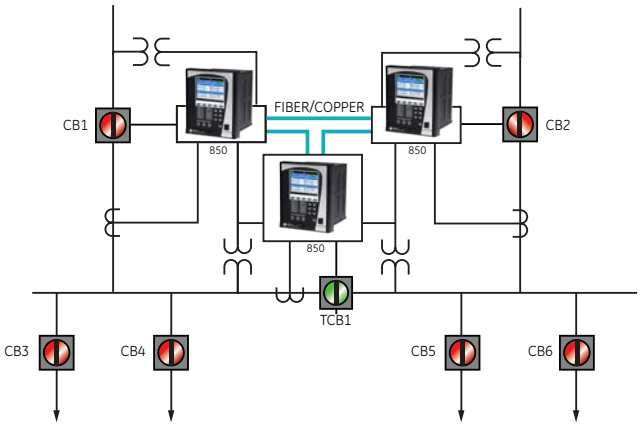
Technical Application Example 1: Industrial Auto Transfer Schemes

Challenge

Bus or source transfer solutions are often necessary for industrial facilities to ensure power reliability and process continuity. Being able to rapidly transfer sources was often accomplished through a complex combination of discrete and auxiliary relays, timers, and/or programmable logic controllers, all wired together. The usage of these independent devices required a precise sequencing of interlocks, timing, and functions to ensure no momentary loss of power could potentially damage critical equipment or loads. In addition, the large number of physical I/O required made these schemes expensive to design and implement and difficult to test.

Solution

The Multilin 850 offers seamless automated bus transfer scheme solutions, maximizing system availability and process uptime. Using a minimal amount of programming, the 850 eliminates the need for any discrete devices and device inter-wiring by integrating all the functions directly into the intelligent device. With advanced communications including embedded support for IEC 61850 peer-to-peer communications, inter-relay wiring and physical I/O can be eliminated. The 850 provides a reliable, automatic bus transfer solution that is easy to design, configure, and maintain.



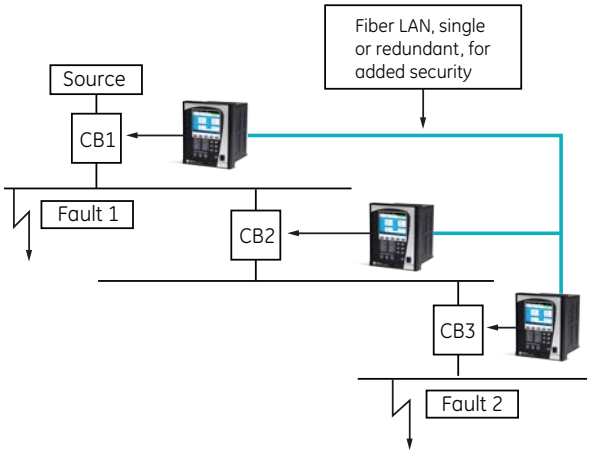
Technical Application Example 2: Zone Selective Interlocking

Challenge

A Fault in an industrial or utility distribution system is a catastrophic event that causes severe damage to equipment and often results in extended system and process downtime. These events require a solution that can quickly and reliably detect and issue a coordinated trip command to clear the fault as fast as possible, reducing total incident energy, equipment damage and system downtime.

Solution

With embedded support for IEC 61850, the 850 provides high-speed data exchange between relays for fast reaction to system issues. As a coordinated system, interlocked protection can be enabled, to provide the necessary bus protection. Fast clearance can be achieved for a fault that occurs at any feeder or bus location by quickly exchanging signals to discriminate the fault location.

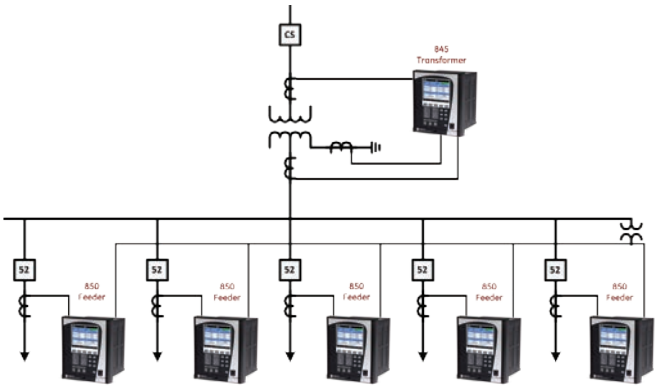


Technical Application Example 3: Intelligent Auto-Reclose

Challenge

A majority of faults that occur on overhead lines are transient in nature, meaning that the fault does not recur when the line is re-energized after tripping. However, in the event the fault is still is present after the 1st reclose attempt, there is a good possibility that next reclose attempts will be successful and power supply to the customer will be restored. Therefore, in order to maintain system availability and security, utility operators need an intelligent auto-reclose solution that allows them to automatically attempt to re-energize a line multiple times, depending on the system conditions and user requirements. Today's environment requires integrated solutions into digital relays.

In a modern distribution feeder topology, substation relay auto-reclose functions should maintain coordination with downstream reclosures installed along the feeder.



Solution

For customers wanting a reliable and customized auto-reclose scheme, a device with integrated logic capabilities is necessary. The 850 offers comprehensive protection and auto-reclose functions integrated in one box.

Up to four auto-reclose operations are possible, each with a programmable dead time. For each reclose shot, the relay can be programmed to block IOC elements, and to adjust the curve characteristics of any TOC element.

The number of shots can be reduced by high currents. Maximum rate per hour reclose shots would prevent breaker drive and insulation overstressing.

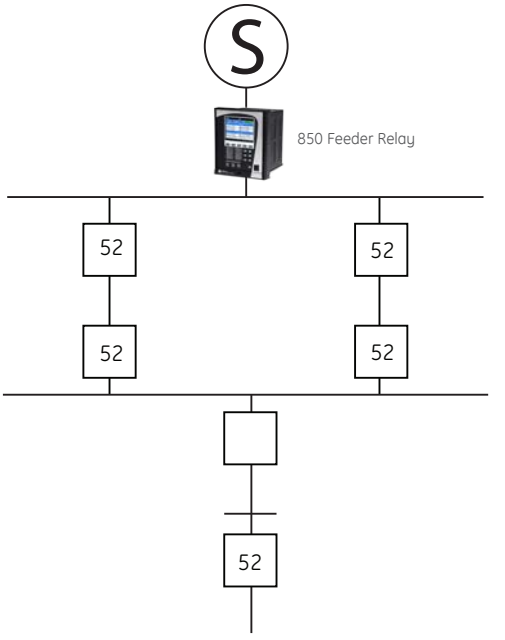
850 relay can be programmed to change protection setting every time the downstream reclosure operates and also maintain same reclosure count as downstream reclosure.

Technical Application Example 4: Adaptive Protection

Challenge:

To effectively manage an electrical distribution system, operators need the ability and flexibility to change power output on a seasonally or even hourly basis due to scheduled maintenance, seasonal load changes and transfers, scheduled switching, transformer inrush or motor starting currents. These distribution changes could have an adverse effect on the reliability of the system and connected loads and requires a protection device that can adapt to ensure secure and dependable protection.

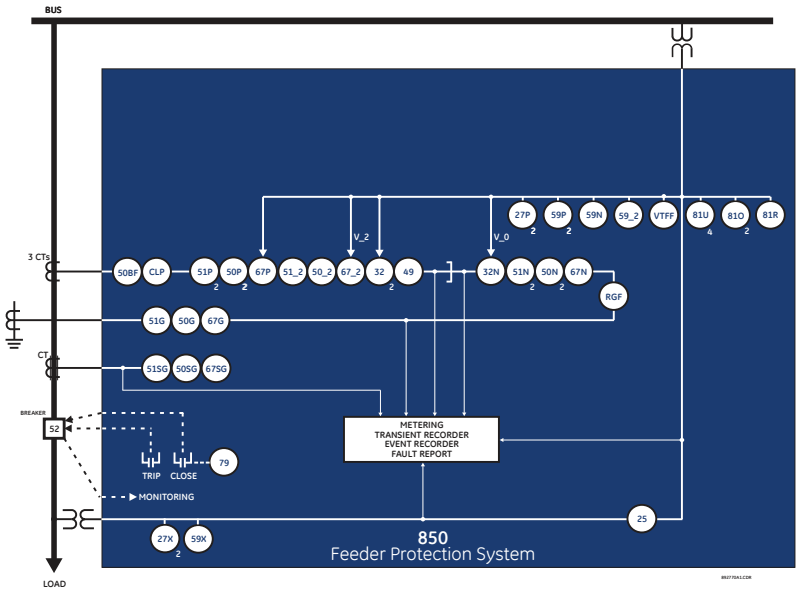
One such application where dynamic setting group change ability is ideal, is with a parallel feeder application where two lines are in service and carry a portion of the required load. If there is an unplanned outage with one of the feeder lines, such that all loads are now supplied by one feeder, key protection settings would need to be adjusted to ensure proper coordination with downstream devices and deliver secure reliable service.



Solution:

The Multilin 850 offers effective, reliable management of distribution feeders. With dynamic, sensitive settings, the 850 provides secure and dependable protection. With six setting groups the 850 provides the sensitive settings range and groups required to ensure no compromise is made to meet changing system conditions. These setting groups can be enabled automatically or manually to address system needs, ensuring greater system reliability and efficiency.

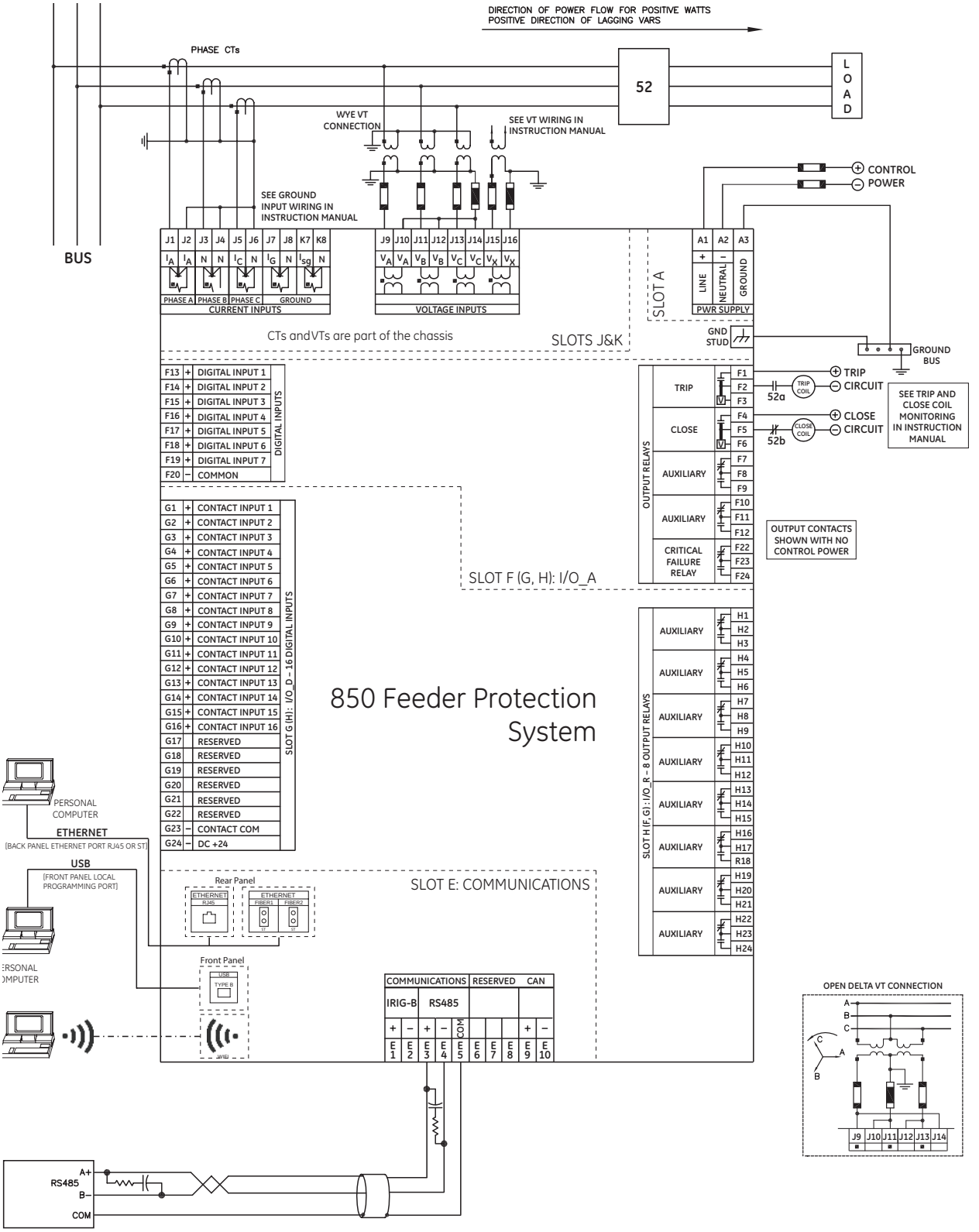
Functional Block Diagram



ANSI Device	Description
25	Synchrocheck
27P (2)	Phase Undervoltage
32 (2)	Directional Power
32N	Wattmetric Ground Fault (Wattmetric zero sequence directional)
27X (2)	Auxiliary Undervoltage
49	Cable Thermal Model
50BF	Breaker Failure
50G	Ground Ground Instantaneous Overcurrent
50SG	Sensitive Ground Instantaneous Overcurrent
50N (2)	Neutral Instantaneous Overcurrent
50P (2)	Phase Instantaneous Overcurrent
50_2	Negative Sequence Instantaneous Overcurrent
51G	Ground Time Overcurrent
51SG	Sensitive Ground Time Overcurrent
51N (2)	Neutral Time Overcurrent
51P (2)	Phase Time Overcurrent
51_2	Negative Sequence Time Overcurrent
52	AC Circuit Breaker
59N	Neutral Overvoltage
59P (2)	Phase Overvoltage
59X	Auxiliary Overvoltage
59_2	Negative Sequence Overvoltage
67G	Ground Directional Element
67SG	Sensitive Ground Directional Element
67N	Neutral Directional Element
67P	Phase Directional Element
67_2	Negative Sequence Directional Element
79	Automatic Recloser
81O	Overfrequency
81U (4)	Underfrequency
81R	Frequency Rate of Change
87G	Restricted Ground Fault
I2/I1	Broken Conductor
VTFF	Voltage Transformer Fuse Failure

Dimensions & Mounting

Typical Wiring



Technical Specifications

POWER SUPPLY

Power Supply

Nominal DC Voltage	125 to 250 V
Minimum DC Voltage	84 V
Maximum DC Voltage	300 V
Nominal AC Voltage	100 to 240 V at 50/60 Hz
Minimum AC Voltage	60 V at 50/60 Hz
Maximum AC Voltage	265 V at 50 to 60 Hz
Voltage loss ride through	20 ms duration

Power Consumption

Typical	10 to 15 W/VA
Maximum	18 W/ 56VA

INPUTS

AC Currents

CT Rated Primary:	1 to 12000 A
CT Rated Secondary	1 A or 5 A based on relay ordering
Nominal Frequency	50 and 60 Hz
Burden	< 0.2 VA at rated secondary
Conversion Range	Standard CT: 0.02 to 46 x CT rating RMS symmetrical Sensitive Ground CT module: 0.002 to 4.6 x CT rating RMS symmetrical
CT Accuracy	0.1 to 2.0 x CT ±0.25% of reading or ±0.1% of rating (whichever is greater) > 2.0 x CT ±1.0%
Short Term CT Withstand	1 second at 100 x rated current 2 seconds at 40 x rated current continuous at 3 x rated current

AC Voltage

VT Range	10 to 260 V
VT Accuracy	±0.5% of reading from 10 to 240 V
Nominal Frequency	20 to 65 Hz
Burden	<0.25 VA at 120 V
Conversion Range.	1 to 275 V
Voltage Withstand	Continuous at 260 V to neutral 1 min/ hr at 420 V to neutral

OUTPUTS

Form-A Relays

Configuration	2 (two) electromechanical
Contact material	silver-alloy
Operate time	<8 ms
Continuous current	10 A
Make and carry for 0.2s	30 A per ANSI C37.90
Break (DC inductive, L/R=40 ms	24 V / 1 A 48 V / 0.5 A 125 V / 0.3 A 250 V / 0.2 A
Break (DC resistive)	24 V / 10 A 48 V / 6 A 125 V / 0.5 A 250 V / 0.3 A
Break (AC inductive)	720 VA @ 250 VAC Pilot duty A300
Break (AC resistive)	277 VAC / 10 A

Form-A Voltage Monitor

Applicable voltage	20 to 300 VDC
Trickle current	1 to 2.5 mA

Form-C Relays

Configuration	electromechanical
Contact material	silver-alloy
Operate time	<8 ms
Continuous current	10 A
Make and carry for 0.2s	30 A per ANSI C37.90
Break (DC inductive, L/R=40 ms)	24 V / 1 A 48 V / 0.5 A 125 V / 0.3 A 250 V / 0.2 A
Break (DC resistive)	24 V / 10 A 48 V / 6 A 125 V / 0.5 A 250 V / 0.3 A
Break (AC inductive)	720 VA @ 250 VAC Pilot duty A300
Break (AC resistive)	277 VAC / 10 A

CONTACT INPUTS

Number of Inputs:	Based on relay ordering
Type	Wet or Dry
Wet Contacts	300 V DC maximum
Selectable thresholds	17, 33, 84, 166 VDC
Tolerance	±10%
Recognition time	<1/8 cycle
Debounce time	0.0 to 16.0 ms in steps of 0.5 ms
Continuous current draw	2 mA

PROTECTION

Phase/Neutral/Ground Time Overcurrent (51)

Current	Phasor or RMS
Pickup Level	0.050 to 30.000 x CT in steps of 0.001 x CT
Dropout Level	97 to 98% of Pickup
Level Accuracy	For 0.01 to 0.2 x CT: ±0.5% of reading or ±0.4% of rated, whichever is greater; For > 0.2 x CT: ±1.5% of reading
Curve Shape	IEEE Extremely/Very/Moderately Inverse ANSI Extremely/Very/Normally/ Moderately Inverse IEC Curve A/B/C and Short Inverse IAC Extremely/Very/ Inverse/Short Inverse FlexCurve™ A, FlexCurve™ B, FlexCurve™ C, FlexCurve™ D I2t, I4t, Definite Time
Curve Multiplier:	0.05 to 600.00 in steps of 0.01
Reset Time	Instantaneous, Timed
Curve Timing Accuracy:	Currents > 1.1 x pickup: ± 3% of operate time or ± ½ cycle (whichever is greater) from pickup to operate

Phase/Neutral/Ground Instantaneous Overcurrent (50P/N/G)

Current (for Phase IOC only)	Phasor or RMS
Current (for Neutral/ Ground IOC only	Fundamental Phasor Magnitude
Pickup Level	0.050 to 30.000 x CT in steps of 0.001 x CT
Dropout Level	97 to 98% of Pickup
Level Accuracy	For 0.01 to 0.2 x CT: ±0.5% of reading or ±0.4% of rated, whichever is greater For > 0.2 x CT: ±1.5% of reading
Operate Time	<12 ms at >3 x Pickup at 60 Hz (Phase/Ground IOC) <16 ms at >3 x Pickup at 60 Hz (Neutral IOC) <15 ms at >3 x Pickup at 50 Hz (Phase/ Ground IOC) <20 ms at >3 x Pickup at 50 Hz (Neutral IOC)
Timer Accuracy	±3% of delay setting or ± ¼ cycle (whichever is greater) from pickup to operate

Phase Directional Overcurrent (67P)

Relay Connection:	90° (Quadrature)
Quadrature Voltage:	ABC phase seq.: phase A (Vbc), phase B (Vca), phase C (Vab); ACB phase seq.: phase A (Vcb), phase B (Vac), phase C (Vba)
Polarizing Voltage Threshold:	0.000 to 3.000 x VT in steps of 0.001 x VT
Current Sensitivity Threshold:	0.05 x CT
Characteristic Angle:	0° to 359° in steps of 1°
Angle Accuracy:	± 2°
Operation Time (FlexLogic™ Operands):	Reverse to Forward transition: < 12 ms, typically; Forward to Reverse transition: <8 ms, typically

Phase Undervoltage (27P)

Voltage:	Fundamental Phasor Magnitude
Minimum Voltage:	0.00 to 1.50 x VT in steps of 0.01 x VT
Pickup Level:	0.00 to 1.50 x VT in steps of 0.01 x VT
Dropout Level:	102 to 103% of pickup
Level Accuracy:	±0.5% of reading from 10 to 208 V
Phases Required for Operation:	Any one, Any two, All three
Undervoltage Curves	Definite Time or Inverse Time
Pickup Time Delay	0.000 to 6000.000 s in steps of 0.001s
Operate Time	< 16 ms at 0.90 x pickup (from 1.1 x pickup) at 60 Hz < 20 ms at 0.90 x pickup (from 1.1 x pickup) at 50 Hz
Curve Timing Accuracy	at < 0.90 x pickup: ± 3.5% of curve delay or ± ½ cycle (whichever is greater) from pickup to operate

Phase Overvoltage (59P)

Voltage:	Fundamental Phasor Magnitude
Pickup level:	0.02 to 3.00 x VT in steps of 0.01 x VT
Dropout level:	97 to 98% of Pickup
Level accuracy:	±0.5% of reading from 10 to 208 V
Phases for operation:	Any one, Any two, All three
Pickup time delay:	0.000 to 6000.00 s in steps of 0.001 s (definite time)
Dropout time delay:	0.000 to 6000.00 s in steps of 0.001 s (definite time)
Operate time:	< 25 ms at 1.1 x pickup at 60Hz < 30 ms at 1.1 x pickup at 50Hz
Timer accuracy:	± 3% of delay setting or ± ¼ cycle (whichever is greater) from pickup to operate

Overfrequency (81O)

Pickup Level:	20.00 to 65.00 Hz in steps of 0.01
Dropout Level:	Pickup - 0.03 Hz
Pickup Time Delay:	0.000 to 6000.000 s in steps of 0.001 s
Dropout Time Delay:	0.000 to 6000.000 s in steps of 0.001 s
Minimum Operating Voltage:	0.000 to 1.250 x VT in steps of 0.001 x VT
Level Accuracy:	± 0.001 Hz
Timer Accuracy:	± 3% of delay setting or ± ¼ cycle (whichever is greater) from pickup to operate
Operate Time:	typically 4 cycles at 0.1 Hz/s change typically 3.5 cycles at 0.3 Hz/s change typically 3 cycles at 0.5 Hz/s change

Underfrequency (81U)

Pickup level:	20.00 to 65.00 Hz in steps of 0.01
Dropout level:	Pickup + 0.03 Hz
Pickup time delay:	0.000 to 6000.000 s in steps of 0.001 s
Dropout time delay:	0.000 to 6000.000 s in steps of 0.001 s
Minimum operating voltage:	0.000 to 1.250 x VT in steps of 0.001 x VT
Minimum operating current:	0.000 to 30.000 x CT in steps of 0.001 x CT
Level accuracy:	±0.001 Hz
Timer accuracy:	± 3% of delay setting or ± ¼ cycle (whichever is greater) from pickup to operate
Operate time:	typically 4 cycles at 0.1 Hz/s change typically 3.5 cycles at 0.3 Hz/s change typically 3 cycles at 0.5 Hz/s change

Frequency Rate Of Change (81R)

df/dt trend:	Increasing, Decreasing, Bi-directional
df/dt pickup level:	0.10 to 15.00 Hz/s in steps of 0.01
df/dt dropout level:	96% of Pickup Level
df/dt level accuracy:	80 mHz/s or 3.5%, whichever is greater
Min frequency:	20.00 to 80.00 Hz in steps of 0.01 Hz
Max frequency:	20.00 to 80.00 Hz in steps of 0.01 Hz
Min voltage threshold:	0.000 to 1.250 x VT in steps of 0.001 x VT
Min current threshold:	0.000 to 30.000 x CT in steps of 0.001 x CT
Pickup time delay:	0.000 to 6000.000 s in steps of 0.001 s
Timer accuracy:	± 3% of delay setting or ± ¼ cycle (whichever is greater) from pickup to operate
95% settling time for df/dt:	< 24 cycles
Operate time:	typically 6.5 cycles at 2 × pickup
	typically 5.5 cycles at 3 × pickup
	typically 4.5 cycles at 5 × pickup

Directional Power (32)

Measured Power:	3-phase
Number of Stages:	2
Characteristic Angle:	0° to 359° in steps of 1°
Calibration Angle:	0.00° to 0.95° in steps of 0.05°
Power Pickup Range:	–1.200 to 1.200 in units of (Rated Power) in steps of 0.001 (Rated Power)
Pickup Level Accuracy:	± 1% or ± 0.001 (Rated Power), whichever is greater
Hysteresis:	2% or 0.001 (Rated Power), whichever is greater
Pickup Time Delay:	0.000 to 6000.000 s in steps of 0.001 s
Operate Time:	< 50 ms at 1.1 x pickup at 60 Hz
	< 60 ms at 1.1 x pickup at 50 Hz
Timer Accuracy:	± 3% of delay setting or ± ¼ cycle (whichever is greater) from pickup to operate

Demand

Measured values:	Phase A/B/C present and maximum current, three-phase present and maximum real/reactive/apparent power
Measurement type:	Thermal Exponential, 90% response time (programmed): 5, 10, 15, 20, 30, or 60 min
	Block Interval / Rolling Demand, time interval (programmed): 5, 10, 15, 20, 30, or 60 min

Current pickup level:	10 to 10000 A in steps of 1 A
Real power pickup level:	0.1 to 300000.0 kW in steps of 0.1 kW
Reactive power pickup level:	0.1 to 300000.0 kVar in steps of 0.1 kVar
Apparent power pickup level:	0.1 to 300000.0 kVA in steps of 0.1 kVA
Apparent power pickup level:	96-98% of Pickup level
Level accuracy:	±2%

Power Factor (55)

Switch-In Level:	0.01 Lead to 1 to 0.01 Lag in steps of 0.01
Dropout Level:	0.01 Lead to 1 to 0.01 Lag in steps of 0.01
Delay:	0.000 to 6000.000 s in steps of 0.001 s
Minimum operating Voltage:	0.00 to 1.25 x VT in steps of 0.01 x VT
Level accuracy:	±0.02
Timer accuracy:	± 3% of delay setting or ± 1¼ cycle (whichever is greater) from pickup to operate

CONTROL

Synchrocheck (25)

Maximum Frequency Difference:	0.01 to 5.00 Hz in steps of 0.01 Hz for frequency window of fnom ± 5 Hz
Maximum Angle Difference:	1° to 100° in steps of 1°
Hysteresis for Maximum Frequency Difference	10 to 600000 V in steps of 1 V
Difference:	0.01 to 0.10 Hz in steps of 0.01 Hz
Breaker Closing Time:	0.000 to 6000.00 s in steps of 0.001 s
Dead Source Function:	None, LB & DL, DB & LL, DB & DL, DB OR DL, DB XOR DL
Dead/Live Levels for Bus and Line:	0.00 to 1.5 x VT in steps of 0.01 x VT

Autoreclose (79)

Number of Breakers:	Single breaker application
Number of Poles:	3-pole tripping/autoreclose schemes
Reclose attempts:	Up to 4 before lockout
Blocking:	Each reclose shot can block IOC, raise TOC Pickup or change the setting group
Adjustability:	Current supervision can adjust the maximum number of shots attempted
Timer Accuracy:	± 3% of delay setting or ± ¼ cycle (whichever is greater) from pickup to operate

AR Current Supervision And AR Zone Coordination

Operating Parameter:	Ia, Ib, Ic, In (Fundamental Phasor Magnitude)
Pickup Level:	0.050 to 30.000 x CT in steps of 0.001 x CT
Dropout Level:	97 to 98% of Pickup
Level Accuracy:	For 0.1 to 2.0 x CT: ± 0.5% of reading or ± 0.4% of rated, whichever is greater
	For > 2.0 x CT: ± 1.5% of reading
Timer Accuracy:	± 3% of delay setting or ± ¼ cycle, (whichever is greater) from pickup to operate

MONITORING AND METERING

Phasors

Currents

Parameters:	Phase A, B, C, Neutral and Ground
Magnitude Accuracy:	± 0.5% of reading or ± 2.0% of rated (whichever is greater) from 0.1 to 2.0 x CT
	± 0.4% of reading > 2.0 x CT
Angle Accuracy:	2°

Voltages

Parameters:	Wye VTs: A-n, B-n, C-n, A-B, B-C, C-A, Average Phase, Neutral and Residual;
	Delta VTs: A-B, B-C, C-A, Neutral and Residual
Magnitude Accuracy:	± 5% of reading from 10 to 208 V
Angle Accuracy:	0.5° (10 V<V< 208 V)
	Positive, Negative and Zero Sequence Current
Magnitude Accuracy:	± 0.5% of reading or ± 0.2% of rated (whichever is greater) from 0.1 to 2.0 x CT
	± 4.0% of reading > 2.0 x CT
Angle Accuracy:	0.5° (at 50/60 Hz, 10 V<V< 208 V)

Current And Voltage Harmonics

Parameters:	Magnitude of each harmonic and THD
Range:	2nd to 25th harmonic: per-phase displayed as % of f1 fundamental frequency
	THD: per-phase displayed as % of f1
Accuracy:	0.2% + (1.8e-5*(f/60)^2.7 of reading)%, where f is the harmonic frequency

Transient Recorder

Default AC Channels:	5 currents + 4 voltages
Configurable Channels:	16 analog and 32 digital channels
Sampling rate:	128 /c, 64/c, 32/c, 16/c, 8/c
Trigger Souce:.	Any element pickup, dropout or operate, digital input or output change of state, FlexLogic operand
Trigger Position:	0 to 100%
Storage Capability:	non-volatile memory

Event Recorder

Number of events	1024
Header:	relay name, order code, firmware revision
Content:	any element pickup, any element operate, digital input change of state, digital output change of state, self-test events
Data Storage:	non-volatile memory
Time-tag Accuracy:	to one microsecond

Digital Counters

Number of Counters	16
Counting	preset, compare
Programmability	reset, up/down, set to pre-set, freeze/reset, freeze/count

RMS Parameters

Currents

Parameters:	Phase A, B, C, Neutral, Ground and Sensitive Ground
Accuracy:	± 0.2% of reading or ± 0.2% of rated (whichever is greater) from 0.1 to 2.0 x CT
	± 0.25% of reading > 2.0 x CT

Voltages

Parameters:	Wye VTs: A-n, B-n, C-n, A-B, B-C, C-A, Average Phase, Neutral and Residual
	Delta VTs: A-B, B-C, C-A, Neutral and Residual
Accuracy:	± 0.5% of reading from 10 to 208 V

Real Power (Watts)

Range:	-214748364.7 kW to 214748364.7 kW
Parameters:	3-phase; per phase if VT is Wye
Accuracy:	± 1.0% of reading or 0.1 kW (whichever is greater) at -0.8 < PF ≤ -1.0 and 0.8 < PF < 1.0

Reactive Power (Vars)

Range:	-214748364.7 kVar to 214748364.7 kVar
Parameters:.	3-phase; per phase if VT is Wye
Accuracy:	± 1.0% of reading or 0.1 kVar (whichever is greater) at -0.2 < PF ≤ 0.2

Apparent Power (VA)

Range:	0 kVA to 214748364.7 kVA
Parameters:	3-phase; per phase if VT is Wye
Accuracy:	± 1.0% of reading or 0.1 kVA (whichever is greater)

Power Factor

Parameters:	3-phase; per phase if VT is Wye
Range:	0.01 Lag to 1.00 to 0.01 Lead
Accuracy:	± 0.02

Watt-hours (positive and negative)

Range:	-2147483.647 MWh to 214748364.7 MWh
Parameters:	3-phase only
Update Rate:	50 ms
Accuracy:	± 2.0% of reading

Var-hours (positive and negative)	
Range:	-2147483.647 MVarh to 214748364.7 MWh
Parameters:	3-phase only
Update Rate:	50 ms
Accuracy:	± 2.0% of reading

COMMUNICATIONS

Ethernet – Base Offering	
Modes:	10/100 Mbps
One Port	RJ45
Protocol	Modbus TCP

Ethernet – Card Option	
Modes	100 MB
Two Ports	ST (with this option both enabled ports are on the communications card; the Ethernet port located on the base CPU is disabled)
Protocols	Modbus TCP, DNP3.0, IEC60870-5-104, IEC 61850 GOOSE, IEEE 1588, SNTP, IEC 62439-3 clause 4 (PRP)

USB	
Standard specification	Compliant with USB 2.0
Data transfer rate	10 MB

Serial	
RS485 port	Isolated
Baud rates	up to 115 kbps
Response time:	10 ms typical
Parity	None, Odd, Even
Protocol	Modbus RTU, DNP 3.0, IEC 60870-5-103
Maximum distance	1200 m (4000 feet)
Isolation	2 kV

WIFI	
Standard specification	IEEE802.11bgn
Range	30 ft (direct line of sight)

Testing and Certification

Test	Reference Standard	Test Level
Dielectric voltage withstand		2.3 kV
Impulse voltage withstand	EN60255-5	5KV
Damped Oscillatory	IEC61000-4-18IEC60255-22-1	2.5 kV CM, 1 kV 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
Power Frequency Immunity	EN61000-4-7/IEC60255-22-7	Class A & B
Voltage interruption and Ripple DC	IEC60255-11	15% ripple, 200msinterrupts
Radiated & Conducted Emissions	CISPR11 /CISPR22/ IEC60255-25	Class A
Sinusoidal Vibration	IEC60255-21-1	Class 1
Shock & Bump	IEC60255-21-2	Class 1
Siesmic	IEC60255-21-3	Class 2
Power magnetic Immunity	IEC61000-4-8	Class 5
Pulse Magnetic Immunity	IEC61000-4-9	Class 4
Damped Magnetic Immunity	IEC61000-4-10	Class 4
Voltage Dip & interruption	IEC61000-4-11	0, 40, 70, 80% dips, 250/300 cycle interrupts
Conducted RF Immunity 0-150khz	IEC61000-4-16	Level 4
Ingress Protection	IEC60529	IP40 front, IP10 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, 2.5 khz
Damped Oscillatory	IEEE/ANSI C37.90.1	2.5KV, 1 Mhz
RF Immunity	IEEE/ANSIC37.90.2	20V/m, 80 MhZ to 1Ghz
ESD	IEEE/ANSIC37.90.3	8KV CD/ 15 kV AD
Safety	UL508	e83849 NKCR
	UL C22.2-14	e83849 NKCR7
	UL1053	e83849 NKCR

Approvals		
	Applicable Council Directive	According to
CE compliance	Low voltage directive	EN60255-5 / EN60255-27
	EMC Directive	EN60255-26 / EN50263 EN61000-6-2 / EN61000-6-4
North America	cULus	UL508 UL1053 C22.2.No 14
ISO	Manufactured under a registered quality program	ISO9001

Environmental	
Ambient temperatures:	
Storage/Shipping: Operating:	- 40C to 85C -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:	III
Ingress Protection:	IP54 Front, IP10 back

Ordering

	850	E	**	NN	**	H	N	N	A	*	N	G	*	*	*	*	*	*	*	*	*	N	Description
Base Unit	850																						English Language; High Voltage PS, Graphical Control Panel
Language		E																					English
Phase Currents - Bank 1/2			P1																				1A three phase current inputs
			P5																				5A three phase current inputs
Ground Currents					G1																		1A ground input
					G5																		5A ground input
					S1																		1A ground + 1A sensitive ground input
					S5																		5A ground + 5A sensitive ground input
Power Supply						H																	110 - 250 V dc/110 - 230 Vac
Slot F - HV I/O									A														2 Form A (Vmon), 3 Form C, 7 Digital Inputs (Low / High voltage, Int/Ext supply)
Slot G - HV I/O										N													None
										A													2 Form A (Vmon), 3 Form C, 7 Digital Inputs (Low / High voltage, Int/Ext supply)
Faceplate												G											Color Graphical Display
Current Protection													S										Basic = 50P, 50N, 50G, 51P, 51N, 51G
													M										Standard = Basic + 50SG, 50_2, 51SG, 51_2, RGF
													A										Advanced = Standard + 49,67P, 67N, 67G, 67SG, 67_2, Load Encroachment, Broken Conductor
Voltage Monitoring & Protection														S									Standard = 27P, 27X, 59P, 59N, 59X, 81O, 81U
														P									Advanced = Standard + 25, 32, 32N, 55, 59_2, 81R
Control															B								Basic
															F								Standard = Basic + Flexlogic, CLP, 50BF, Trip Bus
															C								Advanced = Standard + Autorelcose, Bus Transfer (Requires voltage option P)
Monitoring																B							Basic
																C							Basic + Advanced Breaker Health
Communications																	S	E					Standard = Front USB, 1 x Rear RS485 : Modbus RTU, DNP3.0, IEC60870-5-103 + 1 x Ethernet (Modbus TCP)
																	1	E					Advanced = Front USB, 1 x Rear RS485 + 2 x Ethernet Fiber, MODBUS RTU / TCP, DNP3.0, IEC 60870-5-103/104, 1588, SNTP
																	1	P					Advanced + PRP
																	2	E					Advanced + PRP + IEC 61850
Fiber Optic Connector																			N				None
																			S				ST, Multi-mode 850nm
Wireless Communication																				N			None
																				W			WiFi 802.11
Security																					B		Basic
																					A		Advanced - CyberSentry

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