

# SEL-787L

## Line Current Differential Relay

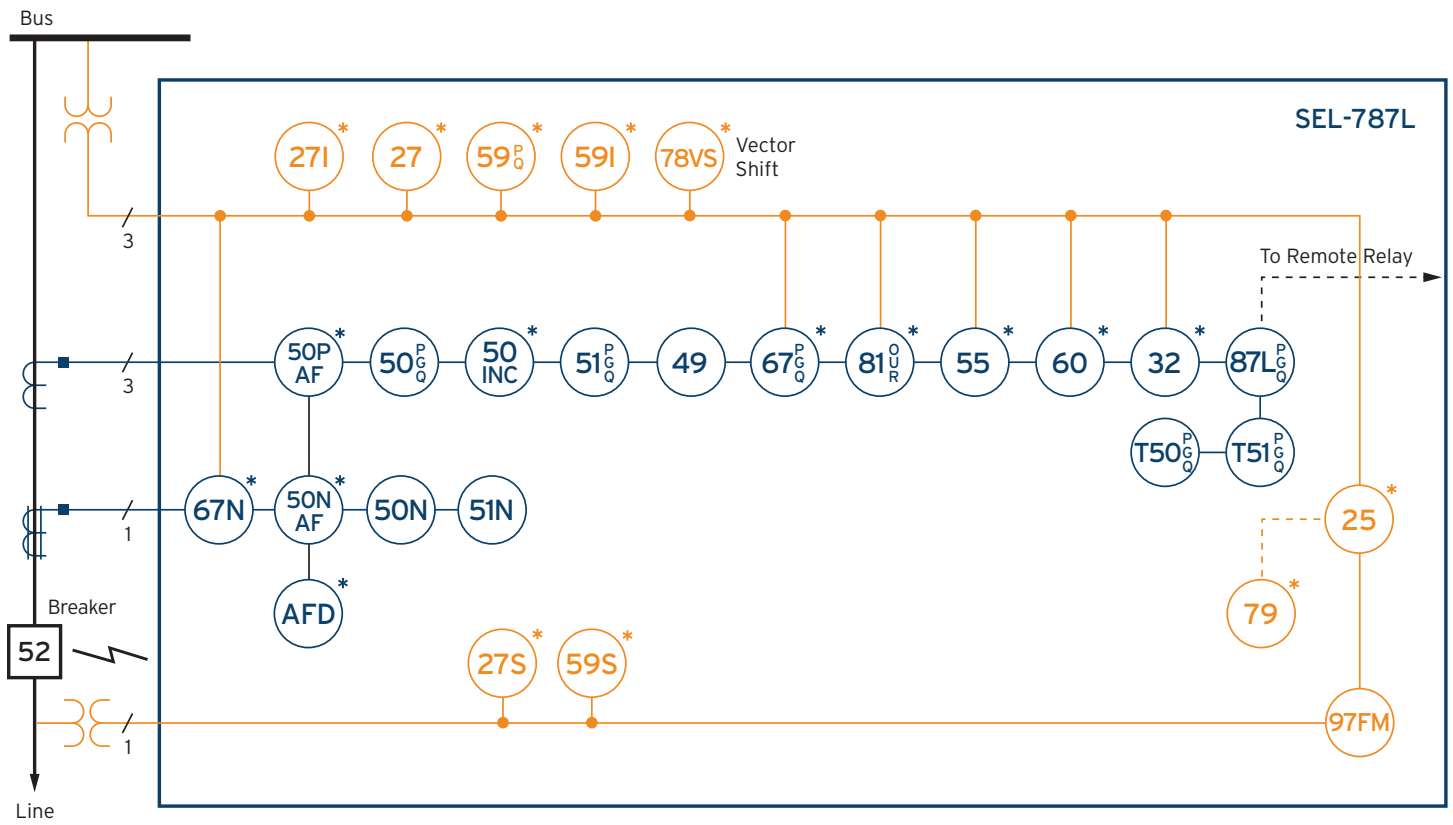


### Secure and dependable line differential protection for lines and feeders

- Protect overhead and underground lines or industrial power networks with a compact line current differential solution.
- Select from a variety of protection options, such as directional overcurrent, earth fault, and voltage- and frequency-based protection, for complete feeder protection.
- Apply a single-mode, IEEE C37.94-compatible direct serial fiber communications interface with a range up to 25 km.
- Prevent misoperation due to channel failure by using the channel monitoring feature, which also provides communication quality metrics.
- Easily integrate the SEL-787L into your system using Ethernet connections that support IEC 61850 Edition 2.1, DNP3, EtherNet/IP, and Modbus protocols.



# Functional Overview



\*Optional Feature



## ANSI Numbers/Acronyms and Functions

25	Synchronism Check*
27S	Synchronism-Check Undervoltage*
32	Directional Power*
49	IEC Cable/Line Thermal
49R	Resistance Temperature Detector (RTD) Thermal*
50	Adaptive Overcurrent
50 (N,P,G,Q)	Overcurrent (Neutral, Phase, Ground, Negative Sequence)
50AF	Arc-Flash Overcurrent
T50 (P,G,Q)	87 Tapped Load Overcurrent Elements (Phase, Ground, Negative Sequence)
51 (N,P,G,Q)	Time Overcurrent (Neutral, Phase, Ground, Negative Sequence)
T51 (P,G,Q)	87 Tapped Load Inverse-Time Overcurrent Elements (Phase, Ground, Negative Sequence)
52PB	Trip/Close Pushbuttons
55	Power Factor*
59 (P,Q)	Definite-Time Overvoltage (Phase, Negative Sequence)*
59S	Synchronism-Check Overvoltage*
60	Loss of Potential*
67 (P,G,Q)	Directional Overcurrent (Phase, Ground, Negative Sequence)*
67N	Directional Neutral Overcurrent*
78VS	Vector Shift*
79	Autoreclosing*
81 (O,U,R,RF)	Over-/Underfrequency (Rate, Fast Rate)*
87L (P,G,Q)	Line Differential (Phase, Ground, Negative Sequence)

## Additional Functions

85 RIO	SEL MIRRORING BITS® Communications
97FM	Frequency Component Detection
AFD	Arc-Flash Detector*
BCD	Broken Conductor Detection
BW	Breaker Wear Monitoring
CLPU	Cold-Load Pickup
DFR	Event Reports
HBL	Harmonic Blocking
HIZ	SEL Arc Sense™ Technology (AST)*
HMI	Operator Interface
LDE	Load Encroachment
LDP	Load Data Profiling
LEA	Rogowski Coil or LPCT Inputs and Low-Energy Analog (LEA) AC Voltage Inputs (8 Vac RMS)
LGC	SELogic® Control Equations
LOC	Fault Locator
PDD	Phase Discontinuity Detection
PMU	Synchrophasors
RTD	10 Internal RTD Inputs*
RTU	Remote Terminal Unit
SBM	Station Battery Monitor
SER	Sequential Events Recorder
WEB	Web Server

\*Optional Feature

# Key Features

## Economical Line Current Differential

Apply the SEL-787L as primary protection for two-terminal lines, critical feeders, and distributed generation tie lines. The differential element operates on percentage-restrained characteristics with settable normal and secure mode slopes. Disturbance detection logic enables the 87L function to operate with exceptional security and sensitivity without the need for user settings. External fault detection logic provides additional security against CT saturation under heavy external fault conditions. Built-in charging current compensation improves the sensitivity and speed of differential protection for long lines.

## Flexible 87L Communications Configurations

Choose the 87L communications channel option that fits your application needs. The SEL-787L supports IEEE C37.94-encoded 850 nm multimode fiber for 1 km point-to-point or MUX applications and 1,310 nm single-mode fiber for 25 km point-to-point applications.

## Directional Overcurrent Protection

A directional control option allows the relay to identify faulted feeders on a multifeeder bus, while Best Choice Ground Directional Element<sup>®</sup> logic optimizes directional element performance and eliminates the need for many directional settings.

## Reliable 87L Communications

To aid in commissioning and to help maintain security and dependability, the SEL-787L provides a set of channel monitoring and alarming functions. It provides an 87L communications report to visualize and summarize the basic 87L configuration as well as real-time and historical channel monitoring and alarming values. The report includes 87L configuration information, diagnostics, channel health information, a channel delay histogram, and worst-case channel delay information.

## LEA Sensor Inputs

Apply the SEL-787L in applications that use low-energy current/voltage sensors. LEA sensors for measurement of primary voltages and currents offer excellent linearity, a wide dynamic range, reduced size and weight, and enhanced personnel safety. The LEA current/voltage input card supports three current channels that are either Rogowski coil or low-power current inputs, three LEA voltage sensor inputs, and one 200 mA neutral input. LEA current and voltage channels accept an RJ45 connector input, and the 200 mA neutral channel accepts a terminal block input.

## Expanded Arc-Flash Solutions

Improve safety with options for either four or eight arc-flash detection (AFD) inputs to improve arc-flash coverage. The SEL-787L offers combined light detection and high-speed overcurrent detection for arc-flash events. This combination provides the ideal solution for speed and security.

## 5-Inch (12.7 cm) Color Touchscreen Display

Access metering data, view event records, control relay operations, edit settings, and more without a laptop. The SEL-787L touchscreen can be configured to display an English or Spanish language interface. The color touchscreen clearly indicates breaker and primary equipment status, improving safety during maintenance operations.

## High-Impedance Fault Detection

Detect downed conductors, even on poorly conducting surfaces, with AST. The AST algorithms detect arcing produced by some high-impedance faults and will send an alarm or trip the breaker. This technology provides an added level of protection over conventional feeder protection methods.

## Islanding Protection

Detect islanding conditions using the vector shift function. The SEL-787L quickly identifies waveform changes during islanding operations and provides logic to support a systematic response to changing grid conditions.

## Automation and Control

Apply the SEL-787L on feeders to provide protection, automation, and control capabilities, all in one package. SELoGic torque control equations support many automated applications without the need for additional automation controllers. The configurable front-panel pushbuttons can replace conventional panel controls and simplify overall applications and wiring. The 14 digital inputs (DI) card option expands available contact inputs for enhanced automation solutions.

## Thermal Protection

Protect cable and feeder insulation against thermal damage using the IEC 49 cable/line thermal element. It extends conductor life and provides backup protection for the overcurrent elements.

### Reliable in Harsh Environments

All SEL relays are designed to operate in harsh environments where other relays may fail. The SEL-787L operates in extreme conditions, with an operating temperature of  $-40^{\circ}$  to  $+85^{\circ}\text{C}$  ( $-40^{\circ}$  to  $+185^{\circ}\text{F}$ ), and is designed and tested to exceed applicable standards, including vibration, electromagnetic compatibility, and adverse environmental conditions.

### Open-Conductor Detection

Apply the SEL-787L to detect and isolate open conductors. The SEL-787L incorporates phase discontinuity detection and optional broken conductor detection to provide a reliable solution for open-conductor faults that convert to high-impedance faults.

### Wildfire Risk Reduction

Identify downed conductors and minimize wildfire risk by detecting high-impedance faults. SEL's unique AST detects and clears faults that might not be detected by traditional overcurrent protection.

### Flexible Communications

Advanced protocols support communications using legacy and modern supervisory and control systems. These protocols include IEC 61850 Edition 2.1, the Rapid Spanning Tree Protocol (RSTP), EtherNet/IP, the IEEE 1588 Precision Time Protocol (PTP), IEC 60870-5-103, DNP3, Modbus TCP/IP, Telnet, FTP, SNTP, MIRRORRED BITS communications, Fixed GOOSE, and ASCII. In addition, the IEC 61850 test mode in the SEL-787L enables in-service testing, which reduces commissioning time.



# Product Overview



# Touchscreen Overview

The 5-inch (12.7 cm) color display with a resolution of 800 × 480 offers direct navigation via a capacitive touchscreen.

A full onscreen keyboard facilitates easy adjustment of settings.

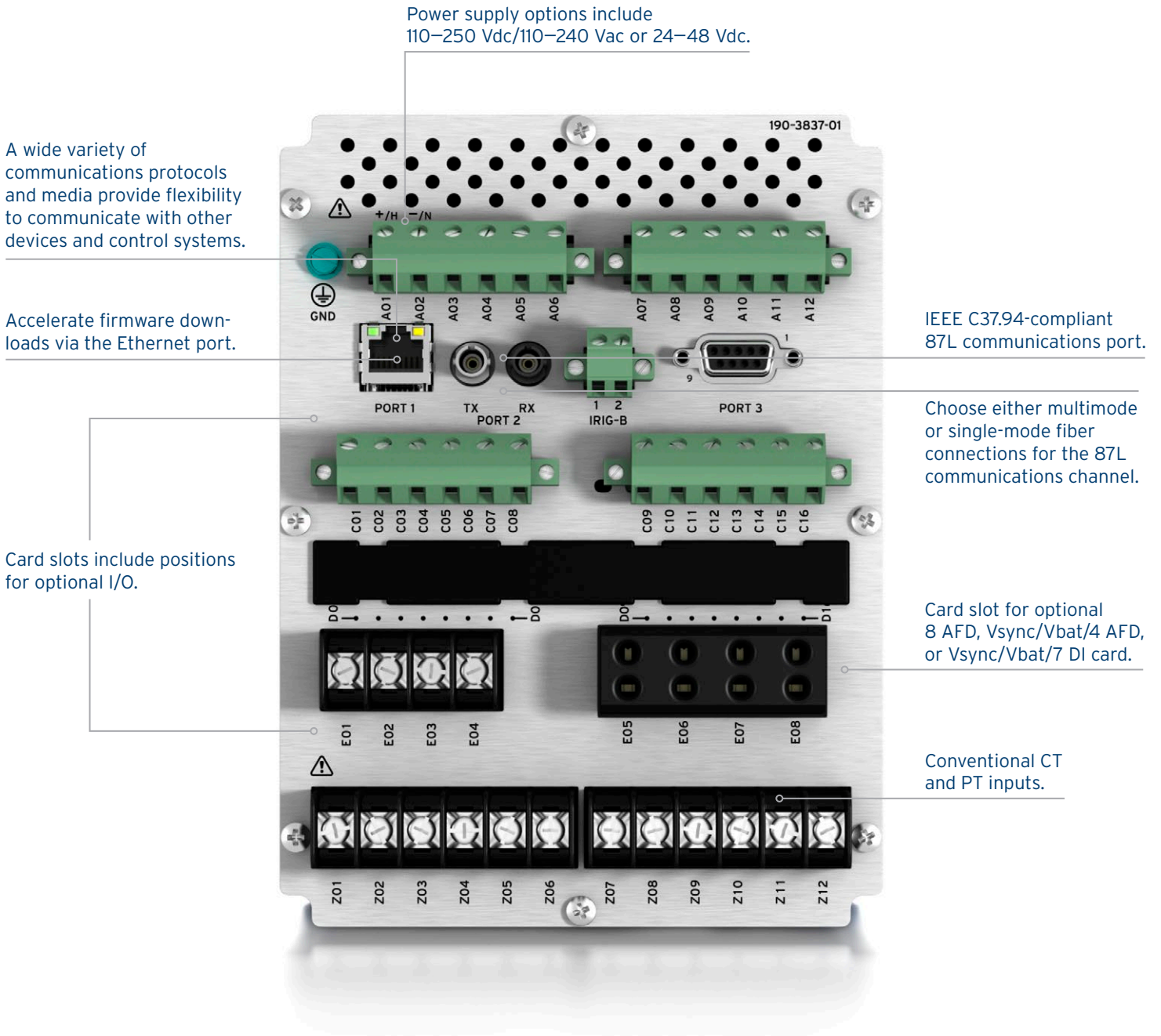
The programmable home pushbutton allows users to easily return to the default home screen or to a variety of meter, report, or monitor screens.

Folders and applications provide quick access to bay screens, metering and monitoring data, reports, settings, and more.

The front panel is available in English or Spanish.



## Conventional CT and PT Input Option





## LEA Current and Voltage Inputs Option

Various contact input voltage levels are available (24, 48, 110, 125, 220, and 250 Vdc/Vac).

Select dual Ethernet ports for redundant communication.

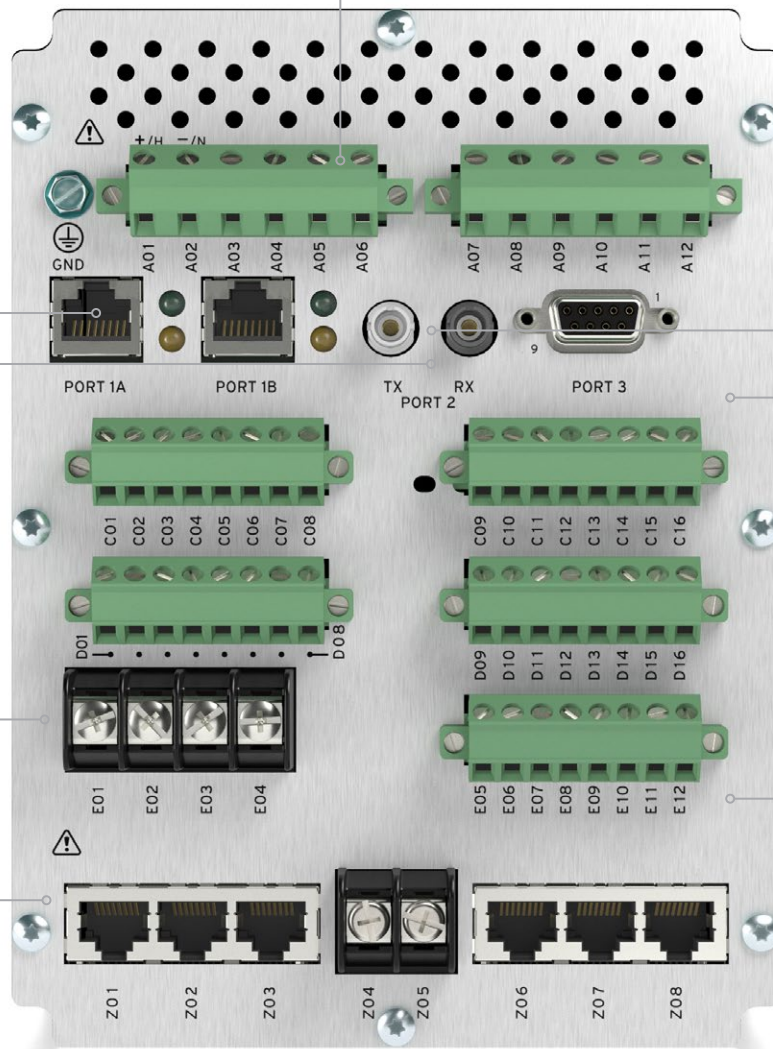
IEEE C37.94-compliant 87L communications port.

Choose either multimode or single-mode fiber connections for the 87L communications channel.

Card slot for optional 8 AFD, Vsync/Vbat/4 AFD, or Vsync/Vbat/7 DI card.

Card slots include positions for optional I/O.

LEA current and voltage sensor inputs.\*



\*Compliant with IEC 61869-10, -11 standards.

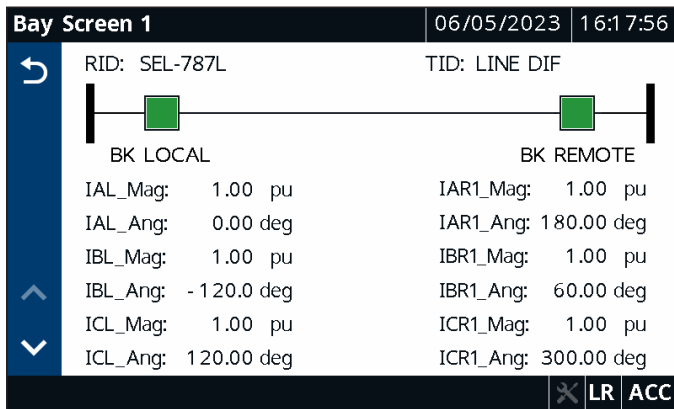
# Touchscreen Display Features and Functions

The SEL-787L 5-inch (12.7 cm), 800 × 480 color touchscreen display mimics a one-line diagram for bay control and monitoring. With it, you can view metered quantities, phasor diagrams, relay settings, event summaries, target statuses, and SER data.

## Bay Screens and Bay Control

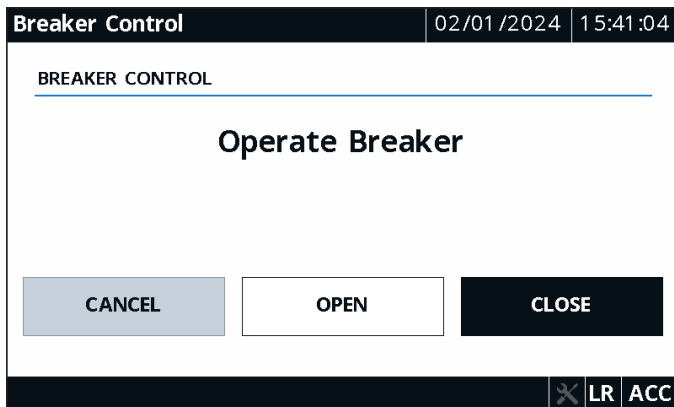
Select from predefined bay screens, or configure as many as five custom bay screens using the acSELEATOR<sup>®</sup> Bay Screen Builder SEL-5036 Software and acSELEATOR QuickSet<sup>®</sup> SEL-5030 Software. You can control one breaker, eight two-position disconnects, and two three-position disconnects; can monitor a remote breaker; and can view analog and digital data in a contextual display.

To control a breaker or disconnect, simply tap the Bay Screens application on the home screen and then the breaker or disconnect you want to control.



Next, enter your Level 2 password and tap Submit. The onscreen keyboard allows you to quickly and easily enter passwords, search for Relay Word bits, and enter settings.

Finally, tap Open or Close to control the breaker. When asked to confirm the action before the operation is completed, choose Yes or No.

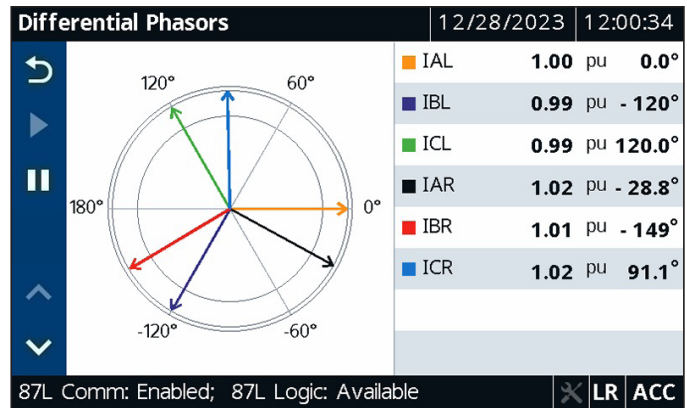


## Meter Fundamentals

View the real, reactive, and apparent power of each phase in your system, and monitor the power factor information to determine if the phase current leads or lags the phase voltage.

## Meter Phasors

View a graphical and textual representation of the real-time voltages and currents in a power system during balanced and unbalanced conditions. The meter differential phasor screen allows representation of aligned local and remote relay current phasors, operate and restraint current magnitudes, and the status of differential element Relay Word bits. By analyzing the phasors, you can determine power system conditions.



## Meter Energy

Display the real, reactive, and apparent energy metering quantities imported and exported by your system. You can reset the energy values via the display and record the time and date of reset. Whether your system is a net energy producer or consumer, metered quantities accurately account for the power system energy flow.

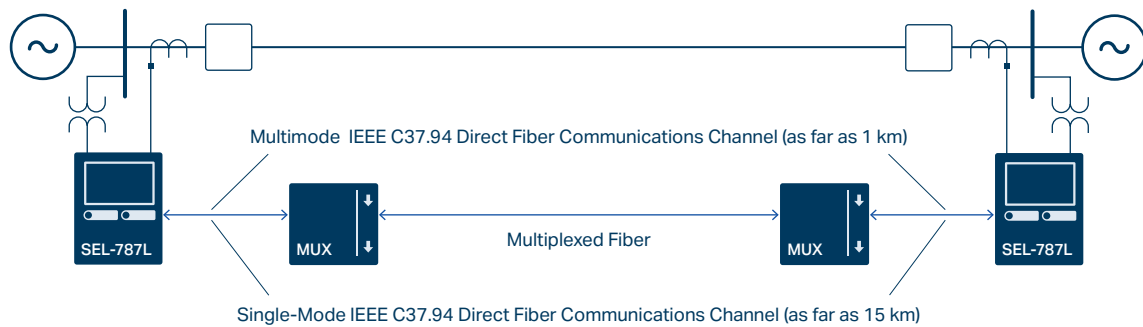
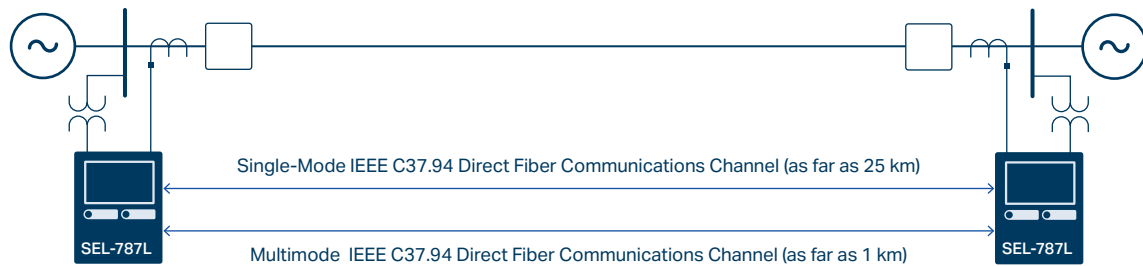
# Applications

## Two-Terminal Line Current Differential Protection

Add line current differential protection for your critical lines and feeders. Overcurrent supervision, external fault detection, and disturbance detection logic enable the 87L function to operate with exceptional security and sensitivity. The SEL-787L supports data exchange over a serial fiber network to provide line current differential protection to two terminals.

## Coordinate Protection

Use SEL MIRRORRED BITS, IEC 61850 GOOSE, or Fixed GOOSE communications to coordinate upstream protection if a fault occurs. Coordination and fast bus trip schemes allow short delays (two or three cycles) for backup protection, reducing arc-flash energy.

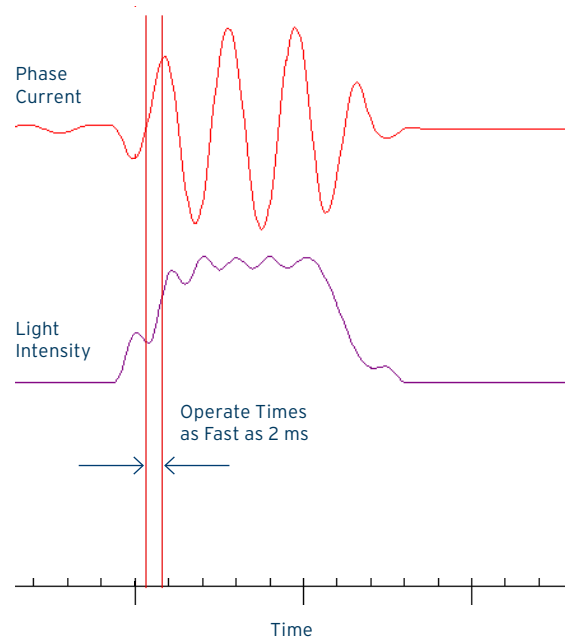


# Reduce Arc-Flash Hazards

The SEL-787L combines light-sensing technology with fast overcurrent protection to provide high-speed arc-flash detection as fast as 2 milliseconds without false tripping.

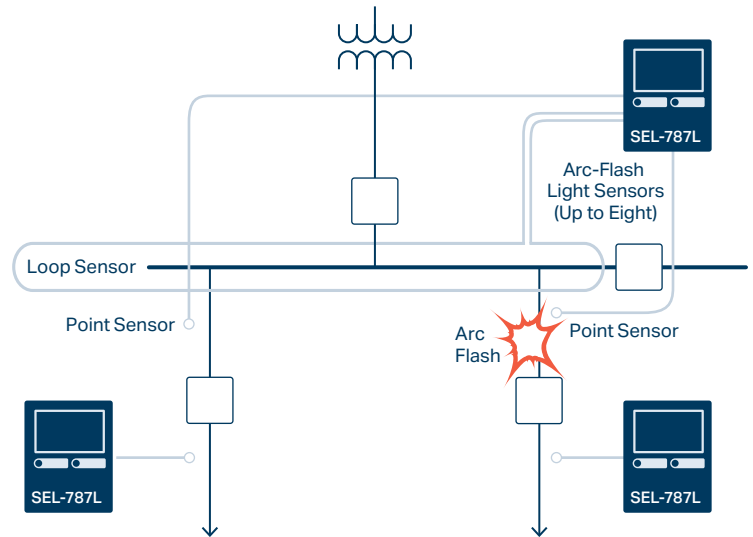
Fast and secure arc-flash mitigation reduces the incident energy of arc-flash events. SEL-787L relays also have integration and communications features for secure remote access to help you keep out of the danger zone while gathering important real-time and historical data from the relays. You can coordinate protection for faster clearing times and stay outside the danger zone completely with wireless or remote communications.

If you must be in the danger zone, know the dangers and wear appropriate personal protective equipment. If you do not know the arc-flash ratings and zones for your gear, the SEL Engineering Services team provides professional arc-flash hazard studies and practical approaches to mitigate arc-flash risks.



## Arc-Flash Mitigation

Improve safety and prevent damage with arc-flash detection in the SEL-787L. Point sensors, window sensors, loop sensors, or a combination protect a variety of switchgear configurations. You can order either four or eight arc-flash sensor inputs. The high-speed output contacts obtain the fastest response to arcing faults.

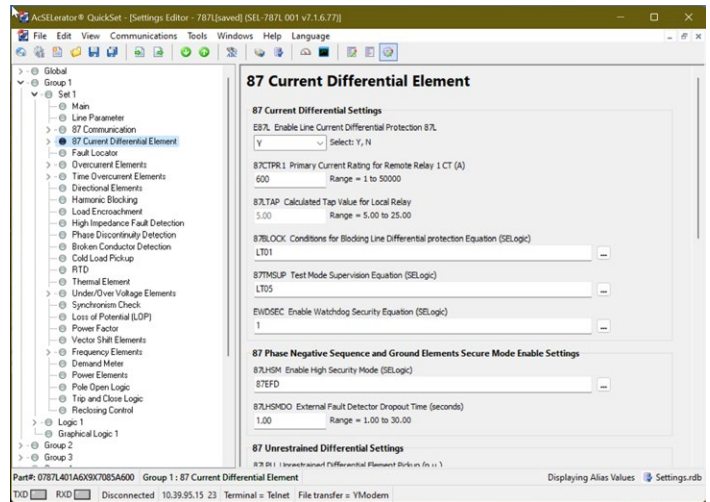


# Easy to Set and Use

## Use QuickSet to Set, Monitor, and Control the SEL-787L

With QuickSet, you can:

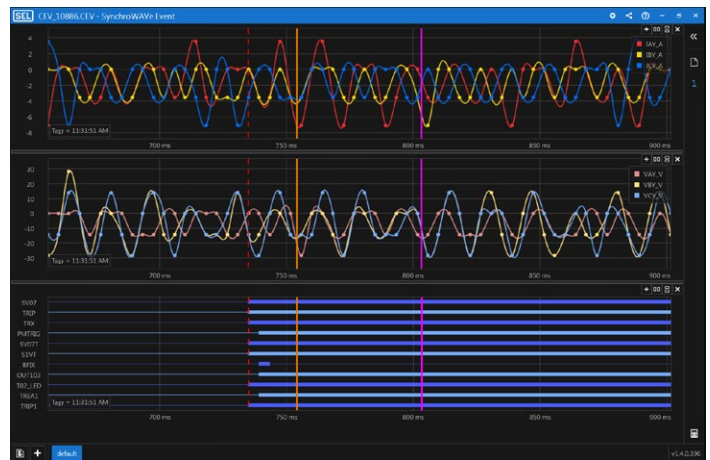
- Save engineering time while keeping flexibility. Communicate with the SEL-787L through any ASCII terminal, or use the QuickSet graphical user interface.
- Develop settings offline with a menu-driven interface and completely documented help screens. You can speed up installation by copying existing settings files and modifying application-specific items.
- Simplify the setting procedure with the rules-based architecture to automatically check interrelated settings. Out-of-range or conflicting settings are highlighted for correction.



## Use SEL-5601-2 SYNCHROWAVE® Event Software to Retrieve and Display Event Reports Recorded by the SEL-787L

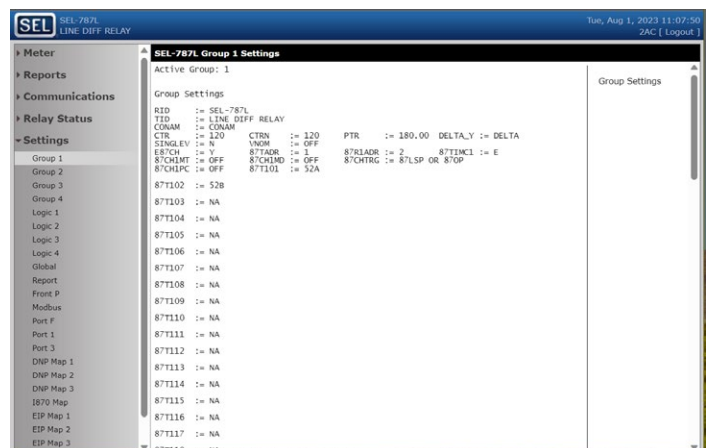
With SYNCHROWAVE Event, you can:

- Display event report oscillograms. You can view each report as a plot of magnitude versus time and select analog and digital points to build a custom display. You can analyze arc-flash events using light intensity and phase current waveforms recorded during the arc fault.
- Display phase and symmetrical component phasors. Displaying the phasor view of electrical data helps you better understand asymmetrical, three-phase faults. You can build a custom plot using per-phase and symmetrical component sequence currents and voltages.
- Retrieve event reports using serial or Ethernet communications links.



## Get Information Easily With the Integrated Web Server

Access basic SEL-787L information on a standard Ethernet network with the built-in web server. You can view the relay status, SER data, metering information, and settings with easy access within a local network. For increased security, web server access requires a relay password and the information is limited to a read-only view. You can also upgrade relay firmware through the web server.



# SEL-787L Options

## Expansion Cards

4 Digital Inputs (DI), 4 Digital Outputs (DO)

4 DI, 4 DO With High-Speed, High-Current DO

4 DI, 3 DO (2 Form C, 1 Form B)

3 DI, 4 DO, 1 Analog Output (AO)

4 Analog Inputs (AI), 4 AO

8 AI

8 DI

14 DI

10 RTD Inputs

8 DO

Three-Phase AC Voltage Inputs (300 Vac)

LEA Voltage Inputs (8 Vac RMS)

LEA Voltage Sensor Inputs, Rogowski Coil/LPCT Inputs, and Conventional 200 mA Sensitive Neutral Input

8 AFD Inputs

Vsync, Vbat, 4 AFD Inputs

Vsync, Vbat, 7 DI

## Other Options

Conformal Coating

Configurable Labels

SEL-4520 Arc-Flash Test Module

SEL-C804/SEL-C814 Fiber-Optic AFD Sensors and Accessories



Order either four or eight arc-flash sensor inputs.

## Retrofit Replacement Kits

Mount the SEL-787L into multiple locations using our complete line of mounting and enclosure options. You can choose from panel-mount, rack-mount, wall-mount, indoor, or outdoor configurations.

No cutting or drilling is required when you use the optional mounting kits. Replacing existing protection is quick and easy!

Visit [selinc.com/applications/mountingselector](http://selinc.com/applications/mountingselector) to see the complete selection of mounting and enclosure kits.



# SEL-787L Specifications

## General

<b>Displays</b>	2 × 16-character LCD 5-inch (12.7 cm) color touchscreen display, 800 × 480 pixels
<b>AC Current Inputs</b>	5 A or 1 A phase and 5 A, 1 A, or 200 mA neutral
<b>Rogowski Coil-Based AC Current Inputs (RJ45)</b>	30 Vac (phase-to-neutral) continuous, $\pm 185 V_{\text{peak}}$ , 200 Vac for 10 seconds Compliant with IEC 61869-10 standard
<b>LPCT Inputs (RJ45)</b>	4 Vac continuous, $\pm 11.3 V_{\text{peak}}$ , 200 Vac for 10 seconds
<b>AC Voltage Inputs</b>	300 Vac continuous, 600 Vac for 10 seconds
<b>LEA Voltage Inputs</b>	8 Vac (phase-to-neutral), $\pm 12 V_{\text{peak}}$ , 300 Vac for 10 seconds
<b>LEA Voltage Sensor Inputs (RJ45)</b>	8 Vac (phase-to-neutral), $\pm 12 V_{\text{peak}}$ , 200 Vac for 10 seconds Compliant with IEC 61869-11 standard
<b>Output Contacts</b>	The relay supports Form A, B, and C outputs.
<b>Optoisolated Control Inputs</b>	DC/AC control signals: 250, 220, 125, 110, 48, or 24 V As many as 26 inputs are allowed in ambient temperatures of 85°C (185°F) or less. As many as 34 inputs are allowed in ambient temperatures of 75°C (167°F) or less. As many as 44 inputs are allowed in ambient temperatures of 65°C (149°F) or less.
<b>Frequency and Phase Rotation</b>	System frequency: 50, 60 Hz Phase rotation: ABC, ACB Frequency tracking: 15–70 Hz
<b>Communications Protocols</b>	SEL (Fast Meter, Fast Operate, and Fast SER), Modbus TCP/IP, Modbus RTU, DNP3, FTP, IRIG-B, Telnet, SNMP, EtherNet/IP, IEEE 1588 PTP, IEC 61850 Edition 2.1, IEC 60870-5-103, the Parallel Redundancy Protocol (PRP), RSTP, Fixed GOOSE, MIRRORRED BITS communications, and IEEE C37.118-2005 (synchrophasors)
<b>Differential Communications</b>	1,310 nm single-mode, IEEE C37.94-compliant (25 km point-to-point range) 850 nm multimode, IEEE C37.94-compliant (1 km point-to-point range)
<b>Language Support</b>	English and Spanish
<b>Power Supply</b>	110–250 Vdc or 110–240 Vac Input voltage range: 85–300 Vdc or 85–264 Vac 24–48 Vdc Input voltage range: 19.2–60 Vdc
<b>Operating Temperature</b>	–40° to +85°C (–40° to +185°F) Note: LCD contrast is impaired for temperatures below –20°C (–4°F) and above +70°C (+158°F).
<b>Certifications</b>	To view certifications for the SEL-787L, please visit <a href="https://selinc.com/company/certifications">selinc.com/company/certifications</a> .

**SEL SCHWEITZER ENGINEERING LABORATORIES**

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