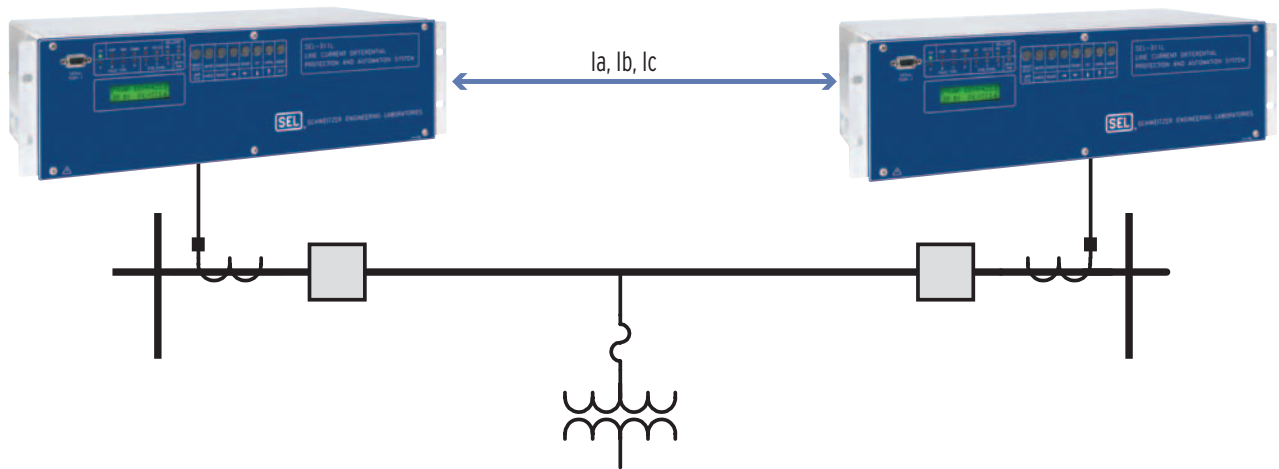# Protect Lines With Easy-to-Use Current Differential Relays

IEC 61850 Compatible

Ia, Ib, Ic

Use SEL-311L Line Current Differential Relays with full-scheme backup for easy-to-apply high-speed line protection.

Features and Benefits

■ **Protect**

Apply single-pole or three-pole subcycle current differential protection. Reduce protection system costs by using built-in distance and/or overcurrent backup functions.

■ **Simplify**

Innovative operating characteristic makes settings easy. No fault studies are required for most differential applications.

■ **Optimize**

Use single or dual channels for reliability. Apply on two- or three-terminal lines with or without tapped lines.

■ **Monitor**

Incorporate synchrophasor measurements into wide-area protection and control systems. Use high-accuracy time correlation to improve event report analysis.
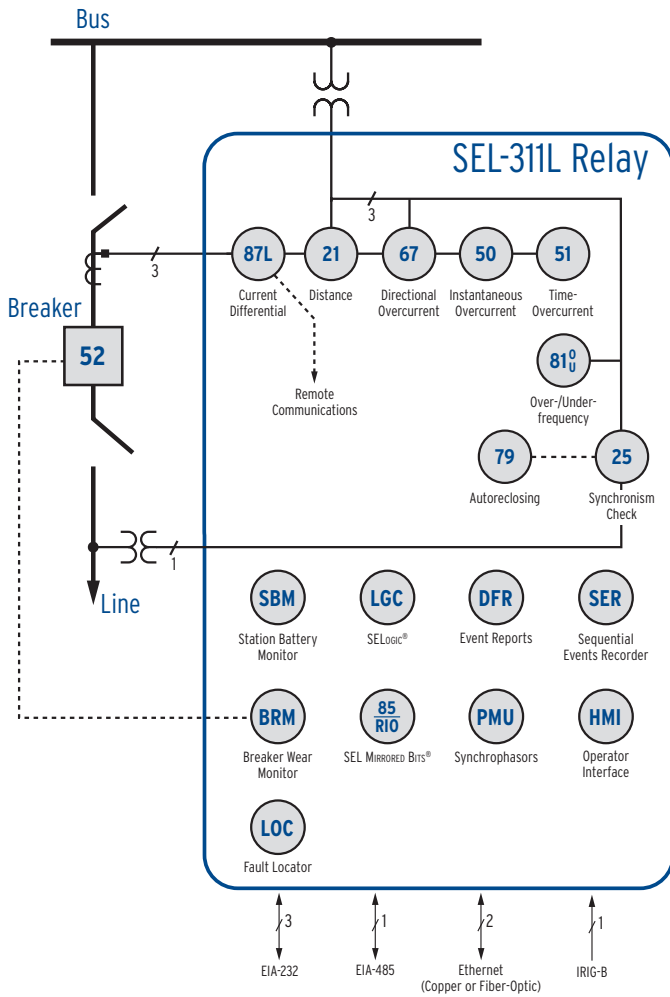
■ **Automate**

Reduce total project construction and operation costs by integrating four-shot recloser and relay logic operators into your automation system.

■ **Integrate**

Improve station integration with serial and Ethernet communications. Use IEC 61850 communications for interoperability between relays with a select-before-operate function for added operational security. Increase communications dependability with dual failover Ethernet.

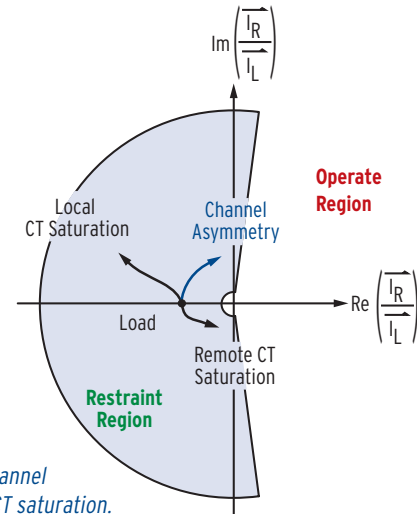## *Making Electric Power Safer, More Reliable, and More Economical*®

Functional Overview

Bus

Breaker

52

Line

SEL-311L Relay

87L Current Differential	**21** Distance	**67** Directional Overcurrent	**50** Instantaneous Overcurrent	**51** Time-Overcurrent

Remote Communications

81$_U^O$ Over-/Under-frequency

79 Autoreclosing

25 Synchronism Check

SBM Station Battery Monitor

LGC SELogic®

DFR Event Reports

SER Sequential Events Recorder

BRM Breaker Wear Monitor

85 RIO SEL Mirrored Bits®

PMU Synchrophasors

HMI Operator Interface

LOC Fault Locator

EIA-232 3
EIA-485 1
Ethernet (Copper or Fiber-Optic) 2
IRIG-B 1

Superior, Sensitive, and Simple

- The SEL-311L Relay uses a vector ratio of the local and remote phase and sequence currents (Alpha Plane restraint) to provide high-speed protection, independent of line loading, CT saturation, or tapped load.

- Proven negative-sequence elements provide sensitivity for unbalanced faults. High-impedance fault detection gives secure operation for faults below load current or line-charging current levels.
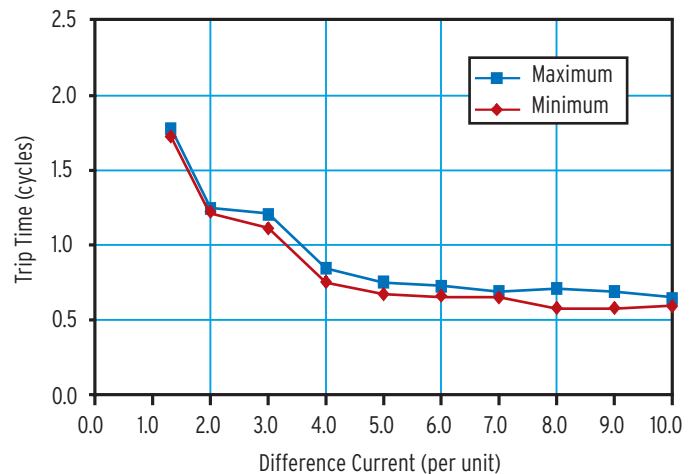
Alpha Plane Restraint and Operate Regions

$Im\left(\dfrac{\overrightarrow{I_R}}{\overrightarrow{I_L}}\right)$

Local CT Saturation

Channel Asymmetry

Operate Region

Load

$Re\left(\dfrac{\overrightarrow{I_R}}{\overrightarrow{I_L}}\right)$

Remote CT Saturation

Restraint Region

Accommodate channel asymmetry and CT saturation.

- Use factory default settings for basic line current differential applications. Configure the channels, select the CT ratios, and the SEL-311L Relay is ready for operation.

- Improve stability for critical systems using optional single-pole differential elements for high-speed fault clearing.
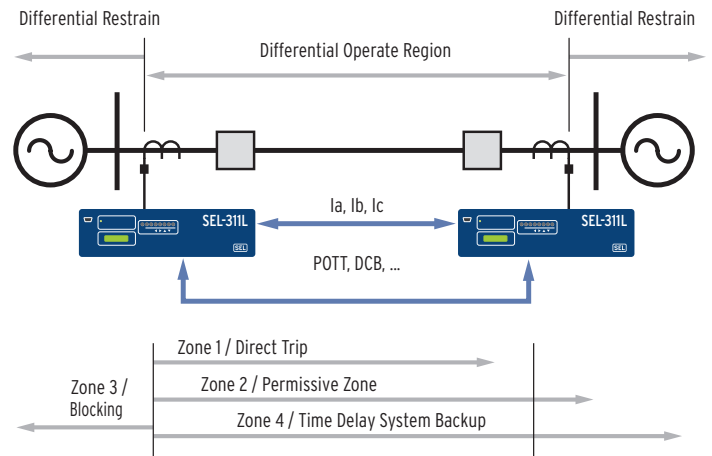
Differential Trip Speed

Legend: Maximum, Minimum

Y-axis: Trip Time (cycles) — 0.0 to 2.5
X-axis: Difference Current (per unit) — 0.0 to 10.0

High-speed protection.

Full Scheme and Overcurrent Backup Included

- Backup protection in the SEL-311L Relay is identical to the complete functionality of the SEL-311C Relay, including four zones of positive-sequence, memory-polarized distance relaying. Sufficient memory time during zero-voltage faults allows distance element backup on short lines. Best Choice Ground Directional Element® overcurrent relaying automatically selects the optimal directional unit for changing system conditions. Use MIRRORED BITS® communications or a traditional channel interface for independent, communications-assisted tripping (e.g., POTT and DCB).

- Set independent backup upon loss of differential channels.

- A complete four-shot recloser with synchronism check is included. Use SELOGIC® control equations to change the protection based on shot count. Use local, remote, and latched control switches to customize the protection system. Change the reclosing logic based on fault type or an external input.

- Six levels of overfrequency and/or underfrequency are included for load shedding and restoration. Combine with protective functions using SELOGIC control equations to optimize relay response, preserving system integrity.

Differential Restrain · Differential Operate Region · Differential Restrain

Ia, Ib, Ic

POTT, DCB, …

Zone 1 / Direct Trip
Zone 2 / Permissive Zone
Zone 3 / Blocking
Zone 4 / Time Delay System Backup

CT Characteristic Security

- Remain secure during external faults when CTs saturate at one or more terminals.

- Accommodate CT saturation, even in the first half cycle.

- Use existing CTs without ratio or characteristic matching.

Ia Amps Secondary

Local

Remote

Time in Seconds
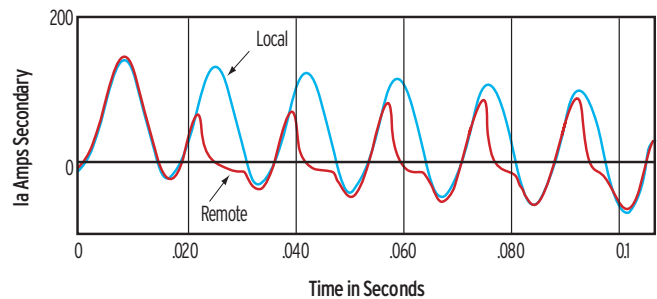
Flexible Channel Selection

- Select either single- or dual-channel operation using any combination of ITU-T G.703, EIA-422 (56 or 64 Kbps), multimode fiber, or single-mode fiber.

- Use hot standby channel to increase dependability and security. Protection is not delayed and security is not compromised when the primary channel fails.

- Accommodate nonsymmetrical channel delays and channel-delay changes without desensitizing or delaying protection.

Ia, Ib, Ic
Primary Channel
Hot Standby Channel
Ia, Ib, Ic
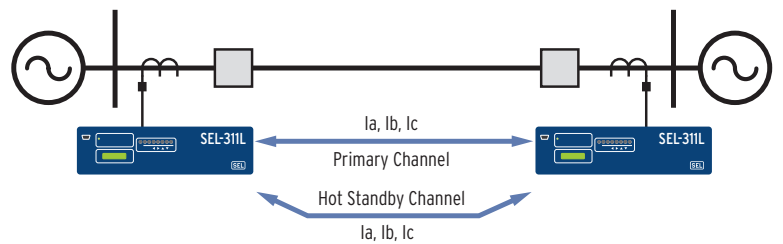
Tapped Line Coordination

- Use SEL-311L Relays on tapped lines without misoperation due to faults on the tap. Differential time-overcurrent elements calculate tap current to coordinate with tap protection.

- Choose between fuse-saving and trip-saving schemes for tapped loads. Use recloser shot count to select protection characteristic.

Tapped Load
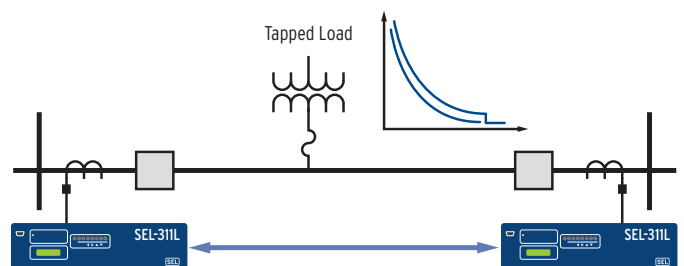
SEL-311L Line Current Differential Protection and Automation System

Three-Terminal Application

- Protect three-terminal lines with two or three channels. If three channels are used, the loss of any channel does not compromise protection.
- Provide high-speed operation for all terminals, even with weak infeed.
- Apply a third SEL-311L Relay at a tapped load, even without a breaker. Differential elements provide high-speed line operation without overtripping for faults on the tap.

Optional Channel
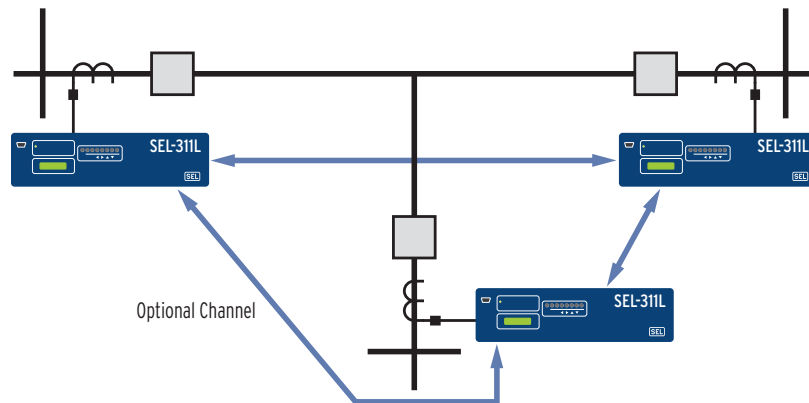
Wide-Area Measurements

Synchrophasor Measurements
View absolute phase angles from across the power system.

High-Accuracy Timing
Use precise time stamping to improve analysis of wide-area events.

SYNCHRO*WAVE*®

SYNCHROWAVE® Software concentrates and displays data from across the power system.

General Specifications

Output Contacts (14 total)

6 High-Speed, High I/C Contacts

Pickup time <200 μs

6 A continuous

30 A make per IEEE C37.90-1989

Break 10 A

8 Standard Contacts

Pickup time <5 ms

6 A continuous

30 A make per IEEE C37.90-1989

Ethernet Communication

Optional Ethernet ports (specify 10BASE-T or 100BASE-FX* when ordering) with dual failover

Web Server–3 simultaneous server, read-only sessions to host

Differential Ports

Any combination of one or two of the following:

ITU-T G.703 codirectional at 64 Kbps

EIA-422 at 56/64 Kbps

850 nm multimode fiber*

1300 nm single-mode fiber*

Operating Temperature

−40° to +85°C (−40° to +185°F)

* Eye-safe, Class 1 laser product per EN 60825-1