



# SEL-551/SEL-551C Overcurrent and Reclosing Relay



## Major Features and Benefits

- Phase, ground, and negative-sequence overcurrent protection
- US and IEC time-overcurrent curves
- Multiple-shot reclosing relay with sequence coordination
- Enhanced SELOGIC<sup>®</sup> control equations to create traditional or advanced schemes
- Local/remote control logic to switch schemes, operate circuit breakers, etc.
- Sequential Events Recorder (SER) log and event reports stored in nonvolatile memory
- Hardware options for mounting, terminals, output contacts, and communications
- Demand ammetering
- Supports ASCII, SEL LMD, and Modbus<sup>®</sup> RTU protocols

### Use the SEL-551/SEL-551C Relay in New and Retrofit Installations:

- Utility distribution feeders
- Industrial distribution feeders—includes core-balance CT input
- Distribution buses, via overcurrent or fast-bus trip scheme
- Transformer banks—includes input for a separate neutral current transformer
- Capacitors, reactors, circuit breakers, etc.
- Panel-mount relays available

# Functional Overview

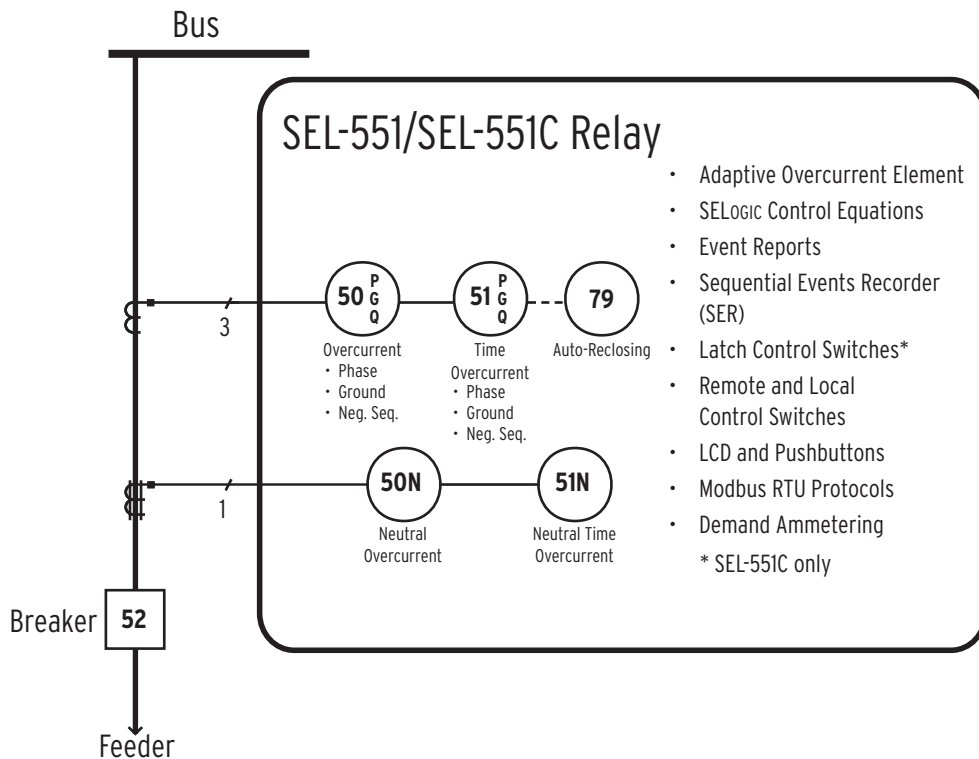


Figure 1 Functional Diagram

## New SEL-551C Relay

The new SEL-551C includes all the same features of the SEL-551, plus the following:

- Optional front EIA-232 serial communications port
- New digital I/O mix with six inputs and three outputs
- Eight programmable latch control switches
- Programmable alarm contact

## Adaptive Overcurrent Element Operates Securely for CT Saturation

The SEL-551/SEL-551C phase instantaneous overcurrent elements normally operate using the output of a cosine filter algorithm. During heavy fault currents when the relay detects severe CT saturation, the overcurrent elements can operate on the adaptive current algorithm.

Based on the level of a “harmonic distortion index,” the adaptive current is either the output of the cosine filter or the output of the bipolar peak detector. When the harmonic distortion index exceeds the fixed threshold that indicates severe CT saturation, the adaptive current is the

output of the bipolar peak detector. When the harmonic distortion index is below the fixed threshold, the adaptive current is the output of the cosine filter.

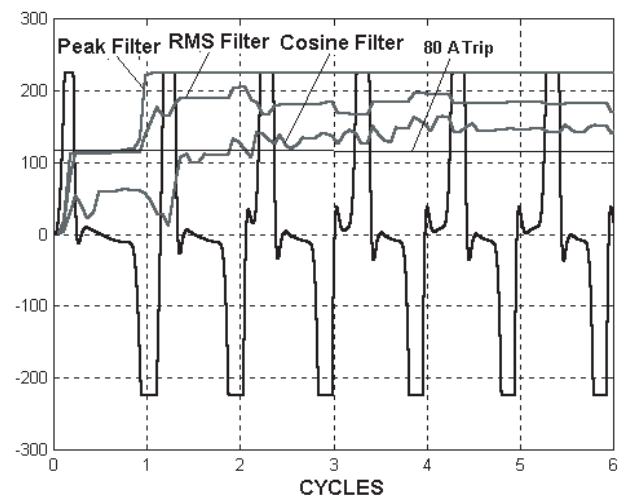


Figure 2 CT Saturated Waveform With Different Filtering

The cosine filter provides excellent performance in removing dc offset and harmonics. However, the bipolar peak detector has the best performance in situations of severe CT saturation when the cosine filter magnitude estimation is significantly degraded, as in *Figure 2*.

Combining the two filters provides an elegant solution for ensuring dependable phase instantaneous overcurrent element operation.

## Overcurrent Elements

	Instantaneous	Time-Overcurrent
Phase	50P1–50P6	51P1T, 51P2T
Single-Phase	50A, 50B, 50C	
Neutral Ground <sup>a</sup>	50N1, 50N2	51N1T
Residual Ground	50G1, 50G2	51G1T
Negative-Sequence ( $3 \cdot I_2$ )	50Q1, 50Q2	51Q1T, 51Q2T
Setting Range, 5 A nominal	OFF, 0.5–80.0 A	OFF, 0.5–16.0 A
Setting Range, 1 A nominal	OFF, 0.1–16.0 A	OFF, 0.1–3.2 A

<sup>a</sup> The neutral ground overcurrent elements (50N1, 50N2, and 51N1T) operate off the separate neutral current input channel IN. All other overcurrent elements operate off the phase current input channels IA, IB, and IC.

## Numerous Instantaneous Overcurrent Elements

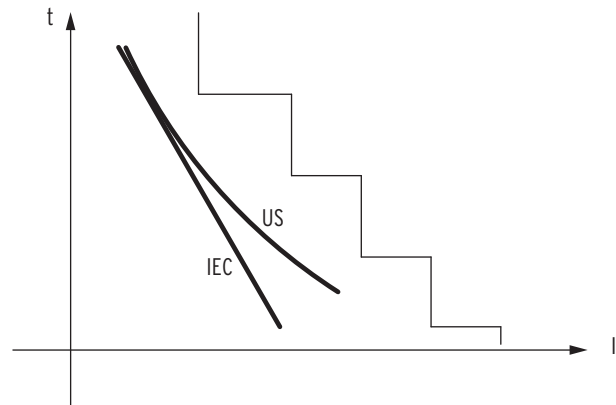
Use the multiple number of provided instantaneous overcurrent elements to do the following:

- Create definite-time overcurrent elements with SELOGIC control equations—combining instantaneous overcurrent elements with timers
- Create “2-out-of-3” phase involvement logic (or other logic) with SELOGIC control equations—using the single-phase elements 50A, 50B, and 50C
- Use negative-sequence overcurrent elements to ignore three-phase load to provide more sensitive coverage of phase-to-phase faults.

## Two Time-Overcurrent Elements of Each Type: Phase, Ground, and Negative-Sequence

Use time-overcurrent elements for the following applications:

- “Fast” and “slow” curve operation in sequence coordination with line reclosers
- Delayed operation during cold load pickup



**Figure 3 Instantaneous, Definite-Time, and Inverse Time-Overcurrent Characteristics**

The following time-overcurrent curves are included:

- US Curves: Moderately Inverse, Inverse, Very Inverse, Extremely Inverse, Short-Time Inverse
- IEC Curves: Class A (Standard Inverse), Class B (Very Inverse), Class C (Extremely Inverse), Long-Time Inverse, Short-Time Inverse

Electromechanical reset emulation and torque control is separately settable for each time-overcurrent element.

## Demand Current Thresholds Alarm for Overload and Unbalance

The SEL-551/SEL-551C provides demand and peak demand current thresholds. When demand current exceeds a threshold, the respective Relay Word bit PDEM, NDEM, GDEM, or QDEM asserts.

PDEM, NDEM, GDEM, or QDEM alarm for phase overload, neutral unbalance, residual unbalance, or negative-sequence unbalance, respectively. The demand meter time constant, DMTC, can be set to 5-, 10-, 15-, 30-, or 60-minute intervals.

## SELogIC Control Equations

Assign the relay inputs to suit your application, logically combine selected relay elements for various control functions, and assign output relays to your logic functions.

- Design unique trip, reclose, and control schemes.
- Replace expensive external timers, auxiliary relays, and their associated wiring and panel space.
- Create custom scheme status labels (e.g., 79 DISABLED) and control their display on the front panel.

Programming SELOGIC control equations consists of combining relay elements, inputs, and outputs with SELOGIC control equation operators. Any element in the Relay Word can be used in these equations.

## Local/Remote Control Logic

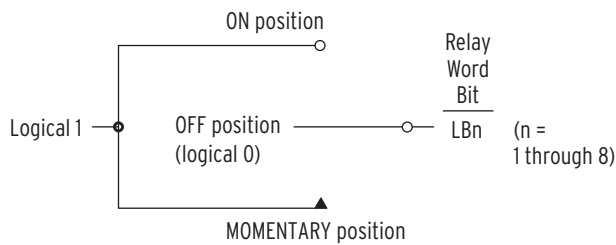
Local/Remote Control Logic is available via front-panel pushbuttons/display (local control) or rear-panel serial communications port (remote control).

The Local Control Switch feature replaces panel-mounted control switches. Each of the eight local control commands emulates a traditional panel switch. Operate these switches using the front-panel pushbuttons/display.

Configure any local control switch to emulate the function of any of the following three switch types:

- ON/OFF
- OFF/MOMENTARY
- ON/OFF/MOMENTARY

Create custom local control switch function labels (e.g., RECLOSER: ENABLE/DISABLE) displayed on the front panel. Combine local/remote control switch functions into various schemes with SELOGIC control equations. For example, use to enable/disable reclosing.



**Figure 4** Local Control Switches Drive Local Bits LB1 Through LB8

## Standard Event Reports and SER

The SEL-551/SEL-551C has two styles of event reports:

- Standard 15-cycle event report
- Sequential events recorder (SER) log

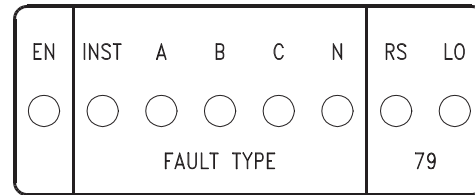
These event reports contain date, time, current, relay element, optoisolated input, and output contact information.

Standard 15-cycle event reports are generated (triggered) by fixed and programmable conditions. These reports show information for 15 continuous cycles. The latest 20 standard 15-cycle event reports are stored in nonvolatile memory. If more than 20 events are triggered, the latest event report will overwrite the oldest event report, and the oldest event report will be lost.

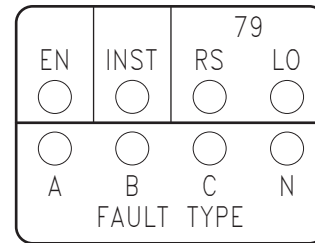
Lines in the sequential events recorder (SER) event report are generated (triggered) by programmable conditions only. Use this feature to gain a broad perspective at a glance. This report lists date- and time-stamped lines of information each time a programmed condition changes state. The latest 512 lines of the SER event report are stored in nonvolatile memory. If the report fills up, newer rows will overwrite the oldest rows in the report.

## Status and Trip Target LEDs

The SEL-551/SEL-551C includes eight status and trip target LEDs on the front panel. The LEDs are explained in *Figure 5*, *Figure 6*, and *Table 1*.



**Figure 5** SEL-551 Status and Trip Target LEDs



**Figure 6** SEL-551C Status and Trip Target LEDs

**Table 1** SEL-551/SEL-551C Front-Panel Target LED Definitions

Target LED	Function
EN	Relay powered and self-tests are okay
INST	Trip due to instantaneous overcurrent element operation
A	Phase A involved in the fault
B	Phase B involved in the fault
C	Phase C involved in the fault
N	Ground involved in the fault
RS	Reclosing relay in the Reset State
LO	Reclosing relay in the Lockout State

## High-Current Interrupting Output Contacts (SEL-551 Option)

The SEL-551 ordered with the plug-in connectors hardware option has high-current interrupting output contacts. This feature allows contacts to safely interrupt trip/close coil currents. The high-current interrupting output contacts will interrupt: 10 A for L/R = 40 ms at 125 Vdc.

These output contacts save money by eliminating the need for tripping auxiliaries. Faster tripping is experienced because you no longer have to wait for the tripping auxiliary to pick up. Wiring errors are avoided because there is no longer an interposing device between the relay and the trip circuit.

See *Specifications on page 18* for more details.

## Programmable Auto-Reclosing

The SEL-551/SEL-551C can auto-reclose a circuit breaker up to four times before lockout. Use SELOGIC control equations to perform a number of these reclosing functions:

- Initiate reclosing for a particular trip operation.
- Drive to lockout immediately from a control operation, external signaling, or high-current trip.
- Skip to the next reclose shot when an overcurrent element picks up.
- Block reset timing to prevent repetitive “trip-reclose” cycling.
- Program sequence coordination to keep the relay in step with downstream reclosers to prevent trip overreaching.

## ACSELERATOR QuickSet SEL-5030 With QuickSet Designer SEL-5031

Use the ACSELERATOR® QuickSet SEL-5030 Software to develop settings off-line. The system automatically checks interrelated settings and highlights out-of-range

settings. Settings created off-line can be transferred by using a PC communications link with the SEL-551/SEL-551C. The software converts event reports to oscillograms with time-coordinated element assertion and phasor/sequence element diagrams. The ACSELERATOR interface supports Microsoft® Windows® operating systems. View real-time phasors via ACSELERATOR.

ACSELERATOR QuickSet Designer SEL-5031 allows users to author personalized Application Designs. Application Designs hide settings you do not want changed (e.g., SELOGIC control equations), while making visible just the minimum necessary settings (e.g., timer and pickup settings) to implement the scheme. All settings can be aliased and manipulated mathematically for simple end-user interfacing. Custom notes and settings ranges can also be defined. These Application Designs also enhance security, allowing access to only a specified group of settings. Create Application Designs that include the most commonly used relay features and settings for your system (see *Figure 7*) and watch commissioning times drop drastically.

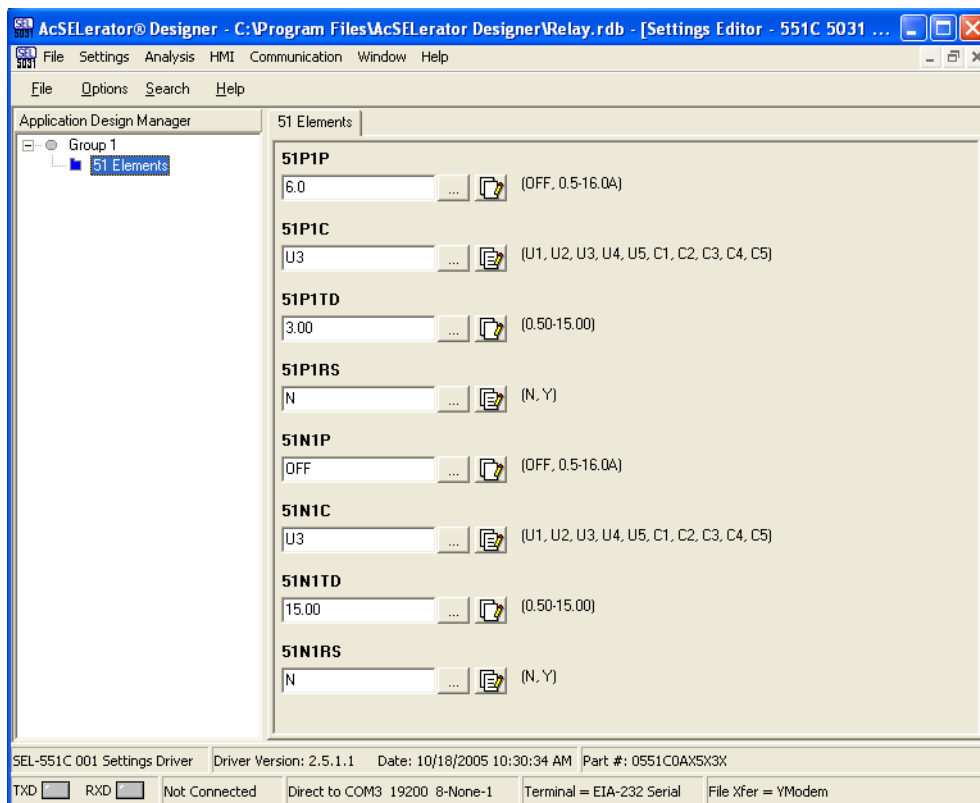


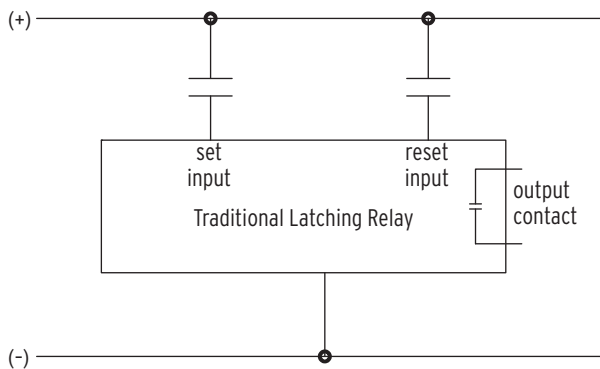
Figure 7 Example Application Design

## Latch Control Switches (SEL-551C Only)

Latch control switches can be used for such applications as:

- Reclosing relay enable/disable
- Ground relay enable/disable
- Sequence coordination enable/disable
- Latching in output contacts

Eight latch control switches are provided in the SEL-551C.

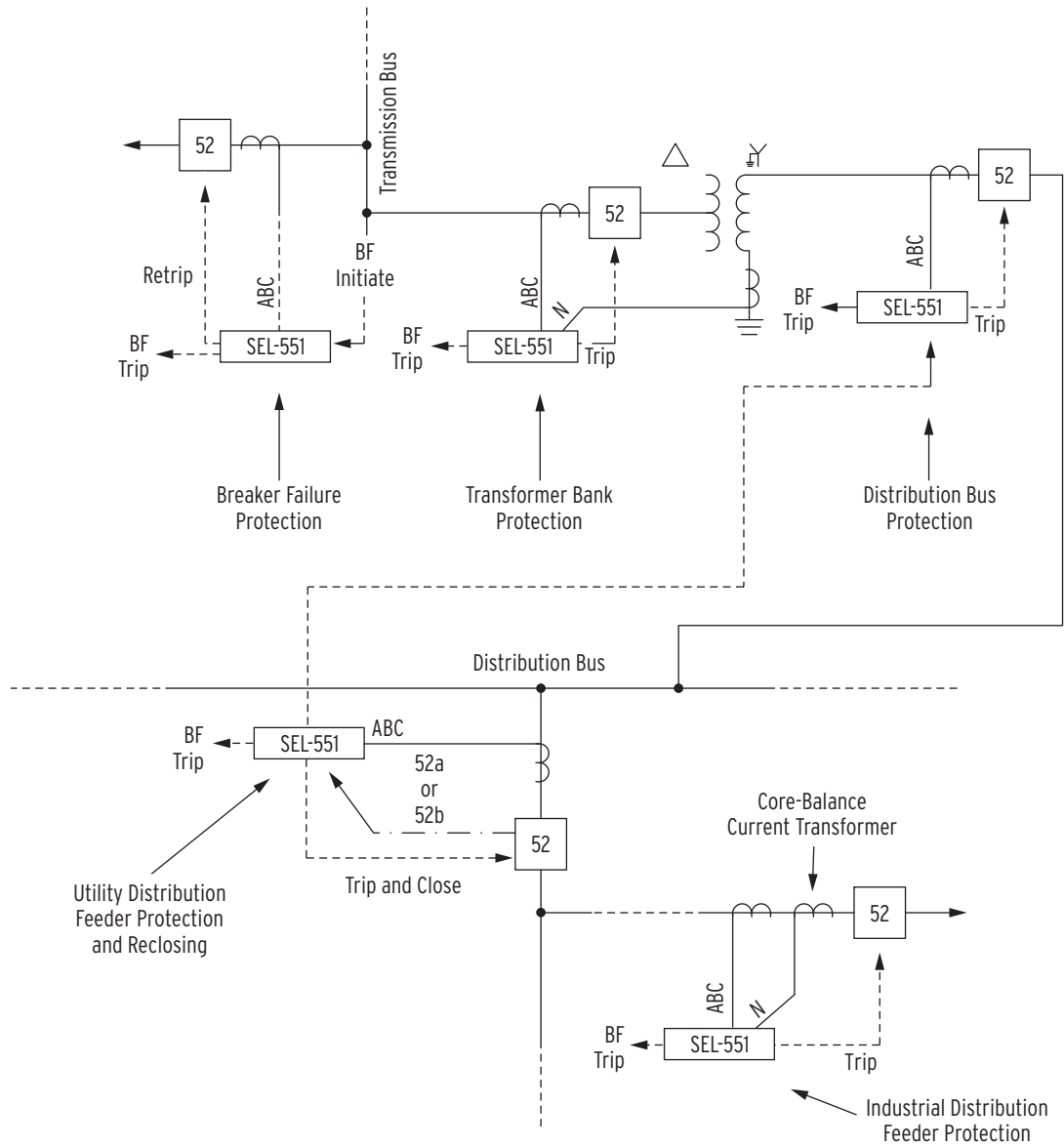


**Figure 8 Traditional Latching Relay**

The latch control switch feature of this relay replaces latching relays. Traditional latching relays maintain their output contact state when set. The SEL-551C latching bit retains memory even when control power is lost. If the latch bit is set to a programmable output contact and control power is lost, the state of the latch bit is stored in nonvolatile memory but the output contact will go to its de-energized state. When the control power is applied back to the relay, the programmed output contact will go back to the state of the latch bit after relay initialization.

The state of a traditional latching relay output contact is changed by pulsing the latching relay inputs (see *Figure 8*). Pulse the set input to close (“set”) the latching relay output contact. Pulse (momentarily operate) the reset input to open (“reset”) the latching relay output contact. Often the external contacts wired to the latching relay inputs are from remote control equipment (e.g., SCADA, RTU).

# SEL-551/SEL-551C Relay Applications



**Figure 9 SEL-551/SEL-551C Relays Applied Through the Power System**

# Hardware Overview

## SEL-551

- Rear-panel: conventional terminal blocks or plug-in connectors
- High-current interrupting output contacts: 10 A for L/R = 40 ms at 125 Vdc (included in the rear-panel plug-in connectors option only)
- Rear-panel serial communications port: EIA-232 or EIA-485 (4-wire)—either port option includes a demodulated IRIG-B time-code input

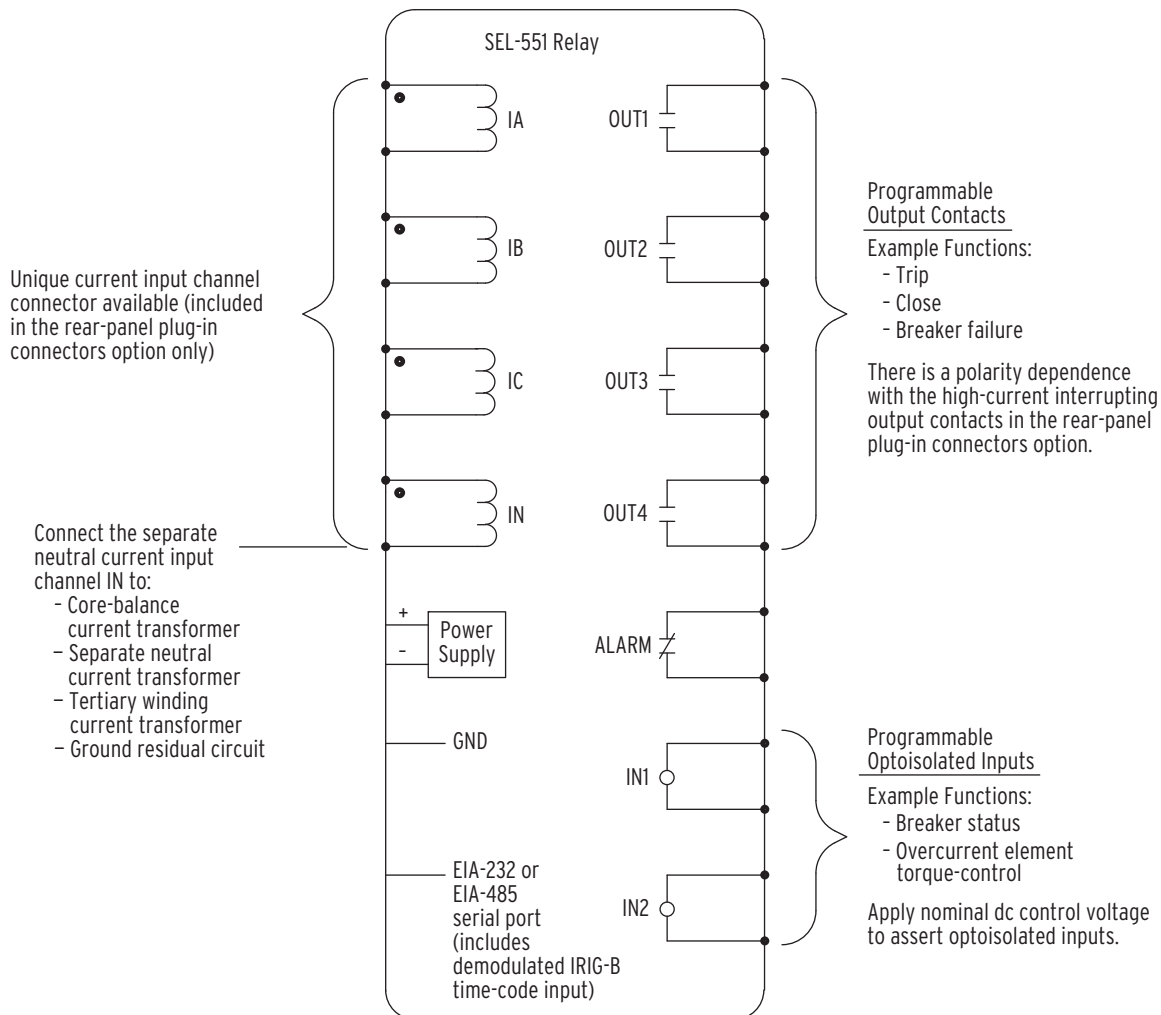
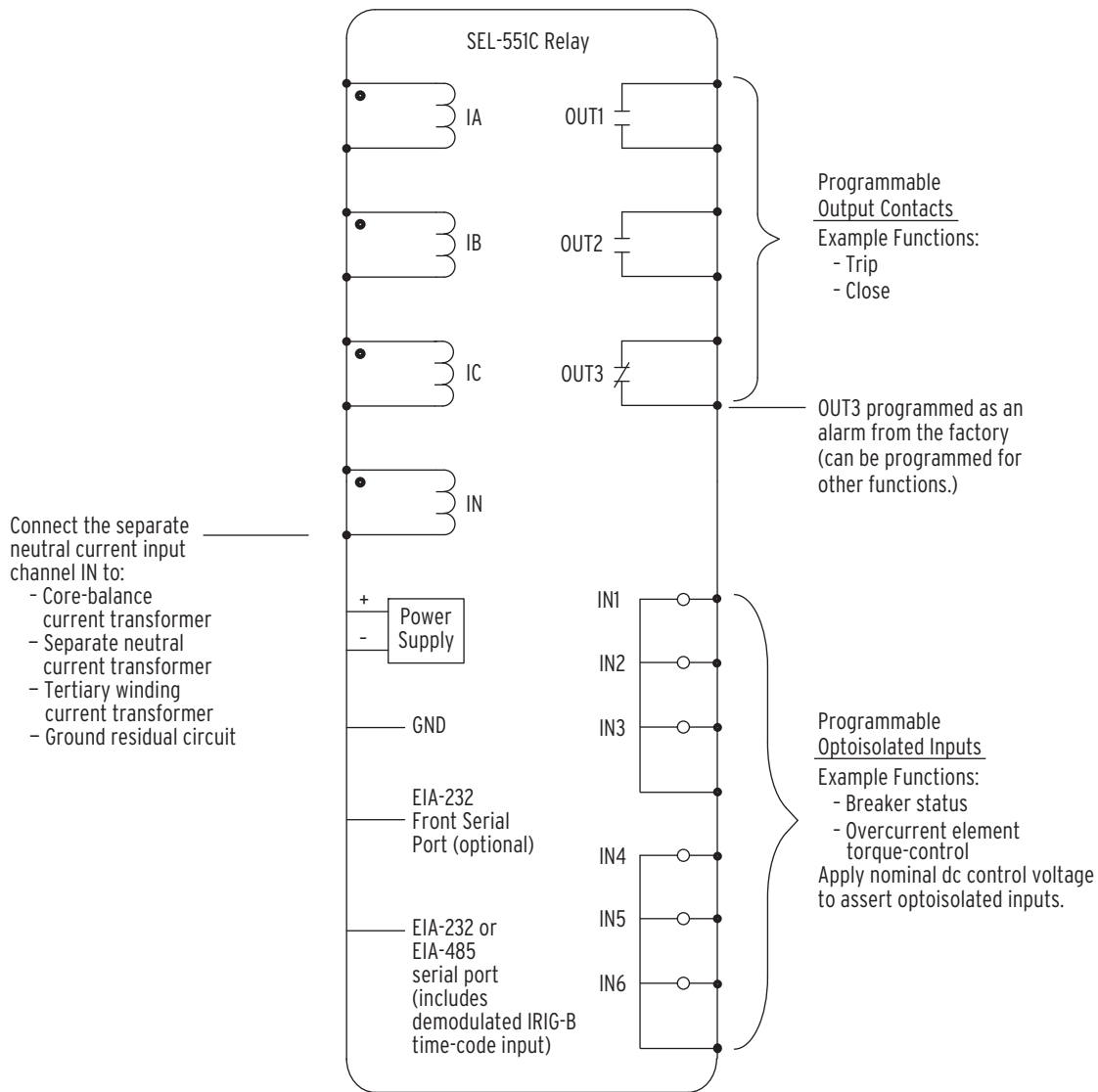


Figure 10 SEL-551 Inputs, Outputs, and Communications Port



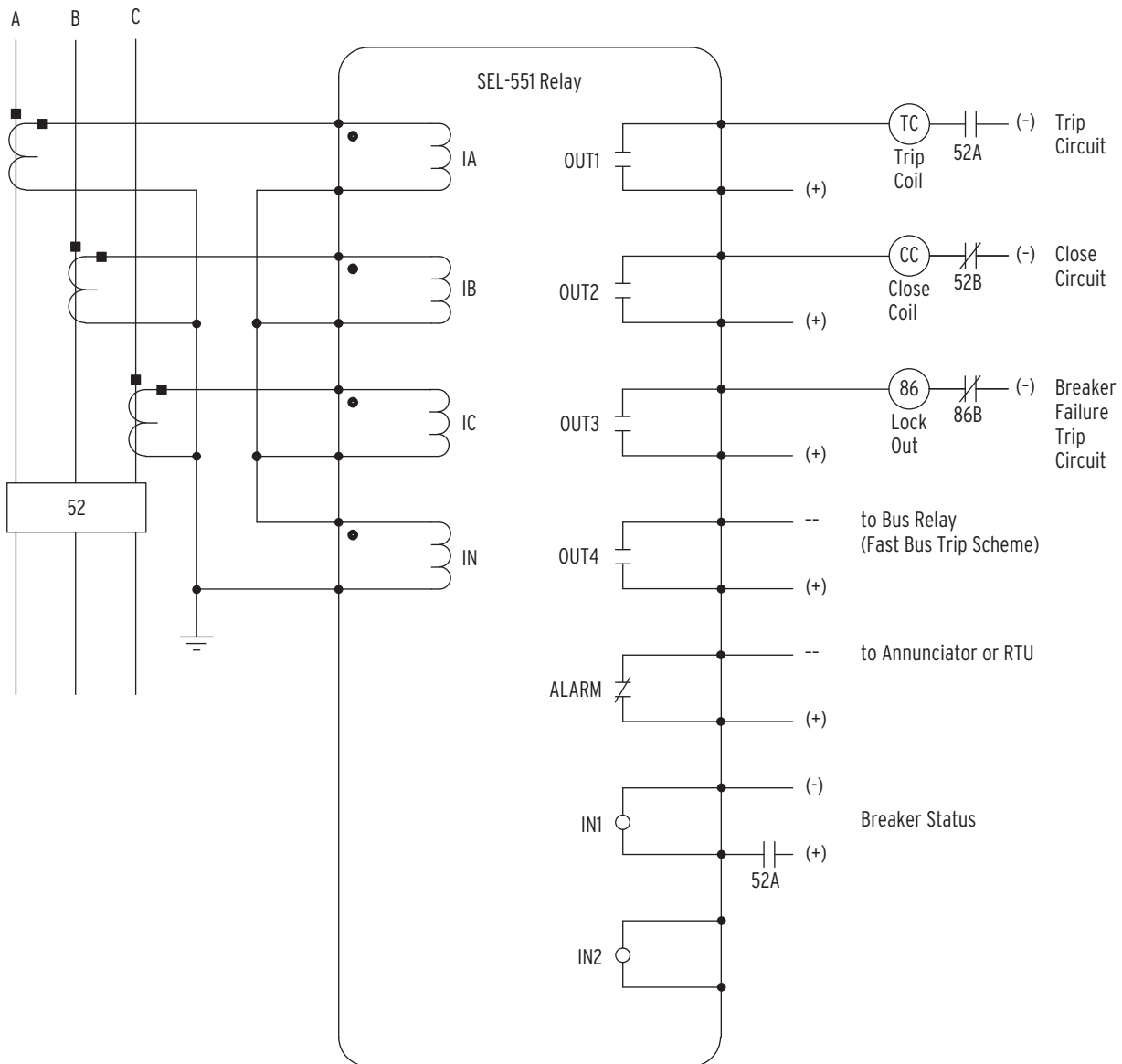
# SEL-551C

- Rear panel: conventional terminal blocks and level-sensitive optoisolated inputs only
- Rear-panel serial communications port: EIA-232 or EIA-485 (4-wire)—either port option includes a demodulated IRIG-B time-code input
- Optional front-panel EIA-232 serial communications port



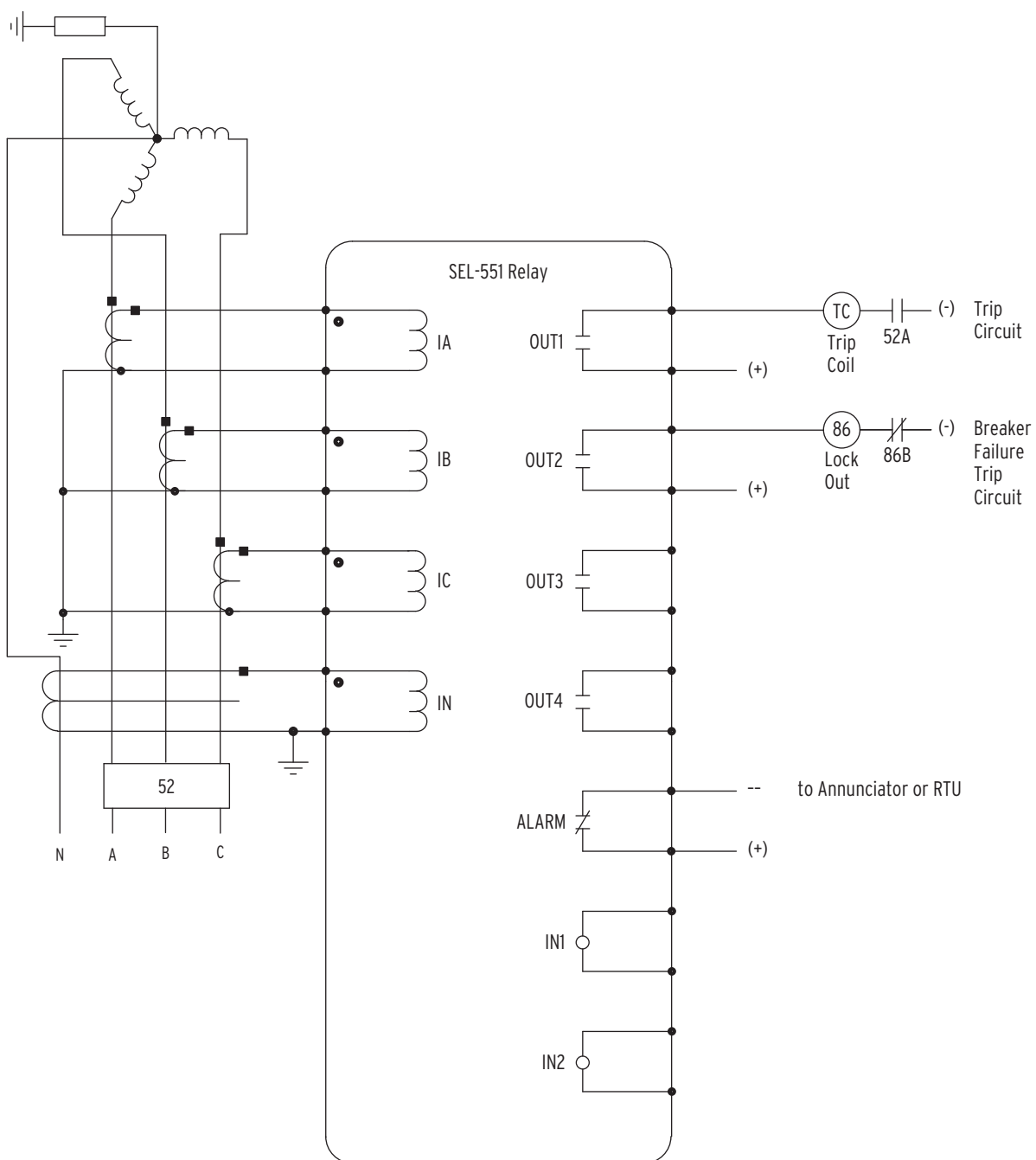
**Figure 11 SEL-551C Inputs, Outputs, and Communications Port**

# SEL-551/SEL-551C AC/DC Connection Diagrams for Example Applications



**Figure 12 SEL-551 Provides Overcurrent Protection and Reclosing for a Utility Distribution Feeder (Includes Fast Bus Trip Scheme; SEL-551C Application Is Similar)**

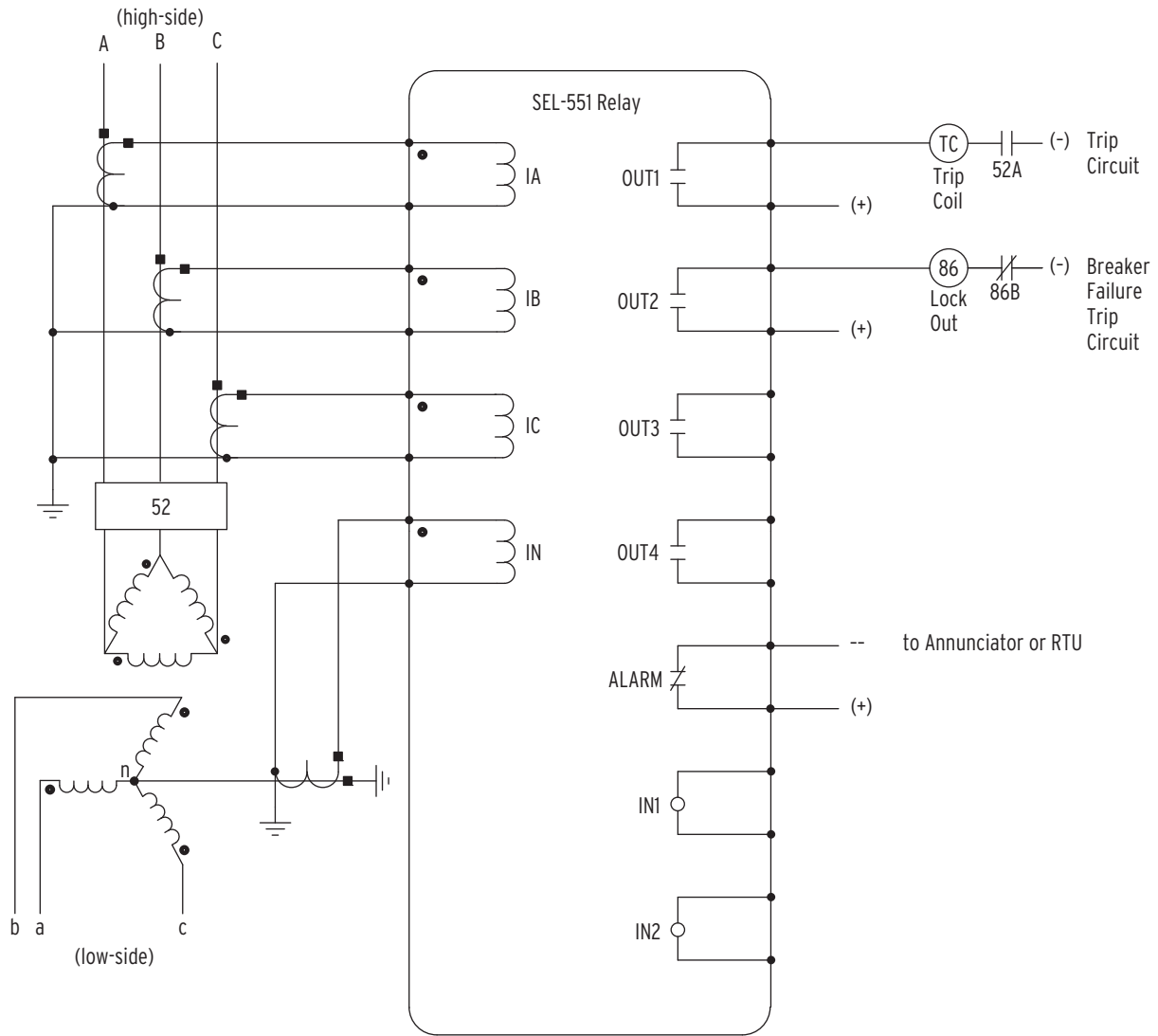
An SEL-551C can also be used in the application in *Figure 12*, but without the breaker failure output or fast bus trip output (unless one of these functions is programmed to output contact **OUT3**, in lieu of the alarm function). Output contact **OUT3** in the SEL-551C can provide the alarm function. See *Figure 11* for the input/output mix of the SEL-551C.



**Figure 13 SEL-551 Provides Overcurrent Protection for an Industrial Distribution Feeder (Core-Balance Current Transformer Connected to Current Input Channel IN; SEL-551C Application Is Similar)**

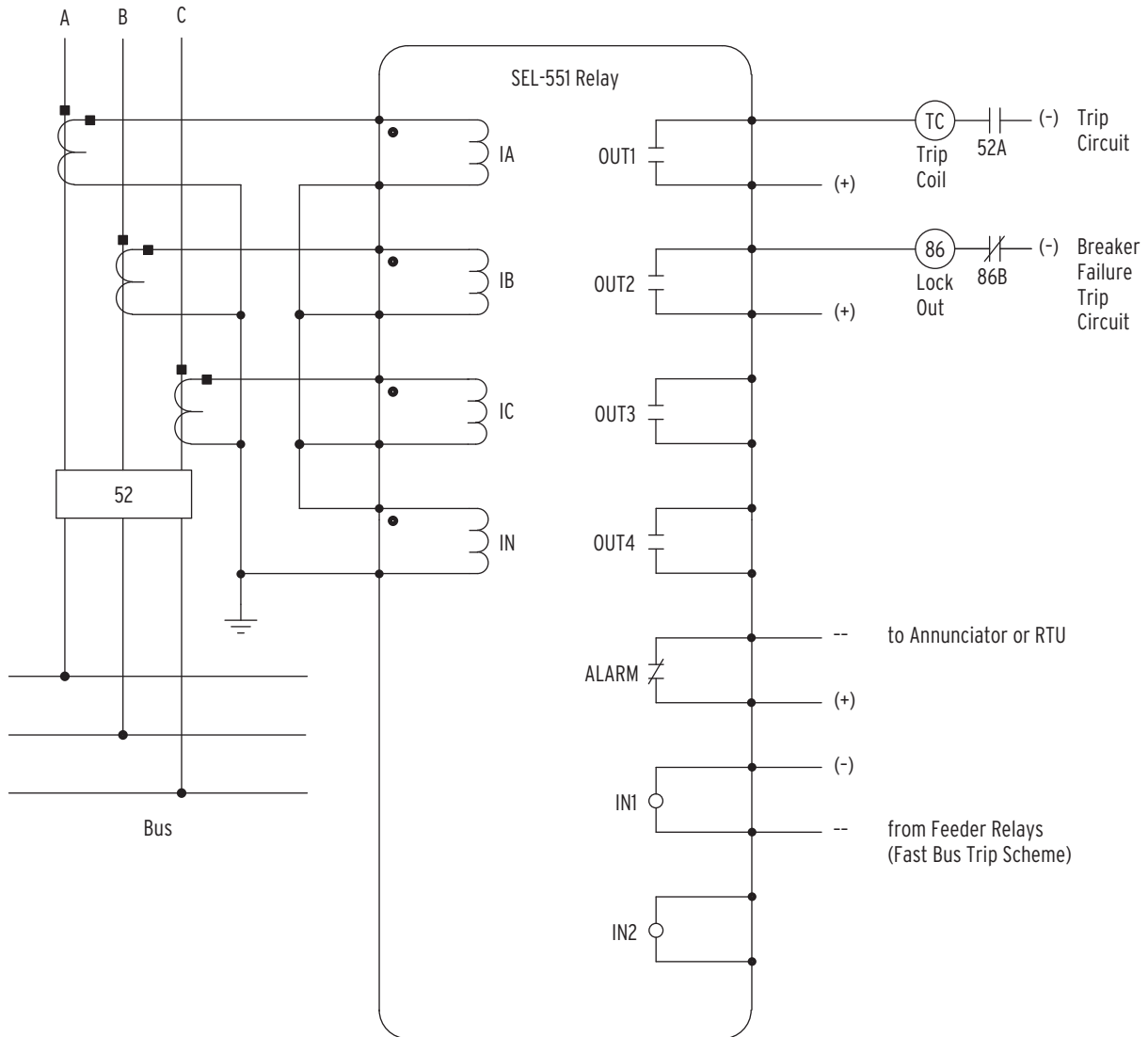
A core-balance current transformer is often referred to as a zero-sequence, ground fault, or window current transformer.

An SEL-551C can also be used in the application in *Figure 13*. Output contact **OUT3** in the SEL-551C can provide the alarm function. See *Figure 11* for the input/output mix of the SEL-551C.



**Figure 14 SEL-551 Provides Overcurrent Protection for a Delta-Wye Transformer Bank (SEL-551C Application Is Similar)**

An SEL-551C can also be used in the application in *Figure 14*. Output contact **OUT3** in the SEL-551C can provide the alarm function. See *Figure 11* for the input/output mix of the SEL-551C.

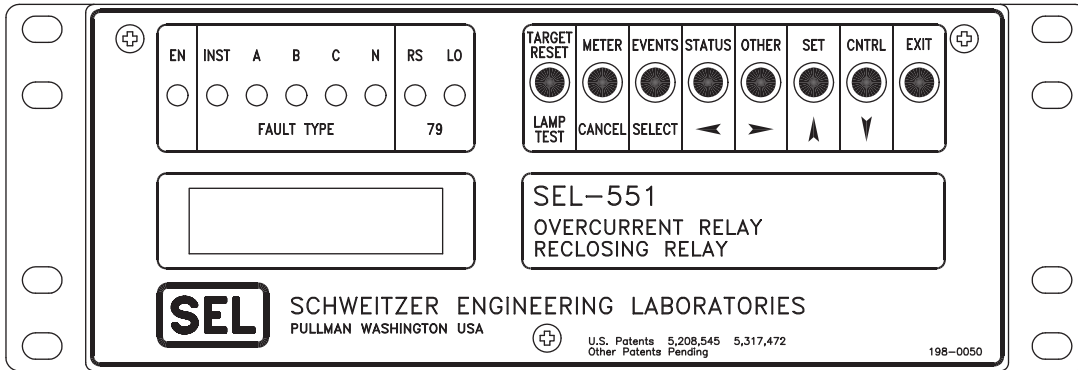


**Figure 15 SEL-551 Provides Overcurrent Protection for a Distribution Bus (Includes Fast Bus Trip Scheme; SEL-551C Application Is Similar)**

The fast bus trip scheme is often referred to as a reverse interlocking or zone interlocking scheme.

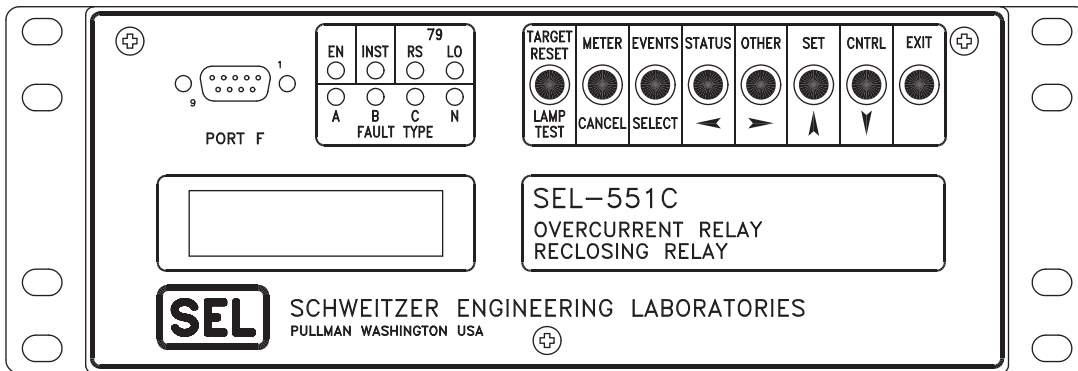
An SEL-551C can also be used in the application in *Figure 15*. Output contact **OUT3** in the SEL-551C can provide the alarm function. See *Figure 11* for the input/output mix of the SEL-551C.

# Front- and Rear-Panel Diagrams



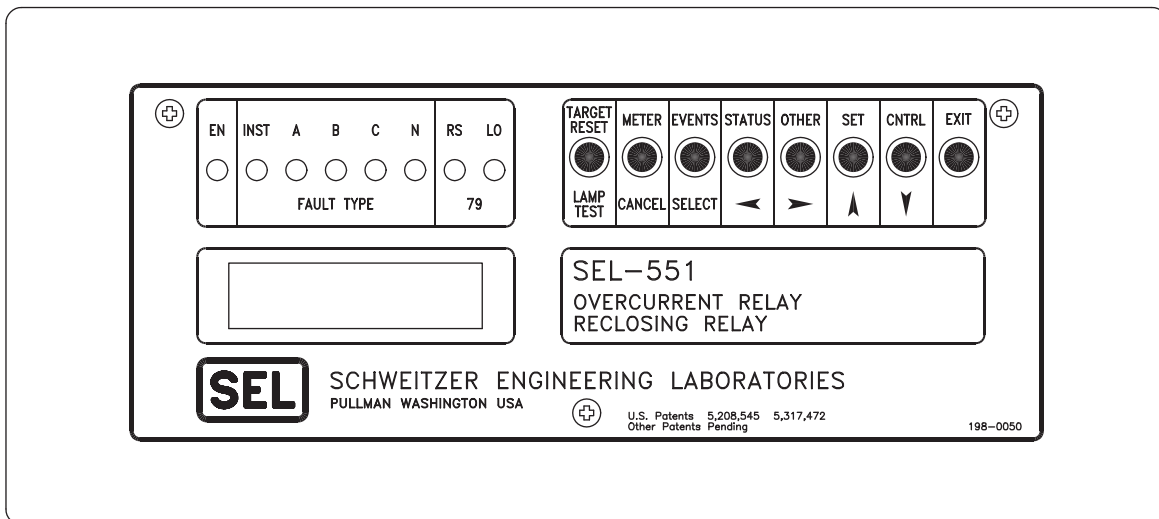
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Figure 16 SEL-551 Front Panel



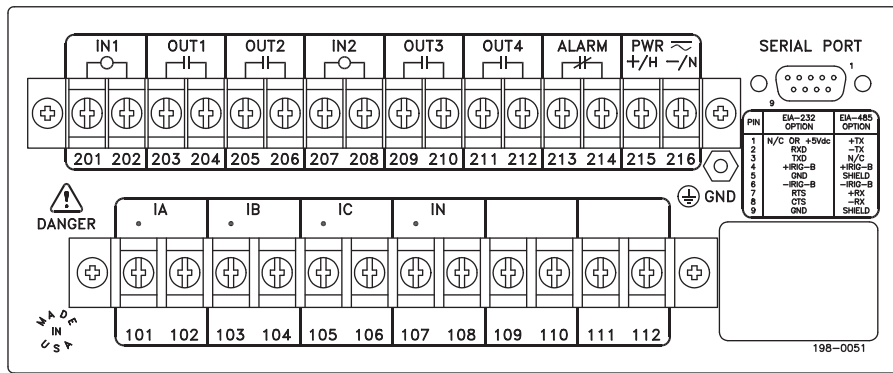
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Figure 17 SEL-551C Front Panel With Optional Front-Panel EIA-232 Serial Communications Port



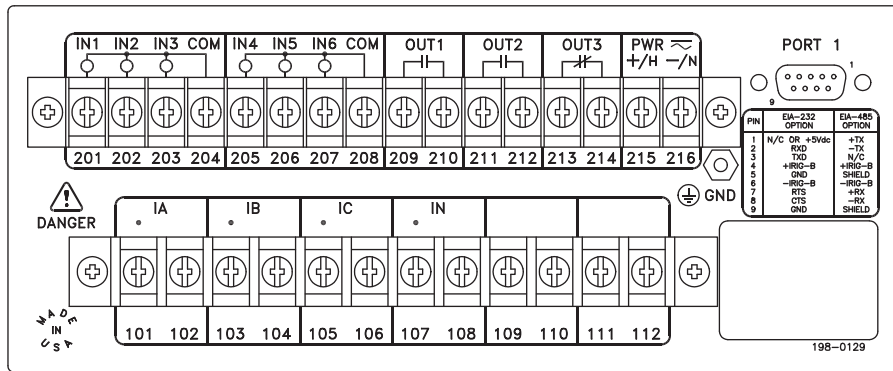
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Figure 18 SEL-551 Front Panel, Panel-Mount Version (SEL-551C Also Available in Panel-Mount Version)



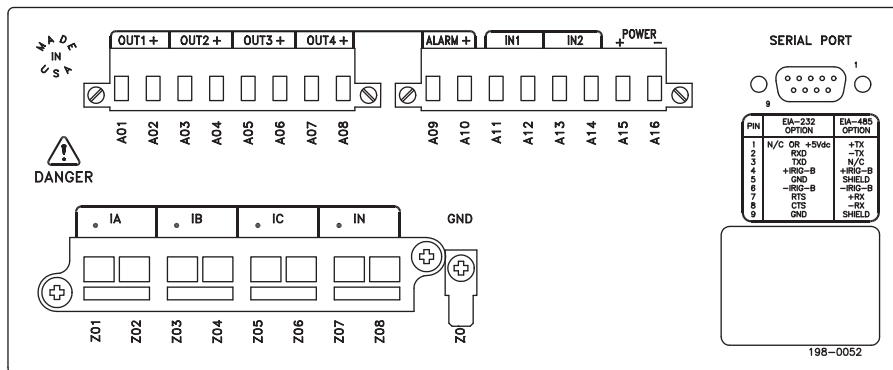
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Figure 19 SEL-551 Rear Panel (Conventional Terminal Blocks Option)



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Figure 20 SEL-551C Rear Panel (Only Available With Conventional Terminal Blocks)

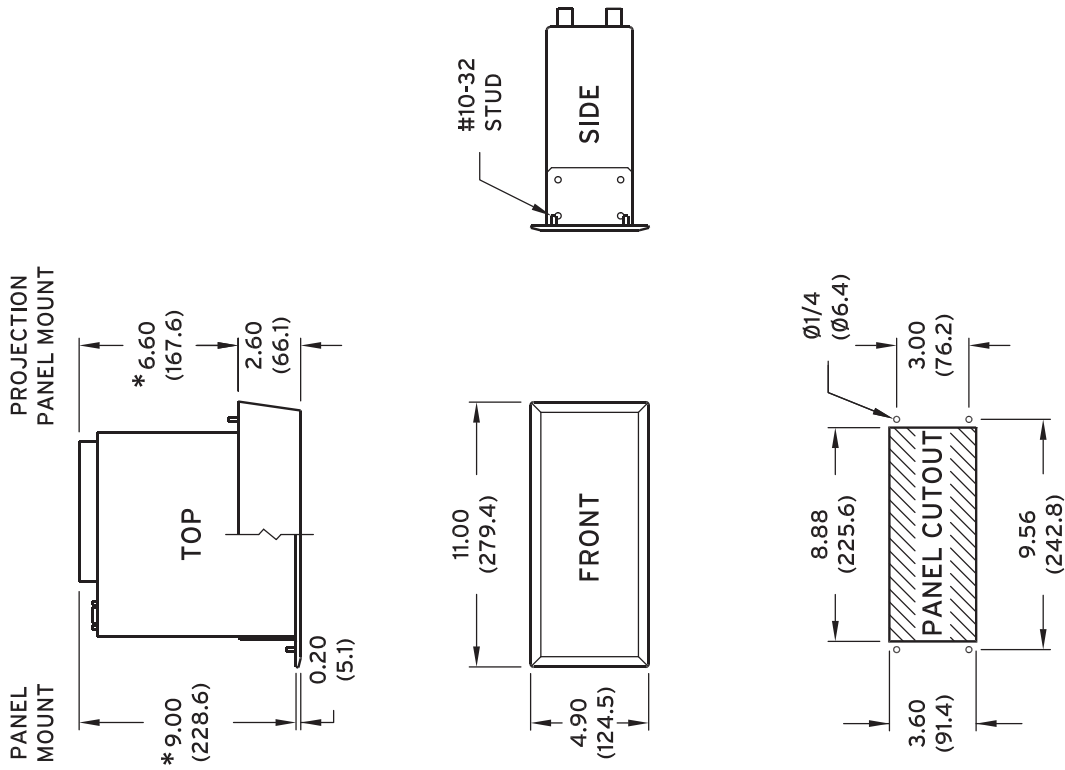


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Figure 21 SEL-551 Rear Panel (Plug-In Connectors Option)

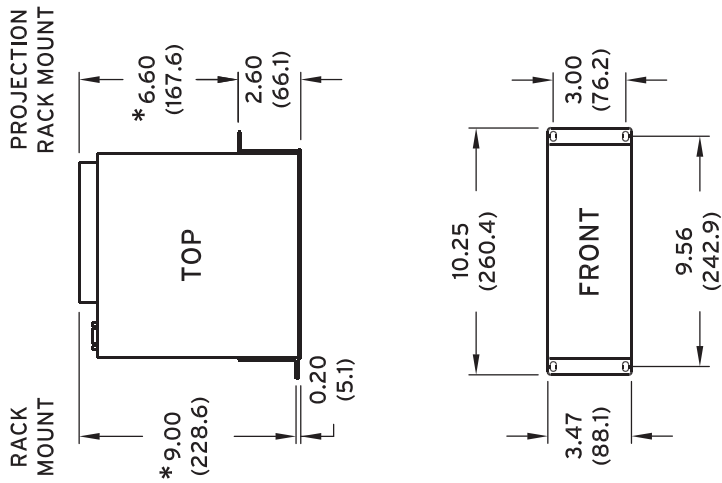
# Relay Dimensions

## PANEL-MOUNT CHASSIS



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## RACK-MOUNT CHASSIS



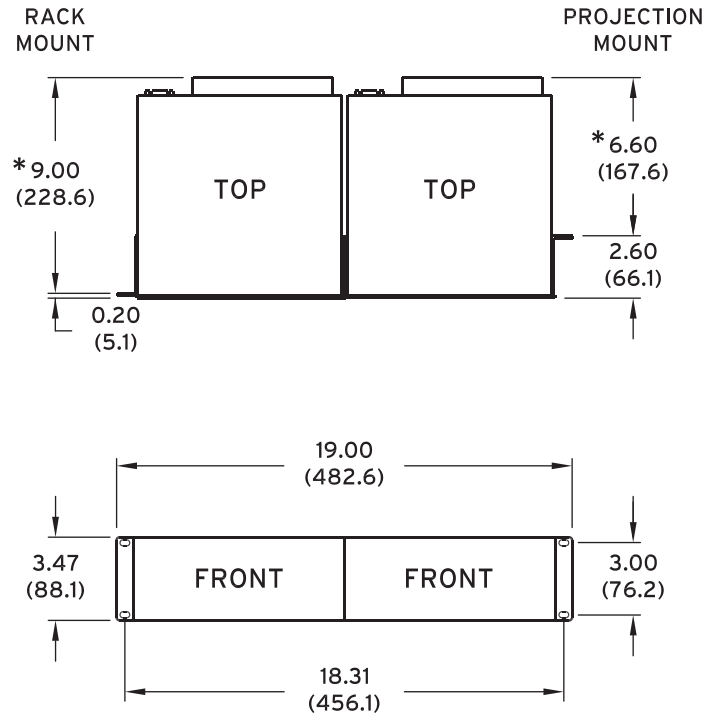
**LEGEND**  
 in  
 (mm)

\* ADD 0.80 (20.3) FOR CONNECTORIZED RELAYS

Figure 22 SEL-551/SEL-551C Dimensions, Panel Cutout, and Drill Plan



## RACK-MOUNT CHASSIS



### LEGEND

← in →  
(mm)

\* ADD 0.80 (20.3) FOR CONNECTORIZED RELAYS

i9024b

**Figure 23 Relay Dimensions and Drill Plan for Mounting Two SEL-500 Series Relays Together Using Mounting Block (SEL P/N 9101)**

# Specifications

## Compliance

Designed and manufactured under an ISO 9001 certified quality management system

UL Listed to US and Canadian safety standards (File E212775; NRGU, NRGU7)

CE Mark

RCM Mark

## General

### AC Input Currents

5 A nominal:	15 A continuous, 500 A for 1 s, linear to 100 A symmetrical.
Limiting Dynamic Value:	1250 A for 1 cycle (sinusoidal waveform)
Burden:	0.16 VA at 5 A 1.15 VA at 15 A
1 A nominal:	3 A continuous, 100 A for 1 s, linear to 20 A symmetrical.
Limiting Dynamic Value:	250 A for 1 cycle (sinusoidal waveform)
Burden:	0.06 VA at 1 A 0.18 VA at 3 A

### Power Supply

125/250 Vdc or Vac

Range:	85–350 Vdc or 85–264 Vac
Burden:	<6.2 W
Interruption:	100 ms at 250 Vdc
Ripple:	100%

48/125 Vdc or 125 Vac

Range:	36–200 Vdc or 85–140 Vac
Burden:	<5.5 W
Interruption:	100 ms at 125 Vdc
Ripple:	5%

24 Vdc

Range:	16–36 Vdc polarity dependent
Burden:	<6.2 W
Interruption:	25 ms at 36 Vdc
Ripple:	5%

**Note:** Interruption and Ripple per IEC 60255-11:1979.

### Output Contacts

Conventional Terminal Blocks Option  
(Per IEC 255-0-20:1974, using the simplified method of assessment)

Make:	30 A
Carry:	6 A continuous carry
1 s Rating:	100 A
MOV Protection:	270 Vac/360 Vdc
Pickup Time:	<5 ms
Dropout Time:	<5 ms

Breaking Capacity (10000 operations):

24 V	0.75 A	L/R = 40 ms
48 V	0.50 A	L/R = 40 ms
125 V	0.30 A	L/R = 40 ms
250 V	0.20 A	L/R = 40 ms

Cyclic Capacity (2.5 cycle/second):

24 V	0.75 A	L/R = 40 ms
48 V	0.50 A	L/R = 40 ms
125 V	0.30 A	L/R = 40 ms
250 V	0.20 A	L/R = 40 ms

Plug-In Connectors Option on SEL-551  
(High Current Interrupting)

Make:	30 A
Carry:	6 A continuous carry
MOV Protection:	330 Vdc
Pickup Time:	<5 ms
Dropout Time:	<8 ms, typical

Breaking Capacity (10000 operations):

24 V	10.0 A	L/R = 40 ms
48 V	10.0 A	L/R = 40 ms
125 V	10.0 A	L/R = 40 ms
250 V	10.0 A	L/R = 20 ms

Cyclic Capacity (4 cycles in 1 second followed by 2 minutes idle for thermal dissipation):

24 V	10.0 A	L/R = 40 ms
48 V	10.0 A	L/R = 40 ms
125 V	10.0 A	L/R = 40 ms
250 V	10.0 A	L/R = 20 ms

**Note:** Do not use high current interrupting output contacts to switch ac control signals. These outputs are polarity dependent.

**Note:** Make per IEEE C37.90:1989; Breaking and Cyclic Capacity per IEC 60255-23 [IEC 255-23]:1994.

### Optoisolated Inputs

**Note:** The input type is dependent on the relay ordering options. Level-sensitive inputs differ from jumper-selectable inputs in that they are guaranteed to deassert below a certain voltage level and they are not user-settable. The inputs are not polarity dependent. With nominal control voltage applied, each input draws approximately 4 mA of current.

### Conventional Terminal Blocks Option

**Note:** The conventional terminal blocks model of the SEL-551 can be ordered with either jumper-selectable voltage optoisolated inputs or level-sensitive optoisolated inputs. The SEL-551C comes only with conventional terminal blocks and can be ordered with level-sensitive optoisolated inputs, except for the 24 Vdc optoisolated inputs option (see below).

### Jumper Selectable Control Voltage

Both inputs may be individually user-configured to operate on any of the following nominal voltages:

24 Vdc:	on for 15–30 Vdc (also available on the SEL-551C, but not jumper selectable)
48 Vdc:	on for 30–60 Vdc
125 Vdc:	on for 80–150 Vdc
250 Vdc:	on for 150–300 Vdc

### Level-Sensitive

Both inputs are factory configured for a fixed voltage level that cannot be changed:

48 Vdc:	on for 38.4–60 Vdc; off below 28.8 Vdc
110 Vdc:	on for 88–132 Vdc; off below 66 Vdc
125 Vdc:	on for 105–150 Vdc; off below 75 Vdc
220 Vdc:	on for 176–264 Vdc; off below 132 Vdc
250 Vdc:	on for 200–300 Vdc; off below 150 Vdc

**Plug-In Connectors Option (SEL-551 only)****Standard (Non-Level Sensitive):**

24 Vdc: on for 15–30 Vdc

**Level-Sensitive**

The plug-in connectors model is equipped with fixed “level-sensitive” inputs. Both inputs are factory-configured to the control voltage specified at the time of ordering:

48 Vdc: on for 38.4–60 Vdc; off below 28.8 Vdc

110 Vdc: on for 88–132 Vdc; off below 66 Vdc

125 Vdc: on for 105–150 Vdc; off below 75 Vdc

250 Vdc: on for 200–300 Vdc; off below 150 Vdc

**Frequency and Rotation**

System Frequency: 50 or 60 Hz

Phase Rotation: ABC or ACB

**Serial Communications**

9-pin sub-D connector

Baud Rate: 300, 1200, 2400, 4800, 9600, 19200, 38400; settable baud rate and protocol

**Protocols**

ASCII  
Distributed Port Switch Protocol (LMD)  
Modbus RTU (rear port only; baud rate limited to 19200)

**Operating Temperature**

IEC Performance Rating: –40° to +85°C (–40° to +185°F)

UL Temperature Rating of +75°C (SEL-551C only):  
250 V on optoisolated inputs IN1, IN3, and IN5  
3 A through all output contacts  
250 Vac on power supply inputs  
5 A on all current input channels

**Humidity**

0% to 95% without condensation

**Altitude**

2000 m maximum

**Operating Environment**

Pollution Degree: 2

Overvoltage Category: II

Indoor Use

**Tightening Torque**

Terminal Block:

Minimum: 1.1 Nm (9-inch-pounds)

Maximum: 1.3 Nm (12-inch-pounds)

Connectorized®

Minimum: 0.6 Nm (5-inch-pounds)

Maximum: 0.8 Nm (7-inch-pounds)

**Terminal Connections**

Terminals or stranded copper wire. Ring terminals are recommended.  
Minimum temperature rating of 105°C.

**Routine Dielectric Strength**

AC current inputs: 2500 Vac for 10 s

Power supply, optoisolated inputs, and output contacts: 3000 Vdc for 10 s

The following IEC 60255-5 Dielectric Tests:1977 are performed on all units with the CE mark:  
2500 VAC for 10 s on analog inputs.  
3100 Vdc for 10 s on power supply, optoisolated inputs, and output contacts.

**Weight**

2.5 kg (5 lbs, 8 oz.)

**Type Tests****Environmental Tests**

Cold:	IEC 60068-2-1:1990 [EN 60068-2-1:1993] Test Ad; 16 hr at –40°C
Damp Heat Cyclic:	IEC 60068-2-30:1980 Test Db; 25° to 55°C, 6 cycles, 95% humidity
Damp Heat Steady State	IEC 60068-2-3:1969 Test Ca; 40°C ±2°C, 93% humidity +2%, –3% 4 days, Energized > 1 day
Dry Heat:	IEC 60068-2-2:1974 [EN 60068-2-2:1993] Test Bd: 16 hr at +85°C

**Dielectric Strength and Impulse Tests**

Dielectric:	IEC 60255-5:1977 IEEE C37.90-1989 2500 Vac on analog inputs; 3100 Vdc (3000 Vdc for Plug-in Connectors option) on power supply, contact inputs, and contact outputs
Impulse:	IEC 60255-5:1977 0.5 J, 5000 V

**Electrostatic Discharge Test**

ESD:	IEC 60255-22-2:1996 [EN 60255-22-2:1996] IEC 60801-2:1991 Level 4
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**RFI and Interference Tests**

Fast Transient Disturbance:	IEC 60255-22-4:1992) IEC 60801-2:1991 Level 4
Radiated EMI:	IEC 60255-22-3:1989 IEC 60801-3:1984 IEEE C37.90.2-1987
Surge Withstand:	IEC 60255-22-1:1988 2.5 kV peak common mode, 2.5 kV peak differential mode IEEE C37.90.1-1989 3.0 kV oscillatory; 5.0 kV fast transient

**Vibration and Shock Tests**

Shock and Bump:	IEC 60255-21-2:1988 Class 2 IEC 60255-21-3:1993 Class 2
Sinusoidal Vibration:	IEC 60255-21-1:1988 Class 2

**Object Penetration**

Object Penetration:	IEC 60529:1989 IP 30, IP 54 from the front panel using the SEL-9103 front- cover dust and splash protection
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**Processing Specifications**

8 times per power system cycle

**Metering Accuracy**

Instantaneous and Demand Ammetering Functions.

Measurement Accuracy: ±2%, I<sub>N</sub> ±5%

# Notes

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