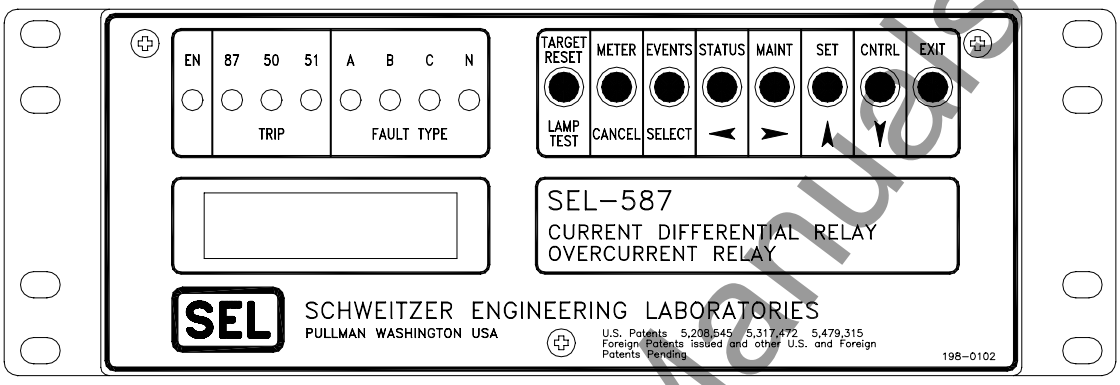
SEL-587 Current Differential Relay

Economical Differential Protection for Power Apparatus



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Major Features and Benefits

The SEL-587 Current Differential Relay combines overcurrent and differential elements in an easy-to-apply power apparatus differential protection package. Relay security is achieved by an optimized set of user-selectable restraining and blocking elements. Dual-slope percentage, harmonic restraint and blocking, plus dc blocking are included. Zero-sequence currents are filtered out from the differential element for any combination of power and transformer CT connections. SELOGIC® control equations provide application flexibility when conditions warrant.

- Protection – Protect two-terminal transformers, generators, reactors, and other power apparatus using a combination of differential, instantaneous, definite-, and inverse-time overcurrent elements. Differential scheme security is achieved by the following:
  - Dual-slope percentage restraint,
  - Second- and fourth-harmonic blocking or restraint plus dc blocking for magnetizing inrush,
  - Fifth-harmonic blocking for transformer overexcitation, and
  - CT and transformer connection compensation.
- Monitoring – Metering quantities are available for phase, ground, negative-sequence, differential, and harmonic currents. Post-fault analysis is simplified by information recorded in Event Reports having 15-cycle duration times. As many as 10 Event Reports are stored in nonvolatile memory. Self-test and alarm functions are standard.

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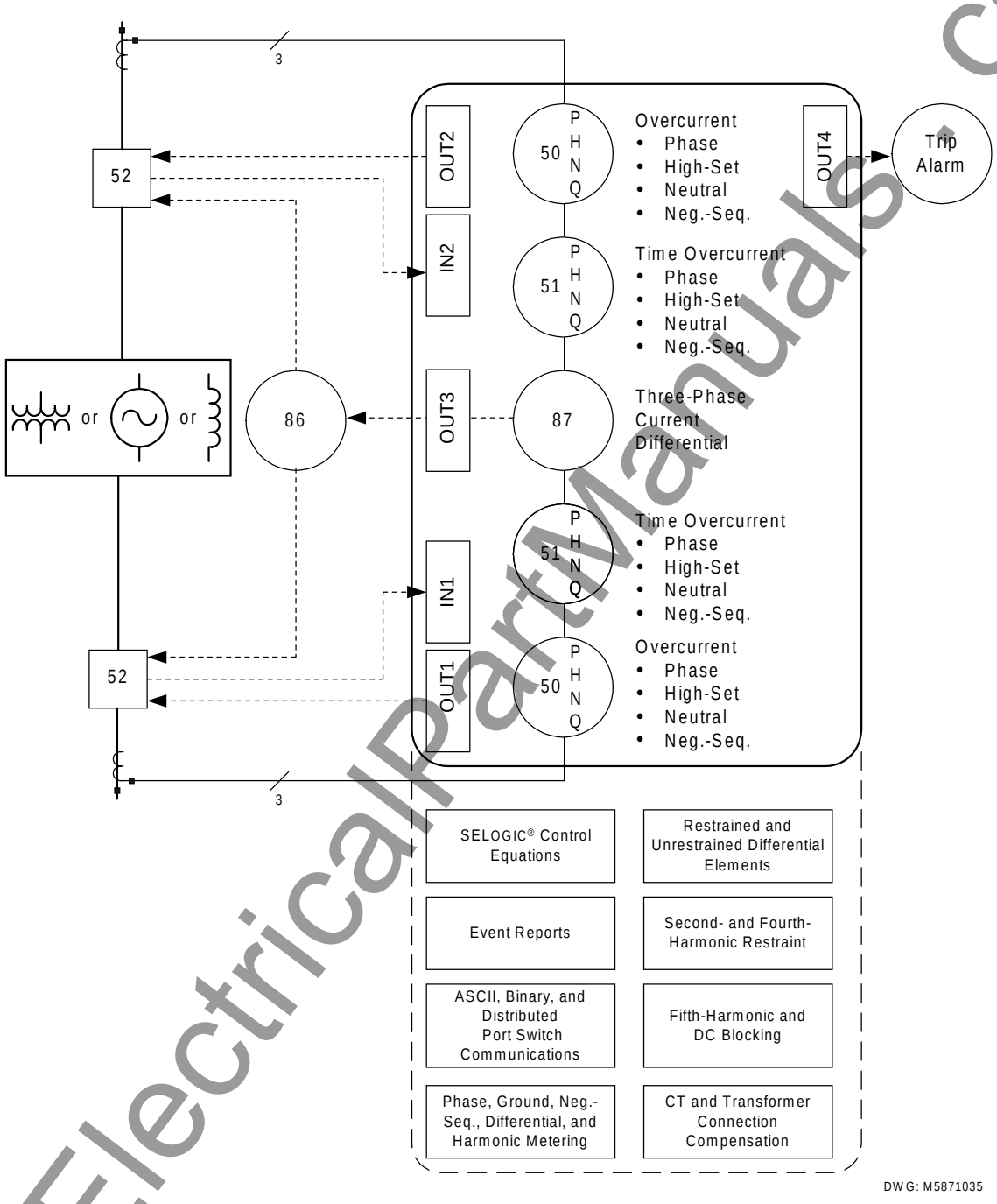
RELAY PROTECTION FUNCTIONS



MODEL VARIATIONS

SEL-587-0 Relay

The SEL-587-0 Relay has provided sophisticated and reliable service for many years. It continues to satisfy the needs of most of our customers. However, we recommend using the SEL-587-1 Relay for new designs because of the additional features it provides.

SEL-587-1 Relay

Differences between the SEL-587-0 Relay and the SEL-587-1 Relay are explained below.

- The SEL-587-0 Relay trip logic can be set in one of two configurations while the SEL-587-1 Relay can be set in one of three configurations. Each relay's trip logic can be set to always latch the trip or to latch the trip if the current is above a certain threshold. The SEL-587-1 Relay adds the ability to block trip latching.
- Each relay provides the ability to protect transformers with a variety of transformer and CT connections. Phase-angle shifts are compensated for and zero-sequence current is removed for most cases. The SEL-587-1 Relay adds the ability to remove zero-sequence current in transformers with grounding banks within the differential zone or zigzag transformer applications.
- In addition to the harmonic blocking capabilities of the SEL-587-0 Relay, the SEL-587-1 Relay provides second- and fourth-harmonic restraint and dc blocking capabilities.

Conventional Terminal Blocks

This model includes hardware that supports six current inputs, two optoisolated inputs, four programmable output contacts, one alarm contact, one EIA-232 port, and IRIG-B time code. It uses terminal blocks that support #6 ring terminals. This robust package meets or exceeds numerous industry standard type tests.

This relay is available in a 3.5" (2U) rack-mount package or a 4.9" panel-mount package.

Plug-In Connectors (Connectorized®)

This model includes hardware that supports all of the features of the conventional terminal block model. It differs in its use of plug-in connectors instead of terminal blocks. In addition, it provides:

- High-current interrupting output contacts.
- Quick connect/release hardware for rear-panel terminals.
- Level-sensitive optoisolated inputs.

This robust package meets or exceeds numerous industry standard type tests. It is available in a 3.5" (2U) rack-mount package or a 4.9" panel-mount package.

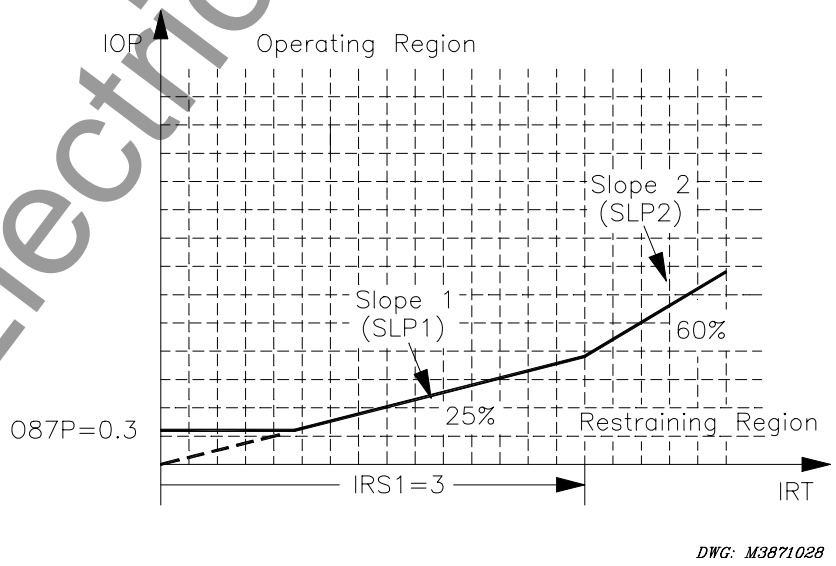
RELAY ELEMENTS

Restrained and Unrestrained Differential Element Settings	Setting	Setting Range
Operating-Current Pickup	O87P	(0.1–1.0), TAP
Restraint Slope 1 Percentage	SLP1	5–100%
Restraint Slope 2 Percentage	SLP2	OFF, 50–200%
Restraint-Current Slope 1 Limit	IRS1	(1–16), TAP
Instantaneous-Unrestrained-Current Pickup	U87P	(1–16), TAP
Second-Harmonic Blocking Percentage	PCT2	OFF, 5–100%
Fourth-Harmonic Blocking Percentage	PCT4	OFF, 5–100%
Fifth-Harmonic Blocking Percentage	PCT5	OFF, 5–100%

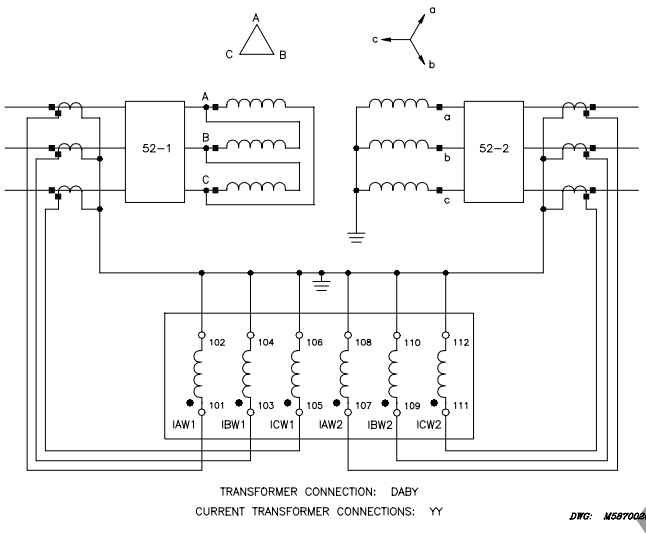
Relay automatically calculates TAP values from transformer ratings, CT ratios, and connections.

Eight Overcurrent Elements for Winding 1	Instantaneous	Definite Time	Inverse Time
Phase	50P1H	50P1	51P1
Negative Sequence		50Q1	51Q1
Residual	50N1H	50N1	51N1
Eight Overcurrent Elements for Winding 2	**Instantaneous**	**Definite Time**	**Inverse Time**
Phase	50P2H	50P2	51P2
Negative Sequence		50Q2	51Q2
Residual	50N2H	50N2	51N2
Setting Ranges, 5 A Model, (A secondary)	OFF, (0.5–80)	OFF, (0.5–80)	OFF, (0.5–16)
Setting Ranges, 1 A Model, (A secondary)	OFF, (0.1–16)	OFF, (0.1–16)	OFF, (0.1–3.2)
	OFF Disables Element		ANSI and IEC curves

PERCENTAGE DIFFERENTIAL ELEMENT

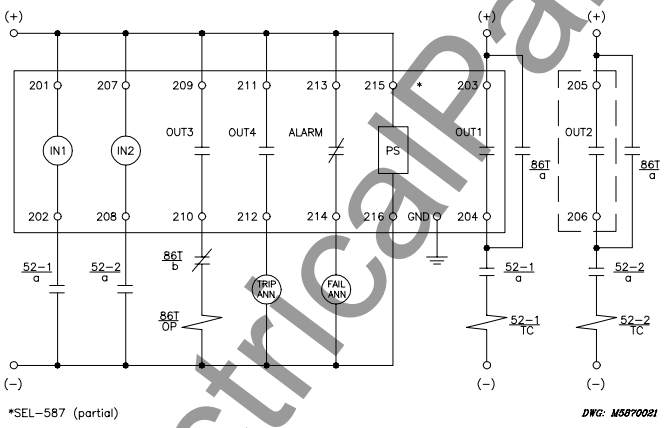


EXAMPLE AC CONNECTIONS



- Relay automatically compensates for power transformer phase shift and ratio scaling.
- Protects delta-wye, wye-delta, delta-delta, and wye-wye transformers.
- Accepts delta- or wye-connected CTs on either side of the transformer.

EXAMPLE DC CONNECTIONS



- Relay outputs are programmable to support a variety of applications.
- In this example OUT1 and OUT2 provide high-side and low-side overcurrent tripping. OUT3 operates the transformer lockout auxiliary for differential element operations.

GENERAL SPECIFICATIONS

AC Current Inputs

5 A nominal: 15 A continuous; 250 A for 1 second; linear to 100 A symmetrical
Limiting Dynamic Value: 625 A for 1 cycle (sinusoidal waveform)
Burden: 0.16 VA @ 5 A, 1.15 VA @ 15 A

1 A nominal: 3 A continuous; 100 A for 1 second; linear to 20 A symmetrical
Limiting Dynamic Value: 250 A for 1 cycle (sinusoidal waveform)
Burden: 0.06 VA @ 1 A, 0.18 VA @ 3 A

60/50 Hz system frequency and ABC/ACB phase rotation are user-settable.

Output Contacts

The output type is dependent on the rear-panel terminal type. Output ratings were determined with *IEC 255-0-20* : *1974*, using the simplified method of assessment.

Standard (Conventional Terminal Blocks Option):

6 A continuous carry
30 A make per *IEEE C37.90 : 1989*
100 A for one second
270 Vac/360 Vdc MOV for differential surge protection
Pickup/dropout time: < 5 ms
Breaking Capacity (L/R = 40 ms):

24 V	0.75 A	10,000 operations
48 V	0.50 A	10,000 operations
125 V	0.30 A	10,000 operations
250 V	0.20 A	10,000 operations

Cyclic Capacity (L/R = 40 ms):

24 V	0.75 A	2.5 cycles per second
48 V	0.50 A	2.5 cycles per second
125 V	0.30 A	2.5 cycles per second
250 V	0.20 A	2.5 cycles per second

High Current Interrupting (Plug-in Connectors Option):

6 A continuous carry
30 A make per *IEEE C37.90 : 1989*
330 Vdc MOV for differential surge protection
Pickup time: < 5 ms
Dropout time: < 8 ms (typical)

Breaking Capacity:	10 A	10,000 operations
	24, 48, and 125 V	(L/R = 40ms)
	250 V	(L/R = 20ms)
Cyclic Capacity:	10 A	4 cycles in 1 second, followed by 2 minutes idle for thermal dissipation
	24, 48, and 125 V	(L/R = 40ms)
	250 V	(L/R = 20ms)

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

Optoisolated Input Ratings

The input type is dependent on the rear-panel terminal type. "Level-sensitive" inputs differ from "standard" 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.

Jumper-Selectable (Conventional Terminal Blocks Option):
The conventional terminal blocks model is equipped with jumper-selectable inputs. Both inputs may be individually user-configured to operate on any of the following nominal voltages:

24 Vdc:	on for	15 – 30 Vdc
48 Vdc:	on for	30 – 60 Vdc
125 Vdc:	on for	80 – 150 Vdc
250 Vdc:	on for	150 – 300 Vdc

Level-Sensitive (Plug-in Connectors Option):
The plug-in connectors model is equipped with fixed "level-sensitive" inputs. Both inputs are factory-configured to the control voltage specified at time of ordering. Please note that the 24 Vdc option is not available as "level-sensitive".

24 Vdc:	on for	15 – 30 Vdc;	
48 Vdc:	on for	38.4 – 60 Vdc;	off below 28.8 Vdc
125 Vdc:	on for	105 – 150 Vdc;	off below 75 Vdc
250 Vdc:	on for	200 – 300 Vdc;	off below 150 Vdc

Power Supply Ratings

24 Volt*:	16 – 36 Vdc	
48/125 Volt:	36 – 200 Vdc	or 85 – 140 Vac
250 Volt:	85 – 350 Vdc	or 85 – 264 Vac

3.5 watts nominal, 5.5 watts maximum.
* The 24-volt power supply is polarity-dependent.

Serial Communications

Rear-panel 9-pin sub-D connector; 300, 1200, 2400, 4800, 9600, 19200, and 38400 baud; settable baud rate and data bit protocols.

Metering Functions

Instantaneous and Demand Ammetering functions.
Measurement Accuracy: ±2%.

Routine Dielectric Test

Current inputs: 2500 Vac for 10 seconds.
Power supply, logic inputs, and contact outputs: 3000 Vdc for 10 seconds.

The following *IEC 255-5 : 1977* dielectric test is performed on all units with the CE mark:
2500 Vac for 10 seconds on analog inputs.
3100 Vdc for 10 seconds on power supply, logic inputs, and contact outputs.

Operating Temp.

–40° to 85°C (–40° to 185°F).

Dimensions

8.81 cm x 21.59 cm x 23.37 cm (3.47" x 8.5" x 9.2") (H x W x D).

Weight

2.6 kg (5 lb, 12 oz).

Relay Shipping Weight

4 kg (9 lb).

Type Tests and Standards

The SEL-587 Relay complies with the rules governing CE marking.

IEEE C37.90 : 1989 IEEE Standards for Relay Systems Associated with Electrical Power Apparatus, Section 8: Dielectric Tests.
Severity Level (Conventional Terminal Blocks Option): 2500 Vac on analog inputs; 3100 Vdc on contact inputs, contact outputs, and power supply.
Severity Level (Plug-In Connectors Option): 2500 Vac on analog inputs; 3000 Vdc on power supply, contact inputs, and contact outputs.

IEEE C37.90.1 : 1989 IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems.
Severity Level: 3.0 kV oscillatory, 5.0 kV fast transient.

IEEE C37.90.2 : 1987 IEEE Trial-Use Standard, Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
Severity Level: Class III of 10 V/m.

Exceptions:

5.5.2 (2)	Performed with 200 frequency steps per octave.
5.5.3	*Digital Equipment Modulation Test* not performed.
5.5.4	Test signal turned off between frequency steps to simulate keying.

IEC 68-2-1 : 1990 Environmental testing, Part 2: Tests - Test Ad: Cold.
Severity Level: 16 hours at –40°C.

IEC 68-2-2 : 1974 Environmental testing, Part 2: Tests - Test Bd: Dry heat.
Severity Level: 16 hours at +85°C.

IEC 68-2-3 : 1969 Basic environmental testing procedure, Part 2: Tests – Test Ca: Damp heat, steady state. (40°C ± 2°C, Relative Humidity: 93% +2%, -3%, Test Duration: 4 days, Energized: >1 day).

IEC 68-2-30 : 1980 Basic environmental testing procedures, Part 2: Tests, Test Db and guidance: Damp heat, cyclic (12 + 12-hour cycle).
Severity Level: 55°C, 6 cycles.

IEC 255-5 : 1977 Electrical relays, Part 5: Insulation tests for electrical relays. Section 6: Dielectric Tests.
Severity Level (Conventional Terminal Blocks Option): 2500 Vac on analog inputs; 3100 Vdc on contact inputs, contact outputs, and power supply.
Severity Level (Plug-In Connectors Option): Series C (2500 Vac on analog inputs; 3000 Vdc on power supply, contact inputs, and contact outputs).
Section 8: Impulse voltage tests.
Severity Level: 0.5 Joule, 5 kV.

IEC 255-21-1 : 1988 Electrical relays, Part 21: Vibration, shock, bump, and seismic tests on measuring relays and protection equipment, Section 1: Vibration tests (sinusoidal).
Severity Level: Class 2.

IEC 255-21-2 : 1988 Electrical relays, Part 21: Vibration, shock, bump, and seismic tests on measuring relays and protection equipment, Section 2: Shock and bump tests.
Severity Level: Class 2.

IEC 255-21-3 : 1993 Electrical relays, Part 21: Vibration, shock, bump, and seismic tests on measuring relays and protection equipment, Section 3: Method A seismic test (not tested below 5 Hz).
Severity Level (Conventional Terminal Blocks Option only): Class 2 (Quake Response).

IEC 255-22-1 : 1988 Electrical disturbance tests for measuring relays and protection equipment, Part 1: 1 MHz burst disturbance tests.
Severity Level: Class III, 2.5 kV peak common mode, 2.5 kV peak differential mode.

IEC 255-22-2 : 1996 Electrical disturbance tests for measuring relays and protection equipment, Section 2: Electrostatic Discharge tests.
Severity Level: 4.

IEC 255-22-3 : 1989 Electrical disturbance tests for measuring relays and protection equipment, Section 3: Radiated electromagnetic field disturbance tests.
Severity Level: Class III of 10 V/m.

Exceptions:
4.3.2.2 Frequency sweep approximated with 200 frequency steps per octave.

IEC 255-22-4 : 1992 Electrical disturbance tests for measuring relays and protection equipment, Section 4: Fast transient disturbance test.
Severity Level: 4 (4 kV at 2.5 kHz on power supply, 2 kV, 5 kHz repetition rate on I/O, signal, data and control lines).

IEC 529 : 1989 Degrees of protection provided by enclosures (IP code): Object penetration and dust ingress.
Severity Level (Conventional Terminal Blocks Option): IP3X.
Severity Level (Plug-In Connectors Option): IP3X Overall (with Phoenix connectors); IP4X Front Panel only.

IEC 801-2 : 1991 Electromagnetic compatibility for industrial-process measurement and control equipment, Part 2: Electrostatic discharge requirements.
Severity Level: 4.

IEC 801-3 : 1984 Electromagnetic compatibility for industrial-process measurement and control equipment, Part 3: Radiated electromagnetic field requirements.
Severity Level: Class III of 10 V/m.

Exceptions:
9.1 Frequency sweep approximated with 200 frequency steps per octave.

IEC 801-4 : 1988 Electromagnetic compatibility for industrial-process measurement and control equipment, Part 4: Electrical fast transient/burst requirements.
Severity Level: 4 (4 kV at 2.5 kHz on power supply, 2 kV, 5 kHz repetition rate on I/O, signal, data and control lines).

UL 508 Industrial Control Equipment Standard for Safety (not applicable for Plug-In Connectors Option).

OPERATION, METERING, CONTROL, AND REPORTING

Apply This Relay to Protect:

- Any two-winding power transformer
- Three-winding power transformers where the tertiary winding is not connected
- Reactors, generators, large motors, and other two-terminal power apparatus

Smart Relay Settings Simplify Current Connections

- Relay accepts delta- or wye-connected CT secondary circuits
- Enter transformer ratings and connections, CT ratios and connections
- Relay calculates TAP values, corrects CT ratio and transformer ratio
- CT secondary circuits are isolated, allowing them to be connected to other protection

High-Side and Low-Side Overcurrent Elements Provide Additional Protection

- Use high-side overcurrent elements for built in transformer backup protection
- Negative-sequence overcurrent elements detect ground faults through delta-wye transformer banks
- Use low-side overcurrent elements for backup distribution bus or feeder protection
- Negative-sequence overcurrent elements provide sensitive phase-phase protection independent of load current

Externally Torque-Controlled Overcurrent Elements

- Optionally, select relay control inputs to supervise overcurrent elements
- Select torque-controlled overcurrent elements individually
- Implement a reverse interlocking scheme for fast-bus tripping on radial systems
- Provide external directional supervision

Operator Controls and Serial Communications

- Front-panel pushbuttons and display
- Complete operation from rear-panel EIA-232 serial communications port
- Full access to event history, relay status, and meter information
- Passcode protected settings and controls

Current Meter Functions

- Provides instantaneous, demand, and peak demand current magnitudes for both windings
- Calculates operate, restraint, second-, and fifth-harmonic current magnitudes
- Records peak demand and peak harmonic current magnitudes

Breaker Monitor and Control

- Saves trip counters and accumulated, interrupted current in nonvolatile memory
- Controls each breaker with separate Open and Close commands

SELOGIC Control Equations

- Assign input functions
- Create application-specific output functions
- Design unique trip and control schemes
- Minimize external timers, auxiliary relays, wiring, and panel space
- Obtain event reporting for all relay elements, inputs, and outputs

Event Reporting

- Relay stores 10 reports in nonvolatile memory
- Reports have 15-cycle duration
- Each event report has two parts:
  - Part 1 shows input currents, overcurrent elements, general differential elements, inputs, and outputs.
  - Part 2 shows operating and restraint currents, maximum second- and fifth-harmonic currents, more detailed information of the differential elements, and the remaining elements.

RELAY MOUNTING

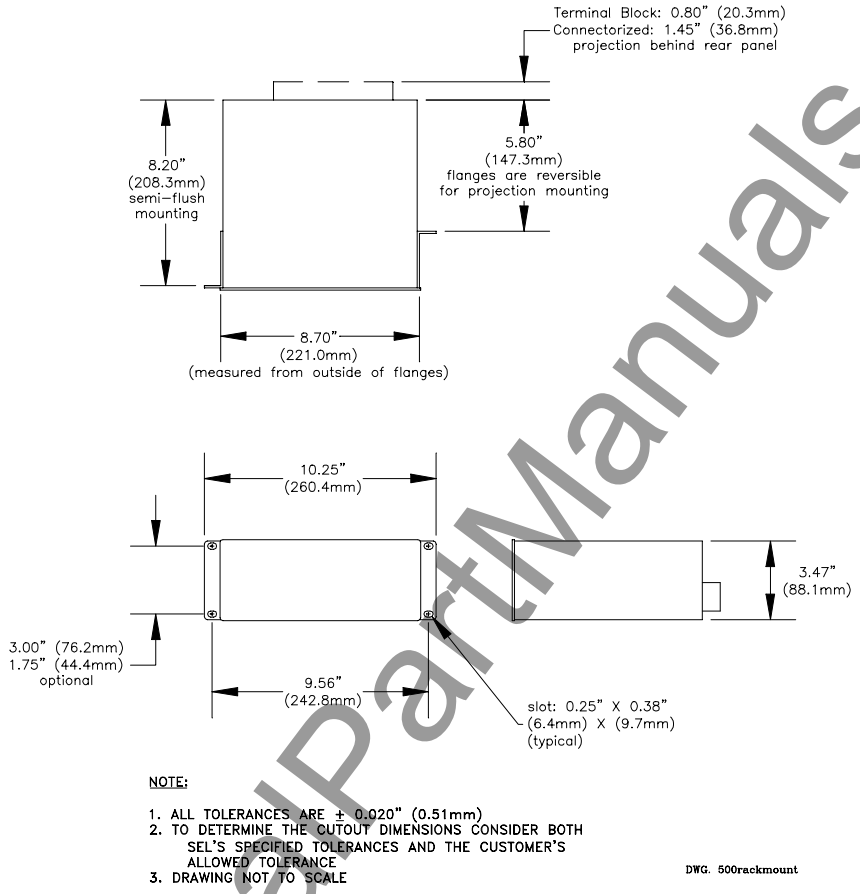


Figure 1: Relay Dimensions and Drill Plan for Single Rack-Mount Relay

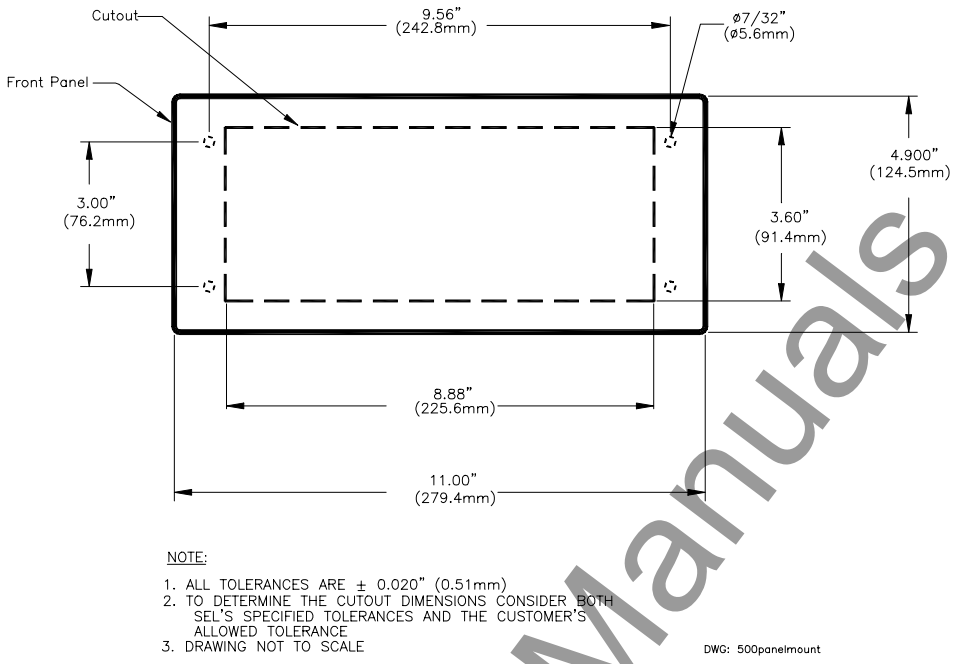


Figure 2: Panel Cutout and Drill Plan for Single Panel-Mount Relay

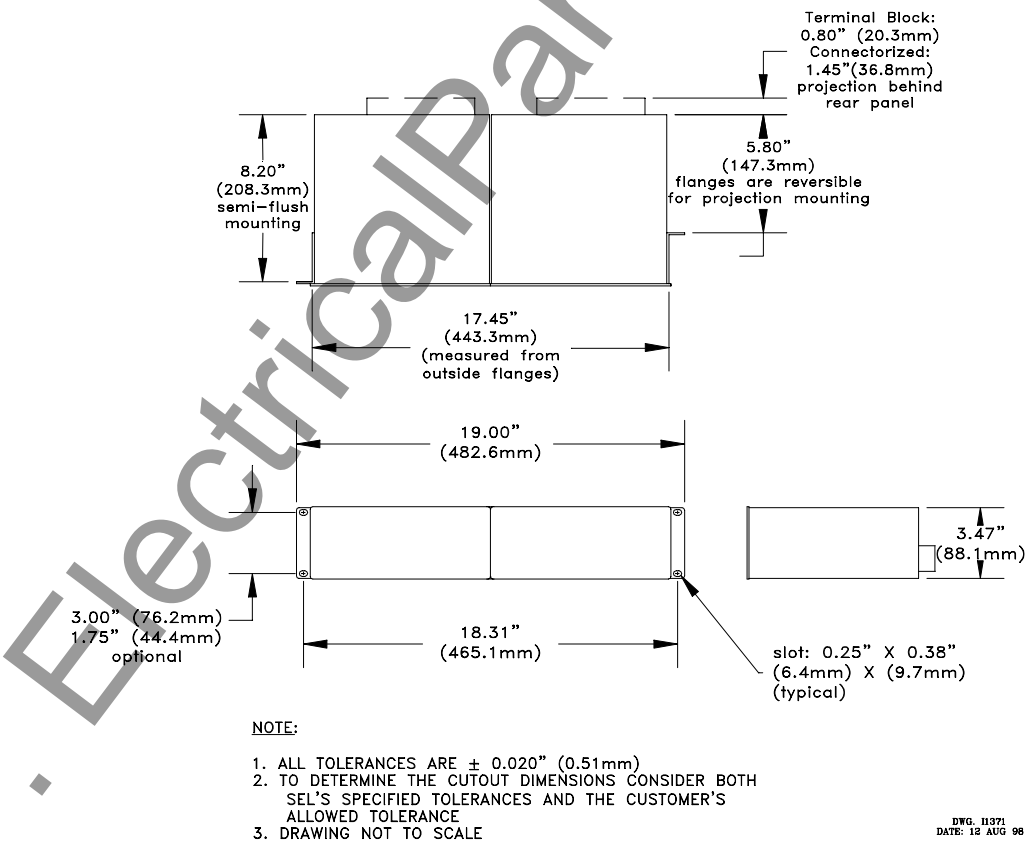


Figure 3: Relay Dimensions and Drill Plan for Mounting Two SEL-500 Series Relays Together Using Mounting Block (SEL P/N 9101)

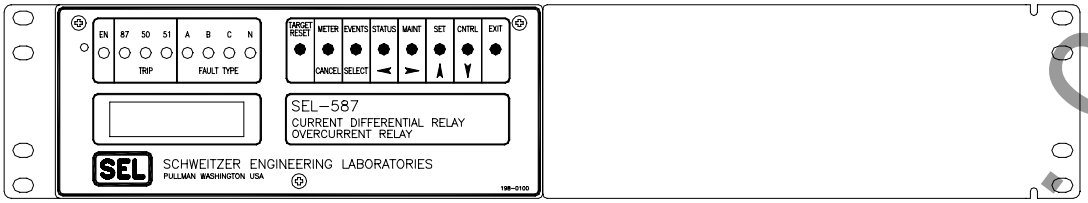


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Figure 4: Relay Fitted With Mounting Bracket (SEL P/N 9100) for Mounting in 19-Inch Rack

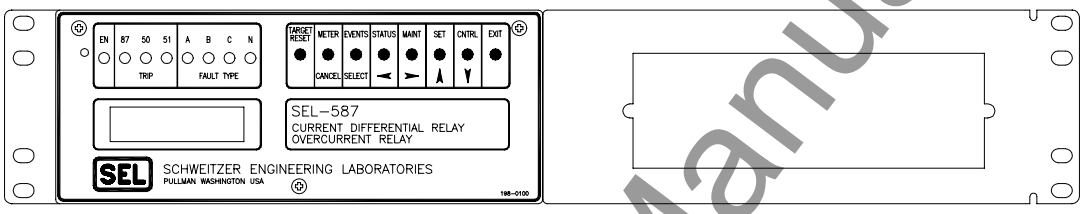

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Figure 5: Relay Fitted With Mounting Bracket (SEL P/N 9102) for Mounting in 19-Inch Rack Including Cutout to Fit an FT-1 Test Switch

TWO REAR-PANEL OPTIONS

Conventional Terminal Blocks

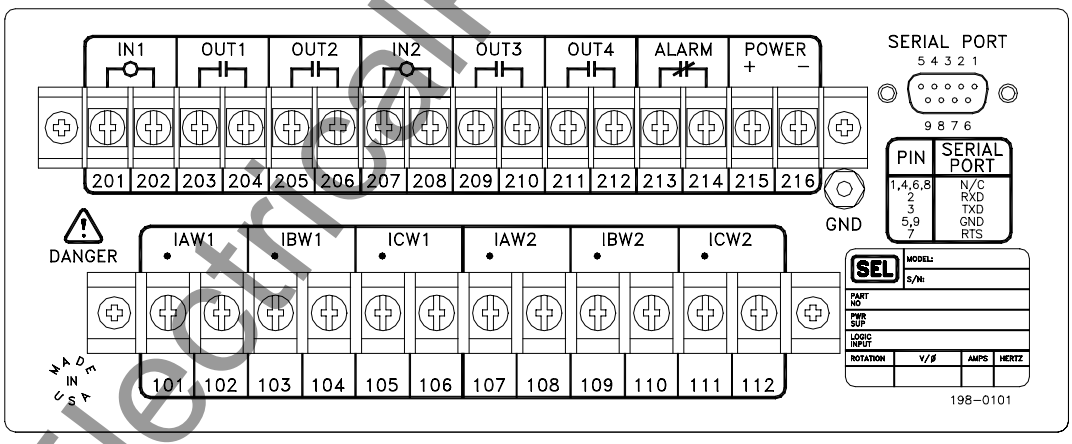

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Figure 6: Relay Rear Panel (Conventional Terminal Blocks Option)

Output contacts OUT1–OUT4 and ALARM are not polarity-dependent.

Optoisolator inputs IN1 and IN2 are not polarity-dependent.

All screws are size #6-32.

Plug-In Connectors (Connectorized)

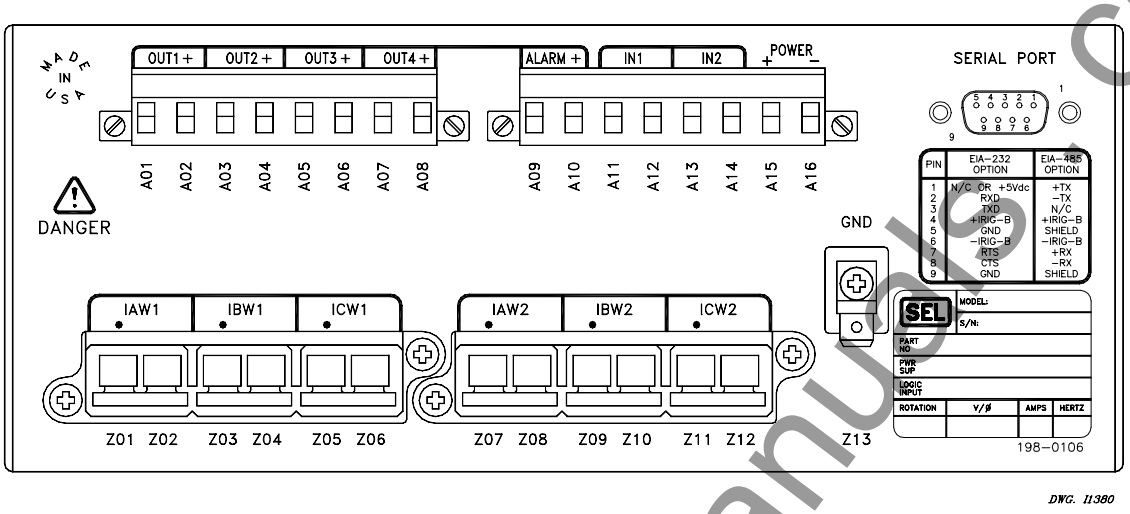

Figure 7: Relay Rear Panel (Plug-In Connectors Option)

Important: Improvements in Connectorized SEL-587 Relays (Plug-In Connectors) Result in Part Number Changes

The current transformer shorting connectors for current channel inputs IAW1, IBW1, ICW1, and IAW2, IBW2, and ICW2 have been made more robust. This improvement makes the new connector design incompatible with the old design. Thus, new Connectorized SEL-587 Relays with this improved connector have a new part number (partial part numbers shown):

Old		**New**
0587xJ	→	0587xW

The respective wiring harness part numbers for these old and new Connectorized SEL-587 Relays are (partial part numbers shown):

Old		**New**
WA0587xJ	→	WA0587xW

The other connectors on the SEL-587 Relay rear panel (power input, output contacts, etc.) are the same for the old or new models. Only the current transformer shorting connectors have changed.

Figure 7 shows the rear panel for new model 0587xW. Because all terminal labeling/numbering remains the same between the new and old relays, these figures can also be used as a reference for old model 0587xJ. Only the connectors and part numbers have changed.

Connector terminals A01–A16 accept wire size AWG 24 to 12 (install wires with a small slotted-tip screwdriver).

Output contacts OUT1–OUT4 and ALARM are polarity-dependent (note the "+" above terminals A02, A04, A06, A08, and A10).

See ***General Specifications*** for high-current interrupting output contact ratings.

Optoisolator inputs IN1 and IN2 are not polarity-dependent.

Current input connector (terminals Z01–Z12):

- Contains current transformer shorting mechanisms
- Accepts wire size AWG 16 to 10 (special tool required to attach wire to connector)
- Can be ordered prewired

Ground connection (terminal Z13): tab size 0.250" x 0.032", screw size #6-32.

FACTORY ASSISTANCE

The employee-owners of Schweitzer Engineering Laboratories are dedicated to making electric power safer, more reliable, and more economical.

We appreciate your interest in SEL products, and we are committed to making sure you are satisfied. If you have any questions, please contact us at:

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We guarantee prompt, courteous, and professional service.

We appreciate receiving any comments and suggestions about new products or product improvements that would help us make your job easier.

SEL-587 Current Differential Relay, Overcurrent Relay Date Code 991215