SEL-501 Dual Universal Overcurrent Relay

Major Features and Benefits

- Features two three-phase, current-based relays in one complete package.
- Protects feeders, buses, transformers, motors, breakers, and other apparatus.
- Is easily set from the front panel or communications port.
- Includes metering, self-testing, alarm, and event reporting.
- Saves 2 full reports and 20 summaries in nonvolatile memory.
- Makes redundant protection practical—ideal for stacked breaker switchgear.
- Includes low-level test interface.
- Supports ASCII, SEL LMD, and Modbus protocol.

Features

Dual Relay Concept

The SEL-501 Dual Universal Overcurrent Relay provides two complete and independent groups of protection functions in one compact unit. The unit contains Relay X and Relay Y, each having separate optoisolated inputs, output contacts, and three-phase current inputs.

Table 1 Relay I/O and Current Inputs

	Input	Output Contacts	Current Inputs
Relay X	XIN	XOUT1, XOUT2	IAX, IBX, ICX
Relay Y	YIN	YOUT1, YOUT2	IAY, IBY, ICY

Five Relay Functions

Select the relay functions independently for Relays X and Y. Choose from five relay functions.

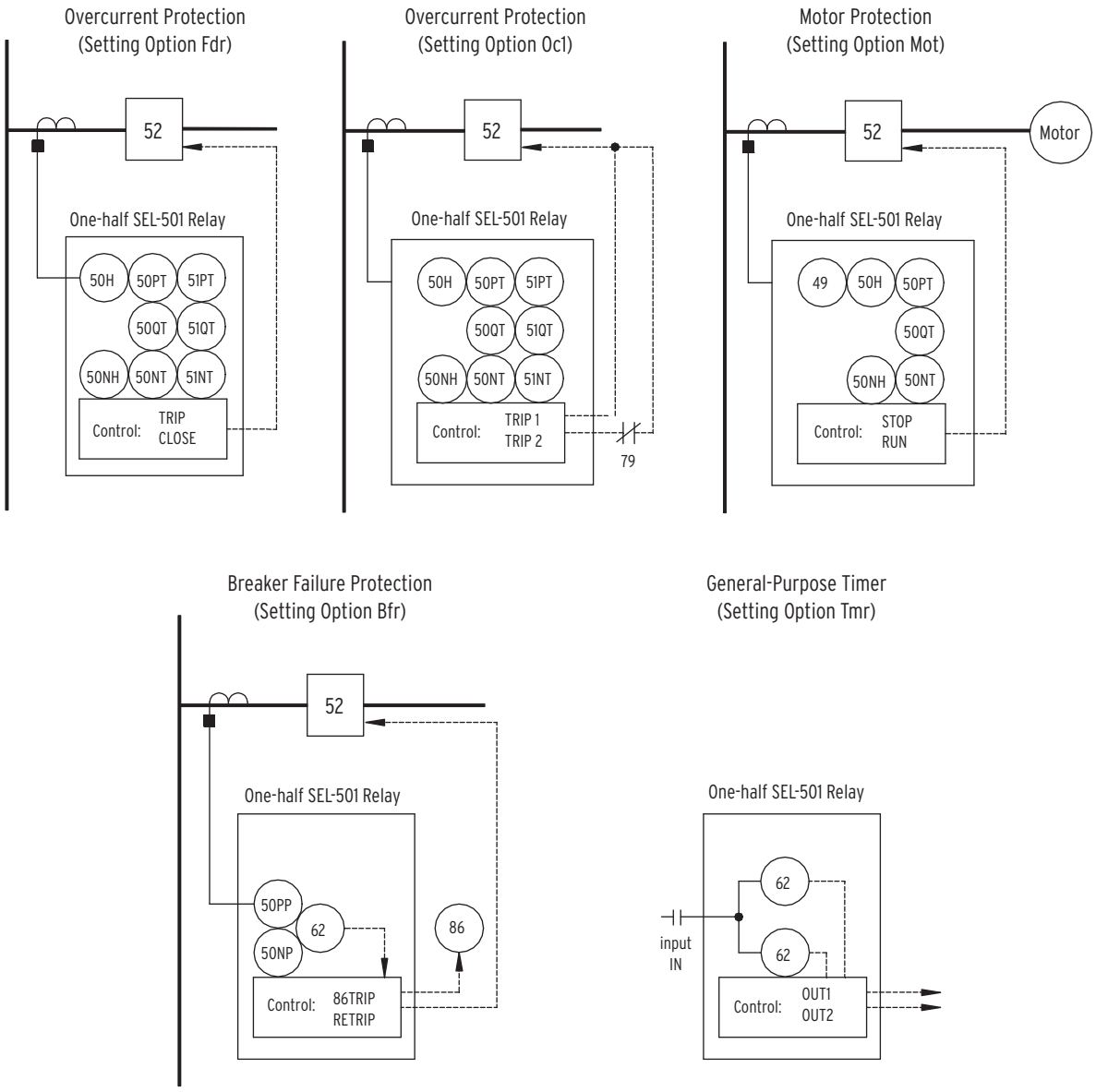
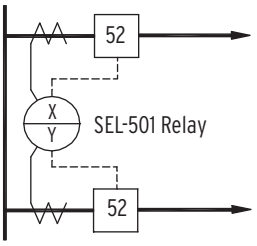


Figure 1 Relay Application Single-Line Diagrams

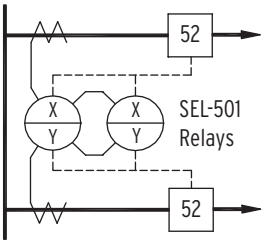
SEL-501 Dual Relay Applications

Protect Two Feeders



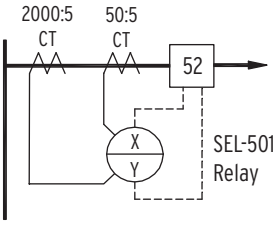
- Complete overcurrent and simple breaker failure protection for two feeders.
- Settable time delay on trip output contact provides simple breaker failure protection.
- Low-cost, compact protection.

Two Relays + Two Feeders = Full Redundancy



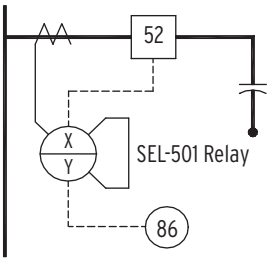
- Ideal for two-high switchgear.
- Front-panel control eliminates the need for manual control switches.
- Includes negative-sequence overcurrent protection for sensitive, fast phase-phase fault coverage.

Cover a Wide Range of Fault Currents



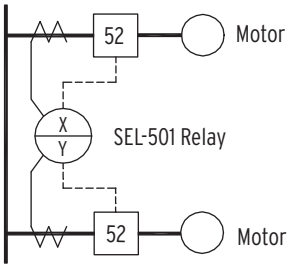
- 2000:5 CT covers fault up to 32,000 amps (5 A Model).
- 50:5 CT meters load accurately, and covers faults down to 5 amps primary (5 A Model).

Capacitor, Reactor, and Breaker Failure Protection



- Protects capacitors, reactors, and bus sections.
- Provides breaker failure protection.

Protect Two Motors



- Complete protection for two motors.
- Ideal for compact motor control centers.
- Stop and start motors from relay front panel.

Figure 2 Example SEL-501 Dual Relay Applications

Overcurrent Protection

The SEL-501 has two overcurrent protection setting options: FDR or OC1. Both options use the same overcurrent elements, but differ in input and output contact functions.

Table 2 Overcurrent Settings and Ranges

Eight Overcurrent Elements	Instantaneous	Definite-Time	Inverse-Time
Phase (Ia, Ib, and Ic)	50H	50PT	51PT
Negative-Sequence (IQ = 3 • I2)		50QT	51QT
Residual (IR = Ia + Ib + Ic)	50NH	50NT	51NT
Ranges (A secondary)			
5 A Model:	0.5–80 A, 0.1 step	0.5–80 A, 0.1 step	0.5–16 A, 0.1 step
1 A Model:	0.1–16 A, 0.1 step	0.1–16 A, 0.1 step	0.1–3.2 A, 0.1 step
Definite-Time Delay		0–16,000 cycles	US and IEC curves

Table 3 Overcurrent Contact Functions

Setting	Input	Output Contacts
FDR	52A	TRIP (OUT1)—select any elements CLOSE (OUT2)
OC1	Programmable—select one	Both trips have time-delay pickup timers, settable 0–16,000 cycles.
	EN—Enable user-selected elements	
	BLK—Block user-selected elements	TRIP1 (OUT1)—select any elements
	ET—External Trigger of event reports	TRIP1 (OUT2)—select any elements

Motor Protection

Table 4 Motor Protection Settings and Ranges

Elements	Instantaneous	Definite-Time
Phase (Ia, Ib, and Ic)	50H	50PT
Negative-Sequence (IQ = 3 • I2)		50QT
Residual (IR = Ia + Ib + Ic)	50NH	50NT
Ranges (A secondary)		
5 A Model:	0.5–80 A	0.5–80 A
1 A Model:	0.1–16 A	0.1–16 A
Definite-Time Delay		0–16,000 cycles

Thermal Model (49) provides locked-rotor, unbalance and overload protection.

Motor operation monitors include load-jam trip, load-loss trip, and a starts per-hour limit.

Input	Output Contacts
52A	TRIP (OUT1) CLOSE (OUT2)

Breaker Failure Protection

Table 5 Breaker Failure Protection Settings and Ranges

Instantaneous Overcurrent Elements		Breaker Failure Timer (62FC)
Phase (Ia, Ib, and Ic)	50PP	0.25–63.75 cycles
Residual (IR = Ia + Ib + Ic)	50NP	
Ranges (A secondary)		**Breaker Retrip Timer (62FC)**
5 A Model:	0.5–80 A	0–63.75 cycles
1 A Model:	0.1–16 A	
Maximum Reset Time	0.75 cycles	
Input	**Output Contacts**	
BFI—Breaker Failure Initiate	86TR—Breaker Failure Trip (OUT1) RETRIP—Breaker Retrip (OUT2)	

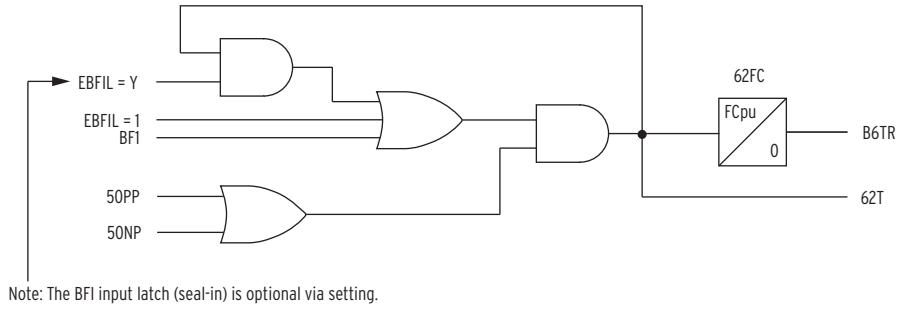


Figure 3 SEL-501 Relay Breaker Failure Logic

General-Purpose Timer

Timer Ranges (62 Device)
Pickup: 0–16,000 cycles
Dropout: 0–16,000 cycles

The timers are completely independent of the relay current inputs.

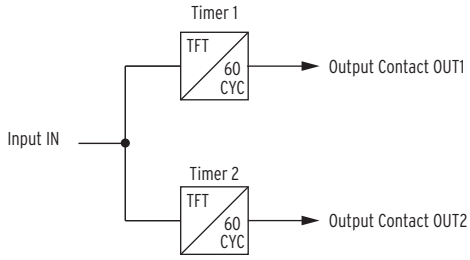


Figure 4 SEL-501 Relay General-Purpose Timer

Operation, Metering, and Communications

- Complete operation from front-panel controls, front-panel serial port, or rear-panel serial port.
- Full access to event history, relay status, and meter information.
- Instantaneous, demand, and peak demand currents metered.
- Settings and control have passcode protection.
- Modbus RTU protocol supports direct integration, via appropriate gateways, into SCADA or DCS systems.

Event Reporting

- Relay stores 12 reports: newest two are in nonvolatile memory.
- Reports have 15-cycle duration and quarter-cycle resolution.
- Unique event headers for each application.

```
FEEDER 1                                   Date: 06/11/94   Time: 06:41:40.913
BFR 1

FID=SEL501-R106-V65X1XXpa-D940525
                                                          Relay X    Relay Y  A
          Relay X                      Relay Y            555555  5O    5 5  BO L
          Amps Pri                     Amps Pri           111OOO  2U    O O6 FU R
  IRX     IAX     IBX     ICX     IRY     IAY     IBY     ICY  PQNPQN  AT    P N2 IT M

    -2     392     224    -618      -0     393     228    -621 ......  *.    P .. .. .
     0    -491     586     -94       2    -495     585     -88 ......  *.    P .. .. .
     1    -389    -230     620      -4    -389    -235     621 ......  *.    P .. .. .
    -2     493    -583      88      -2     494    -585      89 ......  *.    P .. .. .

    -2     386     234    -622       2     386     240    -623 ......  *.    P .. .. .
     4    -495     582     -84      -0    -499     585     -86 ......  *.    P .. .. .
    -2    -382    -239     620       3    -380    -243     626 ......  *.    P .. .. .
    -8     496   -1141     637      -6     500   -1693    1186>pq....  *.    P .. .. .

     8     380    -450      78       8     381   -1172     799 pq....  *.    P .. .. .
     6    -501    2738   -2231       7    -505    3788   -3276 pq....  *.    P .. .. .
   -13    -377    1244    -880     -10    -376    1358    -992 pq....  *.    P .. .. .
    -8     502   -3783    3273     -13     503   -3795    3279 pq....  *.    P .. .. .
                    .
[Four cycles of data]   .
                    .
     5     341   -1126     790      10     342   -1123     791 pq....  *.    P .. .. .
     2    -526    3858   -3330       8    -526    3873   -3338 pq....  *.    P .. .. .
    -5    -339    1105    -770     -11    -341    1094    -764 pq....  *.    P .. .. .
    -3     528   -3863    3333      -8     529   -3878    3340 pq....  *.    P .. .. .

     5     337   -1077     745       6     334   -1058     730 pT....  *1    P .. .. .
     4    -531    3872   -3337       4    -532    3883   -3347 pT....  *1    P .. .. .
    -6    -333    1049    -722     -10    -332    1038    -716 pT....  *1    P .. .. .
    -6     533   -3881    3343     -11     535   -3900    3354 pT....  *1    P .t *. .

     6     329   -1025     702       7     326   -1006     687 pT....  *1    P .t *. .
     4    -535    3887   -3348       5    -534    3897   -3358 pT....  *1    P .t *. .
    -6    -325     998    -678     -10    -324     975    -660 pT....  *1    P .t *. .
    -5     535   -3892    3352      -8     540   -3908    3360 pT....  *1    P .t *. .
                    .
[Two cycles of data]    .
                    .
    -2     178    -449     268     -10      44      21     -74 pT....  *1    P .t *. .
    -1    -180    1122    -943       1       0       0       1 pT....  *1    . .. *. .
     3     -24       7      20      -5      -2      -2      -2 pT....  .1    . .. *. .
     0       0       0       0       0       0       0       0 ......  ..    . .. *. .

     0       0       0       0      -2      -2       0       0 ......  ..    . .. *. .
    -1      -1       0       0      -2      -2       0       0 ......  ..    . .. *. .
    -2      -1      -1       0       1       0       0       1 ......  ..    . .. .. .
     0       0       0       0      -2      -2      -2       1 ......  ..    . .. .. .

     2       1       0       0       1       1       0       0 ......  ..    . .. .. .
    -1       0      -1       0       0       0       0       0 ......  ..    . .. .. .
    -2      -1      -1       0       0       0       0       0 ......  ..    . .. .. .
     0       0       0       0       0       0       0       0 ......  ..    . .. .. .

Event: FAULT X            Targets:X B C Q          Duration:   11.00
Relay X Currents (A Pri), ABCQN:     626   1165    888    242      2
Relay Y Currents (A Pri), ABCQN:     628   1710   1341    481      2

Relay X Settings:
ID    = FEEDER 1
APP   = FDR     CTR   = 120     DATC  = 15
50PP  = 15.5    50PD  = 20.00   50H   = 40.0
50QP  = 10.8    50QD  = 18.00
50NP  = 4.3     50ND  = 15.00   50NH  = 18.0
51PP  = 7.50    51PC  = U4      51PTD = 3.20
51PRS = N
51QP  = 5.00    51QC  = U4      51QTD = 1.10
51QRS = N
51NP  = 2.25    51NC  = U4      51NTD = 2.00
51NRS = N

Relay Y Settings:
ID    = BFR 1
APP   = BFR     CTR   = 120     DATC  = 15
50PP  = 4.0     50NP  = 2.0     FC    = 10.50
                                ERTR  = N
```

Time tag corresponds to the 8th quarter-cycle of this event.

One cycle of data.

Relay Y 50PP element is picked up.

Relay X 51PT and 51QT time-overcurrent elements pick up for BC fault, triggering this report. Breaker is closed.

Relay X 51QT element times out, causing a trip.

Breaker Failure Initiate input is asserted, starting breaker failure timer.

Breaker operates, clearing fault.

Event Summary

Relay X set for overcurrent protection.

Relay Y set for breaker failure protection.

Figure 5 Example Event Report

Two Rear-Panel Options

Conventional Terminal Blocks

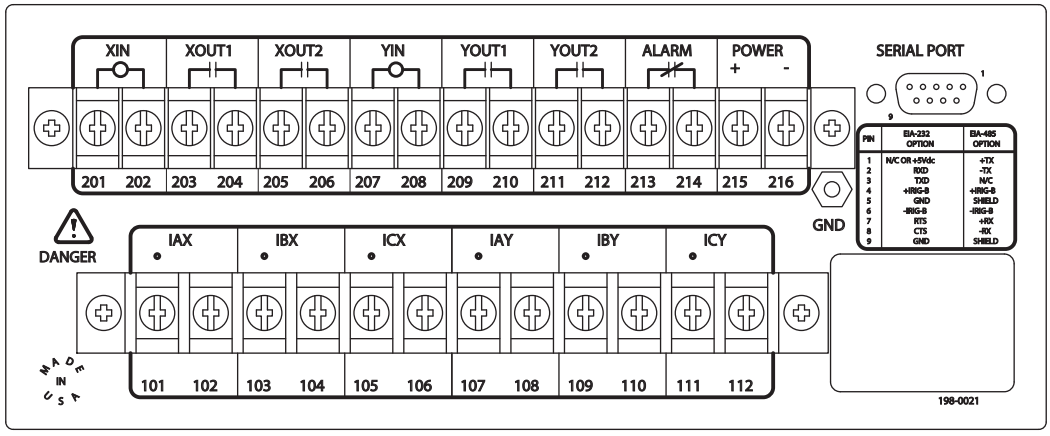


Figure 6 SEL-501 Relay Rear Panel Without Serial Front Port (Conventional Terminal Block Option)

Output contacts **XOUT1**, **XOUT2**, **YOUT1**, **YOUT2**, and **ALARM** are not polarity-dependent.

Optoisolated inputs **XIN** and **YIN** are not polarity-dependent.

All screws are size #6-32.

Connectorized Relay (Plug-In Connectors)

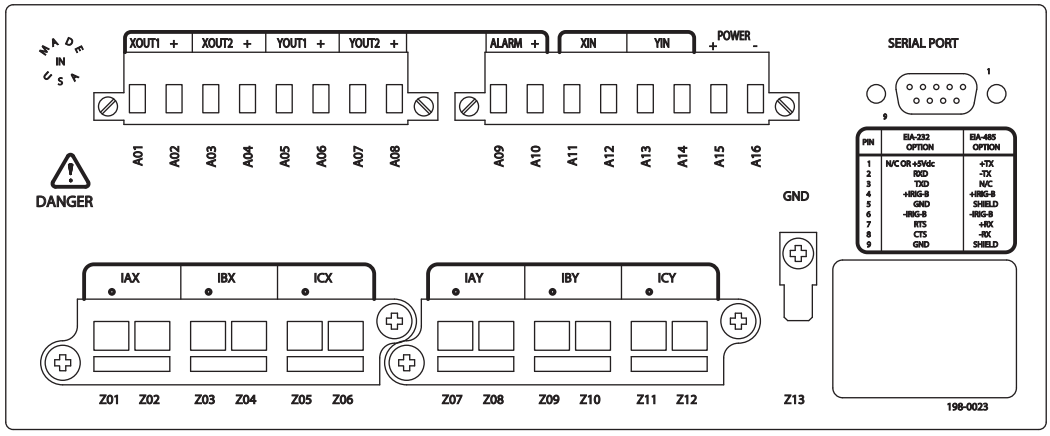


Figure 7 SEL-501 Relay Rear Panel (Plug-In Connectors Option)

Important: Improvements in Connectorized® SEL-501 relays (Plug-In Connectors) resulted in part number changes.

The current transformer shorting connectors for current channel inputs **IAX**, **IBX**, **ICX**, and **IAY**, **IBY**, **ICY** have been made more robust. This improvement makes the new connector design incompatible with the old design. Thus, new Connectorized SEL-501 relays with this improved connector have a new part number (partial part numbers shown):

Old	New
0501xJ	0501xW

The respective wiring harness part numbers for these old and new Connectorized SEL-501 relays are (partial part numbers shown):

Old	New
WA0501xJ	WA0501xW

Figure 7 shows the rear panel for new models 0501xW. Because all terminal/numbering remains the same between the new and old relays, these figures can also be used as a reference for old model 0501xJ. 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 screwdriver).

Output contacts **XOUT1**, **XOUT2**, **YOUT1**, **YOUT2**, and **ALARM** are polarity-dependent (note the **+** above terminal **A02**, **A04**, **A06**, **A08**, and **A10**).

See *Specifications on page 14* for high-current interrupting output contact ratings.

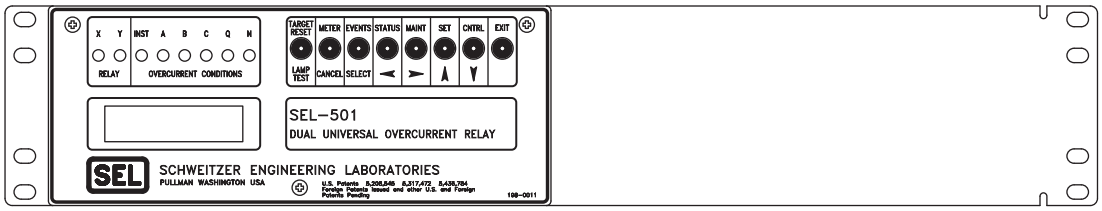
Optoisolated inputs **XIN** and **YIN** are not polarity-dependent.

Current input connector (terminals **Z01**–**Z12**):

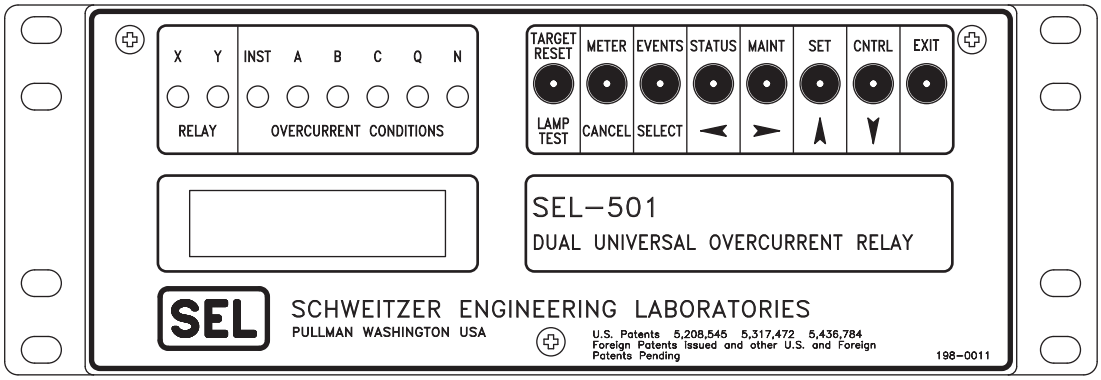
- ➤ Contains current transformer shorting mechanisms
- ➤ Accepts wire size AWG 16 to 10 (special tool required to attach wire to connector)
- ➤ Can be ordered prewired

Ground connection (terminal **Z13**): tab size 0.250 inch • 0.032 inch, screw size #6-32.

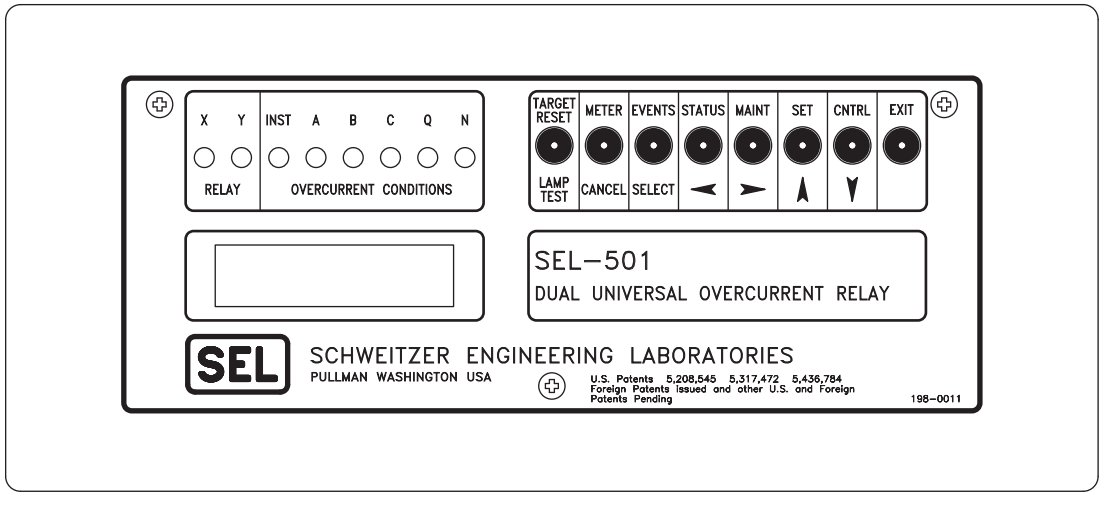
Front- and Rear-Panel Diagrams



SEL-501 Relay Fitted With Mounting Bracket (SEL P/N 9100) for Mounting in 19-Inch Rack

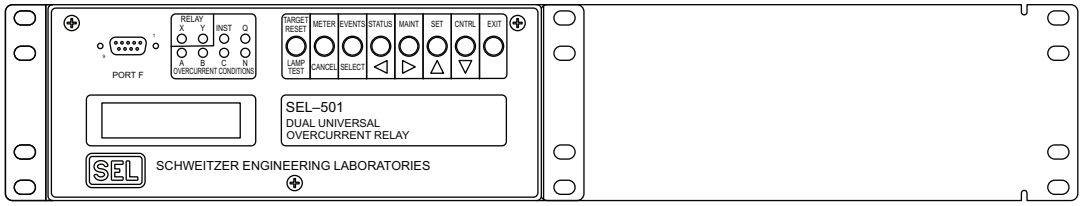


SEL-501 Relay Front Panel, Rack-Mount Version (Half-Rack Width)

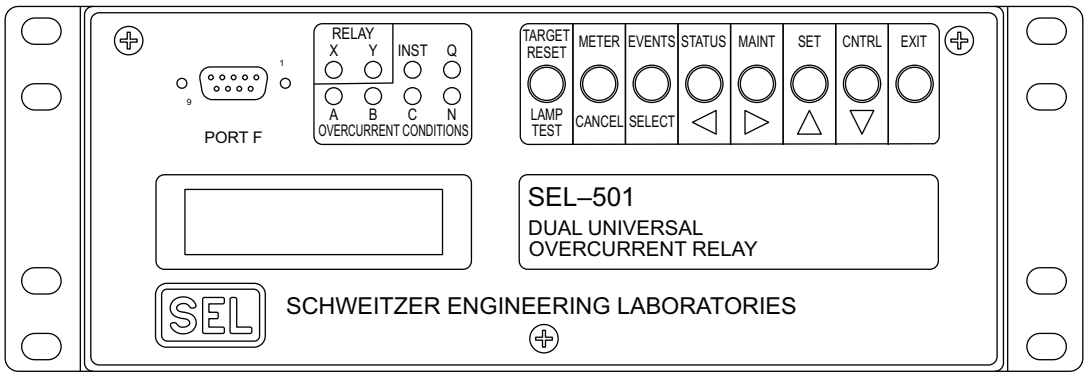


SEL-501 Relay Front Panel, Panel-Mount Version

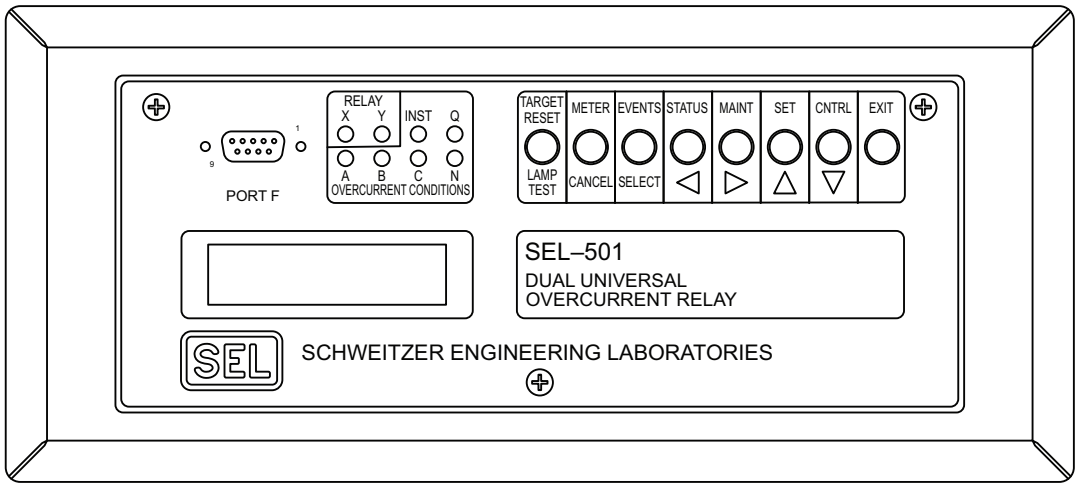
Figure 8 SEL-501 Front Panels Without Front Serial Port



SEL-501 Relay Fitted With Mounting Bracket (SEL P/N 9100) for Mounting in 19-Inch Rack

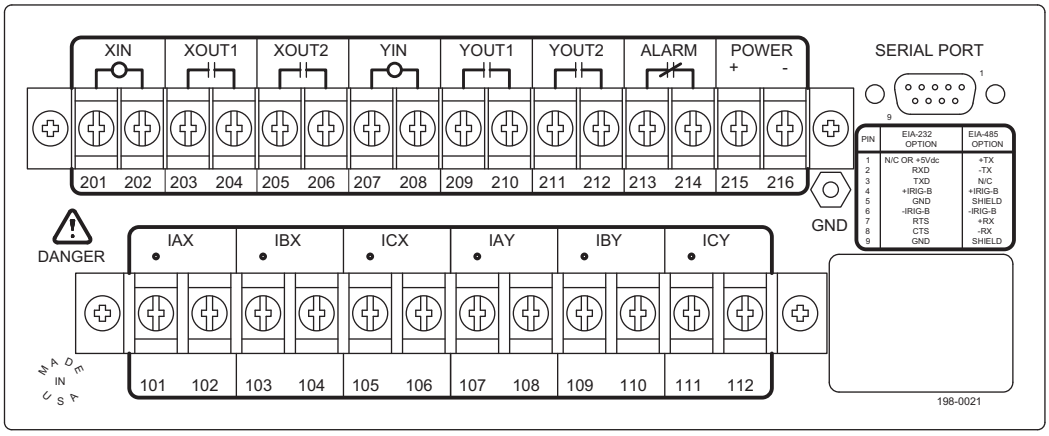


SEL-501 Relay Front Panel, Rack-Mount Version (Half-Rack Width)

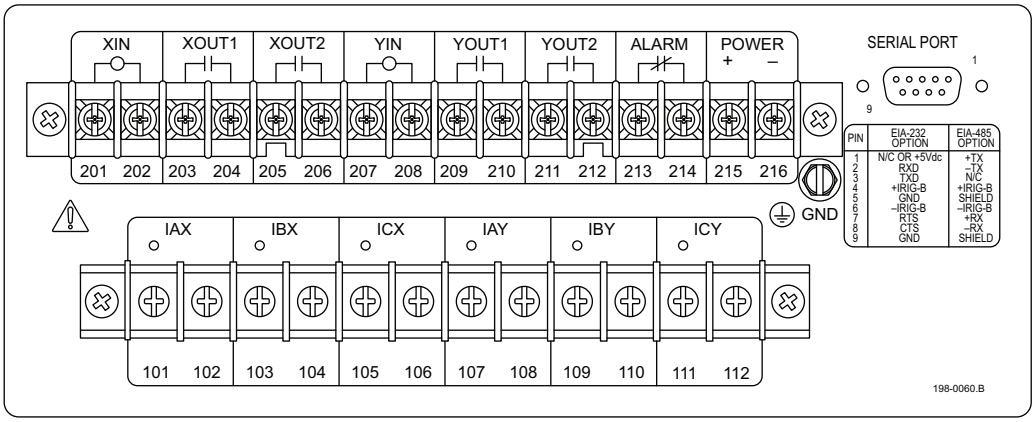


SEL-501 Relay Front Panel, Panel-Mount Version

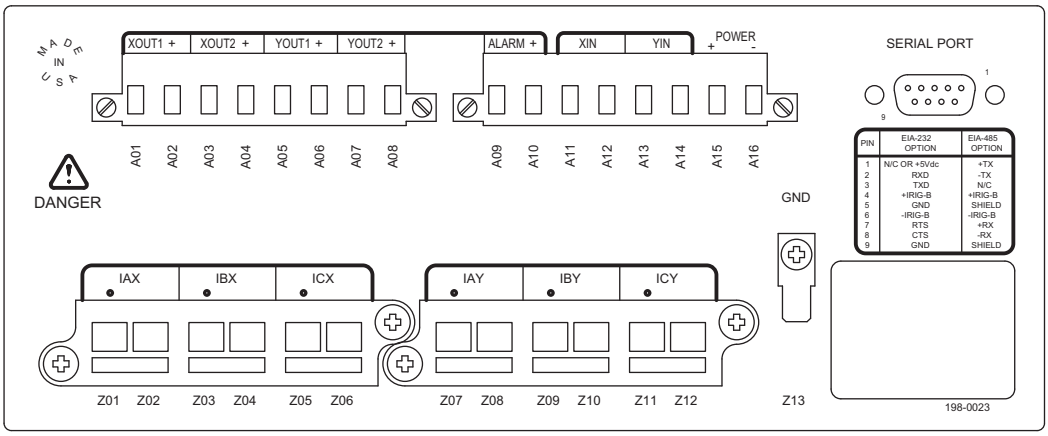
Figure 9 SEL-501 Front Panels With Front Serial Port



SEL-501 Relay Rear Panel Without Front Serial Port (Conventional Terminal Blocks Option)



SEL-501 Relay Rear Panel With Front Serial Port (Conventional Terminal Blocks Option)



SEL-501 Relay Rear Panel (Plug-In Connectors Option)

Figure 10 SEL-501 Rear-Panel Diagrams

Relay Dimensions

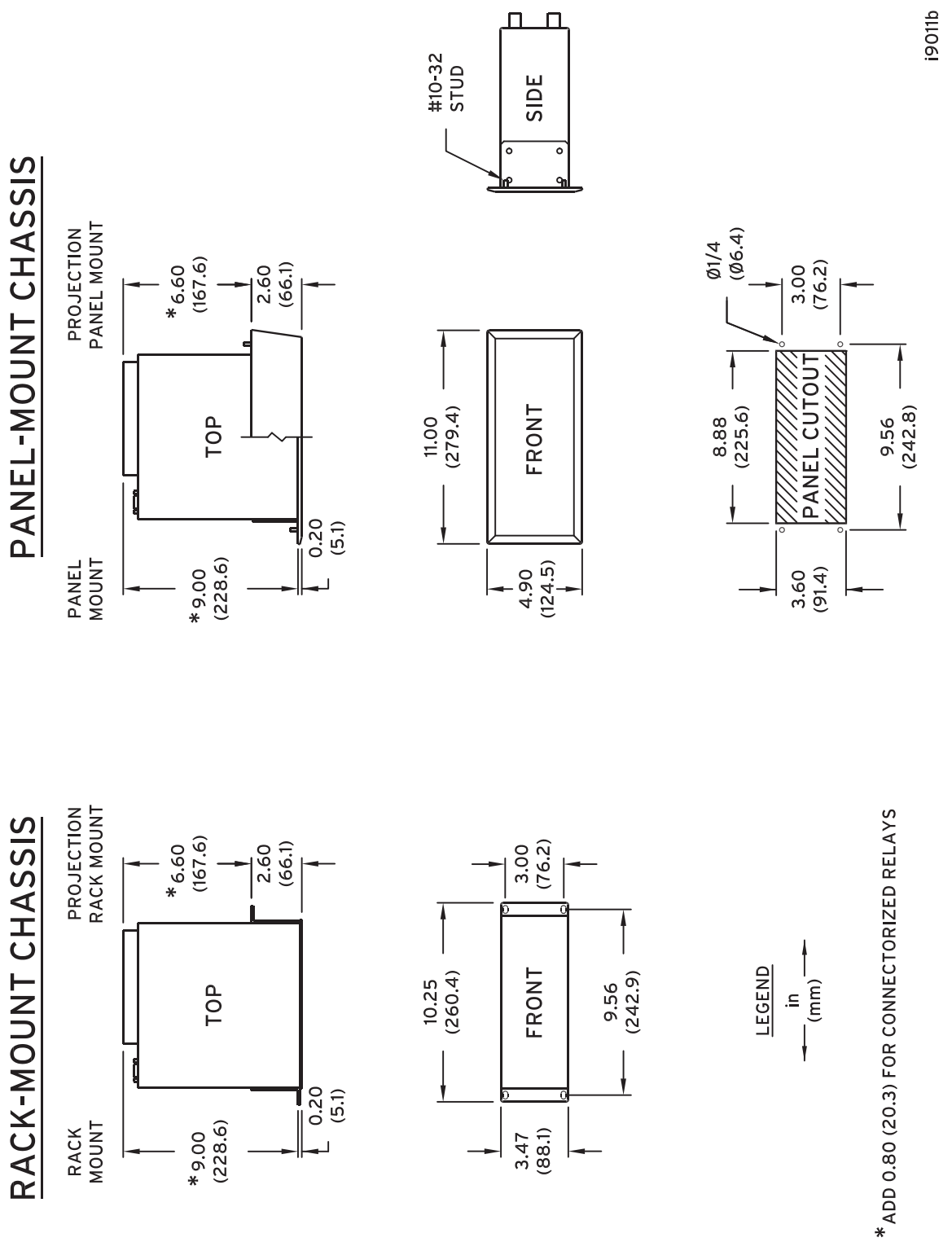


Figure 11 SEL-501 Dimensions and Drill Plan for Single Rack-Mounted Relay

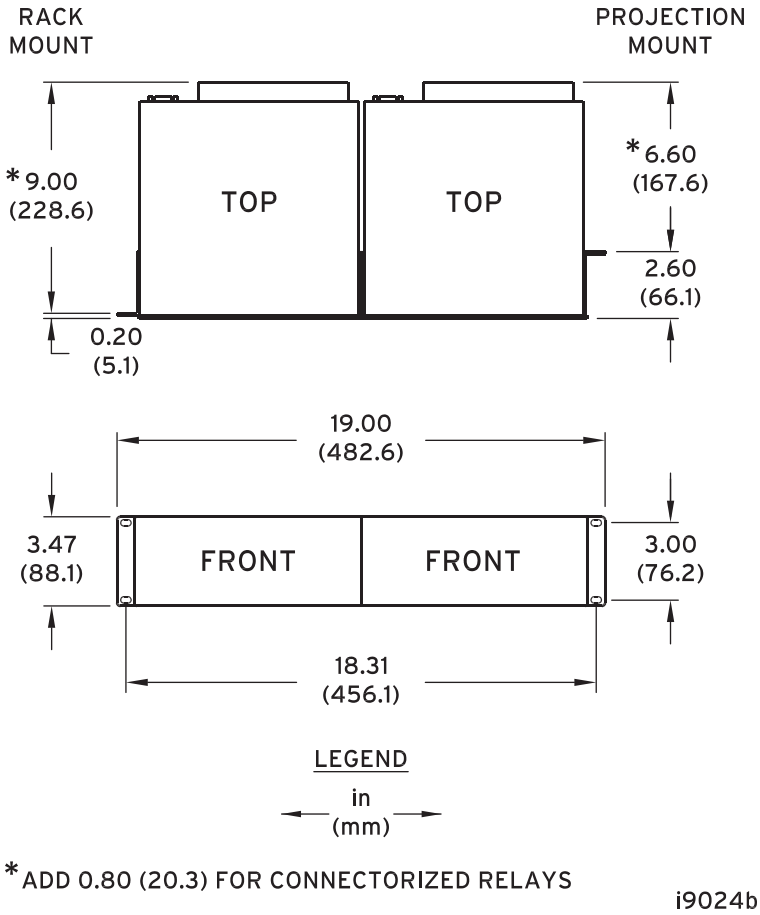


Figure 12 Relay Dimensions and Drill Plan for Mounting Two SEL-500 Series Relays Together Using Mounting Block (SEL P/N 9101)

RACK-MOUNT CHASSIS

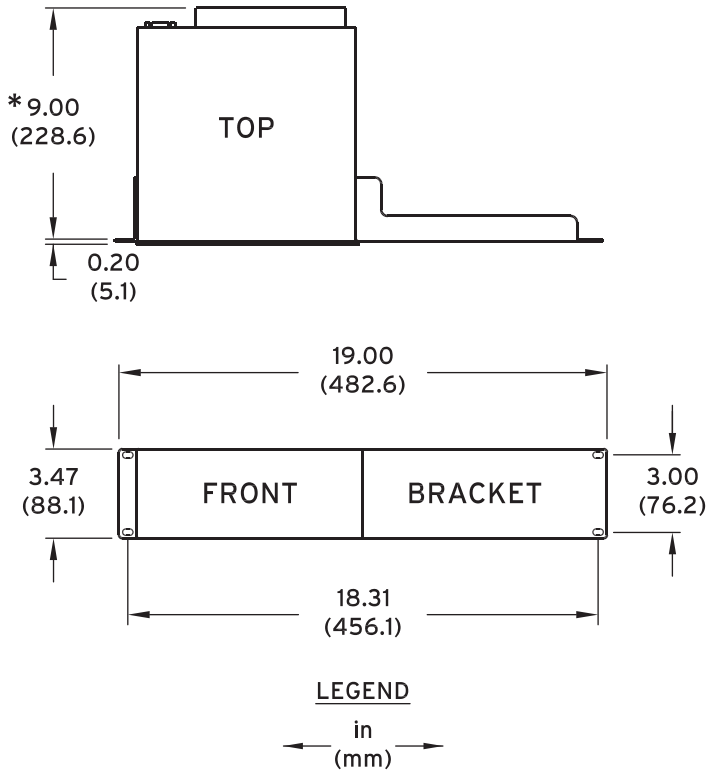


Figure 13 Relay Dimensions and Drill Plan for Mounting an SEL-501 Relay with Rack Mount Bracket 9100 (bracket on right side front view)

Specifications

Compliance

Designed and manufactured under an ISO 9001 certified quality management system

UL Listed to U.S. and Canadian safety standards (File E212775; NRGU, NRGU7)

CE Mark

UKCA Mark

RCM Mark

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

General

Terminal Connections

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

Tightening Torque

Terminal Block

Minimum:	1.1 Nm (9-in-lb)
Maximum:	1.3 Nm (12-in-lb)

Connectorized

Minimum:	0.6 Nm (5-in-lb)
Maximum:	0.8 Nm (7-in-lb)

AC Current Inputs

5 A nominal:	15 A continuous, 500 A for 1 s, linear to 100 A symmetrical. 625 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. 250 A for 1 cycle (sinusoidal waveform)
Burden:	0.06 VA at 1 A 0.18 VA at 3 A

Note: 60/50 Hz system frequency and ABC/ACB phase rotation are ordering options.

Power Supply

125/250 Vdc or Vac

Range:	85–350 Vdc or 85–264 Vac
Burden:	<5.5 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:	<5.5 W
Interruption:	25 ms at 36 Vdc
Ripple:	5%

Note: Interruption and Ripple per IEC 60255-11[IEC 255-11]:1979.

Output Contacts

The output type is dependent on the rear-panel terminal type. Output ratings were determined with IEC 60255-0-20:1974, using the simplified method of assessment.

Standard (Conventional Terminal Block Option)

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

High Current Interrupting (Plug-In Connectors Option)

Make:	30 A
Carry:	6 A continuous carry
MOV Protection:	330 Vdc
Pickup Time:	<5 ms
Dropout Time:	<8 ms, typical
Update Rate:	1/8 cycle

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

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 block 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	150–330 Vdc

Level-Sensitive (Conventional Terminal Blocks Option)
Both inputs can be individually user-configured to operate on any of the following nominal voltages:

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

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. 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
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

Serial Communications

Front and Rear Panel:	9-pin sub-D connector
Baud Rate:	300–38400 baud Settable baud rate and data bit protocol

Time-Code Input

Relay accepts demodulated IRIG-B time-code input at Port 1.

Protocols

Serial Port Protocols:	ASCII Distributed Port Switch Protocol (LMD) Modbus RTU (baud rate limited to 192000; only available in SEL-501) SY/MAX (only available in SEL-501-1)

Metering Functions

Instantaneous and Demand Ammetering Functions

Measurement Accuracy:	5 A Model: ±2% ±0.10 A 1 A Model: ±2% ±0.02 A

Breaker Monitor

Relay counts trip operations and accumulates interrupted current on a pole-by-pole basis.

Routine Dielectric Test

Current Inputs:	2500 Vac for 10 s
Power Supply, Optoisolated Inputs, and Output Contacts:	3000 Vdc for 10 s

The following IEC 60255-5:1977 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, optoisolated inputs, and contact inputs.

Operating Temperature

–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)

Type Tests

Electromagnetic Compatibility Emission (EMC)

Canada ICES-001 (A) / NMB-001 (A)

Environmental Tests

Cold:	IEC 60068-2-1:1990 [EN 60068-1-1:1993] Test Ad; 16 hr at –40°C
Damp Heat, Steady State:	IEC 60068-2-3:1969 Test Ca; 96 hours at +40°C, 93% RH
Damp Heat, Cyclic	IEC 60068-2-30:1980 Test Db; 25° to 55°C, 6 cycles, 95% humidity
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 analogs, contact inputs, and contact outputs; 100 Vdc on power supply; 2200 Vdc on EIA-485 communications port
Impulse:	IEC 60255-5:1977 0.5 J, 5000 V

Electrostatic Discharge Test

ESD:	IEC 60255-22-2:1996 IEC 60801-2:1991 Level 4

RFI and Interference Tests

Fast Transient Burst:	IEC 60801-4:1988 Level 4 (4 kV on power supply, 2 kV on inputs and outputs)
Fast Transient Disturbance:	IEC 60255-22-4:1992 IEC 60801-2:1991 Level 4
Radiated EMI:	IEC 60255-22-3:1989, 10 V/m
Surge Withstand:	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 IP3X

Technical Support

We appreciate your interest in SEL products and services. If you have questions or comments, please contact us at:

Schweitzer Engineering Laboratories, Inc.
2350 NE Hopkins Court
Pullman, WA 99163-5603 U.S.A.
Tel: +1.509.338.3838
Fax: +1.509.332.7990
Internet: selinc.com/support
Email: info@selinc.com

SCHWEITZER ENGINEERING LABORATORIES, INC.
2350 NE Hopkins Court • Pullman, WA 99163-5603 U.S.A.
Tel: +1.509.332.1890 • Fax: +1.509.332.7990
selinc.com • info@selinc.com

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