



# 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 two full reports and twenty summaries in nonvolatile memory.
- Makes redundant protection practical—ideal for stacked breaker switchgear.
- Includes low-level test interface.
- Supports ASCII, SEL LMD, Modbus<sup>®</sup>, and Square-D SY/MAX protocol.

# Features

## Dual Relay Concept

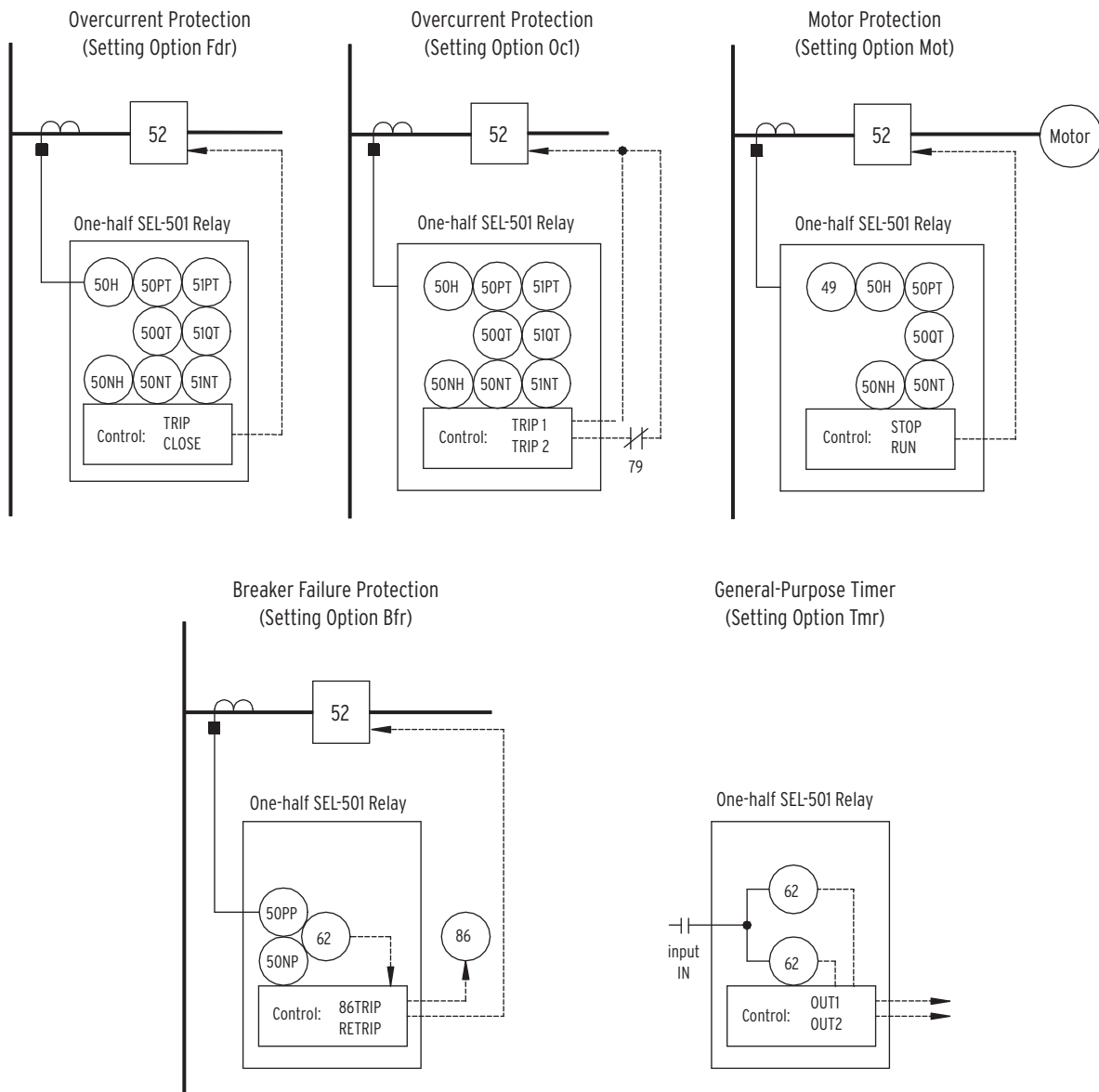
The SEL-501 Dual Universal Overcurrent Relay provides two complete and independent groups of protection functions in one compact unit. The unit contains Relay X and Relay Y, each having separate optoisolated inputs, output contacts, and three-phase current inputs.

**Table 1 Relay I/O and Current Inputs**

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

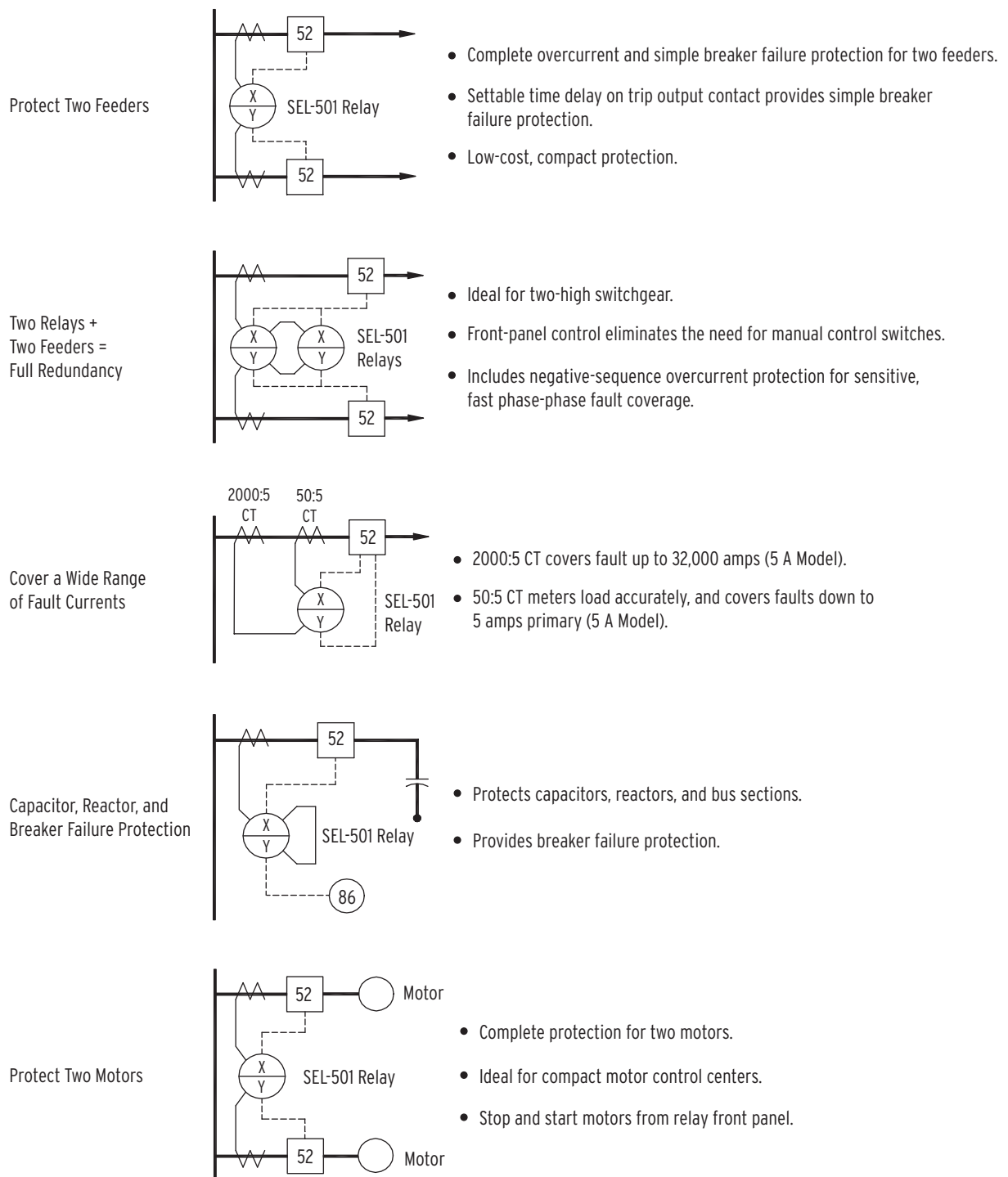
## Five Relay Functions

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



**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 ( $I_Q = 3 \cdot I_2$ )		50QT	51QT
Residual ( $I_R = I_a + I_b + I_c$ )	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 EN—Enable user-selected elements BLK—Block user-selected elements ET—External Trigger of event reports	Both trips have time-delay pickup timers, settable 0–16,000 cycles.  TRIP1 (OUT1)—select any elements 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 ( $I_Q = 3 \cdot I_2$ )		50QT
Residual ( $I_R = I_a + I_b + I_c$ )	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.

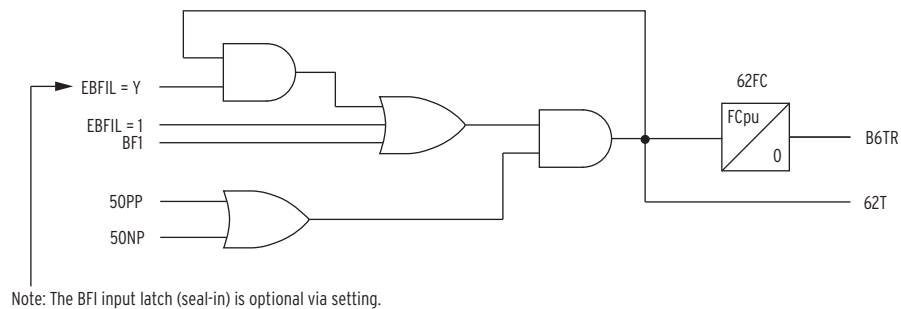
Motor operation monitors include load-jam trip, load-loss trip, and a starts per-hour limit.

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)		<b>Breaker Retrip Timer (62FC)</b>
5 A Model:	0.5–80 A	0–63.75 cycles
1 A Model:	0.1–16 A	
Maximum Reset Time	0.75 cycles	
<b>Input</b>	<b>Output Contacts</b>	
BFI—Breaker Failure Initiate	86TR—Breaker Failure Trip (OUT1)	
	RETRIP—Breaker Retrip (OUT2)	



**Figure 3 SEL-501 Relay Breaker Failure Logic**

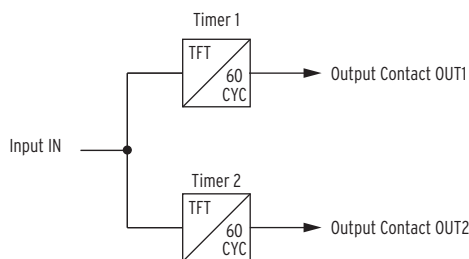
## General-Purpose Timer

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 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.
- One serial port for two relays cuts communications burden in half.
- Modbus RTU protocol supports direct integration, via appropriate gateways, into SCADA or DCS systems.

## Event Reporting

- Relay stores twelve reports: newest two are in non-volatile memory.
- Reports have fifteen-cycle duration and quarter-cycle resolution.
- Unique event headers for each application.

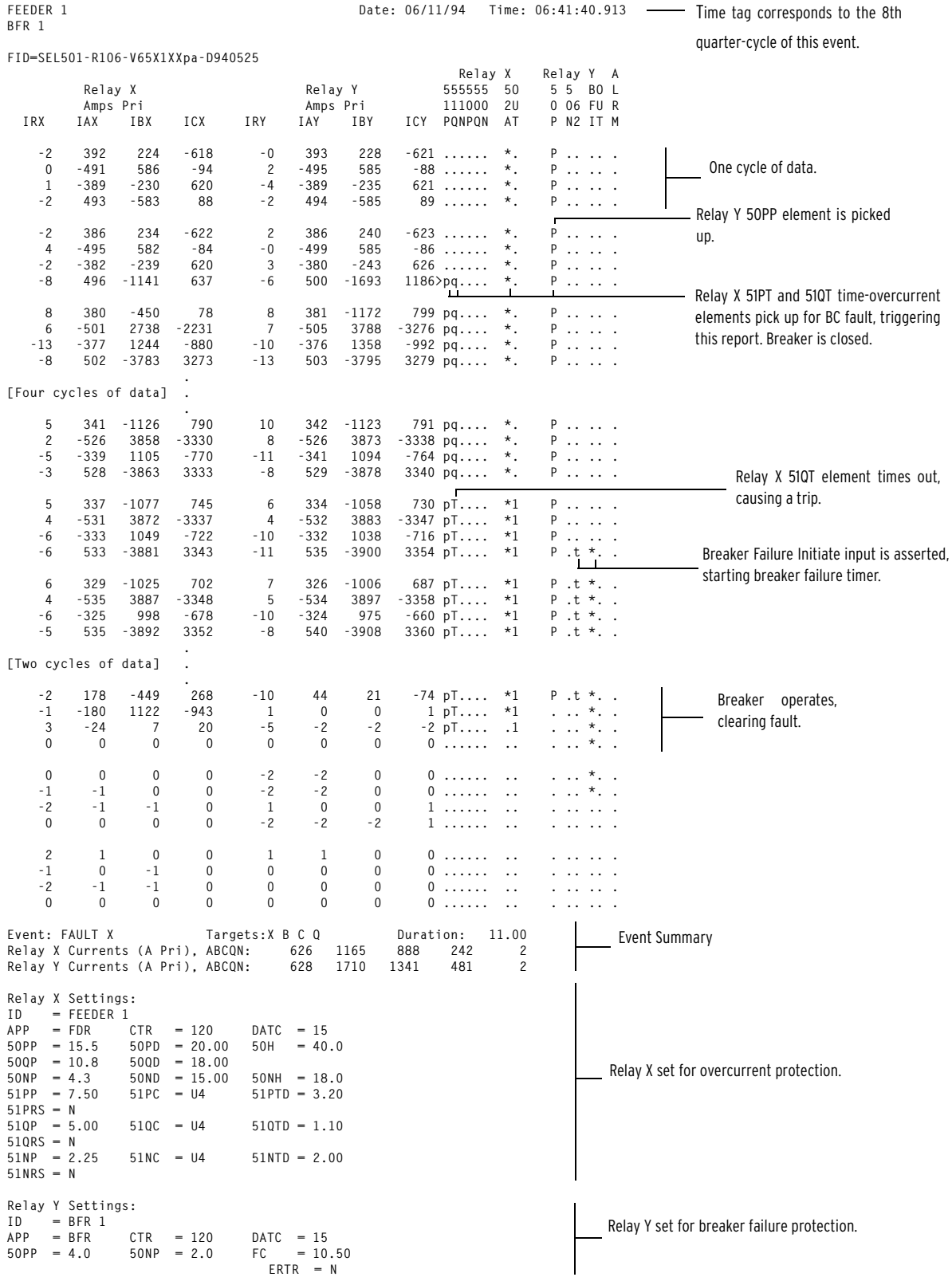
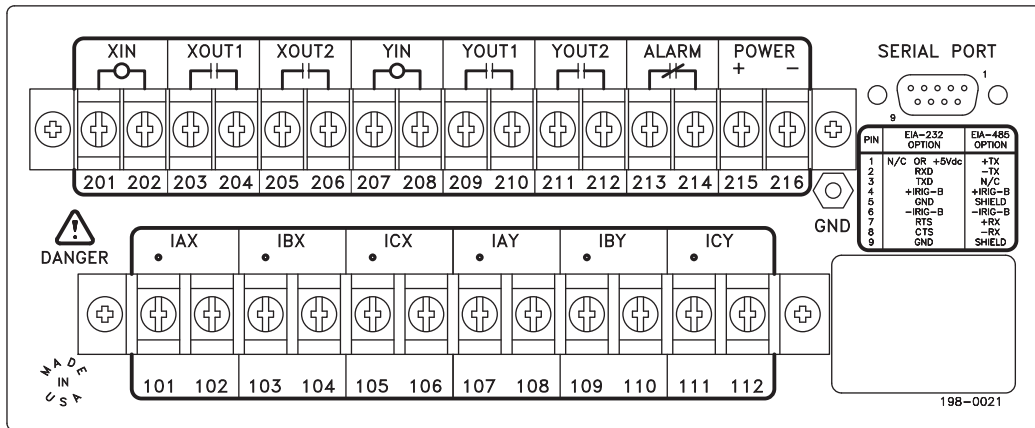


Figure 5 Example Event Report

## Two Rear-Panel Options

### Conventional Terminal Blocks



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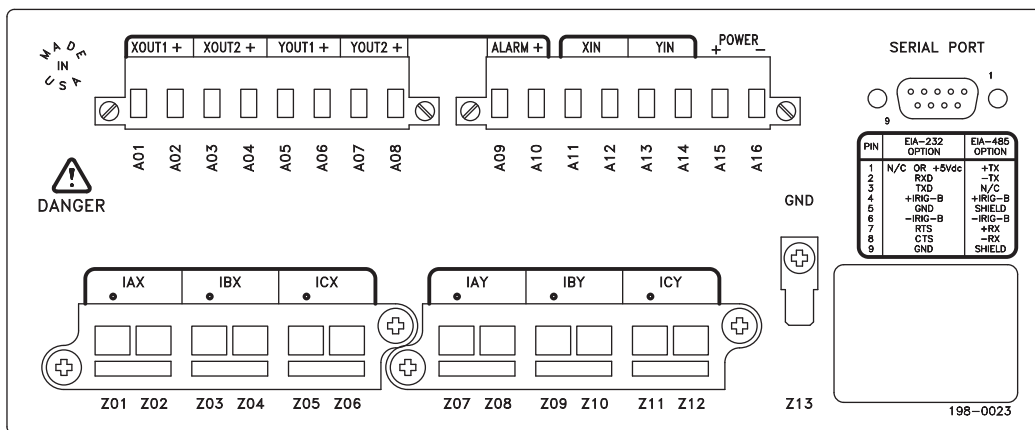
**Figure 6 SEL-501 Relay Rear Panel (Conventional Terminal Block Option)**

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)



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

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

<b>Old</b>	<b>New</b>
0501xJ	0501xW

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):

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

<b>Old</b>	<b>New</b>
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 15* 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.



# Guideform Specification

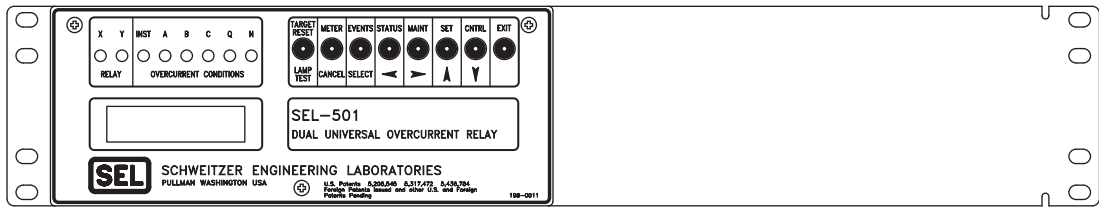
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The microprocessor-based relay shall provide a combination of functions including protection, monitoring, control, and automation. Relay self-checking functions shall be included. Specific operational and functional requirements are as follows.

- ▶ **Dual Relay Configuration.** The relay shall have two independent sets of three-phase current inputs (X and Y) sharing a common data acquisition system, microprocessor, power supply, and alarm. Each set of current inputs and digital I/O shall independently protect, monitor, and control its respective power system application. For each set of current inputs, there shall be one contact input and two contact outputs
- ▶ **Overcurrent Protection.** The relay shall have two overcurrent application settings for relays X and Y, respectively. Selection of overcurrent applications from the operator interface shall determine utilization of input and output contacts. Relay X and Y shall have eight overcurrent elements consisting of phase, negative-sequence, and ground protection elements. The time-overcurrent elements shall be comprised of four US and four IEC-type curves.
- ▶ **Adaptive Phase Overcurrent Elements.** The relay shall incorporate adaptive phase overcurrent elements that perform reliably in the presence of current transformer saturation, DC offset, and off-frequency harmonics.
- ▶ **Motor Protection.** Each relay shall protect motors using a patented thermal model capable of accounting for the thermal effects of both positive- and negative-sequence current. The motor protection application shall trip to prevent overheating for abnormal conditions of overload, locked rotor starting, frequent or prolonged starts, and unbalanced current.
- ▶ **Application Settings and Security.** The relay shall have a user interface with application settings that include feeder protection (FDR), overcurrent protection (OC1), motor protection (MOT), breaker failure protection (BFR), and a general-purpose timer (TMR)\*. The relay shall have two levels of user-controlled password protection.
- ▶ **Event Reporting.** The relay shall store five of the latest 15-cycle events, and event summaries for the latest twenty events. The event information shall present measured quantities for relay X and Y, respectively. The latest event shall be stored in nonvolatile memory.
- ▶ **Communication and Protocol.** The relay shall be equipped with a serial interface capable of hosting Modbus<sup>®</sup> RTU, SEL ASCII, SEL Distributed Port Switch (LMD), and/or SY/MAX protocols. Data rates shall range from 300 to 38,400 baud. Hardware options shall include either an EIA-232 or EIA-485 serial interface.
- ▶ **Temperature Rating.** The relay shall be capable of withstanding operating temperatures ranging from  $-40^{\circ}$  to  $+85^{\circ}\text{C}$  ( $-40^{\circ}$  to  $+185^{\circ}\text{F}$ ).
- ▶ **Packaging.** The relay shall have physical dimensions not to exceed 221 mm wide, 208.3 mm deep, and 88.1 mm high.
- ▶ **Warranty.** The relay shall be covered by a ten-year product warranty.

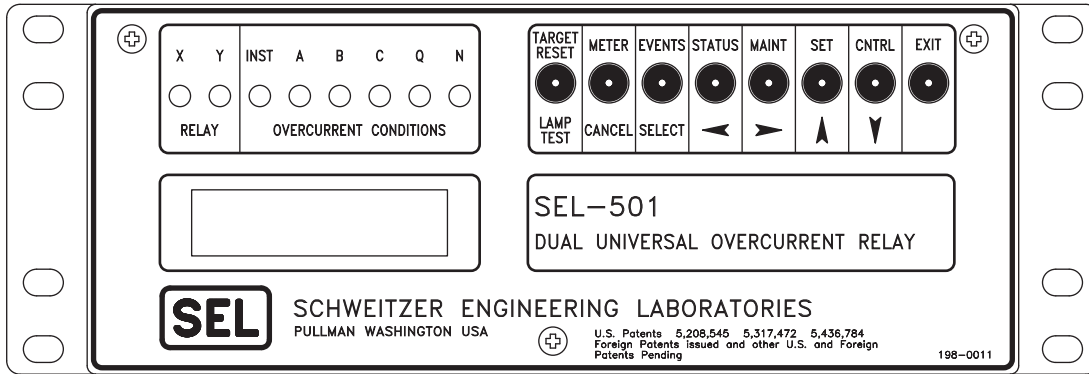
\* The SEL-501-2 is equipped with the OC1 function only.

# Front- and Rear-Panel Diagrams



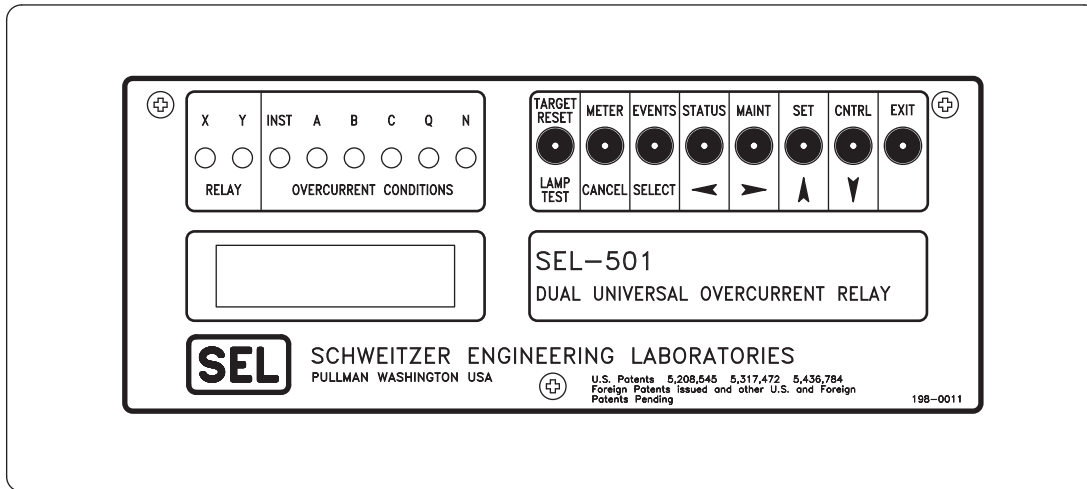
SEL-501 Relay Fitted With Mounting Bracket (SEL P/N 9100) for Mounting in 19-Inch Rack

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

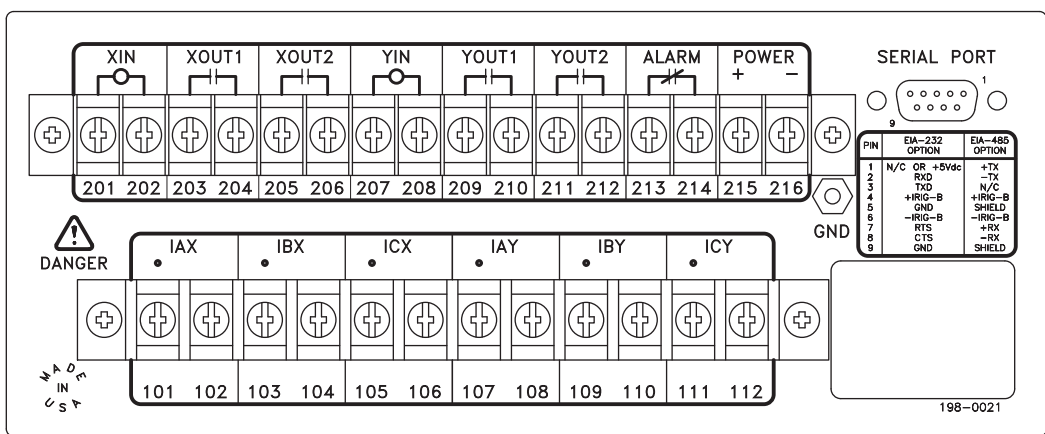
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SEL-501 Relay Front Panel, Panel-Mount Version

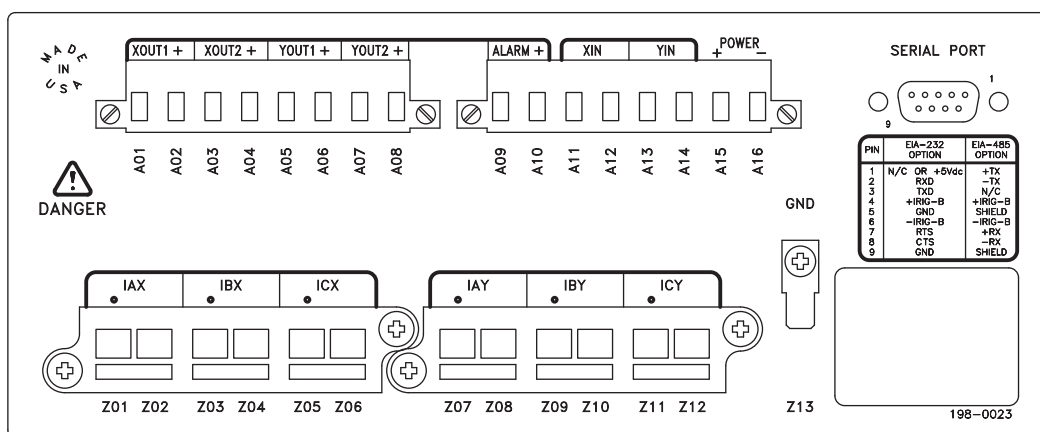
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**Figure 8 SEL-501 Front Panels**



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SEL-501 Relay Rear Panel (Conventional Terminal Blocks Option)



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

Figure 9 SEL-501 Rear-Panel Diagrams

# Relay Dimensions

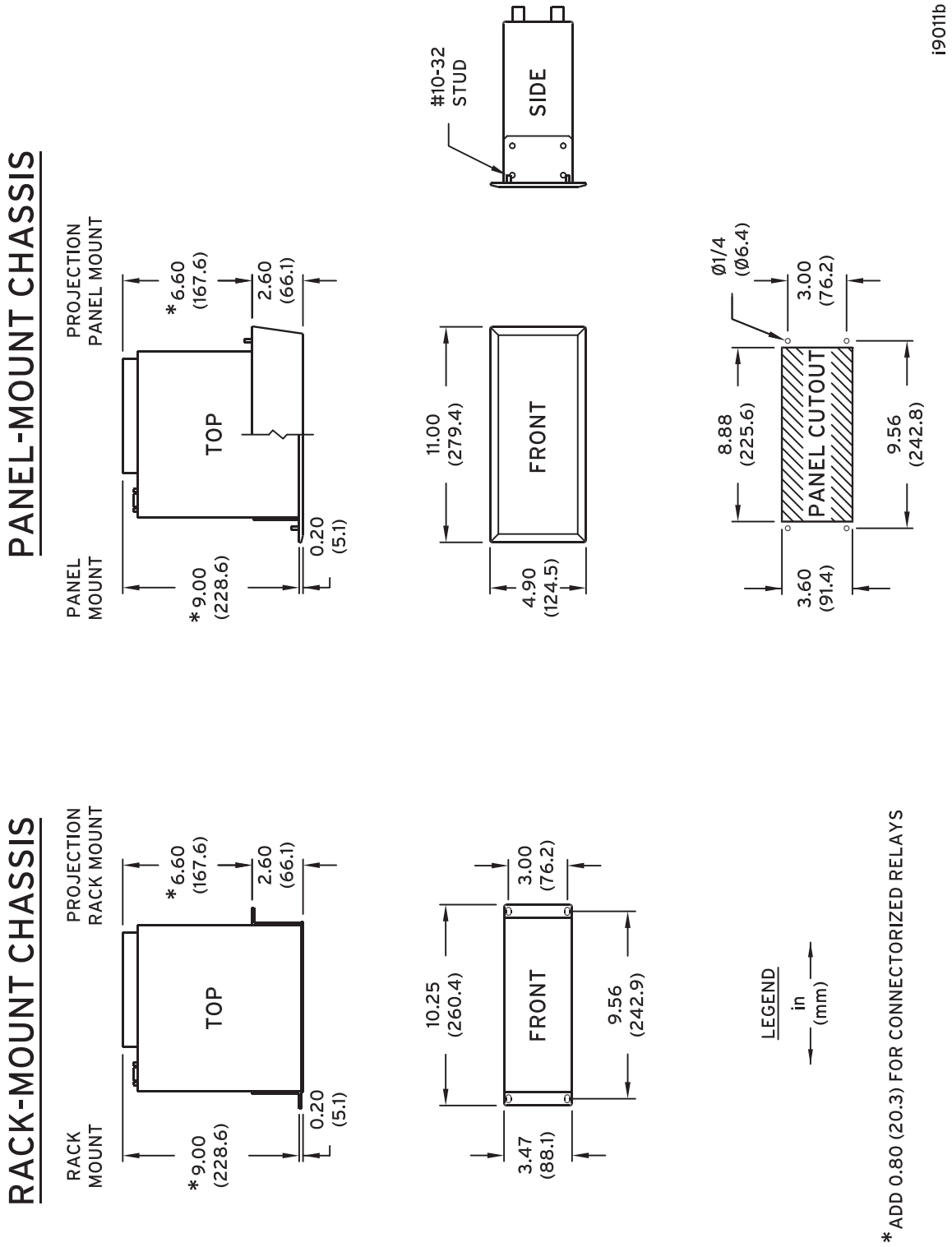
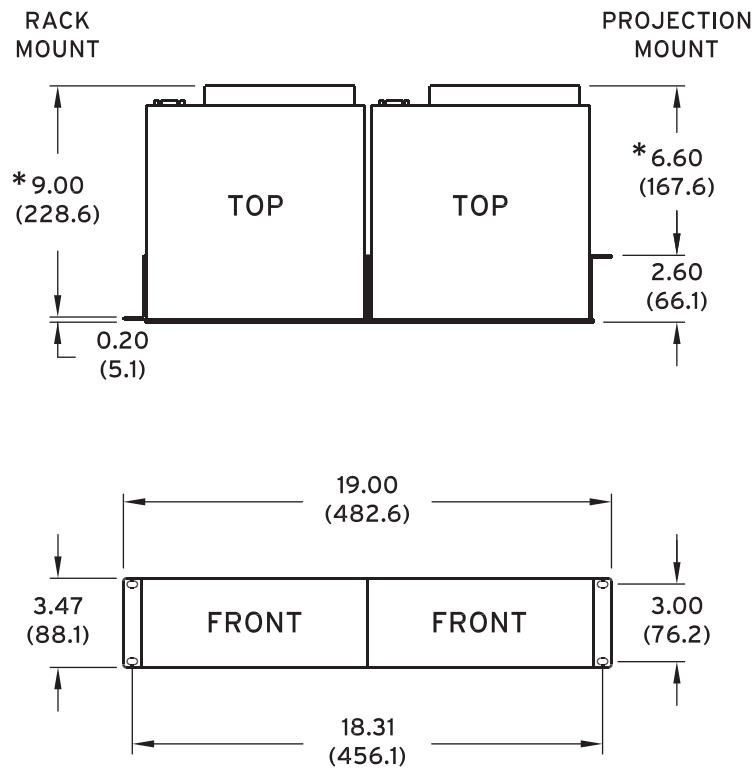


Figure 10 SEL-501 Dimensions and Drill Plan for Single Rack-Mounted Relay

# RACK-MOUNT CHASSIS



### LEGEND

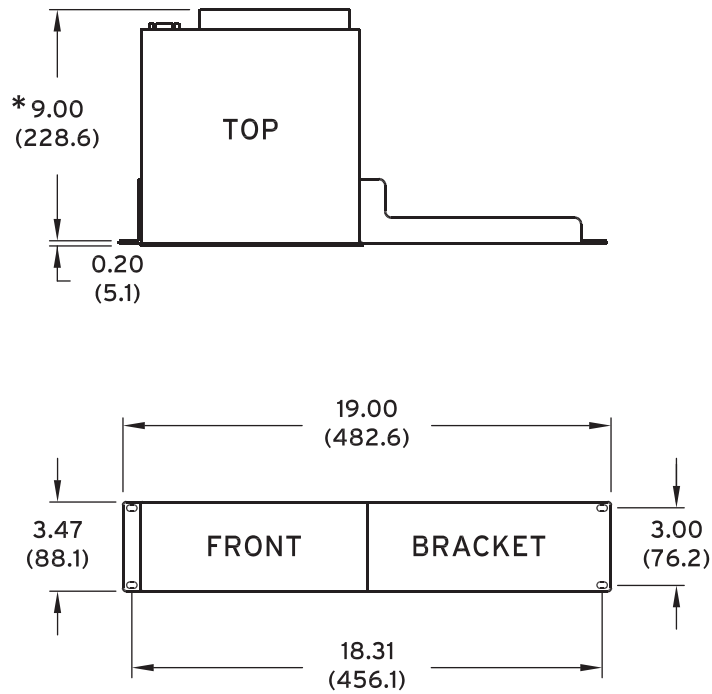
in  
← (mm) →

\* ADD 0.80 (20.3) FOR CONNECTORIZED RELAYS

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**Figure 11 Relay Dimensions and Drill Plan for Mounting Two SEL-500 Series Relays Together Using Mounting Block (SEL P/N 9101)**

## RACK-MOUNT CHASSIS



### LEGEND

in  
← (mm) →

\* ADD 0.80 (20.3) FOR CONNECTORIZED RELAYS

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**Figure 12 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 US and Canadian safety standards (File E212775; NRGU, NRGU7)

CE Mark

## 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 (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

**Serial Communications**

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

**Protocols**

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

Instantaneous and Demand Ammetering functions.  
Measurement Accuracy:  $\pm 2\%$

**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****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
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**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
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