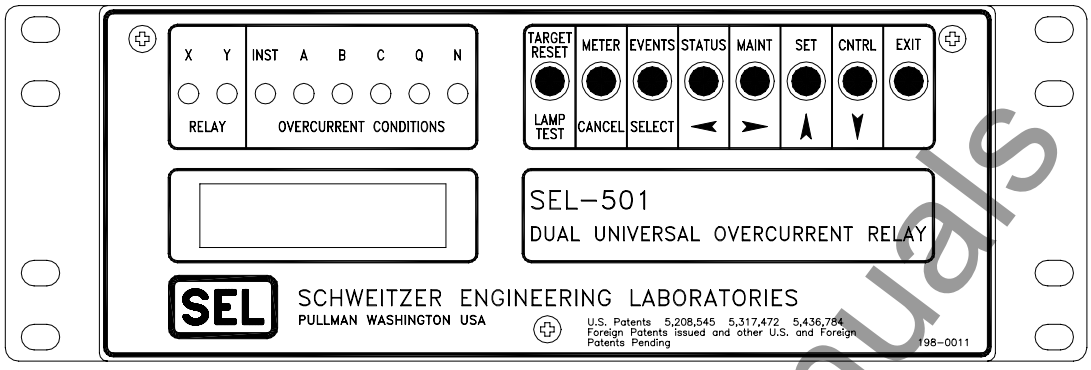
SEL-501 Dual Universal Overcurrent Relay



Dual Universal Overcurrent Relay

DATA SHEET

- Features Two Three-Phase Current-Based Relays in One Compact Package.
- Protects Feeders, Buses, Transformers, Motors, Breakers, and Other Apparatus.
- 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™, and Square-D SY/MAX Protocol.

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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.

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

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

FIVE RELAY FUNCTIONS

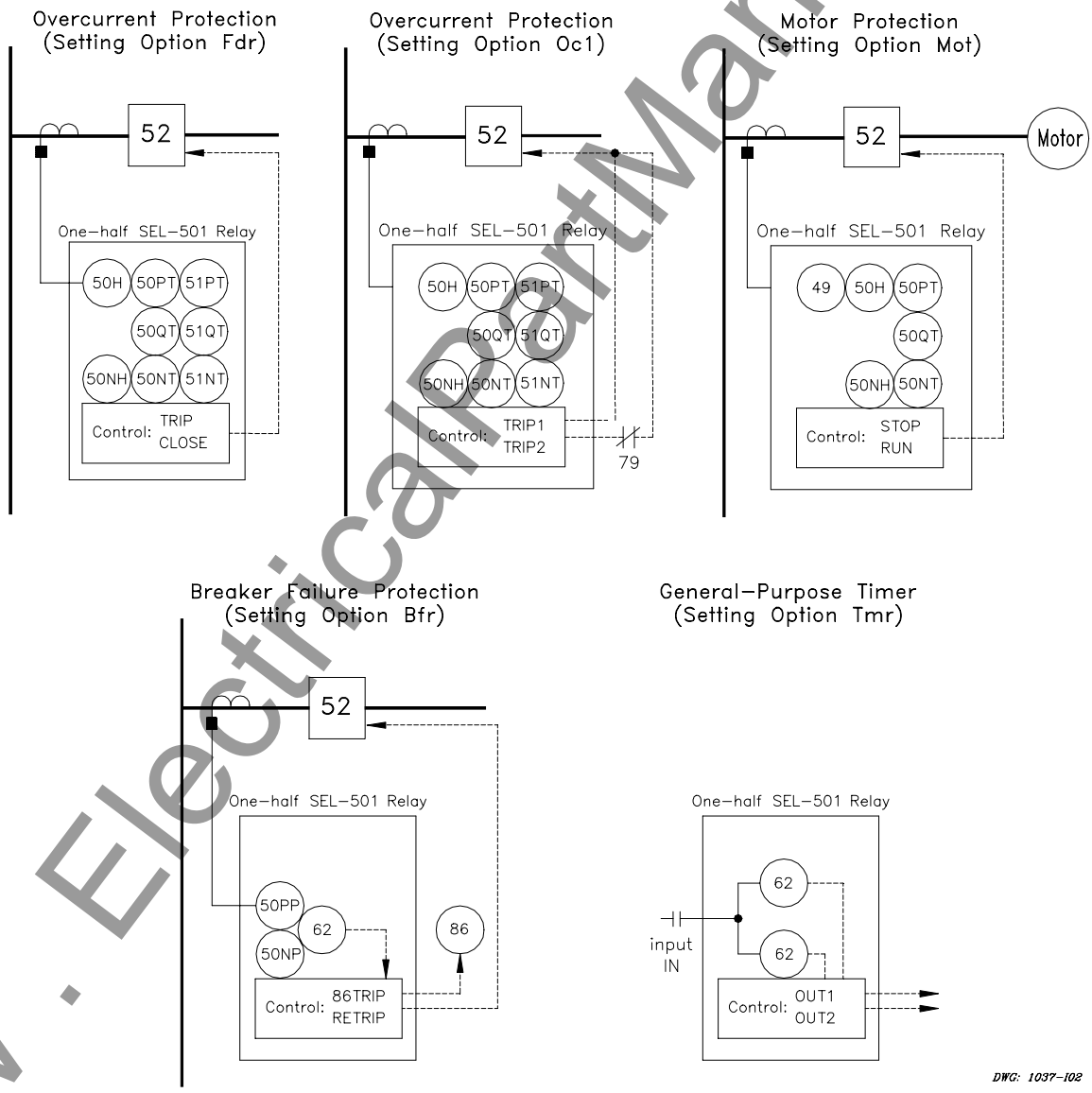
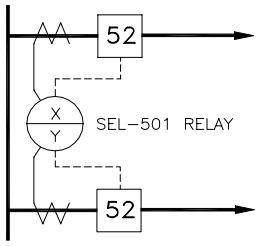


Figure 1: Relay Application Single-Line Diagrams

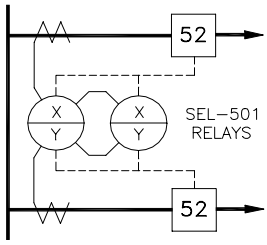
SEL-501 Dual Relay Applications

Protect Two Feeders



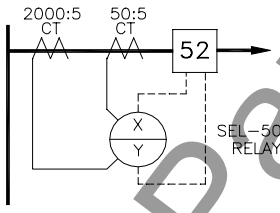
- Complete overcurrent and simple breaker failure protection for two feeders.
- Settable time-delay on trip output contact provides simple breaker failure protection.
- Low cost, compact protection.

Two Relays + Two Feeders = Full Redundancy



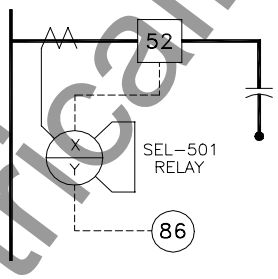
- Ideal for two-high switchgear.
- Front-panel control eliminate the need for manual control switches.
- Includes negative-sequence overcurrent protection for sensitive, fast phase-phase fault coverage.

Cover a Wide Range of Fault Currents



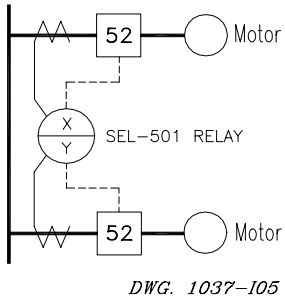
- 2000:5 CT covers fault up to 32,000 amps (5 A Model).
- 50:5 CT meters load accurately, and covers faults down to 5 amps primary (5 A Model).

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

TWO REAR-PANEL OPTIONS

Conventional Terminal Blocks

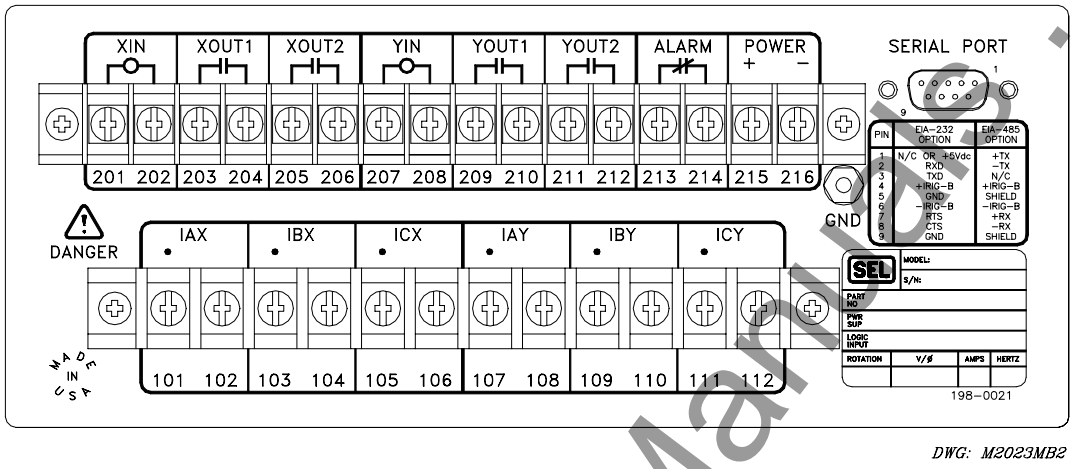


Figure 3: SEL-501 Relay Rear Panel (Conventional Terminal Blocks Option)

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)

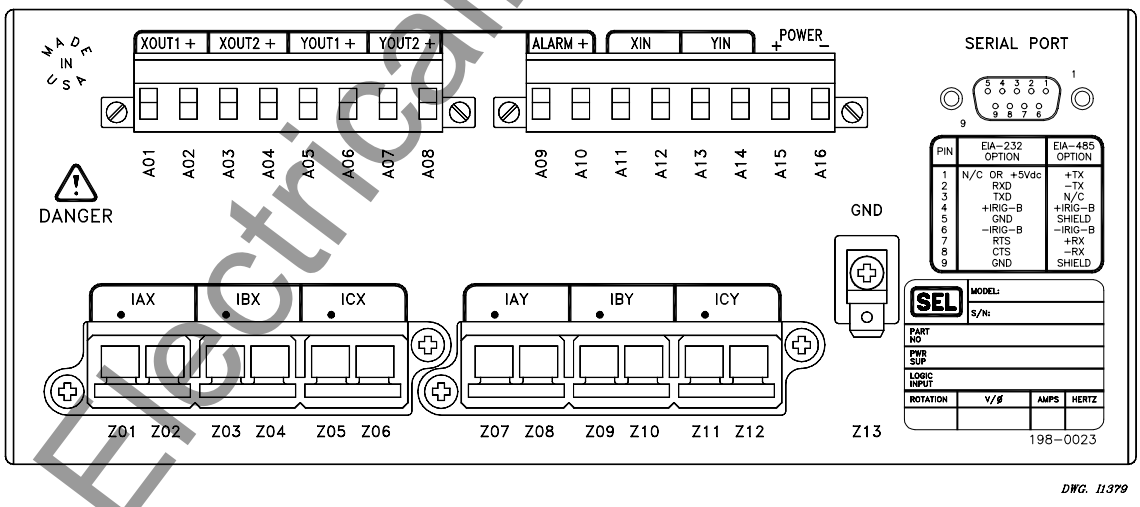


Figure 4: SEL-501 Relay Rear Panel (Plug-In Connectors Option)

Important: Improvements in Connectorized SEL-501 Relays (Plug-In Connectors) Resulted in Part Number changes.

The current tranformer 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 number shown):

Old		New
WA0501xJ	→	WA0501xW

Figure 4 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 terminals A02, A04, A06, A08, and A10).

See ***General Specifications*** 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 x 0.032 inch, screw size #6-32.

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 ordering options.

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

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 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 - 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

24Volt*:	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.
Protocols	The serial port will support the following user selectable protocols. ASCII Distributed Port Switch Protocol (LMD) Modbus RTU (baud rate limited to 19200; only available in SEL-501 Relay) SY/MAX (only available in SEL-501-1 Relay)
Metering Functions	Instantaneous and Demand Ammetering functions. Measurement Accuracy: ±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 seconds. Power supply, optoisolated inputs, and output contacts: 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, optoisolated 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)
Type Tests and Standards	The SEL-501 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: 2500 Vac on analog inputs; 3100 Vdc (3000 Vdc for Plug-In Connectors option) on contact inputs, contact outputs, and power supply. *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: 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 procedures, Part 2: Tests - Test Ca: Damp heat, steady state.
Severity Level: 96 hours at +40°C, 93% RH.

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; Variant 1.

Exceptions:

6.3.3 Humidity not less than 94%

IEC 255-5 - 1977 Electrical relays, Part 5: Insulation tests for electrical relays. Section 6: Dielectric Tests.
Severity Level: Series C (2500 Vac on analog inputs; 3000 Vdc on power supply, contact inputs, and contact outputs).
Section 8: Impulse voltage test.
Severity Level: 0.5 Joule, 5000 volt.

IEC 255-21-1 - 1988 Electrical relays - Part 21: Vibration, shock, bump, and seismic tests on measuring relays and protection equipment, Section 1: Vibration test (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: Seismic tests. (Conventional Terminal Block option only.)
Severity Level: Class 2.

IEC 255-22-1 - 1988 Electrical disturbance tests for measuring relays and protection equipment, Section 1: 1 MHz burst disturbance tests.
Severity Level: 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: 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 on power supply, 2 kV on inputs and outputs)

IEC 529 - 1989 Degrees of protection provided by enclosures.
Severity Level: IP3X.

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: 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 on power supply, 2 kV on inputs and outputs).

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

OVERCURRENT PROTECTION

The SEL-501 Relay has two overcurrent protection setting options: Fdr or Oc1. Both options use the same overcurrent elements, but differ in input and output contact functions.

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	0.5 - 80 A	0.5 - 16 A
	1 A Model:	0.1 - 16 A	0.1 - 16 A	0.1 - 3.2 A
Definite-Time Delay			0 - 16,000 cycles	US and IEC curves

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 ET - External Trigger of event reports	TRIP1 (OUT1) - select any elements TRIP1 (OUT2) - select any elements

MOTOR PROTECTION

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

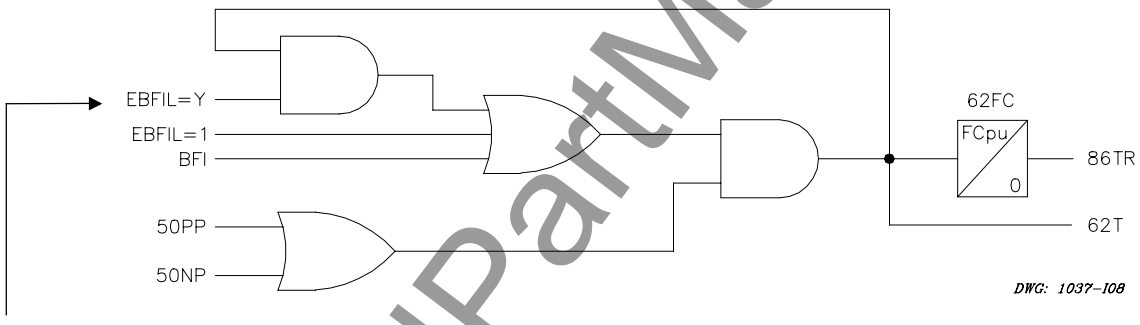
Instantaneous Overcurrent Elements

Phase (Ia, Ib, and Ic)	50PP	
Residual (IR = Ia + Ib + Ic)	50NP	
Ranges (A secondary) 5 A Model:	0.5 - 80 A	
1 A Model:	0.1 - 16 A	
Maximum Reset Time	0.75 cycles	

Breaker Failure Timer (62FC)
0.25 - 63.75 cycles

Breaker Retrip Timer (62FC)
0 - 63.75 cycles

Input	Output Contacts
BFI - Breaker Failure Initiate	86TR - Breaker Failure Trip (OUT1)
	RETRIP - Breaker Retrip (OUT2)



Note: The BFI input latch (seal-in) is optional via setting.

Figure 5: 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.

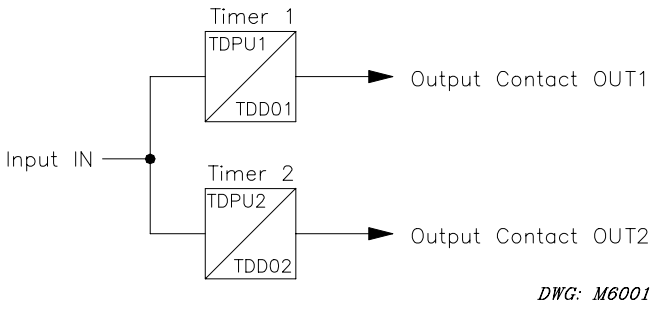


Figure 6: SEL-501 Relay General-Purpose Timer

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 nonvolatile memory.
- Reports have fifteen-cycle duration and quarter-cycle resolution.
- Unique event headers for each application.

Example Event Report

```
FEEDER 1                                         Date: 06/11/94   Time: 06:41:40.913 — Time-tag corresponds to
BFR 1                                                                                  the 8th quarter-cycle of
                                                                                       this event.
FID=SEL501-R106-V65X1XXpa-D940525
                                                             Relay X    Relay Y  A
          Relay X                       Relay Y              555555  50    5 5  BO L
          Amps Pri                      Amps Pri             111000  2U    0 06 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 .. .. .   — One cycle of data.
     1   -389   -230    620     -4   -389   -235     621 ......  *.    P .. .. .
    -2    493   -583     88     -2    494   -585      89 ......  *.    P .. .. .
                                                                                   — Relay Y 50PP element
    -2    386    234   -622      2    386    240    -623 ......  *.    P .. .. .     is picked up.
     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 .. .. .
                                                                                   — Relay X 51PT and
     8    380   -450     78      8    381  -1172     799 pq....  *.    P .. .. .     51QT time-overcurrent
     6   -501   2738  -2231      7   -505   3788   -3276 pq....  *.    P .. .. .     elements pick up for BC
   -13   -377   1244   -880    -10   -376   1358    -992 pq....  *.    P .. .. .     fault, triggering this
    -8    502  -3783   3273    -13    503  -3795    3279 pq....  *.    P .. .. .     report.  Breaker is
                              .                                                      closed.
[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 .. .. .
                                                                                   — Relay X 51QT element
     5    337  -1077    745      6    334  -1058     730 pT....  *1    P .. .. .     times out, causing a trip.
     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 *. .
                                                                                   — Breaker Failure Initiate
     6    329  -1025    702      7    326  -1006     687 pT....  *1    P .t *. .     input is asserted,
     4   -535   3887  -3348      5   -534   3897   -3358 pT....  *1    P .t *. .     starting breaker failure
    -6   -325    998   -678    -10   -324    975    -660 pT....  *1    P .t *. .     timer.
    -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    . .. *. .   — Breaker operates,
     3    -24      7     20     -5     -2     -2      -2 pT....  .1    . .. *. .     clearing fault.
     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   — Event Summary
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                         — Relay X set for overcurrent protection.
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                           — Relay Y set for breaker failure protection.
50PP  = 4.0      50NP  = 2.0      FC    = 10.50
ERTR  = N
```

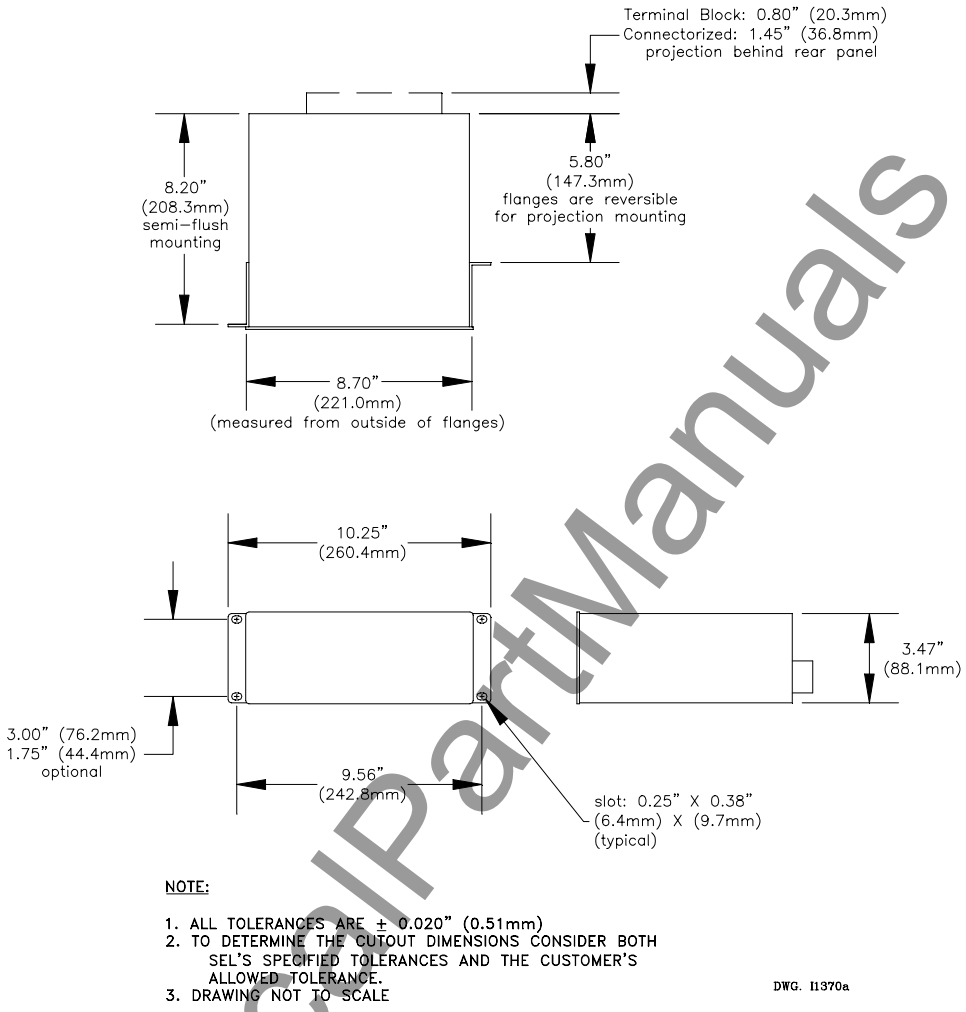


Figure 7: SEL-501 Relay Dimensions and Drill Plan for Single Rack-Mount Relay

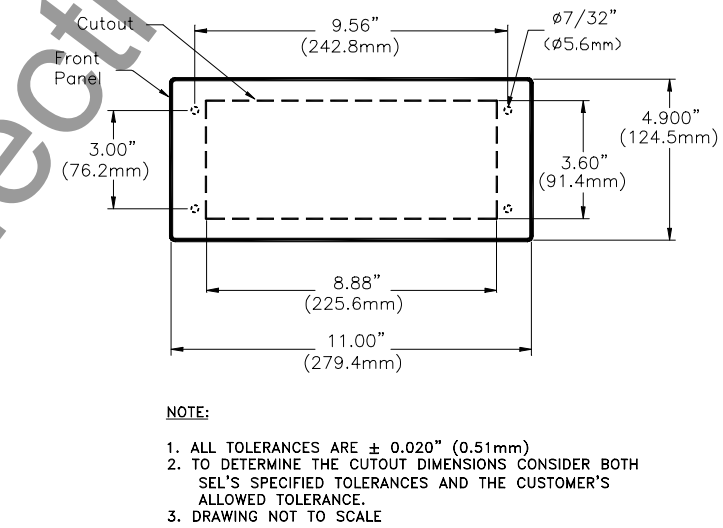


Figure 8: Panel Cut-Out and Drill Plan for Single Panel-Mount Relay

RELAY MOUNTING (TWO SEL-501 RELAYS)

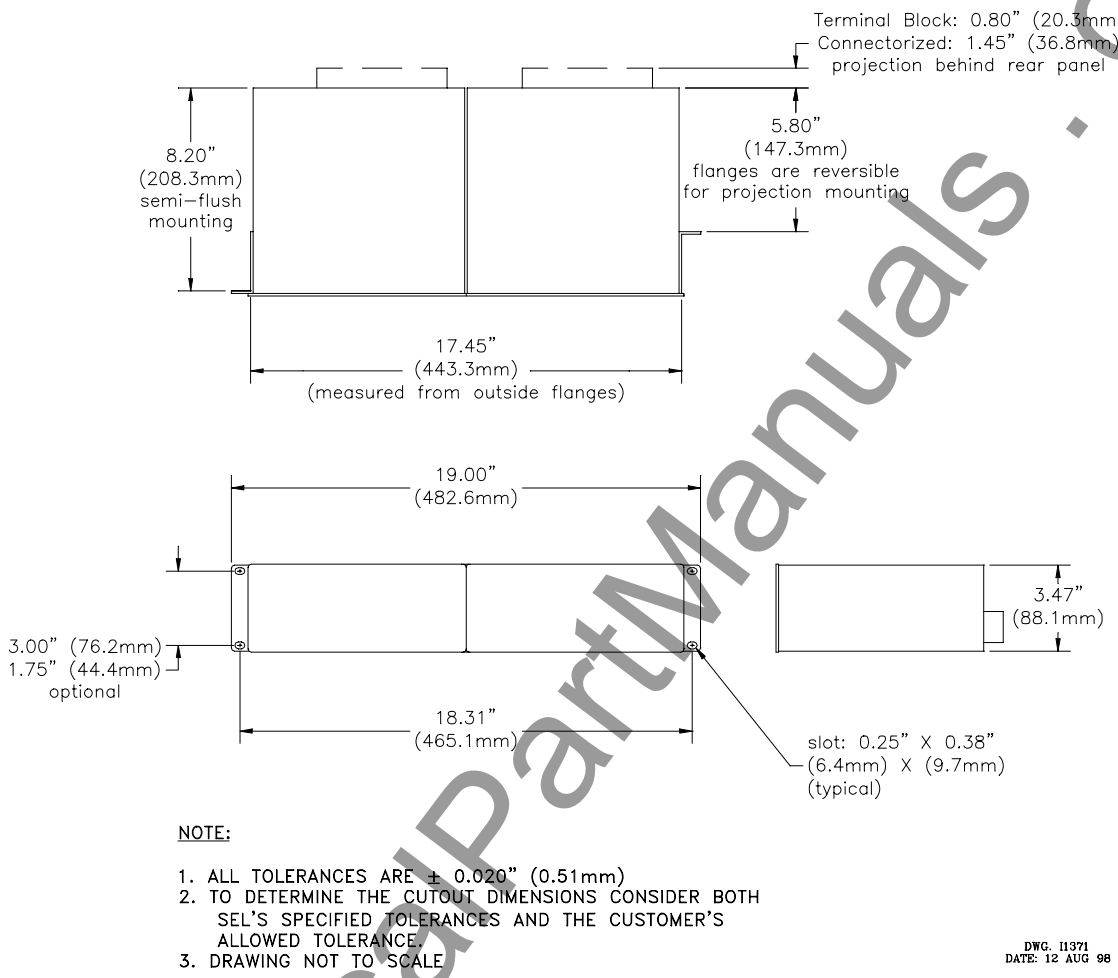


Figure 9: Relay Dimensions and Drill Plan for Mounting Two SEL-500 Series Relays Together Using Mounting Block (SEL P/N 9101)

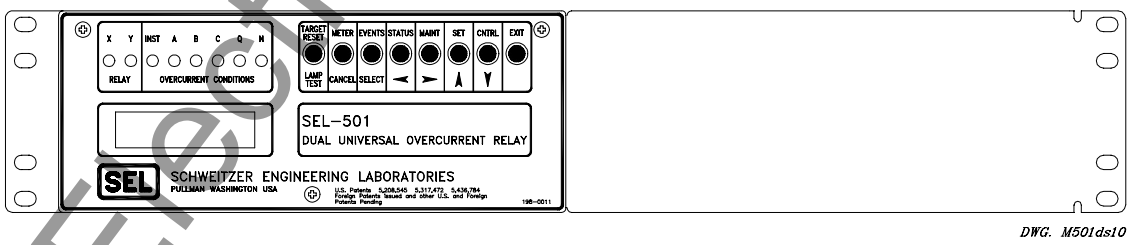


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Figure 10: SEL-501 Relay Fitted with Mounting Bracket (SEL P/N 9100) for Mounting in 19-Inch Rack

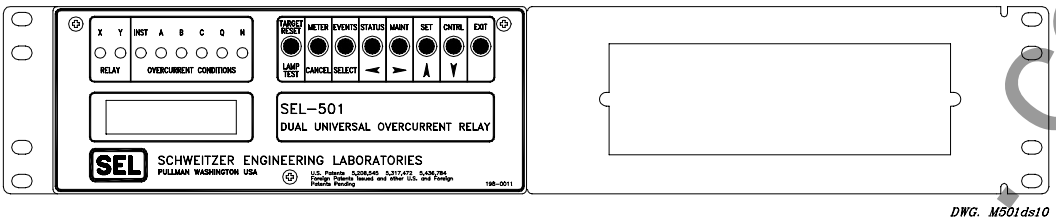

Figure 11: SEL-501 Relay Fitted with Mounting Bracket (SEL P/N 9102) for Mounting in 19-Inch Rack Including Cutout to Fit an FT-1 Test Switch

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SEL-501 Dual Universal Overcurrent Relay Data Sheet 991129

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