SEL-551 Distribution Relay

SEL-551
OVERCURRENT RELAY
RECLOSING RELAY

SCHWEITZER ENGINEERING LABORATORIES
PULLMAN WASHINGTON USA
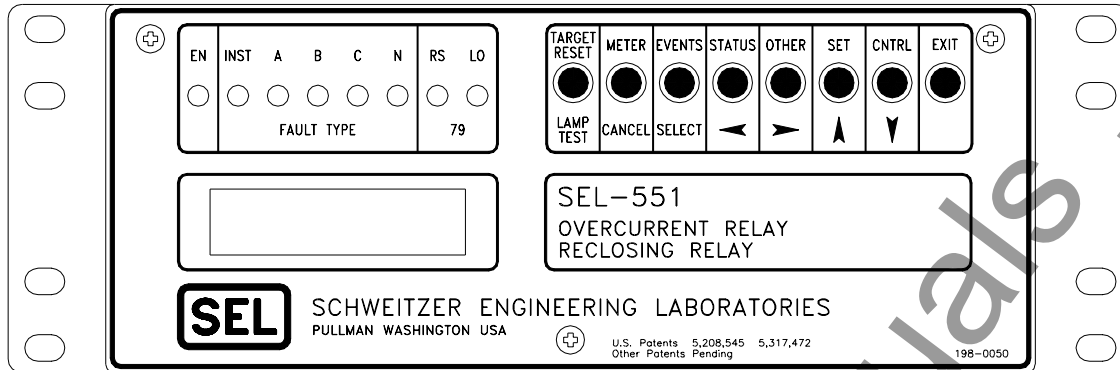
U.S. Patents 5,208,545 5,317,472
Other Patents Pending

198-0050

SEL-551 Overcurrent/Reclosing Relay

Data Sheet

SEL-551 Relay Feature Highlights:

- Numerous Phase, Ground, and Negative-Sequence Overcurrent Elements
- Multiple-Shot Reclosing Relay with Sequence Coordination
- Enhanced SELOGIC® Control Equations to Create Traditional or Advanced Schemes
- Local/Remote Control Logic to Enable/Disable Schemes, Operate Circuit Breakers, etc.
- Sequential Events Recorder (SER) Report and Event Reports Stored in Nonvolatile Memory
- Hardware Options for Rear-Panel Terminals, Output Contacts, and Serial Communications Port
- Demand Ammetering
- Supports ASCII, SEL LMD, and Modbus™ RTU Protocol

Use the SEL-551 Relay in New Installations and Retrofits for Overcurrent Protection of:

- Utility Distribution Feeders - includes reclosing
- Industrial Distribution Feeders - includes connections for a core-balance current transformer
- Distribution Buses - includes fast bus trip scheme
- Transformer Banks - includes connections for a separate neutral current transformer
- Other Power System Apparatus - capacitors, reactors, circuit breakers, etc.

Use the SEL-551 Relay in Line Recloser Installations:

- Overcurrent Protection - "fast" and "slow" curve operation; allowance for cold load pickup
- Reclosing - up to four shots of reclosing available with sequence coordination
- Control - local/remote control switch emulation

ISO 9001
CERTIFIED
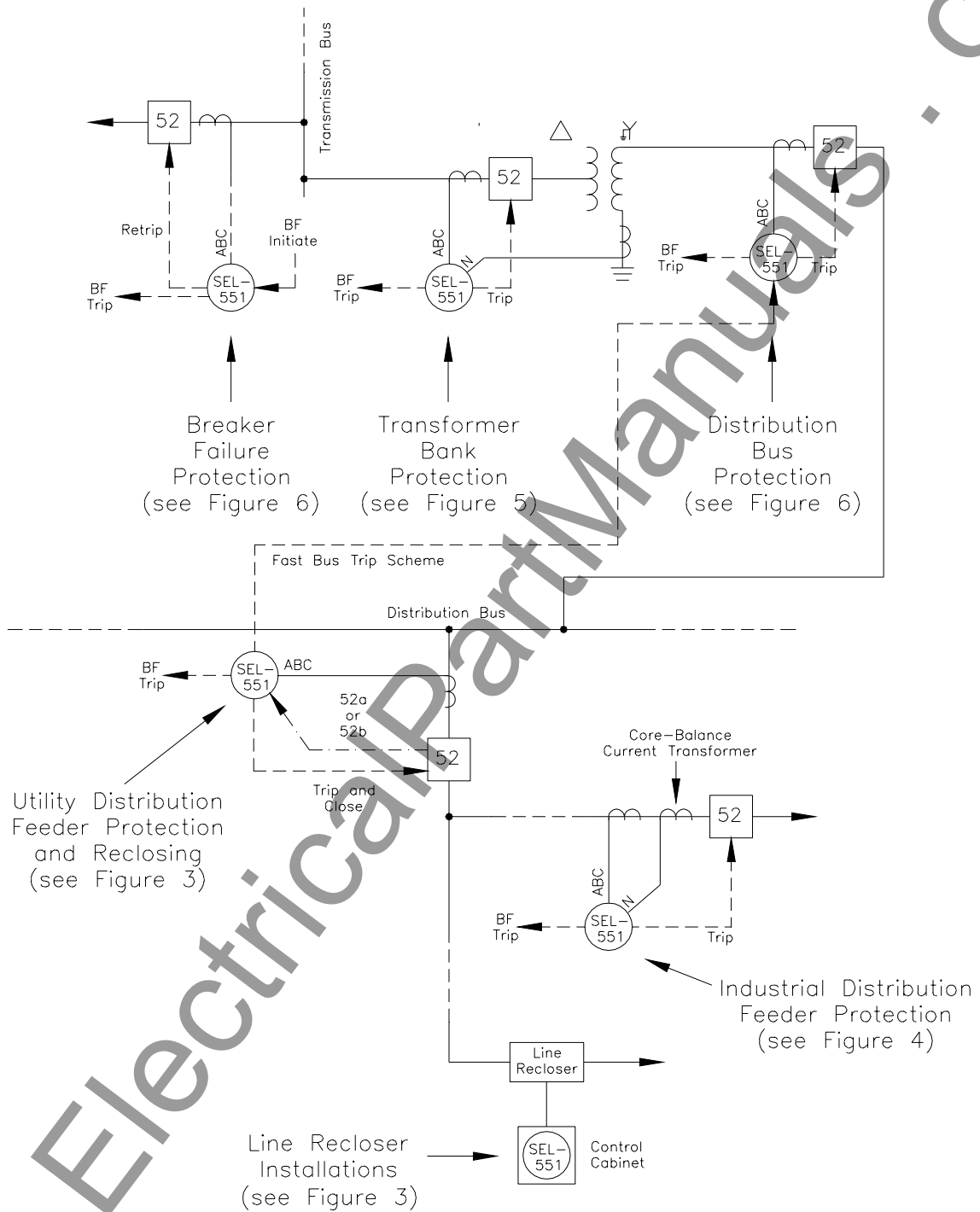
SEL-551 RELAY APPLICATIONS

Figure 1:   SEL-551 Relays Applied Throughout the Power System

HARDWARE OVERVIEW

Hardware Options:

- Rear-panel screw terminals or plug-in connectors (see Figure 7 and Figure 8)

- High-current interrupting output contacts: 10 A for L/R = 40 ms at 125 Vdc (included in the rear-panel plug-in connectors option only - see Figure 8)

- EIA-232 or EIA-485 serial communications port - either port option includes a demodulated IRIG-B time-code input (available with either rear-panel option - see Figure 7 and Figure 8).
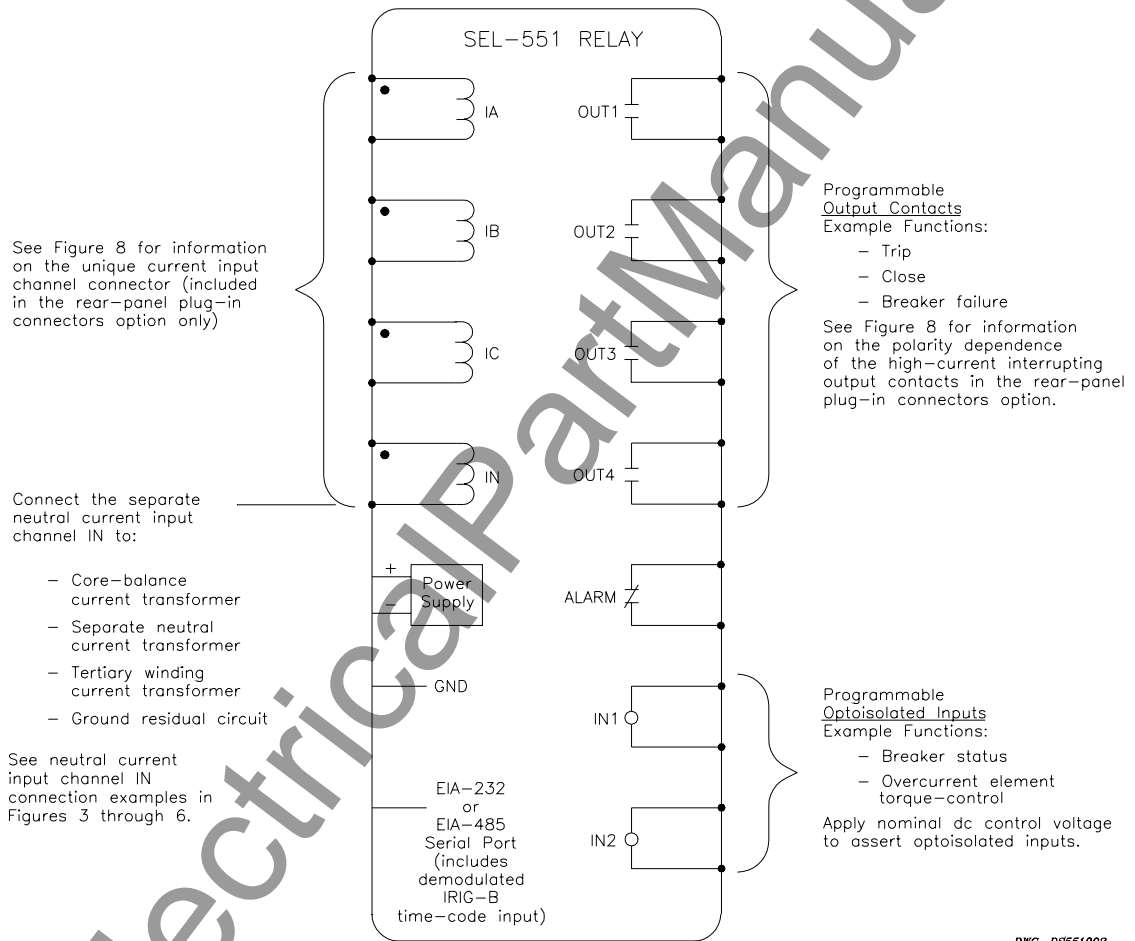

Figure 2:   SEL-551 Relay Inputs, Outputs, and Communications Port

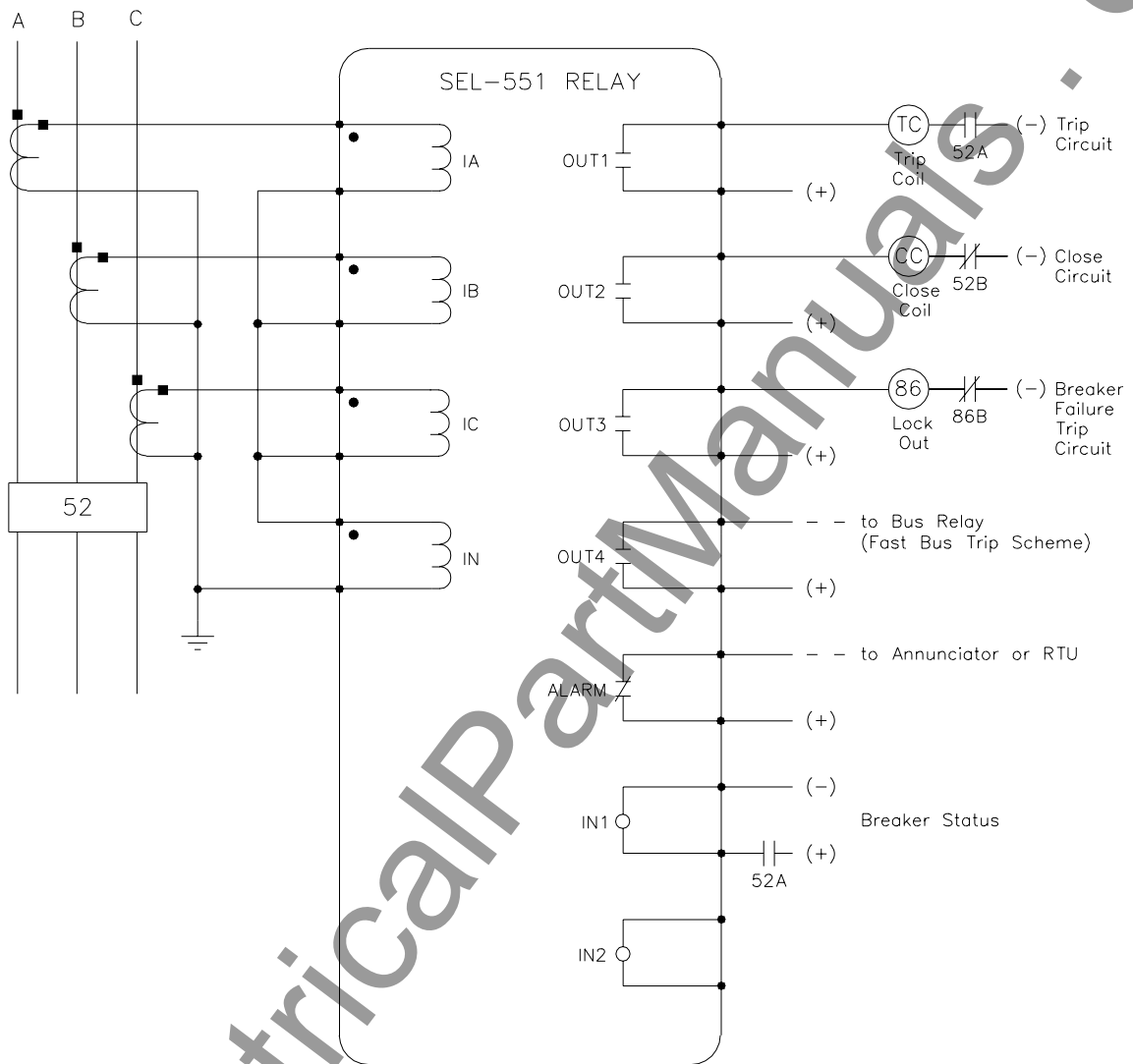# SEL-551 RELAY AC/DC CONNECTION DIAGRAMS FOR EXAMPLE APPLICATIONS

Figure 3: **SEL-551 Relay Provides Overcurrent Protection and Reclosing for a Utility Distribution Feeder (Includes Fast Bus Trip Scheme)**

For line recloser installations, the SEL-551 Relay is connected similar to Figure 3.
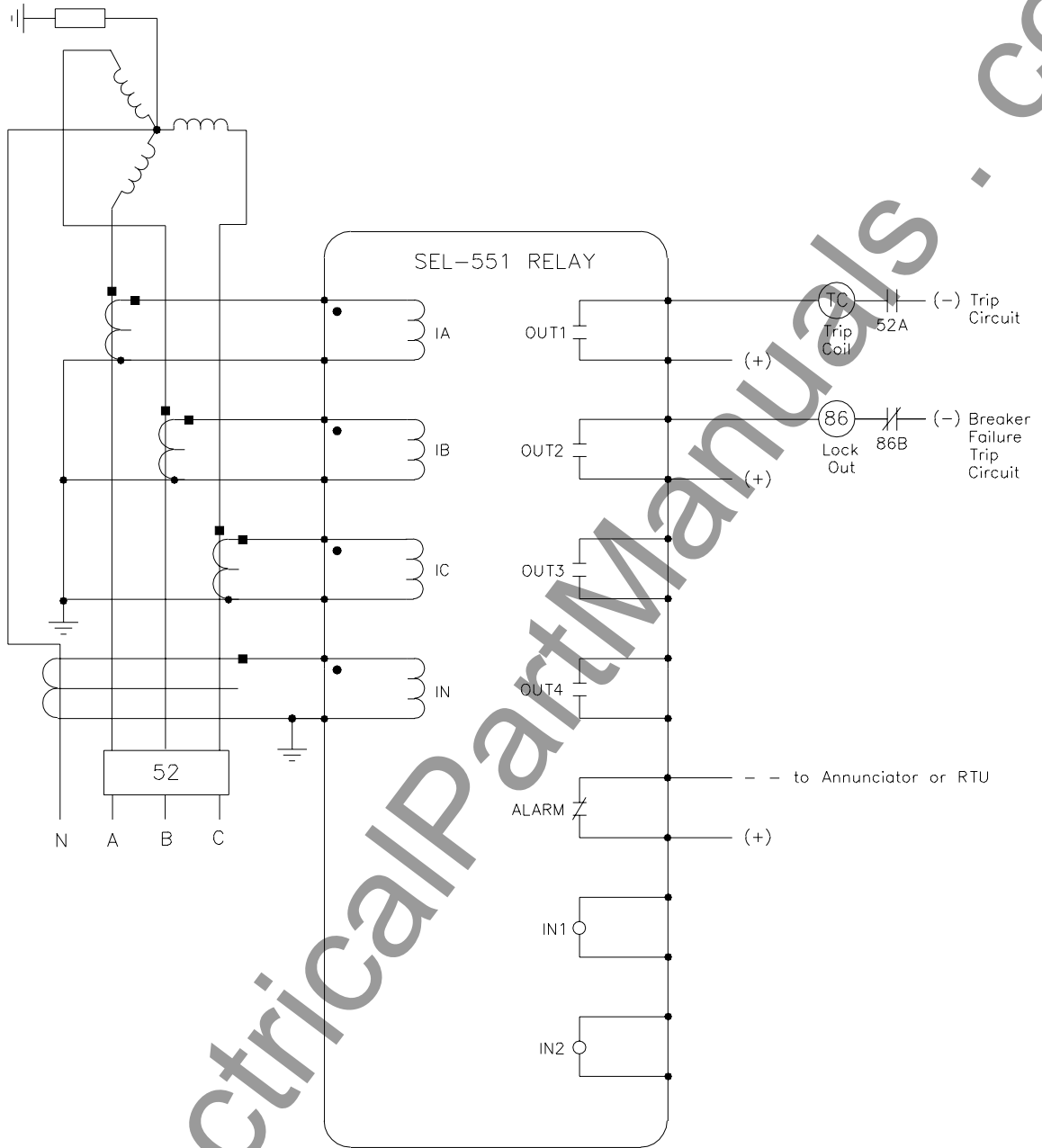
Figure 4:   SEL-551 Relay Provides Overcurrent Protection for an Industrial Distribution Feeder (Core-Balance Current Transformer Connected to Current Input Channel IN)

A core-balance current transformer is often referred to as a zero-sequence, ground fault, or window current transformer.
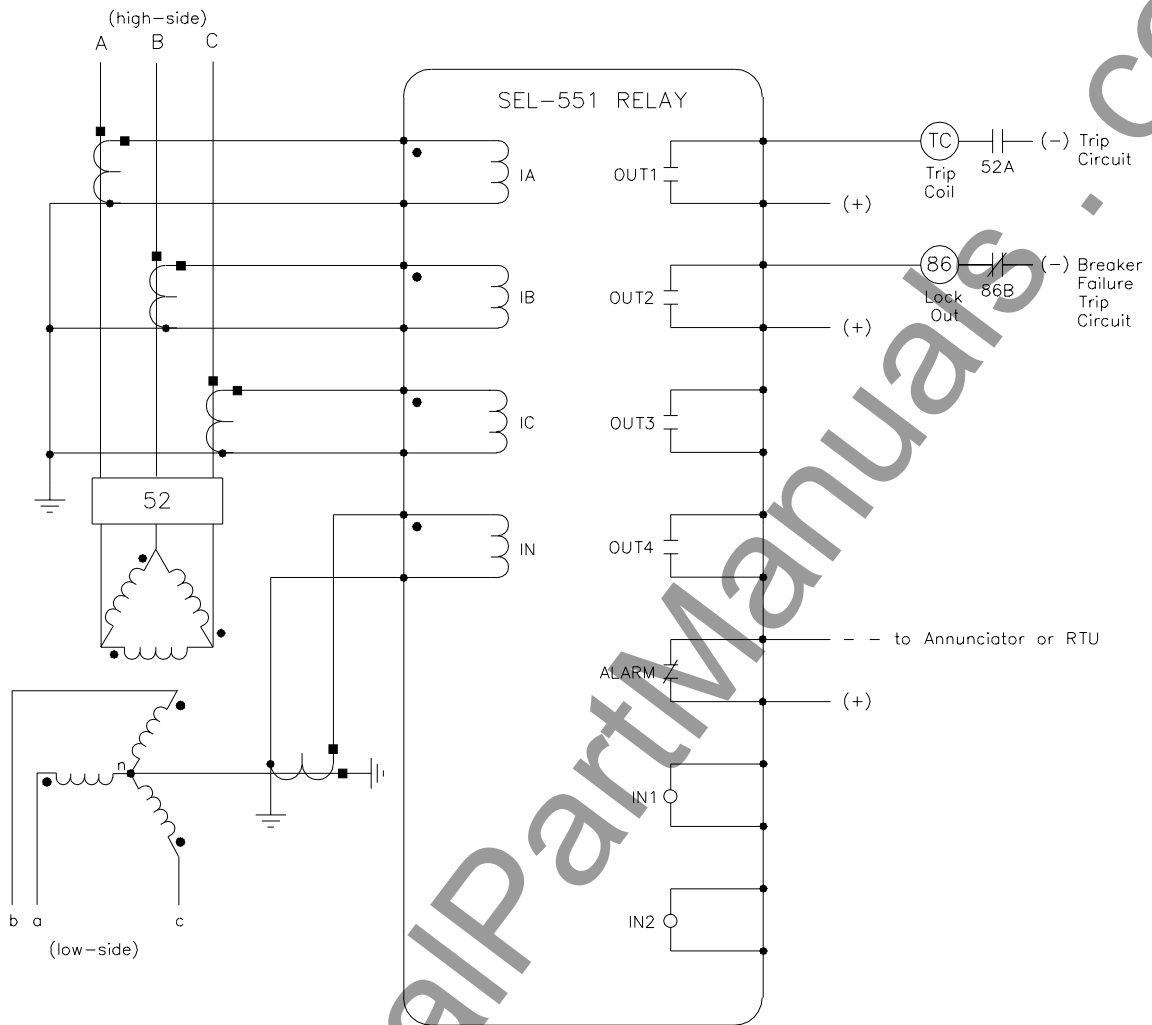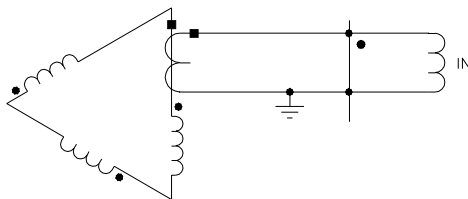
Figure 5: **SEL-551 Relay Provides Overcurrent Protection for a Delta-Wye Transformer Bank**

To provide overcurrent protection for a transformer bank with a tertiary winding, an SEL-551 Relay is connected similar to Figure 5. Current input channel IN can be connected to a current transformer on the tertiary winding:
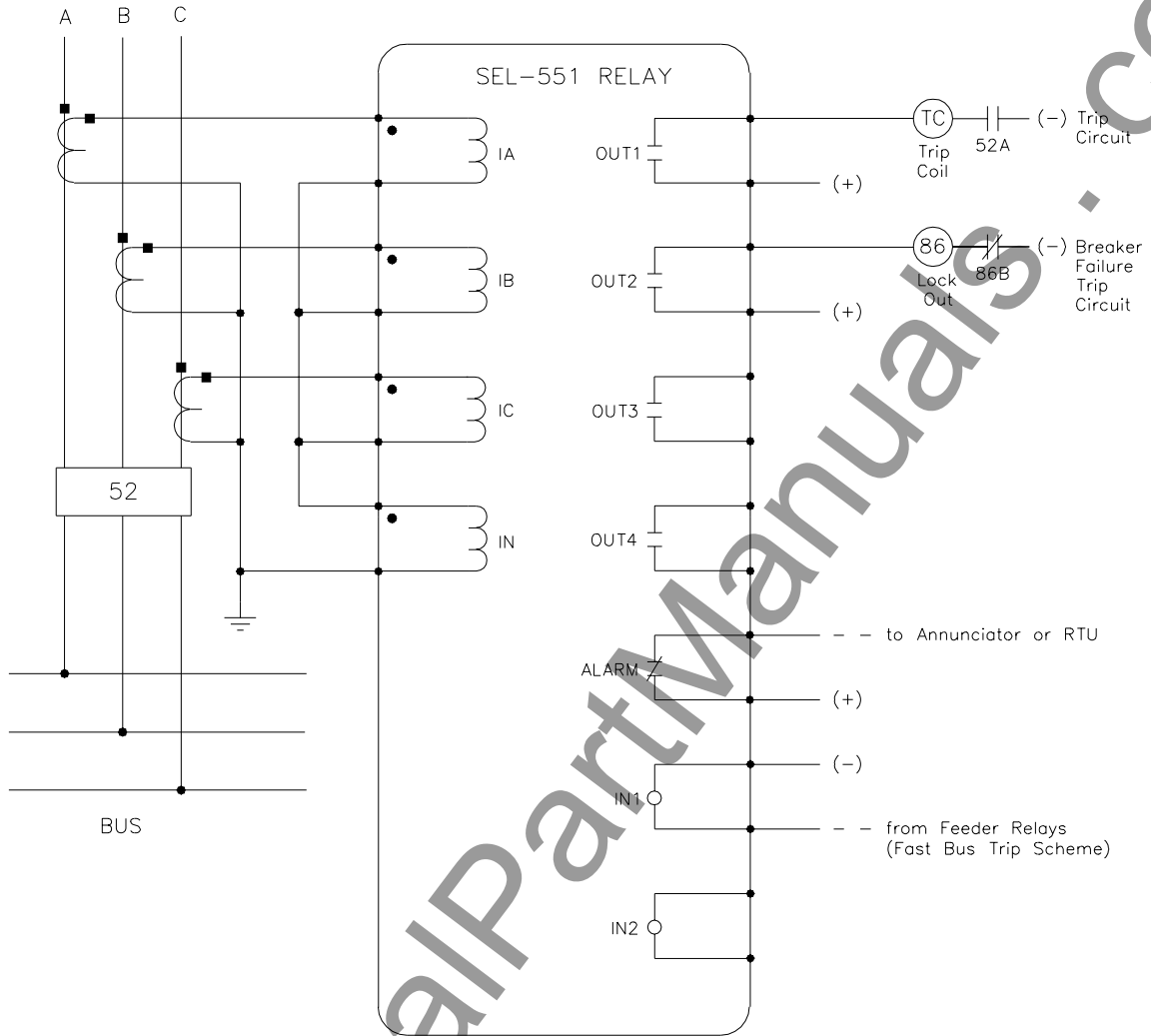
**Figure 6:   SEL-551 Relay Provides Overcurrent Protection for a Distribution Bus
(Includes Fast Bus Trip Scheme)**

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

For dedicated breaker failure protection, the SEL-551 Relay is connected similar to Figure 6, with retrip and breaker failure trip functions programmed to output contacts and a breaker failure initiate function programmed to an input.

TWO REAR-PANEL OPTIONS

Conventional Terminal Blocks
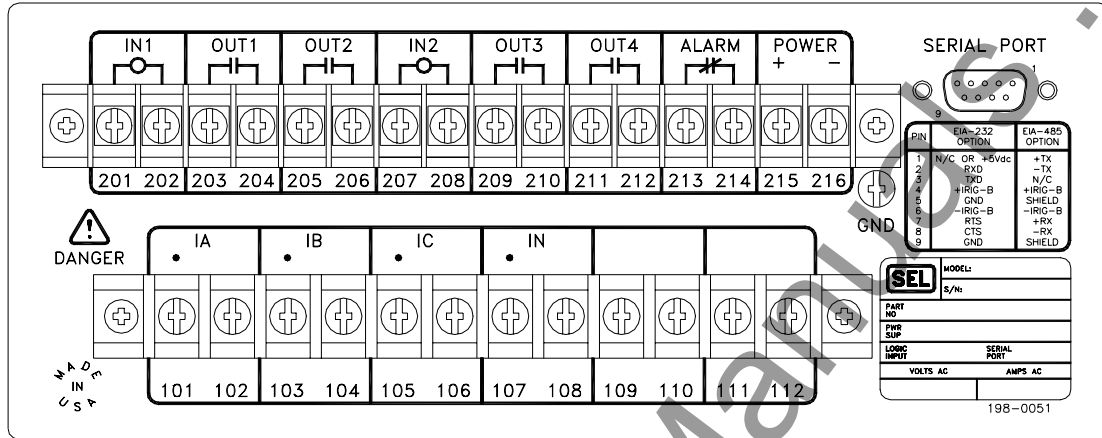
All screws are size #6-32.

Figure 7: SEL-551 Relay Rear Panel (Conventional Terminal Blocks Option)

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

Optoisolated inputs IN1 and IN2 are not polarity-dependent.

All screws are size #6-32.

Connectorized® Relay (Plug-In Connectors)
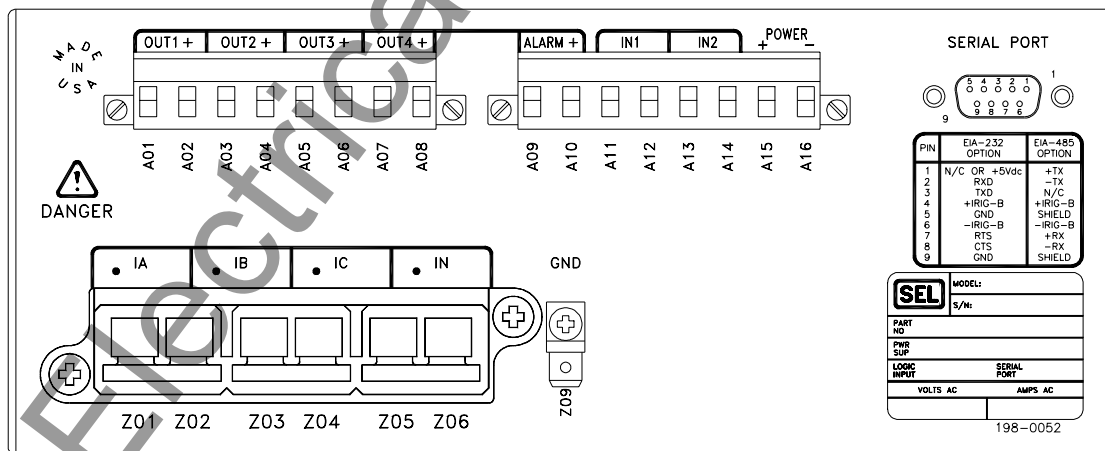
DWG. I1104-R

Figure 8: SEL-551 Relay Rear Panel (Plug-In Connectors Option)

Important: Improvements in Connectorized SEL-551 Relays (Plug-In Connectors) resulted in part number changes.

The current transformer shorting connectors for current channel inputs IA, IB, IC, and IN have been made more robust. This improvement makes the new connector design incompatible with the old design. Thus, new Connectorized SEL-551 Relays with this improved connector have a new part number (partial part numbers shown).

Old		**New**
0551xJ	→	0551xW

The respective wiring harness part numbers for these old and new Connectorized SEL-551 Relays are (partial part numbers shown):

Old		**New**
WA0551xJ	→	WA0551xW

Figure 8 shows the rear panel for new models 0551xW. Because all terminal/numbering remains the same between the new and old relays, these figures can be used as a reference for old model 0551xJ. 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.

Current input connector (terminals Z01 - Z08):

- Contains current transformer shorting mechanisms
- Accepts wire size AWG 16 to 12 (special tool required to attach wire to connector)
- Can be ordered prewired

Ground connection (terminal Z09): 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 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 = 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 de-assert 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
  24V*:   6 - 36 Vdc
48/125 V: 36 - 200 Vdc; 85 - 140 Vac
  250 V: 85 - 350 Vdc; 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)

Metering Functions
Instantaneous and Demand Ammetering functions.
Measurement Accuracy: $\pm2\%$, I_N $\pm5\%$

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 Dielectric Tests* : *1977* are performed on all units bearing the CE mark:

2500 Vac for 10 seconds on analog inputs
3100 Vdc for 10 seconds on power supply, optoisolated inputs, and output contacts

Operating Temperature
-40° to 85°C (-40° to 185°F)

Dimensions
See Figure 12, Figure 13, and Figure 14.

Unit Weight
2.5 kg (5 lb, 8 oz)

Type Tests and Standards   The SEL-551 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 68-2-30 : 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).

STANDARD EVENT REPORTS AND SER

The SEL-551 Relay has two styles of event reports:

- Standard 15-cycle event report

- Sequential events recorder (SER) event report

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

Standard 15-cycle event reports are generated (triggered) by fixed and programmable conditions. These reports show information for 15 continuous cycles. The latest 20 standard 15-cycle event

reports are stored in nonvolatile memory. If more than 20 events are triggered, the latest event report will overwrite the oldest event report, and the oldest event report will be lost.

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

HIGH-CURRENT INTERRUPTING OUTPUT CONTACTS (OPTION)

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

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

See *General Specifications* for more details.

SELOGIC® CONTROL EQUATIONS

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

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

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

LOCAL/REMOTE CONTROL LOGIC

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

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

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

ON/OFF   OFF/MOMENTARY   ON/OFF/MOMENTARY

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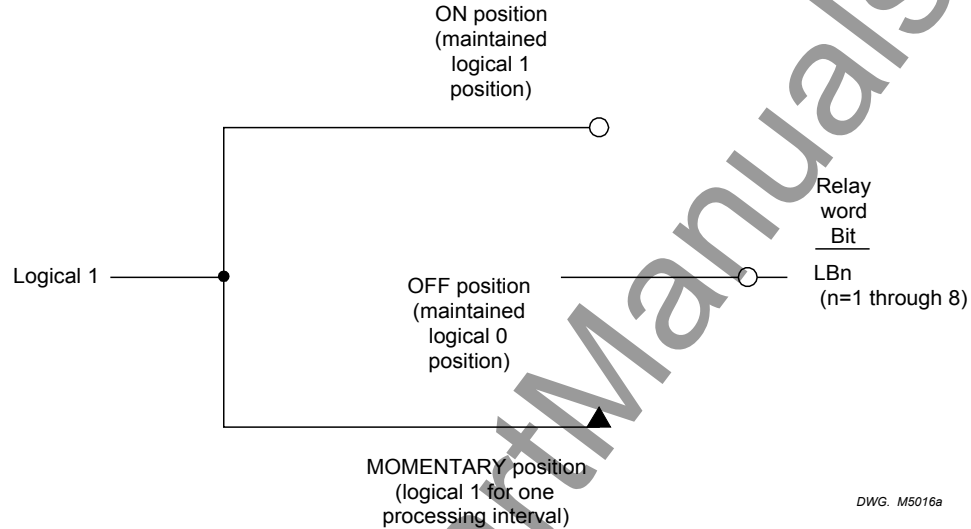

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Figure 9: Local Control Switches Drive Local Bits LB1 Through LB8

OVERCURRENT ELEMENTS

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

The OFF setting disables the overcurrent element.

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

** The available current channel ratings (5 A or 1 A) for phase (IA, IB, and IC) and neutral (IN) are specified separately – refer to the ordering information sheets for the SEL-551 Relay.

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Numerous Instantaneous Overcurrent Elements

Example applications:

- Create definite-time overcurrent elements with SELOGIC Control Equations - combining instantaneous overcurrent elements with timers
- Create "2-out-of-3" phase involvement logic (or other logic) with SELOGIC Control Equations - using the single-phase elements 50A, 50B, and 50C

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

Example applications:

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

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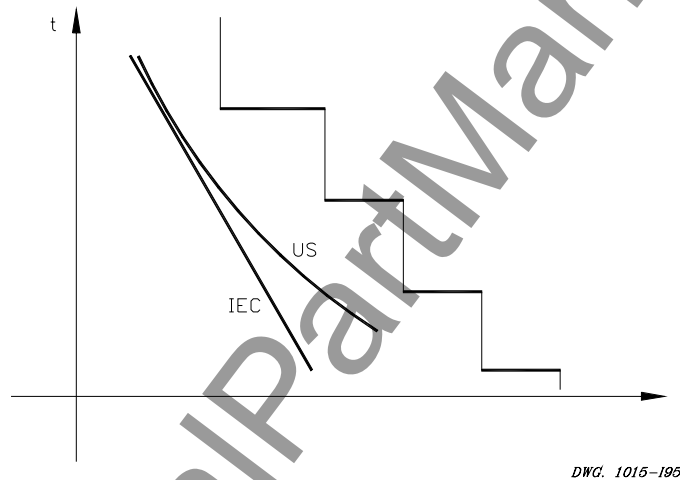
Figure 10: Instantaneous, Definite-Time, and Inverse Time-Overcurrent Characteristics

The following time-overcurrent curves are included:

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

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

Demand Current Thresholds Alarm for Overload and Unbalance

The SEL-551 Relay provides demand and peak demand current thresholds. When demand current exceeds a threshold, the respective Relay Word bit PDEMP, NDEMP, GDEMP, or QDEMP asserts.
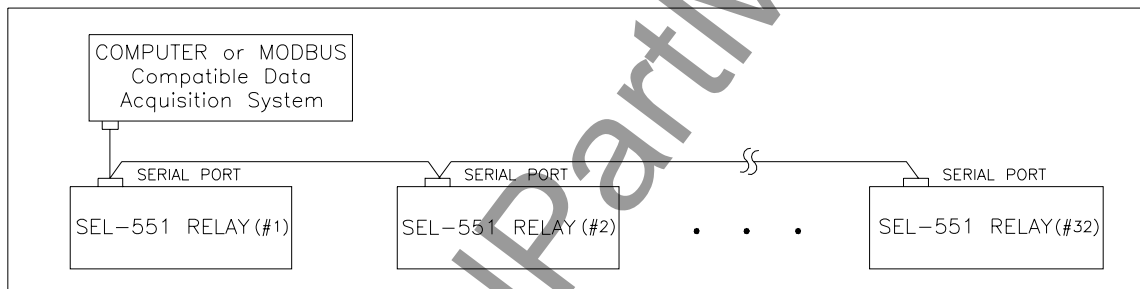
PDEMP, NDEMP, GDEMP, or QDEMP alarm for phase overload, neutral unbalance, residual unbalance, or negative-sequence unbalance respectively. The demand meter time constant, DMTC, can be set to 5-, 10-, 15-, 30-, or 60-minute intervals.
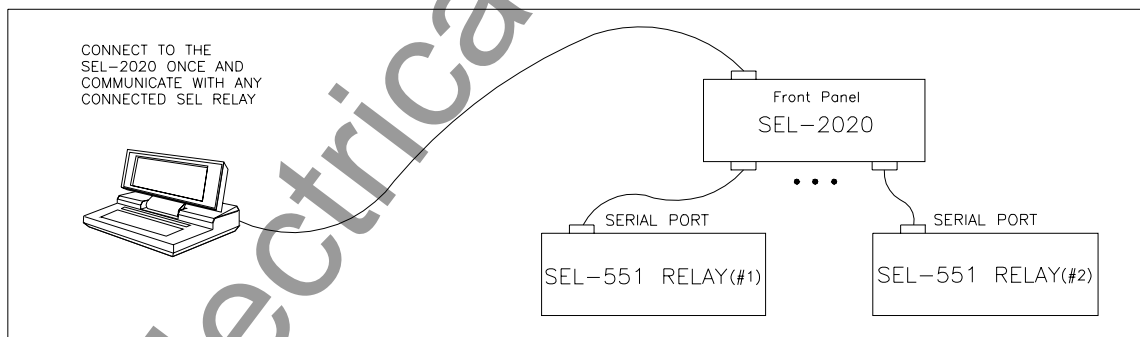
COMMUNICATIONS CONNECTIONS (TYPICAL)

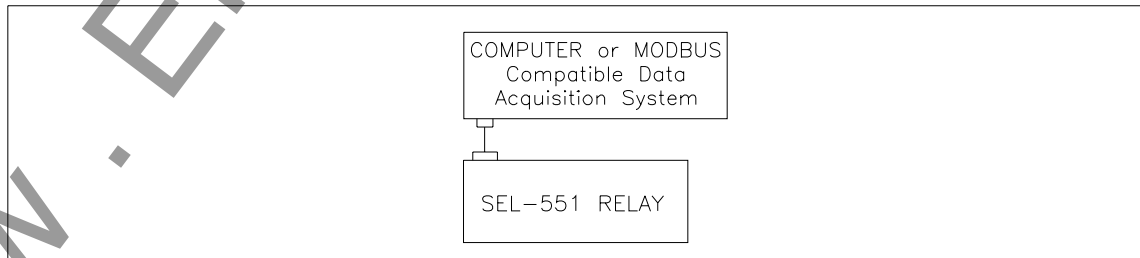DATA AND TIME-SYNCHRONIZATION CONNECTIONS
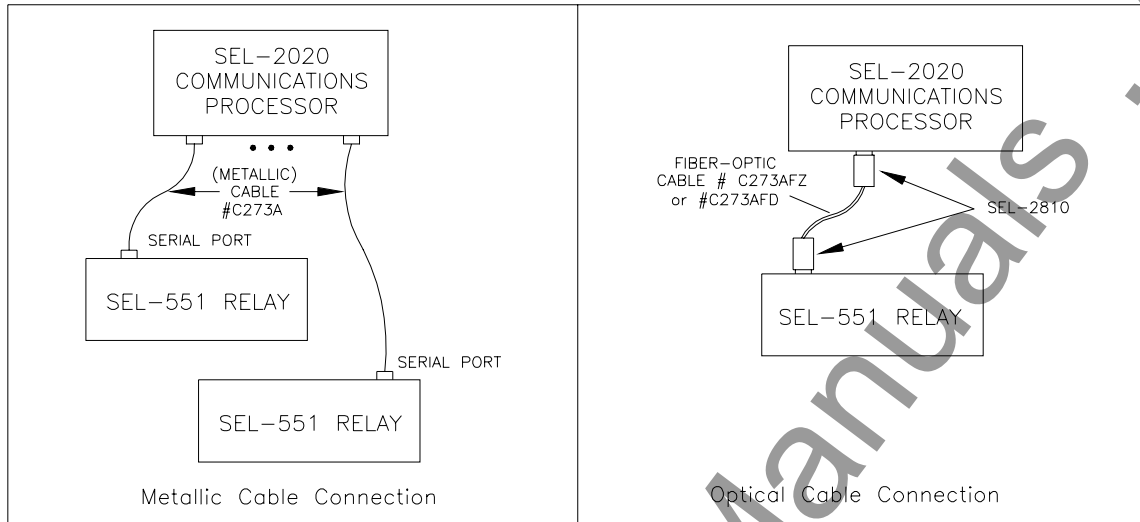
Figure 11: SEL-551 Relay Communications Connection Examples

RELAY MOUNTING

Terminal Block: 0.80" (20.3mm)
Connectorized: 1.45" (36.8mm)
projection behind rear panel

8.20"
(208.3mm)
semi-flush
mounting

5.80"
(147.3mm)
flanges are reversible
for projection mounting

8.70"
(221.0mm)
(measured from outside of flanges)

10.25"
(260.4mm)

3.47"
(88.1mm)

3.00" (76.2mm)
1.75" (44.4mm)
optional

9.56"
(242.8mm)

slot: 0.25" X 0.38"
(6.4mm) X (9.7mm)
(typical)

NOTE:

1. ALL TOLERANCES ARE ± 0.020" (0.51mm)
2. TO DETERMINE THE CUTOUT DIMENSIONS CONSIDER BOTH
   SEL'S SPECIFIED TOLERANCES AND THE CUSTOMER'S
   ALLOWED TOLERANCE.
3. DRAWING NOT TO SCALE

DWG. I1370

Figure 12: SEL-551 Relay Dimensions and Drill Plan for Single Rack-Mount Relay
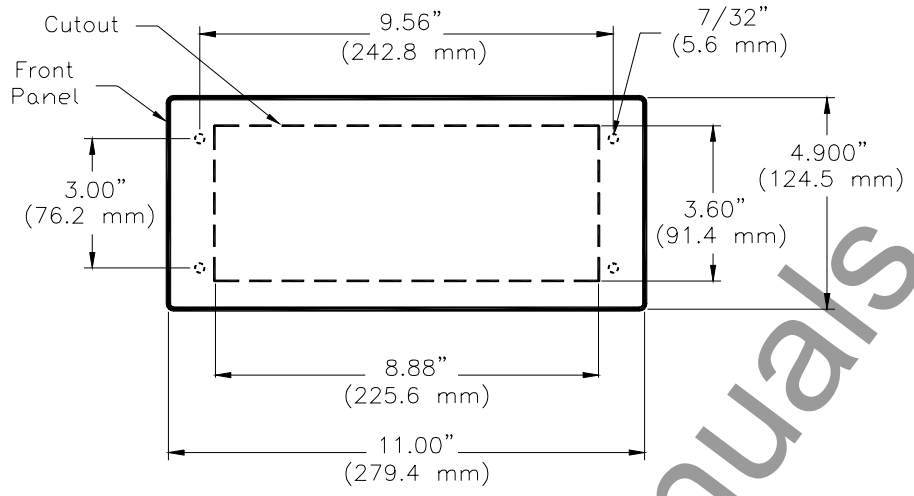
NOTES:

1. ALL TOLERANCES ARE ± 0.020" (0.51 mm)
2. DRAWING NOT TO SCALE

DWG: 500_panelmount

Figure 13: Panel Cutout and Drill Plan for Single Panel-Mount Relay
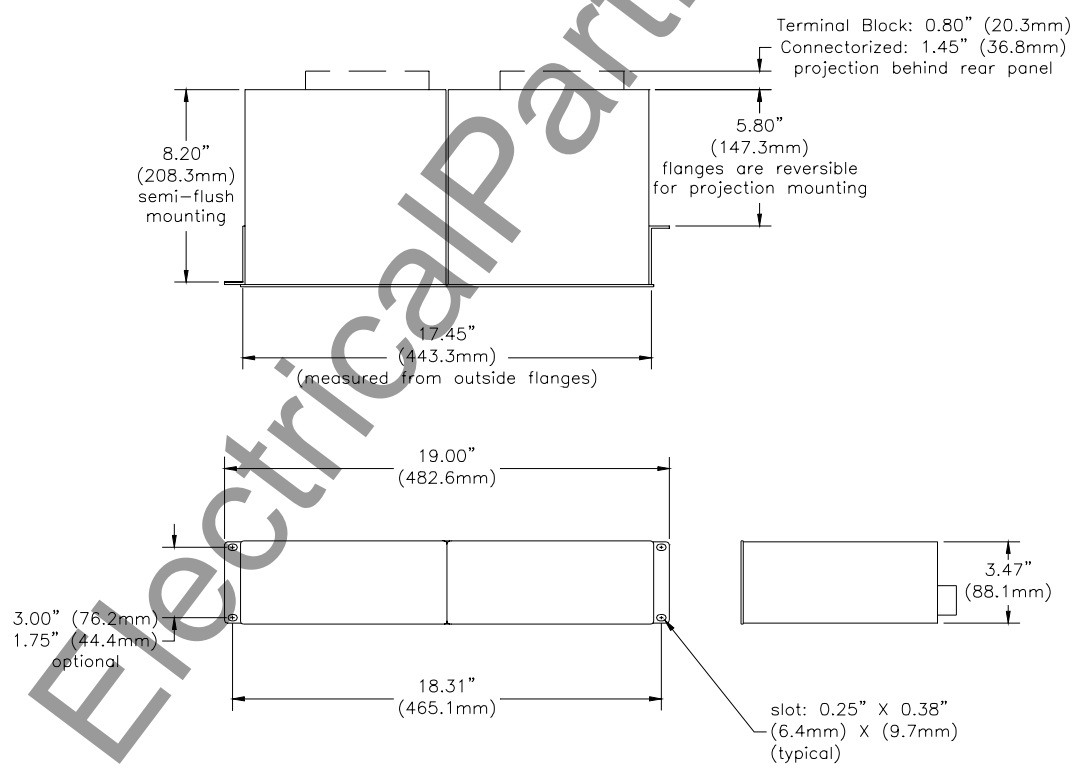
NOTE:

1. ALL TOLERANCES ARE ± 0.020" (0.51mm)
2. TO DETERMINE THE CUTOUT DIMENSIONS CONSIDER BOTH
   SEL'S SPECIFIED TOLERANCES AND THE CUSTOMER'S
   ALLOWED TOLERANCE.
3. DRAWING NOT TO SCALE

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Figure 14: Relay Dimensions and Drill Plan for Mounting Two SEL-500 Series Relays Together Using Mounting Block (SEL P/N 9101)
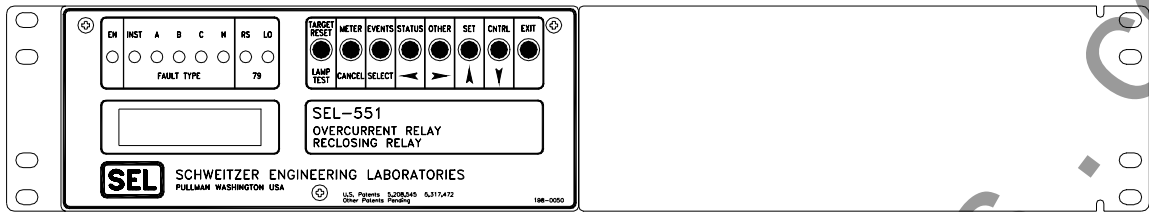
Figure 15: SEL-551 Relay Fitted with Mounting Bracket (SEL P/N 9100) for Mounting in 19-Inch Rack
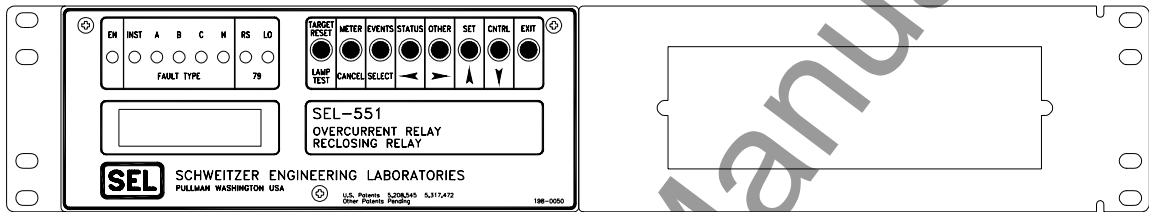
Figure 16: SEL-551 Relay Fitted with Mounting Bracket (SEL P/N 9102) for Mounting in 19-Inch Rack Including Cutout to Fit an FT-1 Test Switch

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:

Schweitzer Engineering Laboratories
2350 NE Hopkins Court
Pullman, WA USA 99163-5603
Tel: (509) 332-1890
Fax: (509) 332-7990

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.

SCHWEITZER ENGINEERING LABORATORIES
2350 NE Hopkins Court · Pullman, WA 99163-5603 USA
Phone: (509) 332-1890 · Fax: (509) 332-7990
Internet: www.selinc.com · E-mail: info@selinc.com