SCHWEITZER ENGINEERING LABORATORIES, INC.
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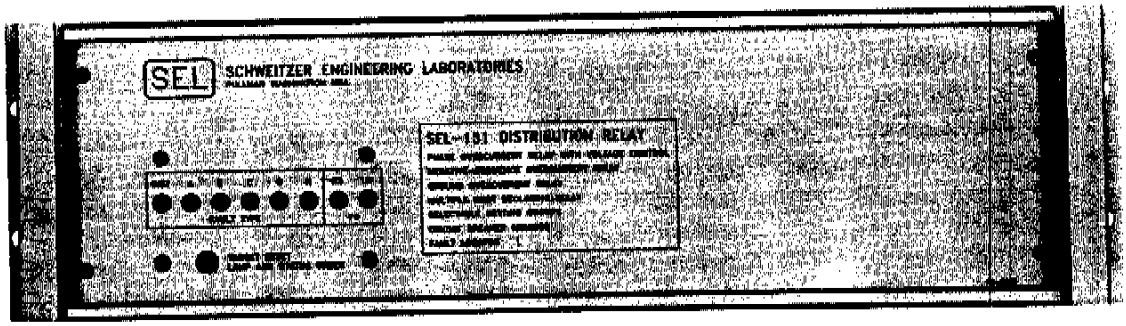

SEL-151 DISTRIBUTION RELAY

PHASE OVERCURRENT RELAY WITH VOLTAGE CONTROL
NEGATIVE-SEQUENCE OVERCURRENT RELAY
GROUND OVERCURRENT RELAY
MULTIPLE SHOT RECLOSING RELAY
SELECTABLE SETTING GROUPS
CIRCUIT BREAKER MONITOR
FAULT LOCATOR
PROGRAMMABLE SELOGIC™

Also Available In LOW-PROFILE Package

DATA SHEET

- Develop traditional and advanced schemes using flexible SELOGIC™
- Phase overcurrent elements have voltage control for load security
- Negative-sequence elements reject load for more-sensitive phase fault protection
- Ground/Residual overcurrent elements cover ground faults
- Choose fast or electromechanical reset characteristic for time-overcurrent elements
- Overcurrent elements inhibit recloser reset, to prevent nuisance "trip-reclose" cycling
- Sequence coordination avoids unnecessary tripping for faults beyond line reclosers
- Six selectable setting groups cover all feeder protection contingencies
- Circuit breaker monitor sums interrupted current in each pole to aid maintenance
- Fault locator reduces line patrol and outage time for increased service reliability
- Eleven cycle event reports simplify fault and system analysis
- Comprehensive voltage, current, power, unbalance, and demand metering
- Connects to SEL-RD RELAY DISPLAY for easy local information access

GENERAL DESCRIPTION

The SEL-151 DISTRIBUTION RELAY protects, controls, and monitors distribution feeders. It offers important new and unique features, like user-programmable SELOGIC™, negative-sequence overcurrent elements, and selectable setting groups. The advanced relay design enhances security, reliability, sensitivity, and operation.

SELOGIC™: The Next Step in Programmable Relay Logic

In 1987, SEL® invented Programmable Mask Logic. The SEL-151 relay offers SELOGIC™, the next step in user-programmability. SELOGIC™ includes ANDing, ORing, and inverting functions, timing, and programmable inputs and outputs. SELOGIC™ adds power and flexibility while simplifying programming.

Phase, Ground, and Negative-Sequence Overcurrent Protection

Phase and negative-sequence overcurrent elements detect phase faults. Negative-sequence overcurrent elements reject three-phase load to provide more sensitive coverage of phase-to-phase faults. Phase overcurrent elements are needed only for three-phase faults where negative-sequence quantities are not produced.

On heavily-loaded feeders, undervoltage torque control of phase overcurrent elements adds security. Choose between three-phase and single-phase-pair undervoltage torque control. When phase overcurrent elements are used only for three-phase faults, three-phase under-voltage torque control enhances security.

Ground/Residual overcurrent elements detect ground faults, and external inputs can torque control selected overcurrent elements.

There are two reset characteristic choices for the time-overcurrent elements. One choice resets the elements if current drops below pickup for at least one cycle. The other choice emulates electromechanical induction disc elements where the reset time depends on the time dial setting, the percentage of disc travel, and the amount of current between zero and pickup.

Sophisticated Multiple-Shot Reclosing Relay Includes Reset Inhibit and Sequence Coordination

The reclosing relay allows up to four reclosing shots with separate, settable open interval timers and reset interval timer. Overcurrent conditions during the reclosing relay reset interval inhibit the reset interval timer. This prevents the reclosing relay from resetting when a trip condition is imminent. A close failure timer limits CLOSE output contact assertion. Reclose cancel conditions are programmable. A programmable input can be used as a reclose enable input to disable/enable the reclosing relay.

The SEL-151 relay includes easily programmable sequence coordination to keep the relay "in step" with line reclosers, preventing undesired tripping for faults beyond line reclosers.

Six Selectable Groups of Settings and Logic

The relay stores six setting groups. Select the active setting group by contact input or command. Use these setting groups to cover a wide range of distribution feeder protection contingencies. Selectable setting groups make the SEL-151 relay ideal for bus-tie and substitute breaker applications, and other applications requiring frequent setting changes.

Circuit Breaker Monitor Tracks Breaker Performance and Helps Maintenance Planning

Separate circuit breaker trip counters differentiate and tally relay-initiated trips and external trips. Running sums of interrupted current for relay and external trips indicate breaker wear on a pole-by-pole basis. Use these data to schedule breaker maintenance.

Trip failure logic provides alarm and breaker failure functions. A close failure alarm indicates circuit breaker closing circuit or mechanism problems. The trip circuit monitor detects abnormal open or short circuits in the circuit breaker tripping circuit or status input.

Fault Locator Reduces Line Patrol and Outage Time

The SEL-151 relay includes a fault locator which uses fault type, prefault, and fault conditions to provide an accurate estimate of fault location without the need for communications channels, special instrument transformers, or source impedance information, even during conditions of substantial load flow and fault resistance. Fault locating reduces line patrol and outage time.

Analyze Operations Using Event Reports

Eleven cycle event reports triggered by user selected conditions provide the current, voltage, and sequence-of-events information you need to understand relay and circuit breaker performance, as well as stress on the feeder for every fault. The relay stores the twelve latest event reports.

Comprehensive Metering Supports Protection, Operation, and Demand Analysis

The relay measures phase, negative-sequence, and zero-sequence voltage and current, as well as MW and MVAR. Demand and peak demand values for current, MW, and MVAR are also available. Metering also supports protection by allowing inspection of the quantities monitored by relay elements and checking for load encroachment and unbalance through instantaneous, demand, and peak-demand measurements.

Access SEL-151 Relay Information Via the SEL-RD RELAY DISPLAY

You can connect up to four SEL-151 relays to one SEL-RD RELAY DISPLAY. Access relay target, meter, status, fault history, and circuit breaker information via the relay display. You can also change the active setting group via the display.

Security, Reliability, Sensitivity, Flexibility, Capability, and Economy

The SEL-151 DISTRIBUTION RELAY improves every aspect of feeder protection:

Security:	Undervoltage supervision and negative-sequence avoid load encroachment
Reliability:	Field-proven hardware; new backup concepts
Sensitivity:	Negative-sequence overcurrent elements for better phase fault coverage
Flexibility:	SELOGIC™ handles virtually every conceivable scheme
Capability:	Brings transmission relay features to distribution applications
Economy:	Low price and unique features make the relay an exceptional value

GENERAL SPECIFICATIONS

Rated Ac Input Voltage	115, 208, or 230 volt nominal phase-to-phase, three-phase, 4-wire connection 220 volt phase-to-neutral saturation limit
Rated Ac Input Current	5 amps nominal 15 amps continuous 110 amps saturation limit 500 amp one second thermal rating
Output Contact Current Ratings	30 amp make per IEEE C37.90, paragraph 6.7.2 6 amp carry continuously; MOV protection provided
Optical Isolator Logic Input Ratings	48 Vdc: 25 - 60 Vdc 125 Vdc: 60 - 200 Vdc 250 Vdc: 200 - 280 Vdc Current = 6 mA at nominal voltage
Time Code Input	Relay accepts demodulated IRIG-B time code input
Communications	Two EIA RS-232-C serial communications ports
Power Supply	48 Volt: 30 - 60 Vdc; 12 watts 125/250 Volt: 85 - 280 Vdc or 85 - 200 Vac; 12 watts
Relay Dimensions	5¼" x 19" x 13" (13.3 cm x 48.2 cm x 33.0 cm) (H x W x D)
Mounting	Available in horizontal and vertical mounting configurations.
Dielectric Strength	V, I inputs: 2500 Vac for 10 seconds Other: 3000 Vdc for 10 seconds (excludes EIA RS-232-C)
Operating Temp.	-40°F to 158°F (-40°C to +70°C)

Environment IEC 68-2-30 Temperature/Humidity Cycle Test - six day (type tested)

Interference Tests IEEE C37.90 SWC Test (type tested)
IEC 255-6 Interference Test (type tested)

Impulse Tests IEC 255-5 0.5 Joule, 5000 Volt Test (type tested)

RFI Tests Type-tested in field from a ¼-wave antenna driven by 20 watts at 150 MHz and 450 MHz randomly keyed on and off one meter from relay.

ESD Test IEC 801-2 Electrostatic Discharge Test (type tested)

Unit Weight 21 pounds (9.1 kg)

Shipping Weight 32 pounds (14.5 kg), including two instruction manuals.

Burn-in Each relay is burned in at 140°F (60°C) for 100 hours.

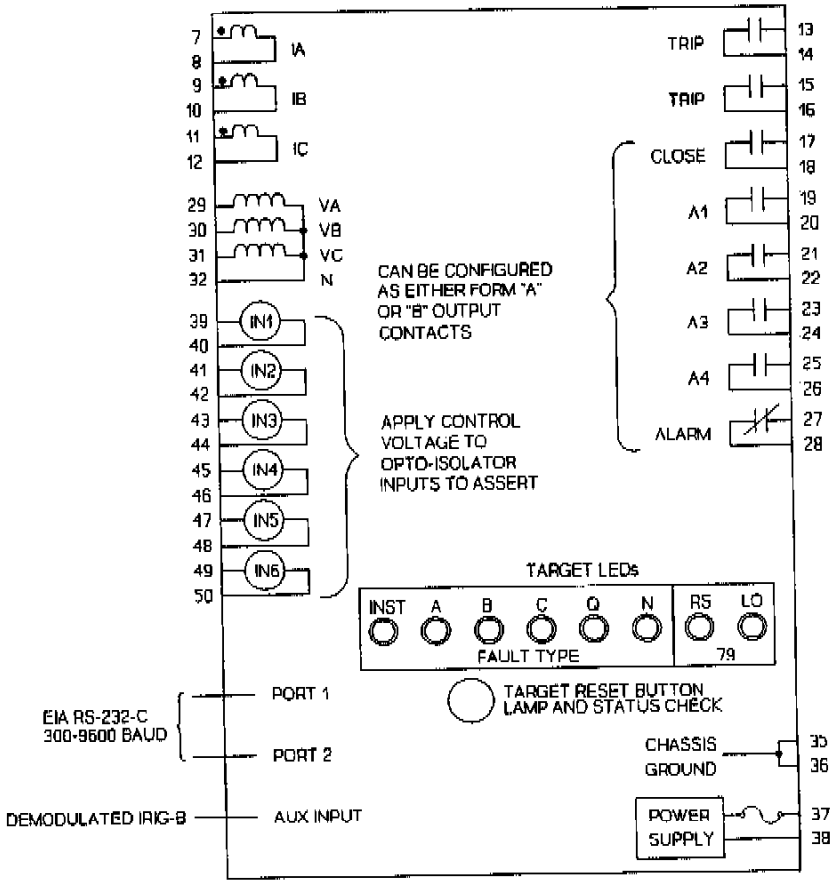

Figure 1: SEL-151 Relay Inputs, Outputs, and Targets Diagram

FUNCTIONAL SPECIFICATIONS

Phase Overcurrent Elements for Phase and Three-Phase Faults (51T, 50LT, 50H, 50C)

51T Phase Time-Overcurrent Element
- Curve families: moderately inverse, inverse, very inverse, extremely inverse
- Time dial: 0.5 to 15.00 in 0.01 steps.
- Pickup (**51P**): 1 to 12 A ±2% of setting ±0.1 A secondary
- Time delay or one cycle reset time
- Timing: ±5% and ±1 cycle for currents between 2 and 20 multiples of pickup
- Internally and externally torque controllable

50LT Phase Definite-Time Overcurrent Element
- Pickup (**50L**): 0.5 to 100 A ±2% of setting ±0.1 A secondary
- Time delay: 0 to 16,000 cycles in 1 cycle steps
- Internally and externally torque controllable

50H Phase Instantaneous Overcurrent Element
- Pickup: 0.5 to 100 A ±2% of setting ±0.1 A secondary
- Internally and externally torque controllable

50C Phase Instantaneous Overcurrent Element
- Pickup: 0.5 to 100 A ±2% of setting ±0.1 A secondary
- Can be used to override voltage control through TCI setting choice

Negative-Sequence Overcurrent Elements for Phase-to-Phase Faults (51QT, 50QT)

51QT Negative-Sequence Time-Overcurrent Element
- Element measures $3xI_2$ negative-sequence current
- Curve families: moderately inverse, inverse, very inverse, extremely inverse
- Time dial: 0.5 to 15.00 in 0.01 steps.
- Pickup (**51QP**): 1 to 12 A ±3% of setting ±0.18 A secondary
- Time delay or one cycle reset time
- Timing: ±5% and ±1 cycle for currents between 2 and 20 multiples of pickup
- Externally torque controllable

50QT Negative-Sequence Definite-Time Overcurrent Element
- Element measures $3xI_2$ negative-sequence current
- Pickup (**50Q**): 0.5 to 100 A ±3% of setting ±0.18 A secondary
- Time delay: 0 to 16,000 cycles in 1 cycle steps
- Externally torque controllable

Residual Overcurrent Elements for Ground Faults (51NT, 50NLT, 50NH)

51NT Ground/Residual Time-Overcurrent Element

- Curve families: moderately inverse, inverse, very inverse, extremely inverse
- Time dial: 0.5 to 15.00 in 0.01 steps
- Pickup (**51NP**): 0.25 to 12 A secondary
- Time delay or one cycle reset time
- Timing: ±5% and ±1 cycle for currents between 2 and 20 multiples of pickup
- Externally torque controllable

50NLT Ground/Residual Definite-Time Overcurrent Element

- Pickup (**50NL**): 0.5 to 100 A secondary (for 1 ≤ 51NP ≤ 12 A secondary)
  0.25 to 50 A secondary (for 0.5 ≤ 51NP < 1 A secondary)
  0.125 to 25 A secondary (for 0.25 ≤ 51NP < 0.5 A secondary)
- Time delay: 0 to 16,000 cycles in 1 cycle steps
- Externally torque controllable

50NH Ground/Residual Instantaneous Overcurrent Element

- Pickup: same range as **50NLT**
- Externally torque controllable

Accuracy

- Residual element pickup accuracy is dependent upon the 51NP setting. Pickup accuracy of the 51NP, 50NL, and 50NH elements is shown below in the given 51NP setting range.

1.0 ≤ 51NP ≤ 12.0 A sec	Pickup ±2% ±0.100 A sec
0.5 ≤ 51NP < 1.0 A sec	Pickup ±2% ±0.050 A sec
0.25 ≤ 51NP < 0.5 A sec	Pickup ±2% ±0.025 A sec

Undervoltage Torque Control Elements for Load Security (27)

- 27AB, 27BC, 27CA Phase-to-Phase Undervoltage Elements
- Setting Range: 0 to 250 V line-to-line secondary ±5%, ±1 V
- Two setting limits: 27H and 27L (high and low, respectively)
- 27 element asserts only if voltage is between 27H and 27L
- User selects either three-phase or phase-to-phase undervoltage condition
- Control can be overridden by **50C** element through TCI setting choice

Time Delayed 52A or 52B Functions Handle Fuse-Saving and Inrush

The time delay pickup and time delay dropout time settings (52APU and 52ADO, respectively) are provided to generate the **52AT** and **52BT** functions. The **52AT** and **52BT** bits can be used to supervise overcurrent elements for fuse saving and inrush conditions.

Demand Current Thresholds Alarm for Overload and Unbalance

Settable demand current thresholds are available for the phase, negative-sequence, and ground/residual demand ammeters. When demand current exceeds a threshold the respective Relay Word bit **PDEM**, **QDEM**, or **NDEM** asserts.

PDEM, **QDEM**, or **NDEM** alarm for phase overload, negative-sequence unbalance, or residual unbalance, respectively. They can provide advance warning of encroachment on relay overcurrent element pickups. The same demand ammeter time constant (DATC = 15 or 60 minutes) is used for all three demand ammeters.

Trip Failure Timer Detects Breaker Failure or Slow Trip

A relay trip starts a trip failure timer. If the trip condition lasts longer than the TFT setting, the **TF** bit in the Relay Word asserts. The **TF** bit deasserts 60 cycles after the trip condition drops out. The **TF** bit can be assigned to an output contact to alarm for slow trips or to provide breaker failure tripping. It can also be used to cancel reclosing or trigger an event report.

Close Failure Timer Detects Failure to Close or Slow Close

A close failure timer monitors the length of time the CLOSE output contact remains asserted. If CLOSE output contact assertion exceeds the CFT time setting, the close attempt is unsuccessful. The relay opens the CLOSE output contact, the reclosing relay locks out, and the **CF** bit in the Relay Word asserts. The **CF** bit asserts for 60 cycles. Use the **CF** bit to alarm for close failures, slow-close conditions and to trigger event reports.

Trip Circuit Monitor Alarm Checks Trip Circuit and Verifies Circuit Breaker Status Input

You can assign one of the six programmable inputs to the trip circuit monitor (TCM) logic.

The TCM logic ensures that the circuit breaker status and TCM inputs agree. If the two inputs disagree for at least 60 cycles, the trip circuit monitor alarm (**TCMA**) bit asserts in the Relay Word. The **TCMA** bit deasserts 60 cycles after the TCMA condition drops out. The **TCMA** bit can be used to alarm, cancel reclosing, or trigger event reports.

SEL-151 RELAY SELOGIC™

SELOGIC™ puts relay logic in the hands of the relay applications engineer. Assign the inputs to suit your application, logically combine selected relay elements for various control functions, use non-dedicated timers for special applications, and assign output contacts to your logic functions.

Programming SELOGIC™ consists of assigning functions to the programmable inputs, designing the internal logic you need, expressing that logic in terms of the relay elements and internal logic variables, and defining the output functions. Complete all SELOGIC™ programming using the SET command.

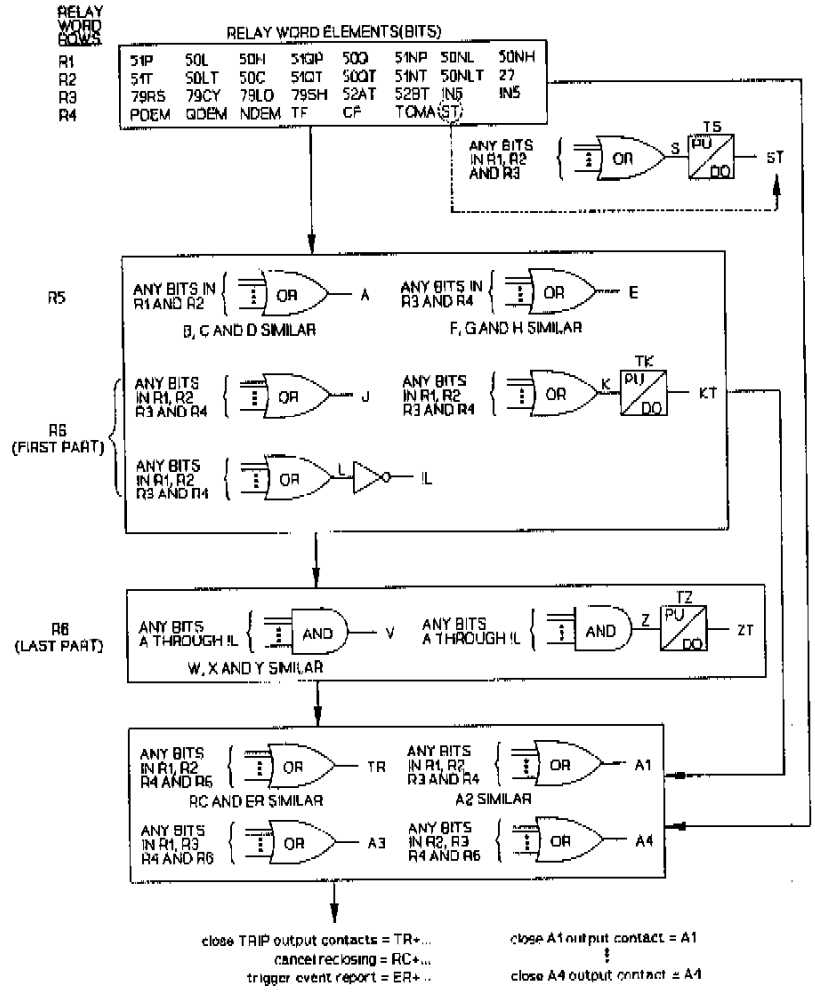

Figure 2: SEL-151 Relay SELOGIC™ Block Diagram

Assign Inputs to the Functions You Need

Program the six isolated inputs (IN1 ... IN6) to the functions your application requires. Choose from the following functions:

SS1	Setting Group Selection Input 1	
SS2	Setting Group Selection Input 2	
SS3	Setting Group Selection Input 3	
TCP	External Torque Control	(Phase and Negative-Sequence Elements)
!TCP	(inverted sense of TCP)	
TCG	External Torque Control	(Residual Overcurrent Elements)
!TCG	(inverted sense of TCG)	
52A	Circuit Breaker Status	
!52A	(inverted sense of 52A)	
DC	Direct Close	(requires circuit breaker status)
RE	Reclose Enable	(requires circuit breaker status)
TCM	Trip Circuit Monitor	(requires circuit breaker status)
ET	External Trigger of Event Report	
DT	Direct Trip	
(blank)	Unassigned input	

Inputs IN5 and IN6 also appear directly in the Relay Word for use in the programmable logic.

Select Combinations of Relay Elements You Need for Tripping and Other Purposes

The 48-bit Relay Word contains relay elements, intermediate logic results, and programmable logic variables.

Table 1: SEL-151 Relay Word

R1	51P	50L	50H	51QP	50Q	51NP	50NL	50NH
R2	51T	50LT	50C	51QT	50QT	51NT	50NLT	27
R3	79RS	79CY	79LO	79SH	52AT	52BT	IN6	IN5
R4	PDEM	QDEM	NDEM	TF	CF	TCMA	ST	
R5	A	B	C	D	E	F	G	H
R6	J	KT	!L	V	W	X	Y	ZT

! indicates NOT

51P	Phase time-overcurrent element pickup
50L	Phase definite-time overcurrent element pickup
50H	Phase instantaneous overcurrent element
51QP	Negative-sequence time-overcurrent element pickup
50Q	Negative-sequence definite-time overcurrent element pickup
51NP	Ground/Residual time-overcurrent element pickup
50NL	Ground/Residual definite-time overcurrent element pickup
50NH	Ground/Residual instantaneous overcurrent element
51T	Phase time-overcurrent element
50LT	Phase definite-time overcurrent element
50C	Phase instantaneous overcurrent element (can override voltage control by **27**)
51QT	Negative-sequence time-overcurrent element
50QT	Negative-sequence definite-time overcurrent element
51NT	Ground/Residual time-overcurrent element
50NLT	Ground/Residual definite-time overcurrent element
27	Phase undervoltage element for internal torque control
79RS	Reclosing relay is in the reset state
79CY	Reclosing relay is in the reclose cycle state
79LO	Reclosing relay is in the lockout state
79SH	"Shot" bit; asserts for shots selected by the M79SH setting
52AT	Time delayed 52A
52BT	Inverse of **52AT**
IN6	Input IN6 bit; asserts for control voltage applied to input IN6
IN5	Input IN5 bit; asserts for control voltage applied to input IN5
PDEM	Phase demand current threshold exceeded
QDEM	Negative-sequence demand current threshold exceeded
NDEM	Ground/Residual demand current threshold exceeded
TF	Trip failure condition
CF	Close failure condition
TCMA	Trip circuit monitor alarm: asserts for abnormal open or short circuit in the circuit breaker tripping circuit or circuit breaker status input (52A)
ST	Output from timer TS, driven by any OR-combination of elements in R1 through R3 assigned to setting S
A B C D	Select any OR-combination of elements in R1 and R2
E F G H	Select any OR-combination of elements in R3 and R4
J	Select any OR-combination of elements in R1 through R4
KT	Output from timer TK, driven by any selected OR-combination of elements in R1 through R4 assigned to setting K
!L	Output from an inverter, driven by any selected OR-combination of elements in R1 through R4 assigned to setting L
V W X Y	Select any AND-combination of elements A through !L
ZT	Output from timer TZ, driven by any selected AND-combination of elements A through !L assigned to setting Z

Program the Output Contacts

Write output equations to define tripping and other control functions.

TRIP:	Select any OR-combination of elements in R1, R2, R4, and R6. (Direct Trip (DT) input and the OPEN command also assert TRIP.)
A1, A2:	Select any OR-combination of elements in R1, R2, R3, and R4.
A3:	Select any OR-combination of elements in R1, R3, R4, and R6.
A4:	Select any OR-combination of elements in R2, R3, R4, and R6.

The CLOSE and ALARM functions have dedicated outputs:

CLOSE:	Asserted by reclosing relay, Direct Close (DC) input, or CLOSE command
ALARM:	Asserts when any self test enters a warning or failure state.

All output contacts except TRIP may be factory-configured as "a" or "b."

Use the SHOWSET Command to See the Logic Equations

Use the SHOWSET command to print all of relay settings, including the SELOGIC™ configuration. You can inspect sample settings in a sample event report in this data sheet.

SELOGIC™ Settings are Part of Each Setting Group

When you switch groups, you switch logic settings as well as relay element settings. So, the six groups can be programmed for different operating conditions, such as feeder paralleling, station maintenance, seasonal operations, and cogeneration on/off.

TARGETS

Read targeting information locally by inspecting the front panel LEDs, remotely using the TARGET command or reading the event reports.

The INST target indicates no overcurrent condition in Relay Word row R1 was asserted longer than the ITT (instantaneous target time) timer setting before the TRIP output contacts asserted. The ITT setting gives you control over what is considered a "close-in" fault.

The phase current indicators (A, B, C) show which phases were above the 51P pickup setting at the time of trip.

The negative-sequence and residual current indicators (Q, N) similarly show if these currents were above the respective 51QP and 51NP pickup settings at the time of trip.

The RS and LO indicators show the state of the reclosing relay (reset or lockout).

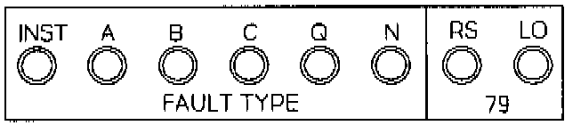

Figure 3: SEL-151 Relay Front Panel Target LEDs

MULTIPLE SHOT RECLOSING RELAY

The four-shot reclosing relay has individual open interval times for each shot and a settable reset interval timer. One input must be designated either 52A or !52A for automatic reclosing and other close operations via the CLOSE output contact (CLOSE Command, Direct Close).

When the circuit breaker recloses successfully, the reset interval timer starts. Assertion of any element in Relay Word row 1 indicates an overcurrent condition. If the relay detects an overcurrent condition, the reset interval timer is reinitialized and inhibited from timing. When the overcurrent conditions drop out, the reset interval timer starts.

Any one of the six programmable inputs can be set as a reclose enable (RE) input. If the RE input is de-energized (RE=0), the relay sends the recloser to lockout (**79LO**=1). When the reclose enable input is de-energized, the CLOSE output contact cannot automatically assert via the internal reclosing relay.

If no input is assigned to the RE input, then RE=1 internally (reclosing is always enabled). If a scheme is set up this way, you can defeat automatic reclosing by setting the first open interval to zero (79OI1=0).

The number of nonzero open interval time periods determines available reclosing shots (four shots maximum). The Relay Word bit **79SH** can assert (**79SH**=1) for different shots, 0 through 4. For example, if **79SH** is to assert only for shots 0 and 1, the following setting is made:

M79SH=11000

79SH can be used to supervise overcurrent elements and reclose cancel conditions.

Reclosing relay timing accuracy is ±1 cycle.

Reclose Cancel Conditions

The internal reclose cancel variable RC can be set equal to any OR-combination of elements in Relay Word rows R1, R2, R4, and R6. Reclosing is also cancelled if:

- An input assigned to RE (reclose enable) is not asserted.
- An input assigned to DT (direct trip) is asserted.
- The CF (close fail) condition occurs.
- The OPEN command is enabled and executed.

Sequence Coordination

To keep in step with downstream line reclosers, the reclosing relay includes sequence coordination. Sequence coordination prevents overreaching relay overcurrent elements from tripping for faults beyond line reclosers.

You can set the internal variable SEQ to any OR-combination of elements in Relay Word row R1. The combination you select determines which overcurrent conditions control sequence coordination. If no trip output is present and the breaker is closed, SEQ assertion followed by dropout advances the shot counter. Advancing the shot counter keeps the SEL-151 relay in step with the line recloser.

SELECTABLE SETTING GROUPS

The relay accepts six separate groups of relay and logic settings.

The relay determines which group of settings and logic to use by monitoring the setting group selection inputs (SS1, SS2, and SS3) or by the GROUP command. To use inputs, program one or more of the setting selection inputs (SS1, SS2, SS3) to one or more respective inputs.

Program relay elements and logic with the SET command.

CIRCUIT BREAKER MONITOR

The SEL-151 relay detects every circuit breaker trip operation. It designates each trip as one caused by the relay or an external trip and maintains a running count of each.

The relay also maintains a running sum of the interrupted current in each circuit breaker pole for relay and external trips. Running sums for relay trips use the current present when the trip output contacts are asserted. Running sums for external trips use the currents present when the circuit breaker status input (52A or !52A) indicates that the circuit breaker is opening.

Display the circuit breaker operation data using the BREAKER command.

```
=>BREAKER <ENTER>

Example 21.6 kV distribution feeder        Date: 4/2/91      Time: 09:09:58

Rly Trips=15      From: 1/1/91   01:01:01
IA=42650      IB=37910     IC=34200

Ext Trips=2       From: 1/1/91   01:01:01
IA=650        IB=670       IC=620
```

Circuit breaker operation data can be reset by command.

METERING

The SEL-151 relay provides complete voltage and current metering. It also determines real and reactive power values, demand values, peak demand values, and negative- and zero-sequence components of the voltages and currents.

Demand ammeters with 15 or 60 minute time constants show phase, negative-sequence, and zero-sequence (ground/residual) currents. Peak demands are saved.

Display metering data using the METER and METER D commands (present and demand metering information, respectively).

```
=>METER <ENTER>

Example 21.6 kV distribution feeder        Date: 4/2/91      Time: 09:10:49

MET IA=356     B=364     C=361     R=6
   3I2=5       P=12.910     Q=1.130

VA=12021  VB=12015  VC=12043  3V0=20
AB=20827  BC=20839  CA=20836  3V2=17
```

```
=>METER D <ENTER>

Example 21.6 kV distribution feeder        Date: 4/2/91      Time: 09:11:03

DEM IA=347     B=349     C=349     R=4
   3I2=3       P=12.897     Q=0.997

PK  IA=412     B=410     C=414     R=15
   3I2=13      P=14.701     Q=1.280
```

Demand and peak demand metering information can also be reset by command.

HISTORY SUMMARY

The HISTORY command quickly retrieves summaries of the last twelve event records, as shown in the following example.

```
=>HISTORY <ENTER>

Example 21.6 kV distribution feeder        Date: 4/2/91      Time: 09:10:27

#   DATE        TIME         EVENT   LOCAT   SHOT   CURR   GROUP   TARGETS
1   4/2/91      01:36:59.070  AG T    2.43     0     2798     2     INSTAQN
2   3/17/91     08:07:40.129  CG T    3.52     1     2361     3     INSTCQN
3   3/17/91     08:07:35.133  CG T    3.51     0     2364     3     INSTCQN
4   3/15/91     01:07:35.862  TRIG            0     345      1
5
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11
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AC CONNECTIONS

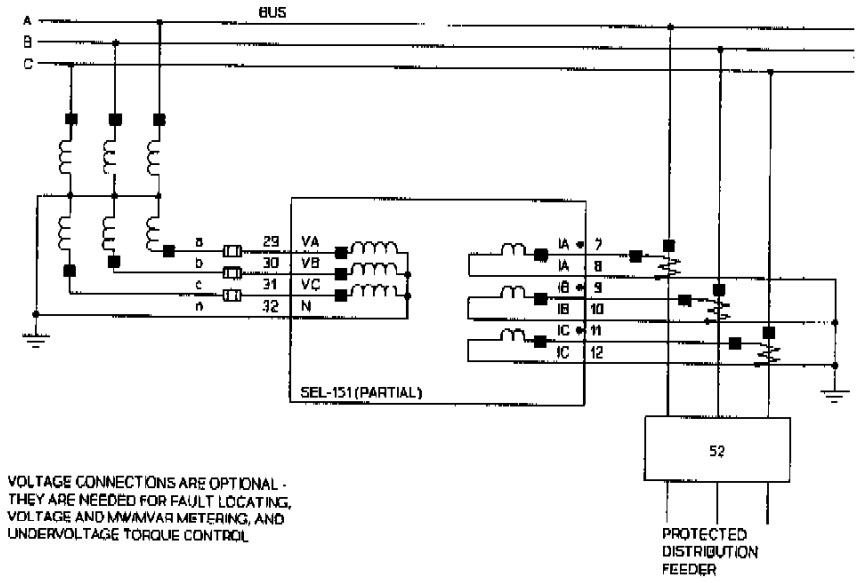


Figure 4: SEL-151 Relay Typical Ac Current and Voltage Connections

DC CONNECTIONS

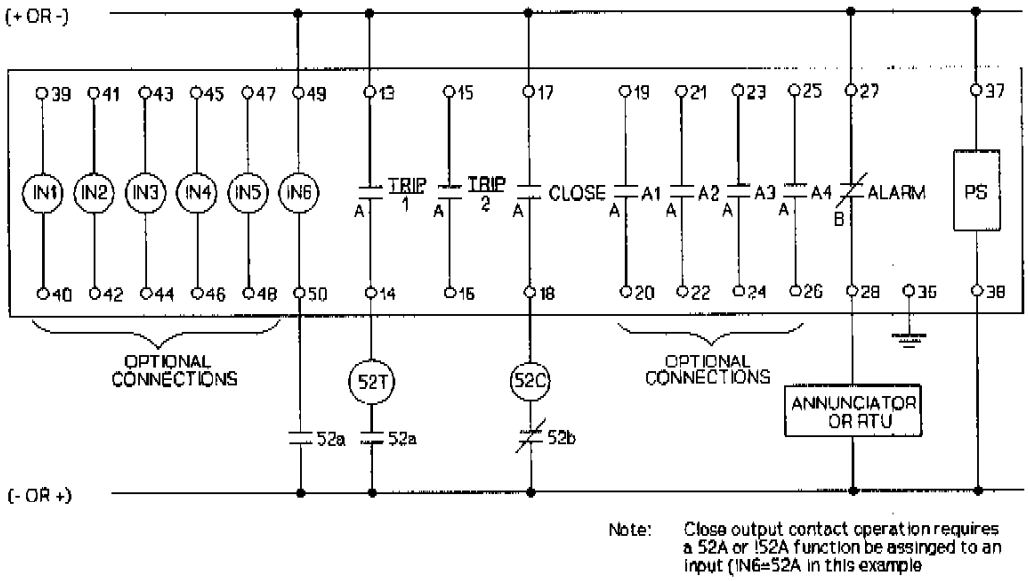


Figure 5: SEL-151 Relay Typical Dc External Connections

APPLICATIONS IDEAS

SELOGIC™ and multiple setting groups invite new applications. The following examples demonstrate the versatility of this new relay.

Feeder Relay Setting Changes

When a faulted feeder section is isolated and customers beyond the fault are backfed, the configurations of two feeders are different. One is shorter with less load, while the other is longer with more load. Save setting groups for different feeder configurations to optimize protection.

One feeder may be paralleled with another for breaker maintenance. Program setting groups for normal and parallel operation.

Bus-tie Relay Setting Changes

In stations where bus-tie breakers substitute for feeder breakers during maintenance, the bus-tie breaker relay can have a setting group for each of the feeders it may protect during maintenance.

Selectively Back Up Feeder Relays with a Bus Relay

A single SEL-151C Distribution Bus Relay on the distribution bus can backup SEL-151 relays installed on individual distribution feeders. The SEL-151 relay ALARM contact can be used to supervise the back up trip from the SEL-151C Distribution Bus Relay. The SEL-151 relay **TF** (trip failure) bit can be used to generate a breaker failure output to trip the distribution bus circuit breaker.

Drive Setting Group Selection Inputs with a Clock

Consider seasonal, weekend/weekday, and daily system changes. Develop optimum settings for various times, and use contacts from an external clock to select the appropriate setting group.

EVENT REPORT

The SEL-151 relay event report displays current and voltage quantities in primary units. The relay encodes relay element states, outputs, and inputs using a simple process, which makes the report compact and easy to interpret.

Event Report Triggering

Set the internal variable ER to any OR-combination of elements in Relay Word rows R1, R2, R4, and R6 to trigger an event report for any desired combination of conditions the relay can detect. Event reports also trigger if:

- The TRIP output contacts are asserted.
- An input assigned to the ET (External Trigger) function is asserted.
- The TRIGGER command is executed.

Event Report Column Headings

Currents	primary amps
IR	residual current
IA	A-phase current
IB	B-phase current
IC	C-phase current
Voltages	primary volts
VA	A-phase voltage
VB	B-phase voltage
VC	C-phase voltage
P	phase elements
51	phase time-overcurrent element
50L	phase definite-time overcurrent element
50H	phase instantaneous overcurrent element
TCI	internal torque control conditions
Q	negative-sequence elements
51	negative-sequence time-overcurrent element
50	negative-sequence definite-time overcurrent element
N	ground/residual elements
51	ground/residual time-overcurrent element
50L	ground/residual definite-time overcurrent element
50H	ground/residual instantaneous overcurrent element
I	demand current
DEM	phase, negative-sequence, and residual demand current thresholds
79	reclosing relay states (reset, reclosing cycle, lockout)
BKR	circuit breaker alarm conditions (trip failure, close failure, and trip coil monitor alarms)
Out	output contacts
T&C	TRIP and CLOSE output contacts
1&2	A1 and A2 output contacts
3&4	A3 and A4 output contacts
ALR	ALARM output contact
In	inputs
1&2	IN1 and IN2 inputs
3&4	IN3 and IN4 inputs
5&6	IN5 and IN6 inputs

Example Event Report

Example 21.6 kV distribution feeder Date: 4/2/91 Time: 01:36:59.0

Time-tag corresponds to the 16th quarter cycle of this event report.

FID=SEL-151-R400-V651rplr-D910329

Currents (A pri)				Voltages (V pri)			P	Q	N	I	Out	In
IR	IA	IB	IC	VA	VB	VC	555T 100C LHI	55 10	555 100 LH	D E M	7B 9K R	T13A &&&L C24R	135 &&& 246
0	98	-296	198	4451	-12313	7864	....	.	R.	....	1BB		
4	287	-59	-225	11650	-1971	-9678	....	.	R.	....	1BB		
0	-98	296	-198	-4450	12314	-7865	....	.	R.	....	1BB		
-4	-287	59	225	-11649	1972	9679	....	.	R.	....	1BB		
0	98	-296	198	4449	-12314	7863	....	.	R.	....	1BB		
4	287	-59	-225	11650	-1971	-9677	....	.	R.	....	1BB		
0	-98	296	-198	-4450	12315	-7863	....	.	R.	....	1BB		
-4	-287	59	225	-11651	1970	9677	....	.	R.	....	1BB		
0	98	-296	198	4450	-12314	7864	....	.	R.	....	1BB		
4	287	-59	-225	11650	-1970	-9678	....	.	R.	....	1BB		
296	200	285	-191	-4211	12207	-7816	....	.	R.	....	1BB		
-206	-468	47	215	-10197	1421	9127	.... .. p..	.	R.	....	1BB		
-1254	-1168	-247	164	3341	-11808	8132	.... .. p..	.	R.	....	1BB		
903	1123	-36	-185	8107	-511	-8402	p... p. p..	.	R.	....	1BB		
2067	1991	215	-143	-2275	11535	-8401	p... p. p..	.	R.	....	1BB		
-1460	-1655	38	164	-7165	155	8164	p... p. pp.	.	R.	....	1BB		
-2267	-2192	-211	138	2215	-11532	8387	p... p. pp.	.	R.	....	1BB		
1537	1728	-36	-160	7147	-132	-8108	p... p. pp.	.	R.	....	1BB		
2268	2193	210	-138	-2214	11530	-8386	p... p. pp.	.	R.	....	1BB		
-1538	-1731	36	160	-7145	132	8110	p... p. pp.	.	R.	....	1BB		
-2270	-2197	-210	138	2215	-11531	8386	p... p. pp.	.	R.	....	1BB		
1538	1733	-36	-160	7146	-133	-8109	p... p. pp.	.	R.	....	1BB		
2270	2197	210	-138	-2215	11531	-8388	p... p. pp.	.	R.	....	1BB		
-1538	-1733	36	160	-7148	131	8109	p... p. pT.	.	C.	T.3.	1BB		
-2272	-2197	-208	138	2214	-11530	8387	p... p. pT.	.	C.	T.3.	13B		
1540	1733	-38	-160	7148	-131	-8108	p... p. pT.	.	C.	T.3.	13B		
2272	2197	208	-138	-2214	11530	-8388	p... p. pT.	.	C.	T.3.	13B		
-1540	-1735	38	160	-7147	132	8107	p... p. pT.	.	C.	T.3.	13B		
-2272	-2195	-210	138	2213	-11531	8388	p... p. pT.	.	C.	T.3.	13B		
1540	1737	-36	-160	7146	-131	-8109	p... p. pT.	.	C.	T.3.	13B		
2272	2193	210	-138	-2213	11530	-8387	p... p. pT.	.	C.	T.3.	13B		
-1540	-1737	36	160	-7146	130	8107	p... p. pT.	.	C.	T.3.	136		
-2256	-2183	-210	138	2213	-11529	8387	p... p. pT.	.	C.	T.3.	136		
1513	1703	-36	-160	7147	-131	-8119	p... p. pT.	.	C.	T.3.	136		
1754	1761	201	-135	-2411	11545	-8379	p... p. p..	.	C.	T.3.	136		
-541	-552	125	42	-8512	707	8591	p... p. p..	.	C.	T.3.	136		
-214	-231	-17	19	3672	-11815	8028	.... .. p..	.	C.	T.3.	136		
17	19	-7	-2	11630	-1851	-9632	....	.	C.	T.3.	136		
9	10	1	-1	-4430	12289	-7847	....	.	C.	T.3.	136		
-2	-2	0	0	-11637	1959	9659	....	.	C.	..3.	136		
-1	-1	0	0	4451	-12313	7864	....	.	C.	..3.	136		
0	0	0	0	11650	-1971	-9678	....	.	C.	..3.	136		
0	0	0	0	-4450	12314	-7865	....	.	C.	..3.	136		
0	0	0	0	-11649	1972	9679	....	.	C.	..3.	136		

Event : AG T Location: 2.43 Shot: 0 Targets: INSTAQN
Currents (A pri), ABCQN 2798 213 211 2741 2742

Event Summary

One cycle of data

Input 1 (1) is energized
Input 2 is not energized
Both (B) inputs 3 and 4 are energized
Both (B) inputs 5 and 6 are energized

Reclosing relay is in the reset state (R; 79RS = 1)

Respective time-overcurrent elements start timing at fault inception (p)

50NL element picks up (p) and initiates this event report; 50NLT element starts timing

Targets, shot, and currents in the Event Summary are set at the time of trip (T)

50NLT element expires after 2 cycles (T; setting 50NLT = 2); TRIP output contact asserts (T;50NLT enabled for tripping)

TRIP output contact (T) is asserted for a minimum of 4 cycles (TDUR = 4)

52A input drops out (IN5 = 52A) indicating that the circuit breaker is opening

All overcurrent elements drop out after the circuit breaker interrupts the fault current

Reclosing relay is in the reclose cycle state (C; 79CY = 1)

Example Event Report, Continued

```
Settings for group 1 ———————————————————— Group 1 is enabled because IN1=SS1 and is energized.
                                            SS2 = SS3 = 0 by default because they are not assigned
                                            to inputs
Example  21.6 kV distribution feeder
CTR  =120.00   PTR  =180.00
R1   =0.58     X1   =1.50     R0   =1.44     X0   =4.56
RS   =0.00     XS   =0.00     LL   =2.42
DATC =15       PDEM =12.00    QDEM =12.00    NDEM =1.00
79OI1=60       79OI2=600      79OI3=900      79OI4=0
79RST=1800     M79SH=00000
50C  =100.00   27L  =0.00     27H  =0.00     27C  =2        TCI  =0
50Q  =100.00   50QT =0
51QP =6.01     51QTD=15.00    51QC =3        51QRS=N
50NL =20.01    50NLT=2        50NH =100.00
51NP =1.50     51NTD=2.00     51NC =3        51NRS=N
50L  =100.00   50LT =0        50H  =40.00
51P  =6.01     51TD =6.00     51C  =3        51RS =N
52APU=1200     52ADO=0        TSPU =0        TSDO =0 ——— There is a time delay pickup (52APU) on the 52AT function
TKPU =0        TKDO =0        TZPU =0        TZDO =0

SELOGIC™ Equations
S(123)  =
A(12)   =
B(12)   =50NLT
C(12)   =50NL
D(12)   =
E(34)   =79RS+79CY+52AT
F(34)   =IN6 ——————————— Input IN6 functions as a permissive trip input for the 50NLT element
G(34)   =
H(34)   =
J(1234) =
K(1234) =
L(1234) =
A1(1234)=TF
A2(1234)=NDEM
V(56)   =6*E*F ————————— The 50NLT element is supervised by 52AT when the reclosing relay is in the lockout
W(56)   =C*E*F             state (79RS = 0 and 79CY = 0 when the reclosing relay is in the lockout state)
X(56)   =
Y(56)   =
Z(56)   =
A3(1346)=79CY
A4(2346)=TCMA
TR(1246)=50H+51T+51NT+V ——— Programmable tripping conditions
RC(1246)=50H+TF+TCMA ———— Programmable reclose cancel conditions
ER(1246)=TF+TCMA+W ————— Programmable event report trigger conditions
SEQ(1)  =
ETC(1)  =
ITC(1)  =

Global settings
DEMR =Y        CFT  =60       TDUR =4        TFT  =30       TGR  =180
ITT  =5        TIME1=15       TIME2=0        AUTO =2        RINGS=3
IN1  =SS1      IN2  =DT       IN3  =RE       IN4  =TCM
IN5  =52A      IN6  =  ———————————————————————————————— Input IN6 is used as a permissive trip
                                                          input in the above logic
```

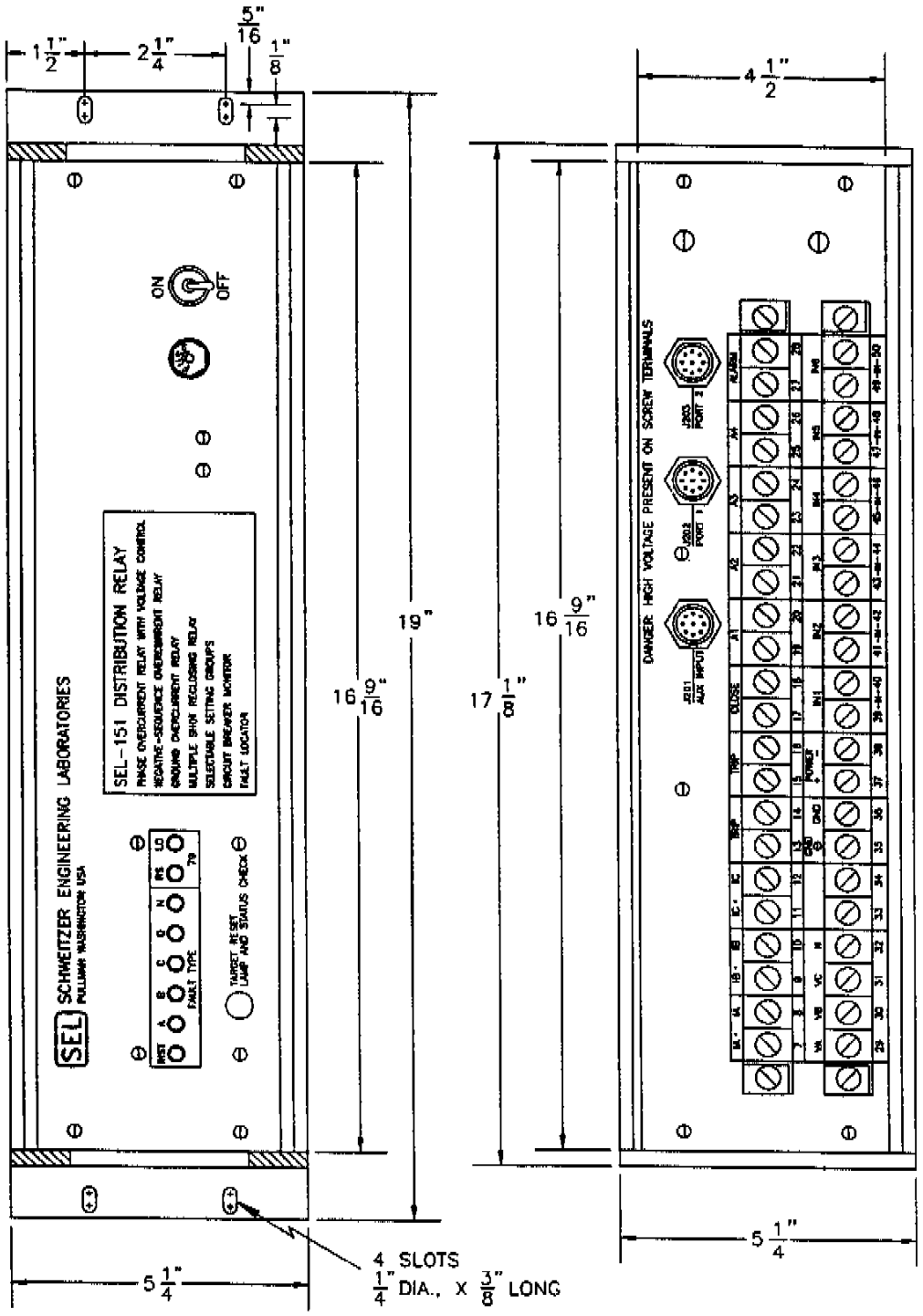
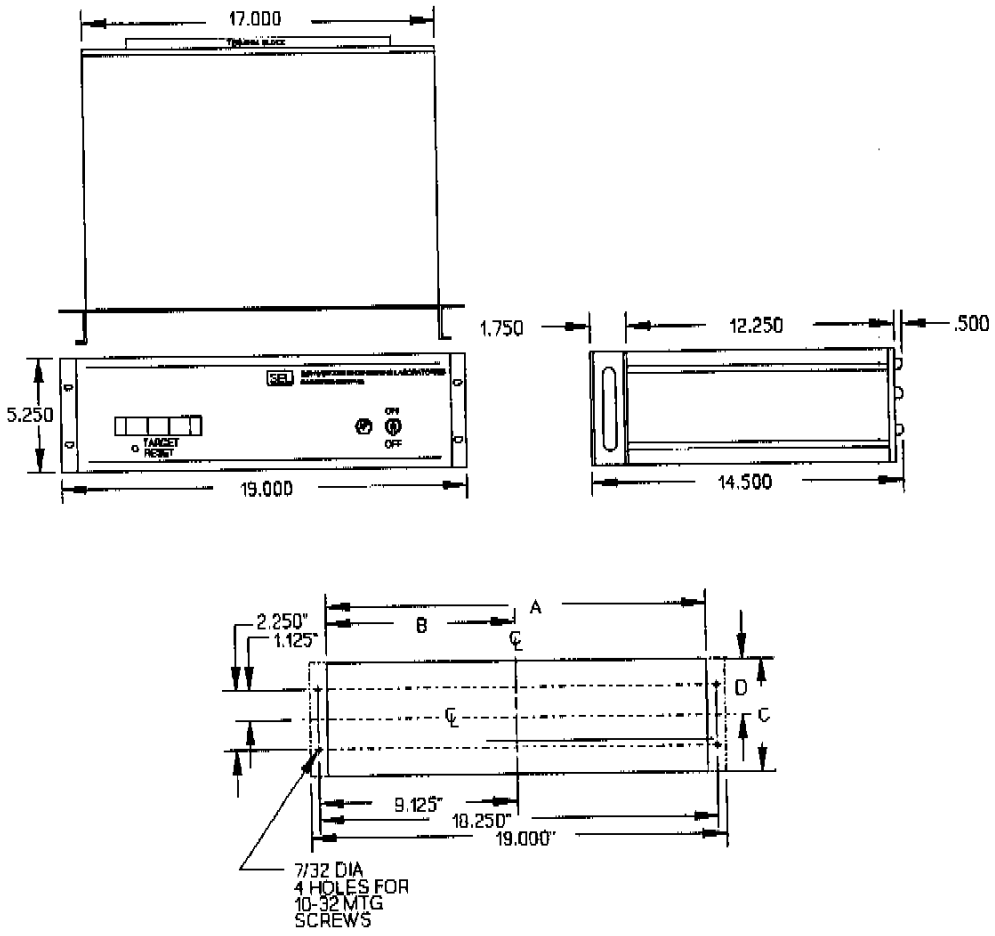


Figure 6: SEL-151 Distribution Relay Horizontal Front and Rear Panel Drawings



DIMENSION A:
CUT OUT: 17.250" - 17.875"
17.375" PREFERRED

DIMENSION B:
CUT OUT: 8.625" - 8.9375"
8.688" PREFERRED

DIMENSION C:
CUT OUT: 5.350" - 5.450"

DIMENSION D:
CUT OUT: 2.675" - 2.725"

NOTE: ALL INSTRUMENTS MAY BE MOUNTED HORIZONTALLY (AS SHOWN) OR VERTICALLY.

PANEL CUTOUT AND DRILL FOR SEMI-FLUSH MOUNTING OF 5.250 INCH HIGH CASE.

Figure 7: Relay Dimensions, Panel Cutout, and Drill Diagrams

SEL-151 RELAY COMMAND SUMMARY

Access Level 0

ACCESS	Answer password prompt to enter Access Level 1.

Access Level 1

2ACCESS	Answer password prompt to enter Access Level 2.
BREAKER	Display trip counters and current sums for relay and external trips.
BREAKER R	Reset trip counters and current sums; save reset date and time.
DATE m/d/y	Set date. Enter DATE alone to display date.
EVENT n	Show nth event record.
HISTORY	Show date, time, event, location, shot, targets, and current for last twelve events.
IRIG	Force immediate attempt to synchronize internal relay clock to time code input.
METER n	Display instantaneous values. Optional n displays METER data n times.
METER D	Display demand and peak demand.
METER RD	Reset demand.
METER RP	Reset peak demand.
QUIT	Return control to Access Level 0; return target display to Relay Targets.
SHOWSET n	Display settings of setting group n without affecting settings (n = 1, 2, 3, 4, 5, or 6).
STATUS	Show self test status.
TARGET n k	Show data and set target LEDs as follows (n = 0, 1, 2, . . . 7, or 8): TAR 0: Front Panel Targets TAR 1 ... 6: Relay Word rows 1 ... 6 TAR 7: Input States TAR 8: Output Contact States Option k displays target data k times.
TARGET R	Clears targets and returns to TAR 0
TIME h/m/s	Set time. Enter TIME alone to display time.
TRIGGER	Trigger and save an event record.

Access Level 2

CLOSE	Close circuit breaker, if allowed by jumper 104 setting.
COPY m n	Copy setting group m to setting group n.
GROUP n	Designate the active setting group when SS1..3 assigned to inputs are all deasserted.
OPEN	Open circuit breaker, if allowed by jumper 104 setting.
PASSWORD	Show or set passwords.
SET n p	Initiate setting procedure for group n at setting p.
SET G p	Initiate setting procedure for the global setting group at setting p.

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