SCHWEITZER ENGINEERING LABORATORIES, INC.
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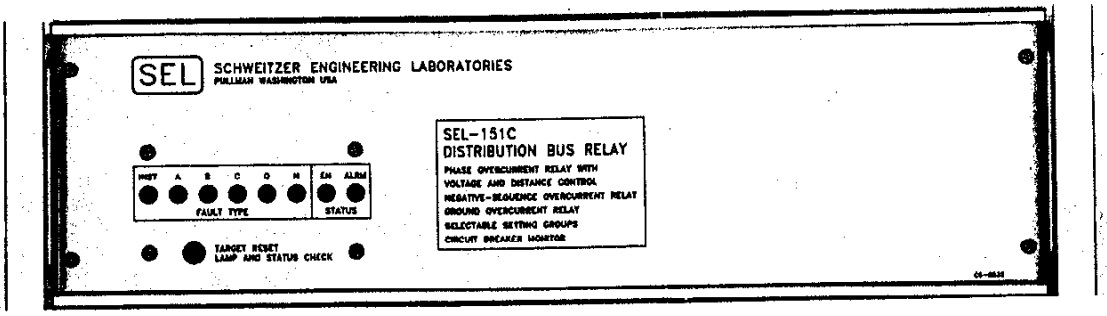


SEL-151C DISTRIBUTION BUS RELAY

PHASE OVERCURRENT RELAY WITH
VOLTAGE AND DISTANCE CONTROL
NEGATIVE-SEQUENCE OVERCURRENT RELAY
GROUND OVERCURRENT RELAY
SELECTABLE SETTING GROUPS
CIRCUIT BREAKER MONITOR

Also Available In LOW-PROFILE Package

DATA SHEET

- Develop traditional and advanced schemes using flexible SELogic™
- Phase overcurrent elements have voltage and distance 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
- Six selectable setting groups cover all bus protection contingencies
- Circuit breaker monitor sums interrupted current in each pole to aid maintenance
- Selectively back up distribution feeder relays
- Eleven cycle event report simplifies fault and system analysis
- Comprehensive voltage, current, power, unbalance, and demand metering
- Connects to SEL-RD RELAY DISPLAY for easy information access

GENERAL DESCRIPTION

The SEL-151C DISTRIBUTION BUS RELAY protects and monitors distribution busses and backs up distribution feeder relays. 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-151C 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, phase distance or undervoltage torque control of phase overcurrent elements adds security. Choose between three-phase and single-phase-pair phase distance or undervoltage torque control. When phase overcurrent elements are used only for three-phase faults, three-phase phase distance or undervoltage 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.

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 bus protection contingencies. Selectable setting groups make the SEL-151C relay ideal for 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.

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 protected system for every fault.

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, because you can inspect the quantities monitored by relay elements. Check for load encroachment and unbalance through instantaneous, demand, and peak-demand measurements.

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

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

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

The SEL-151C DISTRIBUTION BUS RELAY improves every aspect of distribution protection:

Security:	Phase distance supervision avoids 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 Burden: 0.07 VA at 67 V; 0.5 VA at 120 V (phase-to-neutral)
Rated Ac Input Current	5 amps nominal; 0.06 VA burden 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 6.6.2 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.	-4°F to 131°F (-20°C to 55°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 Shipping weight 32 pounds (14.1 kg), including two manuals.

Burn-in 140°F (60°C) for 100 hours.

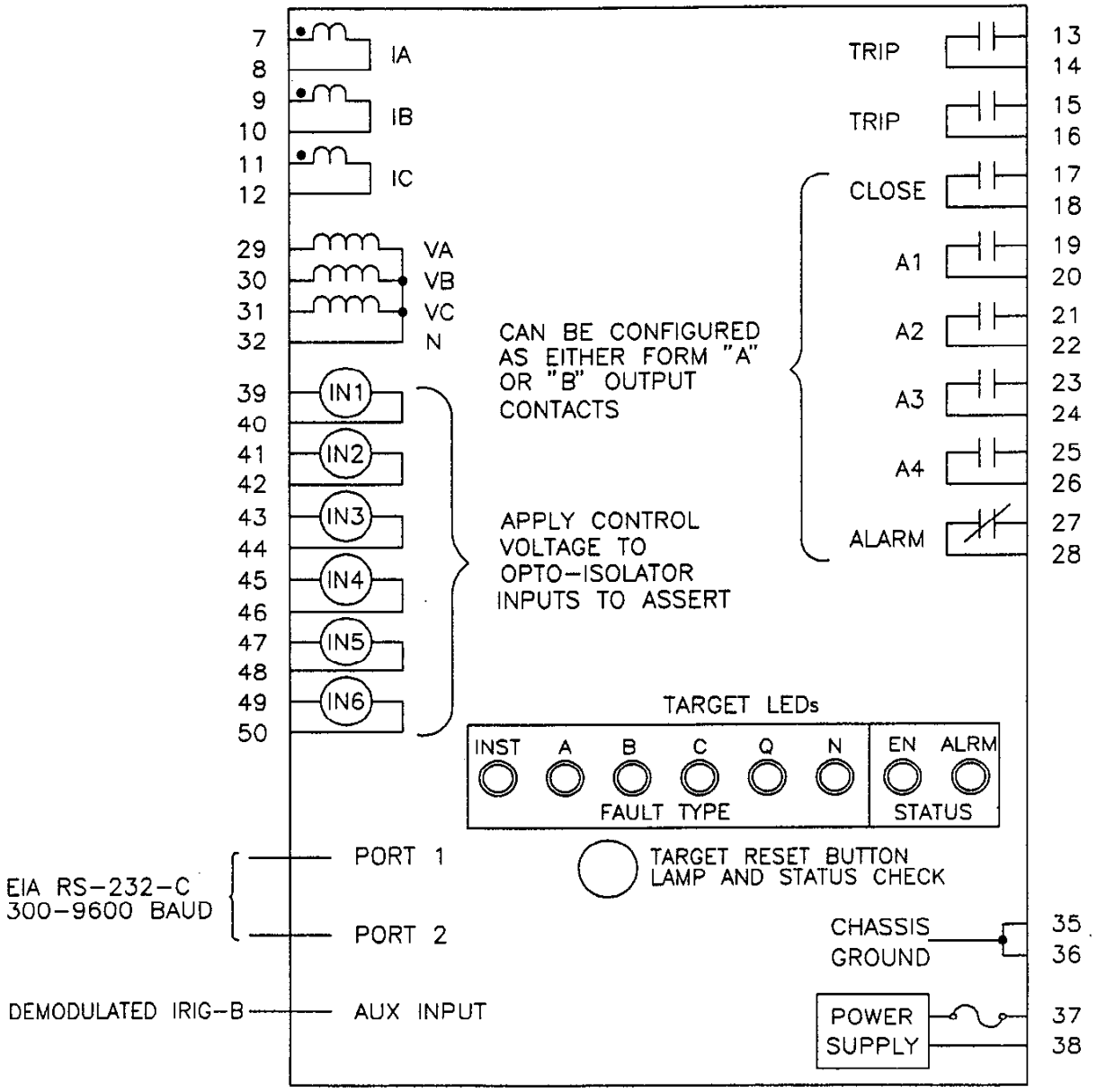


Figure 1: SEL-151C Relay Inputs, Outputs, and Targets Diagram

FUNCTIONAL SPECIFICATIONS

Phase Overcurrent Elements for Phase and Three-Phase Faults (51T, 50LT, 50MT, 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

50MT Phase Definite-Time Overcurrent Element
- Pickup (**50M**): 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

50C Phase Instantaneous Overcurrent Element
- Pickup: 0.5 to 100 A ±2% of setting ±0.1 A secondary
- Can be used to override voltage or distance 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 $1 \leq 51NP \leq 12$ A secondary)
  0.25 to 50 A secondary (for $0.5 \leq 51NP < 1$ A secondary)
  0.125 to 25 A secondary (for $0.25 \leq 51NP < 0.5$ 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.

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

Phase Distance Torque Control Elements for Load Security (21P)

- 21AB, 21BC, 21CA Phase-to-Phase Distance Elements
- Setting Range: 1 to 64 ohms, secondary; 0 to 90 degrees maximum torque angle
- User selects either three-phase or phase-to-phase distance element
- Single zone, self-polarized mho
- Control can be overridden by 50C element through TCI setting choice

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)
- 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 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 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 provide time delayed tripping in a backup scheme or to 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 or 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 or to trigger event reports.

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.

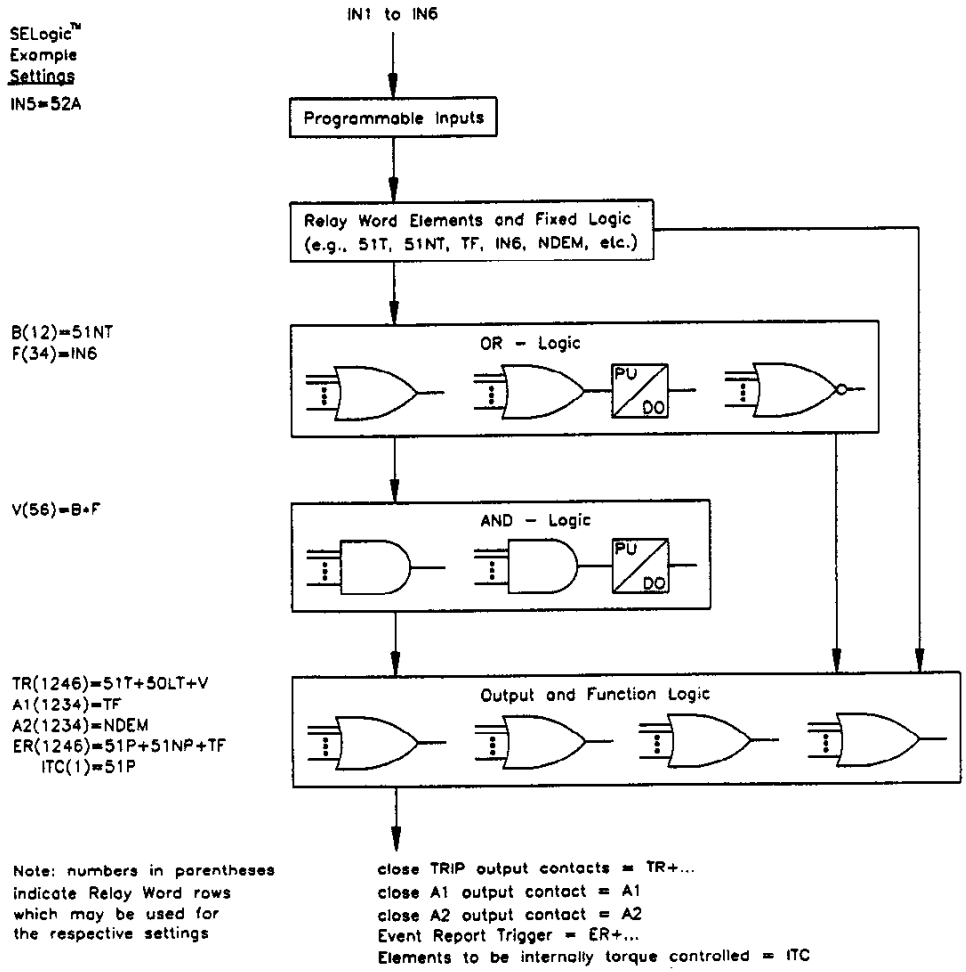


Figure 2: SEL-151C Relay SELogic Block Diagram

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)
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-151C Relay Word

R1	51P	50L	50M	51QP	50Q	51NP	50NL	50NH
R2	51T	50LT	50MT	51QT	50QT	51NT	50NLT	50H
R3	21P	50C	27		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
50M	Phase definite-time overcurrent element pickup
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
50MT	Phase definite-time overcurrent element
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
50H	Phase instantaneous overcurrent element
21P	Single zone, self-polarized mho phase distance element for internal torque control
50C	Phase instantaneous overcurrent element (can override control by **21P** or **27**)
27	Phase undervoltage element for internal torque control
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 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 bus paralleling, station maintenance, seasonal operations, and downstream feeder relay setting changes.

TARGETS

Read targeting information locally by inspecting the LEDs or 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 EN and ALRM indicators show the state of the relay (enabled/normal operation or system alarm).

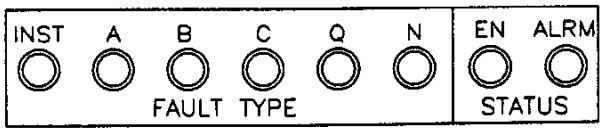


Figure 3: SEL-151C Relay Front Panel Target LEDs

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-151C 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 bus          Date: 5/21/91      Time: 10:18:14

Rly Trips=1      From: 2/1/91   09:58:01
IA=973       IB=8955     IC=1011

Ext Trips=1      From: 2/1/91   09:58:01
IA=1156      IB=1084     IC=1092
```

Circuit breaker operation data can also be reset by command.

METERING

The SEL-151C 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 bus          Date: 5/21/91      Time: 10:19:02


MET IA=1371   B=1392   C=1373   R=20
   3I2=18     P=51.430    Q=4.500

VA=12482  VB=12476  VC=12525  3V0=61
AB=21589  BC=21601  CA=21603  3V2=54
```

```
=>METER D <ENTER>

Example 21.6 kV distribution bus          Date: 5/21/91      Time: 10:21:04

DEM IA=1346   B=1351   C=1347   R=17
   3I2=12     P=50.989    Q=4.384

PK  IA=1491   B=1483   C=1479   R=26
   3I2=23     P=55.101    Q=4.850
```

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 bus          Date: 5/21/91      Time: 14:03:34

#   DATE        TIME        EVENT    CURR    PH     TARGETS
1  5/21/91   05:02:48.625   BG T    8955     B     INSTBQN
2  3/17/91   08:07:40.129   TRIG    1412     A
3
4
5
6
7
8
9
10
11
12
```

AC CONNECTIONS

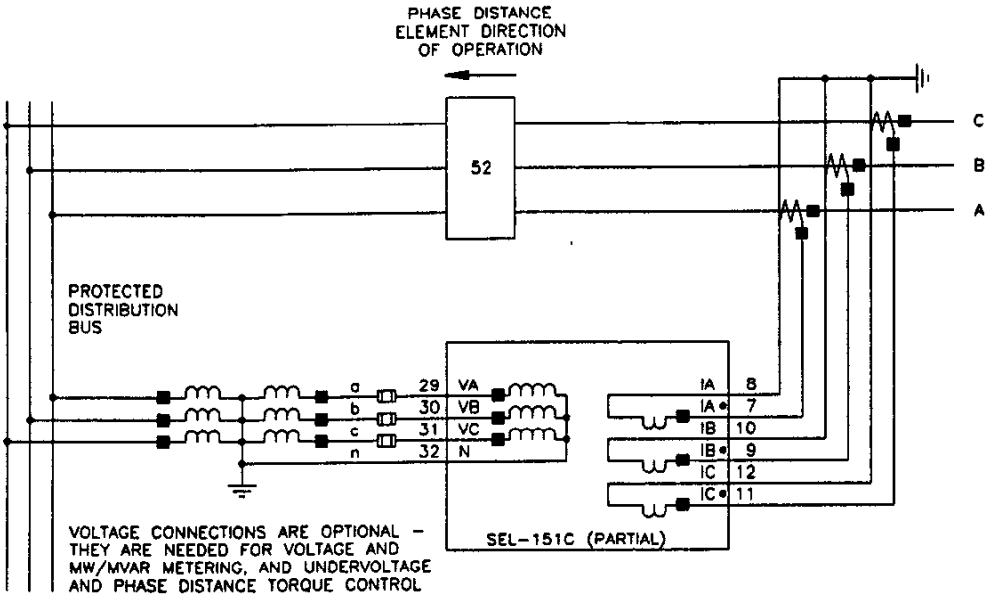
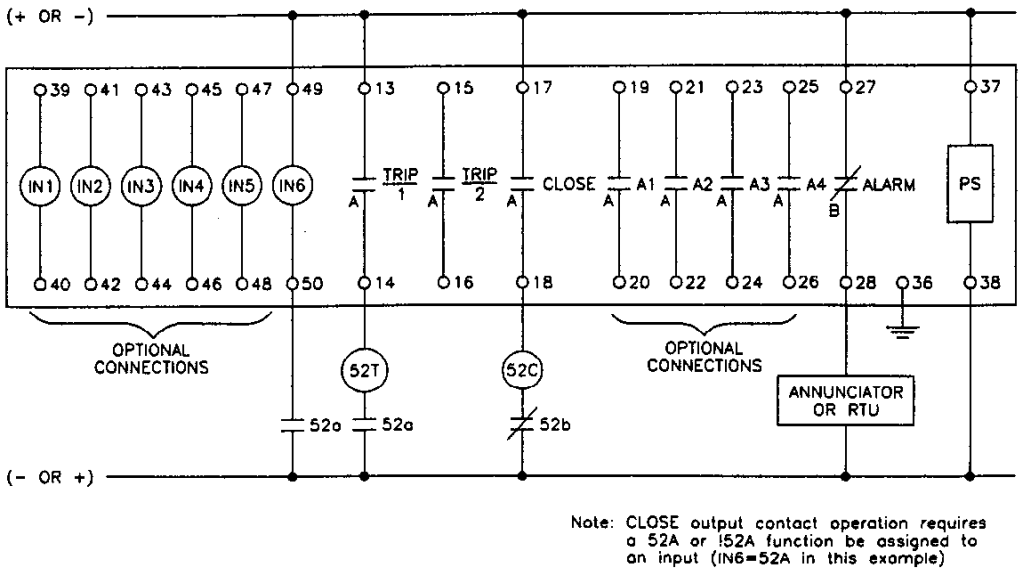


Figure 4: SEL-151C Relay Typical AC Current and Voltage Connections

DC CONNECTIONS



Note: CLOSE output contact operation requires a 52A or !52A function be assigned to an input (IN6=52A in this example)

Figure 5: SEL-151C 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.

Selectively Back Up Feeder Relays with a Bus Relay

Use one SEL-151C relay to back up the SEL-151 relays installed on individual feeders. The feeder relay ALARM contact can supervise a trip from the bus relay because backup is required only when the feeder relay fails. With this supervision, the bus relay TRIP output contacts can be set to operate simultaneously with feeder relay TRIP output contacts, both attempting to trip the feeder circuit breaker.

Time delayed trips from the feeder relays (for feeder circuit breaker failures) and the bus relay can trip the bus breaker. These time delayed trips are possible using the trip failure logic available in the SEL-151 and SEL-151C relays.

Using SELogic (for SEL-151 and SEL-151C relays):

$$A1(1234) = TF$$

The TFT (trip failure time) settings provide the time delay for the A1 output contacts.

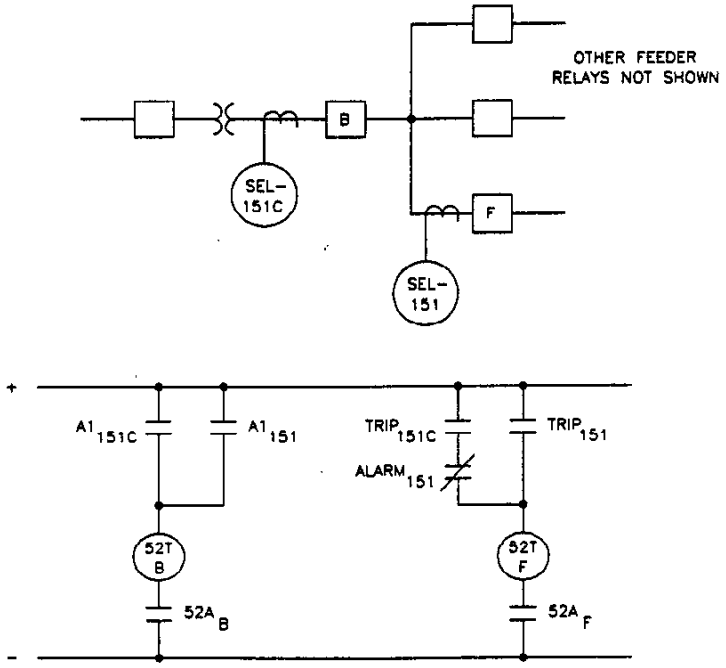


Figure 6: Distribution Feeder Relay Backup Scheme

Bus Relay Setting Changes

The SEL-151C Distribution Bus Relay backs up feeder relays. When feeder relay setting changes are made, new bus relay setting changes may be needed for optimal protection coordination. Program SEL-151C relay setting groups for different backup scenarios.

Distribution bus sections may be paralleled in emergencies or otherwise. Program SEL-151C relay setting groups for normal and parallel operation.

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-151C 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
50M	phase definite-time overcurrent element
TCI	internal torque control conditions
50H	phase instantaneous overcurrent element
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
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 bus Date: 7/1/91 Time: 17:12:51.175 — Time-tag corresponds to the 16th quarter cycle of this event report.

FID=SEL-151C-R400-V656np0e-D910604

	Currents A pri			Voltages V pri			P	Q	N	I	Out	In
							555T5	55	555	D	B T13A	135
IR	IA	IB	IC	VA	VB	VC	100C0	10	100	E	K &&&L	&&&
							LMIH		LH	M	R C24R	246
-0	-580	1540	-980	-4514	12002	-7639	.....	..	...	.	. ....	1.5
-0	-1440	240	1230	-11412	1807	9605	.....	..	...	.	. ....	1.5
5	580	-1540	990	4522	-12002	7632	.....	..	...	.	. ....	1.5
-5	1440	-240	-1230	11405	-1807	-9612	.....	..	...	.	. ....	1.5
-5	-580	1540	-990	-4529	12010	-7625	.....	..	...	.	. ....	1.5
5	-1440	240	1240	-11405	1793	9619	.....	..	...	.	. ....	1.5
5	580	-1540	980	4536	-12002	7618	.....	..	...	.	. ....	1.5
-5	1440	-240	-1240	11405	-1793	-9619	.....	..	...	.	. ....	1.5
-5	-580	1540	-980	-4536	12002	-7618	.....	..	...	.	. ....	1.5
5	-1440	240	1240	-11405	1793	9619	.....	..	...	.	. ....	1.5
-0	580	-1550	980	4543	-12010	7618	.....	..	...	.	. ....	1.5
-0	1450	-230	-1240	11405	-1778	-9626	.....	..	...	.	. ....	1.5
-0	-590	1670	-1090	-4558	11779	-7373	.....	..	...	.	. ....	1.5
-0	-1450	660	800	-11398	1915	9482	.....	p.	...	.	. ....	1.5
5	590	-2120	1540	4558	-11117	6696	.....	p.	...	.	. ....	1.5
-5	1440	-1390	-80	11398	-2369	-9029	p..Z.	p.	...	.	. ....	1.5
-5	-580	2500	-1920	-4558	10613	-6178	p..Z.	p.	...	.	. ....	1.5
10	-1440	1710	-230	-11398	2700	8690	p..Z.	p.	...	.	. ....	1.5
-0	580	-2540	1960	4565	-10519	6077	p..Z.	p.	...	.	. ....	1.5
-10	1440	-1740	270	11390	-2729	-8654	p..Z.	p.	...	.	. ....	1.5
-0	-580	2540	-1960	-4572	10498	-6055	p..Z.	p.	...	.	. ....	1.5
5	-1440	1740	-290	-11390	2736	8654	p..Z.	p.	...	.	. ....	1.5
5	580	-2540	1970	4579	-10498	6048	p..Z.	p.	...	.	. ....	1.5
-5	1450	-1740	290	11390	-2736	-8654	p..Z.	p.	...	.	. ....	1.5
-10	-590	2540	-1970	-4586	10505	-6048	p..Z.	p.	...	.	. ....	1.5
15	-1450	1750	-280	-11383	2729	8654	p..Z.	p.	...	.	. ....	1.5
5	590	-2550	1960	4594	-10512	6048	p..Z.	p.	...	.	. ....	1.5
-15	1450	-1750	280	11376	-2722	-8662	p..Z.	p.	...	.	. ....	1.5
-0	-590	2550	-1970	-4594	10512	-6041	p..Z.	p.	...	.	. ....	1.5
5	-1450	1740	-270	-11376	2722	8669	p..Z.	p.	...	.	. ....	1.5
5	590	-2540	1970	4594	-10512	6034	p..Z.	p.	...	.	. ....	1.5
-5	1450	-1740	270	11383	-2714	-8669	p..Z.	p.	...	.	. ....	1.5
-5	-590	2540	-1970	-4608	10512	-6034	p..Z.	p.	...	.	. ....	1.5
5	-1450	1740	-280	-11376	2700	8669	p..Z.	p.	...	.	. ....	1.5
5	590	-2540	1980	4615	-10512	6034	p..Z.	p.	...	.	. ....	1.5
-5	1440	-1740	280	11369	-2693	-8676	p..Z.	p.	...	.	. ....	1.5
-5	-580	2540	-1980	-4622	10512	-6026	p..Z.	p.	...	.	. ....	1.5
5	-1440	1740	-270	-11369	2693	8683	p..Z.	p.	...	.	. ....	1.5
5	580	-2540	1970	4630	-10512	6019	p..Z.	p.	...	.	. ....	1.5
-5	1450	-1740	270	11369	-2693	-8683	p..Z.	p.	...	.	. ....	1.5
-5	-590	2550	-1970	-4630	10519	-6019	p..Z.	p.	...	.	. ....	1.5
10	-1450	1730	-270	-11369	2686	8683	p..Z.	p.	...	.	. ....	1.5
-0	590	-2550	1970	4637	-10519	6019	p..Z.	p.	...	.	. ....	1.5
-10	1450	-1730	270	11362	-2678	-8690	p..Z.	p.	...	.	. ....	1.5

Event : ER Targets:
Currents (A pri), ABCQN: 1565 3092 1989 3154 15 — Event Summary

One cycle of data

Prefault bus load current is above the pickup of the 51T element (51P). 51P is torque controlled by 21P.

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

Distance element 21P picks up for a feeder BC fault (Z). 51P is then enabled and picks up (p) and initiates this event report.

Phase time-overcurrent element 51T is timing to trip in a backup mode for the relay protecting the faulted feeder.

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
Example 21.6 kV distribution bus             to inputs.
CTR  =500.00  PTR  =180.00
DATC =15      PDEM =12.00   QDEM =12.00   NDEM =0.34
ZP   =25      MTA  =73.00   21PC =2
50C  =100.00  27L  =0.00    27H  =0.00    27C  =2       TCI  =Z —— Internal torque control of designated phase
50Q  =100.00  50QT =0                                              overcurrent elements is provided by the
51QP =1.50    51QTD=15.00   51QC =3       51QRS=N                  distance element 21P (TCI = Z).
50NL =49.99   50NLT=0       50NH =49.99
51NP =0.50    51NTD=3.50    51NC =3       51NRS=N
50L  =21.99   50LT =12      50H  =100.00
51P  =2.80    51TD =7.50    51C  =3       51RS =N
50M  =100.00  50MT =0
52APU=0       52ADO=0       TSPU =0       TSDO =0
TKPU =0       TKDO =0       TZPU =0       TZDO =0

SELogic Equations
S(123)  =
A(12)   =
B(12)   =51NT
C(12)   =
D(12)   =
E(34)   =
F(34)   =IN6 ————————————————————— Input IN6 functions as a permissive trip input for the 51NT
G(34)   =
H(34)   =
J(1234) =
K(1234) =
L(1234) =
A1(1234)=TF
A2(1234)=NDEM
V(56)   =B*F
W(56)   =
X(56)   =
Y(56)   =
Z(56)   =
A3(1346)=
A4(2346)=
TR(1246)=51T+50LT+V ————————————————— Programmable tripping conditions
ER(1246)=51P+51NP+TF ————————————————— Programmable event report trigger conditions
ETC(1)  =
ITC(1)  =51P ————————————————————— 51P and consequently 51T are designated for torque control by the distance
                                       element 21P.
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  =        IN4  =
IN5  =52A     IN6  =  ————————————————————————————— Input IN6 is used as a permissive trip
                                                       input in the above logic.
```

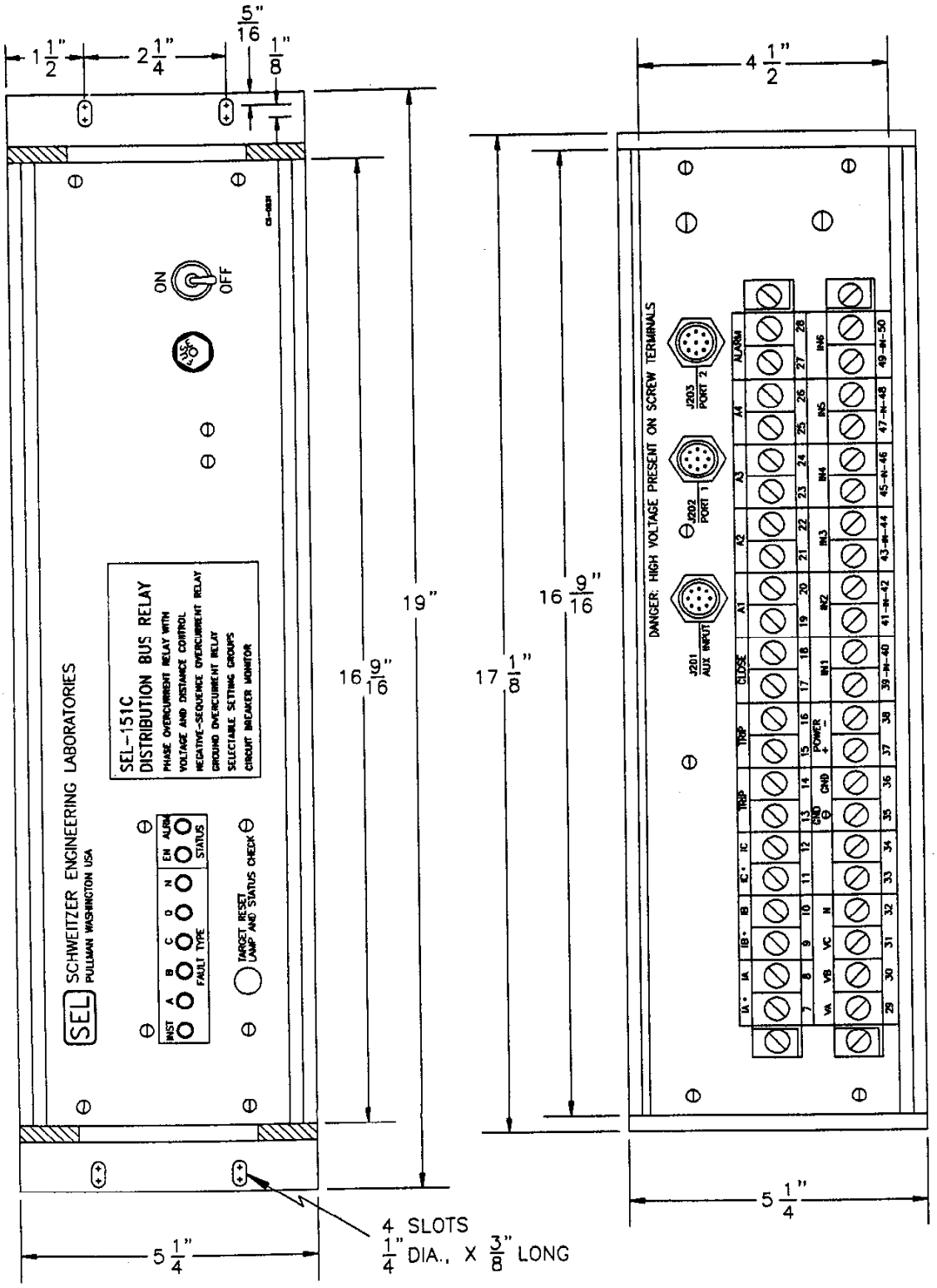
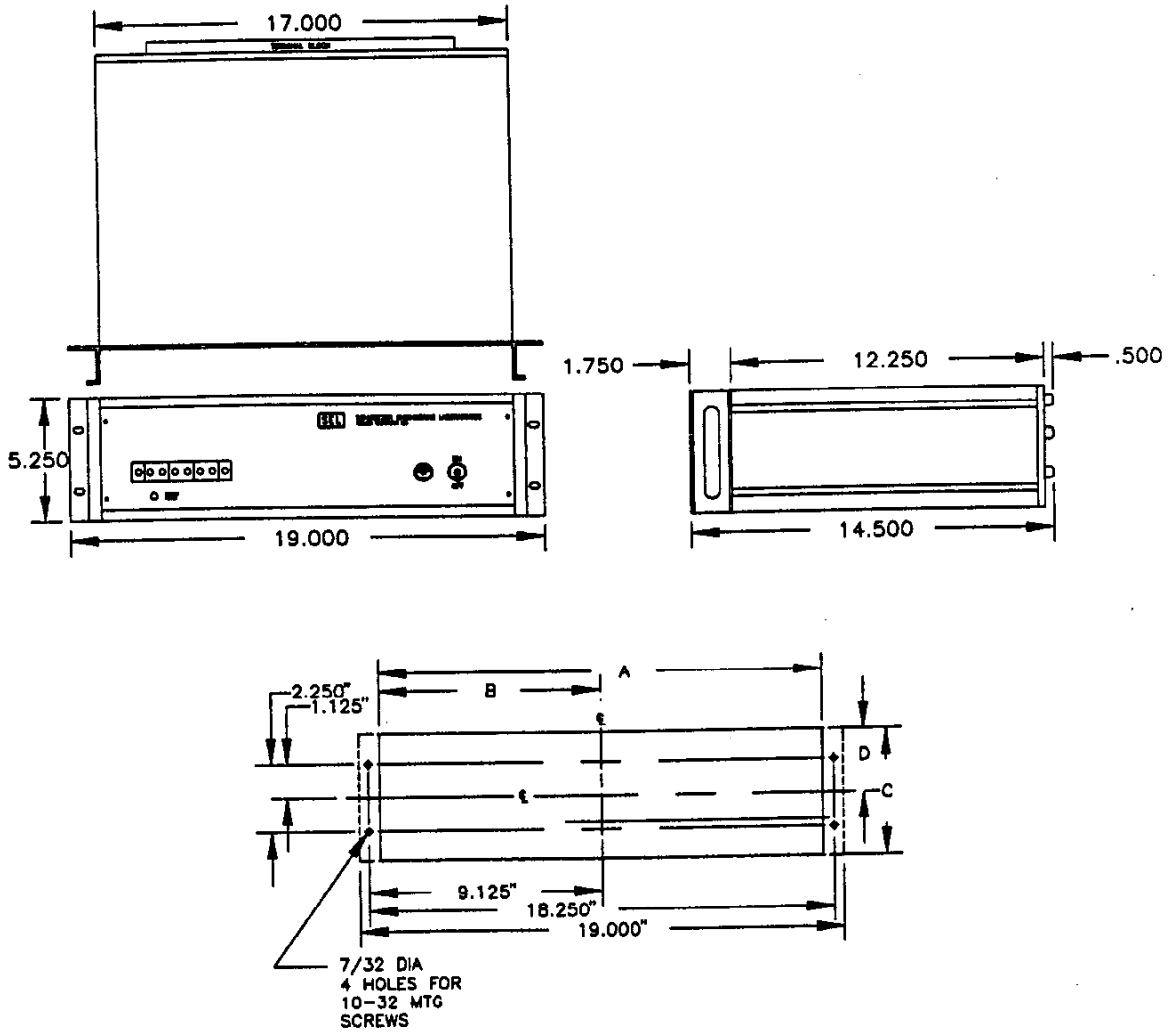


Figure 7: SEL-151C Distribution Bus Relay Horizontal Front and Rear Panel Drawings



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

DWG. NO. A7-0772
DATE: 09-28-90
REV DATE: 10-19-90

Figure 8: Relay Dimensions, Panel Cutout, and Drill Diagrams

SEL-151C 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, 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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