SEL-267D

PHASE AND GROUND DIRECTIONAL OVERCURRENT RELAY
RECLOSED RELAY
FAULT LOCATOR
FOR USE ON GROUNDED SYSTEMS WITH
DELTA-CONNECTED VOLTAGE TRANSFORMERS

DATA SHEET

- Similar to SEL-267 Relay except for delta-connected voltage transformers
- Nine phase overcurrent relays with three timers
- Phase time-overcurrent element with selectable curves
- Phase directional elements for phase faults
- Three residual-overcurrent relays and timers
- Residual time-overcurrent element with selectable curves
- Negative- and zero-sequence ground directional elements
- Programmable logic for outputs, tripping, and reclosing
- Three-shot reclosing with programmable initiate and cancel conditions
- Fault locating, event reporting, metering, and demand ammeter
- Automatic self-testing, EIA RS-232-C communications
- Horizontal and vertical mounting configurations available
GENERAL DESCRIPTION

The SEL-267D Phase and Ground Directional Overcurrent Relay provides high-speed and time delayed directional overcurrent protection for transmission lines, distribution lines, and cables. It is intended for application where open-delta connected PTs are applied. The SEL-267D Relay is very similar to the SEL-267 Relay (which is preferred when four-wire voltages are available).

The fault locator in the SEL-267D Relay is modified to locate ground faults, even though the open-delta PT connection denies the relay the zero-sequence voltage information. The relay does this by estimating the zero-sequence voltage from the product of a setting for the zero-sequence source impedance (R0S, X0S) and the measured zero-sequence current. This field-proven technique was first applied in the SEL-21D Relay, and repeated in the SEL-121D Relay.

Tailor the fault locator to your system. The relay can be set to compensate for shunt load on a radial feeder to provide more accurate fault locations when the relay overlooks more than one feeder, or a feeder with tapped load.

Ground-fault directionality is a negative-sequence directional element or a current-polarized zero-sequence directional element.

Relay overcurrent elements, directional elements, timers, and other data and control bits are combined in a 32-bit Relay Word. Logic, programmable by the application engineer, combines these bits to control tripping, reclosing (initiation and cancellation), and four programmable outputs. Forward- and reverse-looking relay outputs are available.

Because of the many relay elements, programmability, and low cost, the SEL-267D Relay meets the requirements of a broad spectrum of applications. The flexible yet simple programmability provides access to the relay elements (before and after time delays) and logic results such as reclose initiate (or cancel), alarm and trip.

Analog inputs from current and voltage transformers are analog filtered and digitally sampled. Voltage and current magnitudes and angles are used to perform protective functions and saved for additional features, such as event reporting, metering, and fault locating.

The SEL-267D Relay generates an 11-cycle event report following each fault. Each report includes current and voltage information, and sequence-of-events information for relay elements, contact inputs, and contact outputs. The relay saves the twelve latest event reports. You can retrieve any or all of the records remotely or locally through the serial communications ports.

A metering function permits interrogation of the SEL-267D Relay to obtain voltage, current, real power, and reactive power readings. The function includes per-phase measurements of current and phase-to-phase measurements of voltage, as well as indication of the per-phase demand current and peak demand current.

The CLOSE, A1-A4, and ALARM outputs may be specified as an "a" or "b" contact type. The TRIP outputs are always an "a" contact type.
In horizontal configuration, the SEL-267D Relay fits in a standard 19 inch rack. However, it is only 3.5 inches tall and 10.5 inches deep. You can fit more equipment in each protection panel, or consolidate existing panels.

The high reliability of the SEL-100 series relays is improved in the SEL-200 series relays. In the new hardware, all electronic components (excluding the power supply and instrument transformers) are contained on a single printed circuit board.

The SEL-267D Relay is compatible with the SEL-PRTU Protective Relay Terminal Unit, the SEL-DTA Display/Transducer Adapter, and the SEL-RD Relay Display.

APPLICATIONS

Replacement of Outdated Protective Relays

The SEL-267D Relay is ideal to replace obsolete directional overcurrent electromechanical relay schemes. Compact size and simple field wiring make replacement especially convenient in crowded substations. Event-reporting and fault-locating features economically provide valuable engineering and operating information, eliminating the need for event recorders and oscillographs in most applications. Its instrument transformer burden is negligible.

Backup Relaying

Where adequate high-speed primary protection already exists, the SEL-267D Relay can be applied for backup. Programmability and remote-access capabilities allow the relay settings to be adjusted remotely to meet virtually any contingency.

Its application also adds demand ammetering, event reporting, and fault locating.

Other Applications

The relay is cost-effective in these applications: fault locating, temporary installation, bus-tie breaker relaying (where frequent setting changes may be required), and remote control and monitoring.
## GENERAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>Voltage Input</th>
<th>115 V nominal phase-to-phase, three-phase, three-wire connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Inputs</td>
<td>5 A per phase nominal; 15 A per phase continuous; 500 A for one second thermal rating</td>
</tr>
<tr>
<td>Output Contact Current Ratings</td>
<td>30 A make per IEEE C37.90 para 6.7.2</td>
</tr>
<tr>
<td></td>
<td>6 A carry continuously; MOV protection provided</td>
</tr>
<tr>
<td>Optical Isolator Logic Input Ratings</td>
<td>24 Vdc: 10 - 30 Vdc</td>
</tr>
<tr>
<td></td>
<td>48 Vdc: 25 - 60 Vdc</td>
</tr>
<tr>
<td></td>
<td>125 Vdc: 60 - 200 Vdc</td>
</tr>
<tr>
<td></td>
<td>250 Vdc: 200 - 280 Vdc</td>
</tr>
<tr>
<td>Current</td>
<td>= 4 mA at nominal voltage</td>
</tr>
<tr>
<td>Power Supply</td>
<td>24/48 Volt: 20 - 60 Vdc; 12 watts</td>
</tr>
<tr>
<td></td>
<td>125/250 Volt: 85 - 350 Vdc or 85 - 264 Vac; 12 watts</td>
</tr>
<tr>
<td>Time Code Input</td>
<td>Relay accepts demodulated IRIG-B time code input.</td>
</tr>
<tr>
<td>Communications</td>
<td>Two EIA RS-232-C serial communications ports. Port 2 includes front and rear panel connectors. Connectors are standard 9-pin D subminiature type.</td>
</tr>
<tr>
<td>Dimensions</td>
<td>3.5&quot; x 19&quot; x 10.5&quot; (8.89 cm x 48.2 cm x 26.7 cm) (H x W x D)</td>
</tr>
<tr>
<td>Dielectric Strength</td>
<td>V, I inputs: 2500 Vac for 10 seconds</td>
</tr>
<tr>
<td></td>
<td>Other: 3000 Vdc for 10 seconds (excludes EIA RS-232-C)</td>
</tr>
<tr>
<td>Operating Temp.</td>
<td>-40°F to 158°F (-40°C to 70°C)</td>
</tr>
<tr>
<td>Environment</td>
<td>IEC 68-2-30 Temperature/Humidity Cycle Test - six day (type tested)</td>
</tr>
<tr>
<td>Interference Tests</td>
<td>IEEE C37.90 SWC Test (type tested)</td>
</tr>
<tr>
<td></td>
<td>IEC 255-6 Interference Test (type tested)</td>
</tr>
<tr>
<td>Impulse Tests</td>
<td>IEC 255-5 0.5 joule 5000 volt test (type tested)</td>
</tr>
<tr>
<td>RFI Tests</td>
<td>Type-tested in field from a quarter-wave antenna driven by 20 watts at 150 MHz and 450 MHz randomly keyed on and off one meter from relay.</td>
</tr>
<tr>
<td>ESD Test</td>
<td>IEC 801-2 Electrostatic Discharge Test (type tested)</td>
</tr>
<tr>
<td>Weight</td>
<td>16 lbs (7.3 kg); shipping weight 26 lbs (11.8 kg), including two manuals</td>
</tr>
<tr>
<td>Burn-in</td>
<td>140°F (60°C) for 100 hours</td>
</tr>
</tbody>
</table>
FUNCTIONAL SPECIFICATIONS

Relay Functions

Directional overcurrent protection for phase faults:

- Nine phase overcurrent elements, in three groups
- Three timers, one per group
- Polyphase time-overcurrent element with selectable curve shapes
- Phase directional element operates on negative- and positive-sequence quantities, with the negative-sequence voltamperes weighted four times the positive-sequence voltamperes.

Directional residual-overcurrent protection for ground faults:

- Three definite-time elements
- One time-overcurrent element with selectable curve shapes
- Negative- and zero-sequence directional elements for ground faults.
- Zero-sequence element is current polarized.

Automatic reclosing for selectable fault types (3 shots).

Relay Elements

Phase Overcurrent:

- 51P phase time-overcurrent element
  Selectable curve shape (4 curves)
  Time Dial: 0.50 to 15.00 in steps of 0.01
  Pickup: 1 to 12.6 A, +/- 0.05 A +/- 2% of setting

- 50A1, 50B1, 50C1 Zone 1 phase overcurrent elements (50P1)
- 50A2, 50B2, 50C2 Zone 2 phase overcurrent elements (50P2)
- 50A3, 50B3, 50C3 Zone 3 phase overcurrent elements (50P3)
  Pickup: 1 A to 25 times 51P pickup
  Timers are provided for each zone:
  Zone 1 Timer: 0-60 cycles in quarter-cycle steps
  Zone 2 Timer: 0-2000 cycles in quarter-cycle steps
  Zone 3 Timer: 0-2000 cycles in quarter-cycle steps

Ground Overcurrent:

- 51N residual time-overcurrent element
  Selectable curve shape (4 curves)
  Time dial: 0.50 to 15.00 in steps of 0.01
  Pickup: 0.25 to 6.3 A, +/- 0.05 A +/- 2% of setting
• 50N1, 50N2, 50N3 residual overcurrent elements
  Pickup: 0.2 to 47 times 51N pickup
  Timers are provided for 50N1, 50N2 and 50N3:
  Zone 1 Timer: 0-60 cycles in quarter-cycle steps
  Zone 2 Timer: 0-2000 cycles in quarter-cycle steps
  Zone 3 Timer: 0-2000 cycles in quarter-cycle steps

Demand Overcurrent:

• DCTH phase demand overcurrent element
  Pickup: 0.2 to 15 times phase time-overcurrent element pickup
  (51P pickup). (See Metering)

Directional Elements:

• Phase directional element (32PQ):
  Angle: MTA (maximum torque angle) setting (47° - 90° in 1° steps)
  Sensitivity: 1 VA of positive-sequence and 0.25 VA of negative-sequence at MTA
  Memory: 8 cycles

• Negative-sequence directional element (32Q):
  Angle: MTA setting (47 - 90° in 1° steps)
  Sensitivity: Proportional to 51P pickup for 4 < 51PP < 12.6A:
  0.35 VA at 12.6 A pickup at MTA
  0.11 VA at 4.0A pickup and below at MTA

• Zero-sequence directional element (32I):
  Angle: 0°
  Sensitivity: (0.5 amps) x (51N pickup setting), at 0°, in units of
  residual amps squared, and Ipol > 0.5 amps

Note: The MTA setting is common to the 32PQ and 32Q directional elements.

Three-shot reclosing relay:

• 79O11 setting defines open interval 1,
• 79O12 setting defines open interval 2,
• 79O13 setting defines open interval 3:
  Timer range: 0 - 10,000 cycles in quarter-cycle steps; a setting of 0
  disables that shot and successive shots.
• 79RS reset interval:
  Timer range: 60 - 8,000 cycles in quarter-cycle steps
- 50N1, 50N2, 50N3 residual overcurrent elements
  Pickup: 0.2 to 47 times 51N pickup
  Timers are provided for 50N1, 50N2 and 50N3:
  Zone 1 Timer: 0-60 cycles in quarter-cycle steps
  Zone 2 Timer: 0-2000 cycles in quarter-cycle steps
  Zone 3 Timer: 0-2000 cycles in quarter-cycle steps

Demand Overcurrent:

- DCTH phase demand overcurrent element
  Pickup: 0.2 to 15 times phase time-overcurrent element pickup
  (51P pickup). (See Metering)

Directional Elements:

- Phase directional element (32PQ):
  Angle: MTA (maximum torque angle) setting (47° - 90° in 1° steps)
  Sensitivity: 1 VA of positive-sequence and 0.25 VA of negative-sequence at MTA
  Memory: 8 cycles

- Negative-sequence directional element (32Q):
  Angle: MTA setting (47° - 90° in 1° steps)
  Sensitivity: Proportional to 51P pickup for 4 < 51PP < 12.6A:
  0.35 VA at 12.6 A pickup at MTA
  0.11 VA at 4.0A pickup and below at MTA

- Zero-sequence directional element (32I):
  Angle: 0°
  Sensitivity: (0.5 amps) x (51N pickup setting), at 0°, in units of residual amps squared, and Ipol > 0.5 amps

Note: The MTA setting is common to the 32PQ and 32Q directional elements.

Three-shot reclosing relay:

- 79O11 setting defines open interval 1,
- 79O12 setting defines open interval 2,
- 79O13 setting defines open interval 3:
  Timer ranges: 0 - 10,000 cycles in quarter-cycle steps; a setting of 0 disables that shot and successive shots.
- 79RS reset interval:
  Timer range: 60 - 8,000 cycles in quarter-cycle steps
LOGIC INPUTS

The relay has six opto-isolator inputs to sense external conditions: received permissive trip and block trip signals, breaker status, direct close, direct trip, and external event report trigger. Assert an input by applying control voltage to the corresponding rear panel input terminals.

OUTPUT CONTACTS

The relay has seven output contacts: TRIP, CLOSE, ALARM, and four programmable outputs: A1, A2, A3, and A4. Any output contact except TRIP may be factory configured as either Form A or Form B.

RELAY WORD

The Relay Word consists of four eight-bit rows containing relay elements, intermediate logic results, logic inputs, and relay outputs. Each bit in the Relay Word is either a logical 1 or logical 0.

<table>
<thead>
<tr>
<th>Relay Word</th>
</tr>
</thead>
<tbody>
<tr>
<td>51NP</td>
</tr>
<tr>
<td>50N1</td>
</tr>
<tr>
<td>50N2</td>
</tr>
<tr>
<td>50N3</td>
</tr>
<tr>
<td>51PP</td>
</tr>
<tr>
<td>50P1</td>
</tr>
<tr>
<td>50P2</td>
</tr>
<tr>
<td>50P3</td>
</tr>
<tr>
<td>DFP</td>
</tr>
<tr>
<td>67N1</td>
</tr>
<tr>
<td>67N2</td>
</tr>
<tr>
<td>67N3</td>
</tr>
<tr>
<td>DFG</td>
</tr>
<tr>
<td>67P1</td>
</tr>
<tr>
<td>67P2</td>
</tr>
<tr>
<td>67P3</td>
</tr>
<tr>
<td>51NT</td>
</tr>
<tr>
<td>Z1GT</td>
</tr>
<tr>
<td>Z2GT</td>
</tr>
<tr>
<td>Z3GT</td>
</tr>
<tr>
<td>51PT</td>
</tr>
<tr>
<td>Z1PT</td>
</tr>
<tr>
<td>Z2PT</td>
</tr>
<tr>
<td>Z3PT</td>
</tr>
<tr>
<td>ALRM</td>
</tr>
<tr>
<td>TRIP</td>
</tr>
<tr>
<td>TC</td>
</tr>
<tr>
<td>DT</td>
</tr>
<tr>
<td>52BT</td>
</tr>
<tr>
<td>52AT</td>
</tr>
<tr>
<td>TOCP</td>
</tr>
<tr>
<td>DCTH</td>
</tr>
</tbody>
</table>
The Relay Word Bit Summary Table explains the meaning of each bit in the Relay Word.

Table 1: SEL-267D Relay Word Bit Summary Table

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>51NP</td>
<td>Residual time-overcurrent pickup</td>
</tr>
<tr>
<td>50N1</td>
<td>Residual instantaneous-overcurrent element</td>
</tr>
<tr>
<td>50N2</td>
<td>Residual instantaneous-overcurrent element</td>
</tr>
<tr>
<td>50N3</td>
<td>Residual instantaneous-overcurrent element</td>
</tr>
<tr>
<td>51PP</td>
<td>Phase time-overcurrent pickup</td>
</tr>
<tr>
<td>50P1</td>
<td>Phase instantaneous-overcurrent element</td>
</tr>
<tr>
<td>50P2</td>
<td>Phase instantaneous-overcurrent element</td>
</tr>
<tr>
<td>50P3</td>
<td>Phase instantaneous-overcurrent element</td>
</tr>
<tr>
<td>DFP</td>
<td>Direction forward—phase fault</td>
</tr>
<tr>
<td>67N1</td>
<td>Zone 1 ground directional overcurrent element</td>
</tr>
<tr>
<td>67N2</td>
<td>Zone 2 ground directional overcurrent element</td>
</tr>
<tr>
<td>67N3</td>
<td>Zone 3 ground directional overcurrent element</td>
</tr>
<tr>
<td>DFG</td>
<td>Direction forward—ground fault</td>
</tr>
<tr>
<td>67P1</td>
<td>Zone 1 phase directional overcurrent element</td>
</tr>
<tr>
<td>67P2</td>
<td>Zone 2 phase directional overcurrent element</td>
</tr>
<tr>
<td>67P3</td>
<td>Zone 3 phase directional overcurrent element</td>
</tr>
<tr>
<td>51NT</td>
<td>Ground time-overcurrent trip</td>
</tr>
<tr>
<td>Z1GT</td>
<td>Zone 1 timeout-ground</td>
</tr>
<tr>
<td>Z2GT</td>
<td>Zone 2 timeout-ground</td>
</tr>
<tr>
<td>Z3GT</td>
<td>Zone 3 timeout-ground</td>
</tr>
<tr>
<td>51PT</td>
<td>Phase time-overcurrent trip</td>
</tr>
<tr>
<td>Z1PT</td>
<td>Zone 1 timeout-phase</td>
</tr>
<tr>
<td>Z2PT</td>
<td>Zone 2 timeout-phase</td>
</tr>
<tr>
<td>Z3PT</td>
<td>Zone 3 timeout-phase</td>
</tr>
<tr>
<td>ALRM</td>
<td>System alarm</td>
</tr>
<tr>
<td>TRIP</td>
<td>Circuit breaker trip</td>
</tr>
<tr>
<td>TC</td>
<td>Trip (OPEN) command</td>
</tr>
<tr>
<td>DT</td>
<td>Direct trip from DT input</td>
</tr>
<tr>
<td>52BT</td>
<td>Inverse of 52AT</td>
</tr>
<tr>
<td>52AT</td>
<td>Time delayed 52A</td>
</tr>
<tr>
<td>TOCP</td>
<td>Time-overcurrent pickup indicator (51PP + 51NP)</td>
</tr>
<tr>
<td>DCTH</td>
<td>Demand current threshold exceeded</td>
</tr>
</tbody>
</table>

The use of the Relay Word and programmable masks provide the user with great flexibility in applying the SEL-267D Relay, without rewiring panels or changing jumpers on circuit boards.
PROGRAMMABLE OUTPUT LOGIC

The relay uses programmable logic masks to control the TRIP and programmable output relays. Logic masks are saved in nonvolatile memory with the other settings. They are set with the LOGIC command and retained through losses of control power.

To program each logic mask, select elements of the Relay Word. If any element in the Relay Word asserts and the same element is selected in a logic mask, the output contact associated with the logic mask closes.

The output equations follow:

Let \( R = \) Relay Word

- \( MTU = \) mask for trip (unconditional)
- \( MPT = \) mask for trip (with permissive trip input asserted)
- \( MTB = \) mask for trip (with block trip input deasserted)
- \( MTO = \) mask for trip (with breaker open)

Then:

- \( TRIP = R \ast MTU \) unconditional tripping
- \( + R \ast MPT \ast PT \) permissive tripping
- \( + R \ast MTB \ast NOT (BT) \) block tripping
- \( + R \ast MTO \ast 52BT \) breaker-open/just closed tripping

- \( close\ TRIP = TRIP \)
- \( open\ TRIP = NOT (TRIP) * [NOT (Any element in Relay Word row 1 pickup) + TARGET RESET button pushed] * (TRIP Duration Timer Expired (TDUR)) \)

- \( close\ CLOSE = (DC + 79011 + 79012 + 79013 + CLOSE \text{ command}) * NOT (52A) * NOT(TRIP) \)
- \( open\ CLOSE = NOT (CLOSE) + 79RS \)

- \( A1 = R \ast MA1 \)
- \( A2 = R \ast MA2 \)
- \( A3 = R \ast MA3 \)
- \( A4 = R \ast MA4 \)

The "\(*\)" symbol indicates logical "and", and the "\(+\)" indicates logical "or".

RECLOSE RELAY

The reclosing relay provides up to three shots of automatic reclosing for selectable fault types and relay elements contained in the 32-bit Relay Word. The three open intervals and the reset timer are individually settable through the SET command.
To provide flexibility in applying the SEL-267D Relay to various reclosing schemes, the conditions for reclose initiation and cancellation are selected in a similar way to the programming of the output relays:

\[
\begin{align*}
RI &= R \times MRI \\
RC &= R \times MRC
\end{align*}
\]

where MRI is the mask for reclose initiation, and MRC is the mask for reclose cancellation.

The open intervals do not begin until the TRIP output deasserts. Since the TRIP output never asserts for less than the TDUR timer setting, the open interval may start several milliseconds after the fault has actually cleared and the breaker opened.

Reclose is automatically cancelled when the circuit breaker is observed to trip when a fault condition is not present.

**RELAY TARGETS**

The relay normally displays the targets identified on the front panel. Under normal operating conditions, the enable (EN) target lamp is lit. If the relay trips, it illuminates the LED corresponding to the element asserted at the time of trip. The target LEDs latch. The target LEDs which illuminated during the last trip remain lit until one of the following occurs:

- Next trip occurs
- Operator presses front panel TARGET RESET button
- Operator executes TARGET R command

When a new trip occurs, the targets clear and the LEDs display the most recent tripping target.

When you press the TARGET RESET button, all eight indicators illuminate for a one-second lamp test. If no TRIP condition is present, the relay clears the targets and illuminates the Enable light (EN) to indicate that the relay is operational. If a TRIP condition is present, the relay displays the old targets following the lamp test.

Use the TARGET command and display to examine the state of the relay inputs, outputs, and the elements of the Relay Word.

**SERIAL INTERFACES**

The SEL-267D Relay is equipped with two EIA RS-232-C serial communications ports. Port 2 has 9-pin connectors on both the front and rear panels, designated Port 2F and Port 2R, respectively.
Port 2R, located on the relay rear panel, is typically used with an SEL-DTA Display/Transducer Adapter, SEL-RD Relay Display, or local printer. Port 2F is always available for short term local communications with a portable computer or printing terminal. Simply plug the device into the front panel port. The relay automatically discontinues communications with Port 2R and addresses Port 2F. When testing or data retrieval is complete, unplug the temporary device from Port 2F. The relay automatically resumes communications with the device connected to Port 2R.

Serial communications Port 1 and the Auxiliary Input for demodulated IRIG-B time code input remain on the relay rear panel. Generally, Port 1 is used for remote communications via a modem.

Communications port baud rate jumpers are located along the front edge of the circuit board. To select a baud rate for Port 1 or Ports 2, remove the relay front panel. The jumpers are visible near the center of the relay drawout assembly, to the right of the target LEDs. Carefully move the jumpers using needle-nosed pliers. Available baud rates are 300, 600, 1200, 2400, 4800, or 9600.

The serial data format is eight data bits, two stop bits, no parity. Communications use XON/XOFF flow control.

EVENT REPORTING

The relay retains a data record for each of the last twelve events. The record includes fault location, input voltages and currents, relay elements, input contacts, and output contacts. The relay saves a report when any of the following occur:

- The relay trips
- Selected relay elements assert
- User executes the TRIGGER or OPEN commands
- DT (Direct Trip) or ET (External Trigger) input is asserted

Two sample event reports are included near the end of this data sheet.

FAULT LOCATION

The relay computes fault location from event report data stored for each fault or disturbance. The relay uses two fault locating methods: the Takagi method where sound prefault data are available, or simple reactance method when sound prefault data are not available. The Takagi fault locating algorithm compensates for prefault load current to improve fault locating accuracy under load and for high-resistance faults. The relay also includes logic to improve fault locator accuracy when applied on radial lines with tapped loads.
METERING

The meter function shows the line-line ac voltage, phase current values, demand and peak demand current values, megawatts (P to represent real power), and megavars (Q to represent reactive power) in primary values. You can display these values locally or remotely with the METER command.

SELF-TESTING

The relay runs a variety of self-tests. Some tests have warning and failure states; others only have failure states. The relay generates a status report after any self-test warning or failure.

The relay closes the ALARM contact after any self-test fails. When the relay detects certain failures, it disables the breaker control functions and places the output relay driver port in an input mode. No outputs may be asserted when the relay is in this configuration. The relay runs all self-tests at least every five minutes.

Table 2 shows a list of the self-tests performed by the relay.

<table>
<thead>
<tr>
<th>Test</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offset</td>
<td>Measures dc offset of analog input channels.</td>
</tr>
<tr>
<td>Power Supply</td>
<td>Measures internal power supply voltages.</td>
</tr>
<tr>
<td>Random-Access Memory</td>
<td>Verifies RAM operation.</td>
</tr>
<tr>
<td>Read-Only Memory</td>
<td>Verifies ROM operation.</td>
</tr>
<tr>
<td>Analog-to-Digital Converter</td>
<td>Verifies A/D operation.</td>
</tr>
<tr>
<td>Master Offset</td>
<td>Measures dc offset of multiplexer channel.</td>
</tr>
<tr>
<td>Settings</td>
<td>Verifies checksum of setting group.</td>
</tr>
</tbody>
</table>
SETTING PROCEDURE

The SET command invokes the relay setting procedure. Each setting is presented and prompted for in turn. If a new setting value is desired, it is entered in response to the appropriate prompt, while just pressing carriage return retains the old setting and prompts for the next one.

In the example beginning on the next page, only the X0 value was changed. It was changed from 152.34 to 143.07. Note that the new value of 143.07 is presented at the end of the procedure before enabling, along with all other settings. This provides a final inspection for typographical or other errors.

As a convenience, the operator could have typed END in response to the prompt for Line Length (or any other setting except Relay ID), and gone directly to the final presentation of settings, without having to scroll through the rest of the prompts.

As an option, the operator could type any setting descriptor (except for the ID setting) with the SET command. All settings prior to the specified setting are skipped when the command is executed in this manner. For example, typing "SET Z3DP <ENTER>" instructs the relay to initiate the setting procedure at the Z3DP setting.
SET COMMAND EXAMPLE

SET clears events. CTRL-X cancels.
Enter data, or RETURN for no change.

ID : Example 69 kV Line
R1 : (Ohms pri.) = 49.83
R0 : (Ohms sec.) = 56.07
X0 : = 143.07 <- operator changes X0
R0S : = 56.07
LL : Line Length (mi.) = 60.00
143.07 <- operator changes X0
R0S : = 56.00
X0S : = 143.07
CCTR : = 60.00
CCTR1 : = 600.00
MTA : Max. Torque Angle (deg.) = 49.00
LOCAT : Locate Faults (L,A,R) = 1
DATC : Demand FC (5-60 min.) = 15
DOTH : Demand Thresh (Amps pri.) = 120.00
79D1: Open Int 1 (cycle) = 40.00
79D2: = 60.00
79D3: = 80.00
79R3: Reset Int = 240.00
5PP : PU (Amps pri.) = 120.00
5PTD : Time Dial = 1.00
5PCI : Curve [1,2,3,4] = 2
5PIFC : Torque Ctrl Y/N = N
5PI1 : PU (Amps pri.) = 1150.00
5PI2 : = 316.00
5PI3 : = 210.00
21DP : Dly-Phase (cycle) = 0.00
22DP : = 160.00
23DP : = 30.00
5INP : PU (Amps sec.) = 30.00
5INCD : Time Dial = 2.00
5INPC : Curve [1,2,3,4] = 2
5INPCA : Torque Ctrl Y/N = N
5R01 : PU (Amps pri.) = 1008.00
5R02 : = 450.00
5R03 : = 30.00
21GN : Dly-Gnc (cycle) = 0.00
22GN : = 30.00
23GN : = 10.00
1DUR : Trip Duration (cycle) = 9.00
52GT : Dly (cycle) = 30.00
52NE3 : Dir (F+Rwd or F-Rvds) = R
57NE : GND Fit Dir (Y/N) = Y
57PE : Phase Fit Dir (Y/N) = Y
32GE : Enable (Y/N) = N
32G1 : = N
TIME1 : Port 1 timeout (min.) = 5
TIME2 : = 0
AUTO : Auto port [1,2,3] = 2
RINGS : (1-30) = 3

New settings for: Example 69 kV Line
R1 = 49.83 X1 = 56.32 R0 = 56.07 X0 = 143.07 LL = 60.00
R0S = 56.07 X0S = 143.07
CCTR = 60.00 CCTR1 = 600.00 MTA = 49.00 LOCAT = L DATC = 15
DOTH = 120.00 79D1 = 40.00 79D2 = 60.00 79D3 = 80.00 79R3 = 240.00
5PP = 120.00 5PTD = 1.00 5PCI = 2
5PIFC = N 21DP = 0.00 22DP = 160.00 23DP = 30.00
5INP = 30.00 5INCD = 2.00 5INPCA = 2
5R01 = 1008.00 5R02 = 450.00 5R03 = 30.00
21GN = 0.00 22GN = 30.00 23GN = 10.00 1DUR = 9.00
52GT = 30.00 52NE3 = R 57NE = Y 57PE = Y
32GE = N 32G1 = N
TIME1 = 5 TIME2 = 0 AUTO = 2 RINGS = 3
# SAMPLE EVENT REPORT

**Example 69 KV Line**

- **Date:** 5/19/89
- **Time:** 16:19:43.100

### Voltages (kV)

<table>
<thead>
<tr>
<th>IPOL</th>
<th>IR</th>
<th>IA</th>
<th>IB</th>
<th>IC</th>
<th>VAB</th>
<th>VBC</th>
<th>VCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>68</td>
<td>-14</td>
<td>-54</td>
<td>66.1</td>
<td>-22.4</td>
<td>-45.3</td>
</tr>
<tr>
<td>0</td>
<td>-7</td>
<td>-24</td>
<td>71</td>
<td>-47</td>
<td>-13.4</td>
<td>-84.1</td>
<td>22.4</td>
</tr>
<tr>
<td>0</td>
<td>-8</td>
<td>-24</td>
<td>71</td>
<td>-47</td>
<td>-13.4</td>
<td>-84.1</td>
<td>22.4</td>
</tr>
</tbody>
</table>

### Relays Outputs Inputs

- **BE55565**
- **TCAAAA**
- **DBPDAE**
- **PL1234L**
- **T10701**
- **T10724**
- **PPP**
- **NN**

## Event:

- **Duration:** 5.75 s
- **Pit Current:** 1273.7 A
- **Target:** G1

### Setting:

- **R1:** 49.83 X1 = 56.07 RO = 56.07 XD = 143.07 LL = 60.00
- **ROS:** 11.21 X0 = 28.01
- **CBT:** 60.00 PIB = 60.00 MTA = 49.00 LOCAT = LOCAT = DACT = 15
- **BCH:** 120.00 7901140.00 79012 = 60.00 79012 = 80.00 79013 = 240.00
- **1PP:** 120.00 51FD = 1.00 51FC = 5
- **5PP:** 158.00 5PP = 518.00 5PP = 210.00
- **Z1LP:** 0.00 22PP = 100.00 22PP = 30.00
- **5IN:** 0.00 31ND = 2.00 51NC = 2
- **5ON:** 100.00 5IN = 45.00 51NO = 30.00 100.00 5IN = 1.00 22LP = 100.00 22LP = 30.00
- **53B:** 30.00 53B = 30.00 22LP = 100.00 22LP = 30.00
- **3F0:** 51NL = 2
- **TIME1:** 5
- **TIME2:** 5
- **AUTO:** 2
- **SLING:** 3

### Logic settings:

- **MTU:**
- **MTB:**
- **MTA:**
- **M21:**
- **M22:**
- **M3:**
- **M4:**
- **M91:**
- **MBC:**

### SEL-267D Data Sheet

- **Date Code:** 930317
EXPLANATION OF EVENT REPORT

Example 69 kV Line  
Date: 5/19/89  Time: 16:19:43.100

FD=SEL-1670-R101-V656m-0890518

Currents Voltages Relays Outputs Inputs

| IPOL | IR | IA | IB | IC | VAB | VBC | VCA | 3PAB92 | UAAAAA | UPBUSE | 0X1071 | 0X2/6 | LIT1227 | A | PPNNNN |
|------|----|----|----|----|-----|-----|-----|--------|--------|--------|--------|--------|--------|--------| |
| 0    | 085| 20 | 13 | 54 | -64.8| 22.4| 42.1 | .3P    | .P     | .P     | .P     | .P     | .P     | A       |
| 0    | -422| -413| -66| 53 | 18.4 | -65.7 | 47.8 | .3P.I  |       |       |       |       |        | A       |
| 0    | 6   | 74 | -14| -55| 59.8 | 22.4 | -37.0| .3P.I  | .P     | .P     | .P     | .P     | .P     | A       |
| 0    | 997 | .006| 50 | 59 | 19.7 | 65.7 | 66.2 | .2P.P  | .P     |       |       |       |       | A       |
| 0    | -190|      | 57 | -52.5| 22.4 | 34.8 | 122P2P | .P     |       |       |       |       |        | A       |

Event: AG  Location: 9.02 mi 11.3 ohms sec
Duration: 5.75  Fit Current: 1273.7 Targets: 61

Currents and voltages are in primary Amps and kV. Rows are quarter-cycle apart. Time runs down page. Obtain phasor RMS value and angle using any entry as the Y-component, and the entry immediately underneath as the X-component. For example, from bottom rows, AY = +275, IAX = +126. Therefore, IA = 126 Amps is phase A, at an angle of ATAN(275/126) = 158°, with respect to the sampling clock.

<Figures>  Identification Data. This line varies according to version.

<Relays> Columns show states of internal relay elements. Designators:

- 5OP: phase overcurrent
- 4TP: directional phase overcurrent
- 4SIP: phase time-overcurrent
- 5MT: inst ground overcurrent
- 4DIP: directional ground overcurrent
- 4H: ground time-overcurrent

<Outputs> Columns show states of output contacts. An = OFF, 1P = TRIP, CL = CLOSE, AL = PROGRAMMABLE, AL = ALARM

<Event> Event type is one of the following:

- 1R: DIRECT TRIP  2P: PASSIVE TRIP  3U: BLOCK TRIP  4D: CLOSING  5S: A-LUMINAL  1I: EXTERNAL TRIGGER (event report)

<Overview> Distance to fault in miles. Indeterminate distance is 999999. Distance to fault in secondary ohms is 999999.

<Duration> Fault duration determined from relay element pickup time

<Fit Current> X-component (primary amps) taken near middle of fault.

<Targets> The targets indicate the relay elements that caused the trip. These targets are the same as the targets displayed on the top panel of the 354 or 355 via the TARGET O command. The Targets Line indicates any combination of the following:

- 1P: Zone 1 phase fault
- 2P: Zone 2 phase fault
- 3SIP: Phase time-overcurrent
- 5D: Zone 1 ground fault
- 6I: Zone 2 ground fault
- 7I: Zone 3 ground fault

Primary series impedance settings for transmission line

SERIES PRIMARY IMPEDANCE SETTINGS

Primary impedances specified for line impedances

<Logic Settings> See LOGIC command for a description of mask setting.

Date Code 930317  SEL-267D Data Sheet  15
SAMPLE COMMAND DISPLAYS

Sample History Command

```plaintext
>>> HISTORY<ENTER>
Example 69 kV Line                  Date: 5/25/89       Time: 11:12:12
#    DATE       TIME     TYPE     DIST     DUR     CURR      TARGETS
1    5/25/89    11:11:28.829 AGT   54.20    10.50    366.5     51W
2    5/25/89    11:11:29.429 AGT   54.54    7.50     365.7
3    5/25/89    11:09:50.346 BC    9.20     4.00     1329.9    P1
4    5/25/89    11:08:58.787 AG    9.08     4.75     1155.9    61
```  

Sample Meter Command

```plaintext
>>>METER
Example 69 kV Line                  Date: 5/25/89       Time: 01:24:56
        A    B    C
I (A)    99    98  100
D (A)    107   105  105
PD (A)   107   105  105
AB       BC    CA
V (KV)   69.6  69.6  69.5
P (MW)   11.95
Q (VAR)  ~0.08
```  

Sample Self-Test Status Report

```plaintext
>>>STATUS
Example 69 kV Line                  Date: 5/25/89       Time: 01:04:56
SELF-TESTS
W=Warn  F=Fail  I=Ind  T=Tms  V=Vol  C=Cap
IP     IR     IA     IB     IC     WAV     VBC     VCA
0      0      0      0      0      0       0       0
PS     4.99   15.14  -14.85
RAM    ROM    A/D    MOP    SET
OK     OK     OK     OK     OK
```
Targets Command

The eight-LED display on the front panel can be programmed to show targets (default), Relay Word bits, contact inputs and contact outputs, as shown below. This feature is especially useful in testing individual relay elements.

<table>
<thead>
<tr>
<th>LED</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>PH1</td>
<td>G1</td>
<td>PH2</td>
<td>B2</td>
<td>PH3</td>
<td>G3</td>
<td>51P</td>
<td>51M</td>
</tr>
<tr>
<td>1</td>
<td>50N1</td>
<td>50N2</td>
<td>50N3</td>
<td>51PP</td>
<td>50F1</td>
<td>50F2</td>
<td>50P3</td>
<td>RELAY TARGETS</td>
</tr>
<tr>
<td>2</td>
<td>DFP</td>
<td>671</td>
<td>672</td>
<td>673</td>
<td>DFG</td>
<td>67P1</td>
<td>67P2</td>
<td>67P3</td>
</tr>
<tr>
<td>3</td>
<td>51NT</td>
<td>Z1GT</td>
<td>Z2GT</td>
<td>Z3GT</td>
<td>51PT</td>
<td>Z1PT</td>
<td>Z2PT</td>
<td>Z3PT</td>
</tr>
<tr>
<td>4</td>
<td>ALRM</td>
<td>TRIP</td>
<td>TC</td>
<td>DT</td>
<td>S2BT</td>
<td>S2AT</td>
<td>TOCP</td>
<td>DCTH</td>
</tr>
<tr>
<td>5</td>
<td>52AT</td>
<td>ET</td>
<td>S2A</td>
<td>DC</td>
<td>BT</td>
<td>PT</td>
<td>DT</td>
<td>CONTACT INPUTS</td>
</tr>
<tr>
<td>6</td>
<td>TRIP</td>
<td>CLOS</td>
<td>A1</td>
<td>A2</td>
<td>A3</td>
<td>A4</td>
<td>ALRM</td>
<td>CONTACT OUTPUTS</td>
</tr>
</tbody>
</table>

The front panel targets can be reset and cleared remotely or locally using the target command. Type "TARGET R <ENTER>" to reset and clear the targets.

Figure 1: SEL-267D Relay AC Connection Diagram
Figure 2: SEL-200 Series (Shallow) Relay Dimensions, Panel Cutout, and Drill Diagrams
SEL-267D RELAY COMMAND SUMMARY

Level 0

ACCESS
Answer password prompt (if password protection enabled) to gain access to Level 1. Three unsuccessful attempts pulses ALARM relay.

Level 1

2ACCESS
Answer password prompt (if password protection enabled) to gain access to Level 2. This command always pulses the ALARM relay.

DATE
Show or set date. DAT 2/3/89 sets date to Feb. 3, 1989. Pulses the ALARM momentarily when a different year is entered than the one previously stored. This setting is overridden when IRIG-B synchronization occurs.

EVENT
Show event record. EVE 1 shows long form of most-recent event.

HISTORY
Show DATE, TIME, EVENT TYPE, FAULT LOCATION, DURATION, CURRENT, and TARGETS for the 12 most-recent faults.

IRIG
Force immediate execution of time-code synchronization task.

METER
Show primary current, demand current, peak demand, voltage, and real and reactive power. METER runs once. METER N runs N times. METER R resets the peak demand currents.

QUIT
Return to Access Level 0 and react targets to Target 0.

SHOWSET
Show the relay settings and logic settings—does not affect the settings. The logic settings are shown in hexadecimal format for each.

STATUS
Show relay self-test status.

TARGET
Show data and set target lights as follows:
- TAR 0: Relay Targets
- TAR 2: Relay Word #2
- TAR 4: Relay Word #4
- TAR 6: Contact Outputs
- TAR 1: Relay Word #1
- TAR 3: Relay Word #3
- TAR 5: Contact Inputs
- TAR R: Returns to TAR 0 and clears

Be sure to return to TAR 0 when done, so LEDs display fault targets.

TIME
Show or set time. TIM 13/32/00 sets clock to 1:32:00 PM. This setting is overridden when IRIG-B synchronization occurs.

TRIGGER
Trigger and save an event record. (Type of event is EXT).

Level 2

CLOSE
Close circuit breaker, if allowed by jumper setting.

LOGIC
Show or set logic masks MTU, MPT, MTO, MTB, MRI, MRC, MA1-MA4

OPEN
Open circuit breaker, if allowed by jumper setting.

PASSWORD
Show or set passwords. Pulses the ALARM momentarily when new passwords are set.
- PAS 1 OTTER sets Level 1 password to OTTER.
- PAS 2 TAIL sets Level 2 password to TAIL.

SET
Initiate setting procedure. SET N initiates setting procedure at setting N.

Use the following to separate commands and their parameters: space, comma, semicolon, colon, slash.

* ALARM relay closes momentarily while the new settings are stored in EEPROM and event data buffers are cleared.

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SEL/3-93