



# SEL-352 Data Sheet

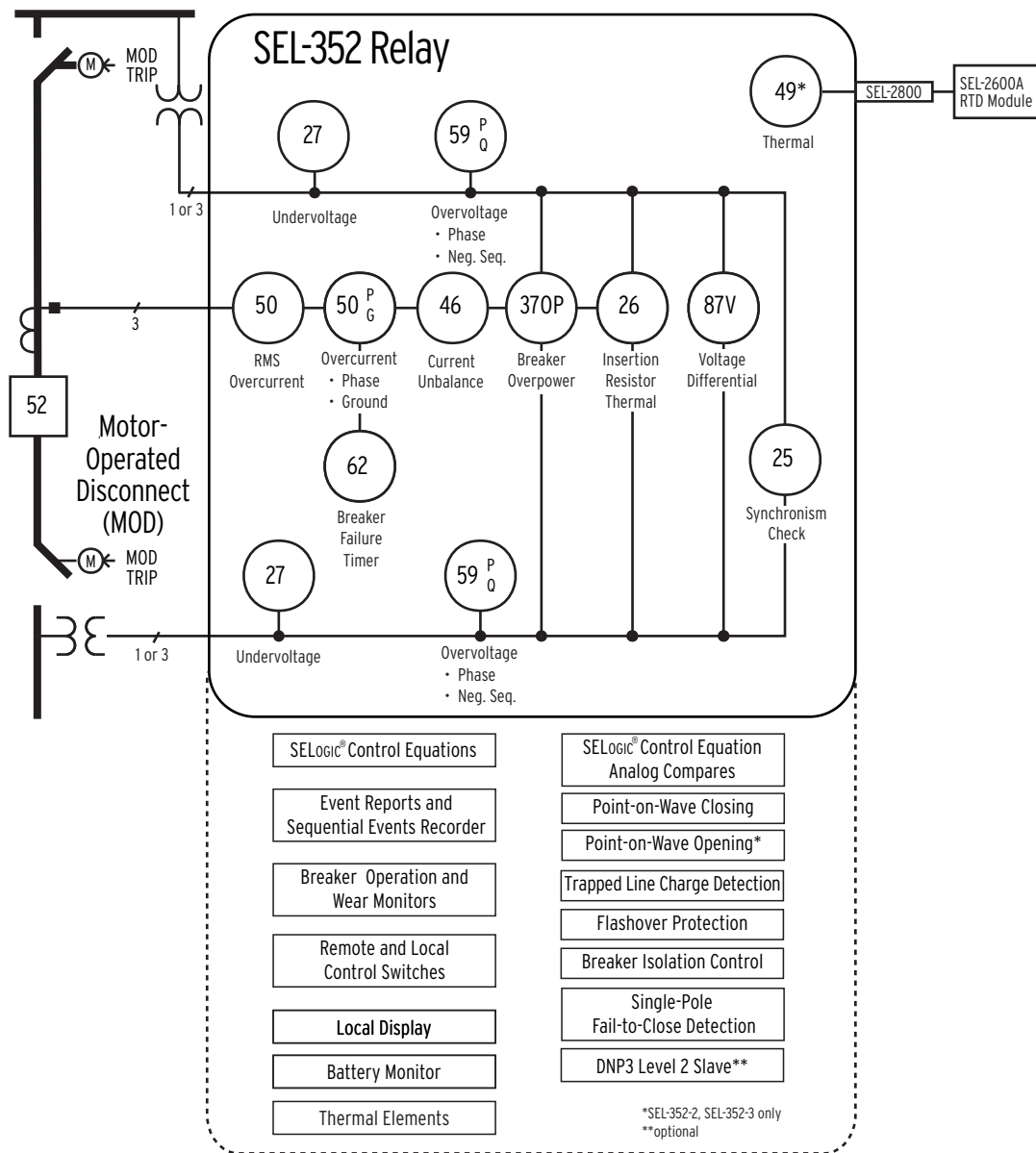
## Breaker Failure Relay, Control Relay, Data Recorder



## Major Features and Benefits

- **Circuit Breaker Failure Detection:**
  - Failure while tripping fault conditions
  - Failure while tripping load conditions
  - Failure to close (pole disagreement detection)
  - Failure while open (breaker pole flashover detection)
  - Failure to complete a trip or close (resistors still inserted)
  - Loss-of-dielectric pressure
- **Control Logic:**
  - Motor-Operated Disconnect (MOD) trip and power circuit breaker isolation security logic
  - Retripping (instantaneous and time-delayed)
  - Point-on-Wave (POW) breaker control functions
  - Synchronism checking close logic
  - Trapped charge polarity detection
- **Data Recording:**
  - Event report provides 8 seconds of analog fault data and digital oscillography data at 64 samples per cycle
- 512 Sequential Event Recorder (SER) reports (inputs, outputs, and relay elements)
- 512 breaker operation events
- Six voltage measurements
- Three current measurements
- **Additional Features:**
  - Multiple I/O configurations
  - SELOGIC® control equations:
    - Modify default schemes
    - Complete custom applications
    - Design a recloser
  - Programmable targets for testing
  - Detailed metering
  - Three EIA-232 serial ports
  - EIA-485 serial port
  - Front-panel display:
    - Setting and monitoring functions
  - Automatic self-tests
  - Clock synchronization input, IRIG-B
  - Optional DNP3 Level 2 Slave

# Functional Overview



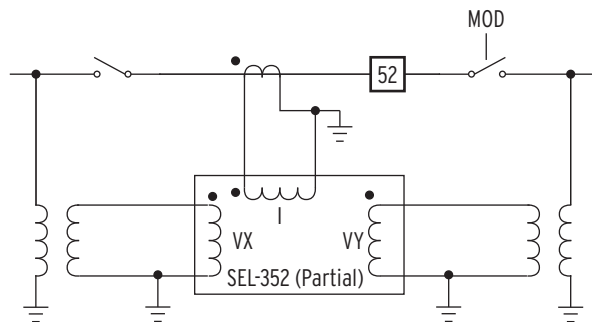
**Figure 1 Functional Diagram**

# General Description

The SEL-352 relay is a single- or three-pole breaker failure detection, breaker control, and data recording device. Each of the protection schemes is implemented in SELOGIC control equations, giving relay engineers unparalleled flexibility in adapting the relay to their needs. The relay provides classical overcurrent-based breaker failure protection for a wide variety of breaker arrangements. Additionally, protection is provided for circuit breaker trip and close resistors, for current through an open breaker, and for breaker flashover.

Logic to control the closing and opening of the circuit breaker is also included. Additional features include metering, sequence-of-event reporting, digital fault recording, remote setting capabilities, breaker operating time monitors, energy interruption monitors, and breaker resistor thermal protection. Simple hardware design and efficient digital signal processing ensure reliability. Extensive self-testing and communication capabilities enhance availability.

Figure 2 shows a single-phase diagram of the ac connections. All nine connections are not required for most relay functions.



**Figure 2** Single-Phase Diagram of AC Inputs to the Relay

## Circuit Breaker Failure Detection

The SEL-352 has five fault current-driven breaker failure detection schemes, including one specifically designed for ring-bus or breaker-and-a-half applications. Tailor the relay to your circuit breaker failure detection requirements by selecting the most appropriate scheme or use SELOGIC control equations to implement your own scheme.

The relay detects failures to interrupt fault, load, or line-charging current. It also detects failure of breaker poles to complete a close sequence and can detect open breaker

flashover failures. If trip or close resistors remain in service after an operation, the relay detects this failure using a thermal model.

Independent phase current detectors, protection logic, and timers make the relay easy to apply on both simple systems and more complicated breaker arrangements such as single-pole trip installations.

The SEL-352 stores summaries of the last 512 breaker operations in nonvolatile memory. Event type, maximum current, mechanical and electrical operating times, and breaker energy are stored along with the date and time of operation. Using this breaker history, you can monitor breaker wear and effectively schedule routine breaker maintenance.

When a motor-operated disconnect switch (MOD) is used with the protected breaker, the SEL-352 can trip the MOD to isolate the failed breaker when phase current drops below a settable value. When a MOD is not installed, use the MOD logic to indicate a “Safe to Disconnect” condition to personnel.

The relay also includes SELOGIC control equations, which allow you to configure the programmable outputs to operate when any of the protective elements pick up. You can implement complete application-specific protective schemes with a minimum of wiring and panel space. SELOGIC control equations also simplify relay testing.

## Control Logic

Control logic provides flexibility for closing, opening, and tripping. For minimal breaker wear, the SEL-352 can be used to close the breaker at an optimum time. Close using a simple pole staggered close or utilize complete control by monitoring synchronism, trapped charge polarity, and zero crossings. Use controlled breaker opening in the SEL-352-2 and SEL-352-3 for synchronizing the maximum breaker contact separation to peak or zero voltage crossings to help reduce the occurrence of re-strike in reactive loads. Utilize ambient temperature and dc control voltage monitoring to compensate for variations in breaker close and opening times in the controlled opening and closing schemes. Control breaker tripping through lockout and reset conditions, instantaneous retripping, and time-delayed retripping.

Use the flexible SELOGIC control equations to create your own recloser, implement manual closing supervision, and /or change existing control logic to meet your needs.

## Data Recording

A wide range of user-selectable events trigger the sequence-of-events recording (SER) and digital fault recording (DFR) functions, including any input or output assertion. Breaker Failure Trip (86BFT) output assertion automatically generates a DFR record, and you can set the relay to trigger an event for OPEN, CLOSE, or TRIP input assertions. This ensures a record of every normal circuit breaker operation as well as every circuit breaker failure.

The recorded data contain all information needed to determine the cause of relay and breaker operations. The data collected include current through the circuit breaker, voltage on both sides of the circuit breaker, input, output, and relay element data. Parameters such as event type, relay response time, circuit breaker operation time, currents, voltages, and breaker power dissipation appear directly in the breaker monitor report or can be calculated from the data stored. All event reports are time-tagged by a self-contained clock/calendar.

## Additional Features

Additional features make the SEL-352 reliable and economical. The communication functions provide remote and local examination of a wide range of data, including the voltages and currents presented to the instrument, relay settings, history of events, breaker alarms, sequence-of-events, and self-test status data. You can enter and modify relay settings remotely; you can also control all outputs via the communications channel.

A three-level password scheme protects settings and circuit breaker control. The SEL-352 monitors password execution and closes the ALARM contact output to indicate possible unauthorized access. The relay requires no special communications software. Access the relay with a dumb terminal, printing terminal, or computer with serial port and terminal emulation software. The SEL-5010 Relay Assistant is also available for communication and settings database management.

# Circuit Breaker Failure Detection

## Protection Overview

The SEL-352 provides protection for several circuit breaker failure modes:

- Failure to clear a fault (five available schemes)
- Failure to trip during load conditions (two available schemes)
- Failure to complete trip sequence due to trip resistor(s) remaining inserted
- Failure to complete close sequence due to close resistor(s) remaining inserted
- Failure to close: pole disagreement detection
- Failure while open: breaker pole flashover detection
- Loss of dielectric pressure

## Protection While Tripping Fault Current

The SEL-352 provides five different protection schemes to detect the failure of the circuit breaker to clear a fault. While the schemes share elements and timers, each is independent. You may enable only one protection scheme at a time. The SEL-352 applies the single chosen scheme to all three breaker poles. The SEL-352 provides instantaneous overcurrent elements (50FT) with fast reset times, even in the presence of subsidence current after the breaker opens.

In ring-bus and breaker-and-a-half installations, two circuit breakers must operate to interrupt line current. Current distribution between the two breakers is unknown until the first breaker opens. This causes an

uncertainty with respect to the timing of 50FT overcurrent element assertion. This uncertainty is not present in a single breaker arrangement.

Timing uncertainty is accounted for in the SEL-352 breaker failure detection schemes intended for these complex bus/breaker arrangements. The SEL-352 is intended to monitor a single breaker, regardless of the bus/breaker arrangement. In breaker-and-a-half and ring-bus arrangements, you must use an independent breaker failure relay for each breaker.

An overview of the five protection schemes is shown below.

### Scheme 1: Protection for Simple and Complex Arrangements

In this scheme, the breaker failure timer starts independently from 50FT assertion. This independence allows scheme usage in bus configurations where the 50FT element may assert after trip input assertion, such as ring-bus and breaker-and-a-half bus arrangements.

Logic latches in the trip signal so that trip signal dropout does not affect the breaker protection scheme.

### Scheme 2: Basic Protection for Simple Arrangements

In a single breaker arrangement, fault current causes 50FT assertion immediately after fault inception and just prior to trip input assertion. In Scheme 2, the breaker

failure timer does not start until the trip input and 50FT element are asserted. This allows definite, predictable scheme timing in single-breaker configurations.

### **Scheme 3: Simple Arrangement Protection Independent of 50FT Reset Time**

Scheme 3 is intended for a single breaker arrangement. When a fault occurs, 50FT asserts. The line protective relay asserts the SEL-352 trip input, and the breaker failure timer starts. If the trip input and 50FT are asserted until the timer expires, a breaker failure condition is declared.

In Scheme 3, the trip input must remain asserted while current flows in the protected breaker. Scheme 3 resets when either the trip input deasserts or the 50FT element drops out.

### **Scheme 4: Sensitive Scheme for Simple or Complex Arrangements**

When the SEL-352 trip input is asserted, the breaker failure pickup timer starts. The trip input is latched and may be deasserted after a single quarter-cycle assertion. The breaker failure timer output asserts a settable time after a trip input asserts and remains asserted for a settable dropout time. A breaker failure condition is declared if the timer output is high and the phase 50FT element is asserted.

### **Scheme 5: Scheme for Simple or Complex Arrangements**

When the trip input is asserted, the breaker failure timer starts. If 50FT is asserted when the timer expires, a breaker failure condition is declared. If the trip input deasserts or 50FT drops out before the timer expires, the logic resets.

This scheme is similar to Scheme 3 because the trip input must remain asserted while current still flows in the protected breaker.

### **Protection While Tripping Load or Line-Charging Current**

Two different schemes detect breaker failures when tripping the breaker under load or line charging current conditions. While the schemes share elements and timers, each is independent. You may enable only one protection scheme at a time or customize the logic.

Both schemes require that the breaker is closed, and the relay received a trip input. The difference between the two schemes is how they determine a closed breaker condition.

Scheme 1 determines a closed breaker condition by comparing the phase current with the 50LD setting. Because this logic is very sensitive, the trip input must be asserted for two consecutive quarter-cycles before this logic acknowledges the input.

In some applications, current through the closed breaker may be below the minimum setting of the 50LD element. Scheme 2 uses the same logic as Scheme 1 but adds the 52A monitoring condition as an additional means for determining an open or closed breaker.

### **Thermal Protection of Close and Trip Resistors**

If the protected breaker is equipped with trip and close resistors and three-phase potentials are available on both sides of the breaker, you can use the SEL-352 thermal protective elements to protect breaker resistors. Occasionally, a trip or close resistor can be left in service following a breaker operation. The SEL-352 can detect that condition, model the energy accumulated in the resistor, and trip the protected breaker or 86 lockout relay when resistor energy reaches a preset level.

A “Close Resistor Thermal Failure” or “Trip Resistor Thermal Failure” is declared when any close or trip resistor thermal model has reached the failure energy level and current is flowing in the hot resistor phase.

The relay models cooling of the breaker resistors using settable time constants. The thermal elements do not drop out until the resistor thermal models have cooled below the element thresholds. This function helps prevent hot resistors from being returned to service.

### **Voltage Nulling**

The thermal protection and flashover protection both require a measurement of the transient voltage difference across the circuit breaker. Voltage nulling logic removes the steady state voltage difference that appears across the breaker. With the steady state voltage difference nulled from the voltage difference measurement, any difference is due to transient conditions.

### **Protection for Current Through an Open Breaker (Flashover)**

Two schemes to detect circuit breaker flashover are provided. While the schemes share elements and timers, each is independent. You may enable only one flashover detection scheme at a time, or you can customize the logic.

Scheme 1 uses voltage across the circuit breaker and the current through the breaker to detect flashover. Scheme 2 uses a single set of voltages on one side of the breaker, the current through the breaker, and the breaker monitor input to detect flashover.

## Protection for Failure to Close

The SEL-352 includes logic which detects a failure of one or two breaker poles to close. Because the logic operates based on current flowing in the breaker poles, protection is not dependent upon the operation of auxiliary contacts. Thus, this logic is not subject to misoperation due to mechanical failure in the breaker or contacts.

## Loss of Dielectric Protection

The SEL-352 loss of dielectric protection logic uses dc input from pressure switches. Breakers equipped with dielectric gas pressure switches close contacts when the pressure drops below a preset level. One input that indicates current transformer dielectric failure can be used for alarming or tripping. Two additional inputs that monitor two thresholds of the dielectric gas pressure of the interrupter can be used for alarming, tripping, or breaker failure tripping.

# Control Logic

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The SEL-352 provides the following control logic:

- Staggered Closing
- Point-on-Wave Closing, which includes:
  - Synchronism Checking
  - Zero-Crossing Detection
  - Trapped Charge Polarity Detection
  - High-Resolution Controlled Close Output Timers
  - Ambient Temperature Compensation (SEL-352-2 and SEL-352-3)
  - DC Control Voltage Compensation (SEL-352-3)
- Point-on-Wave Opening, which includes:
  - Zero-Crossing Detection
  - High-Resolution Controlled Open Output Timers
  - Ambient Temperature Compensation (SEL-352-2 and SEL-352-3)
  - DC Control Voltage Compensation (SEL-352-3)
- Circuit Breaker Retrip Logic
- Breaker Failure Trip and Reset Logic

## Staggered Close

Scheme 1 of the controlled close logic is a staggered close scheme that allows the user to close each pole of a circuit breaker pole at a settable time. The pickup time for each phase timer is settable to allow the user to select the delay between each phase.

## Point-on-Wave Close

The second closing scheme that the SEL-352 provides is a point-on-wave close. Scheme 2 controls at what point on the voltage waveform the circuit breaker closes. The point-on-wave close logic is designed to provide a closing scheme that minimizes breaker wear and system impact when the breaker closes. Point-on-wave closing includes synchronism checking, zero crossing detection, and output timers. Use the ambient temperature

compensation available in the SEL-352-2 and SEL-352-3 and dc control voltage compensation in the SEL-352-3 to provide consistent point-on-wave closing results over a wide range of operating conditions.

## Synchronism Checking

Angle and frequency differences between the X-side and the Y-side voltage are compared against two sets of settings. For example, one set of settings may be used to supervise automatic reclosing you programmed in SELOGIC control equations, and the other set of settings may be used to supervise manual closing through an output contact.

## Zero-Crossing Detection

The SEL-352 determines when a zero crossing of the measured voltage will occur. The point-on-wave close logic closes the breaker based on this detection and the close output timers.

## Trapped Charge Detection

When the SEL-352 detects a positive or negative charge on the line after the breaker opens, the point-on-wave close logic will close on a positive or negative voltage condition, respectively. This minimizes the voltage difference as the breaker closes, minimizing breaker wear.

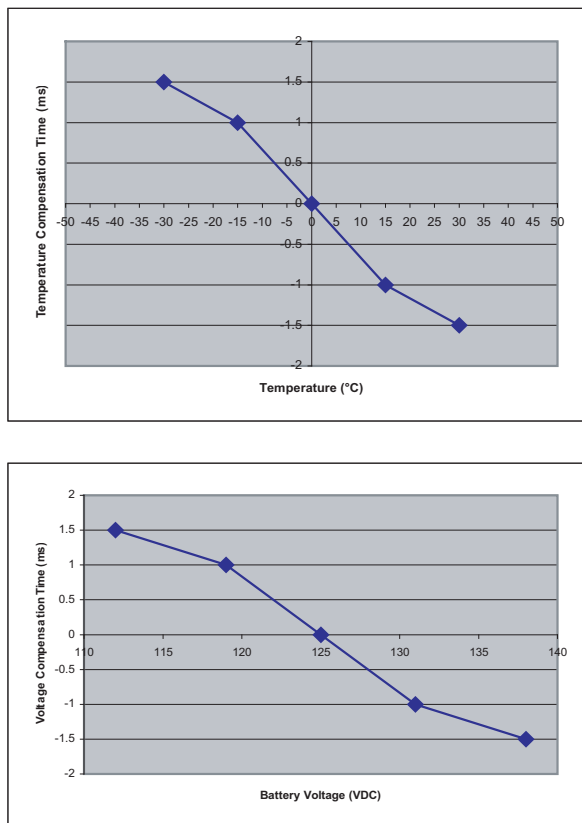
## Controlled Close Output Timers

The output timer logic allows you to set the SEL-352 according to actual breaker operate times. Point-on-wave closing has better than 200  $\mu$ s accuracy for all three phases.

## Point-on-Wave Opening

Controlled opening of the breaker is useful in helping to reduce re-ignition across the breaker contacts in specific applications. Re-ignition takes place when the arcing time is too short and the contact separation is small. This

presents a low dielectric boundary to the recovery voltage after the arc is extinguished, and re-ignition occurs across the open contacts of the breaker. Re-ignition is especially prevalent in applications, such as shunt-connected reactive loads, where there is a high transient recovery voltage and low load current present at the time the breaker contacts open. The SEL-352-2 and SEL-352-3 relays are capable of providing point-on-wave opening control logic. This logic allows the synchronization of maximum breaker contact separation to occur at the voltage peak or zero crossing point, with additional high-resolution timers and voltage and temperature compensation (SEL-352-3) to provide highly repeatable results over a wide range of operating conditions.



**Figure 3 Temperature and Voltage Compensation**

**Table 1 SEL-352 Relay Optional Interface Board Configurations**

Board Type	Outputs		Inputs	
	Number	Type	Number	Type
1	16	Standard, Shared Terminals	8	Standard
2	12	Standard, Independent Terminals	8	Standard
4	4	Standard, Independent Terminals	16	Standard
6	8	Fast Hybrid (High Current Interrupting)	8	Standard
5	12	Hybrid (High Current Interrupting)	8	Standard

## Retripping

Retrip your breaker instantaneously or with a time delay. The two available schemes can also be modified to conform to your specifications for qualifying a retrip condition.

## 86BF Trip and Reset

Lockout relay trip and reset logic is provided for installations with and without automatic breaker isolation schemes.

Use Scheme 1 for breaker failure tripping and “Safe to Reset Lockout Relay” conditions.

Use Scheme 2 to automatically isolate the failed breaker with motor-operated disconnects (MOD). The SEL-352 trips the MOD when current drops below a settable threshold. This scheme can also be used to indicate “Safe to Disconnect” conditions for manual disconnect switches.

## Inputs/Outputs

The SEL-352 has many configurations of input and output options. The basic relay has a main board that includes inputs and outputs, but you may add up to two interface boards for expanded input and output capability.

### Main Board

The main board includes seven programmable output contacts, one ALARM contact, and six optoisolated inputs. A jumper allows Output 7 to follow the ALARM.

### Interface Boards

Table 1 lists the interface boards that expand the dc input and output capability of your SEL-352 to meet your specific needs. Contact the SEL Customer Service Department for ordering options.

# Data Recording

## Event Report

The SEL-352 saves an event report in nonvolatile memory when any of the following occur:

- The relay trips
- User-selected relay elements, input, or outputs assert
- User executes the **TRIGGER** command

Event reporting has three user-selectable configurations:

Event Length	# of Events Stored
15 Cycles	72
30 Cycles	36
60 Cycles	18

The header of each event gives the date and time stamps of the trigger condition and relay identification. Each event report contains all unfiltered analog measurements, all digital inputs and outputs, and selected digital relay logic elements. The event type, system frequency, and voltage nulling calculations are reported just before the settings. The settings are listed at the end of the report for verification.

The relay stores 64 samples per cycle of unfiltered data. Display options allow the user to view the event in a 4-, 8-, or 64-sample per cycle format and to select the number of event report cycles to display.

## Sequential Events Recorder

The SEL-352 stores 512 changes of state for user-selected relay elements, inputs, and output contacts. Each record is time tagged to within two milliseconds. The **SER** command allows the user to display a specific range of events based on the date and time stamp.

## Metering

The meter function shows the values of ac current through the breaker, voltage across and on both sides of the breaker, and three-phase real and reactive power of the system at the breaker.

## Breaker Operation Records

The SEL-352 stores 512 breaker operation records in nonvolatile memory. The event records contain breaker operation data: event date and time, operation type, electrical and mechanical operating times, interrupted energy, and interrupted current. This information is reported on a per-pole basis.

## Breaker Operation Summary

A breaker operation summary report uses data from the breaker operation records to provide breaker information: average and last electrical operating times, average and last mechanical operating times, total interrupted energy, and total interrupted current. The SEL-352-2 and SEL-352-3 add a percent wear estimation to the summary. Use this information to monitor breaker wear and more effectively schedule routine maintenance.

## Breaker Alarms

The BALRM (Breaker Alarm) setting is available for indicating specific breaker alarm conditions. Depending on its setting, the BALRM bit indicates dangerous or abnormal conditions related to operation of the circuit breaker.

Breaker alarm occurrences are stored in memory; the memory resets when settings are changed or a loss of power condition occurs. You can set a programmable output contact to close and indicate when the relay detects a breaker alarm condition.

The default relay settings for BALARM set the BALRM bit for one second and store a message in the alarm message buffer when any of the following conditions are detected:

Failed CB trip resistors put in service	Potential transformers disagree
Failed CB close resistors put in service	Current after MOD trip
52A contradicts voltage	MOD contradicts current
Current while open	Volts across closed CB
Trip while open	Slow trip
CD did not close	Slow close

A history of the breaker alarms is available with the **BREAKER** command.

## Oscillography

Optional software is available to display the SEL-352 event reports in an oscillographic format. Contact the Customer Service Department for more information about the ACSELERATOR Analytic Assistant® SEL-5601 Software.



# Additional Features

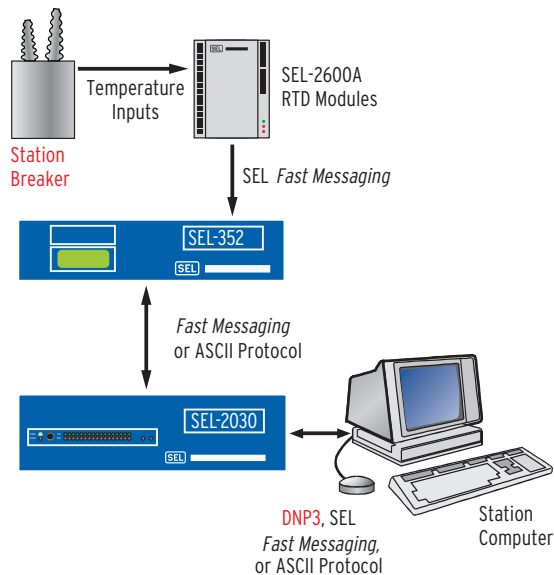
## Serial Interface

The SEL-352 is equipped with three EIA-232 serial ports and one isolated EIA-485 serial port. Each serial port operates independently of the other serial ports.

For connecting devices at over 100 feet, fiber-optic transceivers are available. The SEL-2800 and SEL-2810 provide fiber-optic links between devices for electrical isolation and long distance signal transmission. Contact the SEL Customer Service Department for further information.

## Direct SEL-2600A RTD Module Communications

Program any serial port on the SEL-352-2 or SEL-352-3 to accept fiber-based communications from the SEL-2600A RTD Module. Use an SEL-2600A with the SEL-2800 fiber-optic transceiver on the selected port to provide up to 12 temperature inputs to the relay. Use these temperature inputs for ambient temperature compensation for point-on-wave open and close operations, and as many as 24 individual thermal elements.



**Figure 4 Communications with the SEL-2600A RTD Module (SEL-2800 not shown)**

## Front Panel

The SEL-352 front panel includes a 2-line, 16-character LCD display; 16 LED target/indicators; and 8 pushbuttons. The LCD display shows event information, metering information, and self-test status. The display is controlled with 8 multifunction pushbuttons.

## Targeting

The target LEDs on the front panel illuminate based on various relay conditions. View these targets remotely by issuing the **TARGET** command to one of the serial ports. Front-panel targets illuminate for the conditions shown in *Table 2*.

**Table 2 Front-Panel Target LED Indication**

Target LED	Condition for Illumination	Target LED	Condition for Illumination
Top Row:		Bottom Row:	
EN	Normal Operation	A	Phase A Breaker Failure
PF	Breaker Pending Failure	B	Phase B Breaker Failure
86BFT	Lockout Relay Trip	C	Phase C Breaker Failure
86RS	Lockout Relay Reset	FAULT	Fault Current Protection
TRIP	Breaker Trip Received	LOAD	Load Current Protection
CLOSE	Breaker Close Received	UBAL	Current Unbalance Protection
52A	52A Status Input Assertion	FLASH	Flashover Protection
MOD	MOD Status Input Assertion	THERM	Thermal Failure Protection

## Time Clock Synchronization (IRIG-B)

The SEL-352 accepts a demodulated IRIG-B format signal for synchronizing its internal clock to some external source such as the SEL-2030 or SEL-2020 Communications Processor or SEL-IDM.

# Model Variations

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## SEL-352-1 Relay

The SEL-352-1 has provided sophisticated and reliable service for many years. It continues to satisfy the needs of most of our customers. However, we recommend using the SEL-352-2 and SEL-352-3 for new designs because of the additional features they provide.

## SEL-352-2 Relay

The SEL-352-2 provides the following additional features:

- Overcurrent elements for detecting rms overcurrent conditions on a per-pole or three-phase basis (50R, 50RA, 50RB, and 50RC).
- Percent wear function for estimating the amount of breaker contact wear per pole.
- **BREAKER W** command for preloading the number of operations, total current, total energy, and percent wear fields in the operation summary on a per-pole basis.
- Direct SEL-2600A RTD module communications
- Ambient temperature compensation for point-on-wave breaker opening and closing operations.

## SEL-352-3 Relay

The SEL-352-3 provides the following features in addition to those shown for the SEL-352-2 Relay:

- Battery Voltage Monitoring—up to four setpoints for monitoring station dc battery system health.
- DC Voltage compensation for point-on-wave breaker opening and closing operations.

## Conventional Terminal Blocks

This model includes hardware that supports three current inputs, six voltage inputs, six optoisolated inputs, seven programmable output contacts, one alarm contact, three EIA-232 ports, one EIA-485 port, and IRIG-B time code. It uses terminal blocks that support #6 ring terminals. This robust package meets or exceeds numerous industry standard type tests.

This relay is available in a 3.50" (2U), 5.25" (3U), or 7.00" (4U) rack-mount package or 4.9", 6.65", or 8.40" panel-mount package. Additional optoisolated inputs and programmable output contacts are available with the larger packages.

## Plug-In Connectors (Connectorized®)

This model includes hardware that supports all of the features of the conventional terminal blocks model. It differs in its use of plug-in connectors instead of terminal blocks. In addition, it provides:

- Quick connect/release hardware for rear-panel terminals
- Level-sensitive optoisolated inputs

This robust package meets or exceeds numerous industry standard type tests. It is available in a 5.25" (3U) rack-mount package or a 4.9" panel-mount package.

# Guideform Specification

The microprocessor-based relay shall be applied on a per-breaker basis and provide a combination of functions including protection, monitoring, control, and automation. Relay self-checking functions shall be included. Specific requirements are listed below:

- **Six Voltage Measurements.** The relay shall measure three-phase voltage quantities on both sides of a circuit breaker.
- **Three Current Measurements.** The relay shall measure three-phase current quantities through the circuit breaker. The relay shall provide instantaneous overcurrent elements with fast reset times, even in the presence of subsidence current after the breaker opens.
- **Failure While Tripping Faults.** The relay shall provide five different protection schemes to detect the failure of a circuit breaker to clear a fault. Protection scheme logic shall be provided for simple and complex breaker arrangements, consisting of one or two circuit breakers.
- **Failure While Tripping Load.** The relay shall provide two different protection schemes to detect failure to trip load or line-charging current.
- **Failure to Close (Pole Disagreement Detection).** The relay shall include logic to detect a failure of one or two breaker poles to close.
- **Failure While Open (Breaker Pole Flashover Detection).** The relay shall detect when an open breaker pole flashes over.
- **Failure to Complete a Trip or Close (Resistors Still Inserted).** The relay shall model the energy accumulated in breaker trip and close resistors if they are left in service following a breaker operation. A trip output shall occur when resistor energy reaches a preset level.
- **Loss-of-Dielectric Pressure.** The relay shall include protection logic that uses dc inputs from breaker dielectric gas pressure switches.
- **Motor-Operated Disconnect (MOD) Trip and Power Circuit Breaker Isolation Security Logic.** The relay shall trip the MOD to isolate the failed breaker when phase current drops below a settable value. When an MOD is not installed, the relay logic shall provide indication of “Safe to Disconnect” condition to personnel.
- **Retripping.** The relay shall provide a choice of instantaneous or time-delayed retripping of the protected circuit breaker.
- **Point-on-Wave (POW) Closing.** The relay shall include scheme logic to control at what point on the voltage waveform the circuit breaker closes.
- **Point-on-Wave (POW) Opening.** The relay shall provide the logic to control at what point on the voltage waveform the circuit breaker opens under normal breaker operating conditions.
- **Synchronism Check.** The relay shall measure angle and frequency differences between voltage sources on either side of an open circuit breaker. Two user-selectable settings shall be provided to supervise automatic and manual closing of the breaker.
- **Trapped Charge Polarity Detection.** The relay shall include detection of trapped charge polarity for use with point-on-wave close logic.
- **Circuit Breaker Monitor.** The relay shall include a breaker wear monitor with user-definable wear curves, operation counters, and accumulated interrupted currents per phase.
- **Status and Trip Target LEDs.** The relay shall include 16 status and trip target LEDs.
- **Event Reporting and Sequential Events Recorder (SER).** The relay shall be capable of automatically recording disturbance events of 15, 30, or 60 cycles with settable prefault duration and user-defined triggering. Events shall be stored in nonvolatile memory. The relay shall include an SER that stores the latest 512 entries.
- **Distributed Network Protocol (DNP).** The relay shall incorporate certified DNP3 Level 2 Slave protocol communications capability. The DNP capability shall include automatic dial-out for settings-based DNP events and virtual terminal support with full ASCII capability.
- **Relay Logic.** The relay shall include programmable logic functions for a wide range of user-configurable protection, monitoring, and control schemes.
- **Auxiliary Inputs/Outputs.** The relay shall include fully programmable optoisolated inputs and output contacts.
- **Metering.** The relay shall include metering capabilities for ac current through the breaker, voltage across and on both sides of the breaker, and three-phase real and reactive power of the system at the breaker.
- **Communication.** The relay shall include three independent EIA-232 serial ports and one EIA-485 serial port for external communications. The communication ports shall operate at a speed of 300–19200 bits per second. Three-level password protection shall be included to provide secure remote communications.
- **Internal Real-Time Clock.** The relay shall include a real-time clock, with battery backup, synchronizable to demodulated IRIG-B input, to provide accurate time stamps for event records.
- **Low-Level Testing.** The relay shall include a low-level test interface to permit relay testing with low energy test equipment.

- **Ambient Temperature Compensation.** The relay shall provide the ability to set temperature compensation times for point-on-wave breaker control based upon measured ambient temperature.

- **Control Voltage Compensation.** The relay shall provide the ability to set control voltage compensation times based upon measured control voltage. The control voltage compensation will be used with point-on-wave breaker control operations.

## Wiring Diagrams

### AC Diagram

Connect the SEL-352 to the breaker current transformers for current-only, breaker-failure detection. Obtain voltage monitoring with the addition of three voltages on one side of the breaker. Supply at least one voltage on

each side of the breaker to obtain synchronism checking. By connecting current and supplying three voltages on each side of the breaker, you can obtain thermal protection in addition to breaker-failure detection, voltage monitoring, and synchronism checking.

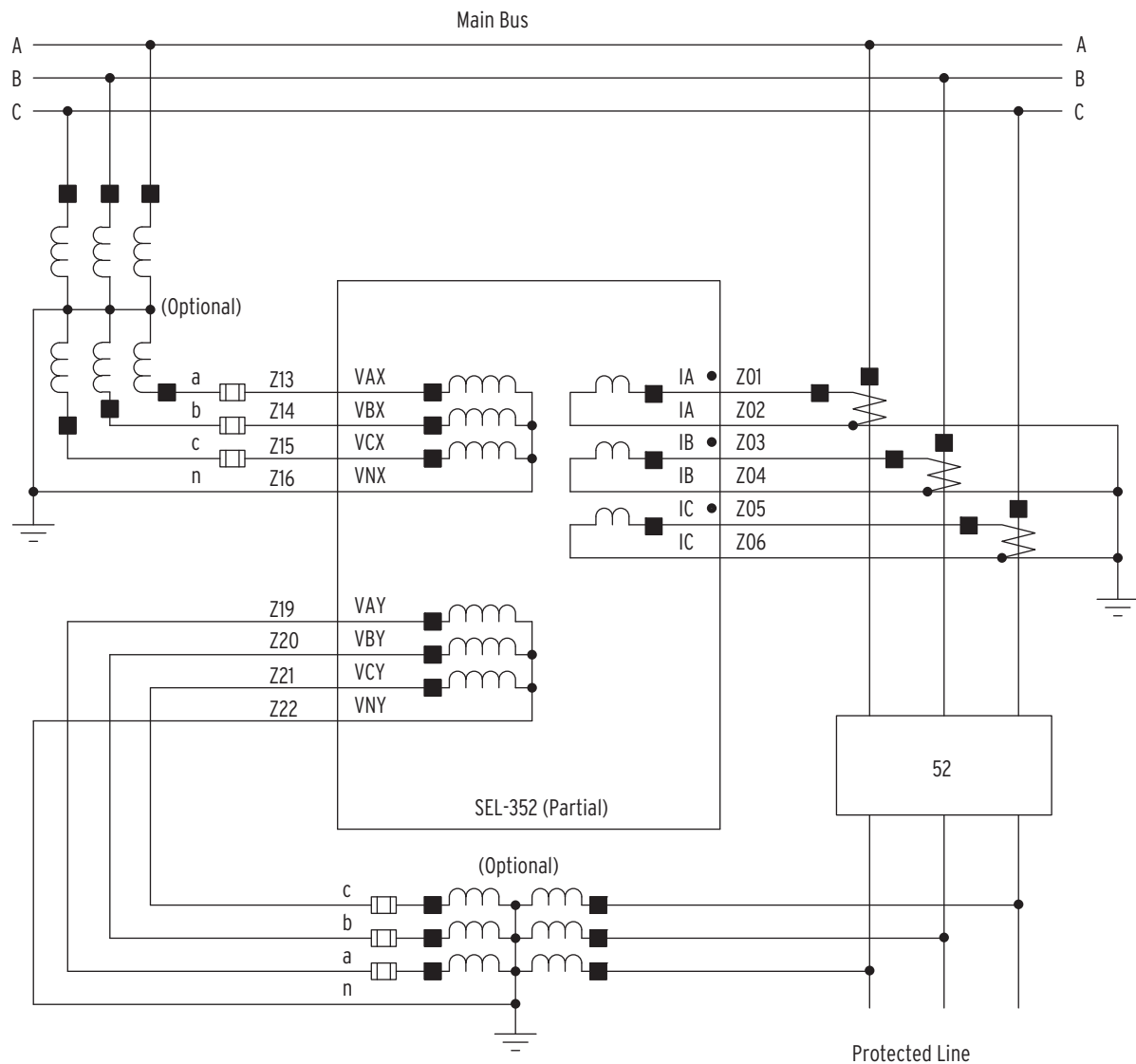
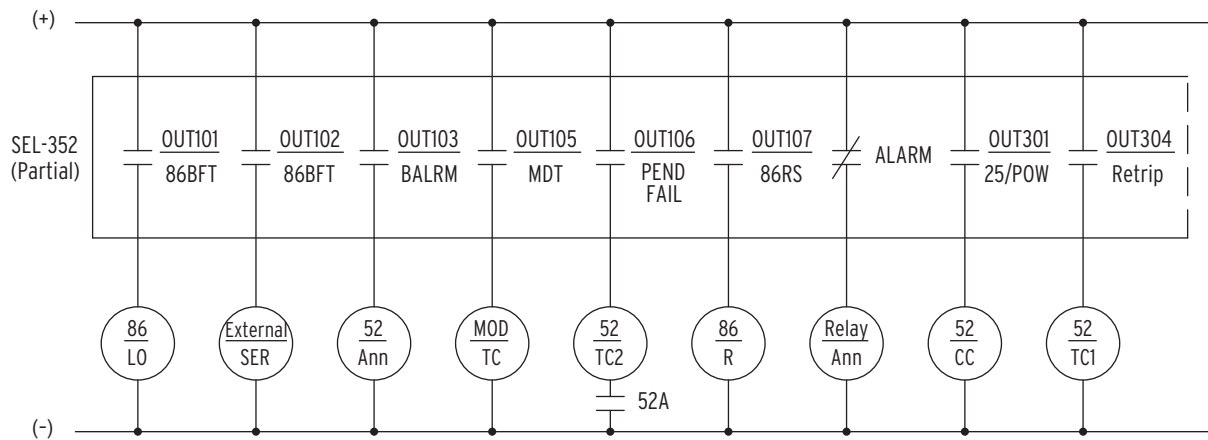


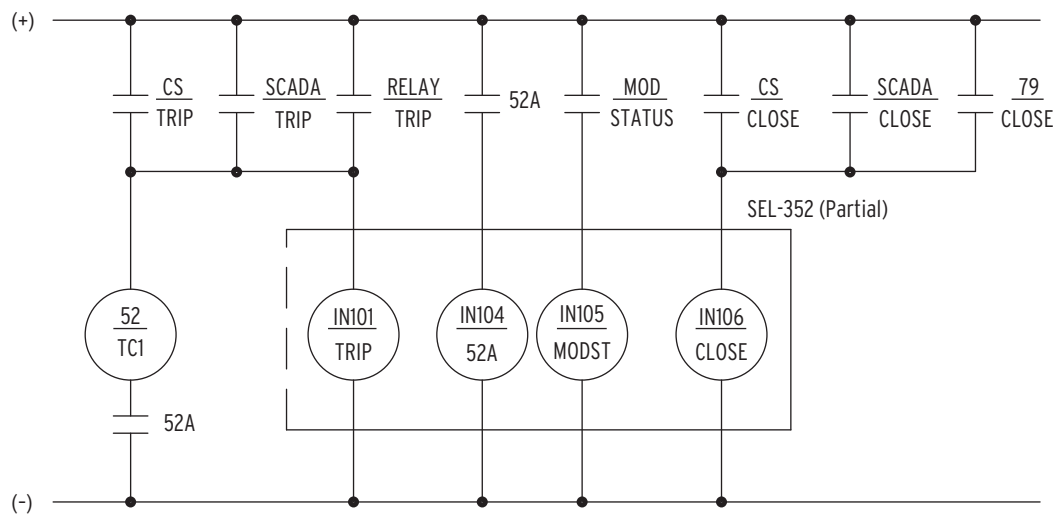
Figure 5 Typical External AC Connections

## DC Diagram

The following diagrams give a simple example of how the SEL-352 can be connected. Inputs and outputs of the SEL-352 are fully programmable for application flexibility. Optional interface boards provide additional outputs and inputs, as described in *Table 1*.

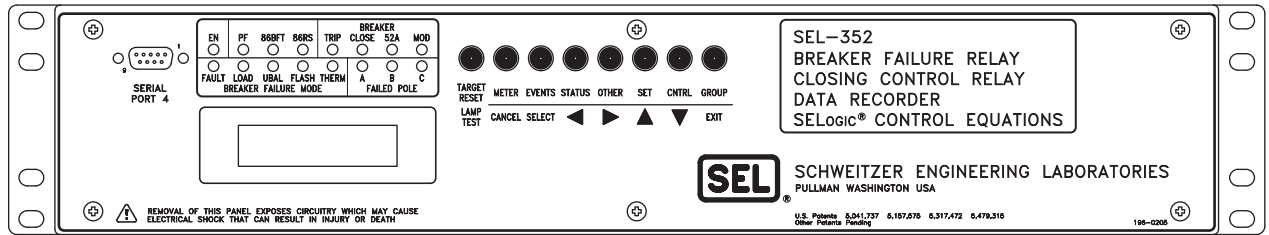


**Figure 6** Example DC Output Contact Connections

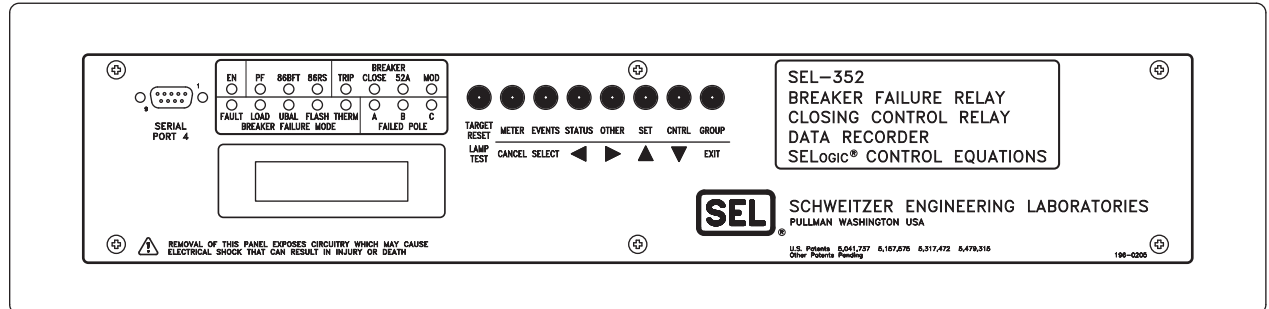


**Figure 7** Example DC Input Connections

# Front- and Rear-Panel Diagrams

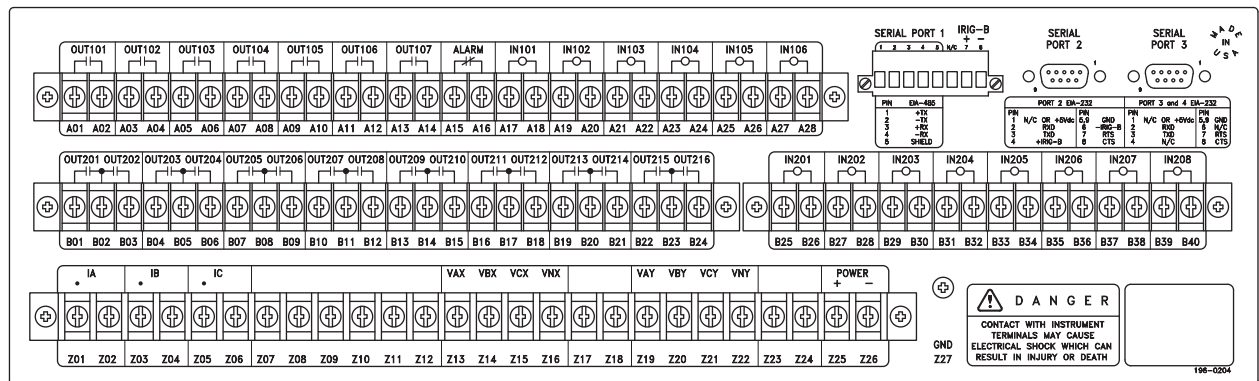


i3152b

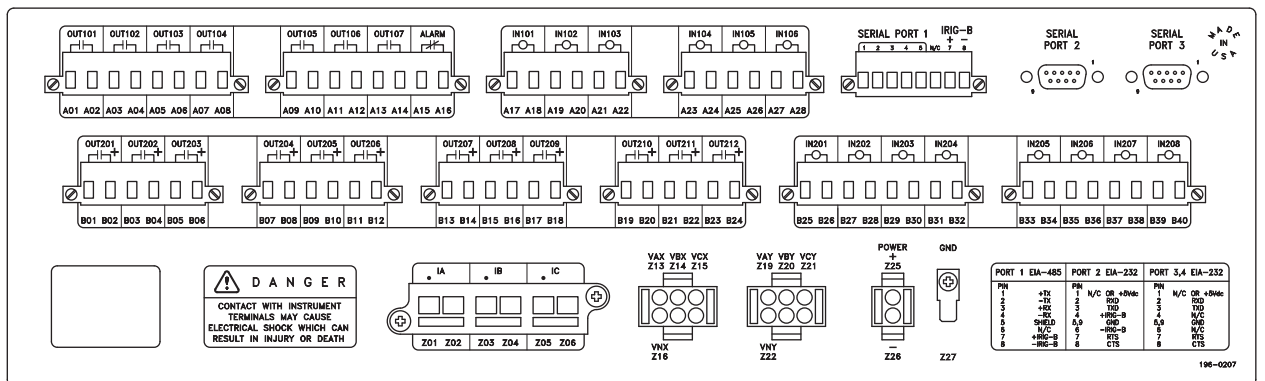


i3154b

Figure 8 SEL-352 Front-Panel Diagrams



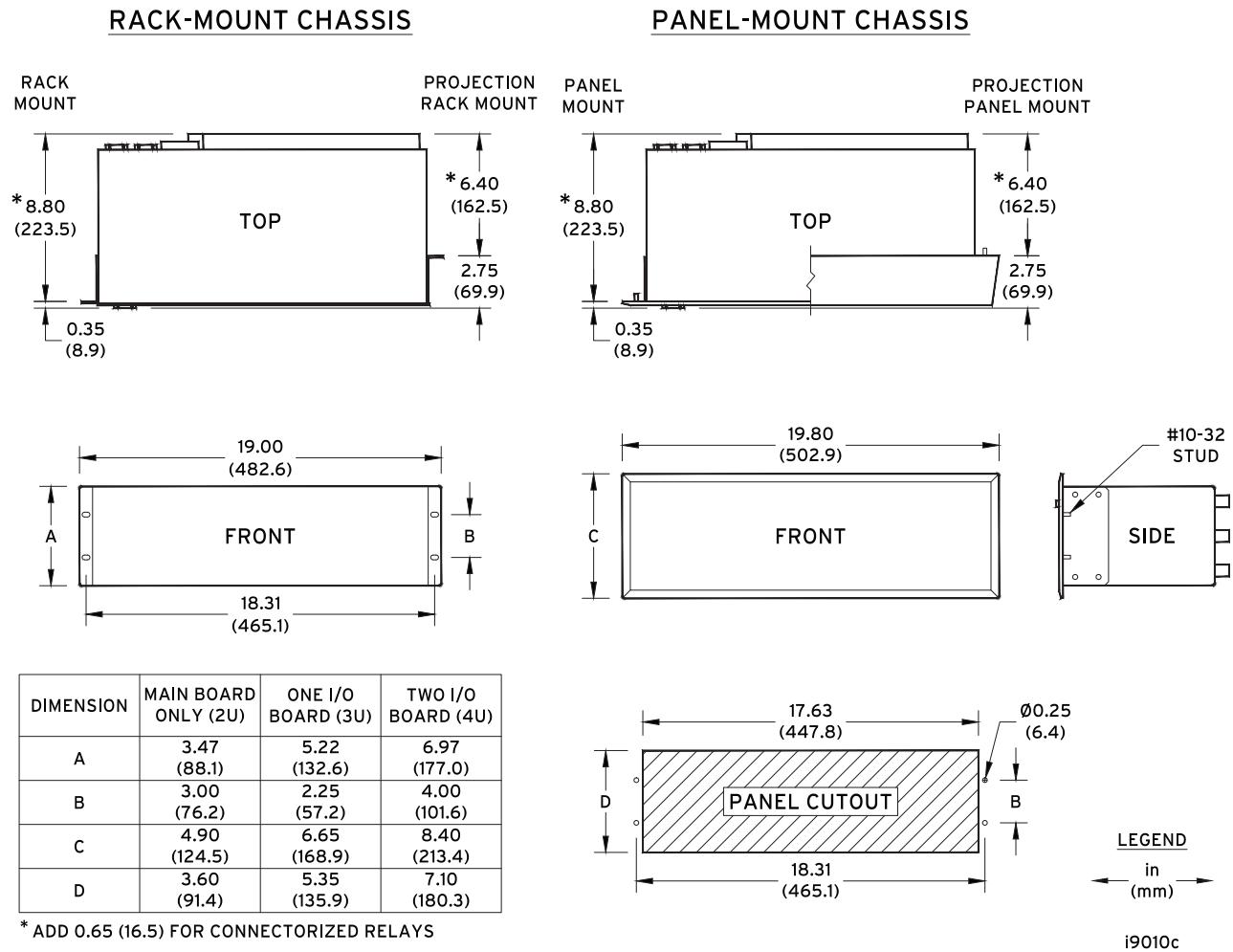
i3161c



i3170b

Figure 9 SEL-352 Rear-Panel Diagrams

# Relay Dimensions



**Figure 10 SEL-352 Dimensions for Rack- and Panel-Mount Models**

# Specifications

## Compliance

Designed and manufactured under an ISO 9001 certified quality management system  
UL Listed to U.S. and Canadian safety standards (File E212775; NRGU, NRGU7)  
CE Mark

## Signal Processing

Analog Data Acquisition:	–3 dB cutoff at 1200 Hz, 64 samples per cycle
Digital Filtering:	Half cosine filter for the 50FT overcurrent elements. Cosine filter for all other elements.
Processing Intervals	
1/8 cycle:	Event Report Triggers Targets Optoisolated inputs Local Bits Remote Bits Contact Output Elements Fault Current Prot. Elements 86BF Trip and Reset Elements SELOGIC control equation SET A Elements SELOGIC control equation Analog Compares
1/4 cycle:	All other elements

## General

### AC Current Inputs

5 A nominal:	15 A continuous, 500 A for 1 s, linear to 100 A symmetrical. 1250 A for 1 cycle.
Burden:	0.27 VA at 5 A 2.51 VA at 15 A
1 A nominal:	3 A continuous, 100 A for 1 s, linear to 20 A symmetrical. 250 A for 1 cycle.
Burden:	0.13 VA at 1 A 1.31 VA at 3 A

### AC Voltage Inputs

120  $V_{L-N}$ , three-phase, four-wire connection.  
150  $V_{L-N}$  continuous (connect any voltage up to 150 Vac)  
365 Vac for 10 s

Burden: 0.13 VA at 67 V; 0.45 VA at 120 V

### Power Supply

125/250 Vdc or Vac	
Range:	85–350 Vdc or 85–264 Vac
Burden:	<25 W
Interruption:	30 ms at 125 Vdc
Ripple:	100%
24/48 Vdc	
Range:	20–60 Vdc polarity dependent
Burden:	<25 W
Interruption:	30 ms at 48 Vdc
Ripple:	5%

**Note:** Interruption and Ripple per IEC 60255-11[IEC 255-11]1979.

## Output Contacts

Standard:

Make:	30 A
Carry:	6 A continuous carry at 70°C 4 A continuous carry at 85°C

1 s Rating: 50 A

MOV Protection: 270 Vac/360 Vdc; 40 J

Pickup Time: <5 ms

Dropout Time: <5 ms, typical

Breaking Capacity (10000 operations):

24 V	0.75 A	L/R = 40 ms
48 V	0.50 A	L/R = 40 ms
125 V	0.30 A	L/R = 40 ms
250 V	0.20 A	L/R = 40 ms

Cyclic Capacity (2.5 cycles/second):

24 V	0.75 A	L/R = 40 ms
48 V	0.50 A	L/R = 40 ms
125 V	0.30 A	L/R = 40 ms
250 V	0.20 A	L/R = 40 ms

High Current Interrupting Option

Make:	30 A
Carry:	6 A continuous carry at 70°C 4 A continuous carry at 85°C

1 s Rating: 50 A

MOV Protection: 330 Vdc; 40 J

Pickup Time: <5 ms

Dropout Time: <8 ms, typical

Breaking Capacity (10000 operations):

24 V	10.0 A	L/R = 40 ms
48 V	10.0 A	L/R = 40 ms
125 V	10.0 A	L/R = 40 ms
250 V	10.0 A	L/R = 20 ms

Cyclic Capacity (4 cycles in 1 second followed by 2 minutes idle for thermal dissipation):

24 V	10.0 A	L/R = 40 ms
48 V	10.0 A	L/R = 40 ms
125 V	10.0 A	L/R = 40 ms
250 V	10.0 A	L/R = 20 ms

**Note:** Do not use high current interrupting output contacts to switch ac control signals. These outputs are polarity dependent.

Fast High Current Interrupting Option

Make:	30 A
Carry:	6 A continuous carry at 70°C 4 A continuous carry at 85°C

1 s Rating: 50 A

MOV Protection: 330 Vdc; 40 J

Pickup Time: <200  $\mu$ s

Dropout Time: <8 ms, typical

Breaking Capacity (10000 operations):

24 V	10.0 A	L/R = 40 ms
48 V	10.0 A	L/R = 40 ms
125 V	10.0 A	L/R = 40 ms
250 V	10.0 A	L/R = 20 ms



Cyclic Capacity (4 cycles in 1 second followed by 2 minutes idle for thermal dissipation):

24 V	10.0 A	L/R = 40 ms
48 V	10.0 A	L/R = 40 ms
125 V	10.0 A	L/R = 40 ms
250 V	10.0 A	L/R = 20 ms

**Note:** Fast High Current Interruption Option output contacts **are not** polarity dependent.

**Note:** Make per IEEE C37.90-1989; Breaking and Cyclic Capacity per IEC 60255-23 [IEC 255-23]:1994.

### Optoisolated Inputs

250 Vdc:	Pickup 200–300 Vdc; Dropout 150 Vdc
125 Vdc:	Pickup 105–150 Vdc; Dropout 75 Vdc
110 Vdc:	Pickup 88–132 Vdc; Dropout 66 Vdc
48 Vdc:	Pickup 38.4–60 Vdc; Dropout 28.8 Vdc
24 Vdc:	Pickup 15.0–30 Vdc

**Note:** 24, 48, and 125 Vdc optoisolated inputs draw approx. 4 mA of current; 110 Vdc inputs draw approx. 8 mA of current; and 250 Vdc inputs draw approx. 5 mA of current. All current ratings are at nominal input voltage.

### Frequency and Rotation

System Frequency:	50 or 60 Hz
Phase Rotation:	ABC or ACB

### Frequency Tracking

NFREQ = 60	Tracking range is 55–63 Hz
NFREQ = 50	Tracking range is 45–55 Hz

### Communications Ports

EIA-232:	1 front and 2 rear
EIA-485:	1 rear, 2100 Vdc isolation
Baud Rate:	300–19200 baud

### Operating Temperature

–40° to +85°C (–40° to +185°F)

### Time-Code Input

Relay accepts demodulated IRIG-B time-code input at Port 1 or 2. Relay is time synchronized to within  $\pm 5$  ms of time source input.

### Tightening Torque

Terminal Block	
Minimum:	9-in-lb (1.1 Nm)
Maximum:	12-in-lb (1.3 Nm)
Connectorized®	
Minimum:	5-in-lb (0.6 Nm)
Maximum:	7-in-lb (0.8 Nm)

### Terminal Connections

Terminals or stranded copper wire. Ring terminals are recommended. Minimum temperature rating of 105°C.

### Routine Dielectric Strength

AC current and voltage inputs:	2500 Vac for 10 s
Power supply, optoisolated inputs, and output contacts:	3100 Vdc for 10 s

### Weight

2U rack unit height:	15 lbs (6.8 kg)
3U rack unit height:	17.75 lbs (8 kg)

## Type Tests

### Emissions

*Generic Emissions, Heavy Industrial:	EN 50081-2:1993, Class A
*Generic Immunity, Heavy Industrial:	EN 50082-2:1995
*Radiated and Conducted Emissions:	EN 55011:1998, Class A
*Conducted Radio Frequency:	EN 61000-4-6:1996, ENV 50141:1993, 10 Vrms
Radiated Radio Frequency (900 MHz with modulation):	ENV 50204:1995, 10 V/m

**Note:** \* = Terminal Block version only.

### Environmental Tests

Cold:	IEC 60068-2-1:1990 [EN 60068-1-1:1993] Test Ad; 16 hr at –40°C
Damp Heat Cyclic:	IEC 60068-2-30:1980 Test Db; 25° to 55°C, 6 cycles, 95% humidity
Dry Heat:	IEC 60068-2-2:1974 [EN 60068-2-2:1993] Test Bd; 16 hr at +85°C

### Dielectric Strength and Impulse Tests

Dielectric:	IEC 60255-5:1977 IEEE C37.90-1989 2500 Vac on analogs, contact inputs, and contact outputs; 3100 Vdc on power supply; 2200 Vdc on EIA-485 communications port
Impulse:	IEC 60255-5:1977 0.5 J, 5000 V

### Electrostatic Discharge Test

ESD:	IEC 60255-22-2:1996 IEC 61000-4-2:1995 Level 4
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### RFI and Interference Tests

1 MHz Burst Disturbance:	IEC 60255-22-1:1988 Class 3
Fast Transient Disturbance:	IEC 60255-22-4:1992) IEC 61000-4-4:1995) Level 4
Radiated EMI:	IEC 60255-22-3:1989 ENV 50140:1993 IEEE C37.90.2-1995, 35 V/m
Surge Withstand:	IEEE C37.90.1-1989 3.0 kV oscillatory; 5.0 kV fast transient

### Vibration and Shock Tests

Shock and Bump:	IEC 60255-21-2:1988 Class 1 IEC 60255-21-3:1993 Class 2
Sinusoidal Vibration:	IEC 60255-21-1:1988 Class 1

### Object Penetration

Object Penetration:	IEC 60529:1989 IP 30, IP 54 from the front panel using the SEL-9103 front-cover dust and splash protection
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## Processing Specifications

64 samples per power system cycle

## Relay Elements

### Overcurrent Element

#### 50FT–Fault Current Element With Subsidence Current Logic

Setting ranges	
$I_{nom} = 5 \text{ A}$ :	0.50–45.00 A secondary, 0.01 A steps
$I_{nom} = 1 \text{ A}$ :	0.10–9.00 A secondary, 0.01 A steps
Pickup time:	less than 0.55 cycles at 2 multiples of pickup
Dropout time:	less than 0.75 cycle
Pickup and dropout:	$\pm 0.025 \text{ A secondary} \pm 5\%$ of setting
Transient overreach	$\pm 14\%$ of setting

#### 50MD–MOD Current Element

#### 50LD–Load/Line-Charging Current Element

Setting ranges	
$I_{nom} = 5 \text{ A}$ :	0.10–45.00 A secondary, 0.01 A steps
$I_{nom} = 1 \text{ A}$ :	0.02–9.00 A secondary, 0.01 A steps
Pickup time:	less than 0.9 cycles at 2 multiples of pickup
Dropout time:	less than 1.35 cycles
Pickup and dropout:	$\pm 0.025 \text{ A secondary} \pm 5\%$ of setting
Transient overreach	$\pm 5\%$ of setting

#### 50MN–Minimum Current Element

Current threshold (fixed)	
$I_{nom} = 5 \text{ A}$ :	0.10 A secondary
$I_{nom} = 1 \text{ A}$ :	0.02 A secondary
Pickup time:	less than 0.9 cycles at 2 multiples of pickup
Dropout time:	less than 1.35 cycles
Pickup and dropout:	$\pm 0.03 \text{ A secondary}$
Transient overreach:	$\pm 5\%$ of setting

#### 50N–Ground Overcurrent Element

Setting ranges	
$I_{nom} = 5 \text{ A}$ :	0.10–45.00 A secondary, 0.01 A steps
$I_{nom} = 1 \text{ A}$ :	0.02–9.00 A secondary, 0.02 A steps
Pickup time:	less than 0.9 cycles at 2 multiples of pickup
Dropout time:	less than 1.35 cycles
Pickup and dropout:	$\pm 0.025 \text{ A secondary} \pm 5\%$ of setting
Transient overreach:	$\pm 5\%$ of setting

#### 50R–RMS Overcurrent Element (Only available in the SEL-352-2 and SEL-352-3)

Setting ranges	
$I_{nom} = 5 \text{ A}$ :	0.50–45.00 A secondary, 0.10 A steps
$I_{nom} = 1 \text{ A}$ :	0.10–9.00 A secondary, 0.02 A steps
Pickup time:	less than 0.9 cycles at 2 multiples of pickup
Dropout time:	less than 1.125 cycles
Pickup and dropout:	$\pm 0.1 \cdot I_{nom} \text{ A secondary} \pm 5\%$ of setting
Transient overreach:	$\pm 5\%$ of setting

### Voltage Element

#### 87H–Voltage Across Breaker to Cause Flashover Overvoltage Element

#### 87FO–Voltage Across Flashed Over Breaker Overvoltage Element

#### 87TH–Voltage Across the Breaker Required to Enable the Thermal Models

Setting range:	1.0–150.0 V secondary, 0.1 V steps
Pickup time:	less than 1.35 cycles

Dropout time:	less than 1.55 cycles
Pickup and dropout:	$\pm 0.09 \text{ V secondary} \pm 5\%$ of setting
Transient overreach:	$\pm 5\%$ of setting

#### X47Q–Negative-Sequence Overvoltage Element and Y47Q–Negative-Sequence Overvoltage Element

Setting range:	2.0–140.0 V secondary, 0.1 V steps
Pickup time:	less than 1.35 cycles
Dropout time:	less than 1.55 cycles
Pickup and dropout:	$\pm 0.27 \text{ V secondary} \pm 6\%$ of setting
Transient overreach:	$\pm 5\%$ of setting

#### X59H–High-Set Overvoltage Element

Setting range:	1.0–130.0 V secondary, 0.1 V steps
Pickup time:	less than 1.35 cycles
Dropout time:	less than 1.55 cycles
Pickup and dropout:	$\pm 0.09 \text{ V secondary} \pm 5\%$ of setting
Transient overreach:	$\pm 5\%$ of setting

#### X27D–Dead Line Undervoltage Element

#### Y27D–Dead Line Undervoltage Element

Setting range:	1.0–120.0 V secondary, 0.1 V steps
Pickup time:	less than 1.35 cycles
Dropout time:	less than 1.55 cycles
Pickup and dropout:	$\pm 0.09 \text{ V secondary} \pm 5\%$ of setting
Transient overreach:	$\pm 5\%$ of setting

#### X59L–Line Line Overvoltage Element

#### Y59L–Live Line Overvoltage Element

Setting range:	10.0–120.0 V secondary, 0.1 V steps
Pickup time:	less than 1.35 cycles
Dropout time:	less than 1.55 cycles
Pickup and dropout:	$\pm 0.09 \text{ V secondary} \pm 5\%$ of setting
Transient overreach:	$\pm 5\%$ of setting

### Synchronism Check Element

#### 25SC–Maximum Slip Frequency for Controlled Close

#### 25SM–Maximum Slip Frequency for Manual Close

Setting range:	0.005–0.500 Hz, 0.001 Hz steps
Pickup and dropout:	$\pm 0.002 \text{ Hz} \pm 5\%$ of setting

#### 25AC–Maximum Controlled Close Angle

#### 25AM–Maximum Manual Close Angle

Setting range:	$32 \cdot (25SC \text{ or } 25SM) - 90^\circ$ , min = $1^\circ$ , 0.1° steps
Pickup and dropout:	$\pm 0.5^\circ \pm 5\%$ of setting

### Current Unbalance Element

#### 46P–Phase Current Unbalance Element

46P detects phase discordance when the protective breaker closes. For example, A-phase is unbalanced if phase current is above the 50LD setting in one or more phases and:

$$|I_A| < (|I_A| + |I_B| + |I_C|) / 46UB \text{ setting where } 46UB \text{ setting} = 8, 16, 32, \text{ or } 64.$$

Time to stabilize measurement due to transient conditions:	less than 1.35 cycles
--	-----------------------

## Overpower Elements

### 37OP—Breaker Overpower Element

Setting ranges	
$I_{nom} = 5 \text{ A}$ :	0.10–3400.00 W secondary, 0.01 W steps
$I_{nom} = 1 \text{ A}$ :	0.02–680.00 W secondary, 0.01 W steps
Pickup time:	less than 2.10 cycles
Dropout time:	less than 3.00 cycles
Maximum element error, secondary units:	$\pm 2.25 \text{ mW} \pm 10.25\%$ (measured input power) $\pm 2.63\%$ (measured voltage) $\pm 9.45\%$ (measured current)

### Breaker Resistor Thermal Elements

26CF—Close Resistor Failure Element  
 26CP—Close Resistor Pending Failure Element  
 26TF—Trip Resistor Failure Element  
 26TP—Trip Resistor Pending Failure Element

Setting ranges	
$I_{nom} = 5 \text{ A}$ :	0.01–1000.00 Joules secondary, 0.001 J steps
$I_{nom} = 1 \text{ A}$ :	0.002–200.000 Joules secondary, 0.001 J steps

Pickup error is based on 37OP element over time.

### Temperature Elements (SEL-352-2, SEL-352-3)

49Ann—Thermal Alarm Element	
49Tnn—Thermal Trip Element	
Setting range:	–50° to +250°C, 1°C steps
Accuracy:	$\pm 2^\circ\text{C}$

### Substation Battery Voltage Monitor (SEL-352-3 only)

Setting range:	20–300 Vdc
Accuracy:	$\pm 2\%$ of setting

### Settable Timers

SYNCT—Synchronizing Time Dropout (SYNCdo)	
Setting range:	0.00–99999.00 cycles, 1/4-cycle steps
Pickup setting:	$\pm 0.25$ cycle or $\pm 0.25\%$ of setting

62TT—Failure-to-Trip Fault Current Trip Input Timer	
62FC—Failure-to-Trip Fault Current Failure Timer	
62T1—General Purpose Timer 1	
62M2—Maximum Bus Clearing Time	
62M3—Maximum MOD Operate Time	
Setting range:	0.0–8191.0 cycles, 1/8-cycle steps
Pickup setting:	$\pm 0.125$ cycle or $\pm 0.25\%$ of setting

SCT—Synchronous Close Timer (CLSdo)  
 62LD—Failure-to-Trip Load Current Failure Timer  
 62LP—Failure-to-Trip Load Current Pending Failure Timer  
 62AF—Failure of Breaker 52A Contact to Indicate Operation Failure Timer  
 62AP—Failure of Breaker 52A Contact to Indicate Operation Pending Failure Timer  
 62FF—Flashover Failure Timer  
 62FP—Flashover Pending Failure Timer  
 62UC—Phase Discordance Close Input Pickup Timer  
 62OP—Trip and Close Resistor Heating Pickup Timer  
 62L2—Loss-of-Dielectric Timer  
 62UF—Phase Discordance Failure Timer  
 62UP—Phase Discordance Pending Failure Timer  
 62T3—General Purpose Timer 3  
 62T4—General Purpose Timer 4  
 62RT—Delayed Trip Time  
 62RC—Staggered Close Time

Setting range:	0.00–16383.00 cycles, 1/4-cycle steps
Pickup setting:	$\pm 0.25$ cycles or $\pm 0.25\%$ of setting

62ZCA—A-Phase Zero-Crossing Timer  
 62ZCB—B-Phase Zero-Crossing Timer  
 62ZCC—C-Phase Zero-Crossing Timer  
 62PCA—A-Phase Peak-Crossing Timer  
 62PCB—B-Phase Peak-Crossing Timer  
 62PCC—C-Phase Peak-Crossing Timer  
 62COA—A-Phase Controlled Opening Timer  
 62COB—B-Phase Controlled Opening Timer  
 62COC—C-Phase Controlled Opening Timer

Setting range:	0.00–40.00 ms, 0.01 ms steps
Pickup setting:	$\pm 200 \mu\text{sec}$

### 62VN—Voltage Nulling Delay Timer

Setting range:	0.00–240.00 minutes, 0.01 min steps
Pickup setting:	$\pm 0.25$ cycles or $\pm 0.25\%$ of setting

### Fixed Timers

62F1—Flashover Voltage Timer Delayed Dropout Timer	5 cycles $\pm 0.25$ cycle
62F2—Load Current Pickup timer (Flashover Logic)	5 cycles $\pm 0.25$ cycle
62F3—Trip or Close Dropout Timer (Flashover Logic)	6 cycles $\pm 0.25$ cycle
62M1—86BF Reset Signal Duration Timer	60 cycles $\pm 0.125$ cycle
62M4—86BF Reset Time Delay, MOD Logic Enabled	300 cycles $\pm 0.125$ cycle
62LT1—Loss-of- Dielectric Input Debounce Timer	60 cycles $\pm 0.25$ cycle
62LT3—Loss-of- Dielectric Input Debounce Timer	60 cycles $\pm 0.25$ cycle
MCT—Manual Close Input Dropout Timer	2 cycles $\pm 0.25$ cycle
SEN—Synchronism Calculation Enable Pickup Timer	15 cycles $\pm 0.25$ cycle
SS—Slip Security Pickup Timer	4.5 cycles $\pm 0.25$ cycle
T1A—Controlled Opening Bypass Timer	10.0 cycles $\pm 0.25$ cycle

### Internal Logic Timers

62XZPB—B-Phase Positive Zero-Crossing Delay Timer for X Side	0.33 cycles
62XZNB—B-Phase Negative Zero-Crossing Delay Timer for X Side	0.33 cycles
62XZPC—C-Phase Positive Zero-Crossing Delay Timer for X Side	0.66 cycles
62XZNC—C-Phase Negative Zero-Crossing Delay Timer for X Side	0.66 cycles
62YZPB—B-Phase Positive Zero-Crossing Delay Timer for Y Side	0.33 cycles
62YZNB—B-Phase Negative Zero-Crossing Delay Timer for Y Side	0.33 cycles

62YZPC—C-Phase Positive Zero-Crossing Delay Timer for Y Side	0.66 cycles
62YZNC—C-Phase Negative Zero-Crossing Delay Timer for Y Side	0.66 cycles
62CODB—B-Phase Controlled Opening Delay Timer	0.33 cycles
62CODC—C-Phase Controlled Opening Delay Timer	0.66 cycles
62T—Trapped Charge Trip Input Dropout Timer	4 cycles
62V—Trapped Charge Voltage Dropout Timer	7 cycles
TCDpu—Trapped Charge Detection Pickup Timer	1 cycles
TCDdo—Trapped Charge Detection Dropout Timer	12 cycles
62BALRM—Breaker Alarm Dropout Timer	60 cycles
62OI—Operation Input Dropout Timer for Breaker Alarms	5 cycles
62BDNC—BDNC Breaker Alarm Close Inputs Pickup Timer	3 cycles
62TWO—Trip Input Dropout Debounce Timer	0.25 cycles

### Metering

VAX:	A-Phase Voltage for the X Side ac inputs
VBX:	B-Phase Voltage for the X Side ac inputs
VCX:	C-Phase Voltage for the X Side ac inputs
VAY:	A-Phase Voltage for the Y Side ac inputs
VBY:	B-Phase Voltage for the Y Side ac inputs
VCY:	C-Phase Voltage for the Y Side ac inputs
Units:	kilovolts (kV) primary
Accuracy:	±0.67 V secondary
IA:	A-Phase current ac input
IB:	B-Phase current ac input
IC:	C-Phase current ac input
Units:	Amps (A) primary
Accuracy	
I <sub>nom</sub> = 5 A:	±0.05 A secondary
I <sub>nom</sub> = 1 A:	0.01 A secondary

### Multiple Setting Groups

SS1:	Setting group selection input 1
SS2:	Setting group selection input 2
Number of setting groups:	3
Setting group change delay:	TGR setting and up to 3 seconds uncertainty

### Data Recording Specifications

#### Event Records

##### MER—Event Report Trigger

Pickup accuracy:	0.000 to 0.125 cycle
Number of events:	600/LER setting (15, 30, or 60 cycles)

SER1—Sequential-Event-Recorder Trigger List 1  
 SER2—Sequential-Event-Recorder Trigger List 2  
 SER3—Sequential-Event-Recorder Trigger List 3

Pickup accuracy:	0.00 to 0.125 cycle
Number of trigger elements:	24 per list, 72 total
Number of events displayed:	512

#### Breaker Monitor Reporting

Electrical operate time units:	ms
Mechanical operate time units:	ms
Energy units:	MJ, primary
Current units:	A, primary
Breaker contact wear: (SEL-352-2 and SEL-352-3 relays only)	%
Number of operations displayed:	512

Other relay elements determine accuracy.

### Serial Port Specifications

Port 1:	EIA-485 with IRIG-B inputs
Port 2:	EIA-232 with IRIG-B input and +5 Vdc output. Maximum total current draw on +5 Vdc supply through serial ports is 1 A.
Port 3:	EIA-232 with +5 Vdc output
Port 4:	EIA-232

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