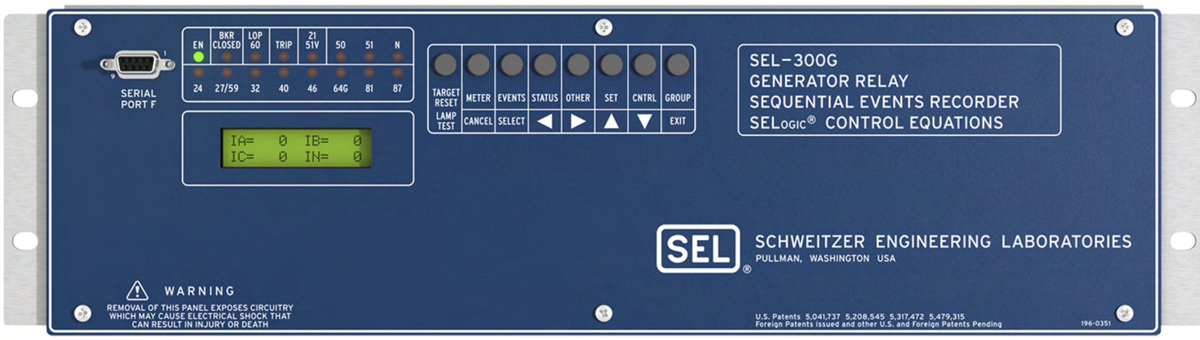
SEL-300G Generator Relay



The SEL-300G Generator Relay is a comprehensive, multifunction relay intended for primary and/or backup protection for any size synchronous machine.

Features

Protection

- ➤ 100% Stator Ground
- ➤ Field Ground (with SEL-2664 Field Ground Module)
- ➤ Phase (optional) or Ground Differential
- ➤ Volts/Hertz
- ➤ Reverse or Low Forward Power
- ➤ Backup Overcurrent Protection
- ➤ Negative-Sequence Overcurrent
- ➤ Loss-of-Field
- ➤ Six Levels of Over- or Underfrequency, Plus Time Accumulators
- ➤ Over- and Undervoltage
- ➤ Inadvertent Energization
- ➤ Loss-of-Potential
- ➤ Synchronism Check (optional)
- ➤ Out-of-Step (single or dual blinder schemes)
- ➤ Compatibility With SEL-2600 Series RTD Module (optional)

Monitoring and Metering

- ➤ Full Event Reports, Sequential Events Recorder (SER), and Unsolicited Fast SER Messages
- ➤ Breaker Monitor and Battery Monitor
- ➤ High-Accuracy Metering

Communications

- ➤ ASCII, Binary, and Modbus Communications on EIA-232 and/or EIA-485 Ports
- ➤ Unsolicited Fast SER Protocol
- ➤ IRIG-B Time Code Input

Control

- ➤ Advanced SELOGIC® Control Equations for Traditional or Custom Logic Implementation

Relay and Logic Settings Software Support

- ➤ ACSELERATOR QuickSet® SEL-5030 Software Support for Ease of Relay Settings and Logic Programming

Applications

The SEL-300G can be applied in primary or backup applications for complete generator or unit protection.

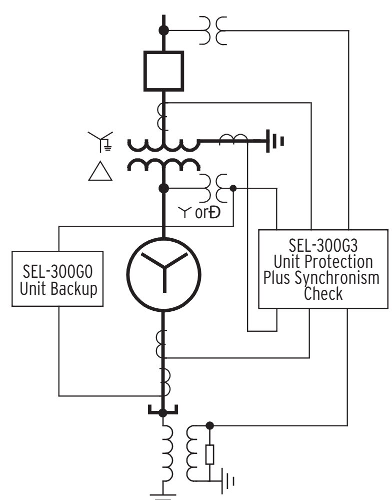
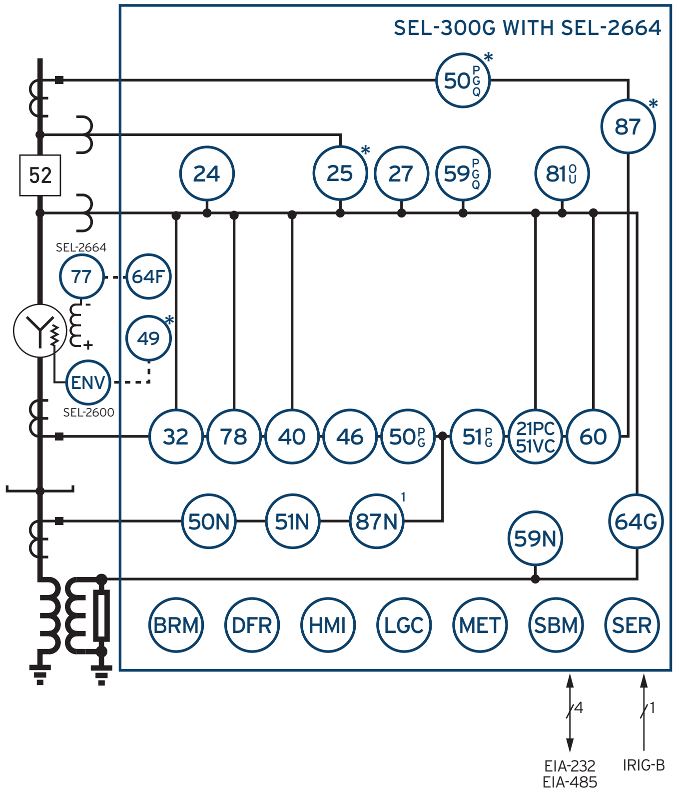


Figure 1 Typical Application

Functional Overview



ANSI NUMBERS/ACRONYMS AND FUNCTIONS	
21PC/51VC	Phase Mho or Compensator Distance/Voltage Restrained/Controlled Time-Overcurrent
24	Volts/Hertz
25	Synchronism Check
27	Undervoltage
32	Directional Power
40	Loss-of-Field
46	Neg. Seq. Overcurrent
49	Thermal Overload
50N	Neutral Overcurrent
50 (P, G, Q)	Overvoltage (Phase, Ground, Neg. Seq.)
51 (P, G)	Time-Overcurrent (Phase, Ground)
51N	Neutral Time-Overcurrent
59N	Neutral Overvoltage
59 (P, G, Q)	Overvoltage (Phase, Ground, Neg. Seq.)
60	Loss-of-Potential
64F	Field Ground
64G	100 Percent Stator Ground
78	Out-of-Step
81 (O, U)	Over-/Underfrequency
87	Three-Phase Current Differential
87N	Neutral Current Differential

ADDITIONAL FUNCTIONS	
BRM	Breaker Wear Monitor
DFR	Event Reports
ENV	SEL-2600
HMI	Operator Interface
LGC	SELOGIC® Control Equations
MET	High-Accuracy Metering
SBM	Station Battery Monitor
SER	Sequential Events Recorder

Figure 2 Functional Overview

Relay Features and Benefits

AC Analog Inputs

The SEL-300G has between eight and eleven analog inputs, depending on the options selected. All analog inputs are recorded for event reporting and oscillography.

Optional Differential Protection

When specified, the SEL-300G detects stator faults by using a secure, sensitive current differential function. This function provides a sensitive percentage-restrained differential element and an unrestrained element. The differential function provides the unique capability of power transformer and CT connection compensation. This allows you to conveniently include the unit step-up transformer in the generator differential zone by using wye-connected CTs for both input sets.

User-programmable second-harmonic blocking detects transformer inrush when the differential zone includes the generator step-up transformer. The dual-slope percentage restraint characteristic improves element security for through-fault conditions. The high-security mode provides additional security against CT saturation during external events, including external transformer energization, external faults, etc.

Optional Ground Differential Protection

SEL-300G relays that do not include the optional percentage-restrained differential elements described above are equipped with a ground differential function that provides selective ground fault detection for solidly grounded and low-impedance grounded generators. This function helps protect generators on multimachine buses, because the element does not respond to ground faults on the parallel generators.

Optional Synchronism Checking

You can order the SEL-300G Relay with a built-in synchronism-checking function. The synchronism-check function is extremely accurate and provides supervision for acceptable voltage window and maximum percentage difference, maximum and minimum allowable slip frequency, target closing angle, and breaker closing delay. The synchronism-check report gives complete information on the three latest paralleling operations, including generator and system voltages and frequencies, slip frequency, and phase angle when the close was initiated. The relay also keeps a running average of the breaker close time.

100 Percent Stator Ground Detection

The SEL-300G detects stator ground faults on high-impedance grounded generators by using a conventional neutral overvoltage element with a third-harmonic voltage differential detection scheme for 100% stator winding coverage. The neutral overvoltage element detects winding ground faults in approximately 85% of the winding. Faults closer to the generator neutral do not result in high neutral voltage but are detected using third-harmonic neutral and terminal voltages. The combination of the two measuring methods provides ground fault protection for the full winding. Use an SEL-2664S Stator Ground Protection Relay for multi-frequency injection-based protection.

Field Ground Protection

The SEL-300G, with the SEL-2664 Field Ground Module, detects field ground faults by measuring field insulation-to-ground resistance using the switched dc voltage injection method. Two-level protection for alarm and trip functions is provided.

Directional Power Detection

Sensitive directional power elements in the SEL-300G provide antimotoring and/or low forward power tripping. Two elements having independent time-delays and sensitivities are provided. Directly trip the generator under loss-of-prime mover conditions to prevent prime movers from motoring, or use low forward power indication as a tripping interlock when an orderly shutdown is required.

Over-Excitation Protection

The SEL-300G provides one definite-time element for alarm and one composite inverse-time volts/hertz element for trip. The composite inverse-time characteristic may be enabled with a two-step definite-time characteristic, a definite/inverse-time characteristic, or a simple inverse-time characteristic.

Loss-of-Field Protection

Two offset positive-sequence mho elements detect loss-of-field conditions. Settable time delays help reject power swings that pass through the machine impedance characteristic. By using the included directional supervision, one of the mho elements can be set to coordinate with the generator minimum excitation limiter and its steady-state stability limit.

Out-of-Step Protection

SEL-300G relays use either a single blinder or double blinder, depending on your selection, to detect an out-of-step condition. In addition to the blinders, the scheme uses a mho circle that restricts the coverage of the out-of-step function to the desired extent. Furthermore, both schemes contain current supervision and torque control to supervise the operation of the out-of-step element.

Negative-Sequence Overcurrent Protection

Negative-sequence current heats the rotor at a higher rate than positive-sequence or ground current. The negative-sequence definite-time element provides alarm for early stages of an unbalanced condition. The inverse-time overcurrent element provides tripping for sustained unbalance conditions to prevent machine damage. The inverse-time negative-sequence element provides industry standard I_2^2t protection curves.

System Backup Protection

The SEL-300G offers you the choice of four methods for performing system backup protection. Phase mho distance elements, compensator distance elements, a voltage-restrained phase time-overcurrent element, and a voltage-controlled phase time-overcurrent element are all available; you simply enable the element you wish to use.

Ground Overcurrent Elements

Neutral (I_N) overcurrent elements detect ground faults in low-impedance grounded and solidly grounded machines. Torque control these elements by using an optoisolated contact input or internal logic conditions.

Over- and Undervoltage Protection

Phase undervoltage and overvoltage elements are included for creating protection and control schemes such as

- ➤ Torque control for the overcurrent protection.
- ➤ Trip/alarm or event report triggers for voltage sags and swells.

Desired definite time-delay may be added using a SELOGIC control equation timer.

Negative- and zero-sequence overvoltage elements are included for protection and control.

Thermal Protection

The SEL-300G models compatible with the SEL-2600 Series RTD Module provide thermal protection for the generator and prime mover. The RTD types and locations are individually configurable. Either ambient temperature or generator load current can be configured to bias the winding RTD trip temperature thresholds.

Loss-of-Potential Logic

Relay functions that use phase voltages or symmetrical component voltages rely on valid inputs to make the correct decisions. The SEL-300G includes loss-of-potential logic that detects one, two, or three potentially blown fuses. This logic is unique as it does not require settings and is useful in all applications. This logic replaces traditional voltage unbalance schemes that require inputs from two VT sets.

Inadvertent Energization Detection

Occasionally, the unit breaker for an out-of-service generator is closed inadvertently. The SEL-300G detects this condition by using voltage, current, and other supervisory conditions you select through a SELOGIC control equation.

Frequency Protection

Six levels of over- or underfrequency elements detect abnormal machine operating conditions. Use the independently time-delayed output of these elements to trip or alarm. Phase undervoltage supervision prevents undesired frequency element operation during startup, shutdown, and faults, and while the field is de-energized.

SEL-300G frequency elements have high accuracy and low overshoot. For a step frequency change of ±5 Hz, the steady-state plus transient error is less than 0.01 Hz.

The SEL-300G tracks the total time-of-operation in as many as six off-nominal frequency bands. If the off-nominal time-of-operation exceeds one of the independent time set points, the relay can trip or alarm.

Event Report and SER

You select event trigger conditions and event report length: 15, 30, 60, or 180 cycles. The voltage, current, frequency, and element status information contained in each report confirms relay, scheme, and system performance for every operation. The latest twenty-nine 15-cycle, fifteen 30-cycle, eight 60-cycle, or two 180-cycle event reports are stored in nonvolatile memory. Decide how much detail is necessary when you request an event report: 1/4-cycle or 1/16-cycle resolution, filtered or raw analog data.

The 1/4-cycle report is one-fourth the size of the 1/16-cycle report. Therefore, it is quicker to retrieve and analyze. This advantage is especially valuable following a major disturbance. The full 1/16 sample/cycle report can be retrieved when conditions warrant closer scrutiny.

The relay SER feature stores the latest 512 entries. Use this feature to gain a broad perspective at a glance. An SER entry is triggered by items such as input/output change of state occurrences and element pickup/dropout. The relay also supports user naming of internal conditions and relay inputs. These settable names appear in the SER report and simplify operation analysis.

The IRIG-B time-code input synchronizes the SEL-300G time to within ±5 ms of the time-source input. A convenient source for this time code is an SEL Communications Processor.

Demand Current Thresholds

The SEL-300G offers thermal and rolling demand-measuring techniques. Settable demand current thresholds are available for phase, negative-sequence, and residual/neutral demand measurements. When demand current exceeds a threshold, the respective Relay Word bit PDEM, QDEM, GDEM, or NDEM asserts.

The Relay Word bits PDEM, QDEM, GDEM, or NDEM alarm for generator overload, negative-sequence unbalance, residual, or neutral unbalance, respectively. The demand ammeter time constant can be set to any value between 5 and 60 minutes.

Breaker Wear Monitor

Breakers experience mechanical and electrical wear every time they operate. Breaker manufacturers publish maintenance curves and tables that relate interrupted current to the number of close-to-open (C/O) operations. These data usually are presented in a table in the inspection and maintenance section of the breaker manual.

Every time the breaker trips, the relay counts the close-to-open operation and records the magnitude of the unfiltered current in each phase. When the result of this record exceeds the threshold set by the breaker wear curve (see *Figure 3*), the relay asserts the corresponding breaker contact wear alarm bit: BCWA, BCWB, or BCWC. This method of monitoring breaker wear is solidly based on breaker ratings from the breaker manufacturer.

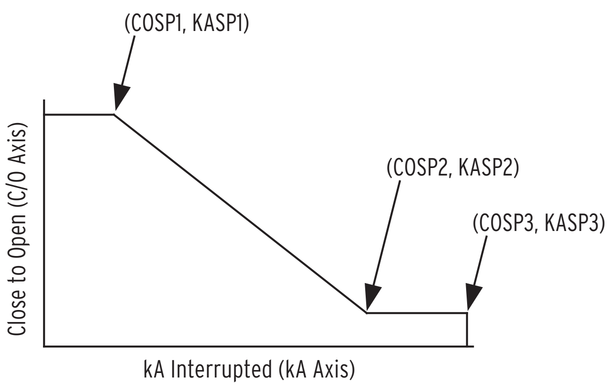


Figure 3 Breaker Contact Wear Curve Settings

Extensive Metering Capabilities

This relay provides extensive high-accuracy metering capabilities. $V_{A,B,C}$ and $I_{A,B,C}$ metering accuracies are 0.1% of input at nominal frequency (voltages: 33.5 V < VAC < 218 V; currents: measured current is greater than 10% of the nominal current rating).

Metered quantities include phase voltages and currents, differential quantities, sequence voltages and currents, power, frequency, substation battery voltage, and energy (including demand), along with maximum and minimum logging of selected quantities.

Station Battery Monitor

The relay measures and reports the substation battery voltage presented to the power supply terminals. The relay includes two settable threshold comparators and associated Relay Word bits (DCLO, DCHI) for alarm and control. For example, if the battery charger fails, the measured dc falls below the DCHI pickup threshold and DCHI drops out. Program this bit to a b contact connected to SCADA (Supervisory Control and Data Acquisition) or an annunciator panel to notify operation personnel before the substation battery voltage falls to dangerous levels or monitor the DCHI bit with an SEL Communications Processor and trigger messages, telephone calls, or other actions.

The measured dc voltage is reported in the METER display and the VDC column of the event report. Use the event report column data to see an oscillographic display of the battery voltage. You can see how much the substation battery voltage drops during trip, close, and other control operations.

Two Independent Setting Groups

The relay stores two setting groups. Select the active setting group by contact input, command, or other programmable conditions. Use these setting groups to cover a wide range of protection and control contingencies. Selectable setting groups make the SEL-300G ideal for adapting the protection to changing system conditions.

When you switch groups, you switch logic settings as well as relay element settings. Groups can be programmed for different operating conditions, such as station maintenance, seasonal operations, or emergency loading contingencies.

Additional Features

Configurable Front-Panel

The SEL-300G LCD display includes the display point feature that, when used with the high-accuracy metering function, replaces separate panel meters. The relay provides a rolling display of as many as eight alphanumeric messages plus meter quantities you select. Each display lasts one second before automatically scrolling to the next pair of messages. This feature allows you to examine the state of the protected machine and review the metered quantities without pressing front-panel buttons or decoding complicated menus.

Operator Controls and Serial Communication

The SEL-300G is equipped with three EIA-232 serial ports (one on the front panel and two on the rear panel) and one isolated EIA-485 serial port (relay rear panel). Each serial port operates independently of the other serial ports. The serial ports provide full access to event history, relay status, and meter information. Three-level password access provides security for control and setting operations. Serial ports support ASCII, Binary (Fast Meter, Fast Operate), Distributed Port Switch, Modbus, and Unsolicited Fast SER Protocol communications.

The relay does not require special communications software. Dumb terminals, printing terminals, or a computer supplied with terminal emulation and a serial communications port is all that is required.

The relay also supports QuickSet.

Advanced SELogic Control Equations

Advanced SELogic control equations allow you to assign the relay inputs to suit your application, logically combine selected relay elements for various control functions, and assign output relays to your logic functions.

Programming SELogic control equations consists of combining relay elements, inputs, and outputs with SELogic control equation operators. Any element in the instruction manual Relay Word bit table can be used in these equations. The SELOGIC control equation operators included are shown in *Table 1*.

Table 1 SELOGIC Control Equation Operators

Symbol	Operator	Description
+	OR	One element on either side of a + symbol must assert before the condition is true.
*	AND	Elements on both sides of the * symbol must assert before the condition is true.
!	Invert	Inverts the element immediately following the ! symbol.
( )	Parentheses	Enclose elements and inputs inside these parentheses to be operated on by the +, !, or * operators. Use these parentheses in SELOGIC control equations to minimize setting entries and create IF-THEN-ELSE statements.
/	Rising Edge	Requires that the element to the right of the / symbol be dropped out one processing interval and not the next before the logic condition is true.
\	Falling Edge	Requires that the element to the right of the \ symbol be picked up one processing interval and not the next before the logic condition is true.

Use this Boolean-type logic to:

- ➤ Define which elements or conditions control each output contact (except ALARM).
- ➤ Define the function of the digital inputs.
- ➤ Define which elements and conditions trigger event reports.
- ➤ Define which elements and conditions add entries to the SER.
- ➤ Select the elements that trip for various conditions.
- ➤ Create breaker trip and close circuit monitoring logic.

Configure the contact outputs to operate when any of the protective elements and/or logic outputs assert. Implement complete protective schemes by using a minimum of wiring and panel space. Programmable contact closure simplifies testing by indicating pickup and dropout of only those elements under test.

The general purpose SELOGIC control equation timers in each setting group eliminate the need for external timers for custom protection or control schemes. Each timer has independent time-delay pickup and dropout timers. You program the input(s) to each timer. Assign the timer output to output contacts or use it in tripping or other control scheme logic.

Unsolicited Fast SER Protocol

SEL Fast SER Protocol provides SER events to an automated data collection system. SEL Fast SER Protocol is available on any serial port. Devices with embedded processing capability can use these messages to enable and accept unsolicited binary SER messages from SEL-300G relays.

SEL relays and communications processors have two separate data streams that share the same serial port. The normal serial interface consists of ASCII character commands and reports that are intelligible to people that use a terminal or terminal emulation package. The binary data streams can interrupt the ASCII data stream to obtain information, and then allow the ASCII data stream to continue. This mechanism allows a single communications channel to be used for ASCII communication (e.g., transmission of a long event report) interleaved with short bursts of binary data to support fast acquisition of metering or SER data.

Contact Inputs and Outputs

The SEL-300G provides six optoisolated contact inputs and eight output contacts. The contact inputs are assignable for control functions, monitoring logic, and general indication. Except for a dedicated alarm output, each output contact is independently programmable by using SELOGIC control equations. All relay output contacts are rated for trip duty.

The optional I/O board is available with either standard or high-current interrupting output contacts that interrupt as high as 10 A of inductive current.

All output contacts are jumper-configurable as either a or b contacts. (Only four outputs are jumper-configurable on the Connectorized® optional I/O board.) The output contact next to the ALARM contact is jumper-configurable to follow the ALARM contact.

Relay and Logic Settings Software

QuickSet is an easy-to-use yet powerful tool to help you get the most out of your SEL-300G.

Using QuickSet, you will be able to:

- ➤ Create, test, and manage settings with a Windows interface.
- ➤ Visually design SELOGIC control equations with the Expression Builder, a rules-based editor.
- ➤ Analyze power system events from an SEL-300G with integrated waveform and harmonic analysis tools.
- ➤ Communicate with an SEL-300G via an HMI interface with integrated meter and control functions.
- ➤ Create, manage, copy, merge, and read relay settings with a settings database manager.

Note: Using QuickSet in SEL-300G relays requires relay firmware version R240 or later or R320 or later.

Hardware Overview

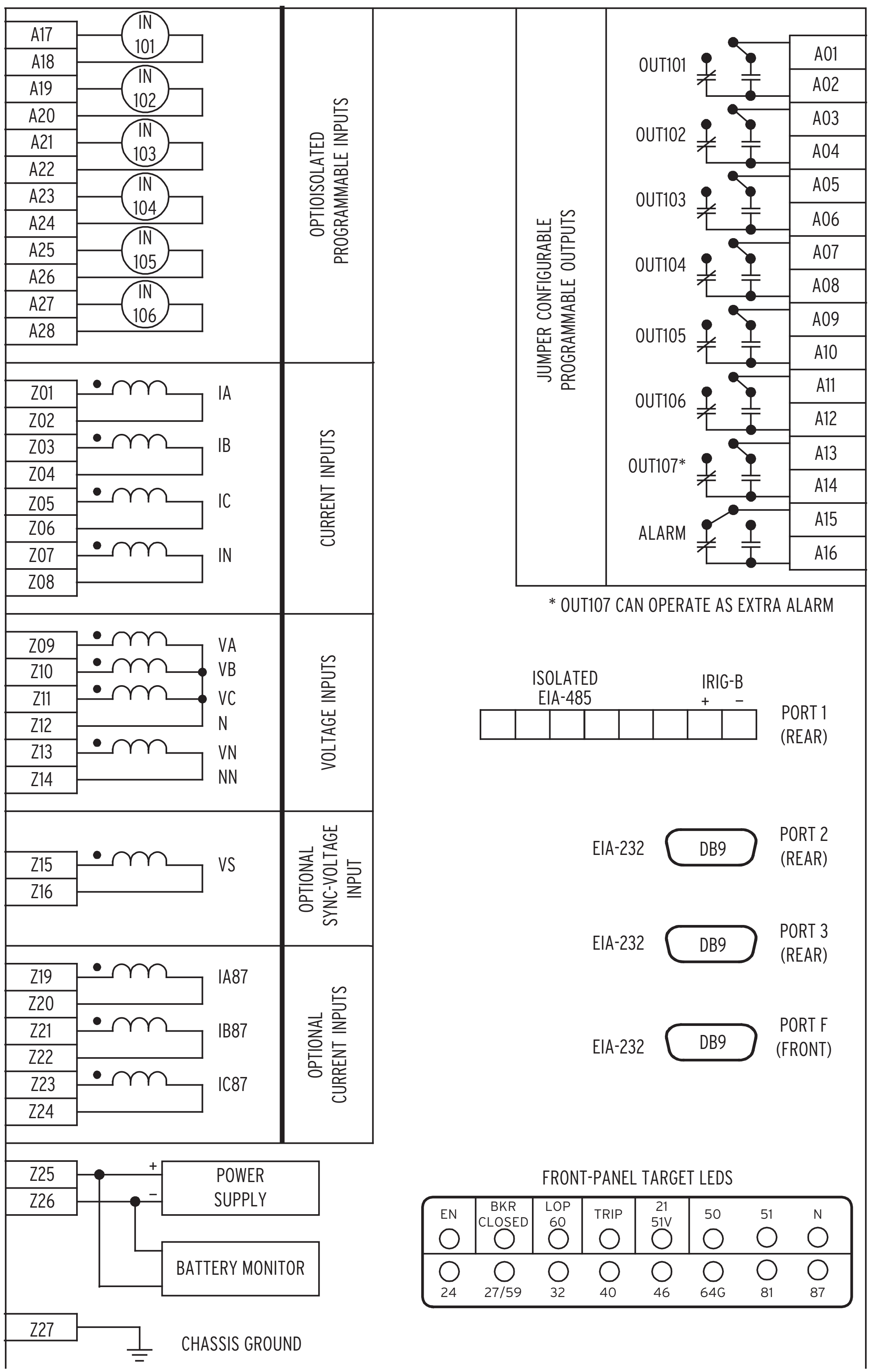


Figure 4 SEL-300G30H Inputs, Outputs, and Target Diagram

Wiring Diagrams

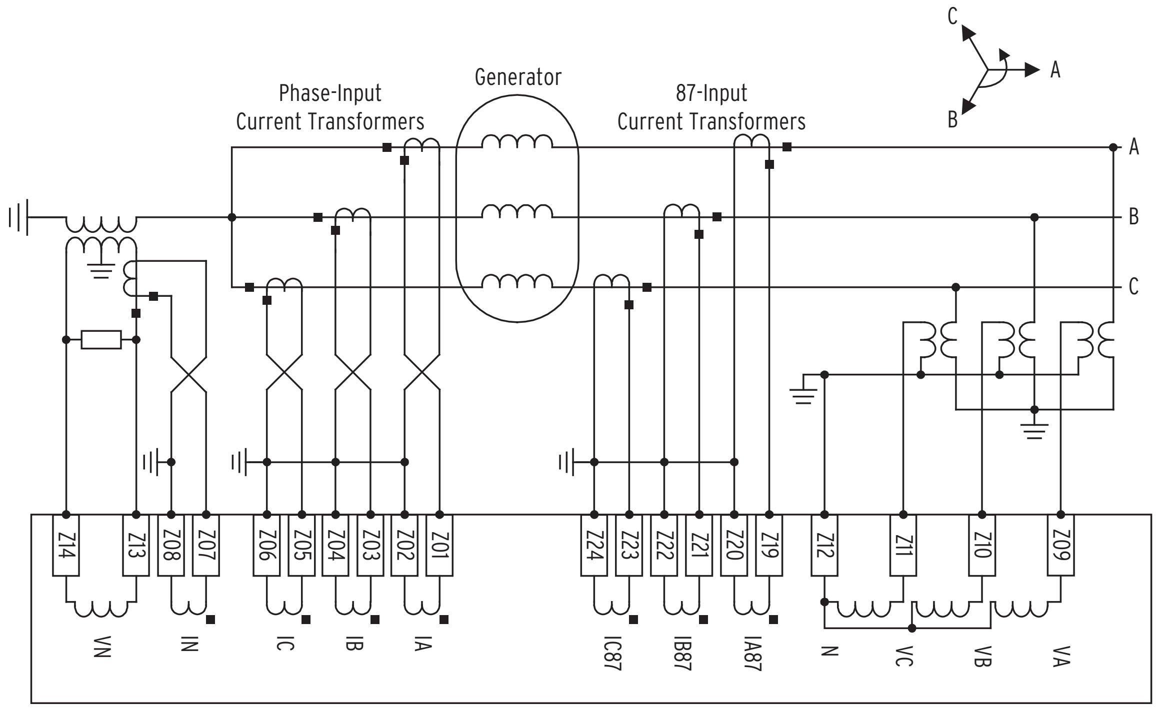


Figure 5 SEL-300G Relay Typical AC Current and Four-Wire Wye Voltage Connection

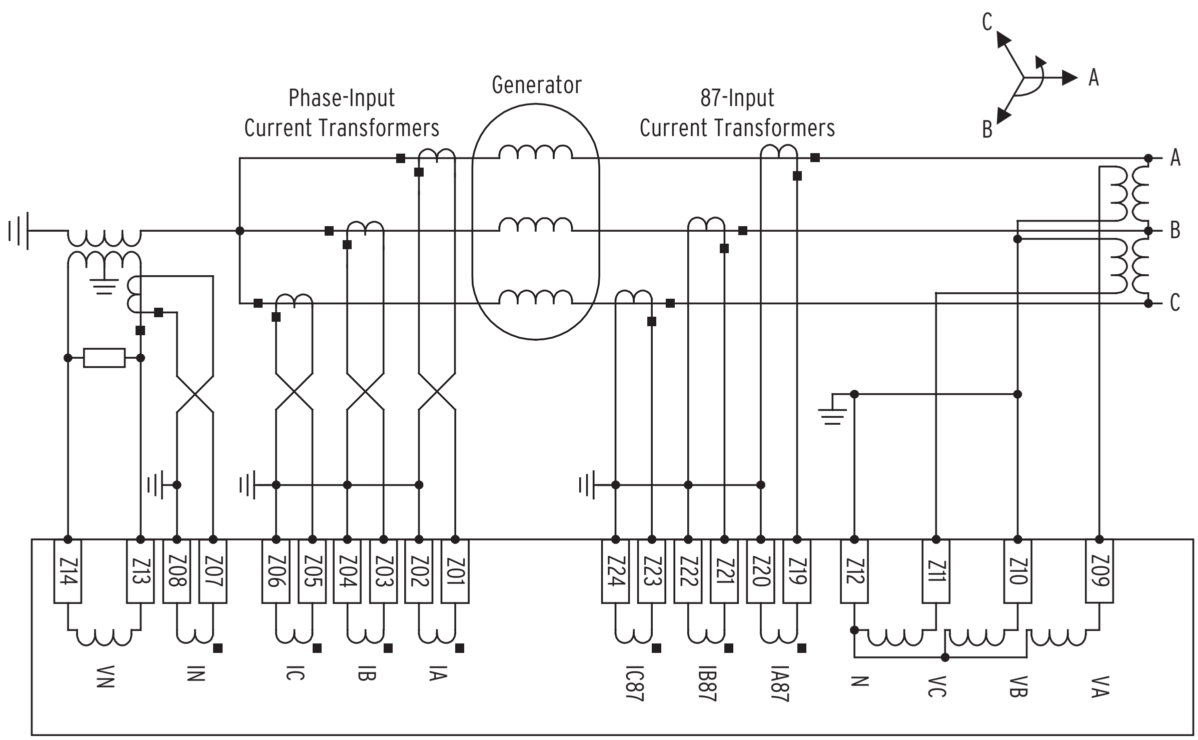


Figure 6 SEL-300G Typical AC Current and Open-Delta Voltage Connections

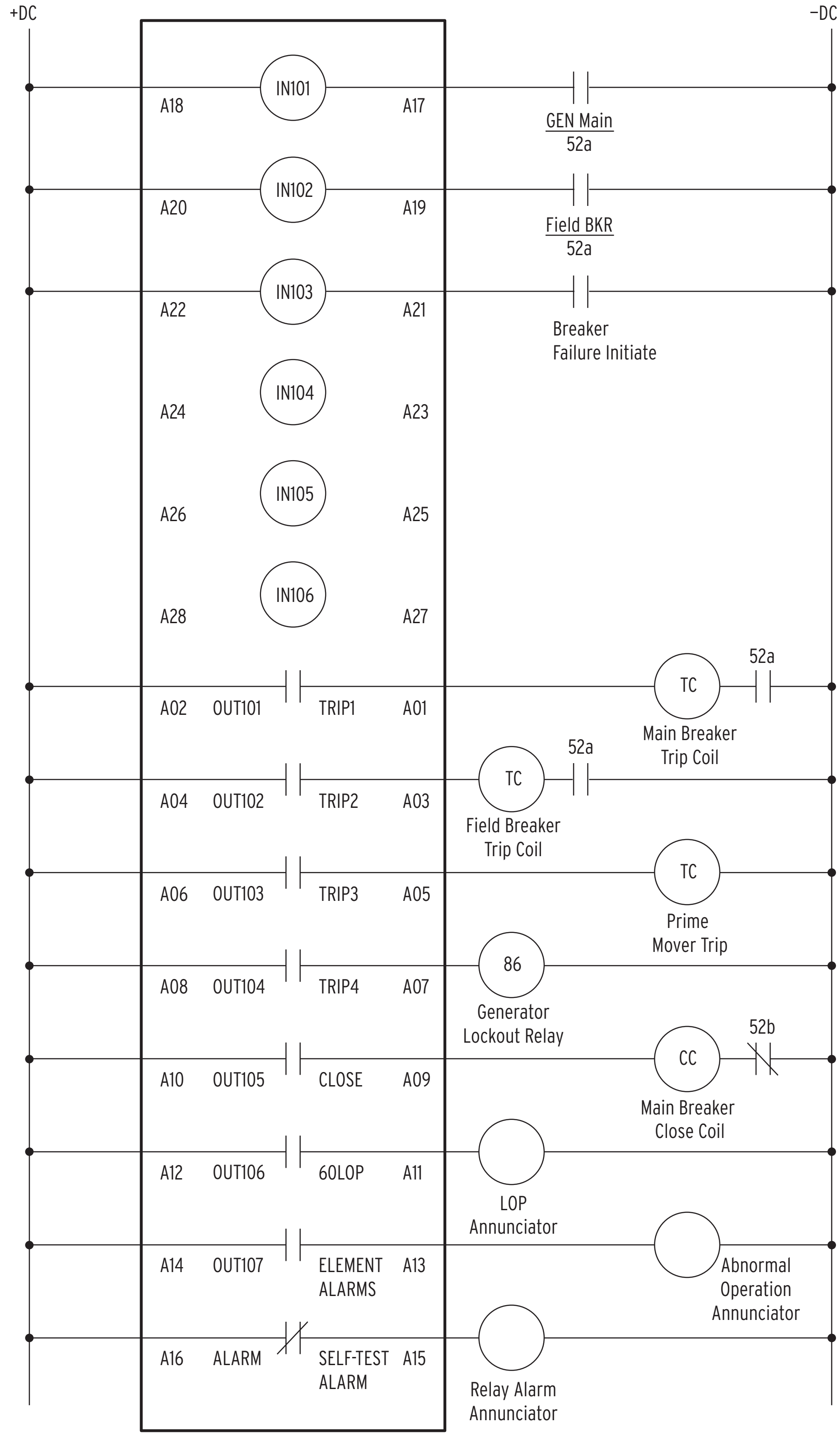
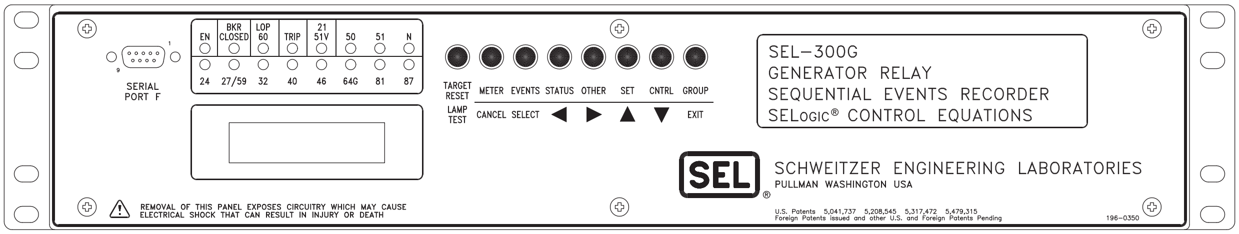
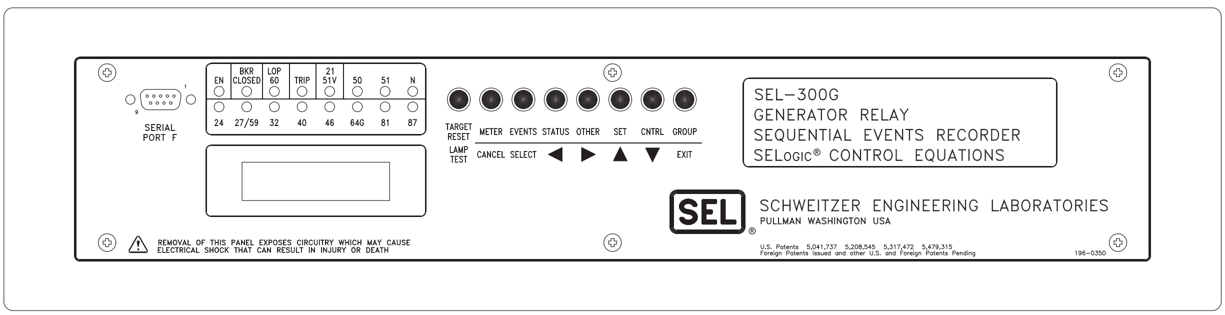


Figure 7 SEL-300G Typical Minimum DC External Connections

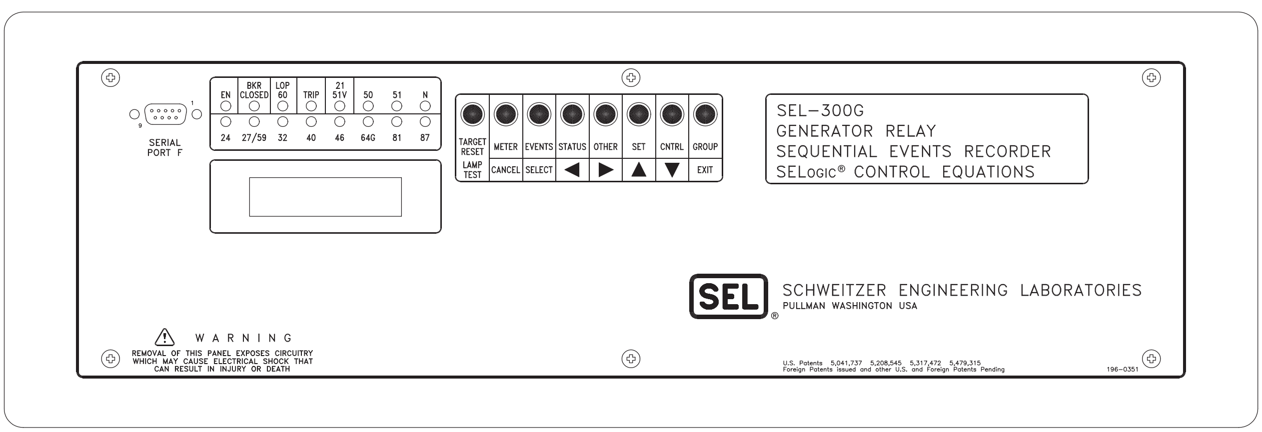
Front-Panel Drawings



2U Rack-Mount Front Panel



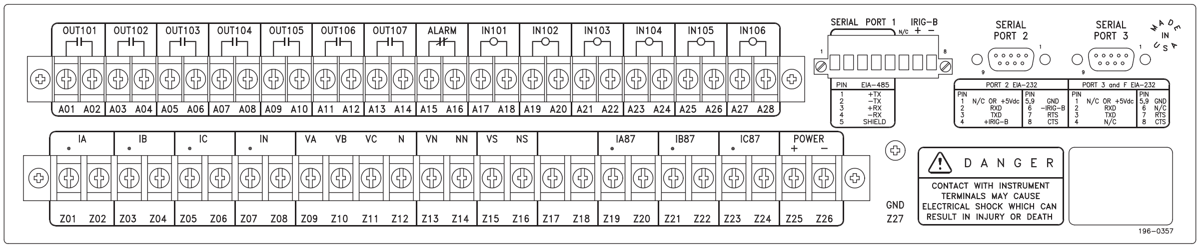
2U Panel-Mount Front Panel



3U Panel-Mount Front Panel

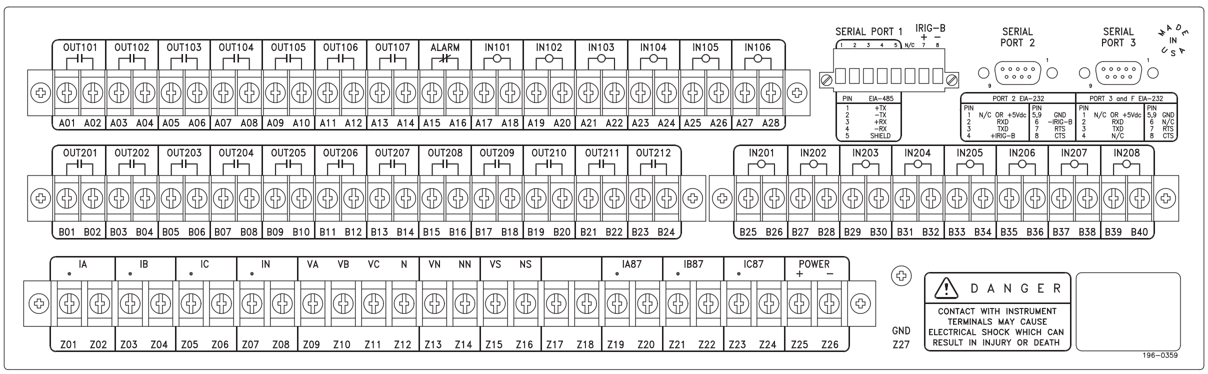
Figure 8 SEL-300G Front-Panel Drawings

Rear-Panel Drawings



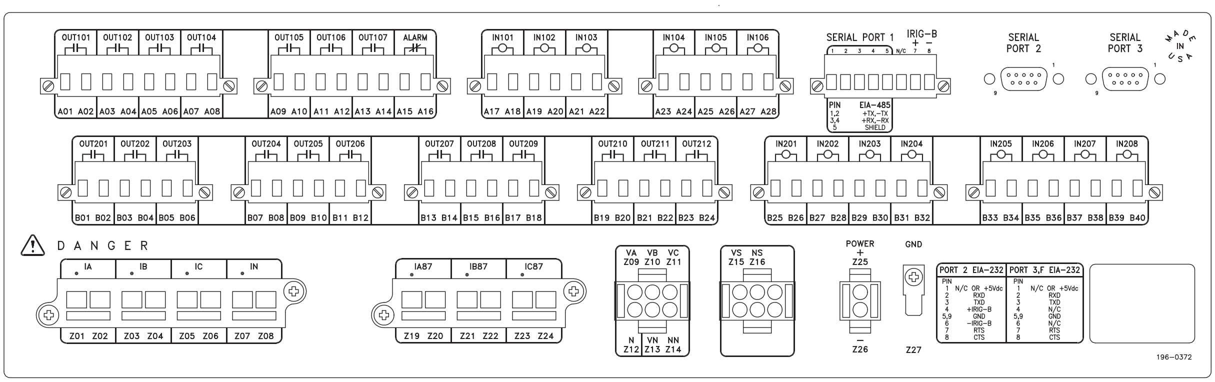
2U Rear Panel, Terminal Block

i3052b



3U Rear Panel, Terminal Block

i3059b

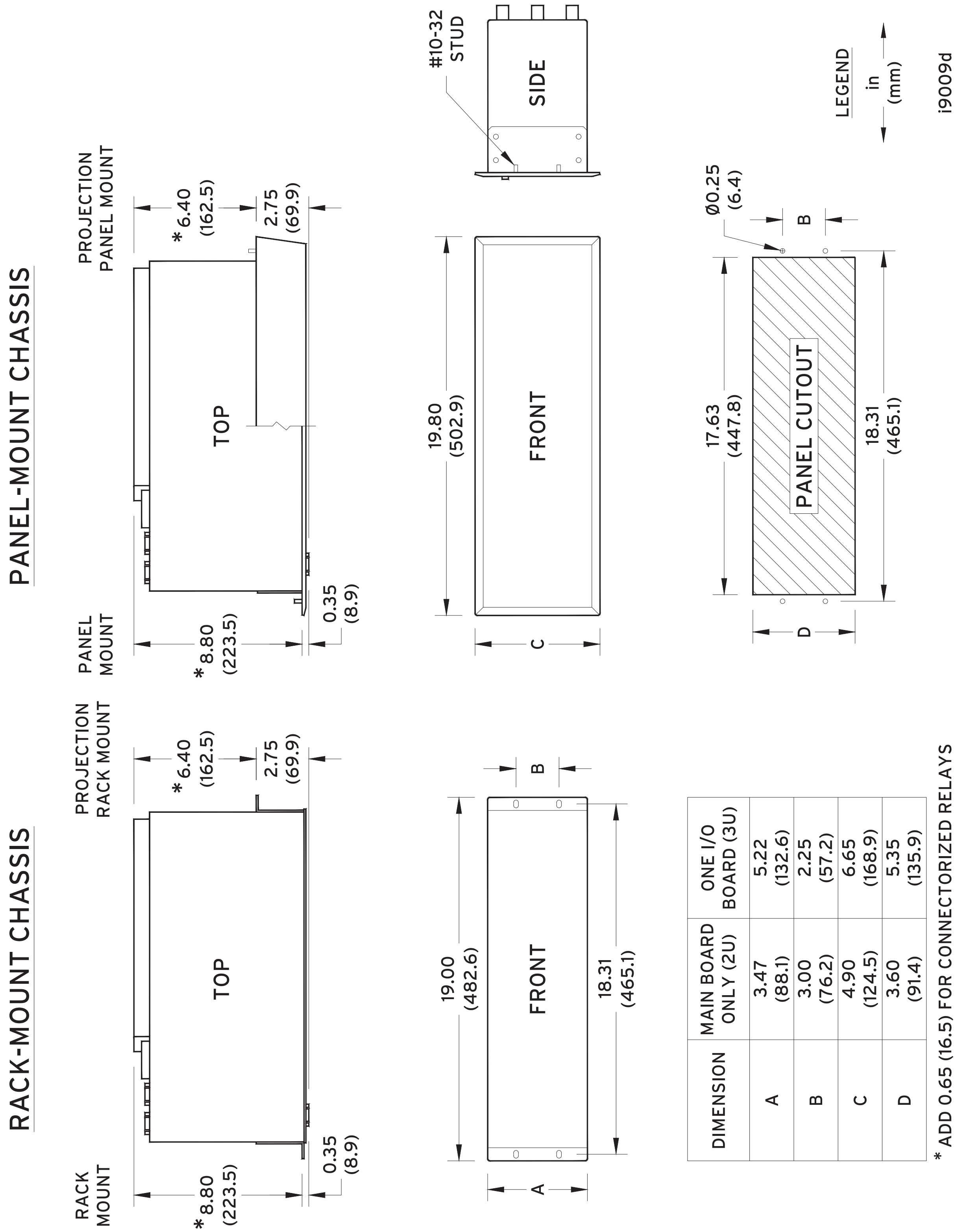


3U Rear Panel, Plug-In Connectors

i3132a

Figure 9 SEL-300G Rear-Panel Drawings

Relay Dimensions



DIMENSION	MAIN BOARD ONLY (2U)	ONE I/O BOARD (3U)
A	3.47 (88.1)	5.22 (132.6)
B	3.00 (76.2)	2.25 (57.2)
C	4.90 (124.5)	6.65 (168.9)
D	3.60 (91.4)	5.35 (135.9)

Figure 10 SEL-300G 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

RCM Mark

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

General

Terminal Connections

Tightening Torque

Terminal Block:	Minimum: 0.9 Nm (8 in-lb)
	Maximum: 1.4 Nm (12 in-lb)
Connectorized:	Minimum: 0.5 Nm (4.4 in-lb)
	Maximum: 1.0 Nm (8.8 in-lb)

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

AC Current Inputs

5 A Nominal

15 A continuous, linear to 100 A symmetrical.
500 A for 1 second.
1250 A for 1 cycle.

Burden:	0.27 VA @ 5 A
	2.51 VA @ 15 A

1 A Nominal

3 A continuous, linear to 20 A symmetrical
100 A for 1 second.
250 A for 1 cycle.

Burden:	0.13 VA @ 1 A
	1.31 VA @ 3 A

AC Voltage Inputs

VNOM Range:
80–208 V_{L-L} Nominal, for 4-wire wye voltage input.
VNOM Range:
80–140 V_{L-L} Nominal, for 3-wire delta voltage input.
300 V_{L-N} continuous limit for 3-phase, 4-wire wye connection.
300 V_{L-L} continuous limit for 3-phase, 3-wire delta connection.
300 V continuous, V_{N-NN} neutral voltage input.
300 V continuous, V_{S-NS} synchronism voltage input.

Note: Synchronism-check voltage window setting range: 20–200 V 365 Vac for 10 seconds.

Burden:	0.13 VA @ 67 V
	0.45 VA @ 120 V
	0.80 VA @ 300 V

Power Supply

125/250 Vdc or Vac

Range:	85–350 Vdc or 85–264 Vac
Burden:	<25 W

48/125 Vdc or 125 Vac

Range:	38–200 Vdc or 85–140 Vac
Burden:	<25 W

24/48 Vdc

Range:	18–60 Vdc polarity-dependent
Burden:	<25 W

Output Contacts

Standard

Make:	30 A
Carry:	6 A @ 70°C
	4 A @ 85°C
1 s Rating:	50 A
MOV:	270 Vac, 360 Vdc, 40 J
Pickup Time:	<5 ms
Dropout Time:	<8 ms, typical

Breaking Capacity (10,000 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 Interruption Option

Make:	30 A
Carry:	6 A @ 70°C
	4 A @ 85°C
MOV:	330 Vdc, 130 J
Pickup Time:	<5 ms
Dropout Time:	<8 ms, typical

Breaking Capacity (10,000 operations):

24 V	10 A	L/R = 40 ms
48 V	10 A	L/R = 40 ms
125 V	10 A	L/R = 40 ms
250 V	10 A	L/R = 20 ms

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

24 V	10 A	L/R = 40 ms
48 V	10 A	L/R = 40 ms
125 V	10 A	L/R = 40 ms
250 V	10 A	L/R = 20 ms

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

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

Optoisolated Inputs

250 Vdc:	Pickup: 200–300 Vdc
	Dropout: 150 Vdc
220 Vdc:	Pickup:176–264 Vdc
	Dropout: 132 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, 125, 220, and 250 Vdc optoisolated inputs draw approximately 5 mA of current and 110 Vdc inputs draw approximately 8 mA of current. All current ratings are at nominal input voltages.

Frequency and Rotation

System Frequency:	60 or 50 Hz
Phase Rotation:	ABC or ACB
Frequency Tracking Range:	20–70 Hz

Note: V_A required for frequency tracking.

Communications Ports

EIA-232:	1 front and 2 rear
EIA-485:	1 rear
Baud rate:	300–38400

Time-Code Input

Relay accepts demodulated IRIG-B time-code input at Port 2.
Relay time is synchronized to within ±5 ms of time-source input.

Dimensions

See *Figure 10* for exact relay dimensions.

Operating Temperature

–40° to +85°C (–40° to +185°F)

Note: LCD contrast impaired for temperatures below –20°C.

Weight

2U Rack Unit:	Minimum: 6.2 kg (13.5 lb)
	Maximum: 6.8 kg (15 lb)
3U Rack Unit:	Minimum: 7.5 kg (16.5 lb)
	Maximum: 8.4 kg (18.5 lb)

Type Tests

Cold:	IEC 60068-2-1:2007
	Test Ad; 16 hr @ –40°C
Dry Heat:	IEC 60068-2-2:2007
	Test Bd: 16 hr @ +85°C
Damp Heat, Cyclic:	IEC 60068-2-30:1980, Test Db; 25° to 55°C, 6 cycles, 95% humidity
Dielectric Strength:	IEC 60255-5:2000 IEEE C37.90-2005 2500 Vac on analogs, contact inputs, and contact outputs 3100 Vdc on power supply 2200 Vdc on EIA-485 communications port Type tested for 1 minute.
Impulse:	IEC 60255-5:2000, 0.5 J, 5000 V
Vibration:	IEC 60255-21-1:1988
	[EN 60255-21-1:1995]
	Class 2 Endurance, Class 2 Response
Shock and Bump:	IEC 60255-21-2:1988
	[EN 60255-21-2:1995], Class 1 Shock Withstand, Class 2 Shock Response
Seismic:	IEC 60255-21-3:1993
	[EN 60255-21-3:1995], Class 2
1 MHz Burst Disturbance:	IEC 60255-22-1:1988, Class 3 (2500 V common and differential mode)
Emissions:	IEC 60255-25:2000 CAN ICES-001(A) / NMB-001(A)
Conducted Radio Frequency:	ENV 50141:1993 10 V/m
	IEC 61000-4-6:1996
	[EN 61000-4-6:1996]
	10 V/m, IEC 60255-22-6:2001 10 V/m
Digital Radio Telephone RF:	ENV 50204:1995 10 V/m at 900 MHz and 1.89 GHz
Electrostatic Discharge:	IEC 60255-22-2:2008 IEC 61000-4-2:2008 IEEE C37.90.3-2001
	Severity Level: Contact Discharge: ±2, 4, 6, and 8 kV Air Discharge: ±2, 4, 8, and 15 kV
Radiated Radio Frequency:	ENV 50140:1993 10 V/m,
	IEC 60255-22-3:2000 10 V/m,
	IEC 61000-4-3:1998 10 V/m,
	IEEE C37.90.2-1995 35 V/m, no keying test, frequency elements accurate to 0.1 Hz
Fast Transient Disturbance:	IEC 60255-22-4:2008 IEC 61000-4-4:2011
	Severity Level: Class A: ±4 kV, 5 kHz ±2 kV, 5 kHz on communication ports
Object Penetration and Dust Ingress:	IEC 60529:1989 [EN 60529:1992] IP30
Protection Against Splashing Water:	IEC 60529:1989 [EN 60529:1992] IP54 from the front panel that uses the SEL-9103
Surge Withstand:	IEC 60255-22-1:2007 Severity Level: Common Mode: 2.5 kV on Power, CT, PT, I/O 1.0 kV on Communication Ports Differential Mode: 1.0 kV on Power, PT, I/O IEEE C37.90.1-2002 Severity Level: Oscillatory: ± 2.5 kV, 1 MHz common mode and differential Fast Transient: ±4.0 kV, 2.5 kHz common mode and differential
Generic Standard:	EN 50082-2:1995

Processing Specifications

AC Voltage and Current Inputs

16 samples per power system cycle, 3 dB low-pass filter cutoff frequency of 560 Hz.

Digital Filtering

- One cycle cosine after low-pass analog filtering.
- Net filtering (analog plus digital) rejects dc and all harmonics greater than the fundamental.
- Second-harmonic current and third-harmonic voltage filters are also included for specific protection functions.

Protection and Control Processing

Four times per power system cycle for all elements except out-of-step, loss-of-field, and RTD elements. Loss-of-field and out-of-step elements are processed two times per power system cycle and the RTD elements once in two seconds.

Relay Element Setting Ranges and Accuracies

Phase Distance Element (21)

5 A Model

Reach:	0.1–100.0 ohms
Offset:	0.0–10.0 ohms
Steady-State Impedance Accuracy:	±5%, ±0.1 ohm
Minimum Phase Current:	0.5 A

1 A Model

Reach:	0.5–500.0 ohms
Offset:	0.0–50.0 ohms
Steady-State Impedance Accuracy:	±5%, ±0.5 ohm
Minimum Phase Current:	0.1 A
Maximum Torque Angle Range:	90–45°, 1° step
Pickup Time:	33 ms at 60 Hz (Max)
Zone 1 and Zone 2 Definite-Time Delays:	0.00–400.00 s
Maximum Time-Delay Accuracy:	±0.1%, ±4.2 ms at 60 Hz

Volts/Hertz Over-Excitation Element (24)

Definite-Time Element

Pickup Range:	100–200%
Steady-State Pickup Accuracy:	±1%
Pickup Time:	25 ms at 60 Hz (Max)
Definite-Time Pickup Range:	0.00–400.00 s
Time-Delay Accuracy:	±0.1%, ±4.2 ms at 60 Hz (Max)

Composite-Time Element

Inverse-Time Pickup Range:	100–200%
Inverse-Time Curve:	0.5, 1.0, or 2.0
Inverse-Time Dial:	0.1–10.0 s
Inverse-Time Steady-State Pickup Accuracy:	±1%
Inverse-Time Timing Accuracy:	±4%, ±25 ms at 60 Hz, for V/Hz above 1.2 multiples of pickup setting, and for operating times greater than 4 s.
Definite-Time Pickup Range:	100–200%
Definite-Time Setting Range:	0.00–400.00 s
Pickup Time:	25 ms at 60 Hz (Max)
Definite-Time Delay Accuracy:	±0.1%, ±4.2 ms at 60 Hz
Linear Reset Time:	0.00–400.00 s

Optional Synchronism Checking Function (25) (Model 0300G2 and Model 0300G3)

Sync-Check Voltage Source:	VA, VB, VC, VAB, or VBC
Supervisory Voltage Setting Range:	20.0–200.0 V
Steady-State Voltage Accuracy:	±5%, ±0.1 V
Maximum Percentage Voltage Difference:	1.0–15.0%
Supervisory Slip Frequency Window Element:	–1.00 Hz to +1.00 Hz
Steady-State Slip Accuracy:	±0.02 Hz
Close Acceptance Angle 1, 2:	0–80°
Target Close Angle:	–15 to +15°
Breaker Close Delay:	0.000–1.000 s
Close Failure Angle:	3–120°
Steady-State Angle Accuracy:	±0.5°
Maximum Transient Angle Accuracy:	±1.8 • slip°, ±0.5°

Directional Power Element (32)

Two Definite-Time Elements

Setting Range:	±0.0015 to ±3.000 pu
Steady-State Pickup Accuracy:	±0.0015 pu ±2% of setting, INOM = 5 A, VNOM = 120 V, PF ≥ 0.2
Pickup Time:	25 ms at 60 Hz (Max)
Definite-Time Setting Range:	0.01–400.00 s
Maximum Definite-Time Delay Accuracy:	±0.1%, ±4.2 ms at 60 Hz

Loss-of-Field Element (40)

Two Mho Zones

5 A Model

Zone 1 Offset:	–50.0–0.0 ohms
Zone 2 Offset:	–50.0 to +50.0 ohms
Zone 1 and Zone 2 Diameter:	0.1–100.0 ohms
Steady-State Impedance Accuracy:	±0.1 ohm, ±5% of offset + diameter
Minimum Pos.-Seq. Signals:	0.25 V V1, 0.25 A I1

1 A Model

Zone 1 Offset:	–250.0–0.0 ohms
Zone 2 Offset:	–250.0–250.0 ohms
Zone 1 and Zone 2 Diameter:	0.5–500.0 ohms
Steady-State Impedance Accuracy:	±0.5 ohm, ±5% of offset + diameter
Minimum Pos.-Seq. Signals:	0.25 V V1, 0.05 A I1
Directional Element Angle:	–20.0°–0.0°
Pickup Time:	50 ms at 60 Hz (Max)
Zone 1 and Zone 2 Definite-Time Delays:	0.00–400.00 s
Maximum Definite-Time Delay Accuracy:	±0.1%, ±8.3 ms at 60 Hz

Negative-Sequence Overcurrent Elements (46)

Definite-Time and Inverse-Time Neg.-Seq. I_2 Pickup:	2%–100% of generator rated secondary current
Generator Rated Secondary Current:	5 A Model: 2.5–10.0 A secondary
	1 A Model: 0.5–2.0 A secondary
Steady-State Pickup Accuracy:	5 A Model: ±0.025 A, ±3%
	1 A Model: –±0.005 A, ±3%
Pickup Time:	50 ms at 60 Hz (Max)
Definite-Time Delay Setting Range:	0.02–999.90 s
Maximum Definite-Time Delay Accuracy:	±0.1%, ±4.2 ms at 60 Hz
Inverse-Time Element Time Dial:	K = 1 to 100 s
Linear Reset Time:	240 s fixed
Inverse-Time Timing Accuracy:	±4%, ±50 ms at 60 Hz for |I2| above 1.05 multiples of pickup

Instantaneous/Definite-Time Overcurrent Elements (50)

Phase, Residual Ground, Neutral Protection

Current Pickup (A secondary):	5 A Model: 0.25–100.00
	1 A Model: 0.05–20.00
Steady-State Pickup Accuracy:	5 A Model: ±0.05 A, ±3%
	1 A Model: ±0.01 A, ±3%
Transient Overreach:	±5% of pickup
Pickup Time:	25 ms at 60 Hz (Max)

Note: 50 ms for 50Q element.

Time Delay:	0.00–400.00 s
Timer Accuracy:	±0.1%, ±4.2 ms at 60 Hz

Inverse Time-Overcurrent Elements (51)

Residual Ground and Neutral Protection

Current Pickup (A secondary):	5 A Model: 0.5–16.0
	1 A Model: 0.1–3.2 A
Steady-State Pickup Accuracy:	5 A Model: ±0.05 A, ±3%
	1 A Model: ±0.01 A, ±3%
Time Dials:	US: 0.5–15.0, 0.01 steps
	IEC: 0.05–1.00, 0.01 steps
Timing:	±4%, ±25 ms at 60 Hz for |I| between 2 and 20 multiples of pickup

Voltage-Restrained Phase Time-Overcurrent Element (51V)

Phase Pickup (A secondary):	5 A Model: 2.0–16.0
	1 A Model: 0.4–3.2
Steady-State Pickup Accuracy:	5 A Model: ±0.05 A, ±3%
	1 A Model: ±0.01 A, ±3%
Time Dials:	US: 0.5–15.0, 0.01 steps
	IEC: 0.05–1.00, 0.01 steps
Timing:	±4%, ±25 ms at 60 Hz for |I| between 2 and 20 multiples of pickup
Voltage Restraint Type:	Linear restraint

Voltage-Controlled Phase Time-Overcurrent Element (51C)

Phase Pickup (A secondary):	5 A Model: 0.5–16.0
	1 A Model: 0.1–3.2
Steady State Pickup Accuracy:	5 A Model: ±0.05 A, ±3%
	1 A Model: ±0.01 A, ±3%
Time Dials:	US: 0.5–15.0, 0.01 steps
	IEC: 0.05–1.00, 0.01 steps
Timing:	±4%, ±25 ms for |I| between 2 and 20 multiples of pickup

Instantaneous/Definite-Time Under- (27)/Overvoltage (59) Elements

Phase and Residual 27/59:	0.0–200.0 V
Phase-to-Phase 27:	0.0–200.0 V
Phase-to-Phase 59:	0.0–300 V (for 4-wire wye-voltage input)
Phase-to-Phase 59:	0.0–200 V (for 3-wire delta-voltage input)
Positive-, Negative-, and Zero-Sequence 59:	0.0–200.0 V
Steady-State Pickup Accuracy:	±5%, ±0.1 V
SELOGIC Control Equation Time-Delay Setting Range:	0.00–3000.00 s

Note: Desired time delay may be added using SELOGIC control equation timers.

100 Percent Stator Ground Protection (64G)

Neutral Fundamental Overvoltage 64G1:	0.0–150.0 V
Steady-State Pickup Accuracy:	±5%, ±0.1 V
Pickup Time:	25 ms at 60 Hz (Max)
Definite-Time Delay:	0.00–400.00 s
Maximum Definite-Time Delay Accuracy:	±0.1%, ±4.2 ms at 60 Hz
Third-Harmonic Voltage Differential or Third-Harmonic Neutral Undervoltage Pickup 64G2:	0.1–20.0 V
Steady-State Pickup Accuracy:	±5%, ±0.1 V
Third-Harmonic Voltage Differential Ratio Setting Range:	0.0 to 5.0
Pickup Time:	50 ms at 60 Hz (Max)
Definite-Time Delay:	0.00–400.00 s
Maximum Definite-Time Delay Accuracy:	±0.1%, ±4.2 ms at 60 Hz

Field Ground Protection (64F) (Optional—Requires SEL-2664 Field Ground Module)

Field Ground Protection Element:	0.5–200.0 kilohms
Pickup Accuracy:	±5% ±500 Ω for 48 ≤ VF ≤ 825 Vdc (VF is the generator field winding excitation dc voltage)
	±5% ±20 kΩ for 825 < VF ≤ 1500 Vdc (VF is the generator field winding excitation dc voltage)
Pickup Time:	≤ 2 s if the injection frequency in the SEL-2664 is selected at 1 Hz
	≤ 8 s if the injection frequency in the SEL-2664 is selected at 0.25 Hz
Definite-Time Delay:	0.0–99.0 s
Maximum Definite-Time Delay Accuracy:	±0.5% ±5 ms

Out-of-Step Element (78)

5 A Model

Forward Reach:	0.1–100.0 ohms
Reverse Reach:	0.1–100.0 ohms
Single Blinder	
Right Blinder:	0.1–50.0 ohms
Left Blinder:	0.1–50.0 ohms
Double Blinder	
Outer Resistance Blinder:	0.2–100.0 ohms
Inner Resistance Blinder:	0.1–50.0 ohms
Steady-State Impedance Accuracy:	±0.1 ohm, ±5% of diameter
Positive-Sequence Current Supervision:	0.25–30.00 A

1 A Model

Forward Reach:	0.5–500.0 ohms
Reverse Reach:	0.5–500.0 ohms
Single Blinder	
Right Blinder:	0.5–250.0 ohms
Left Blinder:	0.5–250.0 ohms
Double Blinder	
Outer Resistance Blinder:	1.0–500.0 ohms
Inner Resistance Blinder:	0.5–250.0 ohms
Steady-State Impedance Accuracy:	±0.5 ohm, ±5% of diameter

Positive-Sequence Current Supervision:	0.05–6.00 A
Pickup Time:	50 ms at 60 Hz (Max)
Definite-Time Timers:	±0.1%, ±8.3 ms at 60 Hz

Definite-Time Under/Overfrequency Elements (81)

Frequency:	20–70 Hz, 0.01 Hz steps
Pickup Time:	60 ms at 60 Hz (Max)
Time Delays:	0.03–400.00 s
Maximum Definite-Time Delay Accuracy:	±0.1%, ±4.2 ms at 60 Hz
Supervisory 27:	20–150 V, ±5%, ±0.1 V
Steady-State Plus Transient Overshoot:	(±0.01 + Δf_{sys}) Hz
Frequency Compensation Over Temperature:	$\Delta f_{sys} = f_{sys} \bullet (0.04 \bullet 10^{-6})\ (T–25°C)^2$ where T = Temperature of relay via STATUS command

Optional Differential Elements (87) (Model 0300G1 and Model 0300G3)

Restrained Element Pickup:	0.04–1.0 • TAP
Steady-State Pickup Accuracy:	5 A Model: ±0.1 A, ±5% 1 A Model: ±0.02 A, ±5%
Slope 1 Range:	5–100%
Slope 2 Range:	OFF, 50–200%
Slope 1 Limit:	1–16 • TAP
2nd-Harmonic Blocking Percentage:	OFF, 5–100%
Unrestrained Element Pickup:	1.0–20.0 • TAP
Steady-State Pickup Accuracy:	5 A Model: ±0.1 A, ±5% 1 A Model: ±0.02 A, ±5%
TAP Range:	$TAP_{MAX}/TAP_{MIN} \leq 7.5$
5 A Model:	0.5–160.0 A secondary
1 A Model:	0.1–32.0 A secondary
Restrained Element Pickup Time:	24/28/38 ms (Min/Typ/Max)
Unrestrained Element Pickup Time:	13/20/32 ms (Min/Typ/Max)

Note: Pickup time accuracies listed at 60 Hz.

Optional Ground Differential Elements (87N) (Model 0300G0 and Model 0300G2)

Ground Differential Pickup:	5 A Model: 0.10–15.00 A
	1 A Model: 0.02–3.00 A
Ratio CTR/CTRN:	1.0–40.0
Steady-State Pickup Accuracy:	5 A Model: ±0.05, ±3% 1 A Model: ±0.01, ±3%
Pickup Time:	25 ms at 60 Hz (Max)
Time Delays:	0.00–400.00 s
Maximum Definite-Time Delay Accuracy:	±0.1%, ±4.2 ms at 60Hz

Optional RTD Elements (Models Compatible With SEL-2600 Series RTD Module)

12 RTD Inputs via SEL2600 Series RTD Module and SEL-2800 Fiber-Optic Transceiver
Monitor Winding, Bearing, Ambient, or Other Temperatures
PT100, NI100, NI120, and CU10 RTD-Types Supported, Field Selectable
Trip, Alarm, and Ambient/Load-Current Bias Settings
As long as 500 m fiber-optic cable to SEL-2600 Series RTD Module

Measuring Range:	–50° to 250°C
Accuracy:	±2°C
RTD Trip/Alarm Time Delay:	Approx. 6 s

Demand Ammeter Elements

Demand Ammeter Time Constants:	5, 10, 15, 30, or 60 min
Demand Ammeter Threshold Range:	5 A Model: 0.5–16.0 A
	1 A Model: 0.1–3.2 A
Steady-State Pickup Accuracy:	5 A Model: ±0.05 A, ±3%
	1 A Model: ±0.01 A, ±3%

Inadvertent Energization Logic

Time-Delay Pickup and Dropout Timers:	0.00–400.00 s
Maximum Definite-Time Delay Accuracy:	±0.1%, ±4.2 ms at 60 Hz

Breaker Failure Protection

Implement using nondedicated overcurrent element and SELOGIC Control Equation Variable Timer.

Phase Overcurrent Pickup (A secondary):	5 A Model: 0.25–100.00 A
	1 A Model: 0.05–20.00 A
Steady-State Pickup Accuracy:	5 A Model: ±0.05 A, ±3%
	1 A Model: ±0.01 A, ±3%
Time-Delay Pickup and Dropout Timers:	0.00–3000.00 s
Maximum Definite-Time Delay Accuracy:	±0.1%, ±4.2 ms

SELOGIC Control Equation Variable Timers

16 Time-Delay Pickup and Dropout Timers:	0.00–3000.00 s
Maximum Definite-Time Delay Accuracy:	±0.1%, ±4.2 ms at 60 Hz

Substation Battery Voltage Monitor

Station Battery Voltage Monitor Pickup Ranges:	20–300 Vdc
Measuring Accuracy:	±2 V, ±2%

Metering Accuracy

Accuracies are specified at 20°C and at nominal system frequency unless noted otherwise.

Voltages V_A, V_B, V_C, V_N, V_S, $3V_0$, V_1, V_2, V_{AB}, V_{BC}, V_{CA}:	±0.1% (33.5–218.0 V)
Currents I_A, I_B, I_C	
5 A Nominal:	±1 mA or ±0.1% (0.5–10.0 A)
1 A Nominal:	±0.2 mA or ±0.1% (0.1–2.0 A)
Temperature Coefficient:	$[(0.0002\%)/(°C)^2] \cdot (\_\_°C - 20°C)^2$ (see following example)
Phase Angle Accuracy:	±0.5°
Currents I_N, I_{A87}, I_{B87}, I_{C87}, I_1, $3I_0$, $3I_2$	
5 A Nominal:	±0.05 A or ±3% (0.5–100.0 A)
1 A Nominal:	±0.01 A or ±3% (0.1–20.0 A)

MW/MVAR (A, B, C, and 3-phase; 5 A nominal; wye-connected voltages)

Accuracy (MW / MVAR)	**at load angle**
for 0.5 A ≤ phase current < 1.0 A:	
0.70% /–	0° or 180° (unity power factor)
0.75% / 6.50%	±8° or ±172°
1.00% / 2.00%	±30° or ±150°
1.50% / 1.50%	±45° or ±135°
2.00% / 1.00%	±60° or ±120°
6.50% / 0.75%	±82° or ±98°
– / 0.70%	±90° (power factor = 0)
for phase current ≥ 1.0 A:	
0.35% /–	0° or 180° unity power factor)
0.40% / 6.00%	±8° or ±172°
0.75% / 1.50%	±30° or ±150°
1.00% / 1.00%	±45° or ±135°
1.50% / 0.75%	±60° or ±120°
6.00% / 0.40%	±82° or ±98°
– / 0.35%	±90° (power factor = 0)

Metering accuracy calculation example for currents I_A, I_B, and I_C because of preceding stated temperature coefficient:

For temperature of 40°C, the additional error for currents I_A, I_B, and I_C is:

$[(0.0002\%)/(°C)^2] \cdot (40°C - 20°C)^2 = 0.08\%$

Technical Support

We appreciate your interest in SEL products and services. If you have questions or comments, please contact us at:

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