SEL-751 Feeder Protection Relay

Directional Overcurrent, Arc-Flash Detection, and High-Impedance Fault Detection

New Features

➤ Disconnect control from the Bay Screens application.
➤ Three-position disconnects for increased safety.
➤ A built-in web server that simplifies access to relay data and supports firmware upgrade.
➤ Faster firmware downloads via the Ethernet port.
➤ IEEE 1588-2008 firmware-based Precision Time Protocol (PTP) provides ease of integration.
➤ EtherNet/IP provides ease of integration for industrial automation applications.
➤ IEC 61850 Test Mode support with standard operating modes for easy commissioning.
➤ Early detection of cable insulation breakdown with incipient cable fault detection.
Major Features and Benefits

The SEL-751 Feeder Protection Relay provides a comprehensive combination of protection, fault-locating features, monitoring, control, and communication in an industrial package.

The SEL-751 protection features depend on the model selected. The models are configured with specific current/voltage input cards. Table 1 shows current (ACI) and voltage (AVI) card selections for the SEL-751 models.

Table 1  Current (ACI) and Voltage (AVI) Card Selection for SEL-751 Models

<table>
<thead>
<tr>
<th>Model Description</th>
<th>Slot Z Card Option (MOT String Digital Number 14, 15)</th>
<th>Slot Z Inputs</th>
<th>Slot E Card Option (MOT String Digits Number 12, 13)</th>
<th>Slot E Inputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base SEL-751 AC Currents Only</td>
<td>4 ACI (A1, A2, A3, A5, A6, A7)</td>
<td>IA, IB, IC, IN</td>
<td>None (0X)</td>
<td>None</td>
</tr>
<tr>
<td>SEL-751 With AC Voltages (300 Vac)</td>
<td>4 ACI/3 AVI (81, 82, 83, 85, 86, 87)</td>
<td>IA, IB, IC, IN, VA, VB, VC</td>
<td>None (0X)</td>
<td>None</td>
</tr>
<tr>
<td>SEL-751 With LEA AC Voltages (8 Vac)</td>
<td>4 ACI/3 AVI (L1, L2, L3, L5, L6, L7)</td>
<td>IA, IB, IC, IN, VA, VB, VC</td>
<td>2 AVI/4 AFDI (70)</td>
<td>VS, VBAT, AF1, AF2, AF3, AF4</td>
</tr>
<tr>
<td>SEL-751 With AC Phase Voltages (300 Vac), Vsync (300 Vac), Vbat (300 V) Input, and 4 Arc-Flash Detection Inputs</td>
<td>4 ACI/3 AVI (81, 82, 83, 85, 86, 87)</td>
<td>IA, IB, IC, IN, VA, VB, VC</td>
<td>2 AVI/4 AFDI (L0)</td>
<td>VS, VBAT, AF1, AF2, AF3, AF4</td>
</tr>
<tr>
<td>SEL-751 With LEA AC Phase Voltages (8 Vac), LEA Vsync (8 Vac), Vbat (300 V) Input, and 4 Arc-Flash Detection Inputs</td>
<td>4 ACI/3 AVI (L1, L2, L3, L5, L6, L7)</td>
<td>IA, IB, IC, IN, VA, VB, VC</td>
<td>2 AVI/4 AFDI (L0)</td>
<td>VS, VBAT, AF1, AF2, AF3, AF4</td>
</tr>
</tbody>
</table>

The SEL-751 offers an extensive variety of protection features, depending on the model and options selected. Table 2 lists the protection features available in each model.

Table 2  SEL-751 Protection Elements (Sheet 1 of 2)

<table>
<thead>
<tr>
<th>Protection Element</th>
<th>Slot Z 4 ACI Card (Current Only Model) With 1 A or 5 A Neutral Channel</th>
<th>Slot Z 4 ACI/3 AVI Card With 1 A or 5 A Neutral Channel</th>
<th>Slot Z 4 ACI/3 AVI Card With 200 mA Neutral Channel</th>
</tr>
</thead>
<tbody>
<tr>
<td>50P  Max. Phase Overcurrent</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>67P  Max. Phase Overcurrent With Directional Control</td>
<td>Xa</td>
<td>Xa</td>
<td>Xb</td>
</tr>
<tr>
<td>50Q  Neg.-Seq. Overcurrent</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>67Q  Neg.-Seq. Overcurrent With Directional Control</td>
<td>Xa</td>
<td>Xa</td>
<td>Xb</td>
</tr>
<tr>
<td>50G  Residual Overcurrent</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>67G  Residual Overcurrent With Directional Control</td>
<td>Xa</td>
<td>Xa</td>
<td>Xb</td>
</tr>
<tr>
<td>50N  Neutral Overcurrent</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>67N  Neutral Overcurrent With Directional Control</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>50INC Incipient Cable Fault Detection</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>51nP  Phase Time Overcurrent (m = A, B, C)</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>51P  Max. Phase Time Overcurrent</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>51P  Max. Phase Time Overcurrent With Directional Control</td>
<td>Xa</td>
<td>Xa</td>
<td>Xb</td>
</tr>
<tr>
<td>51G  Residual Time Overcurrent</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Protection Element</td>
<td>Slot Z 4 ACI Card (Current Only Model) With 1 A or 5 A Neutral Channel</td>
<td>Slot Z 4 ACI/3 AVI Card With 1 A or 5 A Neutral Channel</td>
<td>Slot Z 4 ACI/3 AVI Card With 200 mA Neutral Channel</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
<td>-----------------------------------------------------------------------</td>
<td>--------------------------------------------------------</td>
<td>-------------------------------------------------------</td>
</tr>
<tr>
<td>51G Residual Time Overcurrent With Directional Control</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>51Q Neg.-Seq. Time Overcurrent</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>51Q Neg.-Seq. Time Overcurrent With Directional Control</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>51N Neutral Time Overcurrent</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>51N Neutral Time Overcurrent With Directional Control</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>SEF Sensitive Earth Fault</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>HBL Second- and Fifth-Harmonic Blocking</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>FLOC Fault Locator</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>27 Undervoltage (Phase, Phase-to-Phase, Vsync)</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>59 Overvoltage (Phase, Phase-to-Phase, Seq., Vsync)</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>27I Inverse Time Undervoltage</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>59I Inverse Time Overvoltage</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>60LOP Loss of Potential</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>32 Directional Power</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>49T IEC Thermal (Line/Cable)</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>55 Power Factor</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>78VS Vector Shift</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>81 Over- and Underfrequency</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>81R Rate-of-Change of Frequency</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>81RF Fast Rate-of-Change of Frequency</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>25 Synchronism Check</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>BF Breaker Failure</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>49RTD Resistance Temperature Detectors (RTDs)</td>
<td>X&lt;sup&gt;d&lt;/sup&gt;</td>
<td>X&lt;sup&gt;d&lt;/sup&gt;</td>
<td>X&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>79 Reclosing</td>
<td>X&lt;sup&gt;d&lt;/sup&gt;</td>
<td>X&lt;sup&gt;d&lt;/sup&gt;</td>
<td>X&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>HIF AST High-Impedance Fault Detection With Arc Sense Technology</td>
<td>X&lt;sup&gt;d&lt;/sup&gt;</td>
<td>X&lt;sup&gt;d&lt;/sup&gt;</td>
<td>X&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>AFT Arc-Flash Detection</td>
<td>X&lt;sup&gt;d&lt;/sup&gt;</td>
<td>X&lt;sup&gt;d&lt;/sup&gt;</td>
<td>X&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup> Available when ordered with the directional option. The 1 A/5 A neutral channel is suitable for solidly grounded systems and also impedance-grounded systems, depending on the available fault current level.

<sup>b</sup> Available when ordered with the directional option. The 200 mA neutral channel is suitable for ungrounded, low-impedance grounded, high-impedance grounded, and Petersen coil-grounded applications.

<sup>c</sup> Available with the 2 AVI/4 AFDI card in Slot E.

<sup>d</sup> Available as ordering options.
The SEL-751 offers four front-panel HMI layouts that are front-panel option dependent. Table 3 lists the HMI options for the SEL-751 front panel.

Table 3  SEL-751 Front-Panel Options

<table>
<thead>
<tr>
<th>Model/Display Descriptiona</th>
<th>Front-Panel Option (MOT String Digit Number 16)</th>
<th>Number of Pushbuttons</th>
<th>LED Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEL-751 With Two-Line Display (2 x 16 characters)</td>
<td>0</td>
<td>8</td>
<td>Tricolor</td>
</tr>
<tr>
<td>SEL-751 With Two-Line Display (2 x 16 characters)</td>
<td>1</td>
<td>4</td>
<td>Tricolor</td>
</tr>
<tr>
<td>SEL-751 With Touchscreen Display (5-inch, color, 800 x 480 pixels)</td>
<td>A</td>
<td>8</td>
<td>Tricolor</td>
</tr>
<tr>
<td>SEL-751 With Touchscreen Display (5-inch, color, 800 x 480 pixels)</td>
<td>B</td>
<td>4</td>
<td>Tricolor</td>
</tr>
</tbody>
</table>

a For ordering options, refer to the SEL-751 MOT.

- **Standard Protection Features.** Protect lines and equipment with an extensive range of protection elements, including overcurrent elements, over- and underfrequency elements, second- and fifth-harmonic current blocking (inrush blocking), demand metering elements, breaker failure protection, and incipient cable fault detection. Implement load shedding and other control schemes with under- and overfrequency elements, breaker failure protection, and powerful SELogic® control equations. Also protect and control equipment with cable or line thermal elements that conform to the IEC 60255-149 standard.

- **Additional Protection Features.** Use the SEL-751 with one of the voltage input options to protect lines and equipment with rate-of-change of frequency elements, fast rate-of-change of frequency elements, definite-time and inverse-time over- and undervoltage elements, and load encroachment and directional power elements. Also take advantage of the vector shift elements to aid in islanding detection.

- **Optional Directional Control.** Use overcurrent elements with directional control to optimize radial and looped network protection for lines and equipment. Best Choice Ground Directional Element® logic optimizes directional element performance and eliminates the need for many directional settings.

- **Optional High-Impedance Fault Detection.** Use the high-impedance fault (HIF) detection element to detect small current ground faults typically resulting from downed conductors on ground surfaces such as earth, reinforced concrete, or other poorly conductive materials. HIF event data are available in COMTRADE or Compressed ASCII format.

- **Optional Arc-Flash Protection.** Reduce or eliminate damage from arc-flash events with the optional four- or eight-channel fiber-optic arc-flash detector inputs and protection elements. Settable arc-flash phase and neutral overcurrent elements combined with arc-flash light detection elements provide secure, reliable, and fast arc-flash event protection.

- **Optional Low-Energy Analog (LEA) Voltage Inputs.** Measure voltages as low as 8 Vac rms.

- **Optional Synchronism Check and DC Station Battery Monitor.** Check single-phase voltage across a circuit breaker; measure dc voltage levels in the substation battery.

- **Operator Controls and Reclosing.** Trip and close the breaker easily with four or eight programmable front-panel pushbuttons, each with two tricolor LEDs. Implement remote and local control functions, and selectively reclose with synchronism and voltage checks.

- **Integrated Web Server.** Log in to the built-in web server to view metering and monitoring data and to download events. Use the web server to view relay settings and to perform relay firmware upgrades.

- **Relay and Logic Settings Software.** Reduce engineering costs by using cSELERATOR QuickSet® SEL-5030 Software for relay settings and logic programming and to simplify development of SELogic control equations.

- **Metering and Monitoring.** Use built-in metering functions to eliminate separately mounted metering devices. Analyze Sequential Events Recorder (SER) reports and oscillographic event reports for rapid commissioning, testing, and post-fault diagnostics. Unsolicited SER protocol allows station-wide collection of binary SER messages.
➤ **Optional Fault Location.** Reduce fault location and repair time with built-in impedance-based fault location and faulted phase indication.

➤ **Wye or Delta Voltage Inputs.** Connect voltage inputs that are wye-connected, open-delta-connected, or single voltage.

➤ **Additional Standard Features.** Improve your feeder protection with these additional standard features in every SEL-751: Modbus RTU; Event Messenger support and MIRRORED BITS® communications; load profile and breaker wear monitoring; support for 12 external RTDs (SEL-2600); IRIG-B input; advanced SELogic; and IEEE C37.118-2005-compliant synchrophasor protocol to provide real-time measurement data.

➤ **Optional Features.** Communicate with a number of additional optional communications protocols and ports, digital/analog I/O, and RTDs. Optional communications protocols include IEC 61850 Edition 2; Modbus TCP/IP; Simple Network Time Protocol (SNTP); IEEE 1588-2008 firmware-based PTP, Parallel Redundancy Protocol (PRP) for dual Ethernet models; EtherNet/IP, DNP3 LAN/WAN, DNP3 serial, and IEC 60870-5-103. With an Ethernet equipped relay, use the integrated web server to view settings and metering and monitoring data, download reports, and upgrade firmware. Elective communications ports include EIA-232 or EIA-485 multimode fiber-optic serial port and single or dual, copper or fiber-optic Ethernet ports. Several digital/analog I/O options are available. These include 4 AI/4 AO, 4 DI/4 DO, 8 DI, 8 DO, 8 AI, 3 DI/4 DO/1 AO, 4 DI/3 DO, and 14 DI. An optional 10 internal RTD card is also available for the SEL-751. Conformal coating for chemically harsh and/or high moisture environments is also available as an option.

➤ **Supported Languages.** Choose English or Spanish for your serial ports, including the front-panel serial port. The standard relay front-panel overlay is in English; a Spanish overlay is available as an ordering option.

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**Intertie Standards and Compliance**

The SEL-751 Feeder Protection Relay offers an extensive variety of protection and control features depending on the model and options selected. The SEL-751 can be configured to meet or exceed the protection and control requirements specified in the ANSI/IEEE Std 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces.*
**Functional Overview**

- Low-Energy Analogs (LEA) for AC Voltage Inputs (8 Vac RMS)*
- Sequential Events Recorder
- Event Reports and Load Profile
- Web Server
- Event Messenger Compatible
- Two Inputs and Three Outputs Standard
- I/O Expansion*—Additional Contact Inputs/Outputs, Analog Inputs/Outputs, and RTD Inputs
- ST Fiber-Optic Communications Port*
- Single or Dual Ethernet, Copper or Fiber-Optic Communications Port*
- Battery-Backed Clock, IRIG-B Time Synchronization
- Instantaneous Metering
- Four or Eight Programmable Front-Panel Pushbuttons and Tricolor LED Indicators
- Advanced SELoc® Control Equations
- 32 Programmable Display Messages
- Station Battery Monitor*
- Breaker Wear Monitoring
- Synchronphasor Protocol (IEEE C37.118-2005)
- Arc-Flash Protection*
- Peak Demand, Demand Metering
- Load Encroachment
- High-Impedance Fault Detection*
- Fault Locator
- Directional Protection*
- Maresco Brs Communications
- Front-Panel Tricolor LED Programmable Targets
- Front-Panel HMI With 2 x 16-Character LCD
- 5-inch, Color, 800 x 480 Pixel Touchscreen Display*

*Optional Functions
Protection Features

Overcurrent Elements
The SEL-751 includes a robust set of phase, negative-sequence, residual, and neutral overcurrent elements. Each element type has four levels of instantaneous protection with individual torque control and definite-time delay settings. Each element type has two inverse-time overcurrent elements (except negative-sequence, which has one time-overcurrent element). Table 4 lists the curves available in the SEL-751.

Table 4 Inverse-Time Overcurrent Curves

<table>
<thead>
<tr>
<th>US</th>
<th>IEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderately Inverse</td>
<td>Standard Inverse</td>
</tr>
<tr>
<td>Inverse</td>
<td>Very Inverse</td>
</tr>
<tr>
<td>Very Inverse</td>
<td>Extremely Inverse</td>
</tr>
<tr>
<td>Extremely Inverse</td>
<td>Long-Time Inverse</td>
</tr>
<tr>
<td>Short-Time Inverse</td>
<td>Short-Time Inverse</td>
</tr>
</tbody>
</table>

The SEL-751 has two reset characteristic choices for each time-overcurrent element. One choice resets the elements if current drops below pickup for at least one cycle. The other choice emulates electromechanical induction disc elements, where the reset time depends on the time dial setting, the percentage of disc travel, and the amount of current.

Overcurrent Elements for Phase Fault Detection
The SEL-751 provides the tools necessary for sensitive fault protection while accommodating heavily loaded circuits. Where heavy loading prevents sufficiently sensitive setting of the phase overcurrent elements to detect lower magnitude phase-to-ground faults, residual-ground overcurrent elements are available to provide sensitive ground fault protection without tripping under balanced heavy load conditions. Similarly, when heavy loading prevents sufficiently sensitive setting of the phase overcurrent elements to detect lower magnitude phase-to-phase faults, negative-sequence overcurrent elements are available to provide more sensitive phase-to-phase fault detection without tripping under balanced heavy load conditions. You can set phase overcurrent element pickup sufficiently high to accommodate heavy load while retaining sensitivity to higher magnitude three-phase faults.

On extremely heavily loaded feeders, SEL-751 load-encroachment logic adds security in cases when you cannot set phase overcurrent elements to provide adequate three-phase fault sensitivity while also accommodating load. With this logic, you can set the phase overcurrent elements below peak load current so that the relay can detect end-of-line phase faults in heavily loaded feeder applications. This load-encroachment logic uses positive-sequence load-in and load-out elements to discriminate between load and fault conditions based on the magnitude and angle of the positive-sequence impedance. When the measured positive-sequence load impedance ($Z_1$) is within a region the load-encroachment settings define, load-encroachment logic blocks the phase overcurrent elements. As Figure 2 shows, a phase fault causes $Z_1$ to move from a load region to the line angle and leads to operation of the phase overcurrent elements.

Overcurrent Elements for Ground Fault Detection
Residual-ground ($I_G$) and neutral ($I_N$) overcurrent elements detect ground faults. Increase security by controlling these elements using optoisolated inputs or the internal ground directional element. The SEL-751 protection system includes patented Best Choice Ground Directional Element logic, providing a selection of negative-sequence impedance, zero-sequence impedance, and zero-sequence current polarizing techniques for optimum directional ground element control.

Directional Elements Increase Sensitivity and Security
Phase and ground directional elements come standard in an SEL-751 with the directional control option. An automatic setting mode (EDIR = AUTO) sets all directional threshold settings according to replica positive-sequence and zero-sequence line impedance settings ($Z_{1MAG}$, $Z_{1ANG}$, $Z_{0MAG}$, and $Z_{0ANG}$) for line protection applications. For all non-line protection applications, set EDIR = Y to enable and set appropriate directional element thresholds. Phase directional elements provide directional control to the phase- and negative-sequence overcurrent elements.
Phase directional characteristics include positive-sequence and negative-sequence directional elements working together. The positive-sequence directional element memory provides a reliable output for close-in, forward, or reverse three-phase faults where each phase voltage is zero.

Ground directional elements provide directional control to the residual-ground and neutral overcurrent elements. Patented negative-sequence, zero-sequence impedance directional elements, and the zero-sequence current directional element use the same principles proven in our SEL transmission line relays. Our patented Best Choice Ground Directional Element logic selects the best available ground directional element for the ORDER setting you provide.

**Directional Protection for Various System Grounding Practices**

Current channel IN, ordered with an optional 0.2 A secondary nominal rating, provides directional ground protection for the following systems:

- Ungrounded systems
- High-impedance grounded systems
- Petersen coil-grounded systems
- Low-impedance grounded systems

This optional directional control allows the faulted feeder to be identified on a multifeeder bus with an SEL-751 on each feeder (Figure 3). Alarm or trip for the ground fault condition with sensitivity down to 5 mA secondary.

**Line/Cable Thermal Elements**

Power lines and cables are designed to operate under a certain temperature range. Because equipment is often used as close to the operating limits as possible, the importance of protecting equipment against thermal overloads becomes more critical. The thermal overload protection element is used to protect the overhead lines and cables against thermal damage (including insulation degradation and loss of equipment life) and to monitor the thermal state of the overhead lines and cables. The temperature is calculated using a thermal model according to IEC 60255-149.

**Incipient Cable Fault Detection**

Cable insulation degrades over time. The incipient cable fault detection element can monitor for self-extinguishing, half-cycle overcurrent events that precede typical cable insulation failure. Monitoring the number of incipient faults can provide an early warning of cable insulation breakdown. This information can be used for preventative maintenance.

**Wye or Open-Delta Voltages**

You can apply wye-connected (four-wire) voltages or open-delta-connected (three-wire) voltages to three-phase voltage inputs VA, VB, VC, and N, as shown in Figure 4. You only need to make a global setting change (DELTA_Y = WYE or DELTA_Y = DELTA) and an external wiring change—no internal relay hardware changes or adjustments are necessary. Thus, a single SEL-751 model meets all your distribution protection needs, regardless of available three-phase voltages.
Figure 4 Connect Wye or Open-Delta Voltages to SEL-751 Three-Phase Voltage Inputs

Figure 4 shows the connections for a 3V0 broken delta input.

In addition, the SEL-751 supports single voltage input. For customers with a single PT input, the SEL-751 assumes balanced voltage input for all protection and metering functions.

**Loss-of-Potential Logic**

The SEL-751 includes loss-of-potential (LOP) logic that detects one, two, or three blown potential fuses. This patented LOP logic is unique because it does not require settings and is universally applicable. The LOP feature allows the blocking of protection elements to add security during fuse failure.

**Synchronism Check**

When you order the Vsync, Vbat Voltage Input and 4 Arc-Flash Detection Inputs card (SELECT 2 AVI/4 AFDI), single-phase voltage (phase-to-neutral or phase-to-phase) is connected to voltage input VS/NS for synchronism check across a circuit breaker (or hot/dead line check). You can use synchronism-check voltage to coordinate reclosing with the optional recloser control.

**Voltage and Frequency Elements for Extra Protection and Control**

**Over- and Undervoltage Elements**

Phase-to-ground, phase-to-phase, negative-sequence, and residual overvoltage (59) and phase-to-ground or phase-to-phase undervoltage (27) elements in the SEL-751 can be used to create the following protection and control schemes.

- Trip/alarm or event report triggers for over- and undervoltage conditions.
- Undervoltage (27) load shedding scheme (having both 27 and 81U load shedding schemes allows detection of system MVAR- and MW-deficient conditions).
Inverse-Time Over- and Undervoltage Elements

Custom programmable, IEC equation-based inverse-time overvoltage (59I) and undervoltage (27I) elements in the SEL-751 add flexibility in voltage protection and control schemes.

Over- and Underfrequency Protection

Six levels of secure overfrequency (81O) or underfrequency (81U) elements detect true frequency disturbances. Use the independently time-delayed output of these elements to shed load or trip local generation. The SEL-751 uses the voltage input to make frequency measurements; it switches automatically to current input when voltages are insufficient.

Implement an internal multistage frequency trip/restore scheme at each breaker location using the multiple over- and underfrequency levels. This method avoids the cost of wiring a complicated trip and control scheme from a separate frequency relay.

Rate-of-Change-of-Frequency Protection

Four independent rate-of-change-of-frequency elements are provided with individual time delays for use when frequency changes occur (e.g., when there is a sudden imbalance between generation and load). The elements can call for control action or switching action such as network decoupling or load shedding. Each element includes logic to detect either increasing or decreasing frequency and above or below nominal frequency.

Fast Rate-of-Change-of-Frequency Protection for Aurora Vulnerability Mitigation

The fast rate-of-change-of-frequency protection, 81RF, provides a faster response compared to frequency (81) and rate-of-change-of-frequency (81R) elements. Fast operating speed makes the 81RF element suitable for detecting islanding conditions. The element uses a characteristic (see Figure 6) based on the frequency deviation from nominal frequency (DF = FREQ – FNOM) and the rate-of-change of frequency (DF3C) to detect islanding conditions.

Vector Shift (78VS) Protection

When distributed generators (DG) are connected to a utility network, the vector shift (78VS) element is used to detect islanding conditions and trip the DG. Failure to trip islanded generators can lead to problems such as personnel safety, out-of-synchronization reclosing, and degradation of power quality. Based on the change in the angle of the voltage waveform, the islanding condition can be detected by the vector shift function.

Use the vector shift element with the 81RF element as a backup for fast and secure islanding detection. The vector shift element operates within three cycles, which is fast enough to prevent reclosing out-of-synchronism with the network feeders to avoid generator damage.

Harmonic Blocking Elements Secure Protection During Transformer Energization

Transformer inrush can cause sensitive protection to operate. Use the second- and fifth-harmonic blocking feature to detect an inrush condition and block selected tripping elements until the inrush subsides. Select the blocking threshold as a percentage of fundamental current, and optimize security and dependability with settable pickup and dropout times. Use the programmable torque control equation only to enable the blocking element immediately after closing the breaker.
Power Element Protection
The SEL-751 provides two power elements for detecting real (watts) or reactive (VARs) positive- or negative-power flow levels for the feeder application. Each power element has a definite-time delay setting.

High-Impedance Fault (HIF) Detection
High-impedance faults are short-circuit faults with fault currents smaller than what a traditional overcurrent protective relay can detect. The main causes of HIFs are tree branches touching a phase conductor; dirty or failing insulators that cause flashovers between a phase conductor and the ground; or downed conductors touching the ground. The SEL-751 with the Arc Sense technology (AST) option includes logic that can detect HIF signatures without being affected by loads or other system operation conditions. A running average provides a stable prefault reference, and adaptive tuning learns and tunes out feeder ambient noise conditions. Decision logic differentiates an HIF condition from other system conditions such as switching operations and noisy loads. The relay stores as many as 20 minutes of HIF activity in 2-cycle resolution Compressed ASCII and COMTRADE formats and it stores a summary of HIF activity that you can access through the use of ASCII commands.

Arc-Flash Protection
An arcing short circuit or a ground fault in low- or medium-voltage switchgear can cause serious equipment damage and personal injury, resulting in prolonged and expensive downtime.

The best way to minimize the impact of an arc-flash event is to reduce the detection and circuit breaker tripping times. Conventional protection may need several cycles to detect the resulting overcurrent fault and trip the breaker. In some cases, there may not be sufficient current to detect an overcurrent fault. Tripping may be delayed hundreds of milliseconds for sensitivity and selectivity reasons in some applications.

The arc-flash detection-based (AFD) protection can act on the circuit breaker in a few milliseconds (2–5 ms). This fast response can limit the arc-flash energy, thus preventing injury to personnel and limiting or eliminating equipment damage.

The arc-flash protection option in the SEL-751 adds four or eight-channel fiber-optic AFD inputs and protection elements. Each channel has a fiber-optic receiver and an LED-sourced fiber-optic transmitter that continuously self-tests and monitors the optical circuit to detect and alarm for any malfunction. There are two types of applications supported by the SEL-751: point sensor applications and fiber sensor applications.

Point Sensor Application
The arc is detected by transmitting the arc-flash light captured by the optical diffuser (located appropriately in the switchgear) over a 1000 µm plastic fiber-optic cable to the optical detector in the relay. The relay performs sensor loopback tests on the optical system using an LED-based transmitter to transmit light pulses at regular intervals to the point-sensor assembly (through a second fiber-optic cable). If the relay optical receiver does not detect this light, the relay declares a malfunction and alarms. Figure 7 (top) shows a diagram for the point sensor application.

Fiber Sensor Application
Fiber sensor AFD uses a clear-jacketed 1000 µm plastic fiber-optic cable located in the switchgear equipment. One end of the fiber is connected to the optical detector in the relay and the other end is connected to the LED transmitter in the relay. The LED transmitter injects periodic light pulses into the fiber as a sensor loopback test to verify the integrity of the loop. The relay detects and alarms for any malfunction. Figure 7 (bottom) shows a diagram for the clear-jacketed fiber sensor application.

Figure 7 SEL-751 Arc-Flash Detection System
The SEL-751 AFD system provides four or eight channels per relay that can be configured for the point sensor or the clear-jacketed fiber sensor applications. The optional fast hybrid outputs (high-speed and high-current) of the relay provide fast-acting trip outputs to the circuit breaker (less than 50 µs). The fast breaker tripping can prevent serious damage or personal injury in case of an arc-flash event. The relay also provides light metering and light event capture to aid in setting the relay and capturing the arc-flash event for records and analysis.

Settable arc-flash phase and neutral overcurrent elements are combined with arc-flash light detection elements to provide secure, reliable, and fast acting arc-flash event protection.
RTD Thermal Protection

When the SEL-751 is equipped with either an optional 10 RTD input expansion card or an external SEL-2600 RTD Module with as many as 12 RTD inputs, you can program as many as 12 thermal elements in the relay for two levels of thermal protection per element. Each RTD input provides an alarm and trip thermal pickup setting in degrees Celsius, open and shorted RTD detection, and is compatible with the following three-wire RTD types:

- PT100 (100 Ω platinum)
- NI100 (100 Ω nickel)
- NI120 (120 Ω nickel)
- CU10 (10 Ω copper)

Operator Controls and Reclosing

Operator controls eliminate traditional panel control switches. Four or eight conveniently sized operator controls, each with two programmable tricolor LEDs, are located on the relay front panel (see Figure 8). You can set the SER to track operator controls. Use SELOGIC control equations to change operator control functions. Use configurable labels to change all of the text shown in Figure 8.

The following operator control descriptions are for factory-set logic.

LOCK: The LOCK operator control blocks selected functions. Press it for at least three seconds to engage or disengage the lock function. When the LOCK pushbutton is engaged, the TRIP and CLOSE operators are blocked.

CLOSE and TRIP: Use the CLOSE and TRIP operator controls to close and open the circuit breaker. You can program these controls with intentional time delays to support operational requirements for breaker-mounted relays. This allows you to press the CLOSE or TRIP pushbutton, then move to an alternate location before the breaker command is executed.

AUXn: You can program the AUXn (n = 1, 2, 3, or 4) pushbuttons for additional control of your specific application.

Programmable Autoreclosing

When ordered with optional reclosing, the SEL-751 can autoreclose a circuit breaker as many as four times before lockout. Use SELOGIC control equations to program the SEL-751 to perform the following reclosing functions.

- Allow closing, e.g., when the load-side line is dead, or when the two systems are in synchronism (optional).
- Advance the shot counter without tripping, e.g., when another protective relay clears a fault, also known as sequence coordination.
- Initiate reclosing, e.g., for particular protection trip operations.
- Drive-to-lockout, e.g., when an optoisolated input is deasserted.
Delay reclosing, e.g., after a trip caused by a close-in, high-current fault.
Flexible reclose supervision failure scheme that allows going to lockout or moving to the next available shot.

The reclosing shot counter controls which protective elements are involved in each reclose interval. Applications include fuse- and trip-saving schemes. The front-panel LEDs (RECL RESET and RECL LOCKOUT) track the reclosing state.

**Built-In Web Server**

Every Ethernet-equipped SEL-751 includes a built-in web server. Interface with the relay by using any standard web browser to perform the following actions:
- Log in with password protection.
- Safely read the relay settings.
- Verify the relay self-test status and view the relay configuration.
- Inspect meter reports.
- Download SER and event reports.
- Upload new firmware (firmware upgrade).

*Figure 9* shows the fundamental metering screen that can be accessed by clicking **Meter > Fundamental**. Use the Meter menu to view all the available relay metering statistics.

*Figure 10* shows the Group 1 settings webpage. You can view the settings of each relay settings class by selecting **Settings** and the respective relay settings class.

*Figure 9  Fundamental Meter Report Webpage*

You can upgrade the relay firmware through the relay web server by clicking **System > File Management** (available at Access Level 2) and selecting the firmware upgrade file. *Figure 11* shows the firmware upgrade webpage.

*Figure 10  Group 1 Settings Webpage*

*Figure 11  Upgrade the Relay Firmware From the File Management Webpage*

**Relay and Logic Settings Software**

QuickSet simplifies settings and provides analytical support for the SEL-751. There are several ways to create and manage relay settings with QuickSet:
- Develop settings offline with an intelligent settings editor that only allows valid settings.
- Create SELOGIC control equations with a drag-and-drop text editor.
- Configure proper settings using online help.
- Organize settings with the relay database manager.
- Load and retrieve settings using a simple PC communications link.

With QuickSet, you can verify settings and analyze power system events with the integrated waveform and harmonic analysis tools.

Use the following features of QuickSet to monitor, commission, and test the SEL-751:
- Use the HMI to monitor meter data, Relay Word bits, and output contact statuses during testing.
- Use the PC interface to remotely retrieve power system data.
Use the Event Report Analysis tool for easy retrieval and visualization of ac waveforms and digital inputs and outputs the relay processes.

Use the graphical current phasor display in the HMI to visualize differential current relationships.

Use bay control to design new bay screens and edit existing bay screens by launching ACSELERATOR Bay Screen Builder SEL-5036 Software for SEL-751 relays with the touchscreen display.

**ACSELERATOR Bay Screen Builder SEL-5036 Software**

The SEL-751 with the touchscreen display option provides you with the ability to design bay configuration screens to meet your system needs. You can display the bay configuration as a single-line diagram (SLD) on the touchscreen. You can use ANSI and IEC symbols, along with analog and digital labels, for the SLD to indicate the status of the breaker and disconnects, bus voltages, and power flow through the breaker. In addition to SLDs, you can design the screens to show the status of various relay elements via Relay Word bits or to show analog quantities for commissioning or day-to-day operations. You can design these screens with the help of Bay Screen Builder in conjunction with QuickSet. Bay Screen Builder provides an intuitive and powerful interface to design bay screens to meet your application needs.

![Figure 12 Bay Screen Builder](image)

**Metering and Monitoring**

The SEL-751 provides extensive metering capabilities. See Specifications on page 31 for metering and power measurement accuracies. As shown in Table 5, metered quantities include phase voltages and currents; neutral current, sequence voltages and currents; power, frequency, and energy; and maximum/minimum logging of selected quantities. The relay reports all metered quantities in primary quantities (current in A primary and voltage in V primary).
The SEL-751 features a programmable Load Data Profile (LDP) recorder that records as many as 17 metering quantities into nonvolatile memory at fixed time intervals. The LDP saves several days to several weeks of the most recent data depending on the LDP settings (6500 entries total).

**Synchrophasor Measurements**

Combine the SEL-751 with an SEL-IRIG-B time source to measure the system angle in real time with a timing accuracy of ±10 µs. Measure instantaneous voltage and current phase angles in real time to improve system operation with synchrophasor information. Replace state measurement, study validation, or track system stability. Use SEL-5077 SYNCHROWAVE® Server Software or SEL-5078-2 SYNCHROWAVE® Central Visualization Analysis Software to view system angles at multiple locations for precise system analysis and system-state measurement (see Figure 13).

**Table 5  SEL-751 Metered Values (Model Dependent)**

<table>
<thead>
<tr>
<th>Quantities</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instantaneous Light</td>
<td>Phase current magnitude and angle, primary A</td>
</tr>
<tr>
<td>Math Variables</td>
<td>Neutral current magnitude and angle, primary A</td>
</tr>
<tr>
<td>Demand and Peak Demand</td>
<td>Residual-ground fault current and angle, primary A (IG = 3I0 = IA + IB + IC)</td>
</tr>
<tr>
<td>Voltages VA, VB, VC</td>
<td>Average current magnitude, current imbalance</td>
</tr>
<tr>
<td>Voltages VAB, VBC, VCA</td>
<td>Phase voltage and angles, primary volts, for wye-connected voltage inputs</td>
</tr>
<tr>
<td>Voltages VAVE, UBV</td>
<td>Phase-to-phases voltage and angles, primary volts, for delta-connected voltage inputs</td>
</tr>
<tr>
<td>Voltage VS</td>
<td>Average voltage magnitude, voltage imbalance</td>
</tr>
<tr>
<td>Power kVA, kW, kVAR</td>
<td>Synchronism-check voltage magnitude and angle, primary volts</td>
</tr>
<tr>
<td>Energy MWh, MVARh, MVAh</td>
<td>Calculated apparent, real, and reactive power scales to primary values (single and three-phase)</td>
</tr>
<tr>
<td>Power Factor PF&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Three-phase positive and negative megawatt-hours, megavar-hours, and megavolt-amp-hours</td>
</tr>
<tr>
<td>Sequence I1, 3I2, 3I0, V1, 3V2, 3V0</td>
<td>Single and three-phase power factor (leading or lagging)</td>
</tr>
<tr>
<td>Voltage VDC</td>
<td>Positive-, negative-, and zero-sequence currents and voltages</td>
</tr>
<tr>
<td>Frequency FREQ</td>
<td>Station battery voltage</td>
</tr>
<tr>
<td>Frequency FREQS</td>
<td>Instantaneous system frequency (Hz)</td>
</tr>
<tr>
<td>Light Intensity (%) LS1–LS8</td>
<td>Instantaneous frequency (Hz) of synchronism-check voltage channel</td>
</tr>
<tr>
<td>AL01–AL08 (x = 3, 4, or 5)</td>
<td>Arc-flash light inputs in percentage of full scale</td>
</tr>
<tr>
<td>MV01–MV32</td>
<td>Analog inputs</td>
</tr>
<tr>
<td>RA001–RA128</td>
<td>Math variables</td>
</tr>
<tr>
<td>Thermal Element x</td>
<td>Element x pu current level, thermal capacity, time to trip, and time to reset values, where x = 1, 2, or 3</td>
</tr>
<tr>
<td>Current THIEQ&lt;sub&gt;x&lt;/sub&gt; pu</td>
<td></td>
</tr>
<tr>
<td>TCU THTCU&lt;sub&gt;x&lt;/sub&gt;%</td>
<td></td>
</tr>
<tr>
<td>Trip Time THTRIP&lt;sub&gt;x&lt;/sub&gt; s</td>
<td></td>
</tr>
<tr>
<td>Release Time THRLS&lt;sub&gt;x&lt;/sub&gt; s</td>
<td></td>
</tr>
<tr>
<td>RTD1–RTD12</td>
<td>RTD temperature measurement (degrees C)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Single-phase power and power factor quantities are not available when delta-connected PTs are used.

**Load Profile**

The SEL-751 features a programmable Load Data Profile (LDP) recorder that records as many as 17 metering quantities into nonvolatile memory at fixed time intervals. The LDP saves several days to several weeks of the most recent data depending on the LDP settings (6500 entries total).

Use IEEE C37.118-2005 protocol to send synchrophasor data to SEL synchrophasor applications. These include the SEL-3378 Synchrophasor Vector Processor (SVP), SEL-3530 Real-Time Automation Controller (RTAC), and the SEL-5078-2 SYNCHROWAVE® Central Visualization and Analysis Software suite.

The SEL-3373 Station Phasor Data Concentrator (PDC) and the SEL-5073 SYNCHROWAVE PDC software correlate data from multiple SEL-751 relays and concentrate...
the result into a single output data stream. These products also provide synchrophasor data archiving capability. The SEL-3378 SVP enables control applications based on synchrophasors. Directly measure the oscillation modes of your power system and then act on the result. Use wide-area phase angle slip and acceleration measurements to properly control islanding of distributed generation. With the SVP, you can customize a synchrophasor control application according to the unique requirements of your power system.

The data rate of SEL-751 synchrophasors is selectable with a range of 1–60 messages per second. This flexibility is important for efficient use of communication capacity.

The SEL-751 phasor measurement accuracy meets the highest IEEE C37.118-2005 Level I requirement of 1 percent total vector error (TVE). This means you can use any SEL-751 model in an application that otherwise would require purchasing a separate dedicated phasor measurement unit (PMU).

Use the SEL-751 with SEL communications processors, or the SEL-3530 RTAC, to change nonlinear state estimation into linear state estimation. If all necessary lines include synchrophasor measurements then state estimation is no longer necessary. The system state is directly measured.

**Figure 14** Synchrophasor Measurements Turn State Estimation Into State Measurement

![Diagram of synchrophasor measurements](image)

**Figure 15** Visualization of Phase Angle Measurements Across a Power System

## Improve Situational Awareness

Provide improved information to system operators. Advanced synchrophasor-based tools produce a real-time view of system conditions. Use system trends, alarm points, and preprogrammed responses to help operators prevent a cascading system collapse and maximize system stability. Awareness of system trends provides operators with an understanding of future values based on measured data.

➤ Increase system loading while maintaining adequate stability margins.

➤ Improve operator response to system contingencies such as overload conditions, transmission outages, or generator shutdown.

➤ Advance system knowledge with correlated event reporting and real-time system visualization.

➤ Validate planning studies to improve system load balance and station optimization.

![Diagram of situational awareness](image)

**Figure 16** SEL-5078 SYNCHROWAVE Console Real-Time, Wide-Area Visualization Tool

### Event Reporting and SER

Event reports and the SER simplify post-fault analysis and improve understanding of simple and complex protective scheme operations. In response to a user-selected trigger, the voltage, current, frequency, and element status information contained in each event report confirms relay, scheme, and system performance for every fault. Decide how much detail is necessary when you request an event report (e.g., 1/4-cycle or 1/32-cycle resolution, filtered or raw analog data, respectively).

The relay stores as many as 8 of the most recent 180-cycle event reports, 21 of the most recent 64-cycle event reports, or 44 of the most recent 15-cycle event reports in nonvolatile memory. The relay always appends relay settings to the bottom of each event report.
The following analog data formats are available:
➤ 1/4-cycle or 1/32-cycle resolution, filtered or unfiltered analog, ASCII or Compressed ASCII reports
➤ 1/32-cycle resolution COMTRADE reports

The relay SER feature stores the latest 1,024 entries. Use this feature to gain a broad perspective at a glance. An SER entry helps to monitor input/output change-of-state occurrences and element pickup/dropout.

**Synchronized Measurements**

The IRIG-B time-code input synchronizes the SEL-751 internal clock time to within ±1 µs of the time-source input. Convenient sources for this time code are an SEL-2401 Satellite-Synchronized Clock, an SEL communications processor, or an SEL RTAC (via Serial Port 2 or 3 on the SEL-751). For time accuracy specifications for metering, synchrophasors, and events, see Specifications.

**Substation Battery Monitor**

The SEL-751 relays that include the enhanced voltage option with the monitoring package measure and report the substation battery voltage connected to the VBAT terminals. The relay includes two programmable threshold comparators and associated logic for alarm and control. For example, if the battery charger fails, the measured dc falls below a programmable threshold. The SEL-751 alarms to alert operations personnel before the substation battery voltage falls to unacceptable levels. Monitor these thresholds with an SEL communications processor and trigger messages, telephone calls, or other actions.

The measured dc voltage appears 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. This display shows how much the substation battery voltage drops during trip, close, and other control operations.

**Circuit Breaker Contact Wear Monitor**

Circuit breakers experience mechanical and electrical wear every time they operate. Intelligent scheduling of breaker maintenance takes into account a manufacturer’s published data of contact wear versus interruption levels and operation count. With the breaker manufacturer’s maintenance curve as input data, the SEL-751 breaker monitor feature compares this input data to the measured (unfiltered) ac current at the time of a trip and the number of close-to-open operations.

Every time the breaker trips, the relay integrates the measured current information. When the result of this integration exceeds the breaker wear curve threshold (see Figure 17), the relay alarms via output contact, communications port, or front-panel display. This kind of information allows timely and economical scheduling of breaker maintenance.

**Figure 17  Breaker Contact Wear Curve and Settings**

**Fault Locator**

The SEL-751 provides a valuable estimate of fault location even during periods of substantial load flow. The fault locator uses fault type, replica line impedance settings, and fault conditions to calculate fault location. This feature, which operates without the use of communications channels, special instrument transformers, or pre-fault information, contributes to efficient dispatch of line crews and fast restoration of service. The fault locator uses three-phase voltage inputs. Wye-connected voltages are necessary for phase and ground fault distance calculations.

Only phase fault distance calculations are available with delta-connected voltages. The fault locator is unavailable in the absence of voltage or single-phase voltage connections.

**IEC 61850 Test Mode**

Test Mode allows you to test an in-service relay without operating control output contacts. Test Mode includes five different modes.

**On:** In On mode, the relay operates as normal; it reports IEC 61850 Mode/Behavior status as On and processes all inputs and outputs as normal. If the quality of the subscribed GOOSE messages satisfies the GOOSE processing, the relay processes the received GOOSE messages as valid.

**Blocked:** This mode is similar to On mode, except that the device does not trip any physical contact outputs.

**Test:** In Test mode, the relay processes valid incoming test signals and normal messages and operates physical contact outputs, if the outputs are triggered.

**Test/Blocked:** This is similar to Test mode, except that the device does not trip any physical contact outputs.
Off: The device does not process any incoming data or control commands (except commands to change the mode). All protection logic is disabled and all data quality is marked as invalid.

**Touchscreen Display**

You can order the SEL-751 Feeder Protection Relay with an optional touchscreen display (5-inch, color, 800 x 480 pixels). The touchscreen display makes relay data metering, monitoring, and control quick and efficient. The touchscreen display option in the SEL-751 features a straightforward application-driven control structure and includes intuitive and graphical screen designs.

The touchscreen display allows you to:

- View and control bay screens
- Access metering and monitoring data
- Inspect targets
- View event history, summary data, and SER information
- View relay status and configuration
- Control relay operations
- View and edit settings
- Enable the rotating display
- Program control pushbuttons to jump to a specific screen

You can navigate the touchscreen by tapping the folders and applications. The folders and applications of the Home screen are shown in Figure 18. Folders and applications are labeled according to functionality. Additional folder and application screens for the SEL-751 touchscreen display option can be seen in Figure 19 through Figure 27.

**Bay Screens Application**

The SEL-751 with the touchscreen display option provides you with the ability to design bay configuration screens to meet your system needs. The bay configuration can be displayed as an SLD on the touchscreen. You can create as many as five bay screens with one controllable breaker, eight controllable two-position disconnects, and two controllable three-position disconnects. ANSI and IEC symbols, along with analog and digital labels, are available for you to create detailed SLDs of the bay to indicate the status of the breaker and disconnects, bus voltages, and power flow through the breaker. Figure 19 shows the default SLD for the touchscreen display option.
Meter Folder Applications

The applications in the Meter folder are part-number dependent. Only those metering applications specific to your part number appear in the Meter folder. Tapping an application in the Meter folder shows you the report for that particular application. Tap the Phasor application to view the current and voltage phasors (see Figure 20).

Tap the Energy application to view the energy metering quantities (see Figure 21). A reset feature is provided for the Energy, Max/Min, Demand, and Peak Demand applications. Tap the Reset button (see Figure 21) to navigate to the reset confirmation screen. Once you confirm the reset, the data are reset to zero.

Reports Folder Applications

Tapping the Reports folder navigates you to the screen where you can access the Events, HIF Events (if available), and SER applications. Use these applications to view events and SERs. To view the event summary (see Figure 22) of a particular event record, tap the event record on the Event History screen (for Events and HIF Events). You can also trigger an event report from the Event History screen.

Control Folder Applications

Tapping the Control folder navigates you to the screen where you can access the Breaker Control, Output Pulsing, and Local Bits applications. Use the applications to perform breaker control operations, pulse output contacts (Figure 24), and control the local bits (Figure 25).
Device Info Folder Applications

Tapping the Device Info folder navigates you to the screen where you can access specific device information applications (Status, Configuration, Arc-Flash Diagnostics, and Trip & Diag. Messages) and the Reboot application. Tap the Status application to view the relay status, firmware version, part number, etc. (see Figure 26).

Automation

Flexible Control Logic and Integration Features

The SEL-751 can be ordered with as many as four independently operated serial ports:

- EIA-232 port on the front panel
- EIA-232 or EIA-485 port on the Slot B card in the rear
- EIA-232 fiber-optic port on the Slot B card in the rear
- EIA-232 or EIA-485 port on the optional communications card in Slot C in the rear

Optionally, the relay supports single or dual, copper or fiber-optic Ethernet ports. The relay does not require special communications software. You can use any system that emulates a standard terminal system for engineering access to the relay. Establish local or remote communication by connecting computers, modems, protocol converters, printers, an SEL RTAC, SEL communications processor, SEL computing platform, SCADA serial port, or RTUs. Refer to Table 6 for a list of communications protocols available in the SEL-751.
Apply an SEL communications processor as the hub of a star network with a point-to-point fiber or copper connection between the hub and the SEL-751 (see Figure 28).

The communications processor supports external communications links, including the public switched telephone network, for engineering access to dial-out alerts and private line connections of the SCADA system.

![Example Communications System](image)

SEL manufactures a variety of standard cables for connecting this and other relays to a variety of external devices. Consult your SEL representative for more information on cable availability.

SEL-751 control logic improves integration in the following ways.

- **Replaces traditional panel control switches.** Eliminate traditional panel control switches with 32 local bits. Set, clear, or pulse local bits with the front-panel pushbuttons and display. Program the local bits into your control scheme with SELOGIC control equations. Use the local bits to perform functions such as a trip test or a breaker trip/close.

- **Eliminates RTU-to-relay wiring with 32 remote bits.** Set, clear, or pulse remote bits using serial port commands. Program the remote bits into your control scheme with SELOGIC control equations. Use remote bits for SCADA-type control operations such as trip, close, and settings group selection.
➤ **Replaces traditional latching relays.** Replace as many as 32 traditional latching relays for such functions as remote control enable with latch bits. Program latch set and latch reset conditions with SELLOGIC control equations. Set or reset the non-volatile latch bits using optoisolated inputs, remote bits, local bits, or any programmable logic condition. The latch bits retain their state when the relay loses power.

➤ **Replaces traditional indicating panel lights.** Replace traditional indicating panel lights with 32 programmable displays. Define custom messages (e.g., Breaker Open, Breaker Closed) to report power system or relay conditions on the front-panel display. Use advanced SELLOGIC control equations to control which messages the relay displays.

➤ **Eliminates external timers.** Eliminate external timers for custom protection or control schemes with 32 general purpose SELLOGIC control equation timers. Each timer has independent time-delay pickup and dropout settings. Program each timer input with the element you want (e.g., time qualify a current element). Assign the timer output to trip logic, transfer trip communications, or other control scheme logic.

➤ **Eliminates setting changes.** Selectable setting groups make the SEL-751 ideal for applications requiring frequent setting changes and for adapting the protection to changing system conditions.

The relay stores four setting groups. Select the active setting group by optoisolated input, command, or other programmable conditions. Use these setting groups to cover a wide range of protection and control contingencies. Switching setting groups switches logic and relay element settings. Program groups for different operating conditions, such as feeder paralleling, station maintenance, seasonal operations, emergency contingencies, loading, source changes, and downstream relay setting changes.

### Fast SER Protocol

SEL Fast SER provides SER events to an automated data collection system. SEL Fast SER protocol is available on any rear serial port. Devices with embedded processing capability can use these messages to enable and accept unsolicited binary SER messages from SEL-751 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 using 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 communications (e.g., transmission of a long event report) interleaved with short bursts of binary data to support fast acquisition of metering or SER data.

### Ethernet Network Architectures

![Simple Ethernet Network Configuration](image)

**Figure 29** Simple Ethernet Network Configuration

**Cat 5 shielded twisted pair (STP) cables with RJ45 connectors** (SEL-C627/C628) for copper Ethernet ports

**OR**

**Fiber-optic Ethernet cables with LC connectors** (SEL-C808) for fiber-optic Ethernet ports

Set Port 1 (Ethernet) settings in each relay.
Additional Features

**MIRRORED BITS Relay-to-Relay Communications**

The SEL-patented MIRRORED BITS communications technology provides bidirectional relay-to-relay digital communications. MIRRORED BITS communications can operate independently on as many as two EIA-232 rear serial ports and one fiber-optic rear serial port on a single SEL-751.

This bidirectional digital communication creates eight additional virtual outputs (transmitted MIRRORED BITS) and eight additional virtual inputs (received MIRRORED BITS) for each serial port operating in the MIRRORED BITS mode (see Figure 32). Use these MIRRORED BITS to transmit/receive information between upstream relays and a downstream recloser control (e.g., SEL-351R) to enhance coordination and achieve faster tripping for downstream faults. MIRRORED BITS technology also helps reduce total scheme operating time by eliminating the need to assert output contacts to transmit information.
Status and Trip Target LEDs

The SEL-751 includes 24 status and trip target tricolor LEDs on the front panel. When shipped from the factory, all LEDs are predefined and fixed in settings. You can reprogram these LEDs for specific applications. This combination of targets is explained and shown in Figure 35. Some front-panel relabeling of LEDs may be needed if you reprogram them for unique or specific applications—see Configurable Labels.

Event Messenger Points

The SEL-751, when used with the SEL-3010, allows for ASCII-to-voice translation of as many as 32 user-defined messages, along with analog data that has been measured or calculated by the relay. This combination allows you to receive voice message alerts (on any phone) regarding Relay Word bit transitions in the relay.

Verbal notification of breaker openings, fuse failures, RTD alarms, etc., can be sent directly to your cell phone through the use of your SEL-751 and an SEL-3010 (must be connected to an analog telephone line). In addition, messages can include an analog value such as current, voltage, or power measurements made by the SEL-751.

Configurable Labels

Use the configurable labels to relabel the operator controls and LEDs (shown in Figure 35) to suit your installation requirements. This feature includes preprinted labels (with factory-default text), blank label media, and a Microsoft Word template on CD-ROM. This allows you to create quick, professional-looking labels for the SEL-751. Labels may also be customized without the use of a PC by writing the new label on the blank stock provided. The ability to customize the control and indication features allows specific utility or industry procedures to be implemented without the need for adhesive labels.

Web Server

The web server allows you to communicate with the relay via the Ethernet port without the need for additional communication software (web browser required). The web server allows you to access metering and monitoring data and to perform firmware upgrades.

Firmware Download Via Ethernet Ports

Relay firmware can be securely downloaded to your relay via the Ethernet port. The firmware is digitally signed to prevent malicious modification. Additionally, the Ethernet firmware download allows you to access and update all your network relays simultaneously.

Relay Dimensions

![CHASSIS](i9089b)

**Figure 33** SEL-751 Dimensions for Rack- and Panel-Mount Models
Hardware Overview

**SEL-751 Feeder Protection Relay**

- **Input Power**
  - 110–240 Vac
  - 24–48 Vdc
  - 110–250 Vdc
- **Optional Ethernet (single or dual)**
- **Copper Wire** or **Multimode Fiber**
- **Optional ST Fiber-Optic Inputs**
- **IRIG-B Time Source**
- **Open-Delta Potential, VS, VBAT, and CT Connections**
- **Voltage Inputs (Optional)**
  - VA, VB, VC, N, VS, NS
  - VBAT, VBAT
- **Current Inputs**
  - IA, IB, IC, IN
- **8 Digital Inputs**
  - 10 RTDs
- **4 Digital Inputs / 4 Digital Outputs**
- **3 Digital Inputs / 4 Digital Outputs / 1 Analog Output**
- **14 Digital Inputs**
  - 8 Arc-Flash Detectors
- **4 Digital Inputs / 3 Digital Outputs**
- **8 Analog Inputs**
  - 4 Analog Inputs / 4 Analog Outputs
- **8 Digital Outputs**
- **8 Arc-Flash Detectors**
- **Other lengths available by request**

**SEL Fiber-Optic Cables**
- 240-1506 – 1 m (3.3 ft) ST/ST
- 240-1507 – 5 m (16.4 ft) ST/ST
- 240-1508 – 15 m (49.2 ft) ST/ST
- Other lengths available by request

A diagram for a four-wire wye connection is also available in the instruction manual.

Figure 34 SEL-751 Wiring Diagram
Relay Panel Diagrams

Figure 35  Front Panel With Default Configurable Labels

- Relay powered properly/self-tests are okay
- Trip occurred
- Instantaneous/definite-time overcurrent trip
- Phase time-overcurrent trip
- Ground/neutral time-overcurrent trip
- Negative-sequence time-overcurrent trip
- Over-/underfrequency trip
- Breaker failure trip

Only available in models with 8 pushbuttons

Figure 36  Dual Fiber Ethernet With 2 AVI/4 AFDI Voltage Option With Arc-Flash Detector Inputs, DeviceNet Card, and Fast Hybrid 4 DI/4 DO Card (Relay MOT 751501AA3CA70850830)
Figure 37  Single Copper Ethernet, EIA-485 Communication, 8 DO (Form A) Card, 4 AI/4 AO Card, and 2 AVI/4 AFDI Voltage Option With Arc-Flash Detector Inputs (Relay MOT 751201A2A6X70810320)

Figure 38  Single Copper Ethernet With EIA-232 Communication, 10 RTD Card, 4 DI/4 DO Card, and 2 AVI/4 AFDI Voltage Option Card With Arc-Flash Detector Inputs (Relay MOT 751501A1A9X70850230)
Figure 39  No Ethernet, EIA-232 Serial Communications, EIA-232/EIA-485 Communications Card, 8 DI Card, and 8 DO Card (Form A) (Relay MOT 751401AA03A2A850000)

Figure 40  Dual Copper Ethernet, 4 DI/4 DO Card, 14 DI Card, 8 AFDI Card With Arc-Flash Detector Inputs, 4 ACI/3 AVI Card With 5 A Phase, 200 mA Neutral, and 3-Phase AC Voltage Inputs (300 Vac) (Relay MOT 7515S1A1A4A77870671)
Figure 41  Dual Copper Ethernet, 14 DI Card, 8 DO (Form B) Card, 2 AVI/4 AFDI Card With LEA Vsync, Vbat Inputs, and 4 Arc-Flash Detection Inputs, 4 ACI/3 AVI Card With 5 A Phase, 200 mA Neutral, and 3-Phase LEA Voltage Inputs (8 Vac) (Relay MOT 751501A4A2BL0L70671)

Figure 42  Dual 10/100 Base-T Ethernet, EIA-232 Rear Port, Without Single Multimode ST Fiber-Optic Serial Port Rear, With DeviceNet Card, Fast Hybrid 4 DI/4 DO Card, 8 DI Card, and 4 ACI Card (No Voltage Inputs) (Relay MOT 751001AA3CA3AA50F30)
Applications

Figure 43 shows some typical protection applications for the SEL-751. You can use the SEL-751 directional and non-directional overcurrent functions to protect virtually any power system circuit or device including lines, feeders, transformers, capacitor banks, reactors, and generators. Over- and underfrequency, over- and undervoltage, vector shift elements, rate-of-change-of-frequency elements, and synchronism-check elements are well suited for applications at distributed generation sites. Directional power elements make the relay suitable for utility and customer interface protection in applications with customer generation. IEC cable/line thermal elements can be used to prevent insulation damage.

Special relay versions can be ordered to provide sensitive earth fault (SEF) protection on high-impedance grounded systems, and directional overcurrent ground fault protection on ungrounded, high-impedance grounded and tuned reactance (Petersen coil) grounded systems.

You can use powerful SELOGIC control equations in all SEL-751 models for custom protection and control applications. SEL application guides and technical support personnel are available to help with unique applications.

Figure 43 SEL-751 Feeder Protection Relay Applied Throughout the Power System
Specifications

Compliance

Designed and manufactured under an ISO 9001 certified quality management system

47 CFR 15B, Class A

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.

UL Listed to U.S. and Canadian safety standards (File E212775, NRGU, NRGU7)

Note: UL has not yet developed requirements for products intended to detect and mitigate an arc flash; consequently, UL has not evaluated the performance of this feature. While UL is developing these requirements, it will place no restriction on the use of this product for arc-flash detection and mitigation. For test results performed by an independent laboratory and other information on the performance and verification of this feature, please contact SEL customer service.

CE Mark
RCM Mark

Hazardous Locations

UL Certified for Hazardous Locations to U.S. and Canadian standards CL 1, DIV 2; GP A, B, C, D; T3C, maximum surrounding air temperature of 50°C (File E470448)

EU


Ambient air temperature shall not exceed –20°C ≤ Ta ≤ +50°C

Note: Where so marked, ATEX and UL Hazardous Location Certification tests are applicable to rated supply specifications only and do not apply to the absolute operating ranges, continuous thermal, or short circuit duration specifications.

General

AC Current Input

I_{NOM} = 200 mA, 1 A, or 5 A secondary, depending on the model.

Measurement Category: II

Phase and Neutral Currents

I_{NOM} = 5 A

Continuous Rating: 3 • I_{NOM} @ 85°C
4 • I_{NOM} @ 55°C

A/D Measurement Limit: 217 A peak (154 A rms symmetrical)

Saturation Current Rating: Linear to 96 A symmetrical

1-Second Thermal: 500 A

Burden (per phase): <0.1 VA @ 5 A

I_{NOM} = 1 A

Continuous Rating: 3 • I_{NOM} @ 85°C
4 • I_{NOM} @ 55°C

A/D Measurement Limit: 43 A peak (31 A rms symmetrical)

Saturation Current Rating: Linear to 19.2 A symmetrical

1-Second Thermal: 100 A

Burden (per phase): <0.01 VA @ 1 A

AC Voltage Input

V_{NOM} (L-L) Setting Range: 20–250 V (if DELTA_Y := DELTA)
20–480 V (if DELTA_Y := WYE)

300 Vac Voltage inputs

RATED CONTINUOUS VOLTAGE: 300 Vac (phase-to-neutral)
10-SECOND THERMAL: 600 Vac (phase-to-neutral)

Low-Energy Analog (LEA) Voltage Inputs

RATED CONTINUOUS VOLTAGE: 8 Vac (phase-to-neutral)
Nominal LEA Voltage: 0.5–6.8 Vrms (phase-to-neutral)

Input Range: ±12 Vpeak

10-SECOND THERMAL: 300 Vac (phase-to-neutral)

Burden: 0.0001 VA
Input Impedance: 2 MΩ single-ended (phase-to-neutral)
4 MΩ differential (phase-to-neutral)

Power Supply

Relay Start-Up Time: Approximately 5–10 seconds (after power is applied until the ENABLED LED turns on)

High-Voltage Supply

Rated Supply Voltage: 110–240 Vac, 50/60 Hz
110–250 Vdc

Input Voltage Range (Design Range): 85–264 Vac
85–300 Vdc

Power Consumption: <50 VA (ac)
<25 W (dc)

Interruptions: 50 ms @ 125 Vac/Vdc
100 ms @ 250 Vac/Vdc

Low-Voltage Supply

Rated Supply Voltage: 24–48 Vdc

Input Voltage Range (Design Range): 19.2–60.0 Vdc

Power Consumption: <25 W (dc)

Interruptions: 10 ms @ 24 Vdc
50 ms @ 48 Vdc

Fuse Ratings

Low-Voltage Power Supply Fuse

Rating: 3.15 A
Maximum Rated Voltage: 300 Vdc, 250 Vac
Breaking Capacity: 1500 A at 250 Vac
Type: Time-lag T

High-Voltage Power Supply Fuse
Rating: 3.15 A
Maximum Rated Voltage: 300 Vdc, 250 Vac
Breaking Capacity: 1500 A at 250 Vac
Type: Time-lag T

Output Contacts
General
The relay supports Form A, B, and C outputs.
Dielectric Test Voltage: 2500 Vac
Impulse Withstand Voltage ($U_{IMP}$): 5000 V
Mechanical Durability: 100,000 no-load operations

Standard Contacts
Pickup/Dropout Time: ≤8 ms (coil energization to contact closure)

DC Output Ratings
Rated Operational Voltage: 250 Vdc
Rated Voltage Range: 19.2–275 Vdc
Rated Insulation Voltage: 300 Vdc
Make: 30 A @ 250 Vdc per IEEE C37.90
Continuous Carry: 6 A @ 70°C
1-Second Thermal: 50 A
Contact Protection: 360 Vdc, 115 J MOV protection across open contacts

Breaking Capacity (10,000 Operations) per IEC 60255-0-20:1974:
- 24 Vdc: 0.75 A L/R = 40 ms
- 48 Vdc: 0.50 A L/R = 40 ms
- 125 Vdc: 0.30 A L/R = 40 ms
- 250 Vdc: 0.20 A L/R = 40 ms

Cyclic (2.5 Cycles/Second) per IEC 60255-0-20:1974:
- 24 Vdc: 0.75 A L/R = 40 ms
- 48 Vdc: 0.50 A L/R = 40 ms
- 125 Vdc: 0.30 A L/R = 40 ms
- 250 Vdc: 0.20 A L/R = 40 ms

AC Output Ratings
Maximum Operational Voltage ($U_e$) Rating: 240 Vac
Insulation Voltage ($U_i$) Rating (excluding EN 61010-1): 300 Vac
1-Second Thermal: 50 A
Contact Rating Designation: B300

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Maximum Current</th>
<th>Max VA</th>
</tr>
</thead>
<tbody>
<tr>
<td>120 Vac</td>
<td>240 Vac</td>
<td>—</td>
</tr>
<tr>
<td>30 A</td>
<td>15 A</td>
<td>3600</td>
</tr>
<tr>
<td>3 A</td>
<td>1.5 A</td>
<td>360</td>
</tr>
</tbody>
</table>

PF < 0.35, 50–60 Hz
Utilization Category: AC-15

<table>
<thead>
<tr>
<th>Operational Voltage ($U_o$)</th>
<th>Operational Current ($I_e$)</th>
<th>Make</th>
<th>Break</th>
</tr>
</thead>
<tbody>
<tr>
<td>120 Vac</td>
<td>3 A</td>
<td>15 A</td>
<td>1.5 A</td>
</tr>
<tr>
<td>30 A</td>
<td>15 A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Electromagnetic loads > 72 VA, PF < 0.3, 50–60 Hz

Voltage Protection Across Open Contacts:
- 270 Vac, 40 J

Fast Hybrid (High-Speed, High-Current Interrupting)

DC Output Ratings
Rated Operational Voltage: 250 Vdc
Rated Voltage Range: 19.2–275 Vdc
Rated Insulation Voltage: 300 Vdc
Make: 30 A @ 250 Vdc per IEEE C37.90
Carry: 6 A @ 70°C
1-Second Thermal: 50 A
Open State Leakage Current: <500 µA
MOV Protection (maximum voltage): 250 Vac/330 Vdc
Pickup Time: <50 µs, resistive load
Dropout Time: <8 ms, resistive load

Breaking Capacity (10,000 Operations) per IEC 60255-0-20:1974:
- 48 Vdc: 10.0 A L/R = 40 ms
- 125 Vdc: 10.0 A L/R = 40 ms
- 250 Vdc: 10.0 A L/R = 20 ms

Cyclic Capacity (4 Cycles in 1 Second, Followed by 2 Minutes Idle for Thermal Dissipation) per IEC 60255-0-20:1974:
- 48 Vdc: 10.0 A L/R = 40 ms
- 125 Vdc: 10.0 A L/R = 40 ms
- 250 Vdc: 10.0 A L/R = 20 ms

AC Output Ratings
See AC Output Ratings for Standard Contacts.

Optoisolated Control Inputs
When Used With DC Control Signals
Pickup/Dropout Time: Depends on the input debounce settings
- 250 V: ON for 200.0–312.5 Vdc
  OFF below 150 Vdc
- 220 V: ON for 176–275 Vdc
  OFF below 132 Vdc
- 125 V: ON for 100.0–156.2 Vdc
  OFF below 75 Vdc
- 110 V: ON for 88.0–137.5 Vdc
  OFF below 66 Vdc
- 48 V: ON for 38.4–60.0 Vdc
  OFF below 28.8 Vdc
- 24 V: ON for 14–30 Vdc
  OFF below 5 Vdc

When Used With AC Control Signals
Pickup Time: 2 ms
Dropout Time: 16 ms
- 250 V: ON for 170.6–312.5 Vac
  OFF below 106 Vac
- 220 V: ON for 150.2–275 Vac
  OFF below 93.3 Vac
- 125 V: ON for 85–156.2 Vac
  OFF below 53 Vac
- 110 V: ON for 75.1–137.5 Vac
  OFF below 46.6 Vac
- 48 V: ON for 32.8–60 Vac
  OFF below 20.3 Vac
- 24 V: ON for 14–30 Vac
  OFF below 5 Vac
Current Draw at Nominal DC Voltage:
- 2 mA (at 220–250 V)
- 4 mA (at 48–125 V)
- 10 mA (at 24 V)

Rated Impulse Withstand Voltage ($U_{imp}$):
- 4000 V

**Analog Output (Optional)**

<table>
<thead>
<tr>
<th>1 A0</th>
<th>4 A0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current:</td>
<td>4–20 mA</td>
</tr>
<tr>
<td>Voltage:</td>
<td>—</td>
</tr>
<tr>
<td>Load at 1 mA:</td>
<td>—</td>
</tr>
<tr>
<td>Load at 20 mA:</td>
<td>0–300 Ω</td>
</tr>
<tr>
<td>Load at 10 V:</td>
<td>—</td>
</tr>
<tr>
<td>Refresh Rate:</td>
<td>100 ms</td>
</tr>
<tr>
<td>% Error, Full Scale, at 25°C:</td>
<td>&lt;±1%</td>
</tr>
</tbody>
</table>

Select From: Analog quantities available in the relay

**Analog Inputs (Optional)**

- Maximum Input Range: ±20 mA, ±10 V (operational range set by user)
- Input Impedance:
  - 200 Ω (current mode)
  - >10 kΩ (voltage mode)
- Accuracy at 25°C
  - With User Calibration: 0.05% of full scale (current mode), 0.025% of full scale (voltage mode)
  - Without User Calibration: Better than 0.5% of full scale at 25°C
- Accuracy Variation With Temperature: ±0.015% per °C of full-scale (±20 mA or ±10 V)

**Arc-Flash Detectors (Optional)**

- Multimode fiber-optic receiver/transmitter pair
- Fiber Type: 1000 µm diameter, 640 nm wavelength, plastic, clear-jacketed, or black-jacketed
- Connector Type: V-pin

**Frequency and Phase Rotation**

- System Frequency: 50, 60 Hz
- Phase Rotation: ABC, ACB
- Frequency Tracking: 15–70 Hz

**Time-Code Input**

- Format: Demodulated IRIG-B
- On (1) State: $V_{ih} ≥ 2.2$ V
- Off (0) State: $V_{il} ≤ 0.8$ V
- Input Impedance: 2 kΩ
- Synchronization Accuracy: ±1 μs
- Synchrophasor Reports (e.g., MET PM): ±10 μs
- All other reports: ±5 ms
- SNTP Accuracy: ±2 ms
- PTP Accuracy: ±1 ms
- Unsynchronized Clock Drift: 2 minutes per year
- Relay Powered: ±2 minutes per year

**Communication Ports**

- **Standard EIA-232 (2 ports)**
  - Location: Front Panel, Rear Panel
  - Data Speed: 300–38400 bps

- **EIA-485 Port (optional)**
  - Location: Rear panel
  - Data Speed: 300–19200 bps

- **Ethernet Port (optional)**
  - Single/Dual 10/100BASE-T copper (RJ45 connector)
  - Single/Dual 100BASE-FX (LC connector)
  - Data Speed: 300–38400 bps

- **EIA-232 Multimode Fiber-Optic Port (Optional)**
  - Location: Rear panel
  - Data Speed: 300–38400 bps

**Fiber-Optic Ports Characteristics**

- **Port 1 (or 1A, 1B) Ethernet**
  - Wavelength: 1300 nm
  - Optical Connector Type: LC
  - Fiber Type: Multimode
  - Link Budget: 16.1 dB
  - Typical TX Power: −15.7 dBm
  - RX Min. Sensitivity: −31.8 dBm
  - Fiber Size: 62.5/125 µm
  - Approximate Range: 6.4 km
  - Data Rate: 100 Mbps
  - Typical Fiber Attenuation: −2 dB/km

- **Port 2 Serial**
  - Wavelength: 820 nm
  - Optical Connector Type: ST
  - Fiber Type: Multimode
  - Link Budget: 8 dB
  - Typical TX Power: −16 dBm
  - RX Min. Sensitivity: −24 dBm
  - Fiber Size: 62.5/125 µm
  - Approximate Range: 1 km
  - Data Rate: 5 Mbps
  - Typical Fiber Attenuation: −4 dB/km

- **Channels 1-8 Arc-Flash Detectors (AFDI)**
  - Diagnostic Wavelength: 640 nm
  - Optical Connector Type: V-pin
  - Fiber Type: Multimode
  - Typical TX Power: −12 dBm

**Point Sensor**

- Minimum Receive Sensitivity: −52.23 dB
- Point Sensor Diagnostic
  - Worst Case Loss: −28 dB
  - Link Budget: 12.23 dB
  - Black-Jacketed Fiber Worst Case Loss: −0.19 dBm
  - Black-Jacketed Fiber Typical Loss: −0.17 dBm
ST or V-Pin Connector Splice Loss: –2.00 dB
Approximate Range: As much as 35 m

Fiber Sensor
Minimum Receive Sensitivity: –29.23 dB
Link Budget: 17.23 dB
Clear-Jacketed Fiber Worst Case Loss: –0.19 dB
Clear-Jacketed Fiber Typical Loss: –0.17 dB
ST or V-Pin Connector Splice Loss: –2.00 dB
Approximate Range: As much as 70 m

Optional Communications Cards
Option 1: EIA-232 or EIA-485 communications card
Option 2: DeviceNet communications card

Communications Protocols
SEL, Modbus RTU and TCP/IP, DNP3 serial and LAN/WAN, FTP, Telnet, SNTP, IEEE 1588-2008 firmware-based PTP, IEC 61850 Edition 2, IEC 60870-5-103, EtherNet/IP, PRP, MIRRORED BITS, EVMSG, IEEE C37.118 (synchronphasors), and DeviceNet

Operating Temperature
IEC Performance Rating: –40°C to +85°C (–40°F to +185°F)
(per IEC/EN 60068-2-1 and IEC/EN 60068-2-2)
Note: Not applicable to UL applications.
Note: The front-panel display is impaired for temperatures below –20°C and above +70°C.
DeviceNet Communications Card Rating: +60°C (+140°F) maximum
Optoisolated Control Inputs: As many as 26 inputs are allowed in ambient temperatures of 85°C or less
As many as 34 inputs are allowed in ambient temperatures of 75°C or less
As many as 44 inputs are allowed in ambient temperatures of 65°C or less

Operating Environment
Insulation Class: 1
Pollution Degree: 2
Overvoltage Category: II
Atmospheric Pressure: 80–110 kPa
Relative Humidity: 5%–95%, noncondensing
Maximum Altitude Without Derating (Consult the Factory for Higher Altitude Derating): 2000 m

Dimensions
144.0 mm (5.67 in) x 192.0 mm (7.56 in) x 147.4 mm (5.80 in)

Weight
2.7 kg (6.0 lb)

Relay Mounting Screw (#8-32) Tightening Torque
Minimum: 1.4 Nm (12 in-lb)
Maximum: 1.7 Nm (15 in-lb)

Terminal Connections
Terminal Block
Screw Size: #6
Ring Terminal Width: 0.310-inch maximum

Terminal Block Tightening Torque
Minimum: 0.9 Nm (8 in-lb)
Maximum: 1.4 Nm (12 in-lb)

Compression Plug Tightening Torque
Minimum: 0.5 Nm (4.4 in-lb)
Maximum: 1.0 Nm (8.8 in-lb)

Compression Plug Mounting Ear Screw Tightening Torque
Minimum: 0.18 Nm (1.6 in-lb)
Maximum: 0.25 Nm (2.2 in-lb)

Product Standards
Electromagnetic Compatibility:
IEC 60255-26:2013
IEC 60255-27:2013
UL 508
CSA C22.2 No. 14-05

Type Tests
Environmental Tests
IP65 enclosed in panel
(2-line display models)
IP54 enclosed in panel
(touchscreen models)
IP50 for terminals enclosed in the dust-protection assembly (protection against solid foreign objects only) (SEL Part #915900170). The 10°C temperature derating applies to the temperature specifications of the relay.
IP20 for terminals and the relay rear panel
IEC 60255-27:2013, Section 10.6.2.1
Endurance: Class 2
Response: Class 2
IEC 60255-27:2013, Section 10.6.2.2
IEC 60255-27:2013, Section 10.6.2.3
Withstand: Class 1
Response: Class 2
Bump: Class 1
Seismic (Quake Response): IEC 60255-21-3:1993
IEC 60255-27:2013, Section 10.6.2.4
Response: Class 2
Cold: IEC 60068-2-1:2007
IEC 60255-27:2013, Section 10.6.1.2
IEC 60255-27:2013, Section 10.6.1.4
–40°C, 16 hours
IEC 60255-27:2013, Section 10.6.1.1
IEC 60255-27:2013, Section 10.6.1.3
85°C, 16 hours
IEC 60255-27:2013, Section 10.6.1.5
40°C, 93% relative humidity, 10 days
IEC 60255-27:2013, Section 10.6.1.6
25° to 55°C, 95% relative humidity, 6 cycles

Change of Temperature: IEC 60068-2-14:2009
IEC 60255-1:2010, Section 6.12.3.5
–40° to +85°C, ramp rate 1°C/min, 5 cycles

Dielectric Strength and Impulse Tests

Dielectric (Hi-Pot): IEC 60255-27:2013, Section 10.6.4.3
IEEE C37.90-2005
1.0 kVac on analog outputs, Ethernet ports
2.0 kVac on analog inputs, IRIG
2.5 kVac on contact I/O
3.6 kVac on power supply, IN and VN terminals

Impulse: IEC 60255-27:2013, Section 10.6.4.2
0.5 J, 5 kV on power supply, contact I/O, ac current, and voltage inputs
0.5 J, 530 V on analog outputs
IEEE C37.90:2005
0.5 J, 5 kV
0.5 J, 530 V on analog outputs

RFI and Interference Tests

Electrostatic Discharge Immunity: IEC 61000-4-2:2008
IEC 60255-26:2013, Section 7.2.3
IEEE C37.90:3:2001
Severity Level 4
8 kV contact discharge
15 kV air discharge

Radiated RF Immunity: IEC 61000-4-3:2010
IEC 60255-26:2013, Section 7.2.4
10 V/m
IEEE C37.90:2004
20 V/m

Fast Transient, Burst Immunity: IEC 61000-4-4:2011
IEC 60255-26:2013, Section 7.2.5
4 kV @ 5.0 kHz
2 kV @ 5.0 kHz for comm. ports

Surge Immunity: IEC 61000-4-5:2005
IEC 60255-26:2013, Section 7.2.7
2 kV line-to-line
4 kV line-to-earth

Surge Withstand Capability Immunity: EN 61000-4-18:2010
IEC 60255-26:2013, Section 7.2.6
2.5 kV common mode
1 kV differential mode
1 kV common mode on comm. ports
IEEE C37.90:1-2002
2.5 kV oscillary
4 kV fast transient

Conducted RF Immunity: IEC 61000-4-6:2008
IEC 60255-26:2013, Section 7.2.8
10 Vrms

Magnetic Field Immunity: IEC 61000-4-8:2009
IEC 60255-26:2013, Section 7.2.10
Severity Level: 1000 A/m for 3 seconds
100 A/m for 1 minute; 50/60 Hz
IEEE 61000-4-9:2001
Severity Level: 1000 A/m
Severity Level: 100 A/m
(100 kHz and 1 MHz)

Power Supply Immunity: IEC 61000-4-11:2004
IEC 61000-4-17:1999
IEC 61000-4-29:2000
IEC 60255-26:2013, Section 7.2.11
IEC 60255-26:2013, Section 7.2.12
IEC 60255-26:2013, Section 7.2.13

EMC Emissions

Conducted Emissions: IEC 60255-26:2013 Class A
FCC 47 CFR Part 15.107 Class A
ICES-003 Issue 6
EN 55011:2009 + A1:2010 Class A
EN 55022:2010 + AC:2011 Class A
EN 55032:2012 + AC:2013 Class A
CISPR 11:2009 + A1:2010 Class A
CISPR 22:2008 Class A
CISPR 32:2015 Class A

Radiated Emissions: IEC 60255-26:2013 Class A
FCC 47 CFR Part 15.109 Class A
ICES-003 Issue 6
EN 55011:2009 + A1:2010 Class A
EN 55022:2010 + AC:2011 Class A
EN 55032:2012 + AC:2013 Class A
CISPR 11:2009 + A1:2010 Class A
CISPR 22:2008 Class A
CISPR 32:2015 Class A

Processing Specifications and Oscillography

AC Voltage and Current Inputs: 32 samples per power system cycle
Frequency Tracking Range: 15–70 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.

Protection and Control Processing: Processing interval is 4 times per power system cycle (except for math variables and analog quantities, which are processed every 25 ms). Analog quantities for rms data are derived from data averaged from the previous 8 cycles.

Arc-Flash Processing: Arc-Flash light is sampled 32 times per cycle
Arc-Flash current, light, and 2 fast hybrid outputs are processed 16 times per cycle

Oscillography

Length: 15, 64, or 180 cycles
Sampling Rate: 16 samples per cycle unfiltered
4 samples per cycle filtered
Trigger: Programmable with Boolean expression
Format: ASCII and Compressed ASCII
Binary COMTRADE (32 samples per cycle unfiltered)

Time-Stamp Resolution: 1 ms
Time-Stamp Accuracy: ±5 ms
Sequential Events Recorder

**Time-Stamp Resolution:** 1 ms

**Time-Stamp Accuracy (With Respect to Time Source) for all Relay Word bits except those corresponding to digital inputs (INxxx) and arc-flash elements (TOLx/50xAF/OUTxxx):** ±5 ms

**Time-Stamp Accuracy (With Respect to Time Source) for Relay Word bits corresponding to digital inputs (INxxx) and arc-flash elements (TOLx/50xAF/OUTxxx):** 1 ms

**Relay Elements**

**Instantaneous/Definite-Time Overcurrent (50P, 50G, 50N, 50Q)**

- **Pickup Setting Range, A Secondary:**
  - 5 A models: 0.25–100.00 A, 0.01 A steps
  - 1 A models: 0.05–20.00 A, 0.01 A steps
  - 200 mA model: 0.01–4.00 A, 0.01 A steps (50N)

- **Accuracy:** ±3% of setting plus ±0.02 • I_{NOM} A secondary (steady state)
  ±5% of setting plus ±0.02 • I_{NOM} A secondary (transient)
  ±6% of setting plus ±0.02 • I_{NOM} A secondary (transient for 50Q)

- **Time Delay:** 0.00–400.00 seconds, 0.01 seconds steps

- **Pickup/Dropout Time:** <1.5 cycles

**Arc-Flash Instantaneous Overcurrent (50PAF, 50NAF)**

- **Pickup Setting Range, A Secondary:**
  - 5 A models: 0.50–100.00 A, 0.01 A steps
  - 1 A models: 0.10–20.00 A, 0.01 A steps

- **Accuracy:** 0 to +10% of setting plus ±0.02 • I_{NOM} A secondary (steady state pickup)

- **Time Delay:** 0.00–400.00 seconds, 0.01 seconds steps

- **Pickup/Dropout Time:** <1.5 cycles

**Arc-Flash Time-Overlight (TOL1–TOL8)**

- **Pickup Setting Range, % of Full Scale:**
  - Point sensor: 3.0–80.0%
  - Fiber sensor: 0.6–80.0%

- **Pickup/Dropout Time:** 2–5 ms/1 cycle

**Inverse-Time Overcurrent (51P, 51G, 51N, 51Q)**

- **Pickup Setting Range, A Secondary:**
  - 5 A models: 0.25–24.00 A, 0.01 A steps
  - 1 A models: 0.05–4.80 A, 0.01 A steps
  - 200 mA models: 10.00–960.00 mA, 0.01 mA steps (51N)

- **Accuracy:** ±5% of setting plus ±0.02 • I_{NOM} A secondary (steady state pickup)

- **Time Dial:**
  - U.S.: 0.50–15.00, 0.01 steps
  - IEC: 0.01–1.50, 0.01 steps

- **Accuracy:** ±1.5 cycles, plus ±4% between 2 and 30 multiples of pickup (within rated range of current)

**IEC Thermal Element (49IEC)**

- **Setting Range:** Trip pickup, 1%–150%
  Alarm pickup, 1%–100%

- **Pickup Accuracy:**
  - ±2% (for I ≥ I_{NOM})
  - ±5% (for 0.4 • I_{NOM} < I < I_{NOM})

- **Time to Trip/Reset Accuracy:** ±5% plus ±0.5 s of the calculated value

**Undervoltage (27P, 27PP, 27S)**

- **Setting Range:**
  - OFF, 2.00–300.00 V (phase elements, phase-to-phase elements with delta inputs or synchronism voltage input)
  - OFF, 2.00–520.00 V (phase-to-phase elements with wye inputs)

- **Accuracy:** ±1% of setting plus ±0.5 V

- **Time Delay:** 0.00–120.00 seconds, 0.01-second steps

- **Pickup/Dropout Time:** <1.5 cycles


- **Setting Range:**
  - OFF, 2.00–300.00 V (phase elements, sequence elements, or phase-to-phase elements with delta inputs or synchronism voltage input)
  - OFF, 2.00–520.00 V (phase-to-phase elements with wye inputs)

- **Accuracy:** ±1% of setting plus ±0.5 V

- **Time Delay:** 0.00–120.00 seconds, 0.01-second steps

- **Pickup/Dropout Time:** <1.5 cycles

**Inverse-Time Undervoltage (27I)**

- **Setting Range:**
  - OFF, 2.00–300.00 V (phase elements, sequence elements, or phase-to-phase elements with delta inputs or synchronism-check voltage input)
  - OFF, 2.00–520.00 V (phase-to-phase elements with wye inputs)

- **Accuracy:** ±1% of setting plus ±0.5 V

- **Time Dial:** 0.00–16.00 s

- **Accuracy:** ±1.5 cyc plus ±4% between 0.95 and 0.1 multiples of pickup

**Inverse-Time Overvoltage (59I)**

- **Setting Range:**
  - OFF, 2.00–300.00 V (phase elements, sequence elements, or phase-to-phase elements with delta inputs or synchronism voltage input)
  - OFF, 2.00–520.00 V (phase-to-phase elements with wye inputs)

- **Accuracy:** ±1% of setting plus ±0.5 V

- **Time Dial:** 0.00–16.00 s

- **Accuracy:** ±1.5 cyc plus ±4% between 1.05 and 5.5 multiples of pickup

**Harmonic Blocking**

- **Pickup Range (% of fundamental):** 5%–100%

- **Pickup Accuracy (A secondary):**
  - 5 A models: ±5% plus ±0.10 A of harmonic current
  - 1 A models: ±5% plus ±0.02 A of harmonic current

- **Time Delay Accuracy:** ±0.5% plus ±0.25 cycle
**Vector Shift (78VS)**
- **Pickup Setting Range:** 2.0°–30.0°, 0.1-degree increment
- **Accuracy:** ±10% of the pickup setting, ±1 degree
- **Voltage Supervision**
  - **Threshold:** 20.0%–100.0% • VNOM
- **Pickup Time:** <3 cycles

**Power Elements (32)**
- **Instantaneous/Definite Time:** +W, –W, +VAR, –VAR
- **Three-Phase Elements Type:**
- **Pickup Setting Range, VA Secondary:**
  - 5 A models: 1.0–6500.0 VA, 0.1 VA steps
  - 1 A models: 0.2–1300.0 VA, 0.1 VA steps
- **Accuracy:** ±0.10 A • (L-L voltage secondary) plus ±5% of setting at unity power factor for power elements and zero power factor for reactive power elements (5 A nominal)
  - ±0.02 A • (L-L voltage secondary) plus ±5% of setting at unity power factor for power elements and zero power factor for reactive power elements (1 A nominal)
- **Time Delay:** 0.0–240.0 seconds, 0.1-second steps
- **Pickup/Dropout Time:** <10 cycles

**Power Factor (55)**
- **Setting Range:** OFF, 0.05–0.99
- **Accuracy:** ±5% of full scale for current ≥ 0.5 • INOM
- **Time Delay:** 1–240 seconds, 1-second steps

**Frequency (81)**
- **Setting Range:** Off, 15.00–70.00 Hz
- **Accuracy:** ±0.01 Hz (V1 > 60 V) with voltage tracking
  - ±0.05 Hz (I1 > 0.8 • INOM) with current tracking
- **Time Delay:** 0.00–400.00 seconds, 0.01-second steps
- **Pickup/Dropout Time:** <4 cycles

**Rate-of-Change of Frequency (8IR)**
- **Setting Range:** OFF, 0.10–15.00 Hz/s
- **Accuracy:** ±100 mHz/s, plus ±3.33% of pickup
- **Time Delay:** 0.10–60.00 seconds, 0.01-second steps

**Synchronism Check (25)**
- **Pickup Range, Secondary Voltage:** 0.00–300.00 V
- **Pickup Accuracy, Secondary Voltage:** ±1% plus ±0.5 V (over the range of 2–300 V)
- **Slip Frequency Pickup Range:** 0.05 Hz–0.50 Hz
- **Slip Frequency Pickup Accuracy:** ±0.02 Hz
- **Phase Angle Range:** 0°–80°
- **Phase Angle Accuracy:** ±4°

**Load-Encroachment Detection**
- **Pickup Setting Range**
  - 5 A Model: 0.10–128.00 Ω secondary, 0.01 Ω steps
  - 1 A Model: 0.50–640.00 Ω secondary, 0.01 Ω steps
- **Forward Load Angle:** –90° to +90°
- **Forward Load Angle:** +90° to +270°
- **Accuracy**
  - Impedance Measurement: ±5% plus ±0.5 Ω
  - Angle Measurement: ±3°

**Station Battery Voltage Monitor**
- **Operating Range:** 0–350 Vdc (300 Vdc for UL purposes)
- **Pickup Range:** 20.00–300.00 Vdc
- **Pickup accuracy:** ±2% of setting plus ±2 Vdc

**Timers**
- **Setting Range:** Various
- **Accuracy:** ±0.5% of setting plus ±1/4 cycle

**RTD Protection**
- **Setting Range:** Off, 1°–250°C
- **Accuracy:** ±2°C
- **RTD Open-Circuit Detection:** >250°C
- **RTD Short-Circuit Detection:** <–50°C
- **RTD Types:** PT100, NI100, NI120, CU10
- **RTD Lead Resistance:** 25 Ω max. per lead
- **Update Rate:** <3 s
- **Noise Immunity on RTD Inputs:** As high as 1.4 Vac (peak) at 50 Hz or greater frequency
- **RTD Fault/Alarm/Trip Time Delay:** Approx. 12 s

**Metering**
- Accuracies are specified at 20°C, nominal frequency, ac currents within (0.2–20.0) • INOM A secondary, and ac voltages within 50–250 V secondary (1.33–6.67 V secondary with 8 V LEA option), unless otherwise noted.
  - **Phase Currents:** ±1% of reading, ±1” (±2.5° at 0.2–0.5 A for relays with INOM = 1 A)
  - **Three-Phase Average Current:** ±1% of reading
  - **IG (Residual Current):** ±2% of reading, ±2” (±5.0° at 0.2–0.5 A for relays with INOM = 1 A)
  - **IN (Neutral Current):** ±1% of reading, ±1” (±2.5° at 0.2–0.5 A for relays with INOM = 1 A)
  - **I1 Positive-Sequence Current:** ±1.6 mA and ±1% (0.04–4.0 A) (0.2 A nominal channel IN current input)
  - **3I2 Negative-Sequence Current:** ±2% of reading
  - **System Frequency:** ±0.01 Hz of reading for frequencies within 15–70 Hz (V1 > 60 V)
  - **Line-to-Line Voltages:** ±1% of reading, ±1” for voltages
  - **Three-Phase Average Line-to-Line Voltage:** ±1% of reading for voltages within 24–264 V
  - **Line-to-Ground Voltages:** ±1% of reading, ±1” for voltages within 24–264 V (0.64–7.04 V for LEA inputs)
Three-Phase Average Line-to-Ground Voltages: ±1% of reading for voltages within 24–264 V (0.64–7.04 V for LEA inputs)

Voltage Imbalance (%): ±2% of reading

V1 Positive-Sequence Voltage: ±2% of reading for voltages within 24–264 V (0.64–7.04 V for LEA inputs)

3V2 Negative-Sequence Voltage: ±2% of reading for voltages within 24–264 V (0.64–7.04 V for LEA inputs)

Real Three-Phase Power (kW): ±3% of reading for 0.10 < pf < 1.00

Reactive Three-Phase Power (kV AR): ±3% of reading for 0.00 < pf < 0.90

Apparent Three-Phase Power (kVA): ±3% of reading

Power Factor: ±2% of reading

RTD Temperatures: ±2°C

Energy Meter

Accumulators: Separate IN and OUT accumulators updated once per second, transferred to nonvolatile storage 4 times per day

ASCII Report Resolution: 0.001 MWh

Accuracy: The accuracy of the energy meter depends on applied current and power factor as shown in the power metering accuracy specifications above. The additional error introduced by accumulating power to yield energy is negligible when power changes slowly compared to the processing rate of once per second.

Synchrophasor Accuracy

Maximum Message Rate

Nominal 60 Hz System: 60 messages per second
Nominal 50 Hz System: 50 messages per second

The voltage accuracy specifications are only applicable for the model options with standard voltage inputs (not applicable to LEA option). The current accuracy specifications are applicable for all 1 A and 5 A options.

Note: For the SEL-751 current only model, the accuracy specifications for currents are only applicable when the applied signal frequency equals FNOM.

Accuracy for Voltages

Level 1 compliant as specified in IEEE C37.118 under the following conditions for the specified range.

Conditions

➤ At maximum message rate
➤ When phasor has the same frequency as the positive-sequence voltage
➤ Frequency-based phasor compensation is enabled (PHCOMP := Y)
➤ The narrow bandwidth filter is selected (PMAPP := N)

Range

Frequency: ±5.0 Hz of nominal (50 or 60 Hz)
Magnitude: 30 V–250 V
Phase Angle: −179.99° to 180.00°
Out-of-Band Interfering Frequency (Fs): 10 Hz ≤ Fs ≤ (2 • FNOM)

Accuracy for Currents

Level 1 compliant as specified in IEEE C37.118 under the following conditions for the specified range.

Conditions

➤ At maximum message rate
➤ When phasor has the same frequency as the positive-sequence voltage
➤ Frequency-based phasor compensation is enabled (PHCOMP := Y)
➤ The narrow bandwidth filter is selected (PMAPP := N)

Range

Frequency: ±5.0 Hz of nominal (50 or 60 Hz)
Magnitude: (0.4–2) • INOM (INOM = 1 A or 5 A)
Phase Angle: −179.99° to 180.00°
Out-of-Band Interfering Frequency (Fs): 10 Hz ≤ Fs ≤ (2 • FNOM)

Note: For the SEL-751 current only model, the accuracy specifications for currents are only applicable when the applied signal frequency equals FNOM.

a Front port serial cable (non-fiber) lengths assumed to be <3 m.
Notes