# SEL-2414 Transformer Monitor

## Complete System for Control and Monitoring


# Major Features and Benefits

The SEL-2414 Transformer Monitor provides an exceptional combination of monitoring, control, and communications in a compact package.

- **Thermal Monitoring and Metering Capabilities.** Safeguard transformers from overheating by tracking thermal conditions. Track the minimum and maximum transformer top-oil temperature, hot-spot temperature, and as many as 10 RTDs or thermocouples. Calculate hot-spot temperature according to the IEEE C57.91-2011 or the IEC 60076-7:2018 Ed. 2 standards.
- **Load Tap Position and Control Monitoring.** Monitor tap position and raise and lower controls and as many as 32 tap positions by using digital inputs in the binary-coded decimal (BCD) or binary format.
- **High Reliability, Rugged Design, and Low Price.** Apply the SEL-2414 in harsh physical and electrical environments. The SEL-2414 withstands vibration, electrical surges, fast transients, extreme operating temperatures from –40° to +85°C, and meets stringent utility standards. Compare our superior specification compliance, higher reliability, lower price, and worldwide, ten-year warranty to other transformer monitor alternatives.
- **Flexible I/O for Transformer Status, Alarms, and More.** Take advantage of input/output options including digital inputs for status such as oil level and sudden pressure; RTD and thermocouple inputs for measurements such as ambient, top-oil, and hot-spot temperatures; digital outputs for control and alarms; analog inputs and outputs; and ac current and voltage inputs. Easily program monitoring and control functions with powerful logic, math, timers, counters, and edge-trigger functions. These features allow easy integration with new and retrofit transformer monitor applications. Monitor critical substation assets with comprehensive transformer thermal and through-fault monitoring.

- **Advanced Asset Monitoring.** Monitor critical substation assets with comprehensive transformer thermal and through-fault monitoring. Calculate top-oil, hot-spot, insulation aging acceleration factor, and loss of life while generating hourly and daily data about your transformer. Capture the maximum/minimum values of all transformer model quantities. Capture through-fault current data that could lead to increased transformer wear.
- **Critical Reporting and Logging.** Store as many as 512 Sequential Events Recorder (SER) reports of digital input transitions, time-tagged to the nearest millisecond. Analyze SER reports, analog trending, and oscillographic event reports for rapid commissioning, testing, and post-event diagnostics. Send the SER data to a communications processor or computer for system analysis.
- **Communications and Integration.** Automate fan bank control with flexible communications options that provide easy integration with SCADA. Choose from single and dual Ethernet, Modbus® TCP, DNP3 LAN/WAN, IEC 61850, Modbus Serial, EIA-232, EIA-485, Telnet, and File Transfer protocols.
- **AC Metering Capabilities.** Take advantage of extensive ac metering and monitoring capabilities. Voltage, current, power, energy, power factor, frequency; demand/peak demand metering; and maximum/minimum metering are measured and recorded. Values can be used in programmable calculations and triggers within the meter.
- **Simple Commissioning Tools.** Make use of a front-panel HMI that provides complete configuration access and displays settings, measurements, and calculated values. Easily set with ACSELERATOR QuickSet® SEL-5030 Software.

# Product Summary

The SEL-2414 Transformer Monitor withstands harsh physical and electrical environments and is built and tested to meet mission-critical IEEE and IEC protective relay standards. Apply the SEL-2414 to satisfy standalone or distributed monitoring and control of transformers, or choose from the flexible communications options to connect to a substation distributed SCADA or automation system, or a SCADA master. Communications options include serial, fiber-optic, and Ethernet connections and ASCII, SEL Fast Message, MIRRORED BITS® communications, Modbus, and DNP3 protocols. *Figure 1* shows the SEL-2414 functionality.

Apply flexible I/O options to meet the many needs of new or retrofit transformer installations. The SEL-2414 includes four slots for plug-in I/O cards. Use digital inputs (DI) to monitor critical transformer alarms and status points. Use analog inputs (AI) to measure pressure, oil level, temperatures, tap positions, and process-level signals (e.g., 4–20 mA, 0–1 mA) from transducers. Operate cooling fans, equipment, alarms, or provide indication with relay-contact or solid-state digital outputs (DO) and analog outputs (AO). Measure ac currents and ac voltage to calculate three-phase power, demand, energy, save in oscillographic reports, and for automatic control processes.

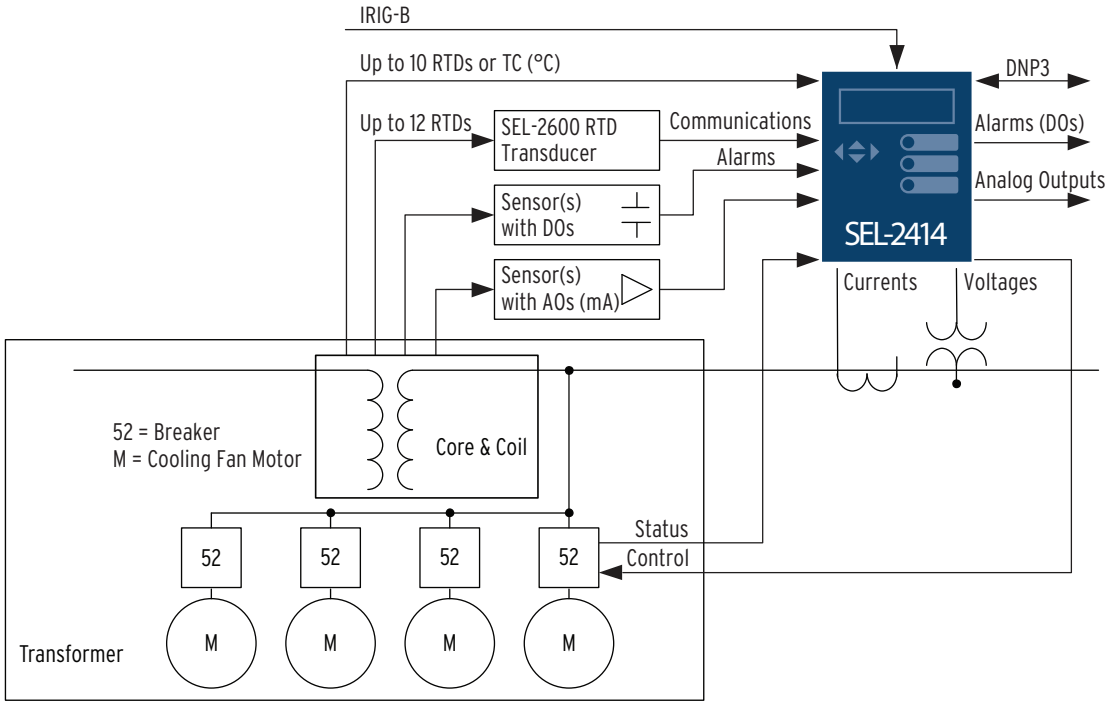



**Figure 1 Transformer Monitor and Control System**

# I/O (Status and Alarms)

Use digital inputs to monitor critical alarms such as oil levels, pressures, and gas accumulation; they may also be used for status points such as fans on/off and breakers open/closed, as shown in *Figure 2*.

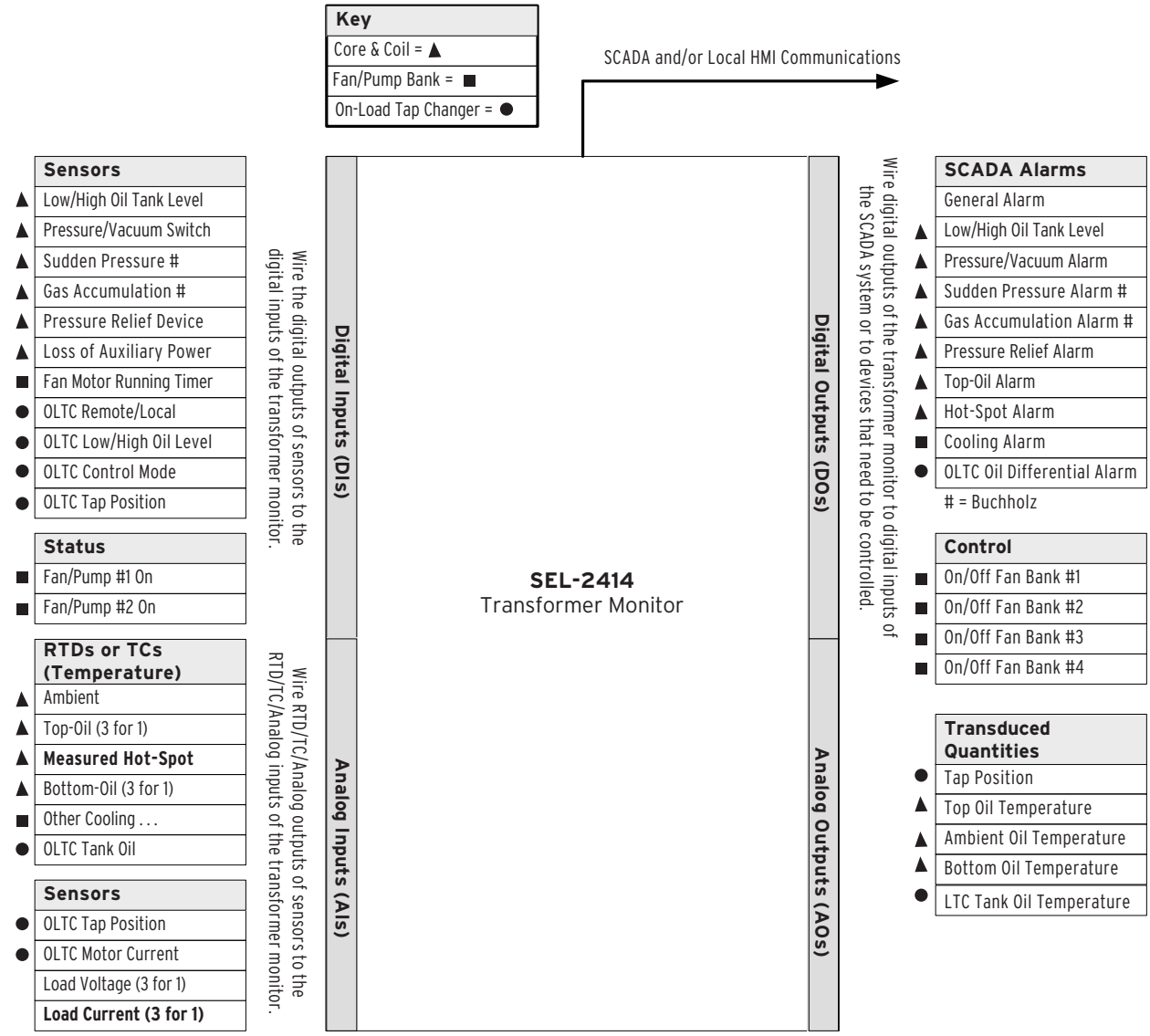



**Figure 2 Monitoring Inputs and Control Outputs**

# Analyze Transformer Sequence-of-Events

Record sequence-of-events related to transformer events or operations with the Sequential Events Recorder (SER) function. With this function, you can analyze assertions and deassertions of digital inputs and outputs; as many as 512 state changes to the millisecond for as many as 96 different digital points. The function also captures when the device powers up and a settings change occurs.

```
SEL-2414                                Date: 04/03/2005 Time: 07:21:19
DEVICE

#      DATE         TIME            ELEMENT              STATE
17  04/03/2005  06:25:51.120  RB01                      Deasserted
16  04/03/2005  06:25:51.125  OUT102                    Deasserted
15  04/03/2005  06:26:03.049  RB01                      Asserted
14  04/03/2005  06:26:03.053  OUT102                    Asserted
13  04/03/2005  06:51:17.748  Device Powered Up
12  04/03/2005  06:51:20.361  OUT101                    Asserted
11  04/03/2005  06:51:21.366  OUT101                    Deasserted
10  04/03/2005  06:54:10.753  Device Settings Changed
9   04/03/2005  06:54:10.762  FAN BANK #2 OFF           Asserted
8   04/03/2005  06:54:11.737  OUT101                    Deasserted
7   04/03/2005  07:06:01.739  FAN BANK #2 ON            Asserted
6   04/03/2005  07:06:02.744  OUT101                    Deasserted
5   04/03/2005  07:06:14.993  Device Settings Changed
4   04/03/2005  07:06:15.002  OUT101                    Asserted
3   04/03/2005  07:06:15.977  FAN BANK #1 ON            Deasserted
2   04/03/2005  07:13:22.947  OUT101                    Asserted
1   04/03/2005  07:13:23.951  OUT101                    Deasserted

SER Number        Element or Condition        Element State
```

**Figure 3 Example SER Report**

# Analyze Transformer Event Waveforms

Record analog and digital waveforms at 32 samples/cycle for as many as 64 power system cycles, approximately 1 s. Use the event report to move the oscillographic data to your PC. You can plot your event report data with the SEL-5601-2 SYNCHROWAVE® Event Software or with Microsoft Excel.

Event reports contain ac currents, ac voltages, and digital inputs and outputs. The report automatically adjusts content to the I/O cards you use. Reports are stored in nonvolatile memory to protect your data even if power is lost. Event reports are optimized for recording power disturbances and relating them to your process.

Set the report to capture either 15 or 64 power system cycles of data around the trigger event. For a 60 Hz system, the event report lengths are 0.25 s and 1.07 s. For a 50 Hz system, the report lengths are 0.30 s and 1.28 s.

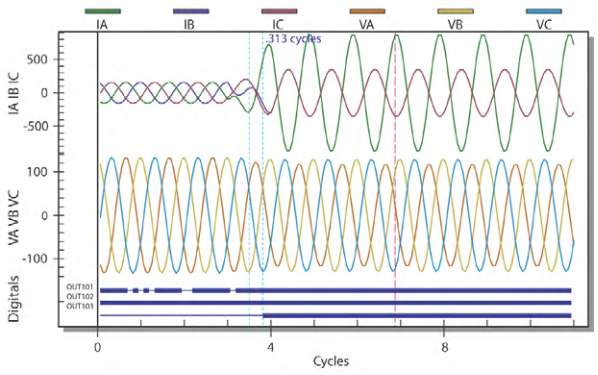



**Figure 4 Example SYNCHROWAVE Event Waveform Plot**

# Trend Transformer Temperatures and Other Analog Inputs

Record measured ambient, transformer top-oil, transformer hot-spot and other analog data (measured or calculated) for trending with the Analog Signal Profile function. This profile (trending) function can track as many as 32 analog channels. The function records the magnitude and time of acquisition of each analog channel. Use the profile report to move trend records to your PC and quickly plot the data with Microsoft Excel or any other spreadsheet application.

```
=>>CPR <Enter>
"REC_NUM","YEAR","MONTH","DAY","HOUR","MIN","SEC","MSEC","VA_MAG","VB_M
AG","VC_M
AG","AI301","AI302","AI303","AI304","AI305","AI306","1D7A"
14,2005,9,1,12,10,4,261,2092.127,2099.499,2089.107,-0.001,-0.000,
-0.001,-0.001,-
0.001,-0.001,"1190"
13,2005,9,1,12,15,3,982,2093.966,2099.176,2088.974,-0.001,-0.001,
-0.001,-0.000,-
0.001,-0.001,"11AC"
12,2005,9,1,12,20,4,82,2091.636,2099.117,2089.346,-0.001,-0.000,
-0.001,-0.001,-0
.001,-0.001,"115C"
11,2005,9,1,12,25,4,332,2092.435,2098.398,2088.487,-0.001,-0.001,
-0.001,-0.001,-
0.001,-0.001,"119C"
10,2005,9,1,12,30,4,36,2092.907,2098.208,2089.058,-0.001,-0.001,
-0.000,-0.001,-0
.001,-0.001,"115C"
9,2005,9,1,12,35,4,186,2093.153,2098.865,2089.091,-0.001,-0.000,
-0.001,-0.001,-0
.001,-0.001,"116F"
8,2005,9,1,12,40,3,978,2094.284,2098.926,2089.732,-0.001,-0.001,
-0.001,-0.001,-0
.001,-0.001,"1179"
```

**Figure 5 Comma-Separated File Format for Easy Display, Analysis, and Archiving**

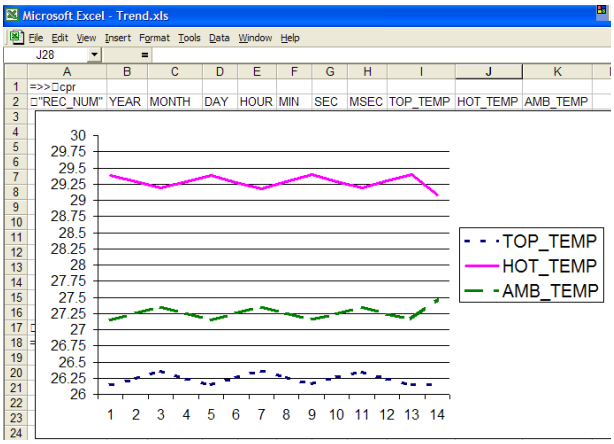



**Figure 6 Excel Graph of Trend Data**

# Transformer Thermal Monitoring

Transformer thermal modeling, per IEEE C57.91-2011 or the IEC 60076-7:2018 Ed. 2, is a standard feature in the SEL-2414. Specify the SEL-2414 to provide this capability for monitoring and protection of a single three-phase transformer, a three-phase transformer with tertiary windings (three-winding mode with separate CT ratios), or three independent single-phase units. Use the thermal element to activate a control action or issue a warning or alarm when your transformer overheats or is in danger of excessive insulation aging or loss-of-life.

Use the thermal event report to capture current hourly and daily data about your transformer. Operating temperature calculations are based on load currents, type of cooling system, and actual temperature inputs (ambient and top-oil). Use as many as four thermal sensor inputs: a single ambient temperature transducer and one transducer for top-oil temperature from each of three single-phase transformers. Temperature data are obtained via an internal RTD/thermocouple card or from an external SEL-2600A RTD Module. While the SEL-2414 can receive temperature data at any rate, the thermal element uses the temperature data once per minute.

The thermal element operates in one of three modes, depending upon the presence or lack of measured temperature inputs: 1) measured ambient and top-oil temperature inputs, 2) measured ambient temperature only, and 3) no measured temperature inputs. If the device receives measured ambient and top-oil temperatures, the thermal element calculates hot-spot temperature. When the device receives a measurement of ambient temperature without top-oil temperature, the thermal element calculates the top-oil temperature and hot-spot temperature. In the absence of any measured ambient or top-oil temperatures, the thermal element uses a default ambient temperature setting that you select and calculates the top-oil and hot-spot temperatures. The device uses hot-spot temperature as a basis for calculating the insulation aging acceleration factor (FAA) and loss-of-life quantities. Use the thermal element to indicate alarm conditions and/or activate control actions when one or more of the following exceed settable limits:

- Top-oil temperature
- Winding hot-spot temperature
- Insulation aging acceleration factor (FAA)
- Daily loss-of-life
- Total loss-of-life

Generate a thermal monitor report that indicates the present thermal status of the transformer. Historical thermal event reports and profile data are stored in the device in hourly format for the previous 24 hours and in daily format for the previous 31 days.

The thermal model can be used even if a current card is not installed. Current magnitude data can be received through communications protocols.

# Through-Fault Event Monitor

A through fault is an overcurrent event external to the differential protection zone. Though a through fault is not an in-zone event, the currents required to feed this external fault can cause great stress on the apparatus inside the differential protection zone. Through-fault currents can cause transformer winding displacement leading to mechanical damage and increased transformer thermal wear because of mechanical stress of insulation components in the transformer. The SEL-2414 through-fault event monitor gathers current level, duration, and date/time for each through fault. The monitor also calculates a $I^2t$ and cumulatively stores these data per-phase. The SEL-2414 through-fault report also provides percent of total through-fault accumulated according to the *IEEE Guide for Liquid-Immersed Transformer Through-Fault-*

*Current Duration, C57.109-1993*. Use through-fault event data to schedule proactive transformer bank maintenance and help justify through-fault mitigation efforts. Apply the accumulated $I^2t$ alarm capability of the device to indicate excess through-fault current over time.

## Load Tap Position and Control Monitoring

The SEL-2414 supports load tap position and control (LTPC) monitoring by using digital inputs in the binary-coded decimal (BCD) or binary format. It can monitor as many as 32 tap positions with one or three neutral tap positions. Additionally, it monitors the raise and lower controls to assert alarms for tap position change failures or unexpected tap positions.

Implement individual tap position statistics monitoring with the nonvolatile counters and voltage regulation by using measured voltages, timers, and analog control variables.

## Simplify Your Transformer Commissioning

The SEL-2414 front panel simplifies commissioning and troubleshooting:

- View field data and calculated values
- Diagnose data flow problems in seconds instead of hours
- Dramatically reduce troubleshooting time
- Eliminate the need for out-of-service time

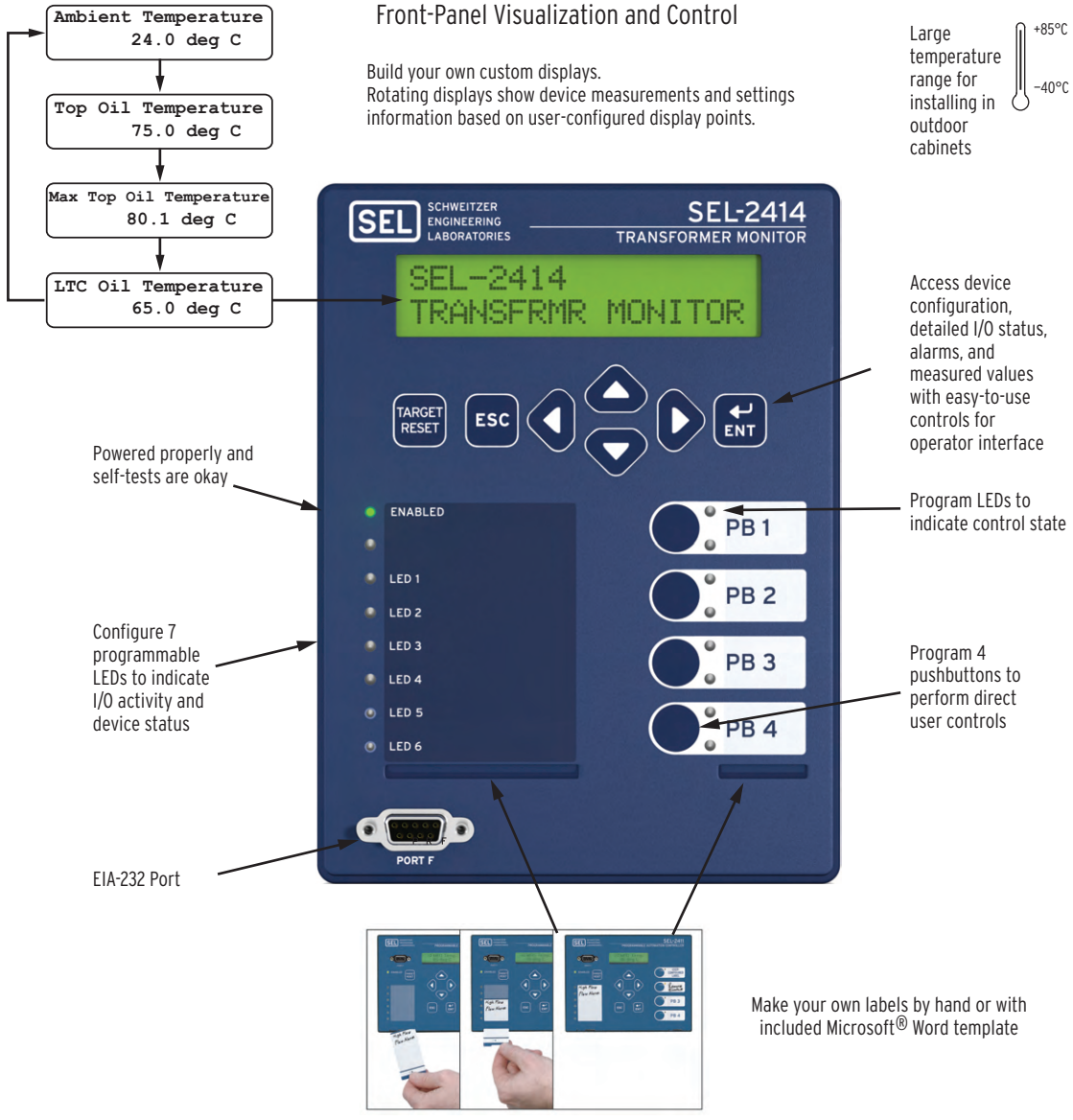


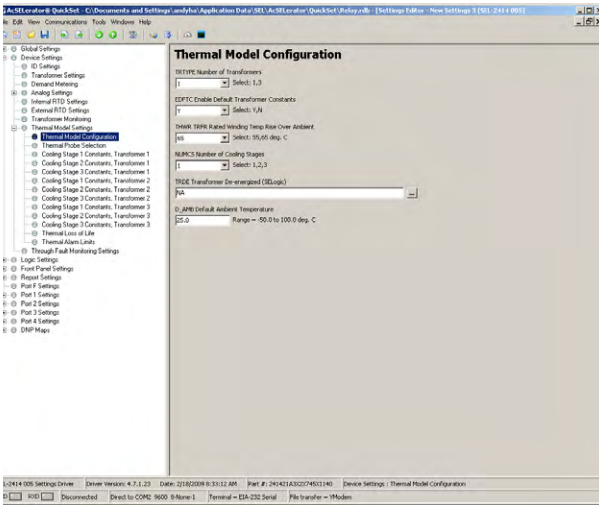

**Figure 7 Simplify Your Commissioning**

# Configuration and Commissioning Software

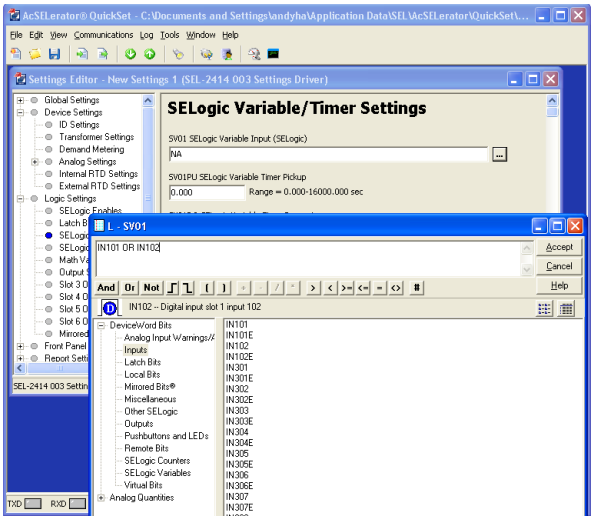
The included ACSELERATOR QuickSet software program simplifies device configuration in addition to providing commissioning and analysis support for the SEL-2414.

- ➤ Access settings creation help online.
- ➤ Organize settings with the device database manager.
- ➤ Load and retrieve settings using a simple PC communications link.
- ➤ Analyze event records with the integrated waveform and harmonic analysis tool.
- ➤ Use the PC interface to remotely retrieve reports and other system data.
- ➤ Monitor analog data, device I/O, and logic point status during commissioning tests.
- ➤ Remotely operate and monitor using the device overview as a virtual front panel.

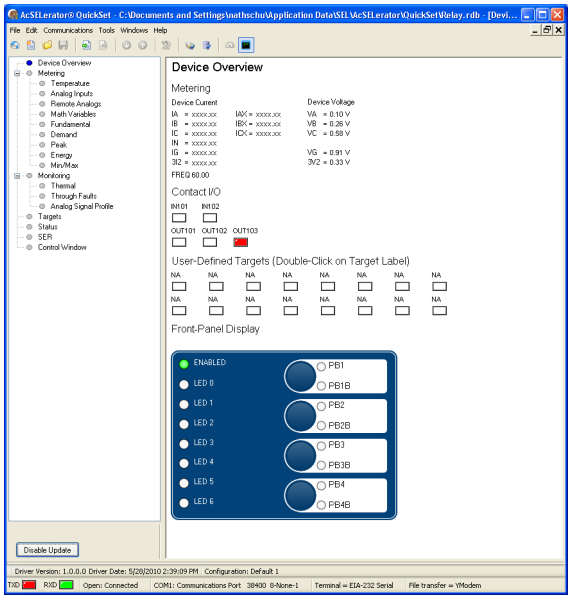
**Settings–Develop Settings Offline With an Intelligent Settings Editor That Only Allows Valid Settings.**




**Settings–Create SELOGIC Control Equations With a Drag and Drop Editor and/or Text Editor.**




**HMI–Device Overview.**



# ACSELERATOR Bay Screen Builder SEL-5036 Software

The SEL-2414 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 device elements via Device 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 (see *Figure 8*). Bay Screen Builder provides an intuitive and powerful interface to design bay screens to meet your application needs.

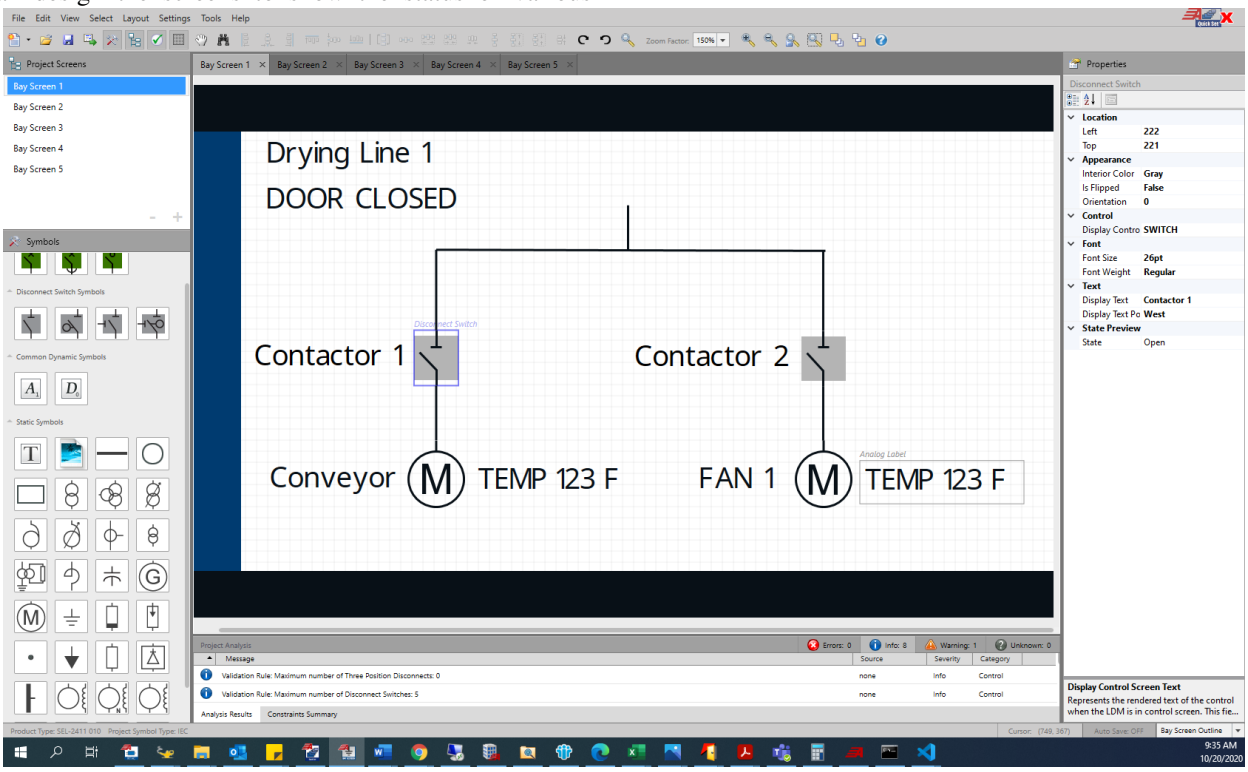



**Figure 8 Bay Screen Builder**

# Metering

The SEL-2414 provides extensive metering capabilities. See *Specifications* for metering and power measurement accuracies. As shown in *Table 1*, metering includes current and voltage based metering and analog input, math variable, and remote analog metering. Fundamental, maximum and minimum, and demand metering typically includes phase voltages and currents; sequence voltages and currents; and power, frequency, and energy.

**Table 1 Metering Types (Sheet 1 of 2)**

| Standard | |
|---|---|
| Fundamental | IA, IB, IC, VA, VB, VC |
| Energy | Real and Reactive (In and Out) |
| Maximum and Minimum | Frequency, Voltages (VA, VB, VC), Currents (IA, IB, IC, 3I2), Reactive, and Real Power |
| Demand and Peak Demand | IA, IB, IC, IG, 3I2 |
| Analog Input | AIx01–AIx08 |
| Math Variable | MV01–MV32 |
| Remote Analog | RA001–RA128 |

**Table 1 Metering Types (Sheet 2 of 2)**

| Standard |
| --- |
| Analog Signal Profiling |
| **Optional** |
| ➤ Temperature and thermal (with the external SEL-2600 RTD Module, internal RTD option, or internal RTD/TC option) |
| ➤ Maximum and Minimum Temperatures |

# Touchscreen Display

You can order the SEL-2414 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-2414 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
- ➤ Visualize Transformer Thermal reports
- ➤ 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 9*. Folders and applications are labeled according to functionality. Additional folder and application screens for the SEL-2414 touchscreen display option can be seen in *Figure 10* through *Figure 24*.

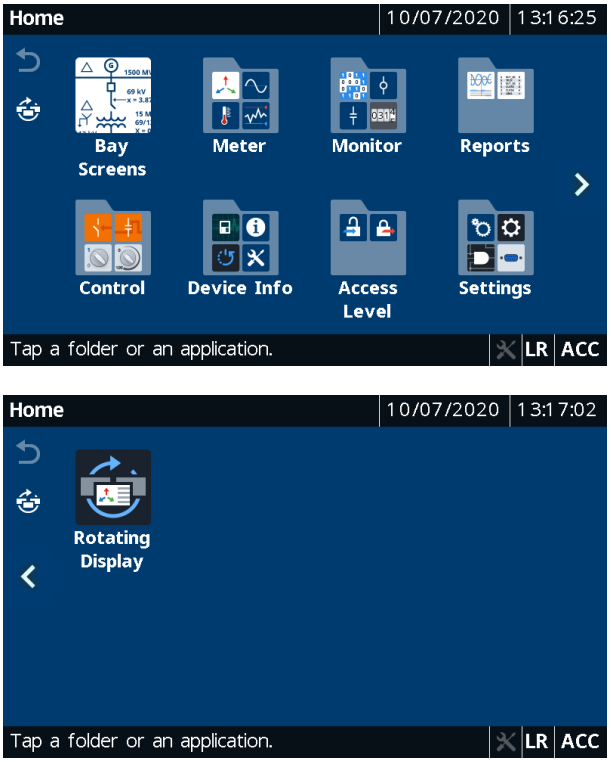



**Figure 9 Home (Default FPHOME Screen)**

## Bay Screen Application

The SEL-2414 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 10* shows the default SLD for the touchscreen display option.

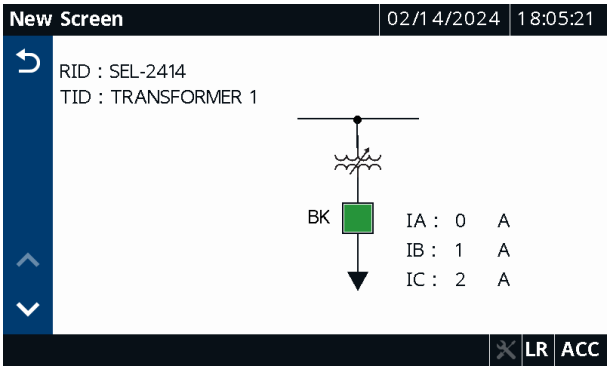



**Figure 10 Default Bay Screen**

# 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 11*).

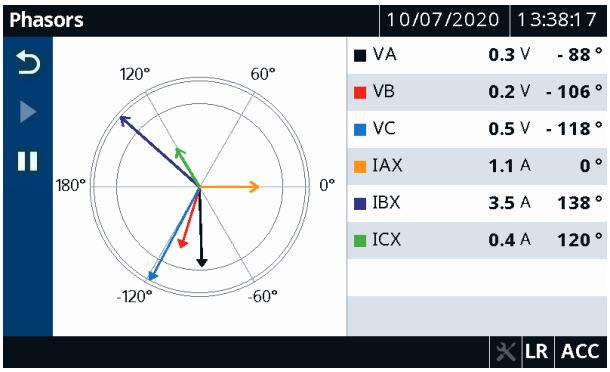



**Figure 11 Meter Phasors**

Tap the **Energy** application to view the energy metering quantities (see *Figure 12*). A reset feature is provided for the Energy, Max/Min, Demand, and Peak Demand applications. Tap the **Reset** button (see *Figure 12*) to navigate to the reset confirmation screen. Once you confirm the reset, the data are reset to zero.

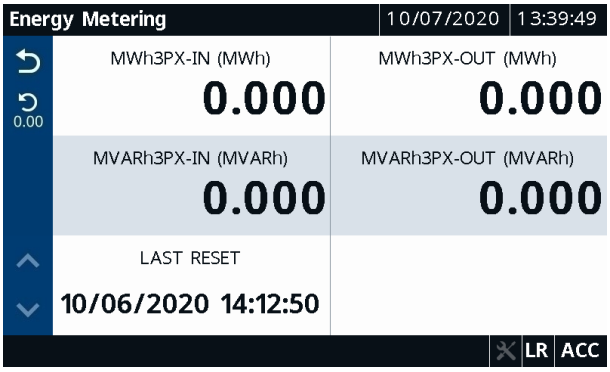



**Figure 12 Meter Energy**

# Monitor Folder Applications

Tapping the **Monitor** folder navigates you to the screen where you can access the status of the Device Word bits, digital outputs, digital inputs, SELOGIC counters, Display Points, and Transformer Thermal report applications. *Figure 13* through *Figure 18* show example screens for each of these applications.

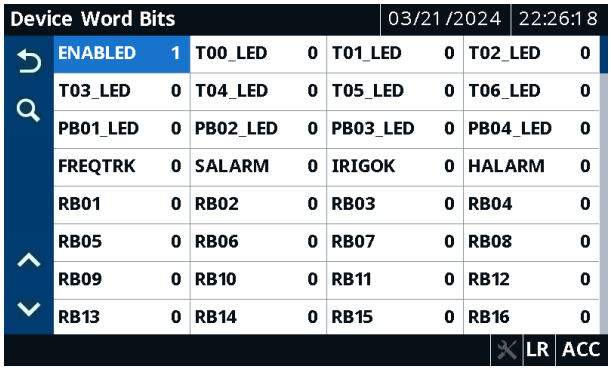



**Figure 13 Sequential Events Recorder**

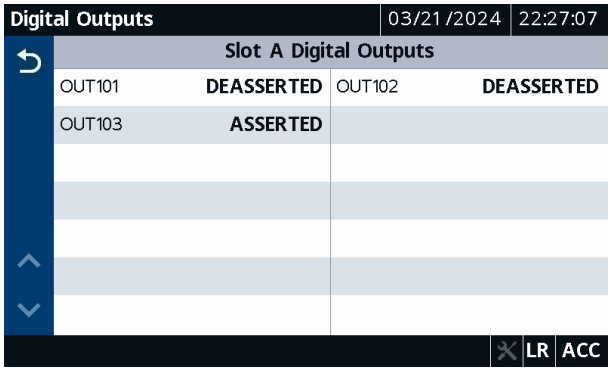



**Figure 14 Digital Outputs**

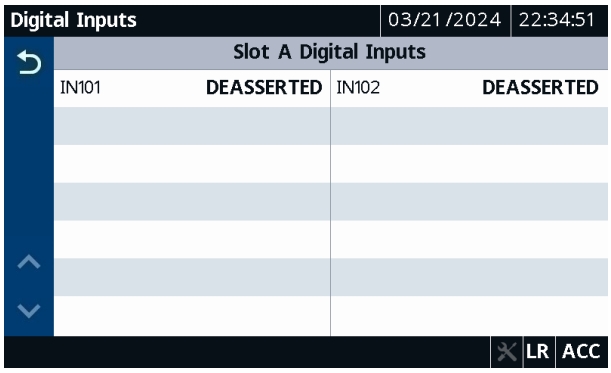



**Figure 15 Digital Inputs**

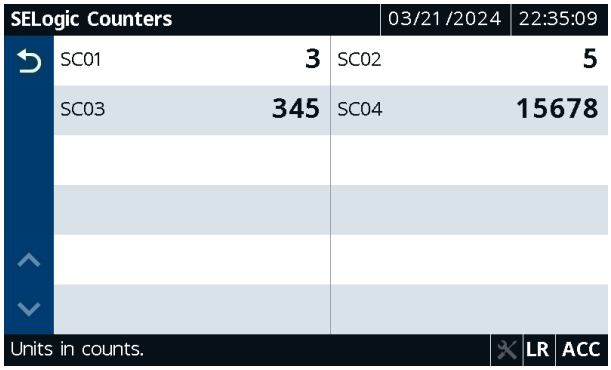



**Figure 16 SELOGIC Counters**

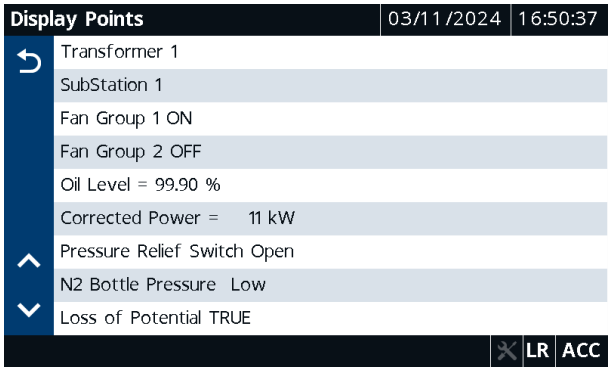



**Figure 17 Display Points**

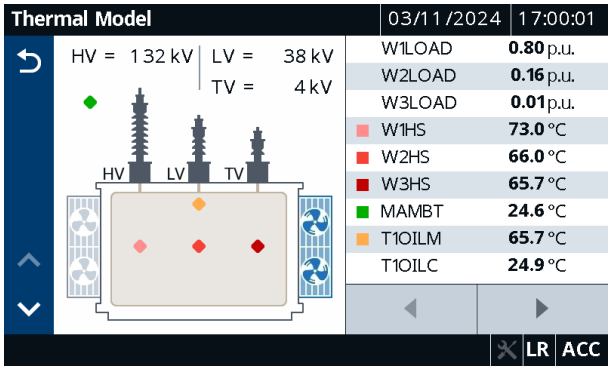



**Figure 18 Transformer Thermal Reports**

# 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 the SER records. To view the event summary (see *Figure 19*) 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.

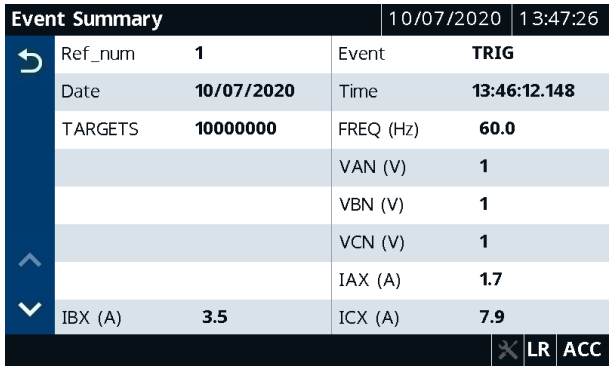



**Figure 19 Event Summary**

Tap the **Sequential Events Recorder** application to view the SER history report (see *Figure 20*).


**Figure 20 SER History Report**

Tapping the **Trash** button, shown in *Figure 20*, on the Event History, HIF Event History, and Sequential Events Recorder screens and confirming the delete action removes the records from the relay.

# 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 21*), and control the local bits (*Figure 22*).

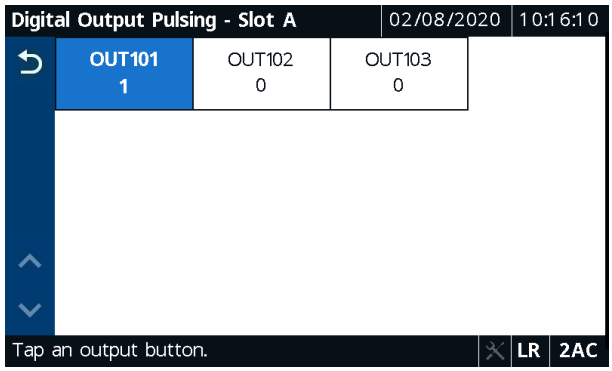



**Figure 21 Digital Output Pulsing – Slot A**

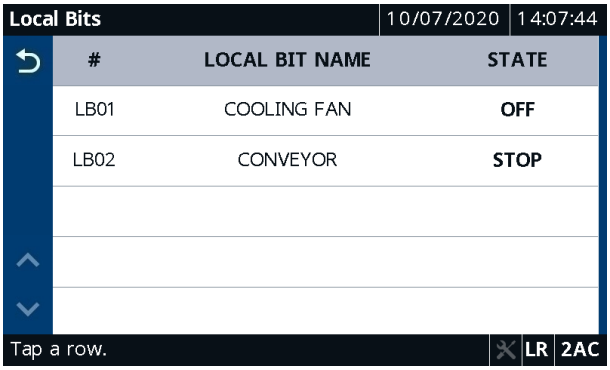



**Figure 22 Local Bits**

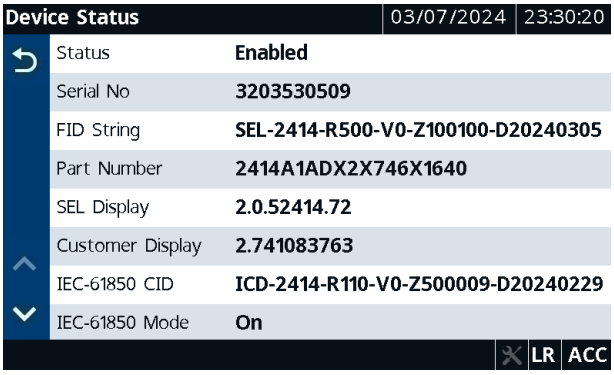



**Figure 23 Device Status**

## Device Info Folder Applications

Tapping the **Device Info** folder navigates you to the screen where you can access specific device information applications (Status, Configuration, and Trip & Diag. Messages) and the Reboot application. Tap the **Status** application to view the relay status, firmware version, part number, etc. (see *Figure 23*).

To view the trip and diagnostic messages, tap the **Trip & Diag. Messages** application (see *Figure 24*). When a diagnostic failure, trip, or warning occurs, the relay displays the diagnostic message on the screen until it is either overridden by the restart of the rotating display or the inactivity timer expires.

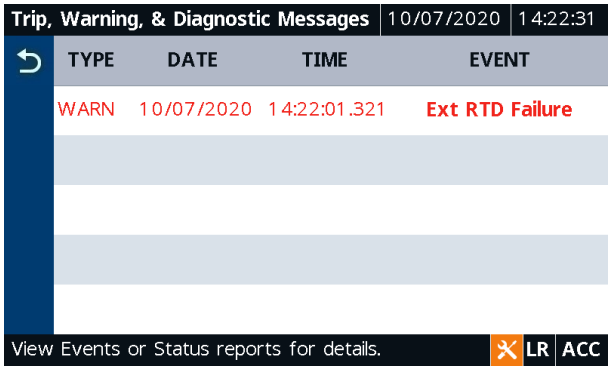



**Figure 24 Trip and Diagnostic Messages**

# Additional Ordering Options

The following options can be ordered for any SEL-2414 model:

| | |
|---|---|
| Digital I/O[a] | 8 DI, 14 DI, 8 DO, 4 DI/4 DO, 4 DI/3 DO with 2 Form C and 1 Form B |
| Analog I/O | 8 AI, 4 AI/4 AO |
| Temperatures | 10 RTDs |
| CTs and PTs | 3 ACI/3 AVI, 4CT, 3 AVI |
| Port 1 | Single/Dual 10/100BASE-T copper (RJ45 connector)<br>Single/Dual 100BASE FX (LC connector) |
| Port 2 | Fiber-Optic Port (62.5 µm core fiber, ST connectors, SEL-2812 compatible) |
| Port 4 | EIA-232 or EIA-485 (PN 9751) |
| Protocols | Serial: DNP3; Ethernet: Modbus TCP, DNP3 LAN/WAN, FTP, Telnet, IEC 61850 |
| Mounting | Surface Mounting kit for in-cabinet installation (PN 915900204) |
| Environment | Conformal coating for chemically harsh and high-moisture environments |

[a] Unless otherwise specified, all digital outputs are Form A.

# Automation

## Flexible Control Logic and Integration Features

The SEL-2414 is equipped with as many as four independently operated serial ports: one EIA-232 port on the front, one EIA-232 or EIA-485 port on the rear, one fiber-optic port, and one EIA-232 or EIA-485 port option card. The device does not require special communications software. Use any system that emulates a standard terminal system for engineering access to the device. Establish communication by connecting computers, modems, protocol converters, printers, an SEL communications processor, SCADA serial port, and an RTU for local or remote communication. Apply an SEL communications processor as the hub of a star network, with point-to-point fiber or copper connection between the hub and the SEL-2414. Included communications protocols are listed below.

### Standard Protocols

- Modbus RTU
- SEL ASCII
- SEL Compressed ASCII
- SEL Fast Meter
- SEL Fast Operate
- SEL Fast SER
- SEL Fast Message
- SEL MIRRORED BITS

SEL-2414 logic improves integration in the following ways.

### Replaces Traditional Panel Control Switches

Eliminate traditional panel control switches with operator control pushbuttons or the 32 local bits, available through the menu system. Program the four conveniently sized operator pushbuttons to control fan banks and fan lockout. 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 breaker trip/close.

### Replaces Traditional Indicating Panel Lights

Replace traditional indicating panel lights with 32 programmable displays. Define custom messages (e.g., Fan On, Fan Off) to report transformer or device conditions on the front-panel display. Use advanced SELOGIC control equations to control which messages the device displays. *Figure 25* shows an example.

### Replaces Traditional Temperature Gauges

Replace traditional temperature gauges that show the temperature, and the maximum and minimum temperature since last reset. The SEL-2414 Max/Min metering records and time stamps the maximum and minimum temperatures and transformer thermal model quantities.

### 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 SELOGIC control equations. Set or reset the nonvolatile latch bits using optoisolated inputs, remote bits, local bits, or any programmable logic condition. The latch bits retain their state when the device loses power.

### Eliminates External Timers

Eliminate external timers for custom protection or control schemes with 32 general purpose SELOGIC control equation timers. Each timer has independent time-delay pickup and dropout settings. Program each timer input with any desired element (e.g., time qualify a current element). Assign the timer output to control scheme logic.

### Eliminates RTU-to-Device Wiring

Eliminate RTU-to-Device 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 and close.

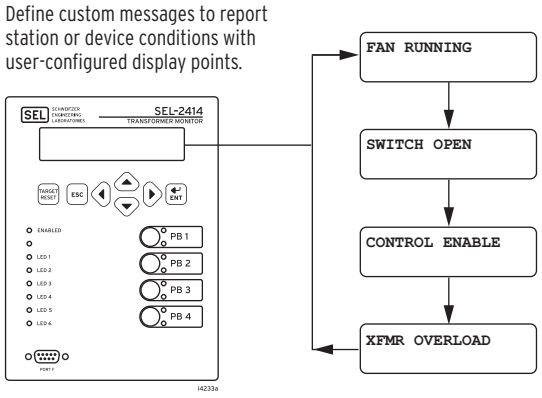



**Figure 25 Define Custom Messages to Report Station or Device Conditions**

# Communications Architectures

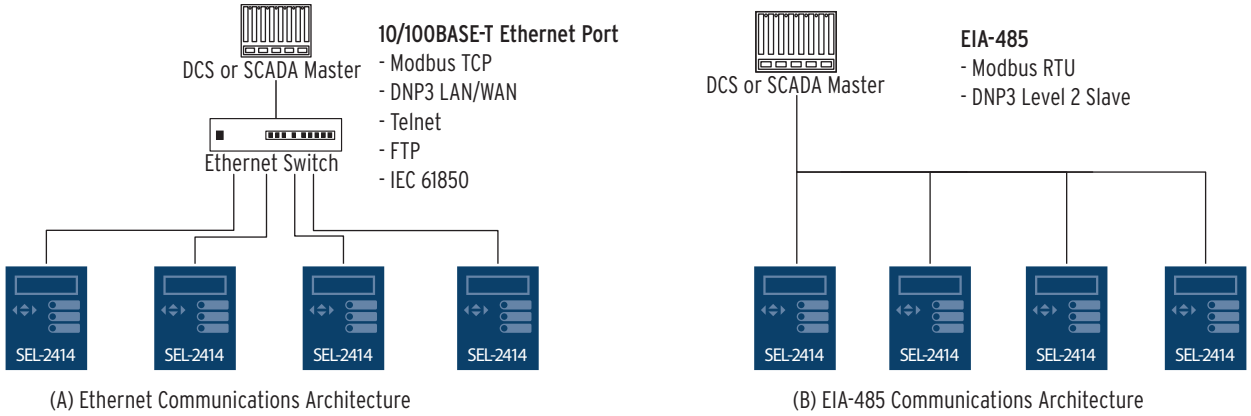



**Figure 26 Typical Ethernet and EIA-485 Communications Architectures**

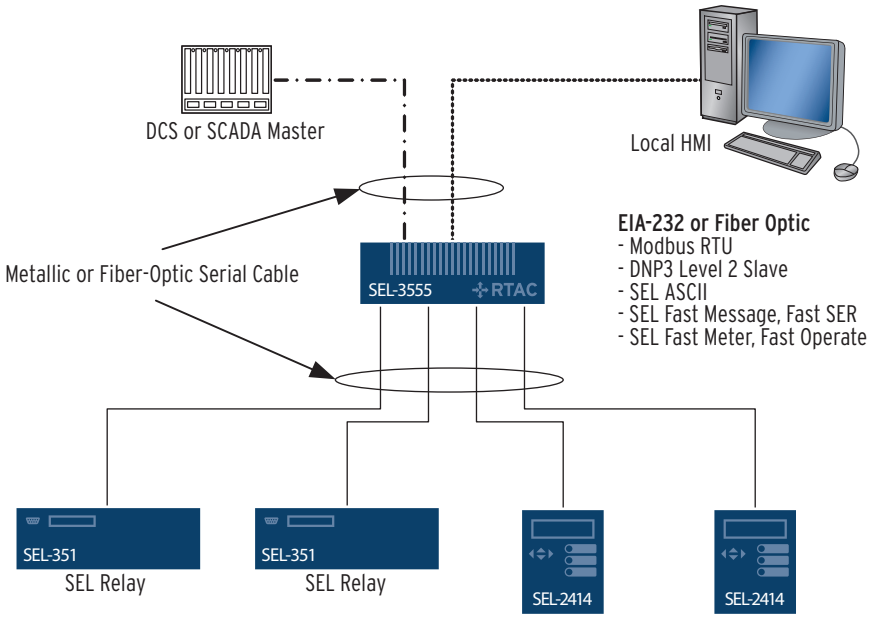



**Figure 27 Typical EIA-232 and Fiber-Optic Communications Architecture**

# Front- and Rear-Panel Diagrams

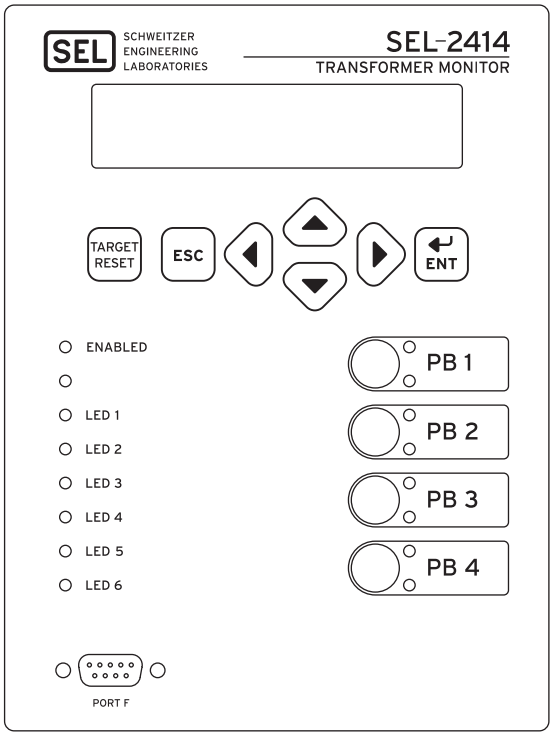
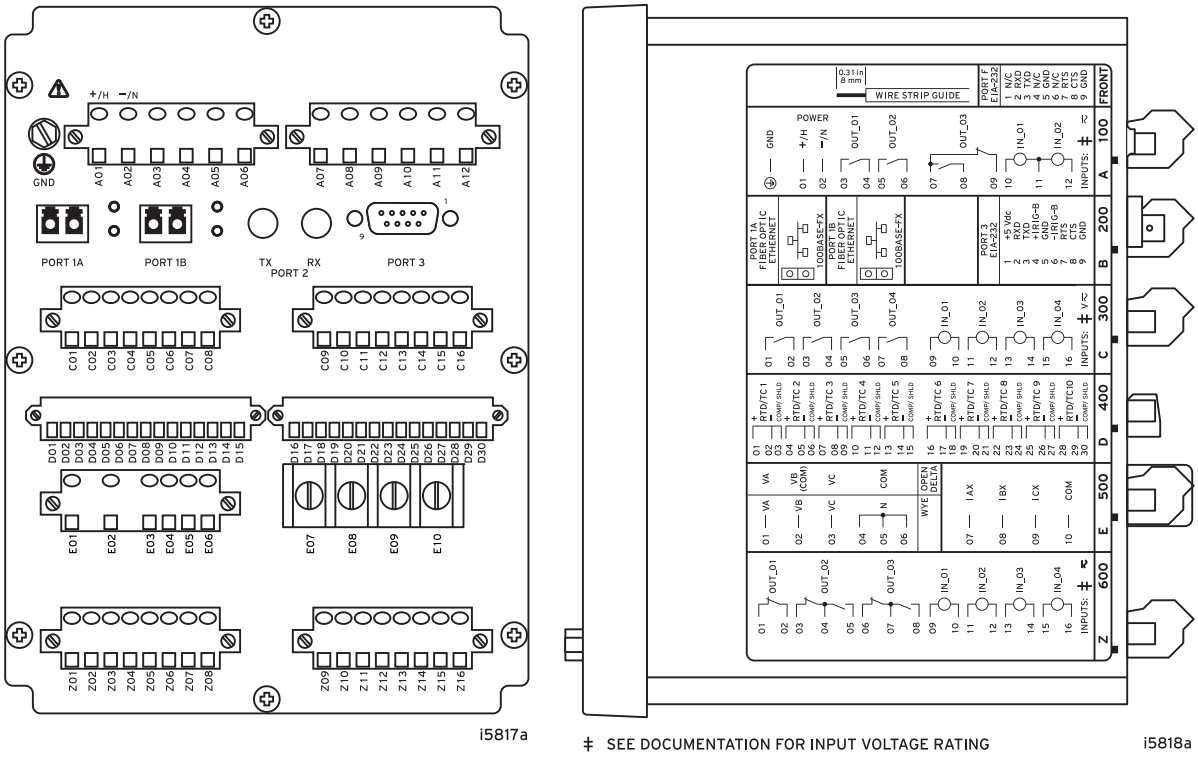



**Figure 28 Front Panel With Default Configurable Labels**




(A) Rear-Panel Layout

(B) Side-Panel Input and Output Designations

**Figure 29 Rear-Panel Connections and Labels**

# Dimensions

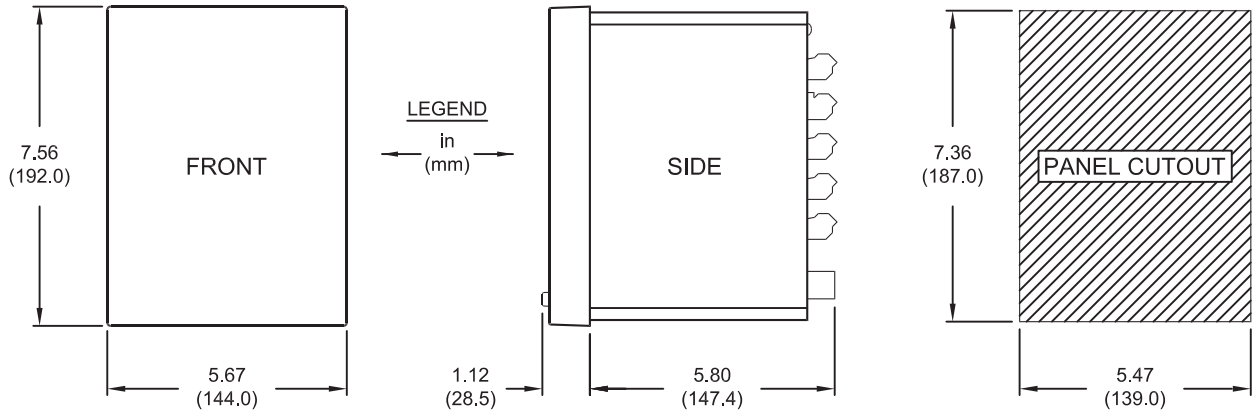



**Figure 30 SEL-2414 Panel-Mount**

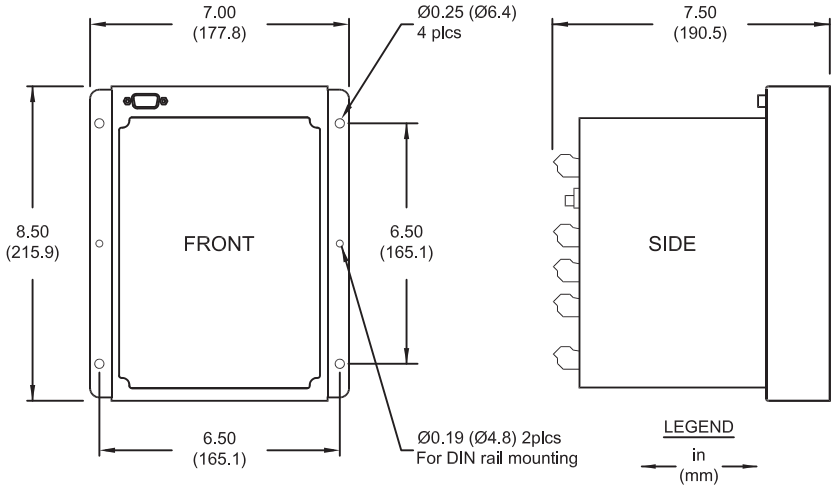



**Figure 31 SEL-2414 Surface-Mount Dimensions**

# Specifications

## Compliance

Designed and manufactured under an ISO 9001 certified quality management system

47 CFR 15B, Class A

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.

CE Mark in accordance with the requirements of the European Union.

RCM Mark in accordance with the requirements of Australia.

UKCA Mark in accordance with the requirements of United Kingdom.

### Normal Locations

UL Listed to U.S. and Canadian safety standards (File E220228; NRAQ, NRAQ7)

–20°C ≤ Ta ≤ 40°C

### Hazardous Locations

UL Listed for Hazardous Locations to Canadian and U.S. Standards (File E475839; NRAG, NRAG7)

CL 1, DIV 2; GP A, B, C, D; T3C

–20°C ≤ Ta ≤ 40°C

EU

SEL 19 ATEX 0001X
II 3 G
Ex ec nC IIC T3 Gc

–20°C ≤ Ta ≤ 50°C

EN 60079-0:2018
EN 60079-7:2015/A1:2018
EN 60079:15:2019

**Note:** Where so marked, ATEX and UL Hazardous Locations 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.

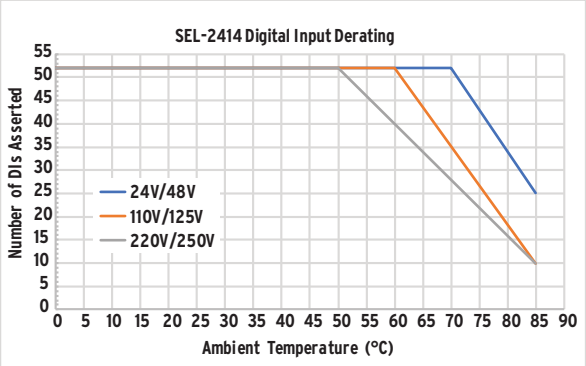
## General

### Operating Temperature Range

IEC Performance Rating: –40° to 85°C (–40° to 185°F)
IEC 60068-2-1 and 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.




### UL/CSA Thermal Derating

Design to ensure that no more than 30 digital I/O are simultaneously energized. This applies to all outputs carrying less than 2 A current and digital inputs rated above 100 V. Inputs rated below 100 V only add half the heat.

### 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

See *Figure 30* and *Figure 31*.

### Weight

2.0 kg (4.4 lb)

## Power Supply

### Rated Supply Voltage

| | |
|---|---|
| Low-Voltage Model: | 24/48 Vdc |
| High-Voltage Model: | 125/250 Vdc<br>120/240 Vac, 50/60 Hz |

### Input Voltage Range

| | |
|---|---|
| Low-Voltage Model: | 19.2–60 Vdc |
| High-Voltage Model: | 85–300 Vdc<br>85–264 Vac |

### Power Consumption (With Front-Panel LCD)

| | |
|---|---|
| AC: | <40 VA |
| DC: | <15 W |

### Power Consumption (With Front-Panel 5″ Color Touchscreen)

| | |
|---|---|
| AC: | <75 VA |
| DC: | <25 W |

### Interruptions

| | |
|---|---|
| Low-Voltage Model: | 10 ms @ 24 Vdc<br>50 ms @ 48 Vdc |
| High-Voltage Model: | 50 ms @ 125 Vac/Vdc<br>100 ms @ 250 Vac/Vdc |

### Fuse Rating

| | |
|---|---|
| High-Voltage Model: | 3.15 A, high breaking capacity, time lag T, 250 V (5x20 mm, T3.15AH 250 V) |
| Low-Voltage Model: | 3.15 A, high breaking capacity, time lag T, 250 V (5x20 mm, T3.15AH 250 V) |

## Inputs

### AC Current Input Phase

| $I_{NOM}$ | $I_{NOM}$ = 5 A | $I_{NOM}$ = 1 A |
|---|---|---|
| Rated Range: | 0.1–96.0 A<br>(according to IEC 60255-5, 60664-1) | 0.02–19.20 A |

**Note:** This is a linearity specification and is not meant to imply continuous operation.

| | | |
|---|---|---|
| Continuous Thermal Rating: | 15 A (according to IEC 60255-6, IEEE C37.90-1989) | 3 A |
| 1 Second Thermal: | 500 A (according to IEC 60255-6) | 100 A |
| Rated Frequency: | 50/60 ±5 Hz | 50/60 ±5 Hz |
| Burden (per phase): | < 0.050 VA | < 0 .002 VA |
| Measurement Category: | II | |

### AC Current Input Neutral

| $I_{NOM}$ | $I_{NOM}$ = 5 A | $I_{NOM}$ = 1 A |
|---|---|---|
| Rated Range: | 0.05–10.00 A (according to IEC 60255-5, 60664-1) | 0.01–2.00 A |

**Note:** This is a linearity specification and is not meant to imply continuous operation.

| | | |
|---|---|---|
| Continuous Thermal Rating: | 15 A (according to IEC 60255-6, IEEE C37.90-1989) | 3 A |
| 1 Second Thermal: | 500 A (according to IEC 60255-6) | 100 A |
| Rated Frequency: | 50/60 ±5 Hz | 50/60 ±5 Hz |
| Burden (per phase): | < 0.1 VA | < 0 .01 VA |
| Measurement Category: | II | |

### AC Voltage Input (300 V)

| | |
|---|---|
| Rated Operating Voltage ($U_e$): | 100–250 Vac |
| Rated Insulation Voltage: | 300 Vac |
| 10-Second Thermal: | 600 Vac |
| Rated Frequency: | 50/60 ±5 Hz |
| Burden: | < 0.1 W |

### DC Transducer (Analog) Inputs

| | |
|---|---|
| Input Impedance: | |
| Current Mode: | 200 Ω |
| Voltage Mode: | >10 kΩ |
| Input Range (Maximum): | |
| Current Mode: | ±20 mA |
| Voltage Mode: | ±10 V |
| Sampling Rate: | At least 5 ms |
| Step Response: | 1 s |
| Accuracy at 25°C: | |
| ADC: | 16 bit |
| With user calibration: | 0.05% of full scale (current mode)<br>0.025% of full scale (voltage mode) |
| Without 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) | |

### DC Transducer (Analog) Inputs Extended Range Option

| | |
|---|---|
| Input Impedance: | |
| Voltage Mode: | >10 kΩ |
| Input Range (Maximum): | |
| Voltage Mode: | ±300 V |
| Sampling Rate: | At least 5 ms |
| Step Response: | 1 s |
| Accuracy at 25°C: | |
| ADC: | 16 bit |
| With user calibration: | 0.025% of full scale (voltage mode) |
| Without calibration: | Better than 0.5% of full scale at 25°C |
| Accuracy Variation With Temperature: | |
| ± 0.015% per °C of full scale (±10 V) | |
| CMRR Typical: | 65 db at 60 Hz |

### Optoisolated Control Inputs

When Used With DC Control Signals:

| | | |
|---|---|---|
| 250 V | ON for 200–275 Vdc | OFF below 150 Vdc |
| 220 V | ON for 176–242 Vdc | OFF below 132 Vdc |
| 125 V | ON for 100–135.5 Vdc | OFF below 75 Vdc |
| 110 V | ON for 88–121 Vdc | OFF below 66 Vdc |
| 48 V | ON for 38.4–52.8 Vdc | OFF below 28.8 Vdc |
| 24 V | ON for 15–30 Vdc | OFF for < 5 Vdc |

When Used With AC Control Signals:

| | | |
|---|---|---|
| 250 V | ON for 170.6–275 Vac | OFF below 106 Vac |
| 220 V | ON for 150.3–264 Vac | OFF below 93.2 Vac |
| 125 V | ON for 85–150 Vac | OFF below 53 Vac |
| 110 V | ON for 75.1–132 Vac | OFF below 46.6 Vac |
| 48 V | ON for 32.8–60 Vac | OFF below 20.3 Vac |
| 24 V | ON for 14–27 Vac | OFF below 5 Vac |

| | |
|---|---|
| Current Draw at Nominal DC Voltage: | 2–4 mA (Except for 240 V, 8 mA) |
| Rated Insulation Voltage: | 300 Vac |
| Rated Impulse Withstand Voltage ($U_{imp}$): | 4000 V |

### RTD Input Card

| | |
|---|---|
| Number of Channels: | Ten 3-wire RTDs |
| Input Type:<br>Supports the following RTD types on each independent input. | 100 Ω platinum (PT100)<br>100 Ω nickel (NI100)<br>120 Ω nickel (NI120)<br>10 Ω copper (CU10) |
| Measuring Range: | –200° to 850°C (PT100)<br>–80° to 250°C (Ni100, Ni120)<br>–200° to 250°C (Cu10) |
| ADC Resolution: | 24 bit |
| Accuracy: | |
| CU10, PT100, NI100, NI120: | ±0.1°C typical at 25°C<br>±2°C worst case |
| Resolution: | 0.1°C |
| Update Rate: | <3 s |
| CMRR (typical): | 100 dBv |
| Noise Rejection: | Up to 1 Vrms 50/60 Hz |

### Universal Temperature Input Card

| | |
|---|---|
| Number of Channels: | Ten (thermocouples or 3-wire RTDs) |
| Input Type:<br>Supports the following RTD or TC types on each independent input. | 100 Ω platinum (PT100)<br>100 Ω nickel (NI100)<br>120 Ω nickel (NI120)<br>10 Ω copper (CU10)<br>J, K, T, E |
| Measuring Range: | |
| RTDs: | |
| PT100: | –200° to 850°C |
| NI100: | –80° to 250°C |
| CU10: | –200° to 250°C |
| Thermocouples (TCs): | |
| J: | –200° to 1200°C |
| K: | –200° to 1370°C |
| T: | –200° to 400°C |
| E: | –200° to 950°C |
| ADC Resolution: | 24 bit |
| Accuracy: | |
| RTDs: | |
| PT100, NI100, NI120, CU10: | ±0.1°C typical at 25°C<br>±2°C worst case |

TCs:

| | |
|---|---|
| J, K, T, E: | ±1°C with field calibration<br>±3°C without field calibration |
| Resolution: | 0.1°C |
| Update Rate: | < 3 s |
| CMRR (typical): | 100 dBv |
| Noise Rejection: | Up to 1 Vrms 50/60 Hz |
| Isolation | |
| Number of Banks: | Two Banks (5 channels each) |
| Max. Working Common Mode: | 250 Vdc |
| Cold Junction Compensation: | Automatic |

### Time-Code Input

| | |
|---|---|
| Format: | Demodulated IRIG-B |
| On (1) State: | $V_{ih} \geq$ 2.2 V |
| Off (0) State: | $V_{ih} \leq$ 0.8 V |
| Input Impedance: | 2 kΩ |
| Accuracy: | ±3 ms |

### Time-Code Input (SNTP)

| | |
|---|---|
| High-Priority Server Accuracy: | ±5 ms |
| Accuracy: | ±25 ms |

### Time-Code Input (PTP)

| | |
|---|---|
| IEEE 1588-2008 Firmware-Based Accuracy: | ±1 ms |

## Outputs

### General

OUT103 is Form C Trip Output, all other outputs are Form A.

| | |
|---|---|
| Dielectric Test Voltage: | 2000 Vac |
| Impulse Withstand Voltage ($U_{imp}$): | 4000 V |
| Mechanical Durability: | 10M no load operations |

### DC Output Ratings

Electromechanical

| | |
|---|---|
| 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; 4 A @ 85°C |
| Continuous Carry (UL/CSA Derating with All Outputs Asserted): | 5 A @ < 60°C; 2.5 A 60 to 70°C |
| Thermal: | 50 A for 1 s |
| Contact Protection: | 360 Vdc, 40 J MOV protection across open contacts |
| Operating Time (coil energization to contact closure, resistive load): | Pickup or Dropout time ≤ 8 ms typical |

| | | | |
|---|---|---|---|
| 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 Capacity (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 |

Fast Hybrid (high-speed high current interrupting)

| | |
|---|---|
| Make: | 30 A |
| Carry: | 6 A continuous carry at 70°C<br>4 A continuous carry at 85°C |
| 1 s Rating: | 50 A |
| MOV Protection (maximum voltage): | 250 Vac/330 Vdc |
| Pickup Time: | < 50 µs, resistive load |
| Dropout Time: | 8 ms, resistive load |
| Update Rate: | 1/8 cycle |

Breaking Capacity (10000 operations):

| | | |
|---|---|---|
| 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):

| | | |
|---|---|---|
| 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 |

**Note:** Per IEC 60255-23:1994, using the simplified method of assessment.
**Note:** Make rating per IEEE C37.90-1989.

### AC Output Ratings

Electromechanical

| | |
|---|---|
| Maximum Operational Voltage ($U_e$) Rating: | 240 Vac |
| Insulation Voltage ($U_i$) Rating (excluding EN 61010-1): | 300 Vac |
| Utilization Category: | AC-15 (control of electromagnetic loads > 72 VA) |
| Contact Rating Designation: | B300 (B = 5 A, 300 = rated insulation voltage) |
| Voltage Protection Across Open Contacts: | 270 Vac, 40 J |
| Rated Operational Current ($I_e$): | 3 A @ 120 Vac<br>1.5 A @ 240 Vac |
| Conventional Enclosed Thermal Current ($I_{the}$) Rating: | 5 A |
| Rated Frequency: | 50/60 ±5 Hz |
| Pickup/Dropout Time: | ≤ 8 ms (coil energization to contact closure) |
| Electrical Durability Make VA Rating: | 3600 VA, cosϕ = 0.3 |
| Electrical Durability Break VA Rating: | 360 VA, cosϕ = 0.3 |

Fast Hybrid (high-speed high current interrupting)

| | |
|---|---|
| Make: | 30 A |
| Carry: | 6 A continuous carry at 70°C<br>4 A continuous carry at 85°C |
| 1 s Rating: | 50 A |
| MOV Protection (maximum voltage): | 250 Vac/330 Vdc |
| Pickup Time: | < 50 µs, resistive load |
| Dropout Time: | 8 ms, resistive load |
| Update Rate: | 1/8 cycle |

Breaking Capacity (10000 operations):

| | | |
|---|---|---|
| 48 Vac | 10.0 A | L/R = 40 ms |
| 125 Vac | 10.0 A | L/R = 40 ms |
| 250 Vac | 10.0 A | L/R = 20 ms |

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

| | | |
|---|---|---|
| 48 Vac | 10.0 A | L/R = 40 ms |
| 125 Vac | 10.0 A | L/R = 40 ms |
| 250 Vac | 10.0 A | L/R = 20 ms |

**Note:** Per IEC 60255-23:1994, using the simplified method of assessment.
**Note:** Make rating per IEEE C37.90-1989.

### Analog Outputs

| | |
|---|---|
| Current Ranges (Max): | ±20 mA |
| Voltage Ranges (Max): | ±10 V |
| Output Impedance For Current Outputs: | ≥100 kΩ |
| Output Impedance For Voltage Outputs: | ≤ 20 Ω |
| Maximum Load: | 0–750 Ω current mode<br>>2 kΩ voltage mode |
| Accuracy: | ±0.55% of full scale at 25°C |
| Step Response: | 100 ms |

## Communications

### Communications Ports

Standard EIA-232 (2 ports)

| | |
|---|---|
| Location (fixed): | Front Panel<br>Rear Panel |
| Data Speed: | 300–38400 bps |

Optional Ethernet port:

Single/Dual 10/100BASE-T copper (RJ45 connector)
Single/Dual 100BASE FX Multimode (LC connector)

Optional multimode fiber-optic serial port:

Class 1 LED product
Complies with IEC 60825-1:1993 + A1:1997 + A2:2001

### 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 |

### Optional Communications Card

Standard EIA-232 or EIA-485 (ordering option)

| | |
|---|---|
| Data Speed: | 300–38400 bps |

### Communications Protocols

Modbus RTU slave or Modbus TCP
DNP3 Level 2 Outstation (LAN/WAN and Serial)
IEC 61850 Communications
Ethernet FTP
SNTP
PTP (firmware-based)
RSTP
Telnet
SEL MIRRORED BITS (MBA, MBB, MB8A, MB8B, MBTB)
Ymodem file transfer on the front and rear port
Xmodem file transfer on the front port
SEL ASCII and Compressed ASCII
SEL Fast Meter
SEL Fast Operate
SEL Fast SER
SEL Fast Message unsolicited write
SEL Fast Message read request
SEL Event Messenger Points

### Maximum Concurrent Connections

| | |
|---|---|
| Modbus Slave: | 1 |
| DNP3 Level 2 Outstation: | 3[a] |
| Ethernet FTP: | 2 |
| Telnet: | 2 |
| IEC 61850 MMS: | 7 |
| IEC 61850 Goose: | 64 Incoming<br>8 Outgoing |

[a] Maximum in any combination of serial and/or LAN/WAN links.

## AC Metering Accuracies

### Current

| | |
|---|---|
| Phase Current: | ±0.5% typical, 25°C, 50/60 Hz, nominal current |
| Neutral Current: | ±0.5% typical, 25°C, 50/60 Hz, nominal current |
| Negative Sequence (3I2): | ±0.5% typical, 25°C, 50/60 Hz, nominal current (calculated) |
| Residual Ground Current: | ±0.5% typical, 25°C, 50/60 Hz, nominal current (calculated) |

### Voltage

| | |
|---|---|
| Line-to-Neutral Voltage: | ±0.5% typical, 25°C, 50/60 Hz, nominal voltage |
| Line-to-Line Voltage: | ±0.5% typical, 25°C, 50/60 Hz, nominal voltage |
| Negative-Sequence (3V2): | ±0.5% typical, 25°C, 50/60 Hz, nominal voltage (calculated) |

### Power

| | |
|---|---|
| Three-Phase Real Power (kW): | ±1% typical, 25°C, 50/60 Hz, nominal voltage and current with 0.10 to 1.00 power factor |
| Three-Phase Reactive Power (kVAR): | ±1% typical, 25°C, 50/60 Hz, nominal voltage and current with 0.00 to 0.90 power factor |
| Three-Phase Apparent Power (kVA): | ±1% typical, 25°C, 50/60 Hz, nominal voltage and current |

### Power Factor

| | |
|---|---|
| Three-Phase (wye connected): | ±1% typical, 25°C, 50/60 Hz, nominal voltage and current (between 0.97 and 1) |

## Sampling and Processing Specifications

### Without Voltage Card or Current Card

| | |
|---|---|
| Analog Inputs | |
| Sampling Rate: | Every 4 ms |
| Digital Inputs | |
| Sampling Rate: | 2 kHz |
| Contact Outputs | |
| Refresh Rate: | 2 kHz |
| Logic Update: | Every 4 ms |
| Analog Outputs | |
| Refresh Rate: | Every 4 ms |
| New Value: | Every 100 ms |
| Timer Accuracy: | ±0.5% of settings and ±4 ms |

### With Either Voltage Card, Current Card, or Both Voltage and Current Cards

| | |
|---|---|
| Analog Inputs | |
| Sampling Rate: | 4 times/cycle |
| Digital Inputs | |
| Sampling Rate: | 32 times/cycle |
| Contact Outputs | |
| Refresh Rate: | 32 times/cycle |
| Logic Update: | 4 times/cycle |
| Analog Outputs | |
| Refresh Rate: | 4 times/cycle |
| New Value: | Every 100 ms |
| Timer Accuracy: | ±0.5% of settings and ±1/4 cycle |

## Processing Specifications and Oscillography

| | |
|---|---|
| AC Voltage and Current Inputs: | 16 samples per power system cycle |
| Frequency Tracking Range: | 44–66 Hz |
| Digital Filtering: | Cycle cosine after low-pass analog filtering. Net filtering (analog plus digital) rejects dc and all harmonics greater than the fundamental. |
| Control Processing: | Four times per power system cycle or 4 ms if no current or voltage card (except for math variables and analog signals used in logic, which are processed every 100 ms) |

### Oscillography

| | |
|---|---|
| Length: | 15 or 64 cycles |
| Sampling Rate: | 16 samples per cycle unfiltered<br>4 samples per cycle filtered |
| Trigger: | Programmable with Boolean expression |
| Format: | ASCII and Compressed ASCII<br>Binary COMTRADE (16 samples per cycle unfiltered) |

**Note:** Binary COMTRADE format as per IEEE C37.11-1999, IEEE Standard Common Format for Transient Data Exchange (COMTRADE) for Power Systems.

### Sequential Events Recorder

| | |
|---|---|
| Time-Stamp Resolution: | 1 ms |
| Time-Stamp Accuracy (with respect to Time Source): | ±1 ms |

## Type Tests

### Environmental Tests

| | |
|---|---|
| Enclosure Protection: | IEC 60529:2001 + CRDG:2003<br>IP65 enclosed in panel (2-line display models)<br>IP54 enclosed in panel (touchscreen models)<br>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.<br>IP10 for terminals and the relay rear panel |
| Vibration Resistance: | IEC 60255-21-1:1988, Class 1<br>IEC 60255-27:2013, Section 10.6.2.1<br>Endurance: Class 2<br>Response: Class 2 |
| Shock Resistance: | IEC 60255-21-2:1988, Class 1<br>IEC 60255-27:2013, Section 10.6.2.2<br>IEC 60255-27:2013, Section 10.6.2.3<br>Withstand: Class 1<br>Response: Class 2<br>Bump: Class 1 |
| Seismic (Quake Response): | IEC 60255-21-3:1993<br>IEC 60255-27:2013, Section 10.6.2.4<br>Response: Class 2 |
| Cold: | IEC 60068-2-1:2007<br>IEC 60255-27:2013, Section 10.6.1.2<br>IEC 60255-27:2013, Section 10.6.1.4<br>–40°C, 16 hours |
| Dry Heat: | IEC 60068-2-2:2007<br>IEC 60255-27:2013, Section 10.6.1.1<br>IEC 60255-27:2013, Section 10.6.1.3<br>85°C, 16 hours |
| Damp Heat, Steady State: | IEC 60068-2-78:2013<br>IEC 60255-27:2013, Section 10.6.1.5<br>40°C, 93% relative humidity, 10 days |
| Damp Heat, Cyclic: | IEC 60068-2-30:2005<br>IEC 60255-27:2013, Section 10.6.1.6<br>25° to 55°C, 95% relative humidity, 6 cycles |
| Change of Temperature: | IEC 60068-2-14:2009<br>IEC 60255-1:2010, Section 6.12.3.5<br>–40° to +85°C, ramp rate 1°C/min, 5 cycles |

### Dielectric Strength and Impulse Tests

| | |
|---|---|
| Dielectric (HiPot): | IEC 60255-27:2013, Section 10.6.4.3<br>IEEE C37.90-2005<br>1.0 kVac on analog outputs, Ethernet ports, Port 3, IRIG<br>2.0 kVac on analog inputs<br>2.5 kVac on contact I/O<br>3.6 kVdc on power supply, current, and voltage inputs |
| Impulse: | IEC 60255-27:2013, Section 10.6.4.2<br>0.5 J, 5 kV on power supply, contact I/O, ac current, and voltage inputs<br>0.5 J, 1 kV on Port 3, RTD, and IRIG ports<br>0.5 J, 530 V on analog outputs<br>IEEE C37.90:2005<br>0.5 J, 5 kV<br>0.5 J, 530 V on analog outputs |

### RFI and Interference Tests

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

#### EMC Immunity

| | |
|---|---|
| Electrostatic Discharge Immunity: | IEC 61000-4-2:2008<br>IEC 60255-26:2013; Section 7.2.3<br>IEEE C37.90.3:2001<br>Severity Level 4<br>8 kV contact discharge<br>15 kV air discharge |
| Radiated RF Immunity: | IEC 61000-4-3:2010<br>IEC 60255-26:2013; Section 7.2.4<br>10 V/m<br>IEEE C37.90.2-2004<br>20 V/m |
| Fast Transient, Burst Immunity: | IEC 61000-4-4:2011<br>IEC 60255-26:2013; Section 7.2.5<br>4 kV @ 5.0 kHz<br>2 kV @ 5.0 kHz for comm. ports |
| Surge Immunity: | IEC 61000-4-5:2005<br>IEC 60255-26:2013; Section 7.2.7<br>2 kV line-to-line<br>4 kV line-to-earth |
| Surge Withstand Capability Immunity: | EN 61000-4-18:2010<br>IEC 60255-26:2013; Section 7.2.6<br>2.5 kV common mode<br>1 kV differential mode<br>1 kV common mode on comm. ports<br>IEEE C37.90.1-2002<br>2.5 kV oscillatory<br>4 kV fast transient<br>Comm. ports, IRIG, and PTC ports Zone B, 2 kV line-to-earth<br>LEA ports compliant with IEC 61869-13 tested to 1 kV, 1 MHz common mode |
| Conducted RF Immunity: | IEC 61000-4-6:2008,<br>IEC 60255-26:2013; Section 7.2.8<br>10 Vrms |
| Magnetic Field Immunity: | IEC 61000-4-8:2009<br>IEC 60255-26:2013, Section 7.2.10<br>Severity Level: 1000 A/m for 3 seconds, 100 A/m for 1 minute; 50/60 Hz<br>IEC 61000-4-9: 2001<br>Severity Level: 1000 A/m<br>IEC 61000-4-10:2001<br>Severity Level: 100 A/m (100 kHz and 1 MHz) |
| Power Supply Immunity: | IEC 61000-4-11:2004<br>IEC 61000-4-17:1999<br>IEC 61000-4-29:2000<br>IEC 60255-26:2013, Section 7.2.11<br>IEC 60255-26:2013, Section 7.2.12<br>IEC 60255-26:2013, Section 7.2.13 |

#### EMC Emissions

| | |
|---|---|
| Conducted Emissions: | IEC 60255-26:2013, Class A<br>FCC 47 CFR Part 15.107, Class A<br>Canada ICES-001 (A) / NMB-001 (A)<br>EN 55011:2009 + A1:2010, Class A<br>EN 55022:2010 + AC:2011, Class A<br>EN 55032:2012 + AC:2013, Class A<br>CISPR 11:2009 + A1:2010, Class A<br>CISPR 22:2008, Class A<br>CISPR 32:2015, Class A |
| Radiated Emissions: | IEC 60255-26:2013, Class A<br>FCC 47 CFR Part 15.109, Class A<br>Canada ICES-001 (A) / NMB-001 (A)<br>EN 55011:2009 + A1:2010, Class A<br>EN 55022:2010 + AC:2011, Class A<br>EN 55032:2012 + AC:2013, Class A<br>CISPR 11:2009 + A1:2010, Class A<br>CISPR 22:2008, Class A<br>CISPR 32:2015, Class A |

# Technical Support

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

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# Notes



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