SEL-2411 Programmable Automation Controller

Complete System for Control and Monitoring

SELECT I/O Family of Cards

Analog I/O Including ac and dc

Digital I/O

High Reliability, Low Price

- Ten-Year, Worldwide Warranty
- –40° to +85°C Operating Temperature
- Ruggedized to Meet Industrial and Utility Standards
- Class I, Division 2 Hazardous Location Approval

Flexible Input, Output, and Logic Choices

- Powerful Logic, Math, and Timer Functions
- Fast 4 ms Logic Loop Time
- Single or Dual Ethernet, Fiber-Optic Serial, EIA-232, and EIA-485 Communications
- Modbus® RTU, Modbus TCP, DNP3, DNP3 LAN/WAN, MIRRORED BITS®, SEL ASCII and Binary Communications, Parallel Redundancy Protocol (PRP), Rapid Spanning Tree Protocol (RSTP), and IEC 61850

Critical Reporting and Logging

- 1 ms Accurate Sequential Events Recorder
- Trending
- Event Recording
- Time Synchronization Sources
  - IRIG-B
  - Firmware-based PTP
  - SNTP
  - DNP

AC Metering Capabilities

- Voltage, Current, Power
- Demand, Energy

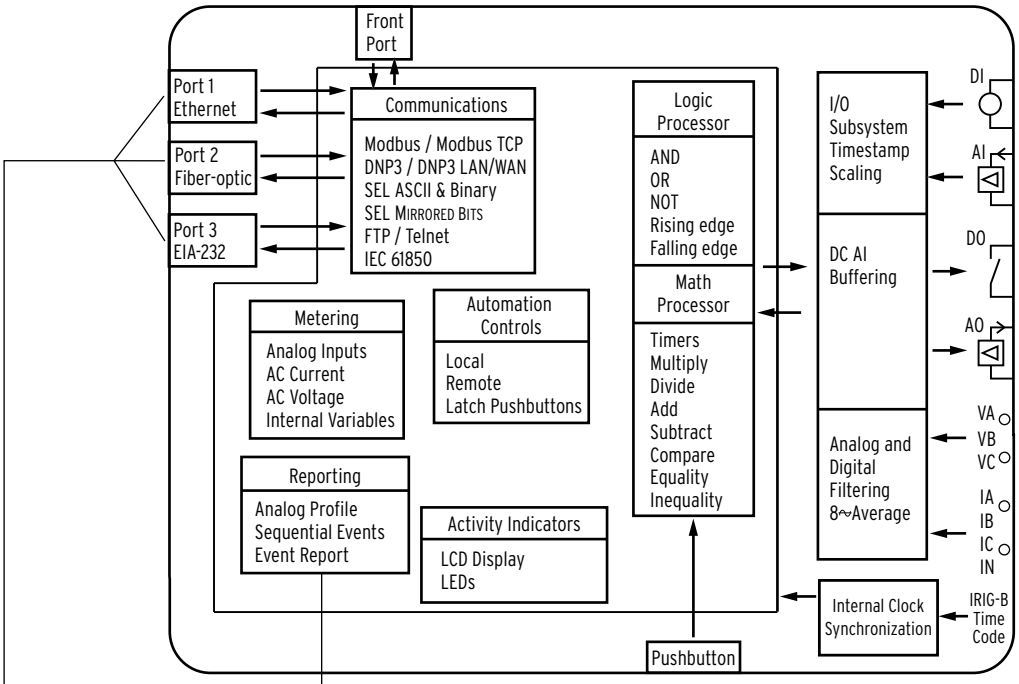
Simple Commissioning Tools

- Front-Panel Configuration and Measurement Display and Access
- Local LCD Display of Settings, Calculated Values, and Statuses
- Programmable Front-Panel Indication and Control
- Simple Programming With ACSELERATOR QuickSet® SEL-5030 Software

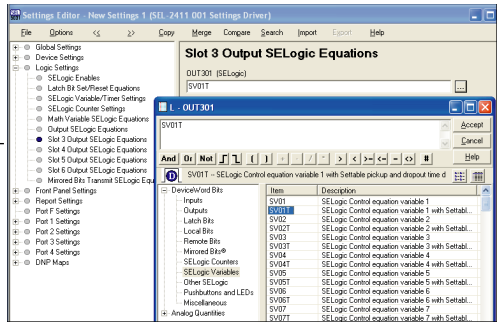
Product Summary

The SEL-2411 Programmable Automation Controller (PAC) automates continuous and discrete processes. A standalone SEL-PAC is a simple solution to monitor and control small waste water plants or small substations. Combine multiple SEL-PACs for applications such as industrial powerhouse DCS, chemical plant automation systems, and large substation SCADA.

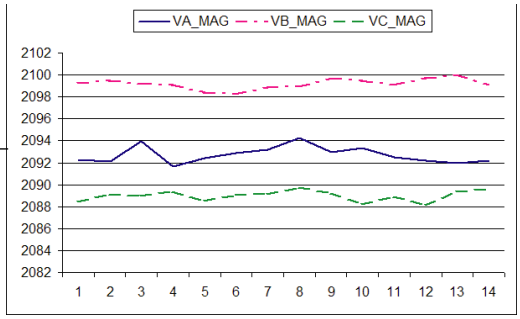
Functional Block Diagram



QuickSet



Analog Profile

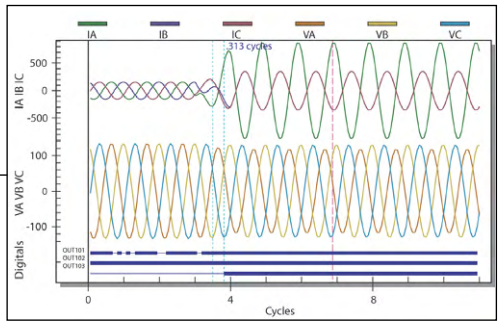


SER

```
SEL-2411                                   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  OUT101                      Asserted
8   04/03/2005  06:54:11.737  OUT101                      Deasserted
```

Event Report



Automation and Control Features

Standard Features

- Chassis
- Front panel
- LCD display
  - Four programmable pushbuttons with LEDs
  - Six programmable LEDs
  - Operator control interface
  - EIA-232 port
- Main board
  - EIA-232 port
  - IRIG-B time-code input
- Power supply
- 2 DI, 3 DO on power supply board
- QuickSet
- Instruction manual, printed or on CD-ROM
- Protocols
  - Modbus RTU
  - SEL MIRRORED BITS
  - SEL ASCII and Compressed ASCII
  - SEL Fast Meter, Fast Operate, Fast SER
  - SEL Fast Message
  - Ymodem file transfer

Additional Ordering Options

The following options can be ordered for any SEL-2411 model (see the SEL-2411 Model Option Table for details):

Touchscreen Display	Five-inch color touchscreen display with eight pushbuttons
Digital I/O[a]	8 DI (PN 9760), 14 DI (PN 1476), 8 DO (PN 9761), 4 DI/4 DO (PN 9764), 4 DI/3 DO with 2 Form C and 1 Form B (PN 9773)
Analog I/O	8 AI (PN 9762), 4 AI/4 AO (PN 9763)
Temperatures	10 RTDs (PN 9772)
CTs and PTs	3 AVI (PN 9769), 4 ACI (PN 9770), 3 ACI/3 AVI (PN 9771),
Port 1	Single or Dual 10/100BASE-T or 100BASE-FX Ethernet Ports
Port 2	Fiber-Optic Serial 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
Environment	Conformal coating for chemically harsh and high-moisture environments

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

Flexible Control Logic and Integration Features

The SEL-2411 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-2411. Included communications protocols are listed.

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-2411 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 to report process control conditions on the front-panel display. Use advanced SELOGIC control equations to control which messages the device displays. *Figure 1* shows an example.

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 through use of 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 trip logic, transfer trip communications, or other control scheme logic.

Eliminates RTU-to-Device Wiring

Eliminate RTU-to-Device wiring with 32 remote bits. Set, clear, or pulse remote bits through use of 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.

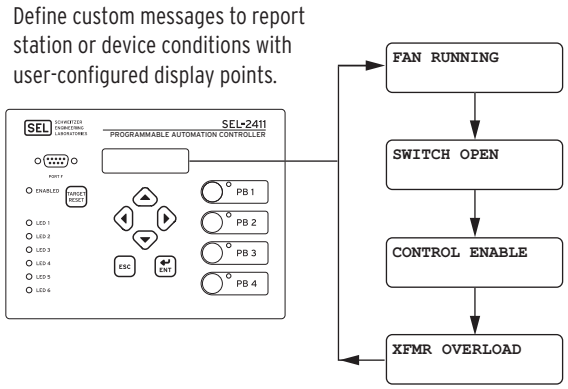
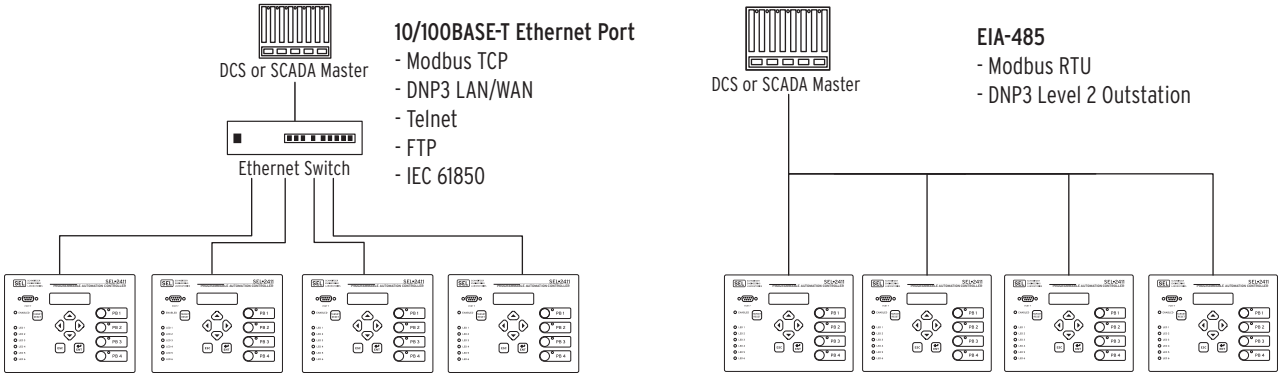


Figure 1 Define Custom Messages to Report Station or Device Conditions

Communications Architectures



(A) Ethernet Communications Architecture (B) EIA-485 Communications Architecture

Figure 2 Typical Ethernet and EIA-485 Communications Architectures

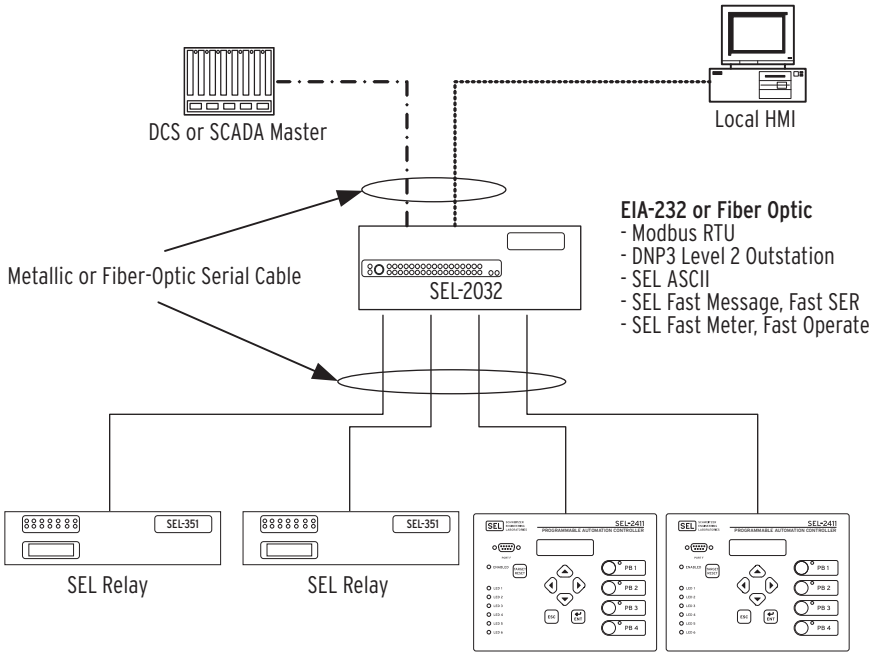


Figure 3 Typical EIA-232 and Fiber-Optic Communications Architecture

Simplify Your Setup and Commissioning

The SEL-2411 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

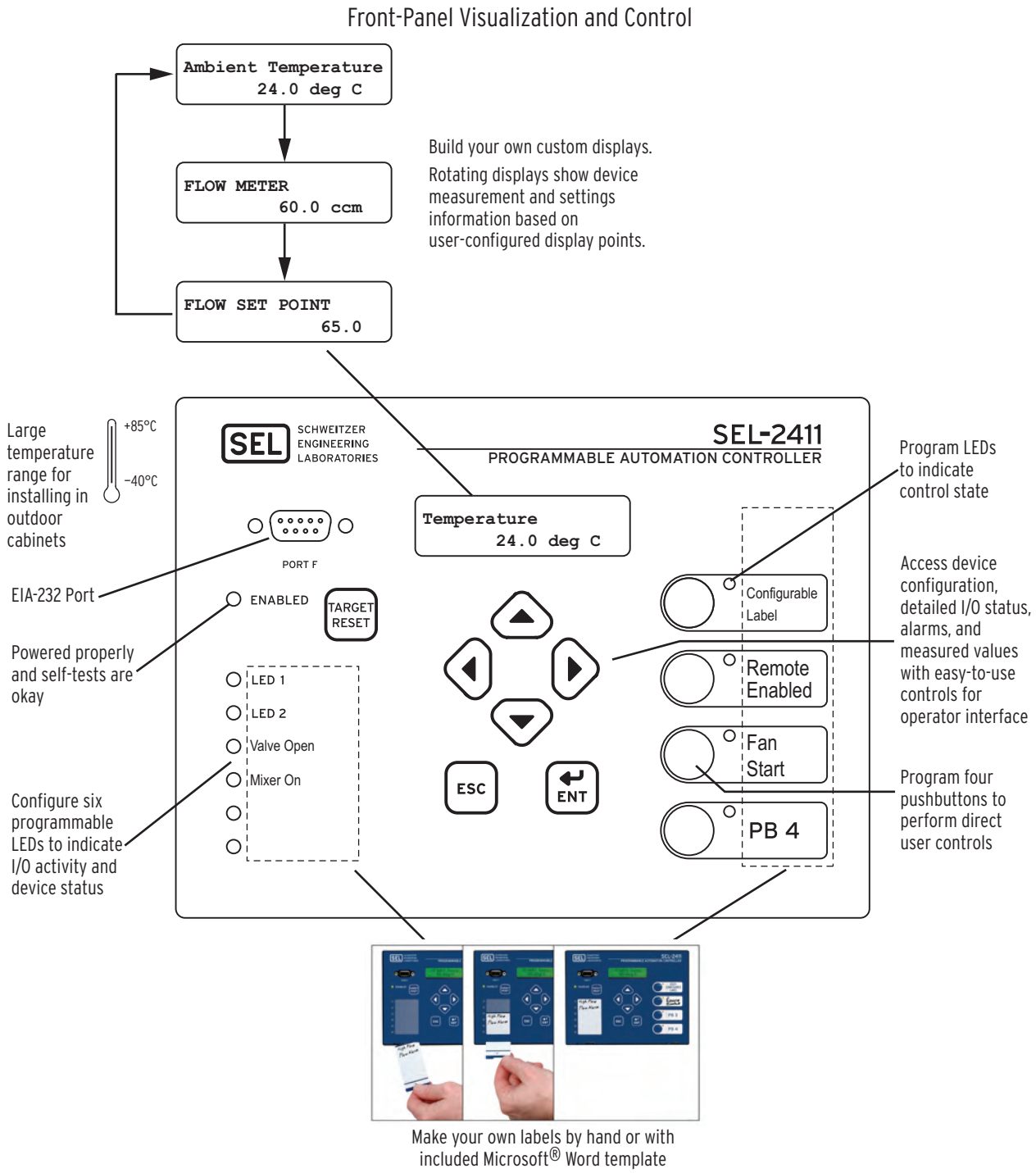


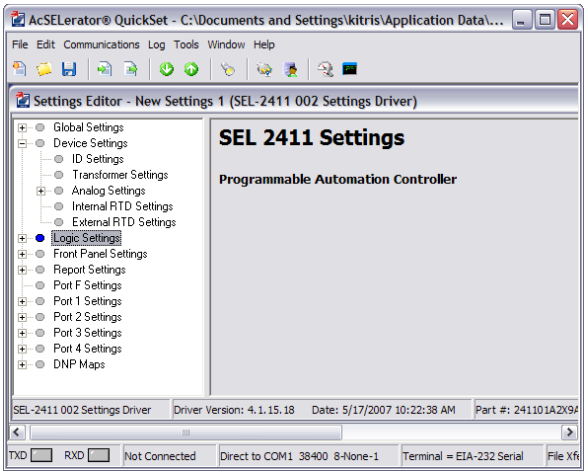
Figure 4 Simplify Your Commissioning

Configuration Software

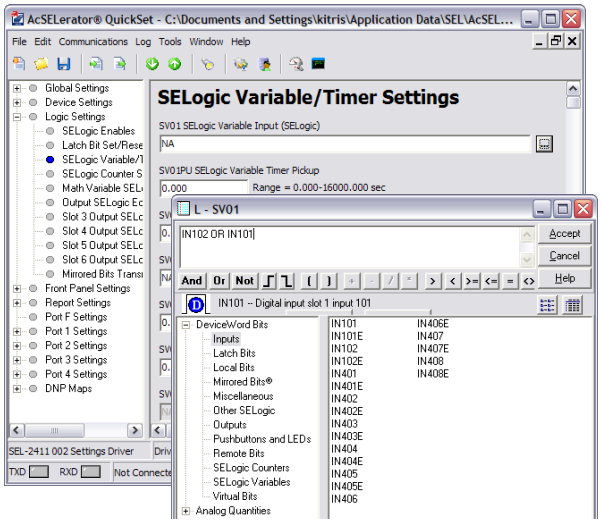
The included QuickSet program simplifies device configuration in addition to providing commissioning and analysis support for the SEL-2411.

- ➤ Access settings creation help online.
- ➤ Organize settings with the device database manager.
- ➤ Load and retrieve settings by 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.

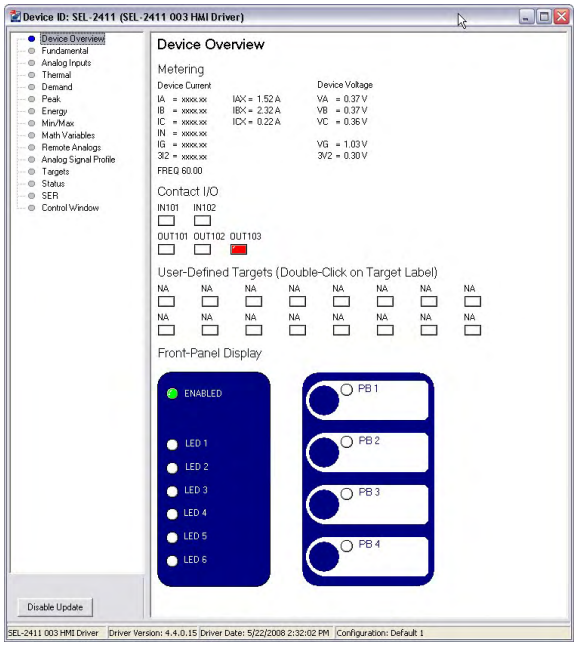
Settings—Develop Settings Offline With an Intelligent Settings Editor That Only Allows Valid Settings



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-2411 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 5*). Bay Screen Builder provides an intuitive and powerful interface to design bay screens to meet your application needs.

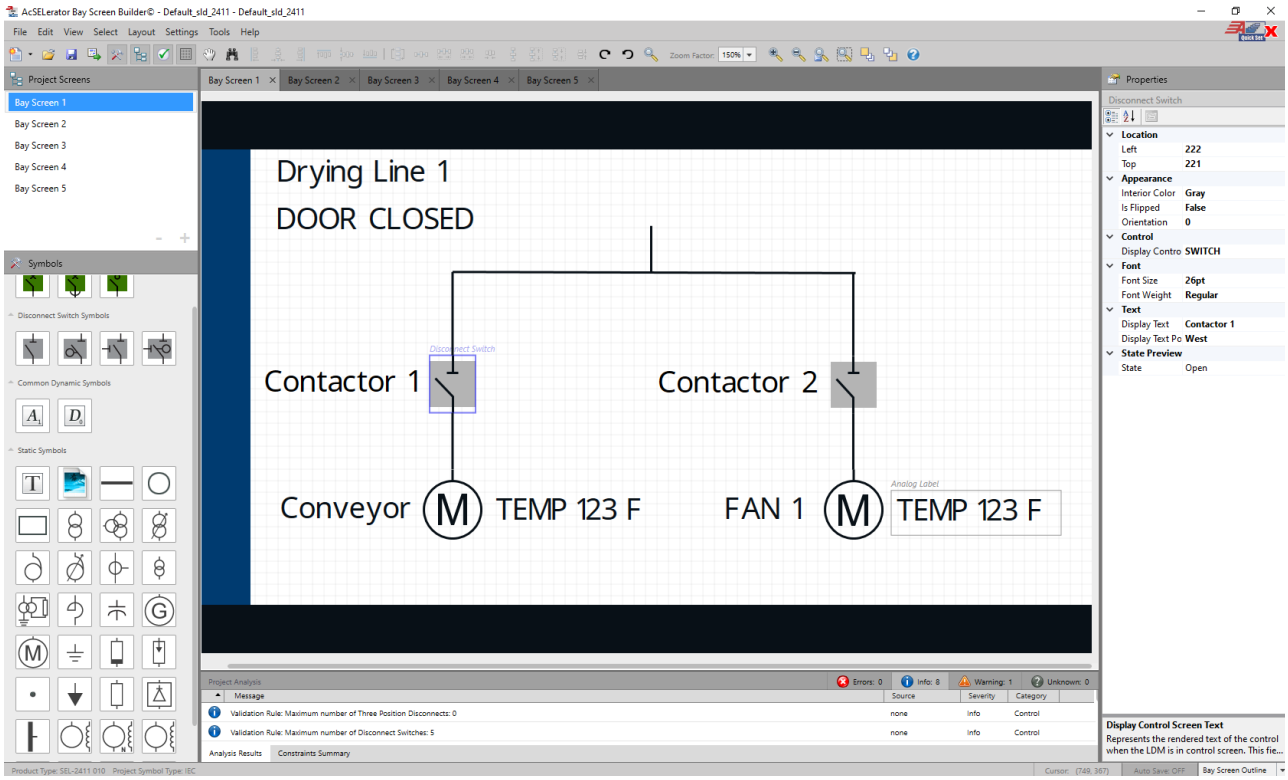


Figure 5 Bay Screen Builder

Monitoring and Metering

Analyze Sequence of Events

Record sequence of events related to process control 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-2411                                   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 6 Example SER Report

Combine SER data from individual SEL-2411 Programmable Automation Controllers into a system-wide log. Synchronize the system with IRIG-B time code and the report data will align perfectly.

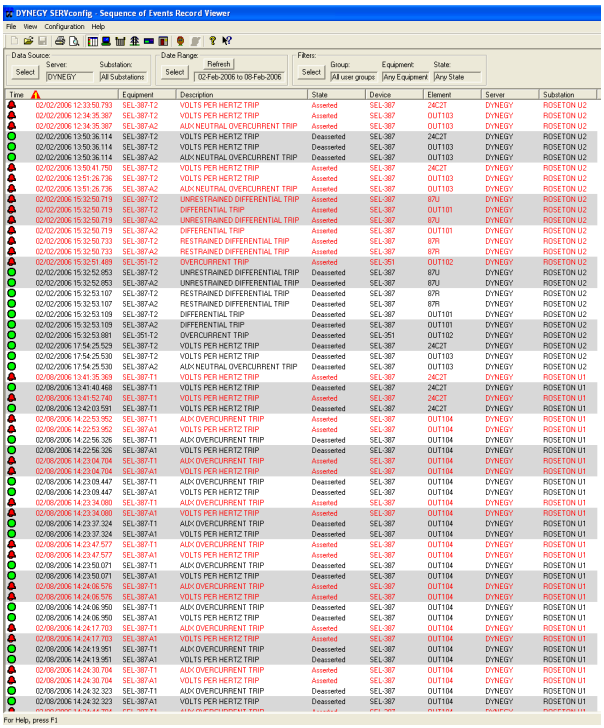


Figure 7 Combine SER Data From Multiple SEL-2411 Programmable Automation Controllers for a System-Wide Log and Display

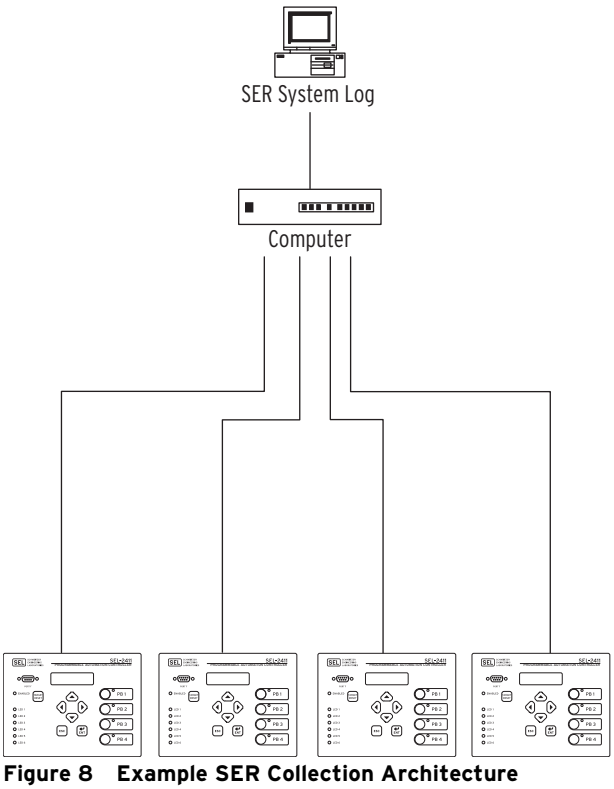


Figure 8 Example SER Collection Architecture

Analyze Event Waveforms

Record analog and digital waveforms at 16 samples/cycle for as many as 64 power system cycles, approximately 1 s. The SEL-2411 provides oscillographic data in EVE, CEV, and COMTRADE-1999 formats. Analyze the event data in these files using SEL 5601-2 SYNCHROWAVE® Event Software or any spreadsheet software.

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 seconds and 1.07 seconds. For a 50 Hz system, the report lengths are 0.30 seconds and 1.28 seconds.

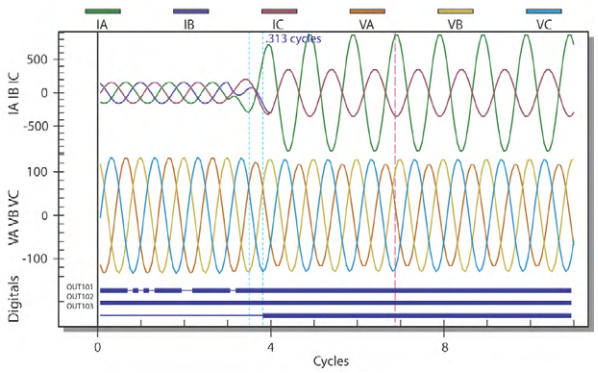


Figure 9 Example SYNCHROWAVE Event Waveform Plot

Trend Analog Inputs

Record measured or calculated process inputs (e.g., temperature, pressure, flow, level, etc.) 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,
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.001,-0.001,"115C"
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Figure 10 Comma-Separated File Format for Easy Display, Analysis, and Archiving

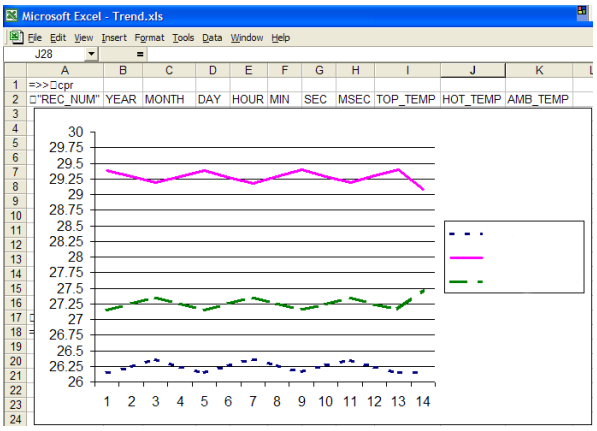


Figure 11 Excel Graph of Trend Data

Metering

The SEL-2411 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

Standard	
Fundamental	IA, IB, IC, VA, VB, VC
Energy	Real, Reactive, Apparent (In and Out)
Maximum and Minimum	Frequency, Voltages (VA, VB, VC), Currents (IA, IB, IC, 3I2), Apparent, Reactive, and Real Power
Demand and Peak Demand	IA, IB, IC, IG, 3I2
Analog Input	AI*x*01–AI*x*08
Math Variable	MV01–MV64
Remote Analog	RA001–RA128
Optional	
Thermal (with the external SEL-2600 RTD Module or internal RTD or TC option)	

Touchscreen Display

You can order the SEL-2411 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-2411 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 12*. Folders and applications are labeled according to functionality. Additional folder and application screens for the SEL-2411 touchscreen display option can be seen in *Figure 13* through *Figure 21*.

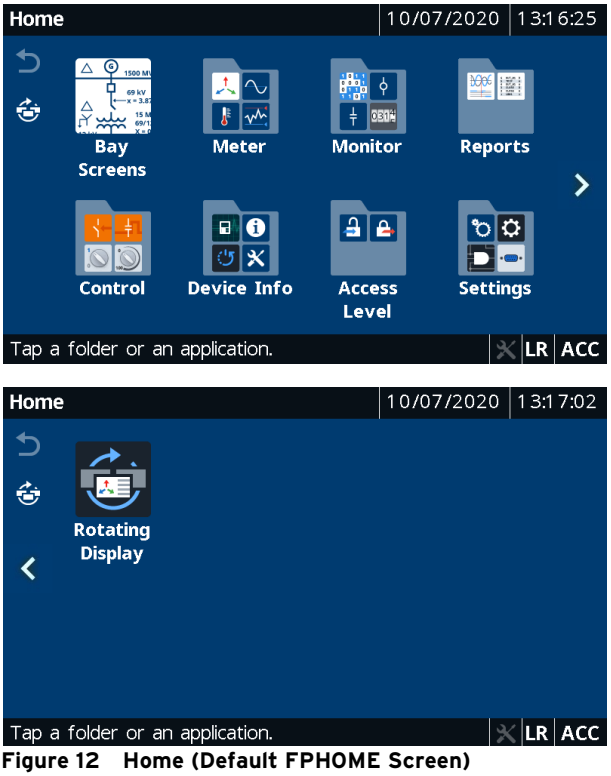


Figure 12 Home (Default FPHOME Screen)

Bay Screens Application

The SEL-2411 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 13* shows the default SLD for the touchscreen display option.

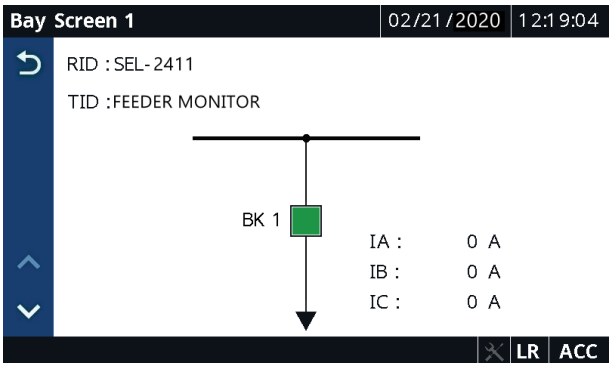


Figure 13 Default Bay Screen

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 14*).

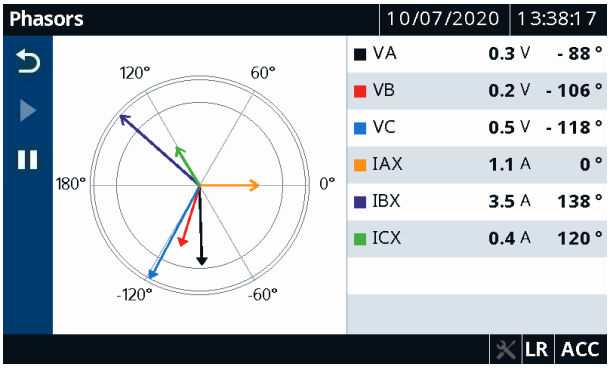


Figure 14 Meter Phasors

Tap the **Energy** application to view the energy metering quantities (see *Figure 15*). A reset feature is provided for the Energy, Max/Min, Demand, and Peak Demand applications. Tap the **Reset** button (see *Figure 15*) to navigate to the reset confirmation screen. Once you confirm the reset, the data are reset to zero.

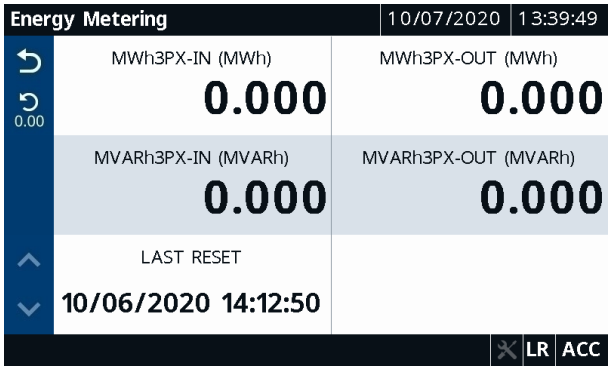


Figure 15 Meter Energy

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 16*) 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.

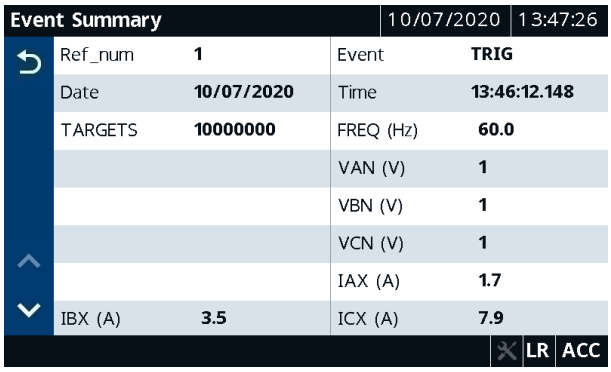


Figure 16 Event Summary

Tap the **Sequential Events Recorder** application to view the SER history report (see *Figure 17*).

Figure 17 SER History Report

Tapping the **Trash** button, shown in *Figure 16*, 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 18*), and control the local bits (*Figure 19*).

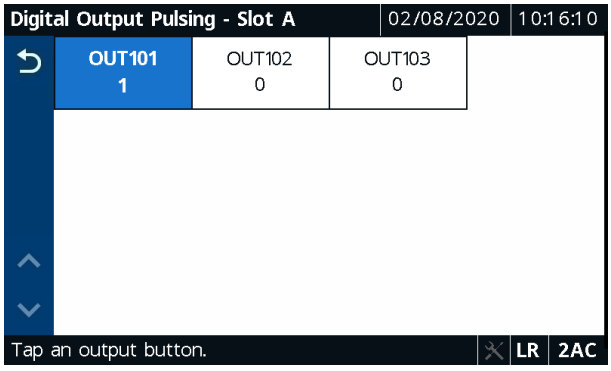


Figure 18 Digital Output Pulsing – Slot A

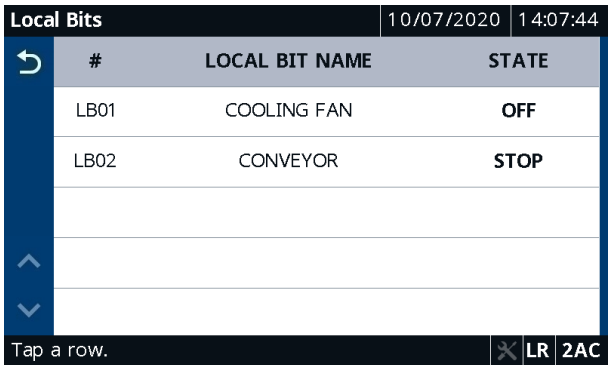


Figure 19 Local Bits

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 20*).

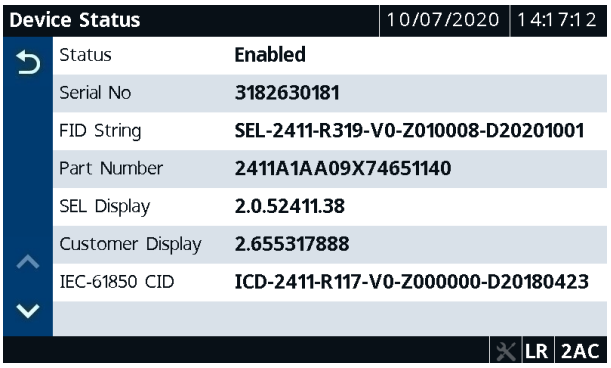


Figure 20 Device Status

To view the trip and diagnostic messages, tap the **Trip & Diag. Messages** application (see *Figure 21*). 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.

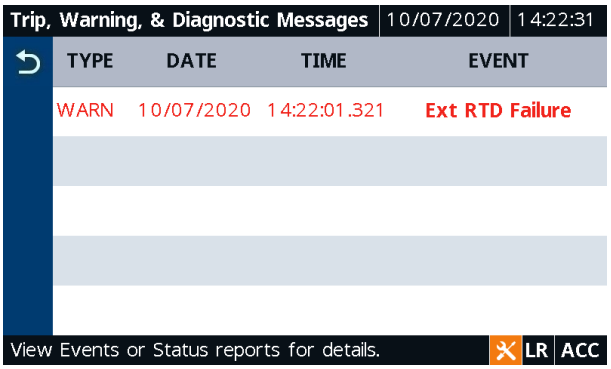


Figure 21 Trip and Diagnostic Messages

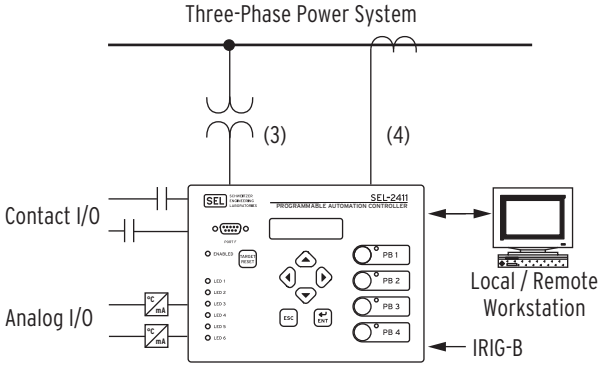
Applications

AC voltage and current measurements, and analog and digital I/O coupled with powerful SELOGIC math provide tools for a wide variety of control and monitoring schemes.

- ➤ Voltage control
- ➤ Undervoltage load shedding
- ➤ Underfrequency load shedding
- ➤ Process control
- ➤ SCADA control
- ➤ VAR control
- ➤ Power Factor Control
- ➤ Overload
- ➤ Loss of Load
- ➤ Thermal Models
- ➤ Protection Backup
- ➤ Oscillographic recording

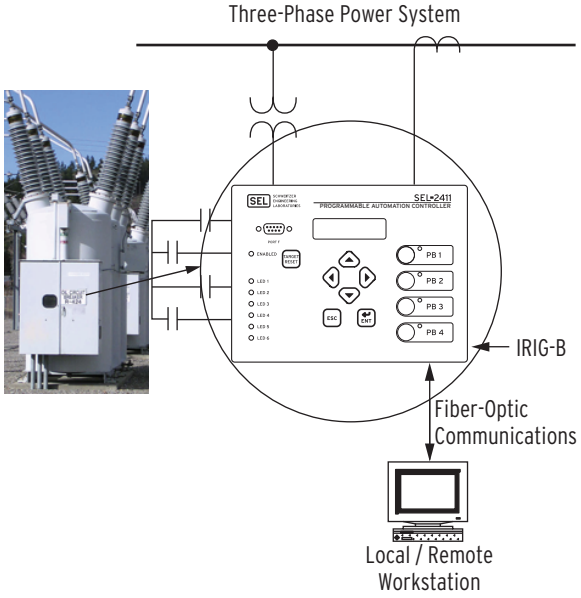
Smart I/O Node

Sends analog and digital input data to a central communications system and receives and executes control commands.



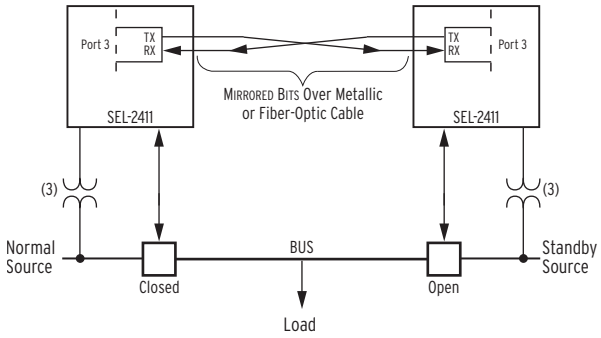
Outdoor Breaker Control

Monitor and control from the circuit breaker cabinet. The SEL-PAC withstands the harsh environment of outdoor enclosures.



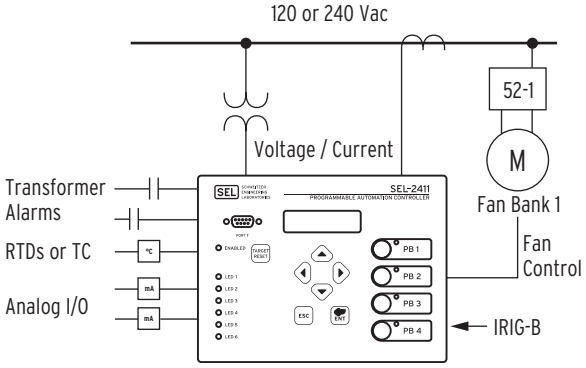
Automatic Transfer Scheme

Sense voltage loss on normal source and transfer load to standby source.



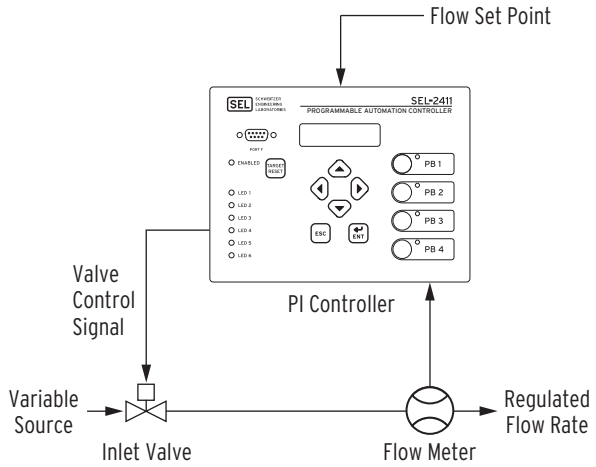
Transformer Monitor and Cooling System Control

Sense transformer alarms and monitor and control fan operation based on temperature. Send warnings to remote monitoring systems and take protection actions.



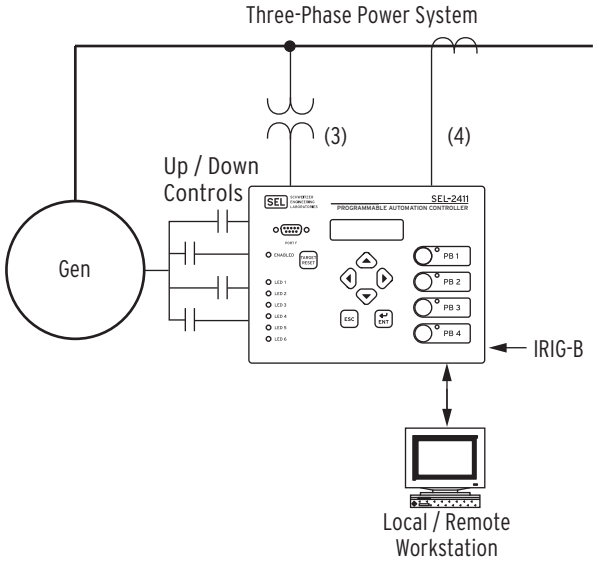
Flow Controller

Regulate the flow in a pipe by adjusting valve position with a single proportional plus integral (PI) controller.



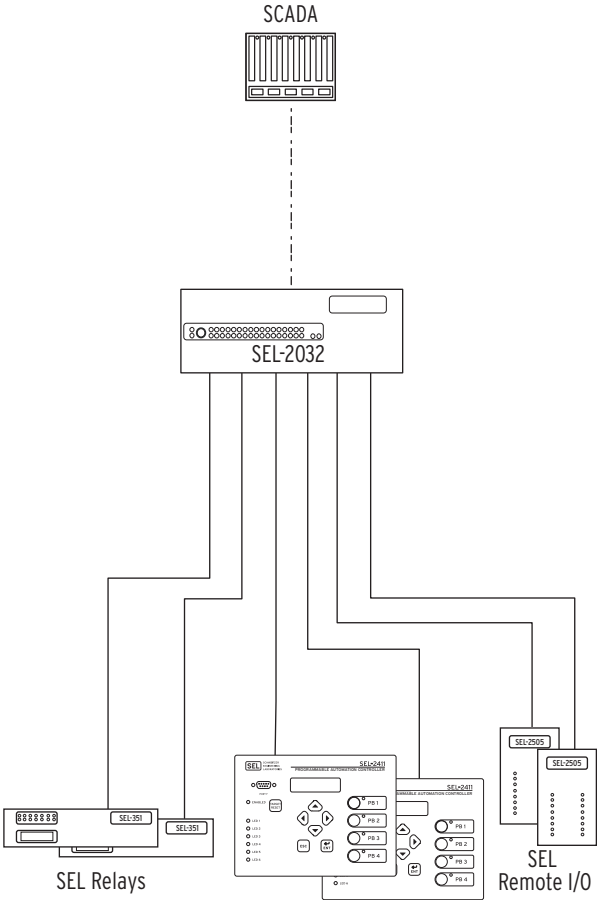
Generator Controller

Maintain power interchange at a utility intertie within predetermined limits by regulating the power output of onsite generators.



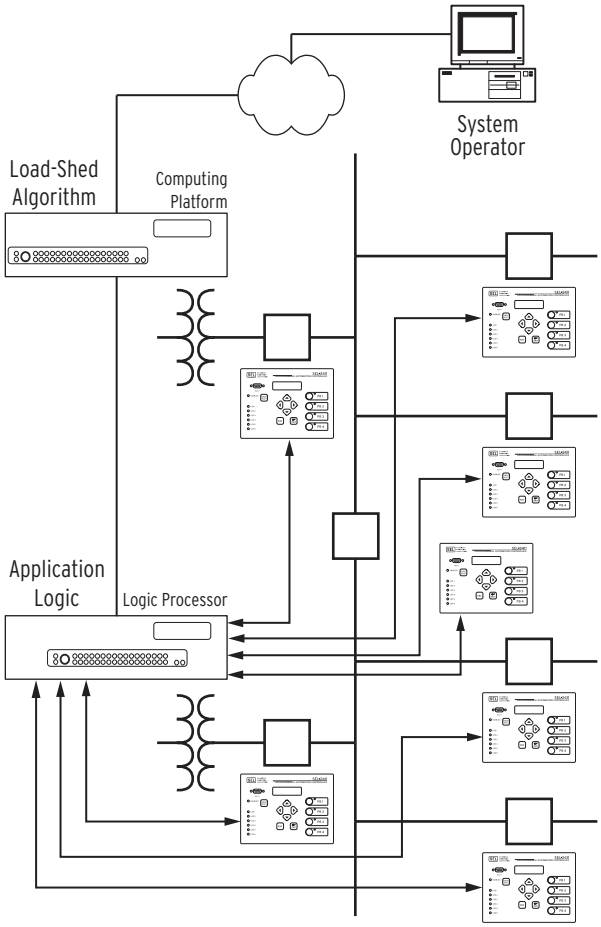
Electrical Substation SCADA

Add digital and analog I/O to SCADA with the SEL-PAC, communications processors, relays and remote I/O modules.

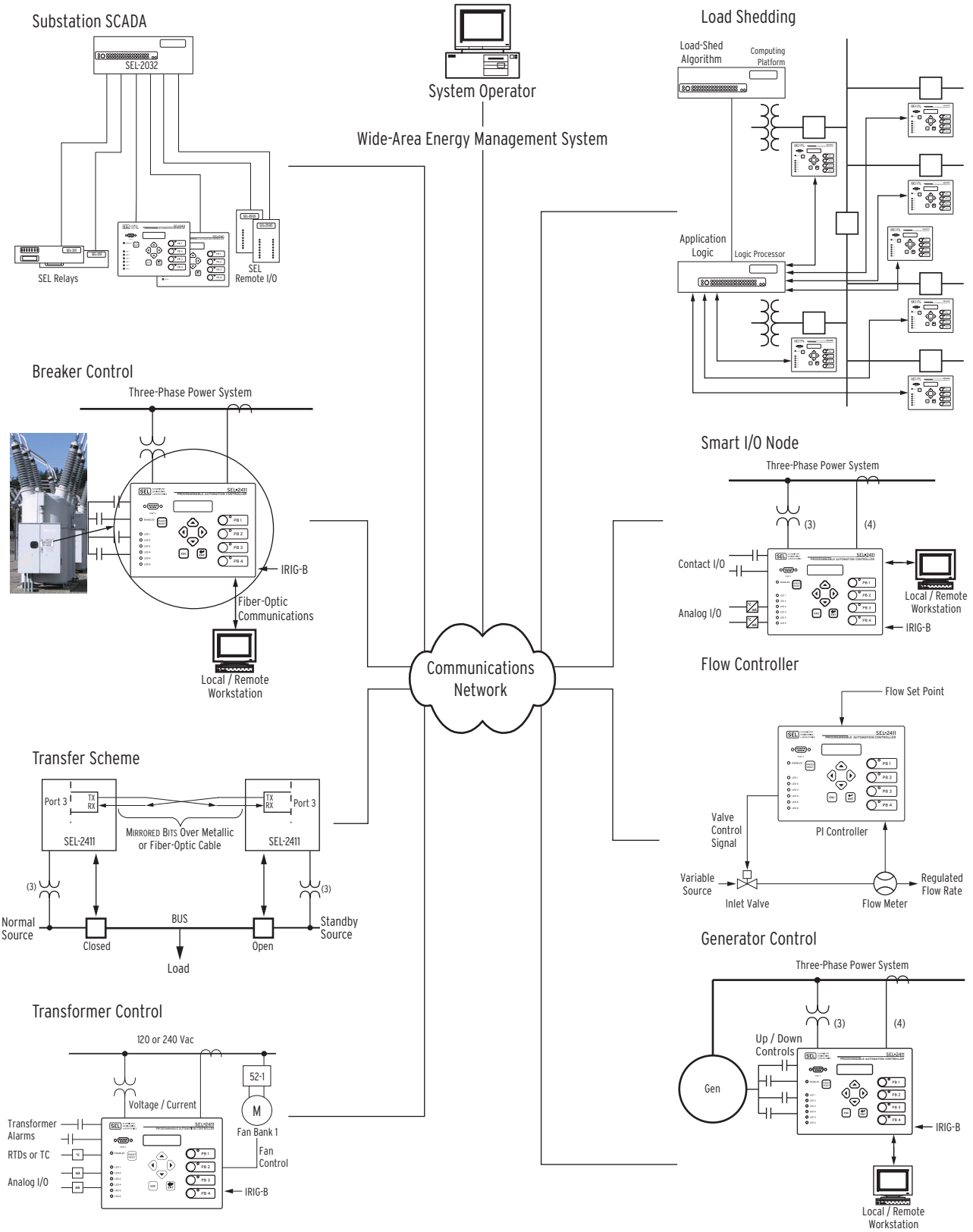


Automatic Load Shed

Combine distributed I/O and logic with computing platforms and logic processors for system-wide load shedding or other remedial action schemes (RAS).



Truly Integrated SEL Control and Energy Management Systems

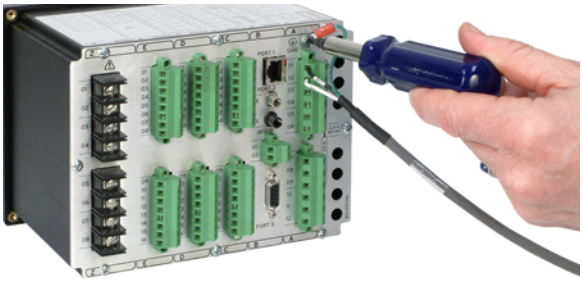


Card Installation

The I/O card mix of the SEL-2411 is easily changed. The simple steps illustrated below demonstrate the process for changing or installing new/different I/O cards.

Detach connectors.
Remove rear cover.

Install cards.
Install new I/O labels on top of chassis.



Replace rear cover.

Energize and accept new I/O configuration.

Front- and Rear-Panel Diagrams

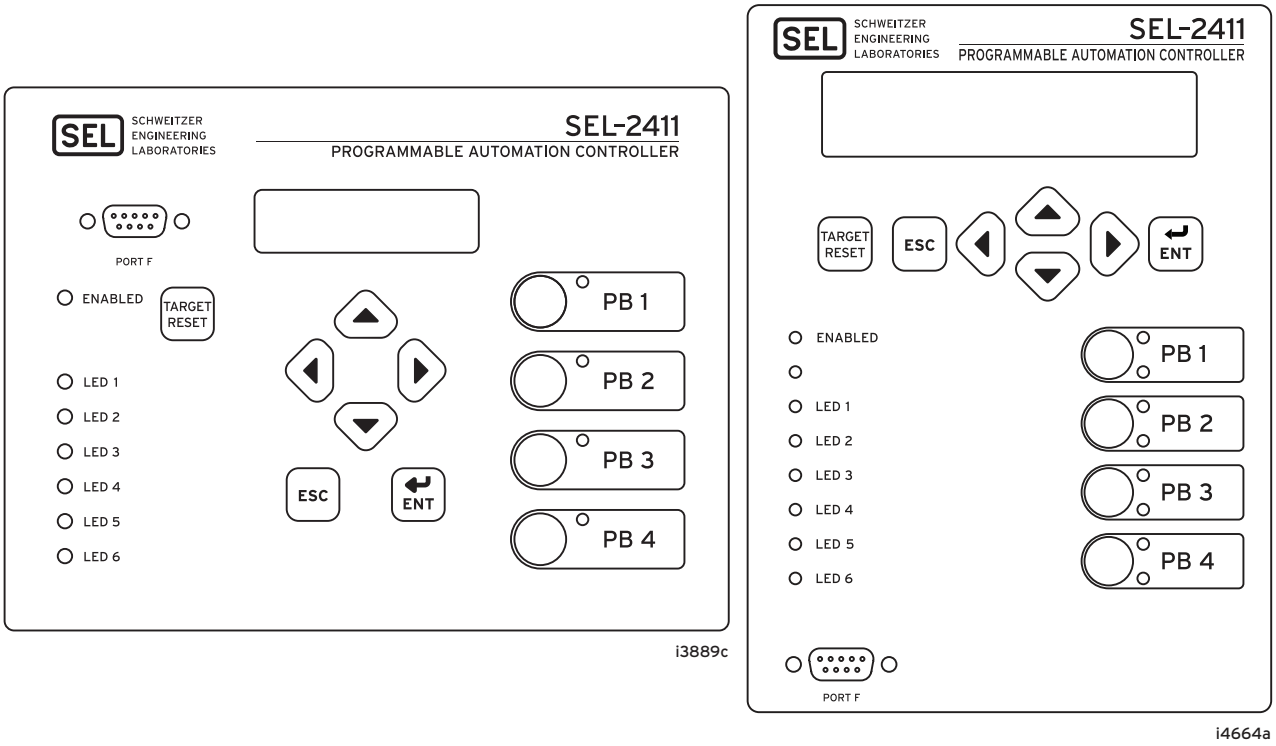
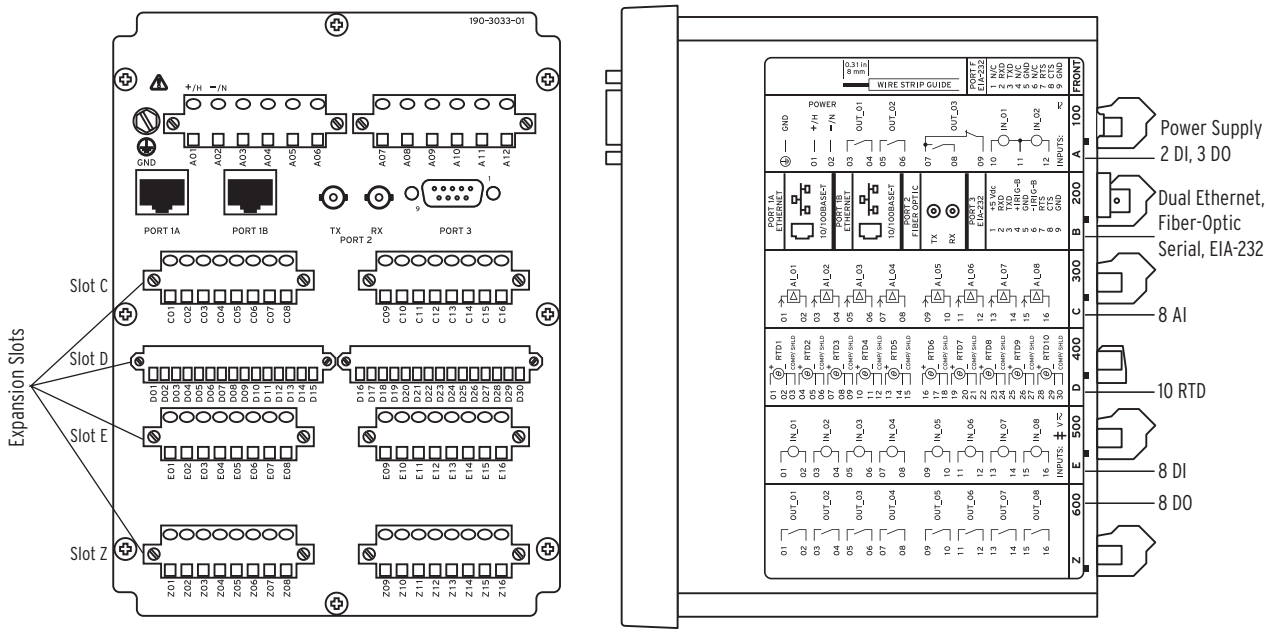


Figure 22 Front Panel With Default Configurable Labels



(A) Rear-Panel Layout

(B) Side-Panel Input and Output Designations

Figure 23 Rear-Panel Connections and Labels

Dimensions

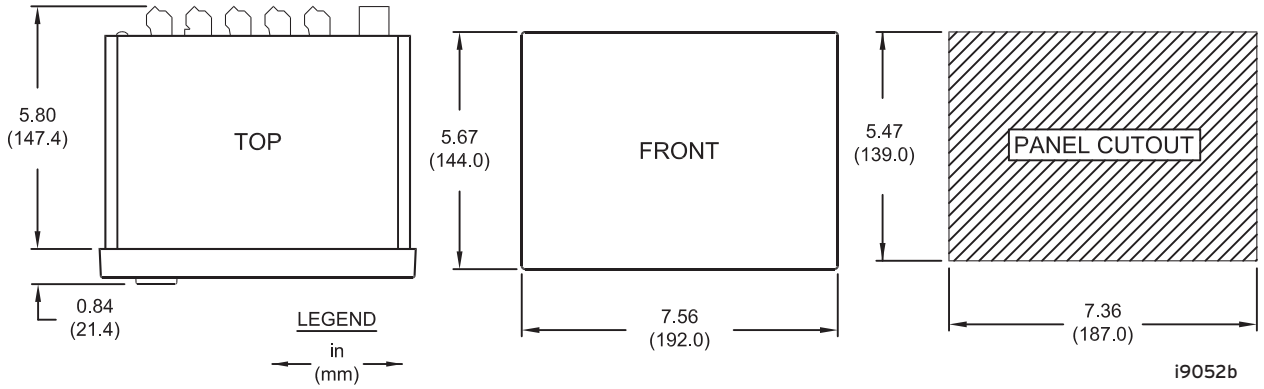


Figure 24 Programmable Automation Controller Horizontal Panel-Mount

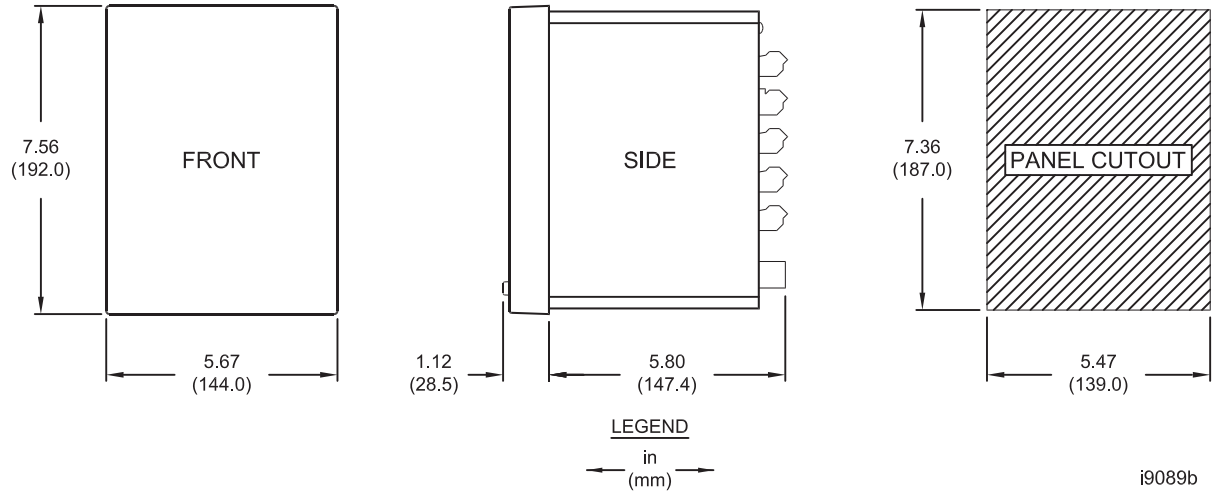


Figure 25 Programmable Automation Controller Vertical Panel-Mount

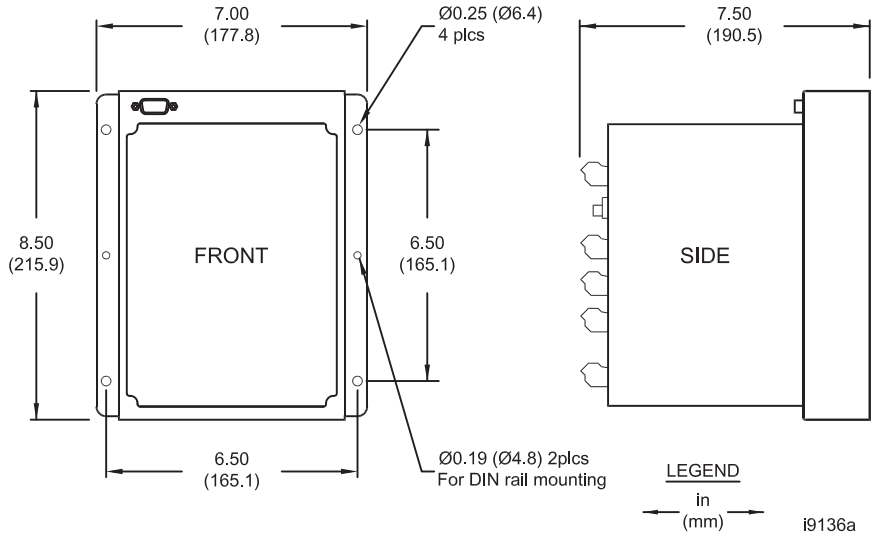


Figure 26 SEL-2411-1 (Surface Mountable)

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.

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

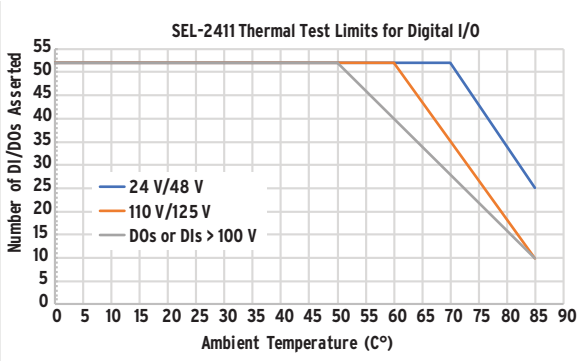
IEC Performance Rating: –40° to 85°C (–40° to 185°F)
IEC 60068-2-1 and 60068-2-2

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 < 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 2.1*, *Figure 2.2*, and *Figure 2.3*.

Weight

2.0 kg (4.4 lb) (Typical configuration)

Power Supply

Rated Supply Voltage

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

Input Voltage Range

Low-Voltage Model:	19.2–60 Vdc
High-Voltage Model:	85–300 Vdc 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 50 ms @ 48 Vdc
High-Voltage Model:	50 ms @ 125 Vac/Vdc 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}	5 A	1 A (4 ACI Only)
Rated Range:	0.1–96.0 A (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}	5 A	1 A (4 ACI Only)
Rated Range:	0.05–10.0 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):	<0.050 VA	< 0.002 VA
Measurement Category:	II	

AC Voltage Input

V_{NOM}	300 V	8 V
Rated Operating Voltage (U_e):	100–250 Vac	2.67-6.67 Vac
Rated Insulation Voltage:	300 Vac	8 Vac
10-Second Thermal:	600 Vac	16 Vac
Rated Frequency:	50/60 ± 5 Hz	50/60 ± 5 Hz
Burden:	<0.1 W	<0.1 W

DC Transducer (Analog) Inputs

Input Impedance	
Current Mode:	200 Ω
Voltage Mode:	>10 kΩ
Input Range (Maximum):	±20 mA (transducers: 4–20 mA, 0–20 mA, or 0–1 mA typical) ±10 V (transducers: 0–5 V or 0–10 V typical)
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) 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):	±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

Auxiliary DC Transducer (Analog) Inputs

(Available only with 8 V 3 ACI/3 AVI card with VSCALE = CUSTOM)

Input Range (Maximum):	±7.5 V
Sampling Rate:	16 samples/cycle
Step Response:	<2 ms
Accuracy at 25°C	
With User Calibration:	<0.1% of full scale
Without Calibration:	<4% of full scale

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 below 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 24 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: Supports the following RTD types on each independent input.	100 Ω platinum (PT100) 100 Ω nickel (NI100) 120 Ω nickel (NI120) 10 Ω copper (CU10)
Measuring Range:	–200° to 850°C (PT100) –80° to 250°C (Ni100, Ni120) –200° to 250°C (Cu10)
ADC Resolution:	24 bit
Accuracy:	
CU10, PT100, NI100, NI120:	±0.1°C typical at 25°C ±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: Supports the following RTD or TC types on each independent input.	100 Ω platinum (PT100) 100 Ω nickel (NI100) 120 Ω nickel (NI120) 10 Ω copper (CU10) 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
PT100, NI100, NI120, CU10:	±2°C worst case
TCs:	
J, K, T, E:	±1°C with field calibration ±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:	$V_{il} \leq 0.8$ V
Input Impedance:	2 kΩ
Accuracy:	±3 ms

Time-Code Input (Demodulated IRIG-B)

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

Time-Code Input (SNTP)

High-Priority Server Accuracy:	±5 ms
Low-Priority 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 Thermal Derating):	0–2 A per output if no more than 30 digital outputs and inputs are energized simultaneously. 2–5 A continuous carry is allowed if the output counts as 3 outputs towards the quantity limit.
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
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 (10,000 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:	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 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)

Matches DC Output Ratings

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 (10,000 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 >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 Rear Panel
Data Speed:	300–38400 bps

Optional Ethernet Port

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

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

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:	2[a]
DNP3 Level 2 Outstation:	5[a]
Ethernet FTP:	2
Telnet:	3
IEC 61850 MMS:	6
IEC 61850 Goose:	16 Incoming 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, 60 Hz, nominal current
Neutral Current:	±0.5% typical, 25°C, 60 Hz, nominal current
Negative Sequence (3I2):	±0.5% typical, 25°C, 60 Hz, nominal current (calculated)
Residual Ground Current:	±0.5% typical, 25°C, 60 Hz, nominal current (calculated)

Voltage

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

Frequency

±0.05 Hz (V1 > 60 V) with voltage tracking from 44.00–66.00 Hz
±0.10 Hz (I1 > 0.8 • I_{NOM}) with current tracking from 44.00–66.00 Hz

Power

Three-Phase Real Power (kW):	±1% typical, 25°C, 60 Hz, nominal voltage and current with 0.70 ≤ PF ≤ 1.00; ±5% of reading, worst case
Three-Phase Reactive Power (kVAR):	±1% typical, 25°C, 60 Hz, nominal voltage and current with 0.00 ≤ PF ≤ 0.30; ±5% of reading, worst case
Three-Phase Apparent Power (kVA):	±1% typical, 25°C, 60 Hz, nominal voltage and current; ±2% of reading, worst case

Power Factor

Three-Phase (Wye Connected):	±1% typical, 25°C, 60 Hz, nominal voltage and current for 0.97 ≤ PF ≤ 1.00; ±2% of reading, worst case

Fast Analog Alarm Pickup

1 A CT:	±5% ± 0.01 A
5 A CT:	±5% ± 0.05 A
Voltage:	±5% of setting ± 0.5 V

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 ± 1/4 cycle

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 4 samples per cycle filtered
Trigger:	Programmable with Boolean expression
Format:	ASCII and Compressed ASCII 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 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. IP10 for terminals and the relay rear panel
Vibration Resistance:	IEC 60255-21-1:1988, Class 1 IEC 60255-27:2013, Section 10.6.2.1 Endurance: Class 2 Response: Class 2
Shock Resistance:	IEC 60255-21-2:1988, Class 1 IEC 60255-27:2013, Section 10.6.2.2 IEC 60255-27:2013, Section 10.6.2.3 Withstand: Class1 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
Dry Heat:	IEC 60068-2-2:2007 IEC 60255-27:2013, Section 10.6.1.1 IEC 60255-27:2013, Section 10.6.1.3 85°C, 16 hours
Damp Heat, Steady State:	IEC 60068-2-78:2013 IEC 60255-27:2013, Section 10.6.1.5 40°C, 93% relative humidity, 10 days
Damp Heat, Cyclic:	IEC 60068-2-30:2005 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 (HiPot):	IEC 60255-27:2013, Section 10.6.4.3 IEEE C37.90-2005 1.0 kVac on analog outputs, Ethernet ports, Port 3, IRIG 2.0 kVac on analog inputs 2.5 kVac on contact I/O 3.6 kVdc on power supply, current, and voltage inputs
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, 1 kV on Port 3, RTD, and IRIG ports 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

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

EMC Immunity

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 C37.90.2-2004 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 oscillatory 4 kV fast transient Comm. ports, IRIG, and PTC ports Zone B, 2 kV line-to-earth LEA ports compliant with IEC 61869-13 tested to 1 kV, 1 MHz common mode
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 IEC 61000-4-9: 2001 Severity Level: 1000 A/m IEC 61000-4-10:2001 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 Canada ICES-001 (A) / NMB-001 (A) 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 Canada ICES-001 (A) / NMB-001 (A) 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

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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