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), and IEC 61850

Critical Reporting and Logging

- 1 ms Accurate Sequential Events Recorder
- Trending
- Event Recording
- IRIG-B Satellite Time Synchronization

AC Metering Capabilities

- Voltage, Current, Power
- Demand, Energy

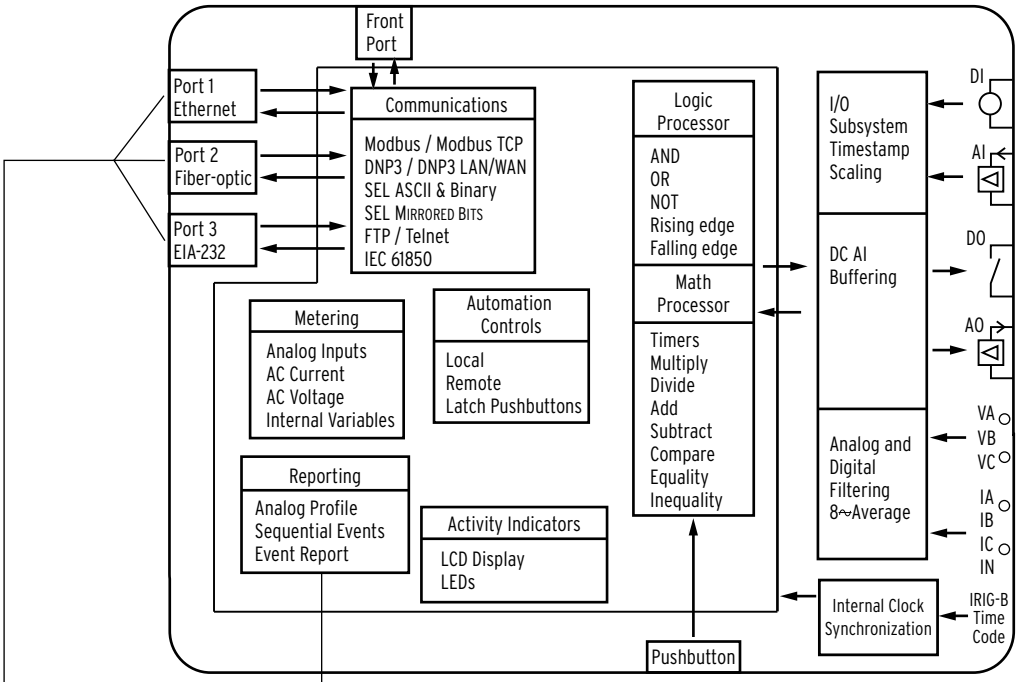
Simple Commissioning Tools

- 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

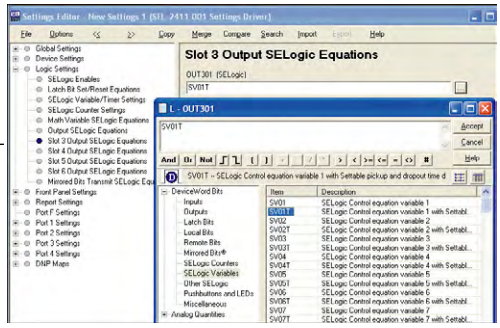
Product Summary

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.

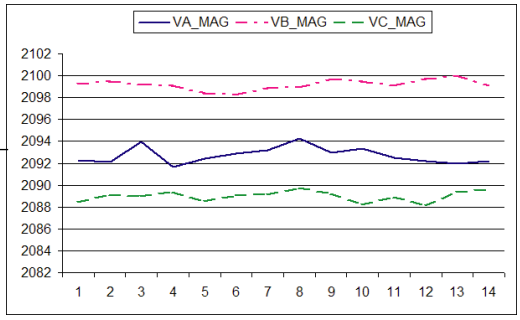
Functional Block Diagram



QuickSet



Analog Profile

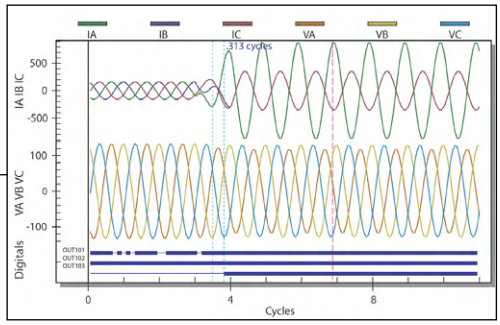


SER

```
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):

Digital I/O[a]	8 DI (PN 9760), 8 DO (PN9761), 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 (PN9762), 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.

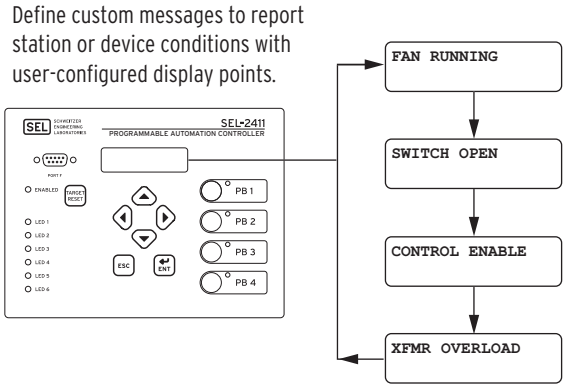
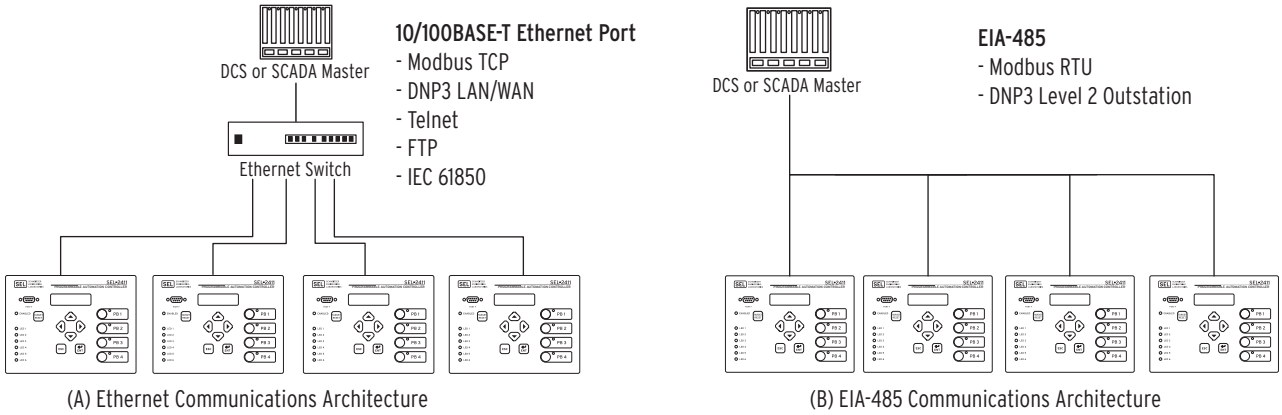


Figure 1 Define Custom Messages to Report Station or Device Conditions

Communications Architectures



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

Figure 2 Typical Ethernet and EIA-485 Communications Architectures

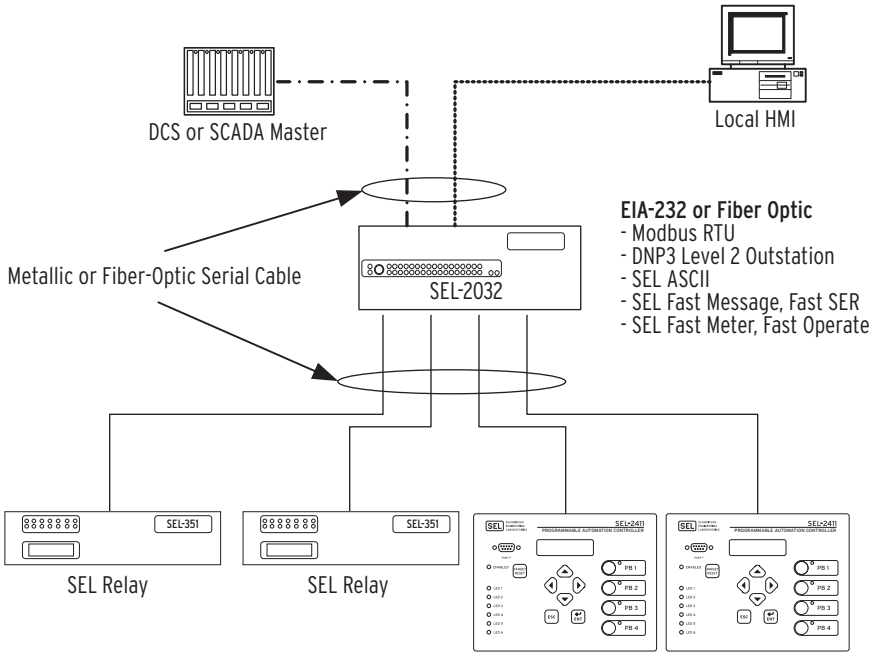


Figure 3 Typical EIA-232 and Fiber-Optic Communications Architecture

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

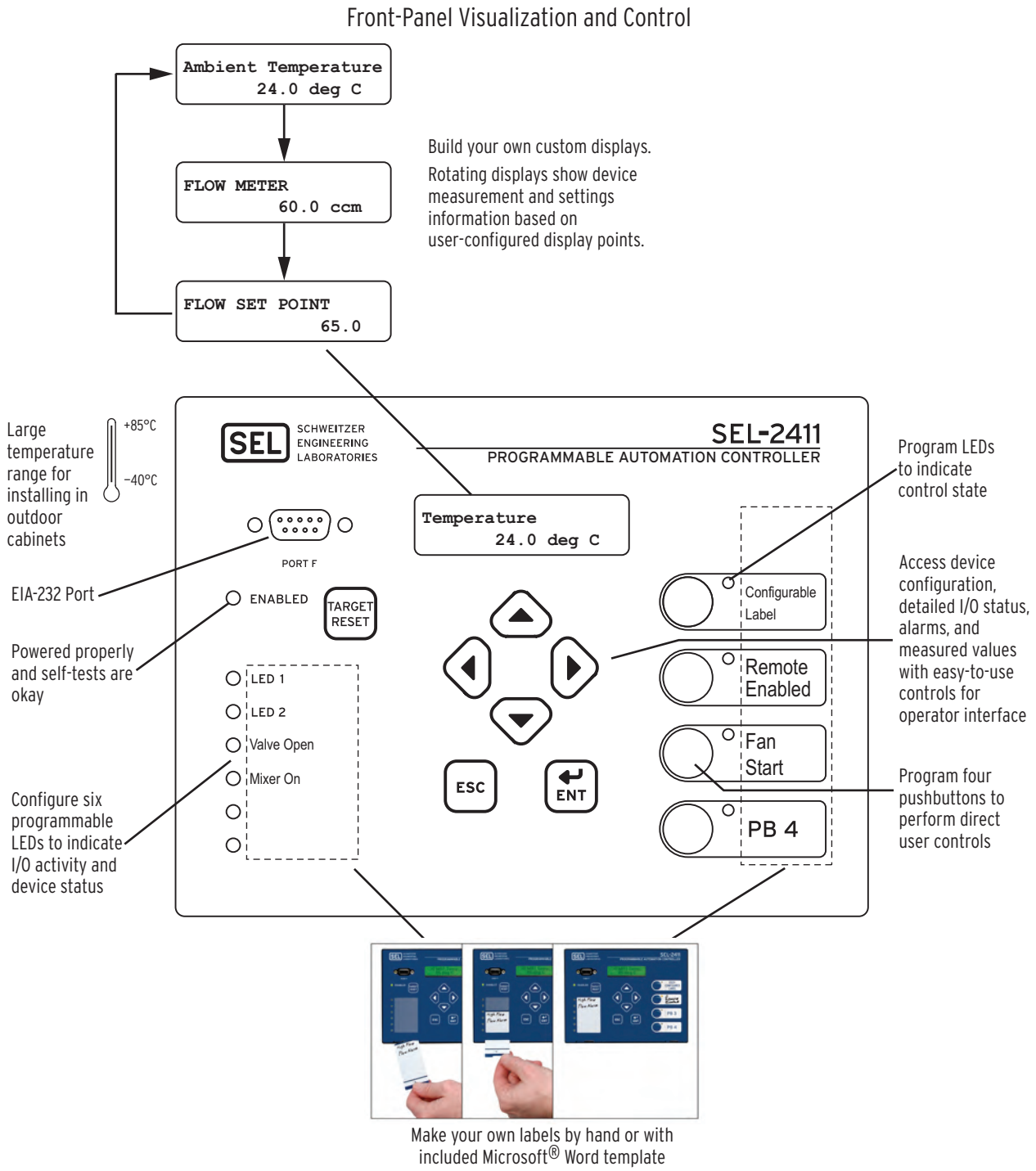


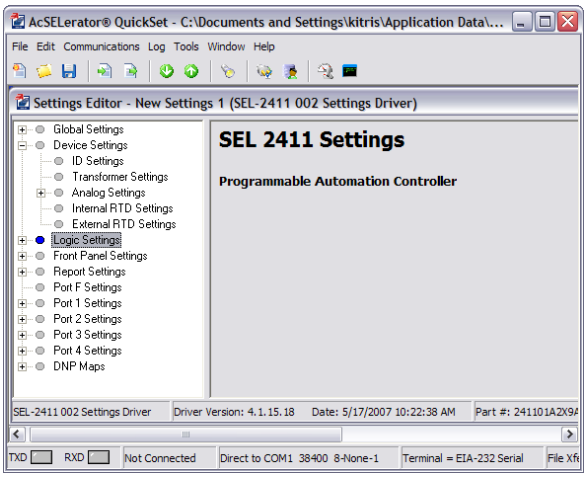
Figure 4 Simplify Your Commissioning

Configuration Software

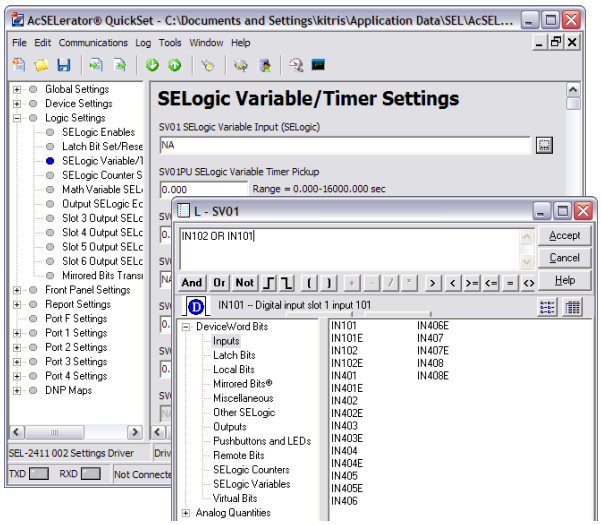
The included QuickSet program simplifies device configuration in addition to providing commissioning and analysis support for the SEL-2411.

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

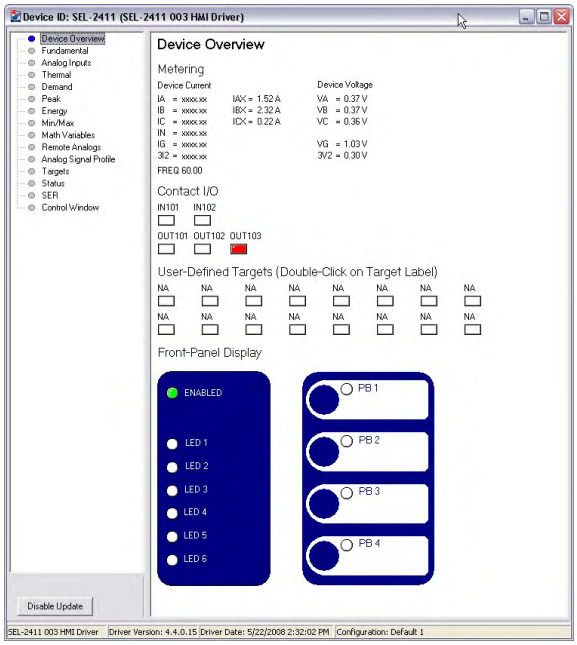
Settings—Develop Settings Offline With an Intelligent Settings Editor That Only Allows Valid Settings



Settings—Create SELOGIC Control Equations With a Drag and Drop Editor and/or Text Editor



HMI—Device Overview



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 5 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.

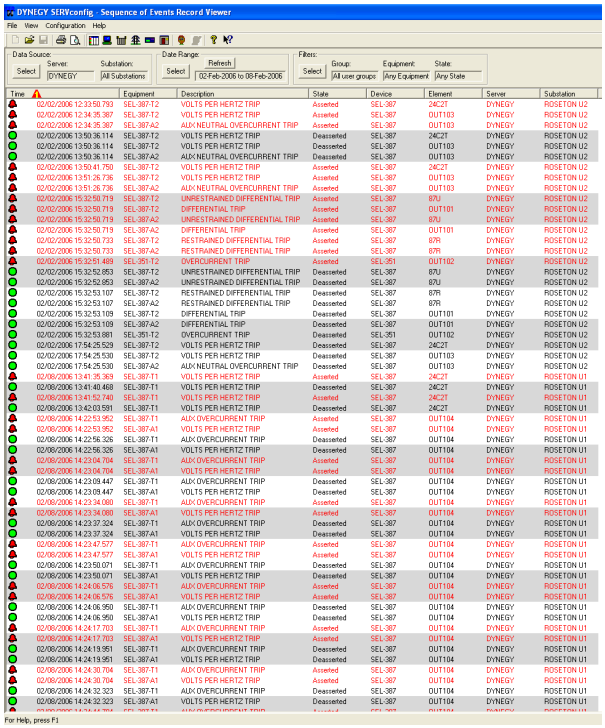


Figure 6 Combine SER Data From Multiple SEL-2411 Programmable Automation Controllers for a System-Wide Log and Display

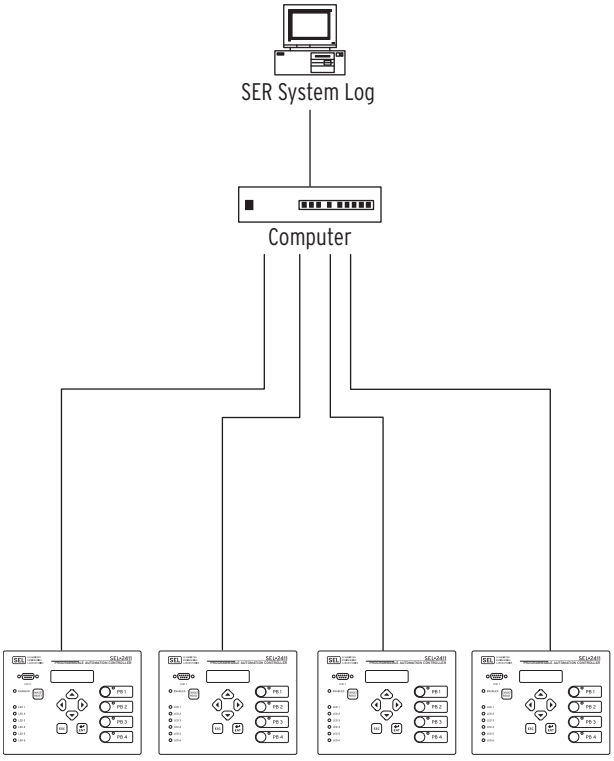


Figure 7 Example SER Collection Architecture

Analyze 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 ACSELERATOR Analytic Assistant® SEL-5601 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 seconds and 1.07 seconds. For a 50 Hz system, the report lengths are 0.30 seconds and 1.28 seconds.

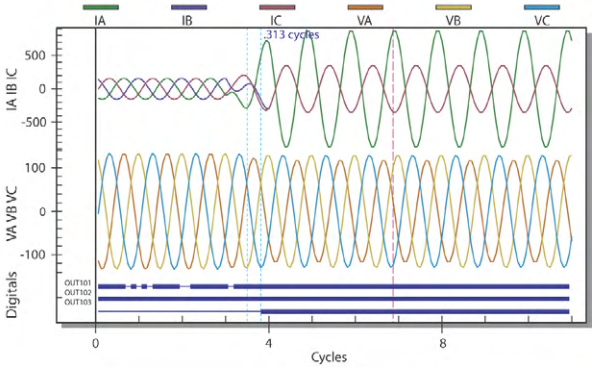


Figure 8 Example SEL-5601 Waveform Plot

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,
-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 9 Comma-Separated File Format for Easy Display, Analysis, and Archiving

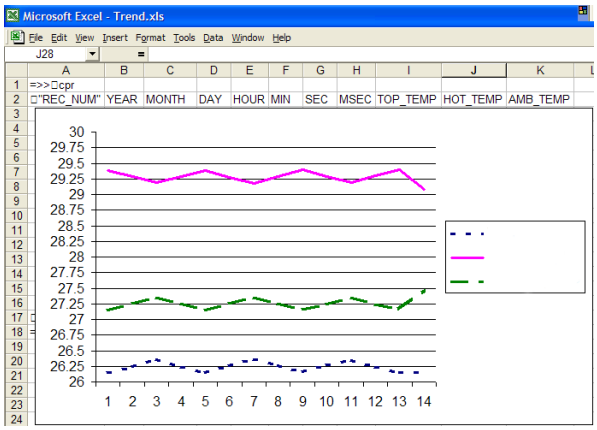


Figure 10 Excel Graph of Trend Data

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–MV32
Remote Analog	RA001–RA128
Optional	
Thermal (with the external SEL-2600 RTD Module or internal RTD or TC option)	

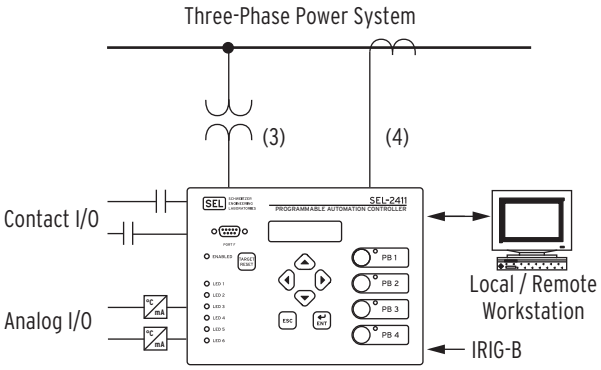
Applications

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

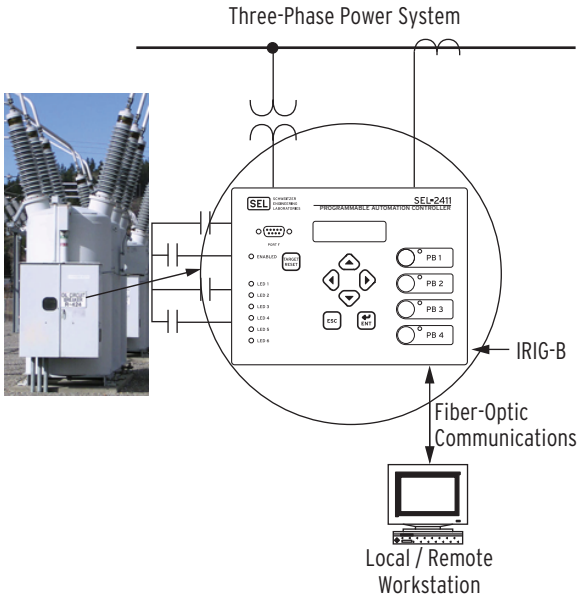
Smart I/O Node

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



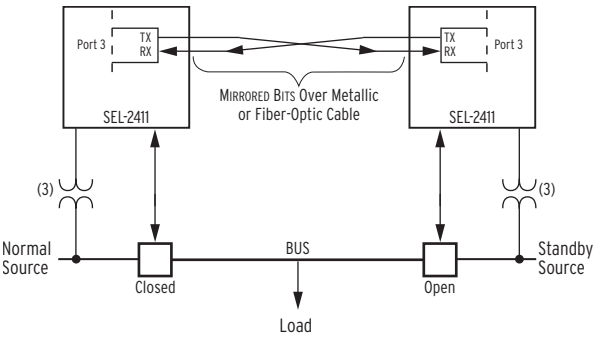
Outdoor Breaker Control

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



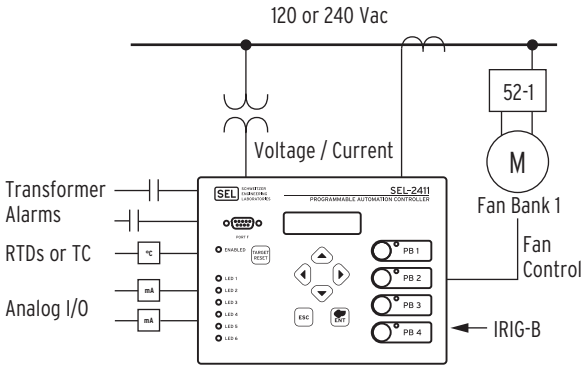
Automatic Transfer Scheme

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



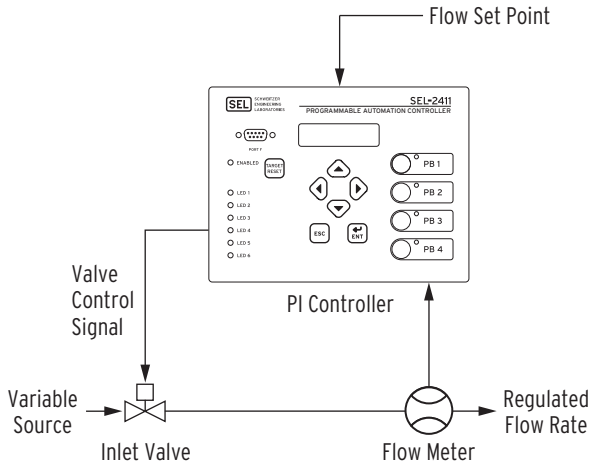
Transformer Monitor and Cooling System Control

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



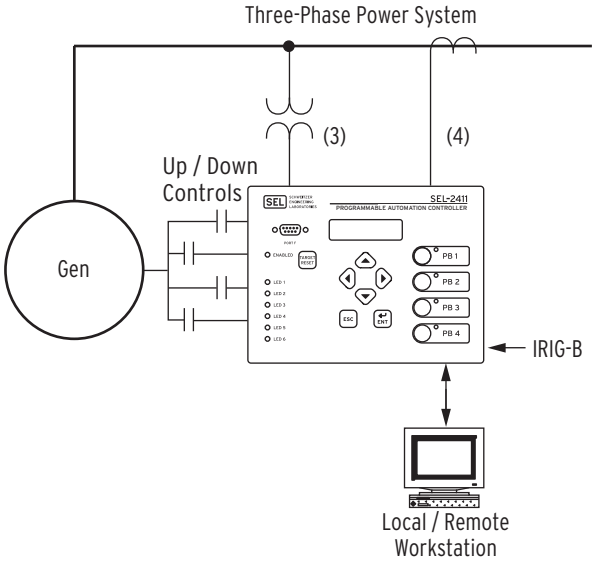
Flow Controller

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



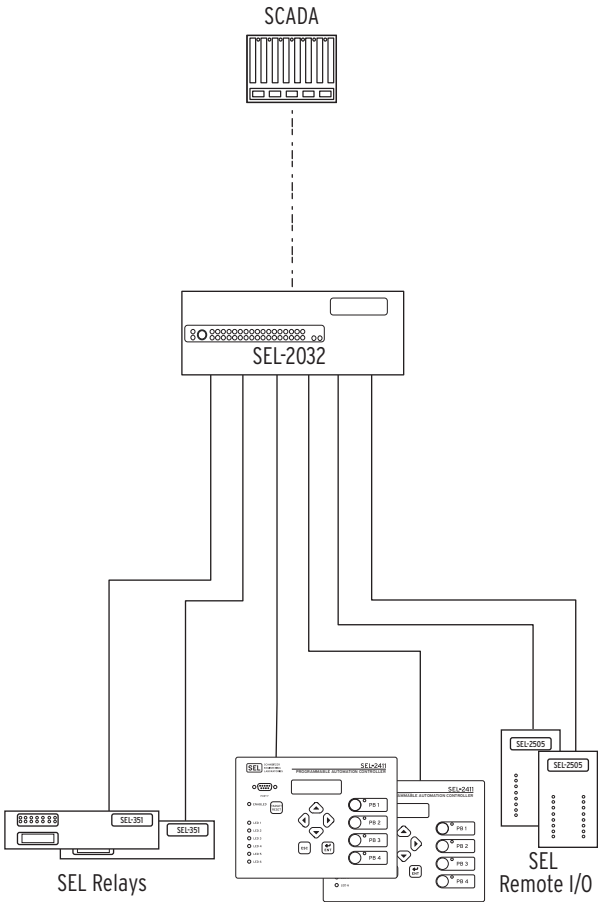
Generator Controller

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



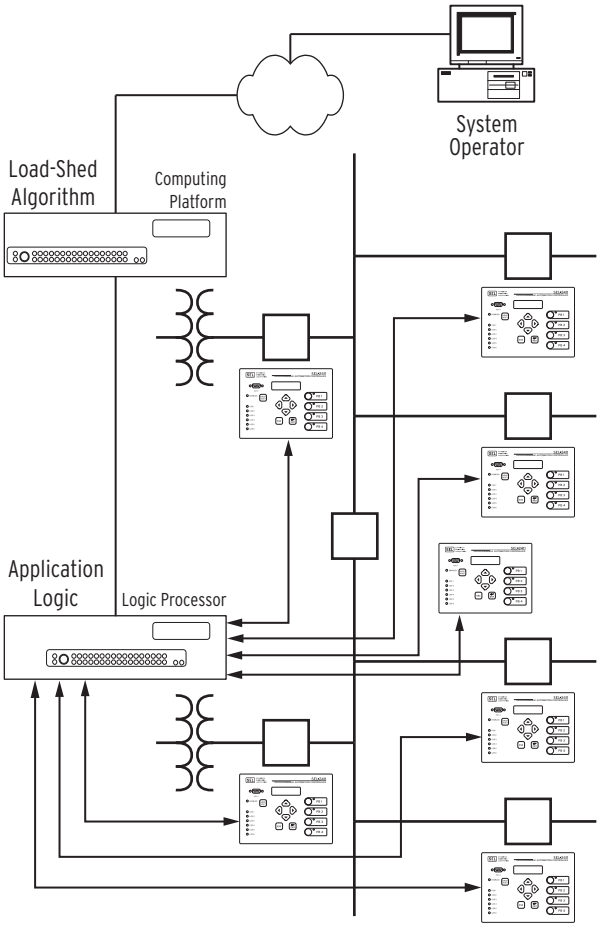
Electrical Substation SCADA

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

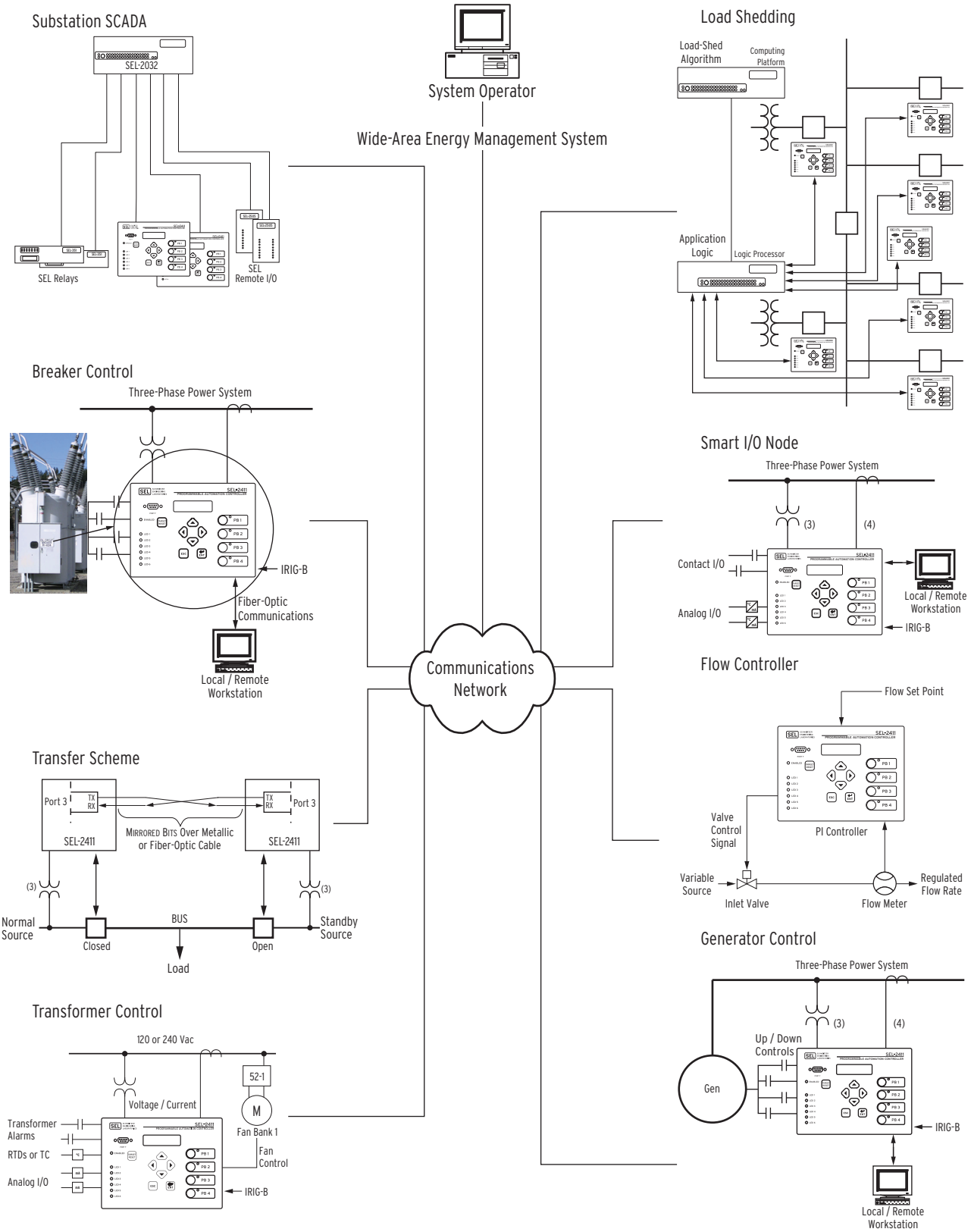


Automatic Load Shed

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

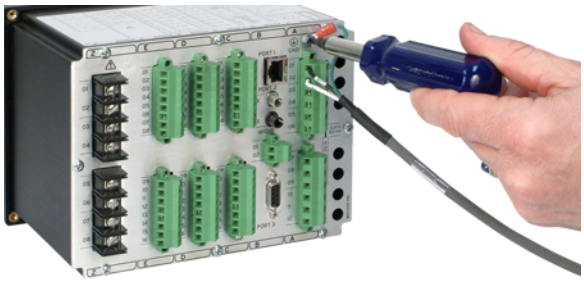


Card Installation

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

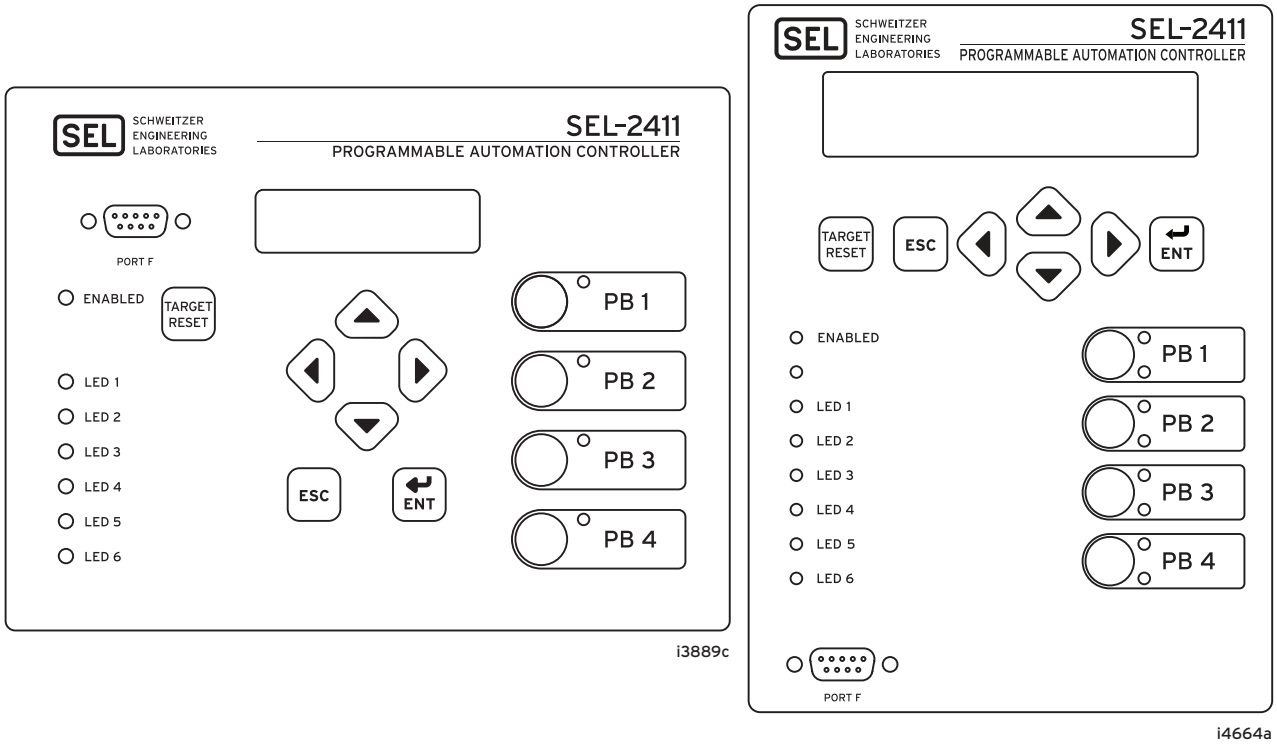
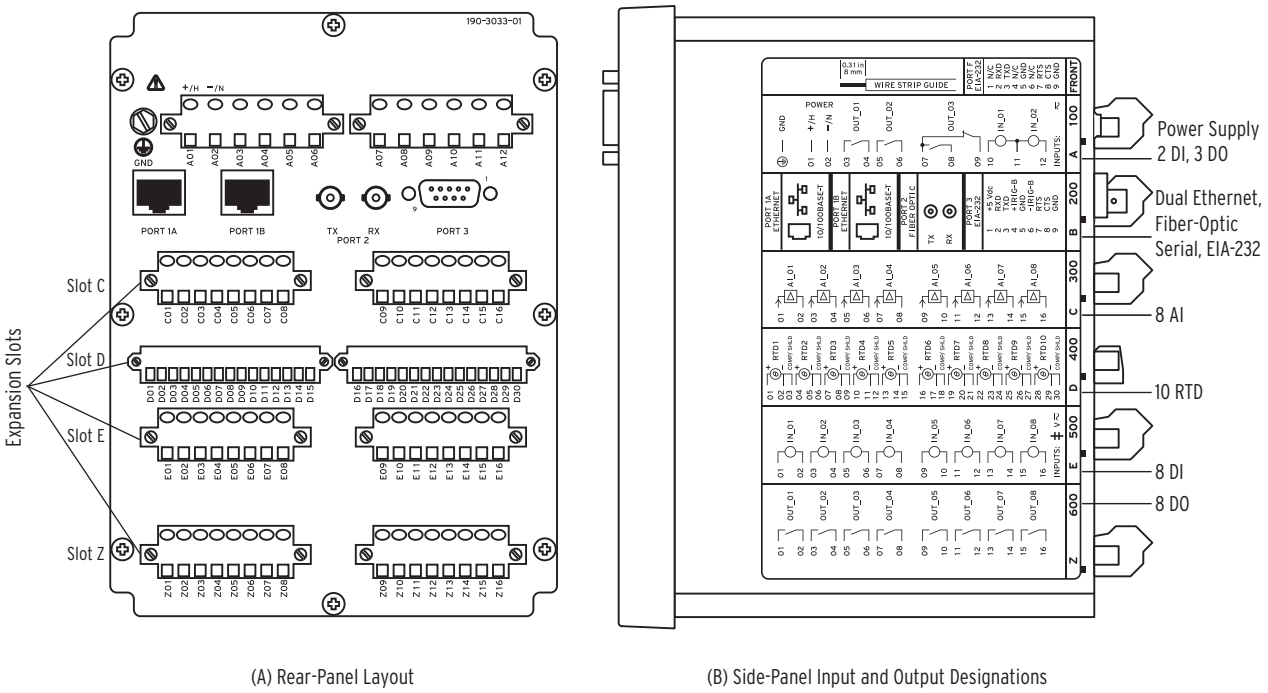


Figure 11 Front Panel With Default Configurable Labels



(A) Rear-Panel Layout (B) Side-Panel Input and Output Designations

Figure 12 Rear-Panel Connections and Labels

Dimensions

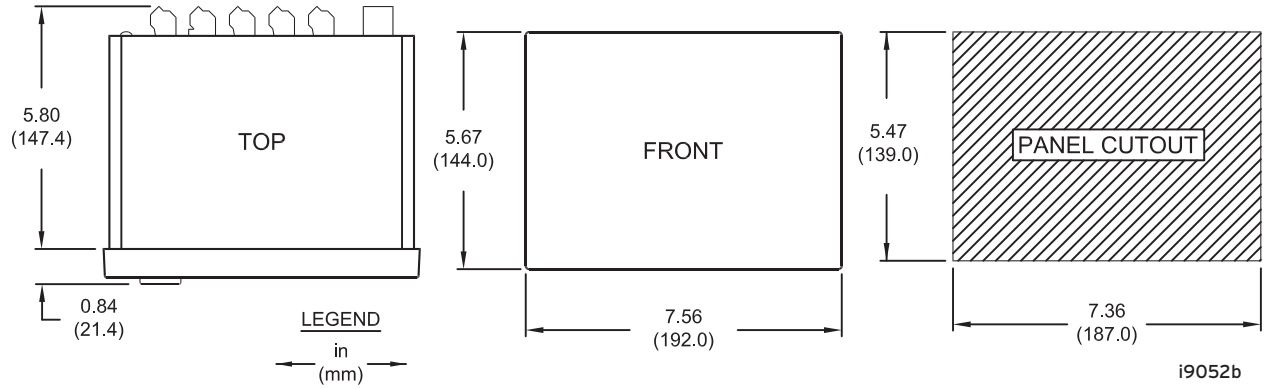


Figure 13 Programmable Automation Controller Horizontal Panel-Mount

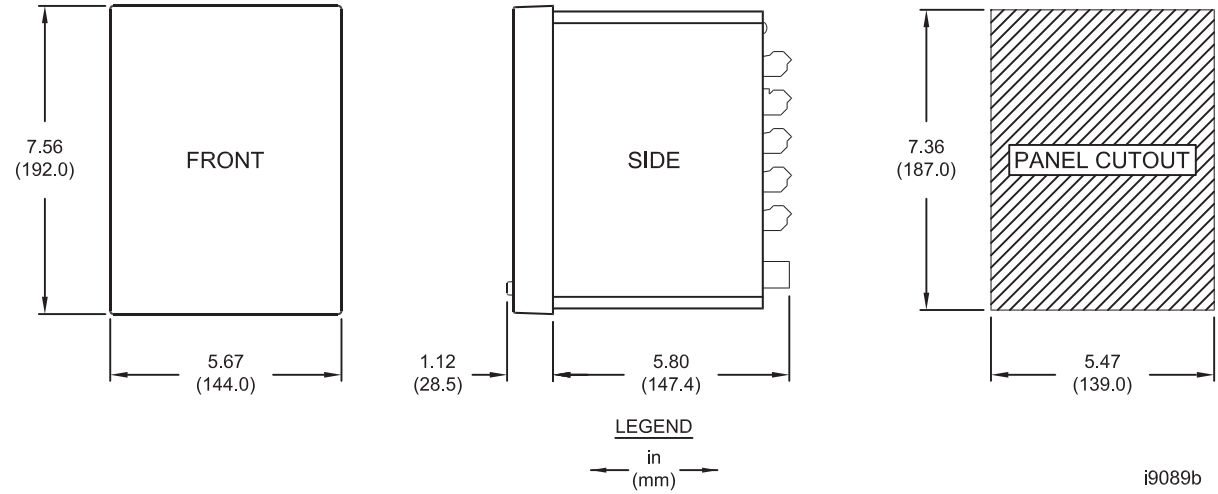


Figure 14 Programmable Automation Controller Vertical Panel-Mount

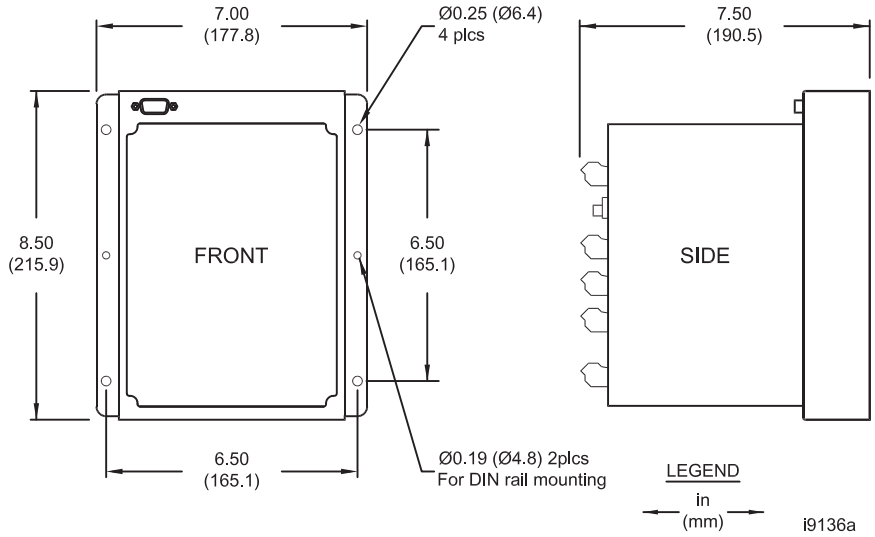


Figure 15 SEL-2411-1 (Surface Mountable)

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.

UL Listed to U.S. and Canadian safety standards (File E220228; NWGQ2, NWGQ8)

CSA certified for Hazardous Locations to Canadian and U.S. standards (File 205948; 2258-02, 2258-82)

CE Mark

General

Operating Temperature Range

–40° to +85°C (–40° to +185°F), per IEC 60068-2-1 and 60068-2-2.

UL CSA Conformal Coated:	–40° to +75°C (–40° to +167°F)
Hazardous Locations Operating Temperature Range:	–20° to +40°C (–4° to +104°F)

Operating Environment

Pollution Degree:	2
Overvoltage Category:	II
Insulation Class:	1
Relative Humidity:	5–95%, noncondensing
Maximum Altitude:	2000 m

Processing and Memory

32-bit 200 MHz Processor

32 MB DDR RAM

Battery-Backed Real-Time Clock

Dimensions

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

Weight

2.0 kg (4.4 lb)

Frequency

System Frequency:	50, 60 Hz

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 3ACI/3AVI 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 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: (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:	–50°C to 250°C
ADC Resolution:	24 bit
Accuracy:	
CU10:	±1°C typical at 25°C
PT100, NI100, NI120:	±1°C typical at 25°C
CU10, PT100, NI100, NI120:	±2°C worst case
Resolution:	±1°C
Update Rate:	1 s
CMRR (typical):	100 dBv
Noise Rejection:	As high as 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:	–50°C to 250°C
TCs	
J:	–210°C to 250°C
K, T, E:	–270°C to 250°C
ADC Resolution:	24 bit
Accuracy	
RTDs	
CU10:	±1°C typical at 25°C
PT100, NI100, NI120, CU10:	±0.1°C typical at 25°C
CU10, PT100, NI100, NI120:	±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:	As high as 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 (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
Accuracy:	±25 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 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 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 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 >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)

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:	50–200 µm
Approximate Range:	~6.4 Km
Data Rate:	100 Mb
Typical Fiber Attenuation:	–2 dB/Km

Port 2 Serial

Wavelength:	850 nm
Optical Connector Type:	ST
Fiber Type:	Multimode
Link Budget:	8 dB
Typical TX Power:	–16 dBm
RX Min. Sensitivity:	–24 dBm
Fiber Size:	50–200 µm
Approximate Range:	~4 Km with 62.5 µm, ~1 Km with 200 µm
Data Rate:	5 Mb
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
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.

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:	18–60 Vdc
High-Voltage Model:	85–275 Vdc 85–264 Vac

Power Consumption

AC:	<40 VA
DC:	<15 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)

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:	±0.08% typical, 25°C, 60 Hz, nominal voltage
Line-Line Voltage:	±0.08% 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

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: 4 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)

Type Tests

Environmental Tests

Enclosure Protection: IEC 60529:2001
IP65 enclosed in panel
IP20 for terminals

Vibration Resistance: IEC 60255-21-1:1988, Class 1
IEC 60255-21-3:1993, Class 2

Shock Resistance: IEC 60255-21-2:1988, Class 1

Cold: IEC 60068-2-1:1990 + A1:1993 + A2:1994
–40°C, 16 hours

Damp Heat, Steady State: IEC 60068-2-78:2001
40°C, 93% relative humidity, 4 days

Damp Heat, Cyclic: IEC 60068-2-30:1980 + A1:1985
25–55°C, 6 cycles,
95% relative humidity

Dry Heat: IEC 60068-2-2:1974 + A1:1993 + A2:1994
85°C, 16 hours

Dielectric Strength and Impulse Tests

Dielectric (HIPOT): IEC 60255-5:2000
IEEE C37.90-1989
2.0 kVac on analog inputs, contact I/O
2.5 kVac on ac current inputs
2.83 kVdc on power supply and analog outputs

Impulse: IEC 60255-5:2000
0.5 J, 4.7 kV on power supply, contact I/O, voltage and current inputs
0.5 J, 530 V on analog inputs and analog outputs

RFI and Interference Tests

EMC Immunity

Electrostatic Discharge Immunity: IEC 61000-4-2:2001
Severity Level 4
8 kV contact discharge
15 kV air discharge

Radiated RF Immunity: IEC 61000-4-3:2002, 10 V/m
IEEE C37.90.2-1995, 35 V/m

Fast Transient, Burst Immunity: IEC 61000-4-4:1995 + A1:2001
4 kV @ 2.5 kHz
2 kV @ 5.0 kHz for comm. ports

Surge Immunity: IEC 61000-4-5:2001
2 kV line-to-line
4 kV line-to-earth

Surge Withstand Capability Immunity: IEC 60255-22-1:2005
2.5 kV common-mode
2.5 kV differential-mode
1 kV common-mode on comm. ports
IEEE C37.90.1-2002
2.5 kV oscillatory, 4 kV fast transient

Conducted RF Immunity: IEC 61000-4-6:2004, 10 Vrms

Magnetic Field Immunity: IEC 61000-4-8:2001
1000 A/m for 3 seconds
100 A/m for 1 minute

EMC Emissions

Conducted Emissions: EN 55011:1998 + A1:1999 + A2:2002, Class A

Radiated Emissions: EN 55011:1998 + A1:1999 + A2:2002, Class A

Notes

SCHWEITZER ENGINEERING LABORATORIES, INC.
2350 NE Hopkins Court • Pullman, WA 99163-5603 U.S.A.
Tel: +1.509.332.1890 • Fax: +1.509.332.7990
selinc.com • info@selinc.com

PDS2411-01

SEL-2411 Data Sheet

Date Code 20180601