Programmable Automation Controller

Complete System for Control and Monitoring

High Reliability, Low Price
- Ten-Year, Worldwide Warranty
- -40° to +85°C Operating Temperature
- Ruggedized to Meet Industrial and Utility Standards
- Class 1, 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, 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

Schweitzer Engineering Laboratories, Inc.  SEL-2411 Data Sheet
Product Summary

The SEL-2411 Programmable Automation Controller (SEL-PAC) automates continuous and discrete processes. A stand-alone 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.
Automation and Control Features

Standard Features

➤ Chassis
➤ Front panel
➤ LCD display
  ➢ 4 programmable pushbuttons with LEDs
  ➢ 6 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
➤ ACSELERATOR QuickSet Software
➤ 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):

<table>
<thead>
<tr>
<th>Digital I/Oa</th>
<th>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)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog I/O</td>
<td>8 AI (PN9762), 4 AI/4 AO (PN 9763)</td>
</tr>
<tr>
<td>Temperatures</td>
<td>10 RTDs (PN 9772)</td>
</tr>
<tr>
<td>CTs and PTs</td>
<td>3 AVI (PN 9769), 4 ACI (PN 9770), 3 ACI/3 AVI (PN 9771),</td>
</tr>
<tr>
<td>Port 1</td>
<td>Single or Dual 10/100BASE-T or 100BASE-FX Ethernet Ports</td>
</tr>
<tr>
<td>Port 2</td>
<td>Fiber-Optic Serial Port (62.5μm core fiber, ST connectors, SEL-2812 compatible)</td>
</tr>
<tr>
<td>Port 4</td>
<td>EIA-232 or EIA-485 (PN 9751)</td>
</tr>
<tr>
<td>Protocols</td>
<td>Serial: DNP3; Ethernet: Modbus TCP, DNP3 LAN/WAN, FTP, Telnet, IEC 61850</td>
</tr>
<tr>
<td>Environment</td>
<td>Conformal coating for chemically harsh and high-moisture environments</td>
</tr>
</tbody>
</table>

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

Flexible Control Logic and Integration Features

The SEL-2411 is equipped with up to 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 up to 32 traditional latching relays for such functions as “remote control enable” with latch bits. Program latch set and latch reset conditions with SELogic control equations. Set or reset the nonvolatile latch bits using optoisolated inputs, remote bits, local bits, or any programmable logic condition. The latch bits retain their state when the device loses power.

Eliminates External Timers

Eliminate external timers for custom protection or control schemes with 32 general purpose SELogic control equation timers. Each timer has independent time-delay pickup and dropout settings. Program each timer input with any desired element (e.g., time qualify a current element). Assign the timer output to 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 using serial port commands. Program the remote bits into your control scheme with SELogic control equations. Use remote bits for SCADA-type control operations such as trip, close, and settings group selection.

Define custom messages to report station or device conditions with user-configured display points.

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

Front-Panel Visualization and Control

Build your own custom displays. Rotating displays show device measurement and settings information based on user-configured display points.

Figure 4 Simplify Your Commissioning
Configuration Software

The included ACSELERATOR QuickSet software 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.

Settings—Develop Settings Off-Line With an Intelligent Settings Editor That Only Allows Valid Settings.

- 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—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; up to 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.

<table>
<thead>
<tr>
<th>SER Number</th>
<th>Element or Condition</th>
<th>Element</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RB01</td>
<td>Deasserted</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>OUT102</td>
<td>Deasserted</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>RB01</td>
<td>Asserted</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>OUT102</td>
<td>Asserted</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Device Powered Up</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>OUT101</td>
<td>Asserted</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>OUT101</td>
<td>Deasserted</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Device Settings Changed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>FAN BANK #2 OFF</td>
<td>Asserted</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Device Settings Changed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>OUT101</td>
<td>Deasserted</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>FAN BANK #1 ON</td>
<td>Deasserted</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>OUT101</td>
<td>Asserted</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>FAN BANK #1 ON</td>
<td>Deasserted</td>
<td></td>
</tr>
</tbody>
</table>

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.
Analyze Event Waveforms

Record analog and digital waveforms at 32 samples/cycle for up to 64 power system cycles, approximately 1 s. Use the event report to move the oscillographic data to your PC. You can plot your event report data with the SEL-5601 Analytic Assistant 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.

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 up to 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.
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

<table>
<thead>
<tr>
<th>Standard</th>
<th>Optional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fundamental</td>
<td>IA, IB, IC, VA, VB, VC</td>
</tr>
<tr>
<td>Energy</td>
<td>Real, Reactive, Apparent (In and Out)</td>
</tr>
<tr>
<td>Maximum and Minimum</td>
<td>Frequency, Voltages (VA, VB, VC), Currents (IA, IB, IC, 3I2), Apparent, Reactive, and Real Power</td>
</tr>
<tr>
<td>Demand and Peak Demand</td>
<td>IA, IB, IC, IG, 3I2</td>
</tr>
<tr>
<td>Analog Input</td>
<td>AIx01–AIx08</td>
</tr>
<tr>
<td>Math Variable</td>
<td>MV01–MV32</td>
</tr>
<tr>
<td>Remote Analog</td>
<td>RA001–RA128</td>
</tr>
<tr>
<td>Optional Thermal</td>
<td>(with the external SEL-2600 RTD Module or internal RTD or TC option)</td>
</tr>
</tbody>
</table>
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

Substation SCADA

Breaker Control

Transfer Scheme

Transformer Control

Load Shedding

Smart I/O Node

Flow Controller

Generator Control

Communications Network

System Operator

Wide-Area Energy Management System
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.

1. Detach connectors.
2. Remove rear cover.
3. Install cards.
4. Install new I/O labels on top of chassis.
5. Replace rear cover.
6. Energize and accept new I/O configuration.
Guideform Specification

The microprocessor-based device shall provide monitoring, control, and automation. Self-checking functions shall be included. Specific requirements are as follows:

➤ **Front-Panel Visualization.** The programmable automation controller shall be capable of displaying measured values, calculated values, I/O statuses, device status, and configuration parameters on a front-panel LCD display. The display shall have a rotating capability to display custom messages and data. Thirty-two display messages shall be provided. The front panel shall also have a minimum of six user-programmable LEDs and four user-programmable pushbutton controls.

➤ **SELOGIC Programming Language.** The programmable automation controller shall be capable of implementing a wide variety of logic and control functions using the tools available in the SELOGIC Programming Language. Logic shall have the ability to use math functions, comparison functions, and Boolean logic functions. Boolean logic loop execution time shall be ≤5 ms.

➤ **Automation.** The programmable automation controller shall include 32 local control logic points, 32 remote control logic points, 32 latching logic points, 32 counters, 32 math variables, 64 logic variables, and 64 timers.

➤ **Small Form Factor.** The programmable automation controller shall have a compact case with quick-disconnect connectors for analog and digital I/O to simplify installation.

➤ **Flexible I/O.** The programmable automation controller shall be configurable based upon end-user application requirements.

➤ **Analog Inputs.** As an option the programmable automation controller shall have the ability to support 32 current or voltage (jumper selectable) analog inputs. The allowed signal input range is ±20 mA, ±10 volts, or ±300 volts.

➤ **Analog Outputs.** As an option the programmable automation controller shall have the ability to support 8 current or voltage (jumper selectable) analog outputs. The allowed signal output range is ±20 mA or ±10 volts.

➤ **IRIG-B Synchronized, Timestamped Events.** The programmable automation controller shall store up to 512 event records with IRIG-B synchronized timestamps. An internal real-time clock shall be used for time stamping if an IRIG-B signal is not available.

➤ **Sequential Event Recorder.** A chronological report shall be provided by the programmable automation controller to help determine the order and cause of events and assist in troubleshooting. The last 512 input, output, and element events shall be recorded with 1 ms accuracy.

➤ **Metering.** The programmable automation controller shall include metering capabilities for real-time current, voltage, power, and energy qualities, as well as phase demand and peak demand current values for all ac current and voltage inputs.

➤ **RTD.** As an option, the SEL-2411 shall have the ability to support up to 10 RTD inputs with an internal SELECT I/O card or 12 RTD inputs in an external module (SEL-2600 series) for temperature measurements.

➤ **Event Record.** The programmable automation controller shall store up to 15 cycles of raw data with 16-sample/cycle resolution. Up to 17 most recent events are timestamped and stored in nonvolatile memory.

➤ **Voltage Inputs.** Optional voltage inputs shall accept 0–300 Vac.

➤ **Current Inputs.** Optional current inputs shall accept 0–5 A or, optionally, 0–1 A nominal current inputs.

➤ **Digital Relay-to-Relay Communications.** The programmable automation controller shall have eight transmit and eight receive logic elements in each of two communications ports for dedicated relay-to-relay communications. These elements shall be available for use in control logic.

➤ **DNP3.** The programmable automation controller shall be capable of operating as a DNP3 Slave Level 2 either serial or LAN/WAN. The device shall allow configuration of any incoming data or data calculated within the device to be available through any of three custom DNP data maps. All control points within the programmable automation controller shall be available as DNP3 control points using latch on/latch off, pulse on/pulse off, or trip/close control functions. SER data shall be available as timestamped DNP event data.

➤ **Modbus.** The programmable automation controller shall be capable of operating as a Modbus slave either through a serial connection or Modbus TCP via Ethernet. The Modbus slave implementation shall allow direct access to any register within the device. The Modbus implementation shall allow control of any control point within the programmable automation controller.

➤ **IEC 61850 Ethernet Communications.** The device shall provide IEC 61850 compliant communications. The IEC 61850 capability shall include GOOSE messaging and defined logical node data points.

➤ **PC Software.** The programmable automation controller shall include compatibility with a PC software program for retrieving event data and for use in programming control settings and logic functions. The PC software is available, but not required, to use the programmable automation controller.

➤ **Operating Temperature.** The programmable automation controller shall have an operating temperature range of –40°C to +85°C (–40°F to +185°F) and a power supply input operating voltage range of 85–264 Vac/85–275 Vdc.

➤ **Specification Compliance.** The programmable automation controller front panel shall meet NEMA 12/IP54. The programmable automation controller shall be type tested to sections of C37.90, IEC 60255, IEC 60068, and IEC 61000 standards.

➤ **Warranty.** The programmable automation controller shall have a minimum 10-year warranty.

Schweitzer Engineering Laboratories, Inc.  SEL-2411 Data Sheet
Front- and Rear-Panel Diagrams

Figure 11 Front Panel With Default Configurable Labels

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

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)
See Table 2 for continuous maximum operation.

Operating Environment
Pollution Degree: 2
Overvoltage Category: II
Relative Humidity: 5–95%, noncondensing
Maximum Altitude: 2000 m

Dimensions
See Figure 13, Figure 14, and Figure 15.

Weight
2.0 kg (4.4 lbs)

Frequency
System Frequency: 50, 60 Hz

Inputs

AC Current Input
Inom: 5 A 1 A (4 ACl Only)
Rated Range: 0.1–96.0 A 0.02–19.20 A
(according to IEC 60255-5, 60664-1)
Note: This is a linearity specification and is not meant to imply continuous operation.
Continuous Thermal Rating: 15 A 3 A
(according to IEC 60255-6, IEEE C37.90-1989)
1 Second Thermal: 500 A 100 A
(according to IEC 60255-6)
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
Rated Operating Voltage (Ue): 100–250 Vac
Rated Insulation Voltage: 300 Vac
10-Second Thermal: 600 Vac
Rated Frequency: 50/60 ±5 Hz
Burden: < 0.1 W

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

Optoisolated Control Inputs
When Used With DC Control Signals:
250 V ON for 200–275 Vdc OFF below 150 Vdc
220 V ON for 176–242 Vdc OFF below 132 Vdc
125 V ON for 100–135.5 Vdc OFF below 75 Vdc
110 V ON for 88–132 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 170.6–300 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 for < 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 (Uimp): 4000 V

RTD Input Card
Number of Channels: Ten 3-wire RTDs
Input Type: 100 Ω platinum (PT100)
Supports the following RTD types on each independent input:
100 Ω nickel (NI100)
120 Ω nickel (NI120)
10 Ω copper (CU10)
Measuring Range: –50°C to 250°C
ADC Resolution: 24 bit
Accuracy:
TU10: ±1°C typical at 25°C
PT100, NI100, NI120: ±0.1°C typical at 25°C
CU10, PT100, NI100, NI120: ±2°C worst case
Resolution: ±0.1°C
Update Rate: 1 s
CMRR (typical): 100 dB
Noise Rejection: Up to 1 Vrms 50/60 Hz

Universal Temperature Input Card
Number of Channels: Ten (thermocouples or 3-wire RTDs)
Input Type: 100 Ω platinum (PT100)
Supports the following RTD or TC types on each independent input:
100 Ω nickel (NI100)
120 Ω nickel (NI120)
10 Ω copper (CU10)
J, K, T, E
Measuring Range: –50°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 dB
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: Vih ≥ 2.2 V
Off (0) State: Vil ≤ 0.8 V
Input Impedance: 2 kΩ
Accuracy: ±3 milliseconds
Outputs
General
OUT103 is Form C Trip Output, all other outputs are Form A.
Dielectric Test Voltage: 2000 Vac
Impulse Withstand Voltage (Uimp): 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 60255-5:1974:
24 V 0.75 A L/R = 40 ms
48 V 0.50 A L/R = 40 ms
125 V 0.30 A L/R = 40 ms
250 V 0.20 A L/R = 40 ms
Cyclic Capacity (2.5 cycles/second) per IEC 60255-5:1974:
24 V 0.75 A L/R = 40 ms
48 V 0.50 A L/R = 40 ms
125 V 0.30 A L/R = 40 ms
250 V 0.20 A L/R = 40 ms
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 (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
Note: Make rating per IEEE C37.90-1989.
AC Output Ratings
Electromechanical
Maximum Operational Voltage (Ue) Rating: 240 Vac
Insulation Voltage (Ui) 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 (Ie):
3 A @ 120 Vac
1.5 A @ 240 Vac
Conventional Enclosed Thermal Current (Ith) 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 (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
Note: Make rating per IEEE C37.90-1989.
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: 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

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 (RJ-45 connector)
  - Single or Dual 100BASE-FX (LC connector)
- Optional multimode fiber-optic serial port
  - Class 1 LED product

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 um
  - Approximate Range: ~6.4 Km
  - Data Rate: 100 Mb
  - 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 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 Slave (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
- DNP3 Level 2 Slave: 3
- Ethernet FTP: 2
- Telnet: 2

* 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: 110–250 Vdc
  - 110–240 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

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)
### 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

### Sampling and Processing Specifications

#### Without Voltage Card or Current Card

**Analog Inputs**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling Rate</td>
<td>Every 4 ms</td>
</tr>
</tbody>
</table>

**Digital Inputs**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling Rate</td>
<td>2 kHz</td>
</tr>
</tbody>
</table>

**Contact Outputs**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refresh Rate</td>
<td>2 kHz</td>
</tr>
<tr>
<td>Logic Update</td>
<td>Every 4 ms</td>
</tr>
</tbody>
</table>

**Analog Outputs**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refresh Rate</td>
<td>Every 4 ms</td>
</tr>
<tr>
<td>New Value</td>
<td>Every 100 ms</td>
</tr>
</tbody>
</table>

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

**Analog Inputs**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling Rate</td>
<td>4 times/cycle</td>
</tr>
</tbody>
</table>

**Digital Inputs**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling Rate</td>
<td>32 times/cycle</td>
</tr>
</tbody>
</table>

**Contact Outputs**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refresh Rate</td>
<td>32 times/cycle</td>
</tr>
<tr>
<td>Logic Update</td>
<td>4 times/cycle</td>
</tr>
</tbody>
</table>

**Analog Outputs**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refresh Rate</td>
<td>4 times/cycle</td>
</tr>
<tr>
<td>New Value</td>
<td>Every 100 ms</td>
</tr>
</tbody>
</table>

### 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, 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:**


-40°C, 16 hours

**Damp Heat, Steady State:**

IEC 60068-2-78:2001

40°C, 93% relative humidity, 4 days

**Damp Heat, Cyclic:**


25–55°C, 6 cycles, 95% relative humidity

**Dry Heat:**


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:**


- 4 kV @ 2.5 kHz

- 2 kV @ 5.0 kHz for comm. ports

IEEE C37.90.1-2002,

- 2.5 kV Oscillatory

- 4 kV fast transient

**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

**Capacitive:**

2.5 kV common-mode

2.5 kV differential-mode

1 kV common-mode on comm. ports

**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:**


**Radiated Emissions:**

Certifications

ISO: Equipment is designed and manufactured using ISO 9001 certified quality program.

UL: UL 61010-1 (with the exception of Universal Temperature Card)

CSA: CSA C22.2 No. 61010-1

CE:
- CE Mark-
- Low Voltage Directive:
  - BS EN 61010-1:2001,
  - BS EN 60947-4-1:2001 + A1:2003,
  - BS EN 60947-5-1:2004,
  - BS EN 60255-6:1995

Hazardous Locations Approvals: Complies with UL1604, CSA 22.2 No. 213, and EN 60079-15.

Table 2  UL/CSA Digital Output Contact Temperature Derating for Operating at Elevated Temperatures With All Output Contacts Asserted

<table>
<thead>
<tr>
<th>Operating Ambient</th>
<th>Maximum Value of Current ($I_{th}$)</th>
<th>Duty Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than or equal to 60°C</td>
<td>5.0 A</td>
<td>Continuous</td>
</tr>
<tr>
<td>between 60° and 70°C</td>
<td>2.5 A</td>
<td>Continuous</td>
</tr>
</tbody>
</table>