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 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

SELECT I/O Family of Cards

Analog I/O Including ac and dc

Digital I/O

Schweitzer Engineering Laboratories, Inc.  SEL-2411 Data Sheet
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.
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):

<table>
<thead>
<tr>
<th>Digital I/O</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 (62.5 µm 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>

* 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/clear.

**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

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.

Settings—Develop Settings Offline 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; 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.

<table>
<thead>
<tr>
<th>SEL-2411 Monitoring and Metering</th>
<th>Date: 04/03/2005 Time: 07:21:19</th>
</tr>
</thead>
<tbody>
<tr>
<td>#</td>
<td>DATE</td>
</tr>
<tr>
<td>----</td>
<td>------------</td>
</tr>
<tr>
<td>17</td>
<td>04/03/2005</td>
</tr>
<tr>
<td>16</td>
<td>04/03/2005</td>
</tr>
<tr>
<td>15</td>
<td>04/03/2005</td>
</tr>
<tr>
<td>14</td>
<td>04/03/2005</td>
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<tr>
<td>13</td>
<td>04/03/2005</td>
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<td>12</td>
<td>04/03/2005</td>
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<tr>
<td>11</td>
<td>04/03/2005</td>
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<td>10</td>
<td>04/03/2005</td>
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<td>04/03/2005</td>
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</tr>
<tr>
<td>3</td>
<td>04/03/2005</td>
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<tr>
<td>2</td>
<td>04/03/2005</td>
</tr>
<tr>
<td>1</td>
<td>04/03/2005</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.

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.

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.
**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>IA, IB, IC, VA, VB, VC</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>
</tbody>
</table>

**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

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).
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.**
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

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

AC Current Input Neutral

<table>
<thead>
<tr>
<th>I_{NOM}</th>
<th>5 A</th>
<th>1 A (4 ACI Only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Range</td>
<td>0.05–10.0 A</td>
<td>0.01–2.00 A</td>
</tr>
<tr>
<td>(according to IEC 60255-5, 60664-1)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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)
1 Second Thermal:
500 A (according to IEC 60255-6)

Rated Frequency:
50/60 ±5 Hz

Burden (Per Phase): <0.050 VA <0.002 VA
Measurement Category: II

AC Voltage Input

<table>
<thead>
<tr>
<th>V_{NOM}</th>
<th>300 V</th>
<th>8 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Operating Voltage (U_e):</td>
<td>100–250 Vac</td>
<td>2.67–6.67 Vac</td>
</tr>
<tr>
<td>Rated Insulation Voltage:</td>
<td>300 Vac</td>
<td>8 Vac</td>
</tr>
<tr>
<td>10-Second Thermal:</td>
<td>600 Vac</td>
<td>16 Vac</td>
</tr>
<tr>
<td>Rated Frequency:</td>
<td>50/60 ±5 Hz</td>
<td>50/60 ±5 Hz</td>
</tr>
<tr>
<td>Burden:</td>
<td>&lt;0.1 W</td>
<td>&lt;0.1 W</td>
</tr>
</tbody>
</table>

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)
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)

Accuracy Variation With Temperature:
±0.015% per °C of full scale (±10 V)

CMRR Typical: 65 dB at 60 Hz

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 (–4° 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

<table>
<thead>
<tr>
<th>I_{NOM}</th>
<th>5 A</th>
<th>1 A (4 ACI Only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Range</td>
<td>0.1–96.0 A</td>
<td>0.02–19.20 A</td>
</tr>
<tr>
<td>(according to IEC 60255-5, 60664-1)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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)
1 Second Thermal:
500 A (according to IEC 60255-6)

Rated Frequency:
50/60 ±5 Hz

Burden (Per Phase): <0.050 VA <0.002 VA
Measurement Category: II

AC Voltage Input

<table>
<thead>
<tr>
<th>V_{NOM}</th>
<th>300 V</th>
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<tr>
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</table>

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)
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)

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/3A VI 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 150.3–264 Vdc OFF below 93.2 Vdc
   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
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
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:
   (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: ±0.1°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

Time-Code Input (Demodulated IRIG-B)
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

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 (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 60255-0-20:1974:
   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 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: 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 V A)
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 (Ithm) 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
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- 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: 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
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: ~6.4 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 Event Messenger Points

Maximum Concurrent Connections

- Modbus Slave: 2⁴
- DNP3 Level 2 Outstation: 5⁴
- Ethernet FTP: 2
- Telnet: 3
- IEC 61850 MMS: 6 Incoming
- IEC 61850 Goose: 8 Outgoing

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 • INOM) 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

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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
  - −40°C, 16 hours
- **Damp Heat, Steady State:** IEC 60068-2-78:2001
  - 40°C, 95% relative humidity, 4 days
  - 25–55°C, 6 cycles, 95% relative humidity
  - 85°C, 16 hours

**Dielectric Strength and Impulse Tests**

- **Dielectric (HIPOT):** IEC 60255-5:2000
  - IEEE C37.90-1989
  - 2.0 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**


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