SEL-2411 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

Analog I/O Including ac and dc

Digital I/O

SELECT I/O Family of Cards
Product Summary

The SEL-2411 Programmable Automation Controller (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
    ➤ 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>Touchscreen Display</th>
<th>Five-inch color touchscreen display with eight pushbuttons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital I/O</td>
<td>8 DI (PN 9760), 14 DI (PN 1476), 8 DO (PN 9761), 4 DI/4 DO (PN 9764), 4 DI/3 DO with 2 Form C and 1 Form B (PN 9773)</td>
</tr>
<tr>
<td>Analog I/O</td>
<td>8 AI (PN 9762), 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/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

![Define Custom Messages to Report Station or Device Conditions](image-url)
Communications Architectures

Figure 2  Typical Ethernet and EIA-485 Communications Architectures

(A) Ethernet Communications Architecture

(B) EIA-485 Communications Architecture

Figure 3  Typical EIA-232 and Fiber-Optic Communications Architecture
Simplify Your Setup and Commissioning

The SEL-2411 front panel simplifies commissioning and troubleshooting:

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

Figure 4 Simplify Your Commissioning
Configuration Software

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

➤ Access settings creation help online.
➤ Organize settings with the device database manager.
➤ Load and retrieve settings by using a simple PC communications link.
➤ Analyze event records with the integrated waveform and harmonic analysis tool.

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
ACSELERATOR Bay Screen Builder SEL-5036 Software

The SEL-2411 with the touchscreen display option provides you with the ability to design bay configuration screens to meet your system needs. You can display the bay configuration as a single-line diagram (SLD) on the touchscreen. You can use ANSI and IEC symbols, along with analog and digital labels, for the SLD to indicate the status of the breaker and disconnects, bus voltages, and power flow through the breaker. In addition to SLDs, you can design the screens to show the status of various device elements via Device Word bits or to show analog quantities for commissioning or day-to-day operations. You can design these screens with the help of Bay Screen Builder in conjunction with QuickSet (see Figure 5). Bay Screen Builder provides an intuitive and powerful interface to design bay screens to meet your application needs.

Figure 5 Bay Screen Builder
Monitoring and Metering

Analyze Sequence of Events

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

Figure 6 Example SER Report

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

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

Figure 8 Example SER Collection Architecture
Analyze Event Waveforms

Record analog and digital waveforms at 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>Optional</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fundamental</strong></td>
<td>Thermal with the external SEL-2600 RTD Module or internal RTD or TC option)</td>
</tr>
<tr>
<td>IA, IB, IC, VA, VB, VC</td>
<td></td>
</tr>
<tr>
<td><strong>Energy</strong></td>
<td></td>
</tr>
<tr>
<td>IA, IB, IC, IG, 3I2</td>
<td></td>
</tr>
<tr>
<td><strong>Maximum and Minimum</strong></td>
<td></td>
</tr>
<tr>
<td>Frequency, Voltages (VA, VB, VC), Currents (IA, IB, IC, 3I2), Apparent, Reactive, and Real Power</td>
<td></td>
</tr>
<tr>
<td><strong>Demand and Peak Demand</strong></td>
<td></td>
</tr>
<tr>
<td>IA, IB, IC, 1G, 3I2</td>
<td></td>
</tr>
<tr>
<td><strong>Analog Input</strong></td>
<td></td>
</tr>
<tr>
<td>AIx01–AIx08</td>
<td></td>
</tr>
<tr>
<td><strong>Math Variable</strong></td>
<td></td>
</tr>
<tr>
<td>MV01–MV64</td>
<td></td>
</tr>
<tr>
<td><strong>Remote Analog</strong></td>
<td></td>
</tr>
<tr>
<td>RA001–RA128</td>
<td></td>
</tr>
</tbody>
</table>

**Touchscreen Display**

You can order the SEL-2411 with an optional touchscreen display (5-inch, color, 800 x 480 pixels). The touchscreen display makes relay data metering, monitoring, and control quick and efficient. The touchscreen display option in the SEL-2411 features a straightforward application-driven control structure and includes intuitive and graphical screen designs.

The touchscreen display allows you to:

- View and control bay screens
- Access metering and monitoring data
- Inspect targets
- View event history, summary data, and SER information
- View relay status and configuration
- Control relay operations
- View and edit settings
- Enable the rotating display
- Program control pushbuttons to jump to a specific screen

You can navigate the touchscreen by tapping the folders and applications. The folders and applications of the **Home** screen are shown in Figure 12. Folders and applications are labeled according to functionality. Additional folder and application screens for the SEL-2411 touchscreen display option can be seen in Figure 13 through Figure 21.
Bay Screens Application

The SEL-2411 with the touchscreen display option provides you with the ability to design bay configuration screens to meet your system needs. The bay configuration can be displayed as an SLD on the touchscreen. You can create as many as five bay screens with one controllable breaker, eight controllable two-position disconnects, and two controllable three-position disconnects. ANSI and IEC symbols, along with analog and digital labels, are available for you to create detailed SLDs of the bay to indicate the status of the breaker and disconnects, bus voltages, and power flow through the breaker. Figure 13 shows the default SLD for the touchscreen display option.

Figure 13 Default Bay Screen

Meter Folder Applications

The applications in the Meter folder are part-number dependent. Only those metering applications specific to your part number appear in the Meter folder. Tapping an application in the Meter folder shows you the report for that particular application. Tap the Phasor application to view the current and voltage phasors (see Figure 14).

Figure 14 Meter Phasors

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

Figure 15 Meter Energy

Reports Folder Applications

Tapping the Reports folder navigates you to the screen where you can access the Events, HIF Events (if available), and SER applications. Use these applications to view events and the SER records. To view the event summary (see Figure 16) of a particular event record, tap the event record on the Event History screen (for Events and HIF Events). You can also trigger an event report from the Event History screen.

Figure 16 Event Summary

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

Figure 17 SER History Report
Tapping the **Trash** button, shown in *Figure 16*, on the Event History, HIF Event History, and Sequential Events Recorder screens and confirming the delete action removes the records from the relay.

### Control Folder Applications

Tapping the **Control** folder navigates you to the screen where you can access the Breaker Control, Output Pulsing, and Local Bits applications. Use the applications to perform breaker control operations, pulse output contacts (*Figure 18*), and control the local bits (*Figure 19*).

![Digital Output Pulsing - Slot A](image1)

*Figure 18 Digital Output Pulsing – Slot A*

![Local Bits](image2)

*Figure 19 Local Bits*

### Device Info Folder Applications

Tapping the **Device Info** folder navigates you to the screen where you can access specific device information applications (Status, Configuration, and Trip & Diag. Messages) and the Reboot application. Tap the **Status** application to view the relay status, firmware version, part number, etc. (see *Figure 20*).

![Device Status](image3)

*Figure 20 Device Status*

To view the trip and diagnostic messages, tap the **Trip & Diag. Messages** application (see *Figure 21*). When a diagnostic failure, trip, or warning occurs, the relay displays the diagnostic message on the screen until it is either overridden by the restart of the rotating display or the inactivity timer expires.

![Trip and Diagnostic Messages](image4)

*Figure 21 Trip and Diagnostic Messages*
Applications

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

➤ Voltage control
➤ Undervoltage load shedding
➤ Underfrequency load shedding
➤ Process control

➤ SCADA control
➤ VAR control
➤ Power Factor Control
➤ Overload
➤ Loss of Load
➤ Thermal Models
➤ Protection Backup
➤ Oscillographic recording

Smart I/O Node
Sends analog and digital input data to a central communications system and receives and executes control commands.

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

Three-Phase Power System
Contact I/O
Analog I/O

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.

Local / Remote
Workstation
Three-Phase Power System
Fiber-Optic
Communications

SEL-2411
BUS
(3) (3)
Open
Closed
TX
RX Port 3
SEL-2411
TX
RX Port 3
MIRRORED BITS Over Metallic or Fiber-Optic Cable

Normal Source
Closed
Load
Standby Source
Open
Flow Controller
Regulate the flow in a pipe by adjusting valve position with a single proportional plus integral (PI) controller.

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

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

Automatic Load Shed
Combine distributed I/O and logic with computing platforms and logic processors for system-wide load shedding or other remedial action schemes (RAS).
Truly Integrated SEL Control and Energy Management Systems

Substation SCADA

Breaker Control

Transformer Control

Transfer Scheme

Flow Controller

Load Shedding

Smart I/O Node

Generator Control
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 22** Front Panel With Default Configurable Labels

**Figure 23** Rear-Panel Connections and Labels
Dimensions

Figure 24  Programmable Automation Controller Horizontal Panel-Mount

Figure 25  Programmable Automation Controller Vertical Panel-Mount

Figure 26  SEL-2411-1 (Surface Mountable)
Specifications

Compliance

Designed and manufactured under an ISO 9001 certified quality management system

47 CFR 15B, Class A

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

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

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

CE Mark

Hazardous Locations

UL Listed for Hazardous Locations to Canadian and U.S. standards EU

Ex ia IIC T3 Gc

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

Note: Where so marked, ATEX and UL Hazardous Locations Certification tests are applicable to rated supply specifications only and do not apply to the absolute operating ranges, continuous thermal, or short circuit duration specifications.

General

Operating Temperature Range

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

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 24, Figure 25, and Figure 26.

Weight

2.0 kg (4.4 lb)

Frequency

System Frequency: 50, 60 Hz

Inputs

AC Current Input Phase

<table>
<thead>
<tr>
<th>( I_{\text{INOM}} )</th>
<th>( I_{\text{RATED}} )</th>
<th>( I_{\text{1S}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 A</td>
<td>0.1–96.0 A</td>
<td>15 A</td>
</tr>
<tr>
<td>1 A (4 ACI Only)</td>
<td>0.02–19.20 A</td>
<td>3 A</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

100 A (according to IEC 60255-6)

Rated Frequency: 50/60 ± 5 Hz

Burden (Per Phase): <0.050 VA

Measurement Category: II

AC Current Input Neutral

<table>
<thead>
<tr>
<th>( I_{\text{INOM}} )</th>
<th>( I_{\text{RATED}} )</th>
<th>( I_{\text{1S}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 A</td>
<td>0.05–10.0 A</td>
<td>15 A</td>
</tr>
<tr>
<td>1 A (4 ACI Only)</td>
<td>0.01–2.00 A</td>
<td>3 A</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

100 A (according to IEC 60255-6)

Rated Frequency: 50/60 ± 5 Hz

Burden (Per Phase): <0.050 VA

Measurement Category: II

AC Voltage Input

<table>
<thead>
<tr>
<th>( V_{\text{INOM}} )</th>
<th>( V_{\text{Ue}} )</th>
<th>( V_{\text{1S}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>300 V</td>
<td>100–250 Vac</td>
<td>1000–2500 Vac</td>
</tr>
<tr>
<td>8 V</td>
<td>2.67–6.67 Vac</td>
<td>2.67–6.67 Vac</td>
</tr>
</tbody>
</table>

Rated Operating Voltage (Ue): 300 Vac

Rated Insulation Voltage: 300 V

10-Second Thermal: 600 Vac

16 Vac

Rated Frequency: 50/60 ± 5 Hz

Burden: <0.1 W

DC Transducer (Analog) Inputs

Input Impedance

Current Mode: 200 Ω

Voltage Mode: >10 Ω

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): ±500 V

Sampling Rate: At least 5 ms
Step Response: 1 s
Accuracy at 25°C
ADC: 16 bit
With User Calibration: 0.025% of full scale (voltage mode)
Without Calibration: Better than 0.5% of full scale at 25°C
Accuracy Variation With Temperature
±0.015% per °C of full scale (±10 V)
CMRR Typical: 65 dB at 60 Hz

Auxiliary DC Transducer (Analog) Inputs
(Available only with 8 V 3 ACI/3 A 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 176–242 Vdc OFF below 132 Vdc
125 V ON for 100–135.5 Vdc OFF below 75 Vdc
110 V ON for 88–121 Vdc OFF below 66 Vdc
48 V ON for 38.4–52.8 Vdc OFF below 28.8 Vdc
24 V ON for 15–30 Vdc OFF below 5 Vdc
When Used With AC Control Signals:
250 V ON for 170.6–275 Vac OFF below 106 Vac
220 V ON for 150.3–264 Vac OFF below 93.2 Vac
125 V ON for 85–150 Vac OFF below 53 Vac
110 V ON for 75.1–132 Vac OFF below 46.6 Vac
48 V ON for 32.8–60 Vac OFF below 20.3 Vac
24 V ON for 14–27 Vac OFF below 5 Vac
Current Draw at Nominal
DC Voltage: 2–4 mA (Except for 24 V, 8 mA)
Rated Insulation Voltage: 300 Vac
Rated Impulse Withstand Voltage ($U_{imp}$): 4000 V

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
RTDs: –50°C to 250°C
TCs: –210°C to 250°C
J, K, T, E: –270°C to 250°C
ADC Resolution: 24 bit
Accuracy
RTDs: ±1°C typical at 25°C
TCs: ±1°C typical with field calibration
±3°C worst case
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: $V_{ih}$ ≥ 2.2 V
Off (0) State: $V_{il}$ ≤ 0.8 V
Input Impedance: 2 kΩ
Accuracy: ±3 milliseconds

Time-Code Input (SNTP)
High-Priority Server
Accuracy: ±5 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
### 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 (Ithc) 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

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### 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

### Electrical Characteristics

- **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):** ≤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

### Analog Outputs

- **Current Ranges (Max):** ±20 mA
- **Voltage Ranges (Max):** ±10 V
- **Output Impedance For Current Outputs:** ≥100 kΩ
- **Output Impedance For Voltage Outputs:** ≤10 kΩ
- **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 Mbps
  - **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 Mbps
Typical Fiber Attenuation: –4 dB/km

Optional Communications Card
Standard EIA-232 or EIA-485 (Ordering Option)
Data Speed: 300–38400 bps

Communications Protocols
Modbus RTU slave or Modbus TCP
DNP3 Level 2 Outstation (LAN/WAN and Serial)
IEC 61850 Communications
Ethernet FTP
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: 2a
DNP3 Level 2 Outstation: 5a
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: 19.2–60 Vdc
High-Voltage Model: 85–300 Vdc
85–264 Vac

Power Consumption (With Front-Panel LCD)
AC: <40 VA
DC: <15 W

Power Consumption (With Front-Panel 5” Color Touchscreen)
AC: <75 VA
DC: <25 W

Interruptions
Low-Voltage Model: 10 ms @ 24 Vdc
50 ms @ 48 Vdc
High-Voltage Model: 50 ms @ 125 Vac/Vdc
100 ms @ 250 Vac/Vdc

Fuse Rating
High-Voltage Model: 3.15 A, high breaking capacity, time lag T1,
250 V (5x20 mm, T3.15AH 250 V)
Low-Voltage Model: 3.15 A, high breaking capacity, time lag T1,
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-to-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

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: Four times per power system cycle or 4 ms if no current or voltage card (except for math variables and analog signals used in logic, which are processed every 100 ms)

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 60608-2-1:2007
~40°C, 16 hours

Damp Heat, Steady State: IEC 60608-2-7:2013
40°C, 93% relative humidity, 4 days

Damp Heat, Cyclic: IEC 60608-2-30:2005
25–55°C, 6 cycles, 95% relative humidity

85°C, 16 hours

Dielectric Strength and Impulse Tests

Dielectric (HiPot): IEC 60255-27:2013
IEEE C37.90-1989
2.0 kV ac on analog inputs, contact I/O
2.5 kV ac on ac current inputs
2.83 kVdc on power supply and analog outputs

Impulse: IEC 60255-27:2013
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 61000-4-2:2008, enclosed in panel
Severity Level 4, front-panel surface and controls
8 kV contact discharge
15 kV air discharge

Radiated RF Immunity: IEC 61000-4-3:2006, 10 V/m
IEEE C37.90.2-2004, 35 V/m

Fast Transient, Burst Immunity:
IEC 61000-4-4:2012
4 kV @ 2.5 kHz
2 kV @ 5.0 kHz for comm. ports

Surge Immunity: IEC 61000-4-5:2005
2 kV line-to-line
4 kV line-to-earth

Surge Withstand Capability Immunity:
IEC 61000-4-18:2006
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 61000-4-6:2013, 10 Vrms
IEEE C37.90.2-2004, 35 V/m

Magnetic Field Immunity:
IEC 61000-4-8:2005
1000 A/m for 3 seconds
100 A/m for 1 minute

EMC Emissions

Class A

Class A

Class A

Class A

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