SEL-401
Protection, Automation, and Control Merging Unit

A merging unit with built-in overcurrent and breaker failure protection

- Analog-to-digital signal conversion in the yard significantly reduces copper wiring, increases safety, and decreases costs.
- Built-in overcurrent and breaker failure elements provide local protection for increased reliability.
- IEC 61850-9-2 compatibility enables interoperability with other devices and equipment.
- Built-in Sampled Values (SV) network testing eases commissioning and troubleshooting.
Functional Overview

ANSI Numbers/Acronyms and Functions
- 50P: Phase Overcurrent
- 50BF: Dual Breaker Failure Overcurrent

Additional Functions
- 85 RIO: SEL Mirrored Bits® Communications
- BRM: Breaker Wear Monitor
- DFR: Event Reports
- DNP3: Distributed Network Protocol
- HMI: Operator Interface
- IEC 61850: MMS, GOOSE, Sampled Values (9-2LE)
- LGC: Expanded SELogic® Control Equations
- MET: High-Accuracy Metering
- PMU: Synchrophasors
- PTP: IEEE 1588 Precision Time Protocol
- SBM: Station Battery Monitor
- SER: Sequential Events Recorder
- SIP: Software-Invertible Polarities
Key Features

State-of-the-Art SV Publisher With Basic Protection Built In
The SEL-401 Protection, Automation, and Control Merging Unit combines built-in phase overcurrent and breaker failure protection with the flexibility of IEC 61850-9-2 SV. It can publish up to seven data streams of IEC 61850-9-2 SV data to any subscriber from any manufacturer, and it comes with built-in communications redundancy.

Self-Test Capabilities
Take advantage of the SEL-401 Merging Unit’s self-test capability, which consists of simulating SV network traffic, to verify network connections during commissioning or testing.

Superior Automation and Control Capabilities
The SEL-401 includes 32 programmable elements for enhanced automation features regarding local control, remote control, protection latching, and automation latching. Take advantage of SELogic control equations with math and comparison functions for control applications.

Gather key information, such as metering data, IEEE C37.118 synchrophasors, Sequential Events Recorder (SER) reports, breaker monitoring, merging unit event reports, and time synchronization.

Secure, High-Speed Breaker Failure Detection
The SEL-401 uses high-speed (5/8-cycle) open-pole detection logic to reduce coordination times for critical breaker failure applications. The merging unit includes logic for three-pole breaker failure retrip and initiation of transfer tripping for one or two breakers.
Control and settings are divided into seven merging unit access levels for increased security. The merging unit has separate breaker, protection, automation, and output access levels, among others. You can set unique passwords for each access level.

Easy-to-use keypad aids simple navigation and set-point adjustment.

Programmable operator pushbuttons with user-configurable labels offer front-panel customization.

The front-panel display provides status indication and control of as many as ten disconnects. The merging unit offers control for up to two breakers and provides status indication for up to three breakers.

Up to 24 programmable target LEDs with user-configurable labels alert operators in the substation to faulted phases, the merging unit's status, and element operation.

User-selectable mimic screens are displayed on the front panel in one-line diagram format. The one-line diagram includes user-configurable labels for disconnect switches, breakers, and the bay name, and it displays as many as six analog quantities.
Six current and six voltage analog inputs, orderable in standard terminal blocks (shown) or a Connectorized® hardware configuration.

Vertical or horizontal, panel-mount or rack-mount hardware package. The size options available are 4U, 5U, or 6U and allow you to order up to three I/O boards (shown as 5U horizontal rack mount with two I/O boards).

Choose from power supply options such as 24–48 Vdc; 48–125 Vdc or 110–120 Vac; or 125–250 Vdc or 110–240 Vac.

Select fiber-optic, copper, or mixed Ethernet. One pair is reserved for the process bus. The other pair is reserved for the station bus.


Three EIA-232 serial ports for Mirrored Bits communications, SCADA, and engineering access provide flexibility to communicate with other devices and control systems. The ports include demodulated IRIG-B for precise-time input.
SV Merging Unit
Publish up to seven streams of IEC 61850-9-2 SV data to any subscriber. The SEL-401 Merging Unit located in the yard digitizes analog signals from primary equipment and then transmits them to SV-compliant relays (subscribers) in the control house via a fiber- or copper-based Ethernet network. The SEL-401 supports self-monitoring of the Ethernet links and validates the data quality, which reduces the need for periodic testing of the communications network.

**Applications**

**Integrated Protection**
Provide local breaker failure and phase overcurrent protection during a loss of a precise-time signal or loss of communication to a main substation subscriber. The SEL-401 uses high-speed (5/8-cycle) open-pole detection logic to reduce coordination times for critical breaker failure applications.

**Dual Breaker Schemes**
Accommodate two sets of three-phase currents and two sets of three-phase voltages to support substations with dual-breaker schemes. You can combine currents within the SEL-401 from two sets of CTs for protection functions while keeping them separately available for monitoring and station integration applications.

**Metering and Monitoring**
Include extensive metering capabilities, such as instantaneous metering, power/energy metering, and comprehensive report of SV communication streams. Event reports and the SER log valuable time-stamped information for commissioning and post-event analysis.

**Synchrophasors**
Provide real-time system state measurement with time-synchronized voltages and currents in the IEEE C37.118 standard format. This, combined with SEL-5078-2 SYNCHROWAVE® Central Software or third-party software, enables you to view and analyze system phase angles, load oscillations, voltage profiles, and other critical system information.
Accessibility and Communications

**Dedicated Bus Access**
The SEL-401 physically segregates the process bus from the station bus with separate Ethernet ports to promote a better-organized and manageable system. SV and protection GOOSE messaging should run exclusively on the process bus. Conversely, engineering access, communications, and time synchronization should run on the station bus, which supports a variety of protocols, including FTP, Telnet, synchrophasors, and DNP3 LAN/WAN.

**Bus Communications Redundancy**
In cases of communications loss on either the process bus or the station bus, the SEL-401 provides built-in overcurrent protection. It also adds redundancy to these two buses by providing two Ethernet ports for each bus, for a total of four ports that can be copper, fiber-optic, or mixed Ethernet, depending on your preferences.

The redundancy method on the process and stations buses is a failover network topology; however, PRP is also an option on the station bus.

**Mirrored Bits Communications**
Mirrored Bits communications is a field-proven technology that provides simple and powerful bidirectional digital communications between devices. For example, in an SV network, Mirrored Bits communications can be another method of communication between two SEL-401 Merging Units in close proximity.

**Web Server**
The web server is a built-in utility that allows access to basic information, such as certain settings, metering information, and status reports. For increased security, web server access requires a username and password and the information displayed is limited to read-only permissions.
# SEL-401 Specifications

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<thead>
<tr>
<th><strong>General</strong></th>
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<tbody>
<tr>
<td><strong>AC Current Inputs</strong>&lt;br&gt; (6 total)</td>
<td>5 A nominal&lt;br&gt; 1 A nominal</td>
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<tr>
<td><strong>AC Voltage Inputs</strong>&lt;br&gt; (6 total)</td>
<td>300 V&lt;sub&gt;L-N&lt;/sub&gt; continuous, 600 Vac for 10 seconds</td>
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<tr>
<td><strong>Serial</strong></td>
<td>3 rear-panel and 1 front-panel EIA-232 serial ports, SEL ASCII commands, SEL Fast Messages, DNP3, IEEE C37.118 synchrophasors</td>
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<tr>
<td><strong>Ethernet</strong></td>
<td>Communications protocols include FTP, Telnet, DNP3 LAN/WAN, PRP, PTPv2, IEC 61850-9-2, and IEC 61850 Edition 2. For PTPv2 implementation, Ports 5A and 5B must be used. Choose from the following media ports: Four 10/100BASE-T twisted-pair network ports Four 100BASE-FX fiber-optic network ports Two 10/100BASE-T twisted-pair network ports and two 100BASE-FX fiber-optic network ports</td>
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<tr>
<td><strong>Precise-Time Input</strong></td>
<td>Demodulated IRIG-B time input and PTPv2</td>
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<tr>
<td><strong>Synchrophasors</strong></td>
<td>IEEE C37.118 standard&lt;br&gt; Up to 60 messages per second</td>
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<tr>
<td><strong>Power Supply</strong></td>
<td>24–48 Vdc&lt;br&gt; 48–125 Vdc or 110–120 Vac&lt;br&gt; 125–250 Vdc or 110–240 Vac</td>
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<tr>
<td><strong>Operating Temperature</strong></td>
<td>−40°C to +85°C (−40 to +185°F)</td>
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