

# SEL-401

## Protection, Automation, and Control Merging Unit

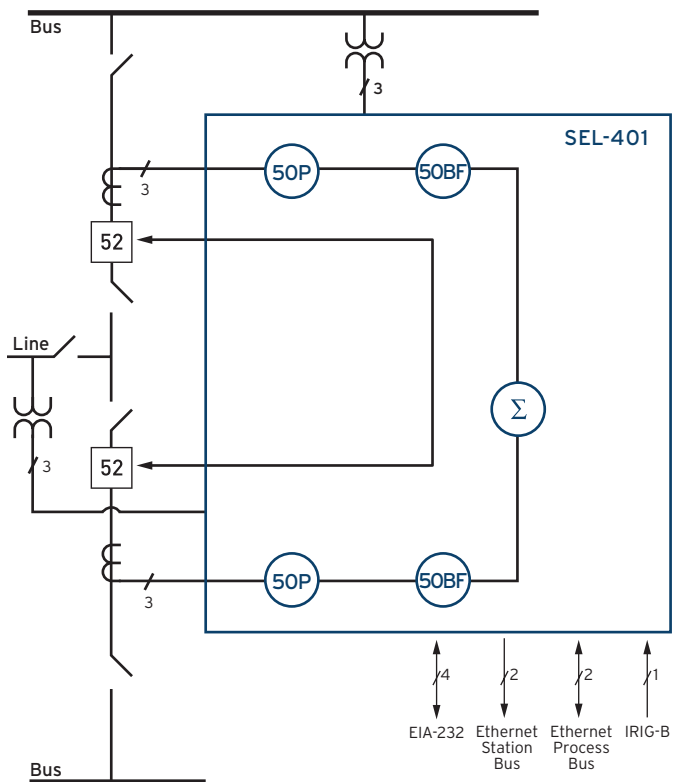


### A merging unit with built-in overcurrent and breaker failure protection

- 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.

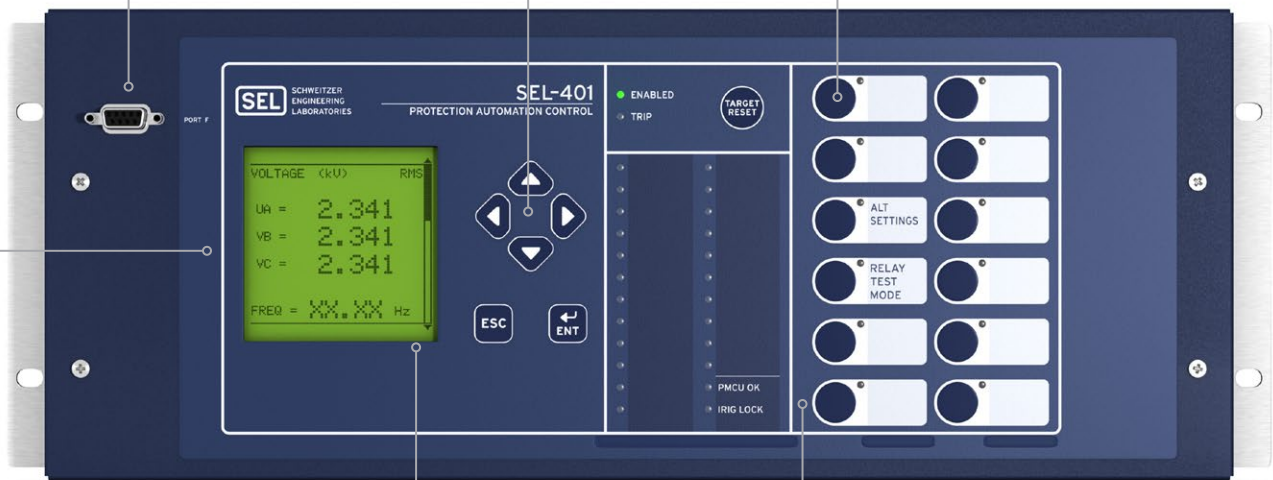


# Product Overview

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.

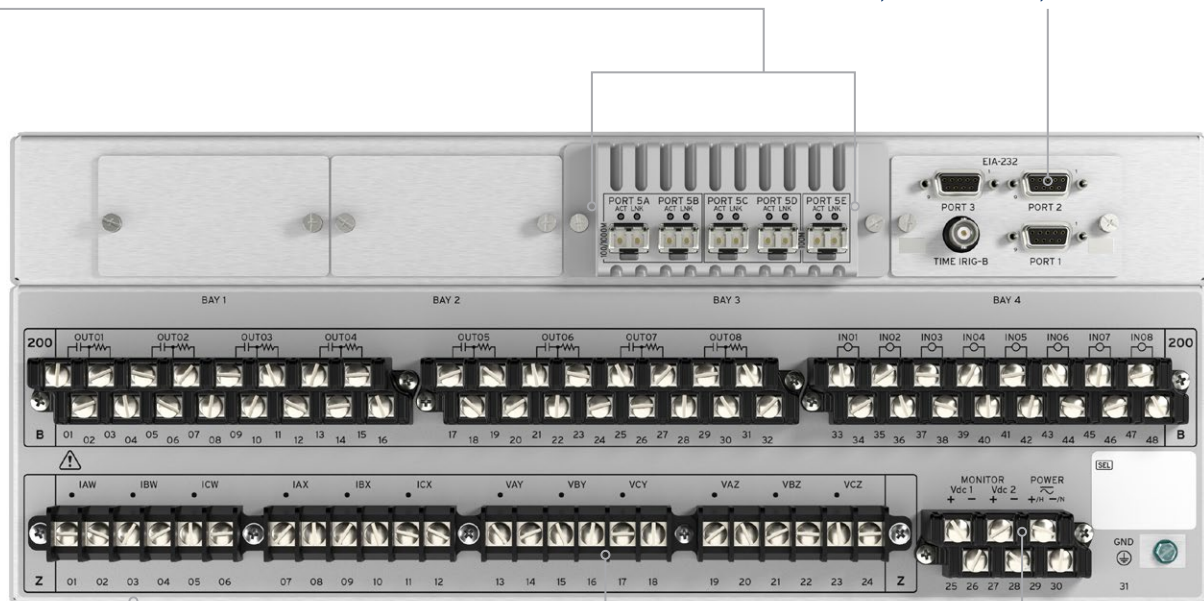
Up to 24 programmable target LEDs with user-configurable labels alert operators in the substation to faulted phases, the merging unit's status, and element operation.

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.

Select fiber-optic, copper, or mixed Ethernet. One pair is reserved for the process bus. The other pair is reserved for the station bus. Select a five-port Ethernet card for dedicated station bus and engineering access ports.

Ethernet communications protocols include FTP, Telnet, synchrophasors, DNP3 LAN/WAN, the Parallel Redundancy Protocol (PRP), the IEEE 1588 Precision Time Protocol Version 2 (PTPv2), IEC 61850-9-2, and IEC 61850 Edition 2.

Three EIA-232 serial ports for MIRRORRED 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.



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).

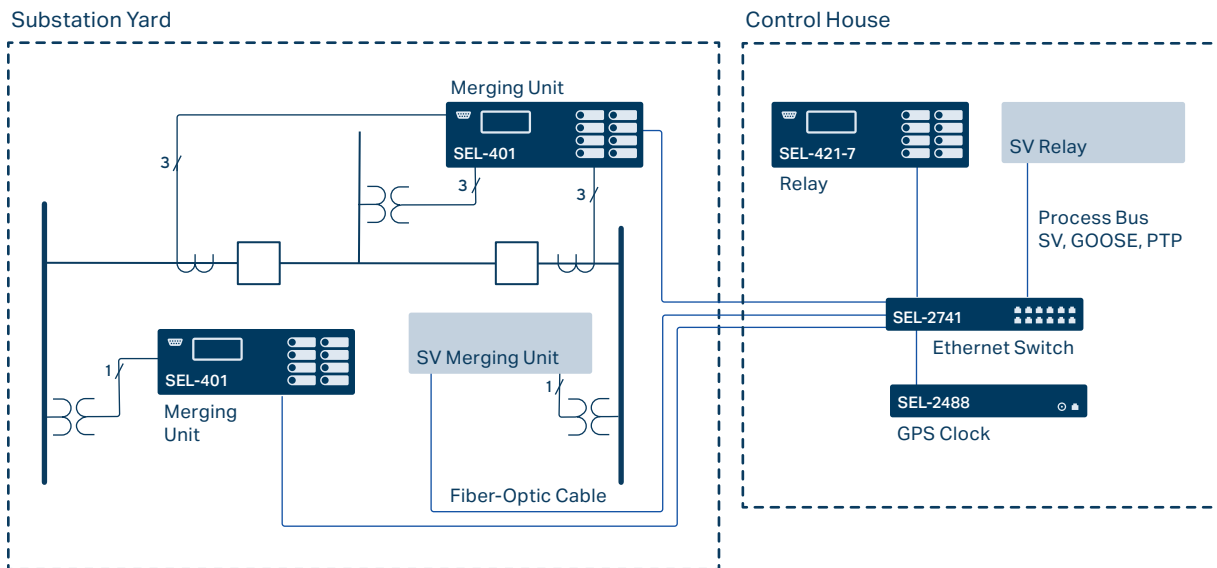
Choose from power supply options such as 24–48 Vdc; 48–125 Vdc or 110–120 Vac; or 125–250 Vdc or 110–240 Vac.

Six current and six voltage analog inputs, orderable in standard terminal blocks (shown) or a Connectorized® hardware configuration.

# Applications

## 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 publishes the samples 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.



## 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<sup>®</sup> 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.

## Flexible Communications Options

The SEL-401 can be configured with a five-port Ethernet card supporting PRP or failover functionality to increase system availability. Use PTPv2 on process bus or station bus ports to provide time synchronization.

This card also features dedicated ports and IP addresses for station bus and engineering access networks to provide selective access control.

Use small form-factor pluggable (SFP) transceivers on process bus, station bus, and engineering access ports. Single- and multimode communications options provide increased flexibility. All ports support 100 Mbps SFPs, and process bus ports also support 1 Gbps SFPs.

## 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.

The screenshot displays the SEL-401 web interface for 'GROUP 1 (SHO)'. The top navigation bar shows 'Device Time: Thu Jan 27 11:48:16 2011', 'ACC [Logout]', and '1 users logged in'. The left sidebar contains a navigation menu with options like Version, History, Recorder, Self-Test Status, Metering, Show Settings, Group Protection, Automation, Port, Global, Output, Front Panel, Report, Alias, Bay Mimic, DNP, Notes, Communications, and Targets. The main content area is divided into several sections:

- Line Configuration:**

CTRw	:= 200	CTRz	:= 200	PTRY	:= 2000.0	VWPHY	:= 115
PTRz	:= 2000.0	VWPHz	:= 115	Z1MAG	:= 7.60	Z1ANG	:= 84.00
Z0MAG	:= 24.80	Z0ANG	:= 81.50	EFLOC	:= Y		
- Relay Configuration:**

E21MP	:= 3	E21XP	:= 3	E21MG	:= 3	E21XG	:= N
ECVT	:= N	ECDFD	:= N	ESOTF	:= Y	EOOS	:= N
ELOAD	:= Y	ESOP	:= L	ESOG	:= N	ESOO	:= N
E31	:= N	E81	:= N	E27	:= N	E39	:= N
E72	:= AUTO	ECONH	:= N	EBLL	:= N	E25BKL	:= N
E70	:= Y	EMANCL	:= Y	ELOP	:= Y1	EDEM	:= N
EADVS	:= N						
- Mho Phase Distance Element Reach:**

Z1MP	:= 6.24	Z2MP	:= 9.36	Z3MP	:= 1.87
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- Quad Phase Distance Element Reach:**

XP1	:= OFF	XP2	:= OFF	XP3	:= OFF
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- Phase Distance Element Time Delay:**

Z1PD	:= 0.000	Z2PD	:= 20.000	Z3PD	:= 60.000
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- Mho Ground Distance Element Reach:**

Z1MG	:= 6.24	Z2MG	:= 9.36	Z3MG	:= 1.87
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- Zero-sequence compensation Factor:**

K0M1	:= 0.726	K0A1	:= -3.69
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- Ground Distance Element Time Delay:**

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# SEL-401 Specifications

General	
<b>AC Current Inputs</b> (6 total)	5 A nominal 1 A nominal
<b>AC Voltage Inputs</b> (6 total)	0–300 V <sub>L-N</sub> operational
<b>Communications Protocols</b>	FTP, Telnet, SEL ASCII, SEL Fast Message, synchrophasors, DNP3, PRP, PTPv2, IEC 61850-9-2, and IEC 61850 Edition 2
<b>Communications Ports</b>	<b>Serial Ports</b> One front-panel and three rear-panel EIA-232 serial ports 300–57,600 bps <b>Four-Port Ethernet Card</b> Four 10/100BASE-T twisted-pair network ports, or Four 100BASE-FX fiber-optic network ports, or Two 10/100BASE-T twisted-pair network ports and two 100BASE-FX fiber-optic network ports <b>Five-Port Ethernet Card</b> Two 100/1000BASE SFP ports Three 100BASE SFP ports
<b>SV Ports</b>	Subscriber: As many as 7 SV data streams Publisher: As many as 7 SV data streams Data rate: 4.8 kHz for 60 Hz system, 4 kHz for 50 Hz system Protocol: IEC 61850-9-2
<b>Precise-Time Input</b>	Demodulated IRIG-B time input and PTPv2
<b>Power Supply</b>	24–48 Vdc 48–125 Vdc or 110–120 Vac 125–250 Vdc or 110–240 Vac
<b>Operating Temperature</b>	–40°C to +85°C (–40 to +185°F)