SEL

# 2021 CATALOG

# 2021 Technology Highlights

### Ultra-High-Speed Protection

Meet the SEL-T401L Ultra-High-Speed Line Relay, which combines time-domain technologies and high-performance distance elements for a complete protection and monitoring system. (Page 46)

### Capacitor Bank Control

Enhance your distribution system using the new SEL-734W Capacitor Bank Control with wireless current sensors to improve power quality. (Page 122)

### Advanced Generator Protection

Provide advanced generator, bus, transformer, and auxiliary system protection for hydro, thermal, and pumped-storage applications with the new SEL-400G. (Page 22)

### Fault Transmitter and Receiver

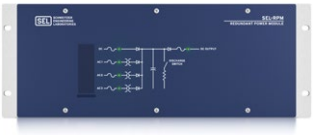
Apply the SEL-FT50 and SEL-FR12 Fault Transmitter and Receiver System to enhance distribution substation protection and improve the reliability and safety of your feeder. (Page 115)

### Synchrowave® Operations Software

Increase grid safety and reliability with situational awareness of power system operations. (Page 186)

### Time-Domain Link (TiDL®) Technology

Convert data using a TiDL merging unit and transport them via fiber to as many as four relays to achieve a simple, secure digital secondary system solution. (Page 74)



### Redundant Power Module

Combine multiple ac and dc power sources with the new SEL-RPM Redundant Power Module to increase control power availability and reliability. (Page 225)

### Software-Defined Networking

Improve local-area networking with deny-by-default cybersecurity and fast failover. (Page 194)

### POWERMAX® Power Management

Intelligent control for seamless islanding as well as comprehensive generation and load management solutions. (Page 244)

## On the Cover

The Tohono O'odham Utility Authority (TOUA) became the world's first subtransmission utility to experience the SEL-T400L relay's unprecedented tripping speed. In just over half an hour, the relay tripped seven times—in under 2 ms each time.

Read the story of how TOUA made electric transmission protection history at selinc.com/featured-stories/TOUA.

"If not for this new technology, the power would have gone out and our crews would have been driving around and trying to restore it in bad weather. Instead, it did the job so well that we didn't even know about the disturbance until later."

—Darrold Hobbs, TOUA Electric Department Operations Manager

# Letter From the President

SEL continues to focus on creating value and partnering with customers to solve tough problems in innovative ways. With country-wide protection schemes; microgrid systems for utility, commercial, and military applications; innovative distribution protection and automation solutions; and, of course, the fastest transmission protection in the world, we're at your service to make electric power safer, more reliable, and more economical.

From new technologies only available from SEL to world-class engineering services and training, the solutions described in this catalog are designed, created, and implemented with quality, innovation, and service driving our work. Our electronic devices are designed and manufactured exclusively in the U.S.A. Some other solutions, such as panels and enclosures, are created around the world to meet customer needs fast and reduce shipping expenses.

One of the most exciting new products highlighted in this catalog is the SEL-T401L Ultra-High-Speed Line Relay. Our SEL-T400L Time-Domain Line Protection has been protecting power systems for nearly four years. In 2020, we launched the SEL-T401L, which merges time-domain technology and phasor-based protection in a single device. The protection world will never be the same: it's like moving from a car to a jet…without the increased expense.

SEL has been concerned about the reliability of dc systems in substations. The SEL-RPM Redundant Power Module boosts dependability by combining multiple power sources for more dependable dc, wherever it's important. Our engineers have also written an outstanding technical paper on the topic of dc reliability, which I encourage you to read on our website.

Cybersecurity remains a focus area, as well. SEL has designed and built cybersecurity capabilities into our products since the introduction of the SEL-21 in 1984. Cyber threats have changed considerably since then, and SEL has responded with both standalone products and features in other devices to mitigate evolving cyber threats. I invite you to read more about SDN, ICON®, and our engineering services offerings in the pages that follow.

SEL continues to deploy real-time control and monitoring solutions worldwide. POWERMAX® systems control microgrids, military forward-operating bases, and industrial sites. For monitoring and analytics, SEL software has become a critical component of the real-time operating environment for utility control centers.

The products and technologies featured in this catalog in many cases are available to ship from stock; nearly all products ship in a matter of 2–4 days.

Like you, we're committed to serving our customers 24/7 to support your critical missions…no matter what is going on in the world. We're part of industries that our world relies on for the most fundamental services: light, heat, commercial and residential products, communication, and so much more.

Thank you for your continued confidence and trust in SEL.

Sincerely,

Edmund O. Schweitzer, III
President
Chief Technology Officer

# Table of Contents

## SEL Overview


| | |
|---|---|
| About SEL | 6 |
| Example Product Applications | 10 |
| Example Network Communications Diagram | 12 |


## Generation Protection


| | |
|---|---|
| Generator and Motor Protection Overview | 14 |
| Generator and Motor Protection Applications | 16 |
| SEL-400G Advanced Generator Protection System NEW | 22 |
| SEL-700G Generator Protection Relay | 24 |
| SEL-300G Generator Relay | 26 |
| SEL-2664S Stator Ground Protection Relay | 27 |
| SEL-2664 Field Ground Module | 28 |
| SEL-2600 RTD Module | 29 |
| SEL-700BT Motor Bus Transfer Relay NEW | 30 |
| SEL-710-5 Motor Protection Relay | 32 |
| SEL-849 Motor Management Relay | 34 |


## Transmission Protection


| | |
|---|---|
| Transmission Protection Overview | 36 |
| Transmission Protection Applications | 38 |
| SEL-T400L Time-Domain Line Protection | 42 |
| SEL-T401L Ultra-High-Speed Line Relay NEW | 46 |
| SEL-T4287 Traveling-Wave Test System | 50 |
| SEL-421 Protection, Automation, and Control System | 51 |
| SEL-411L Advanced Line Differential Protection, Automation, and Control System | 54 |
| SEL-311C Transmission Protection System | 56 |
| SEL-311L Line Current Differential Protection and Automation System | 58 |
| SEL-387L Line Current Differential Protection and Automation System | 59 |


## Substation Protection


| | |
|---|---|
| Substation Protection Overview | 60 |
| Transformer Applications | 64 |
| Bus Applications | 66 |
| Breaker Applications | 67 |
| Capacitor Bank Applications | 68 |
| SEL-787-2/-3/-4 Transformer Protection Relay | 70 |
| SEL-TMU TiDL® Merging Unit NEW | 74 |
| SEL-401 Protection, Automation, and Control Merging Unit | 76 |
| SEL-421-7 Protection, Automation, and Control Merging Unit | 78 |
| SEL-487V Capacitor Protection and Control System | 80 |
| SEL-487E Transformer Protection Relay | 82 |
| SEL-2414 Transformer Monitor | 85 |
| SEL-487B Bus Differential and Breaker Failure Relay | 86 |
| SEL-387/387A Current Differential and Overcurrent Relays | 89 |
| SEL-387E Current Differential and Voltage Relay | 90 |
| SEL-587 Current Differential Relay | 91 |
| SEL-587Z High-Impedance Differential Relay | 92 |
| SEL-352 Breaker Failure Relay | 93 |

## Distribution Protection


| | |
|---|---|
| Distribution Protection Overview | 94 |
| Distribution Protection Applications | 96 |
| SEL-851 Feeder Protection Relay NEW | 98 |
| SEL-751 Feeder Protection Relay | 100 |
| SEL-451 Protection, Automation, and Bay Control System | 102 |
| SEL-351 Protection System | 105 |
| SEL-351A Protection System | 106 |
| SEL-351S Protection System | 107 |
| SEL-501/501-2 Dual Overcurrent Relays | 108 |
| SEL-551/551C Overcurrent/Reclosing Relays | 109 |


## Distribution Control


| | |
|---|---|
| Distribution Control Overview | 110 |
| Distribution Control Applications | 113 |
| SEL-FT50 and SEL-FR12 Fault Transmitter and Receiver System | 115 |
| SEL-651R Advanced Recloser Control | 116 |
| SEL-651RA Recloser Control | 118 |
| SEL-351RS Kestrel® Single-Phase Recloser Control | 120 |
| SEL-734B Advanced Monitoring and Control System | 121 |
| SEL-734W and SEL-8340 Capacitor Bank Control and Wireless Current Sensor | 122 |
| SEL-2431 Voltage Regulator Control | 123 |


## Fault Indicators, Sensors, and CTs


| | |
|---|---|
| Fault Indicators, Sensors, and CTs Overview | 124 |
| Fault Indicators and Sensors Applications | 126 |
| SEL-FLT and SEL-FLR Fault and Load Transmitter and Receiver System | 128 |
| SEL-AR360 and SEL-AR Overhead AutoRANGER® Fault Indicators | 130 |
| SEL-ER Overhead Electrostatic Reset Fault Indicator | 131 |
| SEL-CRD Overhead Current Reset Fault Indicator | 131 |
| SEL-BTRIP Overhead BEACON® Field-Programmable Timed-Reset Fault Indicator | 131 |
| SEL-BTRI Overhead BEACON® Timed-Reset Fault Indicator | 131 |
| RadioRANGER® Underground Wireless Fault Indication System | 132 |
| SEL-8301 Underground Distribution Sensor | 133 |
| SEL-ARU Underground AutoRANGER® Fault Indicator | 134 |
| SEL-TPR Underground Test Point Reset Fault Indicator | 134 |
| SEL-CR Underground Current Reset Fault Indicator | 135 |
| SEL-SR Underground Secondary/Low-Voltage Reset Fault Indicator | 135 |
| SEL-TR Underground Timed-Reset Fault Indicator | 135 |
| SEL-MW Microcontroller-Based Wye Voltage Sensor | 135 |
| SEL-PILC Underground Paper-Insulated Lead-Covered Cable Fault Indicator | 136 |
| SEL-GFD Underground Ground Fault Detector | 136 |
| Remote Display Options | 137 |
| Accessories and Tools | 138 |
| SEL-CT Split-Core Current Transformer | 139 |
| SEL-SCT Submersible Separable-Core Current Transformer | 139 |

## Metering


| | |
|---|---|
| Metering Overview | 140 |
| Metering Applications | 142 |
| SEL-735 Power Quality and Revenue Meter | 144 |
| SEL-5630 ACSELERATOR® Meter Reports Software | 146 |
| SEL-5230 ACSELERATOR® Database API | 147 |


## Automation


| | |
|---|---|
| Automation Overview | 148 |
| Automation Applications | 152 |
| SEL-3355 Automation Controller | 158 |
| SEL-3360 Compact Automation Controller | 160 |
| SEL-3350 Automation Controller NEW | 161 |
| SEL Automation Controllers Operating System Options | 162 |
| SEL-3390 PCIe Expansion Card | 163 |
| SEL-9331 Power Supply | 163 |
| SEL BlueFrame™ Application Platform NEW | 164 |
| Real-Time Automation Controllers (RTACs) SEL-3555/3560/3530/3530-4/3505/3505-3 | 166 |
| SEL-2240 Axion® | 172 |
| SEL-2411P Pump Automation Controller | 174 |
| SEL-2411 Programmable Automation Controller | 175 |
| SEL-2440 Discrete Programmable Automation Controller (DPAC) | 175 |


## Software


| | |
|---|---|
| Software Overview | 176 |
| SEL-5037 Grid Configurator NEW | 177 |
| SEL-5030 ACSELERATOR QuickSet® Software | 178 |
| SEL-5036 ACSELERATOR® Bay Screen Builder Software | 179 |
| SEL RTAC HMI Web-Based HMI Package for RTACs | 180 |
| SEL-5035 ACSELERATOR Diagram Builder™ Software | 181 |
| SEL-5045 ACSELERATOR TEAM® Software | 182 |
| SEL-5032 ACSELERATOR Architect® Software | 184 |
| SEL-5601-2 SYNCHROWAVE® Event Software | 185 |
| Synchrowave® Operations Software NEW | 186 |


## WAN and LAN Networks


| | |
|---|---|
| WAN and LAN Networks Overview | 188 |
| WAN and LAN Networks Applications | 190 |
| SEL ICON® Integrated Communications Optical Network | 192 |
| SEL-2740S/2742S Software-Defined Network Switches NEW | 194 |
| SEL-5056 Software-Defined Network Flow Controller | 195 |
| SEL-5057 SDN Application Suite NEW | 196 |
| SEL-3620/3622 Ethernet Security Gateway/ Security Gateway | 197 |
| SEL-2730M/2730U 24-Port Ethernet Switches | 198 |
| SEL-3025 Serial Shield® | 198 |
| SEL-3610 Port Server | 199 |
| SEL-2725 Five-Port Ethernet Switch | 199 |


## Wireless Communications


| | |
|---|---|
| Wireless Communications Overview | 200 |
| Wireless Communications Applications | 202 |
| SEL-3031 Serial Radio Transceiver | 204 |
| SEL-3061 Cellular Router | 204 |
| SEL-2924 Portable Bluetooth® Serial Adapter | 205 |
| SEL-2925 Bluetooth® Serial Adapter | 205 |


## Precise Time


| | |
|---|---|
| Precise Time Overview | 206 |
| Precise Time Applications | 208 |
| SEL-2488 Satellite-Synchronized Network Clock | 212 |
| SEL-2407® Satellite-Synchronized Clock | 213 |
| SEL-2401 Satellite-Synchronized Clock | 213 |
| SEL-2404 Satellite-Synchronized Clock | 214 |
| SEL-3401 Digital Clock | 214 |
| SEL-9929 Satellite-Synchronized Clock Display Kit | 214 |
| SEL-3400 IRIG-B Distribution Module | 214 |
| SEL-3405 High-Accuracy IRIG-B Fiber-Optic Transceiver | 215 |
| SEL-9524 GNSS Antenna | 215 |

## Annunciation and Notification

Annunciation and Notification Overview 216
Annunciation and Notification Applications 217

## I/O Remote I/O Overview

Remote I/O Overview 218
Remote I/O Applications 219

## Transceivers and Adapters

Transceivers and Adapters Overview 220

## Cables

Cables Overview 222

## Accessories and Tools

Accessories and Tools Overview 224
SEL-RPM Redundant Power Module NEW 225

## Bookstore

Bookstore 226

## SEL University

SEL University 228

## Engineering Services

Engineering Services Overview 230
Protection Services 232
Substation Engineering Services 233
Arc-Flash Risk Assessment Services 234
Transmission Planning Services 235
Synchronizing Systems 236
Phase-Shifting Transformer (PST) Protection and Control Systems 237
Digital Secondary System Solutions 238
Automation Services 240
MOTORMAX® Low-Voltage Motor Management and Protection System 241
Cybersecurity Solutions 242
POWERMAX® Power Management Solutions 244
POWERMAX® for Industrial Power Management 245
POWERMAX® for Utilities 245
POWERMAX® for Mobile Microgrids 246
POWERMAX® for Garrison Microgrids 246
POWERMAX® for Commercial Microgrids 247
Metering Services 248
Design and Drafting Services 249
Government Engineering Services 250
Engineering Studies and Simulation Services 251
Custom Panel and Enclosure Solutions 252
SEL-7200 Configure-to-Order (CTO) Panels and Retrofit Plates NEW 253

## SEL Ordering and Customer Support

United States and Canada Sales Contact Information 254
Global Sales Contact Information 255

## Index

Index 256

## Popular Models

Popular Models Simplify Ordering 258

# About SEL

## Our mission—making electric power safer, more reliable, and more economical

SEL invents, designs, manufactures, and supports a complete line of products and services for the protection, monitoring, control, automation, and metering of electric power systems. Our solutions range from comprehensive generator and transmission protection to distribution automation and control systems.

SEL teams offer services, education, and support for a variety of industries and throughout the power system. Our Engineering Services team provides engineering expertise and system solutions to customers worldwide. SEL University offers training that helps our customers meet the technical challenges of integrating digital technologies into their expanding power system infrastructure.

## Our history

Edmund O. Schweitzer, III, founded SEL in 1982 in Pullman, Washington. SEL introduced the world's first digital protective relay to the electric power industry in 1984. The SEL-21 revolutionized the power protection industry by providing fault locating and real fault data at a much lower cost than traditional electromechanical relays. In 2016, we set the standard for technology with the introduction of the world's fastest transmission line relay, the SEL-T400L Time-Domain Line Protection. And today we've introduced the SEL-T401L Ultra-High-Speed Line Relay that merges time-domain technology with phasor-based protection in a single device.

As part of a long-term strategy for sustained growth, stability, and customer focus, SEL became an employee-owned company in 1994 and transitioned to 100 percent employee ownership in 2009. Our ownership value is at the heart of our employees' hard work to reduce costs, increase quality, and create the superior products that enable us to fulfill our mission.

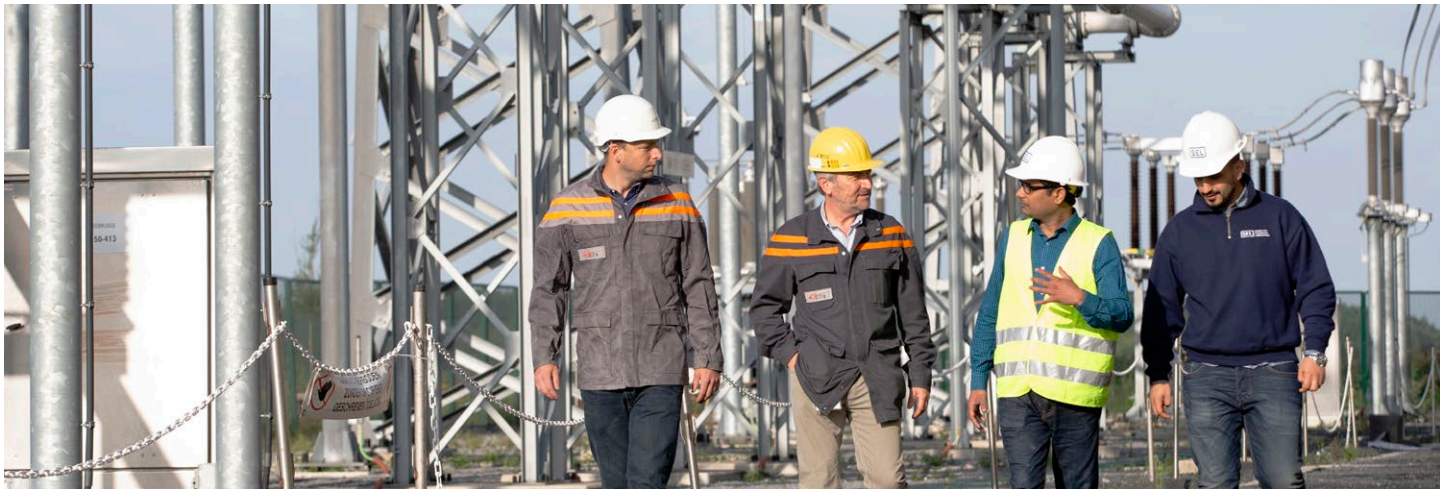
**1984**
SEL-21


**Today**
SEL-T401L

## Industries we serve

From the beginning, we've provided solutions for electric utilities. As our company has grown, so have our product portfolio and the number of industries we serve. From airports and hospitals to the power grids of entire countries, SEL solutions are protecting and controlling critical operations around the world.

- Electric power generation
- Power transmission and distribution
- Oil, gas, and petrochemical
- Renewable energy
- Metals and mining
- Water and wastewater
- Pulp and paper
- Mission-critical power systems
- Government
- Education and healthcare
- Consumer product manufacturing
- Transportation



## Engineering is our middle name

At SEL, we are passionate about our work, knowing it contributes directly to improving the reliability of electric power, keeping people safe, and helping customers conserve resources through efficiency, simplicity, and creativity.

We develop innovative products and services by focusing on the challenges our customers face. This helps us create the best solutions for a wide range of industries and applications. Every day, SEL engineers create new technologies and solutions to solve our industry's challenges.

## Our commitment to quality

Because SEL equipment becomes part of critical—and complex—infrastructure, from the electric power grid to processing and manufacturing facilities, we focus on long-term reliability and quality.

We warranty our products for 10 years and design them to last more than 20 years, and after serving our customers for more than 30 years, we still don't charge for repairs—regardless of the age of the product. Our free repair policy generates useful data that we use to drive product and service improvements. Constant improvement is an integral part of quality at SEL because of the lives and critical infrastructure our products protect.

"As engineers, we work every day to invent, design, and support products that monitor, control, and protect power systems installed all over the world. Serving our industry is a tremendous privilege and responsibility that we take very seriously. Listening to our customers' requirements and needs, we strive to make our solutions innovative, reliable, easy to use, and secure. We invest in our people, tools, and facilities in order to produce designs that exceed our customers' requirements. Engineering is our middle name, and it's what we love to do."

—Dave Whitehead
Chief Executive Officer

## Service and support you can count on

We understand the importance of local support, which is why we have application engineers, customer service representatives, and sales managers in over 100 offices worldwide. Our network of independent sales representatives and distributors provides additional sales support in many regions. This network of local experts supports SEL products and solutions in 165 countries, ensuring the best possible user experience.

SEL's outstanding customer service and support reflect who we are. Our commitment to serving our industry is consistent with our values and ethics. We believe strongly in our core company values, which are not only an essential part of our working environment but also the way we view our community, industry, and the natural environment.


"Society depends upon safe, reliable, and economical electric power. At SEL, we take our responsibility to this industry seriously. We strive to exceed expectations with extraordinary customer service, with expert application engineers who are always available to provide technical support close to our customers, and with sales engineers who solve problems by teaching and by adding value with SEL technology and innovation."

—David Costello
Chief Sales & Services Officer

# Example Product Applications

## Generators


Comprehensive Generator Protection (SEL-400G, SEL-700G)


Resistance Temperature Detection (SEL-2600)


Ground Fault Protection (SEL-2664, SEL-2664S)

## Distributed Generation (DG)


Intertie/Wind Generator Protection (SEL-700GT, SEL-700GW)


DG Interconnection Recloser Control (SEL-651R, SEL-651RA)

## Transmission Lines


Time-Domain Line Protection (SEL-T400L, SEL-T401L)


Traveling-Wave Fault Location (SEL-T400L, SEL-T401L, SEL-411L)


Subcycle Line Differential Protection (SEL-311L, SEL-411L)


Subcycle Distance Protection (SEL-421, SEL-311C)


Merging Unit With Built-In Distance Protection (SEL-421)

## Power Transformers


Five-Winding Transformer Differential and Voltage Protection (SEL-487E)


Four-Winding Transformer Differential Protection (SEL-387)


Three-Winding Transformer Differential and Voltage Protection (SEL-387E)


Two-, Three-, and Four-Winding Transformer Differential and Voltage Protection (SEL-787, SEL-787-2/-3/-4)


Transformer Monitoring (SEL-2414)

## Distribution Feeders


Distribution Protection (SEL-351, SEL-351A, SEL-351S, SEL-851)


Protection, Automation, and Bay Control (SEL-451)


Feeder Protection With Arc-Flash Detection (SEL-751, SEL-751A)

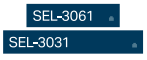

Voltage Regulator Control (SEL-2431)


Capacitor Bank Control (SEL-734B, SEL-734W and SEL-8340)


Fault Transmitter and Receiver System (SEL-FT50 and SEL-FR12)

Overhead and Underground Fault Indication (SEL-AR360, SEL-AR, SEL-ARU, SEL-TPR, SEL-CR)


Recloser Control (SEL-651R, SEL-651RA, SEL-351RS Kestrel®)




Encrypted Wireless Communication (SEL-3031, SEL-3061)


Compact Satellite-Synchronized Precise Time (SEL-2401)


Real-Time Automation Control (SEL-3505)


Wireless Fault Detection and Load Monitoring (SEL-FLT and SEL-FLR, SEL-8301)

## Substations


Satellite-Synchronized Precise Time (SEL-2401, SEL-2404, SEL-2407®, SEL-2488, SEL-3401)


Protection, Automation, and Bay Control (SEL-451)


Low-Impedance Bus Differential Protection (SEL-487B)


Capacitor Protection and Control (SEL-487V)


High-Impedance Differential Protection (SEL-587Z)


Power Quality and Revenue Metering (SEL-735)


Programmable Automation Control (SEL-2411, SEL-2440)


Annunciation and Notification (SEL-2522, SEL-2523, SEL-2533)

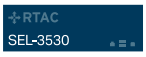

Merging Units With Built-In Protection (SEL-401, SEL-421)


Digital Secondary System Protection and Control (TiDL®, SEL-TMU, SEL-401, SEL-421, SEL-451, SEL-487B, SEL-487E)


Rugged Computing (SEL-3350, SEL-3355, SEL-3360)


Wide-Area Communications (SEL ICON®)

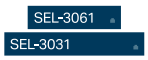

Modular I/O and Real-Time Automation Control (SEL-2240 Axion®)




Real-Time Automation Control (SEL-3530/3530-4, SEL-3555, SEL-3505/3505-3, SEL-3560)


Cybersecurity (SEL-3620, SEL-3622)


Rugged Ethernet Networking (SEL-2730M, SEL-2730U, SEL-2725, SEL-2740S)




Encrypted Wireless Communication (SEL-3031, SEL-3061)


Bluetooth® Serial Communication (SEL-2924, SEL-2925)


High-Speed Remote I/O (SEL-2507)


Fiber-Optic Communication (Fiber-Optic Transceivers)


Control Power Source Diversity (SEL-RPM)

## Industrial/Commercial


Motor Protection (SEL-710-5, SEL-849, MOTORMAX®)


Power Quality and Revenue Metering (SEL-735)


Annunciation and Notification (SEL-2522, SEL-2523, SEL-2533)


Programmable Automation Control (SEL-2411, SEL-2411P, SEL-2440)


Feeder Protection With Arc-Flash Detection (SEL-751)


Rugged Ethernet Networking (SEL-2740S, SEL-2742S)


Fast Motor Bus Transfer (SEL-700BT, SEL-451)

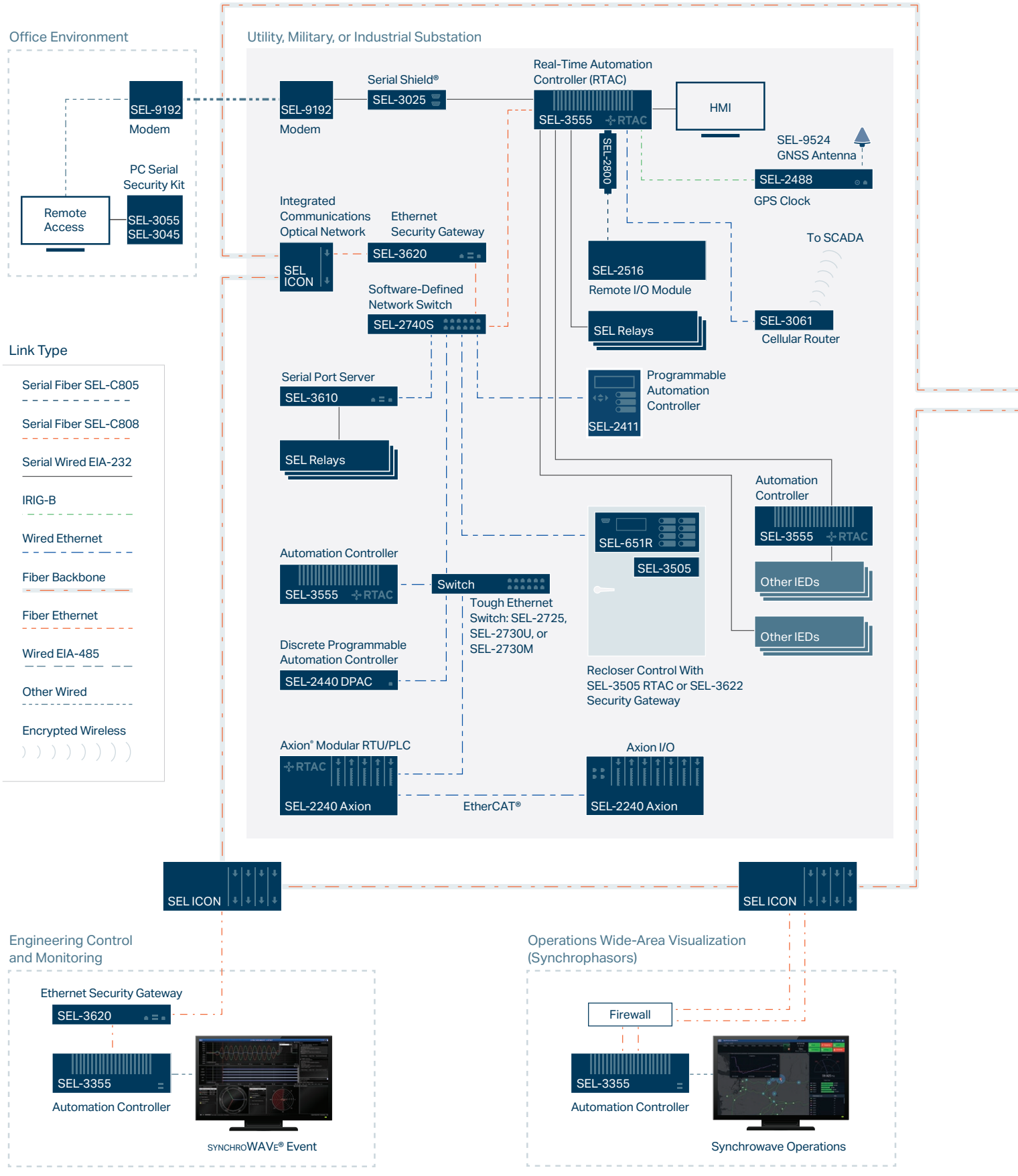

Industrial Automation and Computing (SEL-3350, SEL-3355, SEL-3360)

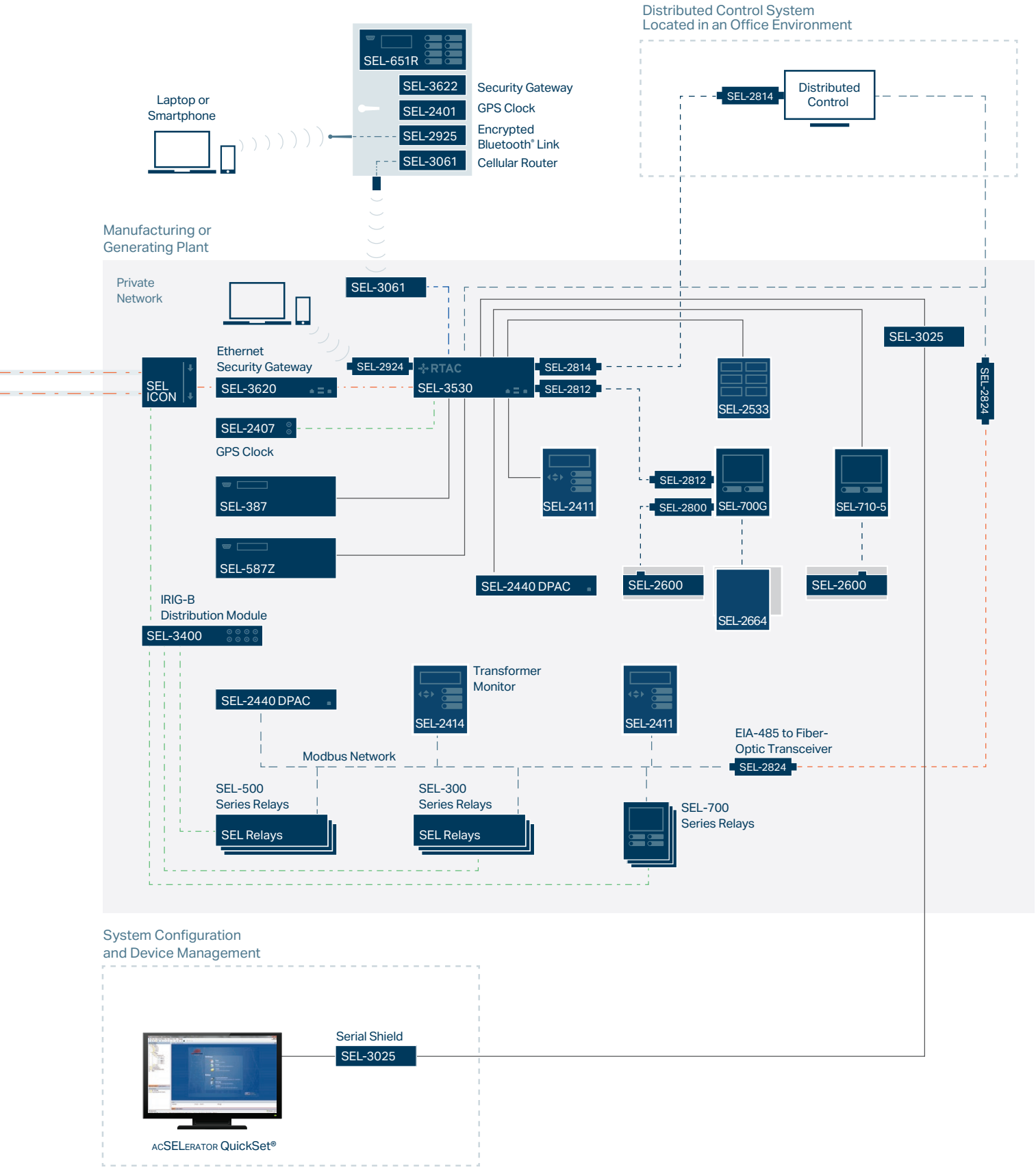

Modular I/O and Real-Time Automation Control (SEL-2240 Axion)


Cybersecurity (SEL-3620, SEL-3622)


Wireless Communications (SEL-3061)

# Example Network Communications Diagram




Distributed Control System
Located in an Office Environment
SEL-2814
Distributed Control
Laptop or Smartphone
SEL-651R
SEL-3622
Security Gateway
SEL-2401
GPS Clock
SEL-2925
Encrypted Bluetooth® Link
SEL-3061
Cellular Router
Manufacturing or Generating Plant
Private Network
SEL-3061
SEL-3025
SEL-2824
Ethernet Security Gateway
SEL-2924
RTAC
SEL-3530
SEL-2814
SEL-2812
SEL ICON
SEL-3620
SEL-2533
SEL-2407
GPS Clock
SEL-2411
SEL-2812
SEL-2800
SEL-700G
SEL-710-5
SEL-387
SEL-587Z
SEL-2440 DPAC
SEL-2600
SEL-2664
SEL-2600
IRIG-B Distribution Module
SEL-3400
SEL-2440 DPAC
Transformer Monitor
SEL-2414
SEL-2411
EIA-485 to Fiber-Optic Transceiver
SEL-2824
Modbus Network
SEL-500 Series Relays
SEL Relays
SEL-300 Series Relays
SEL Relays
SEL-700 Series Relays
System Configuration and Device Management
Serial Shield
SEL-3025
ACSELERATOR QuickSet®

# Generator and Motor Protection Overview

## SEL-400G NEW

Provide unsurpassed protection, integration, control, and monitoring features for all types of generators, including hydropower, pumped-storage hydropower, large steam turbines, and combustion gas turbines.

## SEL-700G

Provide utility and industrial generator protection with an autosynchronizer, flexible I/O, and advanced communications.

## SEL-300G

Implement comprehensive primary and backup generator protection for large and small machines.

## SEL-2664S

Protect high-impedance grounded generators from ground faults at standstill, during startup, and while running.

## SEL-2664

Combine the SEL-2664 with other SEL generator protection devices to continuously monitor field-to-ground resistance and protect critical components, including rotor and stator windings.

## SEL-2600

Measure and transmit data from up to 12 resistance temperature detector (RTD) inputs and one contact input over a single fiber-optic link.

## SEL-700BT NEW

Ensure motor bus system process continuity by allowing the quick transfer of load to an auxiliary feeder during primary feeder line faults.

## SEL-710-5

Provide protection, including optional arc-flash detection, for a full range of medium-voltage, three-phase induction, and synchronous motors.

## SEL-849

Provide current-, voltage-, and thermal-based protection; arc-flash detection; and power metering in motor protection applications.

| Applications | SEL-400G | SEL-700G | SEL-700GT | SEL-700GW | SEL-300G | SEL-700BT | SEL-710-5 | SEL-849 |
|---|---|---|---|---|---|---|---|---|
| Generator Protection | ■ | ■ | + | | ■ | ■ | | |
| Induction Motor Protection | | | | | | | ■ | ■ |
| Synchronous Motor Protection | | | | | | | + | |
| Motor Bus Transfer Protection | | | | | | ■ | | |
| Feeder Protection | | | | ■ | | | | ■ |
| Breaker Failure Protection | ■ | ■ | ■ | | *ƒ* | ■ | ■ | ■ |
| Equipment Thermal Monitoring | ■ | ■ | + | + | + | ■ | + | ■ |
| Generator Intertie Protection | | | ■ | | | | | |
| Synchronism Check | ■ | + | ■ | | + | ■ | | |
| Integrated Synchronizer | + | + | + | | | ■ | | |
| **Instrumentation and Control** | | | | | | | | |
| Breaker Wear Monitor | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Demand Meter | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Load Profile Report | ■ | ■ | ■ | ■ | | ■ | ■ | ■ |
| RTD Inputs | ■ | + | + | + | + | + | + | |
| Ethernet | + | + | + | + | | + | + | ■ |
| IEC 61850 Edition 2 | + | + | + | + | | + | + | + |
| IEC 60870-5-103 | | + | + | + | | + | + | |
| Parallel Redundancy Protocol (PRP) | + | + | + | + | | + | + | ■ |
| DNP3 Serial | ■ | + | + | + | | + | + | + |
| DNP3 LAN/WAN | + | + | + | + | | + | + | + |
| Simple Network Time Protocol (SNTP) | + | + | + | + | | + | + | ■ |
| Built-In Web Server | + | + | + | + | | ■ | + | ■ |
| IEEE 1588 Precision Time Protocol (PTP) | + | + | + | + | | + | + | |
| EtherNet/IP | | + | + | + | | + | + | + |
| Modbus TCP | + | + | + | + | | + | + | + |
| Modbus RTU Outstation | | ■ | ■ | ■ | + | ■ | ■ | ■ |
| Synchrophasors With IEEE C37.118 Protocol | ■ | ■ | ■ | ■ | | | | |
| Mirrored Bits® Communications | ■ | ■ | ■ | ■ | | ■ | ■ | |

| Protection | SEL-400G | SEL-700G | SEL-700GT | SEL-700GW | SEL-300G | SEL-700BT | SEL-710-5 | SEL-849 |
|---|---|---|---|---|---|---|---|---|
| 21P Phase Mho or Compensator Distance | ■ | + | | | ■ | | | |
| 24 Overexcitation (Volts/Hertz) | ■ | ■ | + | | ■ | | | |
| 27/59 Under-/Overvoltage | ■ | ■ | ■ | | ■ | ■ | ■ | + |
| 27I/59I Inverse-Time Under-/Overvoltage | ■ | ■ | ■ | | | ■ | ■ | |
| 32 Directional Power | ■ | ■ | ■ | | ■ | | | + |
| 37 Underpower | | | | | | | ■ | + |
| 40 Loss of Field | ■ | ■ | + | | ■ | | | |
| 46 Current Unbalance | ■ | ■ | + | | ■ | ■ | ■ | ■ |
| 47 Phase Reversal | | | | | | | ■ | ■ |
| 49 Thermal | ■ | ■ | + | | | | ■ | ■ |
| 49R Thermal Overload (Resistance Temperature Detector [RTD]) | ■ | ■ | ■ | ■ | ■ | ■ | + | |
| 50 (P,N,Q) Overcurrent (Phase, Neutral, Negative Sequence) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 50Q Negative-Sequence Overcurrent | | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 51 (N,G) Time Overcurrent (Neutral, Ground) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 51 (P,Q) Time Overcurrent (Phase, Negative Sequence) | ■ | | ■ | ■ | | ■ | ■ | ■ |
| 55 Power Factor | | *ƒ* | *ƒ* | | *ƒ* | | ■ | + |
| 60 Loss of Potential | ■ | ■ | ■ | | ■ | ■ | ■ | + |
| 64G 100 Percent Stator Ground | ■ | + | | | ■ | | | |
| 64F Field Ground | ■ | ■ | + | | ■ | | | |
| 67 (N,G) Directional Overcurrent (Neutral, Ground) | ■ | ■ | ■ | | | ■ | | |
| 78 Out of Step | ■ | + | | | ■ | | ■ | |
| 81 Over-/Underfrequency | ■ | ■ | ■ | | ■ | ■ | ■ | + |
| 87 Current Differential | ■ | + | | | + | | + | |
| REF Restricted Earth Fault | ■ | ■ | + | | | | | |
| Arc-Flash Detection | | | | | | | + | ■ |
| Separate Neutral Overcurrent | ■ | ■ | ■ | | ■ | ■ | ■ | ■ |
| Broken Rotor Bar Detection | | | | | | | ■ | |

■ Standard feature + Model option *ƒ* May be created using settings

# Generator and Motor Protection Applications

## Generator protection

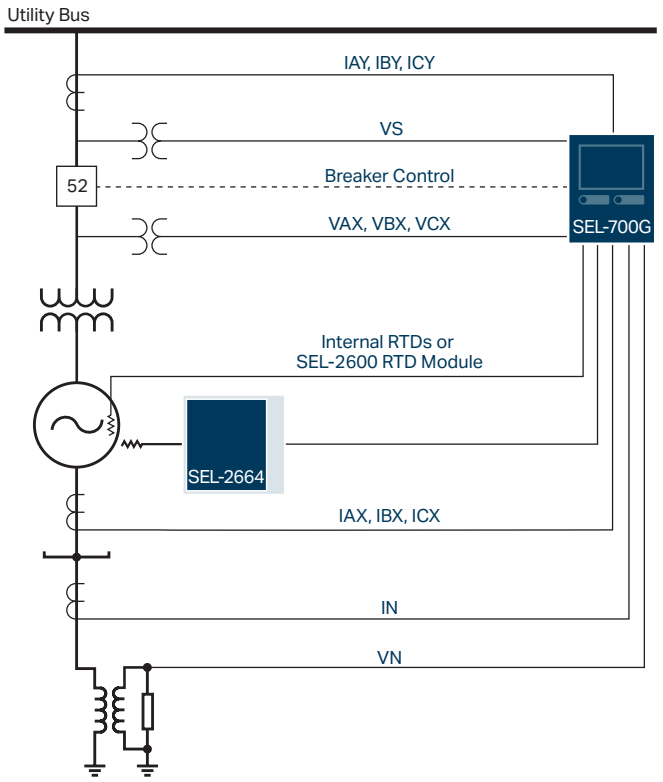
Numerous current, voltage, frequency, distance, power, and out-of-step elements in SEL generator protection relays provide comprehensive protection for large, medium, and small generators.

## Unit protection

Apply sensitive percentage-restrained current differential elements and an unrestrained element, along with synchronism-check and volts-per-hertz elements, to protect both the generator and the step-up transformer. Harmonic-blocking elements protect the unit transformer bushing and end windings while maintaining security for inrush and through-fault conditions.

## Stator/field ground protection

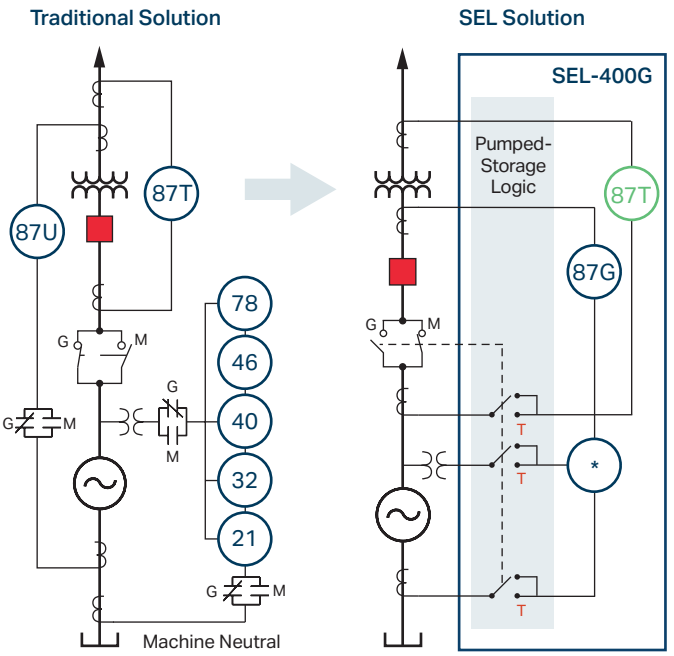
With SEL generator relays, adding the neutral voltage connection provides 100 percent stator ground protection for most machines, based on third-harmonic voltage measurements. Connecting the neutral current input provides protection for solidly grounded or resistance-grounded machines. State-of-the-art voltage injection allows you to monitor field ground resistance.




## Pumped-storage hydropower protection NEW

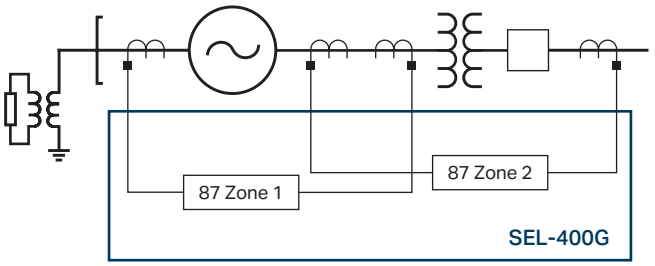
Internal logic in the SEL-400G Advanced Generator Protection System provides pumped-storage hydropower protection without additional equipment to compensate for the phase transposition between pumping and generating. The SEL-400G switches protection element phase currents and voltages at the correct times to ensure protection during pumping and generating. This eliminates the need for separate generation and motor protective relays or external relays to switch the CT/PT wiring, reducing complexity and expenses. Two separate differential zones, with independent frequency tracking and multiple sets of current inputs, eliminate the need to disable protective functions during starting and dynamic braking.

The SEL-400G handles the switching of all the protection elements and connections in the relay when operating in motor or generator mode. Traditionally, this required extensive external switching, which is prone to error. With two differential elements, the relay can also protect the transformer.



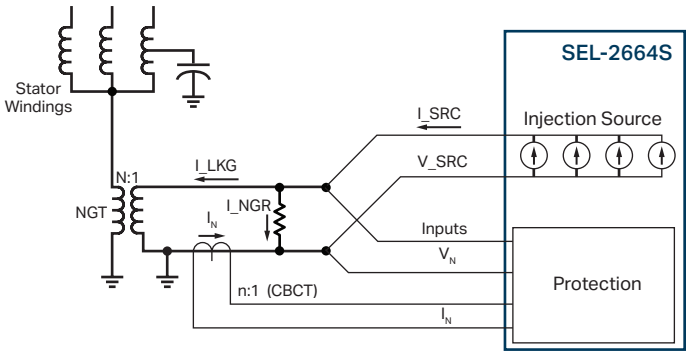
## Dual differential zone protection NEW

The SEL-400G Advanced Generator Protection System has two independent, universal differential elements, which provide protection for two independent protection zones. This allows separate generator and step-up transformer protection in a single device.




## Injection-based stator ground protection

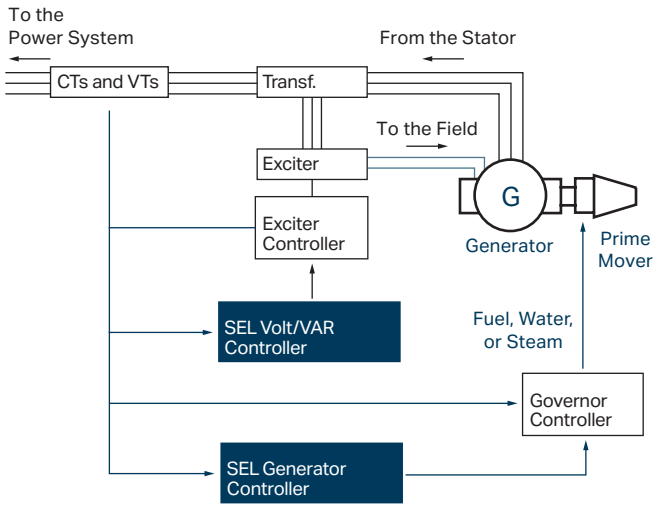
Frequency injection takes advantage of capacitive coupling between the stator winding and the ground. An injected signal passes through this higher impedance capacitive coupling to the ground. If a fault exists at any point in the stator winding, the injected signal will have a much lower impedance path to the ground. By monitoring the impedance to the ground using the injected signal, you can determine if a fault condition exists anywhere along the entire length of the winding. The SEL-2664S Stator Ground Protection Relay injects four frequencies to ensure that the machine is protected at all times, including during startup or over-speed conditions.




## Automatic generator control

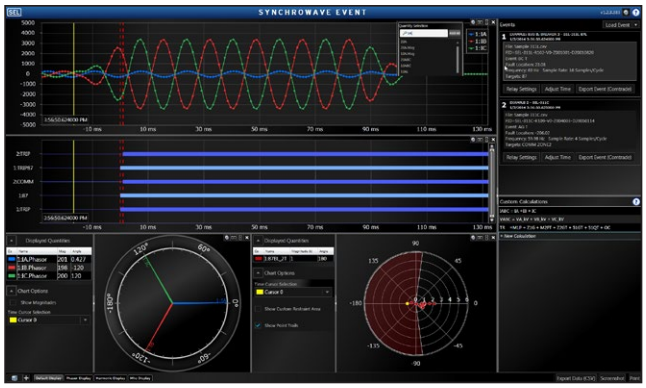
SEL's generation control system regulates generator power outputs and manages utility interties to maximize system stability, minimize electrical disturbances, and mitigate load-shedding requirements. The SEL-700G Generator Protection Relay in combination with the SEL POWERMAX® Power Management and Control System can balance generation loading, control tie line power flow, and maintain bus voltage.

The automatic MVAR and voltage control system maintains MVAR flows on interties and system bus voltages by controlling load tap changers, generator field and large synchronous motor exciters, synchronous and static condensers, and capacitor banks.



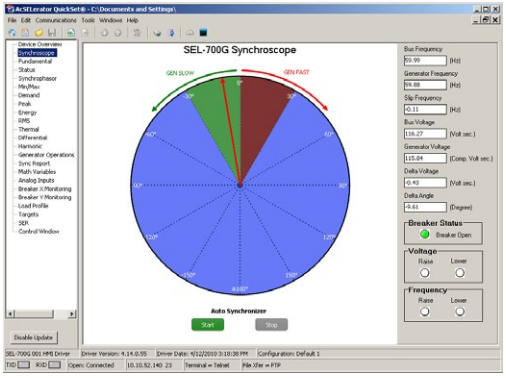
## Advanced generator monitoring and reporting

With SEL software and generator relays, you can view autosynchronizer, Sequential Events Recorder (SER), and 180-cycle oscillographic event reports to analyze generator startup, shutdown, or system faults. You can also measure electrical, thermal, and generator run-time quantities. The breaker monitor function in the SEL-400G Advanced Generator Protection System and in the SEL-700G Generator Protection Relay lets you record accumulated breaker contact wear using manufacturer specifications for defining breaker operation limits. The relay's circuit breaker monitor tracks the total number of close/open operations and interrupted current to determine the percent of contact wear.




## Automatic synchronization

SEL synchronizing systems measure the voltage and frequency of generator and utility systems, sending correction pulses to adjust the governor and exciter as necessary and automatically close the breaker on synchronization. This process enables safe, secure, unattended synchronization of generation with the power system. Users can also visualize and synchronize system parameters on SEL devices available with a color touchscreen display.

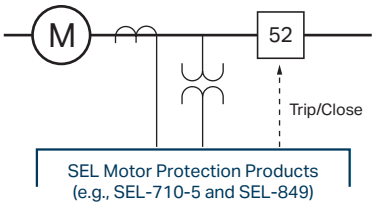



## Synchronized phasor measurement

Combine the SEL-700G Generator Protection Relay or SEL-400G Advanced Generator Protection System with an SEL IRIG-B time source to measure the system angle in real time. The SEL-700G offers a timing accuracy of ±10 µs, and the SEL-400G is accurate to 1 µs. You can measure instantaneous voltage and current phase angles in real time to improve system operation with synchrophasor information. With SEL-5078-2 SYNCHROWAVE® Central Software, you can view system angles at multiple locations for precise system analysis and system-state measurement.

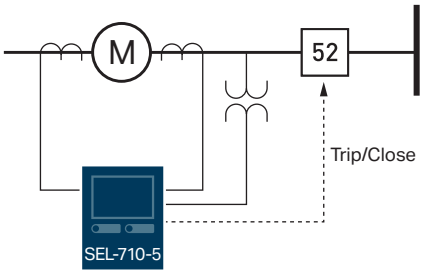
## Motor protection

Protect a wide variety of low- and medium-voltage three-phase induction and synchronous motors using the SEL family of motor protection relays. Phase and neutral current elements feed accurate thermal models that track motor thermal characteristics during the stop/start/run cycles of the motor. One common application is a current-based protection scheme for across-the-line motor starting. Adding the voltage option to certain SEL motor relays enables the slip-dependent AccuTrack™ Thermal Model.




## Differential motor protection

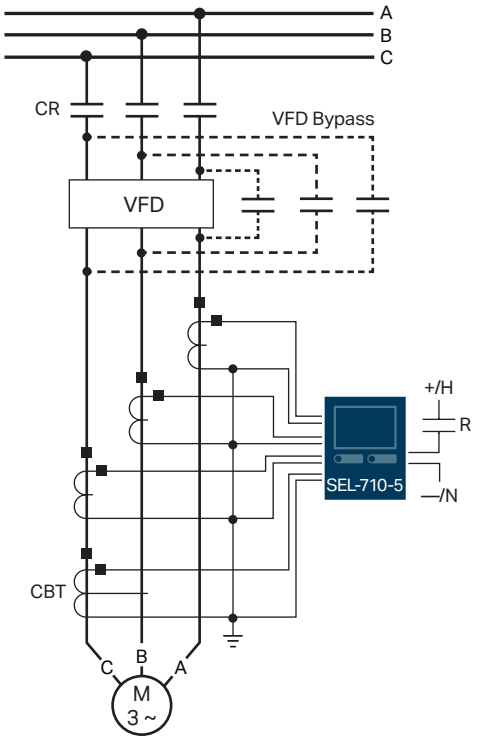
Use optional differential elements to protect the windings in high-value or critical-process motors.




## Variable-frequency drive (VFD) motors

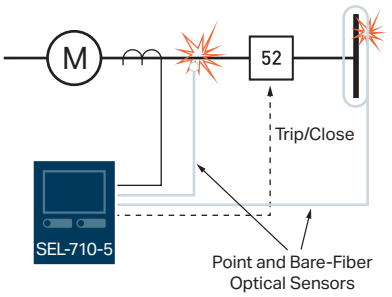
The SEL-710-5 Motor Protection Relay can protect VFD-fed motors, with an enhanced thermal model that tracks key motor characteristics during the stop/start/run cycles of the motor. VFDs are widely used to control the speed of ac motors for conveyor systems, blower speeds, electrical propulsion systems, and other applications that require variable speed.

When VFDs operate induction motors at low speeds, they may lack sufficient airflow to provide adequate cooling. The SEL-710-5 monitors this condition and dynamically compensates for the reduced cooling to provide thermal protection for the motor.



## Arc-flash mitigation

Arc-flash mitigation improves worker safety by reducing the incident energy of the arc flash. Supervised by phase overcurrent elements, SEL relays with arc-flash detection provide secure and fast arc-flash mitigation. The fast response, in as little as 2–4 ms using high-speed, high-current interrupting output contacts, also reduces equipment damage and maintains process continuity.

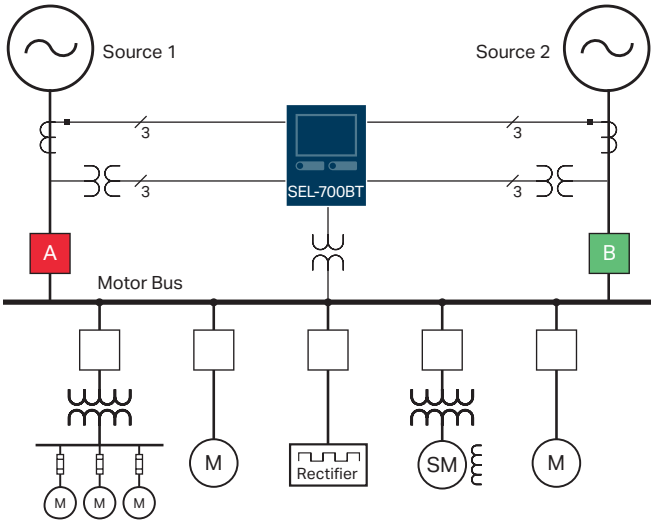



## Fast motor bus transfer NEW

Preserve critical process operations and reduce equipment damage with the SEL-700BT Motor Bus Transfer Relay, which features built-in logic for the following transfer modes:

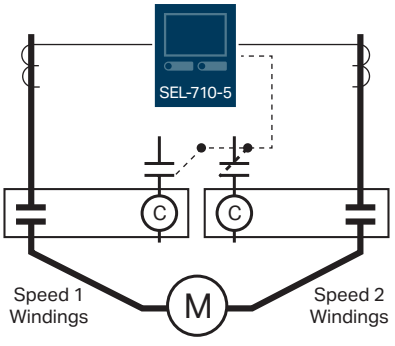
- Fast transfer mode, which switches the motor bus to an alternate source with no intentional delay.
- In-phase transfer mode, which uses phase angle and voltage measurements to safely connect the alternate source by minimizing transient torques and process interruptions.
- Residual voltage and fixed-time transfer modes, which restore power safely in cases where fast and in-phase bus transfers do not occur.

You can manually transfer motor bus loads, or the relay can automatically select one of the transfer modes based on system conditions, maximizing speed, ensuring processes continuity, and minimizing transient torque on machines and equipment.



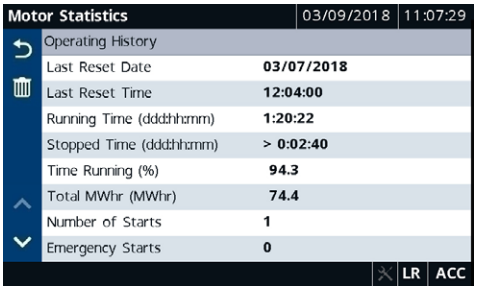

## Flexible motor starting

Take advantage of your SEL relay's ability to control multiple contactors, and apply motor protection in configurations for two-speed motors, full-voltage reversing, and star-delta (reduced-voltage) starting. This diagram shows interlocking contactors for a two-speed start.



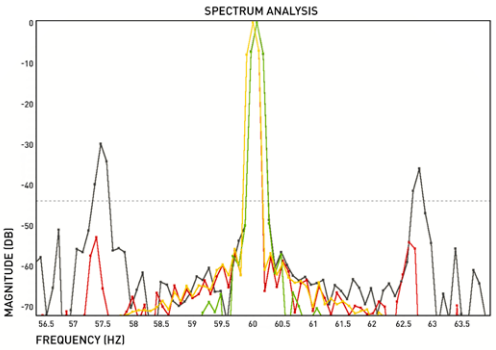

## Asset monitoring

Track the operating characteristics of your motor and accompanying devices with the built-in asset-monitoring capability. The SEL-710-5 Motor Protection Relay can track items, such as vibration, motor start current, motor start times, motor stop times, broken rotor bars, incipient faults, and excessive wear on molded case circuit breakers, in one easy-to-read report via the ASCII terminal or the touchscreen display. This enables you to reduce production losses from unexpected equipment failures and to lower maintenance costs by switching to predefined maintenance schedules.



## Broken rotor bar detection and spectral analysis

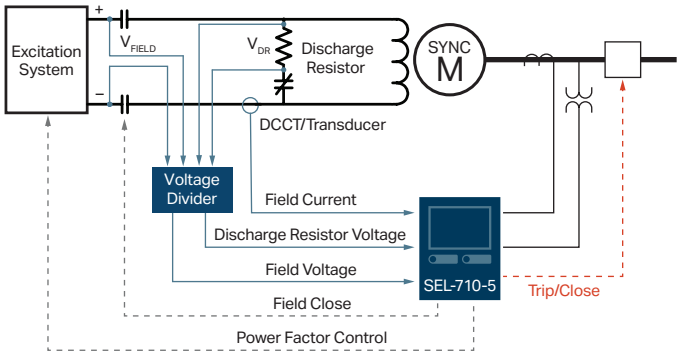
Broken rotor bar detection is an optional feature in the SEL-710-5 Motor Protection Relay. Fully loaded induction machines with broken rotor bars display unique frequency signatures as side-bands to the fundamental frequency. The magnitude of resulting side-band frequencies correlates to the number of broken rotor bars. The image shows a spectrum of a running motor with three broken rotor bars. The SEL-710-5 lets you catch rotor bar damage before it causes catastrophic damage to the motor.




## Synchronous motor protection

Select the SEL-710-5 Motor Protection Relay with the synchronous motor protection option to start and protect synchronous motors. With the SEL-710-5, you can monitor field voltage and current and effectively respond to loss-of-field, field resistance, out-of-step, power factor, and reactive power issues.

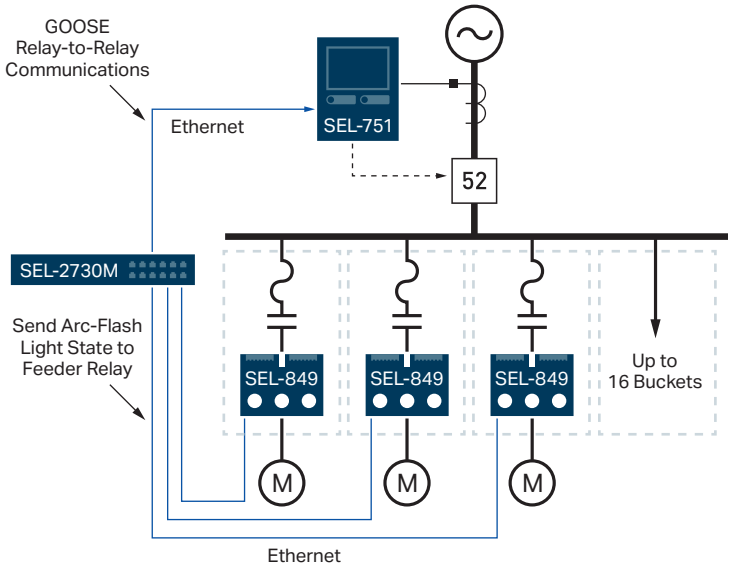
Shown here is a brush-type synchronous motor application where the field winding is connected to the relay through a voltage divider module.




## Centralized motor control

Create fully integrated motor control solutions with SEL motor relays, which include communications and protocol options that simplify device integration. This application shows SEL-849 Motor Management Relays in motor control center (MCC) buckets networked through an SEL-2730M Managed 24-Port Ethernet Switch. The relays share arc-flash detection data with the feeder relay using IEC 61850 GOOSE messaging.

For turnkey applications that require a smart integrated MCC, the SEL MOTORMAX® Low-Voltage Motor Management and Protection System combines motor protection, network management, and real-time automation control. MOTORMAX is a customizable motor management and control system that scales to fit any application. It delivers high-performance motor protection as well as high-speed reporting of motor status, alarms, and operating conditions at the HMI, allowing you to see the bigger picture.



# SEL-400G

## Advanced Generator Protection System NEW

Starting price
**$12,000 USD**

selinc.com/products/400G

The SEL-400G offers unsurpassed protection, integration, control, and monitoring features for all types of generators, including hydro, pumped-storage hydro, large steam turbines, and combustion gas turbines. The relay combines generator, generator bus, and generator step-up (GSU) transformer protection in one package. The SEL-400G also includes SEL Grid Configurator to help you quickly create, manage, and deploy settings for SEL power system devices.

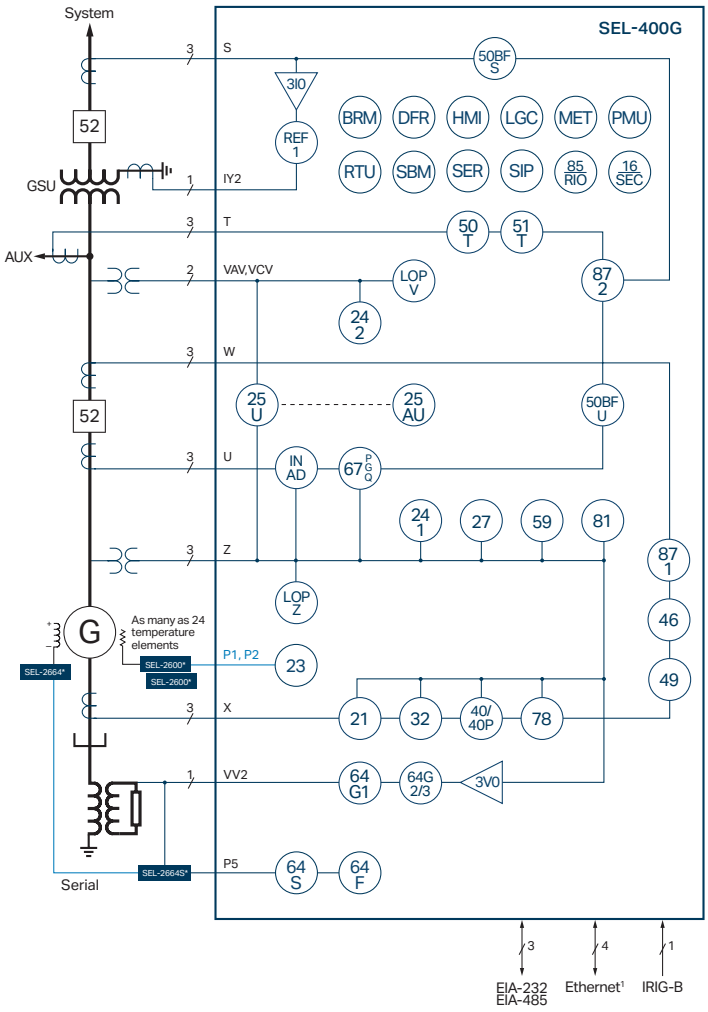
Numerous current and voltage inputs on the SEL-400G enable complex generator protection schemes or protection of other equipment, such as transformers. It detects ground faults across 100 percent of the stator winding and also detects stator winding turn-to-turn faults.

Two independent universal differential elements provide protection for two independent protection zones, which allows protection of both the generator and GSU transformer with a single SEL-400G.

The wide-range frequency tracking (5 to 120 Hz) enables protection during startup when frequencies are low because the generator is not spinning fast. In addition, pumped-storage logic enables pumped-storage hydro protection without the need for external relays to switch CT wiring, which lowers costs and improves reliability.


1. EIA-232 front serial port is quick and convenient for system setup and local access.
2. Front-panel display allows operators to control and view the status of disconnects and breakers.
3. User-selectable mimic screens show the system configuration in one-line diagram format.
4. Easy-to-use keypad aids simple navigation.
5. Front-panel, tricolor LEDs indicate custom alarms and provide fast and simple information to assist dispatchers and line crews with rapid power restoration.
6. Programmable operator pushbuttons with user-configurable labels allow front-panel customization.
7. Choose from a horizontal panel-mount or rack-mount chassis.
8. Communications protocols include FTP, Telnet, synchrophasors, DNP3 LAN/WAN, the Parallel Redundancy Protocol (PRP), the IEEE 1588 Precision Time Protocol Version 2 (PTPv2),** and IEC 61850 Edition 2.
9. Use three rear EIA-232 ports for Mirrored Bits® communications, DNP3, SCADA, and engineering access.
10. The 18 current and 6 voltage channels can be configured for a variety of applications.
11. Power supply options include: 24–48 Vdc; 48–125 Vdc or 110–120 Vac; or 125–250 Vdc or 110–240 Vac.

**For PTPv2 implementation, Ports 5A and 5B must be ordered as an option.




## ANSI Functions

| | |
|---|---|
| 21 | Phase Distance |
| 23 | RTD Temperature—SEL-2600 |
| 24 | Volts/Hertz |
| 25 | Synchronism Check |
| 25A | Autosynchronizer |
| 27 | Undervoltage |
| 32 | Directional Power |
| 40 | Loss of Field |
| 40P | Capability-Based Loss of Field |
| 46 | Current Unbalance |
| 49 | IEC 60255-Compliant Thermal Model |
| 50BF | Breaker Failure Overcurrent |
| 50N | Neutral Overcurrent |
| 50 (P,G,Q) | Overcurrent (Phase, Ground, Negative Sequence) |
| 51N | Neutral Time Overcurrent |
| 51 (P,G,Q) | Time Overcurrent (Phase, Ground, Negative Sequence) |
| 59 | Overvoltage |
| 64G1 | Stator Ground (Fundamental Neutral Overvoltage) |
| 64G2 | Third-Harmonic Difference/Undervoltage |
| 64G3 | Third-Harmonic Ratio |
| 64F | Rotor Ground—SEL-2664 |
| 64S | Stator Ground (Harmonic Injection)—SEL-2664S |
| 67 (P,G,Q) | Directional Overcurrent (Phase, Ground, Neg. Seq.) |
| 78 | Out of Step |
| 81 (O,U) | Over- and Underfrequency |
| 81A | Accumulated Frequency |
| 85 (O,U) | Over- and Under-Rate-of-Change of Frequency |
| 85 RIO | SEL Mirrored Bits Communications |
| 87 (U,R,Q) | Universal Differential (Unrestrained, Restrained, Negative Sequence) |
| DFR | Event and Disturbance Reports |
| HMI | Operator Interface |
| INAD | Inadvertent Energization |
| LGC | Expanded SELogic® Control Equations |
| LOP | Loss of Potential |
| MET | High-Accuracy Metering |
| PMU | Synchrophasors |
| REF | Restricted Earth Fault |
| RTU | Remote Terminal Unit |
| SER | Sequential Events Recorder |

## Additional Functions

| | |
|---|---|
| 16 SEC | Access Security (Serial, Ethernet) |
| BRM | Breaker Wear Monitor |
| LDP | Load Data Profiling |
| SBM | Station Battery Monitor |
| SIP | Software-Invertible Polarities |

*Optional feature [1]Copper or fiber-optic

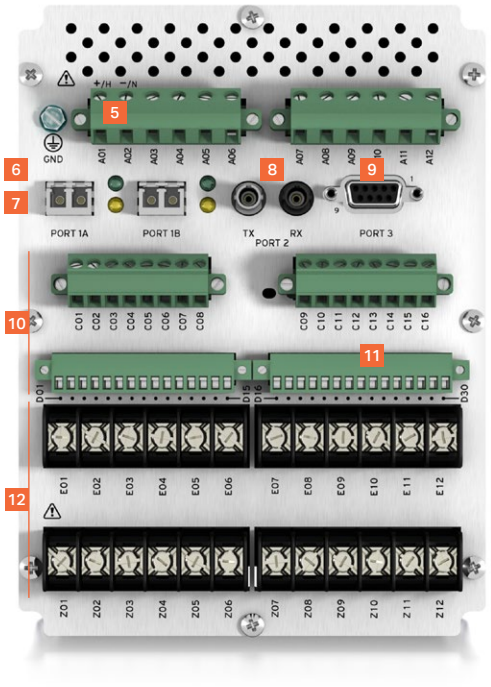
# SEL-700G

## Generator Protection Relay

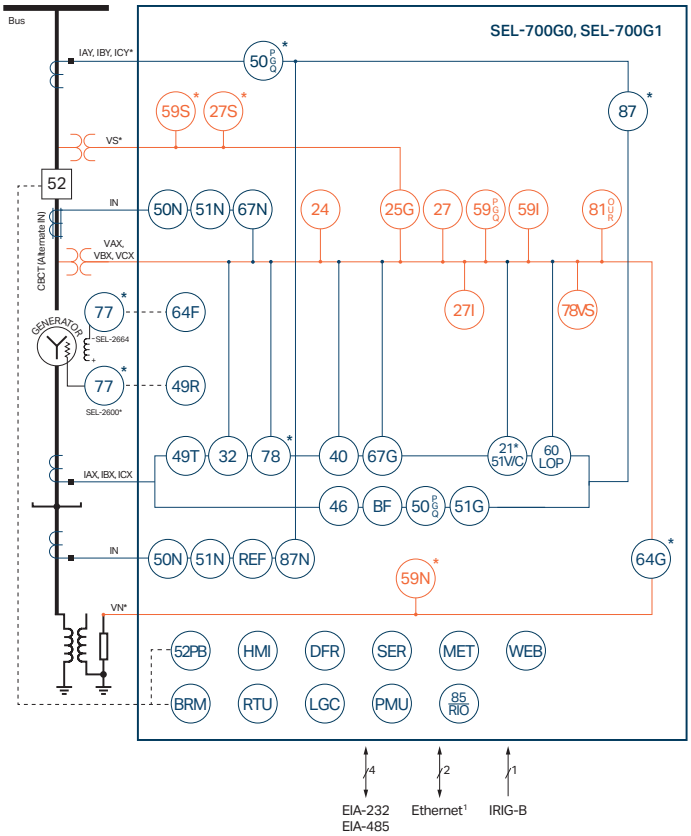
Starting price
**$2,590 USD**

selinc.com/products/700G

The SEL-700G provides comprehensive primary and backup generator protection. With an autosynchronizer, flexible I/O, built-in web server, and advanced communications, it is the right solution for utility and industrial generator protection.


1. The 5-inch, 800 × 480 display offers direct navigation via a capacitive touchscreen.
2. Folders and applications provide quick access to bay screens, metering and monitoring data, reports, settings, and more.
3. Programmable front-panel LEDs with user-configurable labels alert operators to faulted phases, the relay's status, and element operation.
4. Programmable operator pushbuttons with user-configurable labels allow front-panel customization.
5. Power supply options include 24–48 Vdc or 110–250 Vdc/110–240 Vac.
6. An integrated web server enables direct relay access for metering and monitoring data without the need for external PC software.
7. A wide variety of communications protocols and media provide flexibility to communicate with other devices and control systems.
8. Fiber-optic serial port.
9. Mirrored Bits® communications provides fast and reliable relay-to-relay communication.
10. Positions for optional expansion cards.
11. Optional RTD inputs.
12. Voltage and current inputs.




## Model Comparison Table

You can customize the SEL-700G for specific applications by selecting preconfigured model options.

| Model | Application |
|---|---|
| SEL-700G0 or SEL-700G0+ | Basic generator protection |
| SEL-700G1 or SEL-700G1+ | Full generator protection |
| SEL-700GT | Intertie protection |
| SEL-700GT+ | Intertie and generator protection |
| SEL-700GW | Basic dual-feeder protection |

## ANSI Functions

| | |
|---|---|
| 21C/51VC | Compensator Distance, Voltage Restrained/Controlled Time Overcurrent |
| 24 | Volts/Hertz |
| 25G | Synchronism Check |
| 27 | Undervoltage |
| 27I | Inverse-Time Undervoltage |
| 27S | Synchronism Undervoltage |
| 32 | Directional Power |
| 40 | Loss of Field |
| 46 | Current Unbalance |
| 49R | Thermal Overload (Resistance Temperature Detector [RTD]) |
| 49T | Thermal Model |
| 50N | Neutral Overcurrent |
| 50 (P,G,Q) | Overcurrent (Phase, Ground, Negative Sequence) |
| 51 (P,G,Q) | Time Overcurrent (Phase, Ground, Negative Sequence) |
| 51N | Neutral Time Overcurrent |
| 59I | Inverse-Time Overvoltage |
| 59N (64G1) | Neutral Overvoltage |
| 59S | Synchronism Overvoltage |
| 59 (P,G,Q) | Overvoltage (Phase, Ground, Negative Sequence) |
| 60 | Loss of Potential |
| 64F | Field Ground |
| 64G | 100% Stator Ground |
| 67 (P,G,Q) | Directional Overcurrent (Phase, Ground, Negative Sequence) |
| 67N | Directional Neutral Overcurrent |
| 78 | Out of Step |
| 78VS | Vector Shift |
| 81 (O,U,R) | Frequency (Over, Under, Rate) |
| 87 | Three-Phase Current Differential |
| 87N | Neutral Current Differential |
| REF | Restricted Earth Fault |

## Additional Functions

| | |
|---|---|
| 52PB | Pushbutton Trip/Close |
| 85 RIO | SEL Mirrored Bits Communications |
| BF | Breaker Failure |
| BRM | Breaker Wear Monitor |
| DFR | Event Reports |
| ENV | SEL-2600 RTD Module* |
| HMI | Operator Interface |
| LDP | Load Data Profiling |
| LGC | SELogic® Control Equations |
| MET | High-Accuracy Metering |
| PMU | Synchrophasors |
| RTU | Remote Terminal Unit |
| SER | Sequential Events Recorder |
| WEB | Web Server |

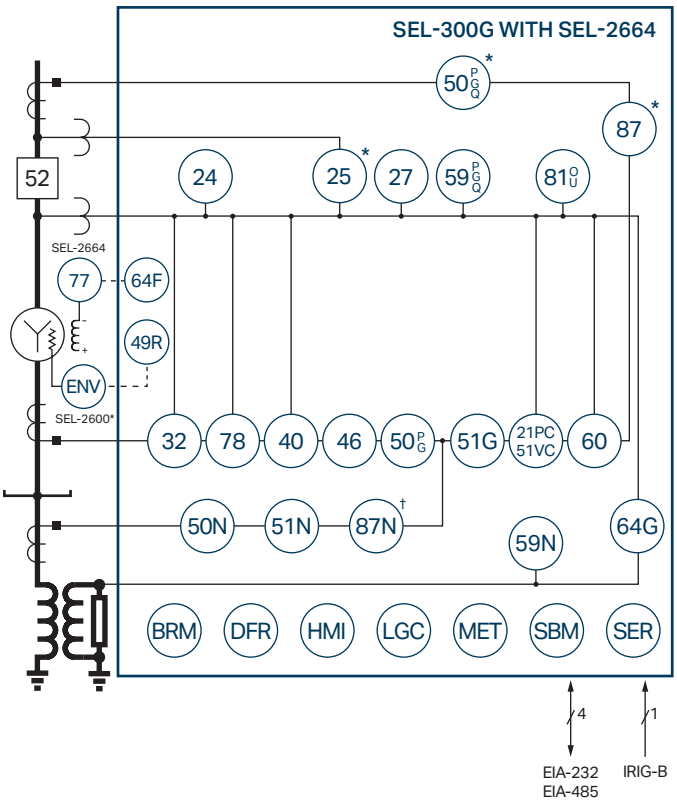
*Optional feature [1]Copper or fiber-optic

# SEL-300G
## Generator Relay

Starting price
**$3,210 USD**

selinc.com/products/300G

The SEL-300G provides proven primary and backup protection for utility and industrial generators, meeting IEEE turbine protection standards. High-speed protection for all types of phase and ground faults limits equipment damage and speeds up repairs. Current and voltage elements protect large and small generators against faults, and optional differential protection provides sensitive and fast protection for generators and unit transformers. In addition, harmonic blocking improves security when transformers are in the generator differential zone. The SEL-300G provides 100 percent stator ground fault protection, using fundamental and third-harmonic voltage signals to protect high-impedance grounded generators. Adding the SEL-2664 Field Ground Module lets you detect field ground faults whether the generator is operating, stopped, or de-energized.


### ANSI Functions

| | |
|---|---|
| 21PC/51VC | Phase Mho or Compensator Distance Voltage Restrained/Controlled Time Overcurrent |
| 24 | Volts/Hertz |
| 25 | Synchronism Check* |
| 27 | Undervoltage |
| 32 | Directional Power |
| 40 | Loss of Field |
| 46 | Negative-Sequence Overcurrent |
| 49R | Thermal Overload |
| 50N | Neutral Overcurrent |
| 50 (P,G,Q) | Overcurrent (Phase, Ground, Negative Sequence)* |
| 51G | Ground Time Overcurrent |
| 51N | Neutral Time Overcurrent |
| 59N | Neutral Overvoltage |
| 59 (P,G,Q) | Overvoltage (Phase, Ground, Negative Sequence) |
| 60 | Loss of Potential |
| 64F | Field Ground |
| 64G | 100 Percent Stator Ground |
| 78 | Out of Step |
| 81 (O,U) | Over-/Underfrequency |
| 87 | Three-Phase Current Differential* |
| 87N | Neutral Current Differential† |

### Additional Functions

| | |
|---|---|
| BRM | Breaker Wear Monitor |
| DFR | Event Reports |
| ENV | SEL-2600 RTD Module* |
| HMI | Operator Interface |
| LGC | SELOGIC® Control Equations |
| MET | High-Accuracy Metering |
| SBM | Station Battery Monitor |
| SER | Sequential Events Recorder |

*Optional feature †Available in models that do not specify 87 element

# SEL-2664S

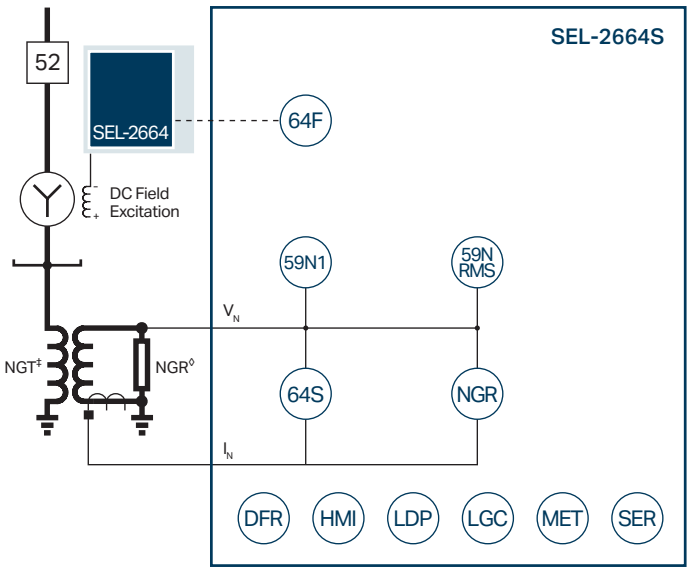
## Stator Ground Protection Relay

Starting price
**$9,320 USD**

selinc.com/products/2664S

The SEL-2664S uses multisine frequency injection and neutral overvoltage-based protection to protect high-impedance grounded generators from ground faults at standstill, during startup, and while running. Up to four individual injected frequencies eliminate protection blind spots during generator startup.

Use the SEL-2664S as a standalone protection device or with the SEL-400G Advanced Generator Protection System, SEL-300G Generator Protection Relay, or SEL-700G Generator Protection Relay. For complete ground fault protection on both the rotor and stator, you can add the SEL-2664 Field Ground Module to the SEL-2664S.


‡Neutral grounding transformer
◊Neutral grounding resistor

### ANSI Functions

| | |
|---|---|
| 59N | Stall-Speed Switch |
| 64F | Undervoltage* |
| 64S | Undercurrent/Underpower* |

### Additional Functions

| | |
|---|---|
| DFR | Event Reports |
| HMI | Operator Interface |
| LDP | Profile Report Monitoring |
| LGC | SELOGIC® Control Equations |
| MET | Metering |
| NGR | Neutral Grounding Resistor Open/Short |
| SER | Sequential Events Recorder |

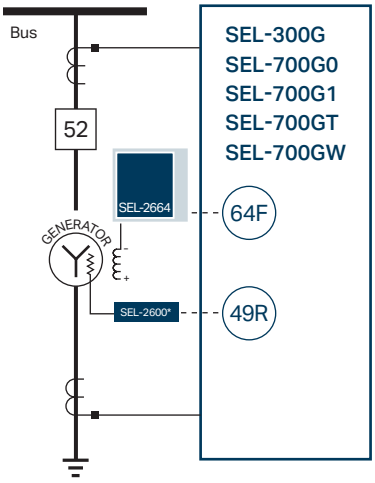
*Optional feature

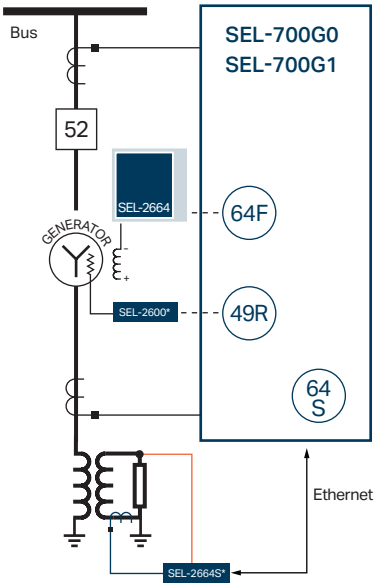
# SEL-2664
## Field Ground Module

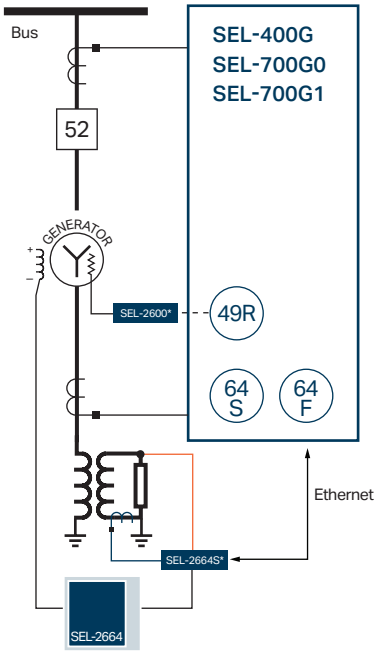
Starting price
**$1,560 USD**

selinc.com/products/2664

The SEL-2664 integrates with the SEL-300G Generator Relay or SEL-700G Generator Protection Relay to protect all the critical components in your generator. You can add the SEL-2664 to the SEL-2664S Stator Ground Protection Relay for complete ground fault protection on both the rotor and stator. Or, you can combine the SEL-2664, SEL-2664S, and SEL-400G Advanced Generator Protection System for an advanced solution.


### ANSI Functions

| | |
|---|---|
| 49R | Thermal Overload (Resistance Temperature Detector [RTD]) |
| 64F | Field Ground |
| 64S | Stator Ground (Harmonic Injection) |

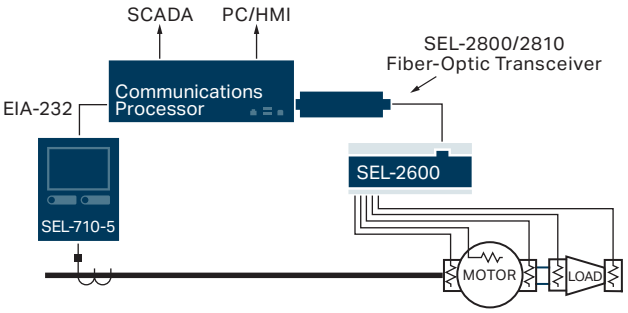
*Optional feature

# SEL-2600
## RTD Module

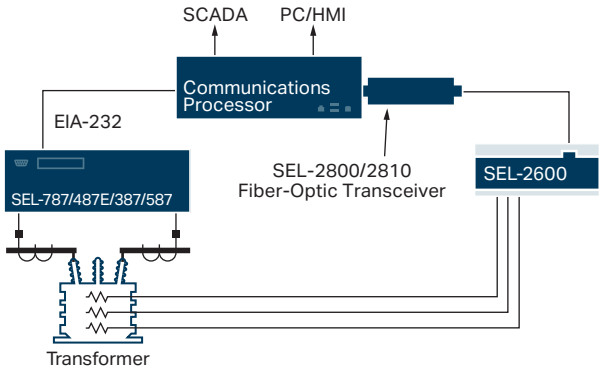
Starting price
**$820 USD**

selinc.com/products/2600 | Select models typically ship in 2 days

The SEL-2600 transmits data from up to 12 resistance temperature detector (RTD) inputs and a single contact input over a fiber-optic link. One module can accommodate multiple RTD types—copper, nickel, and platinum—to reduce equipment costs. With a flexible panel mount and inexpensive fiber-optic communications, you can place the rugged module near equipment to avoid costly cable installation.

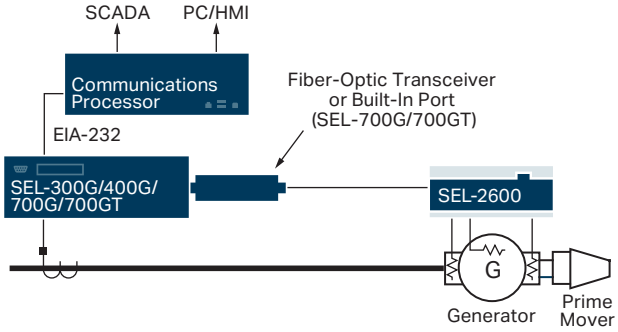



Motor protection with the SEL-710-5.




Transformer protection with the SEL-787, SEL-487E, SEL-387, or SEL-587.

(Note: SEL-387 and SEL-387A relays accept direct SEL-2600 RTD Module connection using SEL-2800 or SEL-2812 Fiber-Optic Transceivers.)




Generator protection with the SEL-300G, SEL-400G, SEL-700G, or SEL-700GT.

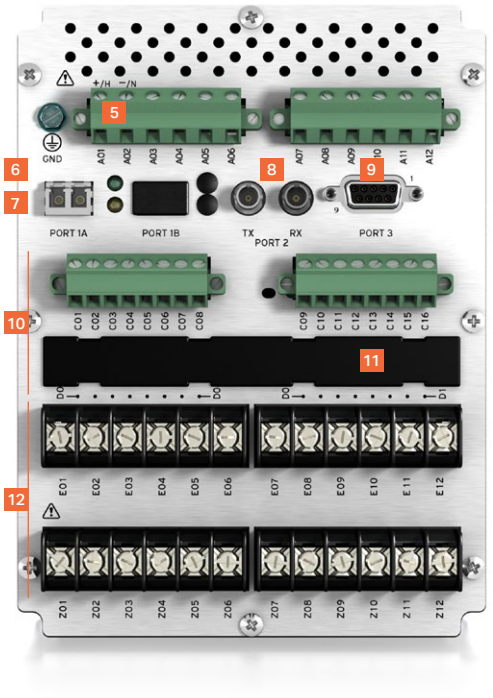
# SEL-700BT

## Motor Bus Transfer Relay NEW

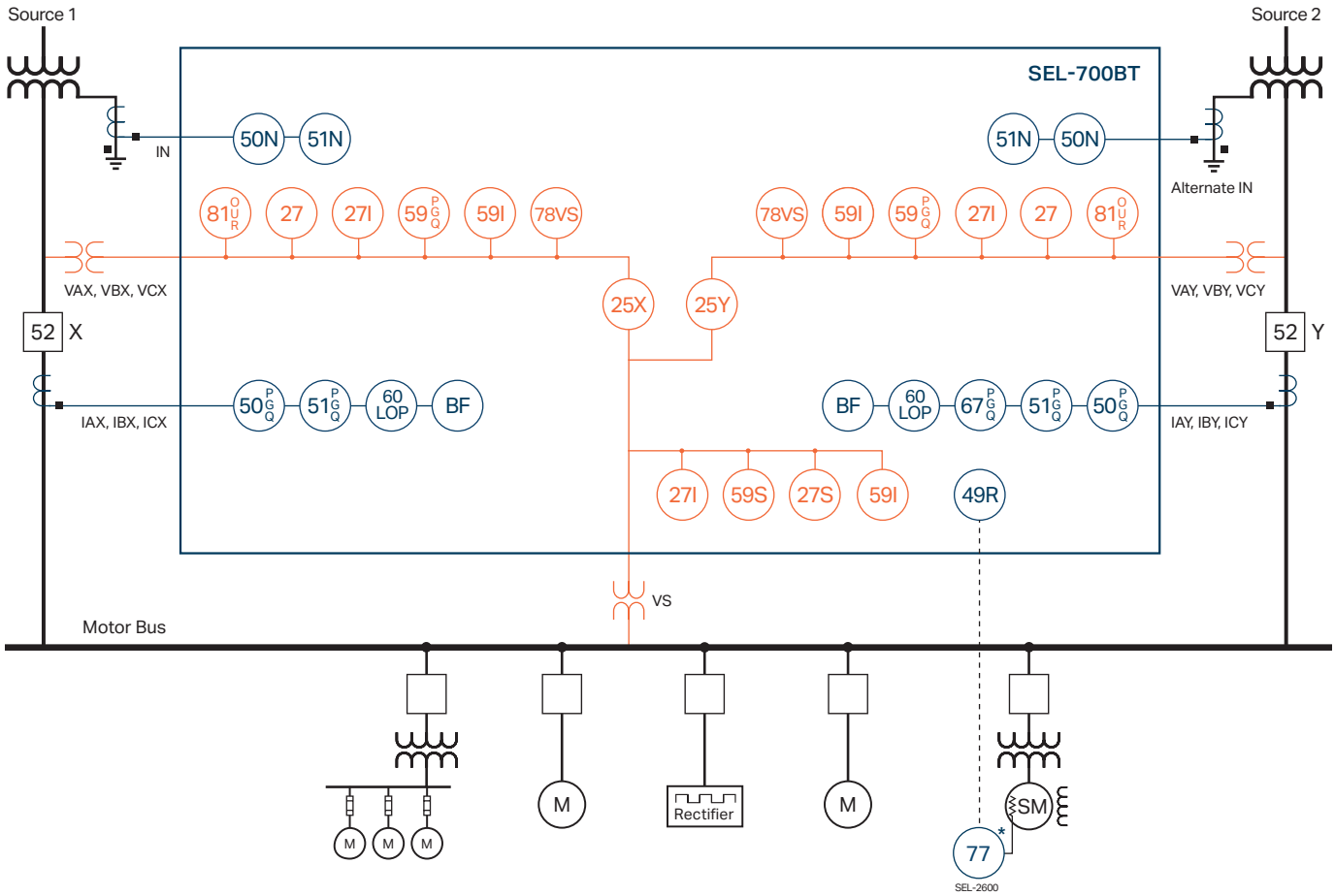
Starting price
**$6,200 USD**

selinc.com/products/700BT | Select models typically ship in 2 days

The SEL-700BT is a single-relay fast motor bus transfer (MBT) solution. Ensure process continuity by transferring critical loads from a primary source to an auxiliary feeder during faults in the primary feeder line. The relay allows automatic and manual transfers of motor buses to keep processes running without requiring a cold start. The SEL-700BT selects from fast, in-phase, residual, and fixed-time bus transfer based on system conditions.


1. The 5-inch, 800 × 480 display offers direct navigation via a capacitive touchscreen.
2. Folders and applications provide quick access to bay screens, metering and monitoring data, reports, settings, and more.
3. Programmable front-panel LEDs with user-configurable labels alert operators to faulted phases, the relay's status, and element operation.
4. Programmable operator pushbuttons with user-configurable labels allow front-panel customization.
5. Power supply options include 24–48 Vdc or 110–250 Vdc, 110–240 Vac.
6. An integrated web server enables direct relay access for metering and monitoring data without the need for external PC software.
7. A wide variety of communications protocols and media provide flexibility to communicate with other devices and control systems.
8. Fiber-optic serial port.
9. Mirrored Bits® communications provides fast and reliable relay-to-relay communication.
10. Positions for optional expansion cards.
11. Optional RTD inputs.
12. Voltage and current inputs.




### ANSI Functions

| | |
|---|---|
| 25G | Synchronism Check |
| 27 | Undervoltage |
| 27I | Inverse-Time Undervoltage |
| 27S | Synchronism Undervoltage |
| 49R | Thermal Overload |
| 50N | Neutral Overcurrent |
| 50 (P,G,Q) | Overcurrent (Phase, Ground, Negative Sequence) |
| 51N | Neutral Time Overcurrent |
| 51 (P,G,Q) | Time Overcurrent (Phase, Ground, Negative Sequence) |
| 59I | Inverse-Time Overvoltage |
| 59S | Synchronism Overvoltage |
| 59 (P,G,Q) | Overvoltage (Phase, Ground, Negative Sequence) |
| 60LOP | Loss of Potential |
| 67 (P,G,Q) | Directional Overcurrent (Phase, Ground, Negative Seq.) |
| 77 | Field Device* |
| 78VS | Vector Shift |
| 81 (O,U,R) | Over-/Underfrequency, Rate-of-Change of Frequency |

### Additional Functions

| | |
|---|---|
| 85 RIO | SEL Mirrored Bits Communications |
| BF | Breaker Failure |
| BRM | Breaker Wear Monitor |
| DFR | Event Reports |
| HMI | Operator Interface |
| LDP | Load Data Profiling |
| LGC | SELogic® Control Equations |
| MET | High-Accuracy Metering |
| SER | Sequential Events Recorder |
| WEB | Web Server |

*Optional feature

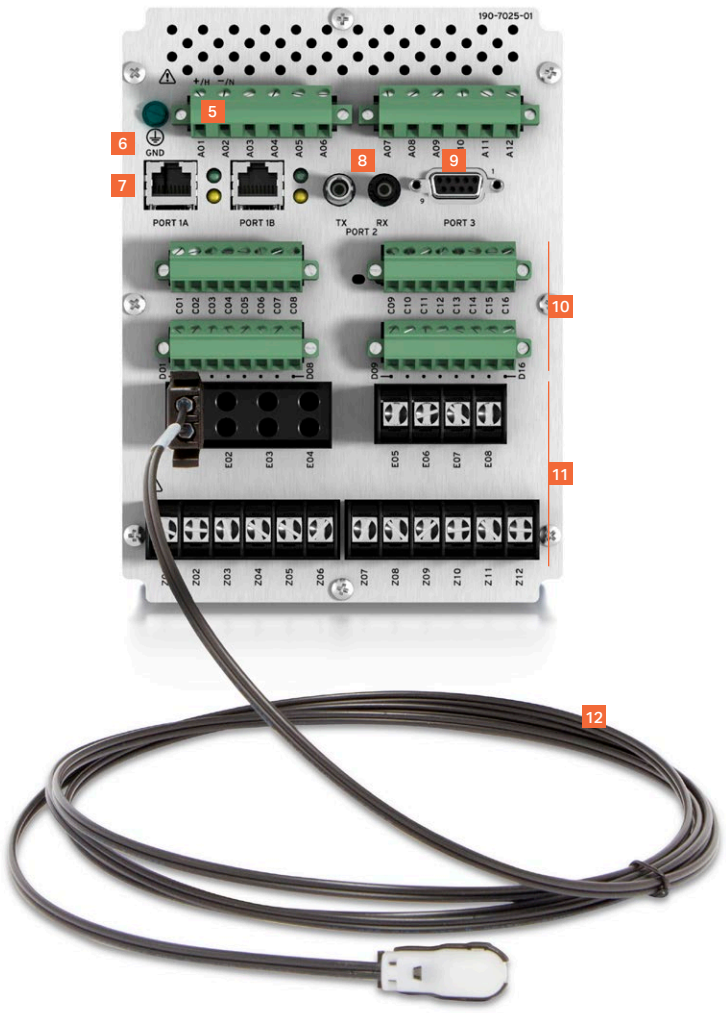
# SEL-710-5

## Motor Protection Relay

Starting price
**$3,110 USD**

selinc.com/products/710-5

A single SEL-710-5 can protect asynchronous (induction) and synchronous motors. Features include broken rotor bar detection, incipient-fault detection, predictive-maintenance capability, and variable-frequency drive (VFD) support as well as options for arc-flash detection (AFD), differential protection, and synchronous motor protection. The synchronous option supports power factor regulation and includes, at no additional cost, a voltage divider accessory to interface with the motor excitation system. Together with the SEL AccuTrack™ Thermal Model, these features provide a solution for all your motor protection applications.


1 The 5-inch, 800 × 480 display offers direct navigation via a capacitive touchscreen.

2 Folders and applications provide quick access to bay screens, metering and monitoring data, reports, settings, and more.

3 Programmable front-panel LEDs with user-configurable labels alert operators to faulted phases, the relay's status, and element operation.

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

5 Power supply options include 24–48 Vdc or 110–250 Vdc/110–240 Vac.

6 An integrated web server enables direct relay access for metering and monitoring data without the need for external PC software.

7 A wide variety of communications protocols and media provide flexibility to communicate with other devices and control systems.

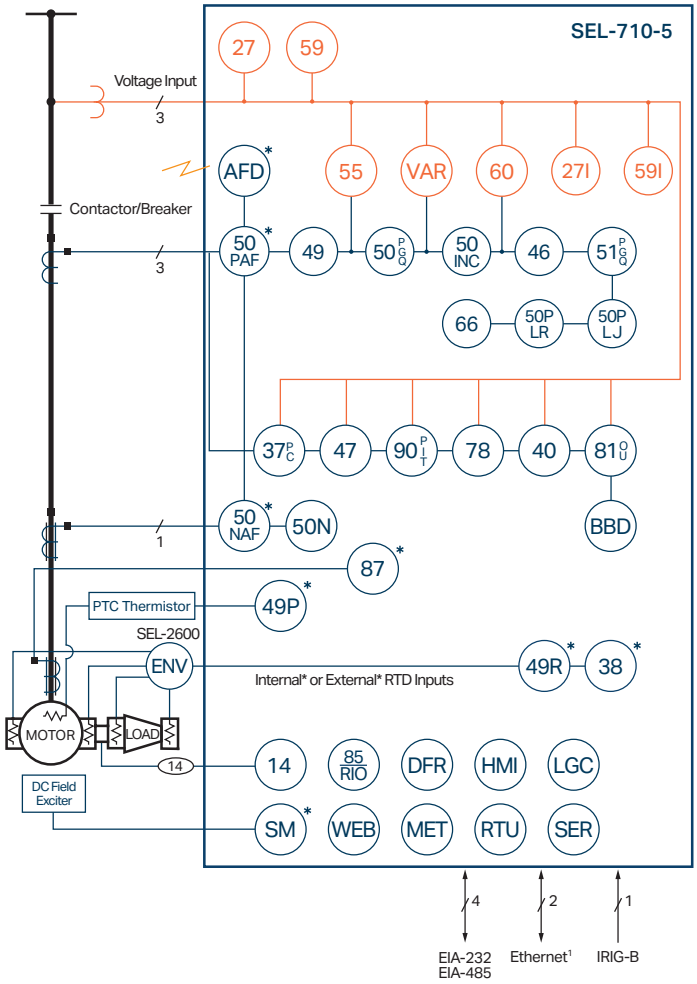
8 Port options include demodulated IRIG-B for precise-time input or a PTC input to protect against overcurrent conditions.

9 Mirrored Bits® communications provides fast and reliable relay-to-relay communication.

10 Card slots include positions for optional I/O, arc-flash detection, or synchronous motor inputs/differential current inputs.

11 CT and PT inputs are located on one card, allowing for more I/O in other slots.

12 Optional optical point sensor for AFD. Bare-fiber optical sensors are also available.




## ANSI Functions

| | |
|---|---|
| 14 | Speed Switch |
| 27 | Phase Undervoltage |
| 27I | Phase Undervoltage With Inverse Characteristic |
| 37 (P,C) | Underpower/Undercurrent |
| 38 | Bearing Temperature* |
| 40 | Loss of Field |
| 46 | Current Unbalance |
| 47 | Phase Reversal |
| 49P | Positive Temperature Coefficient (PTC) Overtemperature* |
| 49R | Resistance Temperature Detector (RTD) Thermal* |
| 49 | Rotor and Stator Thermal Models |
| 50 (P,G,Q) | Overcurrent (Phase, Ground, Negative Sequence) |
| 50INC | Incipient Cable Fault Detection |
| 50NAF | Arc-Flash Neutral Overcurrent* |
| 50PAF | Arc-Flash Phase Overcurrent* |
| 50P LR | Locked Rotor |
| 50P LJ | Load Jam |
| 50N | Neutral Overcurrent |
| 51 (P,G,Q) | Time Overcurrent (Phase, Residual, Negative Sequence) |
| 55 | Power Factor |
| 59 | Phase Overvoltage |
| 59I | Overvoltage With Inverse Characteristic |
| 60 | Loss of Potential |
| 66 | Starts Per Hour |
| 78 | Out of Step |
| 81 (O,U) | Over-/Underfrequency |
| 87 | Current Differential* |
| 90 (P,I,T) | Load Control (Power, Current, Thermal Capacity) |

## Additional Functions

| | |
|---|---|
| 50/51 | Adaptive Overcurrent |
| 85 RIO | SEL Mirrored Bits Communications |
| 97FM | Frequency Component Analyzer |
| AFD | Arc-Flash Detector[2] |
| BBD | Broken Rotor Bar Detection |
| DFR | Event Reports—Motor Starts, Motor Operating Statistics |
| ENV | Optional SEL-2600 RTD Module |
| HMI | Operator Interface |
| LDP | Load Data Profiling |
| LGC | SELogic® Control Equations |
| MET | High-Accuracy Metering |
| RTU | Remote Terminal Unit |
| SDTM | Slip-Dependent AccuTrack™ Thermal Model |
| SER | Sequential Events Recorder |
| SM | Synchronous Motor Control and Protection[2] |
| VAR | Reactive Power |
| VFD | Variable-Frequency Drive Support |
| WEB | Web Server |

*Optional feature [1]Copper or fiber-optic

[2]Mutually exclusive optional features

# SEL-849

## Motor Management Relay

selinc.com/products/849

Select models typically ship in 2 days

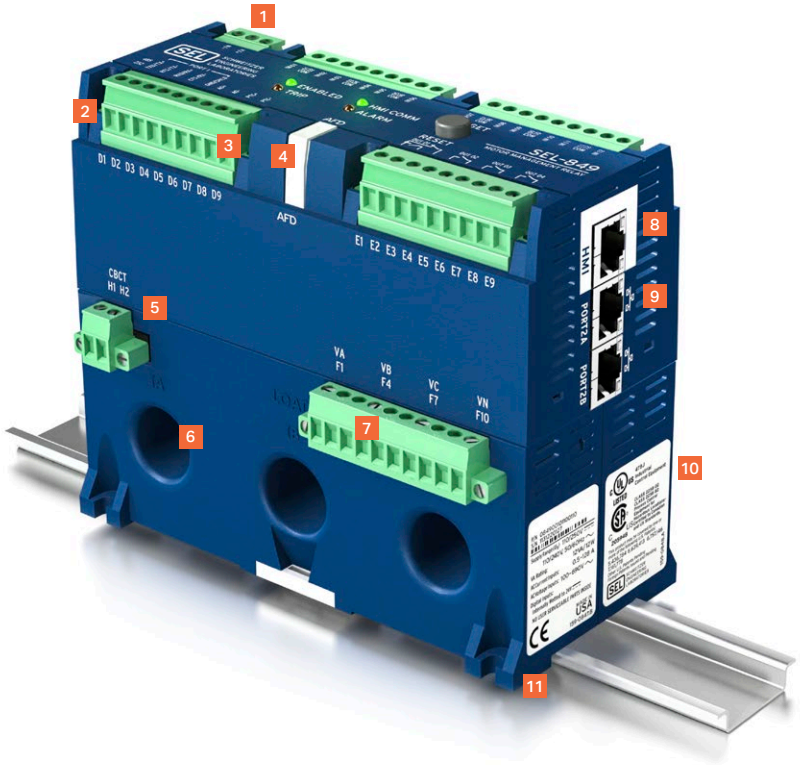
Starting price

**SEL-849: $730 USD**

**SEL-3421: $190 USD**

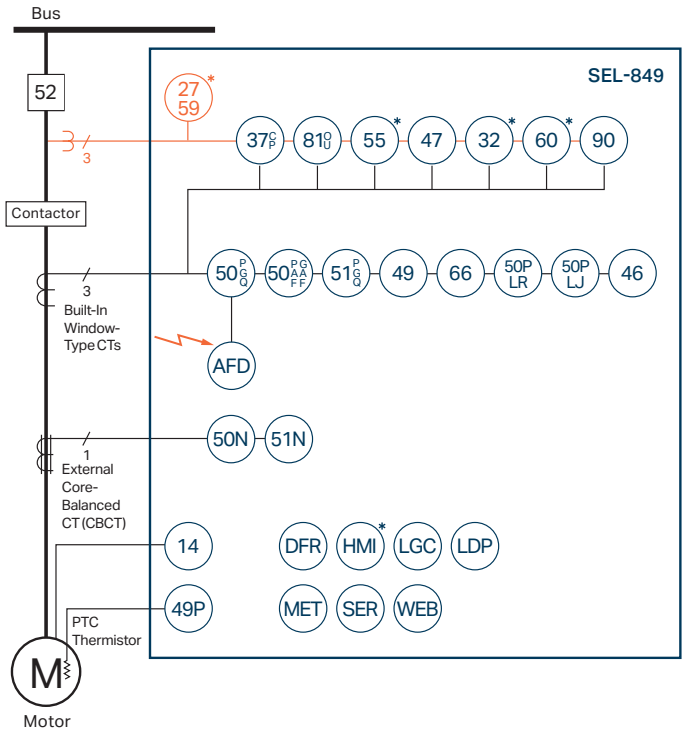
**SEL-3422: $130 USD**

The SEL-849 offers current-, voltage-, and thermal-based motor protection; arc-flash detection; and power metering for low- and medium-voltage industrial applications. It provides all basic motor protection features, including protection for short-circuit, load loss, load jam, frequent starting, unbalanced current, and phase reversal conditions. You can easily install the SEL-849 inside a motor control center (MCC) and add the optional SEL-3421 and SEL-3422 Motor Relay HMIs to the front of the MCC.





1. Power supply options: 110–240 Vac, 125–250 Vdc; or 24–48 Vdc
2. EIA-232 or EIA-485 serial port
3. Analog output and PTC (thermistor) input
4. Optical arc-flash sensor
5. Input for separate CBCT
6. Window-type CTs, 0.5–256 A range
7. Direct-connect voltage inputs (up to 690 Vac)
8. Port for remote HMI with HMI power supply
9. EIA-232/EIA-485 or single or dual Ethernet port(s), Modbus RTU, Modbus TCP, IEC 61850, EtherNet/IP, DNP3, and Parallel Redundancy Protocol (PRP)
10. An integrated web server that enables direct relay access for metering and monitoring data without the need for external PC software
11. DIN rail or surface mount
12. Large LCD display for navigation, relay control, and diagnostics
13. Context-adjusted navigation keys
14. Two fixed and eight programmable tricolored LEDs
15. Fundamental motor controls
16. Simple HMI for status and control
17. Configurable label for programmable LEDs




## ANSI Functions

| | |
|---|---|
| 14 | Speed Switch |
| 27 | Undervoltage* |
| 32 | Directional Power* |
| 37C | Undercurrent |
| 37P | Underpower* |
| 46 | Current Unbalance |
| 47 | Phase Reversal |
| 49 | Thermal Model |
| 49P | Positive Temperature Coefficient (PTC) Overtemperature |
| 50G AF | Arc-Flash Residual Overcurrent |
| 50N | Neutral Overcurrent |
| 50P AF | Arc-Flash Phase Overcurrent |
| 50 (P,G,Q) | Overcurrent (Phase, Ground, Negative Sequence) |
| 50P LJ | Load Jam |
| 50P LR | Locked Rotor |
| 51N | Neutral Time Overcurrent |
| 51 (P,G,Q) | Time Overcurrent (Phase, Residual, Negative Sequence) |
| 55 | Power Factor* |
| 59 | Phase Overvoltage* |
| 60 | Loss of Potential* |
| 66 | Starts Per Hour |
| 81 (O,U) | Over-/Underfrequency* |
| 90 | Load Control |

## Additional Functions

| | |
|---|---|
| AFD | Arc-Flash Detector |
| CC | Conformal Coating* |
| DFR | Event Reports—Motor Starts, Motor Operating Statistics, Sequential Events Recorder |
| HMI | Operator Interface* |
| LDP | Load Data Profiling |
| LGC | SELOGIC® Control Equations |
| MET | Metering—RMS Voltage and Current, Frequency, Power, Power Factor, Energy, Maximum/Minimum, Thermal, Thermal Capacity Used |
| SER | Sequential Events Recorder |
| VFD | Variable-Frequency Drive Support |
| WEB | Web Server |

*Optional feature

# Transmission Protection Overview

## SEL-T400L

Apply the SEL-T400L for ultra-high-speed protection of transmission lines. With breakthrough time-domain technologies, the SEL-T400L trips in as fast as 1 ms, records events with a 1 MHz sampling rate, and locates faults to the nearest tower.

## SEL-T401L NEW

Apply the SEL-T401L, which was built on the field experience of the SEL-T400L, for its unprecedented operating speed and complete suite of primary and backup line protection functions. Use the SEL-T401L as a redundant protection system with other SEL relays without concerns for common-mode failures.

## SEL-T4287

Test traveling-wave fault locators and line protective relays using the SEL-T4287, a simple-to-use, compact, and economical secondary pulse injection test set.

## SEL-421

Employ the SEL-421 for high-speed distance and directional protection and complete control of a two-breaker bay.

## SEL-411L

Apply the SEL-411L for subcycle single- or three-pole line current differential, distance, and directional overcurrent protection. Traveling-wave fault locating pinpoints faults to the nearest tower span.

## SEL-311C

Apply the SEL-311C for three-pole distance protection, reclosing, monitoring, and control of transmission lines.

## SEL-311L

Use the SEL-311L with four-zone distance backup for easy-to-apply, high-speed line protection.

## SEL-387L

Use the SEL-387L for economical, easy-to-apply line protection with zero settings.

| Applications | SEL-T400L | SEL-T401L | SEL-411L | SEL-421 | SEL-311C | SEL-311L | SEL-387L |
|---|---|---|---|---|---|---|---|
| Distance Protection | ■ | ■ | ■ | ■ | ■ | ■ | |
| Line Current Differential | | | ■ | | | ■ | ■ |
| Traveling-Wave Protection | ■ | ■ | | | | | |
| Breaker Failure Protection | | | ■ | ■ | ■ | *ƒ* | |
| Undervoltage Load Shedding | | *ƒ* | *ƒ* | *ƒ* | *ƒ* | *ƒ* | |
| Series-Compensated Lines | ■ | ■ | + | + | | | |
| **Protection** | | | | | | | |
| 21 (G,P,XG,XP) Distance (Mho Ground, Mho Phase, Quad Ground, Quad Phase) | | ■ | ■ | ■ | ■ | ■ | |
| 25 Synchronism Check | | | ■ | ■ | ■ | ■ | |
| 27/59 Under-/Overvoltage | | ■ | ■ | ■ | ■ | ■ | |
| 32 Directional Power | | | ■ | ■ | | | |
| 49 Thermal | | | *ƒ* | *ƒ* | | | |
| 50 (N,G,P,Q) Overcurrent (Neutral, Ground, Phase, Negative Sequence) | | ■ | ■ | ■ | ■ | ■ | |
| 51 (N,G,P,Q) Time Overcurrent (Neutral, Ground, Phase, Negative Sequence) | | ■ | ■ | ■ | ■ | ■ | |
| 67 (N,G,P,Q) Directional Overcurrent (Neutral, Ground, Phase, Neg. Seq.) | | ■ | ■ | ■ | ■ | ■ | |
| 81 Under-/Overfrequency | | | ■ | ■ | ■ | ■ | |
| 87L Line Current Differential | | | ■ | | | ■ | ■ |
| Programmable Analog Math | | | ■ | ■ | | | |
| Out-of-Step Block and Trip | | ■ | ■ | ■ | ■ | ■ | |
| Load Encroachment Supervision | | ■ | ■ | ■ | ■ | ■ | |
| Switch-Onto-Fault | | ■ | ■ | ■ | ■ | ■ | |
| Single-Pole Trip | ■ | ■ | ■ | ■ | + | + | |
| TD21 Incremental-Quantity Distance | ■ | ■ | | | | | |
| TD32 Incremental-Quantity Directional | ■ | ■ | | | | | |
| TW32 Traveling-Wave Directional | ■ | ■ | | | | | |
| TW87 Traveling-Wave Differential | ■ | ■ | | | | | |
| Zone/Level Timers | | ■ | ■ | ■ | ■ | ■ | |
| Pilot Protection Logic | ■ | ■ | ■ | ■ | ■ | ■ | |

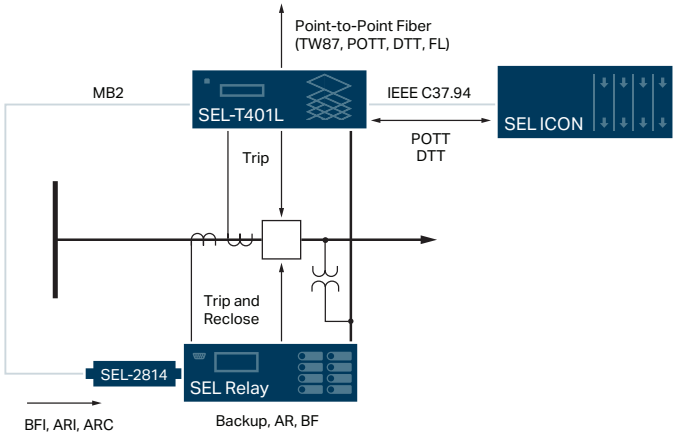
| Instrumentation and Control | SEL-T400L | SEL-T401L | SEL-411L | SEL-421 | SEL-311C | SEL-311L | SEL-387L |
|---|---|---|---|---|---|---|---|
| 79 Automatic Reclosing | | | ■ | ■ | ■ | ■ | |
| Number of Controlled Breakers/ CT Inputs | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| Fault Locating | ■ | ■ | ■ | ■ | ■ | ■ | |
| Traveling-Wave Fault Locating | ■ | ■ | + | | | | |
| Subcycle Distance Elements | | ■ | + | + | + | | |
| SELogic® Control Equations | | ■ | ■ | ■ | ■ | ■ | |
| Nonvolatile Latch Control Switches | | ■ | ■ | ■ | ■ | ■ | |
| SELogic Remote and Local Control Switches | | ■ | ■ | ■ | ■ | ■ | |
| Display Points | | | ■ | ■ | + | ■ | |
| Mirrored Bits® Communications | ■ | ■ | ■ | ■ | ■ | ■ | |
| Substation Battery Monitor | | | ■ | ■ | ■ | ■ | ■ |
| Breaker Wear Monitor | | | ■ | ■ | ■ | ■ | |
| Trip Coil Monitor | | | *ƒ* | *ƒ* | *ƒ* | *ƒ* | |
| Event Report (Multicycle Data) and Sequential Events Recorder | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 1 MHz Event Reports | ■ | ■ | | | | | |
| Instantaneous Metering | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Software-Invertible Polarities | | | ■ | ■ | | | |
| IEC 60255-Compliant Thermal Model | | | ■ | ■ | | | |
| DNP3 Level 2 Outstation | ■ | ■ | ■ | ■ | ■ | + | + |
| Parallel Redundancy Protocol (PRP) | | | ■ | ■ | ■ | | |
| IEEE 1588 Precision Time Protocol Version 2 (PTPv2) | | | + | + | | | |
| IEEE C37.94 Protocol | | ■ | + | | | + | |
| IEC 61850-9-2 Sampled Values Technology | | | | + | | | |
| Time-Domain Link (TiDL®) Technology | | | | + | | | |
| IEC 61850 Communications | | | + | + | + | + | |
| Synchrophasors | | | ■ | ■ | ■ | ■ | |
| Built-In Current and Voltage Playback Capability | ■ | ■ | | | | | |
| SEL Fast Time-Domain Values | ■ | ■ | | | | | |
| **Miscellaneous** | | | | | | | |
| Accepts Delta Voltage Transformers for Protection | | | | | + | | |
| Configurable Labels | ■ | ■ | ■ | ■ | + | | |

■ Standard feature + Model option *ƒ* May be created using settings

# Transmission Protection Applications

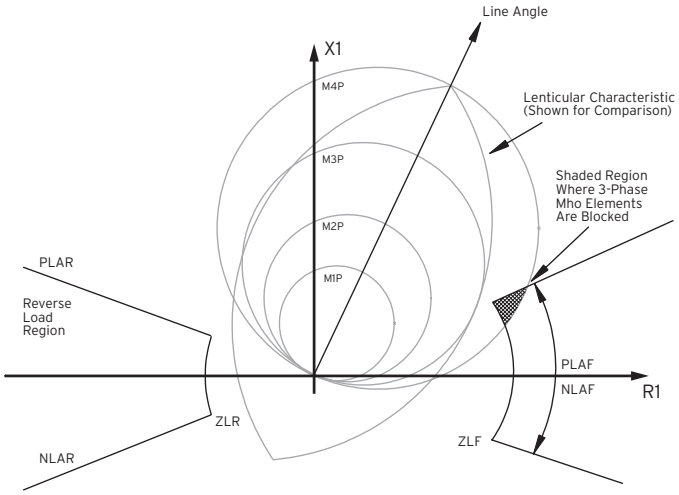
## Time-domain line protection

The SEL-T400L Time-Domain Line Protection and SEL-T401L Ultra-High-Speed Line Relay are designed for speed, security, and ease of use. They can trip in as fast as 1 ms without compromising security. You can apply the SEL-T401L on its own or as part of a redundant protection system with other SEL relays without concerns for common-mode failures.




## Optimized system loading

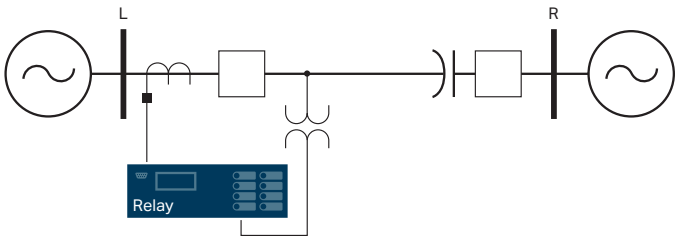
Set the phase distance and phase overcurrent elements independent of load to prevent load from causing the phase protection to operate. Under heavy load conditions, the measured impedance may fall inside the operating characteristic of a traditional phase distance element and cause an undesired operation. Traditional solutions involved reducing mho element reach or using a lenticular characteristic to prevent load encroachment. With built-in load encroachment logic, two load regions are defined on the impedance plane and the relay rejects a minimum portion of the mho element characteristic, as shown. This allows you to securely apply distance protection elements on heavily loaded transmission lines.




## Series-compensated lines

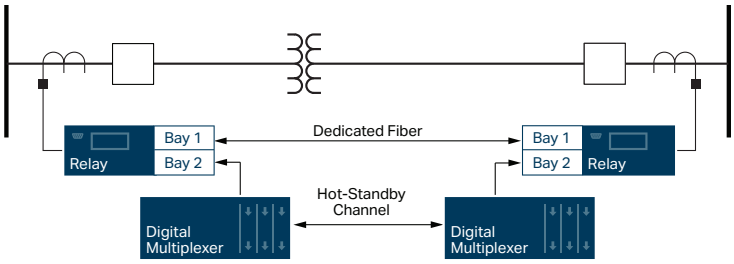
Detect faults beyond a series capacitor and prevent Zone 1 overreach on series-compensated lines with optional logic in the SEL-T400L Time-Domain Line Protection; SEL-T401L Ultra-High-Speed Line Relay; SEL-421-5 Protection, Automation, and Control System; and SEL-411L-1 Advanced Line Differential Protection, Automation, and Control System. Series compensation increases the power transfer capability of transmission lines and improves power system stability. However, when faults occur on series-compensated lines, the resulting voltage inversion or current reversal may cause traditional line protection to misoperate.

It's also important to enable this logic in parallel line applications where there is a series capacitor on the adjacent line. Series compensation logic achieves the desired sensitivity on the protected line, yet it is still secure during the voltage inversion that may occur when the neighboring series-compensated line experiences a fault.



## In-line transformers

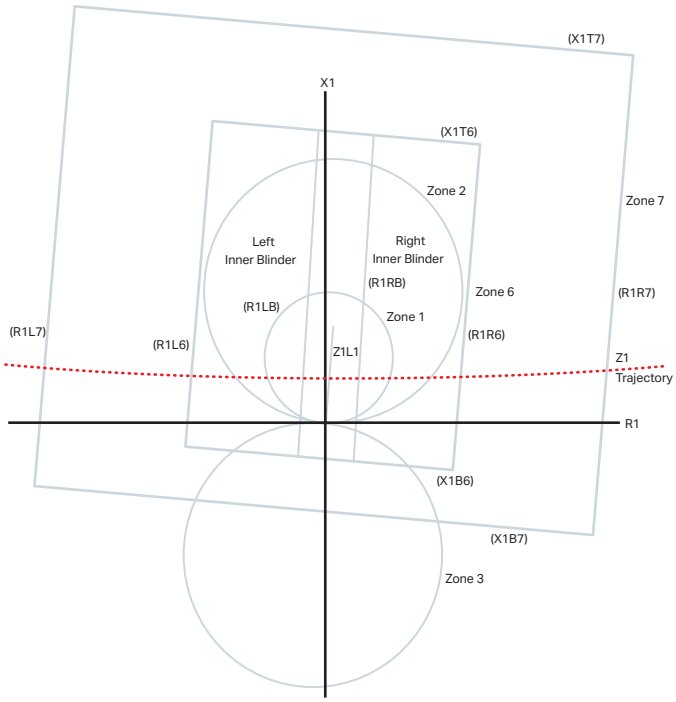
Use negative-sequence overcurrent elements in distance protection relays to protect transmission lines with in-line transformers. In differential relays, such as the SEL-411L Advanced Line Differential Protection, Automation, and Control System, the Alpha Plane operating principle provides for true differential harmonic measurements and allows harmonic blocking, harmonic restraint, or both for security during the magnetizing inrush condition. Additionally, built-in settings allow the relay to perform proper vector group compensation, zero-sequence current balancing, and ratio matching per the principles of transformer differential protection.




## Improved system stability

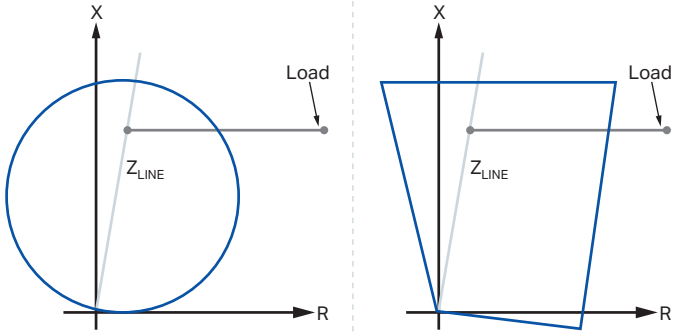
Select from either out-of-step (OOS) blocking of distance elements or OOS tripping during power swings. SEL transmission relays include multizone elements and logic for detection of an OOS condition.

The power-swing detection function differentiates faults from power swings and blocks distance or other relay elements from operating during stable or unstable power swings. The SEL-421 Protection, Automation, and Control System and SEL-411L Advanced Line Differential Protection, Automation, and Control System come with a zero-setting OOS blocking function that is based on a swing-center voltage slope detector, OOS blocking detector, and three-phase fault detector. The zero-setting OOS function improves security during power swings without time-consuming and expensive system stability studies.



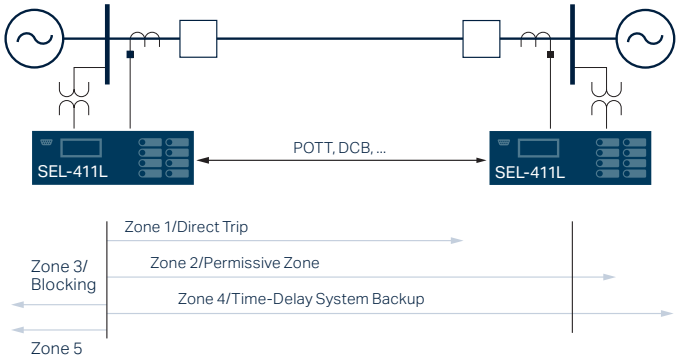

## Mho and quadrilateral distance elements

Select mho distance elements, quadrilateral distance elements, or both with SEL transmission relays. Some utilities prefer the mho distance elements because they are easy to set. However, other utilities favor the quadrilateral distance elements because they offer better resistive coverage. Quadrilateral elements provide the best protection for short lines where the impedance of the transmission line is the same magnitude as the fault resistance.



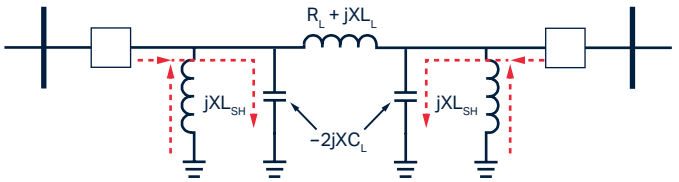
## Communications-assisted tripping

Configure protection for transmission lines without any need for external coordination devices. SEL transmission protection relays offer settings to accommodate many of the common pilot protection schemes, including permissive overreaching transfer trip (POTT), directional comparison unblocking (DCUB), and directional comparison blocking (DCB). These schemes work in both two- and three-terminal line applications.




## Long transmission lines

Enable line-charging current compensation in the SEL-411L Advanced Line Differential Protection, Automation, and Control System for enhanced sensitivity and security for long extra-high-voltage lines or cables. The charging current compensation is based on voltage signals and includes a built-in fallback response if the voltage source suffers loss-of-potential conditions or becomes unavailable. The function performs compensation on a per-phase basis and in the time domain. Therefore, the charging current compensation is accurate under balanced and unbalanced conditions and for line pickup with uneven breaker pole operation, internal faults, and external faults.

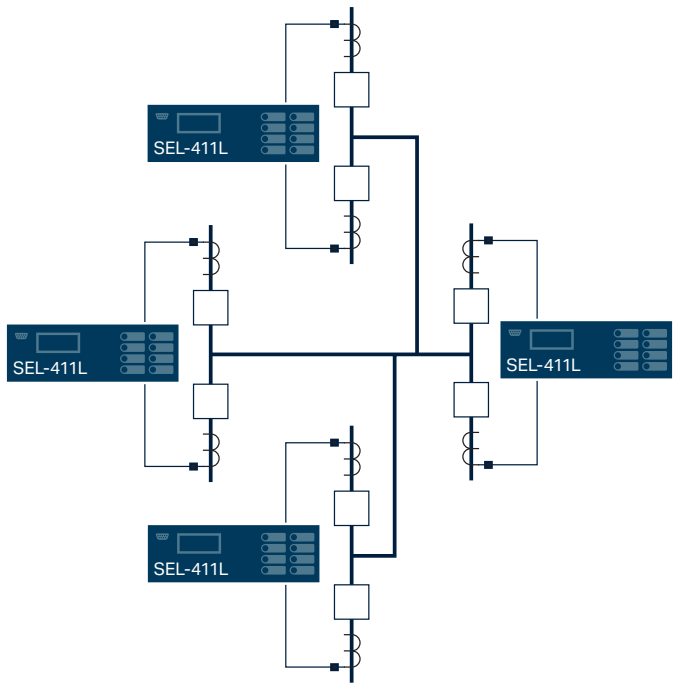



## Differential protection of four-terminal and parallel transmission lines

Perform line current differential protection on lines with up to four terminals by using the 87L-over-Ethernet feature in the SEL-411L Advanced Line Differential Protection, Automation, and Control System. You can use the SEL ICON® multiplexer to interconnect the SEL-411L relays making up the differential zone. The SEL ICON ensures a dedicated LAN with the proper bandwidth and minimal latency needed for secure and reliable 87L-over-Ethernet communications.

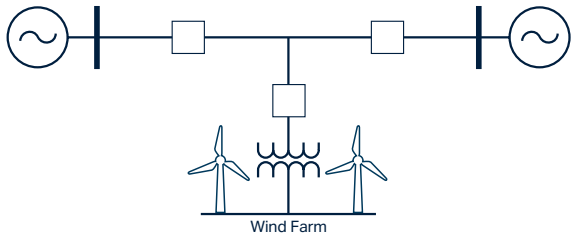
Protect up to three terminals with serial connections with the 87L scheme either in the master mode or master-outstation mode. In the master mode, all the relays act as master units, receive all the differential data, and trip directly on the data. In the case of a missing channel, you can use the relays in the master-outstation mode, where a single master unit receives all the data and sends a direct transfer trip to the slave units through a trip bit in the 87L channel. If the relays are in the master mode and a channel is suddenly lost, the scheme will automatically switch into the master-outstation mode to maintain 87L protection.

In parallel lines, the main issue is mutual coupling. Line current differential is immune to mutual coupling and is therefore very sensitive and secure in parallel-line applications.



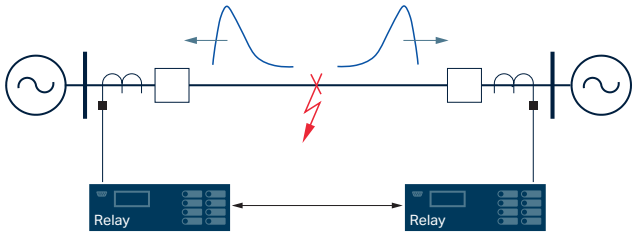
## Weak systems and inverter-based sources

Choose a line current differential scheme for primary line protection when connecting wind farms to the utility grid. Fault current contributed from weak sources, such as doubly fed induction generators (DFIGs) in a wind farm, is just a fraction of the load current. This challenges any current-based distance or overcurrent protection method and requires weak infeed logic to properly protect the line. Line current differential schemes work best because the grid provides enough fault current to drive the differential signal up, while the inverter-based source doesn't create restraining.




## Traveling-wave fault locating

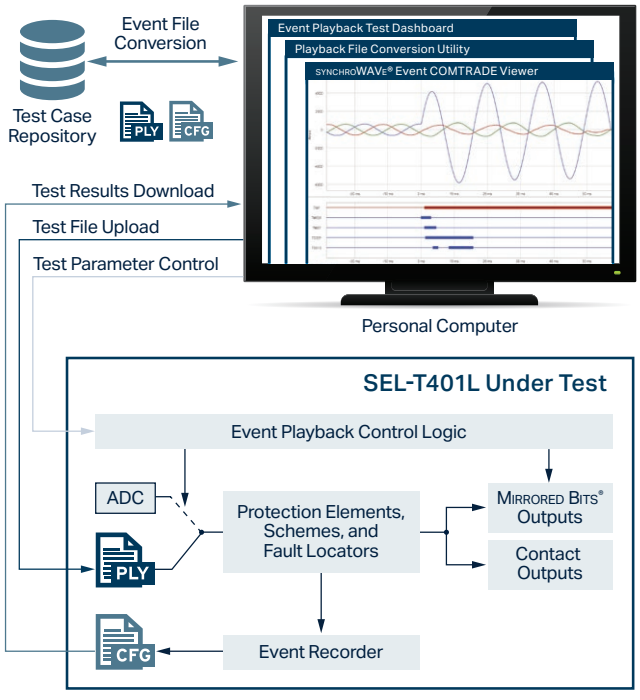
With advanced microprocessor-based relays, you can compute fault locations using four different methods: single-ended impedance-based, double-ended impedance-based, single-ended traveling-wave fault locating (available in the SEL-T400L Time-Domain Line Protection and SEL-T401L Ultra-High-Speed Line Relay), and double-ended traveling-wave fault locating (available in the SEL-411L Advanced Line Differential Protection, Automation, and Control System;, SEL-T400L; and SEL-T401L). Based on input data availability, the relay selects one method of fault locating to provide in a summary report. Traveling-wave fault-locating methods accurately locate faults to within one tower span, allowing you to quickly send crews out to address the problem.




## Testing made easy

The built-in current and voltage playback feature in the SEL-T400L Time-Domain Line Protection and SEL-T401L Ultra-High-Speed Line Relay provides you with new opportunities for relay testing. To test either relay, upload and play back either files generated using transient simulation software or current and voltage signals recorded by the SEL-T400L, the SEL-T401L, SEL-400 series relays, or digital fault recorders in the field.

Secondary injection testing of SEL-T400L and SEL-T401L I/O, metering, and protection elements (except TW32 and TW87) is straightforward. Today's relay test sets provide adequate signals to test incremental-quantity protection elements. Use the SEL-T4287 Traveling-Wave Test System to perform secondary injection testing of the TW32 and TW87 protection and the traveling-wave fault-locating methods.



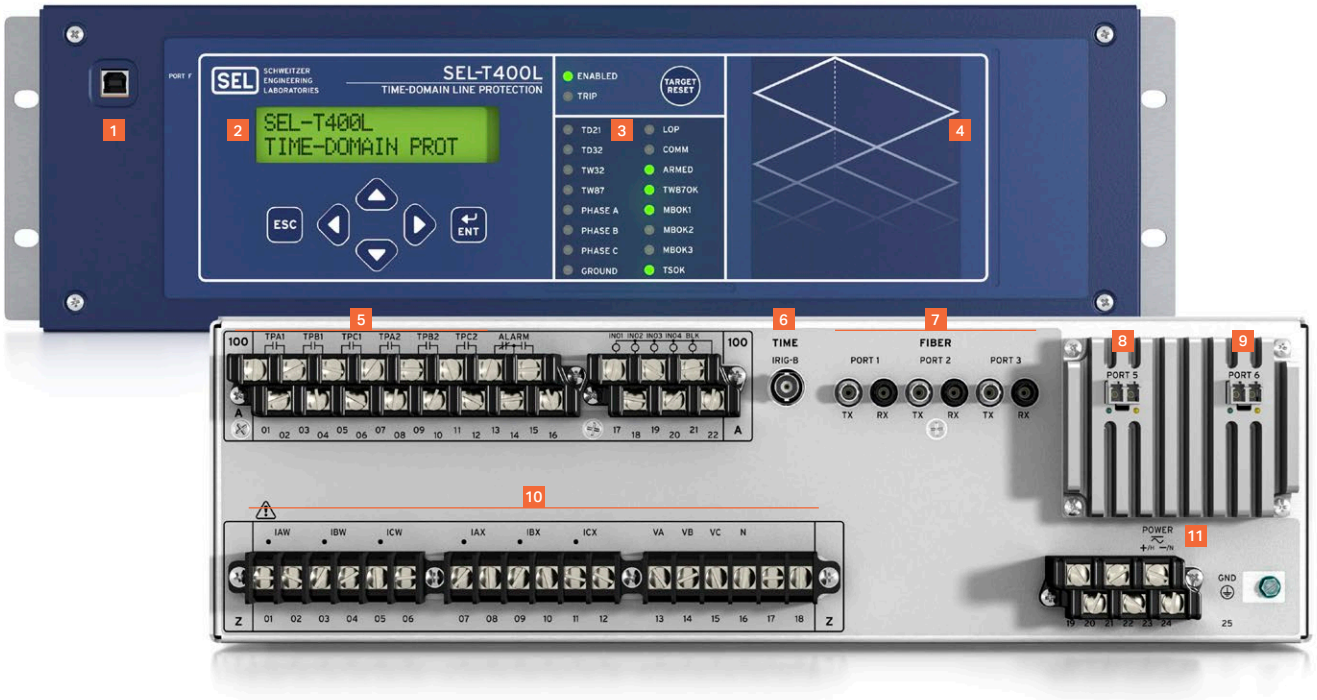
# SEL-T400L

## Time-Domain Line Protection

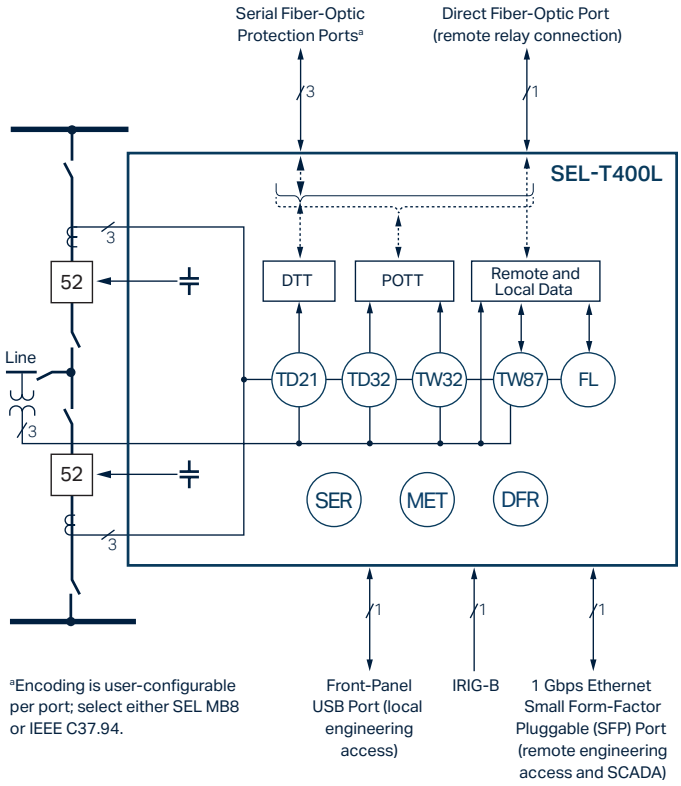
Starting price
**$12,000 USD**

selinc.com/products/T400L | Select models typically ship in 2 days

The SEL-T400L provides ultra-high-speed protection of transmission lines. With breakthrough time-domain technologies, the SEL-T400L trips securely in as fast as 1 ms, records events with a 1 MHz sampling rate, and locates faults to the nearest tower. Adding the SEL-T400L to your line protection system can dramatically reduce your fault-clearing time and let you achieve the many benefits associated with speed.




1. USB 2.0 port for SEL Fast Meter and Fast SER protocols as well as for local engineering access.
2. Display for viewing metering, event, and fault location information.
3. LEDs show faulted phases, element operation, and status of relay and communications.
4. Large slide-in label pocket for diagrams or asset labels.
5. High-speed trip-rated output contacts for ultra-high-speed protection.
6. IRIG-B time input for nanosecond-accurate event reports.
7. Millisecond Mirrored Bits® communications ports for connecting to a remote SEL-T400L (POTT and DTT applications), to a local SEL relay (breaker failure and autoreclose applications), or to an SEL remote I/O module for legacy applications over contact I/O.
8. An 850 nm 1000BASE-SX multimode small form-factor pluggable (SFP) transceiver is installed in Port 5 for remote engineering access with FTP and Telnet and for SCADA applications with SEL Fast Meter, SEL Fast SER protocols, DNP3 LAN/WAN, and Fast Time-Domain Values (FTDV).
9. Install a Gigabit SFP transceiver in Port 6 for the point-to-point fiber-optic differential (TW87) protection channel.
10. Three voltage and six current inputs for single- and dual-breaker applications.
11. Universal power supply operating voltage range:
    85–300 Vdc
    85–264 Vac




## ANSI Functions

| | |
|---|---|
| 1 | Arming and Starting Logic |
| TD21 | Incremental-Quantity Distance |
| TD32 | Incremental-Quantity Directional |
| TW32 | Traveling-Wave Directional |
| TW87 | Traveling-Wave Differential |
| TD50 | Incremental-Quantity Nondirectional Overcurrent Supervision |
| TD67 | Incremental-Quantity Directional Overcurrent Supervision |
| DTT | Direct Transfer Trip Logic |
| POTT | Permissive Overreaching Transfer Trip Logic |
| 94 | High-Speed Trip-Rated Outputs |
| 85 RIO | SEL Mirrored Bits Communications |
| LOP | Loss-of-Potential Logic |
| TWDD | Traveling-Wave Disturbance Detection |
| DFR | 1 MHz Event Recorder |
| SER | Sequential Events Recorder |
| FL | Fault Locator (with traveling-wave and impedance methods, single-ended and double-ended) |
| MET | Metering |
| HMI | Operator Interface |

## Additional Functions

Preconfigured Trip Logic

Single-Pole Tripping Logic

Open-Pole Detection Logic

Adaptive Autoreclose Cancel Logic

Traveling-Wave Test Mode

Event Playback

Front-Panel USB 2.0 Port for Engineering Access

Ethernet Port for Engineering and SCADA Access

Multilevel Passwords for Secure Access

Electromagnetic Interference Monitoring

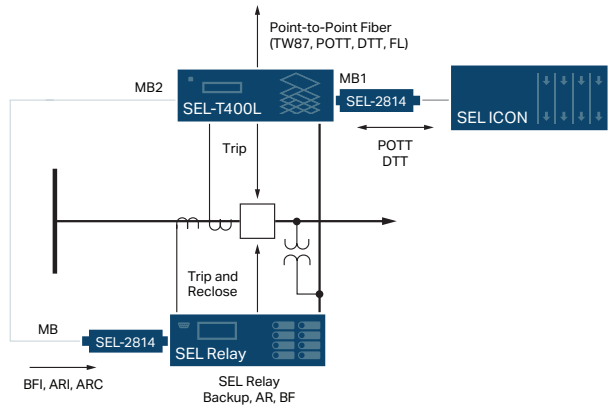
Enhanced Self-Monitoring

Fast Time-Domain Values (FTDV)

## Powerful applications

The SEL-T400L is an easy-to-use ultra-high-speed and secure transmission line protective relay. It provides protection of two-terminal and multiterminal lines with in-line and adjacent series compensation, in three-pole and single-pole tripping applications, for single- or dual-breaker line terminations.

The SEL-T400L also provides key line protection elements and schemes. For auxiliary functions, such as reclosing, synchronism check, breaker failure, communications protocols, and backup protection, you can use a companion relay, such as an SEL-421 Protection, Automation, and Control System or an SEL-411L Advanced Line Differential Protection, Automation, and Control System.




Recommended application of the SEL-T400L.

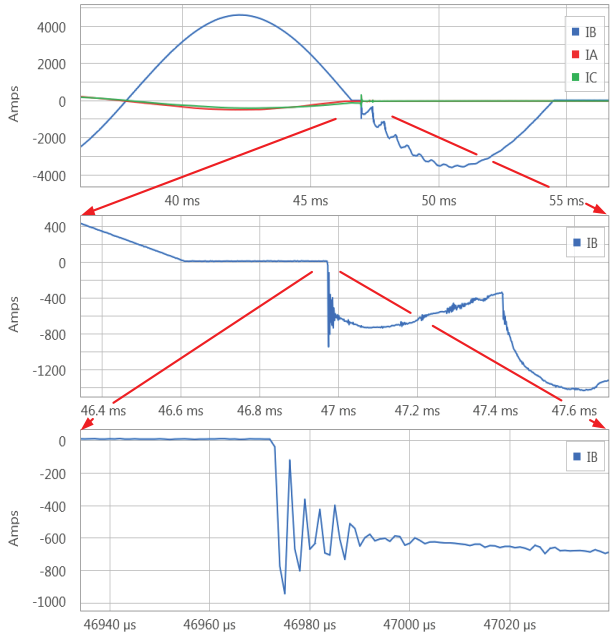
## Ultra-high-speed line protection with security

The SEL-T400L features a traveling-wave differential scheme (TW87) over a dedicated point-to-point fiber channel; an incremental-quantity distance element (TD21); and a POTT scheme with traveling-wave (TW32) and incremental-quantity (TD32) directional elements over a digital or analog protection channel. You can achieve 1–5 ms trip times, depending on the channel, line length, and system conditions.

## High-resolution oscillography

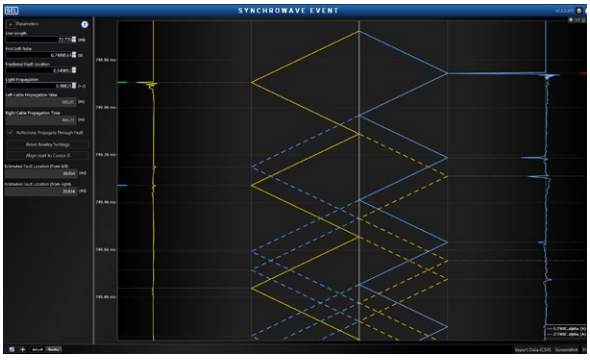
Using the SEL-T400L is like applying an oscilloscope to the power system. Now you can look at currents and voltages through a 1 MHz lens. The SEL-T400L stores as many as 50 events with a back-to-back recording capability and a duration of 1.2 seconds per event. The SEL-T400L also provides a COMTRADE file that contains currents and voltages sampled at 10 kHz, selected operating quantities, Relay Word bits, settings, and fault location and event summary data.

When using a direct fiber-optic channel, the local 1 MHz and 10 kHz records also contain remote voltages and line currents.




## Unparalleled fault-locating accuracy

The SEL-T400L provides you with state-of-the-art fault-locating technology. A simple and robust double-ended traveling-wave fault-locating method gives you a very accurate fault location in the vast majority of cases. The method works over a multiplexed IEEE C37.94 channel with accurate external IRIG-B-connected time sources at both line terminals and over a direct fiber channel (external time not required). The method works well on overhead lines, underground cable lines, and hybrid lines composed of both overhead and underground cable sections. Benefit from the single-ended traveling-wave fault-locating method in applications without relay-to-relay communications or when your digital protection channel is down. Obtain good fault-locating results from the backup double- and single-ended impedance-based fault-locating methods when the point on wave or termination effects prevent the traveling-wave methods from locating the fault.




Visualize traveling-wave event reports using SEL-5601-2 SYNCHROWAVE® Event Software.

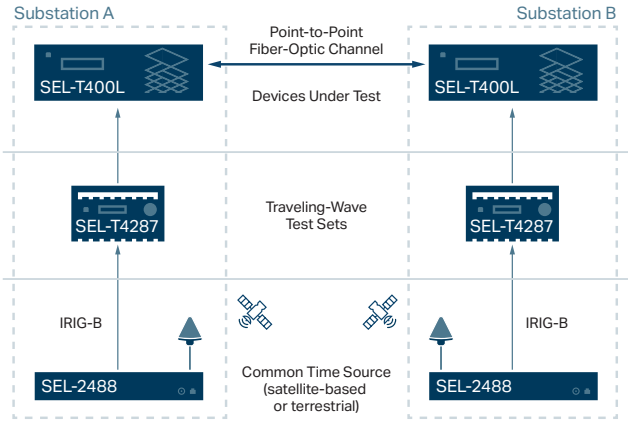
## Refreshing simplicity

Designed with simplicity in mind, the SEL-T400L minimizes the number of settings and keeps the settings selection as straightforward as possible. The SEL-T400L uses preconfigured, easy-to-set protection logic. The relay requires only a handful of protection settings, and most of them are nameplate data, such as CT and PT ratios, line length and impedance, nominal voltage and frequency, and so on.

The SEL-T400L offers refreshing simplicity compared with feature-heavy multifunction IEDs. This simplicity improves your workforce efficiency and enhances protection security by helping you avoid errors.

## Testing made easy

Requiring only a few protection settings, the SEL-T400L is easy to commission. You can apply any standard relay test set for testing the TD21 distance and TD32 directional elements. The SEL-T4287 Traveling-Wave Test System provides end-to-end testing of the TW87 scheme, the TW32 element, and the traveling-wave fault locator. You can upload ultra-high-resolution current and voltage files (recorded by SEL-T400L relays in the field or obtained from your transient simulation software) to the SEL-T400L and test the relay by executing built-in playback.



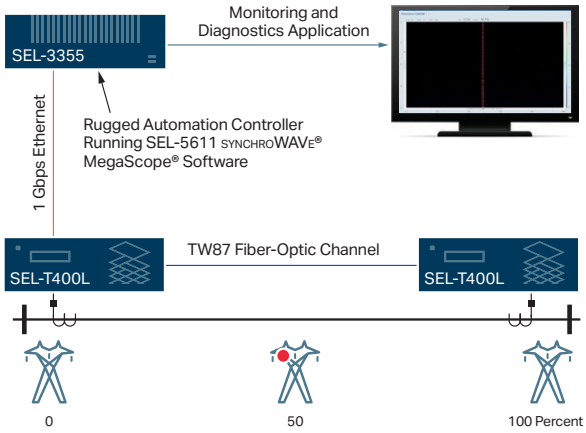

The SEL-T4287 generates nanosecond-timed traveling-wave currents. Perform end-to-end testing with two SEL-T4287 test sets synchronized via satellite clocks.

## Hassle-free installation

Use the SEL-T400L with standard control cables and wiring to connect to conventional current and voltage transformers, including coupling capacitor voltage transformers (CCVTs), and directly to breaker trip coil circuits. The relay uses current traveling waves that are adequately measured with standard CTs and cabling, providing dependable TW32 operation. The SEL-T400L includes SEL protocols for ease of integration with SEL systems; DNP3 over Ethernet for interconnecting with DNP3-based SCADA systems; generic Ethernet file transfer methods for ease of integration with Ethernet-based substation automation systems; and access to relay metering data.

## MegaScope® applications for remote monitoring and diagnostics

With voltages and currents sampled at an unprecedented rate and resolution (1 MHz, 18 bits), the SEL-T400L is a power data acquisition device for advanced remote monitoring and diagnostics applications. The relay streams the high-resolution FTDV data in real time via a Gigabit Ethernet port, opening a whole suite of new applications for viewing power system events. These applications run in real time on high-performance computing platforms, such as the SEL-3355 Automation Controller. You can record and analyze insulation problems, breaker transient voltage recovery or restrike events, switching events, and other high-frequency signatures over wide areas using the SEL-T400L data. For the first time, you have the ability to monitor your system continually across multiple buses at a 1 MHz sampling rate. Contact SEL (selinc.com/support) to obtain a detailed format description and tools (such as the preliminary MegaScope client software) to experiment with this advanced SEL-T400L functionality.



# SEL-T401L

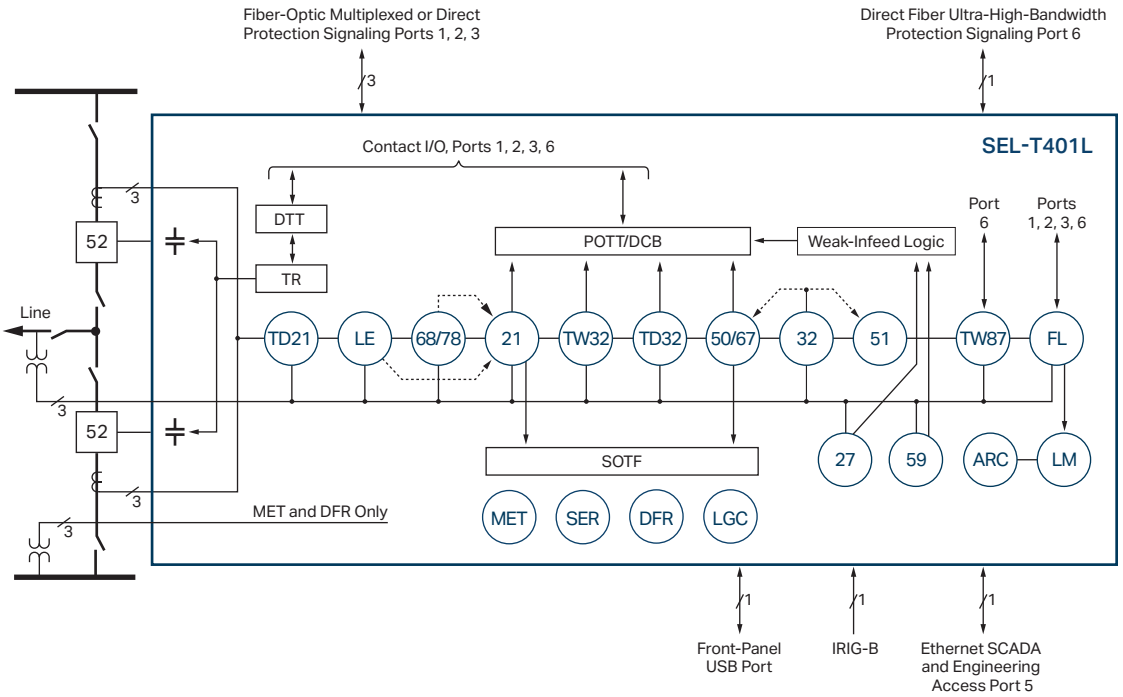
## Ultra-High-Speed Line Relay NEW

Starting price
**$15,000 USD**

selinc.com/products/T401L | Select models typically ship in 2 days

The SEL-T401L provides ultra-high-speed protection of transmission lines by using field-proven traveling-wave and incremental-quantity technologies pioneered in the SEL-T400L Time-Domain Line Protection. The SEL-T401L trips in 1 to 5 ms, samples at 1 MHz, processes data every microsecond, uses high-speed protection signaling, and trips with solid-state trip-rated outputs. It also offers high-performance distance protection with five zones of ground and phase elements and has dependable protection, flexible programming, and supervisory functions. You can apply the SEL-T401L on its own or as part of a redundant protection system with other SEL relays without concern for common-mode failures.


1. USB 2.0 port for local engineering access.
2. Display for viewing metering, event, fault location, and relay status information.
3. Simple HMI navigation.
4. LED targets for viewing trip cause, fault type, and basic relay status.
5. Large slide-in label pocket for diagrams or asset information.
6. Six trip-rated high-speed outputs for single-pole tripping of two breakers.
7. Alarm output.
8. Five inputs with a common terminal.
9. IRIG-B time input.
10. Three fiber-optic ports for multiplexed or direct protection signaling (SEL MB8 or IEEE C37.94).
11. 100 Mbps or 1 Gbps small form-factor pluggable (SFP) Ethernet port for engineering access and SCADA.
12. SFP fiber-optic port for ultra-high-bandwidth protection signaling over direct fiber.
13. Eight outputs for POTT, DCB, DTT, breaker failure initiation (BFI), and other signaling.
14. Eight inputs for POTT, DCB, DTT, triggering, and other signaling.
15. Breaker 1 and 2 current inputs.
16. Line voltage.
17. Auxiliary voltage (metering and digital fault recorder).
18. Power supply: 125–250 Vdc, 110–240 Vac; 48–125 Vdc, 110–120 Vac; or 48–125 Vdc, 110–240 Vac.




## ANSI Functions

| | |
|---|---|
| 21 | Phase and Ground Distance |
| TD21 | Incremental-Quantity Phase and Ground Distance |
| 27 | Undervoltage (Phase, Phase to Phase, and Positive Seq.) |
| 32 | Directional (Phase, Zero Seq., and Negative Seq.) |
| TD32 | Incremental-Quantity Directional |
| TW32 | Traveling-Wave Directional |
| 50 | Instantaneous Overcurrent (Phase, Zero Sequence, and Negative Sequence) |
| 51 | Inverse-Time Overcurrent (Phase, Zero Sequence, and Negative Sequence) |
| 59 | Overvoltage (Phase, Phase to Phase, Positive Sequence, Zero Sequence, and Negative Sequence) |
| 67 | Instantaneous and Definite-Time Directional Overcurrent (Phase, Zero Sequence, and Negative Sequence) |
| 68 | Power-Swing Blocking |
| 78 | Out-of-Step Tripping |
| 85 RIO | SEL Mirrored Bits® I/O With Selectable SEL MB8 or IEEE C37.94 Encoding |
| TW87 | Traveling-Wave Differential |
| 94 | High-Speed Trip-Rated Outputs |
| POTT | Permissive Overreaching Transfer Trip Logic |
| CBECHO | Open-Breaker Echo Logic |
| WI | Weak-Infeed Logic |
| DCB | Directional Comparison Blocking Logic |

## ANSI Functions (Continued)

| | |
|---|---|
| SOTF | Switch-Onto-Fault Logic |
| DTT | Direct Transfer Trip Logic (Intertripping) |
| LOP | Loss-of-Potential Logic |
| OP | Open-Pole Detection Logic |
| LE | Load Encroachment Logic |
| DFR | Digital Fault Recorder |
| SER | Sequential Events Recorder |
| FL | Fault Locator |
| LM | Line Monitor |
| LGC | SELogic® Control Equations |
| MET | Metering |
| ARC | Adaptive Autoreclose Cancel Logic |
| HMI | Local Operator Interface |
| DNP3 | Distributed Network Protocol 3.0 (Ethernet) |
| FTP | File Transfer Protocol |

## Additional Functions

- Arming and Starting Logic for Time-Domain Protection
- Electromagnetic Interference Monitoring for Traveling-Wave Functions
- Traveling-Wave Test Mode
- Event Playback
- Fast Time-Domain Values

## Built on the SEL-T400L Time-Domain Line Protection

The SEL-T401L offers the same capabilities as the field-proven SEL-T400L, including:

### Time-domain protection

Using the field-proven SEL time-domain technologies of traveling waves and incremental quantities, the SEL-T401L trips in 1 to 5 ms. The underreaching distance (TD21) protection element trips using incremental voltages and currents. Not dependent on a protection channel, the TD21 element operates as fast as 2 ms for heavy close-in faults. The incremental-quantity directional (TD32) element is dependable and operates in 1 to 2 ms. The traveling-wave directional (TW32) element operates as fast as 0.1 ms. A field-proven SEL innovation, the traveling-wave differential (TW87) protection scheme uses current traveling waves to detect in-zone faults with operating times in the range of 1 to 5 ms, depending on the line length.

### Unparalleled fault-locating technology

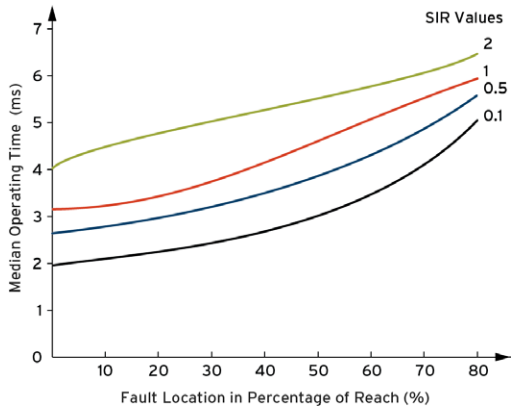
Single- and double-ended traveling-wave and impedance-based fault locating is accurate to a single tower span, making it possible to find and fix faults fast. Autoreclose cancel logic allows you to distinguish faults on overhead line sections from faults on underground cable sections and to control your autoreclose logic accordingly. New in the SEL-T401L is the line-monitoring function, which allows you to perform condition-based line maintenance and discover weak spots along the line.

### High-fidelity recording

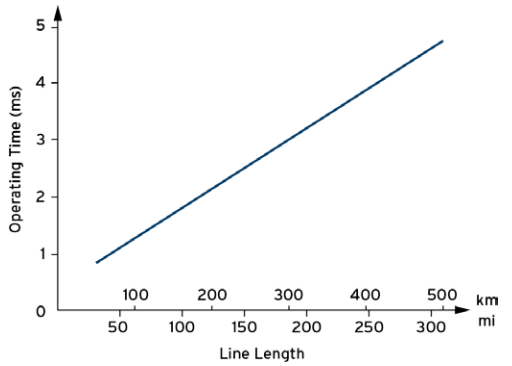
High-resolution voltage and current recording with a 1 MHz sampling rate and an 18-bit resolution provides a detailed view of your system.

### Testing made easy

Built-in current and voltage playback gives you new opportunities for relay testing.



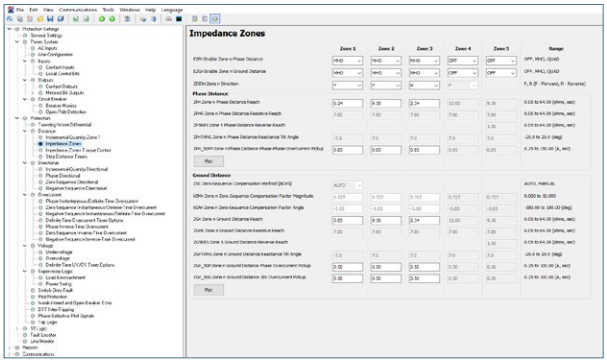

TD21 operating time for a varying fault location under different source-to-line impedance ratios.




TW87 operating time as a function of line length.

## Refreshing Simplicity

The SEL-T401L allows you to reset the complexity of your line protection applications with its simple and robust protection philosophies and a considerably lower setting count, all in a convenient 3U package. The SEL-T401L design balances flexibility and ease of use. Settings are streamlined, named, grouped, and presented for intuitive application and ease of use. Apply the relay with preconfigured logic, or adjust the factory defaults with SELOGIC control equations with gates, timers, and latches.



# Dependable, Flexible, and Simple Protection

## Distance protection

The SEL-T401L provides a total of five phase and ground distance zones for direct tripping, pilot protection, step distance, and switch-onto-fault (SOTF) applications. Zones 1 through 4 are directional; each has an individual direction setting (forward or reverse). Zone 5 is nondirectional (offset) with separate forward and reverse reach settings. You can configure the phase and ground distance elements of each zone as either a mho characteristic or a quadrilateral characteristic. Each ground distance zone uses its own zero-sequence compensation factor. All zones use an overcurrent supervision condition with thresholds that can be set individually for the phase and ground distance elements of each zone.

## Pilot tripping logic

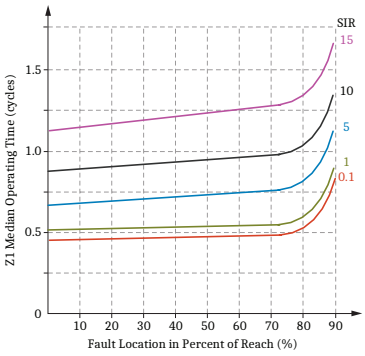
The SEL-T401L offers fast, secure, dependable, and flexible yet easy-to-use POTT and DCB schemes. Select traveling-wave (TW32), incremental-quantity (TD32), negative-sequence (32Q), zero-sequence (32G), or phase (32P) directional elements as well as overreaching distance elements (Zone 2) to detect line faults. A combination of the time-domain TW32 and TD32 elements (speed), the sequence-based 32Q and 32G elements (speed, dependability, and sensitivity), and the distance elements (speed and dependability) allows your POTT scheme to trip with extraordinary speed, iron-clad dependability, and very high sensitivity. Enable open breaker echo and weak-infeed logic in your POTT scheme for dependability on tapped and multiterminal lines and during weak system conditions.

## Supplementary and backup protection

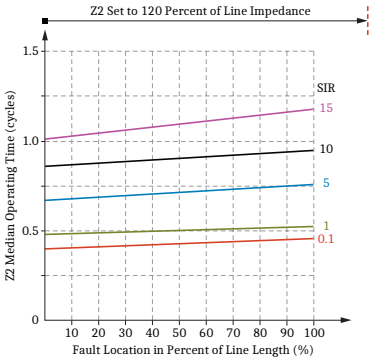
The SEL-T401L offers all core protection elements that you typically want duplicated between the primary and backup relays in a flexible yet easy-to-use package. Cover high-resistance faults through inverse-time and definite-time ground directional overcurrent elements (zero- and negative-sequence). Use phase, zero-, and negative-sequence instantaneous overcurrent elements to clear heavy close-in faults without reliance on voltage or protection channels. Use the inverse-time and definite-time overcurrent elements to coordinate with adjacent relays for backup protection. Use over- and undervoltage instantaneous and time-delayed voltage elements to address out-of-bound voltage system conditions.

## Supervisory elements

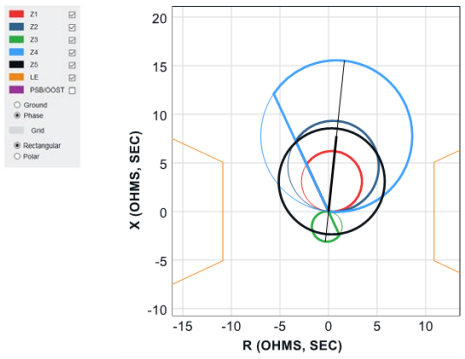
Apply load encroachment logic to secure the SEL-T401L distance and phase overcurrent elements for heavy load conditions. Optimize your single-pole tripping applications by applying separate load encroachment settings for the phase and ground measurement loops. Apply the power-swing blocking logic to secure the SEL-T401L distance elements during power swings. Phase-segregated operation allows dependable blocking of ground elements for power swings under external unbalance conditions, such as single-pole tripping and reclosing on adjacent lines. Two separate unblocking mechanisms allow dependable SEL-T401L operation for faults during power-swing conditions. Apply the out-of-step tripping logic to trip for unstable power swings traversing the protected line. The out-of-step tripping logic is settings-free and applies a simple trip-on-the-way-out operating principle based on the impedance-rate-of-change measurement.



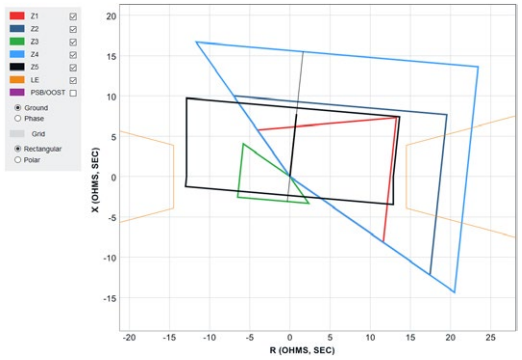

Distance Zone 1 median operating time for varying fault locations and different source-to-impedance ratios (SIRs).




Distance Zone 2 median operating time for varying fault locations and different SIRs.




Phase distance mho elements characteristic plot in ACSELERATOR QuickSet® SEL-5030 Software.




Ground distance quadrilateral elements characteristic plot in QuickSet.

# SEL-T4287

## Traveling-Wave Test System

Starting price
**$4,287 USD**

selinc.com/products/T4287 | Select models typically ship in 2 days

The SEL-T4287 is a simple-to-use, compact, and economical secondary pulse injection test set for traveling-wave fault locators and line protective relays.

### Secondary traveling-wave injection

Traveling-wave fault locators and protection elements and schemes measure sharp changes in their input currents and voltages with rise times as fast as 1 µs. These fault locators and relays respond to relative polarities and the relative timing of these sharp signal changes. The SEL-T4287 generates output current signals with a short rise time, adequately slow decay, and the nanosecond precision necessary for testing traveling-wave protective relays, standalone traveling-wave fault locators, and traveling-wave fault locators embedded in line protective relays.

### Versatile applications

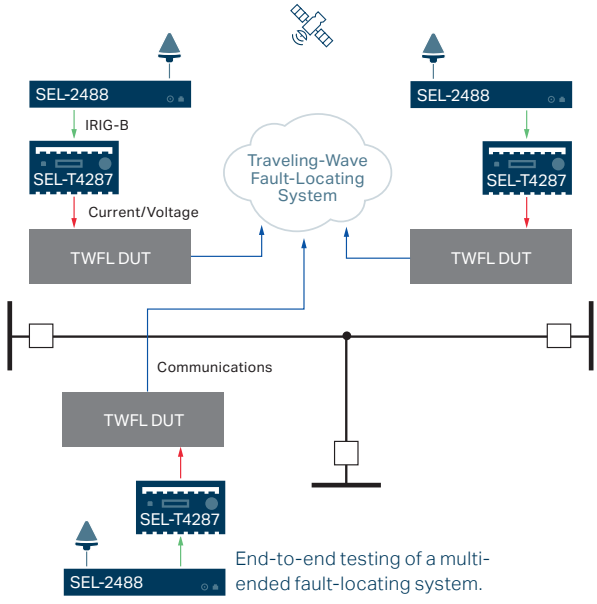
The SEL-T4287 generates two three-phase sets of secondary traveling-wave currents. An included voltage module accessory (containing low-inductance resistors) allows you to convert one current output set into one voltage output set to simulate traveling-wave voltage signals. The SEL-T4287 lets you test current- or voltage-based fault locators or protection elements and schemes, including the single- and multi-ended fault locators, traveling-wave directional element, and traveling-wave differential scheme found in the SEL-T400L Time-Domain Line Protection and SEL-T401L Ultra-High-Speed Line Relay. You can time-synchronize or cross-trigger multiple SEL-T4287 test sets to generate more than two three-phase traveling-wave signals with desired timing patterns as needed by the device under test (DUT).

### Simple test parameter configuration

Specify line and fault parameters, and let the SEL-T4287 calculate and apply the traveling-wave test signals. The simple and intuitive SEL-T4287 HMI allows you to specify test parameters and offers full control of tests without the need for a PC and software.


### End-to-end testing

Perform end-to-end testing of traveling-wave protection schemes and multi-ended fault locators with multiple SEL-T4287 test sets synchronized to substation satellite clocks via IRIG-B inputs. You can preconfigure each test set, schedule a test time, and let the multiple SEL-T4287 test sets apply the right test signals at all terminals of the line. The SEL-T4287 can test multi-ended traveling-wave fault locators for lines with more than two terminals. End-to-end testing is a standard feature included in the base product and can be used with any IEEE C37.118-compliant satellite clock with IRIG-B output.




End-to-end testing of a multi-ended fault-locating system.

# SEL-421

## Protection, Automation, and Control System

Starting price
**$7,180 USD**

selinc.com/products/421

The SEL-421 provides high-speed distance and directional protection and complete control of a two-breaker bay. You can protect any transmission line using a combination of five zones of phase- and ground-distance and directional overcurrent elements. A graphical user interface provides logic and application templates for typical line protection schemes. Patented capacitively coupled voltage transformer (CCVT) transient overreach logic enhances the security of Zone 1 distance elements. Best Choice Ground Directional Element® logic optimizes directional element performance and eliminates many directional settings. Optional additional logic prevents Zone 1 overreach on series-compensated lines. In addition, you can select incremental components for subcycle operation on critical lines requiring high-speed fault clearing. Optional Time-Domain Link (TiDL®) technology and SEL Sampled Values (SV) technology using IEC 61850-9-2 transform the way you modernize your substation.

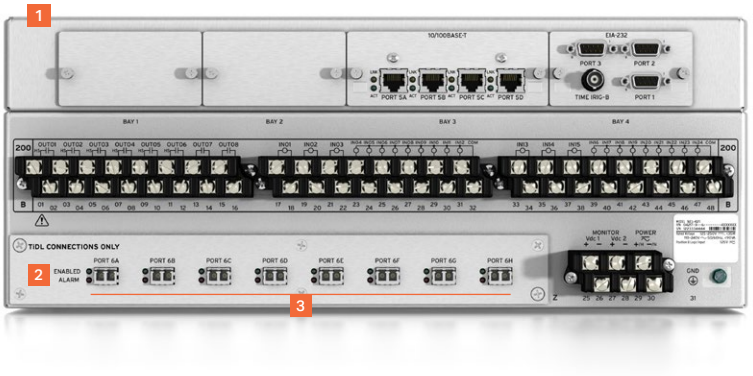

1. EIA-232 front serial port is quick and convenient for system setup and local access.
2. Front-panel display allows operators to control and view the status of disconnects and breakers.
3. User-selectable mimic screens show the system configuration in one-line diagram format.
4. Easy-to-use keypad aids simple navigation.
5. Front-panel LEDs indicate custom alarms and provide fast and simple information to assist dispatchers and line crews with rapid power restoration.
6. Programmable operator pushbuttons with user-configurable labels allow front-panel customization.
7. Choose from a vertical or horizontal, panel-mount or rack-mount chassis and different size options.
8. High-current interrupting output contacts increase contact robustness and reliability.
9. Use one front and three rear EIA-232 ports for Mirrored Bits® communications, DNP3, SCADA, and engineering access.
10. Communications protocols include FTP, Telnet, synchrophasors, DNP3 LAN/WAN, the Parallel Redundancy Protocol (PRP), the IEEE 1588 Precision Time Protocol Version 2 (PTPv2),** and IEC 61850 Edition 2.*
11. Six current and six voltage analog inputs support complete bay control and protection as well as two-breaker bay applications.
12. Power supply options include 24–48 Vdc; 48–125 Vdc or 110–120 Vac; or 125–250 Vdc or 110–240 Vac.

*Optional feature

**For PTPv2 implementation, Ports 5A and 5B must be ordered as an option.

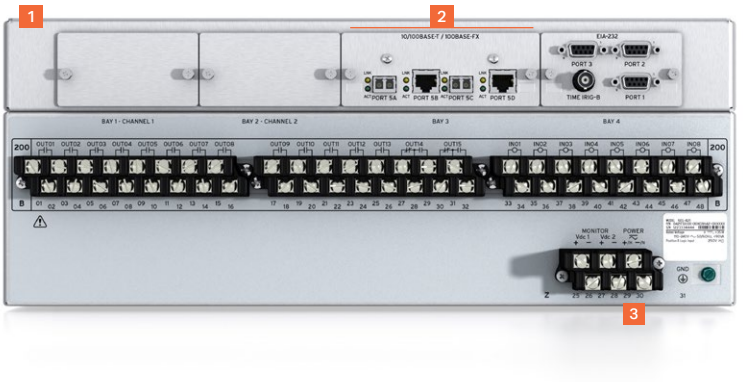
## SEL-421 TiDL OPTION

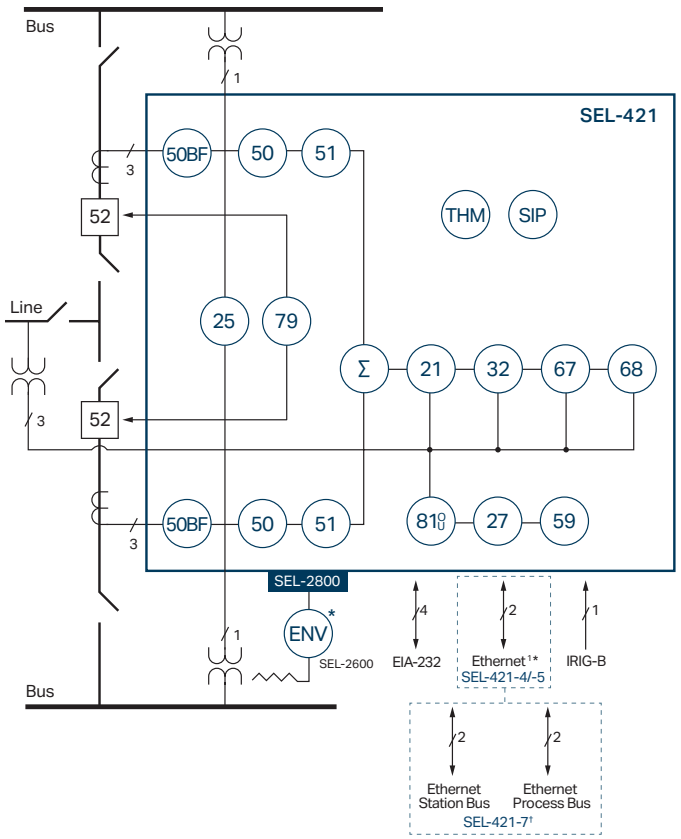
1. 4U chassis with mounting options (vertical or horizontal; panel or rack) accommodate users' application needs.
2. LEDs indicate the connection status to an SEL-TMU TiDL Merging Unit on a per-port basis.
3. Eight 100 Mbps fiber-optic ports allow the TiDL-enabled relay to connect with eight remote SEL-TMU nodes and to receive remote analog and digital data over the network.




## SEL-421 SV OPTION

1. The 4U chassis has various mounting options to accommodate users' hardware needs.
2. Select fiber-optic, copper, or mixed Ethernet with separate ports for SV data and engineering access.
3. Power supply options include 24–48 Vdc; 48–125 Vdc or 110–120 Vac; or 125–250 Vdc or 110–240 Vac.






## ANSI Functions

| | |
|---|---|
| 21 | Phase and Ground Distance |
| 25 | Synchronism Check |
| 27 | Undervoltage |
| 32 | Directional Power |
| 50 | Overcurrent |
| 50BF | Dual Breaker Failure Overcurrent |
| 51 | Time Overcurrent |
| 59 | Overvoltage |
| 67 | Directional Overcurrent |
| 68 | Out-of-Step Block/Trip |
| 79 | Single-/Three-Pole Reclosing |
| 81 (O,U) | Over-/Underfrequency |
| 85 RIO | SEL MIRRORED BITS® Communications |
| DFR | Event Reports |
| ENV | SEL-2600 RTD Module* |
| HMI | Operator Interface |
| LGC | Expanded SELOGIC® Control Equations |
| MET | High-Accuracy Metering |
| PMU | Synchrophasors |
| SER | Sequential Events Recorder |

## Additional Functions

| | |
|---|---|
| BRM | Breaker Wear Monitor |
| LDE | Load Encroachment |
| LOC | Fault Locator |
| SBM | Station Battery Monitor |
| SIP | Software-Invertible Polarities |
| SV | IEC 61850-9-2 Sampled Values Technology*† |
| THM | IEC 60255-Compliant Thermal Model |
| TiDL | Time-Domain Link Technology* |

*Optional feature [1] Copper or fiber-optic

†TiDL and SV relays receive current and voltage values from remote merging units.

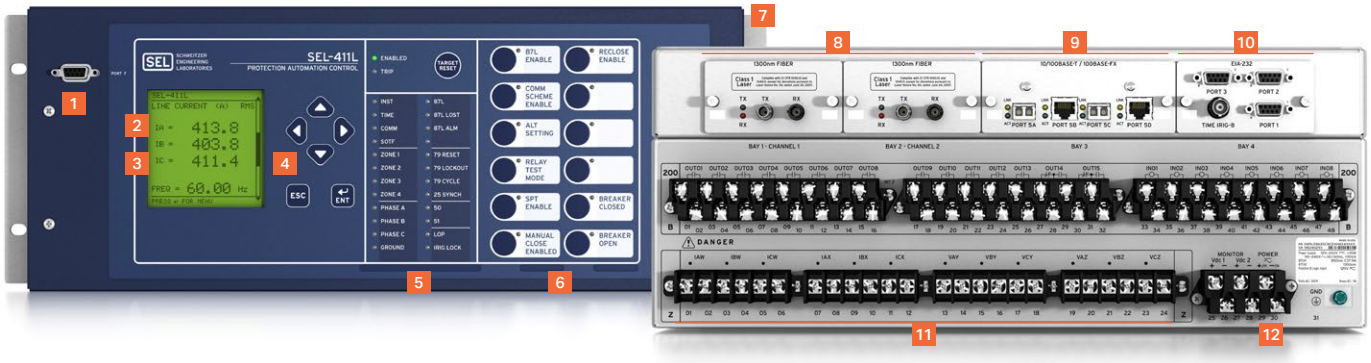
# SEL-411L

## Advanced Line Differential Protection, Automation, and Control System

Starting price
**$8,820 USD**

selinc.com/products/411L

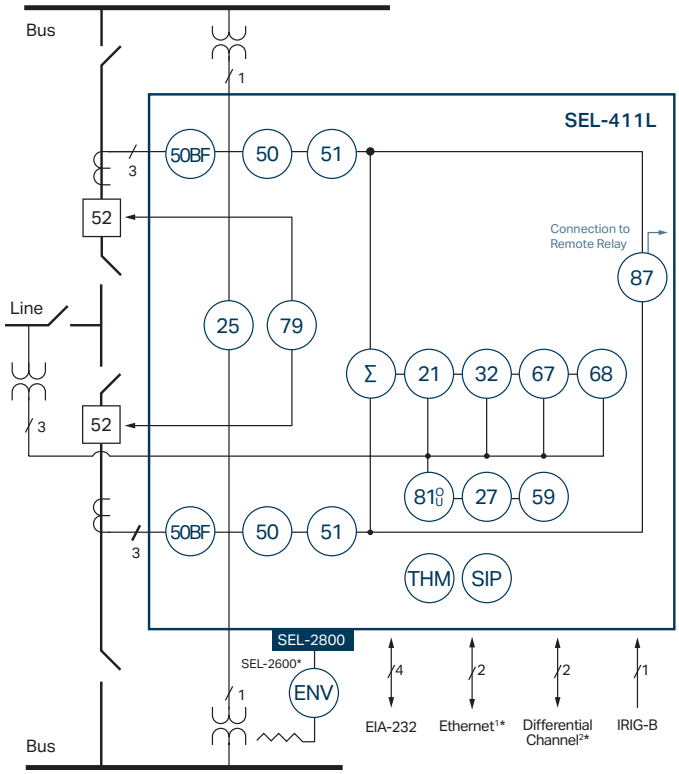
The SEL-411L offers complete protection and control of any transmission line (short, long, or series-compensated) with up to four terminals. Differential protection with both phase- and sequence-based operating elements provides sensitivity and high-speed operation. Complete distance and directional elements provide standalone protection or backup protection in differential schemes in the event communications are lost. In addition to the differential protection, the SEL-411L includes all the features of the SEL-421 Protection, Automation, and Control System. Many popular fiber and multiplexed communications options are available. The SEL-411L accurately locates faults to within a tower span using optional traveling-wave fault locating.




1. EIA-232 front serial port is quick and convenient for system setup and local access.
2. Front-panel display allows operators to control and view the status of disconnects and breakers.
3. User-selectable mimic screens show the system configuration in one-line diagram format.
4. Easy-to-use keypad aids simple navigation.
5. Up to 24 programmable target LEDs with user-configurable labels alert operators in the substation to faulted phases, the relay's status, and element operation.
6. Programmable operator pushbuttons with user-configurable labels allow front-panel customization.
7. Choose from a vertical or horizontal, panel-mount or rack-mount chassis and different size options.
8. Choose either fiber or copper connections for one or two 87L communications channels.
9. Communications protocols include FTP, Telnet, synchrophasors, DNP3 LAN/WAN, the Parallel Redundancy Protocol (PRP), the IEEE 1588 Precision Time Protocol Version 2 (PTPv2),** and IEC 61850 Edition 2.*
10. 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.
11. Six current and six voltage analog inputs support protection for substations with dual-breaker schemes.
12. The power supply allows different options: 24–48 Vdc; 48–125 Vdc or 110–120 Vac; or 125–250 Vdc or 120–240 Vac.

*Optional feature

**For PTPv2 implementation, Ports 5A and 5B must be used for engineering access and SCADA.




## ANSI Functions

| | |
|---|---|
| 21 | Phase and Ground Distance |
| 25 | Synchronism Check |
| 27 | Undervoltage |
| 32 | Directional Power |
| 50 | Overcurrent |
| 50BF | Dual Breaker Failure Overcurrent |
| 51 | Time Overcurrent |
| 59 | Overvoltage |
| 67 | Directional Overcurrent |
| 68 | Out-of-Step Block/Trip |
| 79 | Single-/Three-Pole Reclosing |
| 81 (O,U) | Over-/Underfrequency |
| 85 RIO | SEL MIRRORED BITS Communications |
| 87 | Current Differential |
| DFR | Event Reports |
| ENV | SEL-2600 RTD Module* |
| HMI | Operator Interface |
| LGC | Expanded SELOGIC® Control Equations |
| MET | High-Accuracy Metering |
| PMU | Synchrophasors |
| SER | Sequential Events Recorder |

## Additional Functions

| | |
|---|---|
| BRM | Breaker Wear Monitor |
| LDE | Load Encroachment |
| LOC | Fault Locator |
| SBM | Station Battery Monitor |
| SIP | Software-Invertible Polarities |
| THM | IEC 60255-Compliant Thermal Model |

*Optional feature [1]Copper or fiber-optic [2]Serial or Ethernet

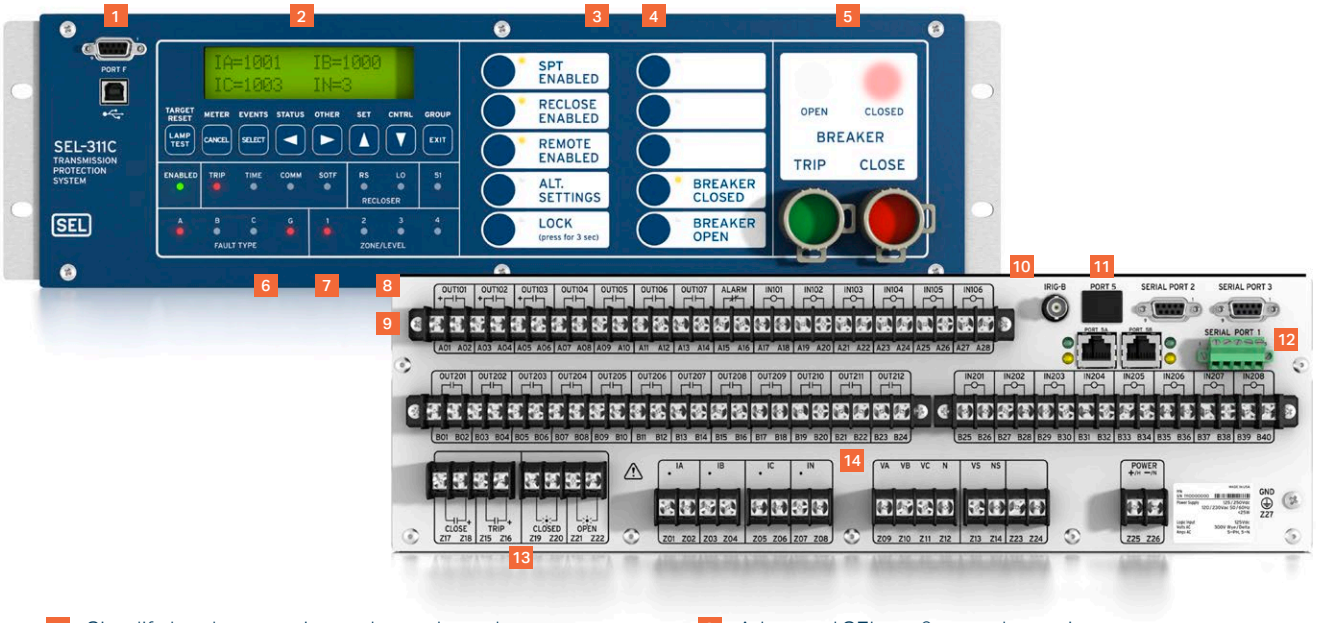
# SEL-311C

## Transmission Protection System

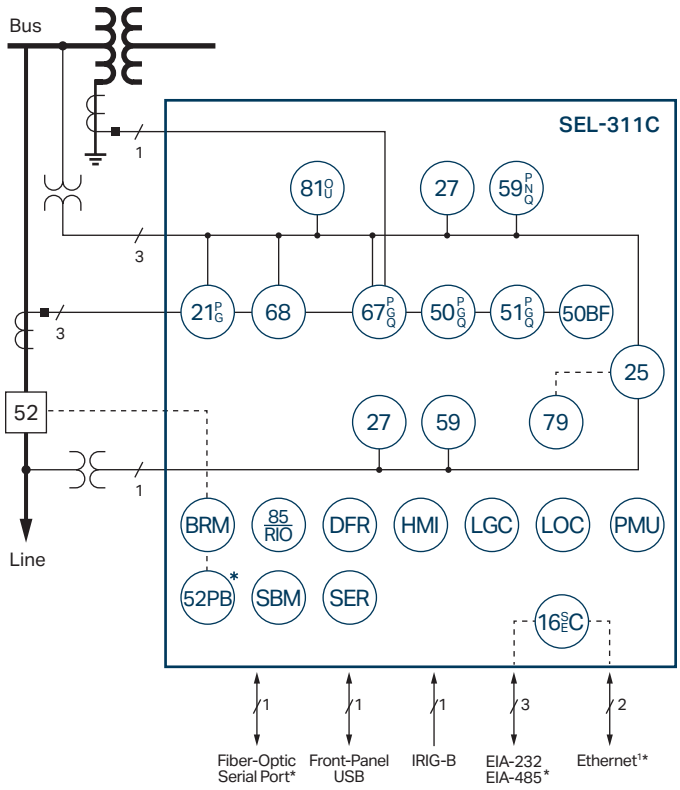
Starting price
**$4,670 USD**

selinc.com/products/311C

The SEL-311C provides protection, reclosing, monitoring, and control of transmission lines. Features include a four-shot recloser; patented capacitance voltage transformer (CVT) transient overreach logic to enhance the security of Zone 1 distance elements; and overcurrent elements with directional control, monitoring, and metering. You can apply three-pole tripping logic or select the SEL-311C-3 for single-pole tripping. The SEL-311C comes standard with EIA-232 serial ports and a 10/100BASE-T Ethernet port for local/remote access and system integration. IEEE C37.118-compliant synchrophasors improve situational awareness.




1. Simplify local connection and speed up relay communications with the front-panel USB port.
2. Use default displays, or program custom messages.
3. Optional field-configurable, programmable operator pushbuttons with user-configurable labels.
4. Optional programmable front-panel LEDs for custom alarms.
5. Optional independent SafeLock® trip/close pushbuttons with high-visibility indication.
6. Mirrored Bits® communications.
7. Built-in phasor measurement unit.
8. Advanced SELogic® control equations.
9. High-current interrupting output contacts.
10. Standard multisession Modbus TCP and DNP3. Optional IEC 61850.
11. Standard dual copper, optional single or dual fiber-optic Ethernet ports, or one copper and one fiber-optic Ethernet port.
12. Standard EIA-485 or fiber-optic serial port, or optional fiber-optic serial port.
13. Independent terminals for SafeLock trip/close pushbuttons.
14. Optional expanded I/O.




## ANSI Functions

| | |
|---|---|
| 16 SEC | Access Security (Serial, Ethernet) |
| 21 (P,G) | Distance (Phase Mho, Ground Mho, Ground Quad) |
| 25 | Synchronism Check |
| 27 | Undervoltage |
| 50 (P,G,Q) | Overcurrent (Phase, Ground, Negative Sequence) |
| 50BF | Breaker Failure Overcurrent |
| 51 (P,G,Q) | Time Overcurrent (Phase, Ground, Negative Sequence) |
| 52PB | Trip/Close Pushbuttons* |
| 59 (P,N,Q) | Overvoltage (Phase, Neutral, Negative Sequence) |
| 67 (P,G,Q) | Directional Overcurrent (Phase, Ground, Negative Sequence) |
| 68 | Out-of-Step Block/Trip |
| 79 | Autoreclosing |
| 81 (O,U) | Over-/Underfrequency |
| 85 RIO | SEL Mirrored Bits Communications |
| DFR | Event Reports |
| HMI | Operator Interface |
| LGC | Expanded SELogic Control Equations |
| MET | High-Accuracy Metering |
| PMU | Synchrophasors |
| SER | Sequential Events Recorder |

## Additional Functions

| | |
|---|---|
| BRM | Breaker Wear Monitor |
| LDE | Load Encroachment |
| LOC | Fault Locator |
| SBM | Station Battery Monitor |

*Optional feature [1]Copper or fiber-optic

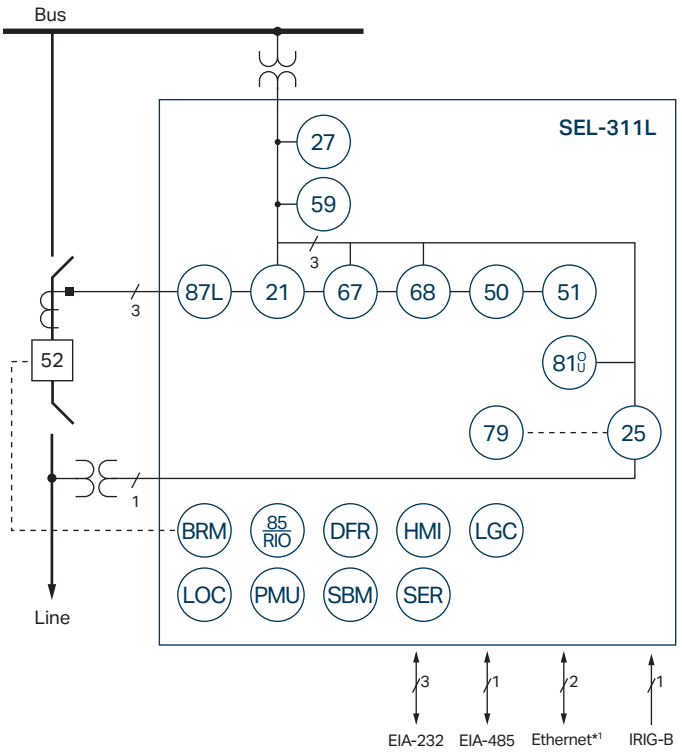
# SEL-311L

## Line Current Differential Protection and Automation System

Starting price
**$5,180 USD**

selinc.com/products/311L

The SEL-311L offers four-zone distance and directional overcurrent backup for easy-to-apply, high-speed line current differential protection. Single or dual differential communications channels provide reliability and security. The SEL-311L can accommodate two- or three-terminal lines, even with weak infeed. In addition, measuring elements provide coordination with tapped loads. You can reduce total project construction and operation costs by integrating the included four-shot recloser and relay logic operators into your automation system.


### ANSI Functions

| | |
|---|---|
| 21 | Phase and Ground Distance |
| 25 | Synchronism Check |
| 27/59 | Under-/Overvoltage |
| 50 | Overcurrent |
| 51 | Time Overcurrent |
| 67 | Directional Overcurrent |
| 68 | Out-of-Step Block/Trip |
| 79 | Single-/Three-Pole Reclosing |
| 81 (O,U) | Over-/Underfrequency |
| 85 RIO | SEL Mirrored Bits® Communications |
| 87L | Current Differential |
| DFR | Event Reports |
| HMI | Operator Interface |
| LGC | SELogic® Control Equations |
| Met | High-Accuracy Metering |
| PMU | Synchrophasors |
| SER | Sequential Events Recorder |

### Additional Functions

| | |
|---|---|
| BRM | Breaker Wear Monitor |
| LDE | Load Encroachment |
| LOC | Fault Locator |
| SBM | Station Battery Monitor |

*Optional feature [1] Copper or fiber-optic

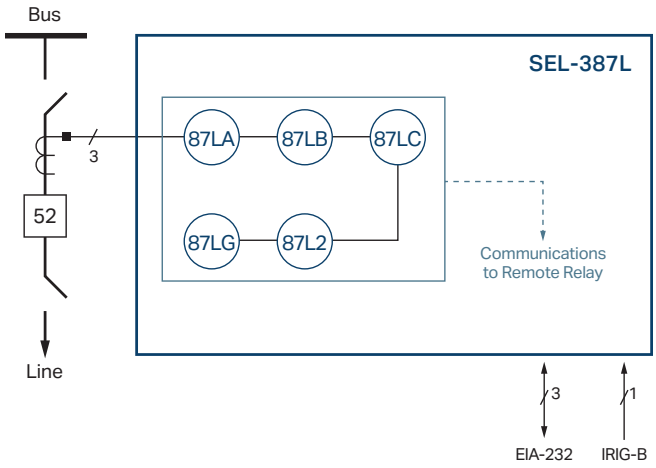
# SEL-387L

## Line Current Differential Protection and Automation System

Starting price
**$3,050 USD**

selinc.com/products/387L

The SEL-387L offers sensitive, fast (subcycle), and secure three-pole current differential protection with zero settings. Negative- and zero-sequence differential elements detect high-resistance ground faults while remaining secure for external faults. The Alpha Plane restraint principle provides security for CT saturation and channel asymmetry. Direct fiber and IEEE C37.94 synchronous optical interfaces are available. Channel monitoring provides measurement of communications quality and prevents misoperation due to channel failure.


### ANSI Functions

| | |
|---|---|
| 87L | Current Differential |
| DFR | Event Reports |
| HMI | Operator Interface |
| LGC | SELOGIC® Control Equations |
| Met | High-Accuracy Metering |
| SER | Sequential Events Recorder |
| SBM | Station Battery Monitor |

# Substation Protection Overview

## SEL-787-2/-3/-4

Apply advanced protection and monitoring with flexible communications to two-, three-, and four-terminal transformers.

## SEL-TMU NEW

Employ the SEL-TMU for remote data acquisition in substations with Time-Domain Link (TiDL®) technology systems. It can share data with up to four TiDL relays.

## SEL-401

Apply the SEL-401 in substations with IEC 61850-9-2 Sampled Values (SV) systems. The SEL-401 is a standalone merging unit with phase overcurrent and breaker failure protection.

## SEL-487V

Protect and control grounded and ungrounded, single- and double-wye capacitor bank configurations.

## SEL-487E

Provide high-speed transformer differential protection for up to five terminals as well as advanced monitoring, metering, automation, and control.

## SEL-2414

Provide complete system monitoring and control for new and existing transformers.

## SEL-487B

Provide bus differential and breaker failure protection, automation, and control in applications with up to seven terminals per relay.

## SEL-587Z

Use the economical SEL-587Z to combine proven high-impedance analog technology with the advantages of microprocessor technology.

## SEL-352

Provide breaker failure protection and breaker control and monitoring with unparalleled flexibility.

# Transformer Protection and Monitoring

| Applications | SEL-487E | SEL-387E | SEL-387 | SEL-387A | SEL-787 | SEL-787-2X/-21/-2E | SEL-787-3E/-3S/-4X | SEL-587 | SEL-2414 |
|---|---|---|---|---|---|---|---|---|---|
| Breaker Failure Protection | ■ | ƒ | ƒ | ƒ | ■ | ■ | ■ | ƒ | ƒ |
| Transformer and Machine Current Differential | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Low-Impedance Bus Differential | ■ | ■ | ■ | | | | ■ | | |
| Underfrequency Load Shedding | ■ | ƒ | | | + | + | + | | |
| Undervoltage Load Shedding | ■ | ƒ | | | + | + | + | | |
| Three-Phase Current Inputs | 5 | 3 | 4 | 2 | 2 | 2+ | 3 or 4 | 2 | 3+ |
| Three-Phase Voltage Inputs | 2 | 1 | | | 1+ | 1+ | 1+ | | 1+ |
| **Protection** | | | | | | | | | |
| 24 Overexcitation (Volts/Hertz) | ■ | ■ | | | + | + | + | | |
| 25 Synchronism Check | ■ | | | | | | + | | |
| 27/59 Under-/Overvoltage | ■ | ■ | | | + | + | + | | |
| 32 Directional Power | ■ | | | | + | + | + | | |
| 46 Current Unbalance | ■ | | | | | | | | |
| 49 Equipment Thermal Monitoring | ■ | | + | ■ | ■ | ■ | ■ | | |
| 50FO Flashover Protection | ƒ | ƒ | | | ƒ | ƒ | ƒ | | |
| 50 (N,G) Overcurrent (Neutral, Ground) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| 50P Phase Overcurrent, 50Q Negative-Sequence Overcurrent | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| 51 (N,G) Time Overcurrent (Neutral, Ground) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| 51P Phase Time Overcurrent | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| 51Q Negative-Sequence Time Overcurrent | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| 67 (P,G,Q) Directional Overcurrent (Phase, Ground, Negative Sequence) | ■ | | | | | | | | |
| 81 Under-/Overfrequency | ■ | ■ | | | + | + | + | | |
| 81R Rate-of-Change of Frequency | ƒ | | | | | | | | |
| 87 Current Differential | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| REF Restricted Earth Fault | ■ | ■ | ■ | + | + | + | ■ | | |

| Instrumentation and Control | SEL-487E | SEL-387E | SEL-387 | SEL-387A | SEL-787 | SEL-787-2X/-21/-2E | SEL-787-3E/-3S/-4X | SEL-587 | SEL-2414 |
|---|---|---|---|---|---|---|---|---|---|
| SELOGIC® Control Equations | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Voltage Check on Closing | ƒ | ƒ | | | ƒ | ƒ | ƒ | | |
| Transformer Cooling Fan Control | ƒ | | | | ƒ | ƒ | ƒ | | ■ |
| Nonvolatile Latch Control Switches | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ |
| SELOGIC Remote Control Switches | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| SELOGIC Local Control Switches | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ |
| Display Points | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ |
| Multiple Settings Groups | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | |
| Substation Battery Monitor | ■ | ■ | ■ | ■ | | + | + | | ƒ |
| Breaker Wear Monitor | ■ | ■ | ■ | ■ | | ■ | ■ | | |
| Event Report (Multicycle Data) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Sequential Events Recorder | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ |
| Instantaneous and Demand Meter | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Load and Temperature Profile Report | ■ | | | | ■ | ■ | ■ | | ■ |
| RTD (Resistance Temperature Detector) Inputs | | | | | + | + | + | | + |
| Built-In Web Server | ■ | ■ | | | | + | + | | |
| Software-Invertible Polarities | ■ | | | | | | | | |
| IEC 60255-Compliant Thermal Model | ■ | | | | | | | | |
| IEEE C37.118 Synchrophasors | ■ | | | | ■ | ■ | ■ | | |
| IEC 61850 | + | + | | | + | + | + | | + |
| IEC 61850-9-2 Sampled Values Technology | + | | | | | | | | |
| Simple Network Time Protocol (SNTP) | ■ | | | | + | + | + | | |
| Parallel Redundancy Protocol (PRP) | ■ | | | | + | + | + | | |
| IEEE 1588 Precision Time Protocol Version 2 (PTPv2) | + | | | | | + | + | | |
| EtherNet/IP | | | | | | + | + | | |
| Time-Domain Link (TiDL®) Technology | + | | | | | | | | |
| Through-Fault Monitor | ■ | ■ | + | ■ | ■ | ■ | ■ | | ■ |
| Thermal Model/SEL-2600 RTD Module Communications | ■ | | + | ■ | ■ | ■ | ■ | | ■ |

■ Standard feature + Model option

ƒ May be created using relay elements, device word bits, analog quantities, and timers

# Bus Protection

| Applications | SEL-387 | SEL-487B | SEL-487E | SEL-587Z |
|---|---|---|---|---|
| Breaker Failure Protection | *ƒ* | ■ | ■ | *ƒ* |
| Bus Differential | *ƒ* | ■ | ■ | ■ |
| Transformer and Machine Current Differential | ■ | | ■ | |
| High-Impedance Bus Differential | | | | ■ |
| Low-Impedance Bus Differential | ■ | ■ | ■ | |
| Three-Phase Current Inputs | 4 | 7/10/21‡ | 5 | Common |
| Three-Phase Voltage Inputs | | 1 | 2 | |
| **Protection** | | | | |
| 27/59 Under-/Overvoltage | | ■ | ■ | |
| 46 Current Unbalance | | *ƒ* | ■ | |
| 47 Voltage Unbalance | | | *ƒ* | |
| 50 (N,G) Overcurrent (Neutral, Ground) | ■ | | ■ | ■ |
| 50P Phase Overcurrent | ■ | ■ | ■ | ■ |
| 50Q Negative-Sequence Overcurrent | ■ | | ■ | ■ |
| 51 (N,G) Time Overcurrent (Neutral, Ground) | ■ | | ■ | ■ |
| 51P Phase Time Overcurrent | ■ | ■ | ■ | ■ |
| 51Q Negative-Sequence Time Overcurrent | ■ | | ■ | ■ |
| 87 Current Differential | ■ | ■ | ■ | |
| 87Z High-Impedance Differential | | | | ■ |
| Single-Pole Trip/Close | | ■ | | |
| Three-Phase Differential Bus Zones | 1 | 2/3/6‡ | 1 | 1 |
| Check Zones | | 3 | | |

| Instrumentation and Control | SEL-387 | SEL-487B | SEL-487E | SEL-587Z |
|---|---|---|---|---|
| 79 Automatic Reclosing | | *ƒ* | *ƒ* | |
| Dynamic Zone Selection | | ■ | | |
| SELOGIC® Control Equations | ■ | ■ | ■ | ■ |
| Nonvolatile Latch Control Switches | ■ | ■ | ■ | |
| SELOGIC Remote/Local Control Switches | ■ | ■ | ■ | ■ |
| Display Points | ■ | ■ | ■ | ■ |
| Multiple Settings Groups | ■ | ■ | ■ | |
| Substation Battery Monitor | ■ | ■ | ■ | |
| Breaker Wear Monitor | ■ | | ■ | |
| Event Report (Multicycle Data) | ■ | ■ | ■ | ■ |
| Sequential Events Recorder | ■ | ■ | ■ | ■ |
| Instantaneous Meter | ■ | ■ | ■ | ■ |
| Demand Meter | ■ | | ■ | ■ |
| Through-Fault Monitor | ■ | | ■ | |
| Software-Invertible Polarities | | | ■ | |
| IEC 60255-Compliant Thermal Model | | | ■ | |
| IEEE C37.118 Synchrophasors | | | ■ | |
| Synchrophasor Real-Time Control | | | ■ | |
| IEC 61850 | | + | + | |
| IEC 61850-9-2 Sampled Values Technology | | + | + | |
| Built-In Web Server | | ■ | ■ | |
| Simple Network Time Protocol (SNTP) | | ■ | ■ | |
| MIRRORED BITS® Communications | | ■ | ■ | |
| Parallel Redundancy Protocol (PRP) | | ■ | ■ | |
| IEEE 1588 Precision Time Protocol Version 2 (PTPv2) | | + | + | |
| Time-Domain Link (TiDL®) Technology | | + | + | |
| **Miscellaneous Features** | | | | |
| Connectorized® (Quick Disconnect) Available | + | + | + | |

■ Standard feature + Model option ‡1/2/3 relay application

*ƒ* May be created using settings

# Breaker Failure and Capacitor Bank Protection

| Applications | SEL-352 | SEL-451 | SEL-487B | SEL-487V |
|---|---|---|---|---|
| Breaker Failure Protection, Number of Three-Phase Breakers | 1 | 2 | 7 | 1 |
| Bus Differential | | | ■ | |
| Shunt Capacitor Bank Protection | | ƒ | | ■ |
| Underfrequency Load Shedding | | ƒ | | ƒ |
| Undervoltage Load Shedding | ƒ | ƒ | ƒ | ƒ |

| Protection | SEL-352 | SEL-451 | SEL-487B | SEL-487V |
|---|---|---|---|---|
| 25 Synchronism Check | ■ | ■ | | |
| 27/59 Under-/Overvoltage | ■ | ■ | ■ | ■ |
| 32/37 Power Elements | ■ | ƒ | ƒ | ■ |
| 46 Current Unbalance | ■ | ƒ | ƒ | ■ |
| 47 Voltage Unbalance | | ƒ | ƒ | ƒ |
| 49 Equipment Thermal Monitoring | + | ƒ | | ƒ |
| 50FO Flashover Protection | ■ | ■ | | ■ |
| 50 (N,G) Overcurrent (Neutral, Ground) | ■ | ■ | | ■ |
| 50P Phase Overcurrent | ■ | ■ | ■ | ■ |
| 50Q Negative-Sequence Time Overcurrent | | ■ | | ■ |
| 51 (N,G) Time Overcurrent (Neutral, Ground) | | ■ | | ■ |
| 51P Phase Time Overcurrent | | ■ | ■ | ■ |
| 51Q Negative-Sequence Time Overcurrent | | ■ | | ■ |
| 60 (N,P) Current Unbalance (Neutral, Phase) | | | | ■ |
| 67 Directional Overcurrent | | ■ | | ■ |
| 81 Under-/Overfrequency | | ■ | | ■ |
| 81R Rate-of-Change of Frequency | | | | ■ |
| 87 Current Differential | | | ■ | |
| 87V Voltage Differential | ■ | ƒ | | ■ |
| Single-Pole Trip/Close | ■ | | ■ | |

| Instrumentation and Control | SEL-352 | SEL-451 | SEL-487B | SEL-487V |
|---|---|---|---|---|
| Open-Pole Detection | | ƒ | ƒ | ■ |
| 79 Automatic Reclosing | ƒ | ■ | ƒ | ƒ |
| SELOGIC® Control Equations | ■ | ■ | ■ | ■ |
| Voltage Check on Closing | | ■ | | |
| Nonvolatile Latch Control Switches | ■ | ■ | ■ | ■ |
| SELOGIC Remote/Local Control Switches | ■ | ■ | ■ | ■ |
| Display Points | ■ | ■ | ■ | ■ |
| Multiple Settings Groups | ■ | ■ | ■ | ■ |
| Substation Battery Monitor | + | ■ | ■ | ■ |
| Breaker Wear Monitor | + | ■ | | ■ |
| Voltage Sag, Swell, and Interruption (VSSI) Recording | | ■ | | ■ |
| Event Report (Multicycle Data) | ■ | ■ | ■ | ■ |
| Sequential Events Recorder | ■ | ■ | ■ | ■ |
| Instantaneous Meter | ■ | ■ | ■ | ■ |
| Demand Meter | | ■ | | ■ |
| Harmonic Metering | | | | ■ |
| Software-Invertible Polarities | | ■ | | |
| IEC 60255-Compliant Thermal Model | | ■ | | |
| IEEE C37.118 Synchrophasors | | ■ | | ■ |
| IEC 61850 | | + | + | + |
| IEC 61850-9-2 Sampled Values Technology | | + | + | |
| Built-In Web Server | | ■ | ■ | ■ |
| Simple Network Time Protocol (SNTP) | | ■ | ■ | ■ |
| Parallel Redundancy Protocol (PRP) | | ■ | ■ | ■ |
| IEEE 1588 Precision Time Protocol Version 2 (PTPv2) | | + | + | |
| Time-Domain Link (TiDL®) Technology | | + | + | |
| SEL-2600 RTD Module Communications | + | ■ | | ■ |

| Miscellaneous Features | SEL-352 | SEL-451 | SEL-487B | SEL-487V |
|---|---|---|---|---|
| Connectorized® (Quick Disconnect) Available | + | + | + | + |
| Synchrophasor Real-Time Control | | ■ | | ■ |

■ Standard feature + Model option

ƒ May be created using relay elements and timers

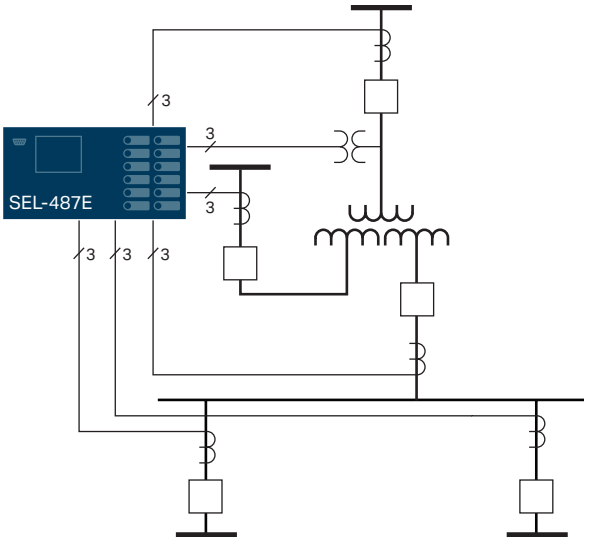
# Transformer Applications

## Multiwinding transformer protection

Provide current differential protection for up to five windings with an adaptive-slope percentage restraint for transformers at power plants, transmission substations, distribution substations, and industrial plants. The remaining three-phase current inputs can provide feeder backup protection.

Combine harmonic blocking and restraint functions in parallel to provide secure operation during inrush conditions. Second- and fourth-harmonic blocking provides security during energization, while fifth-harmonic blocking provides security for overexcitation conditions. The waveform-based inrush detection method augments the harmonic-blocking and -restraint functions to prevent differential element operation during an inrush condition with low second-harmonic content.

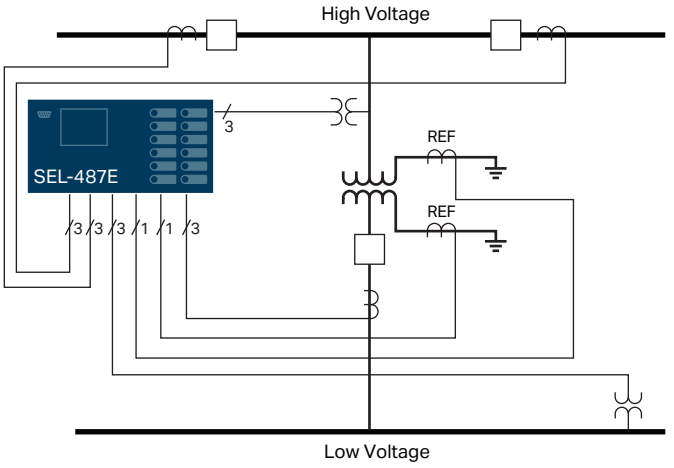
Implement the negative-sequence differential element for sensitive detection of interturn faults within the transformer winding.




## Impedance-grounded transformers

Apply the restricted earth fault (REF) protection feature to provide sensitive detection of internal ground faults on grounded-wye-connected transformer windings and autotransformers. The element is “restricted” in the sense that protection is restricted to ground faults within a zone defined by neutral and line CT placement.

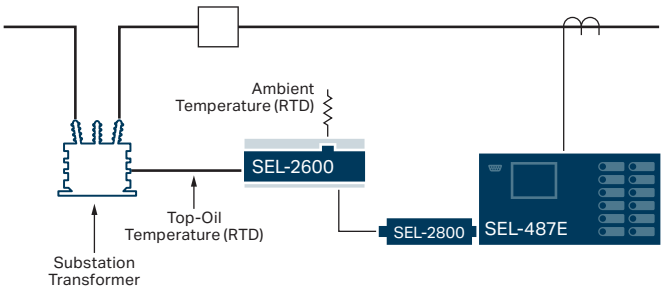
There are three independent REF elements in the SEL-487E Transformer Protection Relay. The SEL-387E Current Differential and Voltage Relay and SEL-387 Current Differential and Overcurrent Relay come standard with an REF element, while this is an optional feature with the SEL-387A Current Differential and Overcurrent Relay and the SEL-787 Transformer Protection Relay.




## Through-fault and thermal monitoring

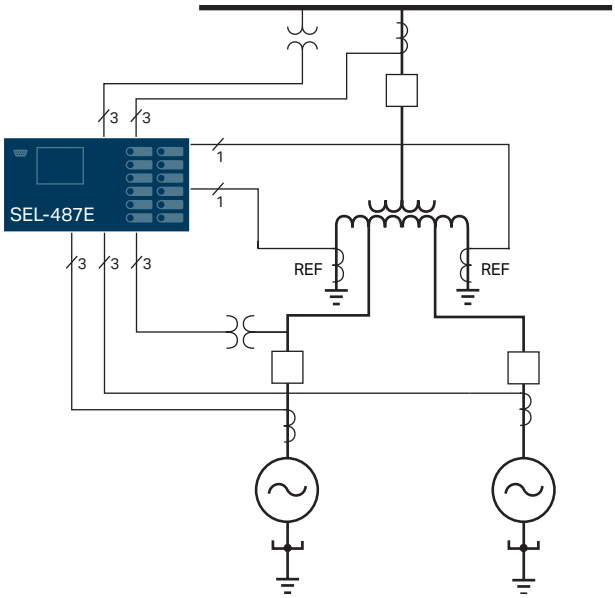
Track transformer wear with through-fault and thermal monitoring using the SEL-2600 RTD Module and SEL-487E Transformer Protection Relay. With the thermal element, you can trip the breaker, activate a control action, or issue an alarm when the transformer is in danger of excessive insulation aging or loss of life.

Gather current levels, through-fault duration, and the date/time of each through fault with transformer through-fault monitoring. Through-fault currents can cause transformer winding displacement, leading to mechanical damage and increased transformer thermal wear. Monitoring through-fault currents allows you to schedule proactive maintenance based on cumulative through-fault duty.



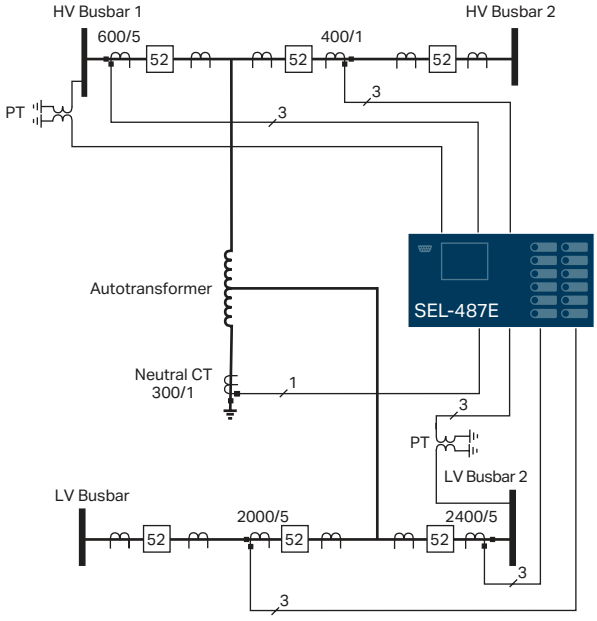
## Generator step-up (GSU) units

Install the SEL-487E Transformer Protection Relay for complete protection of GSU transformer applications. The built-in thermal elements let you monitor both generator and transformer winding temperatures. You can apply the volts/hertz element with two-level settings for overexcitation protection of loaded and unloaded generator operating conditions. The directional power elements detect forward and reverse power flow conditions to monitor and protect the GSU transformer in prime power, standby, base load, and peak-shaving applications.




## Autotransformer protection

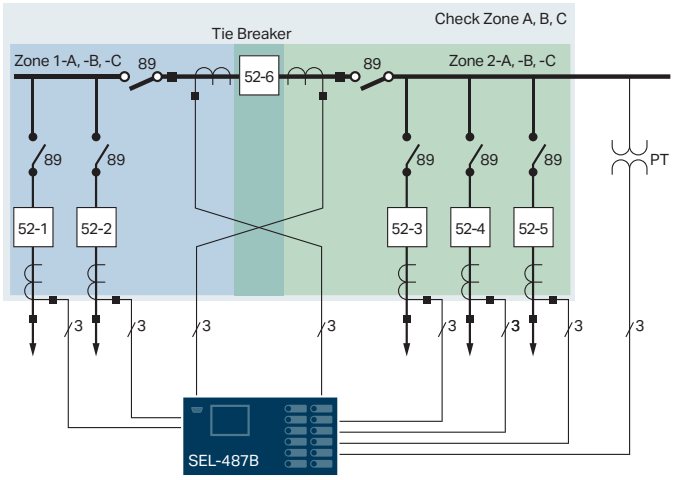
Protect autotransformers, including those with both high-voltage (HV) and low-voltage (LV) busbars configured as breaker-and-a-half busbars. The SEL-487E Transformer Protection Relay accepts CT inputs from up to five sets of phase CTs and up to three neutral CTs and accepts PT inputs from both HV and LV busbars. The voltage inputs provide over-/undervoltage elements, frequency elements, power elements, and volts-per-hertz protection of the transformer.



# Bus Applications

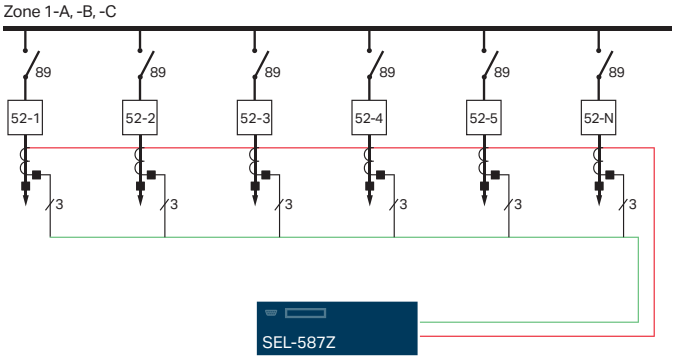
## Low-impedance bus differential protection

Provide two three-phase zones of protection for up to seven three-phase terminals (21 total current inputs) with a single SEL-487B Bus Differential and Breaker Failure Relay. A per-phase check zone increases security. For certain bus topologies, such as breaker-and-a-half, you can use one three-phase voltage input to increase security. The SEL-487B works in systems with nondedicated CTs and CT ratio mismatches up to 10:1, allowing you to use the same CTs in other protection applications. The relay also provides circuit breaker failure protection, control for up to 21 breakers and 60 disconnects, backup overcurrent protection, communications, and programmable logic control options.



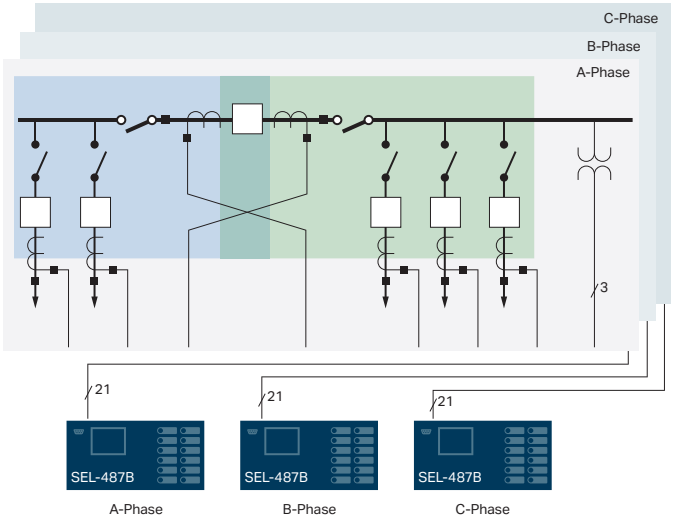

## High-impedance bus differential protection

Implement simple and cost-effective bus protection with the SEL-587Z High-Impedance Differential Relay. A single bus zone protects any number of bus terminals since the current inputs are connected in parallel before being brought to the relay. You can create an easily expandable bus protection solution with simple settings and dedicated same-ratio CTs. The relay can also provide backup overcurrent protection, detect breaker failure, and detect open-circuit CT conditions.



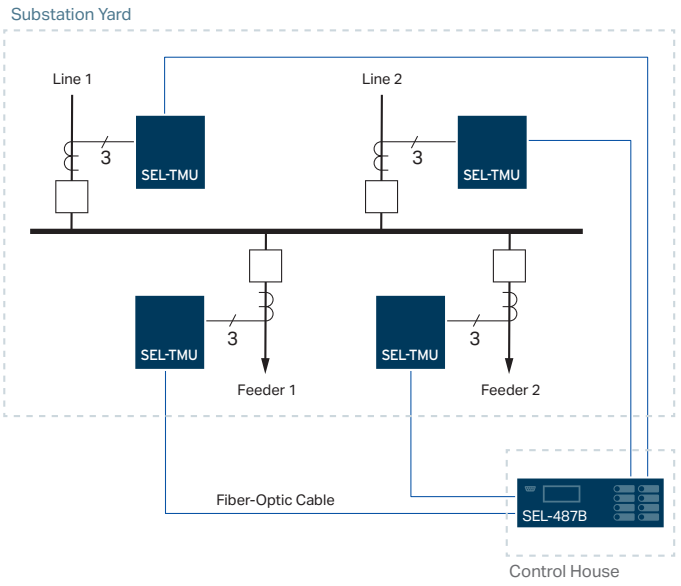

## Large bus configurations

Configure three SEL-487B Bus Differential and Breaker Failure Relays on a per-phase basis for large system bus protection. This configuration offers six three-phase zones of protection, a three-phase check zone, 63 current inputs capable of protecting up to 21 three-phase terminals, and voltage inputs for additional security. With six three-phase zones of protection, an internal fault would remove a minimal number of terminals from service for a complex system. Breaker failure detection is available for each terminal. A three-relay configuration is ideal if you plan to expand the busbar in the near future.



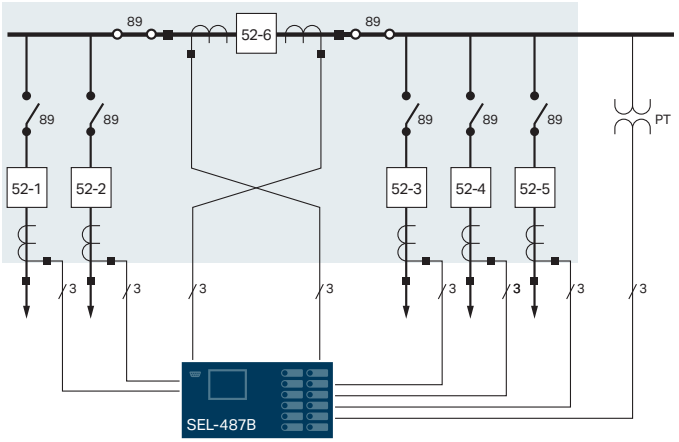
### Distributed bus protection

Build a simplified distributed bus solution using Time-Domain Link (TiDL®) technology and a compatible SEL-400 series relay. In a TiDL system, the SEL-TMU TiDL Merging Units are located in the yard next to primary equipment and act as field modules. They digitize analog signals and transport the data over a point-to-point fiber-optic cable to the SEL-487B Bus Differential and Breaker Failure Relay in the control house. TiDL offers strong cybersecurity and is easy to implement, with no external time source or network engineering required.




### Dynamic zone switching

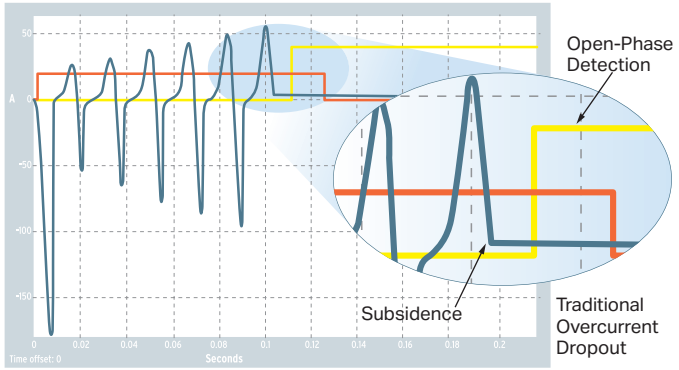
Apply dynamic zone switching with the SEL-487B Bus Differential and Breaker Failure Relay for extra security at busbars with regular disconnect switching. When interbus ties and disconnects change position, the relay will automatically reassign the current inputs to the proper bus zone. In this bus protection application, the disconnects are open and two three-phase bus zones are present. When the disconnects and tie breaker close, only a single three-phase bus zone is needed. When enabled, the SEL-487B will automatically track which current terminals belong to which bus zone based on the disconnect switch position.




## Breaker Applications

### Breaker failure detection

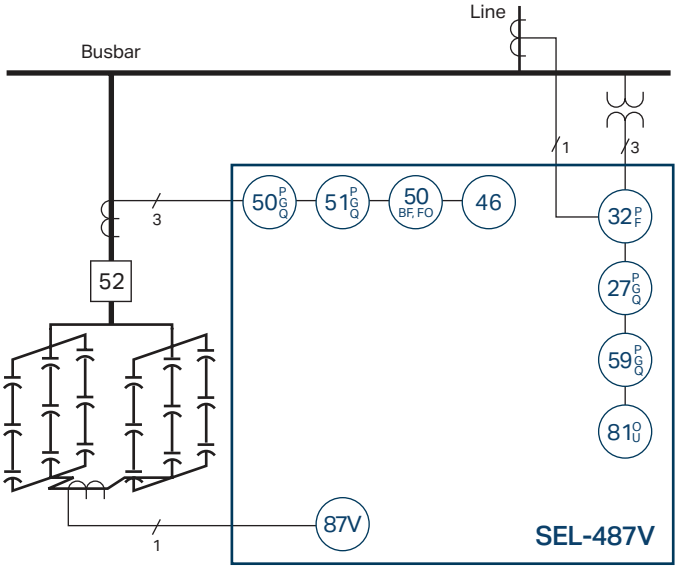
Minimize system clearing times and equipment damage with integrated breaker failure protection and monitoring. Breaker failure detection comes standard with many SEL relays, either with built-in settings or user-implemented SELOGIC® control equations. The built-in breaker failure detection function uses innovative subsidence detection logic to recognize an open-breaker condition by inspection of the ac current waveform. High-speed, open-pole detection logic detects open-pole conditions in fewer than 0.75 cycles to reduce breaker failure coordination times.



# Capacitor Bank Applications

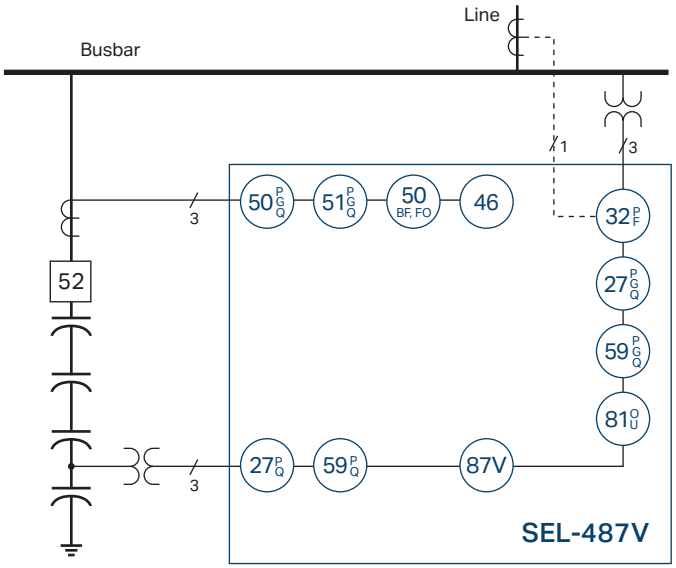
## Ungrounded capacitor banks

Provide protection for many ungrounded capacitor bank configurations with voltage unbalance, neutral current unbalance, and phase current unbalance elements. For example, with ungrounded wye shunt capacitor banks that have neutral current unbalance measurement (shown in the graphic), you can apply neutral current unbalance elements with automatic compensation adjustment. This eliminates any unbalance current caused by capacitor unit manufacturing tolerances or measurement tolerances. RMS or fundamental voltage elements and overcurrent elements provide backup protection.



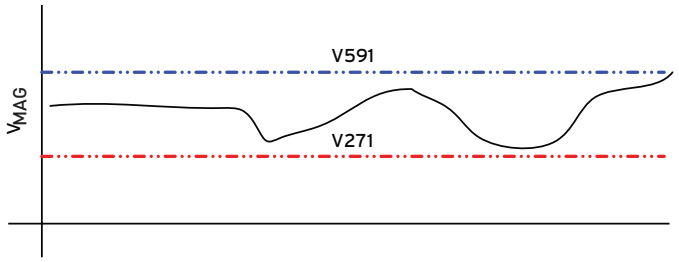

## Grounded capacitor banks

Protect grounded capacitor banks, including wye, double-wye, and H-bank configurations, with the SEL-487V Capacitor Protection and Control System. The relay's directional over-current, voltage unbalance, current unbalance, and voltage differential capabilities offer protection for an assortment of applications. Voltage differential protection provides responsive and efficient protection for applications with a large number of capacitor units where regular unbalance protection may not be sensitive enough to detect faults.



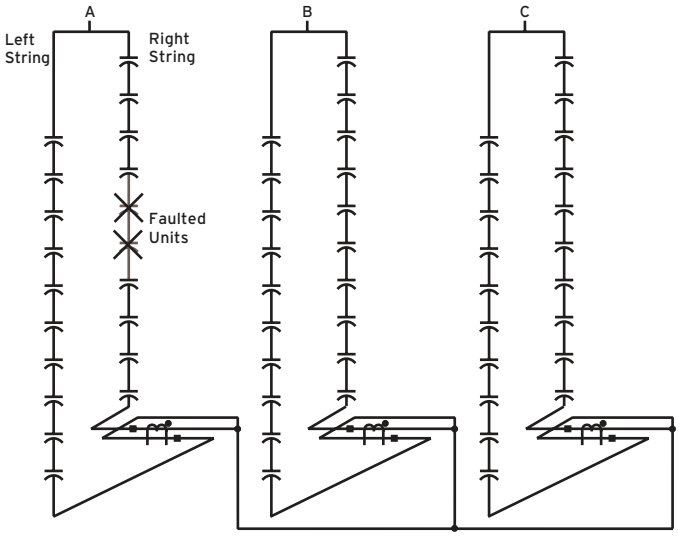
## Capacitor bank control

Control your capacitor banks without wiring and installing additional devices. The SEL-487V-1 Capacitor Protection and Control System has deadband control to keep the system voltage, VAR, or power factor within limits of your choosing. Or, for applications where the reactive power load varies predictably, you can use time-of-day or day-of-week scheduling to switch units in and out. Universal sequencing logic provides flexibility for switching multistaged banks based on the accumulated time in service or other specified conditions. To prevent excessive operation and wear, voltage instability logic detects when the relay is switching the units in a hunting fashion and stops operations or raises an alarm until the issue is resolved.



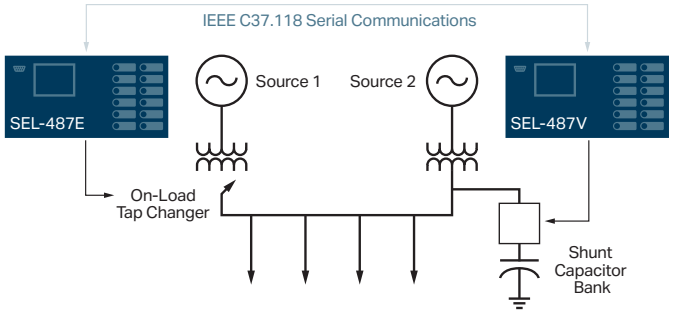

## Faulted-phase location

Assist crews in finding the faulted capacitor unit by using the patented faulted-phase and section identification logic in the SEL-487V Capacitor Protection and Control System. The logic works in any protection scheme that uses current unbalance or voltage differential protection. After a fault, the relay will provide indications of which phase the fault occurred on as well as a discrete indication of the location relative to the tap (top/bottom, left/right). This information saves valuable time in finding the fault and getting the unit back in service.




## Real-time control

Enhance system coordination and situational awareness with the IEEE C37.118-compliant synchrophasors and the real-time control system available in SEL-400 series relays (except the SEL-487B Bus Differential and Breaker Failure Relay). These relays can process up to two sets of remote phasor data over serial communications for use in SELOGIC control equations. This information supports control decisions based on remote and local data. For example, an SEL-487E Transformer Protection Relay and SEL-487V Capacitor Protection and Control System can exchange data to coordinate between a transformer and capacitor bank and maintain the system at an optimum voltage profile.



# SEL-787-2/-3/-4

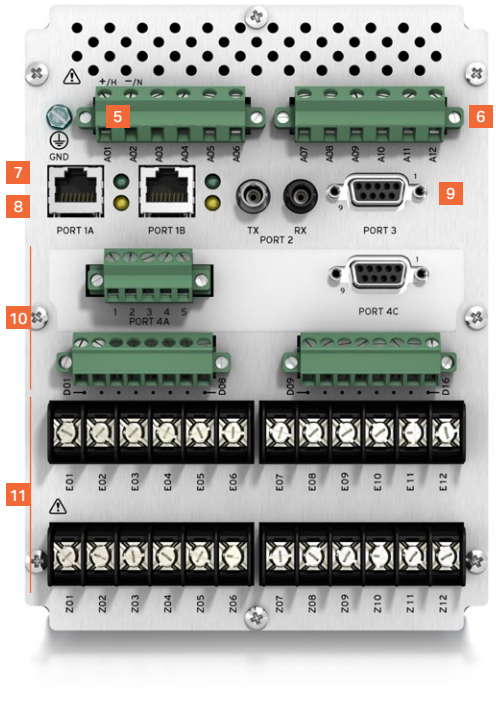
## Transformer Protection Relay

Starting price
**$3,060 USD**

selinc.com/products/787-3-4 | Select models typically ship in 2 days

The SEL-787 provides protection and monitoring for most two-, three-, and four-winding transformers. It offers advanced automation and flexibility, asset management data, and easy retrofitting of most electromechanical relays. The 5-inch, 800 × 480 color touchscreen display option allows you to directly set, monitor, and control your system from the relay front panel.

The SEL-787-2E/-21/-2X models offer two-winding differential protection, and the SEL-787-3E/-3S models offer three-winding differential protection. In addition, select model options include comprehensive transformer protection with a single-phase restricted earth fault (REF) input or a single-phase voltage input. The SEL-787-4X provides current-based, four-winding differential protection.


1. The 5-inch, 800 × 480 color touchscreen display offers direct navigation via a capacitive touchscreen.
2. Folders and applications provide quick access to bay screens, metering and monitoring data, reports, settings, and more.
3. Programmable front-panel LEDs with user-configurable labels alert operators to faulted phases, the relay's status, and element operation.
4. Programmable operator pushbuttons with user-configurable labels allow front-panel customization.
5. Power supply options include 24–48 Vdc or 110–250 Vdc/110–240 Vac.
6. 2 digital inputs (DI) and 3 digital outputs (DO).
7. A wide variety of communications protocols and media for flexibility to communicate with other devices and control systems.
8. An integrated web server enables direct relay access for metering and monitoring data without the need for external PC software.
9. EIA-232 serial port (P3) and fiber-optic EIA-232 serial port (P2) with IRIG-B input.
10. Positions for optional I/O cards (see the table on the next page).
11. Positions for current and voltage options (see the table on the next page).

## Differential protection

Select the SEL-787 for standard dual-slope differential protection with harmonic blocking and restraint for as many as four terminals. The SEL-787 offers as many as three independent REF elements for sensitive ground-fault detection for grounded-wye transformers. The relay also comes with a variety of overcurrent elements for backup protection, including phase, negative-sequence, residual-ground, and neutral-ground elements. Breaker failure protection for as many as four 3-pole breakers is also standard.

## Transformer monitoring

Measure and track accumulated through-fault current levels, and use optional 4 to 20 mA inputs or resistance temperature detector (RTD) thermal inputs to monitor ambient, load tap changer (LTC) tank, or transformer oil temperatures.

## Synchronism check/station dc battery monitor

Program the VS/VBAT voltage channel in the SEL-787-3S to perform a synchronism check across a circuit breaker or to monitor dc voltage levels of the substation battery.

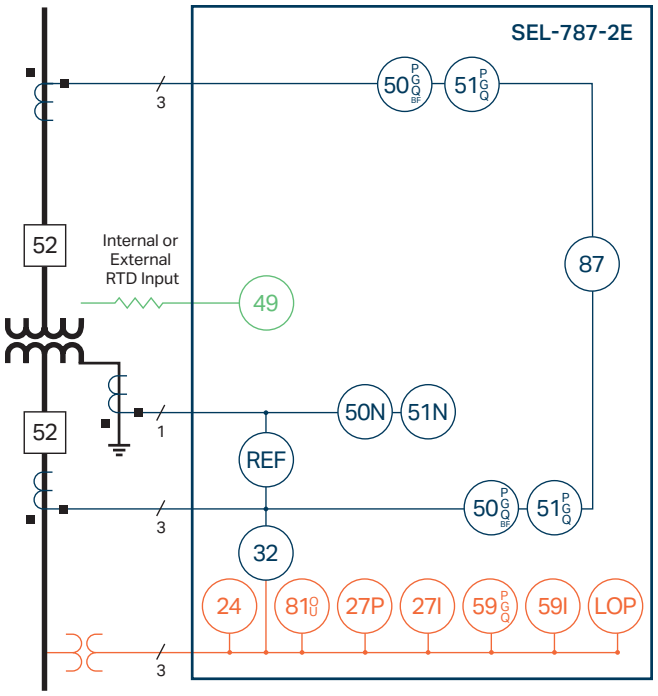
## Metering and reporting

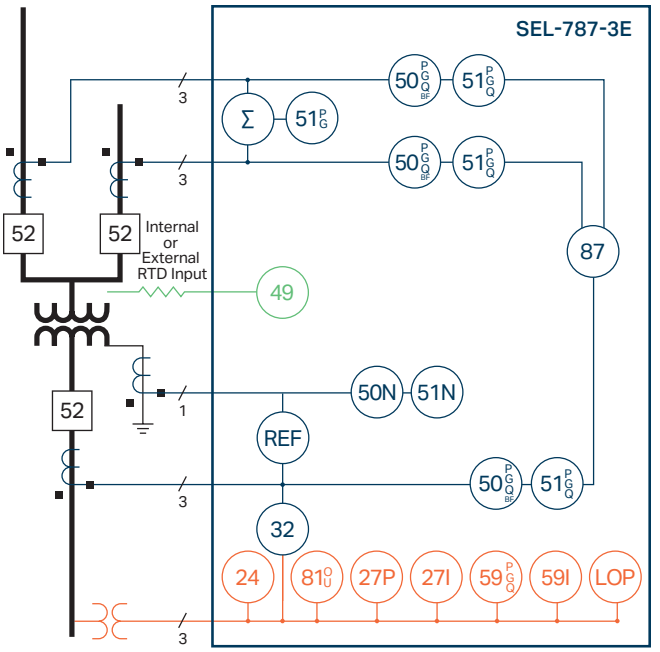
Eliminate separately mounted metering devices with the built-in metering functions. You can analyze Sequential Events Recorder (SER) reports and oscillographic event reports for rapid commissioning, testing, and post-fault diagnostics. The unsolicited SER protocol allows station-wide collection of binary SER messages.

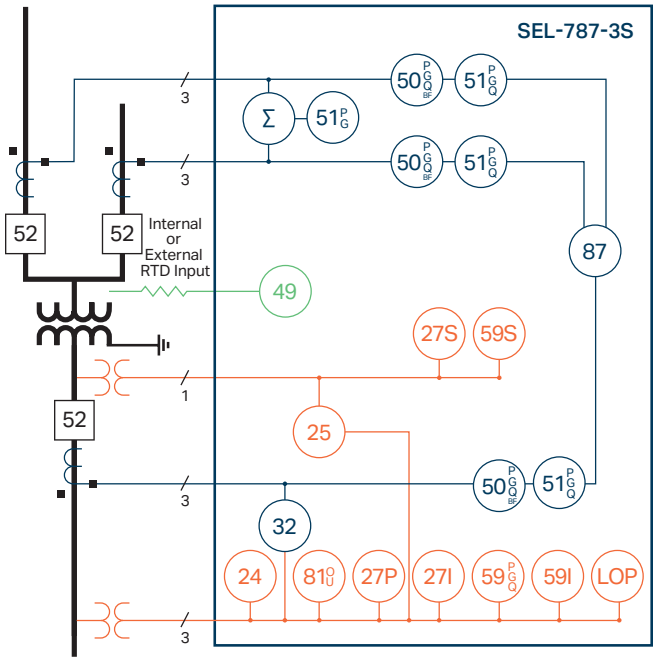
| Current and Voltage Input Cards | Model |
|---|---|
| 6 currents (Slot Z) | SEL-787-2X |
| 6 currents (Slot Z) and 1 neutral current (Slot E) | SEL-787-21 |
| 6 currents (Slot Z) and 1 neutral current, 3 voltages (Slot E) | SEL-787-2E |
| 6 currents (Slot Z) and 3 currents, 1 neutral current, 3 voltages (Slot E) | SEL-787-3E |
| 6 currents (Slot Z) and 3 currents, 3 voltages, 1 voltage (battery or synchronism check) (Slot E) | SEL-787-3S |
| 6 currents (Slot Z) and 6 currents (Slot E) | SEL-787-4X |

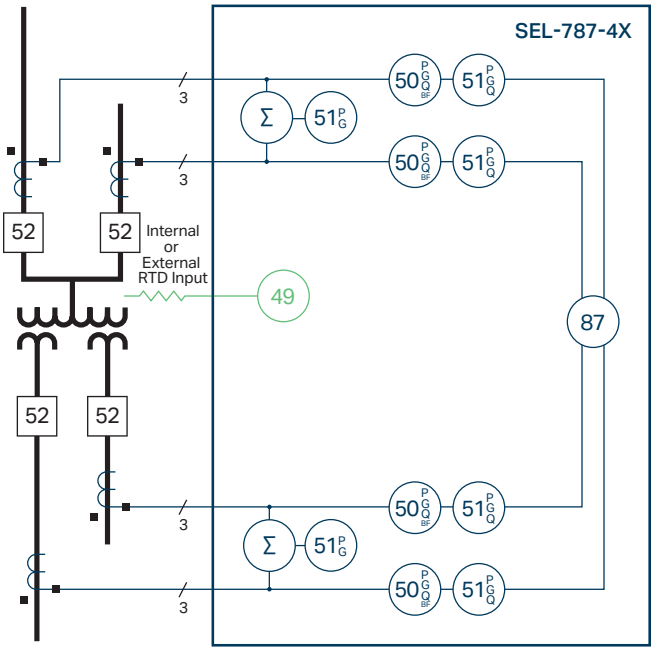
| Optional Communications and I/O Cards |
|---|
| Serial communications card (EIA-232/-485) |
| 3 DI/4 DO/1 4–20 mA analog output (AO) |
| 4 DI/4 DO |
| 8 DO |
| 8 DI |
| 14 DI |
| 4 DI/3 DO (2 Form C, 1 Form B) |
| 4 analog inputs (AI)/4 AO |
| 10 RTD input |

# SEL-787-2/-3/-4 Model Features



| Windings | SEL-787-2X | SEL-787-21 | SEL-787-2E | SEL-787-3E | SEL-787-3S | SEL-787-4X |
|---|---|---|---|---|---|---|
| Windings Protected | 2 | 2 | 2 | 3 | 3 | 4 |
| **CT/PT Inputs** | | | | | | |
| Phase Voltage Inputs | 0 | 0 | 3 | 3 | 3 | 0 |
| Differential Current Inputs | 6 | 6 | 6 | 9 | 9 | 12 |
| Neutral Current | 0 | 1 | 1 | 1 | 0 | 0 |
| VS/VBAT Channel | 0 | 0 | 0 | 0 | 1 | 0 |

| Protection Elements | | SEL-787-2X | SEL-787-21 | SEL-787-2E | SEL-787-3E | SEL-787-3S | SEL-787-4X |
|---|---|---|---|---|---|---|---|
| 24 | Volts/Hertz | | | ■ | ■ | ■ | |
| 25 | Synchronism Check | | | | | ■ | |
| 27I | Inverse-Time Undervoltage (Phase, Phase-to-Phase, Sequential, Vsync) | | | ■ | ■ | ■ | |
| 27P | Undervoltage (Phase) With Inverse Characteristic | | | ■ | ■ | ■ | |
| 27PP | Phase-to-Phase Undervoltage | | | ■ | ■ | ■ | |
| 27S | VS Channel Undervoltage | | | | | ■ | |
| 32 | Directional Power | | | ■ | ■ | ■ | |
| 49 | RTDs | ■ | ■ | ■ | ■ | ■ | ■ |
| 50N | Neutral Overcurrent | | ■ | ■ | ■ | | |
| 50 (P,G,Q,BF) | Overcurrent (Phase, Ground, Negative Sequence, Breaker Failure) | ■ | ■ | ■ | ■ | ■ | ■ |
| 51 (P,G,Q) | Time Overcurrent (Phase, Ground, Negative Sequence) | ■ | ■ | ■ | ■ | ■ | ■ |
| 51N | Neutral Time Overcurrent | | ■ | ■ | ■ | | |
| 51PC | Combined Winding Phase Time Overcurrent | | | | ■ | ■ | ■ |
| 51GC | Combined Winding Ground Time Overcurrent | | | | ■ | ■ | ■ |
| 59 (P,G,Q) | Overvoltage (Phase, Ground, Negative Sequence) | | | ■ | ■ | ■ | |
| 59I | Inverse Time, Overvoltage (Phase, Phase-to-Phase, Sequential, Vsync) | | | ■ | ■ | ■ | |
| 59S | Overvoltage (Synchronism or Battery Voltage) | | | | | ■ | |
| 81 (O,U) | Over-/Underfrequency | | | ■ | ■ | ■ | |
| 87 | Phase Differential | ■ | ■ | ■ | ■ | ■ | ■ |

| Differential and REF Elements | SEL-787-2X | SEL-787-21 | SEL-787-2E | SEL-787-3E | SEL-787-3S | SEL-787-4X |
|---|---|---|---|---|---|---|
| Differential Protection Windings (Standard) | 2 | 2 | 2 | 3 | 3 | 4 |
| REF Elements (Standard) | 0 | 1 | 1 | 1 | 0 | 0 |
| Differential Protection Windings (Winding 3 Configured for REF) | | | | 2 | 2 | 3 |
| REF Elements (Winding 3 Configured for REF) | | | | 2 | 2 | 2 |

| Additional Functions | | SEL-787-2X | SEL-787-21 | SEL-787-2E | SEL-787-3E | SEL-787-3S | SEL-787-4X |
|---|---|---|---|---|---|---|---|
| 85RIO | SEL Mirrored Bits Communications | ■ | ■ | ■ | ■ | ■ | ■ |
| BF | Breaker Failure | ■ | ■ | ■ | ■ | ■ | ■ |
| BW | Breaker Wear Monitoring | ■ | ■ | ■ | ■ | ■ | ■ |
| DFR | Event Reports | ■ | ■ | ■ | ■ | ■ | ■ |
| ENV | SEL-2600 RTD Module* | ■ | ■ | ■ | ■ | ■ | ■ |
| LDP | Load Data Profiling | ■ | ■ | ■ | ■ | ■ | ■ |
| LGC | SELogic® Control Equations | ■ | ■ | ■ | ■ | ■ | ■ |
| LOP | Loss of Potential | | | ■ | ■ | ■ | |
| MET | High-Accuracy Metering | ■ | ■ | ■ | ■ | ■ | ■ |
| RTD | 10 Internal or 12 External (see ENV) RTD Inputs* | ■ | ■ | ■ | ■ | ■ | ■ |
| REF | Restricted Earth Fault | | ■ | ■ | ■ | ■ | ■ |
| RTU | Remote Terminal Unit | ■ | ■ | ■ | ■ | ■ | ■ |
| SER | Sequential Events Recorder | ■ | ■ | ■ | ■ | ■ | ■ |
| TFE | Through-Fault Event Monitor | ■ | ■ | ■ | ■ | ■ | ■ |
| PMU | Synchronized Phasor Measurement | ■ | ■ | ■ | ■ | ■ | ■ |
| WEB | Web Server | ■ | ■ | ■ | ■ | ■ | ■ |

*Optional feature

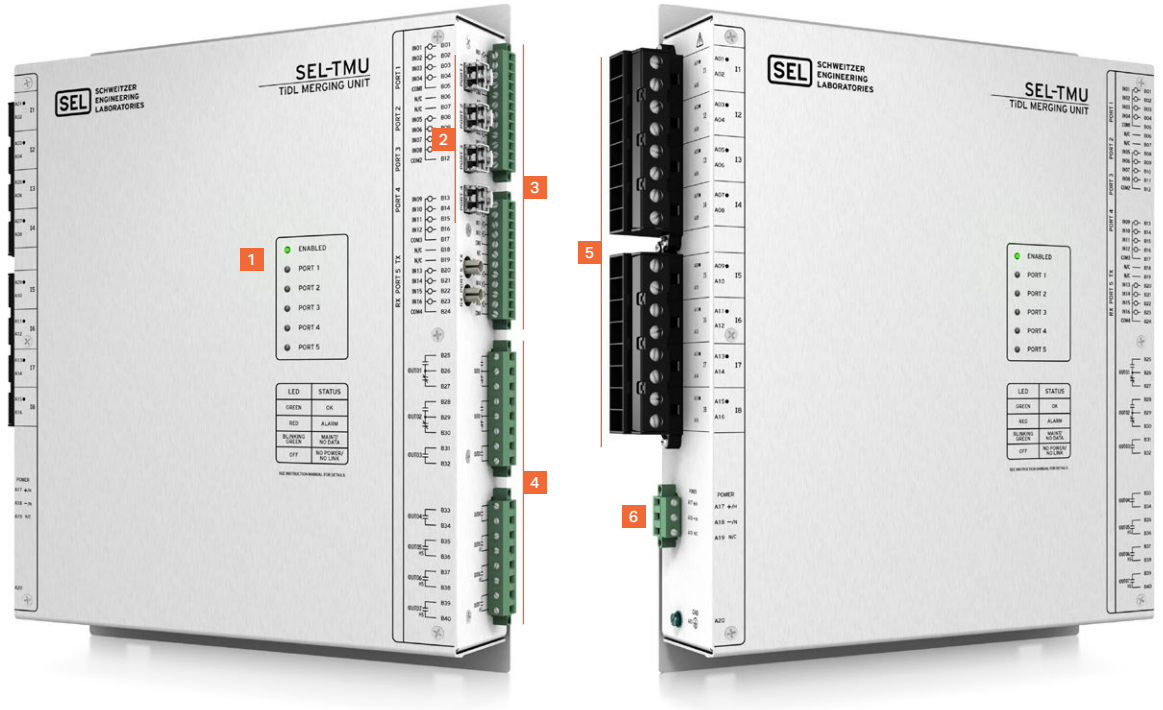
# SEL-TMU

## TiDL® Merging Unit NEW

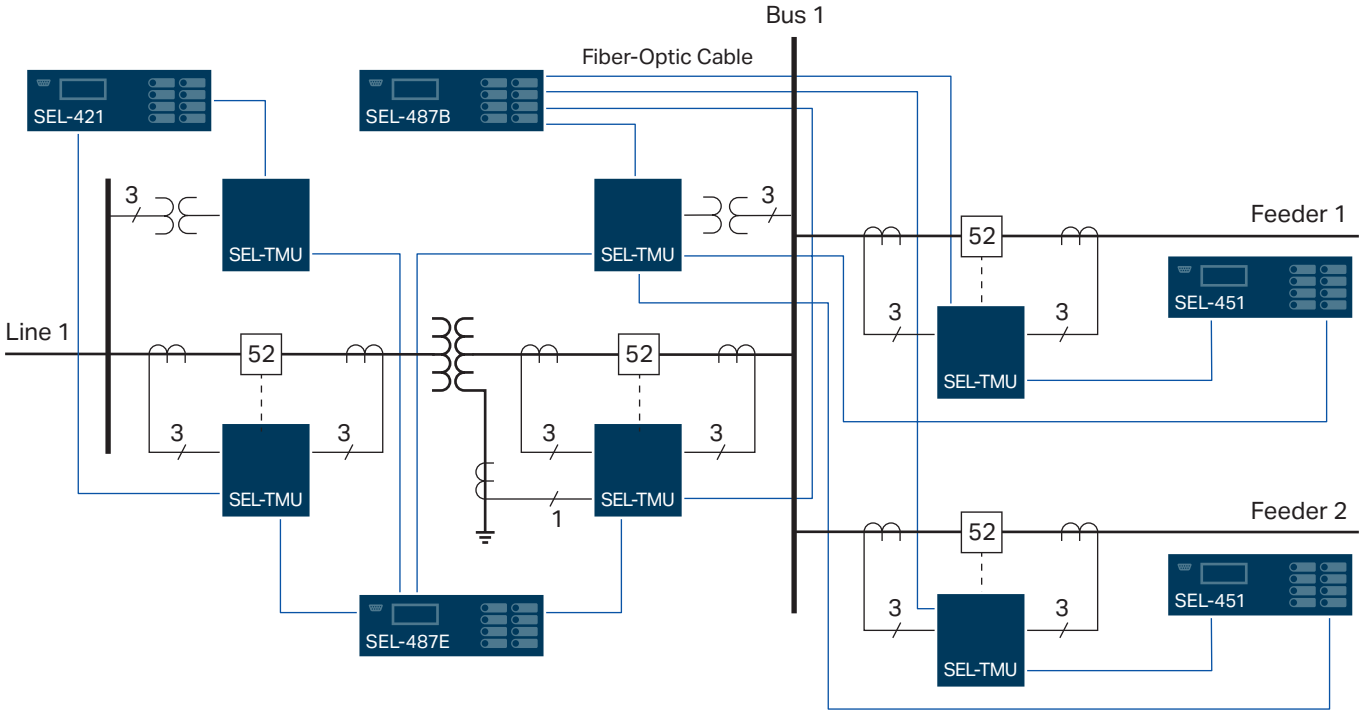
Starting price
**$2,900 USD**

selinc.com/products/TMU | Select models typically ship in 2 days

The SEL-TMU is a remote data acquisition device designed for use in a SEL Time-Domain Link (TiDL) technology network. It digitizes analog signals from primary equipment and then transmits them via fiber-optic cable to an SEL TiDL relay in the control house. TiDL-enabled relays include the SEL-421 Protection, Automation, and Control System; SEL-451 Protection, Automation, and Bay Control System; SEL-487B Bus Differential and Breaker Failure Relay; and SEL-487E Transformer Protection Relay. The SEL-TMU data stream is automatically and independently synchronized to each connected SEL TiDL relay, eliminating the need for an external time source. The direct, point-to-point architecture also alleviates the need for networked switches. An SEL-TMU can communicate with up to four SEL TiDL relays, allowing data sharing. It is a simple plug-and-play device, with network configuration and commissioning performed by the connected SEL TiDL relays.




1. The LED interface indicates the status of each port and the overall hardware health.
2. Small form-factor pluggable (SFP) fiber ports allow the SEL-TMU to communicate with up to four TiDL-enabled relays.
3. The 16 universal contact inputs operate over a range of 24–250 Vdc.
4. Flexible contact outputs support tripping, signaling, or switching applications.
5. Choose a module with 8 current inputs or with 4 current inputs and 4 voltage inputs.
6. The power supply operates over a wide range: 48–250 Vdc, 100–240 Vac.




An SEL-TMU works in various protection applications with TiDL-enabled relays.

# SEL-401

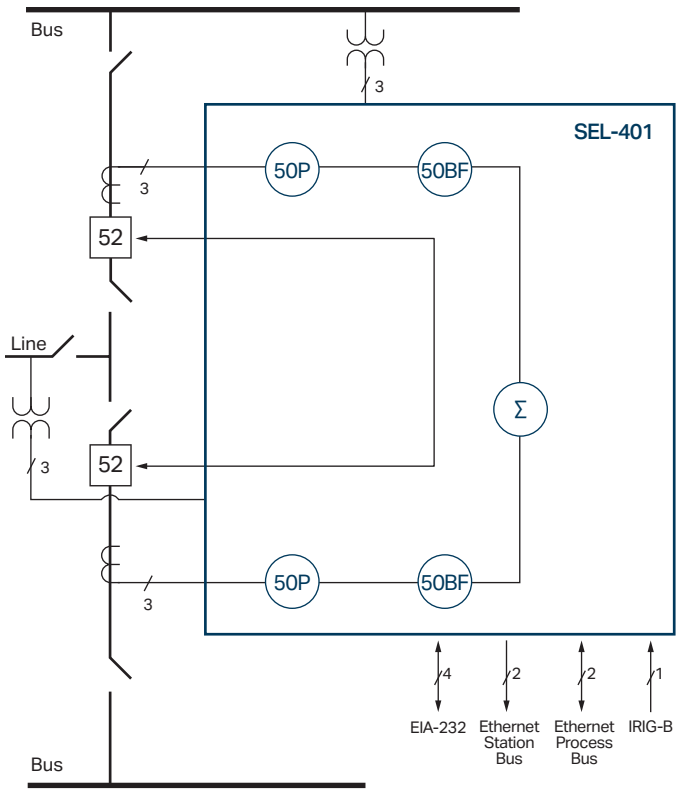
## Protection, Automation, and Control Merging Unit

Starting price
**$5,190 USD**

selinc.com/products/401

The SEL-401 is a merging unit with built-in overcurrent and breaker failure protection. You can apply the SEL-401 in substations with IEC 61850-9-2 Sampled Values (SV) systems to sample analog data, such as currents and voltages, then publish those data to a fiber-based Ethernet network for use in other IEDs, such as SEL-400 series relays with SV capability. The SEL-401 publishes up to seven SV data streams to the process bus network, where data are synchronized using IEEE 1588 Precision Time Protocol Version 2 (PTPv2) or an IRIG-B time input. The SEL-401 also provides local protection. You can use the built-in phase-overcurrent and breaker failure protection as a backup in case of communications system failures.


1. Control and settings are divided into seven relay 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.
2. 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.
3. 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.
4. Easy-to-use keypad aids simple navigation and set-point adjustment.
5. 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.
6. Programmable operator pushbuttons with user-configurable labels offer front-panel customization.
7. 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 4U horizontal rack mount with two I/O boards).
8. Select fiber-optic, copper, or mixed Ethernet. One pair is reserved for the process bus. The other pair is reserved for the station bus. Ethernet communications protocols include FTP, Telnet, synchrophasors, DNP3 LAN/WAN, the Parallel Redundancy Protocol (PRP), IEEE 1588 PTPv2, IEC 61850-9-2, and IEC 61850 Edition 2.
9. 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.
10. Six current and six voltage analog inputs, orderable in standard terminal blocks (shown) or a Connectorized® hardware configuration.
11. Power supply options include 24–48 Vdc; 48–125 Vdc or 110–120 Vac; or 125–250 Vdc or 110–240 Vac.




### ANSI 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 | Manufacturing Message Specification (MMS), GOOSE, Sampled Values (9-2LE) |
| LGC | Expanded SELogic® Control Equations |
| MET | High-Accuracy Metering |
| PMU | Synchrophasors |
| PTP | IEEE 1588 PTPv2 |
| SBM | Station Battery Monitor |
| SER | Sequential Events Recorder |
| SIP | Software-Invertible Polarities |

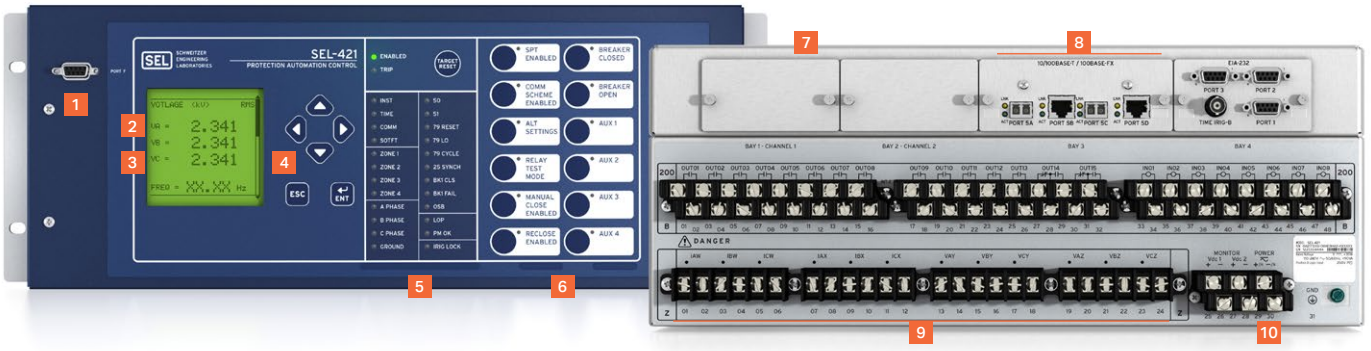
# SEL-421-7

## Protection, Automation, and Control Merging Unit

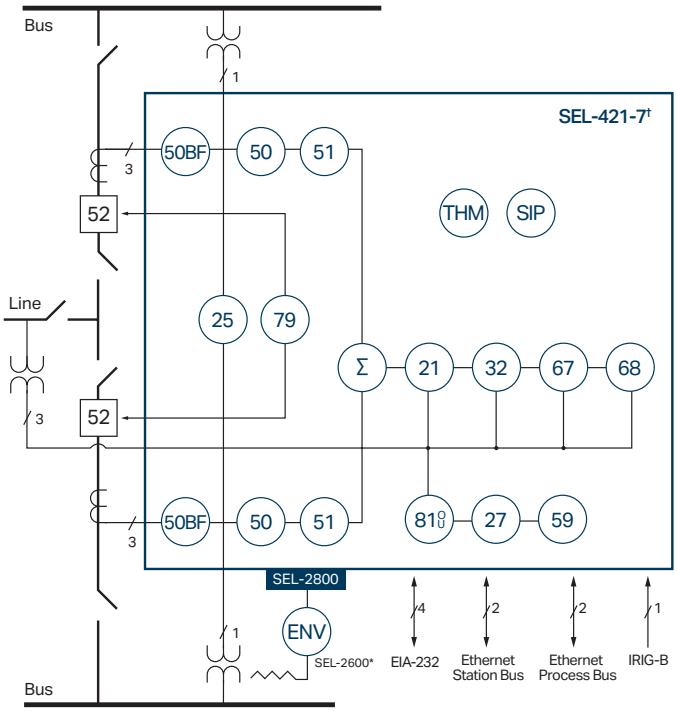
Starting price
**$10,630 USD**

selinc.com/products/421

The SEL-421-7 is a merging unit that combines advanced high-speed transmission line protection with the flexibility of IEC 61850-9-2 Sampled Values (SV) and the UCA 61850-9-2LE guideline. It digitizes analog signals from primary equipment and then publishes as many as seven SV data streams to relays in the control house via an Ethernet network. The data are synchronized using IEEE 1588 Precision Time Protocol Version 2 (PTPv2) or an IRIG-B time input. In the event of lost communications on the IEC 61850 network, the SEL-421-7 can provide standalone protection.




1. EIA-232 front serial port is quick and convenient for system setup and local access.
2. The front-panel display allows operators to control and view the status of disconnects and breakers.
3. The user-selectable mimic screens show the system configuration in one-line diagram format.
4. Easy-to-use keypad aids simple navigation.
5. Front-panel LEDs indicate custom alarms and provide fast and simple information to assist dispatchers and line crews with rapid power restoration.
6. Programmable operator pushbuttons with user-configurable labels allow front-panel customization.
7. Chassis options (for up to three I/O boards) and mounting options accommodate hardware needs.
8. Select fiber-optic, copper, or mixed Ethernet with separate ports for SV data and engineering access.
9. Six current and six voltage analog inputs support signal digitization and local protection schemes.
10. 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.




## ANSI Functions

| | |
|---|---|
| 21 | Phase and Ground Distance |
| 25 | Synchronism Check |
| 27 | Undervoltage |
| 32 | Directional Power |
| 50 | Overcurrent |
| 50BF | Dual Breaker Failure Overcurrent |
| 51 | Time Overcurrent |
| 59 | Overvoltage |
| 67 | Directional Overcurrent |
| 68 | Out-of-Step Block/Trip |
| 79 | Single-/Three-Pole Frequency |
| 81 (O,U) | Over-/Underfrequency |
| 85 RIO | SEL Mirrored Bits® Communications |
| DFR | Event Reports |
| ENV | SEL-2600 RTD Module* |
| HMI | Operator Interface |
| LGC | Expanded SELogic® Control Equations |
| MET | High-Accuracy Metering |
| PMU | Synchrophasors |
| SER | Sequential Events Recorder |

## Additional Functions

| | |
|---|---|
| BRM | Breaker Wear Monitor |
| LDE | Load Encroachment |
| LOC | Fault Locator |
| SBM | Station Battery Monitor |
| SIP | Software-Invertible Polarities |
| SV | IEC 61850-9-2 Sampled Values Technology*† |
| THM | IEC 60255-Compliant Thermal Model |
| TiDL® | Time-Domain Link Technology* |

*Optional feature

†SV subscriber relays have no analog input boards and instead receive voltages and current through Ethernet.

Note: Both copper and fiber-optic Ethernet ports are available.

# SEL-487V

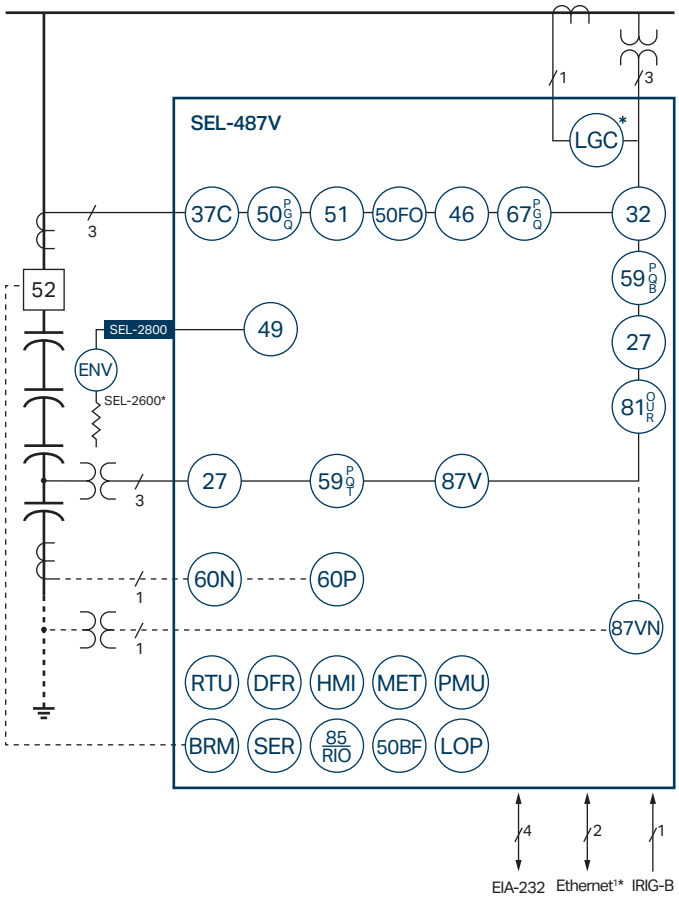
## Capacitor Protection and Control System

Starting price
**$4,350 USD**

selinc.com/products/487V

Use the SEL-487V for all your capacitor bank needs to simplify relay setting and application while reducing inventory. The versatile SEL-487V can handle grounded and ungrounded, single- and double-wye capacitor bank applications. It provides sensitive voltage differential and current unbalance protection and compensates for small voltage differential variations in individual capacitor elements from manufacturing, PT, or instrument transformer measurement errors. Application-based settings simplify setup and installation while fault-finding logic locates faulty capacitor units to speed up necessary maintenance. Synchrophasor technology provides situational awareness and real-time control.


1. EIA-232 front serial port is convenient for system setup and local access.
2. LCD allows you to control and view the status of disconnects and breakers.
3. Easy-to-use keypad aids simple navigation.
4. Front-panel LEDs indicate custom alarms and provide information to assist dispatchers and line crews with rapid power restoration.
5. Programmable operator pushbuttons with user-configurable labels allow front-panel customization.
6. Choose from a vertical or horizontal, panel-mount or rack-mount chassis and different size options.
7. Use one front and three rear EIA-232 ports for Mirrored Bits® communications, DNP3, SCADA, and engineering access.
8. Communications protocols include FTP, Telnet, synchrophasors, DNP3 LAN/WAN, the Parallel Redundancy Protocol (PRP), and IEC 61850.
9. Six current and six voltage channels support applications for grounded and ungrounded, single- and double-wye capacitor configurations.
10. Power supply options include 48–125 Vdc or 110–120 Vac; or 125–250 Vdc or 110–240 Vac.




## ANSI Functions

| | |
|---|---|
| 27 | Undervoltage |
| 32 | Real and Reactive Power |
| 37C | Undercurrent |
| 46 | Current Unbalance |
| 49 | Programmable Thermal Control and Logic |
| 50BF | Breaker Failure Overcurrent |
| 50FO | Flashover Overcurrent |
| 50 (P,G,Q) | Overcurrent (Phase, Ground, Negative Sequence) |
| 51 | Time Overcurrent (Selectable) |
| 59 (P,Q,B,T) | Overvoltage (Phase, Negative Sequence, Bank, Inverse Time) |
| 60N | Neutral Current Unbalance |
| 60P | Phase Current Unbalance |
| 67 (P,G,Q) | Directional Overcurrent (Phase, Ground, Negative Sequence) |
| 81 (O,U,R) | Frequency (Over, Under, Rate) |
| 85 RIO | SEL Mirrored Bits Communications |
| 87V | Phase Voltage Differential |
| 87VN | Neutral Voltage Differential |
| DFR | Event Reports |
| ENV | SEL-2600 RTD Module* |
| HMI | Operator Interface |
| LGC | Capacitor Bank Control* |
| LOP | Loss of Potential |
| MET | High-Accuracy Metering |
| PMU | Synchrophasors |
| RTU | Remote Terminal Unit |
| SER | Sequential Events Recorder |

## Additional Functions

| | |
|---|---|
| BRM | Breaker Wear Monitor |
| LDP | Load Data Profiling* |

*Optional feature [1] Copper or fiber-optic

# SEL-487E

## Transformer Protection Relay

Starting price
**$6,990 USD**

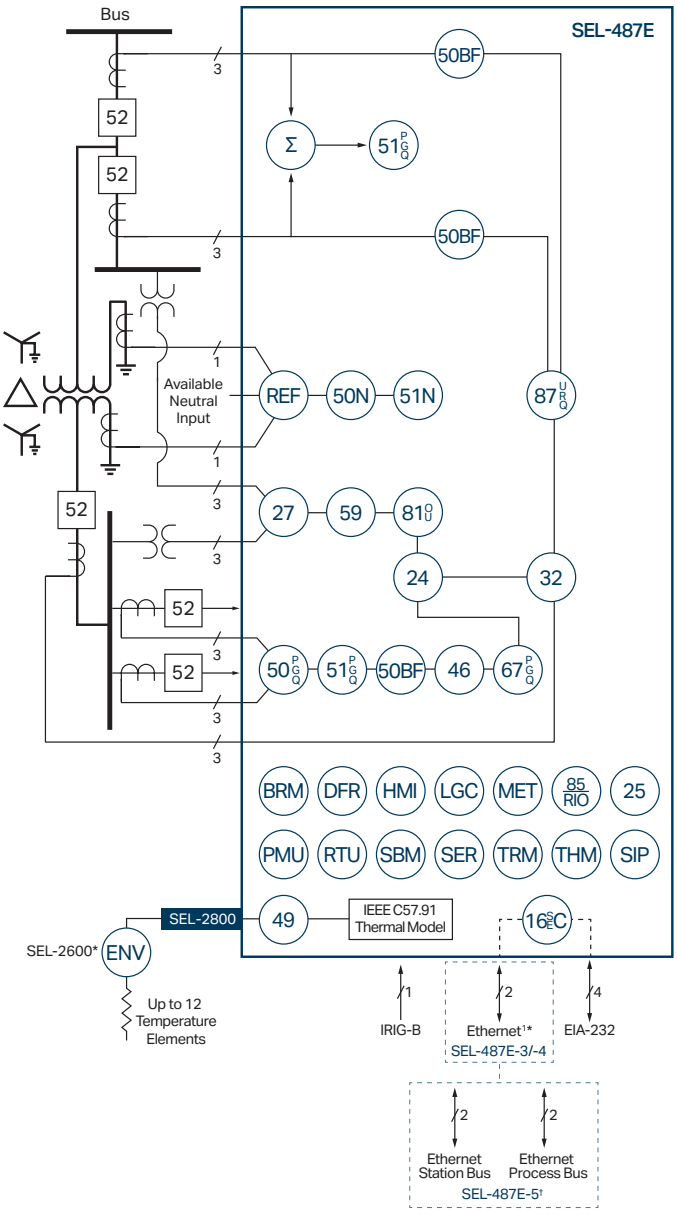
selinc.com/products/487E

The SEL-487E provides protection and monitoring for most transformer applications. The relay offers up to five three-phase restraint inputs, three independent restricted earth fault (REF) protection elements, and two three-phase voltage inputs, all with synchrophasors. The SEL-487E limits transformer damage by responding to internal fault conditions in less than 1.5 cycles and helps avoid catastrophic transformer failure by detecting turn-to-turn faults involving as little as 2 percent of the total winding. Through-fault and thermal monitoring allow you to track transformer wear and schedule maintenance as necessary. Breaker wear monitoring reduces inefficient and costly breaker maintenance, saving time and money. Optional Time-Domain Link (TiDL®) technology and SEL Sampled Values (SV) technology using IEC 61850-9-2 transform the way you modernize your substation.


1. EIA-232 front serial port is quick and convenient for system setup and local access.
2. LCD allows you to control and view the status of disconnects and breakers.
3. Easy-to-use keypad aids simple navigation.
4. Front-panel LEDs indicate custom alarms and provide fast and simple information to assist dispatchers and line crews with rapid power restoration.
5. Programmable operator pushbuttons with user-configurable labels allow front-panel customization.
6. Choose from a vertical (5U only) or horizontal, panel-mount or rack-mount chassis and different size options.
7. Communications protocols include FTP, Telnet, synchrophasors, DNP3 LAN/WAN, the Parallel Redundancy Protocol (PRP), the IEEE 1588 Precision Time Protocol Version 2 (PTPv2),** and IEC 61850 Edition 2.*
8. Use one front and three rear EIA-232 ports for Mirrored Bits® communications, DNP3, SCADA, and engineering access.
9. The 18 current and 6 voltage channels support transformer differential protection for up to 5 three-phase terminals, 3 independent REF elements, and voltage elements.
10. Connectorized® hardware configuration or a Euro connector with low-energy analog (LEA) voltage inputs provide flexibility for different line voltage sensors or optical voltage transformers.
11. 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.

*Optional feature

**For PTPv2 implementation, Ports 5A and 5B must be ordered as an option.




## ANSI Functions

| | |
|---|---|
| 16 SEC | Access Security (Serial, Ethernet) |
| 24 | Volts/Hertz |
| 25 | Synchronism Check |
| 27 | Undervoltage |
| 32 | Directional Power |
| 46 | Current Unbalance |
| 49 | Thermal |
| 50BF | Breaker Failure Overcurrent |
| 50N | Neutral Overcurrent |
| 50 (P,G,Q) | Overcurrent (Phase, Ground, Negative Sequence) |
| 51N | Neutral Time Overcurrent |
| 51 (P,G,Q) | Time Overcurrent (Phase, Ground, Negative Sequence) |
| 59 | Overvoltage |
| 67 (P,G,Q) | Directional Overcurrent (Phase, Ground, Negative Sequence) |
| 81 (O,U) | Over-/Underfrequency |
| 85 RIO | SEL Mirrored Bits Communications |
| 87 (U,R,Q) | Transformer Differential (Unrestrained, Restrained, Neg. Seq.) |
| DFR | Event Reports |
| ENV | SEL-2600 RTD Module* |
| HMI | Operator Interface |
| LGC | Expanded SELogic® Control Equations |
| MET | High-Accuracy Metering |
| PMU | Synchrophasors |
| REF | Restricted Earth Fault |
| RTU | Remote Terminal Unit |
| SER | Sequential Events Recorder |

## Additional Functions

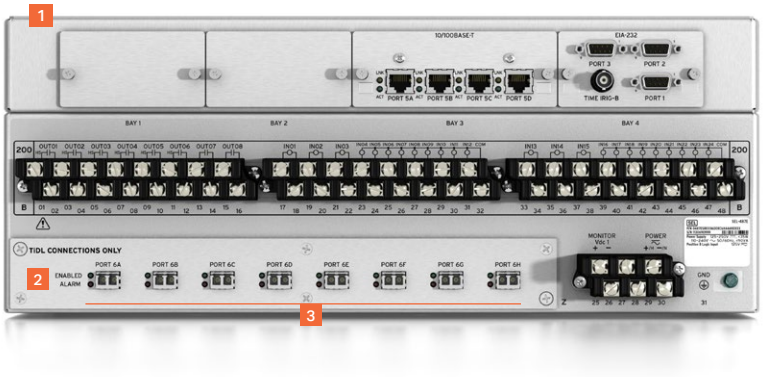
| | |
|---|---|
| BRM | Breaker Wear Monitor |
| LDP | Load Data Profiling |
| SBM | Station Battery Monitor |
| SIP | Software-Invertible Polarities |
| SV | IEC 61850-9-2 Sampled Values Technology*† |
| THM | IEC 60255-Compliant Thermal Model |
| TiDL | Time-Domain Link Technology* |
| TRM | Transformer Monitor |

*Optional feature †Copper or fiber-optic

†TiDL and SV relays receive current and voltage values from remote merging units.

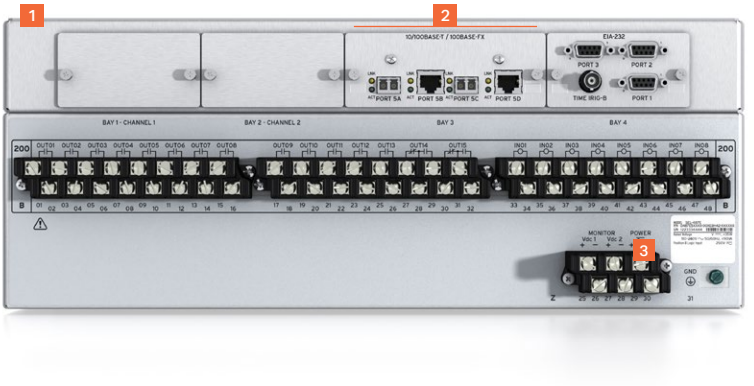
## SEL-487E TiDL Option

1. 4U chassis with horizontal mounting options (panel or rack) accommodates your application needs.
2. LEDs indicate the connection status to an SEL-TMU TiDL Merging Unit on a per-port basis.
3. Eight 100 Mbps fiber-optic ports allow the TiDL-enabled relay to connect with eight remote SEL-TMU nodes and to receive remote analog and digital data.




## SEL-487E SV Option

1. The 4U chassis has various mounting options to accommodate hardware needs.
2. Select fiber-optic, copper, or mixed Ethernet with separate ports for SV data and engineering access.
3. 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.

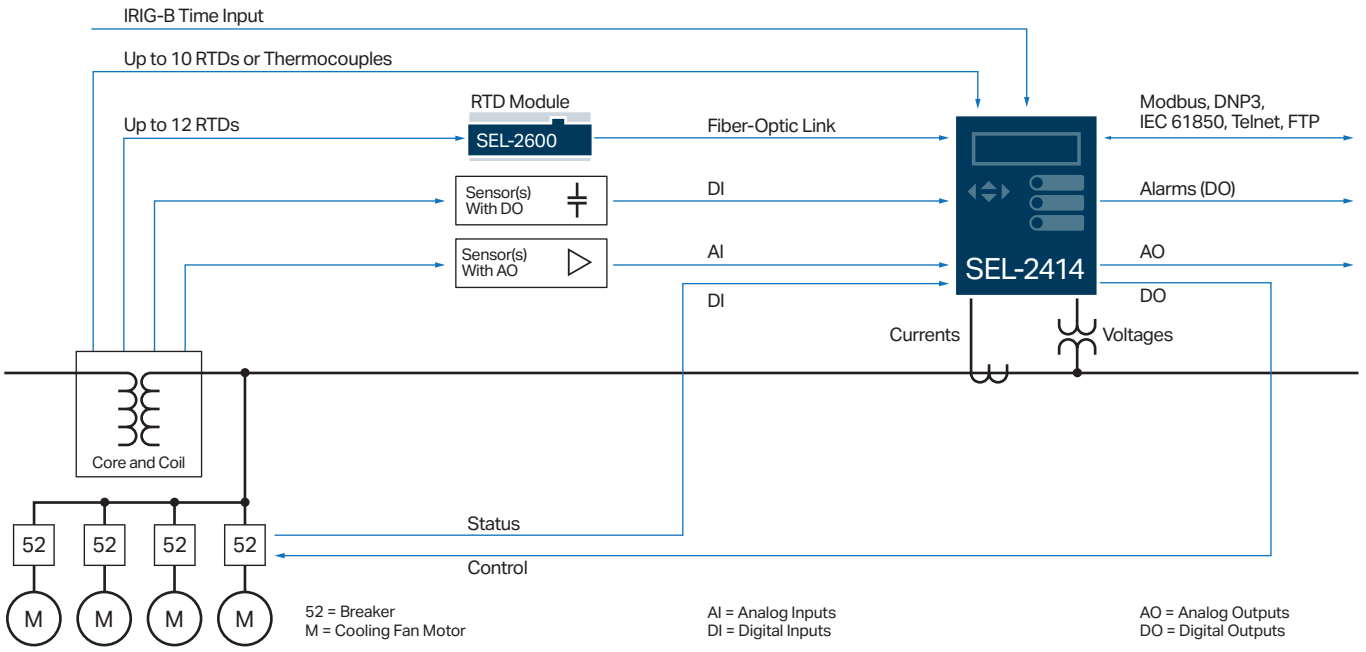


# SEL-2414
## Transformer Monitor

Starting price
**$1,200 USD**

selinc.com/products/2414

The SEL-2414 provides standalone or distributed monitoring and control of transformers. With flexible communications options, it can connect to a SCADA or automation system. Multiple I/O options are available to help you monitor your system, from detecting oil levels and sudden pressure to alerting alarm systems or control functions. The SEL-2414 withstands harsh physical and electrical environments and is built and tested to meet mission-critical IEEE and IEC protective relay standards.


Input diagram for typical transformer monitoring, cooling, and control applications.

# SEL-487B

## Bus Differential and Breaker Failure Relay

Starting price
**$7,070 USD**

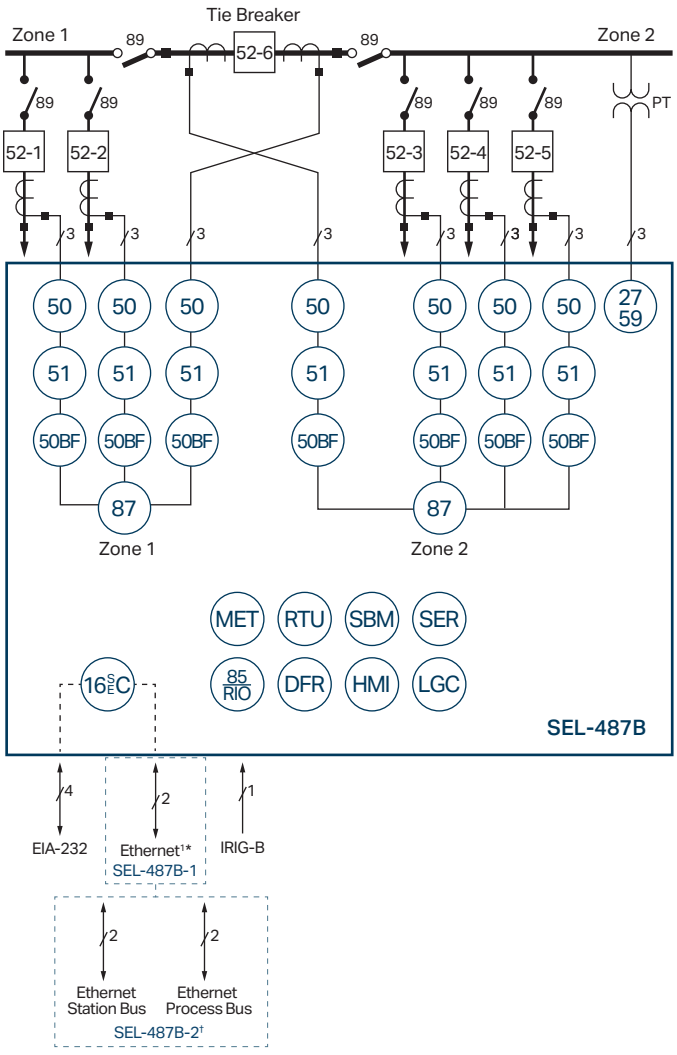
selinc.com/products/487B

The SEL-487B provides optimized, low-impedance bus differential fault detection by using high-speed, subcycle protection coupled with high-security operation for external faults. Superior protection performance and integrated station automation features provide a seamless solution for new and retrofit applications. Optional Time-Domain Link (TiDL®) technology and SEL Sampled Values (SV) technology transform the way you modernize your substation. The SEL-487B with TiDL technology is a simple way to provide distributed busbar protection. The TiDL architecture simplifies network engineering and fiber-optic cable routing in the field and makes the commissioning process quick and easy.


1. EIA-232 front serial port is quick and convenient for system setup and local access.
2. LCD automatically scrolls between custom displays.
3. Easy-to-use keypad aids simple navigation.
4. Front-panel LEDs indicate custom alarms and provide fast and simple information to assist dispatchers and line crews with rapid power restoration.
5. Programmable operator pushbuttons with user-configurable labels allow for front-panel customization.
6. Choose from a horizontal panel-mount or rack-mount chassis and different size options.
7. Use one front and three rear EIA-232 ports for Mirrored Bits® communications, DNP3, SCADA, and engineering access.
8. Communications protocols include FTP, Telnet, DNP3 LAN/WAN, the Parallel Redundancy Protocol (PRP), the IEEE 1588 Precision Time Protocol Version 2 (PTPv2),** and IEC 61850 Edition 2.*
9. 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.
10. 21 current and 3 voltage channels accommodate different busbar configurations.

*Optional feature

**For PTPv2 implementation, Ports 5A and 5B must be ordered as an option.




## ANSI Functions

| | |
|---|---|
| 16 SEC | Access Security (Serial, Ethernet) |
| 27/59 | Over-/Undervoltage |
| 50 | Overcurrent |
| 50BF | Breaker Failure Overcurrent |
| 51 | Time Overcurrent |
| 85 RIO | SEL Mirrored Bits Communications |
| 87 | Current Differential |
| DFR | Event Reports |
| HMI | Operator Interface |
| LGC | Expanded SELogic® Control Equations |
| MET | High-Accuracy Metering |
| RTU | Remote Terminal Unit |
| SER | Sequential Events Recorder |

## Additional Functions

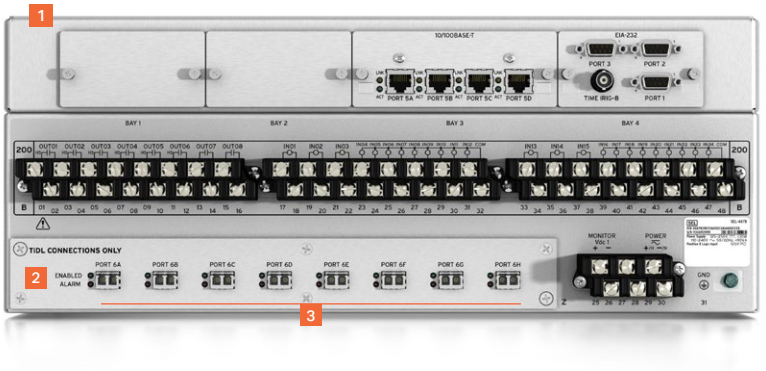
| | |
|---|---|
| SBM | Station Battery Monitor |
| SV | IEC 61850-9-2 Sampled Values Technology*† |
| TiDL | Time-Domain Link Technology* |

*Optional feature [1] Copper or fiber-optic

[†]TiDL and SV relays receive current and voltage values from remote merging units.

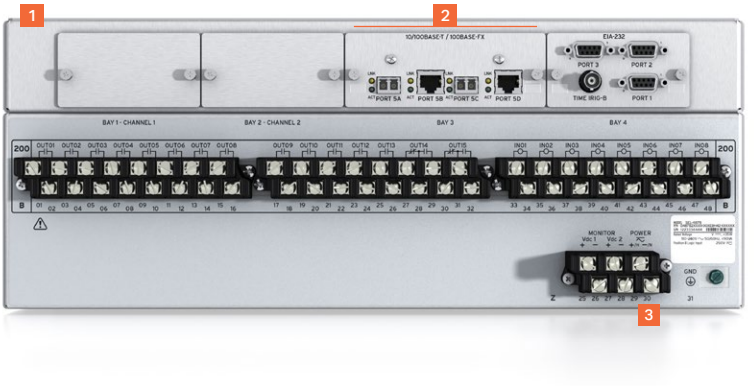
## SEL-487B TiDL Option

1. 4U chassis with horizontal mounting options (panel or rack) accommodates your application needs.
2. LEDs indicate the connection status to an SEL-TMU TiDL Merging Unit on a per-port basis.
3. Eight 100 Mbps fiber-optic ports allow the TiDL-enabled relay to connect with eight remote SEL-TMU nodes and to receive remote analog and digital data.




## SEL-487B SV Option

1. The 4U chassis has various mounting options to accommodate hardware needs.
2. Select fiber-optic, copper, or mixed Ethernet with separate ports for SV data and engineering access.
3. 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.



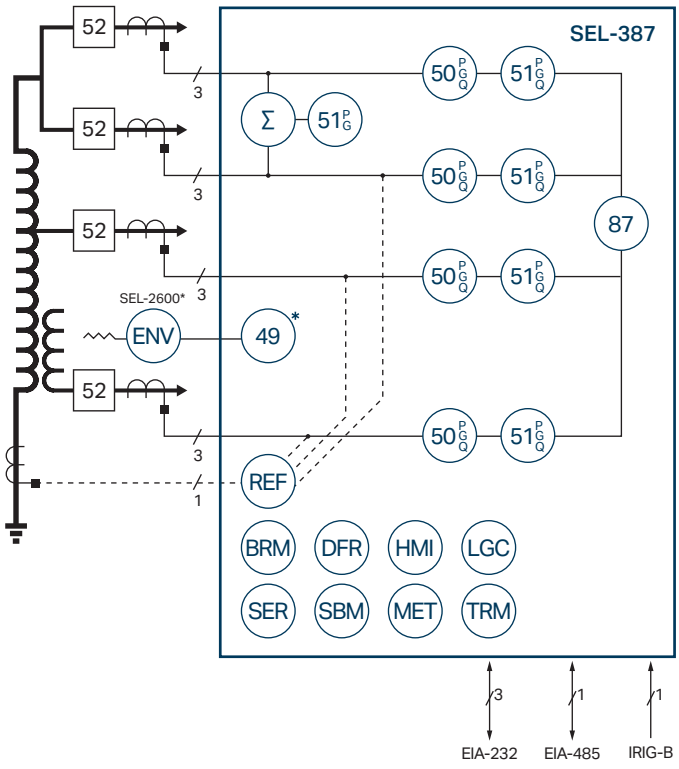
# SEL-387/387A

## Current Differential and Overcurrent Relays

Starting price
**SEL-387: $5,440 USD**
**SEL-387A: $3,810 USD**

selinc.com/products/387 or selinc.com/products/387A

The SEL-387 provides protection, control, and metering for transformers, buses, breakers, and feeders. Features include four three-phase current inputs with independent restrained and unrestrained differential protection, programmable single- or dual-slope differential characteristics, a circuit breaker monitor, a battery voltage monitor, and enhanced SELOGIC® control equations. The SEL-387A offers restrained and unrestrained differential protection for two terminals. Second-, fourth-, and fifth-harmonic elements, enhanced by the dc element, provide security during transformer energization and overexcitation conditions in a user-defined choice of either harmonic restraint or harmonic blocking. Overcurrent elements provide backup protection that contributes to the versatility of the SEL-387A.


### ANSI Functions

| | |
|---|---|
| 49 | Thermal Monitoring* |
| 50 (P,G,Q) | Overcurrent (Phase, Ground, Negative Sequence) |
| 51 (P,G,Q) | Time Overcurrent (Phase, Ground, Negative Sequence) |
| 87 | Current Differential |
| DFR | Event Reports |
| ENV | SEL-2600 RTD Module* |
| HMI | Operator Interface |
| LGC | SELOGIC Control Equations |
| MET | High-Accuracy Metering |
| REF | Restricted Earth Fault |
| SER | Sequential Events Recorder |

### Additional Functions

| | |
|---|---|
| BRM | Breaker Wear Monitor |
| SBM | Station Battery Monitor |
| TRM | Transformer Monitor |

*Optional feature

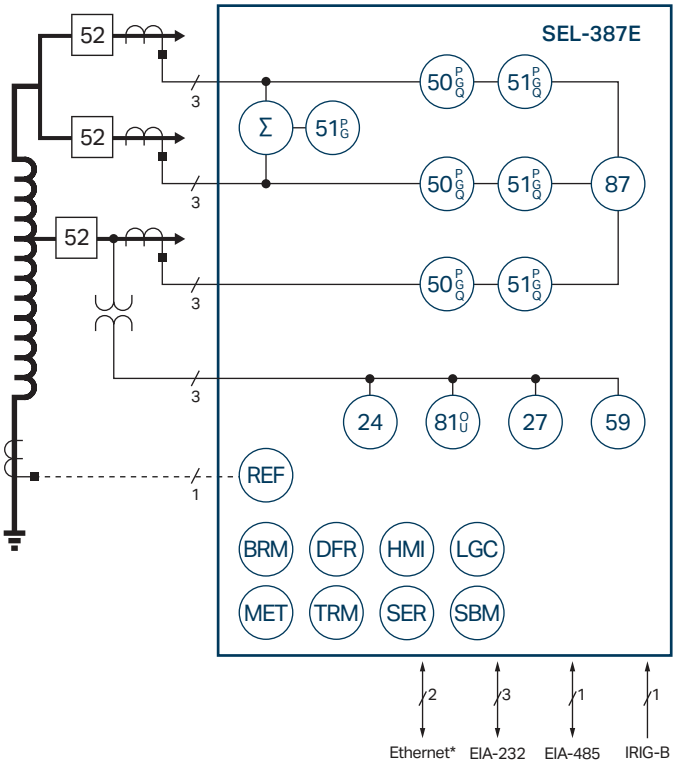
# SEL-387E

## Current Differential and Voltage Relay

Starting price
**$5,990 USD**

selinc.com/products/387E

The SEL-387E protects two- or three-winding power transformers. Voltage inputs for power metering, overexcitation protection, and over-/underfrequency load shedding provide versatile solutions for power system equipment protection. Automation features reduce total project construction and operation costs through elimination of traditional external control switches, meters, and indicating lamps.


### ANSI Functions

| | |
|---|---|
| 24 | Volts/Hertz |
| 27 | Undervoltage |
| 50 (P,G,Q) | Overcurrent (Phase, Ground, Negative Sequence) |
| 51 (P,G,Q) | Time Overcurrent (Phase, Ground, Negative Sequence) |
| 59 | Overvoltage |
| 81 (O,U) | Over-/Underfrequency |
| 87 | Current Differential |
| DFR | Event Reports |
| HMI | Operator Interface |
| LGC | SELOGIC® Control Equations |
| MET | High-Accuracy Metering |
| REF | Restricted Earth Fault |
| SER | Sequential Events Recorder |

### Additional Functions

| | |
|---|---|
| BRM | Breaker Wear Monitor |
| SBM | Station Battery Monitor |
| TRM | Transformer Monitor |

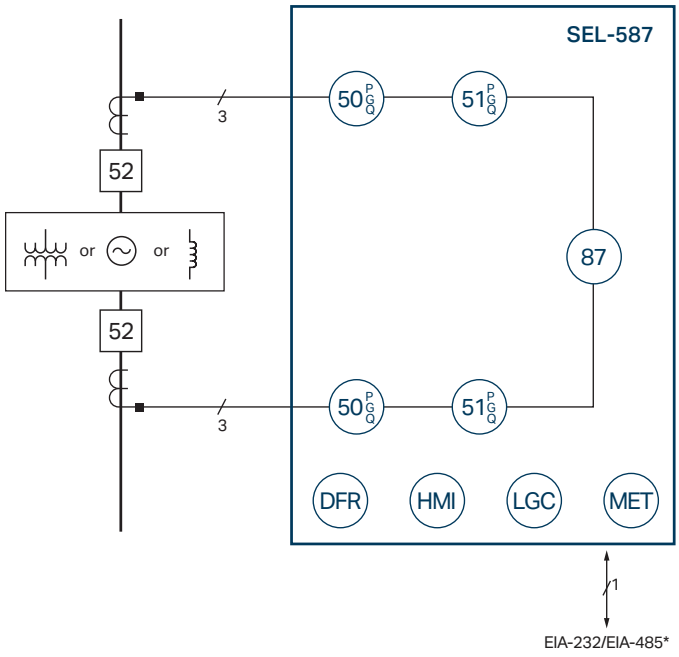
*Optional feature

# SEL-587
## Current Differential Relay

Starting price
**$2,160 USD**

selinc.com/products/587

The SEL-587 provides current differential protection with programmable single- or dual-slope percentage restraint for two-winding transformers, reactors, generators, large motors, and other two-terminal equipment. You can expand beyond basic transformer protection by applying individual winding phase, ground, and negative-sequence overcurrent elements. The SEL-587 also provides event reports for quick post-event analysis.


### ANSI Functions

| | |
|---|---|
| 50 (P,G,Q) | Overcurrent (Phase, Ground, Negative Sequence) |
| 51 (P,G,Q) | Time Overcurrent (Phase, Ground, Negative Sequence) |
| 87 | Current Differential |
| DFR | Event Reports |
| HMI | Operator Interface |
| LGC | SELOGIC® Control Equations |
| MET | High-Accuracy Metering |

*Optional feature

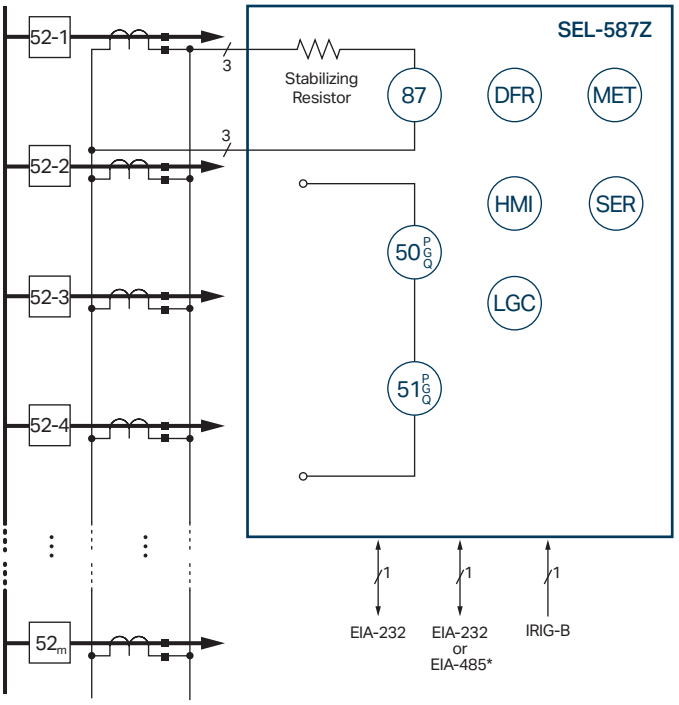
# SEL-587Z

## High-Impedance Differential Relay

Starting price
**$4,080 USD**

selinc.com/products/587Z | Select models typically ship in 2 days

The SEL-587Z is an economical and flexible relay that combines proven high-impedance analog technology with the advantages of microprocessor technology. Designed primarily for high-impedance bus protection, the relay is also suitable for restricted earth fault applications on transformers with grounded-wye windings. The high-impedance differential elements provide fast tripping for in-zone faults while offering security during heavy through faults and CT saturation. The relay includes the resistors and metal-oxide varistors (MOVs) required for high-impedance differential protection. You can use the independent overcurrent elements to complement the high-impedance differential elements. Event reports and the Sequential Events Recorder (SER) simplify post-event analysis.


### ANSI Functions

| | |
|---|---|
| 50 (P,G,Q) | Overcurrent (Phase, Ground, Negative Sequence) |
| 51 (P,G,Q) | Time Overcurrent (Phase, Ground, Negative Sequence) |
| 87 | Three-Phase High-Impedance Differential Elements |
| DFR | Event Reports |
| LGC | SELOGIC® Control Equations |
| HMI | Operator Interface |
| MET | High-Accuracy Metering |
| SER | Sequential Events Recorder |

*Optional feature

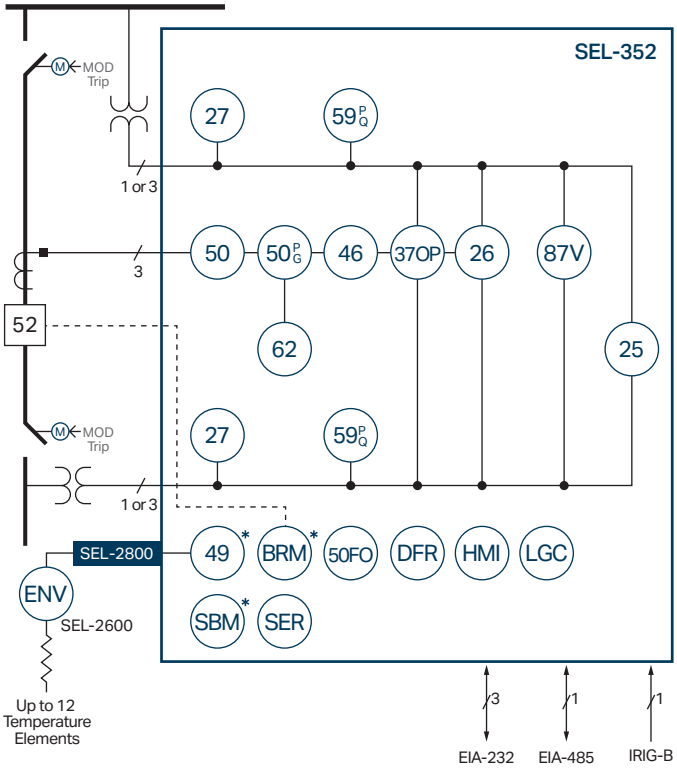
# SEL-352

## Breaker Failure Relay

Starting price
**$3,700 USD**

selinc.com/products/352

The SEL-352 provides breaker failure protection, breaker control, and breaker monitoring. A cost-saving data recorder and sophisticated breaker monitor and controller reduce maintenance and supervise manual operations. With flexible SELOGIC® control equations, you can use the SEL-352 for a variety of applications.


### ANSI Functions

| | |
|---|---|
| 25 | Synchronism Check |
| 26 | Insertion Resistor Thermal |
| 27 | Undervoltage |
| 37OP | Breaker Overpower |
| 46 | Current Unbalance |
| 49 | Thermal* |
| 50 | RMS Overcurrent |
| 50FO | Flashover Overcurrent |
| 50 (P,G) | Overcurrent (Phase, Ground) |
| 59 (P,Q) | Overvoltage (Phase, Negative Sequence) |
| 62 | Breaker Failure Timer |
| 87V | Voltage Differential |
| DFR | Event Reports |
| ENV | SEL-2600 RTD Module* |
| HMI | Operator Interface |
| LGC | SELOGIC Control Equations |
| SER | Sequential Events Recorder |

### Additional Functions

| | |
|---|---|
| BRM | Breaker Wear Monitor* |
| SBM | Station Battery Monitor* |

*Optional feature

# Distribution Protection Overview

## SEL-851 NEW

A compact relay for utility and industrial applications that provides powerful feeder protection, monitoring, and control as well as fast and secure arc-flash detection.

## SEL-751

Ideal for industrial and utility feeder protection, offering an intuitive color touchscreen, fast and secure arc-flash detection, flexible I/O, and advanced communications.

## SEL-451

Flexible overcurrent protection with complete substation bay control.

## SEL-351

Transmission or distribution overcurrent protection, monitoring, and control.

## SEL-351A

An economical solution for distribution feeder protection.

## SEL-351S

Comprehensive feeder and overcurrent protection perfect for industrial and utility feeder applications.

## SEL-501

Two complete and independent groups of protection in one low-cost unit for feeders, buses, transformers, motors, and breakers.

## SEL-551/551C

Distribution protection and control in new and retrofit installations.

| Applications | SEL-451 | SEL-351 | SEL-351A | SEL-351S | SEL-851 | SEL-751 | SEL-751A | SEL-501/501-2 | SEL-551/551C |
|---|---|---|---|---|---|---|---|---|---|
| Distribution Feeder Protection | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Breaker Failure Protection | ■ | ■ | *ƒ* | ■ | ■ | ■ | ■ | + | *ƒ* |
| Generator Intertie Protection | ■ | ■ | ■ | ■ | | + | + | | |
| Synchronism Check | ■ | ■ | ■ | ■ | | + | + | | |
| Underfrequency Load Shedding | *ƒ* | ■ | ■ | ■ | ■ | ■ | ■ | | |
| Undervoltage Load Shedding | *ƒ* | ■ | ■ | ■ | + | + | + | | |
| **Protection** | | | | | | | | | |
| 27/59 Under-/Overvoltage | ■ | ■ | ■ | ■ | + | + | + | | |
| 32 Directional Power Elements | ■ | + | | + | + | + | + | | |
| 49 IEC Line/Cable Thermal Overload | *ƒ* | | | | | ■ | | | |
| 50 (P,N,G,Q) Overcurrent Element (Phase, Neutral, Ground, Negative Sequence) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 51 (P,N,G,Q) Time Overcurrent Element (Phase, Neutral, Ground, Negative Sequence) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| 67 (P,N,Q) Directional Overcurrent (Phase, Neutral, Negative Sequence) | ■ | ■ | ■ | ■ | | + | | | |
| 78VS Vector Shift | | | | | | + | | | |
| 81 Over-/Underfrequency | ■ | ■ | ■ | ■ | + | ■ | + | | |
| Separate Neutral Overcurrent | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ |
| Load Encroachment Supervision | ■ | ■ | ■ | ■ | | ■ | | | |
| Low-Energy Analog (LEA) Voltage Inputs | + | | | | | + | | | |
| Directional Sensitive Earth Fault Protection | | + | + | + | | + | | | |
| Pilot Protection Logic | ■ | ■ | | ■ | | | | | |
| Rate-of-Change of Frequency (df/dt) | ■ | ■ | ■ | ■ | | + | + | | |
| Harmonic Blocking | ■ | ■ | + | ■ | ■ | ■ | | | |
| Arc Sense™ Technology (AST) High-Impedance Fault Detection | + | | | | | + | | | |
| Arc-Flash Detection | | | | | + | + | + | | |
| Phantom Phase Voltage | | ■ | ■ | ■ | | | | | |
| Current/Voltage Channels | 6/6 | 4/4 | 4/4 | 4/4 | 4/3 | 4/3<br>4/5+ | 4/0<br>4/5+ | 6/0 | 4/0 |
| Complete Two-Breaker Control | ■ | | | | | | | ■ | |

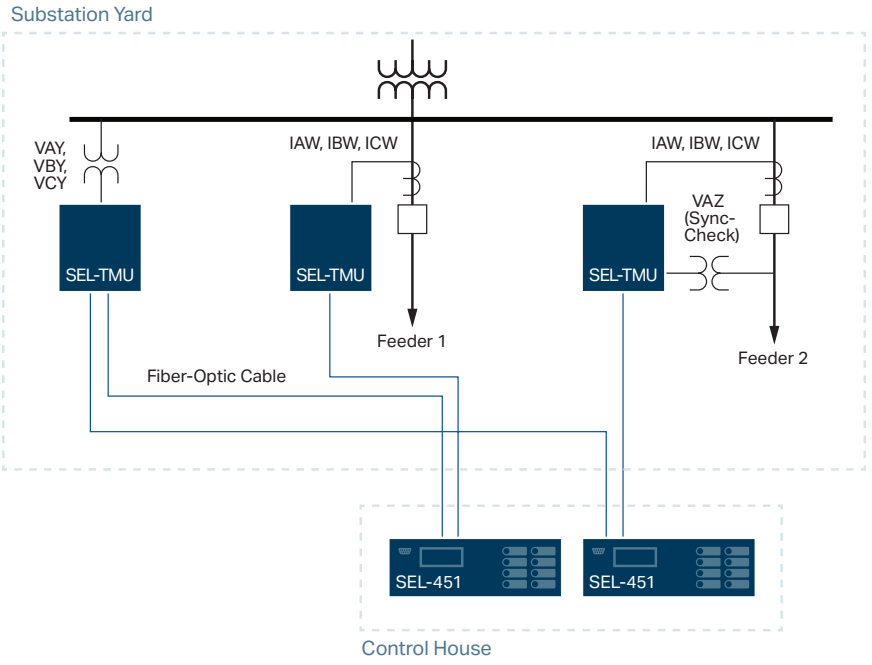
| Instrumentation and Control | SEL-451 | SEL-351 | SEL-351A | SEL-351S | SEL-851 | SEL-751 | SEL-751A | SEL-501/501-2 | SEL-551/551C |
|---|---|---|---|---|---|---|---|---|---|
| 79 Automatic Reclosing | ■ | ■ | ■ | ■ | ■ | + | + | | ■ |
| Fault Locating | ■ | ■ | ■ | ■ | | + | | | |
| SELOGIC® Control Equations With Remote Control Switches | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ |
| SELOGIC Counters | ■ | | | | ■ | ■ | ■ | | |
| Voltage Check on Closing | ■ | ■ | ■ | ■ | | + | + | | |
| SELOGIC Nonvolatile Latch | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | + |
| Nonvolatile Local Control Switches | ■ | ■ | + | ■ | | ■ | ■ | | ■ |
| Substation Battery Monitor | ■ | ■ | ■ | ■ | | + | + | | |
| Breaker/Recloser Wear Monitor | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | |
| Trip Coil Monitor | *ƒ* | *ƒ* | *ƒ* | *ƒ* | | *ƒ* | *ƒ* | | *ƒ* |
| Voltage Sag, Swell, and Interruption (VSSI) | ■ | + | | + | | | | | |
| Load/Signal Profile Recorder | ■ | + | | + | ■ | ■ | ■ | | |
| Sequential Events Recorder | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | ■ |
| Software-Invertible Polarities | ■ | | | | | | | | |
| IEC 60255-Compliant Thermal Model | ■ | | | | | | | | |
| DNP3 Level 2 Outstation | ■ | ■ | ■ | ■ | + | + | + | | |
| Parallel Redundancy Protocol (PRP) | + | ■ | ■ | ■ | | + | | | |
| IEEE 1588 Precision Time Protocol Version 2 (PTPv2) | + | | | | | + | | | |
| Time-Domain Link (TiDL®) Technology | + | | | | | | | | |
| IEEE C37.118 Synchrophasors | ■ | ■ | ■ | ■ | | ■ | ■ | | |
| Bay Control | ■ | | | | | + | | | |
| Ethernet | + | ■ | ■ | ■ | + | + | + | | |
| EtherNet/IP | | | | | | + | | | |
| IEC 61850 | + | + | + | + | + | + | + | | |
| IEC 61850 Edition 2 | + | | | | + | + | | | |
| IEC 61850-9-2 Sampled Values Technology | + | | | | | | | | |
| Simple Network Time Protocol (SNTP) | ■ | ■ | ■ | ■ | + | + | + | | |
| Harmonic Metering | | ■ | ■ | ■ | ■ | | | | |
| RMS Metering | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | |

■ Standard feature + Model option *ƒ* May be created using settings

# Distribution Protection Applications

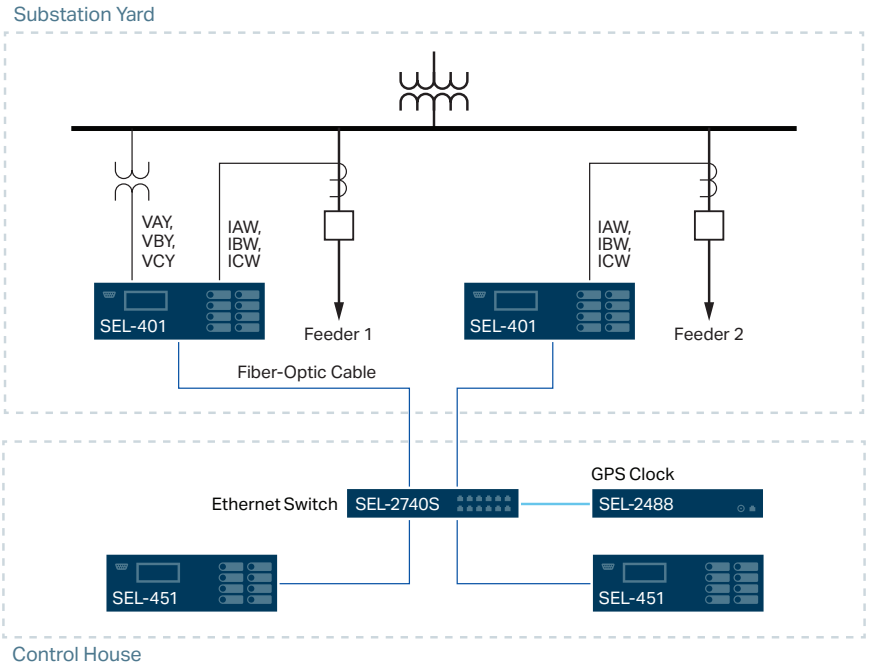
## Time-Domain Link (TiDL®) technology

TiDL is a simple and innovative digital secondary system solution that is easy to implement, with no external time source or network engineering required. The SEL-TMU TiDL Merging Unit in the yard provides remote I/O, digitizes analog signals, and sends the signals over fiber-optic cables to the TiDL-enabled SEL-451 Protection, Automation, and Bay Control System in the control house.



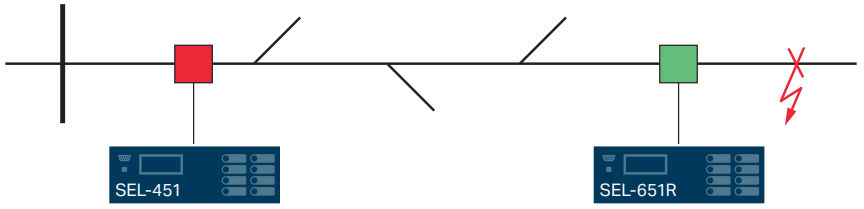

## SEL Sampled Values (SV) technology

SEL SV combines protection in the merging unit with the flexibility of IEC 61850-9-2. The SEL-451-6 with SEL SV technology receives SV data from SEL merging units or other SV-compliant units via a fiber-based Ethernet network.



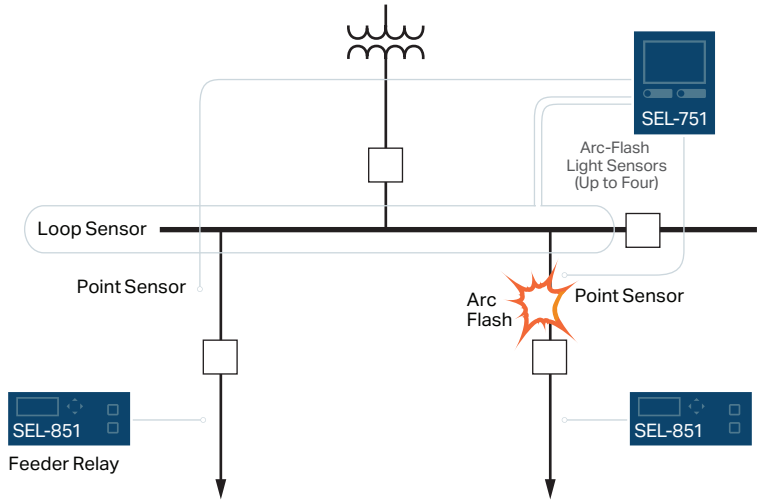

## High-impedance fault detection

Detect high-impedance, arcing faults by using Arc Sense™ technology (AST). SEL relays with AST will send an alarm or trip signal for faults that produce low fault current and are undetectable with conventional overcurrent relays.



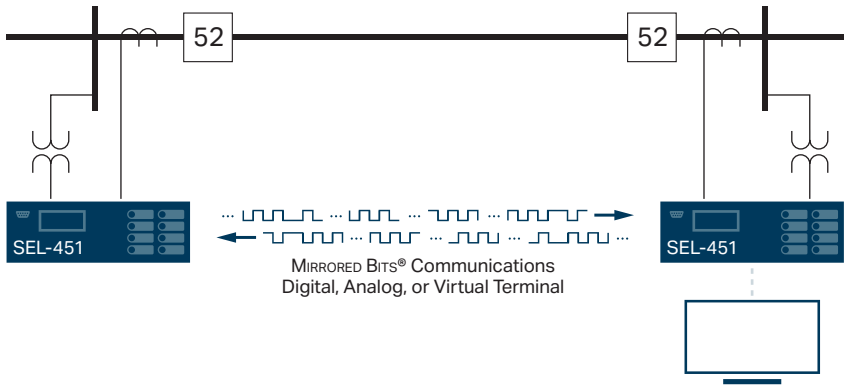
## Arc-flash mitigation

Improve safety and prevent equipment damage with arc-flash detection in the SEL-851, SEL-751, and SEL-751A Feeder Protection Relays. Light-sensing technology combined with fast overcurrent protection provides high-speed arc-flash detection as fast as 2 ms without false tripping. You can choose point sensors, loop sensors, or a combination to protect a wide variety of switchgear configurations.



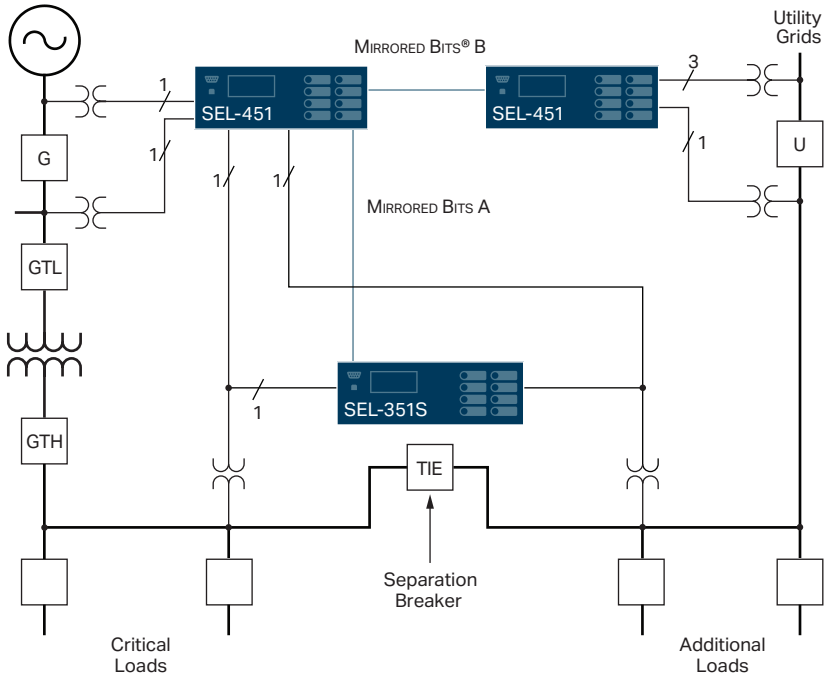

## Mirrored Bits® communications

This field-proven technology provides simple and powerful bidirectional digital communications between devices. Mirrored Bits communications can transmit/receive information between upstream relays and downstream recloser controls to enhance coordination and generate faster tripping for downstream faults.




## Autosynchronization

Automatically close the breaker that separates two systems after measuring the voltage and frequency of a generator and the power system. You can send control signals to adjust the governor and exciter as necessary to ensure safe and secure connection of generation.

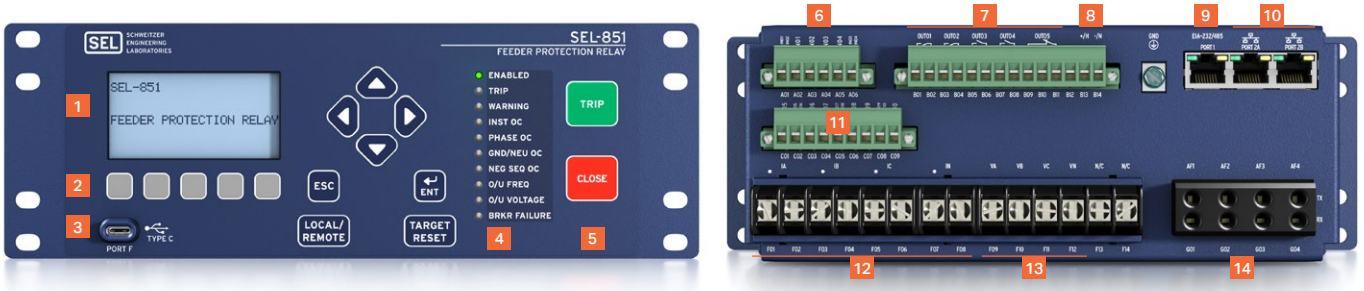


# SEL-851

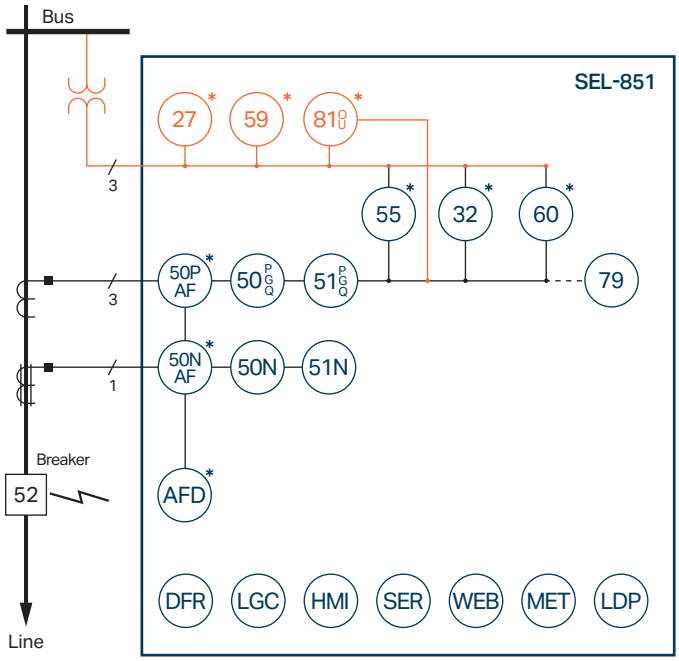
## Feeder Protection Relay NEW

selinc.com/products/851 | Select models typically ship in 2 days

The SEL-851 provides powerful feeder protection, monitoring, and control for utility and industrial applications in a compact device. It includes arc-flash protection that significantly reduces incident energy by sending a trip signal to a breaker in as fast as 1 ms. With high-resolution currents and voltages sampled at 10 kHz, the SEL-851 allows you to gain better visibility of your system. It includes SEL-5037 Grid Configurator Software to help you quickly create, manage, and deploy settings for SEL power system devices.




1. Large LCD display for navigation, relay control, and diagnostics
2. Context-adjusted navigation keys
3. USB port
4. Two fixed and eight programmable tricolor LEDs
5. Fundamental feeder controls
6. 4 digital inputs
7. 5 digital outputs (1 Form C, 2 Form A Standard, 2 Form A Hybrid)
8. Universal power supply (24–250 Vdc, 110–240 Vac)
9. EIA-232/EIA-485 serial port
10. Single or dual 10/100BASE-T Ethernet port(s)
11. 6 additional digital inputs
12. Current inputs
13. Three-phase ac voltage inputs (300 Vac)
14. 4 arc-flash inputs




## ANSI Functions

| | |
|---|---|
| 27 | Undervoltage* |
| 32 | Directional Power* |
| 50N | Neutral Overcurrent |
| 50 (P,G,Q) | Overcurrent (Phase, Ground, Negative Sequence) |
| 50N AF | Arc-Flash Neutral Overcurrent* |
| 50P AF | Arc-Flash Phase Overcurrent* |
| 51 (P,G,Q) | Time Overcurrent (Phase, Ground, Negative Seq.) |
| 51N | Neutral Time Overcurrent |
| 55 | Power Factor* |
| 59 | Overvoltage* |
| 60LOP | Loss of Potential* |
| 79 | Autoreclosing |
| 81 (O,U) | Over-/Underfrequency* |

## Additional Functions

| | |
|---|---|
| 85 RIO | SEL Mirrored Bits® Communications |
| AFD | Arc-Flash Detector* |
| BF | Breaker Failure |
| DFR | Event Reports |
| HMI | Operator Interface |
| LDP | Load Data Profiling |
| LGC | SELogic® Control Equations |
| MET | High-Accuracy Metering |
| SER | Sequential Events Recorder |
| WEB | Web Server |

*Optional feature

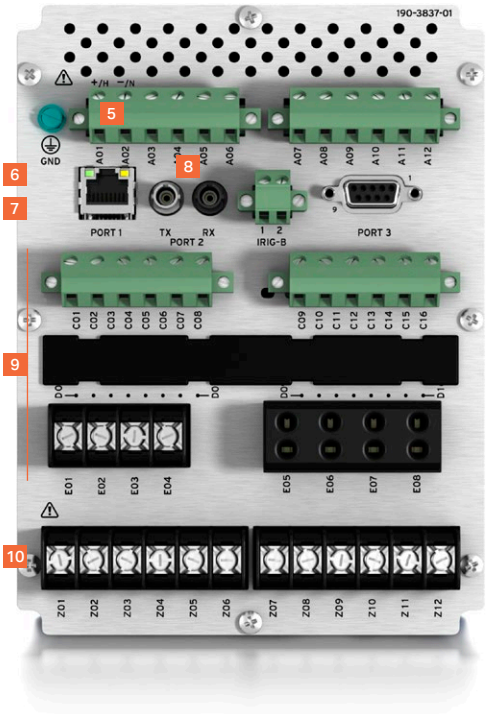
# SEL-751

## Feeder Protection Relay

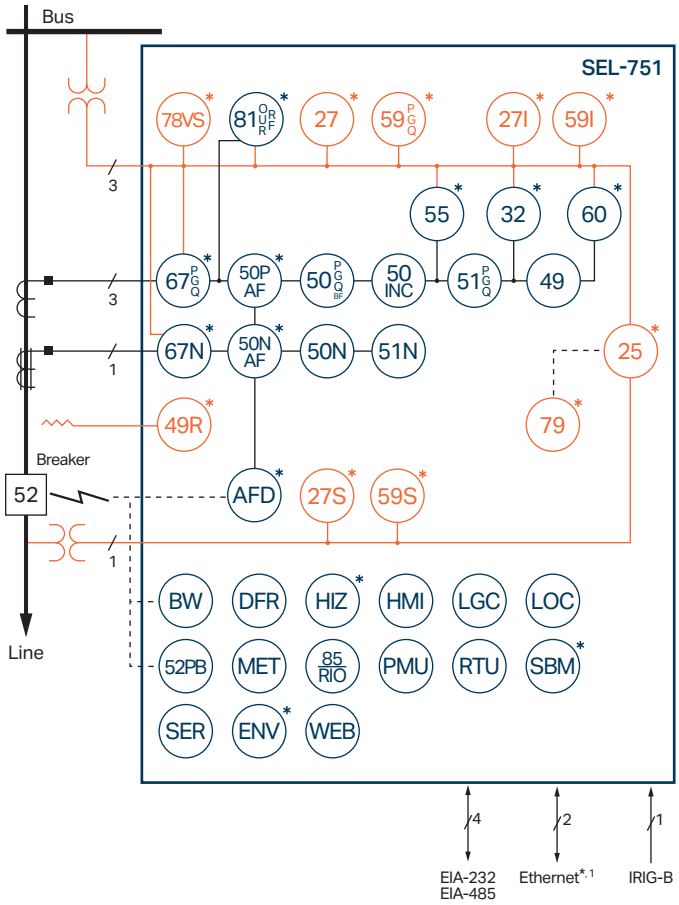
Starting price
**$990 USD**

selinc.com/products/751 | Select models typically ship in 2 days

The SEL-751 is ideal for directional overcurrent, fault location, arc-flash detection, incipient-fault detection, and high-impedance fault detection applications. Flexible I/O options, easy mounting, and fast settings make the SEL-751 the right solution for industrial and utility feeder protection. It provides complete feeder protection, with overcurrent, overvoltage, undervoltage, directional power, IEC cable/line thermal, vector shift, sensitive earth fault (SEF), load encroachment, and frequency elements. The 5-inch, 800 × 480 color touchscreen display option lets you directly set, monitor, and control your system. A small form factor and multiple mounting adapters let you easily upgrade protection without cutting or drilling existing cutouts. You can quickly integrate the SEL-751 into serial- or Ethernet-based communications with IEC 61850 Edition 2, IEC 60870-5-103, the IEC 62439 Parallel Redundancy Protocol (PRP), MIRRORED BITS® communications, Modbus, DNP3, EtherNet/IP, the IEEE 1588 Precision Time Protocol (PTP), and other protocols.


1. The 5-inch, 800 × 480 display offers direct navigation via a capacitive touchscreen.
2. Folders and applications provide quick access to bay screens, metering and monitoring data, reports, settings, and more.
3. Programmable front-panel LEDs with user-configurable labels alert operators to faulted phases, the relay's status, and element operation.
4. Programmable operator pushbuttons with user-configurable labels allow front-panel customization.
5. Power supply options include 24–48 Vdc or 110–250 Vdc/110–240 Vac.
6. A wide variety of communications protocols and media provide flexibility to communicate with other devices and control systems.
7. An integrated web server enables direct relay access for metering and monitoring data without the need for external PC software.
8. The optional fiber-optic serial port provides quick and easy engineering access.
9. Card slots include positions for optional I/O or an arc-flash detection/Vsync/Vbat card.
10. CT and PT inputs are located on one card, allowing more I/O in other slots.




## ANSI Functions

| | |
|---|---|
| 25 | Synchronism Check* |
| 27 | Definite-Time Undervoltage* |
| 27I | Phase Undervoltage With Inverse Characteristic* |
| 27S | Synchronism-Check Undervoltage* |
| 32 | Directional Power* |
| 49 | IEC Cable/Line Thermal |
| 49R | RTD Thermal* |
| 50 | Adaptive Overcurrent |
| 50 (P,G,Q) | Overcurrent (Phase, Ground, Negative Sequence) |
| 50BF | Breaker Failure |
| 50INC | Incipient Cable Fault Detection |
| 50N | Neutral Overcurrent |
| 50N AF | Arc-Flash Neutral Overcurrent* |
| 50P AF | Arc-Flash Phase Overcurrent* |
| 51 (P,G,Q) | Time Overcurrent (Phase, Ground, Negative Sequence) |
| 51N | Neutral Time Overcurrent |
| 52PB | Trip/Close Pushbuttons |
| 55 | Power Factor* |
| 59 (P,G,Q) | Definite-Time Overvoltage (Phase, Ground, Negative Seq.)* |
| 59I | Overvoltage With Inverse Characteristic* |
| 59S | Synchronism-Check Overvoltage* |
| 60 | Loss of Potential* |
| 67 (P,G,Q) | Directional Overcurrent (Phase, Ground, Negative Seq.)* |
| 67N | Directional Neutral Overcurrent* |
| 78VS | Vector Shift* |
| 79 | Autoreclosing* |
| 81 (O,U,R,RF) | Over-/Underfrequency (Rate, Fast Rate)* |

## Additional Functions

| | |
|---|---|
| 85 RIO | SEL Mirrored Bits Communications |
| AFD | Arc-Flash Detector* |
| BW | Breaker Wear Monitoring |
| DFR | Event Reports |
| ENV | SEL-2600 RTD Module Support* |
| HIZ | SEL Arc Sense™ Technology (AST)* |
| HMI | Operator Interface |
| LDE | Load Encroachment |
| LDP | Load Data Profiling |
| LEA | Low-Energy Analog (LEA) for AC Voltage Inputs (8 Vac RMS) |
| LGC | SELogic® Control Equations |
| LOC | Fault Locator |
| PMU | Synchrophasors |
| RTD | 10 Internal or 12 External (see ENV) RTD Inputs* |
| RTU | Remote Terminal Unit |
| SBM | Station Battery Monitor* |
| SER | Sequential Events Recorder |
| WEB | Web Server |

*Optional feature [1]Copper or fiber-optic

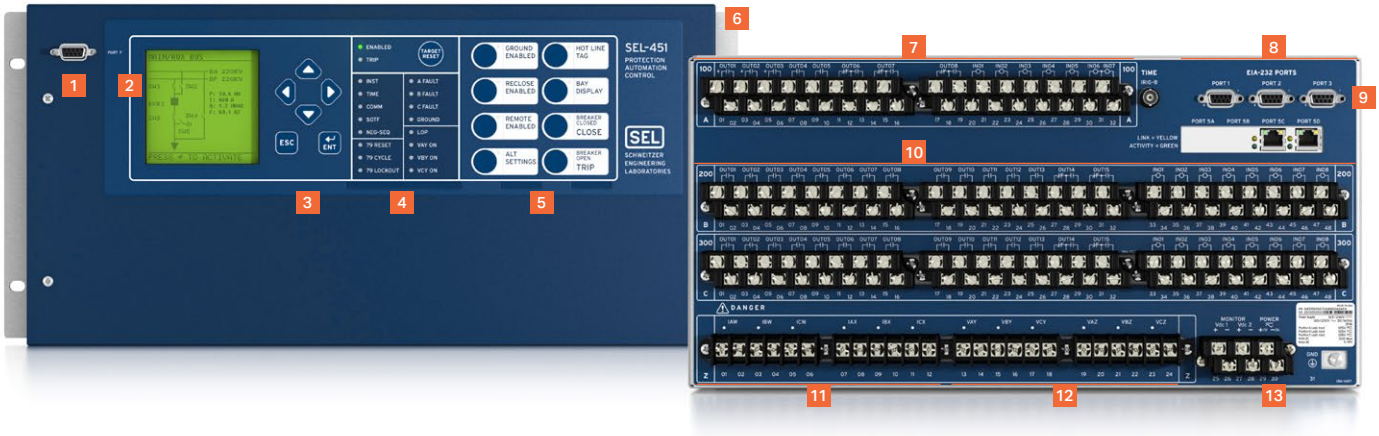
# SEL-451

## Protection, Automation, and Bay Control System

Starting price
**$4,350 USD**

selinc.com/products/451

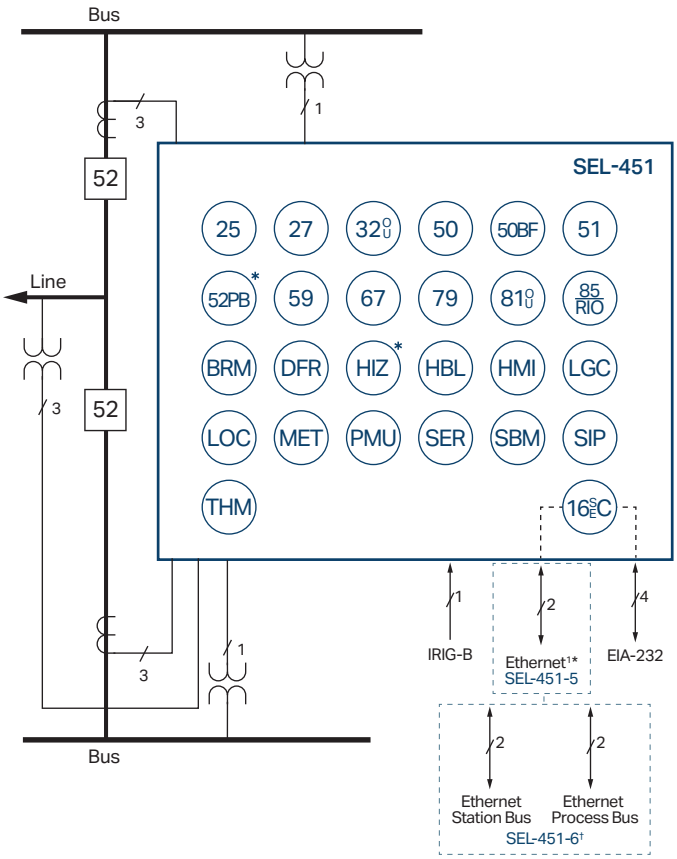
The SEL-451 is a standalone system with the speed, power, and flexibility to combine complete substation bay control with high-speed breaker protection in one economical system. You can use the SEL-451 as an integral part of a full substation protection, control, and monitoring solution. It lets you reduce maintenance costs by accurately tracking the breaker operation. Monitoring breaker interruption times and the accumulated breaker duty makes it easy to determine the need for proactive maintenance. Integrating information with SCADA or automation systems is simple through a communications processor or directly via the Ethernet port. Optional Time-Domain Link (TiDL®) technology and SEL Sampled Values (SV) technology using IEC 61850-9-2 transform the way you modernize your substation.




1. EIA-232 front serial port is quick and convenient for system setup and local access.
2. Interactive bay display with user-configurable apparatus labels allows the operator to view the status of breakers and disconnect switches and to control them.
3. Easy-to-use keypad aids simple navigation.
4. Front-panel LEDs indicate custom alarms and provide fast and simple information to assist dispatchers and line crews with rapid power restoration.
5. Programmable operator pushbuttons with user-configurable labels allow front-panel customization.
6. Choose from a vertical or horizontal, panel-mount or rack-mount chassis and different size options.
7. Use a maximum of 68 output contacts.[1]
8. Communications protocols include FTP, Telnet, synchrophasors, DNP3 LAN/WAN, the Parallel Redundancy Protocol (PRP), the IEEE 1588 Precision Time Protocol Version 2 (PTPv2),** and IEC 61850 Edition 2.*
9. Use one front and three rear EIA-232 ports for MIRRORED BITS® communications, DNP3, SCADA, and engineering access.
10. Use a maximum of 103 input contacts.[1]
11. Order six current inputs in standard terminal blocks (as shown) or a Connectorized® hardware configuration.
12. Choose six voltage inputs in either standard terminal blocks, a Connectorized hardware configuration, or a low-energy analog (LEA) hardware configuration.
13. 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.

[1]Requires 8U chassis  *Optional feature

**For PTP implementation, Ports 5A and 5B must be ordered as an option.




## ANSI Functions

| | |
|---|---|
| 25 | Synchronism Check |
| 27 | Undervoltage |
| 32 (O,U) | Over- and Underpower |
| 50 | RMS Overcurrent |
| 50BF | Dual Breaker Failure Overcurrent |
| 51 | Time Overcurrent |
| 52PB | Trip/Close Pushbuttons* |
| 59 | Overvoltage |
| 67 | Directional Overcurrent |
| 79 | Autoreclosing |
| 81 (O,U) | Over-/Underfrequency |

## Additional Functions

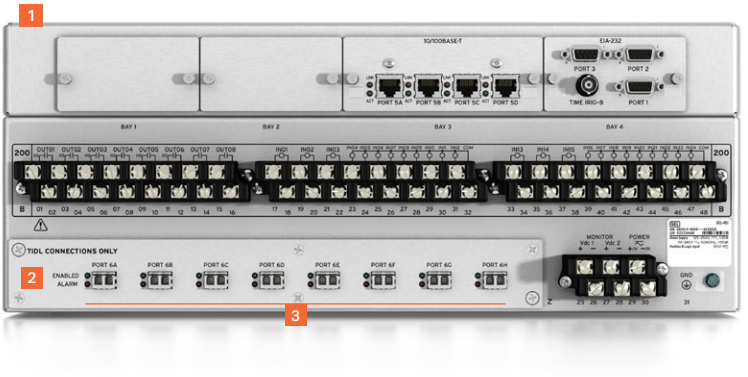
| | |
|---|---|
| 16 SEC | Access Security (Serial, Ethernet) |
| 50G | Best Choice Ground |
| 85 RIO | SEL Mirrored Bits Communications |
| BRM | Breaker Wear Monitor |
| DFR | Event Reports |
| HBL | Harmonic Blocking |
| HIZ | High-Impedance Fault Detection With Arc Sense™ Technology* |
| HMI | Operator Interface |
| LDE | Load Encroachment |
| LGC | Expanded SELogic® Control Equations |
| LOC | Fault Locator |
| MET | High-Accuracy Metering |
| PMU | Synchrophasors |
| SBM | Station Battery Monitor |
| SER | Sequential Events Recorder |
| SIP | Software-Invertible Polarities |
| SV | IEC 61850-9-2 Sampled Values Technology*† |
| THM | IEC 60255-Compliant Thermal Model |
| TiDL | Time-Domain Link Technology* |

*Optional feature †Copper or fiber-optic

†TiDL and SV relays receive current and voltage values from remote merging units.

## SEL-451 TiDL Option

1. 4U chassis with horizontal mounting options (panel or rack) accommodates your application needs.
2. LEDs indicate the connection status to an SEL-TMU TiDL Merging Unit on a per-port basis.
3. Eight 100 Mbps fiber-optic ports allow the TiDL-enabled relay to connect with eight remote SEL-TMU nodes and to receive remote analog and digital data.




## SEL-451 SV Option

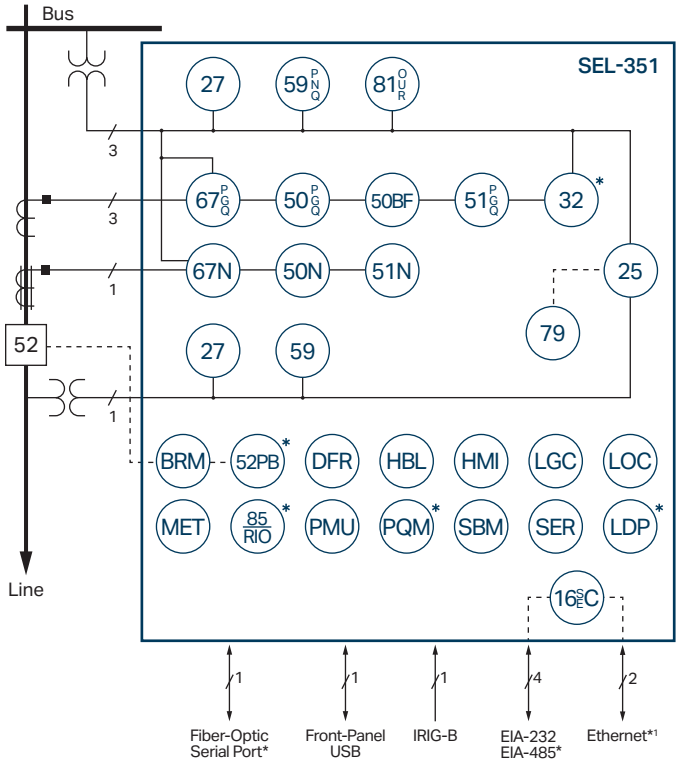
1. The 4U chassis has various mounting options to accommodate hardware needs.
2. Select fiber-optic, copper, or mixed Ethernet with separate ports for SV data and engineering access.
3. Choose from power supply options such as 24–48 Vdc; 48–125 Vdc or 110–120 Vac; or 125–250 Vdc or 110–240 Vac.

# SEL-351
## Protection System

selinc.com/products/351

Starting price
**SEL-351-5, -6: $2,570 USD**
**SEL-351-7: $3,230 USD**

The SEL-351 has built-in Ethernet and IEEE C37.118 synchrophasors and is ideal for directional overcurrent applications. Optional MIRRORED BITS® communications and power quality monitoring add flexibility. The SEL-351 is the protection standard for utility and industrial electrical systems around the world.


### ANSI Functions

| | |
|---|---|
| 16 SEC | Access Security (Serial, Ethernet) |
| 25 | Synchronism Check |
| 27 | Undervoltage |
| 32 | Directional Power* |
| 50BF | Breaker Failure Overcurrent |
| 50N | Neutral Overcurrent |
| 50 (P,G,Q) | Overcurrent (Phase, Ground, Negative Sequence) |
| 51N | Neutral Time Overcurrent |
| 51 (P,G,Q) | Time Overcurrent (Phase, Ground, Negative Sequence) |
| 52PB | Trip/Close Pushbuttons* |
| 59 (P,N,Q) | Overvoltage (Phase, Neutral, Negative Sequence) |
| 67N | Directional Neutral Overcurrent |
| 67 (P,G,Q) | Directional Overcurrent (Phase; Ground, SEF*; Neg. Seq.) |
| 79 | Autoreclosing |
| 81 (O,U,R) | Frequency (Over, Under, Rate) |
| 85 RIO | SEL MIRRORED BITS Communications* |
| DFR | Event Reports |
| HMI | Operator Interface |
| LGC | SELOGIC® Control Equations |
| MET | High-Accuracy Metering |
| PMU | Synchrophasors |
| PQM | Voltage Sag, Swell, and Interruption* |
| SER | Sequential Events Recorder |

### Additional Functions

| | |
|---|---|
| BRM | Breaker Wear Monitor |
| HBL | Harmonic Blocking |
| LDE | Load Encroachment |
| LDP | Load Data Profiling* |
| LOC | Fault Locator |
| PPV | Phantom Phase Voltage |
| SBM | Station Battery Monitor |

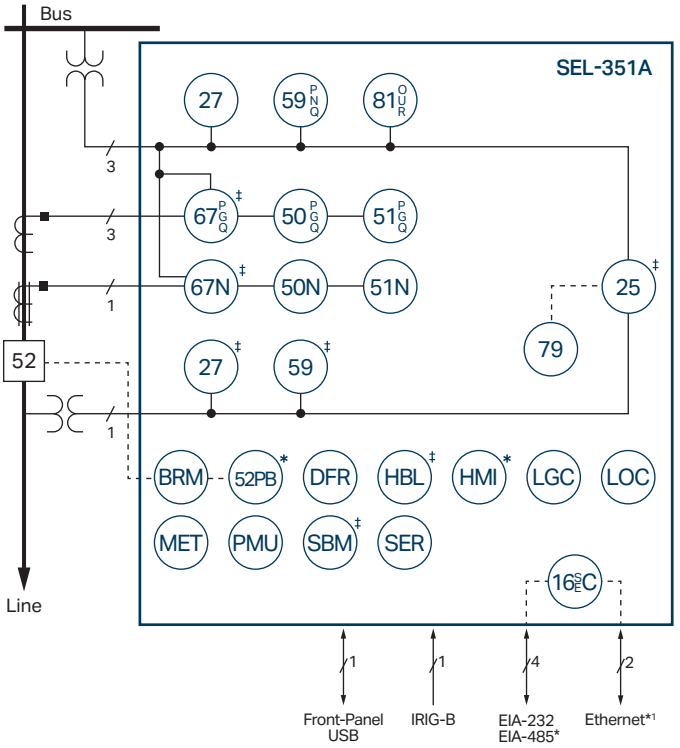
*Optional feature [1] Copper or fiber-optic

# SEL-351A
## Protection System

selinc.com/products/351A

Starting price
**SEL-351A-1: $1,410 USD**
**SEL-351A-0: $1,600 USD**

The SEL-351A has built-in Ethernet and IEEE C37.118 synchrophasors and is the economical solution for overcurrent protection. Easy-to-use feeder protection and innovative features like SEL's Best Choice Ground Directional Element® logic and SELOGIC® control equations provide superior protection on utility and industrial power systems.


### ANSI Functions

| | |
|---|---|
| 16 SEC | Access Security (Serial, Ethernet) |
| 25 | Synchronism Check‡ |
| 27 | Undervoltage |
| 50N | Neutral Overcurrent |
| 50 (P,G,Q) | Overcurrent (Phase, Ground,‡ Negative Sequence) |
| 51N | Neutral Time Overcurrent |
| 51 (P,G,Q) | Time Overcurrent (Phase, Ground, Negative Sequence) |
| 52PB | Trip/Close Pushbuttons* |
| 59 (P,N,Q) | Overvoltage‡ (Phase, Neutral, Negative Sequence) |
| 67N | Directional Neutral Overcurrent‡ |
| 67 (P,G,Q) | Directional Overcurrent (Phase; Ground, SEF*; Neg. Seq.)‡ |
| 79 | Autoreclosing |
| 81 (O,U,R) | Frequency (Over, Under, Rate) |
| DFR | Event Reports |
| HMI | Operator Interface* |
| LGC | SELOGIC Control Equations |
| MET | High-Accuracy Metering |
| PMU | Synchrophasors |
| SER | Sequential Events Recorder |

### Additional Functions

| | |
|---|---|
| BRM | Breaker Wear Monitor |
| HBL | Harmonic Blocking‡ |
| LDE | Load Encroachment‡ |
| LOC | Fault Locator |
| PPV | Phantom Phase Voltage |
| SBM | Station Battery Monitor‡ |

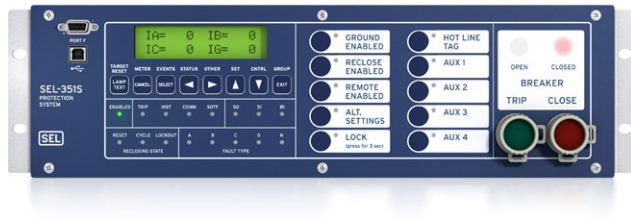
*Optional feature [1] Copper or fiber-optic
‡Available on the SEL-351A-0

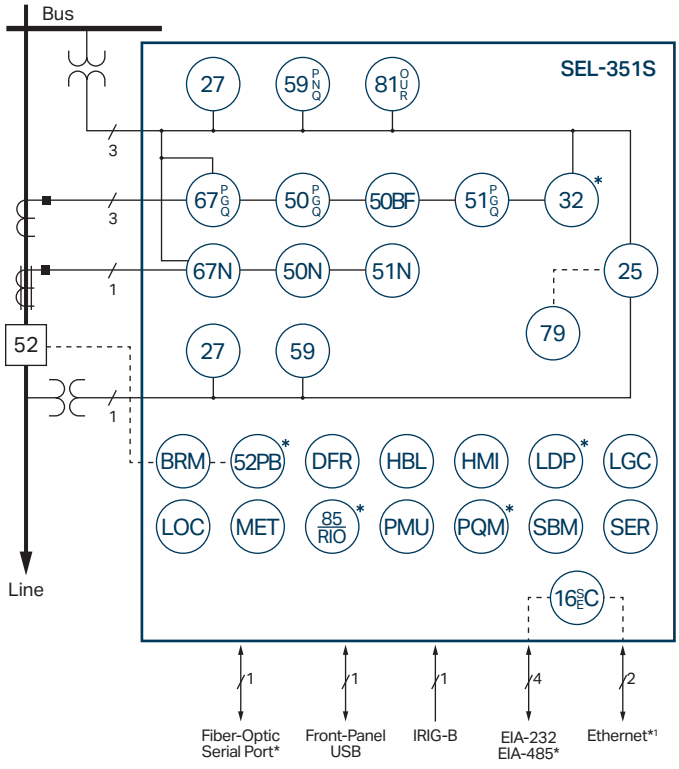
# SEL-351S
## Protection System

selinc.com/products/351S

Starting price
**SEL-351S-5, -6: $2,750 USD**
**SEL-351S-7: $3,410 USD**

The SEL-351S offers comprehensive feeder and overcurrent protection that is perfect for industrial and utility feeder applications. The relay enhances your quality of service with lower costs and innovative features like MIRRORED BITS® communications, IEEE C37.118 synchrophasors, expanded operator controls, and SEL's Best Choice Ground Directional Element® logic.




### ANSI Functions

| | |
|---|---|
| 16 SEC | Access Security (Serial, Ethernet) |
| 25 | Synchronism Check |
| 27 | Undervoltage |
| 32 | Directional Power* |
| 50BF | Breaker Failure Overcurrent |
| 50N | Neutral Overcurrent |
| 50 (P,G,Q) | Overcurrent (Phase, Ground, Negative Sequence) |
| 51N | Neutral Time Overcurrent |
| 51 (P,G,Q) | Time Overcurrent (Phase, Ground, Negative Sequence) |
| 52PB | Trip/Close Pushbuttons* |
| 59 (P,N,Q) | Overvoltage (Phase, Neutral, Negative Sequence) |
| 67N | Directional Neutral Overcurrent |
| 67 (P,G,Q) | Directional Overcurrent (Phase; Ground, SEF*; Neg. Seq.) |
| 79 | Autoreclosing |
| 81 (O,U,R) | Frequency (Over, Under, Rate) |
| 85 RIO | SEL MIRRORED BITS Communications* |
| DFR | Event Reports |
| HMI | Operator Interface |
| LGC | SELOGIC® Control Equations |
| MET | High-Accuracy Metering |
| PMU | Synchrophasors |
| PQM | Voltage Sag, Swell, and Interruption* |
| SER | Sequential Events Recorder |

### Additional Functions

| | |
|---|---|
| BRM | Breaker Wear Monitor |
| HBL | Harmonic Blocking |
| LDE | Load Encroachment |
| LDP | Load Data Profiling* |
| LOC | Fault Locator |
| PPV | Phantom Phase Voltage |
| SBM | Station Battery Monitor |

*Optional feature [1]Copper or fiber-optic

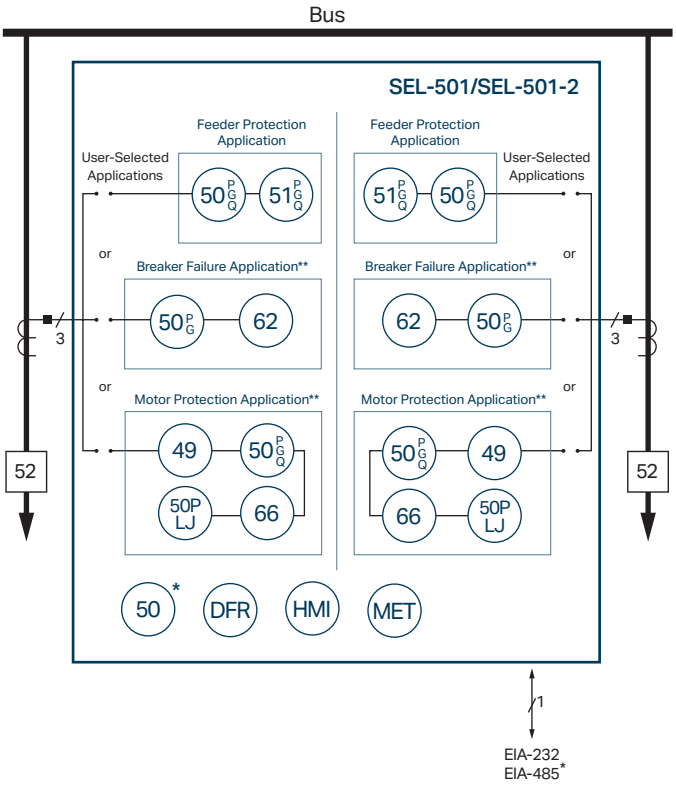
# SEL-501/501-2

## Dual Overcurrent Relays

Starting price
**$1,040 USD**

selinc.com/products/501

The SEL-501 provides simple and economical protection for transformers, breakers, motors, capacitor banks, feeders, and other apparatus, with two independent three-phase overcurrent relays in a single compact package. The SEL-501-2 is a dual overcurrent relay for feeders, buses, and other apparatus. Both relays contain Relay X and Relay Y, each having separate optoisolated inputs, output contacts, and three-phase current inputs. They also provide numerous protection schemes with user-enabled settings.


### ANSI Functions

| | |
|---|---|
| 49 | Thermal |
| 50 (P,G) | Overcurrent (Phase, Ground) |
| 50 (P,G,Q) | Overcurrent (Phase, Ground, Negative Sequence) |
| 50P (LJ) | Load Jam/Loss |
| 50 | Adaptive Overcurrent* |
| 51 (P,G,Q) | Time Overcurrent (Phase, Ground, Negative Sequence) |
| 62 | Timer |
| 66 | Starts Per Hour |

### Additional Functions

| | |
|---|---|
| DFR | Event Reports |
| HMI | Operator Interface |
| MET | High-Accuracy Metering |

*Optional feature **Not supported by SEL-501-2

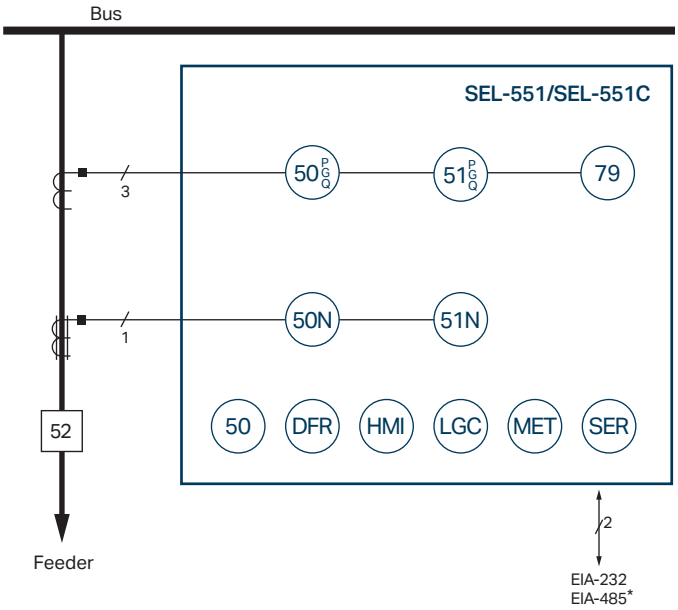
# SEL-551/551C

## Overcurrent/Reclosing Relays

Starting price
**$870 USD**

selinc.com/products/551 or selinc.com/products/551C

The SEL-551 provides complete overcurrent protection and multishot reclosing in one compact relay. It replaces many relays and control switches and much of the wiring required in traditional distribution substation protection and control panels. The relay also replaces line recloser control packages at a fraction of the cost. The SEL-551C provides flexibility in distribution system protection by offering six inputs, three outputs, and two communications ports for more control options. SELOGIC® control equations offer rising- and falling-edge triggers and latches for custom logic applications.


### ANSI Functions

| | |
|---|---|
| 50N | Neutral Overcurrent |
| 50 (P,G,Q) | Overcurrent (Phase, Ground, Negative Sequence) |
| 50 | Adaptive Overcurrent |
| 51N | Neutral Time Overcurrent |
| 51 (P,G,Q) | Time Overcurrent (Phase, Ground, Negative Sequence) |
| 79 | Autoreclosing |

### Additional Functions

| | |
|---|---|
| DFR | Event Reports |
| HMI | Operator Interface |
| LGC | SELOGIC Control Equations |
| MET | High-Accuracy Metering |
| SER | Sequential Events Recorder |

*Optional feature

# Distribution Control Overview

### SEL-FT50 and SEL-FR12

The SEL-FT50 and SEL-FR12 system improves distribution protection by providing fault indication in 6 ms, allowing relays and recloser controls to make better tripping decisions.

### SEL-651R

The SEL-651R provides Automatic Network Reconfiguration, three-phase and single-phase tripping, and other distribution automation solutions. It is compatible with popular reclosers.

### SEL-651RA

The SEL-651RA is a powerful, cost-effective, and flexible recloser control for 14-pin applications. It is compatible with popular reclosers.

### SEL-351RS Kestrel®

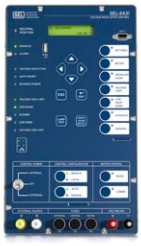
The SEL-351RS provides integrated logic and communications and comprehensive protection for single-phase applications.

### SEL-734B

The SEL-734B includes low-energy analog inputs and provides advanced monitoring and control capabilities for applications such as capacitor bank control and feeder monitoring.

### SEL-734W

The enhanced SEL-734W and SEL-8340 Wireless Current Sensor solution provides advanced capacitor bank control to improve power quality.



### SEL-2431

The SEL-2431 optimizes system voltages by using directional voltage profiles and detailed tap change event reports.

| Applications | SEL-351RS | SEL-651RA | SEL-651R |
|---|---|---|---|
| Distribution Feeder Protection | ■ | ■ | ■ |
| Breaker Failure Protection | ƒ | ƒ | ƒ |
| Generator Intertie Protection | | ■ | ■ |
| Synchronism Check | | + | ■ |
| Underfrequency Load Shedding | ■ | ■ | ■ |
| Undervoltage Load Shedding | ■ | ■ | ■ |

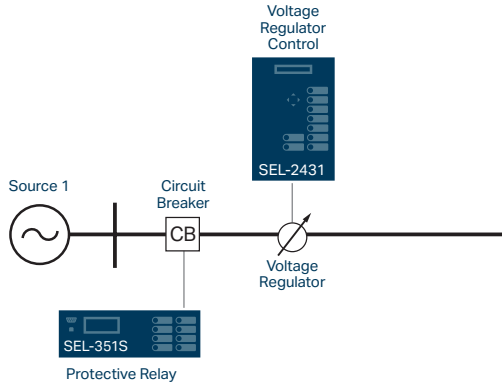
| Protection | | | |
|---|---|---|---|
| 25 (G,T) Generator/Intertie Synchronism Check | | ■ | ■ |
| 27/59 Under-/Overvoltage | ■ | ■ | ■ |
| 32 Directional Power Elements | ■ | + | ■ |
| 50 (P,N,G,Q) Overcurrent Element (Phase, Neutral, Ground, Negative Sequence) | ■ | ■ | ■ |
| 51 (P,N,G,Q) Time-Overcurrent Element (Phase, Neutral, Ground, Negative Sequence) | ■ | ■ | ■ |
| 67 (P,N,Q) Directional Overcurrent (Phase, Neutral, Negative Sequence) | | ■ | ■ |
| 78VS Vector Shift | | ■ | ■ |
| 81 Over-/Underfrequency | ■ | ■ | ■ |
| Separate Neutral Overcurrent | | ■ | ■ |
| Load Encroachment Supervision | | ■ | ■ |
| Low-Energy Analog (LEA) Voltage Inputs | | + | + |
| Directional Sensitive Earth Fault Protection | | ■ | ■ |
| Pilot Protection Logic | | ƒ | ƒ |
| Rate-of-Change of Frequency (df/dt) | ■ | ■ | ■ |
| Fast Rate-of-Change of Frequency | | ■ | ■ |
| Harmonic Blocking | ■ | ■ | ■ |
| Arc Sense™ Technology (AST) High-Impedance Fault Detection | | + | + |
| Phantom Phase Voltage | ■ | ■ | ■ |
| Current/Voltage Channels | 1/1 | 4/1<br>4/6+ | 4/6 |

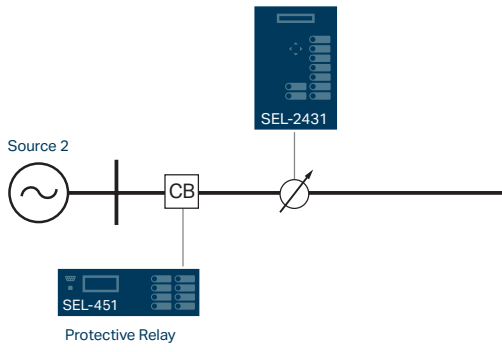
| Instrumentation and Control | SEL-351RS | SEL-651RA | SEL-651R |
|---|---|---|---|
| 79 Automatic Reclosing | ■ | ■ | ■ |
| Fault Locating | ■ | + | ■ |
| SELOGIC® Control Equations With Remote Control Switches | ■ | ■ | ■ |
| SELOGIC Counters | ■ | ■ | ■ |
| Voltage Check on Closing | ■ | ■ | ■ |
| SELOGIC Nonvolatile Latch | ■ | ■ | ■ |
| Nonvolatile Local Control Switches | ■ | ■ | ■ |
| Breaker/Recloser Wear Monitor | ■ | ■ | ■ |
| Trip Coil Monitor | ƒ | ƒ | ƒ |
| Voltage Sag, Swell, and Interruption (VSSI) | ■ | + | ■ |
| Load/Signal Profile Recorder | ■ | ■ | ■ |
| Sequential Events Recorder | ■ | ■ | ■ |
| DNP3 Level 2 Outstation | ■ | ■ | ■ |
| IEEE C37.118 Synchrophasors | ■ | ■ | ■ |
| Ethernet | ■ | ■ | ■ |
| IEC 61850 | + | + | + |
| Simple Network Time Protocol (SNTP) | ■ | ■ | ■ |
| Harmonic Metering | ■ | ■ | ■ |
| RMS Metering | ■ | ■ | ■ |

■ Standard feature + Model option ƒ May be created using settings

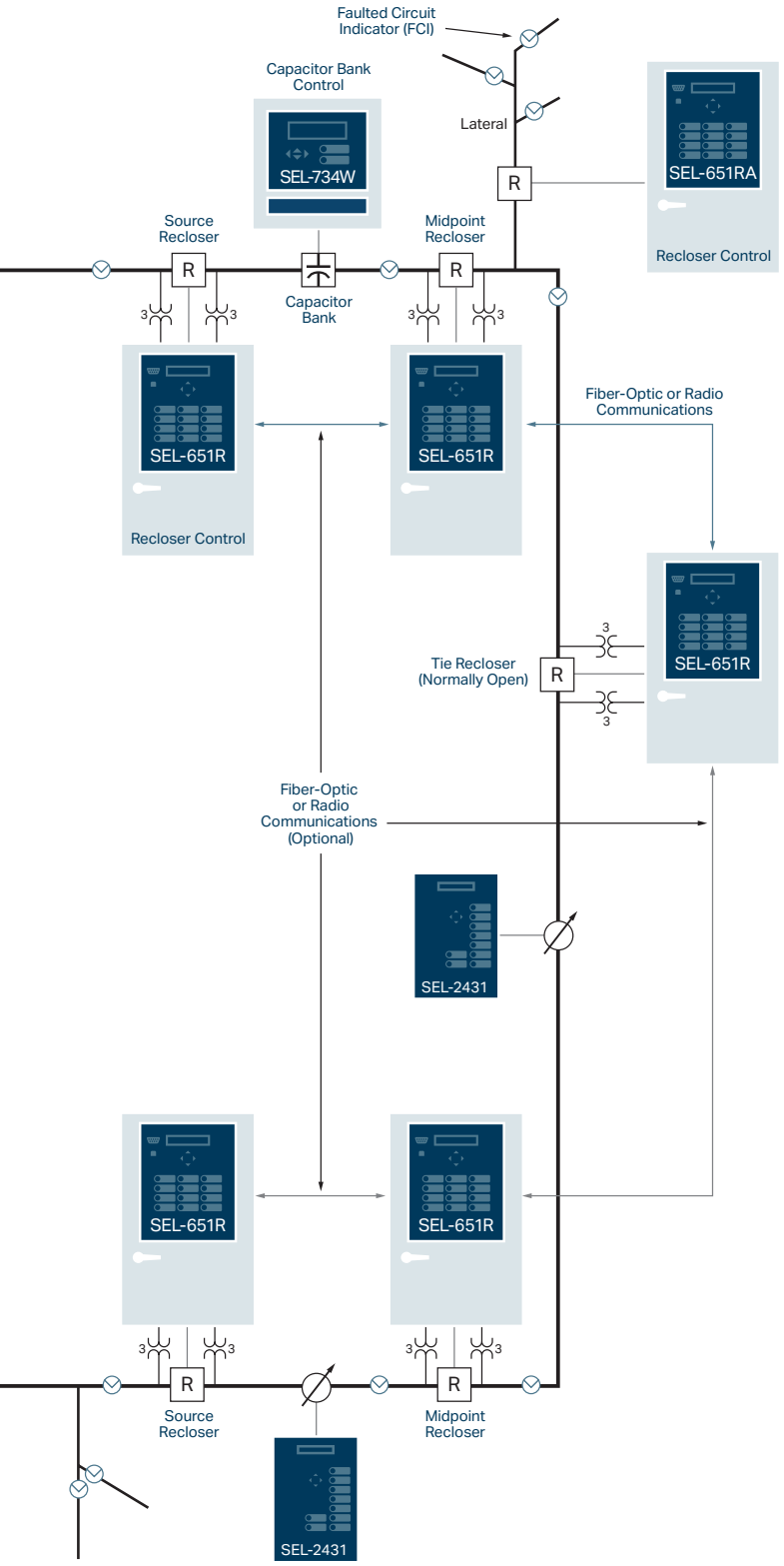
## Recloser Compatibility

| G&W | SEL-351RS | SEL-651RA | SEL-651R |
|---|---|---|---|
| Control Power Viper-S | | | ■ |
| Viper-G | | ■ | ■ |
| Viper-LT | | | ■ |
| Viper-S | | ■ | ■ |
| Viper-SP | ■ | | ■ |
| Viper-ST | | | ■ |
| **Other Reclosers** | | | |
| Elastimold Molded Vacuum Recloser (MVR) | ■ | | ■ |
| Joslyn TriMod 300R | | ■ | ■ |
| Joslyn TriMod 600R | | | ■ |
| OVR-3 24-Pin (15 and 27 kV) | | | ■ |
| Gridshield 32-Pin (15, 27, and 38 kV) | | | ■ |
| Gridshield 42-Pin (15, 27, and 38 kV) | | | ■ |
| VR-3S (15 and 27 kV) | | | ■ |
| CXE | | ■ | ■ |
| NOVA Auxiliary-Powered | | ■ | ■ |
| NOVA Control-Powered | | | ■ |
| NOVA NX-T | | | ■ |
| NOVA Triple-Single | | | ■ |
| RE | | ■ | ■ |
| RVE | | ■ | ■ |
| RXE | | ■ | ■ |
| VSA | | ■ | ■ |
| VSO | | ■ | ■ |
| VWE | | ■ | ■ |
| VWVE 27 | | ■ | ■ |
| VWVE 38X | | ■ | ■ |
| WE | | ■ | ■ |
| WVE 27 | | ■ | ■ |
| WVE 38X | | ■ | ■ |
| GVR (when equipped with interface module) | | ■ | ■ |
| SDR Triple-Single | | ■ | ■ |
| SDR Three-Phase | | ■ | ■ |
| OSM_150_AI_4 | | | ■ |



# Distribution Control Applications




## DNA® (Distribution Network Automation)

Use SEL DNA solutions to automate complex distribution networks by combining SEL distribution relays, recloser controls, voltage regulators, capacitor bank controllers, and automation controllers. You can reconfigure and optimize networks based on a complex combination of load, capacity, and other criteria.

### Automatic Network Reconfiguration (ANR)

Improve service reliability with ANR by isolating permanently faulted segments and quickly restoring service to nonfaulted segments. ANR is possible in a variety of systems, either with or without communications. With single-phase tripping, you can isolate only the faulted phase for additional service reliability.

### Capacitor bank control

Combine volt/VAR-based capacitor bank control with power quality monitoring and advanced reporting to improve power factor and system efficiency. The SEL-734B Advanced Monitoring and Control System adapts to multiple capacitor bank control applications, ranging from basic three-phase control to intelligent single-phase control.

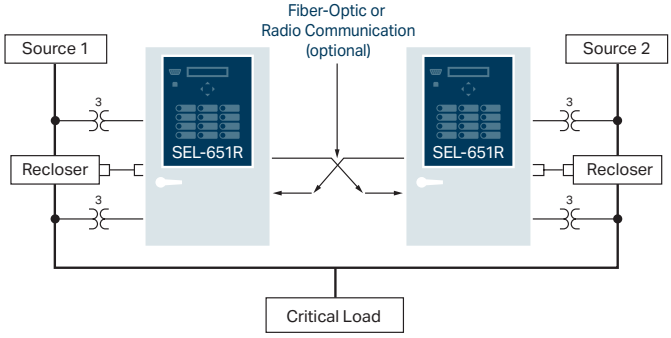
### Voltage regulation

Control your single-phase voltage regulators to level the voltage profile and optimize your system. Voltage regulation is adaptable to fit your application. For example, you can select the locked-forward mode with traditional radial feeders. For looped systems, a bidirectional mode offers different settings based on the direction of current flow.

## Autosource transfer schemes

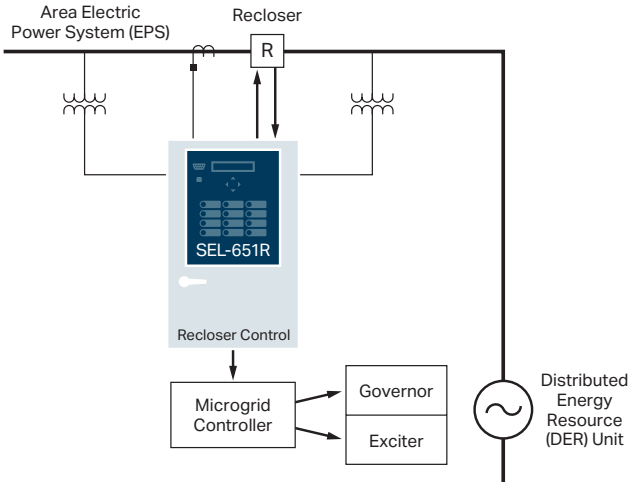
Maintain reliable power with the SEL-651R Advanced Recloser Control for critical loads that require dual-feeder service. You can make intelligent operation decisions to bring nonfaulted loads back online using SEL MIRRORED BITS® communications technology between recloser controls. MIRRORED BITS lets you communicate securely and share recloser status, source status, and other logic information between SEL-651R recloser controls.

Customize the return-to-normal action by incorporating a synchronism check for parallel source return or break-before-make when source voltages are not in phase.




## Distributed energy resource interconnection

Meet synchronization and tripping requirements when connecting microgrids and distributed generation to distribution systems. Voltage, frequency, synchronism-check, and automatic synchronizing elements provide seamless connections. You can easily disconnect generation from the distribution system for faults, islanding, and other abnormal conditions.



# SEL-FT50 and SEL-FR12

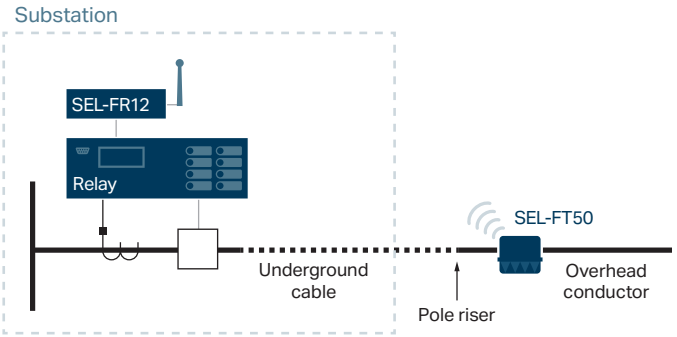
## Fault Transmitter and Receiver System

Starting price
**SEL-FT50 Fault Transmitter: $180 USD**
**SEL-FR12 Fault Receiver: $549 USD**

selinc.com/products/FT50 | Select models typically ship in 2 days

The SEL-FT50 and SEL-FR12 system provides an innovative approach to improve the reliability and safety of your feeder. You can apply this system with your existing protection schemes to block reclosing for underground faults. The system consists of line-powered SEL-FT50 Fault Transmitters communicating wirelessly with an SEL-FR12 Fault Receiver. The system communicates the fault data using high-speed MIRRORED BITS® communications in less than 6 ms.

Fast detection and communications from the SEL-FT50 and SEL-FR12 system provide additional information to protective relays, enabling coordination and protection tailored to specific events based on the location of the fault. This allows your protection to trip for faults as fast as possible and allows you to selectively decide when reclosing should be enabled, improving safety and reducing wear on equipment. You can install SEL-FT50 Fault Transmitters on laterals, branches, and the main line to provide additional information for protection decisions.




Block reclosing for underground faults to enhance protection based on the fault location.

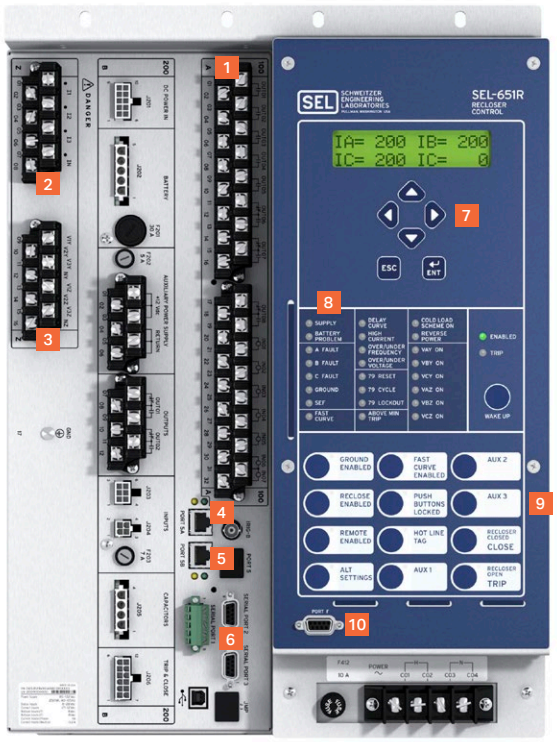
# SEL-651R

## Advanced Recloser Control

Starting price
**$6,060 USD**

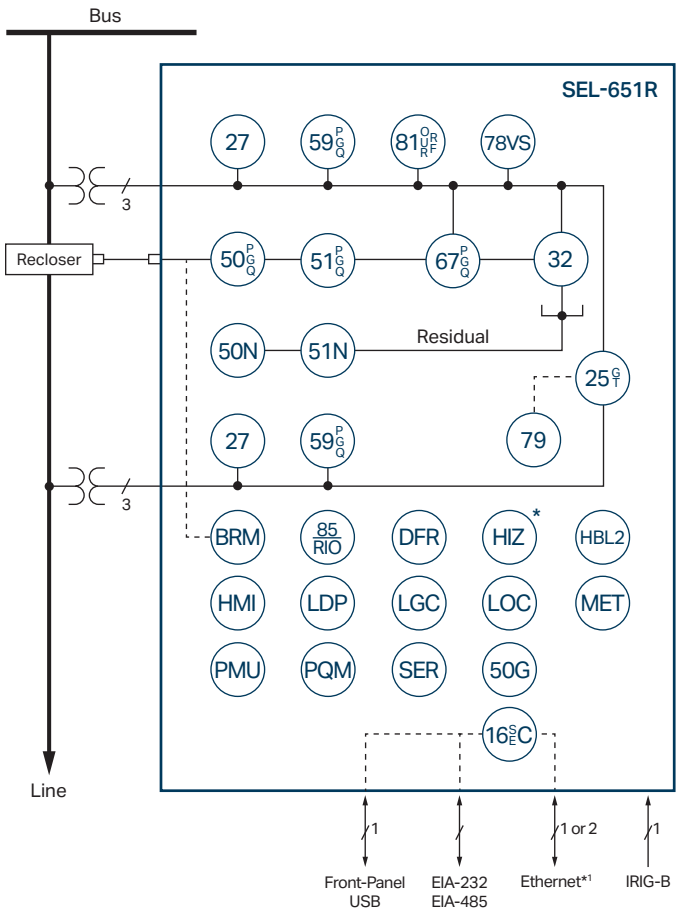
selinc.com/products/651R

The SEL-651R offers exceptional protection and communications capabilities for Automatic Network Reconfiguration, single- and three-phase tripping, distributed energy resource (DER) interconnections, turnkey point of common coupling solutions, and other distribution automation needs. These capabilities help you maintain reliable service to as many customers as possible in the event of a fault. You can quickly commission the SEL-651R by applying just the settings you need using ACSELERATOR QuickSet® SEL-5030 Software. Easy-to-use design templates simplify the settings interface, and you can customize them for your needs. For quick access when making settings changes, you can store templates on the recloser control.





1. 64 SELOGIC® variables replace traditional panel switches with 32 latching, 16 local, and 32 remote control points.
2. Built-in synchrophasor measurements for real-time electrical quantities.
3. Standard six voltage inputs with PT and low-energy analog (LEA) options for measurements on both sides of the recloser.
4. Standard multisession Modbus TCP and DNP3 and optional IEC 61850 easily integrate with existing systems.
5. Standard dual copper Ethernet ports and optional single or dual fiber ports for improved communications.
6. Two standard EIA-232 ports, an EIA-485 port, and a USB port provide several communications options.
7. Navigation controls make information readily accessible.
8. Optional software-programmable tricolored LEDs for improved status indication.
9. Programmable control pushbuttons and configurable labels for ease of operation.
10. EIA-232 front serial port provides local access.
11. Single-door control option shown.




### ANSI Functions

| | |
|---|---|
| 16 SEC | Access Security (Serial, Ethernet) |
| 25 (G,T) | Generator/Intertie Synchronism Check |
| 27 | Undervoltage |
| 32 | Directional Power |
| 50G | Best Choice Ground |
| 50N | Neutral Overcurrent |
| 50 (P,G,Q) | Overcurrent (Phase, Ground, Negative Sequence) |
| 51 (P,G,Q) | Time Overcurrent (Phase, Ground, Negative Sequence) |
| 51N | Neutral Time Overcurrent |
| 59 (P,G,Q) | Overvoltage (Phase, Ground, Negative Sequence) |
| 67 (P,G,Q) | Directional Overcurrent (Phase, Ground, Neg. Seq.) |
| 78VS | Vector Shift |
| 79 | Autoreclosing |
| 81 (O,U,R) | Frequency (Over, Under, Rate) |
| 81RF | Fast Rate-of-Change of Frequency |
| 85 RIO | SEL Mirrored Bits® Communications |
| DFR | Event Reports |
| HIZ | SEL Arc Sense™ Technology (AST)* |
| HMI | Operator Interface |
| LGC | SELogic Control Equations |
| MET | High-Accuracy Metering |
| PMU | Synchrophasors |
| PQM | Voltage Sag, Swell, and Interruption |
| SER | Sequential Events Recorder |

### Additional Functions

| | |
|---|---|
| BRM | Breaker Wear Monitor |
| HBL2 | Second-Harmonic Blocking |
| LDP | Load Data Profiling |
| LOC | Fault Locator |

*Optional feature [1]Copper or fiber-optic

## Compatible with popular reclosers

The SEL-651R works with a wide range of reclosers for complete plug-and-work capability. All interfaces are designed and tested to exceed the IEEE C37.60 standard. Certificates are available at selinc.com/products/SEL-651R.

### G&W

- Control Power Viper-S
- Viper-LT
- Viper-S
- Viper-SP
- Viper-ST
- Viper-G

### Other Reclosers

- Elastimold Molded Vacuum Recloser (MVR)
- Joslyn TriMod 300R
- Joslyn TriMod 600R
- OVR-3 24-Pin (15 and 27 kV only)
- Gridshield 32-Pin (15, 27, and 38 kV)
- Gridshield 42-Pin (15, 27, and 38 kV)
- VR-3S (15 and 27 kV only)
- CXE
- NOVA Auxiliary Powered
- NOVA Control Powered
- NOVA NX-T
- NOVA Triple-Single
- RE
- RVE
- RXE
- VSA
- VSO
- VWE
- VWVE 27
- VWVE 38X
- WE
- WVE 27
- WVE 38X
- GVR[2]
- SDR Triple-Single
- SDR Three-Phase
- OSM_150

[2]When equipped with interface module

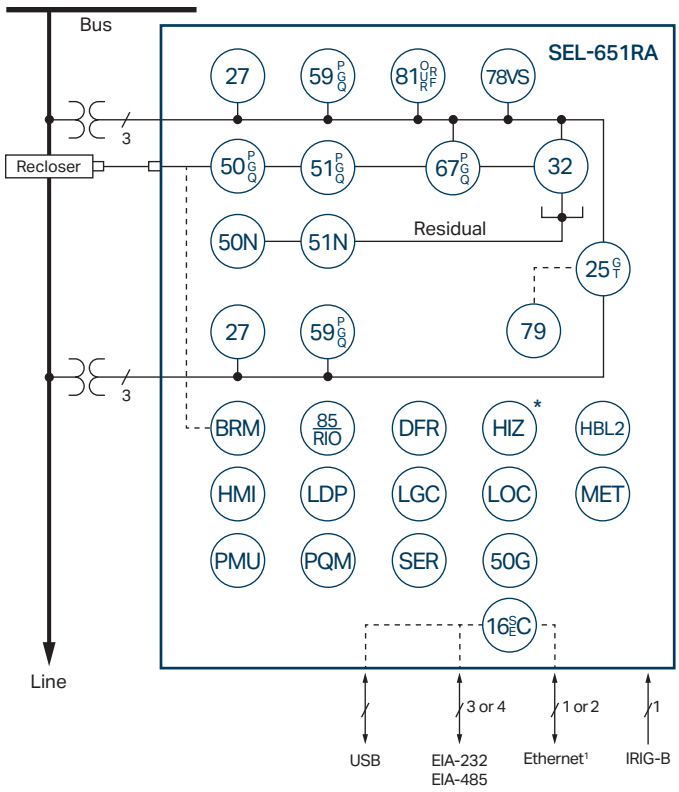
# SEL-651RA
## Recloser Control

Starting price
**$4,040 USD**

selinc.com/products/651RA

The SEL-651RA offers exceptional protection and communications capabilities for Automatic Network Reconfiguration, distributed energy resource (DER) control, turnkey point of common coupling solutions, and other distribution automation needs. These capabilities help you maintain reliable service to as many customers as possible in the event of a fault. You can quickly commission the SEL-651RA by applying just the settings you need using ACSELERATOR QuickSet® SEL-5030 Software. Easy-to-use design templates simplify the settings interface, and you can customize them for your needs. For quick access when making settings changes, you can store the templates on the recloser control. Familiar EZ recloser control settings further simplify and speed commissioning for basic applications.


1. Corrosion-resistant painted aluminum cabinet provides a maintenance-free enclosure.
2. Standard three-point latch for physical security.
3. EIA-232 front serial port provides local access.
4. USB port provides fast local access.
5. Navigation controls make information readily accessible.
6. Optional software-programmable tricolored LEDs for improved status indication.
7. Programmable control pushbuttons and configurable labels for ease of operation.




### ANSI Functions

| | |
|---|---|
| 16 SEC | Access Security (Serial, Ethernet) |
| 25 (G,T) | Generator/Intertie Synchronism Check |
| 27 | Undervoltage |
| 32 | Directional Power |
| 50G | Best Choice Ground |
| 50N | Neutral Overcurrent |
| 50 (P,G,Q) | Overcurrent (Phase, Ground, Negative Sequence) |
| 51 (P,G,Q) | Time Overcurrent (Phase, Ground, Negative Sequence) |
| 51N | Neutral Time Overcurrent |
| 59 (P,G,Q) | Overvoltage (Phase, Ground, Negative Sequence) |
| 67 (P,G,Q) | Directional Overcurrent (Phase, Ground, Negative Seq.) |
| 78VS | Vector Shift |
| 79 | Autoreclosing |
| 81 (O,U,R) | Frequency (Over, Under, Rate) |
| 81RF | Fast Rate-of-Change of Frequency |
| 85 RIO | SEL Mirrored Bits® Communications |
| DFR | Event Reports |
| HIZ | SEL Arc Sense™ Technology (AST)* |
| HMI | Operator Interface |
| LGC | SELogic® Control Equations |
| MET | High-Accuracy Metering |
| PMU | Synchrophasors |
| PQM | Voltage Sag, Swell, and Interruption |
| SER | Sequential Events Recorder |

### Additional Functions

| | |
|---|---|
| BRM | Breaker Wear Monitor |
| HBL2 | Second-Harmonic Blocking |
| LDP | Load Data Profiling |
| LOC | Fault Locator |

*Optional feature

[1] Copper or fiber-optic

## Compatible with popular reclosers

The SEL-651RA works with traditional 14-pin reclosers and can be configured for complete plug-and-work capability. The interface is designed and tested to exceed the IEC 62271-111/IEEE C37.60 standard. Certificates for the Eaton (Cooper) NOVA and G&W Viper-S reclosers are available at selinc.com/products/SEL-651RA.

### G&W

- Viper-S
- Viper-G

### Other Reclosers

- Joslyn TriMod 300R
- NOVA Auxiliary Powered
- CXE
- RE
- RVE
- RXE
- VSA
- VSO
- VWE
- VWVE 27
- VWVE 38X
- WE
- WVE 27
- WVE 38X
- GVR[2]

[2] When equipped with interface module

# SEL-351RS Kestrel®

## Single-Phase Recloser Control

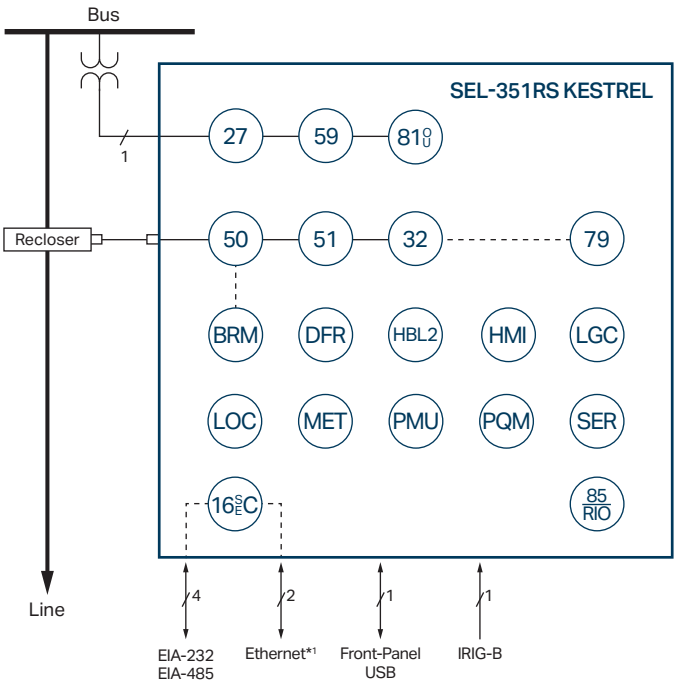
Starting price
**$2,590 USD**

selinc.com/products/351RS_Kestrel

The lightweight SEL-351RS provides integrated logic, communications, and comprehensive protection for single-phase applications. Convenient operator controls allow easy local access to metering and event data. The rugged, painted aluminum enclosure reduces the need for cabinet maintenance and repairs. With built-in USB, serial, and Ethernet media and protocols, including IEC 61850 and IEEE C37.118 synchrophasors, you can easily integrate this control into new or existing systems. Familiar EZ recloser control settings further simplify and speed commissioning for basic applications.

### Compatible with popular reclosers

The SEL-351RS works with single-phase reclosers, such as the G&W Viper-SP and the ABB Elastimold Molded Vacuum Recloser (MVR)—Single Phase, and it can be configured for complete plug-and-work capability. The interface is designed and tested to exceed the IEC 62271-111/IEEE C37.60 standard. Certificates for popular single-phase reclosers are available at selinc.com/products/351RS_Kestrel.




### ANSI Functions

| | |
|---|---|
| 16 SEC | Access Security (Serial, Ethernet) |
| 27 | Undervoltage |
| 32 | Directional Power |
| 50 | Overcurrent |
| 51 | Time Overcurrent |
| 59 | Overvoltage |
| 79 | Autoreclosing |
| 81 (O,U) | Over-/Underfrequency |
| 85 RIO | SEL Mirrored Bits® Communications |
| DFR | Event Reports |
| HMI | Operator Interface |
| LGC | SELogic® Control Equations |
| MET | High-Accuracy Metering |
| PMU | Synchrophasors |
| PQM | Voltage Sag, Swell, and Interruption |
| SER | Sequential Events Recorder |

### Additional Functions

| | |
|---|---|
| BRM | Breaker Wear Monitor |
| HBL2 | Harmonic Blocking |
| LDP | Load Data Profiling |
| LOC | Fault Locator |

*Optional feature [1] Copper or fiber-optic

# SEL-734B

## Advanced Monitoring and Control System

Starting price
**$1,660 USD**

selinc.com/products/734B

The SEL-734B with low-energy analog (LEA) inputs provides advanced monitoring and control capabilities for applications such as capacitor bank control and feeder monitoring. LEA sensor compatibility allows safe, fast, and inexpensive installations. Advanced communications let you report data to SCADA systems and allow remote operations from a control center. You can order enclosures with preloaded control schemes or design custom controls, such as capacitor bank controllers or sectionalizers, using ACSELERATOR QuickSet® SEL-5030 Software templates. SEL's capacitor bank control and sectionalizer templates improve efficiency, increase reliability, and reduce installation time and maintenance costs. User-customized templates add flexibility, improving any smart grid installation.

### Capacitor bank control

Choose capacitor bank switching strategies for voltage, kVAR, current, and power factor control with the SEL-734B. Easily toggle control strategies, such as between SCADA and automatic control, from the control center with DNP3 binary objects. Implement a SCADA heartbeat to switch to islanded automatic control if SCADA communication is lost. Customizable logic allows you to modify and create control schemes to adapt to your application.

### Complete automation

Order the SEL-734B preprogrammed for capacitor bank control, or customize it to suit virtually any need. Program the SEL-734B for sectionalizing, feeder monitoring, overcurrent detection (for use in locating faults), or virtually any other application demanded. Thirty-two SELOGIC® control equation elements allow powerful control and monitoring schemes. With features from the SEL-734 Revenue Meter included, the SEL-734B offers the most flexible monitoring and control solution on the market.

In addition to the compact enclosure, the SEL-734B is available as a standalone unit or in a full-size enclosure.

### Plug-and-play connections

Choose from multiple enclosure styles, various sensor input ranges, and customizable enclosures to make the SEL-734B a plug-and-play device. The SEL-734B is offered as a standalone device or is installed in a compact or full-sized enclosure with a variety of connections. Make your commissioning a plug-and-play experience with the SEL-734B.

# SEL-734W and SEL-8340

## Capacitor Bank Control and Wireless Current Sensor

Starting price
**SEL-734W: $1,760 USD**
**SEL-8340: $630 USD**

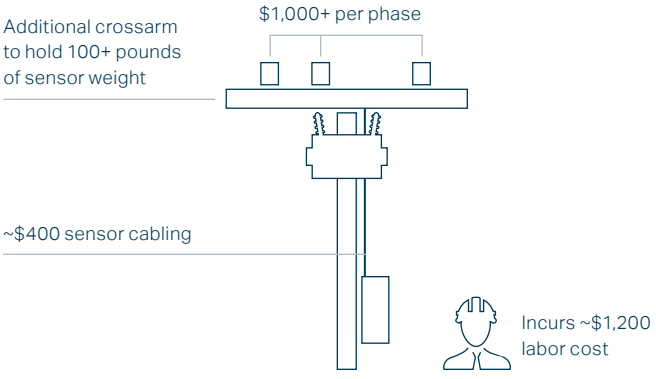
selinc.com/products/734W

The SEL-734W and SEL-8340 solution is a quicker, simpler, and safer way to improve power quality. The SEL-734W uses current, voltage, kVARs, and power factor control to optimize capacitor bank switching. The SEL-734W and SEL-8340 solution makes replacing time- and temperature-based capacitor bank controls faster and easier. This is the first capacitor bank control to use wireless technology to improve power quality while avoiding difficult-to-install line post current sensors.

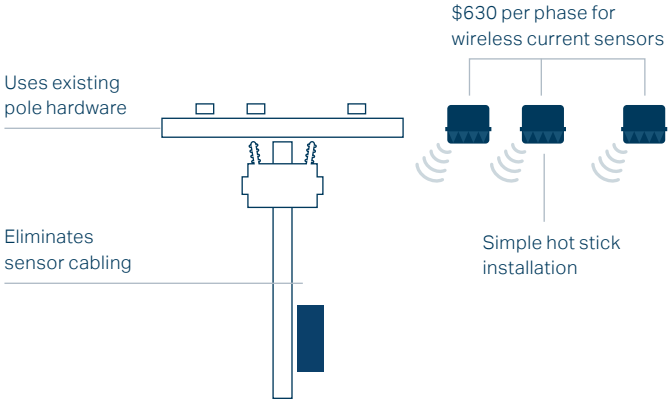

An SEL-734W Capacitor Bank Control is paired with one to three SEL-8340 Wireless Current Sensors.

### Ease of installation

The lightweight current sensors install on an overhead distribution line using a single hot stick. There is no need for an outage or significant hot-line work.



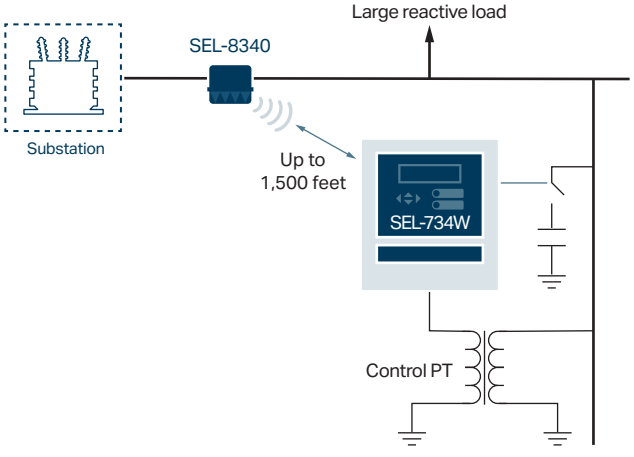

Traditional Installation




SEL-734W Capacitor Bank Control and SEL-8340 Wireless Current Sensor Solution

### Location flexibility

Mount the wireless current sensors closer to your inductive loads, not just at the control. The sensors can be mounted up to 1,500 feet away from the capacitor bank installation.



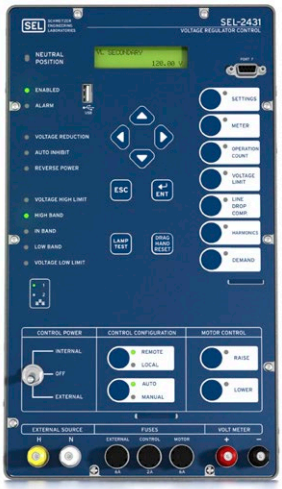
# SEL-2431

## Voltage Regulator Control

Starting price
**$970 USD**

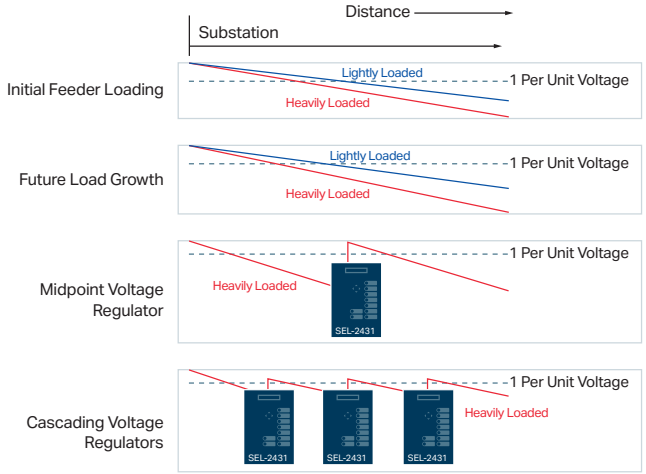
selinc.com/products/2431 | Select models typically ship in 2 days

The SEL-2431 is compatible with most 32-step, single-phase voltage regulators manufactured in North America. Various hinge and wiring kits let you easily upgrade existing controls without removing the regulator from service. You can quickly integrate the SEL-2431 into Ethernet or serial communications networks using fiber or copper options.



### Creating the optimum profile

Apply the SEL-2431 to your single-phase voltage regulators to optimize your voltage profile. After initial construction, feeder load growth causes drastic, unplanned voltage deviations. Single-phase voltage regulators installed at the midpoint or cascaded throughout the feeder can dramatically flatten the voltage profile.




### Modes of operation

Program the SEL-2431 quickly and easily for your application. With configurable modes of operation, you can apply the SEL-2431 in locked-forward, locked-reverse, bidirectional, idle-reverse, or cogeneration modes.

For example, you can select the locked-forward mode for systems configured with traditional radial feeders. For looped systems where current can flow in either direction, the bidirectional mode will dynamically change the voltage regulation settings based on the direction of current flow.

| | Reverse Current | 0 | Forward Current |
|---|---|---|---|
| Locked Forward | Operation Inhibited | Forward Operation | |
| Locked Reverse | Reverse Operation | | Operation Inhibited |
| Bidirectional | Reverse Operation | Operation Inhibited | Forward Operation |
| Idle Reverse | Operation Inhibited | | Forward Operation |
| Cogeneration | Forward Operation (Reverse LDC) | Operation Inhibited | Forward Operation (Forward LDC) |

# Fault Indicators, Sensors, and CTs Overview

### SEL-FLT and SEL-FLR

Improve distribution reliability with the SEL-FLT and SEL-FLR system, which enables faster fault locating, reduces outage durations, and improves the average restoration time.

### SEL-AR360 and SEL-AR

Locate momentary and permanent faults in overhead applications. The SEL-AR360 and SEL-AR automatically adjust their trip thresholds to coordinate with the load current in distribution systems up to 69 kV.

### SEL-ER

Provide maintenance-free fault indication with a battery-free design and automatic voltage reset.

### SEL-BTRIP

Locate momentary and permanent faults in overhead applications. The SEL-BTRIP provides four field-selectable trip thresholds so you can stock one fault indicator for multiple applications.

### RadioRANGER®

Reduce the need to access vaults or open pad-mounted enclosures to retrieve the fault indicator status, decreasing fault-locating time and improving safety.

### SEL-8301

Optimize outage management and improve underground system reliability.

### SEL-ARU

Use the Dynamic Delayed Trip feature to improve coordination with upstream protection, maximizing reliable performance.

### SEL-TPR

Easily install the SEL-TPR on most brands of 200 A or 600 A elbows with capacitive test points. It is ideal for pad-mounted transformer and switchgear applications.

### SEL-CR

Monitor underground systems with the SEL-CR, which is powered by the load current present on an energized line.

### SEL-SR

Apply the SEL-SR to pad-mounted transformers when there is insufficient primary current to power and reset current-powered fault indicators.

### SEL-TR

Indicate both momentary and permanent faults in underground distribution systems with low load and low voltage.

### SEL-MW

Use the SEL-MW in place of PTs to detect system voltage loss where exact system voltage measurement reporting is not required. The SEL-MW indicates voltage loss via a contact output.

### SEL-PILC

Apply the SEL-PILC on paper-insulated lead-covered cables. It features a rugged design and can be submerged in up to 15 feet of water.

### SEL-GFD

Apply the SEL-GFD over a three-phase cable bundle at ground potential in switch-gear to identify faults on circuits feeding medical facilities, mining equipment, and other industrial equipment.

### SEL-MR

Troubleshoot overhead and underground applications up to 38 kV with this portable, fault-powered manual reset fault indicator.

### SEL-VIN

Easily install SEL-VINs on the test point of a 200 A elbow, 600 A T-body, or 600 A basic insulating plug. The line-powered SEL-VIN indicates the presence of voltage at or above 2 kV (phase to ground) by flashing a neon lamp.

### SEL-CT

Economically add SEL CTs to existing wiring and electrical equipment without interrupting service.

### SEL-SCT

Easily add the SEL-SCT in subsurface vaults where flooding can occur. The separable-core design allows the SEL-SCT to be opened and installed without interrupting the connection.

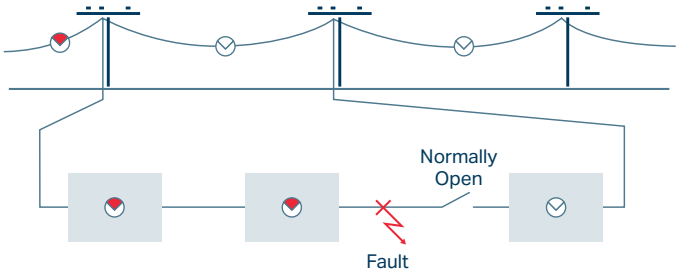
# Fault Indicators and Sensors Applications

## Overhead, underground, and wireless applications

Easy-to-see displays on SEL fault indicators lead the line crew to the faulted section of the overhead line or underground cable, allowing personnel to visually identify the faulted line section without going through a time-consuming re-fuse and sectionalize process. Applying fault indicators in areas affected by permanent and momentary outages helps resolve disruptions quickly.

Wireless technology further speeds up fault-finding times by reducing the need for patrolling the line to locate the fault. Use SEL fault indicators with distribution protection and automation equipment to improve system reliability indices and reduce operational and maintenance costs.

Improve system planning and operational decision-making by using accurate load data from the SEL-FLT and SEL-FLR Fault and Load Transmitter and Receiver System. These solutions provide underground or overhead load monitoring capability in addition to fault indication.

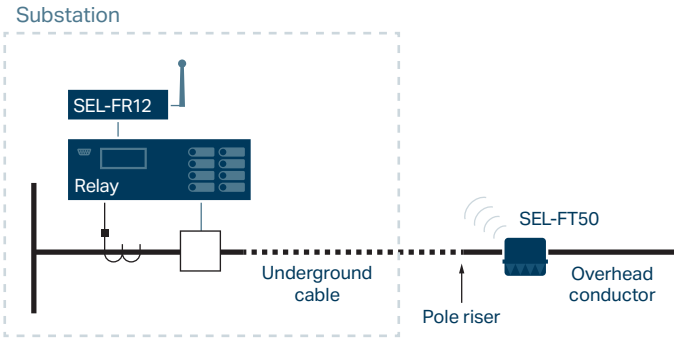



Reduce fault-locating time by 50 percent or more.

## High-speed distribution protection

Improve speed, selectivity, and safety in distribution protection by using the SEL-FT50 and SEL-FR12 Fault Transmitter and Receiver System. Using low-latency communications, the system is fast enough to adapt protection schemes to speed up tripping, block reclosing for underground faults, and improve coordination.

To learn more about the SEL-FT50 and SEL-FR12 system, visit **selinc.com/products/FT50**.



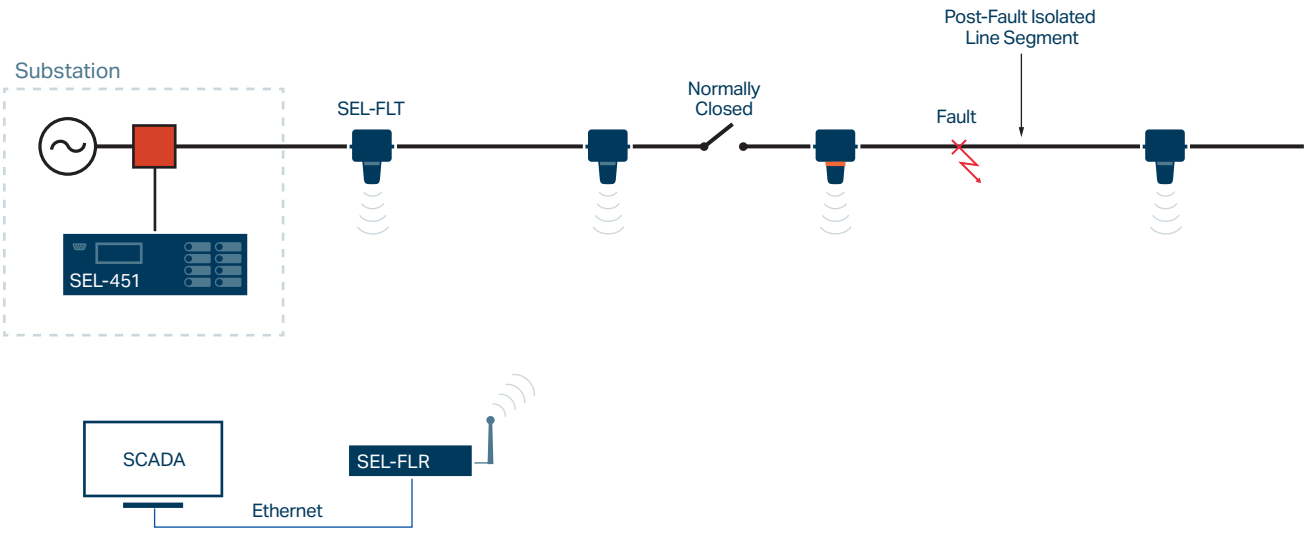

Fast communications: <6 ms from the time of fault detection to relay input for enhanced protection and coordination.

## Integration with distribution systems

The SEL-FLT and SEL-FLR Fault and Load Transmitter and Receiver System interconnects with existing SCADA, outage management, and distribution management systems to improve situational awareness.

Place SEL-FLT transmitters next to manual- or remote-operated switches to quickly communicate fault and load status to a single SEL-FLR connected to a distribution management system through an IP backhaul. This provides operations personnel with the status confirmation needed to reconfigure the circuit and restore power to as many customers as possible.


SEL-FLT and SEL-FLR Fault and Load Transmitter and Receiver System.




Communicate the fault location to a SCADA system for quick power restoration.

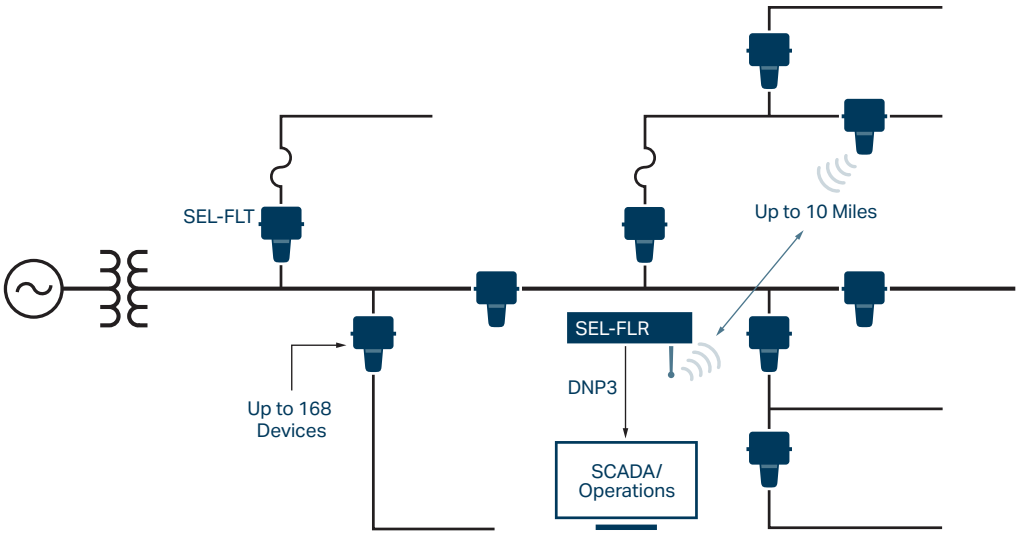
# SEL-FLT and SEL-FLR

## Fault and Load Transmitter and Receiver System

Starting price
**SEL-FLT Fault and Load Transmitter: $850 USD**
**SEL-FLR Fault and Load Receiver: $1,200 USD**

selinc.com/products/FLT

The SEL-FLT and SEL-FLR system improves the overall reliability of your distribution system through accurate fault indication and load monitoring. The SEL-FLT Fault and Load Transmitter and the SEL-FLR Fault and Load Receiver work together over unlicensed 900 MHz wireless communications to locate faults faster and make informed switching decisions. Restoring power quickly is essential to ensuring satisfied customers and better Customer Average Interruption Duration Index (CAIDI) reliability metrics. Locating momentary faults also allows you to address system issues and improve Momentary Average Interruption Frequency Index (MAIFI) metrics. Highly accurate (1% typical) load data enable phase balancing and system planning. Line powering, with as little as 3.5 A of continuous current, reduces ongoing maintenance and allows you to use the SEL-FLT throughout your distribution system. SEL-FLR receivers are easy to integrate in existing systems with DNP3/IP output and comprehensive security.

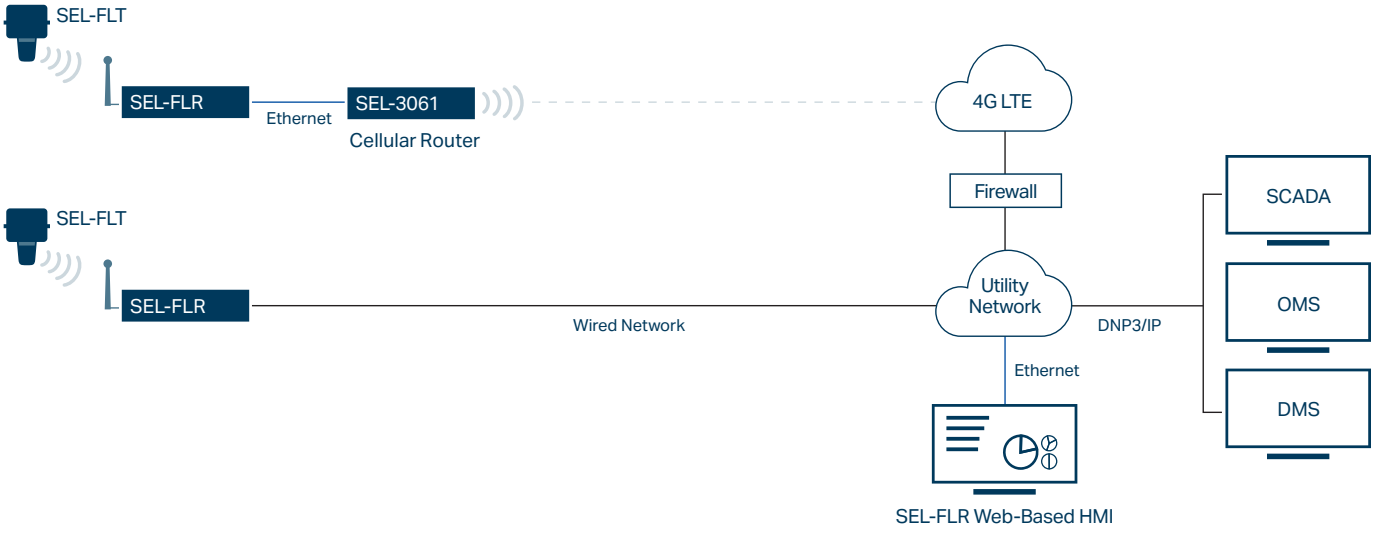
## SEL-FLT and SEL-FLR system integrates with your existing system

The SEL-FLR integrates easily into existing networks and centralized SCADA systems with standard Ethernet ports and DNP3/IP output. The SEL-FLR can pair with a cellular modem/router or Ethernet radio or can plug directly into a wired Ethernet network. Once connected, data from the SEL-FLT transmitters can flow into a SCADA system, outage management system (OMS), or distribution management system (DMS). You can perform configuration and troubleshooting of the SEL-FLT and SEL-FLR system over the network.

With fault information from the SEL-FLT and SEL-FLR system, utility operations teams can dispatch crews to fault locations faster, speeding up restoration. Flashing LEDs on the SEL-FLT transmitters help line crews confirm the fault location reported through a SCADA system or OMS.

The SEL-FLT and SEL-FLR system can also help locate momentary faults. Addressing the causes of these faults, such as overgrown tree limbs or aging insulators, reduces future faults and momentary interruptions.

Highly accurate and frequent load data from SEL-FLT transmitters on taps and laterals enables better decision-making in emergency switching situations. Load data are also essential for phase balancing, system planning, and identifying power theft.



# SEL-AR360 and SEL-AR

## Overhead AutoRANGER® Fault Indicators

Starting price
**SEL-AR360: $220 USD**
**SEL-AR: $170 USD**

selinc.com/products/AR

The SEL-AR360 and SEL-AR are self-adjusting fault indicators for distribution systems. The advanced algorithms in the microprocessor-based technology continually measure the load current and automatically step up or down the trip threshold to coordinate with the load. After an event, the fault indicators analyze system conditions to determine a display notification of either a momentary or permanent fault. They also use inrush restraint technology that activates on the loss of current or voltage to prevent tripping on reclosing attempts.

### SEL-AR360

The SEL-AR360 works on systems up to 34.5 kV and offers 1,800 flashing hours and a 360-degree ultrabright flashing LED display.

Momentary fault indication.

Permanent fault indication.

### SEL-AR

The SEL-AR works on systems up to 69 kV and offers 2,500 flashing hours and a forward-facing LED display.



Momentary fault indication.


Permanent fault indication.

# SEL-ER

## Overhead Electrostatic Reset Fault Indicator

selinc.com/products/ER

Starting Price
**$100 USD**

The line-powered SEL-ER displays a permanent fault condition by showing a large reflective red target. The red target remains visible until after the line is re-energized. The hermetically sealed UV-stabilized housing and stainless-steel clamp make the SEL-ER tough enough to handle harsh outdoor environments.

# SEL-CRD

## Overhead Current Reset Fault Indicator

selinc.com/products/CRD

Starting Price
**$160 USD**

Powered by load current, the SEL-CRD reduces fault-finding time on overhead power distribution systems. It indicates a faulted line condition by showing a large red reflective target display. The SEL-CRD automatically resets upon restoration of load current.

# SEL-BTRIP

## Overhead BEACON® Field-Programmable Timed-Reset Fault Indicator

selinc.com/products/BTRIP

Starting Price
**$200 USD**

The SEL-BTRIP locates momentary or permanent faults in 4,160 V to 69 kV overhead system applications. It is quick and easy to apply using a single hot stick. The field-selectable trip threshold provides control of settings while allowing you to stock only one model. A super-bright flashing LED display provides clear indication of an overcurrent event. The SEL-BTRIP is completely powered by a 3.6 V high-capacity 8.5 Ah lithium battery with a 20-year shelf life.

# SEL-BTRI

## Overhead BEACON Timed-Reset Fault Indicator

selinc.com/products/BTRI

Starting Price
**$130 USD**

The battery-powered overhead SEL-BTRI provides automatic reset at the end of a fixed reset period to allow time for crews to locate permanent and momentary faults. It is ideal for locations where false resets from backfeed are a concern, such as applications with single-phase sectionalizing on a three-phase circuit. The loss-of-voltage-activated inrush restraint feature prevents the SEL-BTRI from responding to automatic reclosing events.

# RadioRANGER®

## Underground Wireless Fault Indication System

Starting price
**Interface, Reader, and 3 FCIs: $943 USD**

selinc.com/products/RadioRANGER

The RadioRANGER system reduces the need to access vaults to retrieve the status of faulted circuit indicators (FCIs), decreasing fault-locating times and improving utility personnel safety. Utility personnel can quickly and safely retrieve the subsurface FCI status at street level through communication between the SEL-8300 RadioRANGER Wireless Interface and the handheld SEL-8310 RadioRANGER Remote Fault Reader. A two-way communications link transmits both faulted (tripped) and normal (reset) status information, preventing any uncertainty in determining if FCIs are plugged into the interface and functioning.

The IP68-rated SEL-8300 and waterproof interconnection system (rated to 4.5 m [15 ft] of submersion in water) ensure environmental integrity for vault applications. Up to 12 SEL FCIs equipped with magnetic RadioRANGER Interface Probes inductively communicate their status to an SEL-8300. The rugged SEL-8310 provides the ID of nearby SEL-8300 Wireless Interfaces as well as the phase and direction of the fault path. To maximize application efficiency, the modular and scalable system works in a variety of vault configurations and offers an estimated 15 years of product life.

Look for this symbol to identify RadioRANGER-compatible fault indicators and sensors.


### SEL-8300 RadioRANGER Wireless Interface

The Wireless Interface communicates fault indicator information to the Remote Fault Reader.

1. Integrated antenna (or optional remote antenna).
2. Sealed, waterproof, and IP68-rated case.
3. Eight easy-to-set IDs allow application in dense areas.
4. Circuit and cable phase labels debossed next to ports to make it simple to match FCIs with cables and circuits during installation.
5. Connects up to 12 fault indicators wired with RadioRANGER Interface Probes.

### SEL-8310 RadioRANGER Remote Fault Reader

The Remote Fault Reader identifies the phase and location of underground faults.

6. Flexible antenna.
7. Durable, buoyant case rated to IP54.
8. Wireless Interface health monitor.
9. Displays up to eight unique Wireless Interface IDs.
10. Communicates fault indicator presence and status:
    Red—Tripped fault indicator
    Green—Untripped fault indicator
    Off—No fault indicator present
11. Operates on three alkaline or rechargeable AA batteries.
12. Easy-to-use keypad.

# SEL-8301
## Underground Distribution Sensor

Starting price
**Three-Phase System: $2,190 USD**

selinc.com/products/8301

The SEL-8301 optimizes outage management and improves power system reliability. Using a wireless RPMA network, the SEL-8301 sends fault, load current, and water depth information to your control center so you can efficiently dispatch repair crews and reduce outage durations. With a line current measurement accuracy of 1.5 percent, it enables effective switching decisions, letting you restore power to more customers. The flexible design makes the SEL-8301 ideal for underground vaults, pad-mounted switchgear and transformers, and high-rise distribution feeders and transformer rooms.


1. Twist-lock keyed connectors and magnetic mounting make installation easy, even when wearing gloves.
2. Water depth sensor uses ultrasonic waves to determine the water volume in the vault.
3. SEL-8302 Current Transformers can continuously monitor up to 12 different phases. The split-core design makes it easy to attach the sensors to insulated, shielded distribution cables.
4. You can mount remote antennas up to 20 feet from the unit for improved wireless signal strength in underground vaults.

# SEL-ARU

## Underground AutoRANGER® Fault Indicator

Starting price
**$120 USD**

selinc.com/products/ARU | Compatible With RadioRANGER®

The SEL-ARU is a reliable, settings-free fault indicator that automatically selects a minimum trip threshold based on the sampled load current. This feature simplifies ordering and inventory, reduces maintenance, and simplifies applications. The Dynamic Delayed Trip feature automatically adjusts the trip response time to better coordinate with upstream protection, maximize performance, and increase the reliability of underground distribution systems.

Display options provide flexibility for pad-mounted or vault installations. The power options (line-powered or battery) and restoration reset features ensure reliable performance for any application.

SEL-ARU with integrated display.

SEL-ARU with fiber-optic display. Other display options are available.

# SEL-TPR

## Underground Test Point Reset Fault Indicator

Starting price
**$72 USD**

selinc.com/products/TPR | Compatible With RadioRANGER®

The SEL-TPR is an underground fault indicator that attaches to capacitive test points in single- or three-phase systems. It replaces the protective cap on capacitive test points, with the benefit of providing fault indication. The SEL-TPR eliminates the need to account for the position of the concentric neutral, as is common with cable-mounted fault indicators. It automatically resets upon system voltage restoration. The SEL-TPR is easy to install with a hot stick attached to its molded rubber hook eye. Powered by line voltage, the SEL-TPR does not have a minimum current requirement, making it great for lightly loaded circuits.

You can choose from a variety of display options, including a built-in, battery-free mechanical flag display or a remote bright BEACON® LED display. Remote display options reduce fault-finding times by eliminating the need for crews to open medium-voltage enclosures during patrols.

# SEL-CR

## Underground Current Reset Fault Indicator

selinc.com/products/CR

Compatible With RadioRANGER®

Starting Price
**$110 USD**

The SEL-CR uses continuous load current to automatically reset so it is ready to respond to faults. Powered by the load current on an energized underground distribution cable, the SEL-CR responds to a fault and remains in the faulted-display condition until the line is energized with normal line load.

# SEL-SR

## Underground Secondary/Low-Voltage Reset Fault Indicator

selinc.com/products/SR

Starting Price
**$88 USD**


Apply the SEL-SR in single- and three-phase pad-mounted transformer applications where there is insufficient load current or no capacitive test points to power fault indicators. The SEL-SR's reset cable feeds off the transformer secondary voltage to operate, eliminating the need for a battery.

# SEL-TR

## Underground Timed-Reset Fault Indicator

selinc.com/products/TR

Starting Price
**$120 USD**


The SEL-TR holds its tripped status indication for a set time, regardless of the presence of current or voltage on the distribution circuit, making it ideal for underground systems. You can use this functionality for applications where backfeed voltage or current can falsely reset restoration-reset faulted circuit indicators in the fault path. The SEL-TR is available with a long-lasting nonreplaceable battery for installations that require zero maintenance.

# SEL-MW

## Microcontroller-Based Wye Voltage Sensor

selinc.com/products/MW

Starting Price
**$350 USD**

More economical than a PT or analog sensor, the SEL-MW detects system voltage loss where exact system voltage measurement reporting is not required. You can easily install the SEL-MW on capacitive test points of distribution elbows. It learns and adapts to the unique voltage output level of the capacitive test points to simplify product calibration.

# SEL-PILC

## Underground Paper-Insulated Lead-Covered Cable Fault Indicator

Starting price
**$620 USD**

selinc.com/products/PILC | Compatible With RadioRANGER®

SEL-PILCs support a wide range of paper-insulated lead-covered cable (PILC) configurations and applications, including triplexed, single-phase, and three-phase sector (or round) cables from 5.58 to 11.78 cm (2.2 to 4.64 in.) in diameter. A split-core design lets you quickly and easily install the SEL-PILC without disconnecting the cable. Its rugged construction can withstand submersion in up to 4.5 m (15 ft) of water. The SEL-PILC is compatible with the RadioRANGER Underground Wireless Fault Indication System. Together, they make it easier and faster to find faults on urban systems.

# SEL-GFD

## Underground Ground Fault Detector

Starting price
**$220 USD**

selinc.com/products/GFD

The SEL-GFD detects ground faults by sensing the vector sum of the current flowing through a three-conductor cable. You can install the split-core sensor on three-phase cables or a bundle of three single-phase cables without opening the primary. Three reset options are available: secondary voltage, load current, or time.

# Remote Display Options

## Underground Fault Indicators

Choose from a variety of display options, including nonbattery mechanical flag displays and bright BEACON® LED displays.

Remote displays eliminate the need for crews to open high-voltage enclosures or enter subsurface vaults, improving fault-finding times and reducing arc-flash risks.

Standard “V” Display (BEACON versions also available)

Large “L” Display (BEACON versions also available)


SEL-8310 RadioRANGER® Remote Fault Reader

BEACON Bolt® Display

Tamperproof Bolt Display

BEACON Fiber-Optic Display

# Accessories and Tools

### SEL-MR Manual Reset Fault Indicator

Troubleshoot overhead and underground applications.

Starting Price
**$38 USD**

### MT Manual Reset Tool

Reset the SEL-MR.

Starting Price
**$63 USD**


### SEL-VIN Voltage Indicator

Install this line-powered tool on test point elbows, T-bodies, or basic insulating plugs to indicate the presence of voltage.

Starting Price
**$39 USD**


### HHT Silver Tamperproof Bolt Test Tool

Determine the status (tripped or untripped) of fault indicators with tamperproof bolt displays.

Starting Price
**$63 USD**

### BTT BEACON Bolt® Test Tool

Field-test fault indicators with BEACON Bolt displays.

Starting Price
**$32 USD**

### CRSRTT Current and Secondary Reset Test Tool

Field-test and manually reset the SEL-AR, SEL-ARU, SEL-BTRI, and other current reset and timed-reset products.

Starting Price
**$52 USD**

### ERLTT Electric Field Reset Test Tool

Field-test the SEL-ER Overhead Electrostatic Reset Fault Indicator.

Starting Price
**$52 USD**

### MCL120 Mini Current Loop

Use the MCL120 for demonstration purposes or to trip or reset fault indicators.

Starting Price
**$320 USD**

### SEL-MCG Magnetic Cable Guide

Keep remote display and sensor cables neat and secure.

Starting Price
**$7 USD**


### SEL-MR Manual Reset Fault Indicator With Reset Button

Troubleshoot underground applications.

Starting Price
**$45 USD**


### FCRT Fault Counter Reset Tool

Reset an SEL-FC without removing it from the line.

Starting Price
**$260 USD**

### SEL-FC Overhead Fault Counter Fault Indicator

Narrow down the source of intermittent, hard-to-find temporary or permanent faults on overhead circuits.

Starting Price
**$220 USD**

# SEL-CT

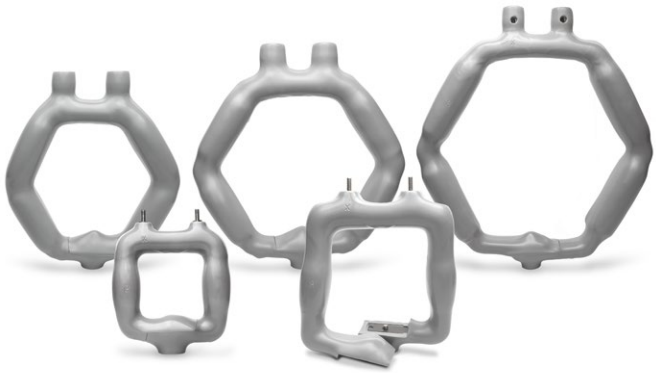
## Split-Core Current Transformer

Starting price
**$150 USD**

selinc.com/products/CT

SEL-CTs are designed for applications where it is difficult or uneconomical to open the primary conductor to install a solid-core-type current transformer. The flexible split-core design uses M-6 silicon steel formed into a hexagonal or rectangular shape. This allows you to open the core to install it over cables.

The SEL-CT is encapsulated in a flexible vinyl plastic with 600 V-class insulation. The secondary terminals and hardware are nickel-plated brass.



# SEL-SCT

## Submersible Separable-Core Current Transformer

Starting price
**$220 USD**

selinc.com/products/SCT

SEL-SCTs are designed for applications where it is difficult or uneconomical to open the primary conductor to install a solid-core-type CT. The separable-core design allows you to open the SEL-SCT to the nominal window diameter and install it over bushings or cables without interrupting the connection. SEL-SCTs are held in place with cable ties. The submersible design provides reliable use in subsurface vaults where flooding can occur.

The SEL-SCT is encapsulated in flexible vinyl plastic with 600 V-class insulation and consists of a separable two-part assembly. The SEL-SCT base and body can be pulled apart, placed around a cable, and reconnected. Two included stainless-steel worm gear clamps secure the base and body of the CT while also preventing water intrusion into the CT core.

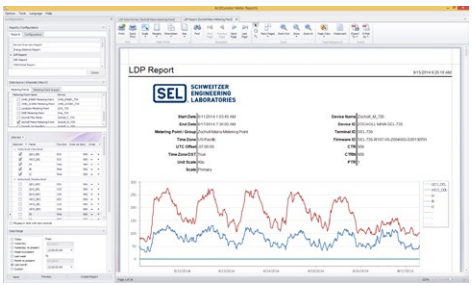
# Metering Overview

## SEL-735 Power Quality and Revenue Meter

Achieve high-accuracy revenue and power quality metering for any application. The SEL-735 offers 1 GB of recording memory for up to 20 years of storage and is now available with a color touchscreen display. Multiple enclosure and mounting options are available.

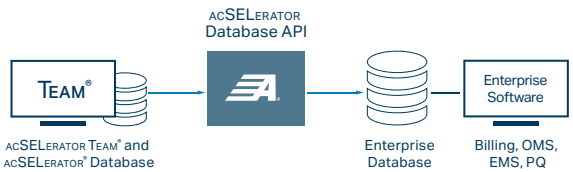
## Meter Installation Options and Accessories

Mount SEL meters and accessory devices into a variety of locations using a complete line of mounting kits. You can choose from rack-mount, wall-mount, indoor, or outdoor configurations. If you have an existing panel cutout, you can retrofit your meter using our retrofit bezels. For more information, visit selinc.com/products/73x/meter-options.




## ACSELERATOR® Meter Reports

Transform metering data into action with ACSELERATOR Meter Reports SEL-5630 Software. The software offers interactive charts, fast database interrogation, and the ability to customize metering reports for utilities, industrial operations, and site-wide campus monitoring.




## ACSELERATOR Database API

Allow third-party systems to access ACSELERATOR TEAM® SEL-5045 Software data with the SEL-5230 ACSELERATOR Database API. This allows different enterprise-level systems, such as an energy management system or a billing system, to integrate data reporting.

## SEL-735 Power Quality Options

| General | Basic | Intermediate | Advanced |
|---|---|---|---|
| Display | Customizable three-line or single-line display | Customizable three-line or single-line display | Customizable three-line or single-line display; 5-inch, 800 × 480 color touchscreen display* |
| Type-C USB Front Port | No | No | Yes* |
| Memory | 128 MB | 256 MB | 1 GB |
| Maximum Harmonic Order | 15th | 63rd | 63rd |
| Interharmonic Quantities | No | No | Yes |
| Harmonic Angles | No | No | Yes |
| Power Harmonics | No | No | Yes |
| Portable Case | No | No | Yes* |
| **Waveform Capture** | | | |
| Samples Per Cycle | 16 | 16, 128 | 16, 128, 512 |
| Duration (Cycles) | 15 | 15–600 | 15–600 |
| Number of Events | 256 | 33–6,200 | 101–10,000 |
| COMTRADE Reports | Yes | Yes | Yes |
| Wave View Oscillography | No | No | Yes |
| **Load Profile Data** | | | |
| Recorders × Channels | 1 × 16 | 12 × 16 | 32 × 16 |
| Acquisition Rates | 1–120 min | 3–59 s, 1–120 min | 3–59 s, 1–120 min |
| **Storage Duration for 10-Minute Interval Data** | | | |
| 16 Channels | 10 years | 20 years | 20 years |
| 192 Channels | N/A | 1.5 years | 9.5 years |
| 512 Channels | N/A | N/A | 3.5 years |
| **Voltage Sag, Swell, and Interruption (VSSI) Recorder** | | | |
| Typical Number of Summary Events | 260 | 260 | 600 |
| Number of Detailed Rows | 60,000 | 60,000 | 130,000 |
| Minimum Disturbance Duration | 1/4 cycle | 1/4 cycle | 1/4 cycle |
| Sampling Rate | 4 samples/cycle–1 sample/day, adaptive | 4 samples/cycle–1 sample/day, adaptive | 4 samples/cycle–1 sample/day, adaptive |
| **Sequential Events Recorder (SER)** | | | |
| Number of Events | >80,000 | >80,000 | >80,000 |
| Number of Channels Monitored | ≤72 | ≤72 | ≤72 |
| **IEC 61000-4-30 Power Quality Compliance** | | | |
| 150/180-Cycle, 10-Minute, 2-Hour Aggregation | – | Class A | Class A |
| Flicker | – | Class A (10 min, 2 hr updates) | Class A (1 min, 10 min, 2 hr updates) |
| Voltage Harmonics | Class A | Class A | Class A |
| Harmonic Currents | Class A | Class A | Class A |

*Optional feature

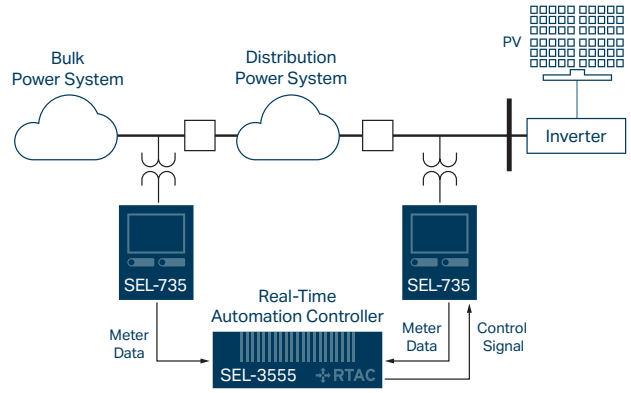
# Metering Applications

## Improve grid operation

Improve reliability and enhance the integration of variable resources into the bulk power system. Meters installed at renewable energy generation points provide fast streams of accurate synchrophasor data to the system operator.

The SEL-735 Power Quality and Revenue Meter includes the latest version of the synchrophasor standard, IEEE C37.118.1a-2014 Class P, making it ideal for applications requiring fast response times under dynamic conditions.

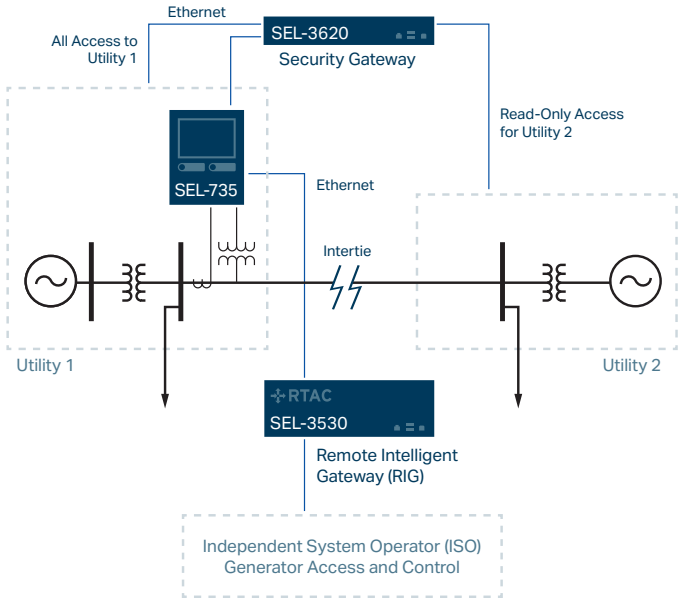
As part of a NERC PRC-002 disturbance monitoring system, you can connect the SEL-735 to SEL-5073 SYNCHROWAVE® Phasor Data Concentrator (PDC) Software. This lets you distinguish between utility outages and transient disturbances to quickly choose when to island the system.




## Communicate intertie and generation data securely

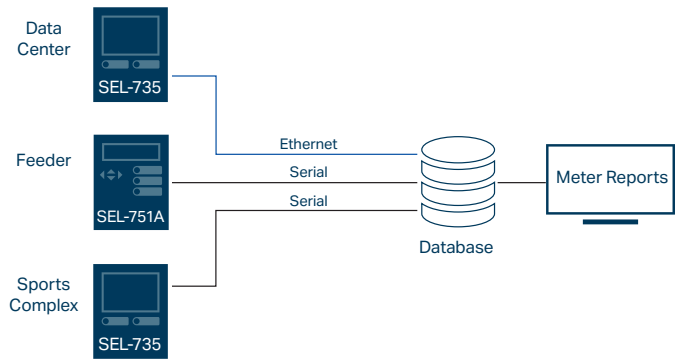
Share intertie data and limit privileges to read-only access using the SEL-3620 Ethernet Security Gateway. Alternatively, you can choose the SEL Remote Intelligent Gateway (RIG) solution for read and control access. The SEL-3530 Real-Time Automation Controller (RTAC) allows the independent system operator (ISO) access to plant information for generation control.

The SEL-735 Power Quality and Revenue Meter provides uninterrupted information access with up to ten simultaneous communications sessions. Advanced communications deliver critical and historical information in real time to virtually any communications system. Cryptographically signed firmware ensures that the meter integrity is not compromised.




## Automate data collection

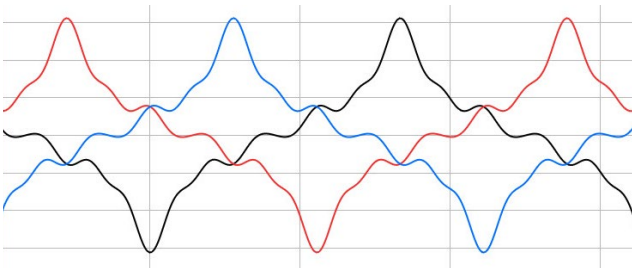
Automate data collection and improve efficiency by eliminating the need to collect data from field devices manually. To streamline the process, ACSELERATOR TEAM® SEL-5045 Software identifies new reports, downloads them, and stores the information. TEAM collects event reports; Sequential Events Recorder (SER) data; voltage sag, swell, and interruption (VSSI) data; and load profile data for historical analysis. After TEAM gathers and stores the data from the metering devices, ACSELERATOR® Meter Reports SEL-5630 Software displays the information to help you make planning, operating, and accounting decisions that will increase efficiency and reduce costs. With the ACSELERATOR Database API, third-party software tools can access metering data and use the data in different enterprise-level systems, such as an energy management system or a billing system.



## Achieve accurate revenue metering

Achieve high-accuracy revenue metering under real-world power quality conditions. The SEL-735 Power Quality and Revenue Meter exceeds the ANSI C12.20-2015 0.1 accuracy class and the IEC 62053-22:2003 0.1 S accuracy class over a wide current range.

The SEL-735 accurately reports energy even in the presence of harmonics and distorted waveforms. When tested with peaked waveform distortion, the SEL-735 reports with an error of just 0.006%. The table shows SEL-735 performance with peaked waveform distortion.

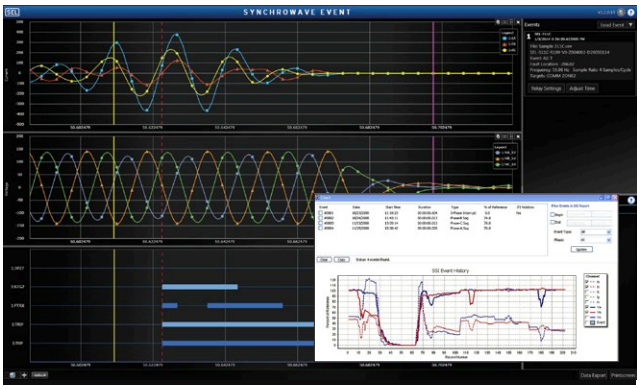


ANSI Test #41: Peaked Current Waveform

| Voltage Waveform | Current Waveform | 0.1 Class Allowable Error % | Measured SEL-735 Error % |
|---|---|---|---|
| Sinusoidal | Sinusoidal | ±0.05 | 0.003 |
| Sinusoidal | Peaked | ±0.2 | 0.006 |
| Peaked | Peaked | ±0.3 | 0.006 |

## Reduce system downtime

Access critical information directly at the control center with SCADA-ready SEL meters. Reports with voltage sag, swell, and interruption (VSSI) data and events plotted on the ITI (CBEMA) chart can help both plant operators and power producers resolve issues before they affect consumers. The ITI curve classifies voltage events to indicate disturbance severities that cause malfunctions, such as insulation failure, overvoltage trip, or load dropout. The Sequential Events Recorder (SER) in SEL devices monitors and records device events, such as power loss, settings changes, voltage disturbances, or any change in the state of digital status bits. Wave View, a real-time oscillography tool in the SEL-735 Power Quality and Revenue Meter, gives system operators a snapshot of their system for actionable intelligence.



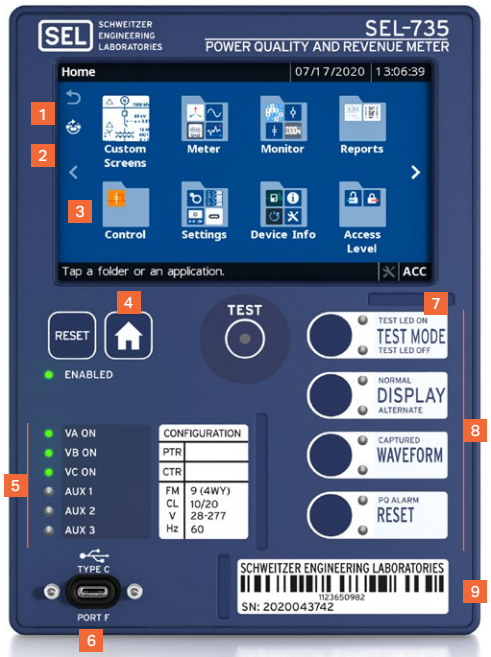
# SEL-735

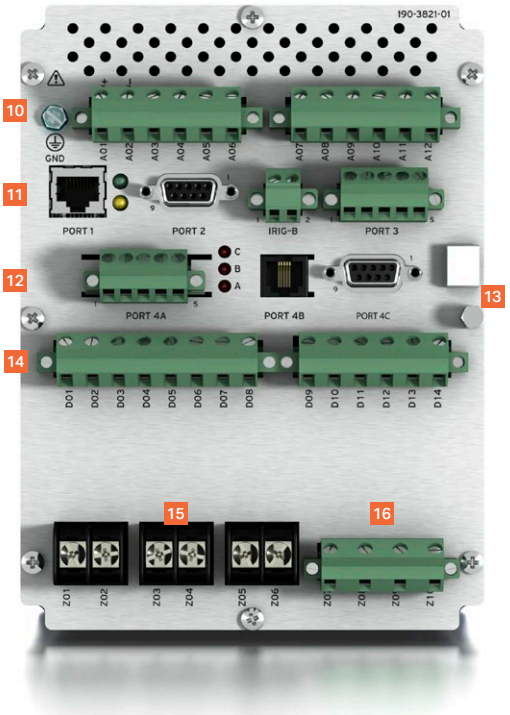
## Power Quality and Revenue Meter

Starting price
**$1,560 USD**

selinc.com/products/735 | Select models typically ship in 2 days

The SEL-735 is fully Class A-compliant to the IEC 61000-4-30 power quality (PQ) standard. With reliable Class A measurement, operators can identify power system anomalies and isolate their source with confidence. The 5-inch, 800 × 480 color touchscreen display option allows you to view metered quantities, phasor diagrams, voltage and current waveforms, and more. For high-accuracy revenue metering applications, the SEL-735 exceeds ANSI C12.20-2015 0.1 and IEC 62053-22:2003 0.1 S accuracy class requirements over a wide current range. This makes the SEL-735 the premiere choice for generation, interchange, transmission, distribution, or industrial applications. You can enhance the capabilities of SEL meters with ACSELERATOR® Meter Reports SEL-5630 Software. Meter Reports allows you to optimize your system by analyzing data, identifying usage trends, and diagnosing system problems.




1. Capacitive 5-inch, 800 × 480 color touchscreen
2. Full onscreen keyboard
3. Folders and applications to access information
4. Pushbutton to return to default home screen
5. Six programmable LEDs
6. USB Type-C port
7. Simple Test Mode access
8. Customizable local controls
9. Custom nameplate and barcode
10. Power supply board: 2 inputs, 3 outputs
11. Main board: RJ45 copper or fiber-optic Ethernet, EIA-232, IRIG-B, EIA-232/-485
12. Communications board (Expansion Slot #1): EIA-485, telephone modem, EIA-232
13. Sealing provision
14. I/O board (Expansion Slot #2): 4 inputs, 4 outputs (solid-state or electromechanical); or 4 analog outputs, 4 solid-state outputs
15. CT board: Ia, Ib, Ic
16. PT board: Va, Vb, Vc, Vn

## Accurate revenue metering

Exceed ANSI C12.20 0.1 and IEC 62053-22 0.1 S accuracy class requirements with bidirectional, full four-quadrant energy metering. Transformer and line-loss compensation adds to meter accuracy when the meter location and billing points differ. Instrument transformer compensation removes the magnitude and phase error introduced by CTs and PTs.

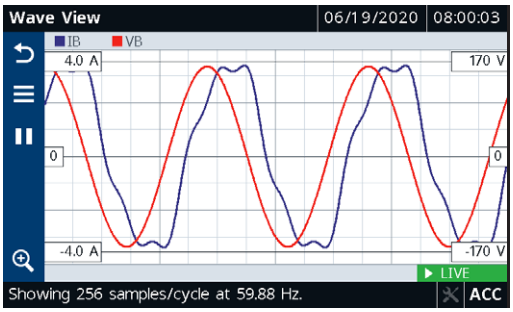
## Reliable PQ indicators

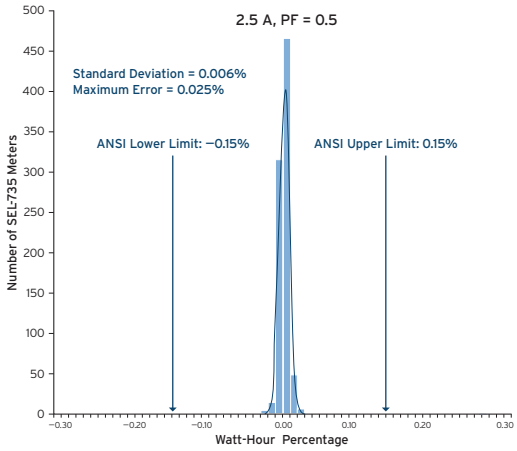
Ensure precise and reliable measurements with IEC 61000-4-30 Class A PQ compliance. You can size feeders appropriately, safeguard equipment, and plan upgrades using PQ indicators for predictive maintenance. The SEL-735 measures harmonics, interharmonics, flicker, power factor, voltage disturbances, K-factor, and other key PQ indicators.

Other popular applications include troubleshooting voltage disturbances, monitoring photovoltaic (PV) inverter interconnections, and monitoring sine wave purity for critical industrial facilities. The SEL-735 allows you to quickly identify PQ problems before equipment damage or misoperation occurs.

## Wave View

SEL-735 meters with the Advanced PQ and Recording option include the Wave View monitoring tool in the ACSELERATOR QuickSet® SEL-5030 HMI. The tool is also available via the optional touchscreen display. Wave View allows you to view voltage and current waveforms in real time using an oscilloscope-like functionality. Waveforms in Wave View can be viewed immediately without having to retrieve and import files. The HMI provides the time-domain display as well as the frequency spectrum of any waveform captured.




Accuracy-test results of approximately 1,000 SEL-735 meters report a maximum error of 0.025 percent, outperforming ANSI 0.1 and IEC 0.1 S accuracy class requirements.

## Advanced integration

The SEL-735 integrates seamlessly with Itron MV-90 billing software and IEC 61850, DNP3, IEEE C37.118, Modbus, or SEL communications protocols. Multiple communications ports and protocols enable the SEL-735 to simultaneously communicate with up to ten devices.

The SEL-735 offers three security levels to provide access to only authorized users. In addition, you can independently disable or set each port to provide read-only or read/write access.

For system-level security, adding the SEL-3620 Ethernet Security Gateway offers user account management, substation firewall protection, and NERC CIP compliance support. The SEL Real-Time Automation Controller (RTAC) provides secure, encrypted communications and works as a remote intelligence gateway. Cryptographically signed firmware ensures that the meter integrity is not compromised.

# SEL-5630

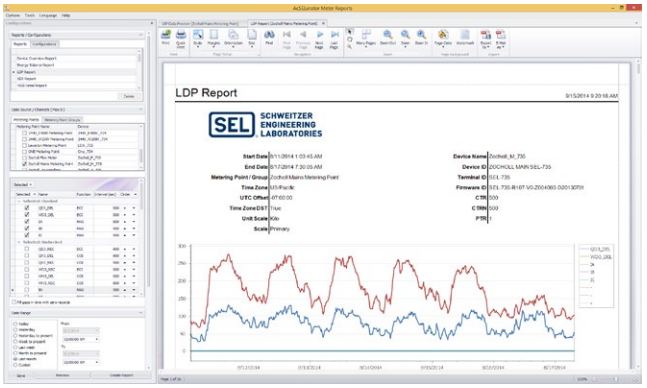
## ACSELERATOR® Meter Reports Software

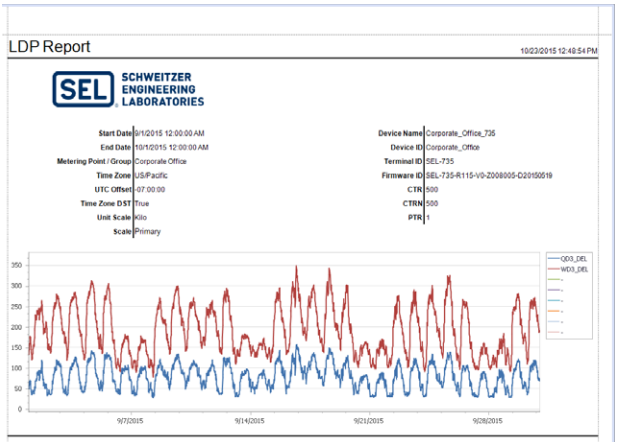
Starting price
**$2,590 USD**

selinc.com/products/5630

Requires ACSELERATOR TEAM® SEL-5045 Software for meter data collection.

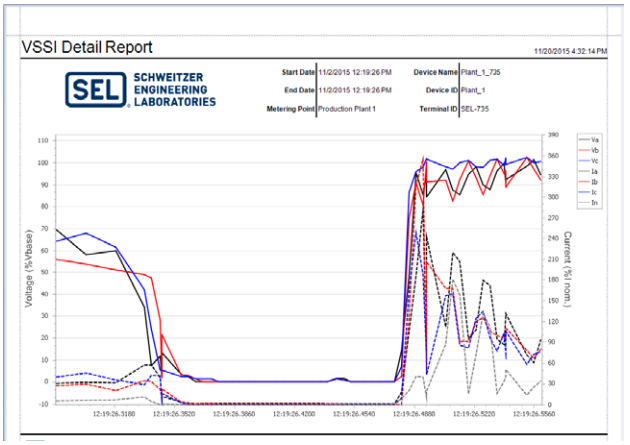
Meter Reports enhances the visualization and analysis of data captured by SEL meters in your system. You can combine SEL meters with pulse-type or DNP3-enabled devices to monitor consumption of resources, such as water, air, gas, and steam. ACSELERATOR TEAM SEL-5045 Software automatically retrieves and stores metering data on these resources in a centralized database. Meter Reports then displays the information so you can drive planning, operating, and accounting decisions that will increase efficiency and reduce costs.




### LDP Report

Avoid peak demands by analyzing the electrical usage for processes in your facility. An interactive view of the information lets you refine the load data profile (LDP) data selection for a specified time period. You can create a report or hover your mouse over data points to view channel values at that point in time. Graphical and tabular views of LDP information from a metering point, device, or group make it easy to analyze trends and inspect records.




### VSSI Detail Report

Investigate power quality events with voltage sag, swell, and interruption (VSSI) data at your fingertips. You can perform VSSI event analysis with detailed VSSI data (using variable sampling rate records) in graphical and tabular format. The 4 ms resolution makes it easy to identify points of interest and determine the time, duration, severity, and location of power quality disturbances.

# SEL-5230

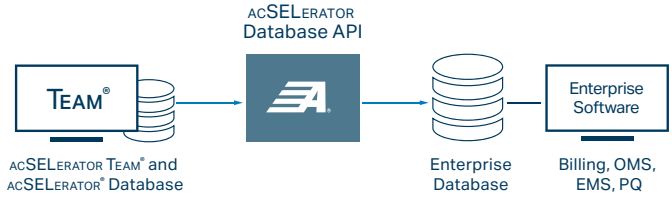
## ACSELERATOR® Database API

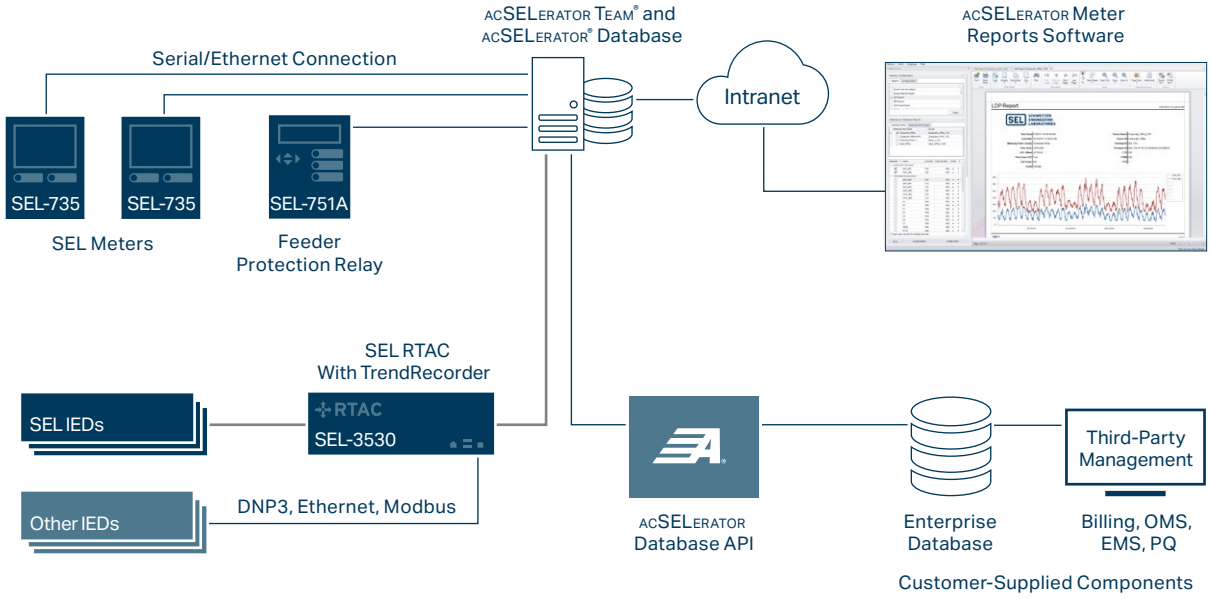
Starting price
**$5,180 USD**

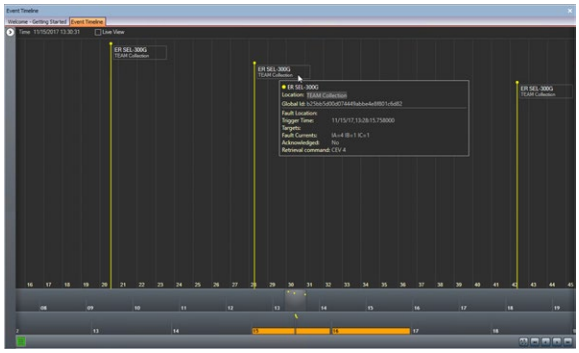
selinc.com/products/5230

Requires ACSELERATOR TEAM® SEL-5045 Software for meter data collection.

ACSELERATOR Database API SEL-5230 Software provides third-party software tools with access to data collected by ACSELERATOR TEAM SEL-5045 Software and archived in the ACSELERATOR Database. This allows different enterprise-level systems, such as an energy management system (EMS) or a billing system, to integrate data reporting. SEL offers two API configuration options, depending on the database integration and client requirements. Contact SEL Engineering Services for custom integrated solutions.



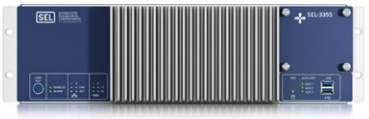



### ACSELERATOR TEAM Software

TEAM automates the collection of power system data from multiple devices and stores the data in a central location for easy access. When something happens, whether it's a relay trip, system fault, or security notification, TEAM is ready to help with continuous background monitoring, collection, notification, and storage. This ensures that the data are there when you need them to help discover root cause, maintain records for regulatory compliance, and keep your system running at peak efficiency.

# Automation Overview



## SEL-3355

The SEL-3355 is a server-class automation controller built to with-stand harsh environments in utility substations and industrial control and automation systems. It can be configured as an RTAC, as a computer, or with the SEL BlueFrame™ application platform.

## SEL-3360S/3360E

The SEL-3360S and SEL-3360E match the performance, ruggedness, and configuration flexibility of the SEL-3355 and are ideal for surface- or panel-mount applications.

## SEL-3350 NEW

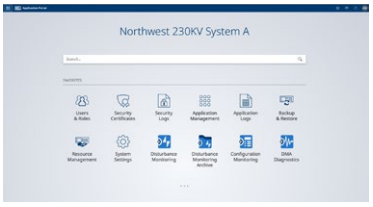
The SEL-3350 is ideal for limited-space, dedicated embedded applications that require midlevel I/O and computation. It can be configured as an RTAC, as a computer, or with the SEL BlueFrame application platform.

## SEL-3390

SEL PCIe expansion cards let you add ports and connectivity to various industrial automation platforms.

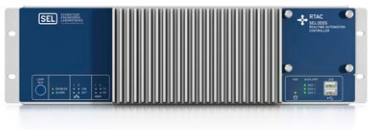
## SEL-9331

The SEL-9331 powers equipment in industrial environments where many power supplies cannot maintain operation.




## SEL BlueFrame NEW

Scalable and flexible, SEL BlueFrame provides a secure platform for installing applications and for managing and exchanging data between supported applications, like SEL Data Management and Automation applications.



### SEL-3555 RTAC

Powerful processing for large-scale automation projects.

### SEL-3560E/3560S RTACs

Powerful processing for large-scale automation projects in a compact form factor.

### SEL-3530/3530-4 RTACs

Complete and flexible system control with integrated security, seamless configuration, unified logic, and high reliability.

### SEL-3505/3505-3 RTACs

Powerful automation, reporting, and control for low-power, limited-space applications.

### SEL-2240 Axion®

A fully integrated, modular I/O and control solution for utility and industrial applications.

### SEL-2411P

Hardened, SCADA-ready pump automation controller with flexible I/O that is easy to install, set, and customize.

### SEL-2411

Flexible I/O for automatic control, SCADA, station integration, remote monitoring, and plant control systems.

### SEL-2440

Utility-grade I/O, powerful processing, flexible communications, and microsecond timing.

| Applications | SEL-3355 | SEL-3360E | SEL-3360S | SEL-3350 |
|---|---|---|---|---|
| Computing in Harsh Environments | ■ | ■ | ■ | ■ |
| Running Multiple Applications Simultaneously | ■ | ■ | ■ | ■ |
| Installing Third-Party Software | ■ | ■ | ■ | ■ |
| Embedding Into Automation and Monitoring Systems | ■ | ■ | ■ | ■ |
| HMI | ■ | ■ | ■ | ■ |
| Security Gateway to Help Satisfy NERC CIP Requirements | ■ | ■ | ■ | ■ |
| Network Monitoring and Intrusion Detection | ■ | ■ | ■ | ■ |
| Virtualization Server | ■ | ■ | ■ | ■ |
| Engineering Access Point | ■ | ■ | ■ | ■ |
| IRIG-B Time Distribution and Network Time Protocol (NTP) Conversion | ■ | ■ | ■ | ■ |
| Video Surveillance Control and Archiving/Physical Security Monitoring and Notification | ■ | ■ | ■ | ■ |
| SEL Secure Kiosk | ■ | ■ | ■ | ■ |
| Parallel Redundancy Protocol (PRP) | ■ | ■ | ■ | ■ |

| Supported Operating Systems and Software | SEL-3355 | SEL-3360E | SEL-3360S | SEL-3350 |
|---|---|---|---|---|
| SEL Real-Time Automation Controller (RTAC)* | + | + | + | + |
| SEL BlueFrame™ Operating System (With Kiosk Mode)* | + | + | + | + |
| SEL Software* | + | + | + | + |
| Microsoft Windows 10 IoT Enterprise LTSC* | + | + | + | + |
| Windows Server 2019 Standard* | + | + | + | + |
| McAfee Whitelist Antivirus* | + | + | + | + |

See Page 162 for a complete list of operating system options.

| Hardware | SEL-3355 | SEL-3360E | SEL-3360S | SEL-3350 |
|---|---|---|---|---|
| Intel Xeon E3-1505L Quad-Core 2.0 GHz 64-Bit CPU | ■ | ■ | ■ | |
| Intel Xeon E3-1515M Quad-Core 2.8 GHz 64-Bit CPU | + | | + | |
| Intel Atom x5-E3940 Quad-Core 1.6 GHz 64-Bit CPU | | | | ■ |
| 4 GB DDR4 ECC PC4-17000 (2,133 MHz) System Memory | ■ | ■ | ■ | |
| Up to 32 GB DDR4 ECC PC4-17000 System Memory | + | + | + | |
| 8 GB DDR3L ECC PC3-1600 (800 MHz) System Memory | | | | ■ |
| Triple Independent Video Displays (2 DVI-D and 1 DisplayPort) | ■ | ■ | ■ | |
| Single DisplayPort With Audio Output (3 Monitors With DisplayPort Hub) | | | | ■ |
| HD Audio Ports, Line In, Line Out, Microphone | ■ | ■ | ■ | |

| Hardware (Continued) | SEL-3355 | SEL-3360E | SEL-3360S | SEL-3350 |
|---|---|---|---|---|
| 4 Rear and 2 Front USB Ports, USB 3.1-Compliant, 2.0 A Max. Current Limit Each | ■ | ■ | ■ | |
| 4 Rear USB 2.0 Ports and 2 Front USB 3.1 Ports, 1.5 A Combined Current on Front Ports, 1.5 A Combined Current on Rear Ports | | | | ■ |
| Front 10/100/1000 Mbps Independent Copper Ethernet Ports | | | | ■ |
| Rear 10/100/1000 Mbps Independent Ethernet Ports | 2 | 2 | 2 | |
| Copper RJ45 and Fiber Small Form-Factor Pluggable (SFP) Ports (4 RJ45, 2 RJ45 and 2 SFP, or 4 SFP) | | | | ■ |
| EIA-232 Serial Ports, DB-9 Connectors, 300 to 115,000 bps | 2 | 2 | 2 | |
| EIA-232/422/485 Serial Ports, RJ-45 Connectors, 300 to 115,200 bps, IRIG-B Output | | | | 16 |
| IRIG-B Input (on COM1) | ■ | ■ | ■ | |
| IRIG-B Input and Output (PCIe Card) | + | + | | |
| IRIG-B Input and Output (BNC and Serial) | | | | ■ |
| 19" Rack-Mount Chassis | ■ | | | ■ |
| Panel Mount | + | | | + |
| Wall-Mount Chassis | | ■ | ■ | |
| Conductive Panel Mount | | + | + | |
| PCI/PCIe Expansion Slots | 5 | 2 | | |
| Additional EIA-232/422/485 Serial Ports, RJ45 Connectors, 300 to 921,000 bps, IRIG-B Inputs/Outputs, +5 Vdc Power Via PCIe Cards | 24 | 12 | | |
| Additional 10/100/1000 Mbps Ethernet Ports, Copper RJ45, or Fiber-Optic SFP LC Connectors Via PCIe Cards | 8 | 8 | | |
| Solid-State Drives (2.5" SLC, iMLC, MLC SATA II, 32 GB–7.6 TB Drives) | 4 | 2 | 2 | 2 |
| Internal 120/230 Vac, 125/250 Vdc, or 48 Vdc Power Supply | ■ | ■ | | ■ |
| Internal Low-Voltage 24–48 Vdc Power Supply | | | | ■ |
| Secondary 120/230 Vac, 125/250 Vdc, or 48 Vdc Power Supply | + | | + | |
| Hot-Swappable Power Supplies | ■ | | ■ | |
| External Power Supply | | | + | |
| Alarm Contact, Alarm LED, Watchdog Processor | ■ | ■ | ■ | ■ |
| Configurable Universal Control Input | | | | ■ |
| Programmable Auxiliary Bicolor LEDs | 3 | 3 | 3 | 4 |
| Intel Active Management Technology (AMT) v11.8 | ■ | ■ | ■ | |
| Infineon Trusted Platform Module (TPM) v2.0 (Hardware) | ■ | ■ | ■ | ■ |

■ Standard feature + Model option *Factory-orderable operating system

| Applications | SEL-3555 SEL-3560E/3560S | SEL-3530 | SEL-3530-4 | SEL-2240 | SEL-3505/3505-3 | SEL-3532/3533 | SEL-2411 | SEL-2411P | SEL-2440 |
|---|---|---|---|---|---|---|---|---|---|
| Collect, Scale Meter Data | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Collect Targets, Contact Input Status, Fault Location | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| Enable Fiber-Optic Links | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Control Through IED Outputs | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| Accept IRIG-B Time Synchronization | ■ | ■ | ■ | ■ | + | + | ■ | ■ | ■ |
| Provide IRIG-B Time Synchronization | ■ | ■ | ■ | ■ | + | + | | | |
| Transparent "Port Switch" | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Web Server HMI | + | + | + | + | | + | | | |
| **Concentrate IED Data For:** | | | | | | | | | |
| Distributed Control System (DCS) | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| SCADA Master or Remote Terminal Unit (RTU) | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| Local or Remote HMI | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| **Features** | | | | | | | | | |
| Protocol Redundancy (DNP3 and IEC 60870-5 101/104 Server) | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| Primary and Standby LAN Support | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Optoisolated Inputs/ Programmable Outputs | ■[1] | + | ■ | + | + | ■[1] | + | + | + |
| Rack-Mount or Panel-Mount Hardware | ■[2] | + | + | + | | ■ | + | + | + |
| IEC 61131 Logic Engine | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| Cybersecurity Management | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| Real-Time Operating System | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **Serial Port Protocols** | | | | | | | | | |
| SEL Mirrored Bits® Communications | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **Client** | | | | | | | | | |
| DNP3 | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| Modbus RTU | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| LG 8979 | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| CP 2179 | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| SEL Fast Messages, Interleaved With ASCII | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| SEL Synchrophasors | ƒ | ƒ | ƒ | ƒ | ƒ | ƒ | | | |
| IEC 60870-5 101 | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| SES-92 | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| ASCII Flex Parse | ■ | ■ | ■ | ■ | ■ | ■ | | | |

| Serial Port Protocols (Continued) | SEL-3555 SEL-3560E/3560S | SEL-3530 | SEL-3530-4 | SEL-2240 | SEL-3505/3505-3 | SEL-3532/3533 | SEL-2411 | SEL-2411P | SEL-2440 |
|---|---|---|---|---|---|---|---|---|---|
| **Server** | | | | | | | | | |
| DNP3 | ■ | ■ | ■ | ■ | ■ | ■ | + | ■ | + |
| Modbus RTU Binary | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| IEC 60870-5-101 | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| LG 8979 | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| SES-92 | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| **Network Protocols** | | | | | | | | | |
| Telnet | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| FTP | | | | | | | ■ | ■ | ■ |
| DNP3 LAN/WAN Client/Server | ■ | ■ | ■ | ■ | ■ | ■ | + | ■ | + |
| Modbus TCP | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| IEC 61850 MMS Client/Server | + | + | + | + | + | + | + | | + |
| IEC 61850 GOOSE | + | + | + | + | + | + | + | | + |
| IEC 60870-5-104 Client/Server | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| IEEE C37.118 Client/Server | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| Flex Parse | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| FTP/SFTP Client/Server | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| SNMP Client/CDC Type 2 Client/ Server | ■ | | | | | | | | |
| Lightweight Directory Access Protocol (LDAP) | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| EtherCAT® | ■[3] | ■ | ■ | ■ | | ■ | | | |
| EtherNet/IP | ■[3] | ■ | ■ | ■ | ■ | ■ | | | |
| Precision Time Protocol (PTP)/ Network Time Protocol (NTP) | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| Simple Network Time Protocol (SNTP) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Parallel Redundancy Protocol (PRP) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |

■ Standard feature + Model option ƒ May be created using settings

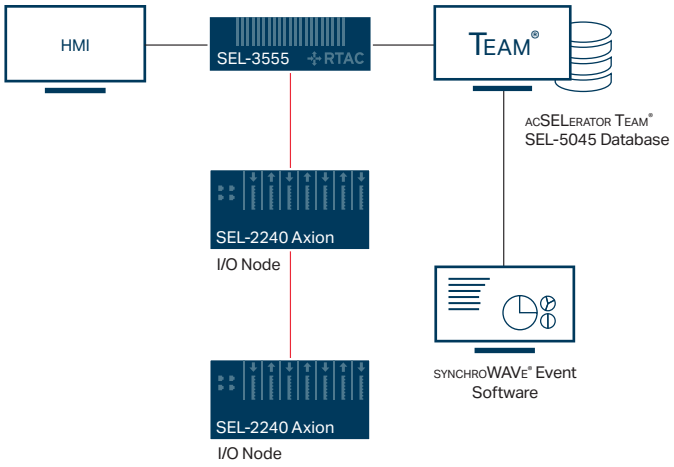
[1]Alarm contact only [2]SEL-3560E/3560S are surface-mount only

[3]Not supported on SEL-3560S

# Automation Applications

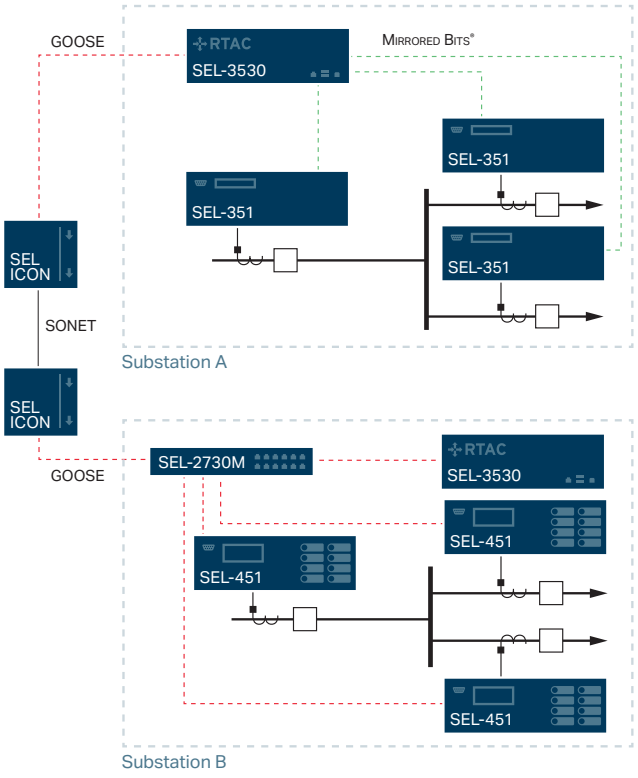
## Dynamic disturbance and fault recording systems

Meet and exceed the requirements of NERC PRC-002 using the SEL-3555 Real-Time Automation Controller (RTAC) to collect dynamic disturbance records, fault records, and event reports from relays. You can also combine the SEL-3555 with the SEL-2245-42 AC Protection Module. The module features 24 kHz recording with recording group configuration for combining multiple module event reports, including digital values, into a single COMTRADE file. The SEL-3555 with SSD storage (up to 1 TB) is the perfect controller for recording applications with its ability to maintain more than the minimum ten-day storage requirement of all fault, dynamic disturbance, and Sequence of Events records in the substation. You can configure automatic retrieval of these data by using ACSELERATOR TEAM® SEL-5045 Software, the Secure File Transfer Protocol (SFTP), or MMS file services. The data can then be analyzed using SEL-5601-2 SYNCHROWAVE® Event Software.




## Power system automation

Enable high-performance control and monitoring schemes. The SEL Real-Time Automation Controller (RTAC) provides a bridge between MIRRORED BITS® communications and IEC 61850 GOOSE networks. Protection applications include directional element-based bus protection and replacement of tone-channel equipment for communications-assisted blocking, unblocking, permissive, and transfer trip schemes.

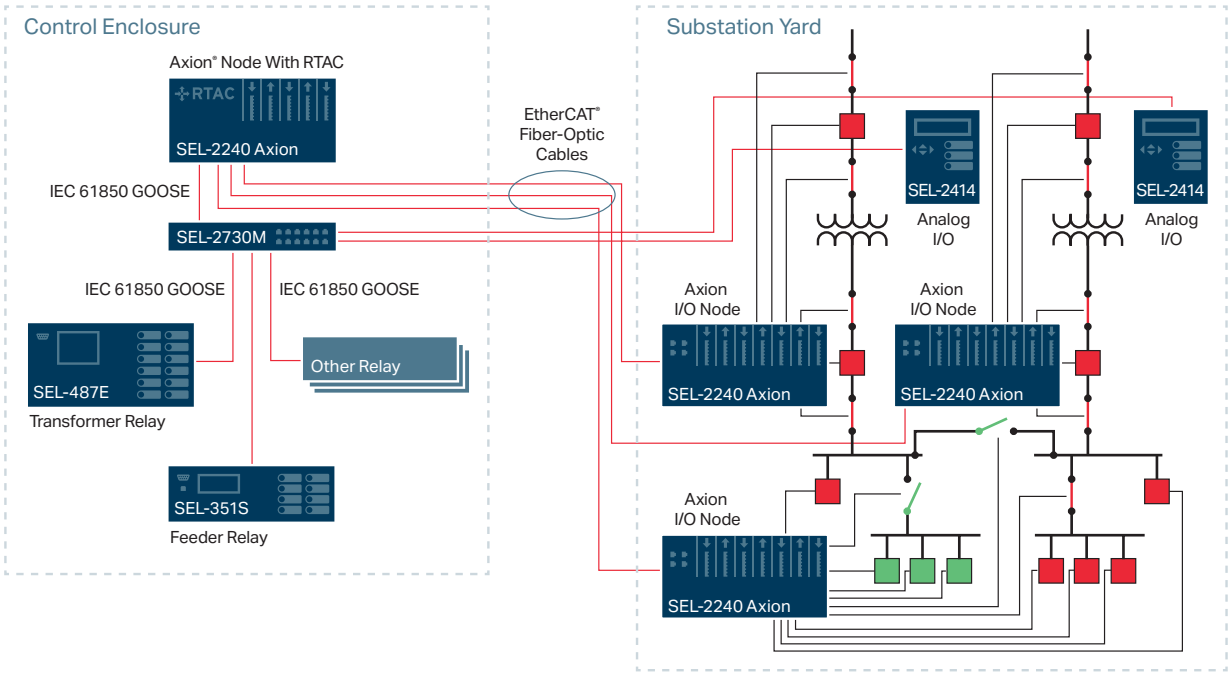


## Substation HMI

Provide cost-effective local and remote monitoring and control for substations and other processes by installing the optional web-based HMI, available for the SEL Real-Time Automation Controller (RTAC) and SEL-2240 Axion®. ACSELERATOR Diagram Builder™ SEL-5035 Software easily maps the RTAC tag database to reduce screen development time. You can use the integrated video port of the SEL-3555 RTAC for local display of the HMI without relying on a separate computer.

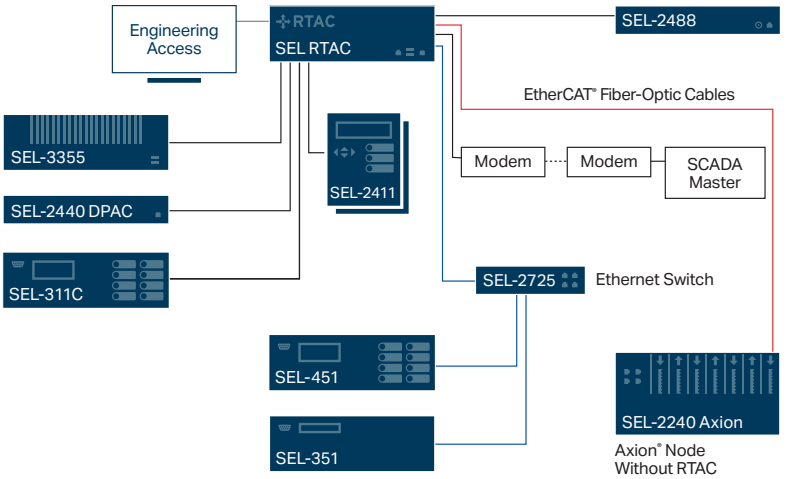
## Substation automation

Use the SEL-2240 Axion to integrate substation I/O into a comprehensive substation control scheme that includes IEC 61850 GOOSE messaging. Connecting enclosures and substation yards with EtherCAT® fiber-optic cables offers signal isolation and flexible modular placement.



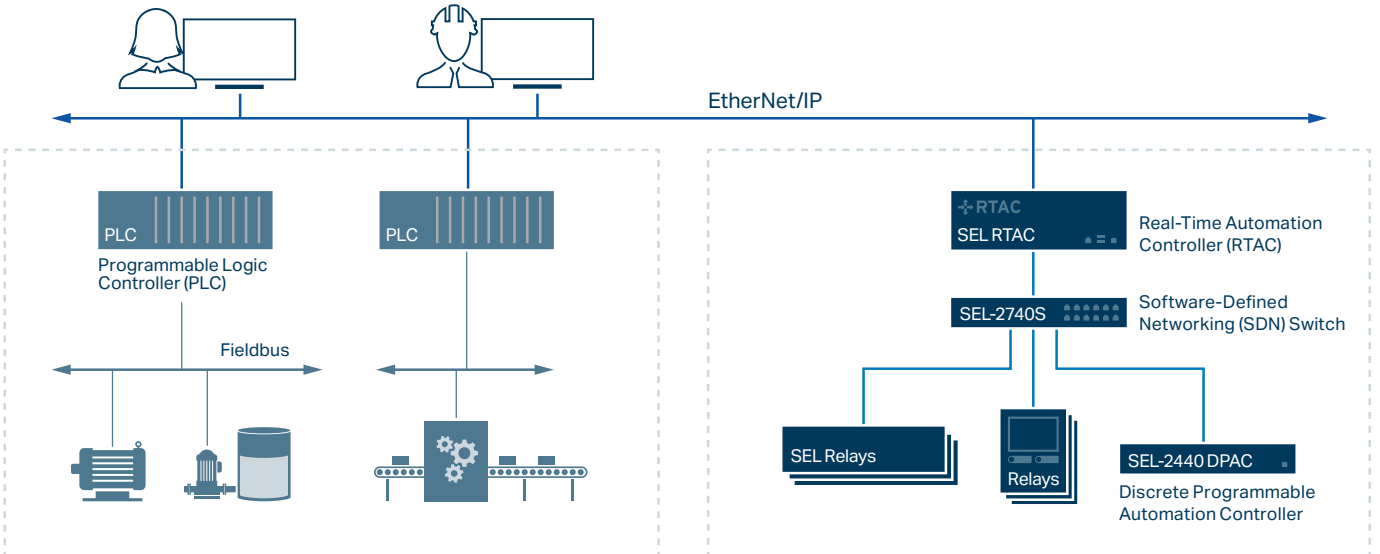
## Data concentration and SCADA

Deploy the SEL Real-Time Automation Controller (RTAC) as a data concentrator using protocols such as IEC 61850, Manufacturing Message Specification (MMS), Modbus, DNP3, IEC 61850 GOOSE, LG 8979, IEC 60870-5-101/104, or MIRRORED BITS communications, and integrate both serial and Ethernet IEDs. By enabling logging on any system or IED tag, you can view and archive station-wide event records. Multiple SCADA connections are possible via serial or Ethernet communications.




## Integrate power management with industrial control

The SEL Real-Time Automation Controller (RTAC) provides a powerful gateway between the substation and the factory using EtherNet/IP. This popular industrial protocol facilitates reliable communication between electronic devices in industrial automation systems. You can use the RTAC EtherNet/IP adapter to exchange critical data for real-time monitoring, process control, and power system integration.




Industrial Control System

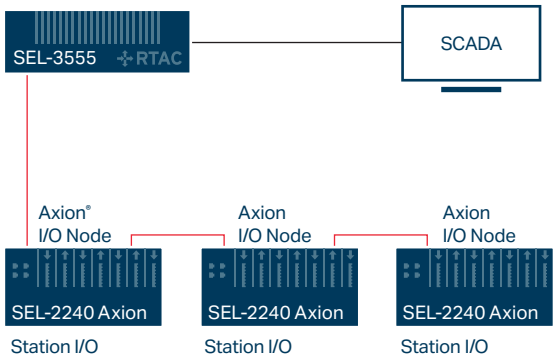
Power Management System/Substation

## High-speed fault recording with Axion I/O

Customize fault recording by choosing from 1 to 24 kHz reports ranging from 1 to 560 seconds. You can store up to 1,024 COMTRADE reports.

Use the advanced SEL logic engine in the SEL-2240 Axion to trigger events. You can cross-trigger other digital fault recorder (DFR) systems or relays using IEC 61850 GOOSE messages or MIRRORED BITS communications.

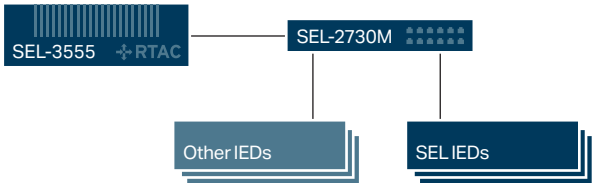
Use SYNCHROWAVE Event Viewer to perform detailed analysis, like Fast Fourier Transform and spectral analysis, to find harmonic content in the power system.




## NERC CIP-007-6 network device audit

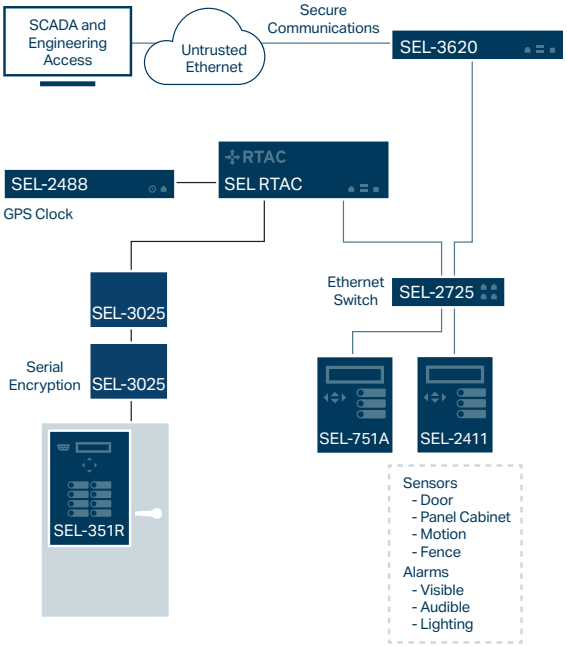
Employ x86 SEL Real-Time Automation Controller (RTAC) platform devices, such as the SEL-3555 RTAC, SEL-3560 RTAC, and SEL-3350 Automation Controller, by integrating them into a network to perform a network audit of devices. You can detect IP and MAC addresses and identify possible duplicate IPs. You can also implement open-port identification and then generate an automatic audit report to review critical assets on your network.

The RTAC offers a self-audit report functionality, which provides the firmware configuration, local user account enumeration, network interface configuration, and open TCP/UPD ports.



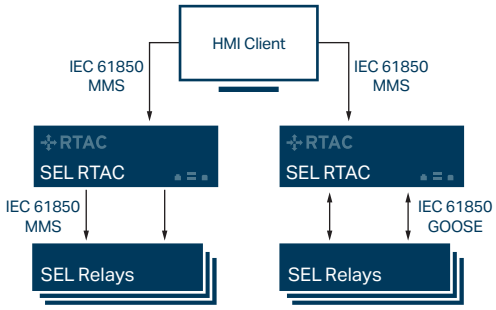

## Secure communications, user management, and engineering access

Employ the SEL Real-Time Automation Controller (RTAC), SEL-3620 Ethernet Security Gateway, and SEL accessories to secure your automation network. Per-user security profiles comply with role-based requirements. The system supports intrusion detection, notification, and logging to help maintain perimeter integrity. Secure Shell (SSH) provides encrypted engineering access through the RTAC while the Lightweight Directory Access Protocol (LDAP) provides centralized user authentication and access control.



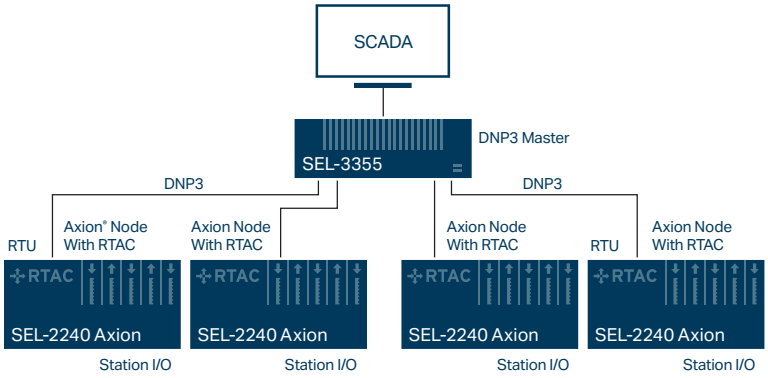
## IEC 61850 system

Implement the SEL Real-Time Automation Controller (RTAC) as a central controller in an IEC 61850 system with IEC 61850 GOOSE and Manufacturing Message Specification (MMS) protocols. With IEC 61850 Edition 1 and 2 support, the RTAC easily integrates with new and existing infrastructure. You can collect data from legacy protocols and convert them to MMS using the RTAC's MMS server.



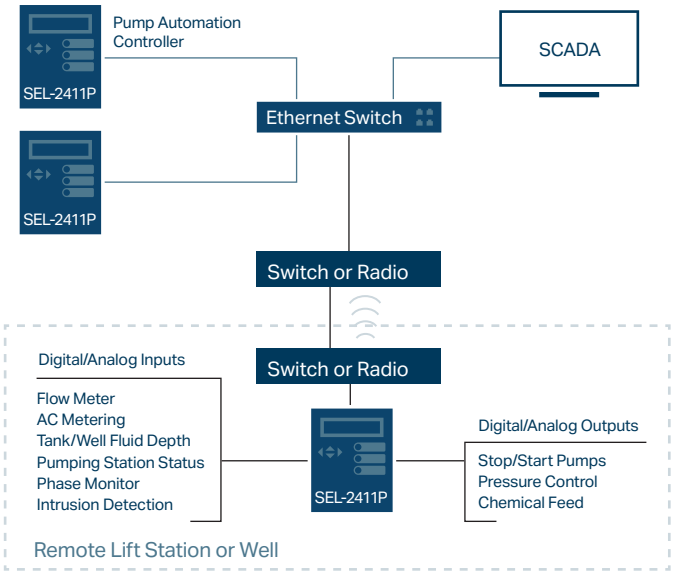

## Substation remote terminal unit (RTU)

Gather digital and analog signals from remote sites with the SEL-2240 Axion, and distribute the data over a variety of industry-standard protocols to a central SCADA system or HMI.



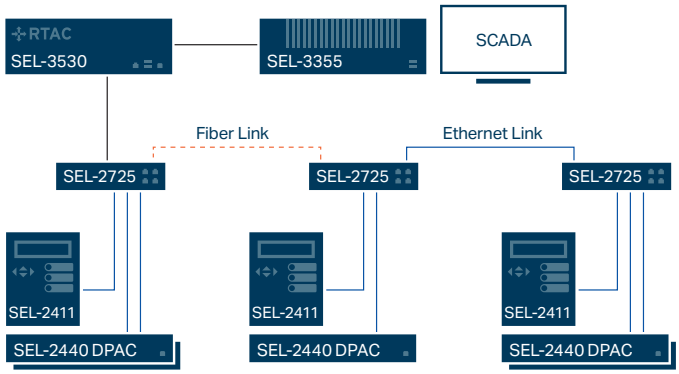

## Pump control and monitoring

Manage fluid levels, pump operations, and pump house security with the SEL-2411P Pump Automation Controller. You can coordinate control and monitoring for wells, lift stations, booster stations, or remote terminal units (RTUs) through wired and wireless communications technologies.



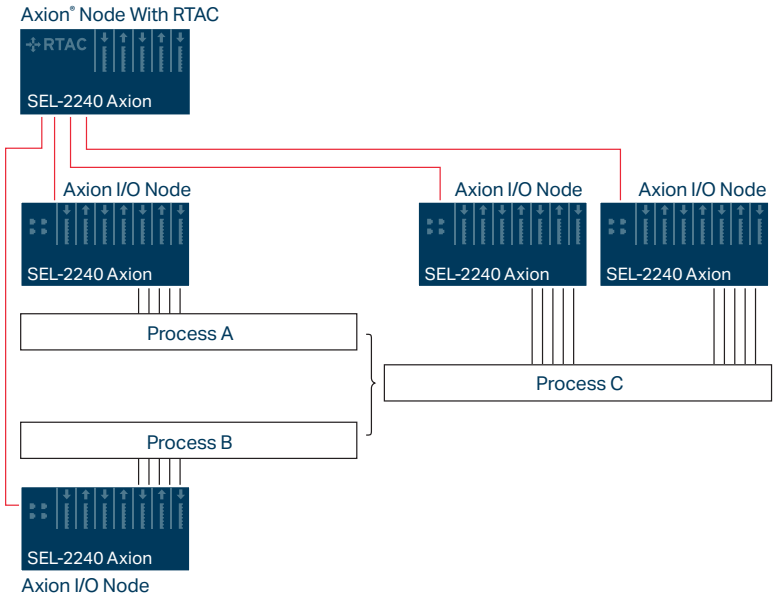
## Distributed I/O monitoring

Measure analog currents, voltages, or the status of contact points with SEL automation controllers. You can use the data locally within the device, send the information to another device within the substation, or send the information to one or more databases for operators, engineers, planners, and administrators.



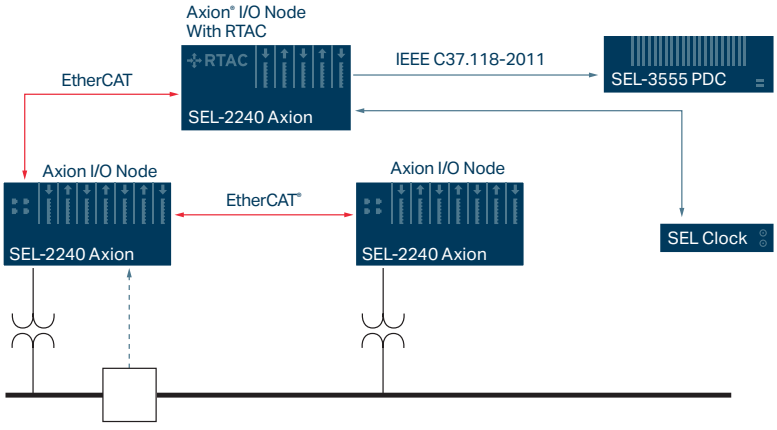

## Process and proportional integral derivative (PID) control

Implement sequential control schemes, enable continuous control algorithms, and monitor critical processes throughout an operating facility with the SEL-2240 Axion. You can also apply advanced PID control libraries to dynamic system processes.




## Flexible phasor measurement unit (PMU)

Apply the SEL-2240 Axion as a scalable and distributable synchrophasor measurement system. A single SEL Real-Time Automation Controller (RTAC) processor in the primary Axion node serves IEEE C37.118.1a-2014 synchrophasor data from remote Axion nodes. Remote Axion nodes use the SEL-2245-4 AC Metering Module located at the measurement points.

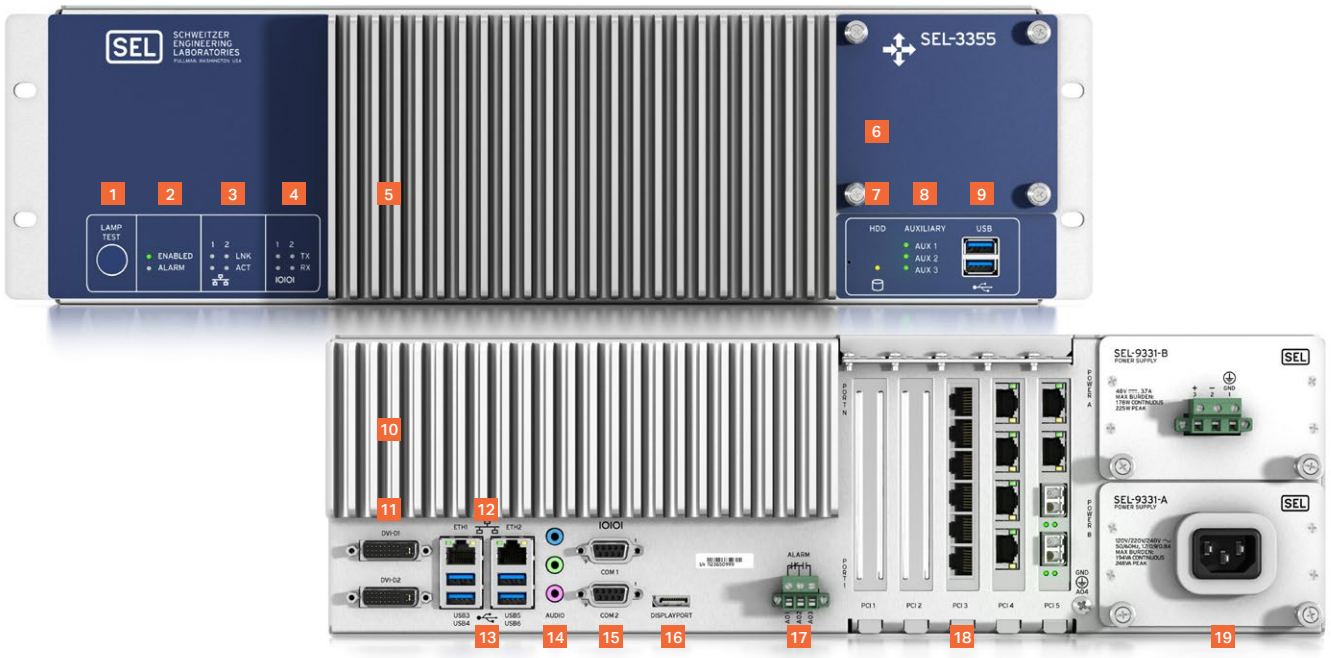


# SEL-3355
## Automation Controller

Starting price
**$3,670 USD**

selinc.com/products/3355

The SEL-3355 is built to withstand harsh environments in utility substations and industrial control and automation systems. SEL automation controllers have over ten times the mean time between failures (MTBF) of typical industrial computers because they eliminate all moving parts, including rotating hard drives and fans, and use error-correcting code (ECC) memory technology.




1. LED lamp test button
2. Alarm and operational status LED indicators
3. Ethernet port link status and network activity LEDs
4. Serial port Transmit and Receive LEDs
5. Front heat sink and no fans or moving parts
6. Up to four hot-swappable SSDs
7. Hard disk drive activity LED
8. Three programmable bicolor LEDs
9. Two front-panel USB 3.1 ports
10. Rear heat sink
11. Two DVI-D ports
12. Two high-speed Gigabit Ethernet ports
13. Four USB 3.1 ports
14. Line-in, line-out, and microphone jacks
15. Two built-in BIOS-configurable EIA-232 ports with +5 V on Pin 1
16. DisplayPort monitor connection technology
17. Form C alarm contact output
18. Up to five expansion slots: one legacy PCI, two x1 PCIe, and two x4 PCIe
19. Dual hot-swappable power supplies

## Performance and Durability

### High-performance processing power

The SEL-3355 has third-generation Intel Xeon E3 quad-core processors, enabling up to 2.8 GHz of processing power. High-speed single-level cell (SLC) SSDs in four slots, with up to 256 GB per slot, and ample system memory (4 to 32 GB of DDR4 ECC memory) provide resources for your most demanding applications. New multilevel cell (MLC) and industrial-grade MLC (iMLC) drive options extend the storage capacity.

### Protective relay standards

The SEL-3355 is suitable for harsh environments, including those with temperatures ranging from –40° to +75°C (–40° to +167°F), up to 15 kV of electrostatic discharge, fast transients, radiated emissions, overcurrents, and pulsed magnetic field disturbances. The SEL-3355 conforms to IEC 61850-3, IEEE C37.90, IEEE 1613, and IEC 60255 standards.

## Reliable, Available, and Serviceable

The SEL-3355 is a server-class automation controller with respect to RAS—reliability, availability, and serviceability. Industrial automation systems need to always be available and easy to service.

### Reliability

SEL designs, manufactures, and tests every automation controller in-house to the same standards as our protective relays. Our automation controllers have an MTBF of over 100 years, ten times higher than that of the typical industrial automation controllers. In addition, the SEL-3355 is backed by a ten-year, no-questions-asked warranty.

### Availability

Features like dual power supplies and Intel Active Management Technology (AMT) for out-of-band remote management keep your system operational.

### Serviceability

AMT allows you to view diagnostic logs for evaluation and service even when the unit is turned off. You can reboot the controller into another OS for diagnostics or to batch software and then can bring the system back online, all remotely. AMT's remote Keyboard-Video-Mouse (KVM)-over-IP feature lets you get hands-on help and guidance from an expert at the central office to speed up serviceability. The SEL-3355 also features the unique SEL system monitor (SysMon) with a watchdog timer. SysMon logs events specific to the installed system to aid in faster recovery.

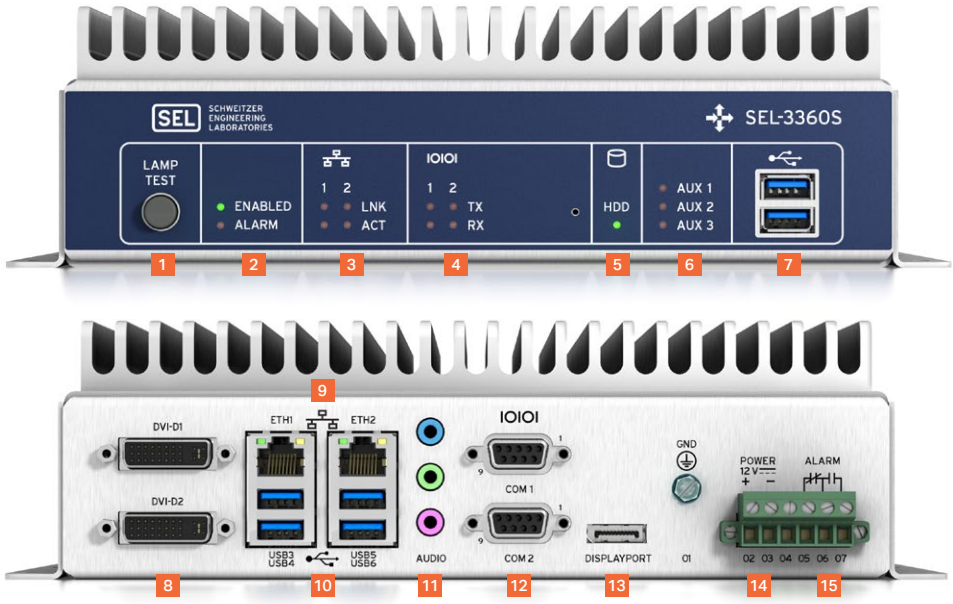
# SEL-3360

## Compact Automation Controller

Starting price
**SEL-3360S: $3,260 USD**
**SEL-3360E: $3,780 USD**

selinc.com/products/3360

The SEL-3360 (a compact version of the SEL-3355 Automation Controller with an Intel Xeon E3 quad-core processor) is built to with-stand harsh environments in utility substations, industrial control systems, and automation systems. By eliminating all moving parts (including rotating hard drives and fans) and using error-correcting code (ECC) memory technology, SEL compact automation controllers have over ten times the mean time between failures (MTBF) of typical automation controllers. Designed, manufactured, and tested to the same standards as our protective relays, every SEL-3360 comes with a ten-year, worldwide SEL warranty.




1. LED lamp test button
2. Alarm and operational status LED indicators
3. Ethernet port link status and network LEDs
4. Serial port Transmit and Receive LEDs
5. Hard disk drive activity LED
6. Three programmable bicolor LEDs
7. Two front-panel USB 3.1 ports
8. Two DVI-D ports
9. Two high-speed Gigabit Ethernet ports
10. Four USB 3.1 ports
11. Line-in, line-out, and microphone jacks
12. Two built-in EIA-232 ports
13. DisplayPort monitor connection technology
14. External power supply connection*
15. Form C alarm contact output

*Add a built-in power supply as well as PCIe expandability with the SEL-3360E (expandable model). The SEL-3360S (standard model) is shown.

# SEL-3350

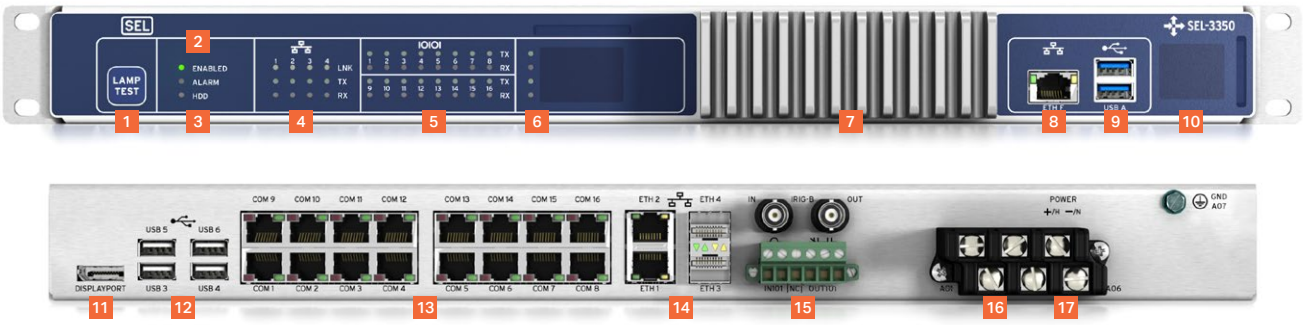
## Automation Controller NEW

Starting price
**$2,500 USD**

selinc.com/products/3350

The SEL-3350 is a versatile automation controller ideal for dedicated embedded applications. The SEL-3350 uses the Intel Atom x5-E3940 quad-core processor with 8 GB of RAM and is built to withstand harsh environments in utility substations, industrial control systems, and automation systems. By eliminating all moving parts (including rotating hard drives and fans) and using error-correcting code (ECC) memory technology, SEL automation controllers have over ten times the mean time between failures of typical industrial controllers. Designed, manufactured, and tested to the same standards as our protective relays, every SEL-3350 comes with a ten-year, worldwide warranty.

For secure automation application needs, you can configure the SEL-3350 as a Real-Time Automation Controller (RTAC) or with the SEL BlueFrame™ application platform. Alternatively, the SEL-3350 can be configured to run as a computer with Microsoft Windows or Linux operating systems.



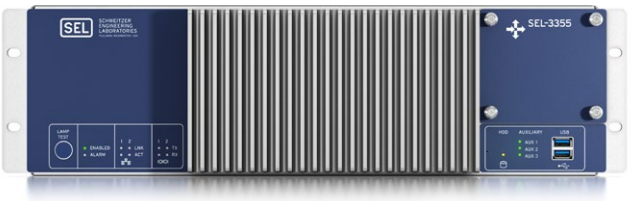

1. LED lamp test button
2. Alarm and operational status LED indicators
3. Hard disk drive activity LED
4. Ethernet port link status and network LEDs
5. Serial port Transmit and Receive LEDs
6. Four programmable bicolor LEDs
7. Front heat sink and no fans or moving parts
8. Front Gigabit Ethernet port
9. Two front-panel USB 3.1 ports
10. Two hot-swappable SSDs
11. DisplayPort monitor connection technology
12. Four USB 2.0 ports
13. 16 built-in RJ45 EIA-232 ports
14. Four high-speed Gigabit Ethernet ports with the following configuration options:
    - 4 RJ45 ports
    - 2 RJ45 and 2 small form-factor pluggable (SFP) ports
    - 4 SFP ports
15. Configurable digital/analog input
16. Form C alarm contact output
17. Built-in power supply connections

# SEL Automation Controllers

## Operating System Options

SEL-3355, SEL-3360, and SEL-3350 Automation Controllers support various operating system installation options. The controllers can be purchased as hardware without an operating system installed, providing flexibility to install your own custom operating system image.

For secure automation application needs, you can configure an SEL automation controller as a Real-Time Automation Controller (RTAC) or as an application platform with SEL BlueFrame™. SEL automation controllers also support computer configurations with factory-installed Microsoft Windows 10 IoT Enterprise Long-Term Servicing Channel (LTSC) and Windows Server operating systems. SEL network and serial port drivers are available to support the installation of other third-party Linux operating systems.



SEL-3355

SEL-3360E and SEL-3360S

SEL-3350

| Operating Systems | SEL-3355 | SEL-3360E | SEL-3360S | SEL-3350 |
|---|---|---|---|---|
| SEL RTAC* | + | + | + | + |
| SEL BlueFrame Operating System* | + | + | + | + |
| Windows 10 IoT Enterprise LTSC* | + | + | + | + |
| Windows Server 2019 Standard* | + | + | + | + |
| Windows 10 IoT LTSB | + | + | + | |
| Windows Server 2012 R2 Standard | + | + | + | |
| Windows Server 2016 Standard | + | + | + | |
| Red Hat Enterprise Linux (RHEL) 7 and 8 | + | + | + | + |
| CentOS Linux 7 and 8 | + | + | + | + |
| Ubuntu 16.04 LTS | + | + | + | + |
| Ubuntu 18.04 LTS | + | + | + | + |
| Microsoft Hyper-V | + | + | + | |
| Linux KVM | + | + | + | |
| VMware ESXi[1] | + | + | + | |
| None | + | + | + | + |

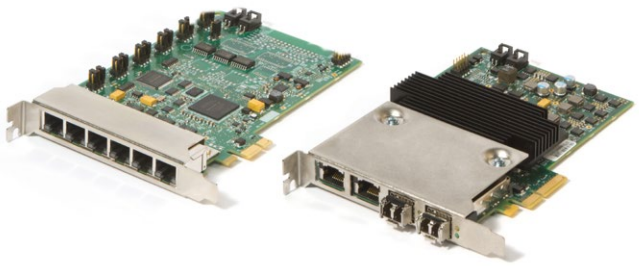
+ Model Option *Factory-orderable operating system

[1]For VMware version compatibility, please contact SEL support.

# SEL-3390
## PCIe Expansion Card

Starting price
**SEL-3390E4: $470 USD**
**SEL-3390S8: $470 USD**

selinc.com/products/3390E4 or selinc.com/products/3390S8



The SEL-3390S8 Serial Adapter Card and SEL-3390E4 Ethernet Network Adapter Card are PCI Express (PCIe) expansion cards. The cards are designed, built, and tested for use in harsh industrial and substation environments, providing a wide operating temperature range and immunity to ESD, shock, and vibration. Both cards offer optional conformal coating for corrosion immunity.

The SEL-3390S8 has six software-configurable EIA-232/422/485 ports with RJ45 connectors. All ports meet EIA-562 and are capable of 300 to 921,600 bps with automatic flow control. You can configure each port to provide +5 V to power modems or transceivers.

The SEL-3390E4 has four independent Gigabit Ethernet ports with improved speed and latency performance. You can choose all copper, all LC fiber, or two copper and two fiber ports.

# SEL-9331
## Power Supply

Starting price
**SEL-9331: $400 USD**

selinc.com/products/9331

The SEL-9331 is a high-output +12 Vdc, 200-watt fanless power supply for SEL-3355 and SEL-3360S/E Automation Controllers. It provides ample power in environments where many supplies cannot. The SEL-9331 can produce 11 A of continuous current from –40° to +85°C (–40° to +185°F) and 17 A of maximum current. High-voltage (120/240 Vac or 125/250 Vdc) and low-voltage (48 Vdc) options provide flexibility for a wide range of power sources.

# SEL BlueFrame™

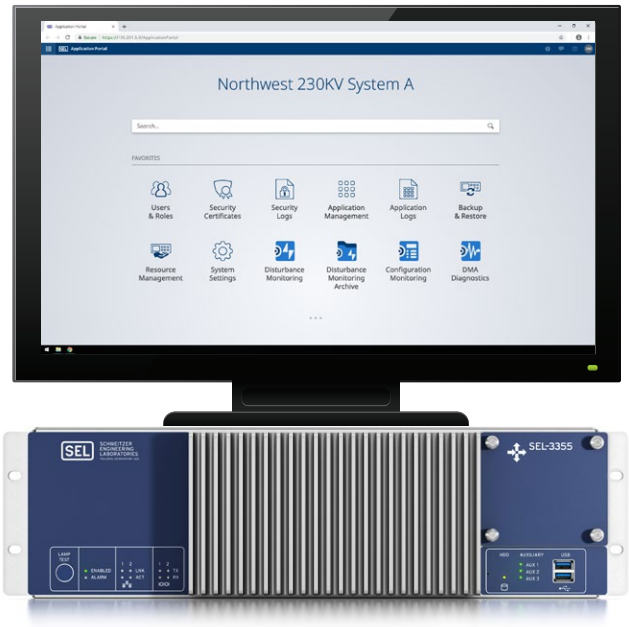
## Application Platform NEW

Contact SEL for More Information

selinc.com/products/BlueFrame

The SEL BlueFrame application platform is a secure system that provides a framework for installing applications and for managing and exchanging data between supported applications. Scalable and customizable, the platform provides a solid foundation to accommodate your system schemes today and in the future. BlueFrame enables you to define and manage parameters and settings across the platform through a simple, user-friendly interface. The platform can collect and consolidate data from many devices to run applications on a single platform. Permissions and robust user management ensure data are restricted to only the personnel that have a need to know.

The BlueFrame operating system is designed with security in mind. It is engineered to minimize the attack surface and deploy several security measures, like whitelisting, to prevent unauthorized access and attacks. You can install BlueFrame on any of the powerful and reliable SEL automation controllers (e.g., SEL-3355, SEL-3360, and SEL-3350) to ensure the availability of your system in the most demanding applications and environments.




### Versatile

BlueFrame simplifies and centralizes user access permissions, security parameters, and IED data management with a single, user-friendly, consolidated interface to perform different tasks based on the applications deployed. BlueFrame also enables you to customize the system functionality by adding more modular applications.

### Scalable

BlueFrame supports installations of any size and is an economical solution for both small and large systems. You can change the applications to accommodate your system's evolving needs. You can also readily scale from one or two targeted applications to multiple application suites.

### Flexible

Tailor your system with the applications and hardware you need. Choose from SEL automation controllers to get the hardware that best fits your requirements and budget. If your system already has an SEL automation controller (e.g., SEL-3355 or SEL-3360), you can repurpose it to deploy the SEL BlueFrame platform to run the application you need.

### Secure

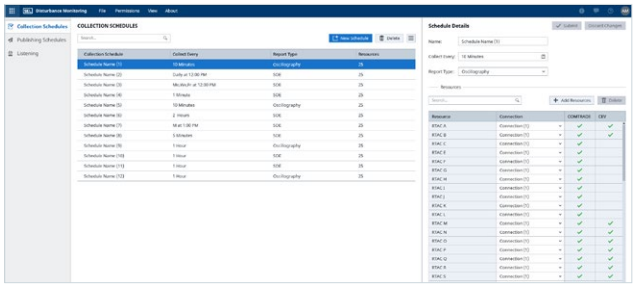
BlueFrame provides secure methods to share information between applications. These applications can only access the data they are permitted to retrieve. Efficient and restricted data exchange allows each application to specialize and provide value-added services to the overall solution. This innovative architecture allows you to customize the automation system and expand it to meet current and future needs.

# SEL BlueFrame Data Management and Automation (DMA) Application Suite

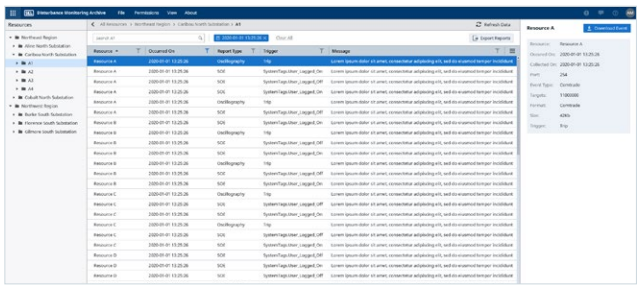
The DMA applications in this first release are designed to automatically collect, store, and manage device-specific information to simplify day-to-day management of your system of devices. DMA applications accelerate the collection of oscillography, Sequence of Events (SOE), and settings information. DMA applications also streamline device audit tasks with automated firmware version and settings checks. By providing system diagnostics and reporting across all the devices in your system, the applications help ensure your system is operating as desired.

## Disturbance Monitoring

Define data collection plans for end-point devices with the Disturbance Monitoring application. The application supports the SEL RTAC, which acts as a data aggregator for monitoring multiple SEL and third-party IEDs. Collected data are stored in a short-term repository with APIs, and the data integrates with the Disturbance Monitoring Archive.

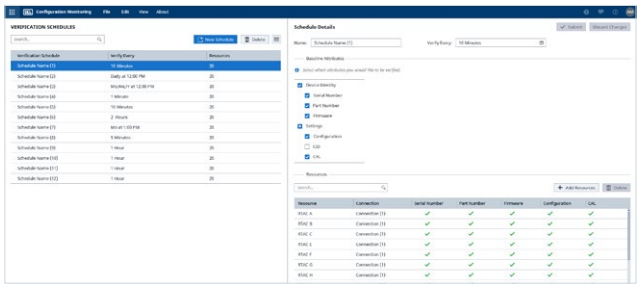


Visualize collected data to view past events with the Disturbance Monitoring Archive application. You can use the built-in filters and predefined views to select information pertinent to your task and download reports for detailed analysis in event analysis tools. The Disturbance Monitoring Archive is included with the purchase of the Disturbance Monitoring application.

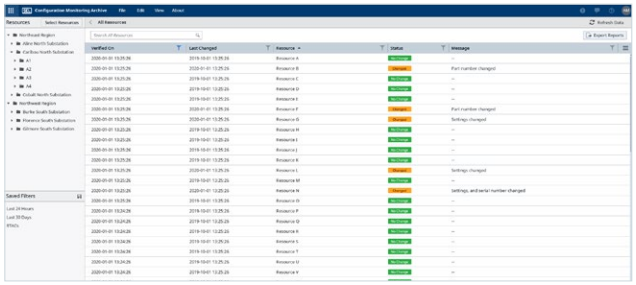


## Configuration Monitoring

Automate checks of active device settings, firmware versions, and device IDs with the Configuration Monitoring application. You can securely move collected settings to a settings management repository for comparison.



View Configuration Monitoring application collected settings versions, firmware, and device ID variances with the Configuration Monitoring Archive application. This application lets you identify devices that are out of compliance and require corrective action. The Configuration Monitoring Archive is included with the purchase of the Configuration Monitoring application.



# Real-Time Automation Controllers (RTACs)

SEL-3555/3560/3530/3530-4/3505/3505-3

Starting Price

| | |
|---|---|
| **SEL-3555: $7,560 USD** | selinc.com/products/3555 |
| **SEL-3560S: $6,680 USD** | selinc.com/products/3560 |
| **SEL-3560E: $7,610 USD** | selinc.com/products/3560 |
| **SEL-3530: $4,660 USD** | selinc.com/products/3530 |
| **SEL-3530-4: $2,950 USD** | selinc.com/products/3530 |
| **SEL-3505: $830 USD** | selinc.com/products/3505 |
| **SEL-3505-3: $1,140 USD** | selinc.com/products/3505 |

Select models typically ship in 2 days

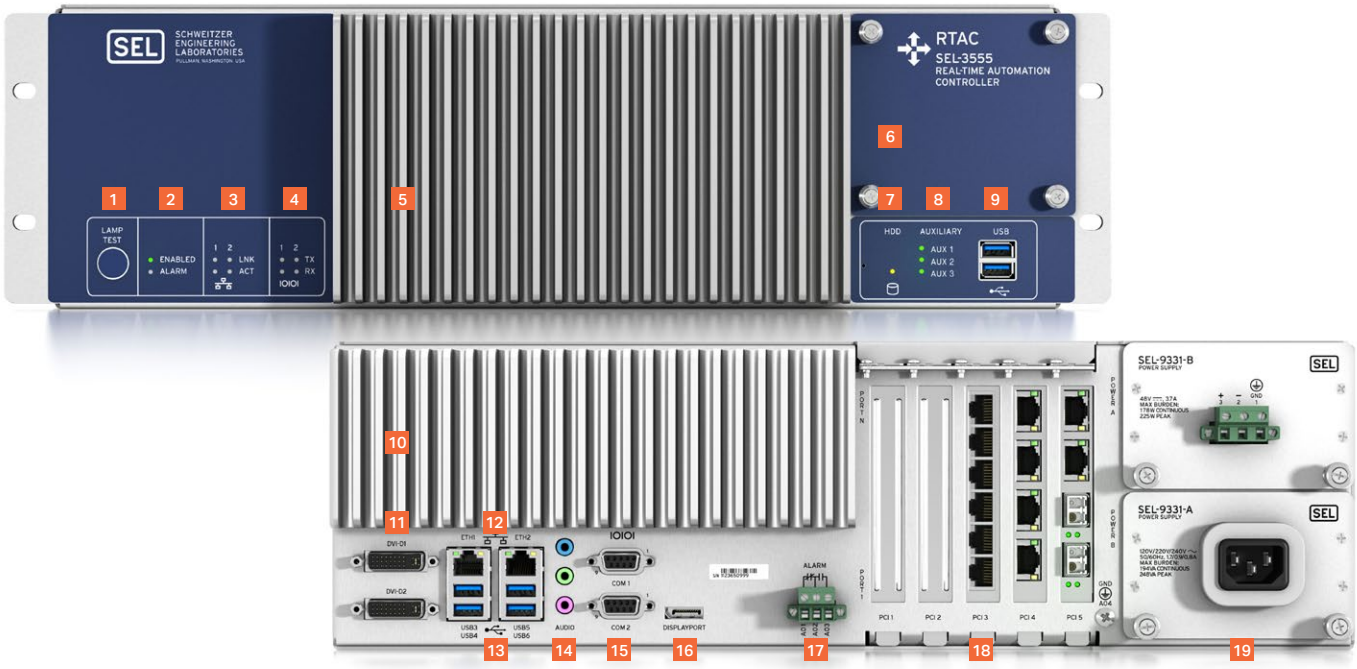
SEL RTACs offer everything from powerful data management solutions to precise, deterministic control for utility and industrial applications. Integrated cybersecurity features facilitate secure, mission-critical monitoring and control while ensuring regulatory compliance. With our ten-year, worldwide warranty and unmatched technical support, the RTAC is the right choice for high-speed, deterministic automation.

## RTAC Comparison Table

| | Powerful Computing Hardware | | Midrange Controllers | | Small Form Factor | Modular Control |
|---|---|---|---|---|---|---|
| **Features** | **SEL-3555** | **SEL-3560** | **SEL-3530** | **SEL-3530-4** | **SEL-3505/ SEL-3505-3** | **SEL-2240 Axion® With SEL-2241 Module** |
| **Processor** | 2.0 GHz Intel Xeon quad-core | 2.0 GHz Intel Xeon quad-core | 533 MHz | 533 MHz | 333 MHz | 533 MHz |
| **RAM** | Up to 16 GB | Up to 16 GB | 1 GB | 1 GB | 512 MB | 1 GB |
| **Storage** | 30 to 480 GB | 30 to 480 GB | 2 GB | 2 GB | 2 GB | 2 GB |
| **Operation Temperature** | –40° to +75°C (–40° to +167°F) | **SEL-3560S:** –40° to +75°C (–40° to +167°F) **SEL-3560E:** –40° to +60°C (–40° to +140°F) | –40° to +85°C (–40° to +185°F) | | | –40° to +85°C (–40° to +185°F) |
| **RTAC Web Interface and Video** | Viewing and control via web browser; integrated video; 1 DisplayPort; 2 DVI-D ports | Viewing and control via web browser; integrated video; 1 DisplayPort; 2 DVI-D ports | Viewing and control via web browser | | | Viewing and control via web browser |
| **Power Supply** | Redundant 120/240 Vac, 125/250 Vdc; and/or 48 Vdc | **SEL-3560S:** Optional redundant **SEL-3560E:** Single 120/240 Vac, 125/250 Vdc; and/or 48 Vdc | Single 120/240 Vac, 125/250 Vdc; 48/125 Vdc, 120 Vac; or 24/48 Vdc | | Single 12/24 Vdc or 24/48 Vdc | Redundant 120/240 Vac, 125/250 Vdc; and/or 24/48 Vdc |
| **Ethernet Ports** | 2 standard (up to 8 additional with PCIe expansion) | **SEL-3560S:** 2 standard **SEL-3560E:** 2 standard (up to 8 additional with PCIe expansion) | 3 | 2 | 2 | 2 |
| **Serial Ports** | 8 standard (up to 18 additional with PCIe expansion) | **SEL-3560S:** 2 standard **SEL-3560E:** 8 standard (up to 18 additional with PCIe expansion) | 33 (3U)/ 17 (1U) | 4 | **SEL-3505:** 4 **SEL-3505-3:** 3 | 4 |
| **USB Ports** | 6 USB 3.1 | 6 USB 3.1 | USB-B | USB-B | USB-B | USB-B |
| **Size/Mounting** | 3U rack/ panel mount | Surface or DIN-rail mount | 3U or 1U rack/ panel mount | 1U half-rack/ panel, surface, or DIN-rail mount | Surface or DIN-rail mount | 5U rack/panel or surface mount (10-slot, 4-slot, and dual 4-slot) |
| **Digital and Analog Inputs and Outputs** | 1 DO | 1 DO | 8 DO/24 DI (3U); 1 DO/1 DI (1U) | 1 DO/1 DI | **SEL-3505:** 1 DO/1 DI **SEL-3505-3:** 3 DO/8 DI | Available Modules DI, DO, Fast high-current DO, dc AI, ac AI, dc AO |
| **Other Features** | Conformal coating | Conformal coating | Conformal coating | Conformal coating | **SEL-3505:** V.92 modem **Both:** Conformal coating, ambient light sensor, and accelerometer | Conformal coating |
| **RTAC HMI** | Embedded RTAC HMI | Embedded RTAC HMI | Embedded RTAC HMI | Embedded RTAC HMI | N/A | Embedded RTAC HMI |

## SEL-3555 Overview

The full-size SEL-3555 is a powerful solution for data management, either in the substation or at a central location. You can manage and archive system data, view real-time information, and control substation equipment. The built-in video port allows you to access an HMI locally or remotely for control, annunciation, and alarm management. The SEL-3555 provides the flexibility, reliability, and power to meet your most demanding substation automation projects. It supports EtherCAT® via the optional SEL-3390E4 Network Adapter Card for communicating with SEL-2240 Axion nodes.

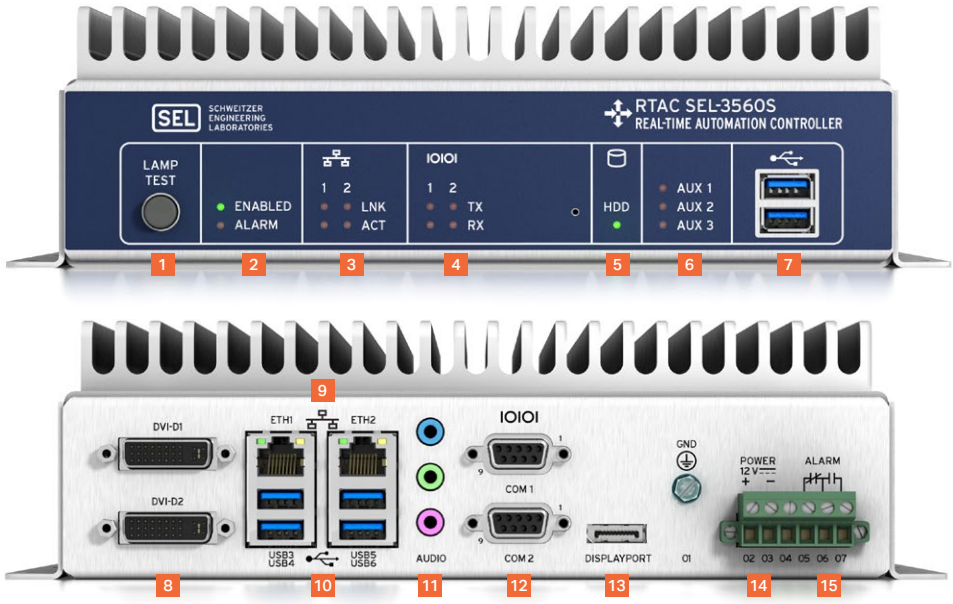



1. LED lamp test button
2. Alarm and operational status LED indicators
3. Ethernet port link status and network activity LEDs
4. Serial port Transmit and Receive LEDs
5. Front heat sink and no fans or moving parts
6. Up to four hot-swappable SSDs
7. Hard disk drive activity LED
8. Three programmable bicolor LEDs
9. Two front-panel USB 3.1 ports
10. Rear heat sink
11. Two DVI-D ports
12. Two high-speed Gigabit Ethernet ports
13. Four USB 3.1 ports
14. Line-in, line-out, and microphone jacks
15. Two built-in BIOS-configurable EIA-232 ports with +5 V on Pin 1
16. DisplayPort monitor connection technology
17. Form C alarm contact output
18. Up to five expansion slots: one legacy PCI, two x1 PCIe, and two x4 PCIe
19. Dual hot-swappable power supplies

## SEL-3560 Overview

The compact SEL-3560 RTAC is built to withstand harsh environments in utility substations, industrial control systems, and automation systems. You can manage and archive system data, view real-time information, and control substation equipment. The built-in video port lets you access an HMI locally or remotely for control, annunciation, and alarm management. The SEL-3560 provides the flexibility, reliability, and power to meet your most demanding substation automation projects.

### SEL-3560S




1 LED lamp test button

2 Alarm and operational status LED indicators

3 Ethernet port link status and network LEDs

4 Serial port Transmit and Receive LEDs

5 Hard disk drive activity LED

6 Three programmable bicolor LEDs

7 Two front-panel USB 3.1 ports

8 Two DVI-D ports

9 Two high-speed Gigabit Ethernet ports

10 Four USB 3.1 ports

11 Line-in, line-out, and microphone jacks

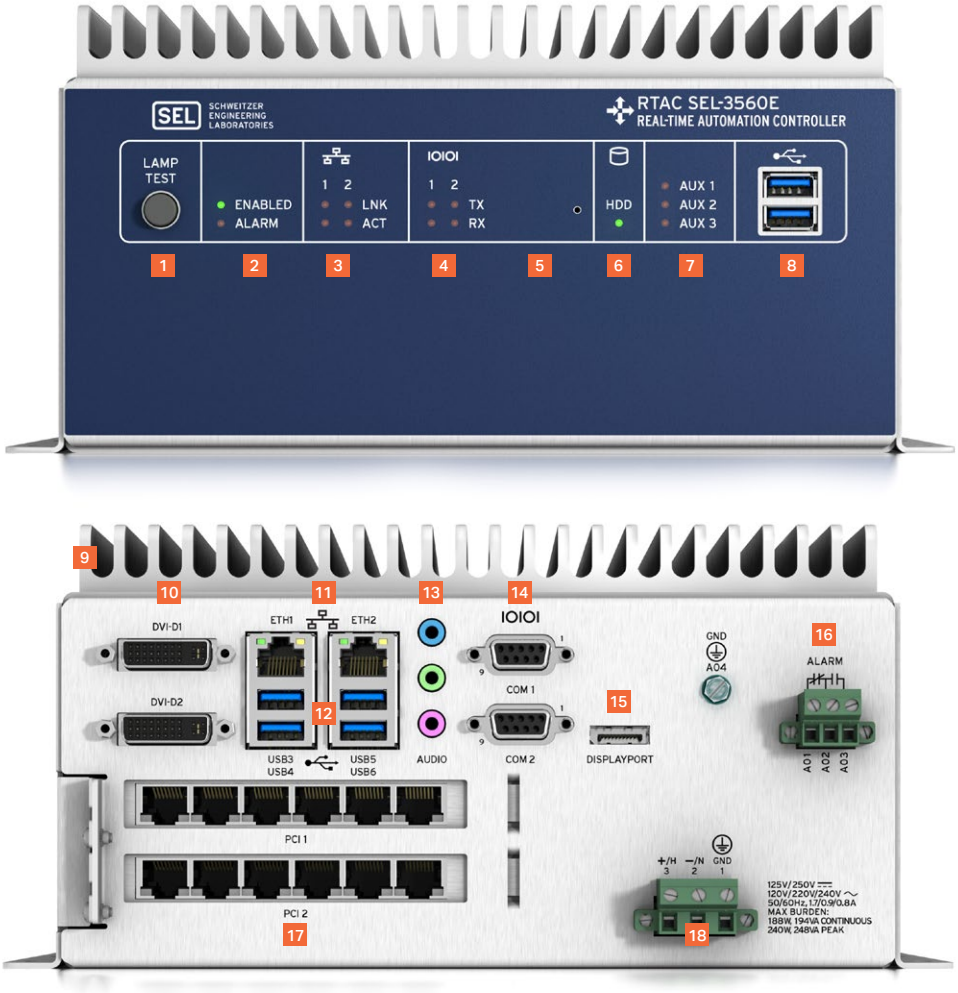
12 Two built-in EIA-232 ports

13 DisplayPort monitor connection technology

14 External power supply connection

15 Form C alarm contact output

## SEL-3560E




1 LED lamp test button

2 Alarm and operational status LED indicators

3 Ethernet port link status and network LEDs

4 Serial port Transmit and Receive LEDs

5 Up to two hot-swappable SSDs

6 Hard disk drive activity LED

7 Three programmable bicolor LEDs

8 Two front-panel USB 3.1 ports

9 Heat sink and no fans or moving parts

10 Two DVI-D ports

11 Two high-speed Gigabit Ethernet ports

12 Four USB 3.1 ports

13 Line-in, line-out, and microphone jacks

14 Two built-in EIA-232 ports

15 DisplayPort monitor connection technology

16 Form C alarm contact output

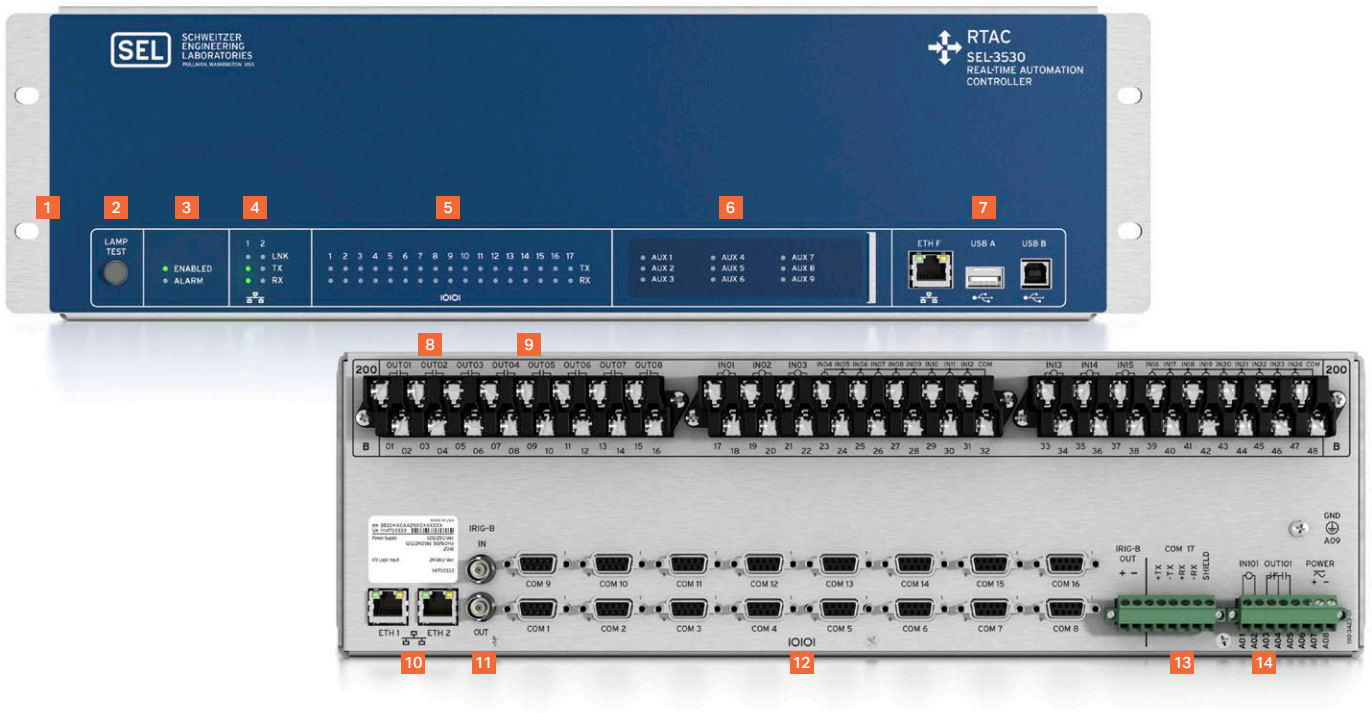
17 Two nonproprietary PCIe expansion slots

18 Built-in ac/dc power supply

## SEL-3530/3530-4 Overview

The midrange SEL-3530/3530-4 RTACs are ideal for substation data concentration, for protocol conversion, and to provide remote HMI access for visualization and control. You can use the RTAC to interface with IEDs and communicate back to your SCADA or energy management system or for secure engineering access to protective relays from your desk.

## SEL-3530




1. Rugged enclosure withstands electromagnetic interference (EMI), radio frequency interference (RFI), shock, and vibration.
2. LED lamp test button.
3. Alarm and operational status LED indicators.
4. Ethernet port link status and network LEDs.
5. Serial port Transmit and Receive LEDs.
6. Programmable bicolor LEDs with configurable labels.
7. Front Ethernet and USB ports.
8. Programmable I/O for local and remote control integration.
9. All terminals are clearly numbered and lettered for wiring and testing.
10. Independent Ethernet ports can be RJ45 or LC fiber.
11. Demodulated IRIG-B input and output for high-accuracy time synchronization.
12. Software-selectable EIA-232/485 serial ports.
13. Isolated EIA-232/485 port.
14. Programmable input and alarm contact.

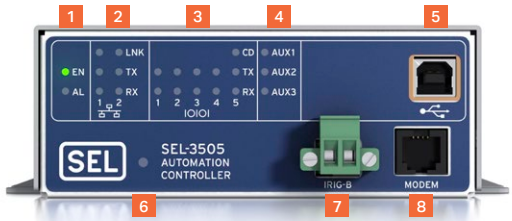
## SEL-3530-4


1. Rugged enclosure withstands EMI, RFI, shock, and vibration.
2. LED lamp test button.
3. Alarm and operational status LED indicators.
4. Ethernet port link status and network LEDs.
5. Serial port Transmit and Receive LEDs.
6. Three programmable bicolor LEDs with configurable labels.
7. USB access port.
8. Independent Ethernet ports can be RJ45 or LC fiber.
9. Demodulated IRIG-B input and output for high-accuracy time synchronization.
10. Software-selectable EIA-232/485 serial ports.
11. All terminals are clearly numbered and lettered for wiring and testing.
12. Programmable input and alarm contact.

## SEL-3505/3505-3 OVERVIEW

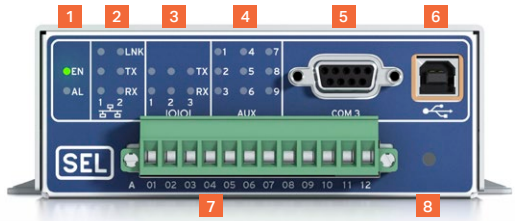
The SEL-3505/3505-3 RTACs are ideally suited for small enclosures, such as recloser controls, capacitor bank controls, or inverter cabinets that are exposed to harsh environmental conditions. You can use these compact, low-cost RTACs for protocol conversion, localized control and industrial applications, secure engineering access, or providing information to distribution automation systems. The SEL-3505 offers four serial ports, and the SEL-3505-3 offers three serial ports.

## SEL-3505




1. Alarm and operational status LED indicators
2. Ethernet port link status and network LEDs
3. Serial port Transmit and Receive LEDs
4. User-programmable, bicolored LEDs
5. USB access port
6. Integrated ambient light sensor and accelerometer
7. Demodulated IRIG-B input
8. Optional integrated 56 kbps dial-up modem

## SEL-3505-3




1. Alarm and operational status LED indicators
2. Ethernet port link status and network LEDs
3. Serial port Transmit and Receive LEDs
4. User-programmable, bicolored LEDs
5. Software-selectable EIA-232/485 serial port
6. USB access port
7. Three digital output points (not shown) and eight digital input points
8. Integrated ambient light sensor and accelerometer

# SEL-2240
## Axion®

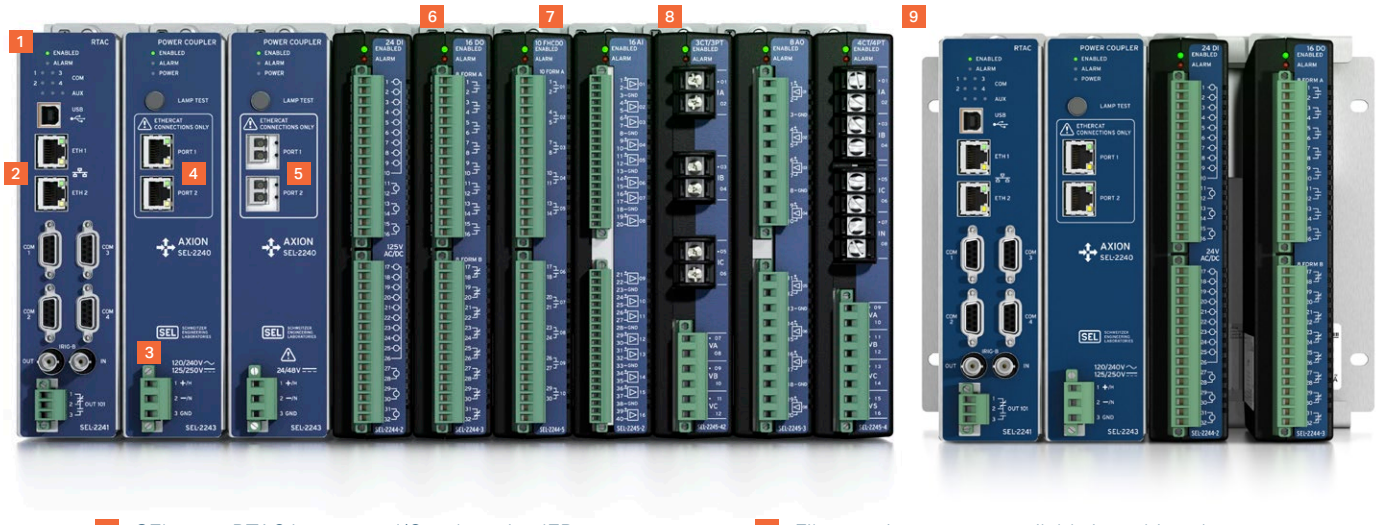
selinc.com/products/2240

Starting Price
**SEL-2241 Real-Time Automation Controller (RTAC) Module: $2,490 USD**
**SEL-2242 Chassis/Backplane (10-Slot): $170 USD**
**SEL-2243 Power Coupler: $320 USD**

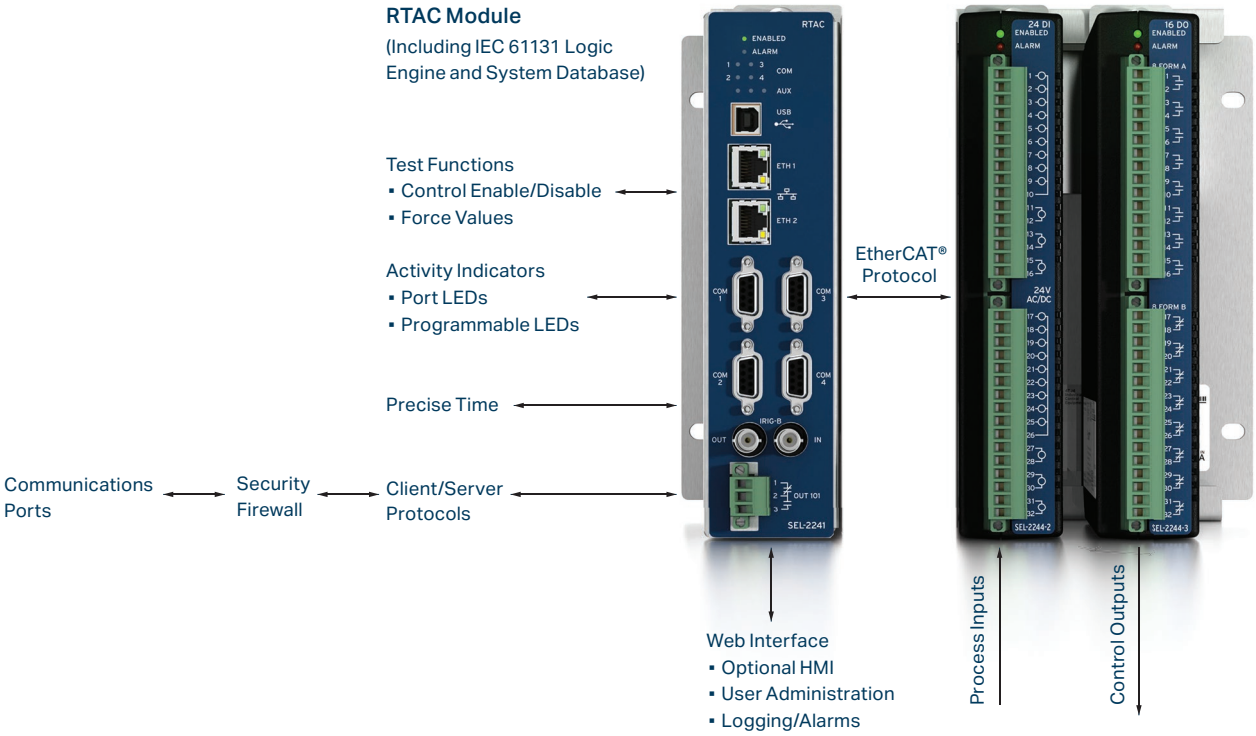
The SEL-2240 Axion is a fully integrated, modular I/O and control solution ideally suited for utility and industrial applications. It combines the communications, built-in security, and IEC 61131 logic engine of SEL Real-Time Automation Controllers (RTACs) with a durable suite of I/O modules that provide high-speed, deterministic control performance over an EtherCAT® network.

Whether your application calls for a remote terminal unit (RTU) or a rugged programmable logic controller (PLC), the Axion is a good match. All the modules are rated from –40° to +85°C (–40° to +185°F) and can include conformal coating. The system is designed to be flexible; you can select a combination of modules and nodes in almost any arrangement. The SEL-2244-3 Digital Output Module has substation-duty contacts (30 A make, 6 A carry) to provide reliable operation and flexible application.

The SEL-3530, SEL-3530-4, and SEL-3555 RTACs and the SEL-2241 RTAC Module can operate as the CPU for an Axion platform. They interface seamlessly with the I/O modules and provide easy integration with other serial and Ethernet devices via preinstalled communications protocols. The RTACs also support multiple SCADA/HMI channels. For high-speed communication, you can use EtherCAT fieldbus connections to I/O modules or optional IEC 61850 GOOSE messaging with station IEDs.




1. SEL-2241 RTAC integrates I/O, substation IEDs, SCADA communications, and security applications.
2. Two independent Ethernet ports are available in either copper or LC fiber and can operate on separate subnets.
3. SEL-2243 Power Coupler is the Axion system power supply.
4. Two EtherCAT ports for additional Axion nodes.
5. Fiber-optic ports are available in multimode or single-mode.
6. Slot identification is visible even when in use.
7. Module alignment guides for easy installation.
8. Surface- or rack-mount chassis.
9. Four-slot, dual four-slot, or ten-slot chassis available.




## Axion Module Options

| | | |
|---|---|---|
| SEL-2241 | RTAC Module | $2,490 |
| SEL-2242 | Chassis/Backplane (10-Slot) | $170 |
| SEL-2242 | Chassis/Backplane (4-Slot) | $150 |
| SEL-2242 | Chassis/Backplane (Dual 4-Slot) | $190 |
| SEL-2243 | Power Coupler | $320 |
| SEL-2244-2 | Digital Input Module | $210 |
| SEL-2244-3 | Digital Output Module | $210 |
| SEL-2244-5 | Fast High-Current Digital Output Module | $470 |

| | | |
|---|---|---|
| SEL-2245-2 | DC Analog Input Module | $1,010 |
| SEL-2245-22 | DC Analog Input Extended-Range Module | $730 |
| SEL-2245-221 | Low-Voltage (LEA) Monitoring Module | $730 |
| SEL-2245-3 | DC Analog Output Module | $1,010 |
| SEL-2245-4 | AC Metering Module | $940 |
| SEL-2245-411 | Standard-Current and Low-Voltage (LEA) Monitoring Module | $940 |
| SEL-2245-42 | AC Protection Module | $1,140 |

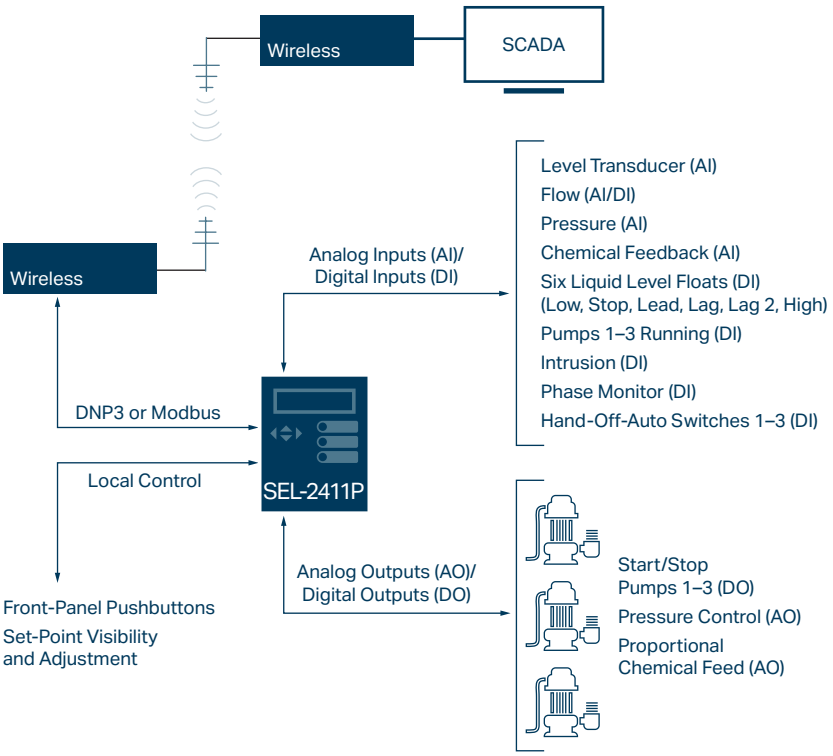
# SEL-2411P

## Pump Automation Controller

Starting price
**$2,130 USD**

selinc.com/products/2411P | Select models typically ship in 2 days

The SEL-2411P is a hardened, standalone, preconfigured, SCADA-ready system for the control and monitoring of multiple water and wastewater pumps that perform liquid level control. It is designed for pump-up and pump-down applications, such as lift stations (pump down) and wells or reservoirs (pump up). The SEL-2411P is UL-listed and withstands harsh water and wastewater environments. It comes with conformal coating to protect against corrosive gases, fumes, or liquids. Flexible I/O options, communications protocols, simple configuration, and connectivity to wired and wireless technologies let you easily integrate the SEL-2411P into new or retrofit applications.


| Feature | Description |
|---|---|
| I/O Plug-In Cards | **Pre-installed cards:** one 14 digital input (DI) card and one 4 DI/4 fast high-current hybrid digital output (DO) card<br>**Configurable I/O card options:** 14 DI card, 8 analog input (AI) card, 4 AI/4 analog output (AO) card, or 3 ac voltage input (AVI) phase monitor card |
| Station Settings | Complete operational configuration from the front panel with four to six settings for most pump applications |
| Protocols | Modbus RTU and TCP, DNP3, DNP3 LAN/WAN, Mirrored Bits®, SEL ASCII, and binary communications |
| Communications | Two 10/100 Ethernet ports and two EIA-232 ports (front and back) |
| Certifications | UL; CSA; Class 1, Div. 2 |

# SEL-2411

## Programmable Automation Controller

Starting price
**$990 USD**

selinc.com/products/2411

The SEL-2411 automates continuous and discrete processes using powerful logic, math, timer, counter, and edge-trigger functions. Designed to withstand harsh physical and electrical environments, the SEL-2411 is built and tested to meet mission-critical IEEE and IEC protective relay standards. With flexible communications and I/O options, the SEL-2411 can easily integrate with SCADA and meets your sequential events reporting, station integration, remote monitoring, ac metering, and plant control system needs. A large touchscreen display option provides an advanced local user interface that is simple to use.


# SEL-2440

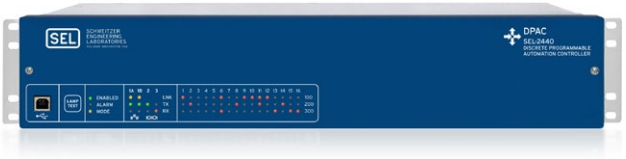
## Discrete Programmable Automation Controller (DPAC)

Starting price
**$1,000 USD**

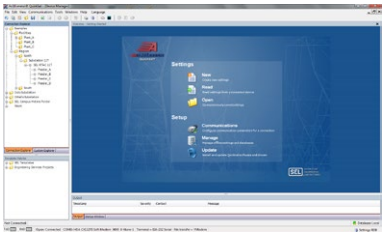
selinc.com/products/2440

Select models typically ship in 2 days

The SEL-2440 is a 48-point automation controller ideally suited for utility and industrial applications that require rugged and reliable I/O. The SEL-2440 is a fast and powerful communications device that is easy to maintain and support, and it meets stringent protective relay standards. Mounting options include rack, panel, surface, and DIN-rail mounts. An optional I/O board provides ten fast high-current digital outputs with a pick-up time of less than 85 µs, depending on the voltage level.

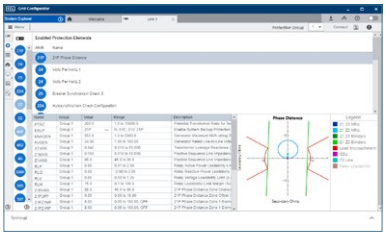


# Software Overview



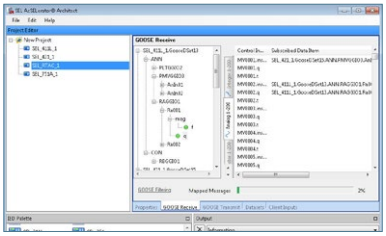
## acSELerator QuickSet®

QuickSet is a tool to quickly and easily configure, commission, and manage devices for power system protection, control, metering, and monitoring.



## SEL Grid Configurator NEW

Grid Configurator is the next evolution in SEL device configuration software, allowing you to quickly and confidently create, manage, and deploy settings.



## acSELerator Architect®

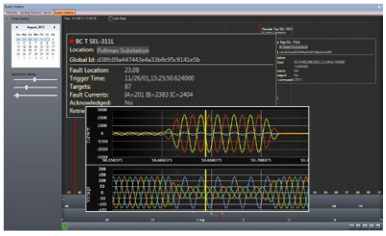
Architect streamlines the configuration and documentation of IEC 61850 messages, controls, and reports.


## SEL RTAC HMI

The SEL Real-Time Automation Controller (RTAC) HMI offers an easy way to visualize data to monitor and control your system.

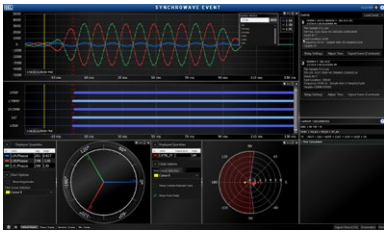

## acSELerator Diagram Builder™

Diagram Builder enables the creation and management of HMI visualization projects for the SEL RTACs in your system.



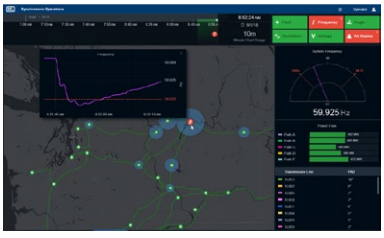
## acSELerator TEAM®

TEAM automates the collection of power system data from multiple devices and stores the data in a central location for easy access.



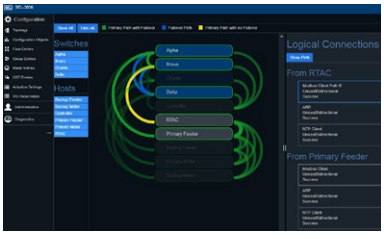
## SYNCHROWAVE® Event

SYNCHROWAVE Event allows you to display and analyze SEL relay event reports and COMTRADE files.




## Synchrowave Operations NEW

Synchrowave Operations improves operator situational awareness with wide-area visualization and analytics solutions for real-time power system operations.




## Software-Defined Network Flow Controller

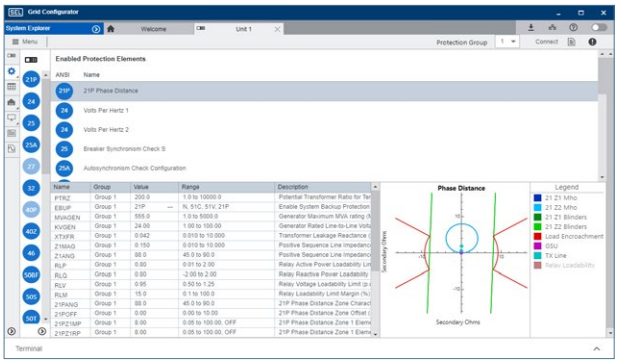
The SEL-5056 Flow Controller is the central interface for the commissioning, configuration, and monitoring of all SEL SDN-enabled Ethernet switches.

# SEL-5037
## Grid Configurator NEW

**Included With Supported Products**

selinc.com/products/5037

Grid Configurator is a freely distributed software tool for engineers and technicians to quickly create, manage, and deploy settings for SEL power system devices. It features a modern interface designed for ease of use, with powerful protection visualization and comprehensive reporting to reduce device deployment complexity.



### Easy device configuration

A user-configurable device hierarchy allows you to quickly identify power system devices, such as relays, meters, and distribution controllers. The spreadsheet-style editor makes finding and editing one or many settings simple. Powerful compare and merge features allow you to manage settings across multiple devices within a single screen.

### Powerful protection visualization

The Device Overview feature provides an immediate high-level summary of how you are using your devices' capabilities. You can also see a graphical configuration for many relay protection functions.

### Comprehensive reporting

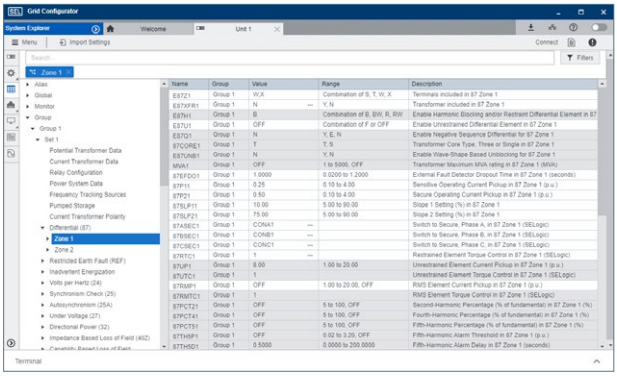
With Grid Configurator, viewing and downloading reports for an entire substation at once is simple. You can filter by date, report type, or device type and download the reports to your laptop with a click.

### Quick settings deployment

Grid Configurator makes it simple to send settings to multiple networked devices at once—no more moving cables from device to device. It provides a report at the end of the process to let you know if there were any concerns during download.

### Simple migration

Avoid data re-entry, decrease settings errors during setup, and save time by importing settings results from external calculation tools into Grid Configurator.



Work efficiently and accurately using the spreadsheet-style editor to configure a single device or a large group of devices.

For the list of supported products, visit selinc.com/5037products.

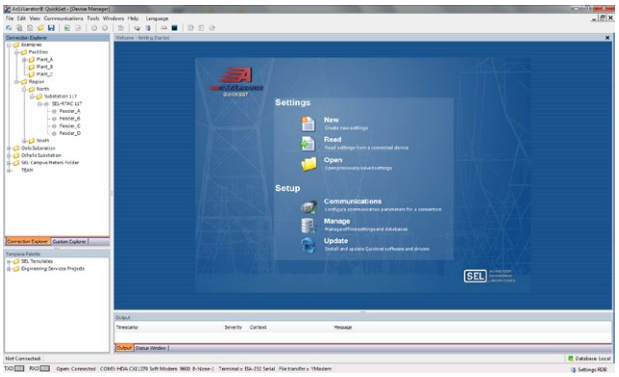
# SEL-5030

## ACSELERATOR QuickSet® Software

**Included With Supported Products**

selinc.com/products/5030

QuickSet is a tool to quickly and easily configure, commission, and manage devices for power system protection, control, metering, and monitoring.

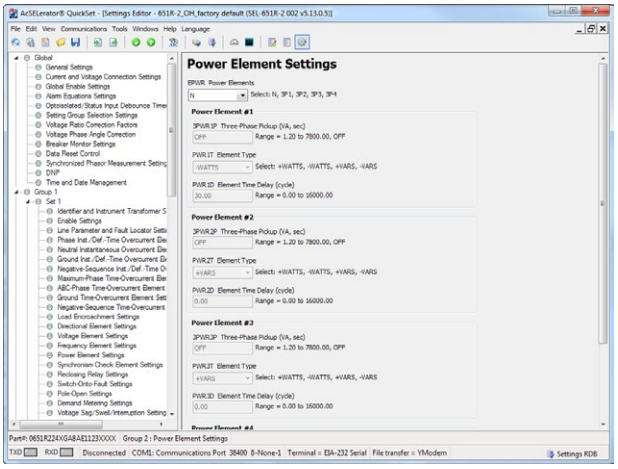



### Streamlined settings creation and validation

View the logical settings groups presented by QuickSet to quickly identify related device settings. QuickSet automatically verifies these settings to ensure they are in range and permitted.

### Reduced logic design time

Generate custom logic with the Graphical Logic Editor (GLE). To simplify logic configuration in supported relays, QuickSet offers drag-and-drop tools for creating diagrams and SELOGIC® control equations specific to your application.




### Device performance monitoring

Use the device HMI within QuickSet to manage and monitor system values. This is ideal for ensuring proper device performance during commissioning.

### Centralized device management

Organize the numerous devices and their related data in a central location with the Device Manager plugin, enabling improved collaboration.

### Standardized new device deployment

Reduce human error when deploying new devices by using the Template Palette. Predefined templates that match your company's standards make it easy to configure new devices.

### Improved configuration collaboration

The Device Manager reduces the time spent with device configuration management and oversight by reconciling collaborator versions using the built-in compare tool.

### File version management

Control versions of settings in a centralized database. The Device Manager lets you create setting baselines, generate comparison reports between setting versions, and meet regulatory requirements.

## QuickSet Ordering Options

### Design templates

Create settings templates for uniform device design.

### Device management for workgroups

Collaborative access to Device Manager data.

For the list of supported products, visit selinc.com/5030products.

# SEL-5036

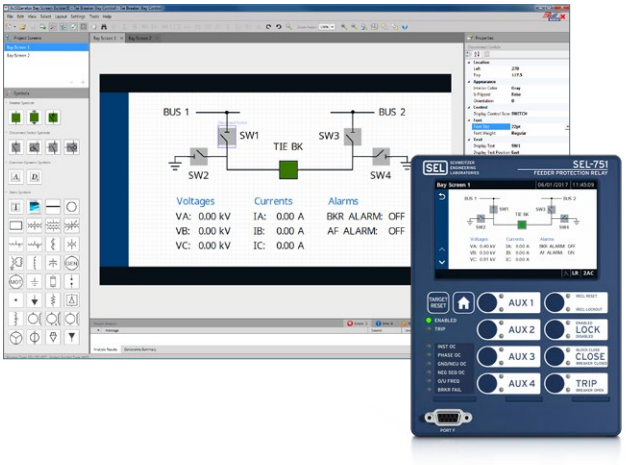
## ACSELERATOR® Bay Screen Builder Software

**Included With ACSELERATOR QuickSet® SEL-5030 Settings Driver for Supported Products**

selinc.com/products/5030

Bay Screen Builder is a Microsoft Windows application that lets you create custom bay screens for SEL devices with touchscreen displays. It works with QuickSet, enabling you to take control of bay screen design and management.

Try a free copy of Bay Screen Builder by downloading it using SEL Compass®, available at **selinc.com/products/compass**.




### Standalone, device-integrated, customized control and monitoring

Leverage the rich, easy-to-use repository of ANSI and IEC symbols in the Bay Screen Builder for a variety of bay screen designs. The software natively supports English, French, German, Italian, Portuguese, Russian, and Spanish. You can deploy bay screens anywhere using fixed images containing other languages.

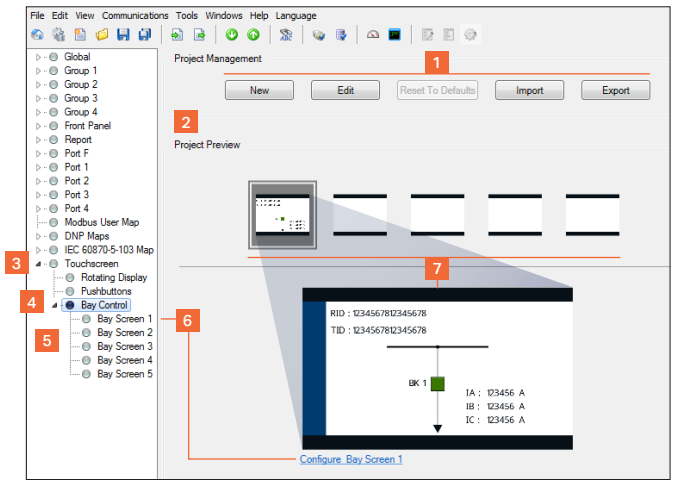
### Efficient bay screen design standardization

Collaborate on and share Bay Screen Builder projects for standardization, and readily update standards by customizing existing designs.

### SEL system integration via simple interface

Launch Bay Screen Builder from within QuickSet for user-friendly access to all items necessary for the bay screen design.

All bay screen editing and management tasks initiate with one button in QuickSet. The bay screens download to the target SEL devices when you send settings.




1. Save time and improve efficiency by sharing Bay Screen Builder projects containing relevant bay screens. Customize the bay screens further for your application by editing the existing ones or creating new ones.
2. Preview bay screens in the device QuickSet Settings Editor.
3. Expand to access touchscreen display and bay control items.
4. Expand to access up-to-date bay screens in the device QuickSet Settings Editor.
5. Click to access Project Management and Project Preview panes.
6. Click to access QuickSet settings for symbols located on the selected bay screen.
7. Choose a device bay screen to preview from the overview.

# SEL RTAC HMI

## Web-Based HMI Package for RTACs

Starting price
**$1,750 USD**

The SEL Real-Time Automation Controller (RTAC) supports an optional web-based HMI system that is well-suited for use in substations and for small processes. The SEL RTAC HMI offers an easy way to visualize data to monitor and control your system without special software.

Order the RTAC HMI as an option with new RTACs, or enable it via a field upgrade.


### Situational awareness and control

Efficiently monitor and control substation performance and critical industrial processes. The RTAC HMI helps you detect changing system conditions, misoperations, and early warning signs so you can make informed real-time decisions as well as plan maintenance for improved system reliability.

### Browser-based secure local and remote access

Access the RTAC HMI locally or remotely via a web browser interface hosted on the web server on the RTAC unit. The HMI provides secure, role-based, authenticated access for multiple users from multiple locations. The HMI runtime system is rendered using the HTML5 standard; no plugins are required on compatible browsers.

### Integrated video provides visualization with SEL-3555 and SEL-3560

Resolve your need for automation processing and HMI visualization by using the integrated video and USB ports in the high-performance SEL-3555 and SEL-3560 RTACs for local display of the HMI.

### Alarm notification

Alert the operators when there is a problem by using the integrated Sequence of Events (SOE) viewer and customizable alarm annunciation.

### Instant feedback and advanced warning

Design trends dynamically in the HMI runtime system to display any value over time, enabling operators to be proactive and make more-informed control decisions.

### SEL system integration

Monitor, control, and analyze your system more efficiently with on-demand, secure, web-based access from anywhere, anytime.

# SEL-5035

## ACSELERATOR Diagram Builder™ Software

**Included With RTAC HMI Purchase**

selinc.com/products/5035

Diagram Builder is a Microsoft Windows application that allows you to create and manage HMI visualization projects in the SEL RTAC HMI for all of the SEL Real-Time Automation Controllers (RTACs) in your system.

Try a free copy of Diagram Builder by downloading it from the product webpage or by using SEL Compass®, available at selinc.com/products/compass.

### Process overview

Efficiently design process overview screens to rapidly gather information regarding the health of your processes. Diagram Builder includes predesigned graphical objects and freehand tools for easy screen development.

### Substation control

Provide consistent power system control screens using the dynamic power system objects loaded in Diagram Builder.

### Alarm management

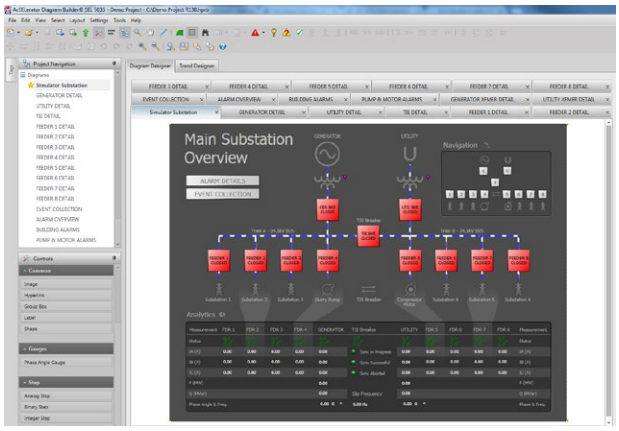
Quickly design professional-quality, customized alarm screens with alarm management objects to provide the right alarm information at the right time.

### Operation improvement and troubleshooting

Use the trend designer to predefine trend displays so system engineers can more easily understand process behaviors and perform detailed root-cause analysis. Additionally, you can dynamically design trends in the HMI runtime system to display any value over time. These trends can help you avoid future system faults and failures.

### Simplified tag mapping and management

Import tags from an existing RTAC project using a simple user interface to save time and effort. You can quickly find the tag you need using an intuitive tag list in Diagram Builder.

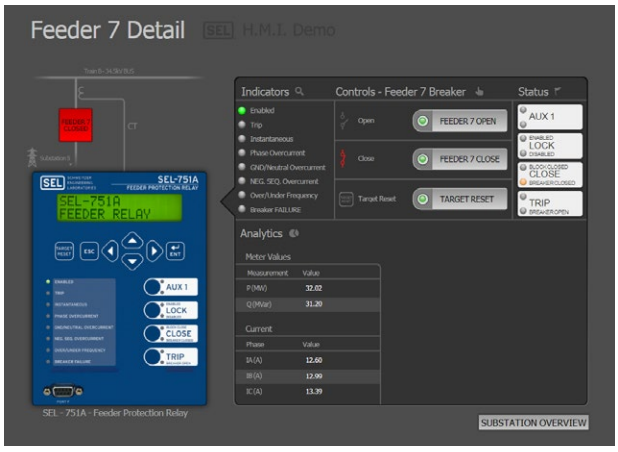



### SEL system integration

Send a Diagram Builder project to an RTAC and access the HMI from anywhere with a network connection to the RTAC through a convenient web interface. The HMI runtime system is rendered using the HTML5 standard.

### System diagram customization

Design every aspect of a diagram, such as the background, colors, and fonts. Layout tools help you keep it all organized.



# SEL-5045

## ACSELERATOR TEAM® Software

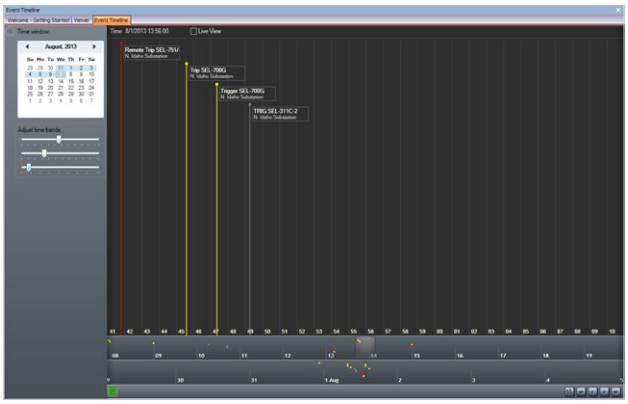
Starting price
**$2,590 USD**

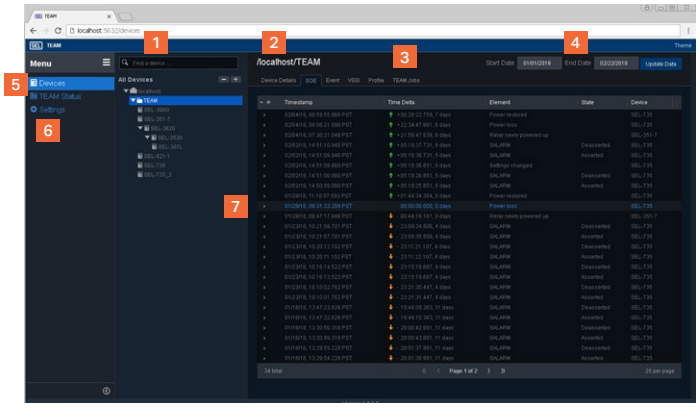
selinc.com/products/5045

TEAM automates the collection of power system data from multiple devices and stores the data in a central location for easy access. When something happens, whether it's a relay trip, system fault, or security notification, TEAM is ready to help with continuous background monitoring, collection, notification, and storage. This ensures that the data are there when you need them to help discover root cause, maintain records for regulatory compliance, and keep your system running at peak efficiency.

TEAM operates as a set of Microsoft Windows services that continuously collects data from devices. All collected data are stored either in the ACSELERATOR® Database (a PostgreSQL database) or at a specified disk location.

TEAM functionality is licensed as four feature sets: TEAM Event, TEAM Profile, TEAM Security, and TEAM Transmission Fault Location (TFL). You can select from the four feature sets to build a TEAM application that best suits your system needs.






1. View multiple ACSELERATOR Databases, and securely provide read-only access to TEAM-collected data.
2. Easily view device configuration attributes with a read-only view organized in a tabbed menu.
3. View and verify TEAM configurations for enabled jobs. You can view the polling frequency, when the job was last executed, and other configuration information.
4. Easily adjust the date range.
5. Access information about your TEAM installation from a network-connected computer. You can verify Windows services, installed versions, and licensing information and review service logs.
6. From the Settings page, enable additional TEAM databases and set the time zone for data viewing.
7. Set a time reference point by simply selecting a data row. The Time Delta adjusts based on the selected row to quickly evaluate the order of operations.

## TEAM Event

TEAM Event makes capturing, evaluating, and sharing event data easy. It automatically captures event data from supported SEL and third-party devices in CEV, COMTRADE, and Sequence of Events (SOE) formats. With TEAM Event, you can designate a query interval for TEAM to periodically query devices for new data. For enhanced data collection speeds, you can integrate TEAM with SEL Real-Time Automation Controllers (RTACs). An RTAC provides secure notifications to TEAM of new events and SOE data available for collection.

Oscillographic event data are beneficial for system monitoring, fault analysis, and troubleshooting purposes. With the Web Viewer, Timeline Viewer, Event Viewer, and SOE Viewer in TEAM Event, you can quickly review oscillographic data and identify important events by type, device, location, or timeline.

TEAM Sync, included with TEAM Event, securely transports event and SOE data between database storage locations for automated data redundancy. TEAM Event can also notify appropriate individuals of new system events through TEAM's automatic email or SMS text messaging.

## TEAM Profile

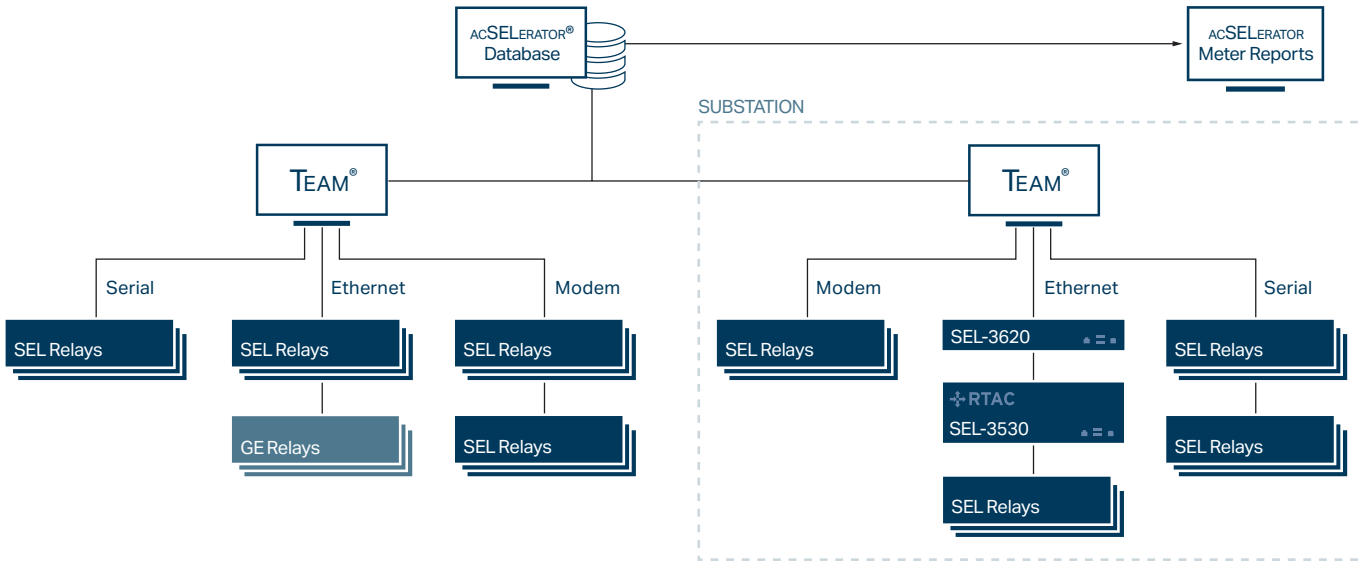
Load data profiling (LDP) information contains energy, demand, voltage, current, harmonic, and frequency trends that are useful when managing a large metered area. TEAM Profile automates the collection of LDP and voltage sag, swell, and interruption (VSSI) data from SEL-735 Power Quality and Revenue Meters and SEL-751A Feeder Protection Relays. With the RTAC Trend Recorder library, you can record IED quantities, collect them with TEAM Profile, and trend them with ACSELERATOR Meter Reports SEL-5630 Software. You can view meter-generated data with Meter Reports to graph forensic data.

## TEAM Security

Use TEAM Security to automate password management and maintain a central repository of managed-device interactions and password reports for disaster recovery. TEAM Security works with the SEL-3620 Ethernet Security Gateway and the SEL-3622 Security Gateway to rotate device passwords on a set interval. When configured, TEAM Security also collects the device commands and the password management and Syslog reports generated by the SEL-3620, SEL-3622, and SEL-3025 Serial Shield® after new passwords are generated or on a specified interval.

## TEAM TFL

Quickly restoring power after a system fault is a top priority. TEAM expedites accurate fault locating and can email or text results to appropriate individuals. Most digital protective relays or other IEDs use local or single-ended measurements to determine the fault location. To increase accuracy, TEAM TFL uses a two-terminal fault-locating method based on event information collected at the transmission line's end terminals. When a fault occurs, TEAM TFL receives time-stamped event reports from IEDs or digital fault recorders (DFRs) at both terminals of a transmission line, checks to see if the events are associated with any of the configured lines, time-aligns the event records, and executes a two-terminal fault-locating algorithm.




TEAM works with multiple devices in a variety of configurations to meet your system needs.

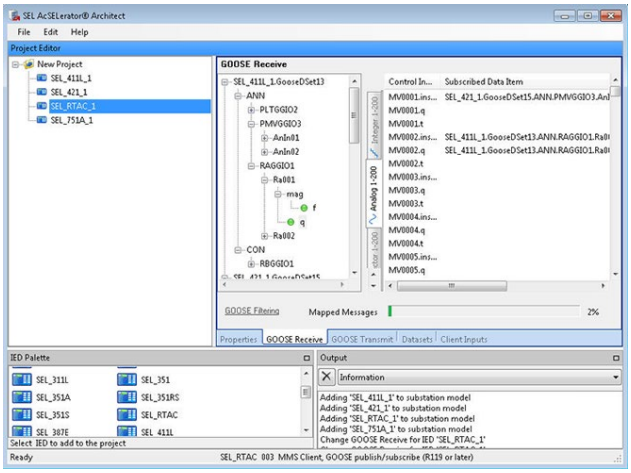
# SEL-5032

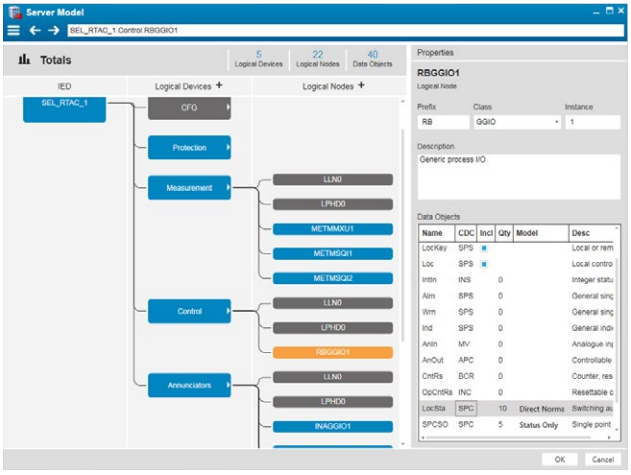
## ACSELERATOR Architect® Software

**Included With Supported Products**

selinc.com/products/5032

Architect configures and documents IEC 61850 systems that include GOOSE, Sampled Values, or Manufacturing Message Specification (MMS) for process bus and SCADA applications.




### Simple device integration

Configure SEL devices in IEC 61850 installations using ACSELERATOR QuickSet® SEL-5030 Software and Architect together. Architect provides a means to configure and document the IEC 61850 communications settings between SEL devices and devices from multiple manufacturers.

With Architect, you can import and export Edition 1 and Edition 2 Substation Configuration Language (SCL) files to simplify system implementation. You can also detect and report errors by automatically comparing SCL files with the IEC 61850 requirements. SCL files include:

- SCD—Substation Configuration Description.
- ICD—IED Capability Description.
- CID—Configured IED Description.

The software is easy to apply with drag-and-drop functionality, an IED palette manager, tab orientation, diagnostic windows, and a settings wizard.

Architect also allows you to create and edit custom buffered and unbuffered MMS reports. You can configure the publications and subscriptions for IEC 61850-9-2LE Sampled Values and create and organize custom logical devices.

### Server model editor

The SEL Real-Time Automation Controller (RTAC) includes MMS server capability that expands its very flexible data concentration capabilities. In systems where the RTAC needs to transmit SCADA data from various client protocol connections (such as SEL, Modbus, or DNP3) in MMS messages, Architect includes the Server Model Editor for configuring MMS server instances in RTACs.

The Server Model Editor provides a graphical representation of the RTAC server model, which enables quick visualization and convenient editing tools for creating and maintaining MMS server applications.

# SEL-5601-2

## SYNCHROWAVE® Event Software

Starting price
**$520 USD**

selinc.com/products/5601-2

SYNCHROWAVE Event helps diagnose a protective relay's behavior during a power system fault. It is a powerful yet easy-to-use solution for displaying and analyzing SEL relay event reports and COMTRADE files.

### Analyze relay event data

Plot relay oscillography, display phasor magnitudes and angles, and monitor the digital status. You can navigate through events with integrated zoom and pan functions.

### Time-align event reports

Easily coordinate multiple event report times for accurate comparison and analysis of signals from multiple relays or past event reports.

### Perform calculations

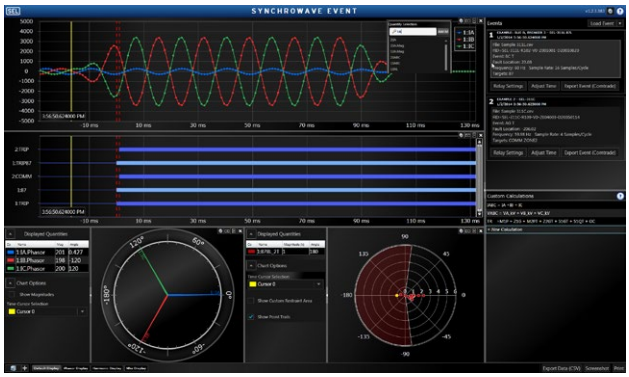
Create equations to analyze specific trip conditions. For quick event analysis, you can instantly plot calculation results. The built-in function library offers endless calculation possibilities.

### Visualize distance elements

Analyze protective relay distance element operation with the exact mho circle diagram. The diagram lets you plot and analyze apparent impedance and distance element characteristics.

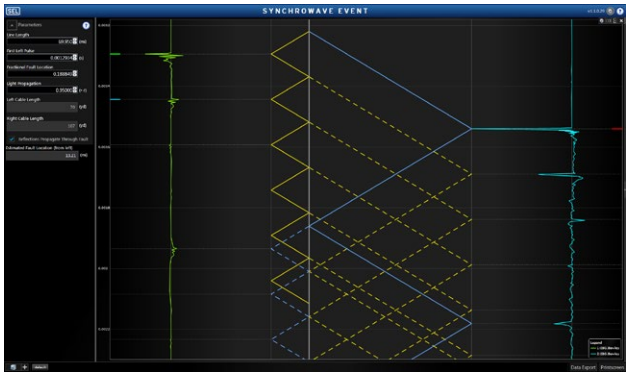
### Save analysis setup time

Create personal and relay-specific analysis templates for a custom view into the relay's operation. For more efficient post-event analysis, you can save and share templates.




### See traveling waves

The SEL-T400L Time-Domain Line Protection, the SEL-T401L Ultra-High-Speed Line Relay, and the SEL-411L Advanced Line Differential Protection, Automation, and Control System can record traveling-wave data to provide a highly accurate fault location. SYNCHROWAVE Event generates a Bewley lattice diagram from the traveling-wave data to enable visualization, analysis, and understanding of the traveling waves recorded for an event.




SYNCHROWAVE Event generates Bewley lattice diagrams from traveling-wave data to enable visualization and analysis.

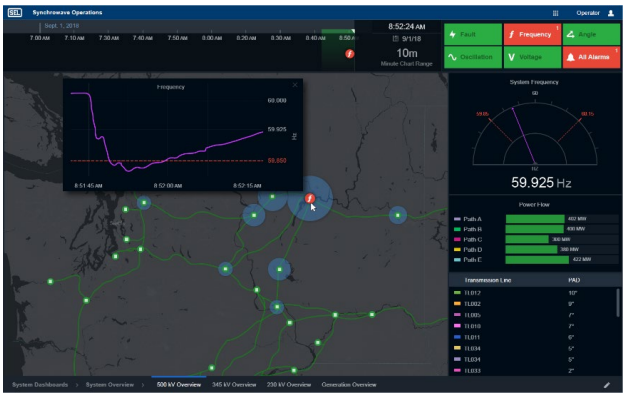
# Synchrowave® Operations

## Software NEW

Contact SEL for More Information

selinc.com/products/5702

Increase grid safety and reliability through situational awareness with high-resolution time-series data, real-time analytics, and geographical information system (GIS) location information. Synchrowave Operations complements traditional SCADA systems and energy management systems (EMSs) by delivering power system insights that SCADA can't provide.




### Wide-area situational awareness

Synchrowave Operations improves situational awareness by providing live, subsecond, and time-aligned information from across the entire power system. Waveform signatures provide additional insight into the dynamic behavior of the power system, which enhances decision making during abnormal conditions.

### Intelligent analytics and notifications

Real-time analytics applications constantly monitor streaming data and provide notifications that give the operator access to key event data, including the location and impact, with a single click.

### Real-time visualization

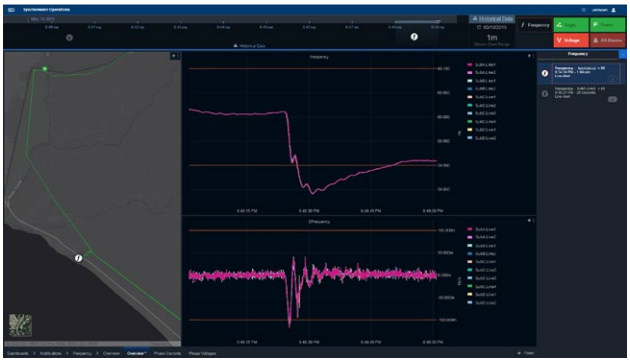
Operators will promptly see the system response after switching a line in or out of service. Unreliable behaviors, like a growing oscillation or a failed breaker reclose cycle, are visible instantaneously with subsecond resolution that enables quick identification and response before the issue impacts the power system.

### Renewable energy monitoring

High-resolution data lets operators measure and track the impact of renewables. Integrating renewable energy into the power system can result in reduced system stability and new oscillatory modes. System dynamics from these generation sources change quickly—too fast to see at traditional SCADA rates.

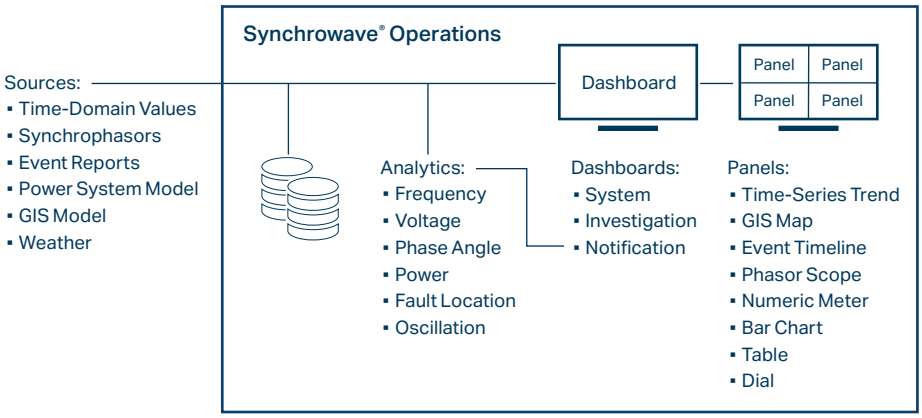
### Power system model validation

To accurately replicate events, power system studies rely on accurate system models. Synchrowave Operations will record the system response to system events, such as capacitor switching, generator trips, load shedding, or other events. Comparing the recording to system models lets operators validate system security and reliability.



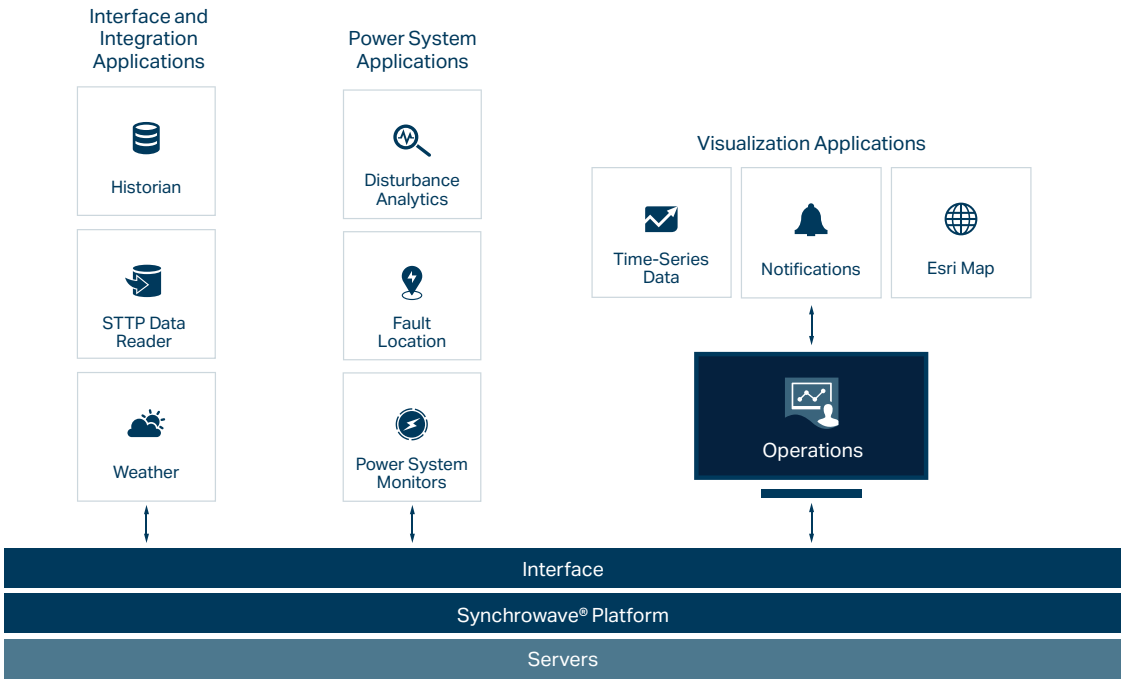
## Synchrowave Operations functional overview

In Synchrowave Operations, time-series sources stream data to a historian, analytics applications, and dashboards. The analytics applications detect power system conditions and provide notifications. Operators then view these notifications and other types of data on custom dashboards built from a selection of panels offering different insights.




## Synchrowave Platform

Synchrowave Operations is built on Synchrowave Platform, a scalable, resilient, and secure application platform for real-time power system operations and analytics. Applications on Synchrowave Platform work together to create new solutions for utility grid operation challenges. Each application is independent and communicates with the platform through interfaces, enabling new applications to quickly be developed and deployed.



# WAN and LAN Networks Overview

## SEL ICON®

The SEL ICON is a WAN multiplexer optimized for industrial and utility applications. By combining TDM and Ethernet transport options with a comprehensive range of data interfaces, the ICON makes it easy to migrate legacy network technologies to a packet-based solution.

## SEL-2740S

The SEL-2740S is the industry's first field-hardened software-defined networking (SDN)-enabled switch and improves cybersecurity and Ethernet performance in mission-critical applications.

## SEL-2742S NEW

The SEL-2742S is a 12-port, DIN-rail mount SDN switch for industrial environments. It combines with SEL-5056 Flow Controller Software to simplify network engineering and improve LAN security.

## SEL-3620/3622

The SEL-3620 and SEL-3622 each function as a router, VPN endpoint, and firewall device. They can provide secure and proxy user access for serial- and Ethernet-based IEDs.

## SEL-2730M/2730U

The SEL-2730M/2730U let you build reliable, safe Ethernet networks in electrical substations, plants, and other mission-critical sites.

## SEL-3610

The SEL-3610 increases the number of serial ports available to communications processors and computers and allows serial products to communicate securely through Ethernet networks.

## SEL-2725

The SEL-2725 allows you to easily connect devices to Ethernet networks.

## SEL-3025

The SEL-3025 protects serial communications with bump-in-the-wire security and strong, authenticated access controls.

| Applications | SEL ICON® | SEL-3620 | SEL-3622 | SEL-3610 | SEL-2725 | SEL-2730M | SEL-2740S | SEL-2742S | SEL-2890 |
|---|---|---|---|---|---|---|---|---|---|
| SONET WAN | ■ | | | | | | | | |
| Ethernet LAN | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Precise Time Distribution | ■ | ■ | ■ | ■ | | | ■ | ■ | |
| Engineering Access Control | | ■ | ■ | ■ | | | ■ | ■ | |
| Connect Multiple Wired-Ethernet Devices to Network | ■ | | | | ■ | ■ | ■ | ■ | |
| Convert Wired 10/100BASE-T Ethernet to Fiber-Optic 100BASE-FX Ethernet | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| Convert Serial Links to Ethernet Links | ■ | ■ | ■ | ■ | | | | | ■ |
| **Features** | | | | | | | | | |
| Cryptography (Encryption and Authentication) | ■ | ■ | ■ | ■ | | | | | |
| User-Based Accounts | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | |
| Centralized Authentication Via Lightweight Directory Access Protocol (LDAP) | ■[8] | ■ | ■ | ■ | | ■ | ■ | ■ | |
| Centralized Authentication Via Remote Authentication Dial-In User Service (RADIUS) | | ■ | ■ | ■ | | ■ | | | |
| Deny-by-Default Firewall | | ■ | ■ | | | | | | |
| Import/Export Configuration Files | | ■ | ■ | ■ | | ■ | ■ | ■ | |
| VPN | | ■ | ■ | | | | | | |
| Syslog Logging | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | |
| Network Management System (NMS) Software | ■ | | | | | ■ | ■ | ■ | |
| GPS Receiver | ■ | | | | | | | | |
| Real-Time Latency Monitor | ■ | | | | | | | | |
| Spanning Tree Protocol (STP) | | ■ | ■ | ■ | | ■[1] | | | |
| VLANs | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | |
| Ethernet Class of Service | ■ | | | | | ■ | ■ | ■ | |
| **Ethernet Ports, Connector** | **Quantities** | | | | | | | | |
| Copper 10BASE-T, RJ45 | | | | | | | | | 1 |
| Copper 10/100BASE-T, RJ45 | 0–16[2] | 3 | 3 | 3 | 3–5 | 0–16[3] | 0–20 | 2–10 | |
| Fiber-Optic 100BASE-FX, LC | 4 | 2 | 2 | 2 | 0–2 | 0–16[3] | 0–20 | 0–6 | |
| Copper Gigabit Ethernet (GigE), RJ45 | 4 | | | | | 4 | 0–4 | 0–4 | |
| Fiber-Optic GigE, LC | 2[6]/4[7] | | | | | 0–4[4] | 0–4 | 0–4 | |
| Small Form-Factor Pluggable (SFP) Cages | 2–6[5] | | | | | 4[4] | | | |

[1]SEL-2730M supports STP plus IEEE 802.1D-2004 Rapid Spanning Tree Protocol (RSTP).

[2]SEL ICON can support up to 16 Ethernet ports using 8-port Ethernet Access Modules or Ethernet Bridging Access Modules.

[3]SEL-2730M base configuration supports sixteen 10/100BASE-T copper ports, with the option to substitute 100BASE-FX fiber-optic ports in groups of four.

[4]SEL-2730M base configuration includes 4 copper GigE ports and 4 SFP cages for optional fiber-optic GigE ports.

[5]SEL ICON uses SFP cages for SONET and GigE fiber-optic interfaces.

[6]SEL-8021-1 Line Module supports 2 fiber-optic Gigabit interfaces.

[7]SEL-8036-1 Ethernet Bridging Access Module supports 4 fiber-optic 100BASE-FX/Gigabit interfaces.

[8]SEL-5052 Server NMS Software provides LDAP centralized authentication for the ICON.

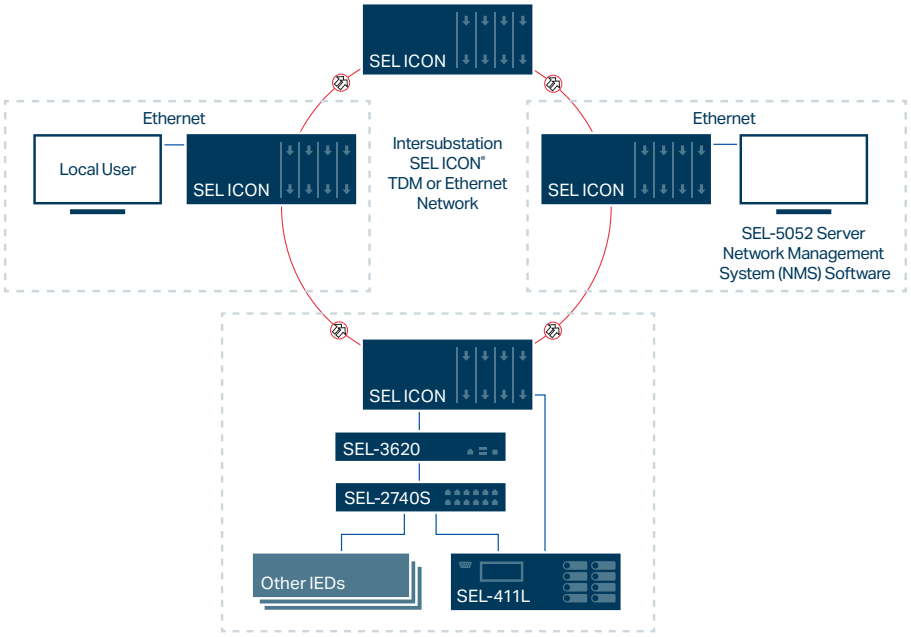
# WAN and LAN Networks Applications

## Maintaining critical services between sites

Install the SEL ICON® Integrated Communications Optical Network to maintain critical services between sites by quickly restoring traffic when an infrastructure disruption, like fiber failure, occurs.

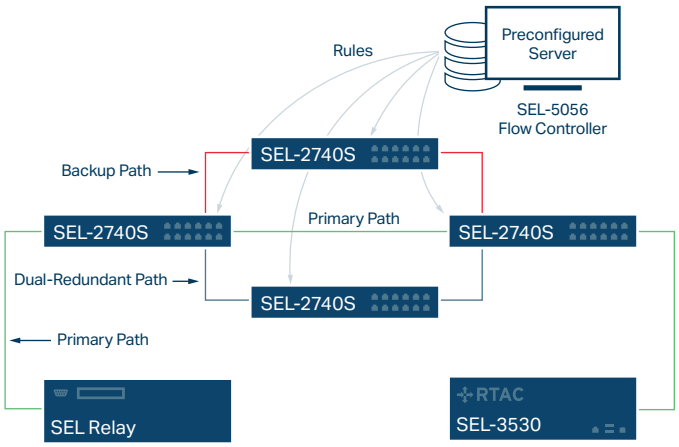
You can configure the ICON to operate as a SONET or Ethernet multiplexer to address the following network use cases:

- Segregated operational technology (OT)—SONET transport (shown here)
- Segregated OT—Ethernet transport
- Converged IT/OT—Multiprotocol Label Switching (MPLS) or Carrier Ethernet core network
- Analog leased line service migration



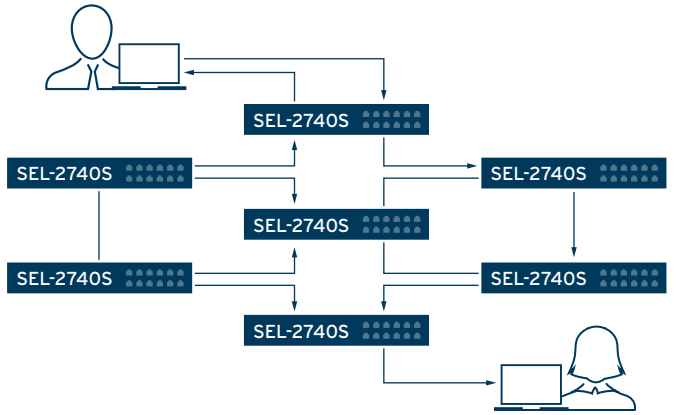

## Improving mission-critical Ethernet performance

The breakthrough software-defined networking (SDN) technology in the SEL-2740S Software-Defined Network Switch solves the inherent limitations of Ethernet networks. Every network path is predefined by the user, enabling precise control over how the system responds to network failures. The SEL-2740S fails over in less than 100 µs, ensuring the performance of mission-critical applications under all conditions. This means no more waiting for discovery or convergence times.



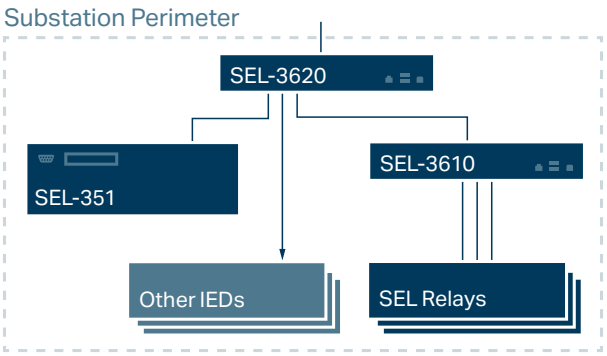

## Redefining security for Ethernet networks

The deny-by-default architecture of the SEL-2740S Software-Defined Network Switch means only preapproved traffic that matches specific rules is allowed onto the network. The switch inspects multiple layers of every packet to see if they match the set of rules you define. If there is a mismatch, the SEL-2740S can immediately drop the packet or forward it to an intrusion detection system for in-depth analysis. In addition, you can change these rules at any time.



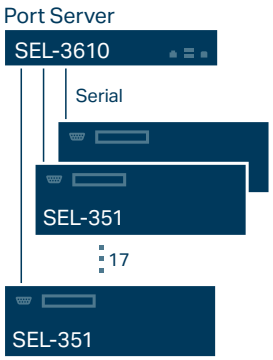
## Managing and securing system communications

Install the SEL-3620 Ethernet Security Gateway to secure your control system communications with a stateful deny-by-default firewall, strong cryptographic protocols, and logs for system awareness. The SEL-3620 also manages protected IED passwords and helps create a user audit trail through strong, centralized, user-based authentication and authorization for modern and legacy IEDs.



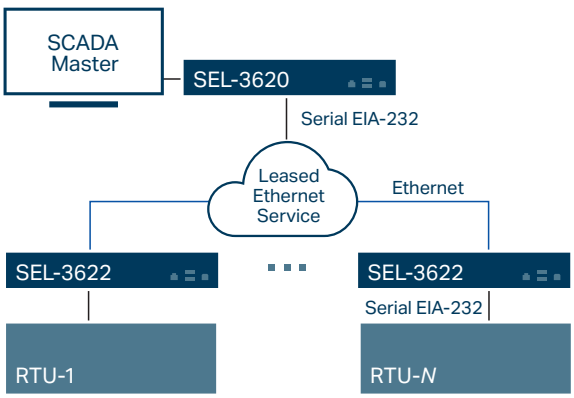

## Connecting to SEL products and other devices for secure serial communications

Add 17 serial ports with the SEL-3610 Port Server to connect SEL products and other devices and allow secure serial communications through Ethernet networks. The SEL-3610 tunnels serial data over an Ethernet connection using Secure Shell (SSH), Telnet, Modbus, or raw TCP encapsulation. The SEL-3610 allows you to restrict all access to unconfigured logical and physical ports.




## Managing transition from analog to Ethernet leased line services

Apply the bit-based serial conversion technology in the SEL-3620 and SEL-3622 Security Gateways to seamlessly convert existing bit-based serial protocols, such as Conitel, Tejas, Van Comm, and Redaj, to Ethernet packets on the near side of a link. Then, reconvert that Ethernet data back into bit-based form on the remote side. This allows the SEL-3620 and SEL-3622 to serve as drop-in replacements for analog line-to-line modem technology without disrupting existing equipment and with minimal additional latency.



# SEL ICON®

## Integrated Communications Optical Network

selinc.com/products/ICON

Starting price
**Configured ICON Node: $6,000 USD**
**SEL-5051 Client Network Management System (NMS) Software: $5,180 USD**
**SEL-5052 Server NMS Software: $5,180 USD**

The SEL ICON is a WAN multiplexer optimized for industrial and utility applications. You can configure the ICON to operate as a SONET or Ethernet multiplexer to address the following network usage cases:

- Segregated operational technology (OT)—SONET transport
- Segregated OT—Ethernet transport
- Converged IT/OT
- Analog leased line service migration

The virtual synchronous networking (VSN) technology in the ICON preserves the performance characteristics of time-division multiplexing (TDM) when converting to Ethernet as a transport protocol. By combining TDM and Ethernet transport options with a comprehensive range of data interfaces, the ICON makes it easy to migrate legacy network technologies to a converged IT/OT packet-based solution. The ICON interoperates with Multiprotocol Label Switching (MPLS) or Carrier Ethernet core networks to provide a hardened OT edge multiplexer for mission-critical applications.

SEL-5051 Client and SEL-5052 Server NMS Software help you maintain a secure, reliable, and efficient communications infrastructure. In the client-server architecture, the SEL-5051 Client Software connects to the SEL-5052 Server Software to provide an efficient solution for managing network access for multiple users. The SEL-5052 Server Software offers centralized user security, settings, alarms, and event management.


1. Protected Line Modules
2. Server Module
3. Ethernet Bridging Access Module
4. IEEE 1613-compliant packaging
5. Seven slots for access modules (Ethernet Bridging Access, Quattro, and Transfer Trip Modules shown)
6. Dual redundant power supplies
7. The ICON is available in a standard 19" rack-mount chassis or in a compact ICON Cube package for limited-space applications.
8. Protected Line Modules
9. Server Module
10. Two slots for access modules (Ethernet Access and Quattro Modules shown)
11. Dual redundant power supplies

# ICON Modules

| Part Number | Description | Starting Price |
|---|---|---|
| **Power Modules** | | |
| 8011-02 | 19-Inch Rack Power Module, High-Voltage AC/DC, 120–240 V, 92 W | $420 |
| 8010-02 | 8-Inch Cube Power Module, High-Voltage AC/DC, 120–240 V, 63 W | $370 |
| **Control Modules** | | |
| 8020-01 | Line Module | $2,110 |
| 8021-01 | Protected Line Module | $1,560 |
| **Server Module** | | |
| 8030-01 | Server Module | $630 |
| **Access Modules** | | |
| 8035-01 | Ethernet Access Module | $730 |
| 8036-01 | Ethernet Bridging Access Module | $1,040 |
| 8036-02 | Ethernet Bridging Access Module With Precision Time Protocol (PTP) | $1,550 |
| 8041-01 | Transfer Trip 4-Function 24/48 VDC TX/RX Teleprotection Module | $1,250 |
| 8041-04 | Transfer Trip 4-Function 125/250 VDC TX/RX Teleprotection Module | $1,250 |
| 8050-01 | Quattro Module (accepts 2 DS1 or 4 non-DS1 submodules) | $230 |
| 8051-01 | Nx64F IEEE C37.94 Multimode Quattro Submodule | $230 |
| 8051-02 | Nx64F IEEE C37.94 Single-Mode Quattro Submodule | $500 |
| 8053-01 | Async Data Quattro Submodule | $220 |
| 8055-01 | 422 Sync Quattro Submodule | $390 |
| 8056-01 | G.703 Quattro Submodule | $390 |
| 8057-01 | DS1 Async (Quad DS1 Ports) Quattro Submodule | $470 |
| 8057-02 | DS1 Sync (Quad DS1 Ports) Quattro Submodule | $830 |
| 8057-03 | DS1 Psync (Quad DS1 Ports) Quattro Submodule | $830 |
| 8065-01 | 4-Wire VF Dual Ports Quattro Submodule | $340 |
| 8065-02 | Single-Port (Dual Connectors) 4-Wire Bridging VF Submodule | $510 |
| 8066-01 | FXS Single-Port Quattro Submodule | $340 |
| 8067-01 | FXO Dual-Port Quattro Submodule | $340 |

# SEL-2740S/2742S

## Software-Defined Network Switches NEW

Starting price
**SEL-2740S: $3,885 USD**
**SEL-2742S: $2,200 USD**

selinc.com/products/2740S or selinc.com/products/2742S

Select models typically ship in 2 days

The SEL-2740S and SEL-2742S are the industry's first software-defined networking (SDN) switches designed for operational technology (OT) networks. The SEL SDN solution includes SEL-2740S and SEL-2742S switches, the SEL-5056 Software-Defined Network Flow Controller, and the SEL-5057 SDN Application Suite. These products work together to create a more secure OT LAN with 100 times faster failover times and greater situational awareness.

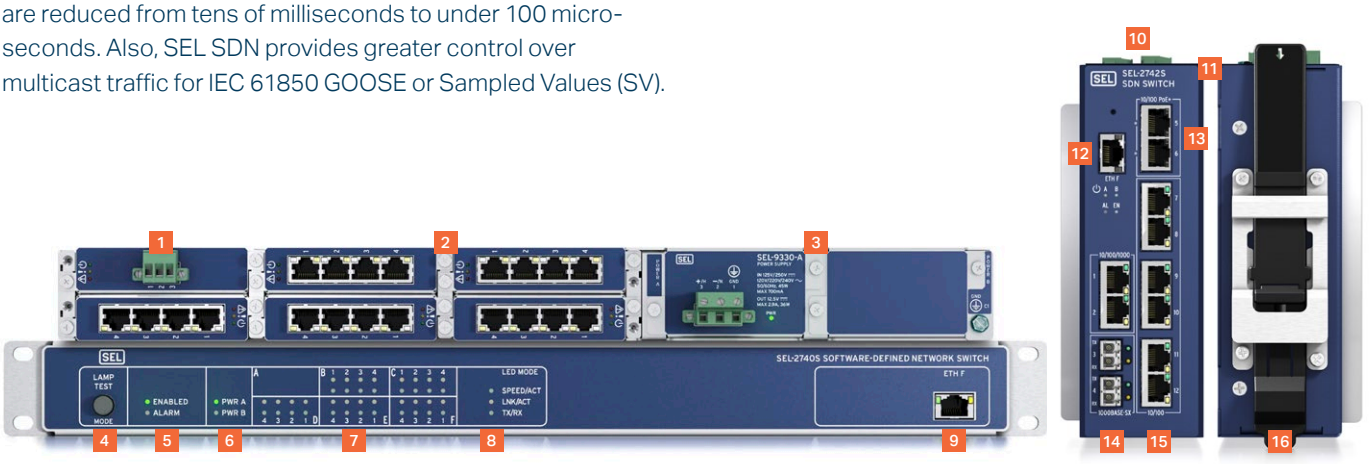
SEL SDN uses a deny-by-default architecture where the SEL-2740S and SEL-2742S switches will only forward authorized traffic. The switches use multilayer packet inspection to ensure that each packet meets predefined criteria. SEL SDN also improves security by eliminating two attack-prone elements of traditional Ethernet switches—the Rapid Spanning Tree Protocol (RSTP) and MAC tables.

SEL SDN offers important benefits for IEC 61850 systems. Because failover paths are predefined, network healing times are reduced from tens of milliseconds to under 100 microseconds. Also, SEL SDN provides greater control over multicast traffic for IEC 61850 GOOSE or Sampled Values (SV).

The SEL-2740S and SEL-2742S can act as transparent Precision Time Protocol (PTP) clocks, supporting the IEEE C37.238 power system profile to ensure submicrosecond time synchronization of end devices. The SEL-2740S, SEL-2742S, and SEL-5056 support Syslog for secure log management.

The SEL-2740S is a 20-port switch designed for use in a 19" rack in utility substations. The SEL-2742S is a DIN-rail-mounted 12-port switch with Power over Ethernet Plus (PoE+) for industrial environments. Both switches can be powered from two sources, and the SEL-2740S offers dual hot-swappable power supplies.

Both switches withstand harsh environments commonly found in the utility and industrial sectors and operate reliably from –40° to +85°C (–40° to +185°F). They meet IEEE 1613 and IEC 61850-3 standards.




1 Flow processor and alarm contact.

2 Five modular slots for copper or fiber Ethernet interface options (in sets of four).

3 Dual power supply options for hot-swappable redundancy.

4 Lamp Test button verifies all LEDs are functional and lets you select the LED mode.

5 General status indicators.

6 Power supply status LEDs.

7 Ethernet port status LEDs.

8 Three LED modes are available for the Ethernet port status.

9 Out-of-band flow controller port.

10 Dual power supply connections.

11 Rugged chassis operates in –40 to 85°C (–40° to +185°F).

12 Ethernet management port.

13 Two 10/100BASE-T PoE+ ports.

14 Four 1 Gbps ports—copper, single-mode fiber, or multimode fiber.

15 Six 10/100BASE-T ports—copper or multimode fiber.

16 Top hat DIN clip.

# SEL-5056

## Software-Defined Network Flow Controller

**Included With SEL Software-Defined Network Switches**

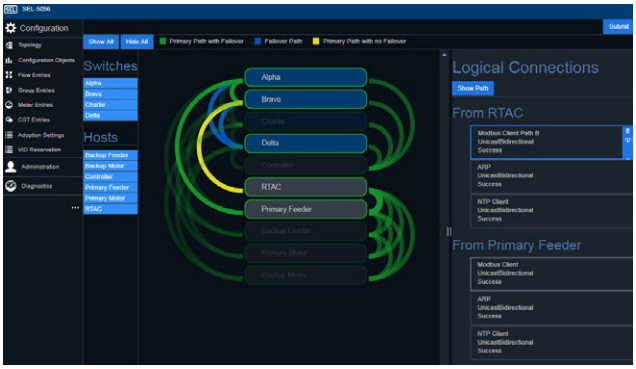
selinc.com/products/5056

The SEL-5056 flow controller is the central interface for the commissioning, configuration, and monitoring of SEL software-defined networking (SDN) switches. The only changes allowed on the network are made through the flow controller. With SEL SDN, you'll have advanced situational awareness. You'll know exactly what devices are on your network and all the conversations each device is having. No additional engineering access interface is necessary on SEL-2740S or SEL-2742S Software-Defined Network Switches.

The SEL-5056 is a server-based software tool. This flow controller configures primary and backup paths for each communications flow on SEL-2740S and SEL-2742S switches by using attributes of a specific protocol session and forwarding paths instead of requiring MAC addresses and VLANs. The SEL-5056 provides comprehensive monitoring of all path- and packet-level network statistics of each communications flow, increasing awareness of the network health and status. In addition, you can programmatically test the network implementation before deployment.

SEL-5056 network configuration can be performed in the field with all IEDs connected or can be performed offline in a lab. Offline configuration provides flexibility and can reduce the downtime required for field installations.

HTTPS provides encryption and authentication for secure management of SEL-5056 web browser communication. SEL-5056 communication to all SEL-2740S and 2742S switches occurs through encrypted and authenticated Transport Layer Security (TLS). Keys are securely managed through X.509 certificates. You can configure user accounts on the SEL-5056 or use the Lightweight Directory Access Protocol (LDAP) to authenticate users. The SEL-5056, SEL-2740S, and SEL-2742S support Syslog for secure log management. In addition, the flow controller provides backup and restore features for maintaining high reliability.




Learn & Lock is an extension for the SEL-5056 that provides supervised automation for commissioning SDN switches, learning what conversations are trying to happen, and provisioning circuits to allow those conversations. Learn & Lock streamlines configuration by discovering devices on the LAN and creating a set of flows for the current traffic.

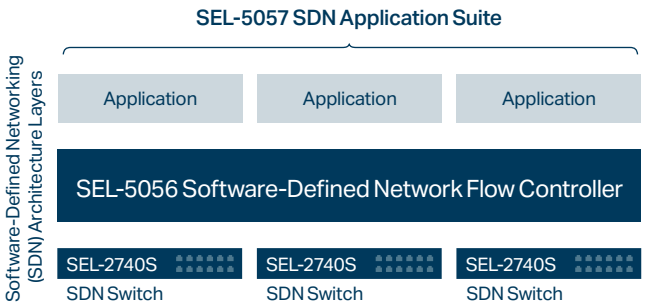
# SEL-5057

## SDN Application Suite NEW

Starting price
**$1,850 USD**

selinc.com/products/5057

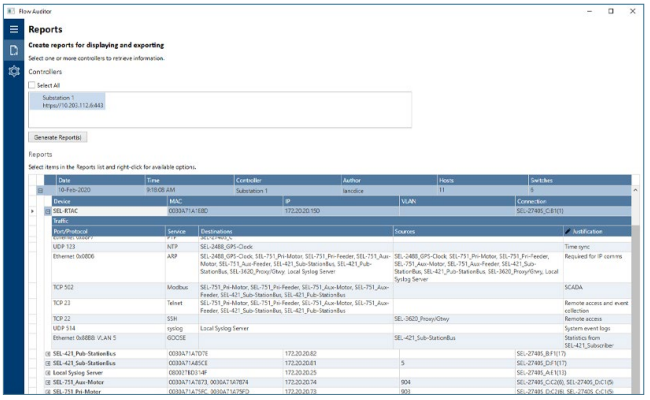
The SEL-5057 SDN Application Suite is a collection of software applications that integrate with the SEL-5056 Software-Defined Network Flow Controller to add capabilities to SEL software-defined networking (SDN) solutions. Flow Auditor is the first SEL SDN application in the suite.




## Flow Auditor

### Streamline data collection for NERC CIP reporting

Use the SEL Flow Auditor application to streamline data collection for NERC CIP-007-6 R1 audit reporting. It collects information on what ports and services are running on the network from the SEL-5056 without the need for network scanning. With Flow Auditor, data collection takes minutes instead of days or weeks.




### Capabilities

Identifying Devices in Your Network—Automate the discovery and documentation of all devices on the LAN.

Documenting Ports and Services—Perform data collection and generate audit reports for NERC CIP-007-6 R1. Flow Auditor does not require network scanning, logging into IEDs, or even logging into the SEL-5056.

Maintaining Security—Use Open Authentication (OAuth) for mutual authentication and encryption between Flow Auditor and the SEL-5056.

# SEL-3620/3622

## Ethernet Security Gateway/Security Gateway

Starting price
**SEL-3620: $2,900 USD**
**SEL-3622: $830 USD**

selinc.com/products/3620 or selinc.com/products/3622

Select models typically ship in 2 days

The SEL-3620 and SEL-3622 each act as a router, VPN endpoint, and firewall device and can perform secure and proxy user access for serial- and Ethernet-based IEDs. They help create a user audit trail through strong, centralized, user-based authentication and authorization for modern and legacy IEDs. Each security gateway secures your control system communications with a stateful deny-by-default firewall, strong cryptographic protocols, and logs for system awareness. They also manage protected IED passwords, ensuring that passwords are changed regularly and conform to complexity rules. Device checkout and common, persistent passwords improve IED access.

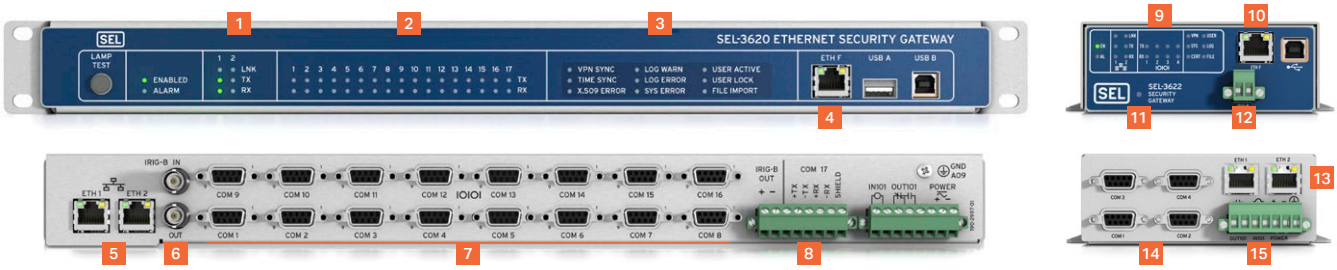
For enhanced security, the SEL-3620 and SEL-3622 help you protect critical cyber assets by employing strong multifactor authentication technologies, such as RSA SecurID, that use the Remote Authentication Dial-In User Service (RADIUS). The SEL security gateways resist known and unknown malware attacks with exe-GUARD® embedded antivirus technology. Powerful rootkit resistance, embedded Linux mandatory access controls, and process whitelisting help mitigate attacks against the gateways and eliminate costly patch management and antivirus signature updates.

The SEL-3620 and SEL-3622 support NERC CIP compliance efforts without needing Technical Feasibility Exceptions (TFEs). They also support the SEL-5827 Virtual Connect Client and SEL-5828 Virtual Port Service Software. These free software applications make remote gateway ports available for existing software and terminal applications on your PC, including those using Modbus TCP/RTU.

The SEL-3620 has 16 serial ports with 5 V power on Pin 1 and comes in a rack-mount form factor. The SEL-3622 has 4 serial ports in a small form factor that is ideal for mounting in cabinets. It detects physical tampering with an onboard accelerometer, light sensor, and input contact sensor and alerts operators when Ethernet cables are connected or disconnected.

SEL designed and built the SEL-3620 and SEL-3622 in cooperation with the U.S. Department of Energy National SCADA Test Bed and the following companies:

- EnerNex Corporation
- Tennessee Valley Authority
- Sandia National Laboratories




1 Ethernet link status LEDs
2 Serial RX/TX LEDs
3 System status indication LEDs
4 Front Ethernet port
5 Rear Ethernet ports
6 IRIG-B input/output BNC ports
7 16 DB-9 EIA-232/-422/-485 software-selectable serial ports with IRIG-B and 5 V power on Pin 1
8 Isolated COM Port 17
9 Status LEDs
10 Front Ethernet port
11 Light sensor
12 IRIG-B input
13 Rear Ethernet ports
14 Software-selectable serial ports with IRIG-B
15 Cabinet door contact sensor input

# SEL-2730M/2730U

## 24-Port Ethernet Switches

Starting price
**SEL-2730M: $1,920 USD**
**SEL-2730U: $1,560 USD**

selinc.com/products/2730M or selinc.com/products/2730U

Select models typically ship in 2 days

The SEL-2730M Managed 24-Port Ethernet Switch and SEL-2730U Unmanaged 24-Port Ethernet Switch support communications infrastructure for engineering access, SCADA, and real-time data communications while offering the same reliability found in SEL protective relays. Both switches are designed for the harsh conditions found in energy and industrial environments and meet or exceed the IEEE 1613 (Class 1), IEC 61850-3, and IEC 60255 industry standards for vibration, electrical surges, fast transients, extreme temperatures, and electrostatic discharge for communications devices in electrical substations.

The SEL-2730M is easy to use and administer, with a web management interface and advanced configuration options to meet your needs. The SEL-2730U is an unmanaged "no settings" switch with ports that automatically configure for crossover cables, speed, and half- or full-duplex operation.

# SEL-3025

## Serial Shield®

Starting price
**SEL-3025: $940 USD**
**PC Serial Security Kit: $420 USD**
**SEL-3045 Secure SCADA Card: $260 USD (included in kit)**

selinc.com/products/3025

The SEL-3025 uses powerful AES 128-/256-bit and SHA-1/-256 key strengths to encrypt and authenticate serial and dial-up links at speeds up to 57,600 bps. The cryptographic module provides confidentiality and integrity for remote monitoring and interactive remote access while locking out hackers and other malicious intruders. With its remote management functionality and wide range of application support, the SEL-3025 is flexible and easy to use.

You can use the SEL-3025 with the PC Serial Security Kit to transform normal serial PC communications to cryptographically secure serial PC communications. Simply plug in the USB card dock and install the virtual port software to use a secured serial port with existing software and terminal applications.

# SEL-3610
## Port Server

Starting price
**$1,870 USD**

selinc.com/products/3610 | Select models typically ship in 2 days

The SEL-3610 is an EIA-232, EIA-422, or EIA-485 serial-to-serial and Ethernet-to-serial cryptographic port server. It increases the number of available serial ports for communications processors and computers and allows serial products to communicate securely through Ethernet networks. The SEL-3610 tunnels serial data over an Ethernet connection using Secure Shell (SSH), Telnet, Modbus, or raw TCP or UDP encapsulation. The SEL-3610 provides highly flexible byte- or bit-based serial and Ethernet port mappings and can filter data based on which connections listen or transmit. You can configure the device to establish virtual bonds between one or more logical Ethernet ports and one or more physical serial ports. The SEL-3610 supports enhanced security, including user authentication through the Lightweight Directory Access Protocol (LDAP). It also supports multifactor authentication technologies, such as RSA SecurID, that use the Remote Authentication Dial-In User Service (RADIUS).

# SEL-2725
## Five-Port Ethernet Switch

Starting price
**$470 USD**

selinc.com/products/2725 | Select models typically ship in 2 days

The SEL-2725 is an unmanaged five-port switch and copper-to-fiber-optic media converter. With the SEL-2725, you can build reliable, safe Ethernet networks in electrical substations, plants, and other mission-critical sites. The SEL-2725 can connect to devices in the same cabinet using shielded twisted-pair Category 5 cable and communicate with the substation or LAN over a fiber-optic link. Mode conversions provide several key network benefits, including regenerating optical signals and extending transmission distances. You can increase the productive life of your existing cabling and active equipment without costly, across-the-board upgrades.

**Port Options**

| Copper | | Fiber |
|---|---|---|
| 3 | and | 2 multimode |
| 3 | and | 2 single-mode |
| 4 | and | 1 multimode |
| 4 | and | 1 single-mode |

# Wireless Communications Overview

## SEL-3031

The SEL-3031 is a 900 MHz ISM serial data radio that supports point-to-point (P2P) and point-to-multipoint (P2MP) operational modes. In P2P mode, the SEL-3031 supports three serial data ports in one radio channel.


## SEL-3061

The SEL-3061 provides remote access for devices using the public cellular radio network. It supports 4G LTE, 3G, and 2G cellular technologies.

## SEL-2924

The portable SEL-2924 connects to an EIA-232 port on a relay, controller, or other device to enable secure Bluetooth® wireless communications from up to 10 m (32 ft) away.

## SEL-2925

The SEL-2925 connects to an EIA-232 serial port in a control cabinet or panel to enable Bluetooth wireless communications from up to 100 m (328 ft) away.

| Applications | SEL-3031 | SEL-3061 | SEL-2924 | SEL-2925 |
|---|---|---|---|---|
| Wireless Communications for SCADA | ■ | ■ | | ■ |
| High-Speed Teleprotection | ■ | | | |
| Distribution Automation | ■ | ■ | | |
| Wireless Communications for Synchrophasor Data | ■ | ■ | | |
| Substation-to-Substation Communications Link | | ■ | | |
| Anti-Island Detection | ■ | ■ | | |
| Wireless Communications for Distributed Generation | ■ | ■ | | |
| Permanent Wireless Cable Replacement | ■ | ■ | | ■ |
| Temporary Wireless Cable Replacement | | | ■ | |
| Remote Engineering Access | ■ | ■ | | |
| Short-Range Engineering Access | ■ | ■ | ■ | ■ |
| LAN Extension | | ■ | | |
| Wireless Backhaul Communications for Fault and Load Transmitters | | ■ | | |

| Features | SEL-3031 | SEL-3061 | SEL-2924 | SEL-2925 |
|---|---|---|---|---|
| 915 MHz ISM Band (License-Free) | ■ | | | |
| 2.4 GHz ISM Band (License-Free) | | | ■ | ■ |
| Serial Communication | ■ | ■ | ■ | ■ |
| Ethernet Communication | | ■ | | |
| Low Latency for Teleprotection | ■ | | | |
| Compatible With SEL Mirrored Bits® Communications | ■ | | | |
| Compatible With Modbus | ■ | ■ | | |
| Compatible With DNP3 and Typical Byte-Oriented Protocols | ■ | ■ | ■ | ■ |
| Encryption | *ƒ* | ■ | ■ | ■ |
| Point-to-Multipoint Capability | ■ | | | |
| Cellular Capability | | ■ | | |
| EIA-232 Port (Quantity) | 3 | 1 | 1 | 1 |
| Wired EIA-485 Port | + | | | |
| High Maximum Throughput (1 Mbps or Greater) | | ■ | | |
| Device Status LEDs | ■ | ■ | ■ | ■ |
| Visible Link Quality Indicator | | ■ | | |

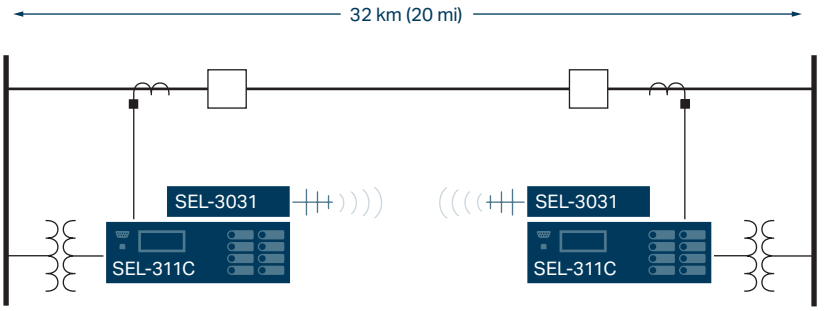
| Setup Method | SEL-3031 | SEL-3061 | SEL-2924 | SEL-2925 |
|---|---|---|---|---|
| USB Port | ■ | | | |
| Secure Web Interface Via Ethernet Port | | ■ | | |
| Control (DIP) Switches | | | ■ | ■ |
| Wireless Configuration | ■ | ■ | ■ | ■ |
| Simple Network Management Protocol (SNMP) | | ■ | | |

■ Standard feature + Model option *ƒ* With SEL-3044 Encryption Card option

# Wireless Communications Applications

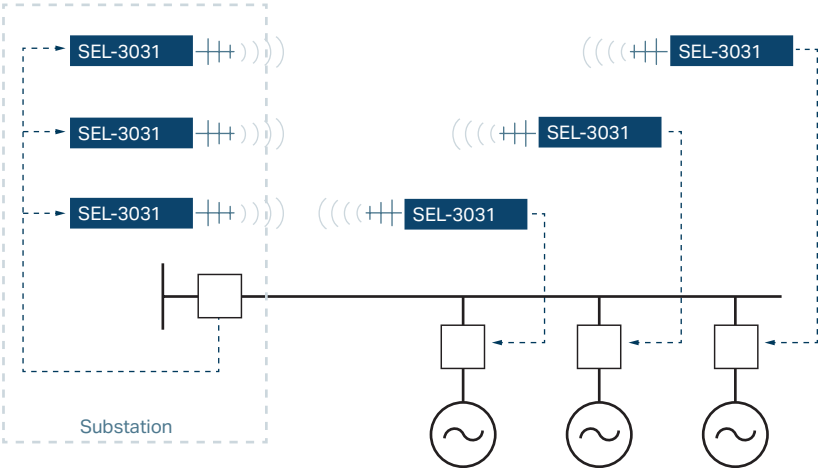
## Electrical transmission lines

Apply SEL-3031 Serial Radio Transceivers for communications-assisted teleprotection instead of local step-distance protection to accelerate the operation time for Zone 2 faults from 20–40 electrical cycles to 2–4 cycles. You can transfer control commands with a typical 5.5 ms latency via SEL Mirrored Bits® communications. The remaining serial channels can provide engineering access and primary or backup SCADA communications.



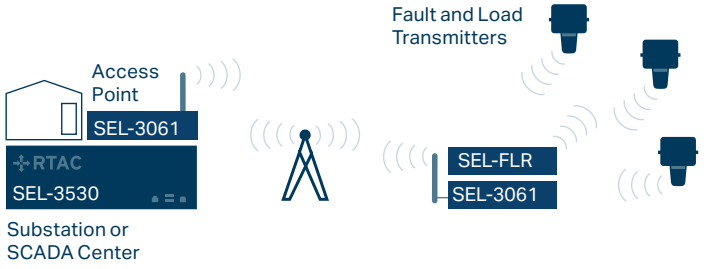

## Distributed generation

A distributed generation source needs a high-speed, low-latency communications link between each distributed generator and the substation to feed power to the electric utility. An SEL-3031 Serial Radio Transceiver communications link allows the control center to monitor each distributed generation site, read meter information, and, most importantly, automatically disconnect the distributed generation site if system issues arise. High-speed radio communications facilitate applications such as anti-island detection and power curtailment control. The low price and installation cost of radios make them an attractive choice for these applications.



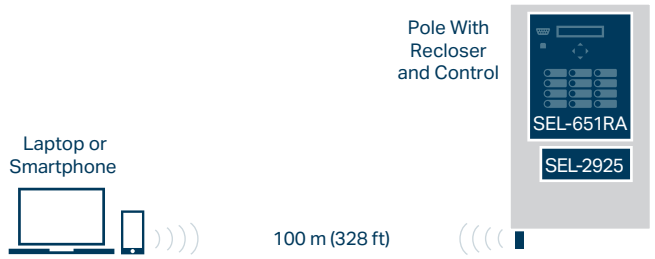

## Backhaul for fault and load transmitter and receiver systems

The SEL-FLR Fault and Load Receiver collects fault and load data from SEL-FLT Fault and Load Transmitters. With the SEL-3061 Cellular Router, you can backhaul that information to a real-time automation controller (RTAC) in the substation or to a centralized location.



### Wireless engineering access

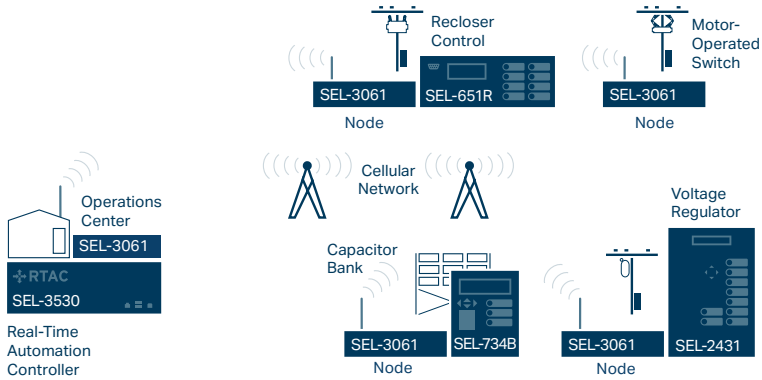
Provide local engineering access with an SEL-2925 Bluetooth® Serial Adapter. This adapter lets you avoid opening the door and exposing the recloser control to precipitation or windblown contaminants. With the SEL-2925, you can access the recloser control from up to 100 m (328 ft) away to avoid hazards to personnel.




## Distribution Network Automation

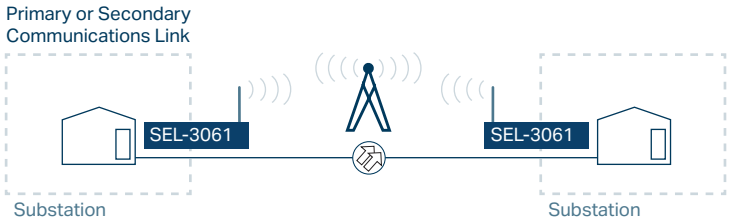
### Distribution system communications

Provide communications for distribution automation with the SEL-3061 Cellular Router. Cellular links are a cost-effective solution for collecting SCADA information from field devices and for engineering access to devices. The SEL-3061 works wherever you have public cellular coverage.




### Communications to substations

Use the SEL-3061 Cellular Router to communicate with substation equipment over secure cellular networks. This can be the primary communications link, or it can be a redundant link for a fiber cable.



# SEL-3031
## Serial Radio Transceiver

Starting price
**$1,010 USD**

selinc.com/products/3031

The SEL-3031 is a 915 MHz ISM serial data radio that supports point-to-point (P2P) and point-to-multipoint (P2MP) operational modes. In P2P mode, the SEL-3031 supports three serial data ports in one radio channel. The ports are completely independent and support a mix of protocols, including DNP3, Modbus, MIRRORED BITS® communications, SEL Fast Message, plain ASCII, and more. In P2MP mode, a one-channel master radio communicates with multiple remote radios for SCADA or other data-gathering applications. SEL Hop-Sync™ technology optimizes co-located radios applied as multiple point-to-point links or as active repeaters. The SEL-3031 is a low-power device using less than 5 W in the wall-mount version, which allows you to incorporate it into recloser controls, such as the SEL-651R Advanced Recloser Control. A 1 RU rack-mount version is also available.

# SEL-3061
## Cellular Router

Starting price
**$780 USD**

selinc.com/products/3061

The SEL-3061 is a secure router for critical applications. For electric utilities, the SEL-3061 provides connectivity to recloser controls, motor-operated switches, capacitor banks, voltage regulators, substations, and much more. The combination of serial and Ethernet ports provides application flexibility, and using public networks with secure tunneling makes installation easy without sacrificing security.

The SEL-3061 ensures the confidentiality and integrity of your data using comprehensive security methods that include IPsec data encryption, secure VPN connections, a stateful packet inspection (SPI) firewall, MAC address filtering, and syslog. You can manage user access using centralized authentication with Remote Authentication Dial-In User Service (RADIUS) support.

# SEL-2924

## Portable Bluetooth® Serial Adapter

Starting price
**$140 USD**

selinc.com/products/2924

The SEL-2924 connects to an EIA-232 port on a relay, controller, or other device as a portable solution for wireless communication from a convenient, safe location. You can use the built-in Bluetooth wireless capability of a laptop, smartphone, or other device to enable a secure wireless link from up to 10 m (32 ft) away. The adapter comes with batteries and a USB Standard-A to Micro-B cable for charging.


# SEL-2925

## Bluetooth Serial Adapter

Starting price
**$140 USD**

selinc.com/products/2925

The SEL-2925 connects to an EIA-232 port on a relay, controller, or other device and is useful for permanent installation to avoid entering hazardous areas. It transmits data at up to 115,200 bps to distances of 100 m (328 ft) in typical applications with a line-of-sight communications path. For even greater distances, you can use directional gain antennas. The adapter receives power via the included USB Standard-A to Micro-B cable. Optional accessories include a worldwide ac power supply or a USB cable with plain wires to connect the SEL-2925 to a 5 Vdc source.

# Precise Time Overview

## SEL-2488

The SEL-2488 receives GNSS time signals and distributes precise time via multiple output protocols, including IRIG-B, PTP, and NTP, with ±40 ns accuracy.

## SEL-2407®

The SEL-2407 provides a time display and high-accuracy timing (±100 ns).

## SEL-2401

The SEL-2401 is a satellite clock with high-accuracy timing (±100 ns) for compact spaces.

## SEL-2404

The SEL-2404 is a high-accuracy (±100 ns) satellite clock with a highly visible time display.

## SEL-3401

The SEL-3401 provides a highly visible time display for use anywhere there are time-critical functions set by IRIG-B synchronization signals.

## SEL-9929

The SEL-9929 kit includes a satellite-synchronized clock, a large digital clock display, and all accessories to work right out of the box.

## SEL-3400

The SEL-3400 verifies time signals and distributes precise time to 240 devices.


## SEL-3405

SEL-3405 transceivers send delay-compensated demodulated IRIG-B signals up to 4 km (2.5 mi) over fiber-optic cable.

## SEL-9524

The SEL-9524 is a rugged and reliable antenna for GNSS devices in critical infrastructure applications.

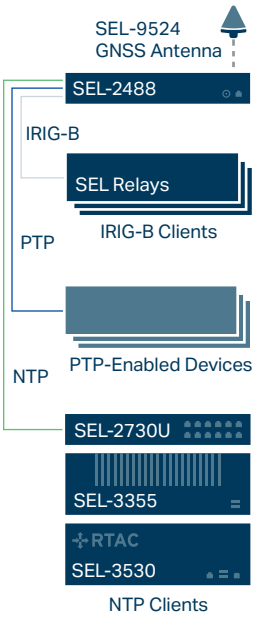
| Applications | SEL-2401 | SEL-2404 | SEL-2407® | SEL-3400 | SEL-3401 | SEL ICON® | SEL-2488 |
|---|---|---|---|---|---|---|---|
| Time Source for Substation | ■ | ■ | ■ | ■ | | ■ | ■ |
| Time Source for Industrial Applications | ■ | ■ | ■ | ■ | | ■ | ■ |
| Time Source for Phasor Measurement Unit (IEEE C37.118.1-2011 Synchrophasors) | ■ | ■ | ■ | ■ | | ■ | ■ |
| Time Source for Recloser | ■ | | ■ | | | | |
| Time Source for Line Current Differential Protection | ■ | ■ | ■ | ■ | | ■ | ■ |
| Time Source for Traveling-Wave Fault Location | ■ | ■ | ■ | ■ | | ■ | ■ |
| Time-Synchronized Event Reporting | ■ | ■ | ■ | ■ | | ■ | ■ |
| Long-Distance Viewing, 61 m (200 ft) | | ■ | | | ■ | | |
| **Time Sources and Time Distribution** | | | | | | | |
| Demodulated IRIG-B Outputs (Quantity) | 1 | 4 | 6 | 12 | 4+ | 4 | up to 8 |
| Modulated IRIG-B Outputs (Quantity) | | | 1 | | | | up to 4 |
| GPS Satellite Tracking | ■ | ■ | ■ | | | ■ | ■ |
| GLONASS Satellite Tracking (Reference Only) | | | | | | | ■ |
| Demodulated IRIG-B Input | | | | ■ | ■ | ■ | |
| Synchronized Pulse Output | ■ | ■ | ■ | | | | ■ |
| Network Time Protocol (NTP) Server | | | | | | | ■ |
| IEEE 1588 Precision Time Protocol (PTP) (With IEEE C37.238 Power System Profile) | | | | | | ■ | + |
| Satellite Signal Verification | | | | | | | ■ |
| **Features** | | | | | | | |
| 76.2 mm (3.0 in) LED Display | | ■ | | | ■ | | |
| 14 mm (0.56 in) LED Display | | | ■ | ■ | | | ■ |
| Rack-Mount Hardware | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Panel-Mount or Wall-Mount Hardware | ■ | ■ | ■ | ■ | ■ | ■ | |
| Universal Power Supply | | | ■ | ■ | | ■ | ■ |
| Dual, Redundant, Hot-Swappable Power Supplies | | | | | | ■ | ■ |
| Power Over Ethernet (PoE) Power Sourcing Equipment (PSE) | | | | | | ■ | |
| Secure Web Interface for Configuration | | | | | | | ■ |
| Serial Ports for Configuration | ■ | ■ | ■ | | | | |
| User-Based Accounts | | | | | | ■ | ■ |
| TCXO Holdover | ■ | ■ | ■ | | | ■ | ■ |
| OCXO Holdover | | | | | | | + |
| Time-Code Cable Delay Compensation | | | | ■ | | ■ | ■ |
| IEEE C37.90 and IEC 60255 Surge and Environmental Standards Compliance | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **Accuracy** | | | | | | | |
| Average Accuracy (ns) | ±100 | ±100 | ±100 | | | | ±40 |
| Peak Accuracy (ns) | ±500 | ±500 | ±500 | | | ±1,000 | ±100 |

■ Standard feature + Model option/accessory

# Precise Time Applications

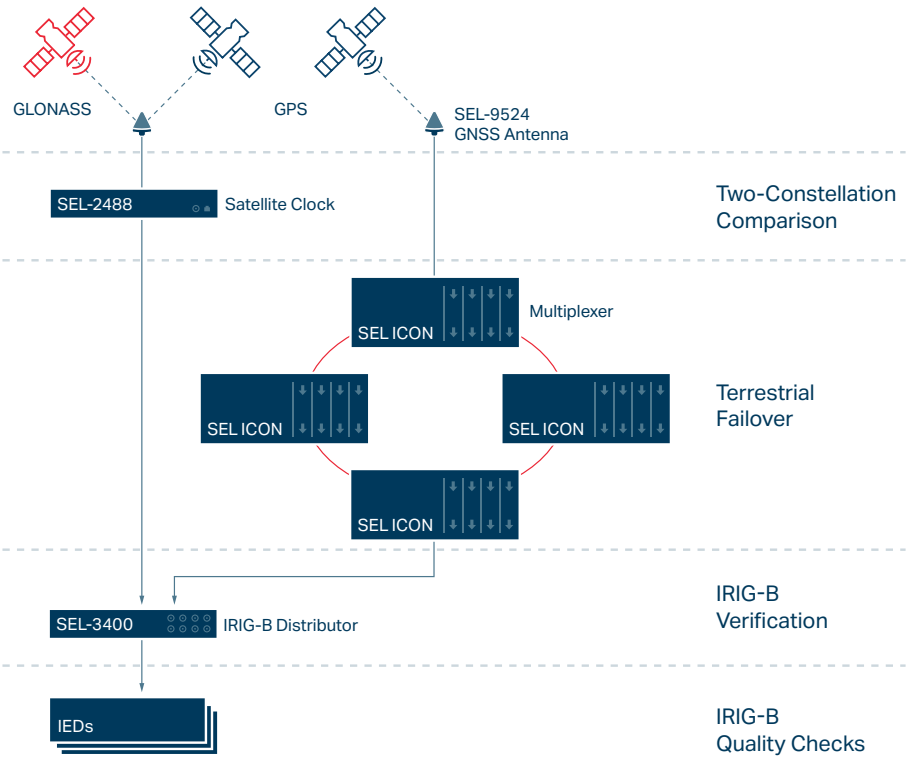
## Time synchronization in the substation

Use the SEL-2488 Satellite-Synchronized Network Clock's demodulated IRIG-B time outputs in electric utility applications to synchronize relays, phasor measurement units, and other IEDs to within ±40 ns average accuracy of UTC. You can configure modulated IRIG-B for as many as four SEL-2488 BNC outputs to synchronize legacy devices. Using the DB-9 port with SEL-3405 High-Accuracy IRIG-B Fiber-Optic Transceivers lets you send IRIG-B time code long distances over fiber-optic cable. The SEL-2488 Ethernet ports can use the Network Time Protocol (NTP) to distribute time to devices on the substation LAN, such as servers, computers, and other devices that set their time through NTP or the Simple Network Time Protocol (SNTP). With the Precision Time Protocol (PTP) option, the SEL-2488 acts as a PTP grandmaster clock, supporting both the default PTP profile (IEEE 1588-2008) and the power system profile (IEEE C27.238). The SEL-2488 can serve NTP or PTP to four independent networks.




## Layers of protection for time synchronization

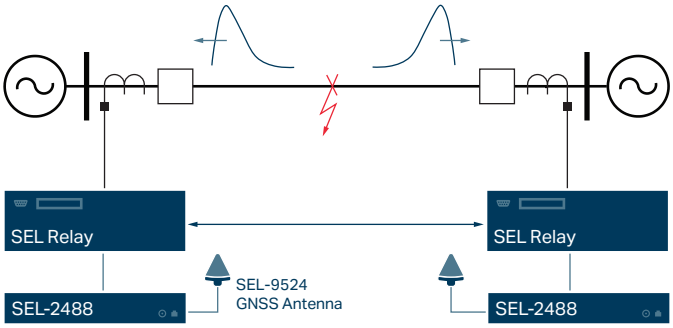
Configure your equipment to detect and respond to signal loss or degradation. Precise time is critical to the optimal operation of your system. You can combine SEL precise-time products into a multilayered system to ensure highly reliable time synchronization, from satellite signal acquisition through time distribution to end devices.

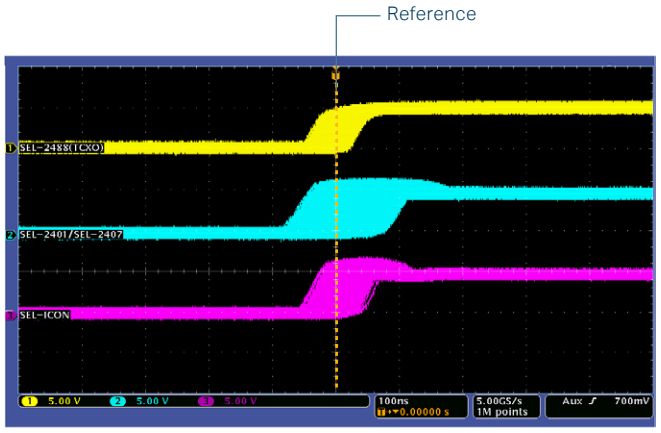


## High-accuracy time synchronization for advanced relaying applications

Take advantage of the high accuracy of SEL clocks to perform time-dependent relaying applications. The SEL time-based system for line current differential protection in SEL-400 series relays requires submicrosecond accuracy in order to operate properly. For traveling-wave fault locating in the SEL-411L Advanced Line Differential Protection, Automation, and Control System, the performance of the application is tied directly to the performance of the time source. SEL clocks have the accuracy required to meet these stringent requirements. With tight initial accuracy and excellent holdover performance, clocks like the SEL-2488 Satellite-Synchronized Network Clock exceed timing needs.

The oscilloscope plot shows the accuracy of SEL products. The offset from zero represents the average accuracy of the clock, and the width of the signal represents the variance in the accuracy; i.e., jitter.

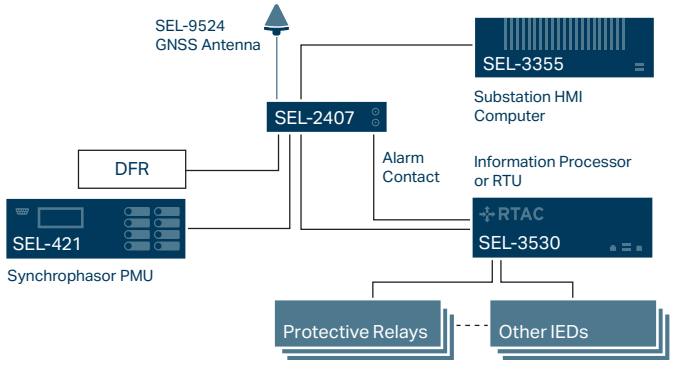



Dotted line represents 100 ns increments.

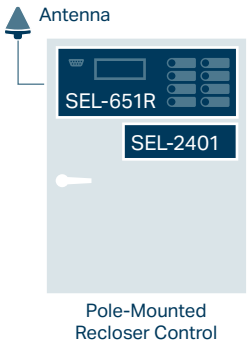
## Time synchronization with the SEL-2407®

Apply the SEL-2407 Satellite-Synchronized Clock in a substation to synchronize relays, phasor measurement units (PMUs), Sequential Events Recorders, information processors, and other devices. You can synchronize up to 120 devices via the six demodulated IRIG-B output ports. The SEL-2407 also has an additional port for distributing modulated IRIG-B.



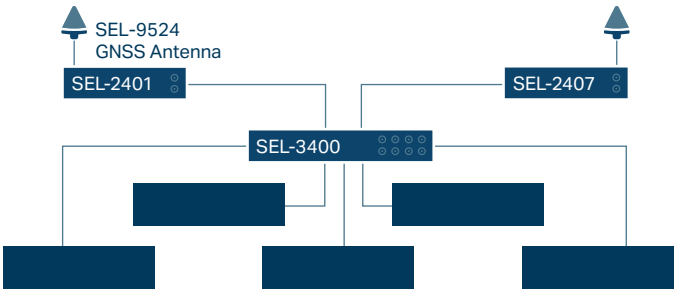
## Synchrophasor control and event reporting with the SEL-2401

Install the SEL-2401 Satellite-Synchronized Clock in recloser control enclosures for synchrophasor control and high-accuracy event correlation and reporting. The SEL-2401 is a compact, low-cost, low-power clock that is reliable in harsh environments.



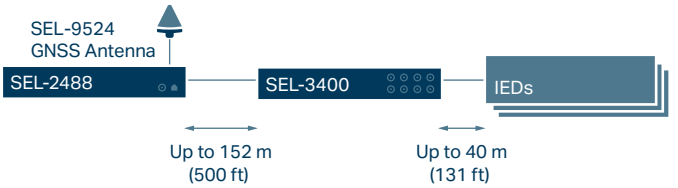

## Time source validation

Connect the SEL-3400 IRIG-B Distribution Module to two IRIG-B inputs. You can configure those inputs for redundancy to maintain accurate time in the event of time source degradation or failure.



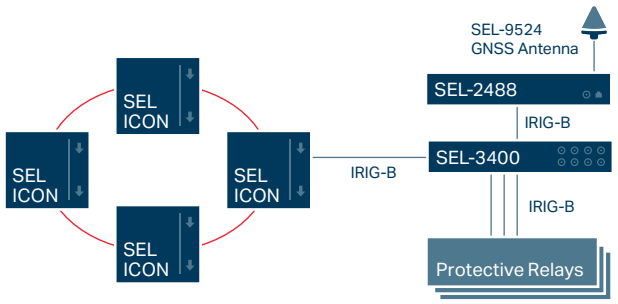

## Increased distance for IRIG-B cabling

Synchronize devices using demodulated IRIG-B by applying an SEL-3400 to extend the distance between the clock and the devices. This is useful in large facilities where you want to avoid using multiple GPS clocks. The SEL-3400 compensates for its input-to-output latency plus the latencies of connected cables.



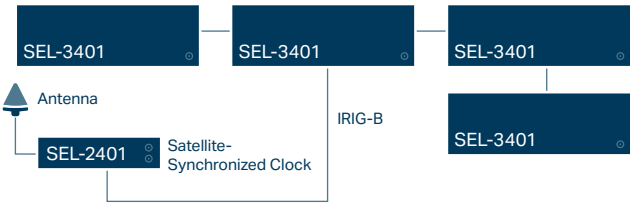
## Precise time distribution with the ICON® and SEL-3400

Distribute precise time throughout a WAN with the SEL ICON Integrated Communications Optical Network, and use the SEL-3400 for convenient distribution within racks or panels. The SEL-3400 receives a precise time signal from an ICON network or other precise time source and distributes time to up to 240 devices via 12 demodulated IRIG-B outputs.



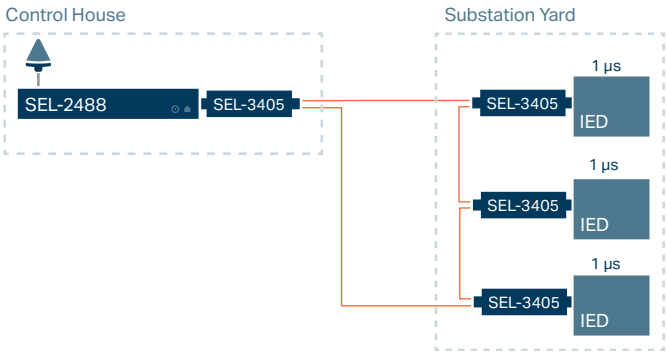

## Time display and communication with the SEL-3401

Use SEL-3401 Digital Clocks to display time in control rooms, substations, and industrial and manufacturing environments. Optional IRIG-B ports let you distribute time signals to additional clocks and devices.




## Time synchronization to remote devices

Use the SEL-3405 High-Accuracy IRIG-B Fiber-Optic Transceiver to send IRIG-B across distances where coaxial cabling is not feasible. Connecting an SEL-3405 at both the clock and the end device enables the device to receive delay-compensated IRIG-B, with no settings to adjust. The SEL-3405 automatically adjusts for the delay that occurs as the signal moves through the multimode fiber. With the SEL-3405, you can send time between individual devices or set up a ring network to provide <1 µs accurate IRIG-B signals to multiple devices simultaneously.

# SEL-2488

## Satellite-Synchronized Network Clock

Starting price
**$2,540 USD**

selinc.com/products/2488 | Select models typically ship in 2 days

The SEL-2488 receives GNSS time signals and distributes precise time via multiple output protocols, including IRIG-B and the Network Time Protocol (NTP). The SEL-2488 provides Parallel Redundancy Protocol (PRP) support as a dual attached node (DAN) device for NTP time distribution. When installed with a dual-constellation antenna, the SEL-2488 offers satellite signal verification by using signals from two satellite constellations to validate GNSS time signals, providing a layer of protection against spoofing attacks. With an optional upgrade, the SEL-2488 can serve as a Precision Time Protocol (PTP) grandmaster clock, as defined by IEEE 1588. The advanced capabilities of the SEL-2488 make it well-suited for demanding applications, such as synchrophasors, and for substations with multiple time synchronization requirements.


1. Status and activity LEDs
2. Multi-information LCD screen
3. Clock status LEDs
4. Local management port
5. Alarm and timer contact
6. Eight configurable BNC time outputs (demodulated IRIG-B, pulse per second [PPS], kPPS, and modulated IRIG-B)
7. Four standard Ethernet ports
8. DB-9 port for IRIG-B output or pulse output
9. Antenna port (TNC)
10. Standard power supply
11. Optional redundant, hot-swappable power supply

# SEL-2407®
## Satellite-Synchronized Clock

Starting price
**$1,250 USD**

selinc.com/products/2407 | Select models typically ship in 2 days

The SEL-2407 is a reliable, durable clock that offers a time display and high-accuracy, satellite-synchronized timing. The SEL-2407 provides ±100 ns average timing accuracy (±500 ns peak) for IEEE C37.118 synchrophasor control function extensions and event correlation and reporting. IEEE C37.90 and IEC 60255 design standards ensure accurate timing over a temperature range of –40° to +80°C (–40° to +176°F) and in the presence of electrical surges and power supply variations. One modulated and six demodulated IRIG-B outputs let you synchronize relays directly or through an SEL information processor.


# SEL-2401
## Satellite-Synchronized Clock

Starting price
**$520 USD**

selinc.com/products/2401 | Select models typically ship in 2 days

The SEL-2401 is a compact, precise-time device that offers ±100 ns timing accuracy for applications such as IEEE C37.118 synchrophasor control function extensions and event correlation and reporting. The SEL-2401 provides accurate operation from –40° to +80°C (–40° to +176°F) and is compliant with IEEE C37.90 and IEC 60255. You can synchronize up to 20 devices from one IRIG-B output. The SEL-2401 is FCC Part 15, Class A emissions-certified for industrial sites.

# SEL-2404
## Satellite-Synchronized Clock

selinc.com/products/2404

Starting Price
**$1,250 USD**


The SEL-2404 is a reliable, durable clock with a 76 mm (3 in) LED time display. Four demodulated IRIG-B outputs with an average accuracy of ±100 ns (±500 ns peak) meet requirements for existing and future timing applications.

# SEL-3401
## Digital Clock

selinc.com/products/3401

Starting Price
**$410 USD**


The SEL-3401 provides a highly visible time display for use anywhere there are time-critical functions. Easy-to-read 76 mm (3 in) LED digits are visible up to 60 m (200 ft) away. The SEL-3401 is set by IRIG-B signals and includes up to four IRIG-B outputs to send time signals to other SEL digital clocks or devices.

# SEL-9929
## Satellite-Synchronized Clock Display Kit

selinc.com/products/9929

Starting Price
**$1,090 USD**


This kit includes a satellite-synchronized clock, a large digital clock display, and all accessories to work right out of the box. The clock supplies accurate time to synchronize up to 15 display clocks. The clock display has high-visibility LED digits that can be read up to 60 m (200 ft) away. The clock and display are designed to work in harsh environments with a wide operating temperature.

# SEL-3400
## IRIG-B Distribution Module

selinc.com/products/3400

Starting Price
**$730 USD**


The SEL-3400 is a cost-effective, reliable, and precise way to distribute demodulated IRIG-B time information. With 12 IRIG-B distribution ports and a bright display, the SEL-3400 is ideal for time distribution in panels. When using two time inputs, the SEL-3400 automatically selects the best source for maintaining time. It exceeds IEEE C37.90 and IEC 60255 protective relay standards and accurately operates from –40° to +85°C (–40° to +185°F).

# SEL-3405

## High-Accuracy IRIG-B Fiber-Optic Transceiver

Starting price
**$200 USD**

selinc.com/products/3405 | Select models typically ship in 2 days

SEL-3405 transceivers provide a multimode fiber link between two DB-9 serial ports, sending delay-compensated demodulated IRIG-B up to 4 km (2.5 mi) over a fiber-optic cable. The transceivers require no settings to accurately calculate the delay compensation.


# SEL-9524

## GNSS Antenna

Starting price
**SEL-9524A: $260 USD**
**SEL-9524B: $320 USD**

selinc.com/products/9524 | Select models typically ship in 2 days

The SEL-9524 is a rugged and reliable antenna designed for GNSS devices in critical infrastructure applications. The antenna is IP68-rated, making it suitable for harsh environments. Industry-leading surge immunity allows this antenna to provide superior performance in the presence of lightning and other surge events. The SEL-9524A receives GPS signals, and the SEL-9524B receives both GPS and GLONASS signals.

# Annunciation and Notification Overview

## SEL-2523

selinc.com/products/2523

Starting Price
**$3,830 USD**

Provide local and remote notifications with the SEL-2523 Annunciator Panel, which includes programmable logic and up to four communications ports.

## SEL-2522

selinc.com/products/2522

Starting Price
**$2,180 USD**

Apply the SEL-2522 Alarm Panel with up to 36 inputs to easily view the status of alarms and operating events.

## SEL-2533

selinc.com/products/2533

Starting Price
**$1,560 USD**

Use the compact, ten-window SEL-2533 Annunciator to provide local and remote annunciation.

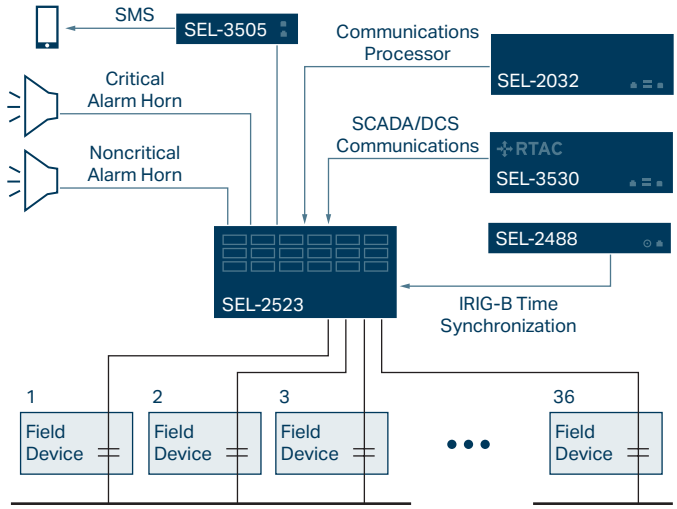
| | SEL-2522 | SEL-2523 | SEL-2533 |
|---|---|---|---|
| **Applications** | | | |
| Local Visual Indication | ■ | ■ | ■ |
| Remote Visual Indication | | ■ | ■ |
| Local Audible Indication | ■ | ■ | ■ |
| Remote Audible Indication | ■ | ■ | ■ |
| Telephone Dial-Out Messages | | ■ | ■ |
| Local SELOGIC® Control Equations and Time Tagging | | ■ | ■ |
| **Mounting and Labeling** | | | |
| Rack Mount | + | + | |
| Panel Mount | + | + | ■ |
| User-Defined Slide-In Labels | ■ | ■ | ■ |
| **Inputs, Outputs, and HMI** | | | |
| General-Purpose Digital Inputs | 36 | 42 | 14+ |
| Acknowledge, Reset, Test Digital Inputs | 3 | 6 | 4+ |
| General-Purpose Digital Outputs | 1 | 11 | 14+ |
| Alarm Digital Output | 1 | 1 | 1 |
| General Display LEDs/Windows | 36 | 36 | 10 |
| Enabled LED | 1 | 1 | 1 |
| Pushbuttons | 3 | 4 | 4 |
| Base Serial Ports | | 3 | 3 |
| Optional Additional EIA-232 or EIA-485 Port | | 1 | 1 |
| IRIG-B Time Input | | 1 | 1 |
| ISA Annunciation Alarm Sequence Choices | 2 | 8 | 8 |
| **Serial Communications Protocols** | | | |
| SEL MIRRORED BITS® Communications | | ■ | ■ |
| SEL Fast Messages | | ■ | ■ |
| Send SEL Messenger Points | | ■ | ■ |
| Modbus RTU | | ■ | ■ |
| DNP3 Level 2 Outstation | | + | + |

■ Standard feature + Model option

# Annunciation and Notification Applications

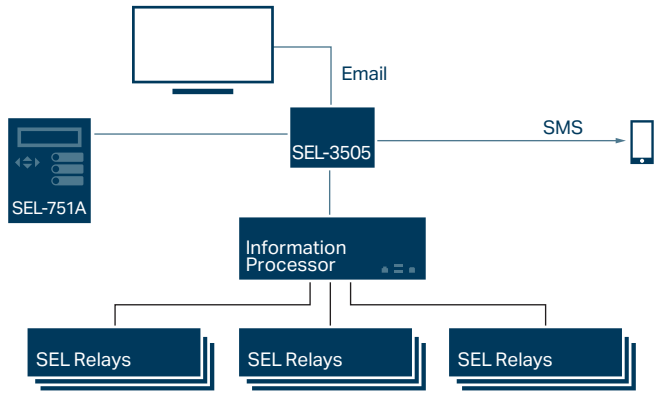
## System monitoring

Receive station equipment status information through hardwired contacts or communications devices to provide a single-point alarm station. SEL annunciators can monitor equipment, report the status of any equipment that has failed, and notify local and remote personnel of current conditions.



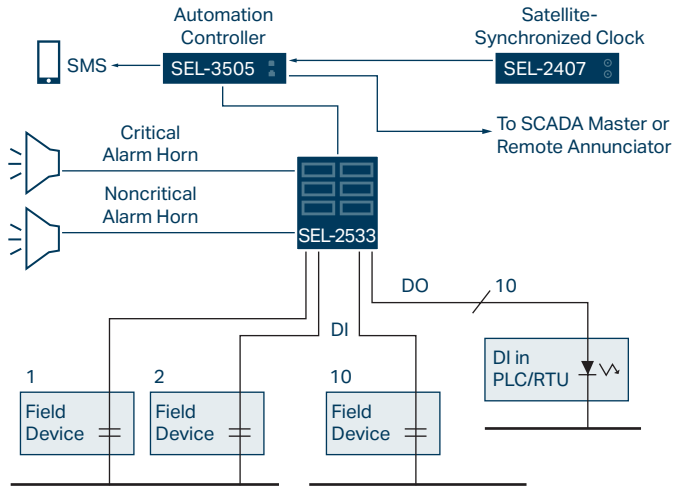

## Remote alarm notification

Transmit important system data and alarm information by phone to on-call operators. SEL annunciators enable on-call responses to critical alarms for municipal and industrial sites.




## Automated alarming

Eliminate control hardwiring with 40 remote control bits. With SELOGIC® control equations, you can program remote bits into custom control schemes, such as SCADA-type control operations (i.e., alarm triggers), acknowledgment, and device status indication.



## SEL-2505/2506/2507

selinc.com/products/2505
selinc.com/products/2506
selinc.com/products/2507
Select models typically ship in 2 days

Starting Price
**$550 USD**


Reduce operating time, add self-wiring, and simplify wiring for auxiliary inputs and outputs with the SEL-2505 Remote I/O Module, SEL-2506 Rack-Mount Remote I/O Module, and SEL-2507 High-Speed Remote I/O Module.

## SEL-2515/2516

selinc.com/products/2515
selinc.com/products/2516

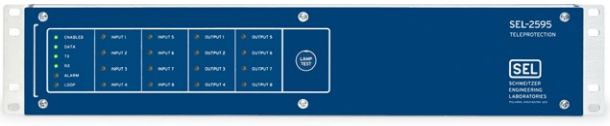
Starting Price
**$550 USD**

Extend contact I/O for SEL information processors with the SEL-2515 Remote I/O Module and the SEL-2516 Rack-Mount Remote I/O Module. They monitor the status of external contacts transmitted via SEL Fast Meter messages to a communications processor and can control contact outputs using SEL Fast Operate commands.

## SEL-2595

selinc.com/products/2595

Starting Price
**$1,740 USD**




Use the SEL-2595 Teleprotection Terminal to securely transfer teleprotection signals through a high-speed IEEE C37.94 optical-fiber interface.

## SEL-3094

selinc.com/products/3094

Starting Price
**$710 USD**

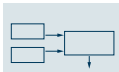

Implement the SEL-3094 Interface Converter to convert electrical teleprotection interfaces to the IEEE C37.94 optical standard for improved safety, signal integrity, and communication over longer distances. Connecting an SEL-3094 to an ITU-T G.703, EIA-422, EIA-485, or EIA-232 device lets you use up to 2 km (1.2 mi) of optical fiber to link to an IEEE C37.94 multiplexer.

| Applications | SEL-2505 | SEL-2506 | SEL-2507 | SEL-2515 | SEL-2516 | SEL-2595 |
|---|---|---|---|---|---|---|
| Save Wiring Via I/O Multiplexing | ■ | ■ | ■ | ■ | ■ | ■ |
| I/O for SEL Relays/SEL-3530/SEL-2100 | ■[1] | ■[1] | ■[1] | | | |
| I/O for Information Processors | | | | ■[1] | ■[1] | |
| Transfer I/O to SEL-2505/2506/2507 | ■ | ■ | ■ | | | |
| Transfer I/O to SEL-2507/T400L With Millisecond Mirrored Bits® Communications | | | ■ | | | |
| Transfer I/O to SEL-2594/2595 | | | | | | ■ |
| Teleprotection | ■ | ■ | ■ | | | ■ |
| Improve Safety With Optical Fiber | ■ | ■ | ■ | ■ | ■ | ■ |

| Number of I/O Channels | SEL-2505 | SEL-2506 | SEL-2507 | SEL-2515 | SEL-2516 | SEL-2595 |
|---|---|---|---|---|---|---|
| Digital Inputs (DI) Base | 8 | 8 | 8 | 8 | 8 | 8 |
| DI Maximum | 8 | 8 | 8 | 8 | 8 | 8 |
| Digital Outputs (DO) Base | 8 | 8 | 8 | 8 | 8 | 8 |
| DO Maximum | 8 | 8 | 8 | 8 | 8 | 8 |
| **Serial Communications Protocols** | | | | | | |
| SEL Mirrored Bits Communications | ■ | ■ | ■ | | | |
| SEL Fast Messages | | | | ■ | ■ | |
| IEEE C37.94 | | | | | | ■ |

■ Standard feature

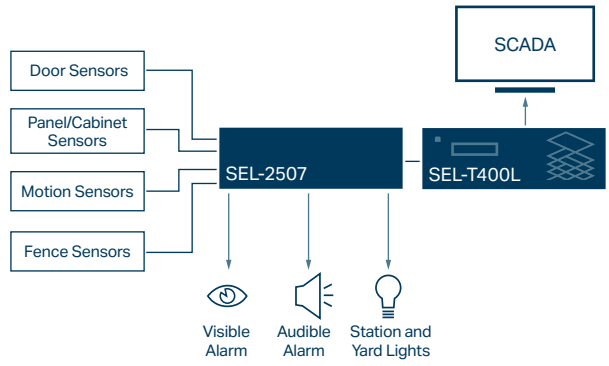
[1]With compatible SEL fiber-optic transceiver or interface option at relay or processor



# Remote I/O Applications

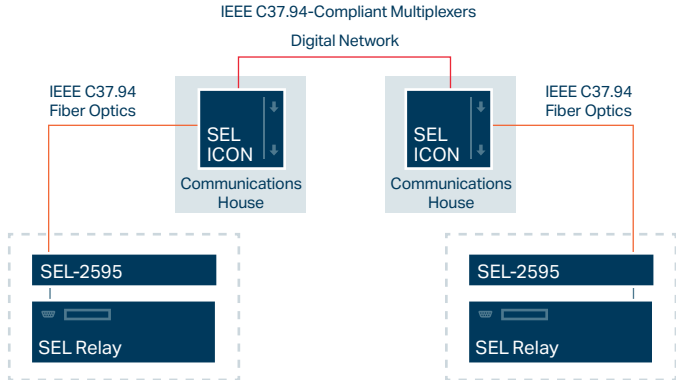
## Substation physical security

Enhance substation security monitoring and protection with motion detectors, touch sensors, visible and audible alarms, and lighting technology. You can send substation security information to a SCADA system with Modbus or DNP3 over serial or Ethernet connections.




## Teleprotection

Send and receive transfer trip commands between substations with high-speed teleprotection equipment and protective relays.



# Transceivers and Adapters Overview


## SEL-2800/2815

Starting Price: **$110 USD**

selinc.com/products/2800
selinc.com/products/2815
Select models typically ship in 2 days

Improve safety, signal integrity, and reliability of EIA-232 communications by using multimode SEL-2800/2815 Fiber-Optic Transceivers instead of wire.

## SEL-2810/2812/2814

Starting Price: **$140 USD**

selinc.com/products/2810
selinc.com/products/2812
selinc.com/products/2814
Select models typically ship in 2 days

Use EIA-232 multimode fiber-optic transceivers instead of wire. The SEL-2810 and SEL-2812 support IRIG-B time signals, while the SEL-2814 works with hardware flow control signals.


## SEL-2829/2830/2831

Starting Price: **$440 USD**

selinc.com/products/2829
selinc.com/products/2830
selinc.com/products/2831
Select models typically ship in 2 days

Apply the SEL-2829/2830/2831 Single-Mode Fiber-Optic Transceiver/Modem to use two optical fibers instead of wire to transfer bidirectional serial data.


## SEL-2820/2824

Starting Price: **$260 USD**

selinc.com/products/2820
selinc.com/products/2824
Select models typically ship in 2 days

Apply SEL-2820/2824 Multimode Fiber-Optic Transceivers to safely add isolated segments to multidrop and point-to-point EIA-485 networks.


## SEL-2890

Starting Price: **$210 USD**

selinc.com/products/2890
Select models typically ship in 2 days

Add Ethernet connectivity to an SEL device using its EIA-232 serial port with the SEL-2890 Ethernet Transceiver.


## SEL-9192

Starting Price: **$260 USD**

selinc.com/products/9192

Connect remote terminal units (RTUs), communications processors, and other equipment with the SEL-9192 Utility-Grade USB Modem for dial-up or dial-out engineering access.

## SEL-9220

Starting Price: **$340 USD**

selinc.com/products/9220

Convert the EIA-485 port of an SEL-300 series relay to a point-to-point fiber-optic port with the SEL-9220 Fiber-Optic Adapter for SEL-300 Series Relays.

## SEL-2894

Starting Price: **$370 USD**

selinc.com/products/2894

Select models typically ship in 2 days

Apply the SEL-2894 Interface Converter to transfer SEL MIRRORED BITS® communications via an IEEE C37.94 fiber-optic link through a communications multiplexer.

## SEL-2886

Starting Price: **$140 USD**

selinc.com/products/2886

Select models typically ship in 2 days

Connect EIA-232 devices to an EIA-485 network with SEL-2886 EIA-232 to EIA-485 Interface Converters.

| | SEL-2800 | SEL-2810 | SEL-2812 | SEL-9220 | SEL-2814 | SEL-2815 | SEL-2820 | SEL-2824 | SEL-2829 | SEL-2830 | SEL-2831 | SEL-2894 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Connector and Optics** | | | | | | | | | | | | |
| V-Pin, 650 nm Wavelength | ■ | ■ | | | | | ■ | | | | | |
| ST, 850 nm Wavelength | | | ■ | ■ | ■ | ■ | | ■ | | | | ■ |
| ST, 1,300 nm Wavelength | | | | | | | | | ■ | ■ | | |
| ST, 1,550 nm Wavelength | | | | | | | | | | | ■ | |
| **Fiber Compatibility** | | | | | | | | | | | | |
| 200 µm Core Multimode Fiber (SEL-C805) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | |
| 50 or 62.5 µm Core Multimode Fiber (SEL-C807, SEL-C808) | | | ■ | ■ | ■ | ■ | | ■ | | | | ■ |
| 9 µm Core Single-Mode Fiber (SEL-C809) | | | | | | | | | ■ | ■ | ■ | |
| **Electrical Features** | | | | | | | | | | | | |
| EIA-232 Asynchronous Serial Data | ■ | ■ | ■ | | ■ | ■ | | | ■ | ■ | | ■ |
| EIA-485 Asynchronous Serial Data | | | | ■ | | | ■ | ■ | | | | |
| DTE/DCE Switch | | | | | ■ | ■ | | | ■ | ■ | | |
| IRIG-B Transfer With Data | | ■ | ■ | ■ | | | | | | | | |
| Hardware Flow Control Lines With Data | | | | | ■ | | | ■ | | | | |
| Power From Electrical Port Pins | ■ | ■ | ■ | ■ | ■ | ■ | | | ■ | ■ | ■ | ■ |
| External Power Jack or Terminals | | | | | ■ | | ■ | ■ | | | | |
| **Distances** | | | | | | | | | | | | |
| Minimum (metric) | 1 m | 1 m | 1 m | 1 m | 1 m | 2 km | 1 m | 1 m | 1 m | 16 km | 16 km | 1 m |
| Minimum (U.S.) | 3.28 ft | 3.28 ft | 3.28 ft | 3.28 ft | 3.28 ft | 1.24 mi | 3.28 ft | 3.28 ft | 3.28 ft | 9.94 mi | 9.94 mi | 3.28 ft |
| Maximum (metric) | 500 m | 500 m | 4 km | 4 km | 4 km | 15 km | 500 m | 4 km | 23 km | 80 km | 110 km | 2 km |
| Maximum (U.S.) | 0.3 mi | 0.3 mi | 2.48 mi | 2.48 mi | 2.48 mi | 9.3 mi | 0.3 mi | 2.48 mi | 14.3 mi | 49.7 mi | 68.3 mi | 1.2 mi |

■ Standard feature

# Cables Overview

## SEL-C804

Starting Price: **$53 USD**

selinc.com/products/C804

Select models typically ship in 2 days

Use SEL-C804 Multimode Arc-Flash Detection Fiber-Optic Cables with the SEL-751, SEL-751A, and SEL-710-5 to detect arc-flash events.

## SEL-C805

Starting Price: **$41 USD**

selinc.com/products/C805

Connect V-pin or ST ports with SEL-C805 200 µm Multimode Fiber-Optic Cable assemblies.

## SEL-C807

Starting Price: **$51 USD**

selinc.com/products/C807

Use SEL-C807 62.5/200 µm Multimode Fiber-Optic Cable assemblies to connect ST or LC ports.

## SEL-C808

Starting Price: **$53 USD**

selinc.com/products/C808

Select models typically ship in 2 days

Connect ST, SC, or LC ports with SEL-C808 62.5/125 µm Multimode Fiber-Optic Cable assemblies.

## SEL-C809

Starting Price: **$56 USD**

selinc.com/products/C809

Use SEL-C809 9 µm Single-Mode Fiber-Optic Cable assemblies to connect ST, SC, or LC ports.

## Electrical Data Cables

Starting Price: **$26 USD**

selinc.com/products/electrical-data-cables

Select models typically ship in 2 days

Apply SEL Electrical Data Cables to reliably connect SEL products and other devices, including relays, information processors, computers, I/O modules, meters, clocks, and modems.

## Coaxial Cables

Starting Price: **$16 USD**

selinc.com/products/coaxial-cables

Select models typically ship in 2 days

Use SEL Coaxial Cables for GPS and radio antenna connections and IRIG-B time distribution.

## Category 5e Ethernet

Starting Price: **$32 USD**

selinc.com/products/category-5e-ethernet

Select models typically ship in 2 days

Apply high-quality, shielded twisted-pair (STP) Category 5e Ethernet cables for copper Ethernet connections.

## USB Serial Cables

Starting Price: **$66 USD**

selinc.com/products/usb-serial

Select models typically ship in 2 days

Add a 1.8 m (6 ft) or 4.6 m (15 ft) EIA-232 serial port cable to a PC USB port to communicate with SEL relays and other devices with EIA-232 serial ports.

| Connector | SEL-C804 | SEL-C805Z | SEL-C805D | SEL-C805G | SEL-C807Z | SEL-C807G | SEL-C808Z | SEL-C808P | SEL-C808G | SEL-C809Z | SEL-C809P | SEL-C809G |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V-Pin | ■ | ■ | ■ | ■ | | | | | | | | |
| ST | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| LC | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| SC | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ |
| **Fiber Diameter (Core/Outer)** | | | | | | | | | | | | |
| 1,000 µm | ■ | | | | | | | | | | | |
| 200 µm | | ■ | ■ | ■ | | | | | | | | |
| 62.5/200 µm | | | | | ■ | ■ | | | | | | |
| 62.5/125 µm | | | | | | | ■ | ■ | ■ | | | |
| 9/125 µm | | | | | | | | | | ■ | ■ | ■ |
| **Wavelength** | | | | | | | | | | | | |
| 650 nm (Multimode) | | ■ | ■ | ■ | | | | | | | | |
| 850 nm (Multimode) | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| 1,300 nm (Multimode) | | | | | ■ | ■ | ■ | ■ | ■ | | | |
| 1,300–1,550 nm (Single-Mode) | | | | | | | | | | ■ | ■ | ■ |
| **Fiber Count** | | | | | | | | | | | | |
| Simplex (1 Fiber) | ■ | ■ | | | ■ | | ■ | ■ | | ■ | ■ | |
| Duplex (2 Fibers) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Quad (4 Fibers) | | | ■ | ■ | | ■ | | | ■ | | | |
| **Cable Ratings** | | | | | | | | | | | | |
| Riser-Rated (OFNR) | | ■ | ■ | | ■ | | ■ | | ■ | ■ | | ■ |
| Plenum-Rated (OFNP) | | | | | | | | ■ | | | ■ | |
| Water-Blocked | | | ■ | | | | | | | | | |
| Waterproof | | | | ■ | | ■ | | | ■ | | | ■ |

| Jacket Material | SEL-C804 | SEL-C805Z | SEL-C805D | SEL-C805G | SEL-C807Z | SEL-C807G | SEL-C808Z | SEL-C808P | SEL-C808G | SEL-C809Z | SEL-C809P | SEL-C809G |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Polyvinyl Chloride (PVC) | | ■ | ■ | | ■ | | ■ | ■ | ■ | ■ | ■ | ■ |
| Polyethylene (PE) | ■ | | | ■ | | ■ | | | | | | |
| **Termination kits** | | | | | | | | | | | | |
| V-Pin Termination Kit | ■ | ■ | ■ | ■ | | | | | | | | |
| ST Termination Kit | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | |
| LC, ST, and SC Termination Kit | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ |
| **Options** | | | | | | | | | | | | |
| Bulk (No Connectors) | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Pulling Loop | | | ■ | ■ | | ■ | | | ■ | | | |
| **Fiber-Optic Compatibility** | | | | | | | | | | | | |
| SEL-2800/2810/2820 | | ■ | ■ | ■ | | | | | | | | |
| SEL-2812/2814/2815/2824/3405/9220 | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| SEL-2829/2830 | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| SEL-2831 | | | | | | | | | | ■ | ■ | ■ |
| SEL-751/751A/710-5 Arc-Flash Detection | ■ | | | | | | | | | | | |
| Multimode Fiber-Optic Ethernet | | | | | ■ | ■ | ■ | ■ | ■ | | | |
| Single-Mode Fiber-Optic Ethernet | | | | | | | | | | ■ | ■ | ■ |

■ Standard feature

# Accessories and Tools Overview

## SEL-4388

Starting Price: **$310 USD**

selinc.com/products/4388

Select models typically ship in 2 days

Accelerate commissioning and bench testing of SEL MIRRORED BITS® links and improve training, maintenance, and cable identification with the SEL-4388 MIRRORED BITS Tester.

## SEL-4520

Starting Price: **$420 USD**

selinc.com/products/4520

Select models typically ship in 2 days

Use the SEL-4520 Arc-Flash Test Module to conveniently test the operation of arc-flash detection relays installed in metal-clad and metal-enclosed switchgear.

## SEL-2652

Starting Price: **$210 USD**

selinc.com/products/2652

Verify circuit breaker or lockout relay trip coil and trip circuit connections with the SEL-2652 Trip Coil Monitor.

## SEL-9510

Starting Price: **$320 USD**

selinc.com/products/9510

Select models typically ship in 2 days

Use the SEL-9510 Control Switch Module where independent local control is needed. High-visibility status indication and arc-suppressed contacts are ideal for breaker control.

## SEL-2126

Starting Price: **$2,830 USD**

selinc.com/products/2126

Apply the SEL-2126 Fiber-Optic Transfer Switch to reroute IEEE C37.94 communications for bypass breaker protection during circuit breaker or station bypass operations.

## SEL-2910

Starting Price: **$90 USD**

selinc.com/products/2910

Select models typically ship in 2 days

Use the SEL-2910 Port Isolator to protect the EIA-232 ports of data terminal or communications equipment from induced voltages.

## SEL-9501/9502

Starting Price: **$87 USD**

selinc.com/products/9501

selinc.com/products/9502

Select models typically ship in 2 days

Decrease maintenance costs, increase contact reliability, and reduce destructive dc circuit overvoltages with the self-powered SEL-9501/9502 Contact Arc Suppressors.

## SEL-9321

Starting Price: **$200 USD**

selinc.com/products/9321

Select models typically ship in 2 days

Convert high-voltage dc battery sources for use with communications or instrumentation devices with the SEL-9321 Low-Voltage DC Power Supply.

## SEL-9322

Starting Price: **$160 USD**

selinc.com/products/9322

Select models typically ship in 2 days

Apply the SEL-9322 15 Vdc Power Supply for ac-to-dc or dc-to-dc conversion in harsh physical and electrical environments, including those found in substations.

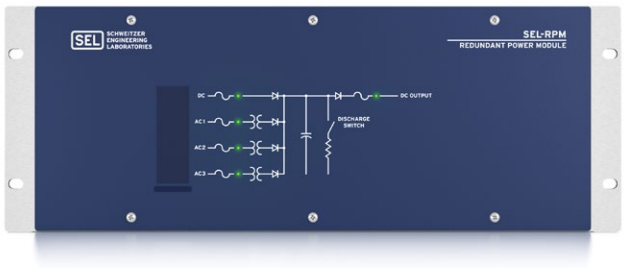
# SEL-RPM

## Redundant Power Module NEW

Starting price
**$1.800 USD**

selinc.com/products/RPM | Select models typically ship in 2 days

The SEL-RPM combines as many as three ac sources and one dc source to provide a single reliable dc output (unregulated 125 Vdc) to power your protection, monitoring, and control equipment. Large energy storage capacitors provide ride-through capability and support switch or breaker trip/close applications when all input sources are lost.




### Improved substation power availability and reliability

By combining multiple sources, the SEL-RPM relies on control power diversity to keep protection, monitoring, and control equipment running during the loss of any single source. A momentary interruption can cause a much longer loss of device availability. The module's reliable unregulated 125 Vdc output helps reduce device restarts and enables equipment to continue operating.

### Ride-through capability

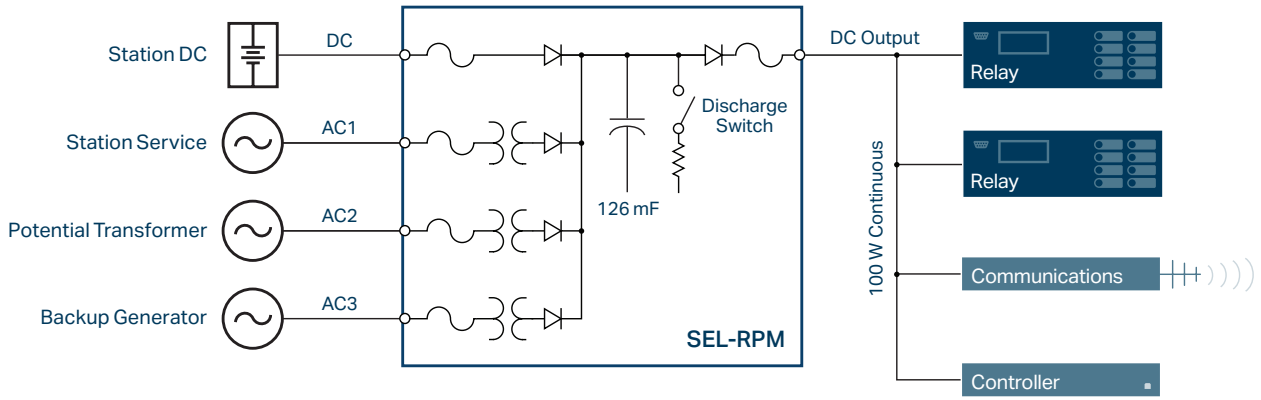
Large energy storage capacitors allow the SEL-RPM to provide significant ride-through time for equipment when all input sources are lost, enabling continued operation through momentary power interruptions. The SEL-RPM provides 60 seconds (nominal) of ride through for a 25 W connected load.

### Breaker tripping

The SEL-RPM allows protection and control equipment to trip breakers before running out of energy in the event of a total loss of power supply. It provides 100 W continuous and 30 A momentary surge current to trip breakers. Even without any energized sources, the SEL-RPM capacitors provide 1,500 watt-seconds (nominal) of energy for tripping purposes.

### Ease of use

The SEL-RPM has no jumpers or settings, making it simple to use. It is also maintenance-free because there are no batteries, firmware, or other components that wear out or need attention. You can install one SEL-RPM in the empty section of each panel to power multiple relays. It provides the source diversity of a dual battery system without the high costs of installing and maintaining a second battery system.



# Bookstore

Order online at selinc.com/bookstore

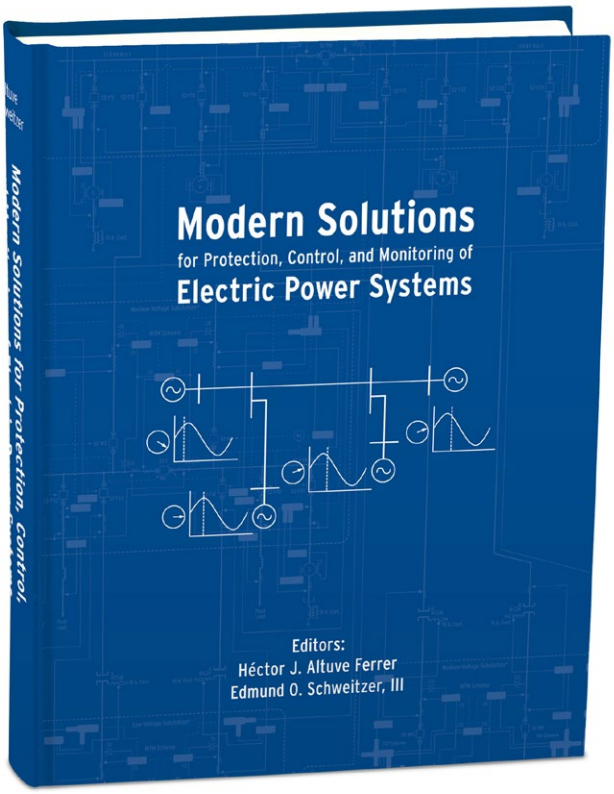
## Modern Solutions for Protection, Control, and Monitoring of Electric Power Systems

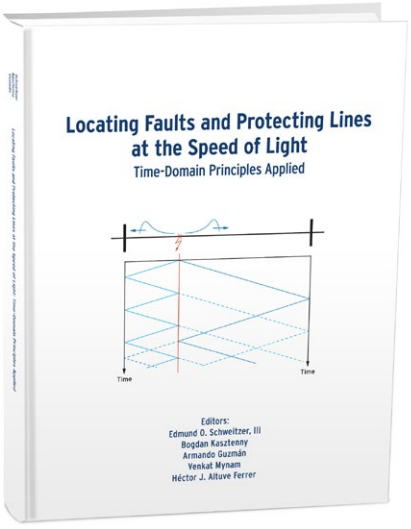
The most comprehensive work of its kind, this book consolidates new, modern solutions for protection, control, and monitoring of electric power systems.

You'll find straightforward presentations and example applications of the following technologies:

- Time-synchronized protection, control, and monitoring.
- Wide-area protection and control using synchrophasors.
- Sensible cybersecurity and a security-in-depth tool kit.
- Distribution systems that deliver safe operation and rapid power restoration after faults.
- Transmission protection solutions that improve stability, detect power swings, and help you get the most out of your primary equipment.

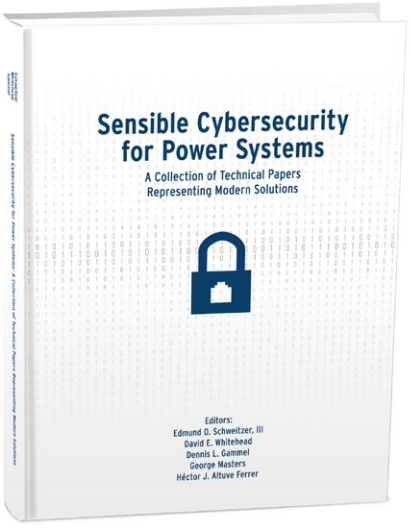
Spanish version available



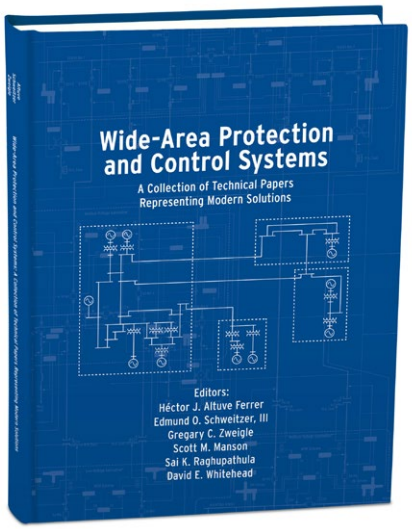

## Locating Faults and Protecting Lines at the Speed of Light

This book, composed of 15 technical papers, explains traveling waves and instantaneous incremental quantities for line protection and fault locating.



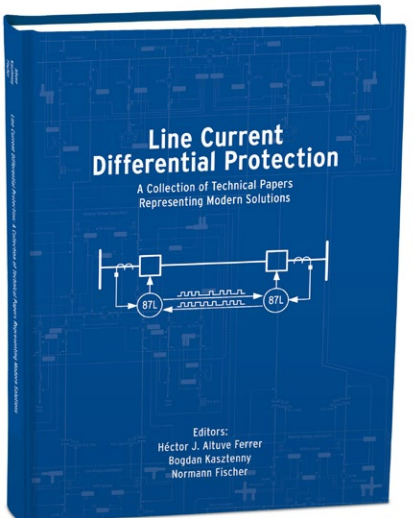

## Sensible Cybersecurity for Power Systems

This book, composed of over 25 technical papers, provides an overview of power system cybersecurity challenges, opportunities, and solutions.



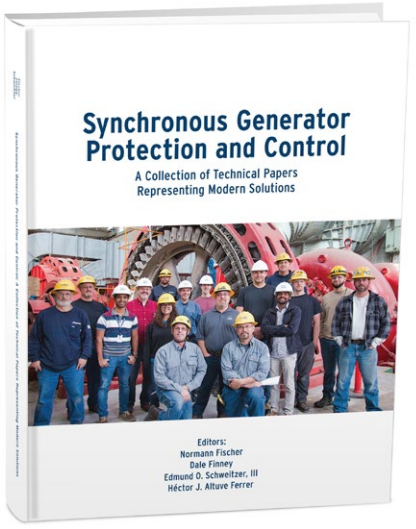

## Wide-Area Protection and Control Systems

This book, composed of 41 technical papers, covers the practical technology and solutions for wide-area protection and control that are in service today.



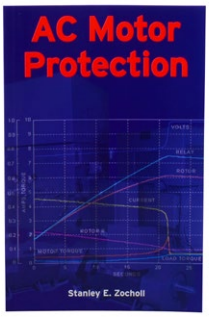

## Line Current Differential Protection

This book, composed of 15 technical papers, addresses the design and application of line current differential protection, communications, and fault locating, from both the protection and communications perspectives.



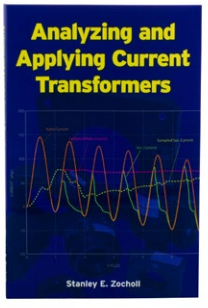

## Synchronous Generator Protection and Control

This book, composed of 27 technical papers, covers modern technologies for synchronous generator protection, control, and monitoring.




## AC Motor Protection

This book, written for the practicing engineer, covers ac motor characteristics and protection principles in a concise and practical way.




## Analyzing and Applying Current Transformers

This concise book explains fundamental concepts for non-linear characteristics, accuracy ratings, and transient behavior of current transformers.

# SEL University

SEL University trains power system professionals in areas ranging from fundamental power system protection principles to hands-on product application and testing. We provide the training you need to make electric power safer, more reliable, and more economical. Our power system experts have trained tens of thousands of industry professionals worldwide. Our instructors are the same industry experts who design SEL equipment and solutions, support customers, and add to the field of knowledge through industry publications.

## Classroom-Based Training

### Scheduled classroom-based courses

With scheduled SEL University courses, you can:

- Learn at convenient locations around the world.
- Receive fundamentals and hands-on training.
- Network with other industry professionals.
- Easily view the course schedule and register online.

### On-site and virtual company training

With our on-site training option, you supply the training room and we provide the equipment, course materials, and instructors. Training can also be delivered virtually using video conferencing software. On-site and virtual training allow you to:

- Choose a standard course or mix and match standard course material to meet your needs.
- Reduce travel expenses and train more employees at one time.
- Address your company's specific training needs in a confidential environment.

## Course Types

### Power system

Power system fundamentals for engineers.

### Protection

Power system protection fundamental principles and applications.

### Communications

Introductory and advanced networking and data communications fundamentals.

### Application

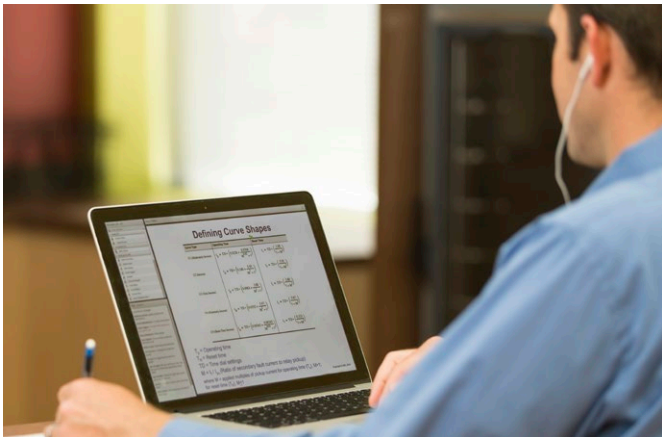
Hands-on settings and applications for SEL products.

### Testing

Hands-on relay testing and troubleshooting.

### Systems

Advanced hands-on integration and design.




## eLearning Courses

SEL University offers several types of eLearning courses that give you flexible training options. These courses act as a supplement or substitute for traditional classroom courses.

### Self-paced training

Access your training content online at any time with our self-paced eLearning courses. From our complimentary overview (CBT 101) to more detailed studies of SEL products and fundamentals, these courses can serve as a foundation or convenient substitute for our in-depth, classroom-based courses.

With SEL University self-paced courses, you can:

- Maximize your training budget.
- Track your eLearning completion status online.
- Earn professional development hours (PDHs) or continuing education units (CEUs).
- Choose an individual or corporate license.

### Live eLearning

Live eLearning courses are held in real time with scheduled instruction to provide a live training experience without the expense of travel. The topics relate to SEL products and fundamentals.

Live eLearning courses enable you to:

- Maximize your training budget.
- Maintain flexibility in your schedule.
- Attend class from anywhere.
- Ask questions and share ideas with your instructor and your peers.
- Use homework assignments to practice the course material before follow-up discussions.
- Earn PDHs or CEUs.

SEL UNIVERSITY

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# Engineering Services Overview



## Protection

### Protection Services

Protection solutions and related services for electric power systems, including scheme designs, relay settings, and more.

### Substation Engineering Services

Comprehensive solutions for power and substation design projects, from initial cost estimates to a completed substation.

### Arc-Flash Risk-Assessment Services

Flexible, customized arc-flash risk assessment services to improve employee safety and address regulations.

### Transmission Planning Services

Transmission planning analysis and design services over a wide range of study scenarios, from 69 kV to 525 kV.

### Synchronizing Systems

Conventional and advanced generator and microgrid synchronizing systems with automatic and manual synchronizing.

### Phase-Shifting Transformer (PST) Protection and Control Systems

Pre-engineered PST protection systems based on the SEL-487E Transformer Protection Relay.

### Digital Secondary System Solutions

SEL Time-Domain Link (TiDL®) and SEL Sampled Values (SV) solutions that advance how you protect and control the primary equipment in your substation.

## Automation

### Automation Services

Proven automation and integration services using SEL technology, including solutions for SCADA, distribution network automation, and renewable energy control.

### MOTORMAX® Low-Voltage Motor Management and Protection System

Centralized motor management system for comprehensive control, protection, analysis, and monitoring in motor control centers (MCCs).

### Metering Services

Metering solutions for both producers and consumers of energy, including custom solutions for electric power, steam, water, or gas applications in new or existing facilities.


## POWERMAX® Power Management

### POWERMAX Power Management Solutions

Integrated control systems composed of scalable relay and control hardware, software, and logic processing and designed by SEL experts.

### POWERMAX for Industrial Power Management

Power management and control systems specifically engineered for industries with critical processes that need to stay online, improving power system reliability, personnel safety, and process uptime.

### POWERMAX for Utilities

Custom solutions that maintain power system stability by detecting abnormal conditions and taking automatic corrective actions, including generation and load shedding and reactive compensation.

### POWERMAX for Mobile Microgrids

Solutions that meet the needs of applications requiring mobility or rapid deployment, such as a military forward operating base (FOB) or a disaster relief effort.

### POWERMAX for Garrison Microgrids

Dependable computing and communications, adaptive relaying, cybersecurity, and a TMS-MIL-STD-compliant microgrid controller that is interoperable with all makes and models of generators, inverters, and loads.

### POWERMAX for Commercial Microgrids

Comprehensive control, protection, and metering systems to keep your power system operating when separated from the bulk electric grid.

## Cybersecurity

### Cybersecurity Solutions

Solutions to improve cyber defense, streamline ongoing management, and respond to incidents.

## General Engineering

### Design and Drafting Services

Full substation design packages, site retrofits for existing electrical gear, and detailed design drawings for power system protection, automation, metering, and control.

### Government Engineering Services

Innovative, technologically advanced power management services and solutions for municipalities and government organizations, including branches of the military, national laboratories, and governmental agencies.

### Engineering Studies and Simulation Services

Hardware-in-the-loop (HIL) testing services, feasibility studies, coordination reports, system stability assessments, and more.

### Custom Panel and Enclosure Solutions

Custom protection, control, and metering panels; control cabinets; and retrofit doors to match your specifications.

# Protection Services

selinc.com/solutions/protection-services

SEL Engineering Services specifies, designs, implements, tests, and commissions protection systems. Our engineers are experts at multifunction microprocessor-based relay technology, and we design protection schemes for generation, transmission, distribution, and low-voltage systems worldwide. We can provide all the design documentation, testing procedures, and setting reports for protection, control, automation, and communications systems.

### Project scope and specification

SEL experts assist you from the conceptual phase of a project through execution and commissioning. Front-end engineering design services range from preliminary designs to complete project estimates.

### Scheme design

Schematics and diagrams prepared by SEL engineers help you take full advantage of SEL multifunctional technology for protection and automation schemes.

### Protection and control retrofit design services

We help you reduce operating costs and improve the reliability of your aging systems by replacing outdated or unreliable equipment with SEL solutions. We have expert teams ready to meet your retrofit requirements.

### Relay settings

We program and configure protection and control equipment for a wide variety of applications.

### Panels and assemblies

SEL experts design, build, assemble, wire, package, and ship panels worldwide and also provide factory and onsite testing.

### Field testing and commissioning

Industry-trained SEL technical staff support field testing and commissioning onsite and provide hands-on training.

### Training

Application-specific training and SEL University courses for protection and automation technology increase the effectiveness of your operations and engineering staff.

### NERC compliance

SEL Engineering Services offers extensive services to support setting up NERC PRC standards compliance programs and completing NERC PRC compliance studies.

Our in-depth knowledge of NERC PRC standards and protection systems allows us to perform compliance verification studies and recommend innovative corrective-action plans for noncompliant protection systems. We have developed reports to clearly demonstrate NERC PRC compliance to auditors.

We have been building continuous monitoring for protection and control systems using microprocessor-based protective relays and real-time automation controllers since before NERC defined the term. Our engineers know industry best practices. Whether or not you need to comply with regulatory standards, we can audit your maintenance programs to determine areas for improvement. Our team of experienced engineers will demonstrate how to leverage the benefits of the IEDs already installed in your system to perform real-time validation and status reporting.

# Substation Engineering Services

selinc.com/solutions/substation-engineering-services

SEL Engineering Services provides comprehensive solutions for substation design projects. Our team has experience providing everything from initial cost estimates to a completed substation. Our experienced project management team provides permitting, scheduling, reporting, and procurement services. SEL licensed professional engineers walk your team through the conceptualization, estimation, budgeting, design, construction, and testing process. We have engineers with expertise in civil, mechanical, and electrical engineering; protection; system modeling, load flow, and short-circuit studies; automation; microgrid controls; networking; and cybersecurity.

## Conceptual design and evaluation

To help establish all of the necessary site conditions, we offer:

- Project basis-of-design information.
- Field surveys, geotechnical investigations, and evaluation of existing utility and elevation layouts.
- Substation, distribution, and transmission planning, initial electrical studies, and analyses.
- Conceptual layout drawings and one-line diagrams.
- Desktop study reports, site surveys (digital and hard copy), and soil resistivity reports.

## Substation design

Our team provides a clear path to completing your substation project, including permitting strategies, timelines, and technical support. The design phase includes detailed engineering calculations, bills of materials (BOMs), studies, analyses, plans, specifications, schedules, and cost estimates. We can provide:

- Civil engineering, including site layout, demolition and removal, erosion and sedimentation controls, site work, utility layout, foundations, steel structures, geotechnical investigations, equipment loading, yard stoning, and fencing.
- Electrical engineering, including grounding, major equipment (transformers, breakers, capacitors, reactors, underground cables, etc.) specification and design, duct bank design, cable and conduit sizing, lightning and surge protection, yard lighting, relay panel and control house design, control and protection design, wiring, and SCADA designs with analyses and studies (relay coordination, temporary overvoltage, harmonics, arc-flash hazards, etc.).
- Complete engineering substation services.

## Request for proposal (RFP) services

The SEL Engineering Services team provides the vital RFP services needed to prepare construction documentation for bidding. We can prepare RFP packages, submit them for bids, select bidders, and perform other activities to support the proposal process.

## Construction support

We provide many of the services necessary for a project's construction. We can serve as your advocate by performing contractor prequalification, evaluation, and selection and providing construction oversight, inspection, management, and record documentation.

# Arc-Flash Risk Assessment Services

selinc.com/solutions/arc-flash-studies

SEL custom arc-flash risk assessments help mitigate arc-flash hazards, improve employee safety, and address a variety of regulations (OSHA 29 CFR 1910.269, IEEE 1584b-2011, NFPA-70E-2018, NESC-2012, and CSA Z462-2015). SEL Engineering Services applies proven methods to create site-specific arc-flash mitigation and personal protective equipment (PPE) requirements. We can provide a complete, cost-effective arc-flash solution for your facility.

## Power system modeling

SEL Engineering Services will create a computer model of your power system in the modeling software of your choice. The model includes facility equipment electrical data for all parts of the system. We can help with compiling data for modeling the system.

We can perform the following services to assist in surveying your facility:

- Obtain and verify electrical equipment nameplate data.
- Record equipment nominal and short-circuit ratings.
- Record the cable types, sizes, lengths, and insulation.
- Document the electrical system topography.
- Record circuit breaker and relay settings.
- Determine the location of arc-flash fiber-optic sensors.

## Short-circuit studies

Computerized short-circuit studies determine fault current levels at all locations in the system for different operating configurations. The values are used to evaluate bus, fuse interrupting capacity, CT saturation, and circuit breaker interrupting ratings.

## Protective-device coordination studies

SEL engineers enter existing protective-device settings in the power system model to determine short-circuit clearing times. They create graphical time current coordination curves to prove adequate sensitivity and speed of operation to protect equipment and personnel and to prove selectivity with protective equipment to isolate as little of the system as possible and prevent disruption. The criteria priority will be based on your specific system.

## Arc-flash analysis studies

SEL engineers calculate arcing fault currents, determine protective-device trip times, and report incident energy, arc-flash boundaries, and PPE categories. Our software computes arcing currents and reports worst-case incident energy. We offer arc-flash analysis studies for both ac (single- and multiphase) and dc systems.

## Arc-flash mitigation studies

We investigate methods to reduce unacceptably high incident energy levels by modeling current-limiting solutions, reducing protective-device clearing times, implementing differential relaying schemes, and applying other economical solutions based on your system topology and available equipment capabilities.

## Arc-flash hazard warning plans

SEL engineers provide customized arc-flash and shock hazard warning and danger labels that detail boundary distances, arc-flash energy levels, PPE classification levels, and other relevant data, as mandated by the appropriate standard. We also provide installation services.

## Arc-flash engineering reports

We compile the results of each study into an easy-to-read and easy-to-understand engineering report. Additionally, we will release the power system model developed for the study to your facility for use and maintenance.

## Detailed engineering studies

If the ratings of existing equipment are inadequate, we can help evaluate alternatives. These studies typically examine ways to redesign the existing electrical system to fix problems, keep personnel safe, and save money.

# Transmission Planning Services

selinc.com/solutions/transmission-planning

The purpose of transmission planning is to maintain reliability, security, and stability while meeting current and future system needs. Transmission planning requirements and processes vary by region. The experienced team at SEL creates transmission plans and analyses that are uniquely suited to meet the requirements for your region over a wide range of study scenarios, from 69 kV to 525 kV.

## Studies for every situation

Using the GE Positive Sequence Load Flow (PSLF) software package and custom tools, we perform the following services:

- Path-rating studies
- FERC generator interconnection studies
- Wires-to-wires interconnection studies
- NERC MOD-026, MOD-027, PRC-006, PRC-019, PRC-024, PRC-025, and PRC-026 compliance studies
- Import/export studies
- Load-serving studies
- Underfrequency load-shedding (UFLS)/undervoltage load-shedding (UVLS) studies
- Wind turbine studies
- Microgrid studies
- Transformer emergency loading above nameplate rating calculations
- Overhead conductor steady-state thermal rating studies
- Protective-relay coordination studies

Even if you are not required to perform these specific types of analyses, you can benefit from transmission planning best practices. We provide hard and electronic copies of all reports and models for future use. It is easy to update system models for future planning needs, saving time and money versus creating new models.

## Powerful software tools

Our team can analyze and provide recommendations for a variety of planning and operating power system scenarios. Software tools we use include the following:

- GE PSLF and ProvisoHD
- Siemens PSS®CAPE (previously Electrocon's CAPE)
- MathWorks Simulink & Simscape
- AspenTech Aspen software
- SKM Power*Tools for Windows (PTW)
- CYME Power Engineering software

With these tools, SEL engineers can perform transient stability, post-transient, and voltage/thermal analyses as well as relay coordination.

## Applications

The results of transmission planning studies can help you:

- Determine facility equipment and operating practices to reliably meet existing and future load needs.
- Identify the facilities needed for new generators while meeting generator interconnection requirements.
- Fulfill compliance requirements for national and regional modeling and planning standards.
- Perform transmission regulatory studies to meet regional resource planning statutes.
- Provide recommendations to mitigate local and wide-area power system disturbances.
- Alleviate system bottlenecks to eliminate or delay the need for new infrastructure.

# Synchronizing Systems

selinc.com/solutions/synchronizing-systems

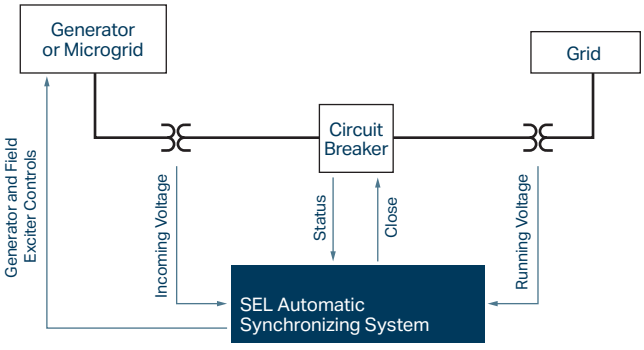
SEL Engineering Services provides both custom and pre-engineered synchronizing systems. These systems adjust the frequency and voltage of the generator or microgrid to bring the frequency difference (slip) and voltage difference into the synchronizing acceptance band and energize the breaker close coil at the slip-compensated advanced angle. An SEL relay with advanced synchrocheck functionality at each point of coupling provides synchrocheck supervision and/or the close command when parameters are acceptable to close the breaker connecting two power systems together.

## Advanced systems

SEL engineers can create custom solutions for applications such as resynchronizing islands, remote synchronization with fiber-optic communications, flexible systems with internal PT signal switching between as many as six PT inputs, systems requiring communications and integration with distributed control systems, systems requiring HMI visualization, and many others.

## Autosynchronization systems

SEL autosynchronizers replace the synchronizing panel hardware and circuits required for manual breaker closing. Autosynchronizers are more precise than manual systems, and SEL solutions include advanced reporting, communications, protection-class equipment, and high-speed communications.




The SEL synchronizing system can include automatic and manual controls to locally close the breaker on achieving synchronism.

## Scalable solutions

SEL synchronizing solutions are scalable to meet your needs, whether your system consists of small emergency generators or large utility generators. You can synchronize multiple machines across multiple locations and set different parameters to optimize each synchronizing scenario using multiple settings groups and flexible logic.

## Pre-engineered and customized solutions

We can build a synchronizing system based on the autosynchronization functions in the SEL-700G Generator Protection Relay or SEL-651R Advanced Recloser Control. Alternatively, we can provide more advanced systems built around a pre-engineered autosynchronizer using the SEL-451 Protection, Automation, and Bay Control System (when purchased with a separate configuration and documentation CD). You can select a standard, pre-engineered SEL-451 autosynchronizer, or we can provide a customized solution that fits the exact needs of your project, operational procedures, and specifications.

# Phase-Shifting Transformer (PST) Protection and Control Systems

selinc.com/solutions/protection-services

SEL Engineering Services provides PST—also known as a phase angle regulating (PAR) transformer—protection and control systems. We have extensive experience with modeling, designing, setting, and testing protection and control systems for the many different configurations of these unique transformers.

## Comprehensive protection in a single relay

SEL provides a pre-engineered PST protection system based on a single SEL-487E Transformer Protection Relay. Traditional protection for conventional, two-core PSTs requires separate differential relays to cover the primary windings (87P) and the secondary windings (87S) of the series and excitation transformers. Typically, four relays are required to provide a redundant protection system. The SEL solution provides both sets of differential elements in a single SEL-487E relay so that only two relays are necessary to provide fully redundant electrical protection.

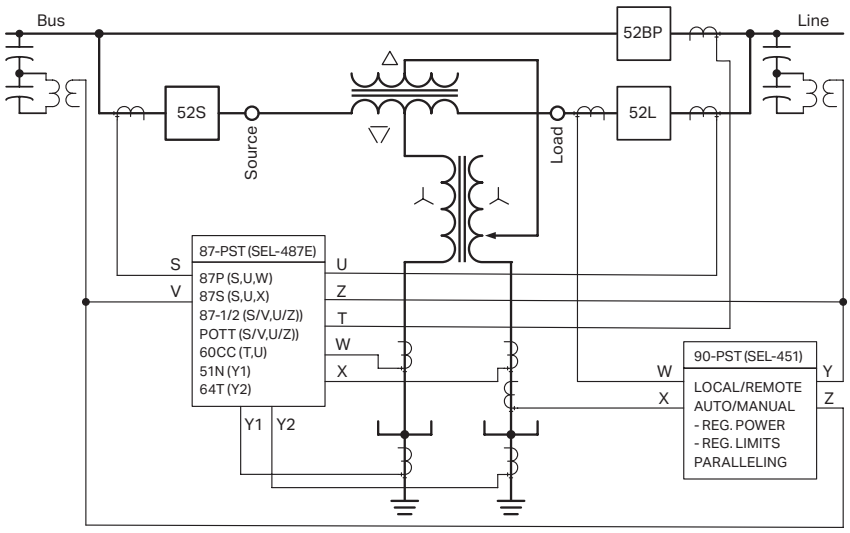
Traditional 87P and 87S elements are blind to turn-to-turn faults in the regulating windings of a PST, where partial winding faults are most likely to occur. SEL supplements the 87P and 87S elements with patented positive- and negative-sequence differential elements (87-1 and 87-2) that compensate for the variable phase shift introduced by the PST. These elements are sensitive to all in-zone fault types, including turn-to-turn faults in the regulating winding of the PST. This significant advancement in PST protection is included in IEEE C37.245-2018.

These patented elements only require CTs at the zone boundaries (source and load sides) and do not require CTs embedded inside the PST, as conventional protection does. This unique capability also makes the SEL PST protection system suitable for modernizing the protection of PSTs without CTs in the correct locations to implement conventional protection.

Additionally, this comprehensive solution provides bypass-off-neutral protection (60CC), system ground backup (51N), and secondary winding ground protection (64T). Primary winding restricted earth fault protection is inherently provided by the 87P elements.

## Pre-engineered and custom on-load tap changer control systems

Traditionally, PSTs have been limited to manual control due to the complexities of automatically regulating real power flow on the grid. SEL has developed technology to automatically control the on-load tap changers that regulate the power flow through a PST. We adapt our extensive library of solutions to the unique needs of your power flow control applications. Our capability includes controls for automatically operating parallel PSTs as well as redundant master/hot-standby automatic control systems.



# Digital Secondary System Solutions

selinc.com/solutions/p/digital-secondary-systems

Digital secondary system solutions advance how you protect and control the primary equipment in your substation. These solutions reduce substation construction and expansion costs, improve personnel safety, and increase flexibility by replacing copper with fiber. You can modernize your substation by choosing from two SEL digital secondary system solutions:

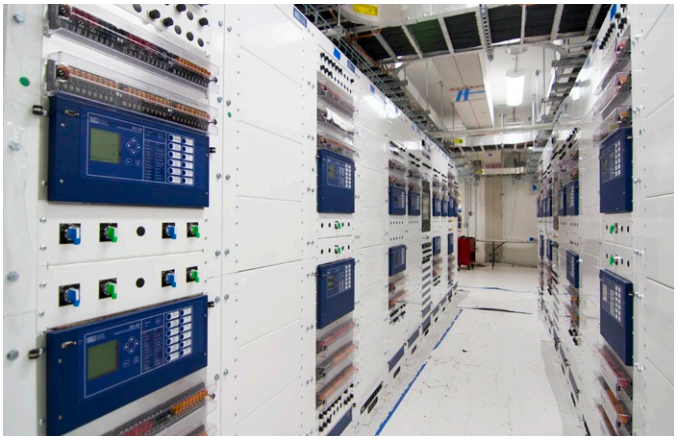
- SEL Time-Domain Link (TiDL®) technology—a protection-centered, point-to-point solution that eliminates complex Ethernet network design.
- SEL Sampled Values (SV) technology—a communications-centric, network-based solution that combines protection in the merging unit with the flexibility of IEC 61850-9-2.

## SEL SV Technology

SEL SV combines protection in the merging unit with the flexibility of IEC 61850-9-2. The merging unit (publisher) digitizes analog signals from primary equipment and then transmits them to an SV-supported relay (subscriber) in the control house via an Ethernet network.

### Merging units with built-in protection

In an SEL SV solution, the SEL-401 Protection, Automation, and Control Merging Unit provides overcurrent and breaker failure protection and the SEL-421 Protection, Automation, and Control Merging Unit provides complete line protection, including five zones of subcycle mho and quadrilateral distance elements. If IEC 61850 network communications are lost, the SEL merging units provide backup standalone protection.



### Interoperability

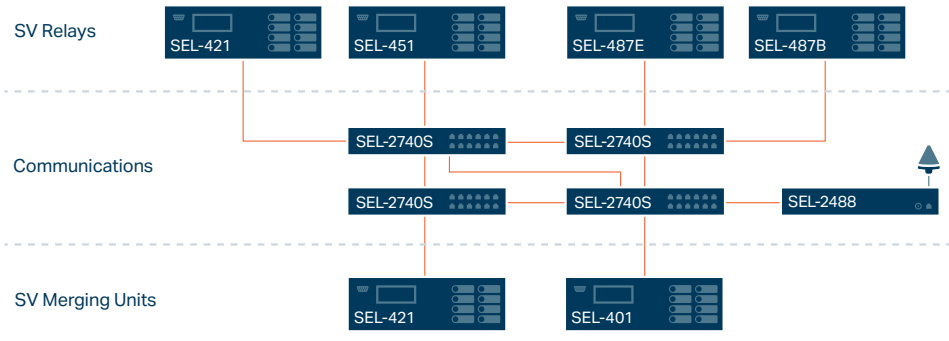
SEL SV devices are fully compliant with IEC 61850-9-2 and the UCA 61850-9-2LE guideline. You can use them with primary equipment that generates SV streams or with other manufacturers' SV-compliant units.

### Unique testing and troubleshooting tools

The COM SV command in SEL merging units provides you with information about your SV configuration, including warning and error codes that detail why a relay rejected an SV stream, which aids troubleshooting. The TEST SV command allows you to check the network connectivity and the CT and PT ratios between publisher and subscriber devices.

### Flexible Ethernet network

SEL SV technology allows you to create a flexible Ethernet-based point-to-multipoint network using tools such as software-defined networks or VLANs to fit your application needs. You can use the SEL-2740S Software-Defined Network Switch to provide centralized traffic engineering and improve Ethernet performance. The switch acts as a transparent Precision Time Protocol clock that supports the IEEE C37.238 power system profile, ensuring submicrosecond time synchronization of the end devices.




A complete SEL SV solution.

## SEL TiDL Technology

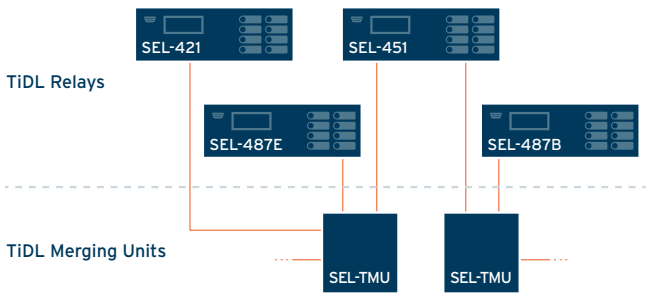
TiDL technology is an innovative digital secondary system solution engineered with simplicity in mind. This technology requires no external time source, has strong cybersecurity, and is easy to implement, with no network engineering required.

### Simple architecture

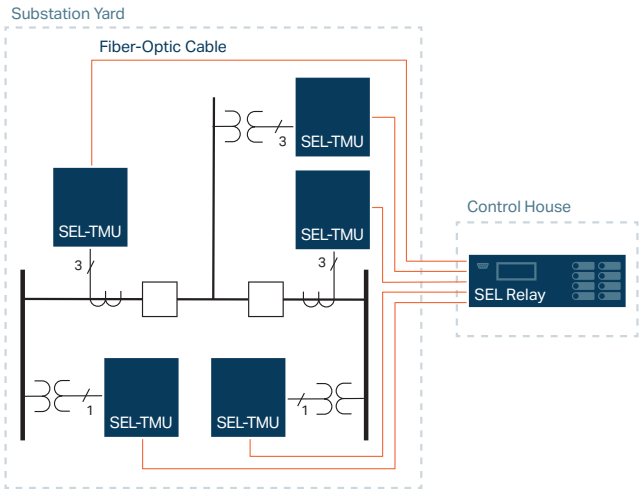
SEL-TMU TiDL Merging Units are placed in the yard close to the primary equipment and digitize discrete I/O signals and analog data, such as voltages and currents. These data are then transported over fiber-optic cables to a TiDL-enabled relay in the control house. With this point-to-point architecture, implementation is simple and requires zero network engineering.

### Data-sharing capabilities

Each SEL-TMU can be paired with up to four SEL-400 series TiDL-enabled relays. This new data-sharing capability gives you flexibility on how to best design protection for your system and makes installations more economical by reducing the device count. In addition, the point-to-point connections make expanding easy.




Each SEL-TMU can share data with up to four TiDL-enabled relays.




TiDL uses a simple point-to-point architecture.

### No external time reference

TiDL maintains relative time; therefore, it does not rely on an external time reference for protection. All data from the SEL-TMU units are synchronized with each other regardless of the number of units connected to the relay or the length of the fiber.

### Strong cybersecurity posture

The dedicated, deterministic TiDL system helps secure mission-critical systems. The isolated point-to-point connections and the absence of switches and routers reduce the electronic security perimeter and limit attack points. This security-minded architecture prevents remote access, and its simplicity eliminates the need for managing port access.

### Minimal training required

TiDL-enabled relay settings are the same as those in the popular SEL-400 series models, providing consistency and simplicity. You can use the same protection schemes and applications for complete distance, feeder, bus, and transformer protection.

# Automation Services

selinc.com/solutions/automation-services

SEL Engineering Services offers proven automation and integration solutions using SEL technology. These solutions support electrical power system substations, commercial buildings, industrial sites, generation plants, and manufacturing sites worldwide. This includes fully configured, tested, and documented settings for networking, control, communications, automation, and protection equipment. We also provide complete substation upgrades and replacement of legacy protection and remote terminal units (RTUs); event monitoring, collection, and analysis; and IED integration. Many standard SEL designs are scalable with various interfaces. We can also engineer individual solutions to meet specific requirements.

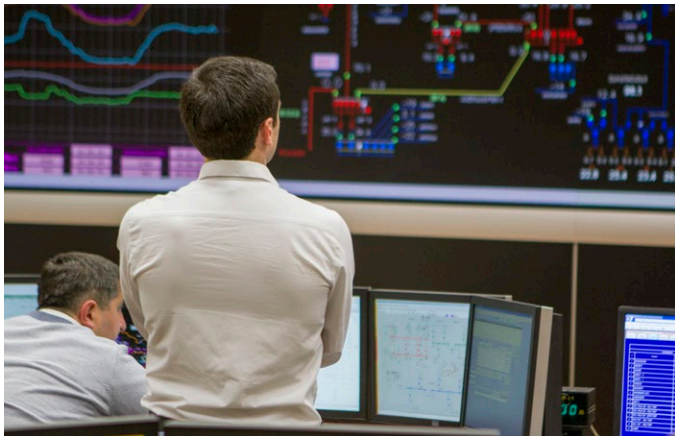
## SCADA solutions

We design, develop, test, and deploy complete SCADA systems to monitor and control your systems or processes. We have experience providing systems of various sizes, ranging from simple standalone systems to complex networked systems. These SCADA systems include the following components:

- Master and local substation HMIs
- Station- and system-wide Sequential Events Recorder (SER)
- System-wide relay event retrieval
- Master SCADA server redundancy
- Remote access
- Enterprise and local power system report managers

## DNA® (Distribution Network Automation)

SEL DNA systems increase system operational efficiency and reduce operating costs to provide affordable and reliable electric service. Our DNA systems combine fast protection with flexible automation control and communications for a distribution automation solution that makes your system safer, more reliable, and more economical. The SEL Distribution Automation Controller (DAC) System is an add-on feature for SEL Real-Time Automation Controllers (RTACs). The DAC provides automatic reconfiguration of distribution networks to restore power to as many customers as possible after system events, such as permanent faults and open-phase conditions. Optionally, the DAC can also provide dynamic feeder optimization, which automates control of voltage- and VAR-regulating devices to achieve goals such as power factor correction and demand reduction.



## Condition-based monitoring

SEL engineers use proven methods to integrate condition-based monitoring systems from multiple vendors into a comprehensive system that monitors the health of your power system. We integrate third-party systems for monitoring transformers, motors, circuit breakers, adjustable-speed drives, generators, uninterruptible power supplies, dc chargers, partial discharge, busbar joints, vibration, the environment, and cables.

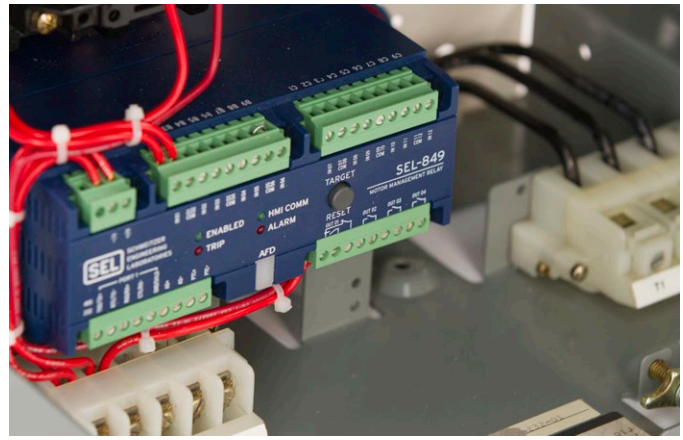
## Renewable energy control

We offer a control system that enables renewable energy installations with dynamic VAR sources to meet utility interconnection and regulatory requirements. The SEL Grid Connection Control System is an add-on feature for SEL RTACs. It simplifies interconnection control and solves common interconnection issues, such as adapting for varying cloud cover, nonresponsive inverter controls, and unexpected voltage excursions. The control system contains pre-engineered function blocks for controlling the point of interconnection (POI) between the utility grid and a power generation source. Using the SEL pre-engineered control system library gets renewable projects online sooner than developing custom, project-specific controls.

# MOTORMAX® Low-Voltage Motor Management and Protection System

selinc.com/solutions/motormax

MOTORMAX is a centralized motor management system that provides comprehensive control, protection, analysis, and monitoring for original equipment manufacturer (OEM) motor control centers (MCCs). It incorporates low-voltage motor control into an overall plant control system. MOTORMAX also works with the SEL POWERMAX® Power Management and Control System for a single-source, fully integrated solution.




## Architecture

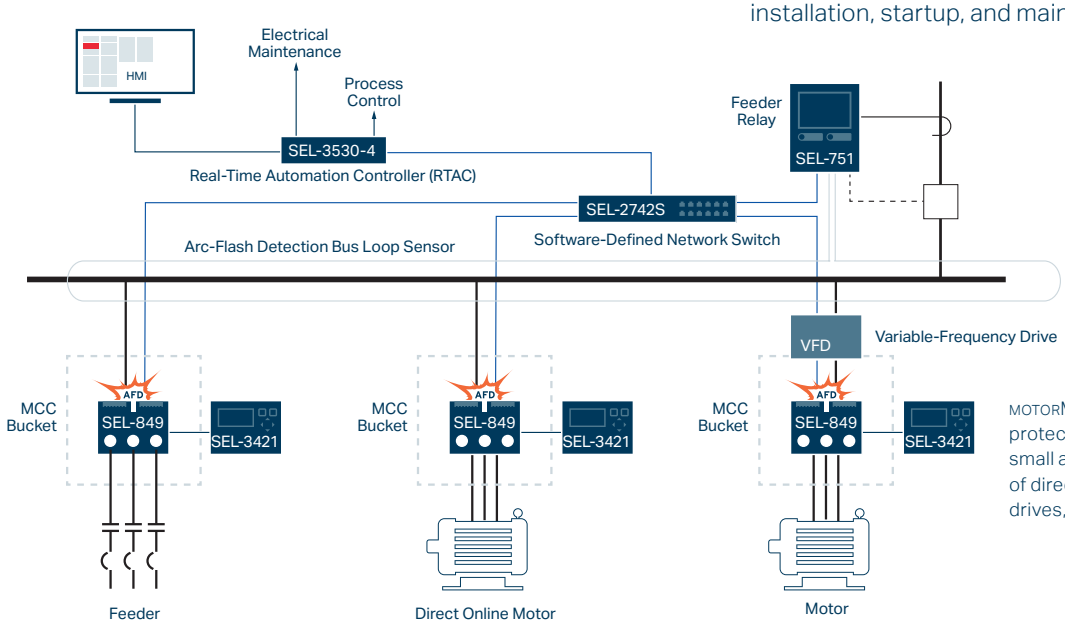
MOTORMAX is a combination of motor protection, network management, and real-time automation control. It uses the SEL-849 Motor Management Relay and features from other key devices, such as the communications abilities in SEL Real-Time Automation Controllers (RTACs) and managed Ethernet switches. Together, these devices deliver high-performance motor protection as well as high-speed reporting of motor status, alarms, and operating conditions at the HMI.

## System delivery

We preconfigure and test all relay, network, and automation control settings to your specifications before shipment. Every system is delivered with a complete test report, a bill of materials, cabling, and labels to simplify onsite installation. A fully tested, preconfigured system reduces installation and commissioning time.

## Benefits over a traditional MCC

- Seamless integration with POWERMAX allows operators to manage a facility's power system, including end devices, from a single HMI screen.
- The absence of programmable logic controllers (PLCs), associated wiring, pushbutton controls, and interposing relays minimizes interconnect cabling.
- Arc-flash detection (AFD) increases safety by reducing incident energy. All incoming breakers are signaled to trip in <16 ms after an arc event anywhere in the MCC.
- SEL-849 relays and SEL-751 Feeder Protection Relays provide more data than traditional MCC components, which gives a better insight of end device operation.
- By using SEL components, the system can achieve higher safety integrity level (SIL) ratings.
- Oscillography and Sequence of Events (SOE) recording enable online diagnostic analysis.
- Our delivery method reduces the time and cost of installation, startup, and maintenance.




MOTORMAX provides complete management, protection, and arc-flash remediation for small and large MCCs with any combination of direct online motors, variable-frequency drives, and feeders.

# Cybersecurity Solutions

selinc.com/solutions/sfci/professional-security-services

Now more than ever, cybersecurity is vital for the protection of critical infrastructure. With extensive operational technology (OT) and cybersecurity expertise, the SEL Secure Solutions team builds effective solutions that improve cyber defense and streamline ongoing management. SEL central asset management solutions maintain system health throughout their life cycle. We offer secure solutions across the five functional areas of the National Institute of Standards and Technology (NIST) cybersecurity framework.

IDENTIFY → PROTECT → DETECT → RESPOND → RECOVER

## Identify

Identify vulnerabilities as the first step to improve cybersecurity. We offer:

- Assessment services conducted to a known cybersecurity framework or standard:
  - **Stage 0 (1–2 days)**—Overview of cybersecurity controls.
  - **Stage 1 (3+ days)**—Evaluating the presence of cybersecurity controls.
  - **Stage 2 (5+ days)**—Validating the application of cybersecurity controls.
  - **Stage 3 (10+ days)**—Testing the effectiveness of cybersecurity controls.
- Development of strategic cybersecurity roadmaps.
- Governance, risk, and compliance reviews and recommendations.
- Consultant services.

## Protect

Provide ongoing protection of your OT system with SEL solutions, including:

- Centralized user access controls.
- Password management.
- Secure remote access.
- Integrated physical security with cybersecurity controls.
- Networking for substation LAN/WAN.
- Security hardening guides.
- Security Technical Implementation Guides (STIGs).
- Cybersecurity interconnection requirements.
- System backups.
- Turnkey program management and integration.
- Unified threat management firewall.

## Detect

Reliably detect cybersecurity events on your system. We offer:

- Centralized asset management software.
- Centralized update management, including firmware, patches, antivirus signatures, and the Microsoft Windows Server Update Service.
- Baseline monitoring.
- System health monitoring.
- System cybersecurity compliance.
- Host-based and network-based intrusion detection systems (IDSs).
- Security information and event management (SIEM) systems for event logging and alerts.

## Respond

Ensure that your organization responds effectively to cybersecurity events. SEL solutions include:

- System and cybersecurity training.
- Incident response and forensics.
- Alarms and alerts.

## Recover

Promptly restore your system with SEL services, including:

- System recovery.
- Resource augmentation.
- Spare parts inventory.

Our specialized team of certified security professionals can help you establish the proactive and sustainable plans, policies, and procedures that you need to keep your systems secure. Our solutions can be tailored to fit your unique security needs and even make it easier to meet and address today's regulatory standards, including NERC CIP. With multidisciplinary experience in substation, control system, and information security design, our cybersecurity team is here to work with you to assess, support, and develop a sensible security approach to protect your assets. SEL cybersecurity services include:

- Security awareness and training
- Compliance support for cybersecurity standards
- Cybersecurity assessments against known frameworks

### Level 5: Perimeter

Enforcement boundary for data transfer and remote access

- Secure data transfer
- Secure remote access
- System alarms and logging
- System backups

### Level 4: SCADA

Centralized human-to-machine system monitoring

- Operating system hardening
- Network monitoring
- Malware protection
- Centralized authentication

### Level 3: Access

Enforcement boundary for networking and user authentication

- Secure communications
- Network alarms and logging
- Network resilience
- Network segmentation
- Intrusion detection and prevention

### Level 2: Automation

Centralized data collection, control algorithms, and human-to-machine monitoring

- Role-based access control
- Network ports, services, and protocols security
- Site-level alarms and logging
- Inbound and outbound traffic enforcement boundary
- Patch management

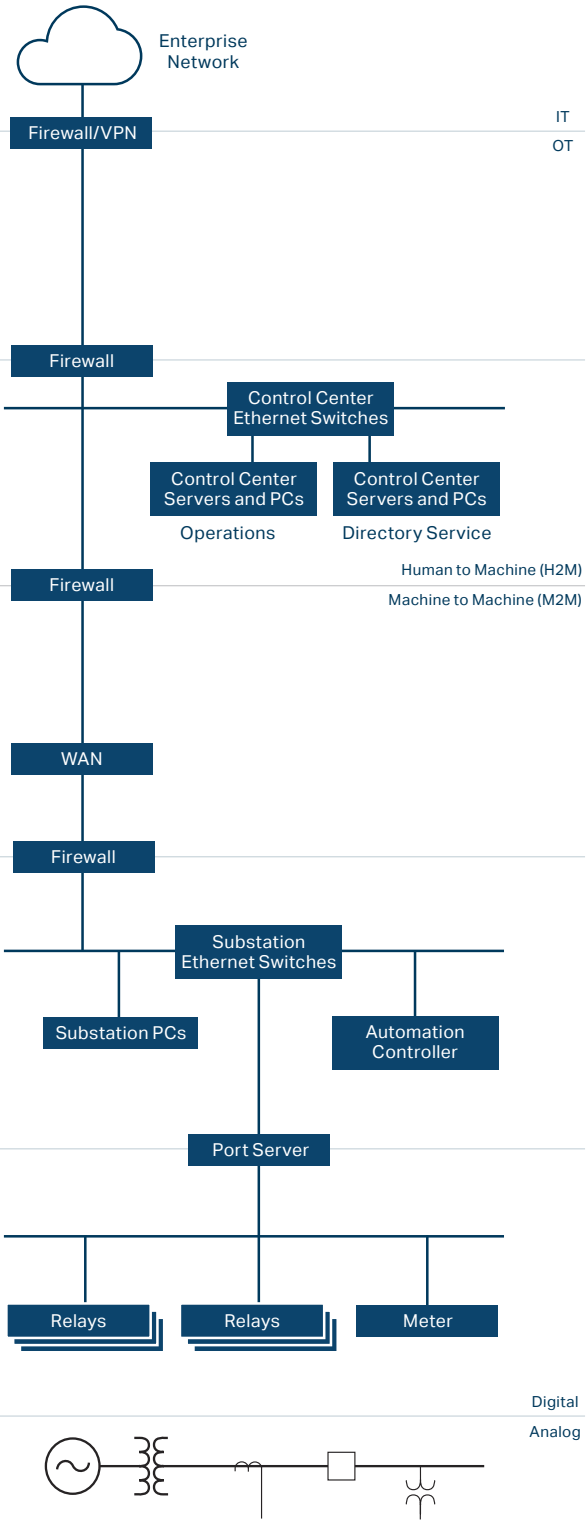
### Level 1: Control

System safety, data measurements, and event recording

- Device alarms and logging
- Password management
- Device hardening
- Transient asset controls
- Asset management

### Level 0: Physical

Secure data sources for sensor accuracy and integrity monitoring



# POWERMAX® Power Management Solutions

selinc.com/solutions/powermax-controls

An SEL POWERMAX Power Management and Control System is an integrated system composed of scalable relay and control hardware, software, and logic processing and designed by our engineering services experts. Ultra-high power system reliability and availability make POWERMAX ideal for locations with onsite generation and/or multiple utility power feeds

Controlling the energy balance in the microgrid system is one of the most difficult challenges for reliable microgrid operation. By operating at relay speeds, the deterministic controller can reliably balance load with the available generation. This speed provides seamless islanding and resynchronizing, so processes stay online.

SEL has designed, tested, and commissioned POWERMAX systems for military, utility, and industrial customers across the globe. Our solutions are based on sound engineering principles, robust system architectures, and industry-leading protection, automation, computing, communications, and security products. POWERMAX systems provide relay-speed operation across wide areas. These solutions are scalable, starting with the control of a simple, isolated microgrid up to a complex wide-area power system. Each solution is tailored in both complexity and cost for your needs.

For small-scale microgrid or distributed energy resource (DER) control, we also offer simple solutions using the standalone SEL relays and Real-Time Automation Controllers (RTACs).

**POWERMAX Solutions**

| Solution | POWERMAX for Mobile Microgrids | POWERMAX for Garrison Microgrids | POWERMAX for Commercial Microgrids | POWERMAX for Industrial Power Management | POWERMAX for Utilities |
|---|---|---|---|---|---|
| Example Applications | Military, disaster relief agencies, mobile operations | Military bases, energy service companies (ESCOs) | Universities, communities | Heavy industries | Utility |
| Power Consumption | <1 MW | <10 MW | <10 MW | >10 MW | >1,000 MW |

# POWERMAX® for Industrial Power Management

selinc.com/solutions/powermax-industries

A POWERMAX system increases process uptime by protecting against blackouts with advanced high-speed protection and control technology. Any production facility with onsite generation will benefit from the stability and protection of a POWERMAX system. These solutions offer:

- Load-shedding systems.
- Steam controls.
- Generation-shedding and runback systems.
- Autosynchronization systems.
- Fast decoupling solutions.
- Generation control systems.
- Factory acceptance tests.
- Control system simulations.
- Cybersecurity.
- Synchrophasor monitoring and control.
- MOTORMAX® Low-Voltage Motor Management and Protection System.

POWERMAX improves personnel safety and reduces equipment damage with adaptive protection, advanced protection systems, and arc-flash mitigation. POWERMAX also improves total system awareness with time-synchronized condition-monitoring systems, which keep track of equipment status, electrical metering, cyber attacks, network traffic, and more.

POWERMAX technology is proven to keep facilities running and is specifically engineered for industries with critical processes that need to stay online. These facilities include:

- Oil and petrochemical refining operations.
- Pulp and paper manufacturing facilities.
- Mining and metals processing facilities.
- Water and wastewater treatment plants.
- Data centers.

# POWERMAX for Utilities

selinc.com/solutions/powermax-ras-utilities

A POWERMAX system for utilities uses a remedial action scheme (RAS) in a control system for large geographic regions of interconnected transmission, generation, and loads. Distributed computing and communications provide smart transmission grid management for integrating renewable generation and distributed energy resources (DERs). This solution is commonly used for the wide-area monitoring, control, and integration of large wind power stations.

A POWERMAX RAS integrates with existing relays, meters, and communications systems to minimize the footprint and complexity.

With a POWERMAX RAS, utilities can function closer to stability limits, operating transmission corridors at a higher capacity than ever before. In some cases, utilities can transmit over 50 percent more power across existing transmission lines. This increases daily revenues and can free up billions of dollars to enhance existing transmission lines instead of building new lines.

# POWERMAX® for Mobile Microgrids

selinc.com/engineering-services/mobile

POWERMAX ensures reliable power for microgrids that require mobility or rapid deployment, such as a military forward operating base (FOB) or a disaster relief effort.

For FOB military applications, you can parallel diesel generators instead of using the traditional setup of a dedicated generator per B-Hut or tent. Instead of sizing a generator to the peak demand of the respective function (e.g., tactical operations center, mess hall, or medical facility) and running it inefficiently most of the time, FOBs can now have parallel generators. This allows you to run a few diesel generators at high efficiency while resting the remaining generators. As loads increase, you can bring more generators online to meet the demand. This process increases operational efficiency by reducing wet stacking (and maintenance) and saving fuel, which prolongs mission operations and increases resiliency.

Additionally, the POWERMAX control system eliminates single points of failure by sharing the load between generators and can be located anywhere within the base, allowing you to be more strategic with the base layout. If a generator or communications are lost, the system reroutes power to keep the lights on. If the generation does not meet the load requirements, POWERMAX prioritizes loads and minimizes load shedding to maintain your critical loads.

What makes SEL's TMS-MIL-STD-compliant microgrid unique is that it works with all makes and models of generators, inverters, and loads. You can easily retrofit existing commercial off-the-shelf and tactical microgrid system (TMS) generators in the field with an SEL control system.

# POWERMAX for Garrison Microgrids

selinc.com/engineering-services/garrison

POWERMAX uses dependable computing and communications, including adaptive relaying and cybersecurity, to provide high-performance control for garrison microgrids.

A microgrid has low inertia compared to the larger macrogrid, which is why the relay-speed POWERMAX system is ideal. Our control algorithms and demand response operate fast enough to preserve the load and generation energy balance, maintain system stability and, most importantly, make sure the base is operating at all times.

With POWERMAX, you can operate an independent power system that prevents blackouts, reduces distributed energy resource (DER) operating costs, and protects people from injury and equipment from damage during faults. Even if closely timed faults occur, subcycle inertial-compensated control algorithms prevent blackouts. And if you want to connect to the bulk electric system, our point of common coupling (PCC) control methods can seamlessly reconnect or island the microgrid. SEL software-defined networking (SDN) ensures that all system communications happen as planned and with complete security.

For military installations that use backup diesel generation, POWERMAX can parallel existing diesel generators. The benefits of paralleling include wet-stacking correction and fuel savings, which prolong mission operations and increase resiliency.

The SEL solution is unique because it uses a TMS-MIL-STD-compliant microgrid controller that works with all makes and models of generators, inverters, and loads. If your device communicates, we can connect, control, and parallel it. Additionally, you do not have to procure the entire control system up front but can purchase and build your system in blocks over time as funding permits.

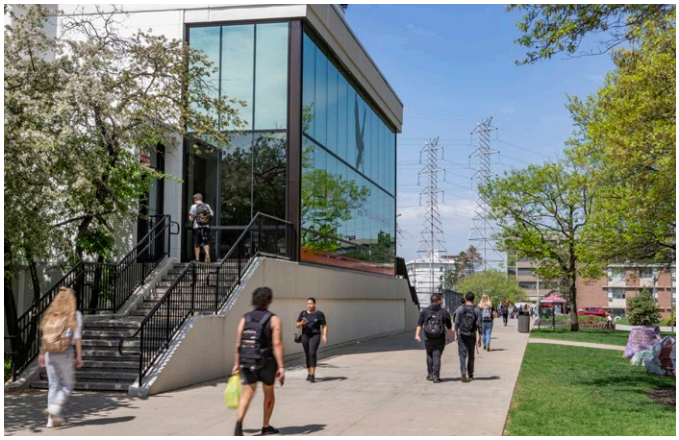
# POWERMAX® for Commercial Microgrids

selinc.com/engineering-services/commercial-campus

SEL POWERMAX commercial microgrids keep the lights on, seamlessly islanding and reconnecting with the bulk electric system. POWERMAX microgrid control systems are efficient, reliable, and secure solutions for guaranteeing uninterrupted energy delivery to your facility and customers. They control and protect both renewable and conventional generation.

In "grid connect" mode, the SEL system manages active and reactive power sharing, maximizes renewable generation, reduces peak charges, and controls the power factor or active-reactive power across the point of common coupling (PCC). SEL systems allow you to operate independently, ensuring a constant supply of energy after the loss of the utility PCC by maintaining island nominal voltage and frequency. These systems also perform PCC smoothing, load shifting, demand response, battery energy storage system (BESS) charge/discharge management, and other ancillary services.

In 2018, the SEL POWERMAX won the National Renewable Energy Lab microgrid shootout, a rigorous 21-week microgrid control and cybersecurity evaluation competition that pitted SEL microgrid controller technology against four competitors. SEL was also selected as the top microgrid provider by Navigant Research as part of their "Navigant Research Leaderboard: Microgrid Controls" report.



Every POWERMAX commercial microgrid control system includes a factory acceptance test (FAT) for you to attend that follows the IEEE 2030.8 testing standard. SEL owns and operates the largest controller hardware-in-the-loop (cHIL) testing facility in North America. This facility contains a large number of Real Time Digital Simulator (RTDS) racks used exclusively for cHIL testing of SEL protection and control systems under realistic conditions. During the FAT, you can observe and verify the full functionality of the system.

# Metering Services

selinc.com/solutions/metering-solutions

SEL Engineering Services provides solutions that ensure the accurate, precise, and reliable operation of meters and support devices. By using best practices, experienced engineers, industry-leading technology, and a gated quality control process, the SEL team can design the best metering solution for your electric power, steam, water, or gas application.

## System design and configuration

Whether for new or existing facilities, we can design metering systems that fit your budget and needs. We provide the following solutions to both producers and consumers of energy:

- Meter programming
- Metering system design
- Power quality studies
- Energy consumption studies
- Onsite accuracy testing and verification
- Metering asset integration
- Demand response and leveling system design
- Campus submetering design
- Pulse input conversion from conventional meters to ACSELERATOR® Meter Reports SEL-5630 Software

## Integration services

Our team provides three tiers of metering asset integration services to deliver custom systems with high reliability and low maintenance costs. We offer:

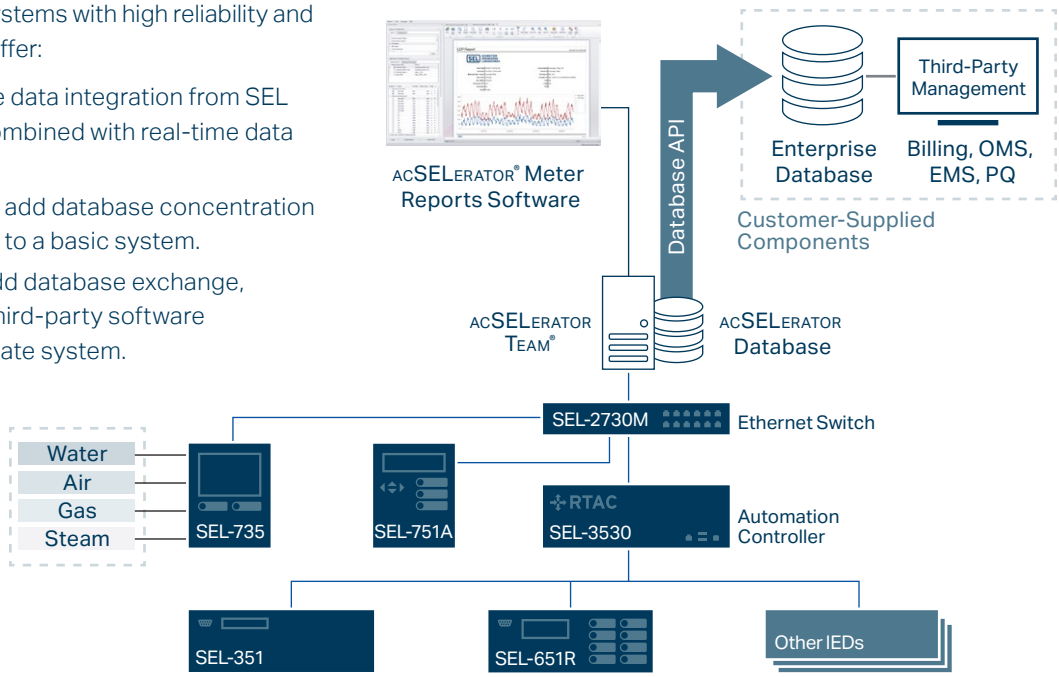
- Basic systems that include data integration from SEL and third-party devices combined with real-time data visualization.
- Intermediate systems that add database concentration and historical visualization to a basic system.
- Advanced systems that add database exchange, customized reports, and third-party software integration to an intermediate system.


## Powerful data

Accurate metering data improve an asset's or system's performance and help you make better decisions. Experienced SEL engineers can also help you analyze your metering data to better understand your assets and processes.

## Time alignment

With large campus metering systems, it is important that the system be time-aligned. We design solutions that incorporate time-aligned Sequence of Events (SOE) reporting to help you better understand event causes and effects across your system. Oscillography is available to assist with troubleshooting without the need for additional test equipment.




SEL solutions simplify site-wide metering and system integration.

# Design and Drafting Services

selinc.com/solutions/design-and-drafting-services

SEL Engineering Services provides local design and drafting services for power and control systems, including critical infrastructure projects, around the world. We create new design and drafting packages and revise existing drawings. The team's drafting processes ensure the final design package is accurate and delivered on time.

## Complete design packages

SEL has experts in all areas of electrical and civil design. We offer full design packages that include ac and dc schematics, one-line diagrams, wiring diagrams, panel layout drawings, logic schematics, and communications and network drawings. We can also convert existing plastic sheet (Mylar), vellum, and paper drawings into electronic files for easier access and storage.

We provide protection and control, automation, and full substation designs. Typical complete design packages include multiple design drawing submittals for each stage of the design, including 30 percent, 60 percent, and 90 percent Issued for Review (IFR) submittals; an Issued for Construction (IFC) submittal; and final construction as-built documentation.

## Versatility

SEL Engineering Services supports multiple software tools to accommodate your preferred software. For drawings, we support Autodesk AutoCAD, AutoCAD Electrical, and AutoCAD Raster Design; Bentley Descartes, MicroStation, and Substation; and SCADA Systems Elecdes. For substation models and site plans, we support Autodesk Inventor and Civil 3D, and we use BlueBeam for creating and editing PDFs. Our design team has developed large libraries of blocks, cells, tables, and other useful tools to aid in our designs. These tools help our designers and drafters produce high-quality drawings with greater efficiency.

We are also versed in utility drafting and design standards, specifications, and procedures. This allows us to readily execute each project with a focus on quality and deliverable timeliness.

## Typical design and drafting drawings

Our extensive experience and drafting resources let us provide the following services to save you time and money and enable you to use your resources more productively:

- AC and dc schematics
- One-line diagrams
- Wiring diagrams
- Panel layout drawings
- Logic schematics
- Communications and network drawings
- Substation layouts and site plans
- Civil substation design drawings
- Demolition and removal design conversion
- Shop drawings
- Retrofit drawings
- Paper-to-electronic file conversion

# Government Engineering Services

selinc.com/solutions/government-services

The SEL Government Engineering Solutions (GES) team understands the unique demands of government projects and offers the industry's best people, products, technology, and services. We offer engineering services and product solutions for government agencies, military installations, and navy ships to create a safer work environment and a more reliable and economical electric power system. Our engineers' many years of experience in the power industry allows them to easily translate your needs into workable solutions.

## Protection services

SEL experts can perform fault, system protection and coordination, and arc-flash studies; recommend protection schemes to match your system and goals; and develop and program relay settings.

## Automation services

GES automation services include communications architecture design, the design and programming of HMIs for small- to large-scale systems, and the development and programming of communications and logic processor settings.

## Microgrid systems

SEL microgrid systems reduce energy costs and emissions through optimized resource management. Our microgrids ensure uninterrupted energy delivery with robust cyber-security and physical security. Our systems control and manage microgrids from 1 MW to more than 1 GW by using a flexible and expandable architecture.

## Application services

Our team reviews system designs and settings to reduce equipment and operational costs while increasing system performance and functionality. We can select the SEL products best suited to your power system protection and automation requirements.

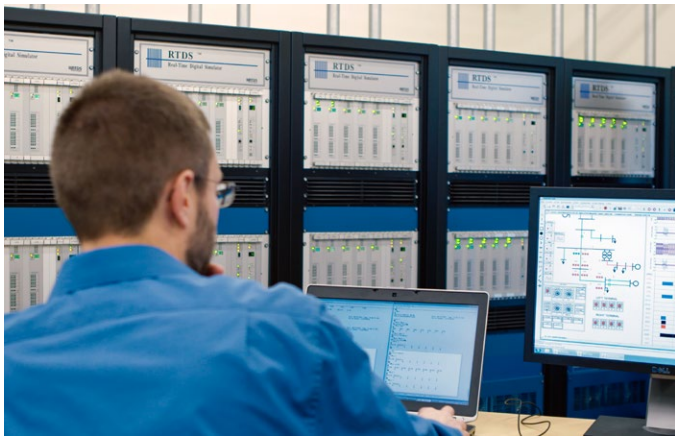
## Field services

The SEL GES team can:

- Upgrade aging infrastructure.
- Perform engineering work that requires a specialized workforce of cleared personnel.
- Provide onsite commissioning support from trained technical staff.
- Support or perform SEL product field testing.
- Analyze event reports to determine ways to improve system performance and increase reliability.
- Provide application-specific training for operations and engineering staff.
- Increase system performance and functionality.

# Engineering Studies and Simulation Services

selinc.com/solutions/system-modeling



SEL Engineering Services conducts power system studies using simulation software. Our experienced team of engineers has the software and equipment necessary to model any power system and operating scenario. The results of these studies increase power system awareness or confirm reliable performance. With this insight and analysis, you can improve performance, ensure safe operation, and optimize device settings in your system.

## Protection studies

Protection studies are important for identifying deficiencies and developing improvements to ensure a reliable electric power system. Our protection studies can improve relay coordination and reduce system outages. We review or build models to determine the system impacts during a faulted condition. To model the entire network, we use software applications, such as Electrocon International's Computer-Aided Protection Engineering (CAPE), AspenTech's software suite, and solutions from SKM Systems Analysis, EasyPower, and ETAP. We then compare model results and calculated values against equipment ratings to verify that the system is protected and operating safely.

Our protection study services include the following:

- Real and reactive (VAR) power flow and optimization
- Voltage drop and regulation analysis
- Short-circuit analysis
- Circuit breaker and bus rating evaluation
- Protection coordination, settings, and conversions
- Arc-flash hazard analysis
- Harmonic and power quality assessment
- Power factor improvement
- Transient stability analysis

## Hardware-in-the-loop (HIL) testing

HIL testing improves power system reliability and reduces the costs associated with real-time transient power system testing. Our engineers build a model of your power system and integrate it with physical protection and control devices to simulate real-time operation. Validated models confirm that the simulated response to a disturbance or event reasonably matches the measured response to a similar disturbance. Incorporating these models with HIL testing demonstrates the performance of the protection and control scheme as well as its effect on the power system. We test scenarios for short-term versus long-term capacity limits to ensure a more accurate representation of a system's operations. Thorough modeling and understanding result in better system performance.

We have the largest commercial simulator for performing HIL testing in the United States, allowing our team to test many complicated scenarios, including the following:

- Communications-assisted tripping schemes
- Autosynchronizing schemes
- Load-shedding schemes
- Generation shedding and runback schemes
- Control schemes
- Islanding detection and decoupling schemes
- Remedial action schemes
- Phase-shifting transformer protection and control schemes
- Open-phase detection schemes

# Custom Panel and Enclosure Solutions

selinc.com/solutions/custom-panel-solutions
selinc.com/solutions/custom-enclosure-solutions

We design, manufacture, test, and deliver custom protection, control, and metering panels, control cabinets, retrofit doors, and enclosures. We integrate multiple pieces of equipment (from SEL and other manufacturers) into a single assembly or kit, enabling one-stop shopping for parts and labor with a quick turnaround time. Our experts will work with you to understand your requirements and challenges and provide innovative, economical solutions built to stringent SEL quality standards.

## Complete design, manufacturing, testing, and commissioning services

To exactly meet your needs, we offer complete panel and enclosure solutions, from design through commissioning. We test the final implementation of every product or system before it ships, reducing your overall project costs and engineering time. This testing makes commissioning easier and faster.

## Complete panel solutions

SEL custom panel solutions come with the following options and services:

- Consulting and engineering design
- Testing and verification, including loading settings, functionality, point-to-point wire connectivity, ac/dc circuit operation, and Megger and HiPot testing
- Protection, automation, and control equipment manufacturing
- Field service
- Standard cabinet design
- Indoor and outdoor design
- Submersible cabinets for underground distribution and automation
- Delivery in 10–12 weeks
- Assigned project manager

## Complete enclosure solutions

SEL custom enclosure solutions offer the following options and capabilities:

- Enclosures, racks, bezels, plates, portable enclosures, swing panels, and doors
- Custom adapters that integrate SEL equipment into your existing systems
- Prewired assemblies for easy installation and minimal field wiring
- Wiring conversion assemblies and terminals
- Fully assembled and wired test racks and simulator systems
- Easily extractable assemblies for SEL-700 and SEL-2400 series products
- Assembly for your pre-existing designs
- Stainless steel, mild steel, aluminum, fiberglass, and polycarbonates
- UL508A and CSA-C22.2 No. 14 certification

# SEL-7200 Configure-to-Order (CTO) Panels and Retrofit Plates NEW

selinc.com/products/7200

SEL-7200 CTO panels and retrofit plates provide predesigned, advanced solutions for protection, control, automation, communications, and cybersecurity for substation applications. These panels offer a consistent, methodical design and manufacturing approach, resulting in higher quality, reliability, and performance than traditional custom panels. They are predesigned and come with prevalidated settings, speeding up deployment while guaranteeing functionality. Additionally, CTO panels ship within 4 weeks and achieve up to a 40 percent savings in total cost of ownership versus a comparable custom panel.

SEL CTO panels are available through our Engineering Services (ES) division and embody SEL best-known engineering methods and field-tested expertise in mechanical design, cable management, protection, precise time, automation, communications, and metering.

Application modules support common protection and automation practices while universal wiring to terminal blocks allows customization flexibility to adapt to any common primary equipment configuration and operation practice.

## Design principles

SEL CTO panels provide the following:

- Fully redundant protection and breaker failure protection at all voltage levels.
- Preconfiguration for cybersecurity framework integration.
- Advanced SEL technology, such as arc-flash protection and zone interlocked bus protection logic, that is ready to deploy.
- Simple integration to SCADA and HMIs.
- Continuous monitoring to reduce the possibility of hidden failures and facilitate extended testing intervals.
- An industrial design for improved human performance.

## Quality

We engineer, manufacture, and test our panels to ensure adequate operation before delivery. When a panel arrives at your site, it is already verified as fully functional. SEL panels are supported by an unmatched ten-year warranty and the industry's best customer service.

For a complete list of available options, visit selinc.com/products/7200.

## Design validation that guarantees expected performance

We develop and test each application module design to ensure it meets functional specifications. This process allows our manufacturing facility to properly document processes and test procedures prior to production.

Available solutions include the following:

### SEL-7201 Feeder Protection Panels

Provide advanced protection and control for up to four feeders using either SEL-351 or SEL-751 Feeder Protection Relays. These panels include protection functions, such as overcurrent, voltage, frequency, and breaker failure, and control functions, such as reclosing, sync-check, and hot-line tagging.

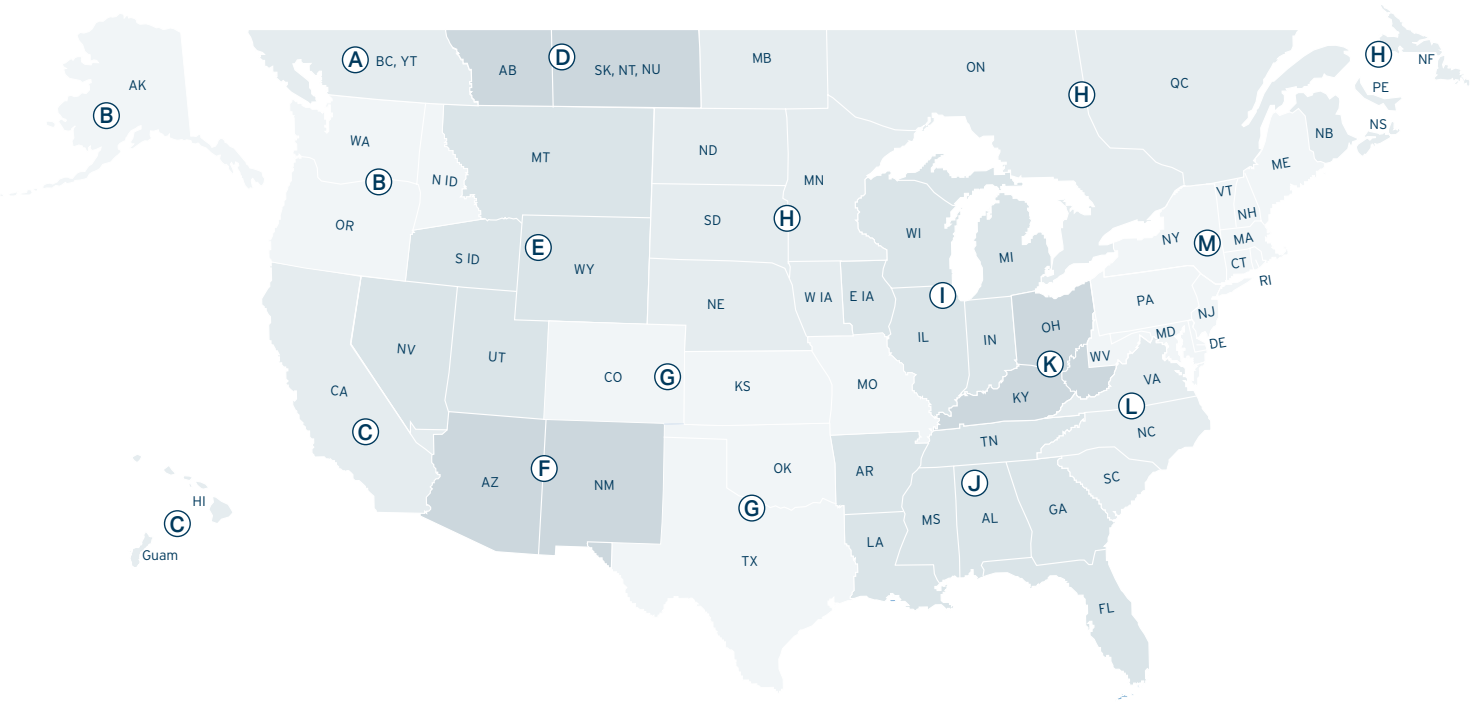
### SEL-7207 Automation and Communications Panels

Provide high-accuracy time synchronization; centralized engineering access with user-based authentication and authorization; data collection for SCADA; and inherently cyber-secure, reliable, and high-performance Ethernet communications using SEL software-defined networking (SDN) technology.

### SEL-7210 Retrofit Plates

Retrofit and modernize existing panels or switchgear, and get all the benefits of CTO panel solutions. Fifteen-foot pigtails provide connection to your existing terminal blocks.

# Ordering and Customer Support

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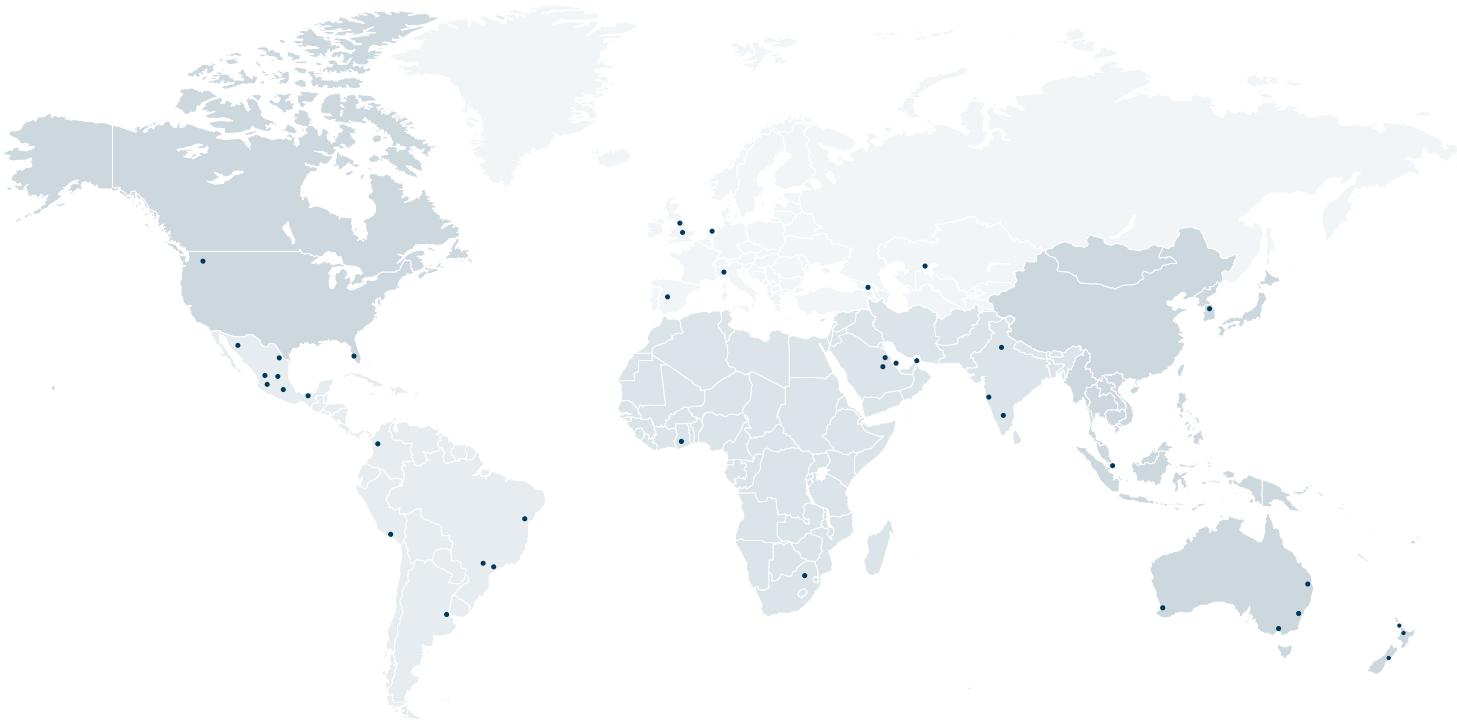

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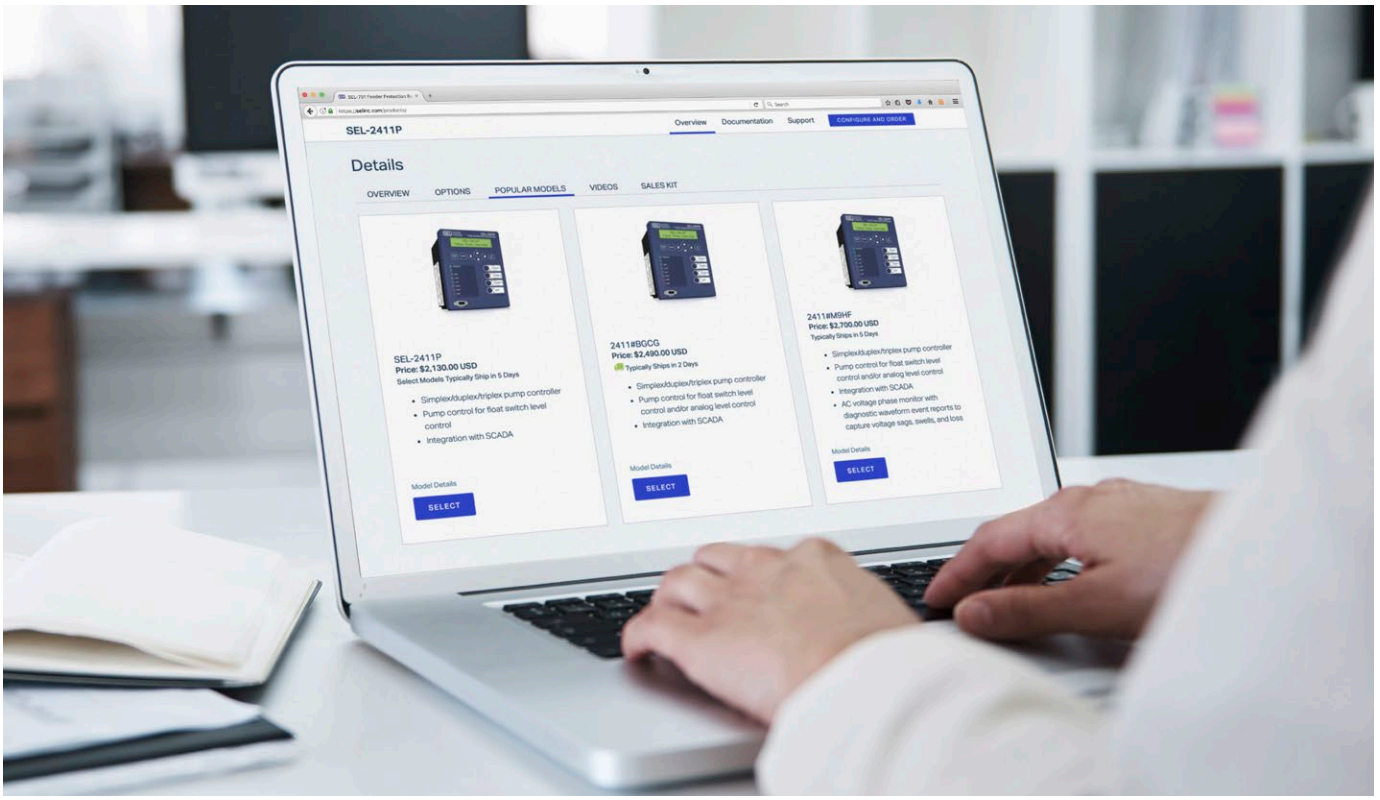
# Index


| | |
|---|---|
| 300G Generator Relay | 26 |
| 311C Transmission Protection System | 56 |
| 311L Line Current Differential Protection and Automation System | 58 |
| 351 Protection System | 105 |
| 351A Protection System | 106 |
| 351RS Kestrel® Single-Phase Recloser Control | 120 |
| 351S Protection System | 107 |
| 352 Breaker Failure Relay | 93 |
| 387 Current Differential and Overcurrent Relay | 89 |
| 387A Current Differential and Overcurrent Relay | 89 |
| 387E Current Differential and Voltage Relay | 90 |
| 387L Line Current Differential Protection and Automation System | 59 |
| 400G Advanced Generator Protection System NEW | 22 |
| 401 Protection, Automation, and Control Merging Unit | 76 |
| 411L Advanced Line Differential Protection, Automation, and Control System | 54 |
| 421 Protection, Automation, and Control System | 51 |
| 421-7 Protection, Automation, and Control Merging Unit | 78 |
| 451 Protection, Automation, and Bay Control System | 102 |
| 487B Bus Differential and Breaker Failure Relay | 86 |
| 487E Transformer Protection Relay | 82 |
| 487V Capacitor Protection and Control System | 80 |
| 501 Dual Overcurrent Relay | 108 |
| 501-2 Dual Overcurrent Relay | 108 |
| 551 Overcurrent/Reclosing Relay | 109 |
| 551C Overcurrent/Reclosing Relay | 109 |
| 587 Current Differential Relay | 91 |
| 587Z High-Impedance Differential Relay | 92 |
| 651R Advanced Recloser Control | 116 |
| 651RA Recloser Control | 118 |
| 700BT Motor Bus Transfer Relay NEW | 30 |
| 700G Generator Protection Relay | 24 |
| 710-5 Motor Protection Relay | 32 |
| 734B Advanced Monitoring and Control System | 121 |
| 734W Capacitor Bank Control | 122 |
| 735 Power Quality and Revenue Meter | 144 |
| 751 Feeder Protection Relay | 100 |
| 787-2/-3/-4 Transformer Protection Relay | 70 |
| 851 Feeder Protection Relay NEW | 98 |
| 849 Motor Management Relay | 34 |
| 2126 Fiber-Optic Transfer Switch | 224 |
| 2240 Axion® | 172 |
| 2401 Satellite-Synchronized Clock | 213 |
| 2404 Satellite-Synchronized Clock | 214 |
| 2407® Satellite-Synchronized Clock | 213 |
| 2411 Programmable Automation Controller | 175 |
| 2411P Pump Automation Controller | 174 |
| 2414 Transformer Monitor | 85 |
| 2431 Voltage Regulator Control | 123 |
| 2440 Discrete Programmable Automation Controller (DPAC) | 175 |
| 2488 Satellite-Synchronized Network Clock | 212 |
| 2505 Remote I/O Module | 218 |
| 2506 Rack-Mount Remote I/O Module | 218 |
| 2507 High-Speed Remote I/O Module | 218 |
| 2515 Remote I/O Module | 218 |
| 2516 Rack-Mount Remote I/O Module | 218 |
| 2522 Alarm Panel | 216 |
| 2523 Annunciator Panel | 216 |
| 2533 Annunciator | 216 |
| 2595 Teleprotection Terminal | 218 |
| 2600 RTD Module | 29 |
| 2664 Field Ground Module | 28 |
| 2664S Stator Ground Protection Relay | 27 |
| 2652 Trip Coil Monitor | 224 |
| 2725 Five-Port Ethernet Switch | 199 |
| 2730M Managed 24-Port Ethernet Switch | 198 |
| 2730U Unmanaged 24-Port Ethernet Switch | 198 |
| 2740S Software-Defined Network Switch | 194 |
| 2742S Software-Defined Network Switch NEW | 194 |
| 2800 Fiber-Optic Transceiver | 220 |
| 2810 Fiber-Optic Transceiver With IRIG-B | 220 |
| 2812 Fiber-Optic Transceiver With IRIG-B | 220 |
| 2814 Fiber-Optic Transceiver With Hardware Flow Control | 220 |
| 2815 Fiber-Optic Transceiver/Modem | 220 |
| 2820 Multimode Fiber-Optic EIA-485 Transceiver | 220 |
| 2824 Multimode Fiber-Optic EIA-485 Transceiver | 220 |
| 2829 Single-Mode Fiber-Optic Transceiver/Modem | 220 |
| 2830 Single-Mode Fiber-Optic Transceiver/Modem | 220 |
| 2831 Single-Mode Fiber-Optic Transceiver/Modem | 220 |
| 2886 EIA-232 to EIA-485 Interface Converter | 221 |
| 2890 Ethernet Transceiver | 220 |
| 2894 Interface Converter | 221 |
| 2910 Port Isolator | 224 |
| 2924 Portable Bluetooth® Serial Adapter | 205 |

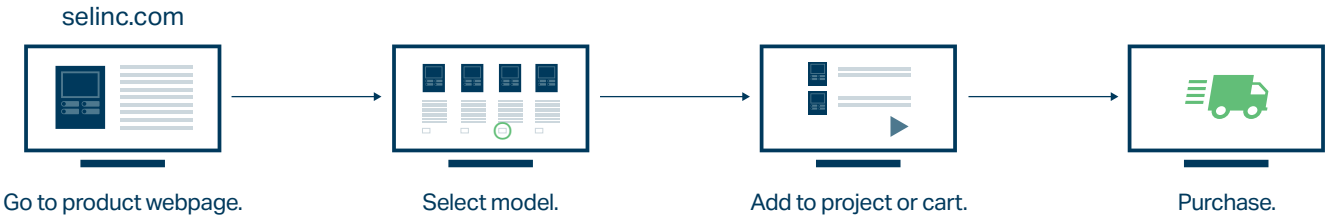
| | |
|---|---|
| 2925 Bluetooth® Serial Adapter | 205 |
| 3025 Serial Shield® | 198 |
| 3031 Serial Radio Transceiver | 204 |
| 3061 Cellular Router | 204 |
| 3094 Interface Converter | 218 |
| 3350 Automation Controller NEW | 161 |
| 3355 Automation Controller | 158 |
| 3360 Compact Automation Controller | 160 |
| 3390 PCIe Expansion Card | 162 |
| 3400 IRIG-B Distribution Module | 214 |
| 3401 Digital Clock | 214 |
| 3405 High-Accuracy IRIG-B Fiber-Optic Transceiver | 215 |
| 3505 Real-Time Automation Controller (RTAC) | 171 |
| 3505-3 RTAC | 171 |
| 3530 RTAC | 170 |
| 3530-4 RTAC | 171 |
| 3555 RTAC | 167 |
| 3560 RTAC | 168 |
| 3610 Port Server | 199 |
| 3620 Ethernet Security Gateway | 197 |
| 3622 Security Gateway | 197 |
| 4388 Mirrored Bits® Tester | 224 |
| 4520 Arc-Flash Test Module | 224 |
| 5030 acSELerator QuickSet® Software | 178 |
| 5032 acSELerator Architect® Software | 184 |
| 5035 acSELerator Diagram Builder™ Software | 181 |
| 5036 acSELerator® Bay Screen Builder Software | 179 |
| 5037 Grid Configurator NEW | 177 |
| 5045 acSELerator Team® Software | 182 |
| 5056 Software-Defined Network Flow Controller | 195 |
| 5057 SDN Application Suite NEW | 196 |
| 5230 acSELerator® Database API | 147 |
| 5601-2 synchroWAVe® Event Software | 185 |
| 5630 acSELerator® Meter Reports Software | 146 |
| 7200 Configure-to-Order (CTO) Panels and Retrofit Plates NEW | 254 |
| 8301 Underground Distribution Sensor | 133 |
| 8340 Wireless Current Sensor | 122 |
| 9192 Utility-Grade USB Modem | 220 |
| 9220 Fiber-Optic Adapter for SEL-300 Series Relays | 221 |
| 9321 Low-Voltage DC Power Supply | 224 |
| 9322 15 VDC Power Supply | 224 |
| 9331 Power Supply | 162 |
| 9501 Contact Arc Suppressor | 224 |
| 9502 Contact Arc Suppressor | 224 |
| 9510 Control Switch Module | 224 |
| 9524 GNSS Antenna | 215 |
| 9929 Satellite-Synchronized Clock Display Kit | 214 |
| AR Overhead AutoRANGER® Fault Indicator | 130 |
| AR360 Overhead AutoRANGER® Fault Indicator | 130 |
| ARU Underground AutoRANGER® Fault Indicator | 134 |
| BlueFrame™ Application Platform | 163 |
| BTRI Overhead BEACON® Timed-Reset Fault Indicator | 131 |
| BTRIP Overhead BEACON® Field-Programmable Timed-Reset Fault Indicator | 131 |
| C804 Multimode Arc-Flash Detection Fiber-Optic Cables | 222 |
| C805 200 µm Multimode Fiber-Optic Cables | 222 |
| C807 62.5/200 µm Multimode Fiber-Optic Cables | 222 |
| C808 62.5/125 µm Multimode Fiber-Optic Cables | 222 |
| C809 9 µm Single-Mode Fiber-Optic Cables | 222 |
| Cables—Coaxial, Electrical Data, Ethernet, and USB Cables | 222 |
| CR Underground Current Reset Fault Indicator | 135 |
| CRD Overhead Current Reset Fault Indicator | 131 |
| CT Split-Core Current Transformer | 139 |
| ER Overhead Electrostatic Reset Fault Indicator | 131 |
| FLR Fault and Load Receiver | 128 |
| FLT Fault and Load Transmitter | 128 |
| FR12 Fault Receiver | 115 |
| FT50 Fault Transmitter | 115 |
| GFD Underground Ground Fault Detector | 136 |
| ICON® Integrated Communications Optical Network | 192 |
| MW Microcontroller-Based Wye Voltage Sensor | 135 |
| PILC Underground Paper-Insulated Lead-Covered Cable Fault Indicator | 136 |
| RadioRANGER® Underground Wireless Fault Indication System | 132 |
| RPM Redundant Power Module NEW | 225 |
| RTAC HMI Web-Based HMI Package for RTACs | 180 |
| SCT Submersible Separable-Core Current Transformer | 139 |
| SR Underground Secondary/Low-Voltage Reset Fault Indicator | 135 |
| Synchrowave® Operations Software NEW | 186 |
| T400L Time-Domain Line Protection | 42 |
| T401L Ultra-High-Speed Line Relay NEW | 46 |
| T4287 Traveling-Wave Test System | 50 |
| TMU TiDL® Merging Unit NEW | 74 |
| TPR Underground Test Point Reset Fault Indicator | 134 |
| TR Underground Timed-Reset Fault Indicator | 135 |

# Popular Models Simplify Ordering




The Popular Models program makes selecting and ordering SEL products simple, fast, and convenient. Through this program, SEL provides preconfigured product models for popular applications. Specific models offer discount pricing and/or ship from stock, typically in 2 business days.

The popular models are displayed on the webpage for the majority of SEL products, and the webpage clearly shows the technical details and popular applications for each model. You can order these models directly online or through your SEL sales representative.



## Example Popular Models for the SEL-2411P Pump Automation Controller

For a complete popular models listing, visit selinc.com/products/popular | Select models typically ship in 2 days

| Application Details | Item No. | Price | |
|---|---|---|---|
| Simplex, duplex, and triplex pump control for float switch level control and integration with SCADA. | 2411#GJ44 | $2,130 USD |  |
| Simplex, duplex, and triplex pump control for float switch level control and/or analog level control and integration with SCADA. | 2411#BGCG | $2,490 USD |  |
| Simplex, duplex, and triplex pump control for float switch level control and/or analog level control, integration with SCADA, and ac voltage phase monitoring with diagnostic waveform event reports. | 2411#M9HF | $2,700 USD |  |

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