2011 SOLUTIONS

Making Electric Power Safer, More Reliable, and More Economical®

Letter From the President

The world of electric power has changed significantly over the past three decades, and the pace may even be accelerating. New regulatory structures, environmental issues, the integration of intermittent sources of energy, increasing reliability expectations, and the basic needs of society for economic sources of energy challenge all of us daily.

Our company's purpose is to make electric power safer, more reliable, and more economical. We focus on innovation, quality, and customer service, in order to pursue our purpose in the context of energy needs. We strive to make it simple to get the job done at all stages: concept, evaluation, specification, purchasing, training, installation, integration, maintenance, and use. We enjoy working closely with you—listening, learning, and sharing—because the world is changing, and we know the problems you may face today may not be solved with yesterday's solutions.

For example, in the United States, vertically integrated, regionally franchised utilities managed all aspects of generation, transmission, and distribution for nearly a century. Two decades of reregulation into generation companies, transmission companies, and distribution companies challenge us all in how to plan, design, and operate electric power systems today. Yesterday's radial feeder may become more like a bus, with sources as well as loads connected almost anywhere. The feeder is a collector too. The concept of "islanding" is changing, and the practices, technology, and laws will change too.

As efficient as today's electric power transmission and distribution systems are, they are becoming even more efficient. We are working on many projects that include volt/VAR control to improve efficiencies, often with the features you already have in your SEL equipment.

Our roots are in power system protection. Today, it is no longer necessary to wait to clear a fault. Time-coordinated protection can generally be relegated to backup functions as we take advantage of many new and low-cost choices for pilot communications, such as dedicated fiber, fiber networks, and point-to-point radio. The advantages are improved safety, less damage, less effect on customers, better voltage and angle stability, and higher quality of service. Virtually all SEL relays come ready to apply in communications-assisted protection schemes, making it easy and inexpensive to clear faults faster than ever.

A few years ago, we asked ourselves: "What should dependable communications for critical infrastructure be?" Today, we are introducing the SEL ICON™ (Integrated Communications Optical Network) as one answer. The ICON operates as both a multiplexer and a high-speed Ethernet switch, supports multiple interfaces, times with microsecond accuracy, and provides maximum data security through an optional cryptomodule.

Sensible cybersecurity is more important than ever, and SEL products have, from the beginning, contained multiple security measures that provide secure system solutions. Recipes are a new SEL solution for power system control, providing another measure of power system security. Using synchrophasors to precisely coordinate control actions, recipes provide operators with an additional level of control for security checking. Recipes also enable operators to complete complex operations simultaneously in milliseconds instead of minutes. This act of synchronous controlled switching prolongs the life of the system, reducing system cost and improving system safety and reliability.

Safety for equipment, operators, and users is paramount in electric power systems. Arc-flash hazards are a serious safety concern in our industry today. Services and equipment offered by SEL significantly reduce arc-flash hazards by employing two-millisecond tripping times. Power system safety is also increased by system stability. SEL's power management and control system, POWERMAX®, combines the innovation and intelligence found in many SEL products to provide ultra-high-speed shedding of load and generation, in a reliable, robust, and cost-effective solution.

More robust, reliable, and cost-effective solutions are detailed in our recently published textbook, *Modern Solutions for Protection, Control, and Monitoring of Electric Power Systems*. This is the collaborative work of 15 SEL engineers, sharing experiences and knowledge learned in the field of electric power.

We continue to learn from our customers, and part of making electric power safer, more reliable, and more economical is providing products that are consistently easy to use. Our new graphical logic editor software delivers relay settings and clear logic diagrams without the need for writing complex logic equations.

The following pages contain more information about these and other SEL 2011 innovations as well as many other SEL products. The privilege of joining with our customers around the world—in thousands of businesses and with many different goals—is truly an honor. All of us at SEL look forward to working together with you to create the best solutions for the electric power industry.

Sincerely,

Edmund O. Schweitzer, III Ph.D.
President

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2011 Innovations

Dependable Communications for Critical Infrastructure

The new SEL ICON™ Integrated Communications Optical Network is a versatile communications solution that can operate as an OC-48 SONET multiplexer and/or a Gigabit/Fast Ethernet switch. In addition to providing flexible transport options, the ICON also offers a broad array of interfaces for Ethernet, voice, data, IEEE C37.94, and teleprotection channel interfaces. The ICON uses an SNMPv3 protocol for secure management access and the SEL-5051 network management software, which automatically reads the connected system and builds a visual network representation, making configuration and management easy. The ICON distributes time for a more fault-tolerant, robust, terrestrial time distribution network. A GPS clock in each ICON node distributes time to the microsecond throughout. Even if all GPS signals are lost, the network maintains relative timing to the microsecond at all nodes. The next generation of communications, the ICON is designed to address security requirements of critical infrastructure. An optional cryptomodule maximizes data security during transport. For more information about the ICON and its applications, please see pages 358–359 of this catalog.

Recipes for Power System Control

Another exciting opportunity is the use of "recipes" to smoothly control the power system. Synchrophasors are used to measure signals in a time-synchronized manner; recipes will allow for time-synchronized control. The "next step" in time-synchronized systems, recipes bring the possibility of precisely coordinated control actions over a wide area and enable operators to carry out complex operations in seconds or milliseconds instead of the minutes it takes them today. To learn more about these innovative recipes and their applications, please contact your local SEL field application engineer or speak with one of SEL's synchrophasor experts.

Sensible Cybersecurity

All SEL solutions, from the first SEL-21 to the newest product lines, contain security measures such as multiple access levels, strong password support, activity logs, memory checks, and alarm contacts. Cybersecurity is woven into the product development lifecycle at SEL, so we can produce the most secure product. Examples of this are our secure coding practices, negative testing, and personnel training, which all result in more reliable, safer products that need fewer updates. Security concerns are now more important than ever as a result of today's highly connected grid. SEL continues to advance the state of substation security with new cybersecurity features and technology that provide stronger access controls, substation firewalls, data integrity cryptography, data encryption, and even central authentication. New solutions such as the SEL-3620 Ethernet Security Gateway, SEL-3025 SCADA Shield, and the SEL authentication proxy will make the grid more secure and enable operators to perform their duties more efficiently. Also, in 2011 SEL University offers two new courses related to cybersecurity—COM 203: Cybersecurity Best Practices for Critical Infrastructure and APP 3620: Sensible Cybersecurity Using the Ethernet Security Gateway. Your local SEL sales representative or field application engineer would be happy to discuss security as it applies to your system and the SEL solutions that you use.

Distribution at Transmission Speeds

Looped distribution systems are becoming increasingly common. Orlando's International Drive project, now in service for over a decade, takes one-tenth of a second (six cycles) to trip and restore power. Today, making distribution systems as reliable as transmission systems is so inexpensive that it's possible to apply the necessary equipment on any distribution system. Cost and technical gaps would have made this impossible 20 years ago. Take a transmission line where today you might be using time coordination and time step distance. With one pair of SEL-3031 radios installed on a short line, you will have dependable, secure, high-speed tripping for the whole length of that line—something that would have cost 30 times as much in the past using fiber optics or leased communications. Opportunities like this open a lot of new doors.

2011 Innovations

Arc-Flash Detection

Arc-flash mitigation and protection are core elements of safe, reliable electric power. SEL offers both services and equipment that reduce arc-flash hazards to protect employees, equipment, and productivity. Our Engineering Services team works with customers to identify and mitigate arc-flash hazards in a variety of facilities and applications. Combined light-sensing technology and fast overcurrent protection provide high-speed, arc-flash detection without false tripping as part of the SEL-751A Feeder Protection Relay, which can initiate tripping in as little as two to four milliseconds! Arc-flash energy reduction is now limited only by the speed of your breaker, not the speed of a time curve, which could be a ten-fold reduction in energy. SEL customers in sectors as diverse as utility, petrochemical, mining, pulp and paper, transportation, government, education, and healthcare are rapidly adopting arc-flash detection, making it a standard approach to arc-flash mitigation. This catalog offers additional information about SEL arc-flash technology and services (pages 33 and 47).

Load Shedding and Generation Control

System stability is critical for the safe and cost-effective operation of industrial facilities, such as power plants, refineries, and paper mills, and is increasingly complicated by the integration of distributed generation sources. SEL's power management and control system, POWERMAX®, uses the intelligence already built into SEL relays, along with SEL information processors, hardened computers, and communications, to provide advanced solutions for automatic generation management, volt/VAR control, and ultra-high-speed shedding of load and generation. The intelligent architecture and software technology of POWERMAX, coupled with services provided by SEL's quickly growing Engineering Services team, results in a robust, reliable, and cost-effective solution. Customers such as Saudi Aramco, Chevron, Marathon Oil, Motor Oil Hellas, and Idaho Power use and trust SEL's innovative and cutting-edge power management solutions. For more information about the solutions and services provided by SEL Engineering Services, please see pages 42–63 of this catalog, or contact your local SEL sales representative.

Distribution Monitoring and Control

Advanced monitoring and control devices installed downstream of distribution substations support volt/VAR control schemes. The SEL-734T Digital Transducer provides high-accuracy reporting along with power quality reports for greatly improved situational awareness of the distribution system. In addition to monitoring, the SEL-734B Monitor and Control System can control capacitor banks locally and through remote commands to improve system efficiencies through volt/VAR control. Compact outdoor enclosures, power supplies, and radios from SEL provide a true plug-and-play solution.

Ease of Use for Optimal Solution Performance

Part of making electric power safer, more reliable, and more economical is the need to provide our customers with products that are consistently easy to use—solutions that you can apply correctly every time. The industry's first relay with zero settings, the SEL-387L Line Current Differential Relay for high-speed line current differential, is now installed in hundreds of locations. The SEL-487E Transformer Protection Relay and SEL-487V Capacitor Protection and Control System automatically provide compensation factors to reduce settings errors. Automatically detecting out-of-step conditions without complex system studies or detailed user-generated settings to detect all possible conditions is now possible with the SEL-421 Protection, Automation, and Control System. Our software is also becoming more user-friendly: SEL graphical logic editor software delivers relay settings and clear logic diagrams without the need for writing complex logic equations.

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SEL Overview

SEL Corporate Headquarters, Pullman, Washington, USA

Who We Are

SEL 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. The SEL Government Services Division is dedicated to the security, safety, and reliability of electric power at facilities ranging from military bases to ships, while Engineering Services provides engineering capabilities and system solutions to national and international customers. SEL University offers training and programs that help our customers meet the technical challenges and complexities of integrating digitally based technologies into the expanding power system infrastructure.

SEL Fault Indicator and Sensor Division, Lake Zurich, Illinois, USA

Support offices around the world ensure the best possible customer experience with SEL solutions. SEL designs and manufactures fault indicators and sensors in Lake Zurich, Illinois, United States, and panels in San Luis Potosí, Mexico. All other product lines are manufactured at corporate headquarters in Pullman, Washington, United States. The close relationship between Manufacturing and R&D enables SEL to rigorously follow quality standards, beginning with first designs and extending through manufacturing and field support.

SEL Mexico, San Luis Potosí, Mexico

SEL is 100 percent employee-owned. Part of SEL's long-term strategy for sustained growth and stability, employee ownership allows us to put our customers and employees first.

In a recent independent study conducted by the Newton-Evans Research Company, international utilities ranked SEL first in overall customer experience. Among North American utilities, SEL ranked first as a protective relay manufacturer in all categories, including technology, price, features, security against hackers, technical support, web information, ease of use, and maintenance costs.

SEL commits to serving our industry in keeping with our corporate responsibility and ethics. We believe in a strong set of core company values, which are an essential part of SEL's working environment as well as the way we view our community, industry, and the natural environment.

For SEL, being "green" is part of being an efficient, customer-focused business. We make products of lasting value, provide upgrades and repairs, constantly reduce waste, provide solutions that improve the efficiency of generation, and deliver the products and services that support a "smarter" grid.

SEL Overview

Who We Serve

SEL customers come from a wide variety of industries, including utilities, rural electric cooperatives, municipalities, government agencies, airports, medical and educational facilities, water treatment facilities, mining operations, factories, research facilities, oil and gas operations, data centers, and renewable energy operations.

From employee-owners answering calls in person to skilled application and integration engineers fielding technical requests wherever our customers need support, SEL constantly strives to "stay close" to our customers. As a result, we can immediately respond to customer questions ranging from manufacturing details to application concerns with sound technical answers.

After a product is installed in the field, SEL engineers and technicians spend time helping customers make the most of their SEL solutions, to really use the information available through the new equipment. As interest in smart grid solutions grows, SEL believes that local technical support for new installations and projects will be increasingly important.

In an ongoing effort to help our communities and support our customers, our company has a standing commitment to discount all products destined for natural disaster relief by 10 percent. When major disasters occur, leaving residents without electric power, we also rush deliveries to our customers and provide field support to restore power as soon as possible.

SEL Values

- Quality
- Customer Focus
- Discipline
- Communication
- Integrity
- Creativity
- Community
- Ownership
- Dignity of Work

"We are a small company in the renewable energy field. We hired SEL to do an analysis for us. They helped us with our design and also in the selection of equipment for proper protection of the system. The SEL name and reputation eased the power company's acceptance of our design. SEL helped put us on the road to a successful project."

Mario LaValva
Ocean Power Technologies

SEL Engineering Services Successes

Stanford University

Saudi Aramco

Riviera Utilities

Plumas-Sierra Rural Electric Cooperative

Petrobras

Overton Power

Oklahoma Gas & Electric

Motor Oil Hellas

Midwest Energy

Marathon Oil

ExxonMobil

Dow Chemical

City of College Station

Chevron

BP

American Electric Power

Abbott Laboratories

Quote From Marathon Oil:

Before SEL: "The existing hardware was all pure analog devices with no historical data-capture capabilities, so pinning down problems was really a series of educated guesses..."

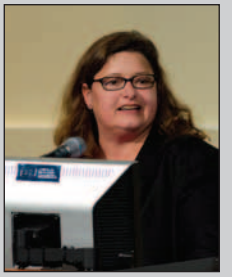
With SEL: "With just a handful of people to support power systems throughout the company...having the ability to remotely manage devices is a tremendous advantage."

SEL Overview

Local Service…Around the World

Teams in 15 countries around the world provide local sales and technical service. With SEL solutions in 140 countries today, we stay close to our customers. Our commitment to quality extends through a product's installation and life as part of our customers' critical infrastructure. Application and integration engineers, customer service representatives, and sales managers (in over 40 offices in the United States and more than 30 internationally) truly understand the importance of local support. The SEL network of independent sales representatives and distributors provides additional sales support in many regions.

See pages 494–495 for detailed maps and contact information.



"SEL is 100 percent employee-owned. What this means for our customers, industry partners, employees, and communities is that SEL has a certain future. This gives us the unique opportunity—and responsibility—to do what's right by each of these groups; it drives our business decisions. The fact that we've never charged a customer for a repair, our warranty, our commitment to local support, and our Product Hospital all reflect the way that SEL views our customers.

"Because we focus on innovation, we are able to provide world-class solutions to our customers at a lower cost than our competitors. But we don't compromise service to the customer."

Nancy Hindman
Chief Operating and Financial Officer

"This was our first purchase of a complete control house from an outside vendor. SEL provided a competitive bid, a flexible design process, and excellent cooperation throughout the construction process. The final product is the best control house we have on the system."

James W. Rice
Plumas-Sierra Rural Electric Cooperative

SEL Overview

Our Roots

Edmund O. Schweitzer, III founded SEL in 1982 in Pullman, Washington, USA. The company introduced the world's first digital protective relay to the electric power industry in 1984. This same year, Otter Tail Power Company in Fergus Falls, Minnesota, became SEL's first customer. The first SEL digital relay, the SEL-21, revolutionized the power protection industry by providing fault locating and real fault data at a much lower cost to the customer than traditional electromechanical relays. With the introduction of the load-encroachment element for feeder protection, synchrophasors as a standard feature in protective relays, and Mirrored Bits® relay-to-relay communications, we continue to set the technology curve.

SEL became an employee-owned company in 1994 and transitioned to 100 percent employee ownership in 2009. With over 2,000 employees around the world, SEL continues to grow in its capacity for innovation and customer support.

E. O. Schweitzer Manufacturing, a company started by Edmund O. Schweitzer Jr. in 1950 to design and manufacture faulted circuit indicators and sensors, became part of SEL in 2005. Because fault indicator technology "completes the job" that protective relays start, leading line crews directly to the location of a fault, the joining together of the two companies provides SEL customers with a more complete solution for distribution fault locating.

Please see page 34 for more information about the benefits of fault indicator technology.

"When we started manufacturing panels in 2000, it was specifically to serve the Mexican market. However, demand from the United States and around the world led us to create world-class panels for export as well. Today, we are exporting panels to more than 15 countries.

"Our success in the panel market led us into the manufacture of control enclosures, which we now design and manufacture for both Mexican and international customers.

"Thanks to our customer service, quality control, and pricing, more and more customers are choosing SEL as their supplier for complete systems. This includes the whole process from engineering and design to manufacturing and commissioning control houses and panels."

Luis D'Acosta
General Director, SEL Mexico

"SEL is a fabricator whose performance far exceeded our expectations. SEL's Charlotte-based project management and Mexico-produced panels were superb."

Sam Rugel, Project Manager
Tucson Electric Power

SEL Overview

Invention, Design, and Innovation

SEL engineers come to work knowing that their designs and solutions contribute directly to improving the reliability of electric power, keeping people safe, and helping customers save resources through efficiency, simplicity, and creativity. We strive to design superior features and implement cost-saving technology in ways that come together in products and services that reflect a constant cycle of two-way communication with our customers. Our customers are our partners in education and innovation.

SEL's engineering team focuses on how people use and interact with our products, and the goals they are trying to accomplish, rather than simply on the products themselves. This helps us to constantly redefine the best solutions for a multitude of industries and applications.

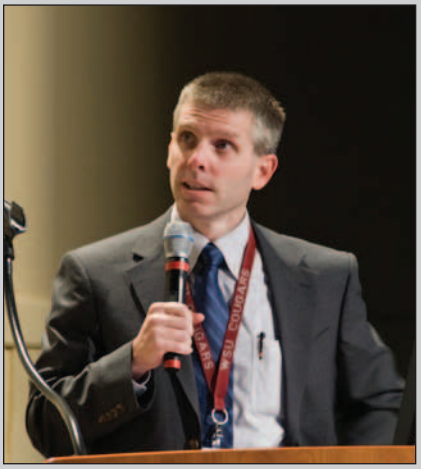
Because SEL equipment becomes part of critical—and complex—infrastructure, ranging from the electric power grid to processing and manufacturing facilities, our engineering team also focuses on long-term reliability and quality. SEL backs these commitments with an unmatched ten-year warranty, no-charge diagnostic and repair services, local support, and a variety of test procedures and certifications.

For some examples of new and upcoming innovations that are particularly exciting, please see pages 40 and 41.

"As engineers at SEL, we continually challenge each other to make products simpler, more reliable, and with better features. This in turn provides a better value to our customers because our products make their jobs easier. Our customers have serious safety and economic concerns. At SEL, we are very cognizant of that.

"I wake up every day just amazed at all of the opportunities that we're presented with as a company and industry. Every day, I go to work with the best tools to do my job, to a president who is passionate and creative when it comes not only to innovation, but also to what's right for our customers. For an engineer, it's just the best place to work."

Dave Whitehead
Vice President, Research and Development



The SEL ten-year, worldwide product warranty is proof of our confidence in the quality products we manufacture following the strictest industry standards.

SEL Overview

World-Class Manufacturing and Quality

State-of-the-art manufacturing facilities reflect SEL's strong commitment to offering our customers unmatched value in products and services by leading in price, quality, features, innovation, delivery, service, and simplicity. A focus on lean manufacturing keeps costs low, translating into better value for our customers.

Our company complies with the highest quality standards—such as IPC-A-610 Class 3 and ISO 9001:2008—and constantly strives to exceed those requirements. In addition to "Design for Manufacturability" and "Design for Testability" guidelines that contain best practices based on manufacturing production yields and processes, SEL uses a formal procedure to plan, monitor, and complete new product introductions.

SEL continually works to exceed customer expectations and quality standards in specific ways:

- Monitoring and controlling processes to exceed the ISO 9001:2008 Quality Management Systems Standard.
- Developing robust, repeatable, and scalable manufacturing processes to address design and process errors.
- Ensuring that our test and calibration laboratories use the latest equipment and follow National Institute of Standards and Technology traceable standards for accuracy and maintenance.
- Partnering with our suppliers for the highest possible quality and value.

As part of our spirit of continuous improvement, SEL constantly strives to find new ways to make our products more reliable and to reduce waste. To ensure superior, reliable functionality, we test our products thoroughly and verify that they will perform for decades under demanding conditions. Doing so eliminates waste due to early product replacement. Our ten-year warranty and Product Hospital enable our customers to buy a long-lasting product with the support and service necessary to use it for many years to come.

Certifications

SEL works with customers, sales partners, and accreditation agencies to obtain the certifications necessary to provide relevant products to a variety of industries and markets around the world. Various SEL products, divisions, and procedures have received certification from the following organizations. For more information about a certification, or which category of SEL product, division, or procedure it accommodates, please contact your local sales representative.

- 10 CFR Appendix B Nuclear Quality Program Approval
- ABS Marine Type Approval
- CE (Europe)
- CPRI (India)
- CSA (Canada)
- ENA (UK)
- EPRI (China)
- IEC, including IEC 61850-10 Conformance and IEC 61850-3 Reliability
- IEEE, including IEEE 1613 Reliability
- IREDA (India)
- ISO 9001:2008
- ISO/IEC 17025/A2LA (coming soon)
- KEMA
- KESCO (Korea)
- LAPEM (Mexico)
- RUS (for rural electric cooperatives)
- TNB Research (Malaysia)
- UL
- VPP Star Safety

"In manufacturing, we differentiate ourselves through quality of our products, customer service, delivery, and value. The idea of continuous improvement of processes has been ingrained in all of us. Improving quality and efficiency, while reducing lead times and total costs, is just part of our ongoing improvement goal. We use both automation and training to make our processes more robust and our goals achievable.

"It is important to me that our industry knows that our focus in manufacturing is on the customer. Whatever it takes, we want to make sure our customers are happy. If there is a problem, we do everything we can to get to root cause and solve it, and we don't believe we get to root cause until we can turn the problem on and off."

Kevin Fritch
Vice President, Operations

Industries Served

Electrical Power Generation and Renewable Energy

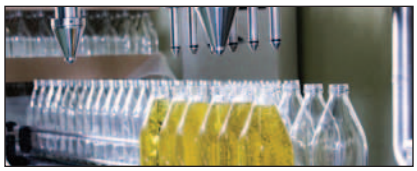
SEL's power interconnection, protection, communications, control, and metering equipment is ideally suited for large and small electrical generation and distributed power sources of all types. SEL products and systems protect and control generators and plants that use hydroelectric, coal, gas, geothermal, wind, biofuel, solar, and other energy sources.

Electrical Power Transmission and Distribution

SEL leads in the protection, monitoring, and control of electrical transmission and distribution lines, apparatus, and stations. Our full line of protective relays, substation automation systems, cybersecurity devices, automation controllers, and networking equipment works together to provide protection, SCADA, automation, monitoring, and asset management.

Commercial Buildings

Keeping the power on during an electrical outage or natural disaster is essential to many businesses and public entities. Rely on utility-hardened SEL devices—the most reliable protection, control, metering, and automation devices in the industry—for your mission-critical power systems. Easily integrate SEL's extensive product line into a customized power system protection, control, and monitoring scheme to maximize uptime for your 24/7 operations.



Consumer Products

SEL's comprehensive power management systems minimize production problems by rerouting energy around system faults, and our metering solutions help lower energy expenses in manufacturing facilities worldwide for food and beverage, pharmaceutical, biotechnology, and other operations. SEL power management solutions integrate seamlessly with existing process control systems, so that energy, material delivery, and production processes are synchronized for maximum production, quality, and efficiency.

Government

SEL is dedicated to the security, safety, and reliability of electric power applications at the municipal, state, provincial, and federal levels. SEL's solutions protect and manage emergency generation and power distribution systems for government facilities, military installations, and marine applications. With design, construction, training, and documentation, SEL offers a full range of systems and services that meet the special needs of the government.

Education and Healthcare

Education and healthcare campuses depend on reliable electric power daily. SEL products and services protect the critical assets in power distribution systems while providing safe operation for patients, students, staff, and visitors. SEL's power management products work continuously to monitor, protect, control, and meter power systems, and are backed by our ten-year, no-questions-asked warranty.

Electronics

Semiconductor and electronics manufacturers worldwide trust SEL to provide mission-critical power protection, communications, and management systems to ensure an uninterrupted supply of high-quality electric power. SEL's comprehensive power management systems optimize power delivery and quickly reroute energy around faults to minimize production interruptions and save money. SEL networking and communications products increase system reliability.

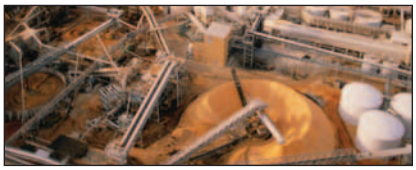
Industries Served

Metals and Mining

SEL's power management, process control, and automation products are designed and proven for the extreme environmental conditions common in mining and metal-forming industries, with appropriate mine safety certifications. SEL products monitor and protect expensive equipment, increase the reliability of instrumentation and control systems, and provide an uninterrupted supply of electric power to every corner of your site or facility.

Oil, Gas, and Petrochemical

Around the world, SEL makes electric power safer, more reliable, and more productive for oil, gas, chemical, and petrochemical companies. For platforms in the North Sea, refineries in the deserts of Saudi Arabia, biofuel plants in the United States, oil sands upgrades in Canada, and SCG/LNG terminals in Australia, over 500 industry customers rely on SEL solutions.



Pulp and Paper

Pulp and paper plants require uninterrupted, high-quality electric power, distributed to machinery operating in very harsh environments. Conformal coating further protects against airborne contaminants such as hydrogen sulfide, chlorine, salt, and moisture. SEL power management solutions modernize your electrical system, so plant equipment operates continuously, efficiently, and safely under all conditions.

Telecommunications and Information Technology

SEL's communications, networking, precise-time, cybersecurity, and electric power protection/management products are designed for the extreme environments of remote telecommunications sites and are the smart choice for data centers. SEL products monitor and protect expensive equipment; increase the reliability of instrumentation and control systems; provide an uninterrupted supply of electric power; and are backed by our ten-year, worldwide, no-questions-asked warranty.

Transportation

SEL instrumentation, control, and protection systems are deployed in harbors, airports, and shipyards as well as in mass-transit applications to maximize the availability of the power supplied by electric utilities, distributed generators, and emergency backup systems. Our hardened controllers, communications, and protective relaying products increase the safety, reliability, and security of land-based and maritime electrical protection, SCADA, and instrumentation and control systems.

Water and Wastewater

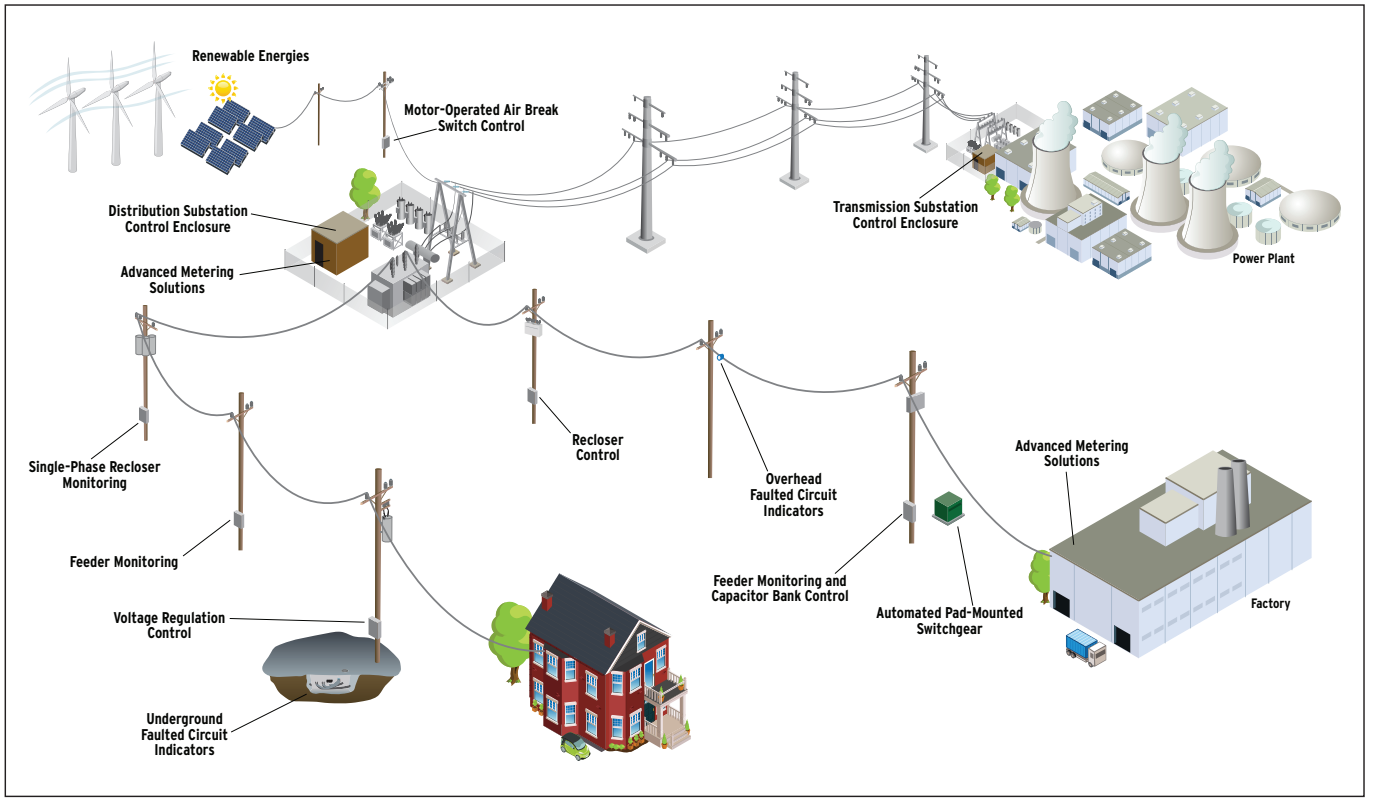
Water and wastewater electrical systems require rugged, reliable equipment. SEL solutions are perfect for the extreme temperatures and high humidity of harsh water and wastewater environments. Our hardened controllers and networking and communications products increase control system reliability and security. SEL relays provide unsurpassed protection for critical equipment, processes, and infrastructure. SEL solutions protect personnel and help optimize energy usage, reduce maintenance costs, and increase overall system reliability.

Smart Solutions for Grid Reliability, Efficiency, and Security

SEL smart grid solutions use information, computation, and communications to improve reliability and efficiency to meet customer needs. The technology that electric power utilities use today from SEL—protection, communications, sensing, monitoring, security, and control—makes the grid smarter. Continued modernization with SEL products makes the grid smarter, more capable, more stable, and more valuable.

Customers around the world apply field-proven SEL solutions to automatically and rapidly isolate faults, restore power, monitor demand, and maintain and restore stability for more reliable electric power. These are true smart grid solutions that pay for themselves, are ready "off the shelf," and can be installed and maintained with existing methods and staff.

Because SEL has provided technology to make the grid smarter for over a quarter century, customers benefit from field-proven solutions and experienced technical support.



From the generating station to the end of a distribution line, SEL solutions make the electric power grid smarter by providing protection, communications, sensing, monitoring, security, and control.

Smart Solutions for Grid Reliability, Efficiency, and Security

Applications

Technologies SEL customers use today already have the communications and control capabilities to make the grid smarter and more secure:

- Transformer protection (SEL-487E and SEL-787) for exception-based maintenance
- Recloser controls (SEL-351R, SEL-351R Falcon™, SEL-351RS Kestral™, and SEL-651R) and communications solutions for a self-healing grid
- Fault indicators for complete fault location and reduced fault-finding time
- Hardened computing platforms and relays (SEL-3354 and SEL-351) for reliable control of advanced technologies
- Advanced metering solutions (SEL-734) for revenue metering, power quality, capacitor bank control, and monitoring that help track energy usage, increase power reliability, and reduce energy use
- Cybersecurity solutions for a more secure grid
- Integration of renewable resources onto the grid
- Communications solutions for peer-to-peer and automatic network reconfiguration
- Multiple, simultaneous communications, including Mirrored Bits®, DNP3, FTP, Telnet, and IEC 61850

Many SEL solutions have additional intelligence built in free of charge:

- Synchrophasors
- Mirrored Bits communications
- Distribution fault locating
- Power quality recording
- Integrated metering
- Advanced security features

SEL provides products, services, and system solutions to customers with a wide range of goals, including:

Progress Energy
Distribution automation and protection reduce outages and improve reliability

PSE&G
Poletop-to-poletop communications eliminate or reduce outage times during automatic network reconfiguration

ComEd
Fault indicators for the wireless mesh network improve distribution reliability

Comisión Federal de Electricidad
Smart load shedding with synchrophasor solutions

Xcel Energy
Protection, automation, and control for Xcel Energy's SmartGridCity™ and smart substation

Review Your Event Reports and Establish Root Cause

SEL invented the relay event report. When faults or other events happen, the relays record voltages, currents, contacts, and relay elements, so you can quickly see exactly what happened. Our first digital relays sampled and reported every 90 electrical degrees, making it simple to take one sample as the Y component and the next sample as the X component of a phasor voltage or current. Today's relays sample faster for better oscillography, and SEL relays give the analyst a choice of display rates. For example, the SEL-421 Protection, Automation, and Control System can display the recorded data up to 8,000 samples per second or, for a quicker look, at four samples per cycle.

Event report analysis may reveal breaker problems, missing wires, failed CCVTs, faulty auxiliary contacts, settings problems, and more. In the past, these problems frequently went undetected until more serious consequences occurred.

It is good practice to examine every event report to see if the operation was normal or exceptional. Scheme performance is easy to ascertain from the detailed data available after each operation.

Use acSELerator Report Server® SEL-5040 Software to automatically collect and index event reports from relays with communications access. View and analyze the summary data with acSELerator Report Viewer® SEL-5042 Software and acSELerator Analytic Assistant® SEL-5601 Software. Retrieve event reports from relays that do not have remote communications by traveling to the site and gathering them with an SEL-4391 Data Courier®, or with a laptop computer with acSELerator QuickSet® SEL-5030 Software. Alternatively, install an SEL-3022 Wireless Encrypting Transceiver and then retrieve event reports using a laptop computer with acSELerator QuickSet Software from the safety and convenience of your truck.

The printed segments below are excerpts of a four-samples-per-cycle event report from an SEL-311C Advanced Distance Relay With Recloser. The relay detected a Phase A-to-Phase B-to-ground fault at a location 22.7 miles from the relay. The polar plots showing the current and voltage phasors prior to and just after the fault are from acSELerator Analytic Assistant screens. Alternatively, you can easily sketch phasors using consecutive quarter-cycle values for the Y and X coordinates, respectively. Phasor V_c is shown below.

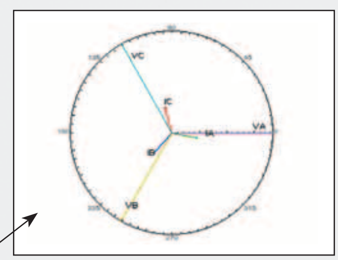
```
SEL-311C: POTT                           Date: 03/07/00    Time: 09:08:55.501
EPEC LUN-DIA 345KV: LUN
FID=SEL-311C-R100-V0-Z001001-D19991203          CID=E6FE

         Currents (Amps Pri)              Voltages (kV Pri)                 V1
    IA      IB      IC      IP      IG     VA      VB      VC      VS   Vdc   Mem
[1]
   318    -195    -136       0     -13   207.3   -79.9  -127.2   -0.0  125   207.3
    21     278    -318       0     -20   -28.8   193.7  -164.9   -0.0  125   -27.0
  -320     194     136      -1      10  -207.3    79.5   127.5    0.0  125  -207.2
   -21    -279     318      -1      18    29.2  -193.8   164.7    0.0  125    27.3
[2]
   318    -194    -138       0     -14   207.2   -79.2  -127.7   -0.0  125   207.2
    20     279    -318      -1     -19   -29.6   194.0  -164.5   -0.0  125   -27.7
  -319     193     137      -1      10  -207.2    78.8   128.0    0.0  125  -207.1
   -20    -280     318       0      18    29.9  -194.1   164.3    0.0  125    28.1
[3]
   318    -193    -138       0     -13   207.1   -78.5  -128.3   -0.0  125   207.1
    18     280    -318       0     -19   -30.3   194.3  -164.0   -0.0  125   -28.4
  -319     192     138      -1      11  -207.1    78.1   128.6    0.0  125  -207.0
   -18    -281     317      -1      18    30.6  -194.4   163.8    0.0  125    28.8
[4]
   318    -192    -138       0     -12   207.0   -77.8  -128.9   -0.0  125   207.0
   489     441    -312       0     618   -46.7   172.6  -166.8   -0.0  125   -29.4
 -1095    1669     143      -1     717  -138.5    41.9   136.1    0.0  125  -198.7
 -1976     -60     338       0   -1698    30.8  -107.5   166.4    0.0  125    29.0>
[5]
  2054   -3592    -116      -1   -1654    61.8    -6.6  -142.0   -0.0  125   180.1
  3282    -968    -351      -1    1962     0.3    62.6  -169.5   -0.0  125   -27.0
 -2034    3719      84       0    1769   -55.3     6.1   138.6    0.0  125  -162.5
 -3457    1252     326       0   -1878    -0.3   -61.7   170.2    0.0  125    25.3*
```

Fault Type   Distance to Fault   Fault Occurrence

```
Event:  ABG T    Location:   22.74   Shot:     Frequency:   59.98
Targets: ZONE1
Currents  (A Pri), ABCPGQ:    4010    3924    337     0    2579   4632
```

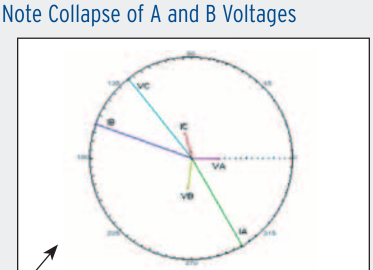
Pre-Fault Phasors

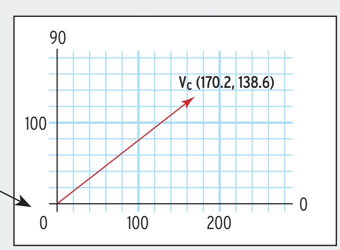
Note Balanced Conditions



Fault Phasors

Note Collapse of A and B Voltages





Automation and Integration Overview

Today, SEL offers technologies, products, systems, and services that address the entire application spectrum, from communicating with a single relay to integrating and automating the metering, control, reporting, and protection for a large system. In electrical substations, commercial sites, and generating, manufacturing, and processing plants, apply SEL microprocessor-based relays to protect the electrical system. Apply SEL networking, control, and communications solutions to integrate devices for data acquisition plus remote and local control.

SEL relays, information processors, and systems support many architectures. SEL information processors include real-time automation controllers (RTACs), communications processors, and tough computers with appropriate software.

Controllers and input/output solutions include the SEL-2411 and SEL-2440 Controllers and the SEL-2240 Modular Control Network, appropriate for a variety of control and I/O mix requirements.

To communicate with serial port devices, we recommend using our information processors as the hubs of star networks, with a point-to-point fiber or copper connection between the hub and each device. Fiber-optic links provide superior noise immunity and safety. Star topologies allow each device to communicate at a different bit rate and with a different command set or protocol. This independence, coupled with the strong parsing and command capabilities of SEL information processors, enables communication with many devices.

Many modern devices communicate via an Ethernet network. Build your Ethernet local-area network (LAN) with SEL-2725 Five-Port Ethernet Switches, SEL shielded Ethernet cables, and SEL fiber-optic cables. SEL-3610 Port Servers connect Ethernet networks to serial devices.

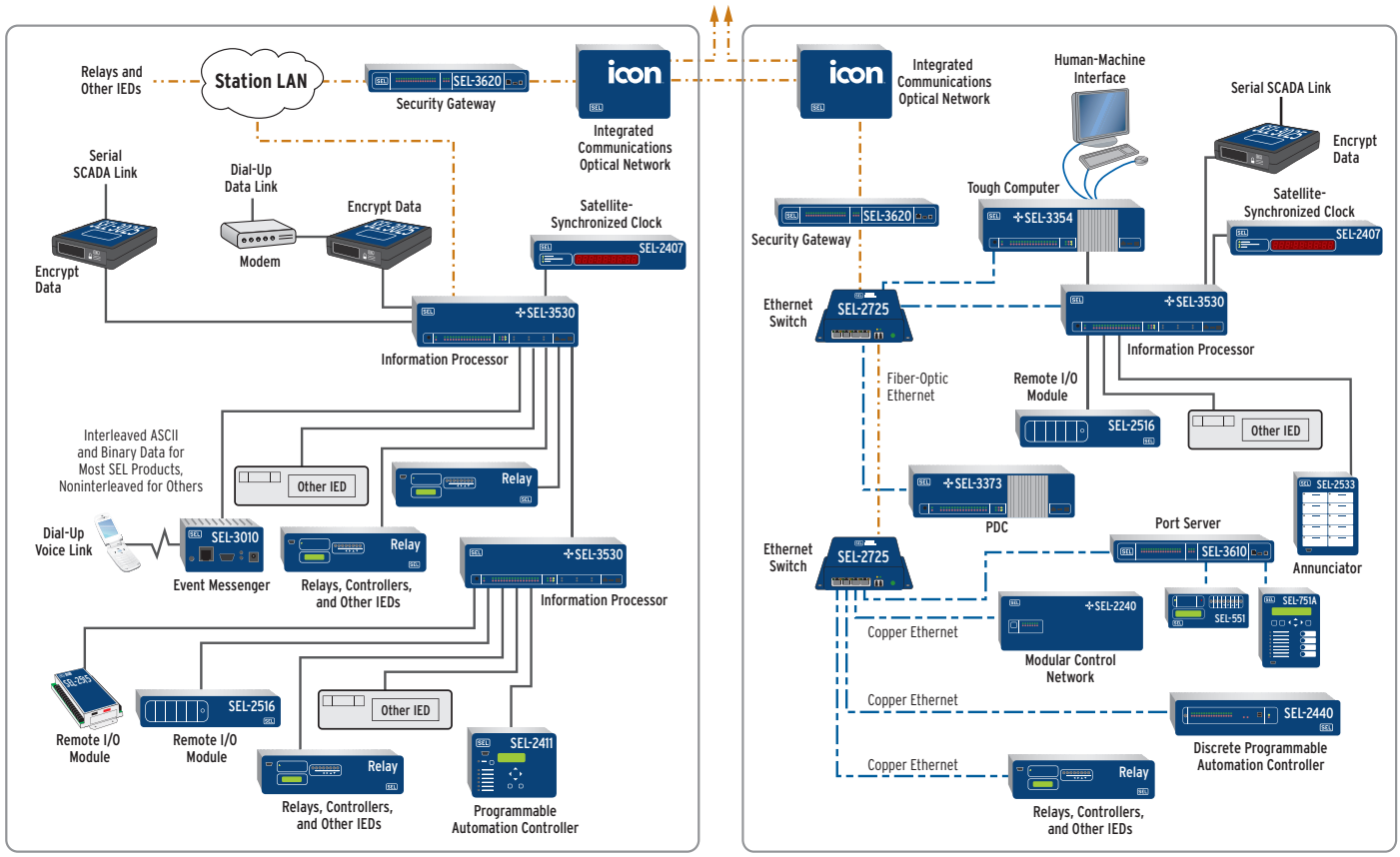
Choose tough SEL computing and networking products that are far more reliable and robust than office or industrial computer equipment and ideal for protocol conversion, local human-machine interfaces, event report collection, data concentration, and more.

Many SEL relays include local, remote, and latched control switches and display points. With these features, you can replace or eliminate many external devices and associated panels, documentation, wiring, commissioning, testing, and maintenance. You benefit from reduced total cost, improved system reliability, and state-of-the-art protection, monitoring, and control.

The SEL-2100 Logic Processor and SEL-3530 or SEL-3530-4 RTAC can economically and simply provide bus and three-terminal line protection as well as automated control by connecting to multiple SEL relays using Mirrored Bits® communications links. They operate on the Mirrored Bits data through control logic and automatically send the proper trip and other control signals. SEL-2505 and SEL-2506 Remote I/O Modules connect to devices without Mirrored Bits communications ports.

Information processors support external communications links, including the public switched telephone network for engineering access or dial-out alerts, private line connections to your SCADA system, and wide-area networks (WANs). Many SEL relays and controllers have integral protocols and ports for connection to networks. The SEL ICON™ provides the fiber-optic communications backbone.

SEL products and services are components of complete SEL solutions for instrumentation, protection, reporting, monitoring, local and remote control, and automation.



SEL Device Communications Provide Flexible Solutions

SEL devices include digital protective relays, meters, recloser and voltage regulator controls, breaker controllers, information processors, logic processors, annunciators, and specialized input/output modules. These devices sense data and derive information useful to people and systems responsible for electrical system protection and planning; remote and local operation; equipment maintenance; outage management; power quality analysis; and other functions. The physical connections include point-to-point and multidrop copper serial links, point-to-point fiber-optic links, and Ethernet copper and fiber links. SEL products use interface standards such as EIA-232, EIA-485, and Ethernet for communication with other link media, including radios, microwave radios, switched telephone networks, cellular telephones, pager networks, programmable logic controller (PLC) networks, local-area networks (LANs), wide-area networks (WANs), and fiber-optic backbones.

Serial SEL ASCII and Compressed ASCII Commands and Responses

SEL devices encode human-readable alphanumeric information into ASCII characters. All SEL relays and information processors accept ASCII commands and respond with ASCII reports, so people can accomplish their tasks without special software. Newer SEL devices also provide "compressed ASCII" reports with comma-delimited formats that users can easily import into spreadsheet and database programs. SEL publishes the ASCII and compressed ASCII protocols and encourages their open use. Because of its present and foreseen ubiquity, ASCII is the protocol that is most likely to survive more than a decade or two unchanged.

Serial SEL Fast Messages

SEL Fast Messages provide efficient, point-to-point serial communication between SEL devices and SEL information processors or other master devices. A powerful feature of these devices is that they "interleave" Fast Messages as binary messages on the same communications link as the ASCII messages. Multiple conversations can occur simultaneously on a single connection between a communications processor and a relay, for example, to send data acquisition and control information to the SCADA system and event reports to protection engineers.

Serial and Ethernet Modbus® Protocol

Many industrial and generating plants use Modbus protocol with PLCs, human-machine interface (HMI) packages, and distributed control systems. SEL-3530 and SEL-3530-4 Real-Time Automation Controllers (RTACs), SEL-3332 Intelligent Servers, and SEL-3354 Embedded Automation Computing Platforms can serve as Modbus masters. Many SEL relays applicable to industrial plants include Modbus communications. In installations with relatively low-speed data retrieval requirements, serial multidrop Modbus may be sufficient. Many SEL devices are equipped with one or more Ethernet ports and support Modbus TCP. By providing Modbus connectivity through information processors and as an integral part of field devices, instrumentation and control system designers can choose the options to best match their Modbus connection requirements.

Serial and Ethernet DNP3 Protocol

The DNP3 protocol was first developed for a SCADA master to communicate with a remote terminal unit (RTU). DNP3 is also used for many substation communications applications that do not involve an RTU. DNP3 supports multidrop addressing and is owned and maintained by an active users group. DNP3 device profiles define standard master and outstation implementations. Generally, outstation devices respond to requests from a master or provide unsolicited information only if first enabled by the master. SEL information processors concentrate data and present a common substation address using DNP3 to communicate with graphical HMI software, RTUs, PLCs, and other DNP3 Master devices. Protect serial DNP3 links against cyberattacks with SEL-3025 SCADA Shields. Many SEL devices are available with optional DNP3 protocol, and, if equipped with an Ethernet port, DNP3 LAN/WAN. The SEL-3530, SEL-3530-4, and SEL-3354 support both DNP3 Master and Outstation versions.

Ethernet IEC 61850

Combine IEC 61850 technology, Ethernet networking, and SEL high reliability to perform station computing and protection, automation, and control for distance, current differential, distribution, transformer, bus, motor, and bay control applications. The standard includes models for substation operational data (logical nodes) and definitions to move control data quickly (GOOSE). Only SEL devices accept Configured IED Description (CID) files to change the configuration of the IEC 61850 messages, as called for by the standard. Streamline configuration with included ACSELERATOR Architect® SEL-5032 Software.

Time-Synchronizing

SEL-2407®, SEL-2404, and SEL-2401 Satellite-Synchronized Clocks provide precise time using IRIG-B time code. SEL relays and controllers accept synchronized time, encoded in the demodulated version of the IRIG-B time format. SEL information processors accept modulated or demodulated signals and redistribute demodulated IRIG-B time signals to the rear-panel ports. If no IRIG-B input signal is available, they generate IRIG-B outputs based on their internal, battery-backed clocks. A single cable to each SEL relay provides serial communications and IRIG-B time synchronization.

Other IED and Master Protocols

SEL information processors include powerful parsing and conversion settings capabilities that support data retrieval and control for many electronic devices, using a variety of commands and responses. If a protocol you need is not listed in this catalog, contact SEL to determine if there is already a Job Done® example of setting the information processor for that protocol or to explore creating new communications settings. The SEL-3530, SEL-3530-4, and SEL-3354 communicate with several protocols, so each substation or plant system can communicate with many different SCADA master systems.

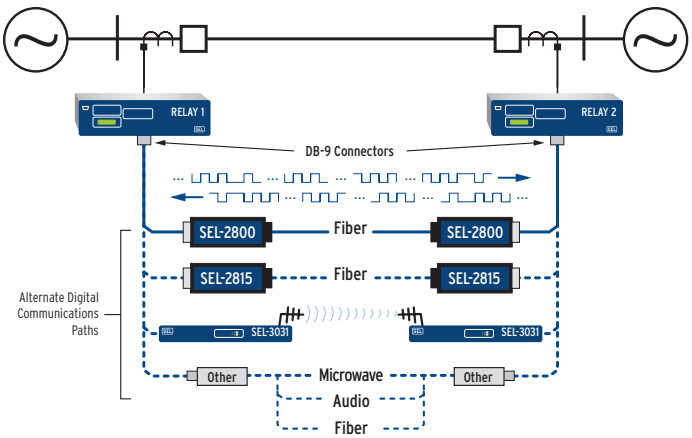
SEL Device Communications Provide Flexible Solutions

Protocol Development

We continually analyze customer needs and determine priorities for new development, including protocol development. Contact SEL if you need a protocol that is not listed in this catalog; we may be developing it. We can work with you to determine a schedule to develop the protocol or refer you to appropriate third-party solutions.

Serial SEL Mirrored Bits® Communications Shares Eight Bits, With Relaying Speed and Security

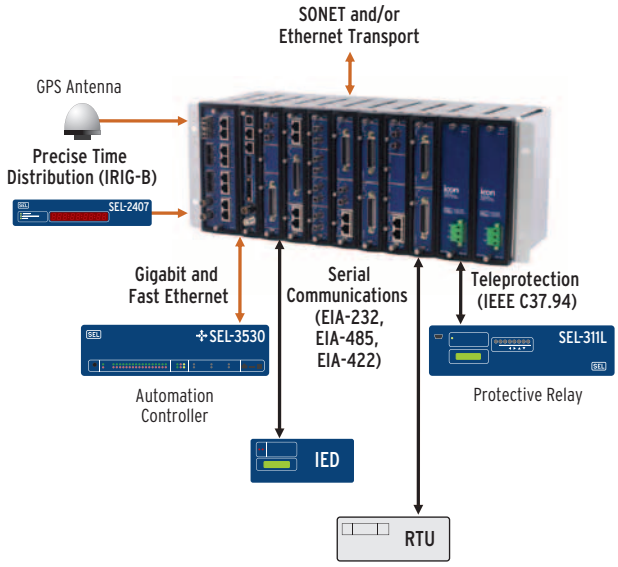
SEL developed Mirrored Bits communications to provide high-speed, secure, point-to-point communication of real or virtual contact-status bits. Protection applications include directional element-based bus protection and replacement of tone-channel equipment for communications-assisted blocking, unblocking, permissive, and transfer trip schemes. Automation applications include high-speed bus protection, sectionalizing, restoration, and interlock schemes. A patented SEL technology available under license to other manufacturers, Mirrored Bits communications is a powerful tool inside the substation as well as over fiber networks, spread-spectrum radio, private microwave, and leased digital or analog circuits. It is included in many SEL products. Four products—the SEL-2100 Logic Processor, the SEL-2505 and SEL-2506 Remote I/O Modules, and the SEL-3530 RTAC—are powerful tools that use Mirrored Bits communications for building reliable, secure, fast, and low-cost protection and automation systems. Use the SEL-4388 Mirrored Bits Tester to accelerate commissioning and testing.



Apply SEL digital relays with Mirrored Bits® communications over your digital channels for superior protection and control.

Fiber-Optic Communications Backbone

The SEL ICON™ supports time-division multiplexing (TDM) and Ethernet traffic in a single product and can transport traffic over SONET and/or Ethernet links. In addition to supporting flexible transport options, the SEL ICON can distribute time for a more fault-tolerant, robust, terrestrial time distribution network. The SEL ICON is easy to configure and manage with software that automatically reads the connected system and builds a visual network representation. The SEL ICON is available in a 19-inch, shelf-mount package and an 8-inch, DIN-rail or panel-mount package.



The SEL ICON™, with other SEL products, provides end-to-end solutions.

Cybersecurity Solutions

Secure Critical Infrastructure

SEL security devices ensure control systems will not fall victim to disgruntled insiders, network hackers, or even cyberterrorism. SEL security solutions are compatible with existing control system communications protocols and have little impact on data flow.

Proven Compatibility With SCADA Systems

Cybersecurity devices must be compatible with existing SCADA communications devices and protocols, such as data radios and modems using DNP3 or Modbus® protocols. Also, SCADA cybersecurity devices must not interfere with data flow on control and/or monitoring systems.

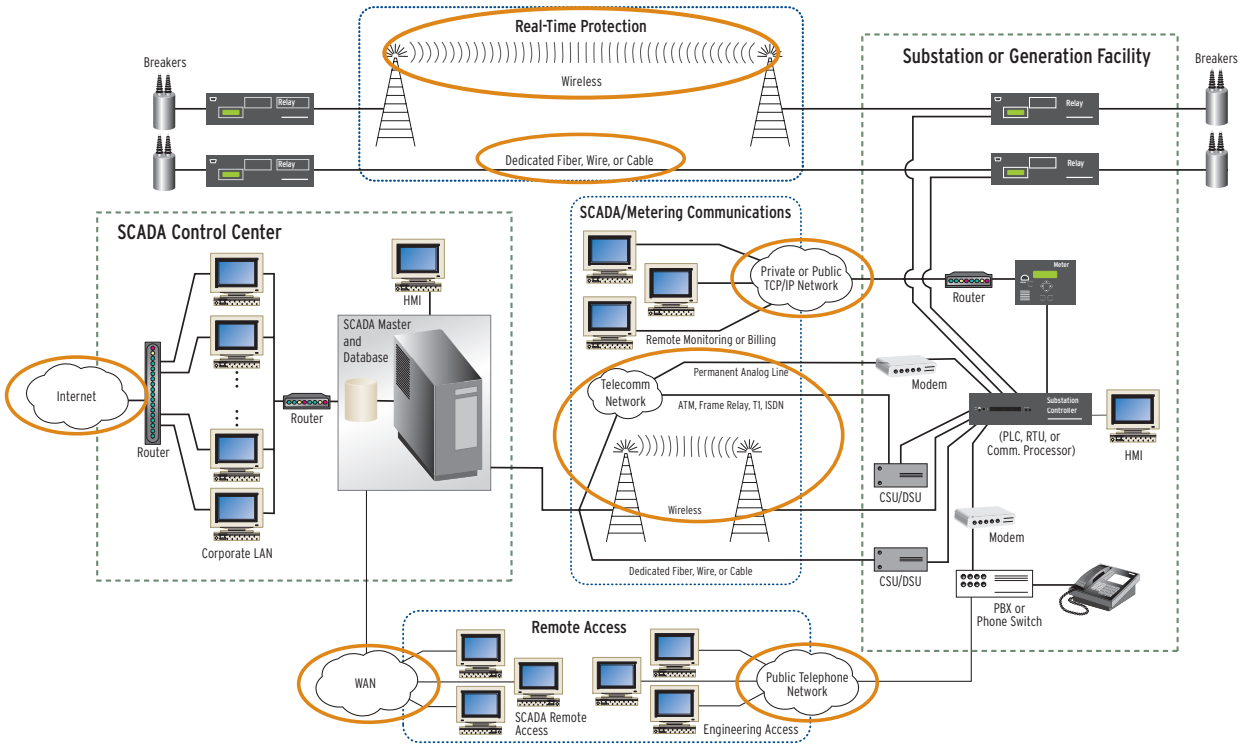
Authentication, Encryption, and Logging

SEL devices secure SCADA systems by authenticating and logging users as well as encrypting and authenticating data on a wide variety of industrial and commercial applications. SEL rigorously tests the operation of its security devices with various SCADA devices and protocols, resulting in designs that have little or no impact on data throughput.

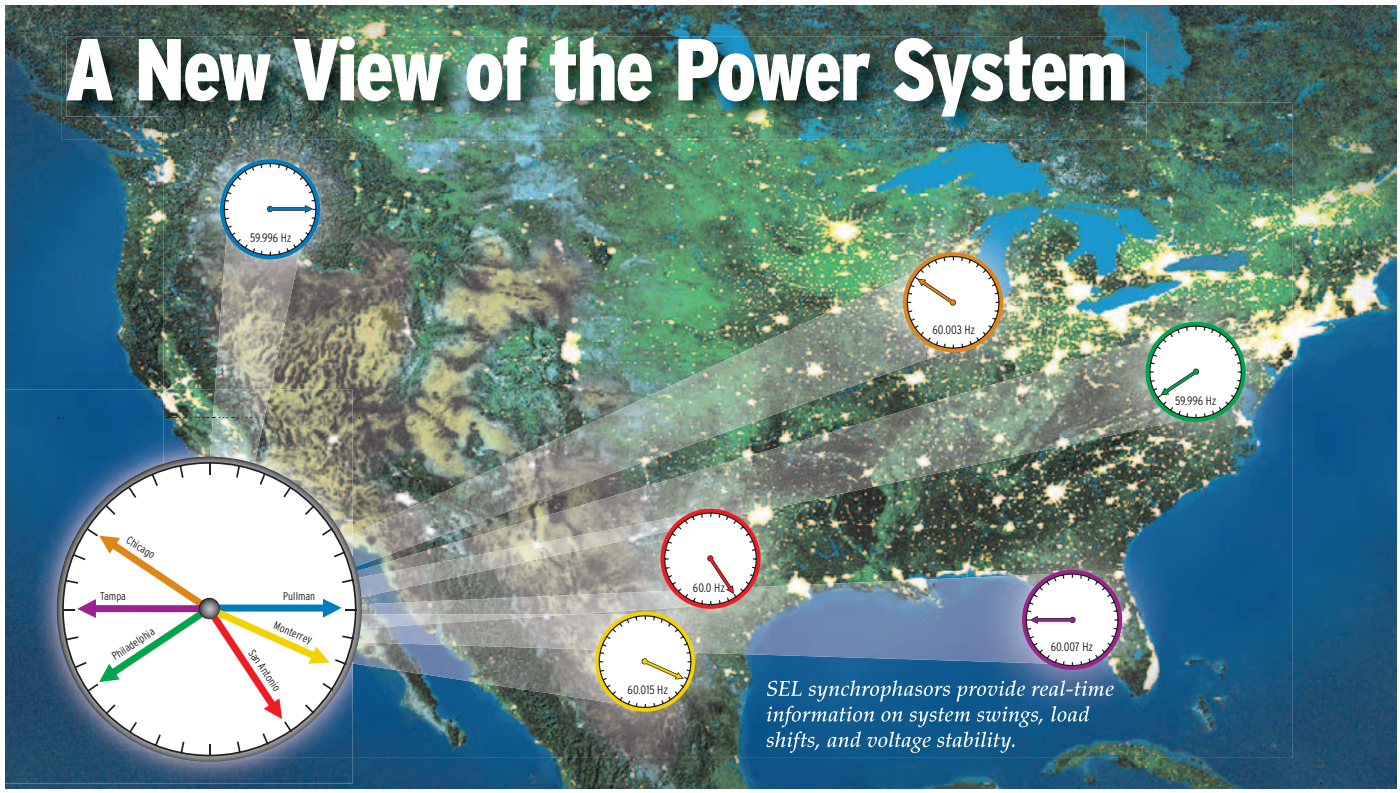
SEL cybersecurity solutions are an essential element to protecting systems that operate our nation's critical infrastructure. Utility executives and technicians alike find that these solutions provide an effective means for reducing electronic vulnerabilities in their critical communications systems. National and international research firms have identified threats and documented specific cases of real cyberattacks. In some cases, it cost hundreds of thousands of dollars to repair the damage. SEL cybersecurity solutions start at just under $500.

Cybersecurity Training

SEL provides real-world, hands-on cybersecurity training to help customers comply with NERC cybersecurity requirements, teaching them to implement strong electronic access controls in SEL relays and communications products. Participants learn how to identify and mitigate possible attacks and to assess real threats and risks to power system security.



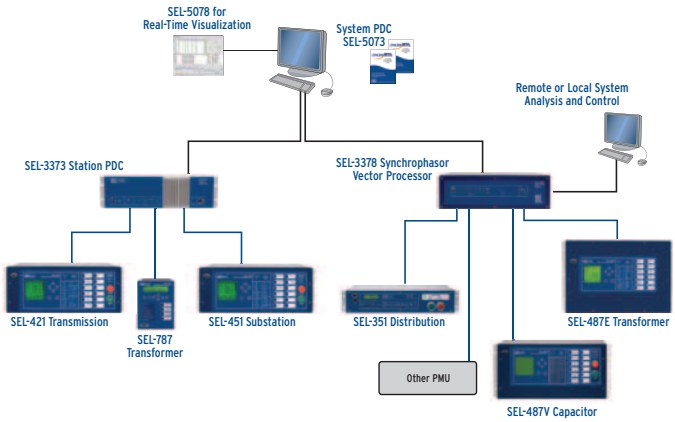
Wide-area network (WAN) access points to consider securing with SEL cybersecurity solutions.



SEL Synchrophasors—Real-Time System Control and Monitoring

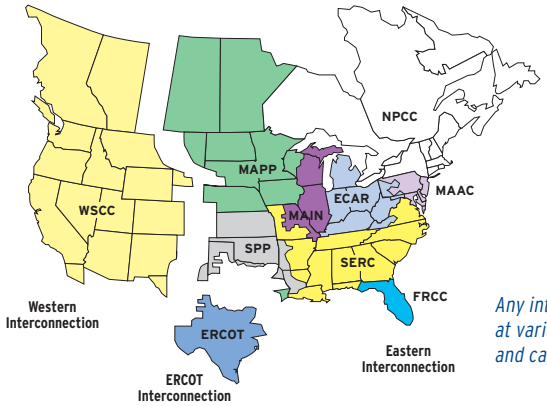
Synchronized phasor measurements (synchrophasors) provide a real-time measurement of electrical quantities from across a power system. These measurements can be used to validate system models, measure stability margin, maximize stable system loading, and implement remedial action schemes (RAS).

- Reduce cost and complexity of wide-area measurement and event recording using SEL synchrophasor technology.
- Improve power system reliability with real-time control.
- Optimize power flow using system-state measurements.
- Use local phase angle measurements to speed up station phasing, check connections, and troubleshoot problems.



SEL Phasor Measurement and Control System

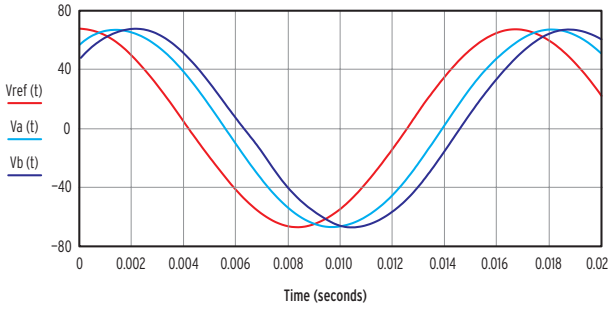
Many SEL relays and meters include built-in synchronized phasor measurements. SEL-311C, SEL-351, SEL-421, SEL-451, SEL-487E, SEL-487V, SEL-700G, SEL-751A, and SEL-787 Relays provide synchrophasor data in IEEE C37.118 format. SEL substation-rated computers provide complete data concentration and display formatting.



Any interconnected system will have phase shifts in voltages and currents at various points on the system. These phase shifts are caused by load flows and can be used to measure the state of the system.

Synchrophasor Technology

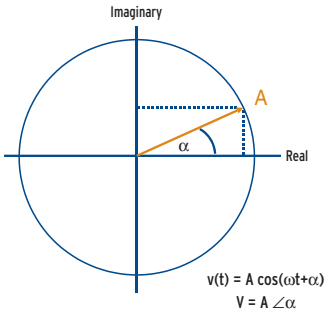
Ideal Time-Domain Waveforms



In each SEL device being used for synchrophasor measurement, a reference is created based on the satellite clock. This puts all the devices on the same standard reference (Vref (t) shown above). With an absolute reference for all locations, it is possible to compare voltages and currents from anywhere on a system.

Synchronized Phasor Measurement

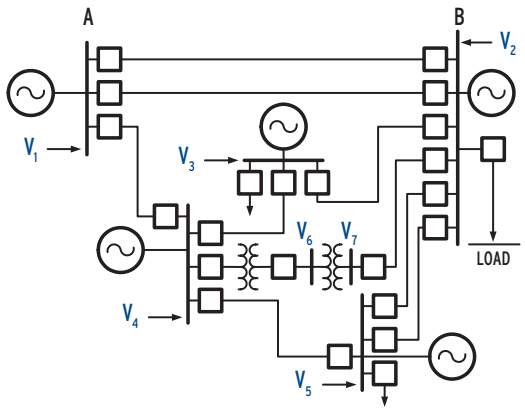
The voltage and current sine waves are converted to a phasor using the formulas shown. The value α is the angle between the signal being measured and the reference. A synchrophasor message provides the magnitude and angle for each measured quantity along with a time stamp. Messages from different locations taken at the same time can be compared to each other with errors of less than one-quarter of an electrical degree.



By convention, the phasor is a counterclockwise rotating vector. Its rotational frequency is the system synchronous frequency (50 or 60 Hz).

Complex Transmission System

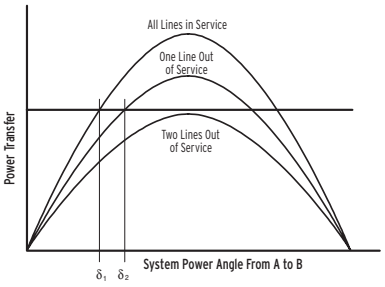
In a simple system, phasors from different locations can be compared by using calculations based on local voltages and currents. In more complex systems, instantaneous power transmission calculations are extremely difficult, if not impossible. This is where synchrophasors become important. Synchrophasors provide a snapshot of the entire system. System angles are measured instead of calculated.



Power Angle Measurement

These curves depict the power transfer conditions for all lines of the example system in service and with one or two lines out of service. Power is expressed in watts. Transmitted power is equated to the product of voltage magnitudes multiplied by the sine of the angle difference between these voltages, all divided by the equivalent transmission line series reactance. (This expression neglects line resistance and shunt admittance.)

The initial operating conditions resulted in a system power angle of δ_1. This represents the "torque angle" between Systems A and B. If a fault takes one line out of service, a new steady-state system power angle, δ_2, is required to maintain the original level of transmitted power from System A toward System B.



Note that for the case of two lines out of service, this example transmission system is not capable of supporting the original level of transmitted power flow from System A toward System B. System B must now obtain more power from local generation sources and/or remote generation sources that are not associated with System A.

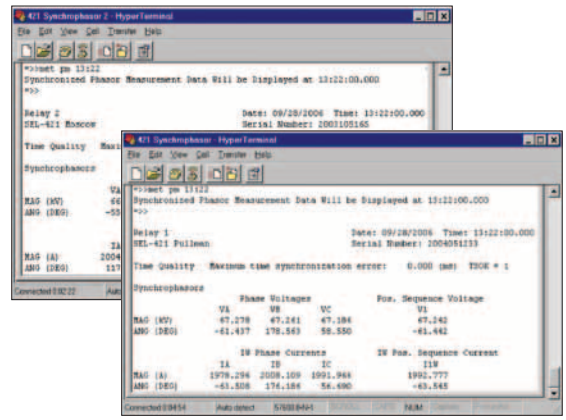
This illustrates the importance of accurate determination of operating system power angles, bus voltages, and equivalent system impedances.

View System State and Stability Margins

Use displayed and recorded synchrophasor information from across the power system to improve transmission and generation dispatching. Use measured system load angles to maximize line loading without exceeding stability limits. SEL synchrophasor technology provides a new tool to economically get more from the power system.

SEL-5078 SYNCHROWAVE® Console Software displays real-time power system operating conditions using synchrophasor data received from SEL-5073 SYNCHROWAVE PDC Software, SEL-3373 Station PDC, SEL-3378 Synchrophasor Vector Processor, SEL-5077 SYNCHROWAVE Server Software, or other IEEE C37.118-compliant system.

Synchrophasor-Equipped Products



The METER PM command can be used to pull PMU data from the relay.

Applications for synchrophasor technology vary in their data requirements. High-speed data are needed for wide-area protection or detailed analysis, while lower speeds are suitable for many monitoring and energy management system (EMS) applications. Use the synchrophasor capabilities built into your SEL products to meet your present and future application demands.

IEEE C37.118-Compliant Phasor Measurement and Control Units

- SEL-351 Protection System
- SEL-351A Protection System
- SEL-351S Protection System
- SEL-421 Protection, Automation, and Control System
- SEL-451 Protection, Automation, and Bay Control System
- SEL-487E Transformer Protection Relay
- SEL-487V Capacitor Protection and Control System
- SEL-700G Generator Protection Relay
- SEL-751A Feeder Protection Relay
- SEL-787 Transformer Protection Relay

SEL-300 and SEL-400 series relays listed above provide synchrophasor measurements at settable rates from 60 messages per second down to 1 message per second. The accuracy is better than 1 percent total vector error at frequencies within 5 Hz of nominal required by the standard (meeting IEEE C37.118 Level 1 accuracy). The SEL-751A and SEL-787 Relays listed above have a maximum rate of 10 messages per second (meeting IEEE C37.118 Level 0 accuracy). The IEEE C37.118 standard format message provides the capability of sending voltage and current synchrophasors as well as any digital and analog data available as measured or calculated quantities within the relay. IEEE protocol is streaming data from a dedicated serial or shared Ethernet port. Fast Meter messages and the METER PM command are also available in many of these products.

Real-Time Control (RTC)

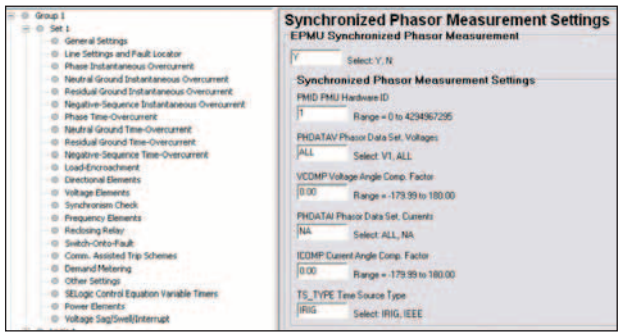
RTC capability is available in the SEL-421, SEL-451, SEL-487E, and SEL-487V Relays and allows these devices to receive IEEE C37.118 synchrophasor messages from up to two phasor measurement units, time-correlate the information, and take control actions based on the messages. Remote angles, currents, and voltages received in the serial synchrophasor message can be combined with local measurements for basic or advanced application.

SEL Fast Message Synchrophasor Devices

SEL-311A, B, L	**Legacy Relays**
SEL-734	SEL-351-5, -6, -7
	SEL-351A
	SEL-351S
	SEL-311C

Use popular SEL relays as input devices to EMS or other applications. Available data include voltage and current phase angle and magnitude as well as frequency, sample time, programmable digital bits, and status information from the device. Message rates are determined by the connected communications processor and can vary from 1 to 60 messages per second. (The SEL-734 Advanced Metering System can transmit up to 20 messages per second using SEL Fast Message.)

The METER PM command provides voltage, current, frequency, and digital information from relays in an easy-to-use, time-synchronized format. No special communications or protocols are required. Use METER PM data for analysis of system parameters, verification of polarity within a substation, or phasing check throughout a system.



Synchrophasor settings are easy to provide to the relay and do not require calculations. There is no interference with protection functions, and relay operation does not interfere with synchrophasor measurements.

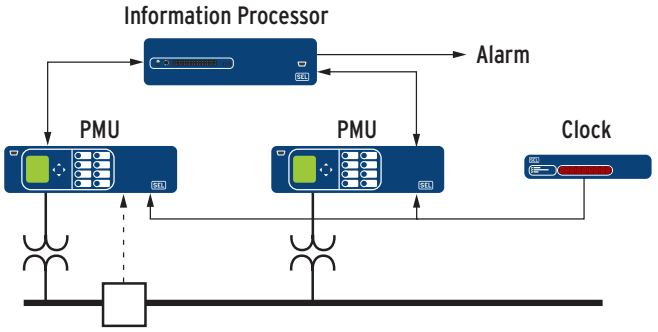
Synchrophasor Solutions

Using SEL synchrophasors can be as simple as manually retrieving synchronized data from two relays using the METER PM command or as complex as collecting and processing data from multiple phasor measurement units (PMUs) and sending control signals back. This section includes typical solutions for common applications.

Automatic Checking Systems

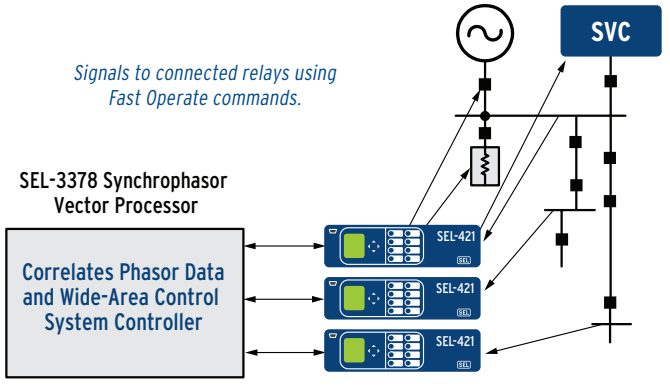
Within a station, or anywhere an information processor can be connected between two or more PMUs, an automatic system can be configured to compare phase angles and/or magnitudes. This comparison can be used to check closing angles, monitor CVT performance for partial failures, or other control functions.

As shown in the figure below, an information processor receives analog data as well as digital system information from the connected PMUs. Digital information can include breaker status, auxiliary device condition such as motor or pump load, or control switch position. Use the SEL-2032 Communications Processor, SEL-3530 Real-Time Automation Controller (RTAC), or SEL-3332 Intelligent Server to perform this comparison function and send a Fast Operate signal back to the connected SEL relay.



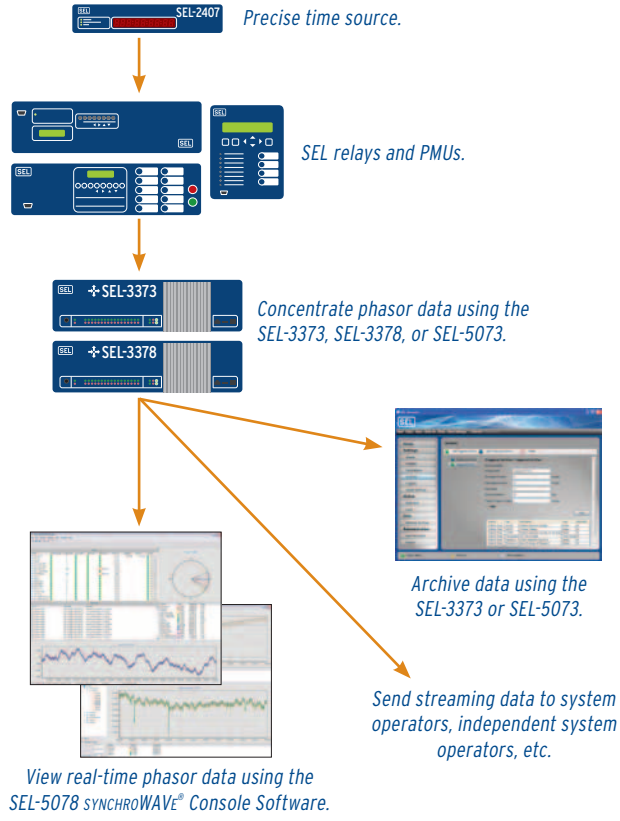
Wide-Area Protection and Control

Many applications require higher speed operation than can be achieved by SCADA and EMS. These include load or generation shedding, out-of-step detection, and other high-speed tripping applications. The SEL-3378 Synchrophasor Vector Processor (SVP) receives PMU data in IEEE C37.118 format. Use the IEC 61131-3 programming environment to calculate operation quantities based on stability, power oscillations, or rate of change of phase angles. Use SEL relays and the SEL-3378 to simplify and improve special protection and control schemes.



Synchrophasor Data Transmission, Viewing, and Archiving

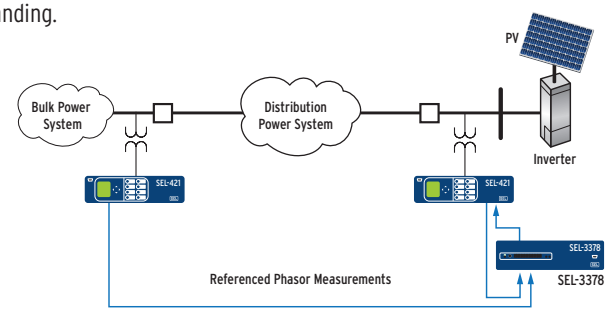
Phasor data concentrators are specialized devices that can transmit "super packets" of synchrophasor data to multiple users for visualization, further data concentration, or data archiving. Use the SEL-3373 Station Phasor Data Concentrator or SEL-5073 SYNCHROWAVE® PDC Software to concentrate data from multiple PMUs and send the data to remote users for their application. View real-time synchrophasor data with SEL-5078 SYNCHROWAVE Console Software. Both the SEL-3373 and the SEL-5073 provide archiving in CSV and COMTRADE formats with IEEE naming for automated recording systems.



Typical synchrophasor visualization and archiving system.

Smart Anti-Islanding Detection and Control

In the scheme shown below, both relays acquire voltage phasor measurements from their corresponding sites. The relays send their measurements to the SEL-3378 SVP where the SVP time-aligns the measurements and performs the angle difference and slip-acceleration methods to detect islanding.



Smart anti-islanding scheme using the SEL-3378 Synchrophasor Vector Processor.

Conformal Coating

Conformal Coating Adds an Extra Level of Protection to Printed Circuit Boards (PCBs)

Conformal coating provides excellent moisture and environmental protection for PCBs and printed wiring assemblies, especially where extended exposure to contaminants may be encountered.

Conformal coating offers protection from harsh environments. SEL meets Mil-1-46058-C Type UR conformal coating on selected products.

SEL products with conformal coating have been tested and approved to the following specifications for mixed flowing gas, hygroscopic dust, and damp heat:

- EIA 364-65A Class IIIA (modified—test duration extended).
- IEC 60068-2-30–1980, 1985, *Basic Environmental Testing Procedures*, Part 2: Tests—Test Db and guidance: damp heat, cyclic (12 + 12-hour cycle), severity level 25° to 55°C, 6 cycles, relative humidity 95 percent.

Mixed flowing gas includes contaminants Cl_2, H_2S, NO_2, and SO_2. Hygroscopic dust includes water-soluble salts, sulfates, nitrites, volatile organic compounds, SO_2, H_2S, ammonia, NO, NO_2, HNO_2, ozone, and gaseous chlorine.

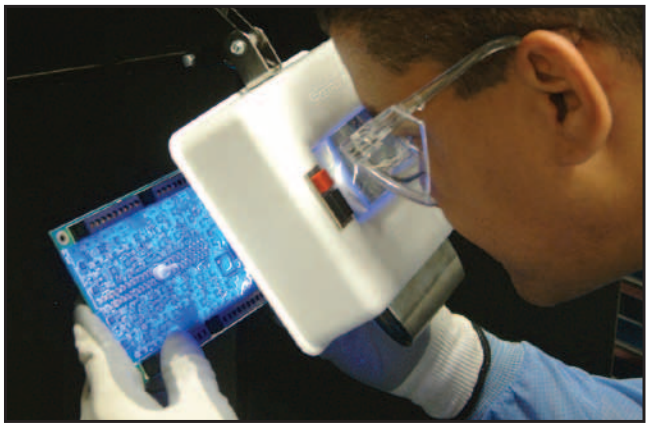
Conformal coating is specially formulated to protect PCBs and related equipment from the environment. This improves and extends the working life of the PCB and ensures security and reliability. The coating conforms to the shape of the board and its components, creating a protective layer that is both lightweight and flexible.

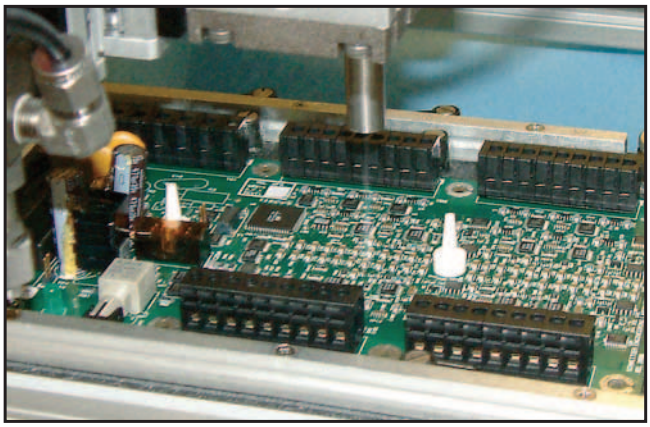
This durable coating protects circuitry from hazards such as chemicals (e.g., fuels, coolants, etc.), vibration, moisture, salt spray, humidity and high temperature, fungus, corrosion, and thermal shock. Check with your customer service representative to see if conformal coating is available for your application.

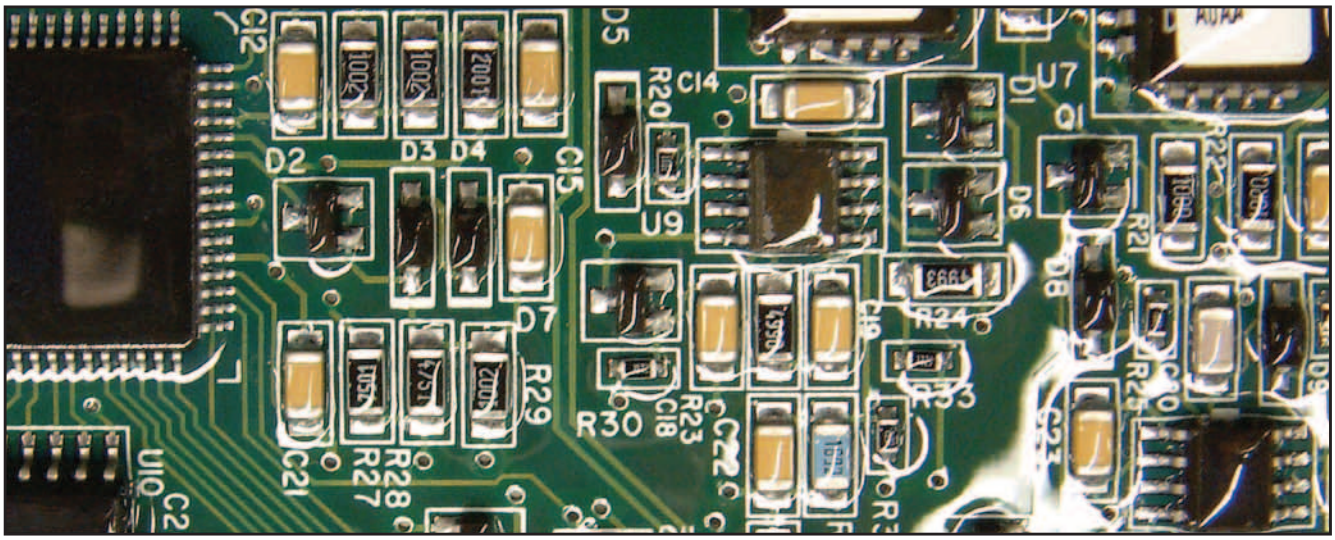
SEL recommends conformal coating on products installed in environments that contain airborne contaminants, such as:

- Coal-fired power plants
- Refineries
- Geothermal power plants
- Pulp and paper mills
- Chemical processing plants
- Mining facilities
- Water treatment facilities

Operating temperatures for some UL and CSA conformal-coated boards are −40° to +75°C (−40° to +167°F).







SEL Safety

Improve Safety by Applying SEL Technology

Significantly improve safety, prevent injuries, and reduce liability exposure by applying SEL products and services. Do more with remote communication to avoid entering hazardous areas, controlling traffic, and suiting up in special protective clothing.

- Use SEL-3022 Wireless Encrypting Transceivers with your wireless laptop PC to remotely access systems, controllers, or relays.
- Apply the RadioRANGER® Wireless Fault Indication System to reduce the need to enter underground vaults.
- Reduce the energy of arc-flash hazards by installing SEL-751A Feeder Protection Relays with arc-flash detectors.
- Operate breakers or contactors from 50 feet away using an SEL-4391 Data Courier® connected to an SEL relay.
- Use I/O points on your relays, programmable automation controllers, and I/O modules to sense and calculate information that system or plant operators can use to help prevent accidents. Connect to devices that detect flammable or other unsafe gases, arc flashes, water levels in underground vaults, and more.
- Monitor the status of relay alarm contacts or other relay diagnostic data, and notify operators of safety hazards caused by having protection out of service.
- Detect and trip arcing downed conductors with SEL Arc Sense™ Technology (AST) in the SEL-451 Protection, Automation, and Bay Control System.
- Use SEL eye-safe, Class 1 fiber-optic communications to prevent the instrumentation and control system from introducing hazards and to reduce costs.
- Work with SEL engineers for studies to identify and categorize arc-flash hazards and determine options to reduce injuries due to arc flashes.
- Apply reliable SEL components to minimize the time service personnel spend traveling and working in hazardous locations.
- Communicate directly with personnel using portable electronics and remote warning indicators, including SEL annunciation products, at the entrance to hazardous locations. Apply the SEL-3010 Event Messenger to call appropriate personnel.

Tel: +1.509.332.1890 | Fax: +1.509.332.7990 | www.selinc.com

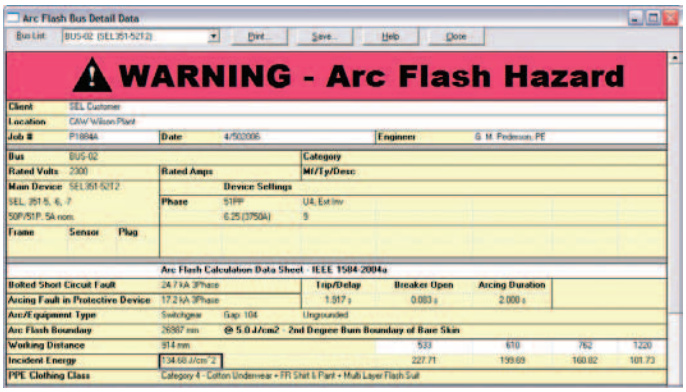
SEL Arc-Flash Solutions

Arc-Flash Hazards Are Very Serious

Electrical arc flashes and associated arc blasts cause 80 percent of electricity-related injuries to experienced electrical workers. The concussive force of even a relatively small 10,000-amp arc at 480 volts is equivalent to approximately eight sticks of dynamite.[1] Between five and ten times per day in the United States, an arc-flash incident sends someone to a special burn center, and one or two people die from arc-flash injuries per day.[2]

Identify and Mitigate Arc-Flash Hazards With SEL Engineering Services

Identify and quantify arc-flash hazards with arc-flash hazard services from SEL to mitigate arc-flash hazard risk, improve employee safety, and address regulatory requirements. SEL uses proven methods to calculate flash-protection boundaries and classify each area into the proper personal protective equipment (PPE) category. See page 47 for more information on SEL arc-flash hazard engineering services.



Reduce Risks by Applying SEL Products

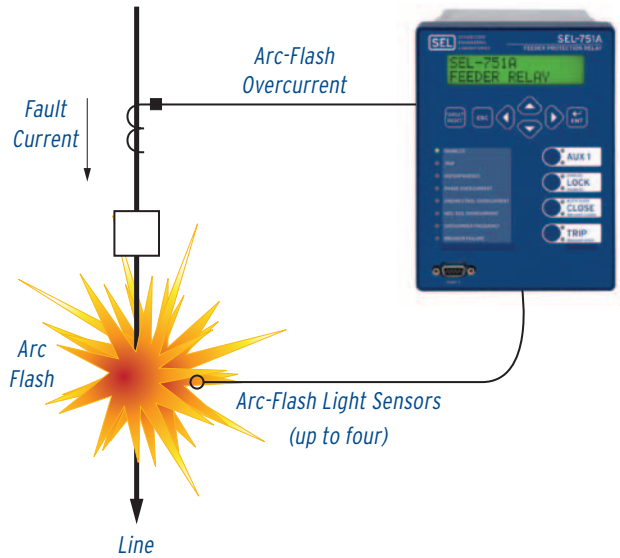
Apply SEL arc-flash detection with SEL-751A Feeder Protection Relays to rapidly detect and trip for electrical arc-flash events (page 134).

Set SEL relays to quickly trip for arc-flash events. Use settings, switches, or other methods to indicate to protective relays that personnel are in the area for faster tripping to enhance safety.

Provide remote access to reduce personnel exposure to hazardous areas with SEL fiber-optic links (page 430) or SEL-3022 Wireless Encrypting Transceivers (page 366) for wireless links.

Apply RadioRANGER® Wireless Fault Indication Systems (page 192) to reduce the need to enter underground vault arc-flash zones.

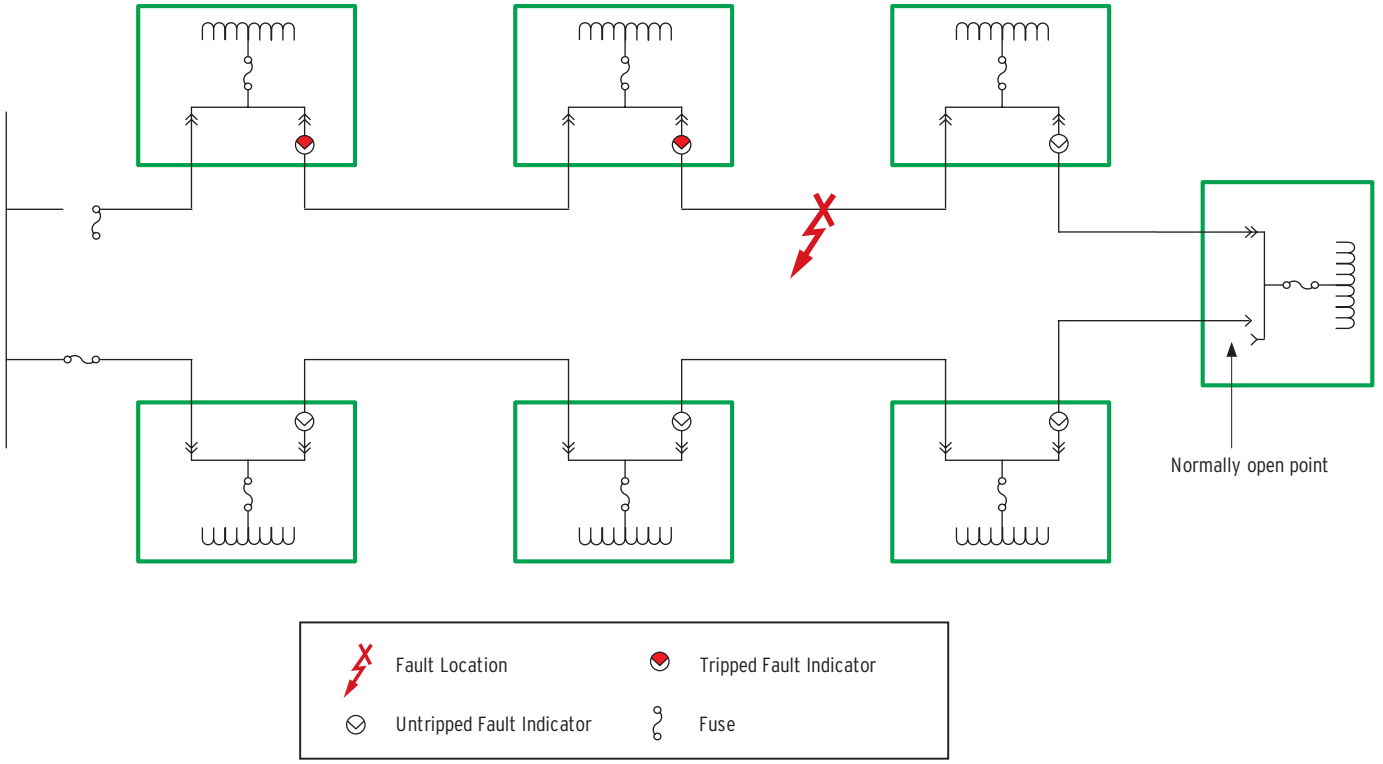
[1] AVO Training Institute, Dallas, TX, USA
[2] Dr. Mary Capelli-Schellpfeffer, CapSchell, Inc., Chicago, IL, USA



For the latest solutions to reduce arc-flash hazards, visit **www.selinc.com/arc-flash**.

Applying SEL Fault Indicators

SEL fault indicators sense the magnetic field produced by current flowing through a conductor. When fault current passes through the fault indicator, the fault indicator "trips," indicating a fault. Because SEL offers a variety of fault indicator displays, the trip might be indicated by a reflective target, flashing light, or combination of the two display types. The Tamperproof Bolt Display, read by a compass-like tool, and RadioRANGER® Remote Fault Reader provide other display options.



Line crews find the location of faults by isolating the section of line between the last tripped (red) fault indicator and the first untripped (white) fault indicator.

Underground

In underground applications, a utility usually places a fault indicator on each primary cable. If a fault causes a feeder fuse to operate, the indicators upstream of the fault trip, and the indicators after the fault remain in the untripped position. As a result, the utility can easily identify the faulted section of cable without going through a time-consuming re-fuse and sectionalize process.

Underground applications include subsurface or pad-mounted transformers, subsurface or pad-mounted switchgear and sectionalizing cabinets, junction boxes, and splices. An auxiliary contact option provides SCADA compatibility.

The RadioRANGER Wireless Fault Indication System, designed for underground vault applications, uses radio frequency to communicate fault status to a handheld Remote Fault Reader (see page 192).

Overhead

When a fault occurs on an overhead system, the easy-to-spot displays on the SEL fault indicators lead the line crew to the faulted section of line.

Overhead applications include unfused taps, long feeders with midline reclosers or sectionalizers, overhead-to-underground transitions, and feeders that experience recurring faults.

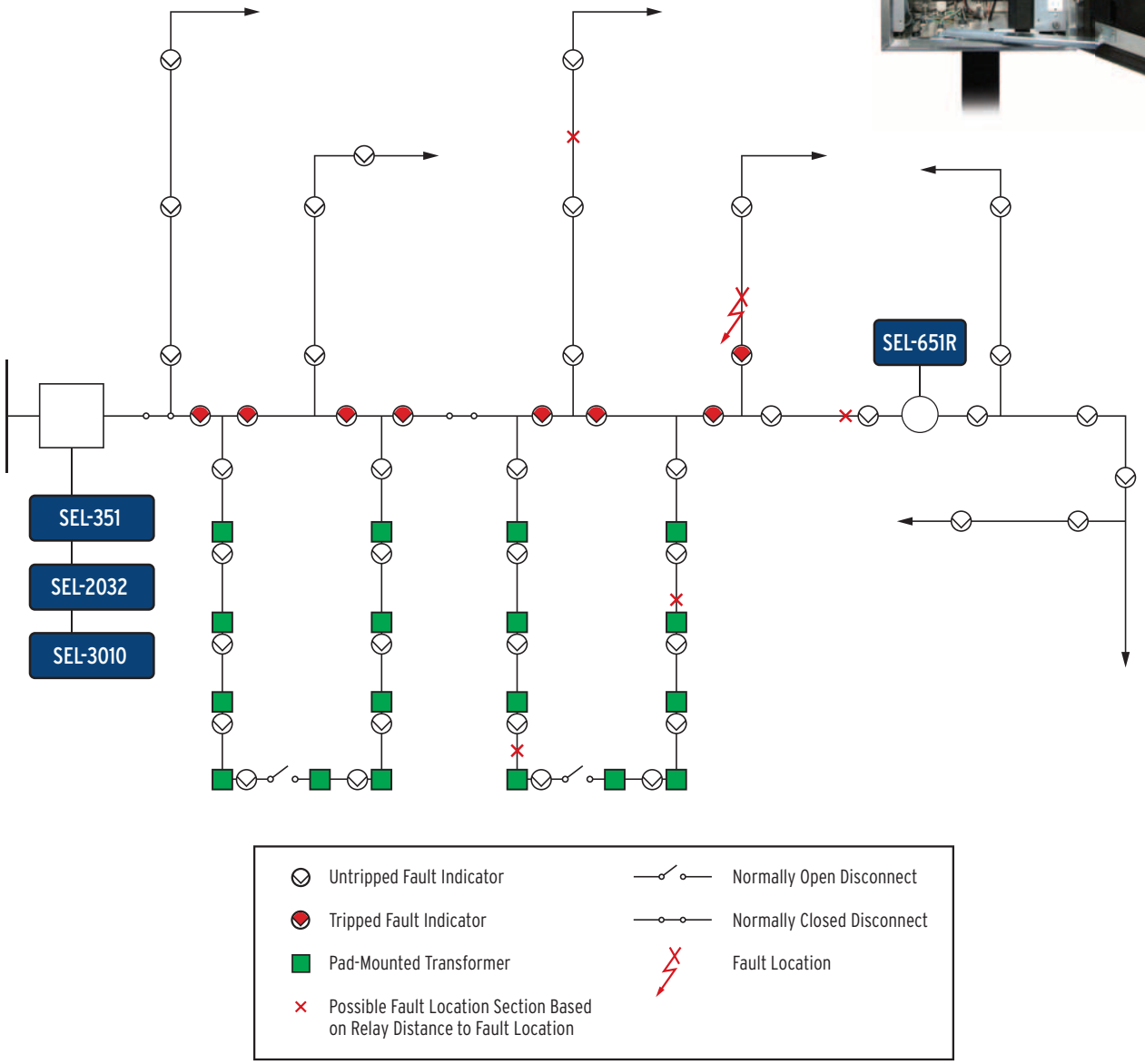
Applying fault counters and timed reset fault indicators in areas affected by momentary outages and flickering lights is an efficient means of identifying the location of temporary faults. This application of fault indicators provides utilities with the information to resolve these disruptions. Using fault indicators reduces costs to utilities and their customers and improves utilities' reliability indices.

Applying Fault Indicators With Other SEL Products

Use SEL fault indicators and distribution protection equipment together to identify the location of a fault.

When a fault occurs, the SEL feeder relay calculates the fault location as a distance from the substation to the fault, information that could be communicated to a lineman's cell phone via the SEL-3010 Event Messenger. When a feeder has multiple taps, as shown in the diagram below, the line crew is unable to determine which tap to follow to find the location of the fault. SEL fault indicators provide a solution by pointing the way to the correct tap, then to the faulted section of line.

Combine fault indicators with recloser controls to find faults even faster. Recloser controls sectionalize the line and quickly determine the distance to a fault. Apply fault indicators to identify faulted circuits and reduce fault-finding time.



Panel-Mount Options

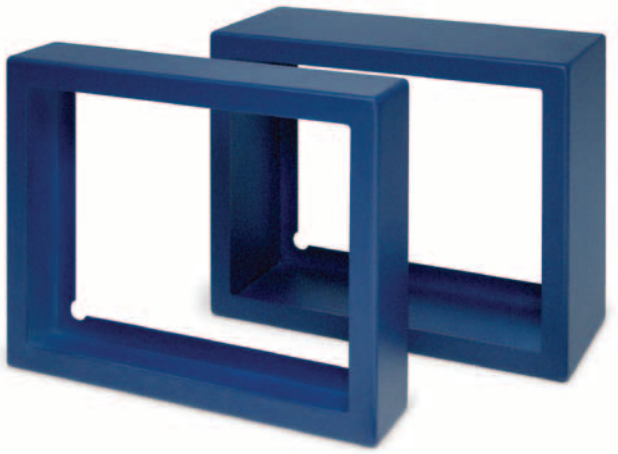
Improve Panel Appearance

Panel-mount options for SEL relays, information processors, and logic processors provide neat, clean hardware installations. The panel-mount options are available for most relays and can be ordered with the device. Projection-mount options provide for mounting when space behind the panel is limited.

There are several mounting configurations throughout different product lines, and many relays are available in both horizontal and vertical mounting. Visit **www.selinc.com/mounting_selector** for more information.

The panel-mount option is available for most SEL-200, -300, -400, -500, -700, -2100, and -2400 series products and information processors.

See also SEL-9103/SEL-9104 Dust and Splash Protection on page 492.



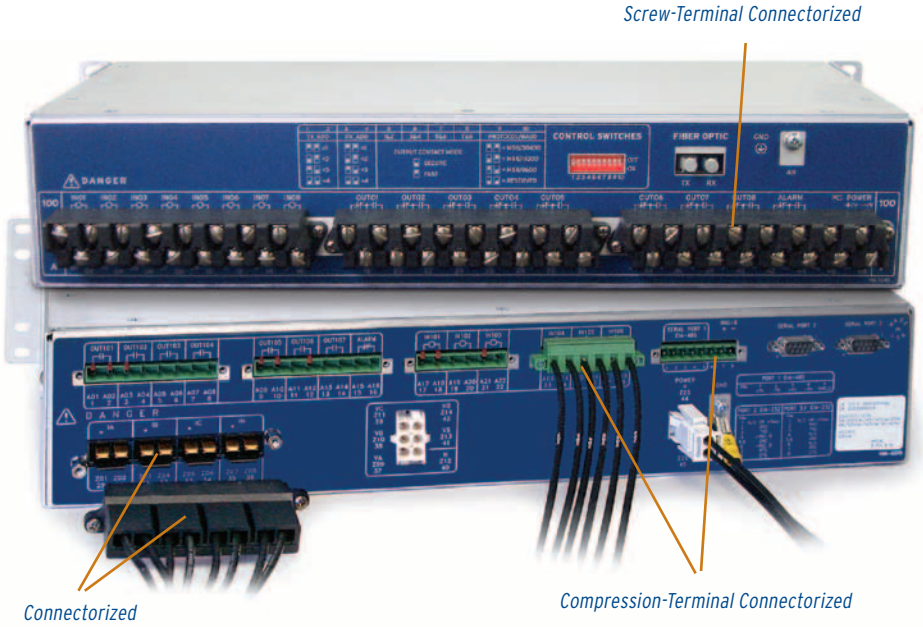
Projection-mounting collars for SEL-700 and SEL-2400 series devices are available in 45 and 90 mm.

SEL-700 series relay and test switch bezel.

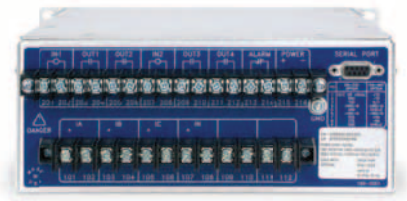
SEL-700 vertical retrofit bezels.

From top to bottom: panel mount, rack mount, and projection panel mount.

Connectorized® Products



More SEL products are available with our Connectorized option for low-cost and reliable installation and removal.



Conventional (standard)

Key Features

- Eliminate exposed circuits.
- Replace without direction checks.
- Remove the relay intact—no wires disturbed.
- Reduce wiring cost with included wiring harness.
  - Prewired voltage and current connectors
  - Precut wire lengths

Connectorized Products

- The following products use Connectorized terminals with shorting for each ac current input (if any), Connectorized terminals for each ac voltage input (if any), and compression terminals for any digital inputs, digital outputs, or analog inputs.
  - SEL-2BFR
  - SEL-251, D
  - SEL-300G
  - SEL-311A, B, C
  - SEL-321
  - SEL-351[1], A[1], S[1]
  - SEL-352
  - SEL-387, E
  - SEL-501
  - SEL-551
  - SEL-587
  - SEL-2431
  - SEL-2440
  - SEL-2522
  - SEL-2523
- The following products use Connectorized terminals with shorting for each ac current input (if any), Connectorized terminals for each ac voltage input (if any), and Screw-Terminal Connectorized (STC) blocks for any digital inputs, digital outputs, or analog inputs.
  - SEL-421
  - SEL-451
  - SEL-487V
  - SEL-2506
  - SEL-2516
  - SEL-2595

[1] Non-Ethernet legacy models only

- Many Connectorized relays also come in package specials.
  - SEL-99000 (SEL-501 and SEL-587)
  - SEL-99002 (SEL-501-2 and SEL-587)
  - SEL-99070 (SEL-501 and SEL-501)
  - SEL-99072 (SEL-501-2 and SEL-501-2)
  - SEL-9915 (SEL-587 and SEL-587)
  - SEL-99180 (SEL-501 and SEL-551)
  - SEL-99182 (SEL-501-2 and SEL-551)
  - SEL-99190 (SEL-551 and SEL-587)
  - SEL-99200 (SEL-551 and SEL-551)

  Other products and packages are being added. Check the SEL website for information.

Connectorized products offer the advantage of robust connections while minimizing installation and replacement time. Now, installing or removing an SEL device with Connectorized terminals takes only a few minutes. All wiring remains connected to the terminal blocks. Each terminal block mates with a connector in the SEL device.

We provide the following styles of proven, high-reliability Connectorized terminal blocks.

- Connectorized Terminals: Crimp wires into connectors that fit in the terminal block; the terminal block is rated for ac current and ac voltage inputs. For current inputs, the block includes automatic shorting of the CT leads.
- Compression Screw Terminals: Insert wires into the terminal block, and tighten screws to secure the wires.
- Screw-Terminal Connectorized (STC): Screw terminals on the plug accept standard ring terminals (Patent D0492,653).

Each of these connectors has been thoroughly tested by its manufacturer and proven over time in many industry applications. In addition, SEL tested these connectors to verify conformance to our standards for protective relay applications.

Call SEL today to learn more about how Connectorized products can save you time and money!

Control Enclosures and Panels

New SEL powerCORE™ Enclosures

The new SEL control enclosure is designed, manufactured, tested, integrated, installed, and commissioned following the leading quality standards, warranty, and vertical integration production philosophy that you have come to expect from SEL.

The innovative construction method is based on standard wall and roof panel designs, which are manufactured in a repeatable process that enables continuous improvement and high quality. The control enclosure is manufactured in a quality-controlled industrial environment, which reduces lead times and engineering costs, and provides flexible sizes, design, and materials. Control enclosures and control panels are built and integrated at the same facility, reducing logistics and allowing extensive and complete in-house testing.

This SEL Job Done® solution provides the most efficient integration of SEL technology for protection, automation, and information management, and provides a turnkey system for drop-in substation applications. SEL quality and values play an essential role in the complete solution from design to commissioning.

The new SEL powerCORE Control Enclosure is a completely designed, manufactured, integrated, tested, and commissioned turnkey solution.

Construction Method

The SEL powerCORE tongue-and-groove panelized construction method provides structural strength. Hot-dipped galvanized frames eliminate the need for paint and increase corrosion resistance and durability.

The resulting enclosure complies with the International Building Code (IBC) and U.S. federal and state agency standards.

Wall and Roof Panel Design

The structural strength of the enclosure comes from the hot-dipped galvanized steel columns and panel frames. This enables customers to select the filler material for walls and roof panels. SEL offers the following standard filler materials:

- Concrete
- Lightweight metal (LWM)
- Painted steel
- Composite

Adaptable Design

The ability to manufacture the powerCORE enclosure in-house gives SEL flexibility to accommodate customer requests, including:

- Live and wind load rates
- Insulation rates
- Wiring practices
- Control panel layout
- Enclosure dimension and exterior finish
- Bullet and fire resistance

Integration and Testing

SEL powerCORE integrated engineering design efficiently implements SEL technology, improving system reliability and reducing maintenance. SEL thoroughly tests every turnkey solution by performing Factory Acceptance Tests (FATs), which include continuity and operational testing. Functional and system integration testing is performed per customer request.

Control Enclosures and Panels

Setup and Commissioning

SEL factory-trained and industry-experienced engineers perform on-site setup and commissioning, from arranging offloading by crane and anchoring the enclosure to performing termination wiring and the Site Acceptance Test (SAT).

Warranty

A focus on quality drives the development of all SEL POWERCORE control enclosures. SEL designs and develops enclosures, control panels, and technology to comply with the highest technical standards and procedures.

As part of our strong commitment to offer unmatched value in our products, the control enclosures include a PVC roof membrane for water penetration resistance, methacrylic adhesive sealant for joining panels, hot-dipped galvanization to prevent steel corrosion, and structural insulating panels (SIPs) for higher energy efficiency.

Our worldwide, ten-year warranty covers the SEL POWERCORE enclosure, including structural and finishing integrity, control panels, and SEL equipment. This reflects our commitment and also demonstrates the quality and value we deliver.

Reduce Total Ownership Cost

- Modular construction method
- Integrated engineering design
- Ten-year, worldwide warranty
- Efficient implementation of technology
- Low maintenance
- Reduced field wiring and commissioning
- High reliability and quality
- Advanced testing
- Reduced lead times
- Turnkey system solution

SEL Job Done Solution

SEL experts design, manufacture, integrate, test, and commission SEL POWERCORE Control Enclosures and control panels to deliver a consistent and complete turnkey solution to customers.

The SEL POWERCORE double-sloped roof maximizes internal space and increases roof load capacities.

"SEL continues to provide value to our customers through vertical integration with the development of our new POWERCORE Control Enclosure.

"This new SEL product family brings a unique approach to the construction of modular enclosures. We are able to standardize our construction while still offering multiple materials such as concrete, lightweight metal, painted steel, and composites. Our extensive use of galvanizing allows us to provide corrosion-resistant solutions that require no paint.

"We are excited about SEL's ability to provide a complete turnkey solution with the high quality and low cost of ownership that our customers expect from us."

Rick Schulz
Project Manager, Control Enclosures

New Product Previews

SEL-2533 Annunciator Panel

Provide local and remote annunciation with compact ten-window annunciator.

Comprehensive Annunciation

Select from six ISA-18.1 standard sequences, use the new custom sequence settings to implement other ISA sequences, or create your own. Super-bright LEDs provide easily visible alarm indication in any lighting condition. Red or amber bicolor LEDs add flexibility.

Flexible Communications

Use up to four high-speed serial ports to communicate with Modbus®, DNP3, SEL Mirrored Bits® communications, or SEL Fast Message protocols. Three EIA-232 ports are standard; one EIA-485 or EIA-232 port is optional.

Configurable Labels

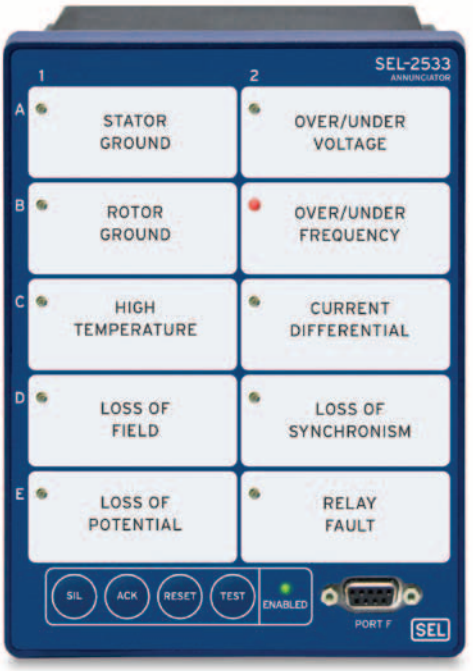
Print custom alarm labels using the terminology that matches your application. Easily reprint labels to accommodate expansion, reconfiguration, or other changes.

Time-Tagged Sequential Event Reporting

Connect an IRIG-B clock synchronization signal to time tag status changes to the nearest millisecond. Report with DNP3 or SEL Fast SER Messages.

Flexible I/O

Order with the digital inputs and outputs that match your needs. Use the base outputs for the device alarm and to operate critical and noncritical sirens or horns. Use the inputs for separate reset and acknowledge functions.



Description	Digital Inputs (DI)	Digital Outputs (DO)
Remote Annunciator Windows driven by data from communications	2	3
Standard Annunciator DI for each window	14	7
Annunciator With Follower Contacts DI and DO for each window	14	15

Example application: Communicate with a compact SEL-700 series relay, SEL-2411 Programmable Automation Controller, or SEL-2414 Transformer Monitor to provide local or distant annunciation of targets and other important information.

SEL-2240 Modular Control Network

Rethinking the RTU—Modernizing the PLC

The SEL-2240 is a modular I/O network that is designed to operate with an integrated SEL-2241 Real-Time Automation Controller (RTAC). The SEL-2240 combines the communications, built-in security, and IEC 61131 logic engine of the RTAC with an economical suite of I/O modules that provide high-speed deterministic control performance.

Configure Just the I/O Needed

Each SEL-2240 node can be custom configured with any combination of up to nine digital I/O modules to suit your application. Each node will include one or two SEL-2243 Power Couplers that provide power and EtherCAT® network connectivity. Modules can be installed in any sequence and combination within the node. Connect multiple nodes together to create a larger system without losing update speed or determinism.

All of the SEL-2240 components are tested to operate from −40° to +85°C with industry-leading reliability. The modules are also available with optional conformal coating. Backed by SEL's worldwide, ten-year warranty, this I/O network is designed for installation at or near critical equipment.

Smart RTU Functionality

The SEL-2240 will operate effectively as a modern remote terminal unit. The SEL-2241 RTAC module provides the IED and SCADA communications, security, web-based HMI, and logic. The I/O nodes can be combined in a flexible network structure, using copper or fiber Ethernet cables, to integrate local and remote signals. Every I/O point can be included in a station-wide 1 ms Sequential Events Recorder (SER).

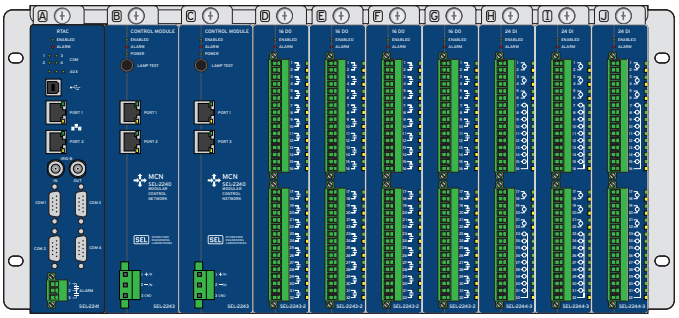
Flexible PLC Applications

The SEL-2240 uses the Ethernet-based EtherCAT protocol to connect all the nodes in a system. EtherCAT is designed to provide the deterministic performance required in control applications and the flexibility of Ethernet. The standard IEC 61131-3 logic editor in ACSELERATOR RTAC™ SEL-5033 Software is all you need to configure all of the SEL-2240 I/O and advanced control applications. Set the update rate appropriate for the control application. Partition the code into independent function blocks to make troubleshooting and maintenance easier.

The web-based HMI and online functions in the RTAC provide the tools you need to quickly commission and tune closed-loop control systems and keep them operating properly.

Economical Solution

Since a single RTAC module can operate as a system controller for multiple SEL-2240 I/O nodes, you can economically configure a system tailored to the particular requirements of your application.



Engineering Services

Systems and services for utility and industrial electric power systems worldwide.

Engineering Services Index

Control Enclosures and Panels Index

Power Management Solutions Index

Engineering Services

SEL provides engineering services that cover complete power system protection, automation, integration, and security. Many projects are currently installed and commissioned in facilities around the world. We have contracted over 150 complete turnkey control buildings and thousands of engineering projects in many different markets.

Electric Utility

- Transmission
- Distribution

Commercial

- Business Parks
- Data Centers
- Hospitals
- Hotels and Casinos
- Shopping Malls

Power Generation

- Biomass
- Waste-to-Energy
- Coal-Fired
- Cogeneration
- Gas-Fired
- Geothermal
- Hydro
- Nuclear
- Solar
- Tidal
- Wind

Water and Wastewater

- Potable Water
- Wastewater

Petrochemical

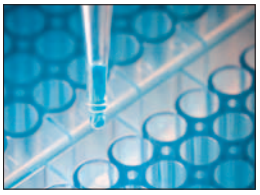
- Chemical
- Liquefied Natural Gas
- Offshore
- Oil and Gas
- Pipeline

Government

- Laboratories
- Regulatory Commissions
- Facilities
- Military

Resource Extraction

- Cement
- Metals
- Mining



Research and Laboratories

- Engineering Facilities
- Research Laboratories
- Universities

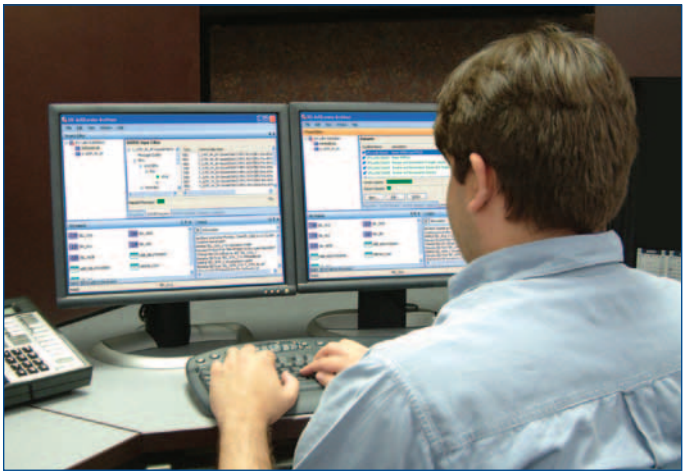
Manufacturing

- Automotive
- Consumer Products
- Electronics
- Food and Beverage
- Pharmaceutical
- Pulp and Paper

Transportation

- Airports
- Heavy Rail
- Light Rail
- Locks
- Marine Ports
- Moving Bridges
- Transit

Protection and Automation Services



SEL engineers understand protection and automation technology, applications, and customer needs. With an in-depth knowledge of the latest technology, SEL creates appropriate, reliable, and cost-effective solutions.

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Key Features

Communications Architecture Design and Programming

SEL engineers perform communications architecture design as well as program settings for POWERMAX® Power Management and Control Systems, and information processors.

Relay Settings

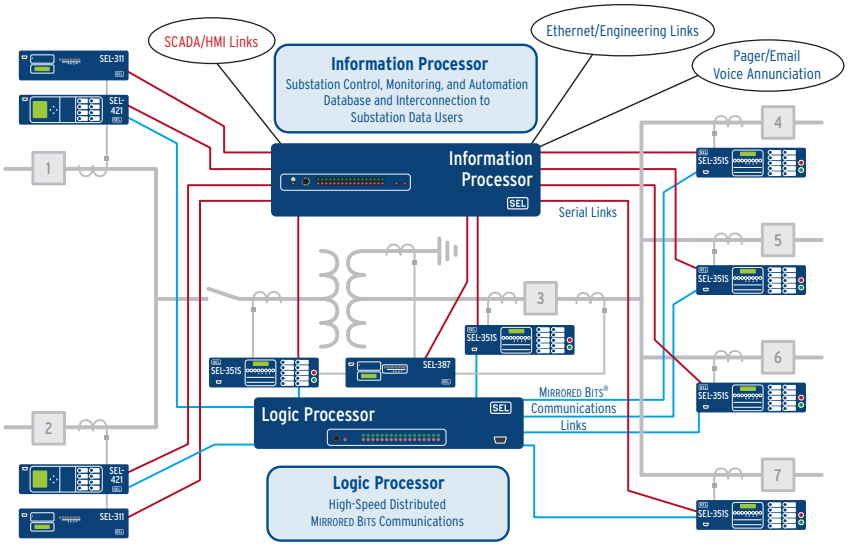
SEL provides assistance in programming and configuring protection equipment for optimum performance. The service includes calculation, documentation, and testing for a wide variety of protection applications.

Scheme Design

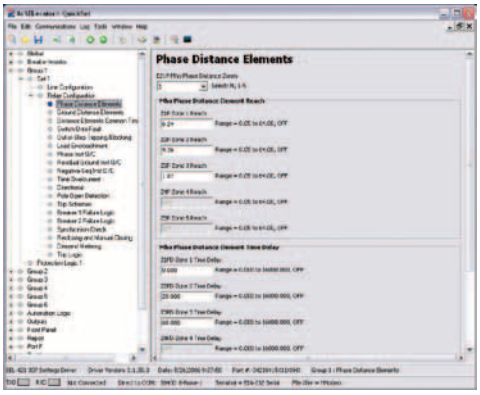
SEL engineers design protection and automation schemes for transmission, distribution, and generation systems that take full advantage of SEL multifunction technology. SEL selects the best technology for your system and prepares the necessary schematics and diagrams.

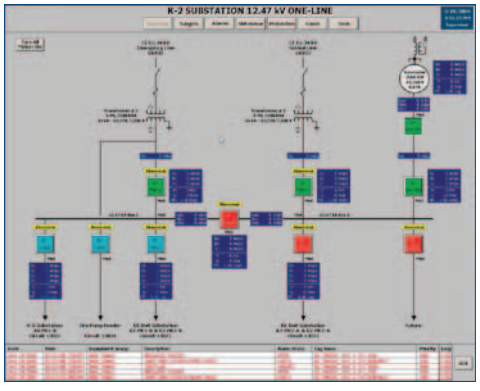
HMI Design and Programming

SEL designs, develops, tests, and deploys custom human-machine interface (HMI) applications for small- to large-scale systems. This service includes HMI screen and settings programming, schematics, and connection diagrams. SEL can program a variety of HMIs, including screens for monitoring the health of communications lines and logic controllers, summarizing power system data (MW, MVAR, voltage, current), and interfacing with settings for power management and remedial action schemes.



SEL designs systems with communications links to provide control and automation functions with reduced control wiring.





SEL engineers can assist customers with relay settings and HMI design and programming.

Protection and Automation Services

SEL protection and automation services have been implemented in power systems around the world. SEL engineers approach each new project with years of experience and a broad knowledge base, providing the best solution for your system.

Key Features

Panels and Assemblies

SEL designs, builds, assembles, wires, tests, packages, and ships panels to customers worldwide and performs factory and on-site tests.

Training

SEL offers application-specific training for protection and automation technology along with SEL University technical courses that increase the effectiveness of your operations and engineering staff.

Field Testing and Commissioning

Bring factory-trained SEL technical staff on-site to support field testing and commissioning efforts and provide hands-on training for your personnel.

Documentation

SEL engineers provide technical documentation to facilitate downloading relay settings, commissioning, application training, historical record-keeping, and day-to-day operations.

Fault and Coordination Studies

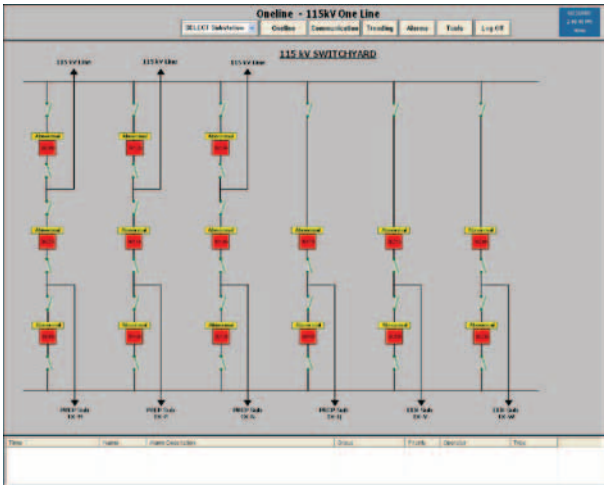
SEL offers fault (short circuit), system protection and coordination, and relay application studies for reliable system operation.

Model Power System Testing

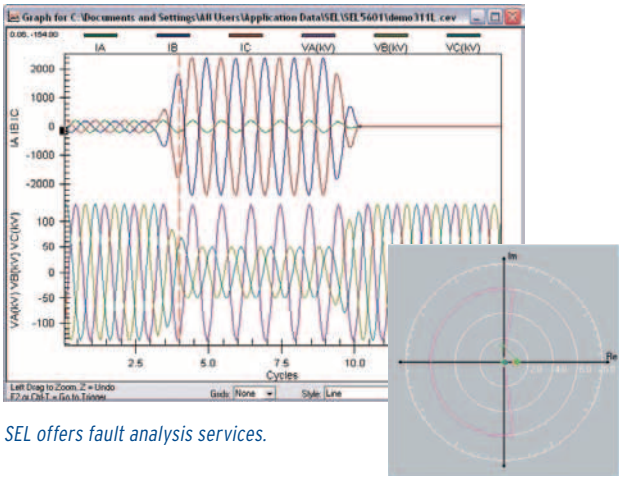
To improve protection system performance in critical applications, SEL validates relay performance and optimizes settings by testing relay operation with inputs created by electromagnetic transient simulations.

Project Scope and Specification

SEL experts can help you from the conceptual phase of a project to execution and commissioning. Services range from preliminary designs to complete project estimates.



Example HMI screen.



SEL offers fault analysis services.

Model Power System Testing Services

Improve system reliability and reduce costs with real-time transient power system testing.

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Design and validate complex, secure, and reliable protection schemes for your power system.

Key Features

Design and Implement Complex Systems

SEL can help you design and implement complex systems with model power system testing. Advanced tools provide realistic, closed-loop, transient, and dynamic simulation of the power system for testing complex systems. Knowledgeable and experienced engineers design the tests and help you analyze the results.

Evaluate Performance of Complex Systems

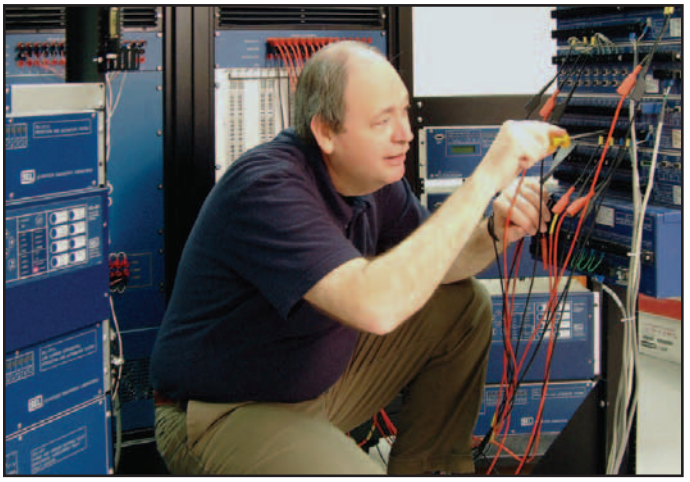
Simulate and evaluate, under real-world conditions, alternative protection and control schemes for your power system. A typical simulation of 500–1,000 fault cases can be run in less than one day, providing the equivalent of many years of operating history.

Waveform Capture in COMTRADE Format

The transient waveforms generated during each simulation are captured for use in subsequent testing or analysis, using relay test equipment and tools.

Comprehensive Test Reports and Recommendations

The large amount of test data is automatically collected and formatted to allow easy analysis with standard tools, such as Microsoft® Excel®. SEL provides a detailed report describing each simulation and any recommendations and/or conclusions from the testing.



Relays are connected to the Real Time Digital Simulator (RTDS®) to simulate their response in various power system stress scenarios.

Key Benefits

Partner with SEL experts to improve your power system reliability.

- Reduce testing costs.
- Test more thoroughly within a given budget.
- Have greater confidence in the results.
- Deploy complex technology to improve power system performance.
- Easily explore performance or operation to eliminate surprises or mistakes.

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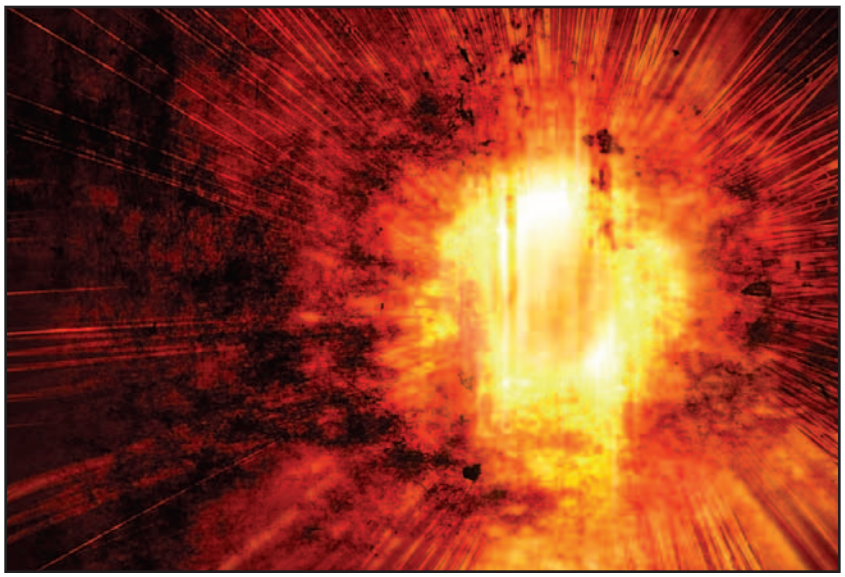
Arc-Flash Hazard Services



Identify arc-flash hazards and solutions.

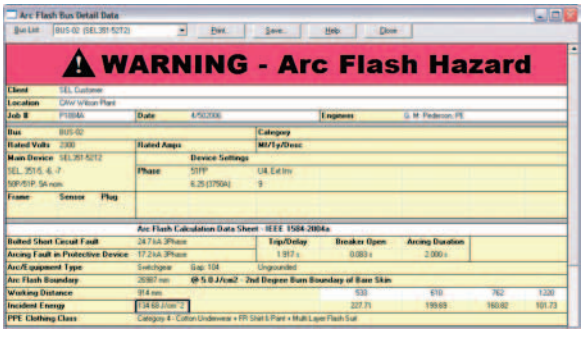
GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Key Features

SEL conducts flexible, customized arc-flash hazard services to mitigate arc-flash hazard risk and improve employee safety. SEL uses proven methods to calculate flash-protection boundaries and classify each area into proper personal protective equipment (PPE) categories, among many other services for providing a complete, cost-effective arc-flash solution for your facility.

- Power system modeling
- Short-circuit study
- Protective-device coordination study
- Arc-flash analysis study
- Arc-flash mitigation study
- Arc-flash hazard warning plan
- Arc-flash engineering report
- Field survey
- Detailed engineering study



SEL uses industry standard analysis software to model the power system and to calculate short-circuit current magnitudes, protective-device clearing times, and arc-flash energy levels and classifications.

Key Benefits

Protect Employees and Improve Safety

Protect employees from arcing faults by designing equipment and the power system for safety. Properly establish flash-protection boundaries, and post required warnings.

Comply With Current Regulations

Address OSHA regulations (29 CFR 1910) and the National Fire Protection Association Standard for Electrical Safety in the Workplace (NFPA 70E).

Identify Potential Hazards

Identify and quantify potential arc-flash hazard areas. Determine incident energy levels, identify the correct hazard/risk category for each area of the plant, and establish flash-protection boundaries. Properly inform employees with detailed warning labels.

Electrical worker with properly selected personal protective equipment for the hazard.

Asset Optimization Services

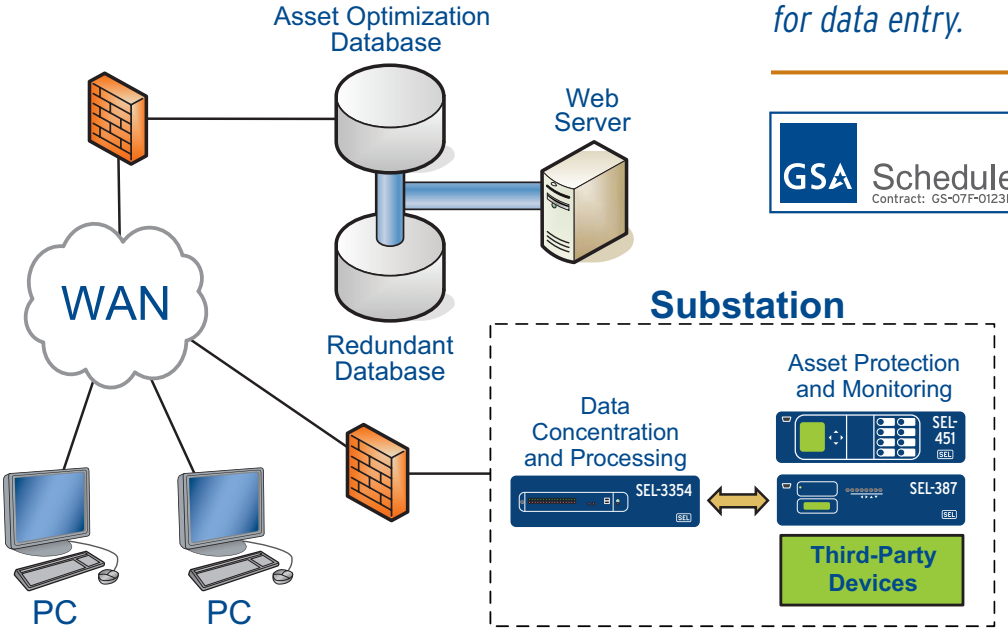
Motors • Transformers • Circuit Breakers • Voltage Regulators • Instrument Transformers • Capacitor Banks • Generators • Reclosers • Relays

Description

SEL provides asset optimization solutions from the ground up. With monitoring functions built into many SEL products, you can monitor key asset wear information as soon as the SEL protective relay is installed. SEL information processors form the data backbone needed to implement a complete substation asset optimization system. By collecting, sorting, and storing information before sending it on to a system-wide database, SEL substation data tools provide secure, concise, controlled data that asset and maintenance managers need.

SEL offers a customizable, periodic reporting service to prioritize maintenance activities. Implement predictive maintenance, justify substation budgets, and avoid catastrophic failures using SEL asset reports. Example report types include: operation overview, wear indication, life-cycle history, maintenance priority, time to failure, and trending.

SEL devices automatically populate asset optimization databases without the need for data entry.



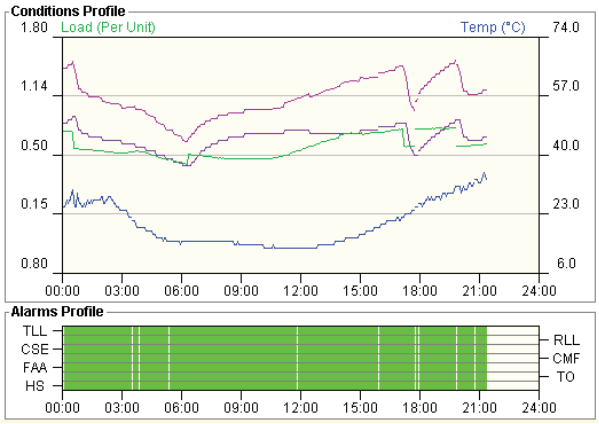
GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Key Benefits

Improve maintenance scheduling, life-cycle management, reliability programs, and power quality management with SEL asset optimization solutions. Use cost-effective, data-driven maintenance schedules to:

- Reduce maintenance cost.
- Increase asset life.
- Make informed decisions.
- Maximize engineering resources.



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General Engineering Services

SEL experts provide traditional consulting engineering services to meet your power system needs.

GSA Schedule
Contract: GS-07F-0123N

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Substation Engineering, Procurement, and Construction (EPC)

SEL provides cost-effective EPC capabilities and delivers complete turnkey solutions. SEL brings factory-trained and industry-experienced engineers to every project to provide the best possible solution.

Project Scope and Specification

SEL experts can help you from the conceptual phase of a project to execution and commissioning. Services range from preliminary designs to equipment parameters to complete project estimates.

Review System Design and Settings

SEL has experienced engineers to perform detailed analysis of your power system. The analysis will identify ways to take full advantage of SEL technology to reduce equipment and operational costs while increasing system performance and functionality.

Engineering Design and Drafting Services

Using computer-aided design and drafting systems, SEL can provide design and drafting services for your electrical power project:

- Complete design and drawing packages
- Staff augmentation
- Bid documents
- Cost estimation
- Engineering studies

Field Testing and Commissioning

Reduce commissioning time and cost. Bring factory-trained SEL technical staff on-site to support testing and commissioning efforts and provide hands-on training for your personnel.

Retrofit Engineering and Implementation

SEL can assist you with your retrofit needs. Services include new relay selection, new relay scheme design, drawing modification, relay settings, training, and field services. SEL can also fabricate retrofit doors, wiring harnesses, panels, and control buildings to replace aging infrastructure.

Synchrophasor Systems

Synchrophasors provide a real-time measurement of electrical quantities from across a power system. SEL can help you apply these measurements to validate system models, measure stability margin, maximize stable system loading, and implement remedial action schemes (RAS).

Cybersecurity Services

SEL cybersecurity services help customers assess, support, and develop control system security infrastructure. Our services support NERC Critical Infrastructure Protection (CIP) standards as well as other security standards and regulations. SEL personnel have multidisciplinary experience in substations, control systems, and information security, and maintain multiple industry security certifications.

POWERCORE™ Substation Control Enclosures

Control enclosure deployed directly to site.

SEL POWERCORE includes all design, assembly, wiring, and testing for utility and industrial applications.

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Key Features

Reduced Total Ownership Costs

- Integrated engineering design.
- Efficient implementation using existing and new technology.
- Consistent operator interface.
- Reduced maintenance.
- Migration path to new technologies.

Simplified Panels

SEL multifunction protective relays minimize the number of devices and simplify wiring.

Improved System Reliability

The use of SEL protection, monitoring, and communications equipment coupled with equipment diagnostics information improves system reliability and enables condition-based control of substation equipment.

Prewired and Factory-Tested

Reduce field wiring and commissioning time and expense. A substation simulator tests protection and automation functions; wiring is complete and tested to the terminal blocks in the yard termination cabinet.

Adaptable Design

SEL can accommodate customer preferences for equipment and design details, such as substation control enclosure layout, battery system, protective relays, panel layout and wiring practices, and communications equipment.

On-Site Delivery and Offloading

The substation control enclosure is delivered directly to the job site or warehouse. SEL can arrange offloading by crane.

Customer-Specific HMI

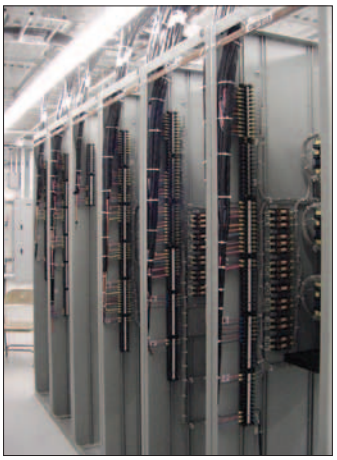
Flexible HMI design allows for quick integration of controls and displays of analog data, status, and alarms. Optional functionality can include tagging, online documentation, historical trended data, and much more.

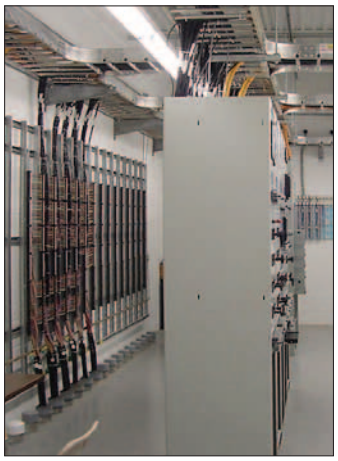
POWERCORE Options

- 8' x 19' Concrete
- 10' x 28' Concrete
- 8' x 19' Steel
- 3' x 24' POWERCORE-M
- 10' x 28' Steel
- 8' x 20' ISO
- 8' x 40' ISO

SEL also designs and builds custom control enclosures.

Customer design preference easily accomplished in flexible panel layout.





Prewired and factory-tested to the termination cabinet for quick commissioning.

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POWERCORE Substation Control Enclosures

Concrete Enclosure

Steel Enclosure

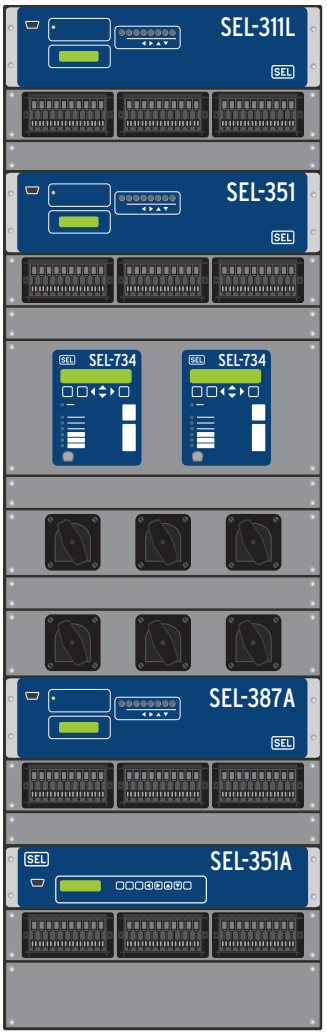
ISO Enclosure

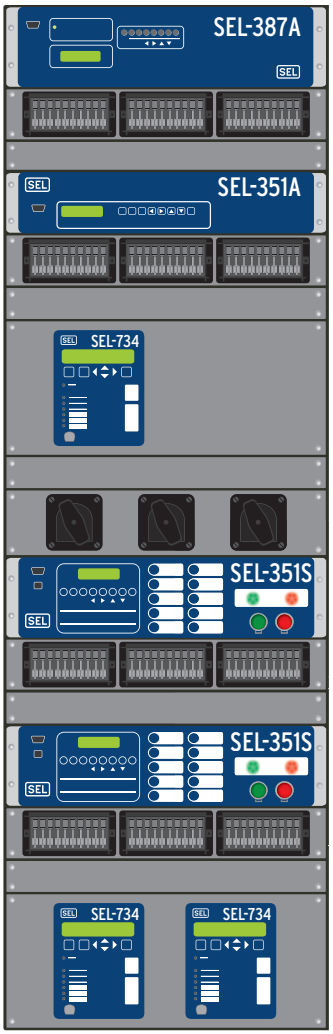
POWERCORE-M™ Enclosure

SEL POWERCORE™ features an integrated engineering design in a concrete, steel, or ISO enclosure.

SEL POWERCORE™ includes all communications, automation, protection, and control equipment for new installations or for replacement of existing, site-built substation control houses.

SELECT™ Modular Panels





Key Features

Complete Quality Solution

SEL panels are engineered, manufactured, wired, and tested to meet and exceed quality standards. Our processes adhere to strict quality controls, thus providing highly reliable products that last. Panels come with nameplates and a complete drawings package, which includes panel layout, bill of materials, ac/dc schematics, wiring diagrams, and logic diagrams.

Mix-and-Match Modules

Choose from 15 standard modules to match your applications, including feeder, distance, line current differential, transformer, breaker failure, capacitor bank, bus differential, and data concentration.

Quick Delivery

SEL provides SELECT Modular Panels with accelerated lead times—only six to eight weeks from order to delivery.

Reduced Total Ownership Costs

Choose SELECT Modular Panels at a fraction of the cost of a custom solution. These panels feature an integrated engineering design with the most efficient implementation of SEL technology for protection, automation, metering, and information management. We perform thorough testing before shipping, which reduces overall project cost and engineering time.

SEL Technology Enabled

Modules are designed with the most advanced technology such as synchrophasors, load encroachment, MIRRORED BITS® communications, and more.

Simple Ordering

1 Select Panel Type

Fully Enclosed

Open Back Rack

2 Select Module(s)

- Breaker Failure
- Bus Differential
- Capacitor Bank
- Data Concentration
- Distance
- Feeder
- Line Current Differential
- Transformer

3 Select Special Add-Ons

SEL-2401 Satellite-Synchronized Clock

SEL-3022 Wireless Encrypting Transceiver

SEL-2404 Satellite-Synchronized Clock

SEL-3031 Serial Radio Transceiver

SELect Modular Panels

Application Module Options

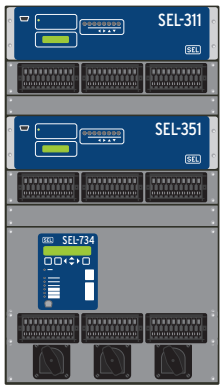
Choose from 15 standard modules to match your applications. Panels can be configured with one to four modules, depending on the type chosen. Prices shown are for two modules per panel (with the exception of the bus differential modules). Each module is integrated using EIA-485 DNP. Mix and match the modules to create a panel solution that works for your system.

Distance Module (SEL-311C Option)

Single-Bus Application (3-Pole)

- SEL-311C Advanced Distance Relay With Recloser
- SEL-351 Protection System
- SEL-734 Advanced Metering System
- Breaker control switch, lockout relay, and selector for reclosing function
- Test blocks

Module Price: $13,100
(based on a 2-module panel)*



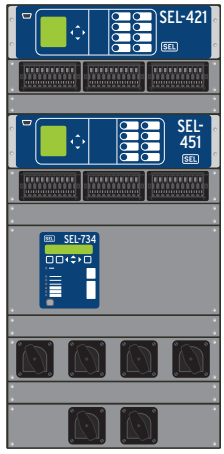
Up to 2 modules per panel

Advanced Distance Module (SEL-421 Option)

Ring Bus or Breaker-and-a-Half Application (3-Pole)

- SEL-421 Protection, Automation, and Control System
- SEL-451 Protection, Automation, and Bay Control System
- SEL-734 Advanced Metering System
- 2 breaker control switches, 2 lockout relays, and 2 selectors for reclosing functions
- Test blocks

Module Price: $18,315
(based on a 2-module panel)*



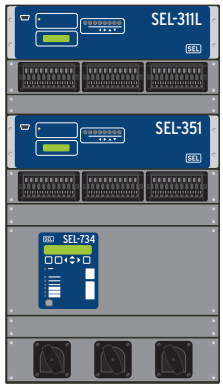
Up to 2 modules per panel

Line Current Differential Module (SEL-311L/SEL-351 Option)

Single-Bus Application (3-Pole)

- SEL-311L Line Current Differential System
- SEL-351 Protection System
- SEL-734 Advanced Metering System
- Breaker control switch, lockout relay, and selector for reclosing function
- Test blocks

Module Price: $14,550
(based on a 2-module panel)*



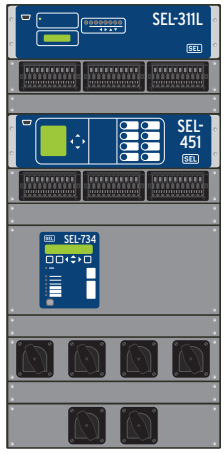
Up to 2 modules per panel

Advanced Line Current Differential Module (SEL-311L/SEL-451 Option)

Ring Bus or Breaker-and-a-Half Application (3-Pole)

- SEL-311L Line Current Differential System
- SEL-451 Protection, Automation, and Bay Control System
- SEL-734 Advanced Metering System
- 2 breaker control switches, 2 lockout relays, and 2 selectors for reclosing functions
- Test blocks

Module Price: $17,250
(based on a 2-module panel)*



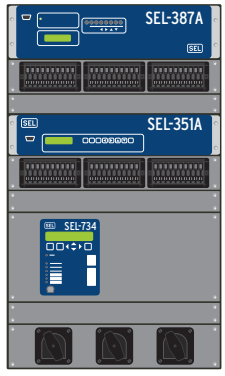
Up to 2 modules per panel

Transformer Module (SEL-387A Option)

2-Winding Transformer Application

- SEL-387A Current Differential and Overcurrent Relay
- SEL-351A Protection System
- SEL-734 Advanced Metering System
- SEL-2600 RTD Module (optional—add $892)**
- High-side breaker control switch and 2 lockout relays
- Test blocks

Module Price: $12,250
(based on a 2-module panel)*



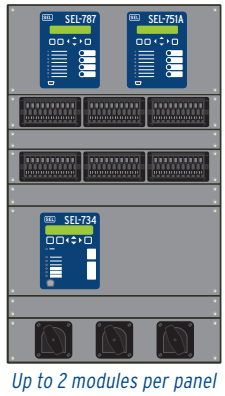
Up to 2 modules per panel

Transformer Module (SEL-787 Option)

2-Winding Transformer Application

- SEL-787 Transformer Protection Relay
- SEL-751A Feeder Protection Relay
- SEL-734 Advanced Metering System
- High-side breaker control switch and 2 lockout relays
- Test blocks

Module Price: $11,020
(based on a 2-module panel)*



Up to 2 modules per panel

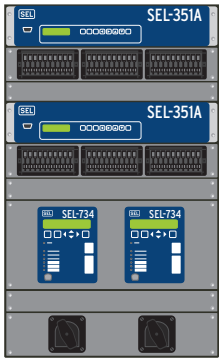
SELect™ Modular Panels

Feeder Module (SEL-351A Option)

2-Feeder Application

- SEL-351A Protection Systems (2)
- SEL-734 Advanced Metering Systems (2)
- Breaker control switches (2)
- Test blocks

Module Price: $8,440
(based on a 2-module panel)*



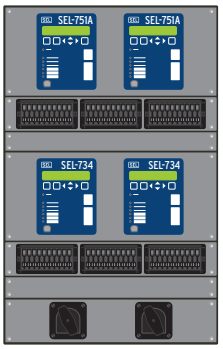
Up to 2 modules per panel

Feeder Module (SEL-751A Option)

2-Feeder Application

- SEL-751A Feeder Protection Relays (2)
- SEL-734 Advanced Metering Systems (2)
- Breaker control switches (2)
- Test blocks

Module Price: $8,430
(based on a 2-module panel)*



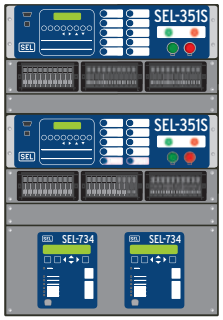
Up to 2 modules per panel

Advanced Feeder Module (SEL-351S Option)

2-Feeder Application

- SEL-351S Protection Systems (2)
- SEL-734 Advanced Metering Systems (2)
- Breaker control switches (2)—Breaker control using relay pushbuttons
- Test blocks

Module Price: $11,950
(based on a 2-module panel)*



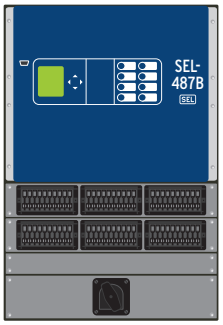
Up to 2 modules per panel

Bus Differential Modules

6-Feeder Bus Differential Application (shown)

- SEL-487B Bus Differential and Breaker Failure Relay
- Lockout relay
- Test blocks

Module Price: $12,600



Only 1 module per panel

9-Feeder Bus Differential Application

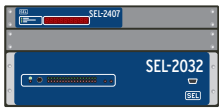
- SEL-487B Bus Differential and Breaker Failure Relays (2)
- Lockout relay
- Test blocks

Module Price: $24,500

Data Concentration Module (SEL-2032 Option)

- SEL-2032 Communications Processor
- SEL-2407® Satellite-Synchronized Clock
- SEL copper communications cables (up to 14 devices)

Module Price: $6,200
(based on a 2-module panel)*

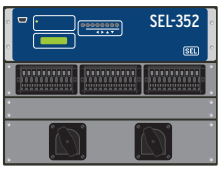


Up to 4 modules per panel

Breaker Failure Module

- SEL-352 Breaker Failure Relay
- Breaker control switch and lockout relay
- Test blocks

Module Price: $6,270
(based on a 2-module panel)*

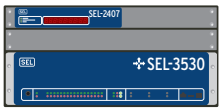


Up to 4 modules per panel

Data Concentration Module (SEL-3530 Option)

- SEL-3530 Real-Time Automation Controller (RTAC)
- SEL-2407 Satellite-Synchronized Clock
- SEL copper communications cables (up to 14 devices)

Module Price: $7,800
(based on a 2-module panel)*



Up to 4 modules per panel

Capacitor Bank Module

- SEL-487V Capacitor Protection and Control System
- Breaker control switch
- Test blocks

Module Price: $7,300
(based on a 2-module panel)*

Up to 4 modules per panel

* *For panels with only one module, add $500. Prices include predetermined SEL model options for the application (see website for available model options).*

** *Includes one SEL-2600A or SEL-2600D, one SEL-2800 Fiber-Optic Transceiver, and up to 8 meters of fiber-optic zipcord cable.*

Custom Panels

SEL panel and system manufacturing adheres to strict quality controls for design, manufacturing, testing, and commissioning.

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

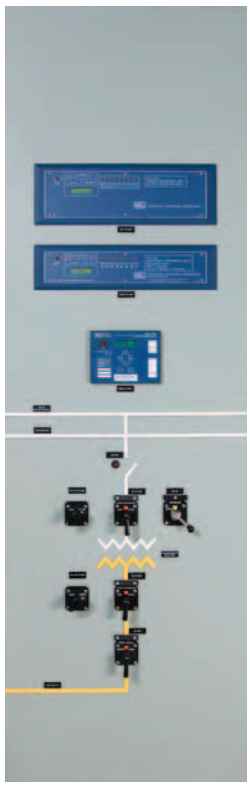
Description

SEL designs, manufactures, tests, and delivers custom protection, control, and metering panels as well as control cabinets and retrofit doors. SEL panels are supported by an unmatched warranty and extraordinary customer service. Panels, cabinets, and doors are built to match customer specifications and needs.

SEL tests the final implementation of every manufactured system before shipping, reducing overall project costs and engineering time. SEL's testing contributes to easier and faster commissioning.

Complete Panel Solutions

- ☑ **Consulting and Engineering Design**
- ☑ **Panel Manufacturing and Testing**
- ☑ **Protection, Automation, and Control Equipment Manufacturing**
- ☑ **Field Service**



Custom Enclosures

Description

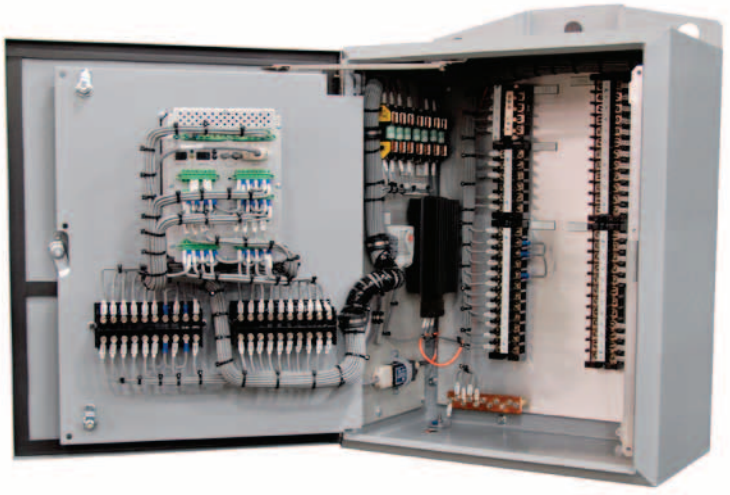
SEL integrates multiple pieces of equipment (from SEL and other vendors) into a single enclosure, enabling one-stop shopping for parts and labor with a quick turnaround time. Every custom enclosure is designed, assembled, wired, and tested to your specifications. SEL creates a single part number for your design, simplifying ordering and approvals.

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Example Projects

- Enclosures for relays and a power supply
- Prewired assemblies for easy integration and minimal field wiring
- Enclosures with recloser controls, communications products, and test switches
- Wiring conversion assemblies and terminals
- Test racks, fully wired and assembled
- Custom adapters and rack panels to integrate SEL relays into your existing systems



Standard Enclosure Offerings

For fastest delivery cycle, these standard enclosures can be customized to meet your unique specifications. SEL can also accommodate requests for enclosures with other sizes, materials, and features.

SIZE	MATERIAL	SINGLE DOOR	DUAL DOOR	SWING PANEL	19-INCH RACK	REMOVABLE CONNECTOR PANEL	WALL MOUNT	POLE MOUNT	STATION MOUNT
18" H x 16" W x 8" D	Fiberglass			X			X		
22" H x 18" W x 13.5" D	Stainless Steel	X		X			X	X	
22" H x 18" W x 13.5" D	Painted Steel	X		X			X	X	
33" H x 17" W x 13.5" D	Stainless Steel	X				X	X	X	
33" H x 17" W x 13.5" D	Painted Steel	X				X	X	X	
30" H x 24" W x 16.6" D	Stainless Steel		X		X	X	X	X	
30" H x 24" W x 16.6" D	Painted Steel		X		X	X	X	X	
33" H x 24" W x 14.73" D	Stainless Steel	X		X		X	X	X	X
33" H x 24" W x 14.73" D	Painted Steel	X		X		X	X	X	

SEL-7000 Integrated Substation System

Integrated system for control, automation, monitoring, and protection, using highly reliable devices.

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Key Features

Increase Reliability

Lower the device count by fully utilizing the automation and protection features in SEL relays. Use high-reliability SEL devices and self-diagnostics to quickly detect and correct substation alarms.

Lower Initial Costs

Reduce training, engineering design, and documentation labor with an SEL preconfigured solution.

Decrease Maintenance and Operating Expenses

Minimize maintenance activities and prolong asset life using high-reliability SEL devices that intelligently monitor and control.

Streamline Access to Valuable Information

Optimize engineering time through automatic event report collection, settings management, and event report analysis software. Receive automatic alarm/event notification via pager, email, and voice annunciation.

Adaptable Design

SEL can accommodate customer preferences for equipment and design details, such as panel construction and layout, wiring practices, and communications equipment.

Applications

Save time and money with pre-engineered control, automation, and protection systems.

Simplify Protection Communications

Direct digital communication to the relay replaces tone equipment for transfer trip schemes.

Lower Installation Costs by Supplanting the Need for Transducers and PLCs

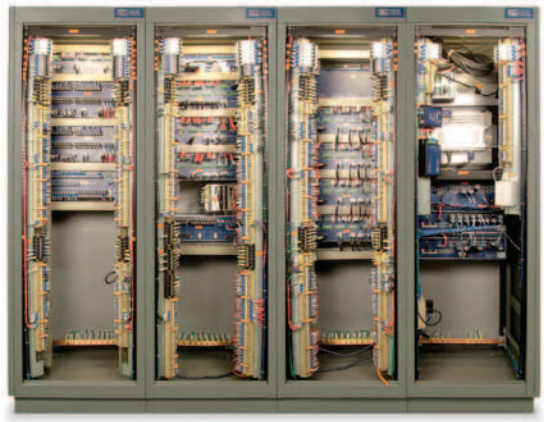
Relay meter data replace less-reliable transducers. Relay and logic processor replace less-reliable PLCs.

Reduce Installation Time With Pre-Engineered Automation Logic Settings

Relays and logic processors are pre-set for breaker failure tripping, distribution bus tripping, and transformer and bus lockouts.

Simplify Drawing Creation and Documentation With Pre-Engineered Panels

Each subsystem comes installed and wired with a complete set of as-built documentation.



POWERMAX® Power Management and Control System

Key Features

Advanced, Automated Control System

- Flexible, high-speed load shedding
- Islanding detection and intelligent system separation
- Generation and frequency control
- Voltage and MVAR control

Complete System Monitoring, Diagnostics, and Reporting

- SCADA systems
- Asset management systems
- Annunciation
- Revenue metering
- Power quality monitoring
- Automated data collection and analysis

Dynamic Load Management

- Load management schemes

Robust, Intelligent Designs

- Fault-tolerant designs
- Flexible, robust system designs

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Key Benefits

Maximize System Uptime

Mitigate problems before you experience an outage with proactive, high-speed load shedding, generation control, voltage control, and load management.

Increase Reliability With a Robust, Multifunction System

Perform protection, control, automation, and management functions with one system consisting of high-quality hardware and software.

Provide Total System Awareness

Reduce analysis time through graphical user interfaces, automatic waveform capture collection, report analysis software, and report generation tools.

Optimize Maintenance Schedules

Base preventive maintenance on actual performance statistics rather than periodic time schedules. Detect the earliest signs of failure using trended motor operating statistics, instantaneous quantities, and harmonic components.

Improve Operations With Synchrophasor Data

Incorporate real-time synchrophasor data to improve critical system operation. Optimize power flow using system-state measurements, and calculate operations quantities based on stability, power oscillations, or rate of change of phase angles.

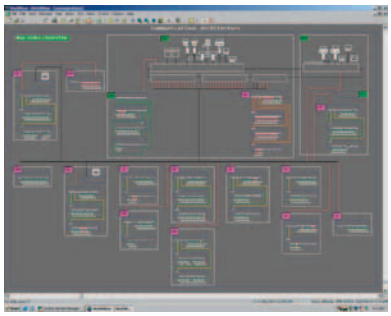
POWERMAX Power Management and Control System

Industry Applications

Perform all protection, control, automation, and management with one robust, multifunction system.

SEL POWERMAX uses:

- Field-proven hardware, software, and protocols, tested to industry standards, that provide the most reliable system available.
- Data redundancy and reasonability checks to qualify incoming data, find new sources for unacceptable data, and keep the system running.
- Innovative, fault-tolerant software architecture that reacts when data become unavailable and allows the system to run without interruption.

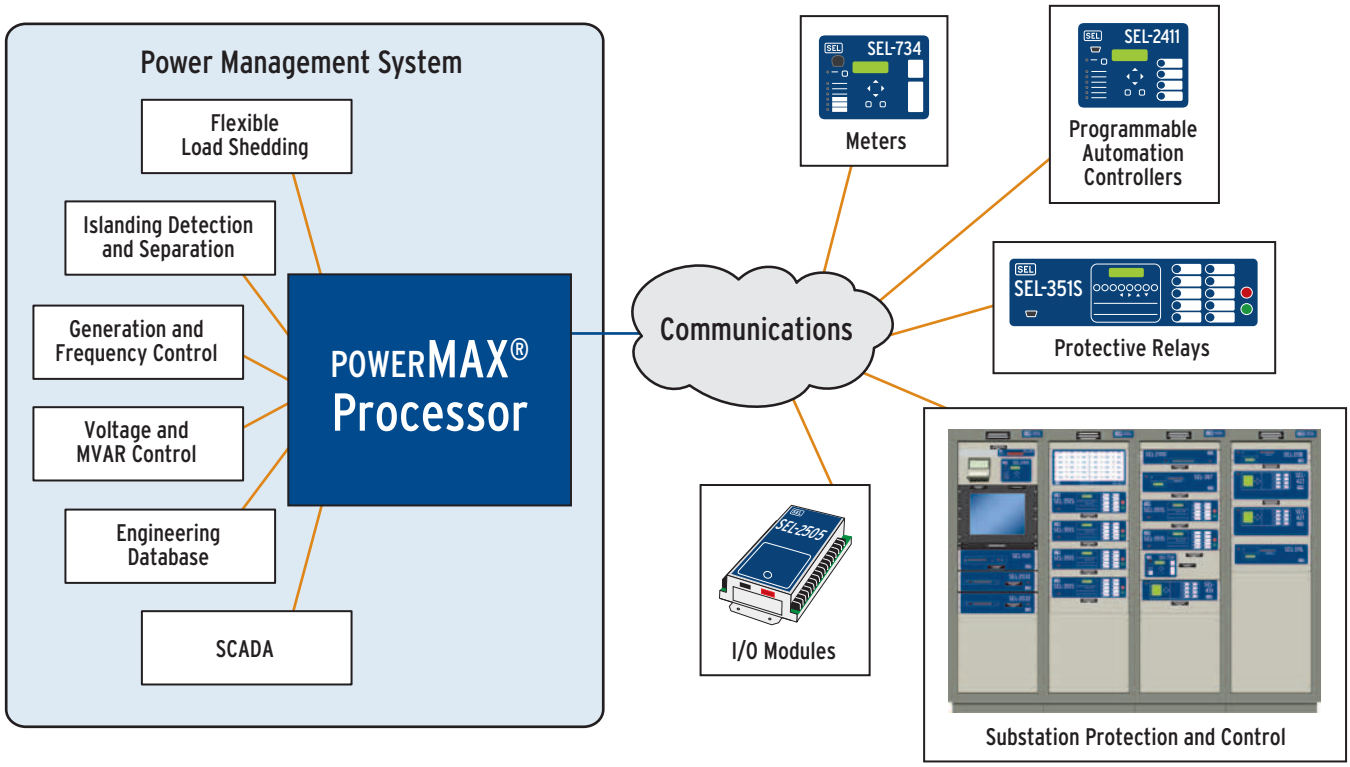


Communications one-line diagram provides immediate notification of problems.

Flexible, high-speed load shedding, generation and frequency control, voltage and MVAR control, and complete SCADA systems are fully operational at the Motor Oil Hellas Corinth Refineries S.A., Greece facility.

Total Power Management System With Complete Protection and Control

SEL POWERMAX is the most flexible, robust, cost-effective, and comprehensive system available for power management and control. The system performs advanced wide-area control using reliable, field-proven SEL hardware devices and universally accepted IEC 61131-3 software programmability. SEL POWERMAX avoids proprietary databases and is configured with your HMI preference. All wide-area control algorithms run autonomously, providing the highest system availability in the industry.



Support innovative power management applications with secure, high-speed communications.

SCADA System Solutions

Reduce outage times and save money with a robust, reliable SCADA system.

Description

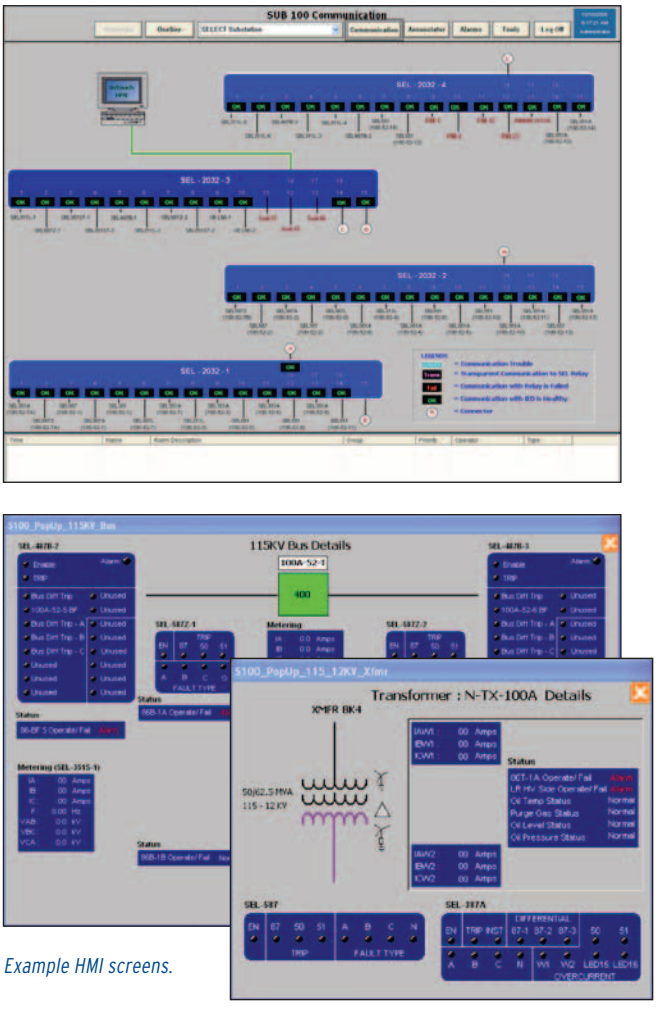
SEL designs, develops, tests, and deploys complete supervisory control and data acquisition (SCADA) systems to monitor and control your systems and processes. We have experience providing various system sizes, ranging from simple, standalone to complex, networked systems.

We design SCADA systems to assist with outage management, asset optimization, just-in-time (JIT) maintenance, load shedding, load restoration, access control, cybersecurity, and more.

Our knowledgeable engineers will work with your operations requirements, preferred SCADA software, and existing equipment to create a SCADA solution that is right for you.

Key Benefits

SEL-customized SCADA systems offer streamlined access to valuable information, improved reliability and performance, and expanded power system management capabilities. We provide an all-in-one solution for new and legacy equipment with unmatched support that is less expensive than traditional SCADA applications.



Example HMI screens.

Tel: +1.509.332.1890 | Fax: +1.509.332.7990 | www.selinc.com

SCADA System Solutions

Key Features

- Master and local substation human-machine interfaces (HMIs)
- Protection data network
- Station- and system-wide sequential events recording (SER)
- System-wide relay event retrieval
- Master SCADA server redundancy
- Remote access
- Fast response to HMI control outputs
- 1 ms SER resolution
- Self-testing
- Time synchronization
- IED polling
- Enterprise and local power system report manager
- Industry-standard protocols

HMI Design and Programming

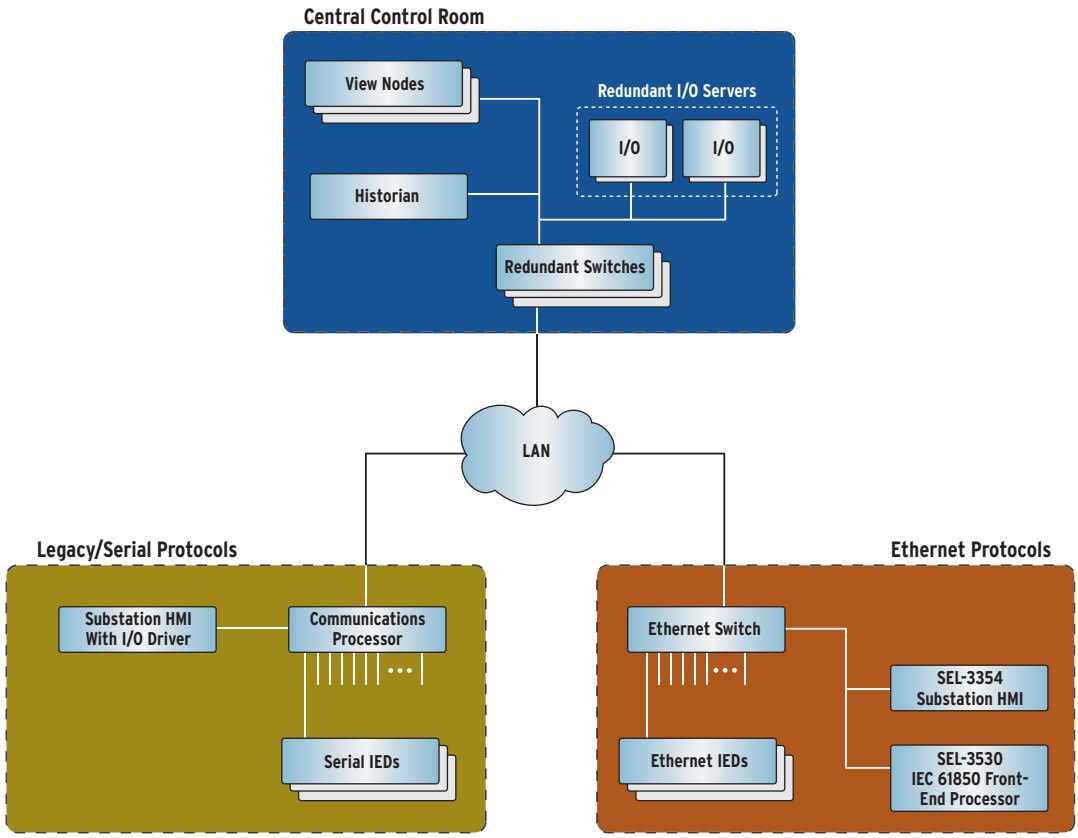
SEL designs and develops custom HMI applications for small- to large-scale systems. This service includes HMI screens, settings programming, schematics, and connection diagrams.

We can program various HMIs, including screens for monitoring the health of communications lines and logic controllers, summarizing power system data (MW, MVAR, voltage, current), and interfacing with settings for power management and remedial action schemes. HMIs include the following features:

- Calculation scripting
- Clearance tags
- Security
- Screen header/menu
- Scrolling alarm bar
- One-line display
- Breaker and relay control
- Tag application screen
- Communications screen
- Alarm summary screen
- Alarm history screen

Example Screens

SEL can design and implement a system with one or more of these components or with custom components to meet your needs. We also work with local and remote locations, multiple protocols, and various communications options.



Remedial Action Schemes

Maintain system stability using proactive controls and contingency-based actions.

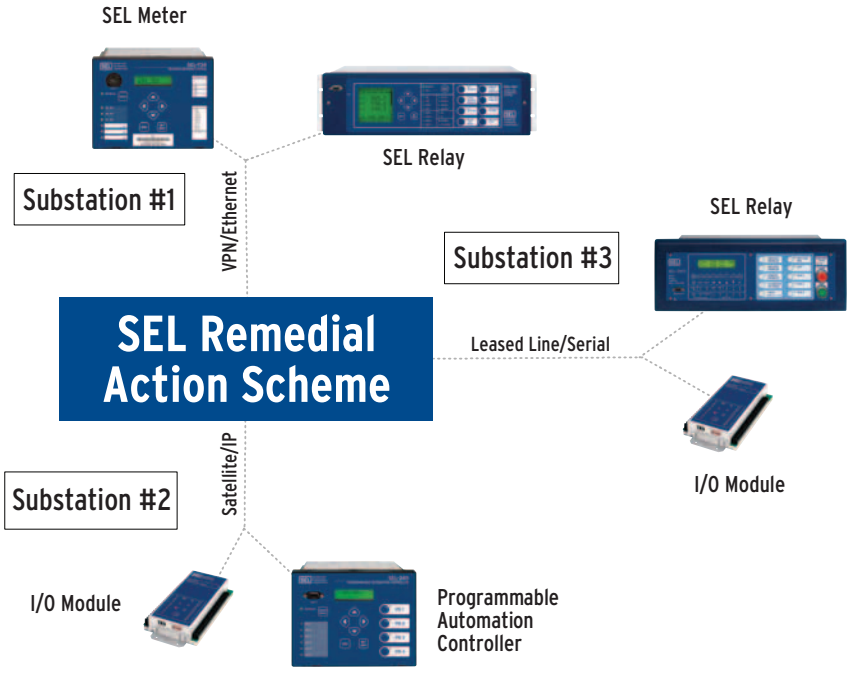
GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Description

SEL remedial action schemes detect conditions in your power system and take automatic corrective actions. SEL engineers have the knowledge and experience to integrate these schemes into your current system. The SEL solution has flexible communications channels and device options.

The intent of these schemes is to protect against blackouts and system instability, increase corridor capacity limits, and provide the ability to operate your system closer to its stability limits.



Protect against blackouts.

Increase corridor capacity limits and operate closer to stability limits.

Integrate into existing systems.

Autosynchronization Systems

Safe, secure, automatic synchronization of generation onto the power system.

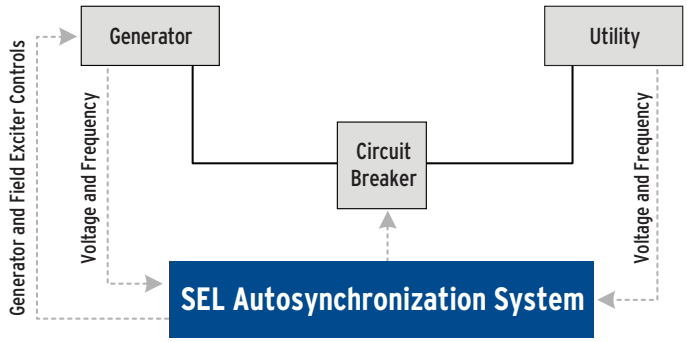
GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Description

SEL Autosynchronization Systems measure voltage and frequency on the generator and the utility system, send proportional 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 onto the power system.

The base system includes an SEL-451 Protection, Automation, and Bay Control System with installed settings for autosynchronization. The system software selects synchronization voltage sources from six independent single-phase inputs, eliminating the need for complicated synchronization switches and manually selecting voltages.



The SEL system includes a proprietary algorithm for accurate autosynchronization.

Key Benefits

Precise, Automatic Synchronization

SEL Autosynchronization Systems replace synchroscope hardware and manual breaker closing. These systems are more precise than manual systems, include advanced reporting and communications capabilities, and do not require external switching of VT signals. They feature protection-class equipment and high-speed (subcycle) communications over long distances.

Scalable Solution

SEL Autosynchronization Systems are scalable from small emergency generators to large utility generators. They can synchronize multiple machines across multiple locations. Multiple settings groups and flexible logic allow the user to set different parameters to optimize each synchronization scenario.

Flexible Settings

The system provides a configurable angle window, breaker close mechanism time compensation, voltage magnitude difference, frequency magnitude difference, frequency rate of change, and voltage rate of change acceptance criteria to allow automatic closing.

Government Engineering Solutions

SEL's Government Services Division understands the unique demands of government projects and offers its customers the industry's best people, products, technology, and services.

USS Makin Island (LHD-8).

Overview

SEL established its Government Services Division (GSD) to research and develop full service solutions that meet the unique mission and security needs of its customers.

The Government Engineering Solutions (GES) team supports GSD's mission by providing engineering services and product solutions for government agencies, military installations, and Navy ships, so our government customers have a safer work environment and a more reliable and economical electric power system.

GES personnel have many years of experience in the power industry providing complete solutions for government electrical power systems. Our engineers will easily translate your needs into workable solutions.

Key Services

Protection Services

- Perform fault, system protection and coordination, and arc-flash studies
- Recommend protection schemes to best match your system and goals
- Develop and program relay settings

Automation Services

- Perform communications architecture design
- Design and program human-machine interfaces (HMI) for small- to large-scale systems
- Develop and program communications and logic processor settings

Application Services

- Review system designs and settings to reduce equipment and operational costs while increasing system performance and functionality
- Select SEL products best suited for your power system protection and automation requirements

Field Services

- Provide on-site commissioning support from trained technical staff
- Support or perform field testing of SEL products
- 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

Product Development and Testing Services

- Develop or modify protection and automation equipment to meet specific military standards or unique government applications
- Perform lightweight shock testing according to specification MIL-S-901D requirements for shock testing on shipboard machinery, equipment, and systems

Government Engineering Solutions

GSA-Approved Products and Services

SEL Contract Details—Contract: GS-07F-0123N

- **Schedule 056:** Building and building materials/industrial services and supplies
- **FSC 61:** Power distribution equipment, generators, and batteries
- **SIN 412.50:** Ancillary services related to power distribution equipment
- **SIN 412.52:** Power systems engineering support
- Contract expires October 31, 2012

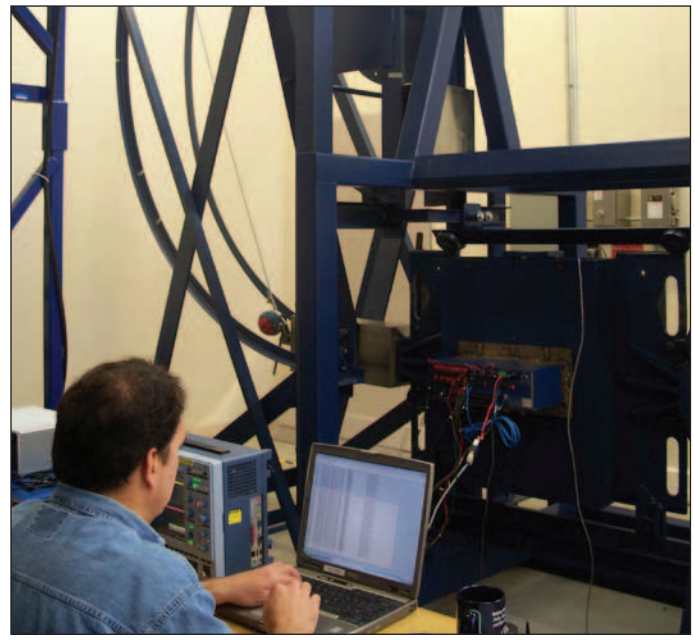
GSA Schedule
Contract: GS-07F-0123N

SEL Products Approved for Use in Marine Applications

SEL has received Marine Type Approval from the American Bureau of Shipping (ABS), certifying that 35 SEL products are safe to install on ocean vessels or structures. With this certification, SEL is setting a new standard for shipboard protection systems, designing and building protection for the newest naval fleet. Now this technology is available to all marine applications.

The following SEL products hold the ABS certification:

SEL-300G Generator Relay
SEL-311A, SEL-311B, and SEL-311C Distance Relays
SEL-311L, SEL-311M, SEL-311N, and SEL-387L Line Current Differential Relays
SEL-351, SEL-351A, and SEL-351S Protection Systems
SEL-352 Breaker Failure Relay
SEL-387, SEL-387A, and SEL-387E Current Differential Relays
SEL-3306 Synchrophasor Processor
SEL-3332 Intelligent Server
SEL-3351 System Computing Platform
SEL-2505 and SEL-2515 Remote I/O Modules
SEL-2032, SEL-2030, and SEL-2020 Communications Processors
SEL-2100 Logic Processor
SEL-710 Motor Protection Relay
SEL-734 Advanced Metering System
SEL-751A Feeder Protection Relay
SEL-787 Transformer Protection Relay and SEL-2414 Transformer Monitor
SEL-2411 Programmable Automation Controller
SEL-2600A RTD Module



Related Projects

Marine Applications

- Aircraft Carriers
- Amphibious Assault Ships
- Submarines
- Radar Platforms

Government Facilities

- Data Centers
- Military Bases
- NASA Space Centers
- VA Medical Centers

Studies

- Mitigating the Aurora Vulnerability With Existing Technology
- Critical Infrastructure and Key Resources (CIKR)

Practical, Relevant Technical Training

SEL UNIVERSITY

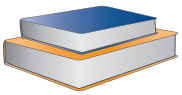
U

Our Mission

Since its inception, SEL University has had one clear purpose—to provide the education and training needed to make electric power safer, more reliable, and more economical. SEL University develops programs to help you meet the technical challenges of integrating digitally based technologies into your expanding power system infrastructure.

Course Structure and Delivery

SEL University offers instructor-led classroom courses, either at scheduled locations or at your site, and e-learning courses, both as self-paced courses and with remote instructors.



Many SEL University courses are organized into programs consisting of one or more tracks. Tracks are a recommended sequence for engineers, technicians, and power systems specialists who are concerned with protection, monitoring, control, automation, metering, and management of utility and industrial electric power systems.

"All sections of the course were valuable, and all questions that I could ask were answered in extreme detail."

Les Walton, Training Director
U.S. Navy MUSE

Practical, Relevant Technical Training

Classroom-Based Courses

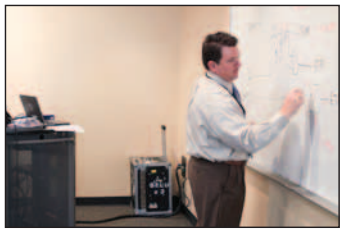
SEL University offers training in cities around the world. Courses are taught in multiple, convenient locations, allowing students to always find training nearby. Additionally, SEL University hosts many courses and program tracks at SEL corporate headquarters in Pullman, Washington. There are several advantages to attending training at SEL:

- Confer with SEL experts about your application.
- Complete a program track at one time and place.
- Tour SEL's state-of-the-art manufacturing facility.
- Receive a 10 percent discount on all Pullman courses.

"SEL training seems to me to be the best. I rate other classes using SEL training as the standard."

Stuart Dixon, Electrical Engineer
Chevron

SEL Event Center
SEL University Training Facility
SEL Campus, Pullman, WA, USA



Qualified Instructors

SEL University instructors are industry experts with a wealth of technical knowledge and practical experience. Courses focus on practical applications and real-world problem solving, and include the latest advances in power system protection and integration technology. Specialized courses address real-world issues in managing power systems by teaching topics such as modern communications protocols and applied synchrophasor technology. To ensure that instruction is relevant and at the appropriate technical level, student feedback is always requested and evaluated.

Continuing Education

AUTHORIZED IACET PROVIDER

SEL University, through its affiliation with the International Association for Continuing Education and Training (IACET), is authorized to provide continuing education units (CEUs) for all courses.

SEL University Training at Your Location

Looking to dramatically reduce travel expenses? Consider an on-site course. You supply the training room, and SEL University brings the equipment, course materials, and instructor.

Practical, Relevant Technical Training

Convenient, Online E-Learning Courses

E-learning is training enhanced by computer technology. SEL University's e-learning program offers skills-based online technical training—a flexible option for students with time and budget constraints. Courses include interactive, self-paced, and live online technical training.

Our e-learning resources help students develop the knowledge and job-relevant skills required for power system protection, monitoring, communication, and control. With engaging and realistic simulations, settings exercises, and knowledge assessment, these courses offer a comprehensive training experience.

Computer-Based Training (CBT)

CBT facilitates learning through robust and media-rich demonstrations, simulations, and job-relevant exercises. SEL University offers CBT courses that can serve as self-paced product introductory training or preparatory training for attending classroom or web-based courses.

SEL University also offers training for individuals and corporations:

- Single-user licenses never expire but are limited to one end user.
- Corporate license software is hosted on a corporate intranet and can be accessed by multiple users.

Web-Based Training (WBT)

Can't travel? Attend a WBT from anywhere in the world with a high-speed connection, and receive live instruction from an industry expert. Web-based courses usually include homework, interactive exercises, and virtual classroom sessions. Most WBT courses have a CBT prerequisite.

For more information about how SEL University can benefit you, visit **www.selinc.com/selu**.

mySELU Online Training

Your mySELU online training plan is an individualized list of your purchased SEL University online courses. Once you have purchased an online training course, it will automatically be added to your mySELU online training plan. Use your mySELU training plan to:

- View and sort your SEL University online courses.
- Access your online courses.
- View your online training completion status.

Visit www.selinc.com/selu for a complete schedule of SEL University courses and registration information.

Technical Books

Modern Solutions for Protection, Control, and Monitoring of Electric Power Systems

Edited by Héctor J. Altuve Ferrer and Edmund O. Schweitzer, III

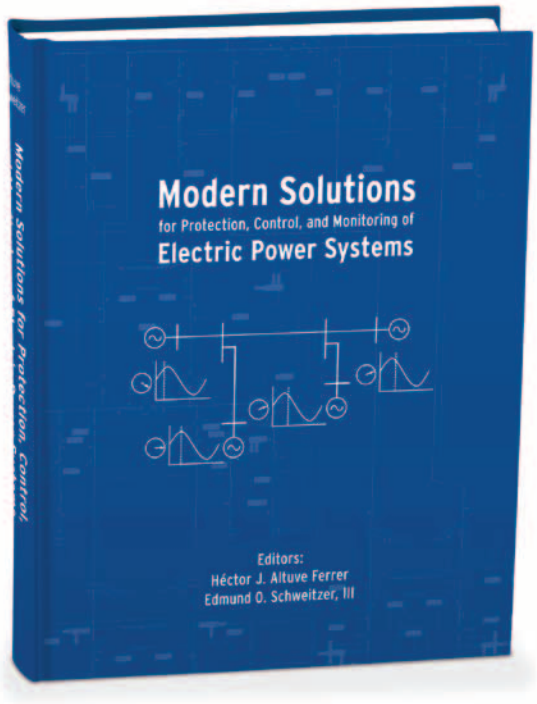
The most comprehensive work of its kind, this book consolidates into one volume new, modern solutions for protection, control, and monitoring of electric power systems.

You'll find straightforward presentations and example applications of the following technologies:

- Time-synchronized protection, monitoring, and control
- Wide-area protection and control using synchrophasors
- Cybersecurity threats and 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

For more information about *Modern Solutions*, including a full table of contents, book reviews, contributing author list, author biographies, and more, please visit www.selinc.com/bookstore.

- List price: $151.21
- Order online! **www.selinc.com/bookstore**



Analyzing and Applying Current Transformers

Stanley E. Zocholl

Current transformers (CTs) are used throughout the world as current transducers for protective relays in industrial, commercial, and utility applications. Standard ratings and application guides deal with the steady-state sine wave behavior of current transformers. Despite the use of recommended rules applied to avoid transient saturation, it always occurs in certain critical relay applications. This book presents transformer concepts that provide the fundamentals to understand the nonlinear characteristics, accuracy ratings, and transient behavior of current transformers.

- List price: $34.95
- Order online! **www.selinc.com/bookstore**

GSA Schedule Contract: GS-07F-0123N

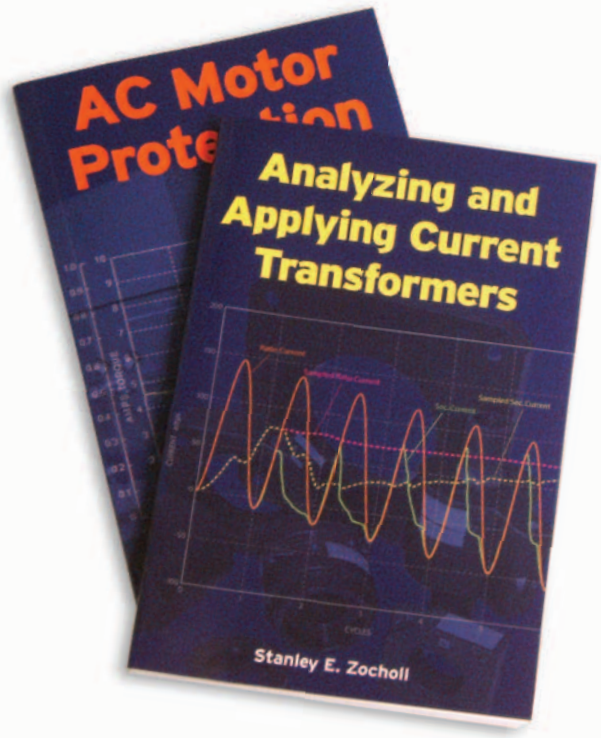
AC Motor Protection

Stanley E. Zocholl

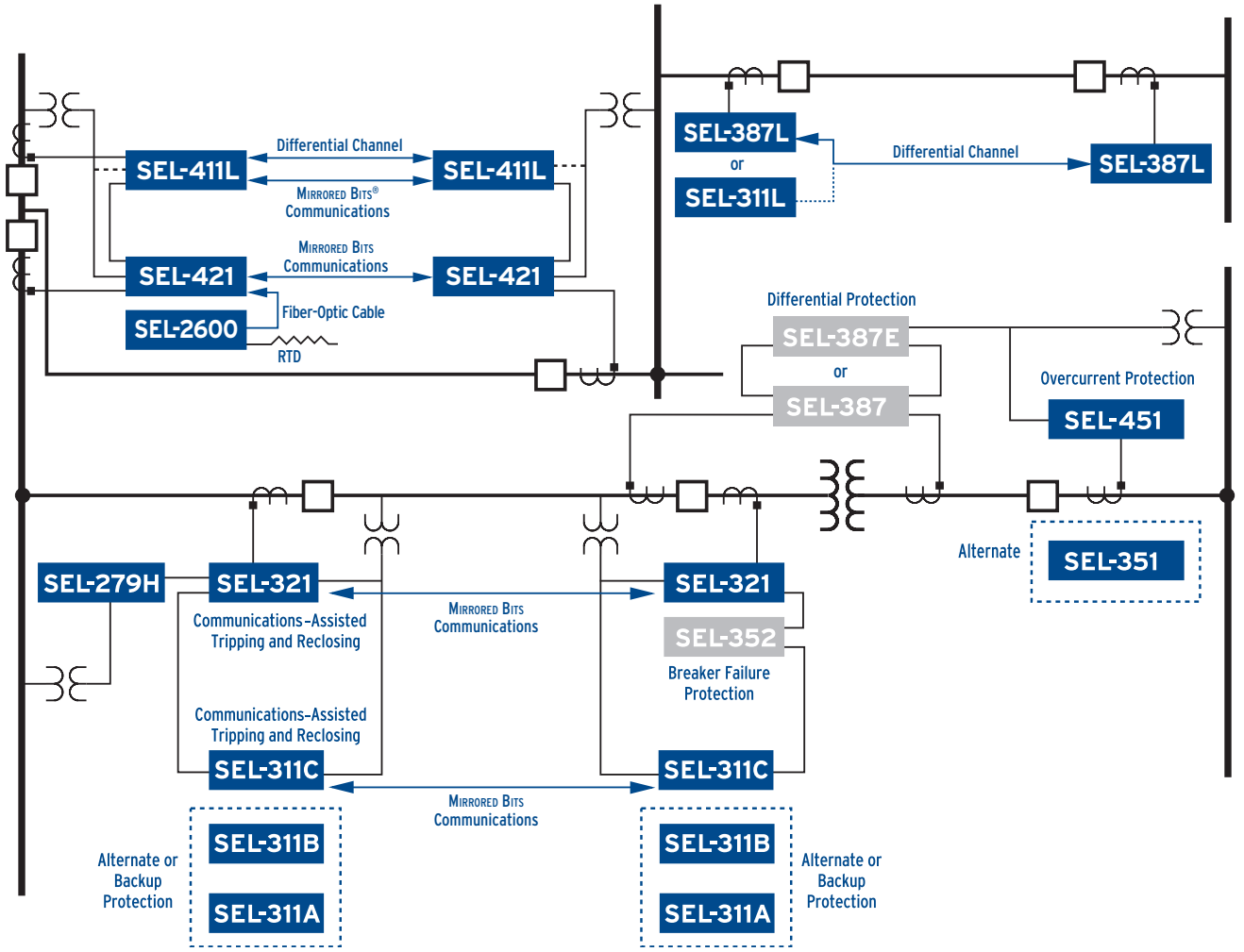
AC motor protection presents a unique challenge to facility, maintenance, and protection engineers. Comprehensive motor protection requires knowledge of all the characteristics of the motor in operation. AC motors, induction or synchronous, require electrical, mechanical, and thermal models to determine the motor characteristics to provide optimized thermal and fault protection. Written for the professional engineer, all of the steps necessary to develop this vital information are included in this concise handbook.

- List price: $34.95
- Order online! **www.selinc.com/bookstore**

GSA Schedule Contract: GS-07F-0123N



Transmission and Subtransmission Applications



Transmission Product Index

Transmission Features

Transmission Line Protection

	SEL-411L	SEL-421	SEL-311A	SEL-311B	SEL-311C	SEL-311L	SEL-387L	SEL-311M	SEL-321	SEL-451	SEL-351
APPLICATIONS											
Distance Protection	•	•	•	•	•	•			•		
Breaker Failure Protection	•	•	*f*	*f*	*f*	*f*		*f*	*f*	•	*f*
Automatic Reclosing	•	•		•	•	•			*f*	•	•
Synchronism Check	•	•		•	•	•		•		•	•
Undervoltage Load Shedding	•	*f*		*f*	*f*	*f*		*f*	*f*	*f*	*f*
Line Current Differential	•					•	•	•			
Synchrophasors	•	•	•	•	•	•				•	•
PROTECTION											
21G Mho Ground Distance	•	•	•	•	•	•			•		
21XG Quad Ground Distance	•	•			•	•			•		
21P Mho Phase Distance	•	•	•	•	•	•			•		
27 Undervoltage	•	*f*		•	•	•		•	•	*f*	•
49 Thermal	*f*	*f*								*f*	
50N/G Ground - O/C	•	•	•	•	•	•		•	•	•	•
50P Phase - O/C	•	•	•	•	•	•		•	•	•	•
50Q Negative-Sequence - O/C	•	•		•	•	•		•	•	•	•
51N/G Ground Time - O/C	•	•	•	•	•	•		•	•	•	•
51P Phase Time - O/C	•	•	•	•	•	•		•	•	•	•
51Q Negative-Sequence Time - O/C	•	•		•	•	•		•	•	•	•
59 Overvoltage	•	*f*		•	•	•		•	•	*f*	•
67N/G Ground Directional - O/C	•	•	•	•	•	•		•	•	•	•
67P Phase Directional - O/C	•	•	•	•	•	•		•		•	•
67Q Negative-Sequence Directional - O/C	•	•		•	•	•		•	•	•	•
87L Line Current Differential	•					•	•	•			
Sensitive Earth Fault (SEF)								•			*
Programmable Analog Math	•	•								•	
Out-of-Step Block and Trip	•	•			•	•			•		
Load-Encroachment Supervision	•	•	•	•	•	•		•	•	•	•
Switch-Onto-Fault	•	•	•	•	•	•		•	•	•	•
Single-Pole Trip	•	•			*	*			•		
Mirrored Bits® Communications	•	•	•	•	•	•		•	•	•	•
Zone/Level Timers	•	•	•	•	•	•		•	•	•	•
Pilot Protection Logic	•	•			•	•		•	•	•	•
INSTRUMENTATION AND CONTROL											
79 Automatic Reclosing	•	•	*f*	•	•	•			*f*	•	•
Number of Controlled Breakers	2	2	1	1	1	1	1	1	1	2	1
Fault Locating	•	•	•	•	•	•			•	•	•
SELogic® Control Equations	•	•	•	•	•	•		•	•	•	•
25 Synchronism Check	•	•		•	•	•		•		•	•
81 Underfrequency/Overfrequency	•	•			•	•		•		*f*	•
Nonvolatile Latch Control Switches	•	•	•	•	•	•		•		•	•
Remote Control Switches	•	•	•	•	•	•		•	•	•	•
Local Control Switches	•	•	*	*	*	•		•		•	•
Display Points	•	•	*	*	*	•		•		•	•
Advanced Mirrored Bits Communications	•	•								•	
Substation Battery Monitor	•	•	•	•	•	•	•	•		•	•
Breaker Wear Monitor	•	•	•	•	•	•		•		•	•
Trip Coil Monitor	*f*	*f*	*f*	*f*	*f*	*f*		*f*	•	*f*	*f*
Event Report (Multicycle Data)	•	•	•	•	•	•	•	•	•	•	•
Sequential Events Recorder	•	•	•	•	•	•	•	•	*	•	•
Instantaneous Meter	•	•	•	•	•	•	•	•	•	•	•
DNP3 Level 2 Outstation	•	•	*	*	•	*	*		*	•	•
IEC 61850 Communications		*			*	*				*	
Synchrophasors (SEL Format)		•	•	•	•	•				•	
Synchrophasors (IEEE C37.118 Format)	•	•			•					•	•
MISCELLANEOUS FEATURES											
Accepts Delta Voltage Transformers					•						•
Connectorized® (Quick Disconnect) Available		*	*	*	*				*	*	*
Configurable Labels		•								•	*

• *Standard Feature* * *Model Option* *f* *This function may be created using settings*

SEL-421 Protection, Automation, and Control System

Apply innovative line protection as part of a comprehensive station automation package.

SEL IEC 61850

SEL Synchrophasors™

Key Features

High-Speed Operation for Critical Systems

CCVT transient detection prevents overreaching. High-speed quadrilateral and mho distance and directional elements provide subcycle operating times to improve system stability.

Thermal Overload Protection

Use the SEL-421 with an SEL-2600 RTD Module for dynamic overload protection using SELOGIC® control equations.

Complete Reclosing System With Synchronism Check for Two Breakers

Logic and settings are included for control of two circuit breakers. Settable voltage inputs provide for flexible operation.

High-Speed Breaker Failure Detection for Two Breakers

Open-pole detection in less than 5/8 cycle allows the use of shorter breaker failure margin times. Independent current inputs provide protection for two circuit breakers.

Synchrophasor Measurements to Increase Asset Utilization

Validate system load flow and fault models using instantaneous voltage angles. Use system-state measurements to increase stable system loading through reduced margin requirements. Use IEEE C37.118 format with 1–60 messages per second or SEL Fast Message format for interleaved communications. Apply direct relay-to-relay synchrophasors for wide-area-based control without additional devices.

Advanced MIRRORED BITS® Communications

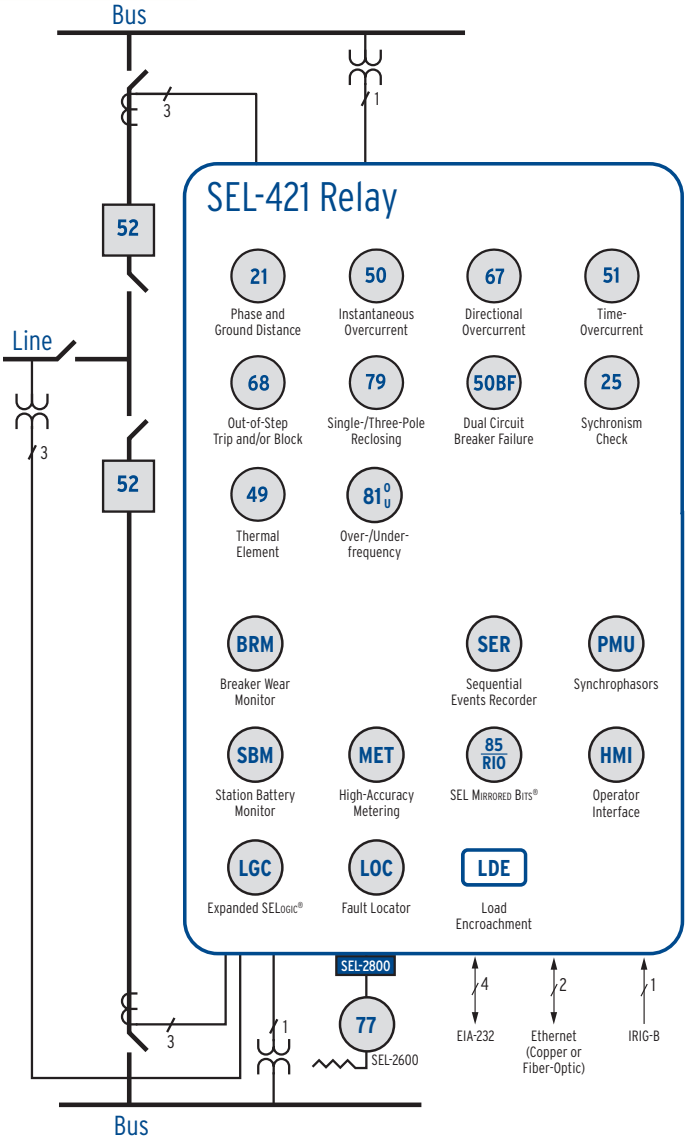
Transmit digital, analog, and virtual terminal information over the same digital communications channel.

True Digital Fault Recorder (DFR) Functionality

Use binary COMTRADE event reports sampled at 8 kHz directly from the relay, without expensive auxiliary equipment.

Graphical Logic Editor (GLE)

Simplify the SEL-421 configuration process with the GLE in ACSELERATOR QuickSet Designer® SEL-5031 Software. The GLE lets you design your SELOGIC® control equations graphically, so your settings files can be documented for easier validation and commissioning. Convert existing control equations to easy-to-read diagrams, and save with QuickSet settings.



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SEL-421 Protection, Automation, and Control System

Applications

- Use high-speed single- or three-pole distance protection for critical transmission lines.
- Simplify out-of-step detection by using the zero-setting out-of-step element.
- Apply complete bay control, reclosing, and breaker failure protection for two breakers.
- Connect to Ethernet networks to simplify and speed information distribution.
- View synchronous phasors from any location with an SEL-421 to measure the system state. Use 1–60 messages per second in high-accuracy IEEE C37.118 data format.
- Control generators or shed loads using synchrophasors directly from another SEL-421 Protection, Automation, and Control System.
- Monitor circuit breaker performance, including average and last tripping time, compressor run time, and contact-interrupting duty.
- Use expanded SELOGIC control equations for custom applications, such as capacitor voltage differential, voltage-restrained overcurrent, or thermal emulation of transmission lines.
- Combine the DFR functions of the SEL-421 with ACSELERATOR Report Server® SEL-5040 Software to view system-wide events. High-accuracy timing makes report comparisons easy and accurate.
- Provide thermal overload protection.*

  * Connect to an SEL-2600 RTD Module using a fiber-optic transceiver.

Optional Features

- Subcycle elements, series-compensated line application, added automation logic.
- Vertical or horizontal, panel-mount or rack-mount hardware package.
- Additional inputs/outputs (settable or level-sensitive, optoisolated).
- Ethernet communications.*
- DNP3 LAN/WAN.
- IEC 61850 communications.
- Connectorized® hardware configuration.
- Additional control pushbuttons and LEDs.
- Two direct-acting pushbuttons.
- Conformal coating.

  * Eye-safe, Class 1 LED product per EN 60825-1

Hardware Specifications

AC Voltage Inputs (6 total)

300 V_{L-N} continuous, 600 Vac for 10 seconds

Burden 0.03 A @ 67 V; 0.06 VA @ 120 V

AC Current Inputs (6 total)

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical, 1250 A for 1 cycle

Burden 0.27 VA @ 5 A; 2.51 VA @ 15 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical, 250 A for 1 cycle

Burden 0.13 VA @ 1 A; 1.31 VA @ 3 A

Power Supply Ratings

125/250 Vdc or Vac

Range 85–300 Vdc or 85–264 Vac

48/125 Vdc or 125 Vac

Range 38–140 Vdc or 85–140 Vac

24/48 Vdc

Range 18–60 Vdc

Standard Input/Output

3 high-interrupt outputs

2 standard speed Form A outputs

3 standard speed Form C outputs

7 digital inputs

Operating Temperature

–40° to +85°C (–40° to +185°F)

(Note: LCD contrast impaired for temperatures below –20°C)

Price

Budgetary Retail, Quantity 1: $6,930

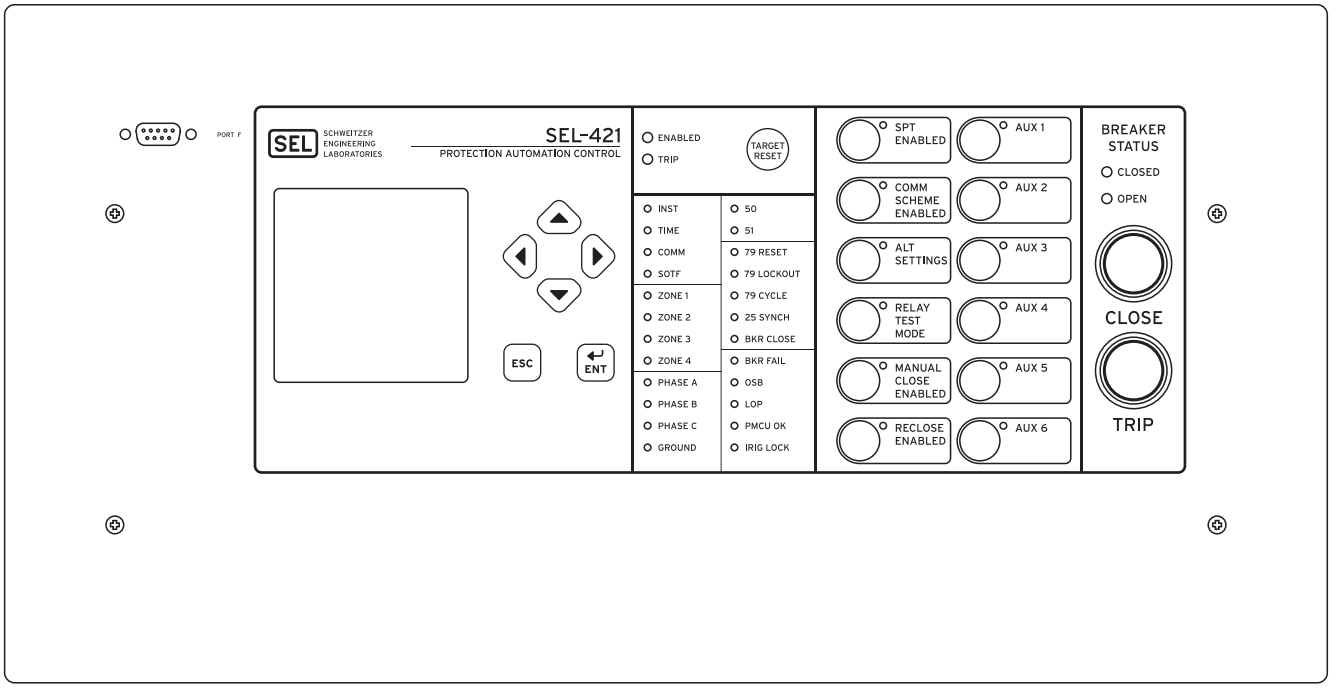
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

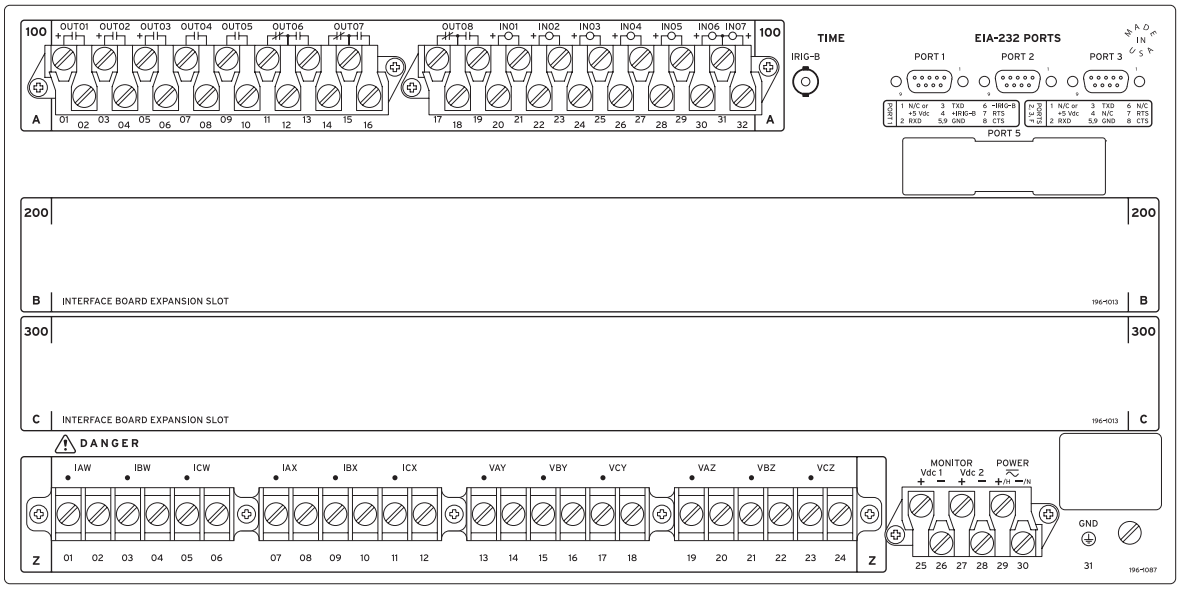
SEL-421 Protection, Automation, and Control System

Front View - Panel-Mount



i4091a

Rear View – With Space for Additional I/O Boards (5U)



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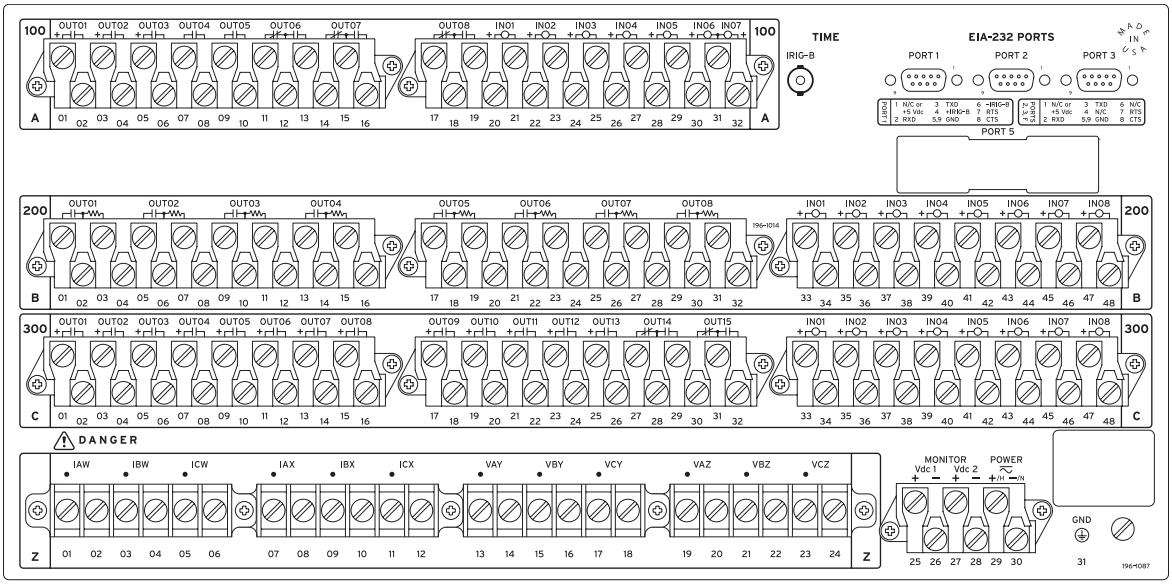
SEL-421 Protection, Automation, and Control System

Rear View – Conventional Terminal Blocks - Two Additional I/O (5U)



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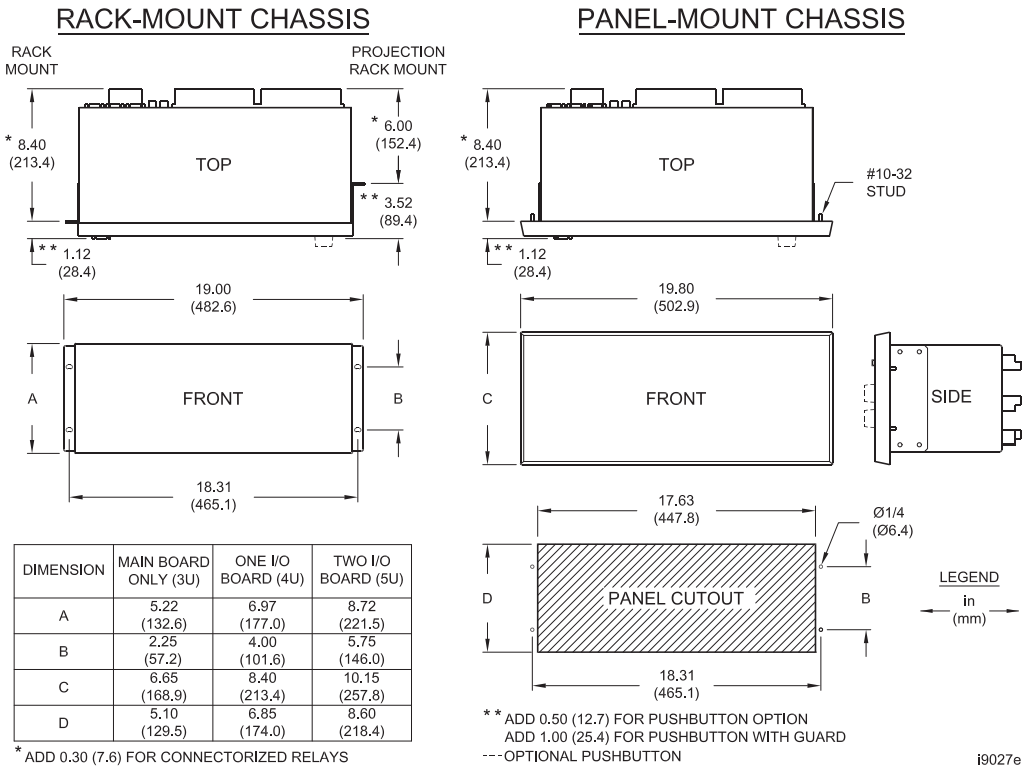
Dimensions



DIMENSION	MAIN BOARD ONLY (3U)	ONE I/O BOARD (4U)	TWO I/O BOARD (5U)
A	5.22 (132.6)	6.97 (177.0)	8.72 (221.5)
B	2.25 (57.2)	4.00 (101.6)	5.75 (146.0)
C	6.65 (168.9)	8.40 (213.4)	10.15 (257.8)
D	5.10 (129.5)	6.85 (174.0)	8.60 (218.4)

* ADD 0.30 (7.6) FOR CONNECTORIZED RELAYS

i9027e

Visit www.selinc.com for more detailed information and configuration options.

SEL-411L Line Current Differential Protection, Automation, and Control System

Apply innovative line current differential protection as part of a comprehensive station automation package.

Key Features

High-Speed and Security in Line Differential Protection

Differential elements provide subcycle operating times to improve system stability. Line charging current compensation provides an accurate response for long or short lines. Apply the proven Alpha Plane operating principle for reliable and secure operation. Multiterminal lines and transformers in the differential zone are protected.

Reliable Backup Protection

Complete distance and directional elements provide backup protection in case the differential communications channel is lost. All the features of the SEL-421 line protection relay are included in addition to the differential protection.

Complete Reclosing System With Synchronism Check and High-Speed Breaker Failure Detection for Two Breakers

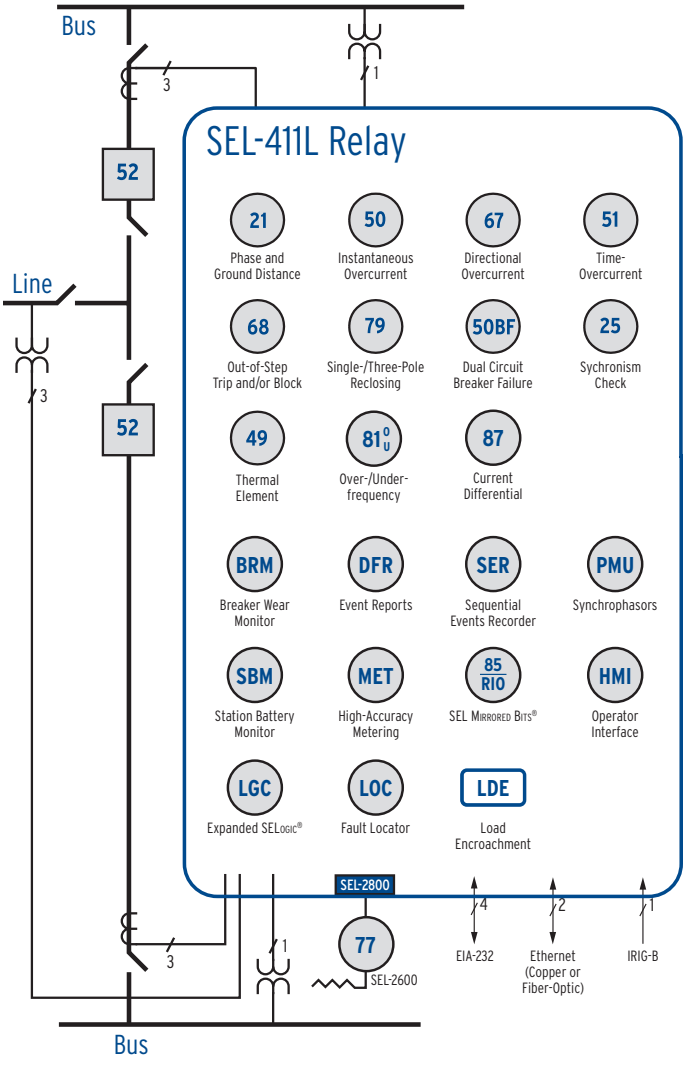
Dual CT and VT input logic and settings are included for control of two circuit breakers. Settable voltage inputs provide flexible operation. Open-pole detection in less than 5/8 cycle allows the use of shorter breaker failure margin times. Independent current inputs provide protection for two circuit breakers.

Synchrophasor Measurements to Increase Asset Utilization

Validate system load flow and fault models using instantaneous voltage angles. Use system-state measurements to increase stable system loading through reduced margin requirements. Use IEEE C37.118 format with 1–60 messages per second or SEL Fast Message format for interleaved communications. Apply direct relay-to-relay synchrophasors for wide-area-based control without additional devices.

True Digital Fault Recorder (DFR) Functionality

Use binary COMTRADE event reports sampled at 8 kHz directly from the relay without expensive auxiliary equipment.



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SEL-411L Line Current Differential Protection, Automation, and Control System

Applications

- Use high-speed single- or three-pole line current differential with distance protection backup for critical transmission lines.
- Connect to serial or Ethernet networks for differential communications.
- Apply complete bay control, reclosing, and breaker failure protection for two breakers.
- View synchrophasors from any location with an SEL-411L to measure the system state. Use 1–60 messages per second in high-accuracy IEEE C37.118 data format.
- Control generators or shed loads using synchrophasors directly from another device with IEEE C37.118 synchrophasors.
- Monitor circuit breaker performance, including average and last tripping time, compressor run time, and contact-interrupting duty.
- Use expanded SELOGIC® control equations for custom applications, such as capacitor voltage differential, voltage-restrained overcurrent, or thermal emulation of transmission lines.
- Combine the DFR functions of the SEL-411L with SEL software to view system-wide events with microsecond timing accuracy.
- Provide thermal overload protection.*

* Connect to an SEL-2600 RTD Module using a fiber-optic transceiver.

Optional Features

- Subcycle distance and directional elements suitable for series-compensated lines.
- Conformal coated circuit boards.
- Ethernet communications.
- IEC 61850 communications.
- Channel interface:
  - Isolated EIA-422
  - Isolated ITU-T G.703
  - 850 nm or 1300 nm fiber, IEEE C37.94 encoding*
  - 1300 nm single- or multimode fiber*
  - 1550 nm single-mode fiber*
- One or two channels.
- Vertical or horizontal, panel-mount or rack-mount hardware package.
- Inputs/outputs (settable or level-sensitive, optoisolated).

* Connect to an SEL-2600 RTD Module using a fiber-optic transceiver.

Hardware Specifications

AC Voltage Inputs (6 total)

300 V_{L-N} continuous, 600 Vac for 10 seconds

Burden 0.03 A @ 67 V; 0.06 VA @ 120 V

AC Current Inputs (6 total)

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical, 1250 A for 1 cycle

Burden 0.27 VA @ 5 A; 2.51 VA @ 15 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical, 250 A for 1 cycle

Burden 0.13 VA @ 1 A; 1.31 VA @ 3 A

Power Supply Ratings

125/250 Vdc or Vac

Range 85–300 Vdc or 85–264 Vac

48/125 Vdc or 125 Vac

Range 38–140 Vdc or 85–140 Vac

24/48 Vdc

Range 18–60 Vdc

Operating Temperature

–40° to +85°C (–40° to +185°F)

(Note: LCD contrast impaired for temperatures below –20°C)

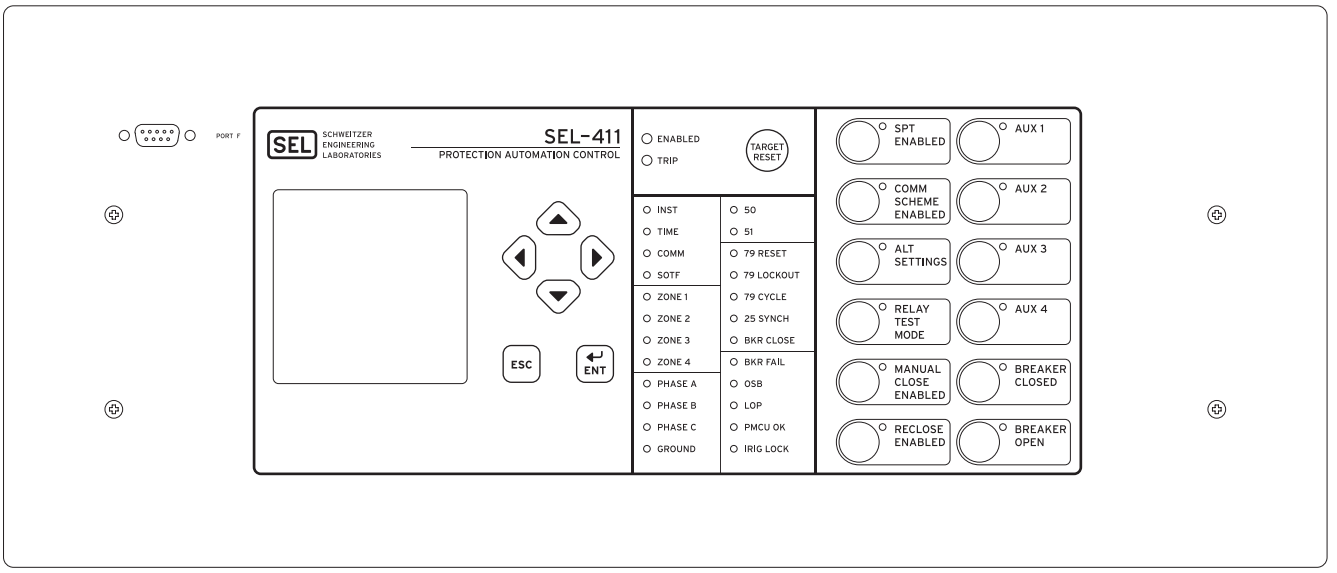
Price

Budgetary Retail, Quantity 1: Contact factory for pricing.

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

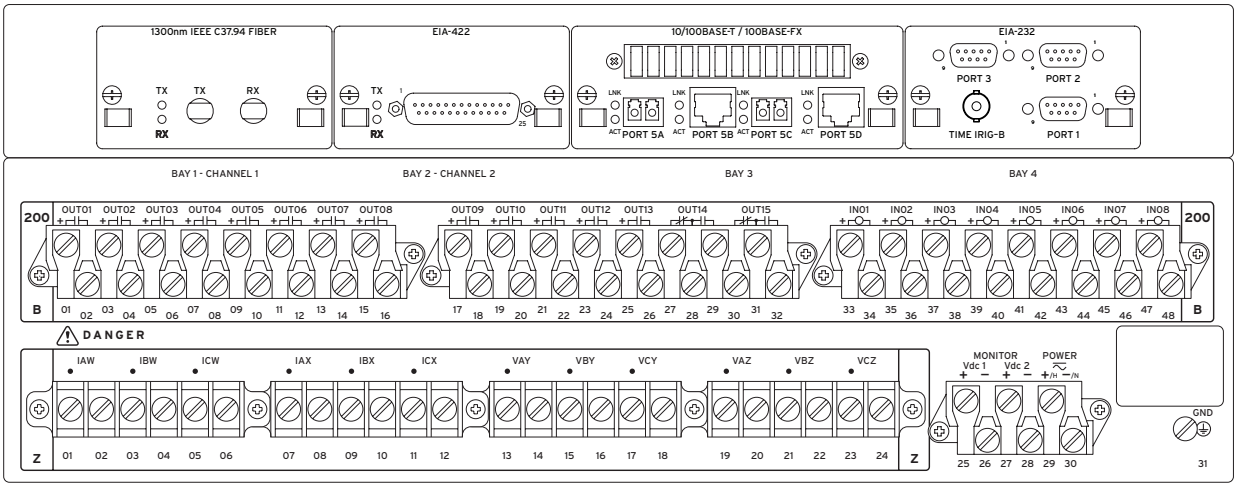
SEL-411L Line Current Differential Protection, Automation, and Control System

Front View - Panel-Mount (5U)



i5036a

Rear View - With I/O Board (4U)



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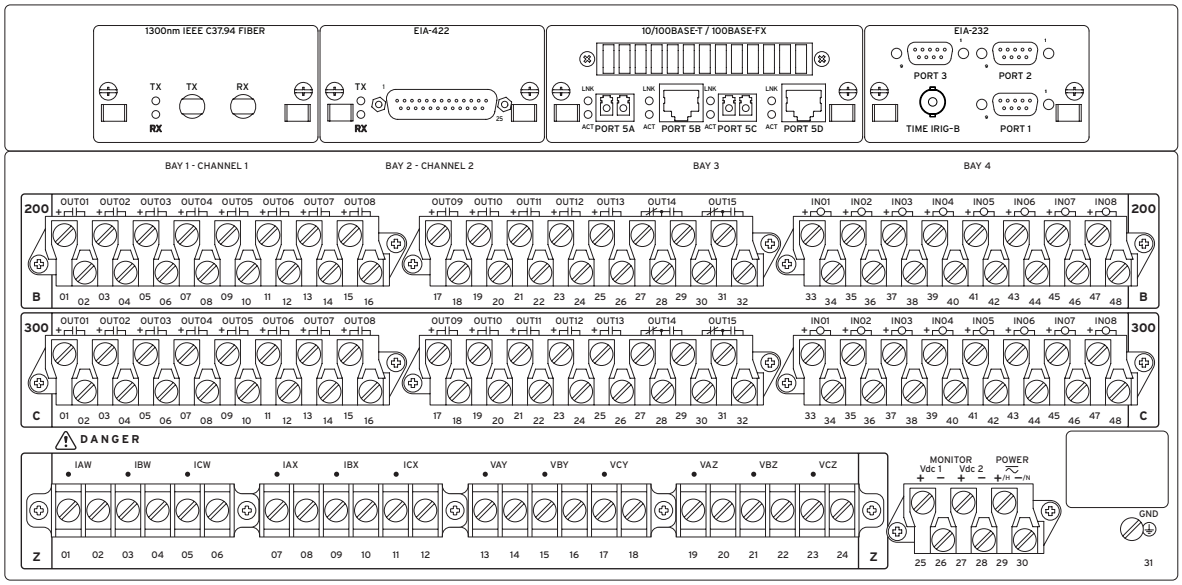
SEL-411L Line Current Differential Protection, Automation, and Control System

Rear View – Conventional Terminal Blocks - Two I/O Boards (5U)



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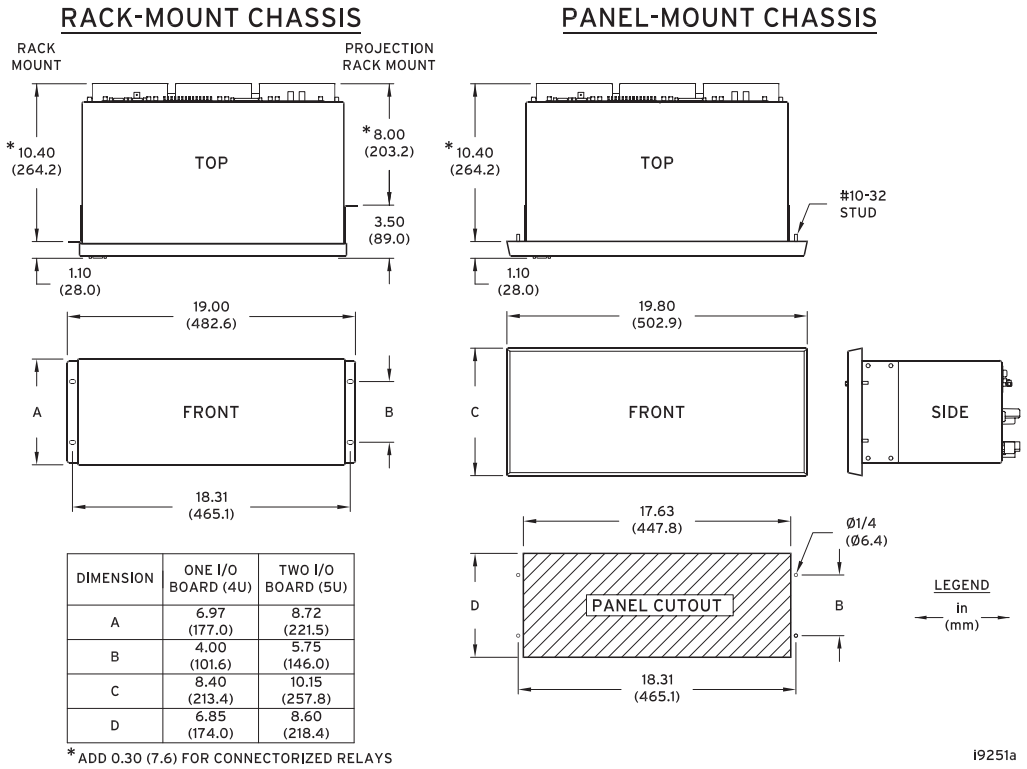
Dimensions



DIMENSION	ONE I/O BOARD (4U)	TWO I/O BOARD (5U)
A	6.97 (177.0)	8.72 (221.5)
B	4.00 (101.6)	5.75 (146.0)
C	8.40 (213.4)	10.15 (257.8)
D	6.85 (174.0)	8.60 (218.4)

* ADD 0.30 (7.6) FOR CONNECTORIZED RELAYS

i9251a

Visit www.selinc.com for more detailed information and configuration options.

SEL-311A Phase and Ground Distance Relay

Implement backup distance protection at very low cost with the SEL-311A Relay.

SEL Synchrophasors™

Key Features

Simple and Economical Line Protection

Two forward-looking zones of phase and ground mho distance elements provide simple and economical distance protection. Phase and ground inverse-time and definite-time overcurrent elements supply backup protection.

Innovative Logic for Secure and Stable Operation

CCVT transient detection logic prevents Zone 1 overreach. Positive-sequence memory voltage polarization provides dependable, secure operation for close-in faults by expanding the mho operating characteristics in proportion to the source impedance. Employ Best Choice Ground Directional Element® logic for adaptive ground fault directional polarization, and use compensator distance setting for accurate phase distance reach through a delta-wye transformer.

Monitoring and Metering

Improve analysis and equipment management with event reports, Sequential Events Recorder (SER), circuit breaker contact wear monitor, substation battery monitor, and instantaneous and demand metering. Simplify operator interface with programmable rotating display showing system status with numerical and text messages.

Communications

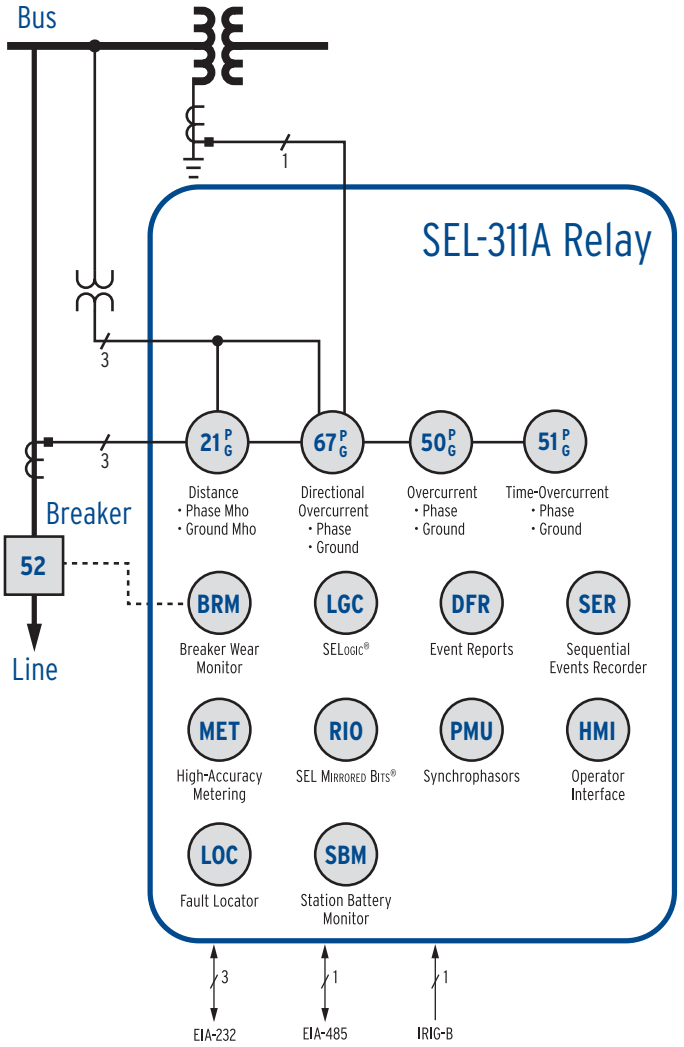
EIA-232 and EIA-485 serial ports allow local/remote access and system integration. Mirrored Bits® communications provides eight channels of secure relay-to-relay logic communication available on all communications ports.

Advanced Protection and Control Logic

SELogic® control equations with 16 SELogic variables, 16 timers, 16 latch bits, and 16 remote control elements allow customization of advanced protection and control schemes. Apply 16 local control elements and 16 programmable display points with optional front-panel LCD and operator pushbuttons.

Synchrophasor Measurements to Increase Asset Utilization

Validate system load flow and fault models using instantaneous voltage angles. Use system-state measurements to increase stable system loading through reduced margin requirements. Send synchrophasor data at rates of up to 60 messages per minute, using SEL Fast Messages, to communications processors and phasor data concentrators.



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SEL-311A Phase and Ground Distance Relay

Applications

- Implement wire-alike and application settings upgrades for popular SEL-2PG10 distance relay applications.
- Use step distance protection for primary and backup three-pole tripping on non-series-compensated transmission and subtransmission lines.
- Use compensator distance setting for accurate phase distance reach through a delta-wye transformer.
- Use accurate fault locator to efficiently dispatch line inspection and repair personnel.
- Program breaker failure logic with SELOGIC control equations.
- Back up transformer and generator protection with zone distance and overcurrent elements.
- Schedule as-needed circuit breaker maintenance, and send alarms when the breaker wear monitor detects excess breaker contact wear from the number of operations and magnitude of interrupted current.
- Alarm for low-voltage conditions on station battery.
- Transmit synchrophasor data to SEL-3306 Synchrophasor Processors or to a computer running SEL-5077 SYNCHROWAVE® Server Software for use in wide-area control and measurement systems.

Optional Features

- Vertical panel-mount or rack-mount hardware package.
- Horizontal panel-mount or rack-mount hardware package.
- Projection panel mounting.
- Liquid crystal display and operator pushbuttons (2U vertical package not available with LCD or operator pushbuttons).
- DNP3 Level 2 Outstation communications protocol.
- Connectorized® hardware configuration.
- Conformal coating.

Hardware Specifications

AC Voltage Inputs

67 V_{L-N} nominal, three-phase, four-wire connection

150 V_{L-N} continuous, 365 Vac for 10 seconds

Burden 0.13 VA @ 67 V; 0.45 VA @ 120 V

AC Current Inputs

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical, 1250 A for 1 cycle

Burden 0.27 VA @ 5 A; 2.51 VA @ 15 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical, 250 A for 1 cycle

Burden 0.13 VA @ 1 A; 1.31 VA @ 3 A

Power Supply Ratings

24/48 V 20–60 Vdc

125/250 V 85–350 Vdc

85–264 Vac

15 W maximum for all supplies

Standard Control Input and Output Ranges

24, 48, 110, 125, or 250 Vdc

Standard configuration provides 6 inputs and 8 outputs, <5 ms pickup/dropout times with 30 A make, 6 A continuous duty

Operating Temperature

–40° to +85°C (–40° to +185°F)

(Note: LCD contrast impaired for temperatures below –20°C)

Price

Budgetary Retail, Quantity 1: $1,890

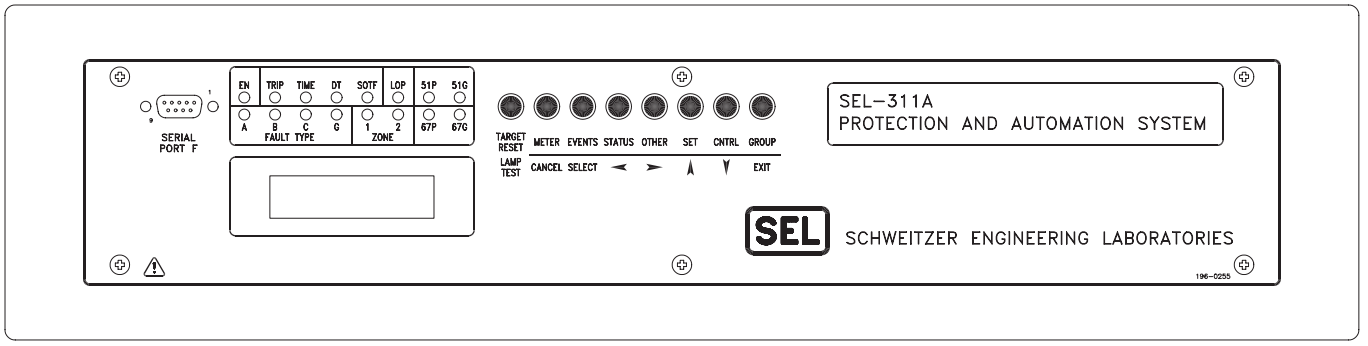
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

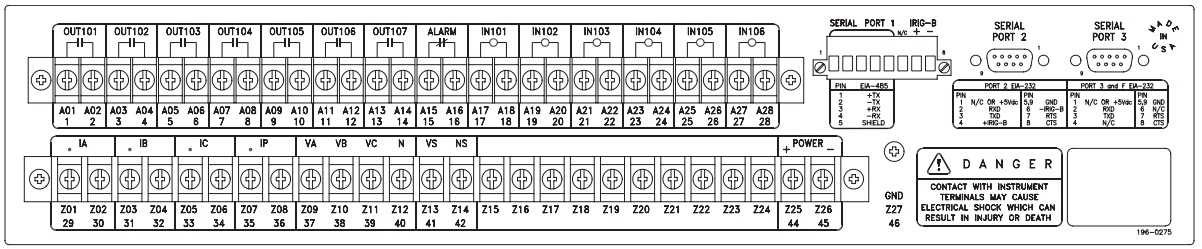
SEL-311A Phase and Ground Distance Relay

Front View – Panel-Mount



13067a

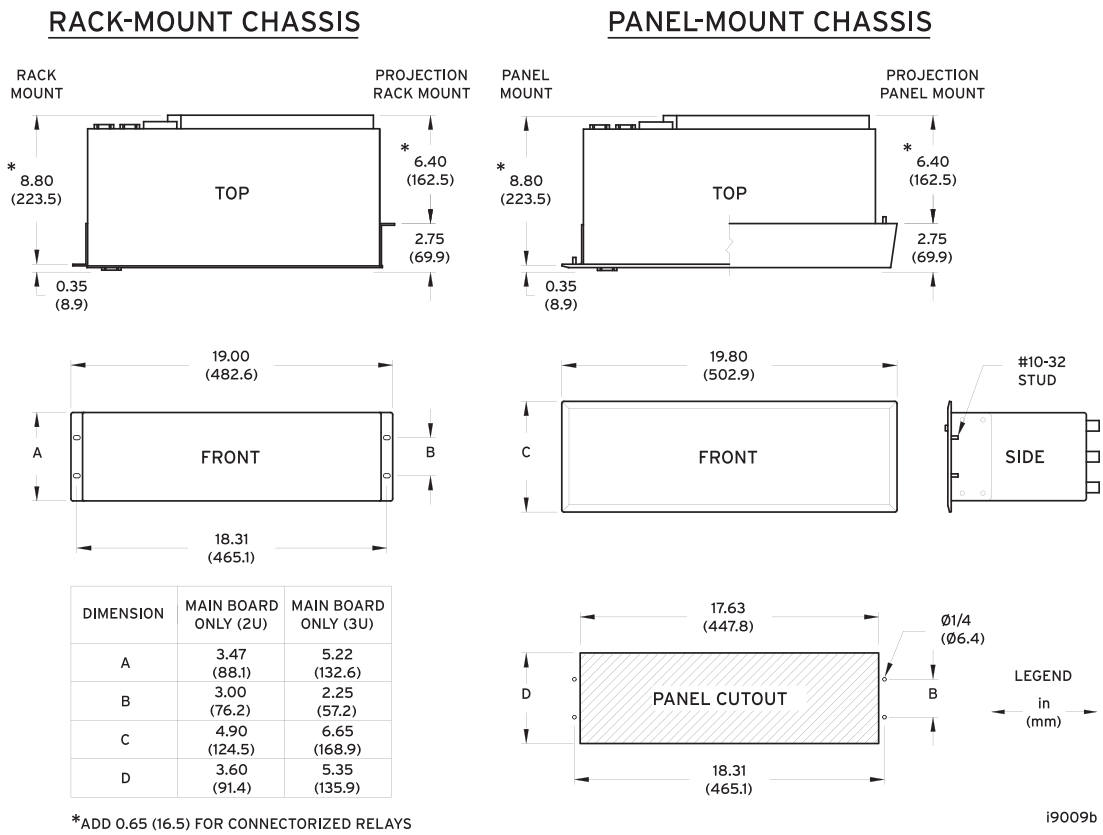
Rear View – Conventional Terminal Blocks (2U)



13069b

SEL-311A Phase and Ground Distance Relay

Dimensions



DIMENSION	MAIN BOARD ONLY (2U)	MAIN BOARD ONLY (3U)
A	3.47 (88.1)	5.22 (132.6)
B	3.00 (76.2)	2.25 (57.2)
C	4.90 (124.5)	6.65 (168.9)
D	3.60 (91.4)	5.35 (135.9)

*ADD 0.65 (16.5) FOR CONNECTORIZED RELAYS

Visit www.selinc.com for more detailed information and configuration options.

SEL-311B Distance Relay With Recloser

Create step distance protection using the SEL-311B Relay with four-shot reclosing and synchronism check elements.

SEL Synchrophasors™

Key Features

Basic Standalone Line Protection

Three zones of phase and ground mho distance elements, including one reversible and two forward zones, provide reliable distance protection. Flexible protection includes two forward plus one reversible definite-time directional negative-sequence and residual ground overcurrent elements as well as Zone 1 extension logic.

Innovative Logic for Secure and Stable Operation

CCVT transient detection logic prevents Zone 1 overreach. Positive-sequence memory voltage phase directional polarization provides three-phase fault directional security. Employ Best Choice Ground Directional Element® logic for adaptive ground fault directional polarization. Load-encroachment logic improves security during heavy loads. Use compensator distance setting for accurate phase distance reach through a delta-wye transformer.

Monitoring and Metering

Retrieve data with event reports, Sequential Events Recorder (SER), circuit breaker contact wear monitor, substation battery monitor, instantaneous and demand metering, and optional local display panel. Simplify operator interface with programmable rotating display showing system status with numerical and text messages.

Reclosing

Restore service following transient faults using programmable four-shot breaker autoreclose with synchronism and voltage check logic.

Communications

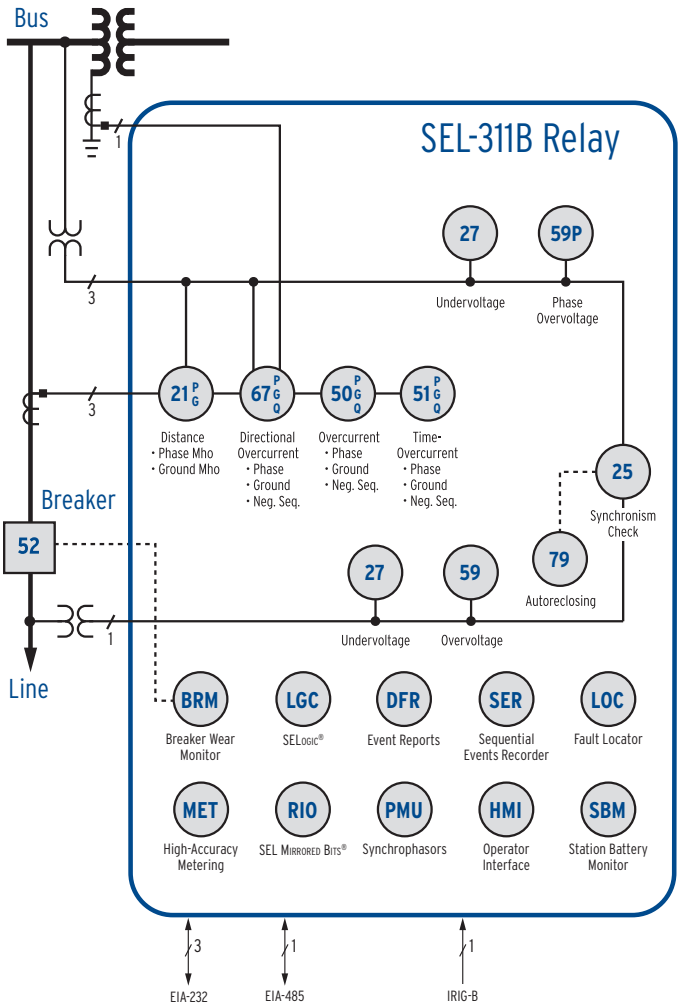
EIA-232 and EIA-485 serial ports allow local/remote access and system integration. Mirrored Bits® communications provides eight channels of secure relay-to-relay logic communication available on all communications ports.

Advanced Protection and Control Logic

SELogic® control equations with 16 SELogic variables, 16 timers, 16 latch bits, and 16 remote control elements allow customization of advanced protection and control schemes. Apply 16 local control elements and 16 programmable display points with optional front-panel LCD and operator pushbuttons. Includes phase under- and overvoltage elements.

Synchrophasor Measurements to Increase Asset Utilization

Validate system load flow and fault models using instantaneous voltage angles. Use system-state measurements to increase stable system loading through reduced margin requirements. Send synchrophasor data at rates of up to 60 messages per minute, using SEL Fast Messages, to communications processors and phasor data concentrators.



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SEL-311B Distance Relay With Recloser

Applications

- Implement wire-alike and application settings upgrades for popular SEL-221-16, SEL-221C, SEL-221F, and SEL-221F-3 distance relay applications.
- Use step distance protection for primary and backup three-pole tripping on non-series-compensated transmission and subtransmission lines.
- Use compensator distance setting for accurate phase distance reach through a delta-wye transformer.
- Program up to four shots of automatic breaker reclosing with synchronism and voltage checks to optimize system restoration.
- Use the built-in fault locator to efficiently dispatch line inspection and repair personnel.
- Program breaker failure logic with SELOGIC control equations.
- Back up transformer and generator protection with zone distance and overcurrent elements.
- Schedule as-needed circuit breaker maintenance, and send alarms when the breaker wear monitor detects excess breaker contact wear from the number of operations and magnitude of interrupted current.
- Alarm for low-voltage conditions on station battery.
- Transmit synchrophasor data to SEL-3306 Synchrophasor Processors or to a computer running SEL-5077 SYNCHROWAVE® Server Software for use in wide-area control and measurement systems.

Optional Features

- Vertical panel-mount or rack-mount hardware package.
- Horizontal panel-mount or rack-mount hardware package.
- Projection panel mounting.
- Liquid crystal display and operator pushbuttons (2U vertical package not available with LCD or operator pushbuttons).
- DNP3 Level 2 Outstation communications protocol.
- Connectorized® hardware configuration.
- Conformal coating.

Hardware Specifications

AC Voltage Inputs

67 V_{L-N} nominal, three-phase, four-wire connection

150 V_{L-N} continuous, 365 Vac for 10 seconds

Burden 0.13 VA @ 67 V; 0.45 VA @ 120 V

AC Current Inputs

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical, 1250 A for 1 cycle

Burden 0.27 VA @ 5 A; 2.51 VA @ 15 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical, 250 A for 1 cycle

Burden 0.13 VA @ 1 A; 1.31 VA @ 3 A

Power Supply Ratings

24/48 V 20–60 Vdc

125/250 V 85–350 Vdc

85–264 Vac

15 W maximum for all supplies

Standard Control Input and Output Ranges

24, 48, 110, 125, or 250 Vdc

Standard configuration provides 6 inputs and 8 outputs,
<5 ms pickup/dropout times with 30 A make, 6 A continuous duty

Operating Temperature

–40° to +85°C (–40° to +185°F)

(Note: LCD contrast impaired for temperatures below –20°C)

Price

Budgetary Retail, Quantity 1: $3,150

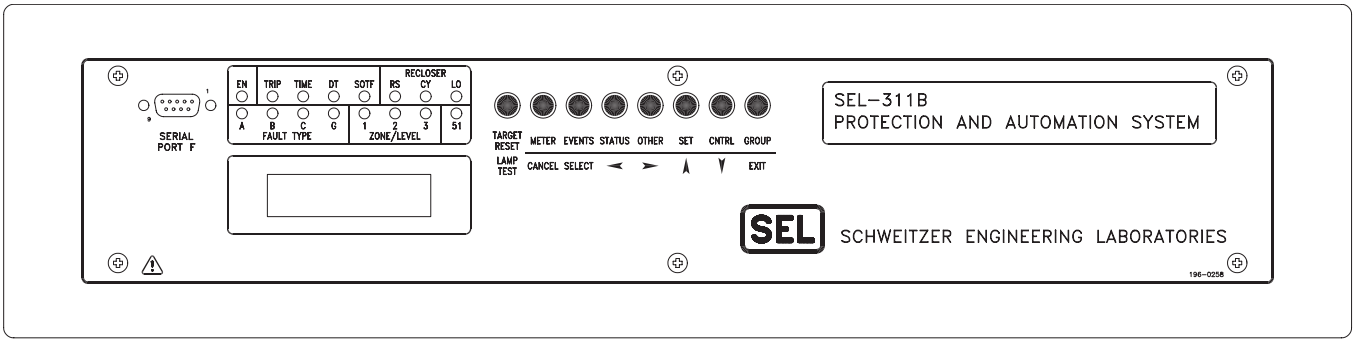
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

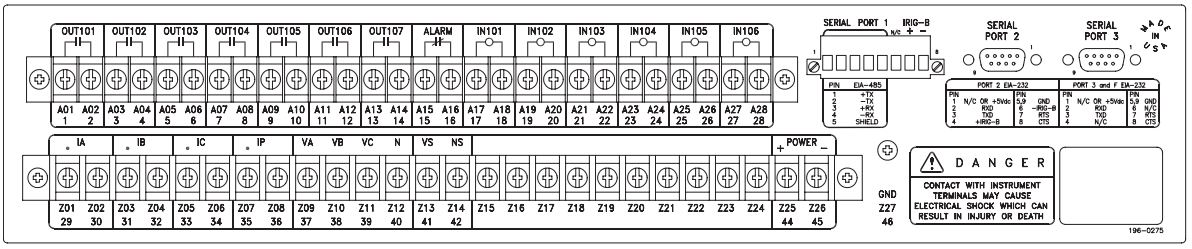
SEL-311B Distance Relay With Recloser

Front View – Panel-Mount



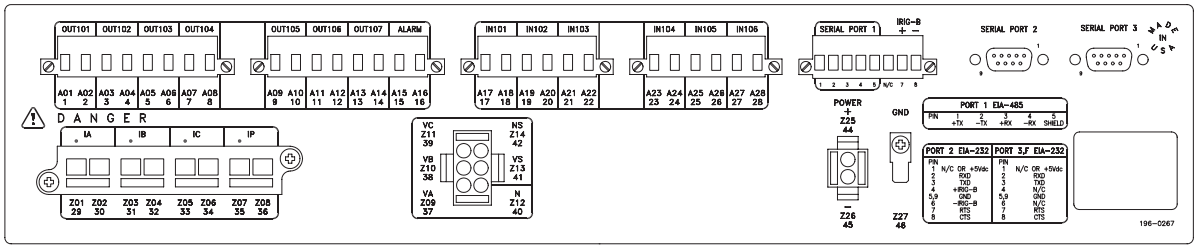
13074a

Rear View – Conventional Terminal Blocks (2U)



13069b

Rear View – Connectorized®

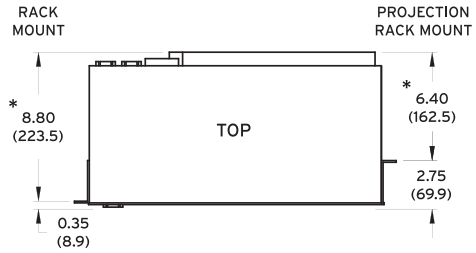


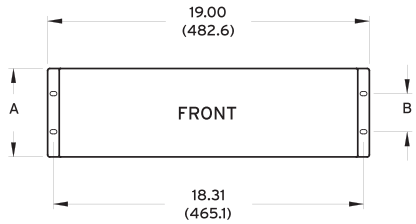
13464b

SEL-311B Distance Relay With Recloser

Dimensions

RACK-MOUNT CHASSIS

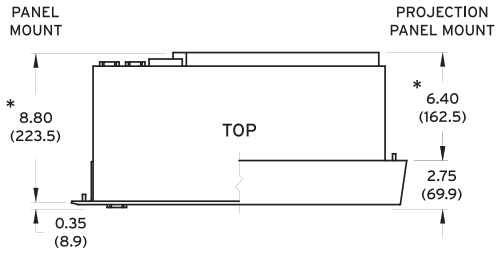


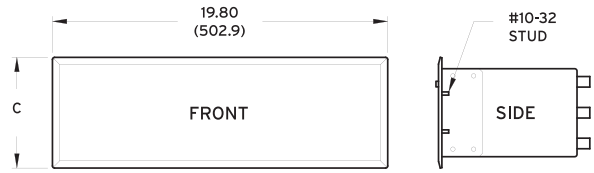


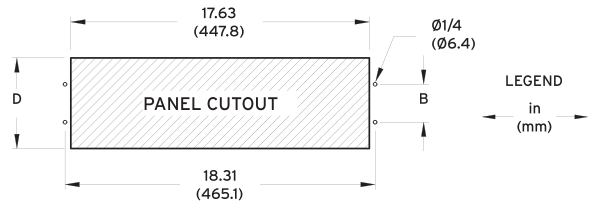
DIMENSION	MAIN BOARD ONLY (2U)	MAIN BOARD ONLY (3U)
A	3.47 (88.1)	5.22 (132.6)
B	3.00 (76.2)	2.25 (57.2)
C	4.90 (124.5)	6.65 (168.9)
D	3.60 (91.4)	5.35 (135.9)

*ADD 0.65 (16.5) FOR CONNECTORIZED RELAYS

PANEL-MOUNT CHASSIS







i9009b

Visit www.selinc.com for more detailed information and configuration options.

SEL-311C Distance Relay With Recloser

Shown with configurable labels.

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

SEL Synchrophasors™

Key Features

Complete Line Protection

Four zones of phase and ground mho elements plus four zones of ground distance quadrilateral elements, each with two forward and two reversible zone elements, provide reliable distance protection. Includes full pilot scheme logic and Zone 1 extension logic.

Innovative Logic for Secure and Stable Operation

CCVT transient detection logic prevents Zone 1 overreach. Positive sequence memory voltage phase directional polarization provides three-phase fault directional security. Employ Best Choice Ground Directional Element® logic for adaptive ground fault directional polarization. Load-encroachment logic improves security during heavy loads. Use compensator distance setting for accurate phase distance reach through a delta-wye transformer.

Monitoring and Metering

Retrieve data with event reports, Sequential Events Recorder (SER), circuit breaker contact wear monitor, substation battery monitor, instantaneous and demand metering, and optional local display panel. Simplify operator interface with programmable rotating display showing system status with numerical and text messages.

Reclosing

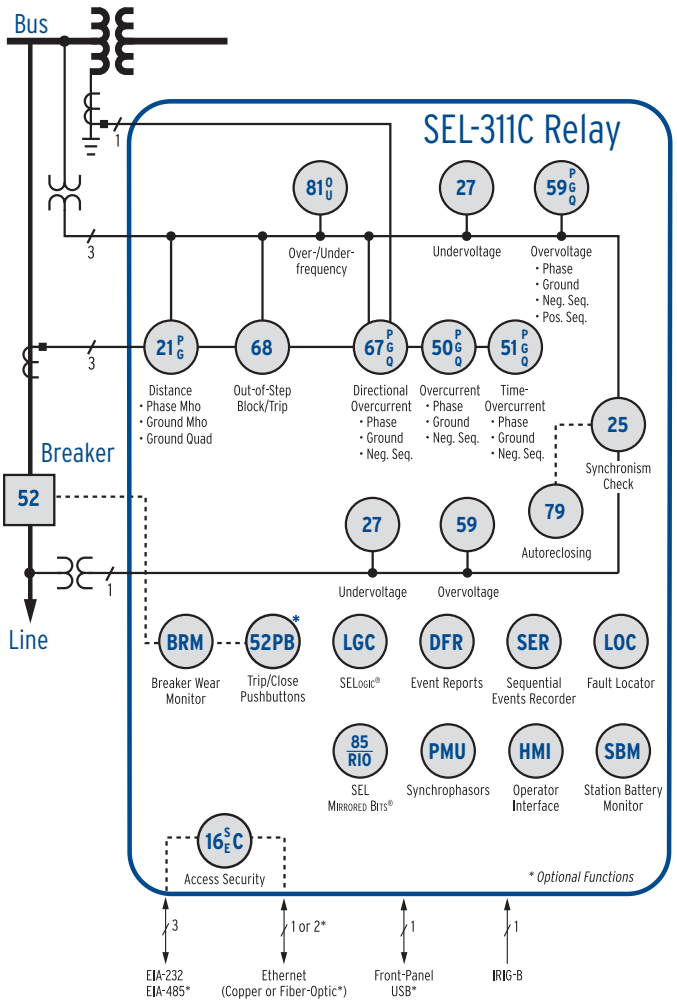
Restore service following transient faults using programmable four-shot breaker autoreclose with synchronism and voltage check logic.

Communications and Automation

Built-in Ethernet communications, EIA-232 serial ports, and available EIA-485 serial port provide easy local/remote access and system integration. The optional front-panel USB port simplifies local connection and speeds relay communication and event retrieval. Apply Mirrored Bits® communications protocol for eight channels of secure relay-to-relay logic communications on both rear-panel EIA-232 serial ports. Programmable relay logic affords increased ability for user-defined automation requirements.

Synchrophasor Measurements to Increase Asset Utilization

Validate system load flow and fault models using instantaneous voltage angles. Use system-state measurements to increase stable system loading through reduced margin requirements. Send synchrophasor data at rates of up to 60 messages per second to information processors and phasor data concentrators.



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SEL-311C Distance Relay With Recloser

Applications

- Protect non-series-compensated transmission and subtransmission lines with complete standalone and pilot relaying.
- Choose from among the many communications-assisted tripping schemes available (POTT, DCUB, DCB, PUTT, DUTT, and DTT), including unique Mirrored Bits communications.
- Use compensator distance settings for accurate phase distance reach through a delta-wye transformer.
- Program up to four shots of automatic breaker reclosing with synchronism and voltage checks to optimize system restoration.
- Apply six frequency elements for load-shedding and restoration schemes.
- Use the built-in fault locator to efficiently dispatch line inspection and repair personnel.
- Program breaker failure logic with SELogic® control equations.
- Schedule as-needed circuit breaker maintenance, and send alarms when the breaker wear monitor detects excess breaker contact wear from the number of operations and magnitude of interrupted current.
- Alarm for low-voltage conditions on station battery.
- Transmit synchrophasor data to IEEE C37.118 compatible phasor data concentrators such as the SEL-3373 Station PDC or SEL-3378 Synchrophasor Vector Processor.

Optional Features

- Single-pole trip with three-pole reclosing.
- Additional I/O board with contact-sensing inputs and standard or high-current interrupting contact outputs.
- Single or dual fiber-optic Ethernet or dual copper Ethernet communications port.
- IEC 61850 communications.
- Conformal coating of printed circuit boards.
- Front-panel USB communications port.
- USB interface, programmable target LEDs, and SafeLock™ Trip/Close pushbuttons.
- Vertical or horizontal, panel-mount or rack-mount hardware package.

Related Products

Fiber-Optic Transceivers.....432–439
SEL-3373 Station Phasor Data Concentrator (PDC).....328
SEL-3530/3530-4 Real-Time Automation Controllers (RTACs).....338
SEL-9220 Fiber-Optic Adapter for SEL-300 Series Relays.....440

Hardware Specifications

AC Voltage Inputs

300 V_{L-N} or V_{L-L} continuous, 600 Vac for 10 seconds (wye or delta)

Burden 0.03 VA @ 67 V; 0.06 VA @ 120 V; 0.8 VA @ 300 V

AC Current Inputs

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical, 1250 A for 1 cycle

Burden 0.27 VA @ 5 A; 2.51 VA @ 15 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical, 250 A for 1 cycle

Burden 0.13 VA @ 1 A; 1.31 VA @ 3 A

Power Supply Ratings

24/48 V supply	18–60 Vdc; <25 W
48/125 V supply	38–200 Vdc or 85–140 Vac; <25 W
125/250 V supply	85–350 Vdc or 85–264 Vac; <25 W

Standard Control Input and Output Ranges

24, 48, 110, 125, 220, or 250 Vdc, level sensitive
(specify voltage at time of order)

Standard configuration provides 6 inputs and 8 outputs, <5 ms pickup/dropout times with 30 A make, 6 A continuous duty.

Additional I/O board may be selected with standard inputs and outputs or with a combination of standard inputs and high-current interrupting outputs.

Operating Temperature

–40° to +85°C (–40° to +185°F)

(Note: LCD contrast impaired for temperatures below –20°C)

Price

Budgetary Retail, Quantity 1: $4,410

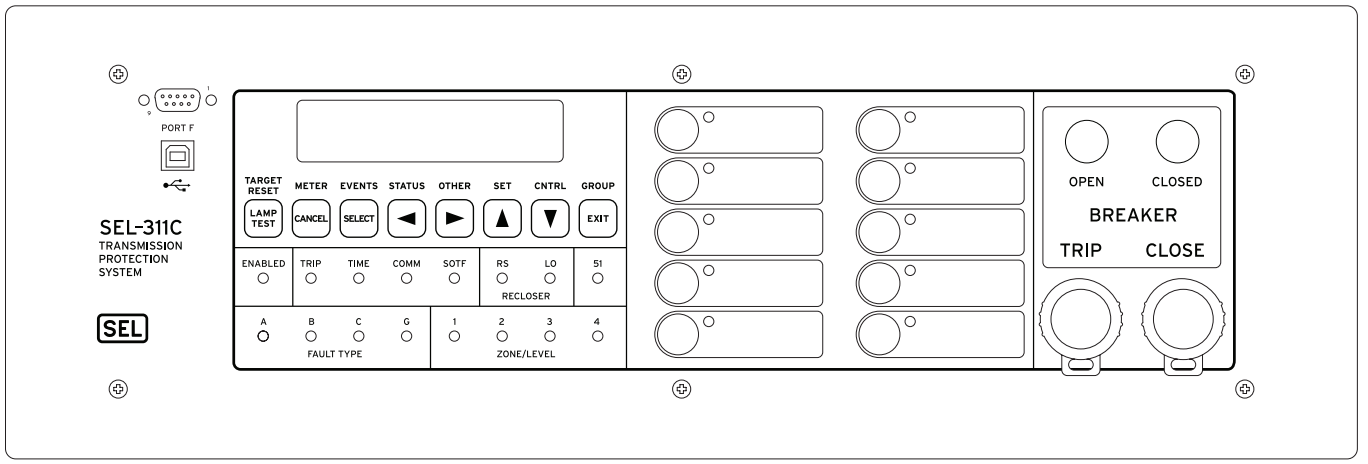
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

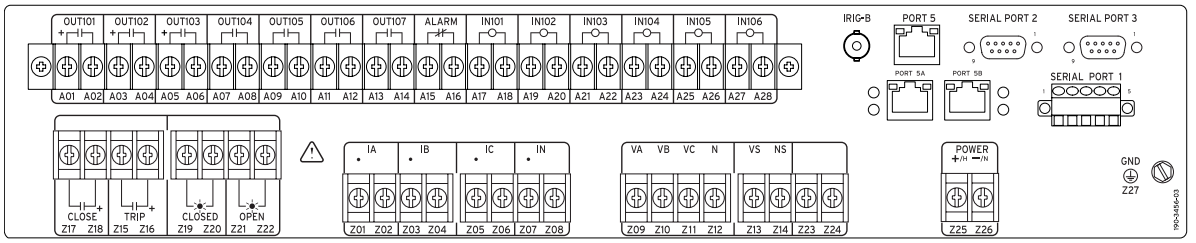
SEL-311C Distance Relay With Recloser

Front View – Panel-Mount



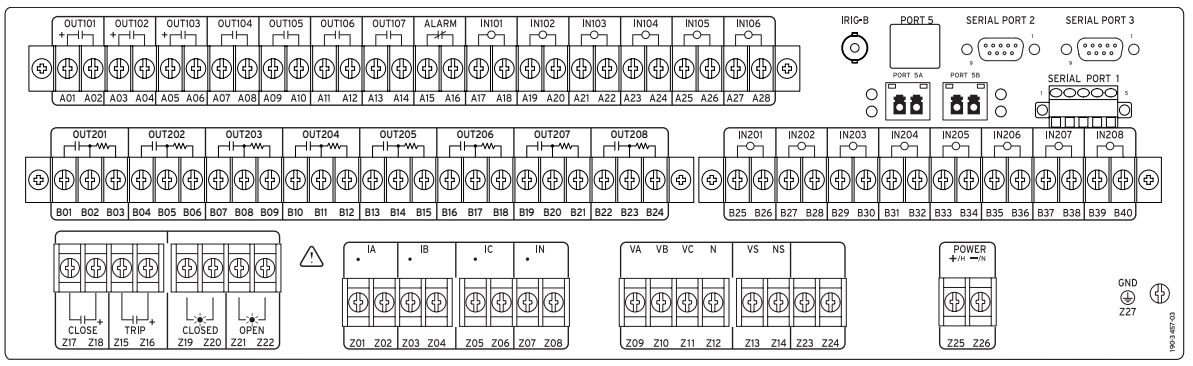
i5029a

Rear View – Conventional Terminal Blocks (2U)



i5031a

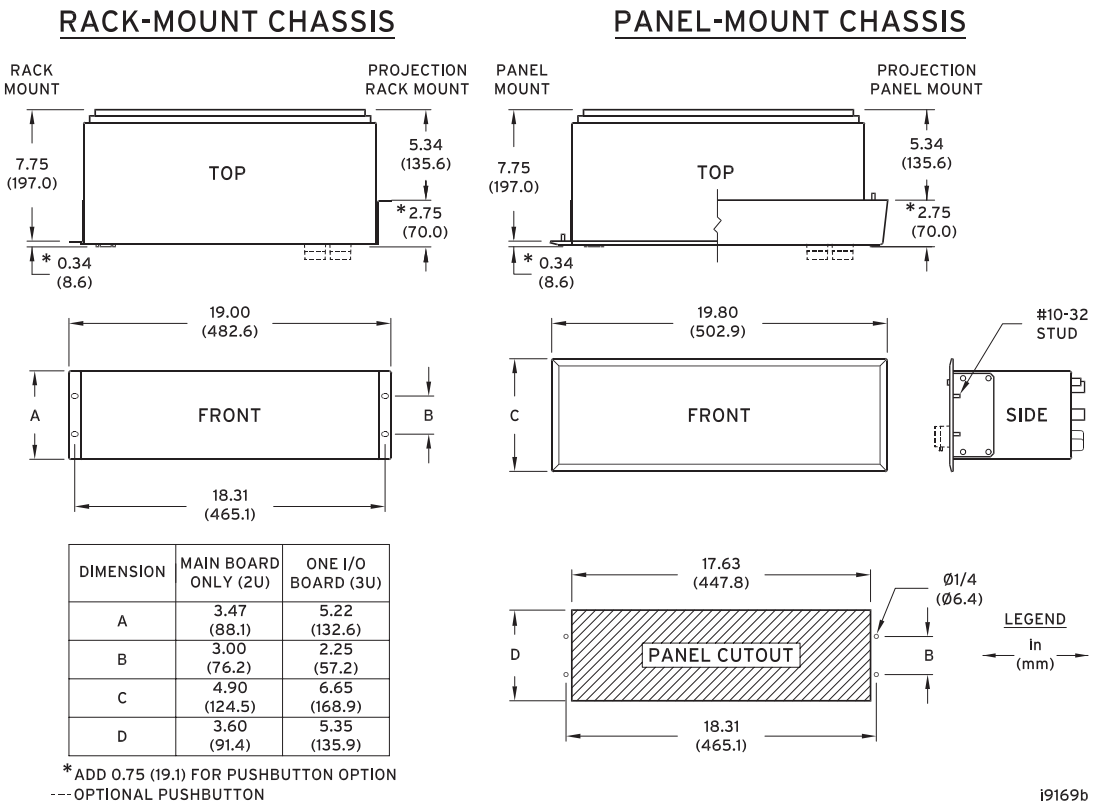
Rear View – Conventional Terminal Blocks – Additional I/O (3U)



i5030a

SEL-311C Distance Relay With Recloser

Dimensions



DIMENSION	MAIN BOARD ONLY (2U)	ONE I/O BOARD (3U)
A	3.47 (88.1)	5.22 (132.6)
B	3.00 (76.2)	2.25 (57.2)
C	4.90 (124.5)	6.65 (168.9)
D	3.60 (91.4)	5.35 (135.9)

*ADD 0.75 (19.1) FOR PUSHBUTTON OPTION
---OPTIONAL PUSHBUTTON

Visit www.selinc.com for more detailed information and configuration options.

SEL-311L Line Current Differential System

Use the SEL-311L Line Current Differential System with full-scheme backup for easy-to-apply, high-speed line protection.

SEL IEC 61850

SEL Synchrophasors™

Key Features

Innovative Differential Elements Provide Speed and Security

The SEL-311L Line Current Differential System uses a vector ratio of the local and remote phase and sequence currents (Alpha Plane restraint) to provide subcycle operate times for severe faults and security for external faults. Differential comparison of each phase current, negative-sequence current, and zero-sequence current provides for high speed on severe faults and sensitivity for faults below load current.

Complete Distance and Overcurrent Backup Included

Four zones of distance protection plus directional and nondirectional overcurrent elements provide a full backup protection system. All of the protection, reclosing, and control functions of the SEL-311C Distance Relay With Recloser are included. Use distance backup full time or only on loss-of-differential communication. CCVT transient detection prevents overreaching.

Direct Optical Fiber or Multiplexed Communications

One or two communications channels provide reliability and security. Select from ITU-T G.703 or EIA-422 electronic interface, IEEE C37.94, 1300 nm single- or multimode optical fiber, or 1550 nm single-mode optical fiber. The unique Alpha Plane restraint characteristic accommodates channel asymmetry and switching without loss of security or sensitivity. True hot-standby means no loss of protection during loss of a communications channel.

Three-Terminal and Tapped Transmission Lines

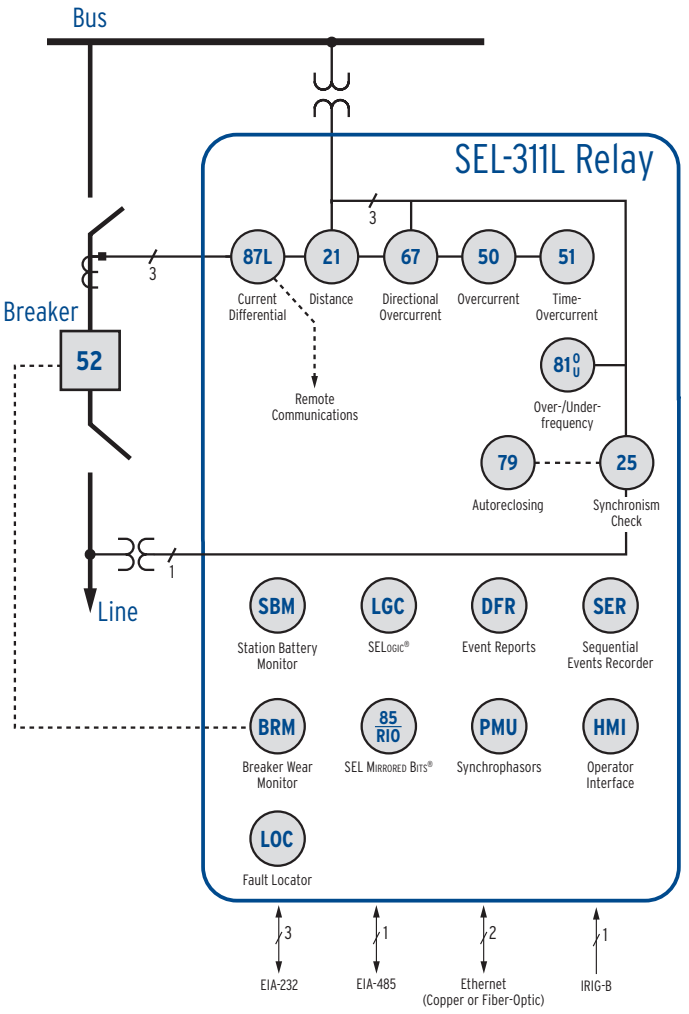
Tapped line settings make maximum use of communications for secure protection. Three-terminal lines are easily accommodated, even with weak infeed.

Simple Fiber Connection to Multiplexer

Optional SEL-3094 Interface Converter converts a non-fiber-optic interface on a digital multiplexer to a fiber-optic interface, providing a safe, isolated, fiber-optic link to the SEL-311L.

Synchrophasor Measurements to Increase Asset Utilization

Validate system load flow and fault models using instantaneous voltage angles. Use system-state measurements to increase stable system loading through reduced margin requirements. Send synchrophasor data at rates of up to 60 messages per minute, using SEL Fast Messages, to communications processors and phasor data concentrators.



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SEL-311L Line Current Differential System

Applications

- Use single- or three-pole differential protection for critical transmission lines.
- Apply full-scheme distance backup protection with four-shot reclosing with independent protection in the same relay.
- Protect three-terminal lines, even with weak infeed or outfeed at one terminal.
- Coordinate with tapped load protection for maximum sensitivity and speed.
- Apply with switched communications, such as SONET ring, without a loss of security during switching operations or steady-state channel asymmetry.
- Accommodate mixed-ratio CTs with different knee-point characteristics. Alpha Plane restraint provides security for CT saturation.
- Use true hot-standby differential channel for increased dependability and security. Loss of primary channel does not cause loss of protection or false tripping.
- Transmit synchrophasor data to SEL-3306 Synchrophasor Processors or to a computer running SEL-5077 SYNCHROWAVE® Server Software for use in wide-area control and measurement systems.

Optional Features

- Single-pole current differential tripping.
- Single-pole Zone 1 distance backup tripping.
- Vertical or horizontal, panel-mount, rack-mount, or projection panel-mount hardware packages.
- Channel interface.
  - Isolated EIA-422
  - Isolated ITU-T G.703
  - 850 nm or 1300 nm fiber, IEEE C37.94 encoding*
  - 1300 nm single- or multimode fiber*
  - 1550 nm single-mode fiber*
- One or two channels.
- DNP3 Level 2 Outstation communications protocol.
- IEC 61850 communications.
- Conformal coating.
- Additional inputs and additional standard, high-current interrupting or high-speed, high-current interrupting output contacts.
- Ethernet communications 10/100BASE-T or 100BASE-FX.*

* Eye-safe, Class 1 laser product per EN 60825-1

Hardware Specifications

AC Voltage Inputs

67 V_{L-N} three-phase, four-wire connection

150 V_{L-N} continuous, 365 Vac for 10 seconds

Burden 0.13 VA @ 67 V; 0.45 VA @ 120 V

AC Current Inputs

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical, 1250 A for 1 cycle

Burden 0.27 VA @ 5 A; 2.51 VA @ 15 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical, 250 A for 1 cycle

Burden 0.13 VA @ 1 A; 1.31 VA @ 15 A

Power Supply Ratings

125/250 Vdc or Vac

Range 85–300 Vdc or 85–264 Vac

48/125 Vdc or 125 Vac

Range 36–200 Vdc or 85–140 Vac

24/48 Vdc

Range 18–60 Vdc

Burden <25 W

Standard Control Input and Output Ranges

6 high-speed, high-interrupt outputs

8 standard-speed outputs

6 optoisolated inputs

Price

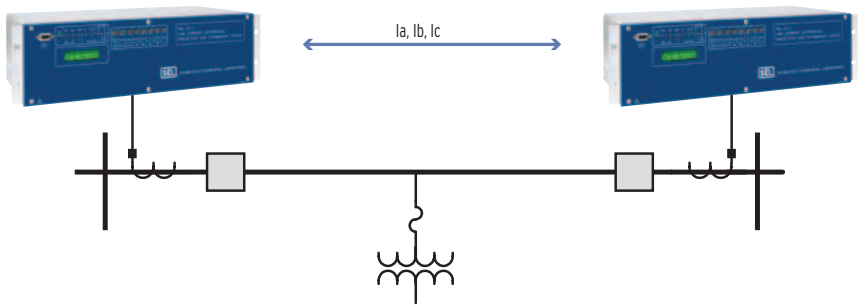
Budgetary Retail, Quantity 1: $5,265

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

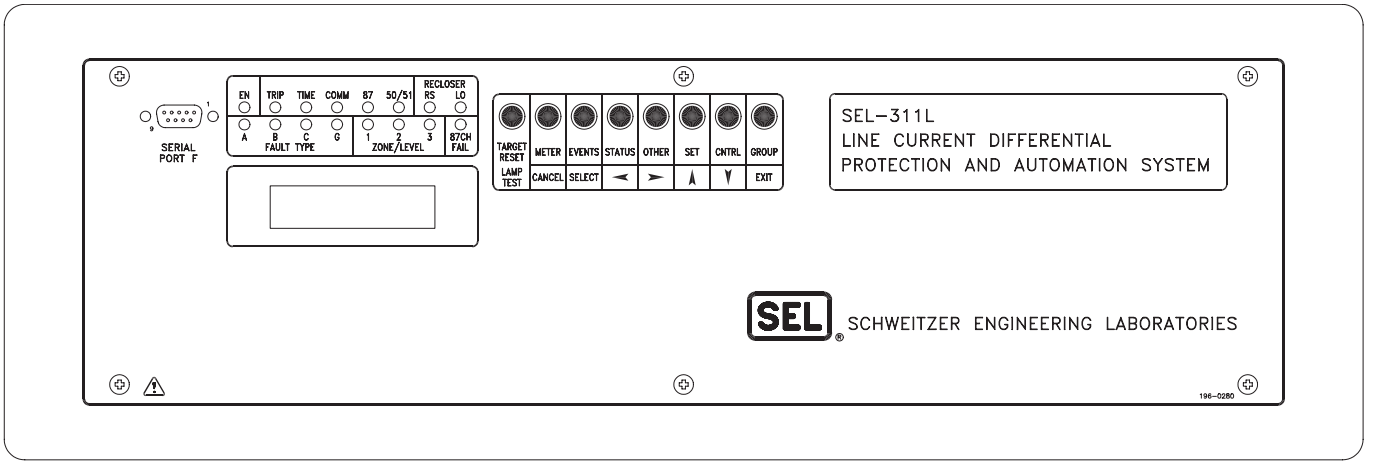
This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Protect Lines With Easy-to-Use Current Differential Relays



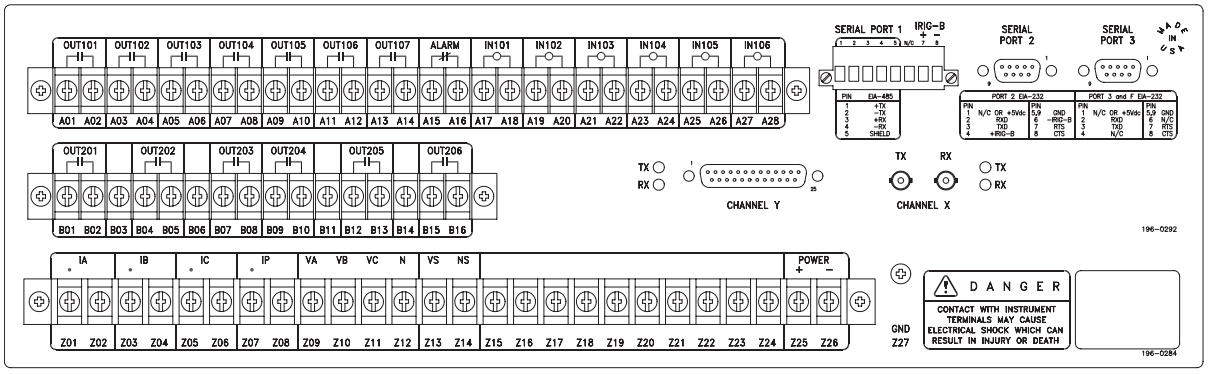
SEL-311L Line Current Differential System

Front View – Panel-Mount



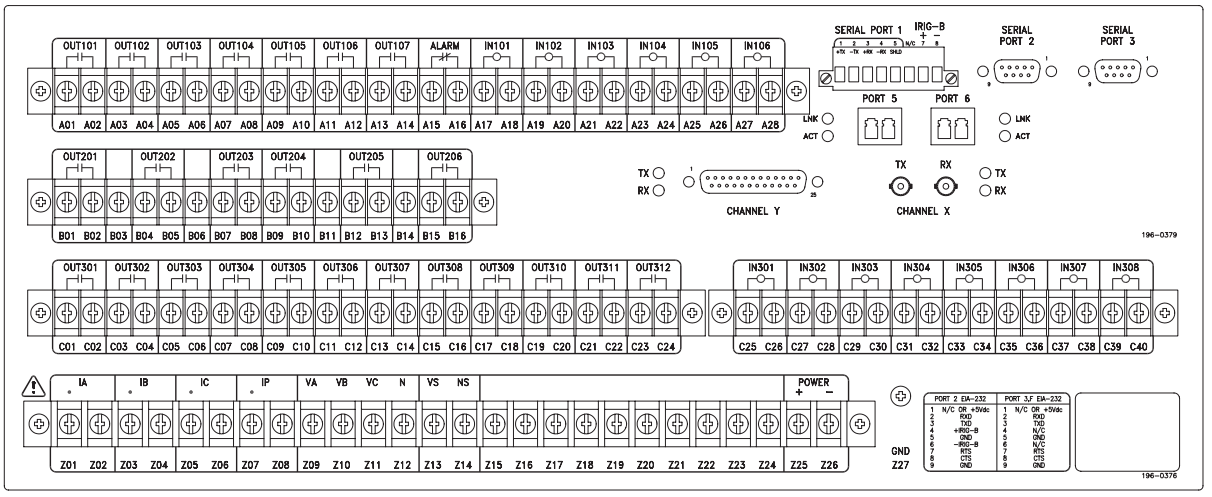
I3437a

Rear View – Channel Y Electrical, Channel X Fiber



I3440b

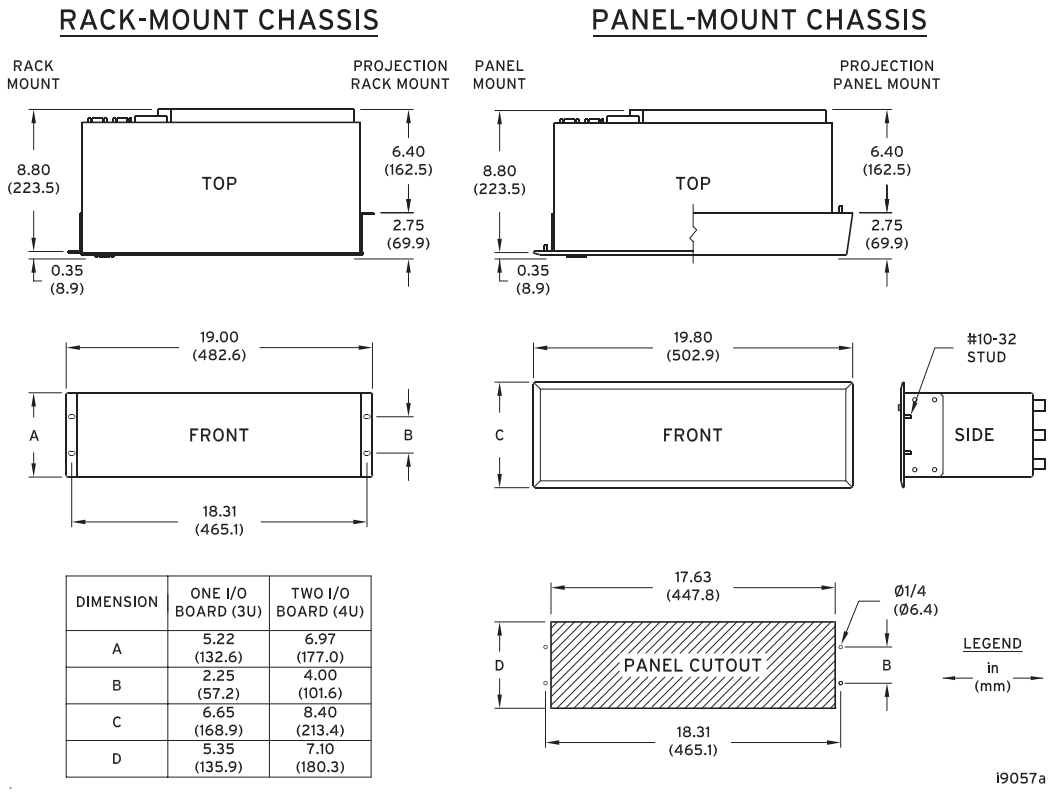
Rear View – Conventional Terminal Blocks - Additional I/O (4U) - Ethernet Access



I3979a

SEL-311L Line Current Differential System

Dimensions



DIMENSION	ONE I/O BOARD (3U)	TWO I/O BOARD (4U)
A	5.22 (132.6)	6.97 (177.0)
B	2.25 (57.2)	4.00 (101.6)
C	6.65 (168.9)	8.40 (213.4)
D	5.35 (135.9)	7.10 (180.3)

Visit www.selinc.com for more detailed information and configuration options.

SEL-311M Line Current Differential System

Provide superior security, speed, and sensitivity to your ungrounded or high-impedance grounded power system.

Key Features

Secure Differential Relaying

Primary protection with phase and ground differential elements provides secure fault detection without overreaching. Security during CT saturation is an inherent part of the Alpha Plane operation system. Dual-fiber differential channels offer true hot-standby redundancy. Differential elements allow subcycle operation for fault currents four times greater than the pickup setting.

Sensitive Backup Protection

Instantaneous overcurrent elements allow subcycle operation for fault currents greater than five times the pickup setting. The sensitive ground fault element operates independently of the differential channel for reliable backup protection even for low-level faults in ungrounded or high-impedance grounded systems.

Single Channel or Hot Standby

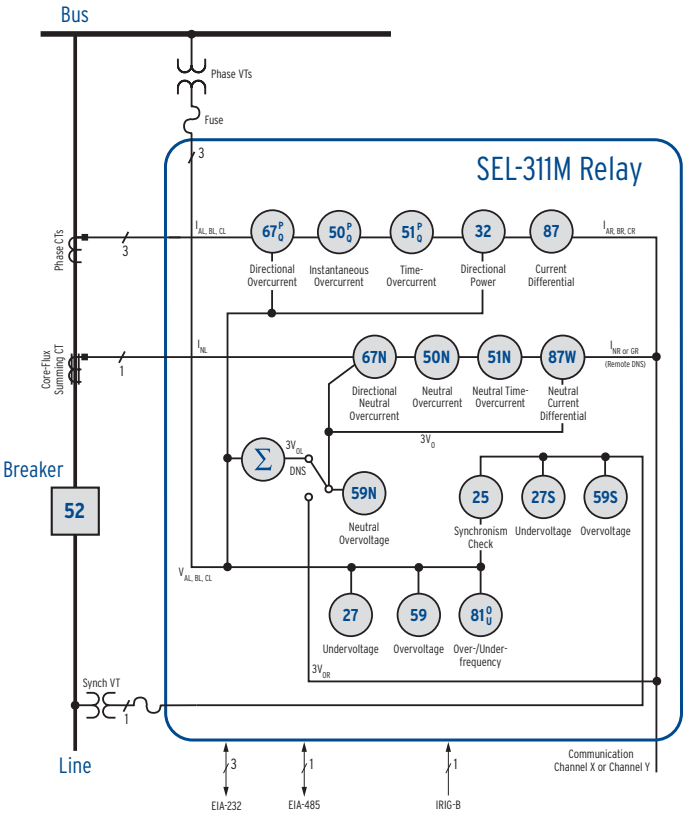
Connect either one or two communications channels. When a second channel is used, the line differential protection on the second channel is in "hot standby" mode. Upon the loss of the primary channel, the protection switches over to the secondary channel in less than half a cycle, resulting in almost no delay in operation.

Additional Functions for Complete System Protection

Voltage and frequency elements provide flexible system alarms and control elements to detect and correct abnormal operating conditions. Battery and breaker wear monitoring provide early warning of possible problems or required maintenance.

Flexible Communications for Engineering Access

Three EIA-232 serial ports and one isolated EIA-485 serial port provide access to the relay's status, event history, oscillographic event report data, and metering information. Open communications protocols allow the relay to be programmed and the data to be collected and saved via a simple terminal interface. Apply automated data collection and relay control through communications processors or tough computers.



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SEL-311M Line Current Differential System

Applications

- Protect ungrounded and high-impedance grounded power lines with high-speed differential and overcurrent protection in the same relay.
- Communicate over dual 850 nm IEEE C37.94 fiber-optic cable.
- Accommodate mixed-ratio CTs with different knee-point characteristics. Alpha Plane restraint provides security for CT saturation.
- Use built-in sensitive ground fault backup protection for sensitivity to low-current ground faults when loss of communications disables line differential protection.
- Apply with direct or switched communications, such as SONET ring, without loss of security during switching operations or channel asymmetry.
- Connect to two communications channels for true hot-standby differential protection. Loss of primary channel does not cause loss of protection or false tripping.

Optional Features

- Rack-mount or panel-mount hardware packages.
- 24/48, 48/125, or 125/250 Vdc power supply.
- 24, 48, 110, 125, 220, or 250 Vdc or Vac control input voltage.

Price

Budgetary Retail, Quantity 1: $6,050

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

Hardware Specifications

AC Voltage Inputs

300 V_{L-N}, three-phase, four-wire (wye) connection

Continuous	300 V (connect any voltage from 0 to 300 Vac) 600 Vac for 10 seconds
Burden	0.03 VA @ 67 V; 0.06 VA @ 120 V; 0.8 VA @ 300 V

AC Current Inputs

5 A Nominal (IA, IB, IC)

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical, 1250 A for 1 cycle

Burden	0.27 VA @ 5 A; 2.51 VA @ 15 A

1 A Nominal (IA, IB, IC)

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical, 250 A for 1 cycle

Burden	0.13 VA @ 1 A; 1.31 VA @ 3 A

0.2 A Nominal (IN)

15 A continuous, 500 A for 1 second, linear to 5.5 A symmetrical, 1250 A for 1 cycle

Burden	0.002 VA @ 0.2 A, 1.28 VA @ 15 A

Note: The 0.2 A nominal neutral channel IN option is used for directional control on low-impedance grounded and ungrounded/high-impedance grounded systems. The 0.2 A nominal channel can also provide nondirectional SEF protection.

Power Supply

125/250 Vdc or Vac

Range	85–350 Vdc or 85–264 Vac

48/125 Vdc or 125 Vac

Range	38–200 Vdc or 85–140 Vac

24/48 Vdc

Range	18–60 Vdc polarity dependent
Burden	<25 W

Control Inputs and Outputs

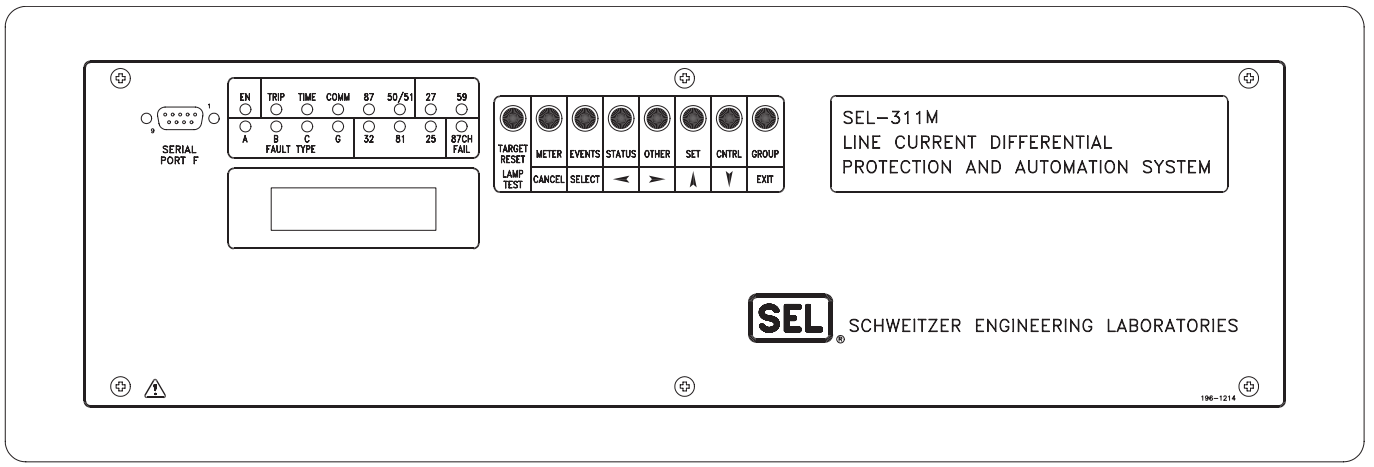
8 standard outputs

6 high-speed, high-current interrupting outputs

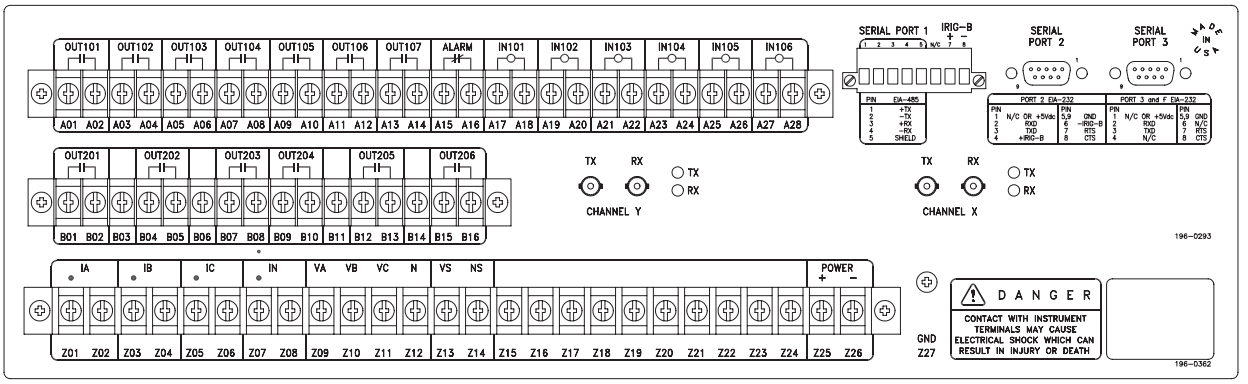
6 optoisolated inputs

SEL-311M Line Current Differential System

Front View – Panel-Mount



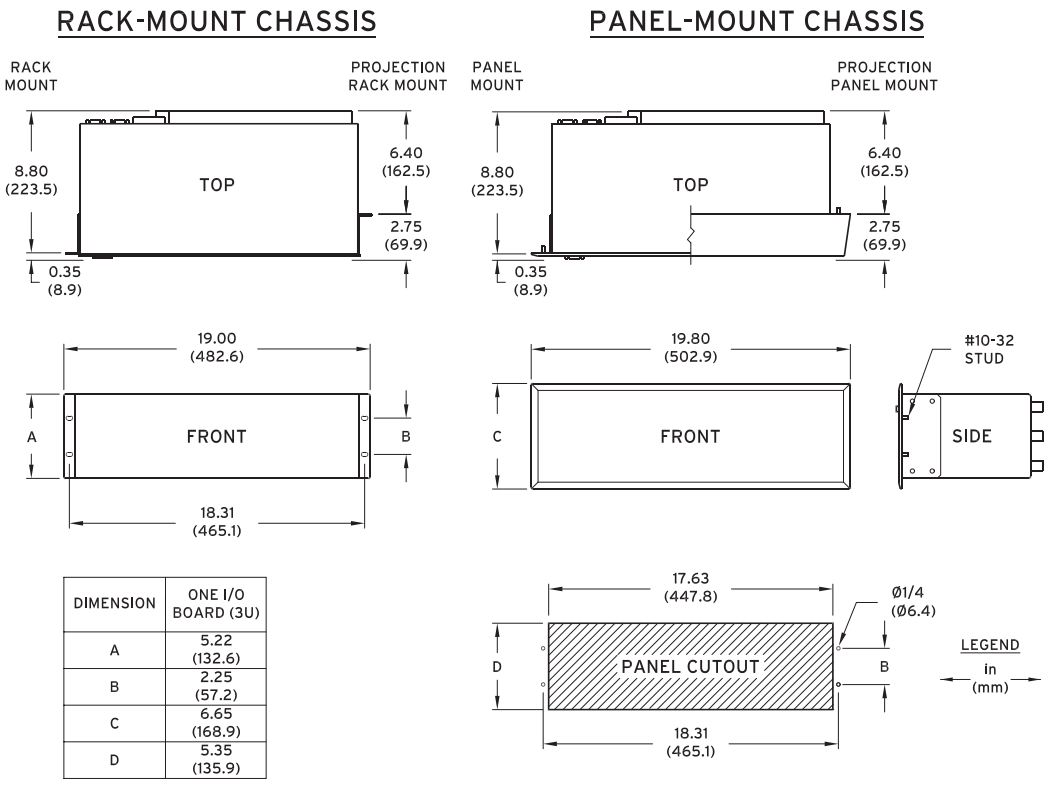
Rear View



i3685a

SEL-311M Line Current Differential System

Dimensions



DIMENSION	ONE I/O BOARD (3U)
A	5.22 (132.6)
B	2.25 (57.2)
C	6.65 (168.9)
D	5.35 (135.9)

Visit www.selinc.com for more detailed information and configuration options.

SEL-387L Line Current Differential Relay

Use SEL-387L Line Current Differential Relays for economical, easy-to-apply line protection with zero settings.

Key Features

Simple Application

Proven differential operating system requires no settings. The user only needs to label the relay and terminal, and provide a unique address for the transmit and receive communications.

Innovative Differential Elements Provide Speed and Security

The SEL-387L Line Current Differential Relay uses a vector ratio of the local and remote phase, and sequence currents (Alpha Plane restraint) to provide 1.5-cycle operate times and security for external faults. Differential comparison of each phase current, negative-sequence current, and zero-sequence current provides for high speed on severe faults and sensitivity for faults below load current.

The unique Alpha Plane restraint characteristic accommodates channel asymmetry and switching without loss of security or sensitivity.

Multiplexed or Direct Fiber-Optic Communications

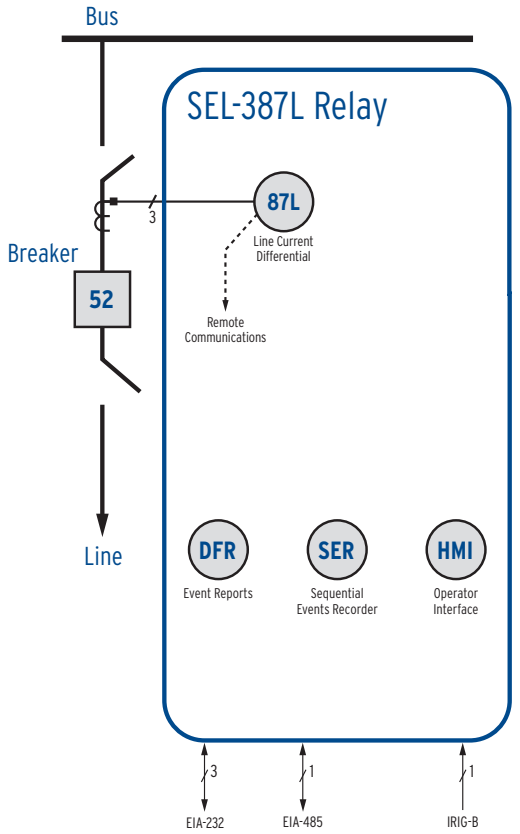
IEEE C37.94 optical fiber (standard) or single-mode fiber (optional) provides secure multiplexed or direct communications.

Three-Terminal and Tapped Transmission Lines

Two SEL-387L Relays communicate with one SEL-311L Line Current Differential System for three-terminal and tapped-load applications.

Simple Fiber Connection to Multiplexer

Optional SEL-3094 Interface Converter converts a non-fiber-optic interface on a digital multiplexer to a fiber-optic interface, providing a safe, isolated, fiber-optic link to the SEL-387L.



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SEL-387L Line Current Differential Relay

Applications

- Provide simple line current differential protection.
- Protect three-terminal lines, even with weak infeed or outfeed at one terminal, when used with an SEL-311L Relay at one terminal.
- Coordinate with tapped load protection for maximum sensitivity and speed by using the SEL-387L Relay with the SEL-311L Relay.
- Apply with switched communications, such as SONET ring, without a loss of security during switching operations or steady-state channel asymmetry.
- Accommodate mixed-ratio CTs with an SEL-311L Relay at one line terminal.
- Use the SEL-387L Relay at a remote station (industrial or cogeneration site) with the SEL-311L Relay at the local end with all settings.

Optional Features

- Vertical or horizontal, panel-mount, rack-mount, or projection panel-mount hardware packages.
- Channel interface.*
  - 850 nm or 1300 nm IEEE C37.94 fiber
  - 1300 nm single- or multimode fiber
  - 1550 nm single-mode fiber
- DNP3 Level 2 Outstation communications protocol.

* Eye-safe, Class 1 laser product per EN 60825-1

Hardware Specifications

AC Current Inputs

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical, 1250 A for 1 cycle

Burden 0.27 VA @ 5 A; 2.51 VA @ 15 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical, 250 A for 1 cycle

Burden 0.13 VA @ 1 A; 1.31 VA @ 15 A

Power Supply Ratings

125/250 Vdc or Vac

Range 85–300 Vdc or 85–264 Vac

48/125 Vdc or 125 Vac

Range 36–200 Vdc or 85–140 Vac

24/48 Vdc

Range 18–60 Vdc

Burden <25 W

Control Inputs and Outputs

7 standard-speed outputs

6 high-speed outputs

6 optoisolated inputs

Price

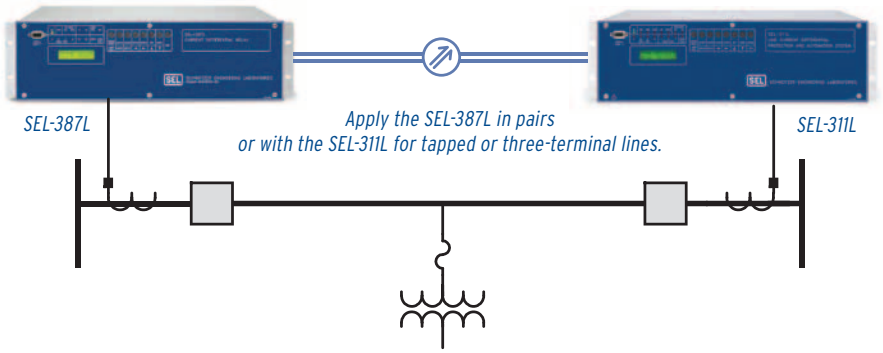
Budgetary Retail, Quantity 1: $2,940

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

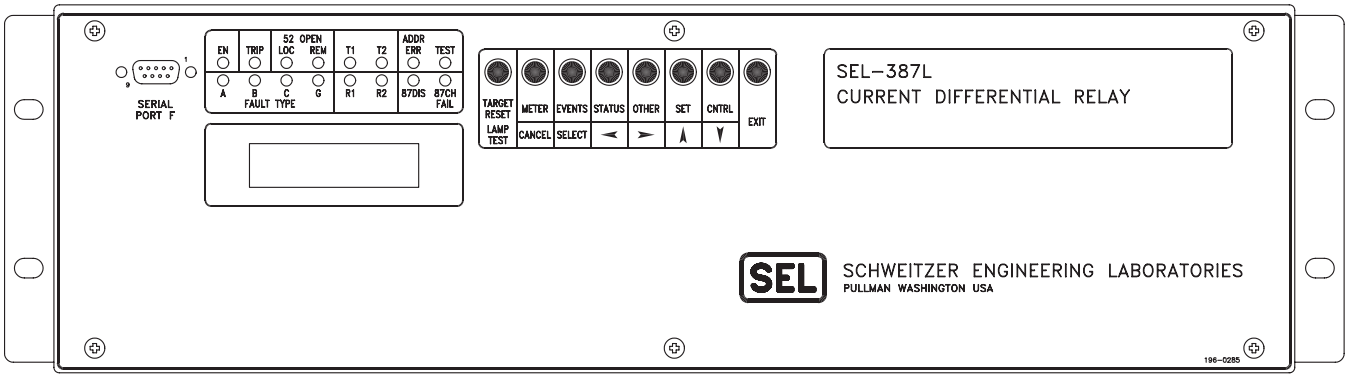
This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Protect Lines With Easy-to-Use Current Differential Relays



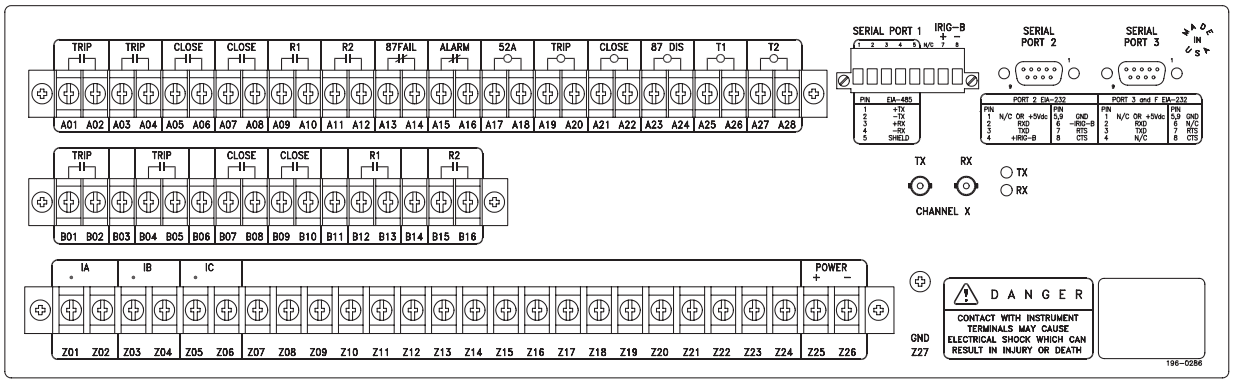
SEL-387L Line Current Differential Relay

Front View – Rack-Mount



I3668d

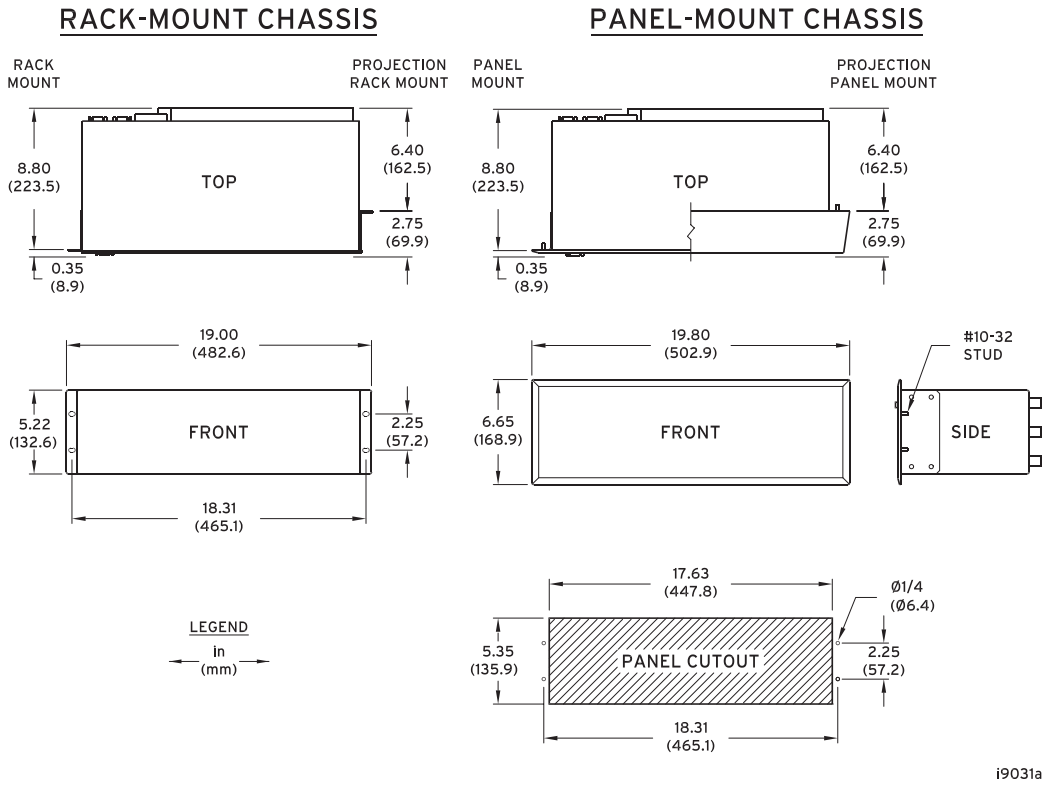
Rear View



I3669d

SEL-387L Line Current Differential Relay

Dimensions



Visit www.selinc.com for more detailed information and configuration options.

SEL-321 Phase and Ground Distance Relay

Select the SEL-321 Relay for complete distance protection, including single-pole tripping and series-compensated lines.

Key Features

Comprehensive and Secure Distance Protection

Four zones of phase and ground mho elements plus four zones of ground distance quadrilateral elements, each reversible, with independent phase and ground timers give complete distance protection. Positive-sequence memory voltage polarization with long memory time constant provides three-phase fault directional security. Negative-sequence impedance directional element polarization ensures sensitive and secure operation during unbalanced faults.

Extensive Supplemental Protection Elements and Logic

Includes four residual and negative-sequence overcurrent elements with negative-sequence directional control; phase, sequence, and ground time-overcurrent elements for backup protection; out-of-step elements for power swing blocking and tripping; phase and sequence under- and overvoltage elements; load-encroachment logic for improved security during heavy loads; single-pole tripping logic; built-in communications-assisted tripping scheme logic; and SELOGIC® control equations for custom scheme logic.

Multiple Settings Groups

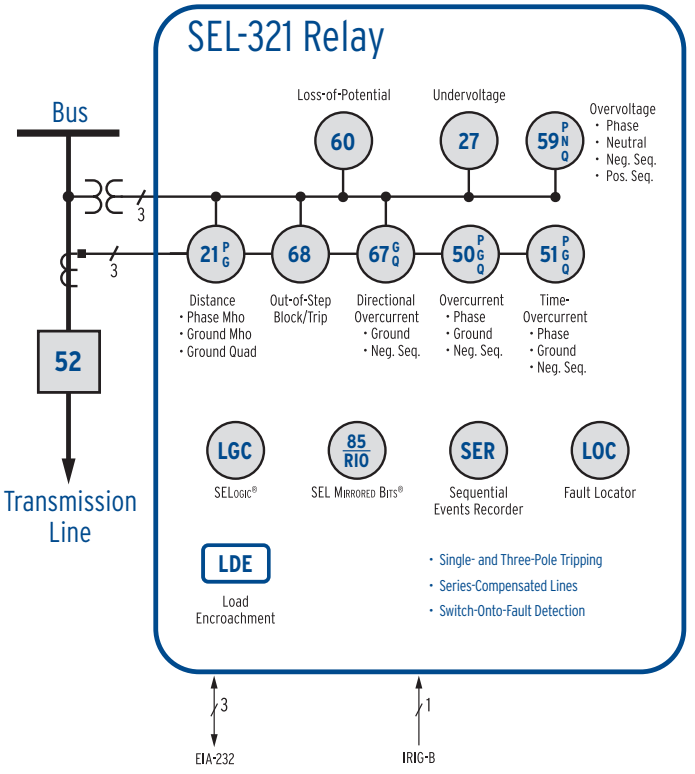
Six settings groups, for maximum protection scheme flexibility, allow application with bus-tie breakers or for remote system reconfiguration.

Fault Locating

Use the built-in fault locator to efficiently dispatch line inspection and repair personnel.

Communications

Patented MIRRORED BITS® communications and communications-assisted tripping schemes.



SEL-321 Phase and Ground Distance Relay

Applications

- Apply the SEL-321 Relay for primary and/or backup single- or three-pole trip transmission line protection, including series-compensated lines.
- Use the advanced single-pole tripping logic with phase selection, open-pole interval protection, and phase discordance logic with three-pole trip to protect against excessive single-pole-open events.
- Choose from among the many communications-assisted tripping schemes available (POTT, DCUB, DCB, PUTT, DUTT, and DTT), including unique Mirrored Bits communications.
- Select the load-encroachment feature to prevent operation of three-phase elements under high-load conditions.
- Use the time-overcurrent elements to provide current-dependent, time-delayed fault detection along the protected line and backup protection for remote terminals.
- Use weak-infeed logic to rapidly clear both line terminals for internal faults near the weak terminal.
- Select the SEL-321-5 Relay for enhanced performance on 50 Hz systems.

Optional Features

- Chassis available for one additional interface I/O board.
- I/O boards with contact-sensing inputs and standard control outputs, high-current interrupting outputs, or high-speed, high-current interrupting outputs.
- Connectorized® hardware configuration.
- Vertical or horizontal, panel-mount or rack-mount hardware packages (panel-mount available in Connectorized version only).
- Five-second event reports, including oscillography, available in the SEL-321-2 Relay.
- Additional memory for storage of up to 20 events available in the SEL-321-4 Relay.
- DNP3 Level 2 Outstation communications protocol.
- Mirrored Bits communications and communications-assisted tripping schemes.

Hardware Specifications

AC Voltage Inputs

67 V_{L-N} nominal, three-phase, four-wire connection

150 V_{L-N} continuous, 365 Vac for 10 seconds

Burden 0.13 VA @ 67 V; 0.45 VA @ 120 V

AC Current Inputs

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical, 1250 A for 1 cycle

Burden 0.27 VA @ 5 A; 2.51 VA @ 15 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical, 250 A for 1 cycle

Burden 0.13 VA @ 1 A; 1.31 VA @ 3 A

Power Supply Ratings

24/48 V 20–60 Vdc

125/250 V 85–350 Vdc

85–264 Vac

15 W maximum for all supplies

Standard Control Input and Output Ranges

24, 48, 110, 125, or 250 Vdc

Standard configuration provides 6 inputs and 8 outputs, <5 ms pickup/dropout times with 30 A make, 6 A continuous duty

Operating Temperature

–40° to +85°C (–40° to +185°F)

(Note: LCD contrast impaired for temperatures below –20°C)

Price

Budgetary Retail, Quantity 1: $5,250

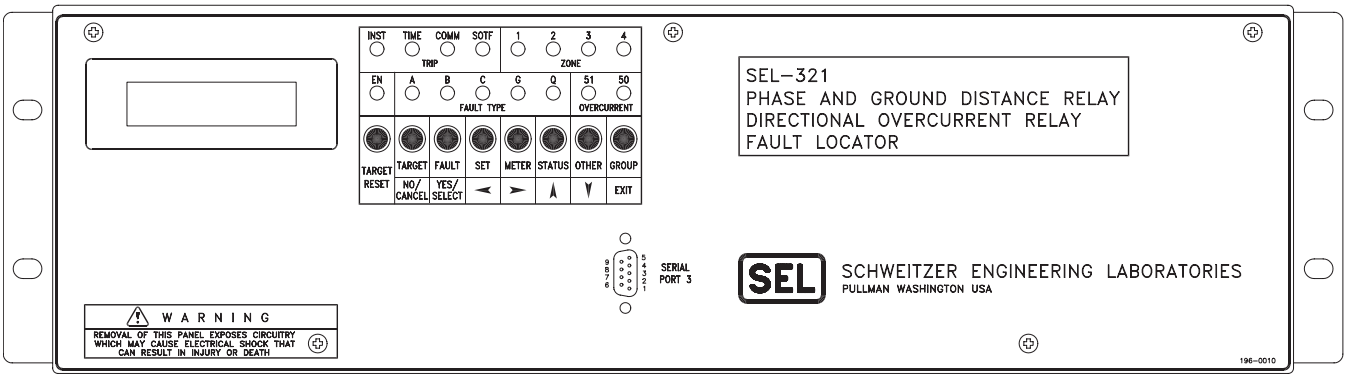
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

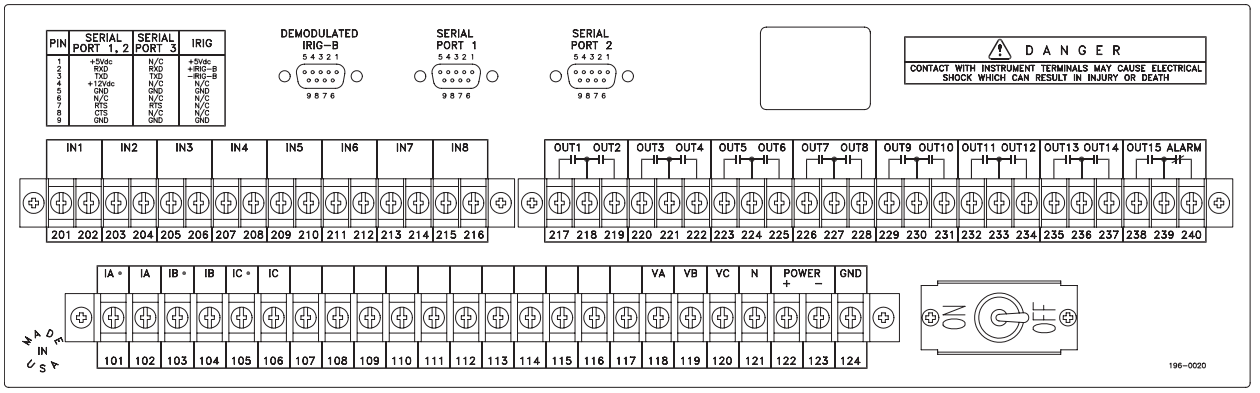
SEL-321 Phase and Ground Distance Relay

Front View – Rack-Mount



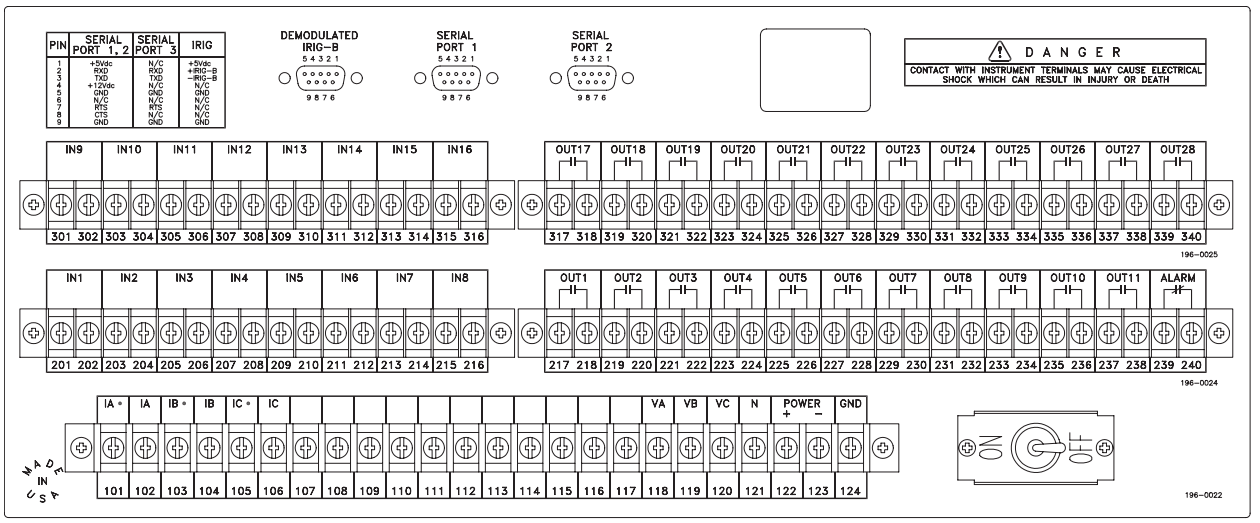
I3303b

Rear View – Conventional Terminal Blocks (3U)



I3305a

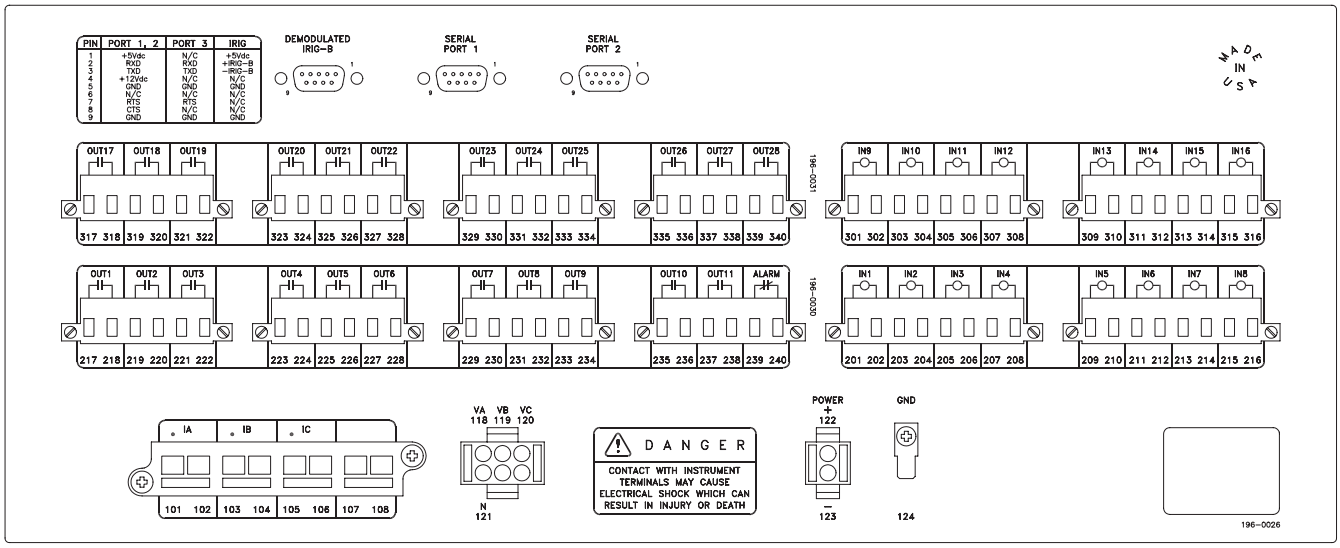
Rear View – Conventional Terminal Blocks – Additional I/O (4U)



I3389a

SEL-321 Phase and Ground Distance Relay

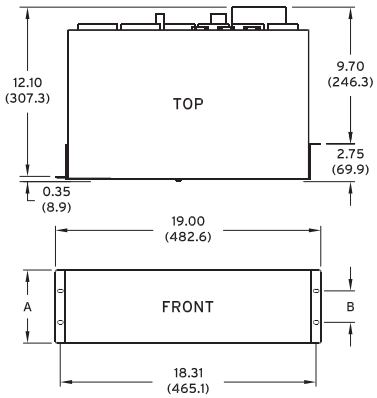
Rear View – Connectorized® – Additional I/O (4U)



I3422a

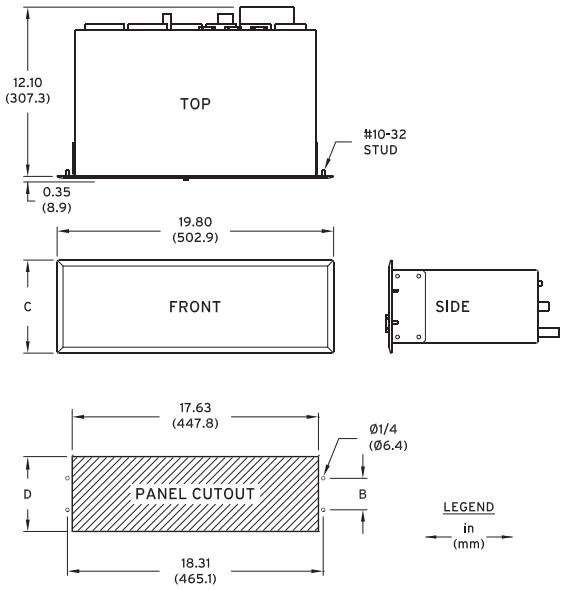
Dimensions – Connectorized

CONNECTORIZED RACK-MOUNT CHASSIS



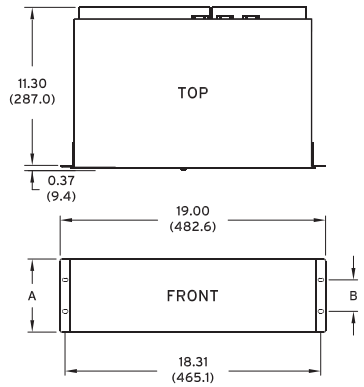
DIMENSION	ONE I/O BOARD (3U)	TWO I/O BOARD (4U)
A	5.22 (132.6)	6.97 (177.0)
B	2.25 (57.2)	4.00 (101.6)
C	6.65 (168.9)	8.40 (213.4)
D	5.35 (135.9)	7.10 (180.3)

CONNECTORIZED PANEL-MOUNT CHASSIS



Dimensions – Terminal Block

TERMINAL BLOCK RACK-MOUNT CHASSIS

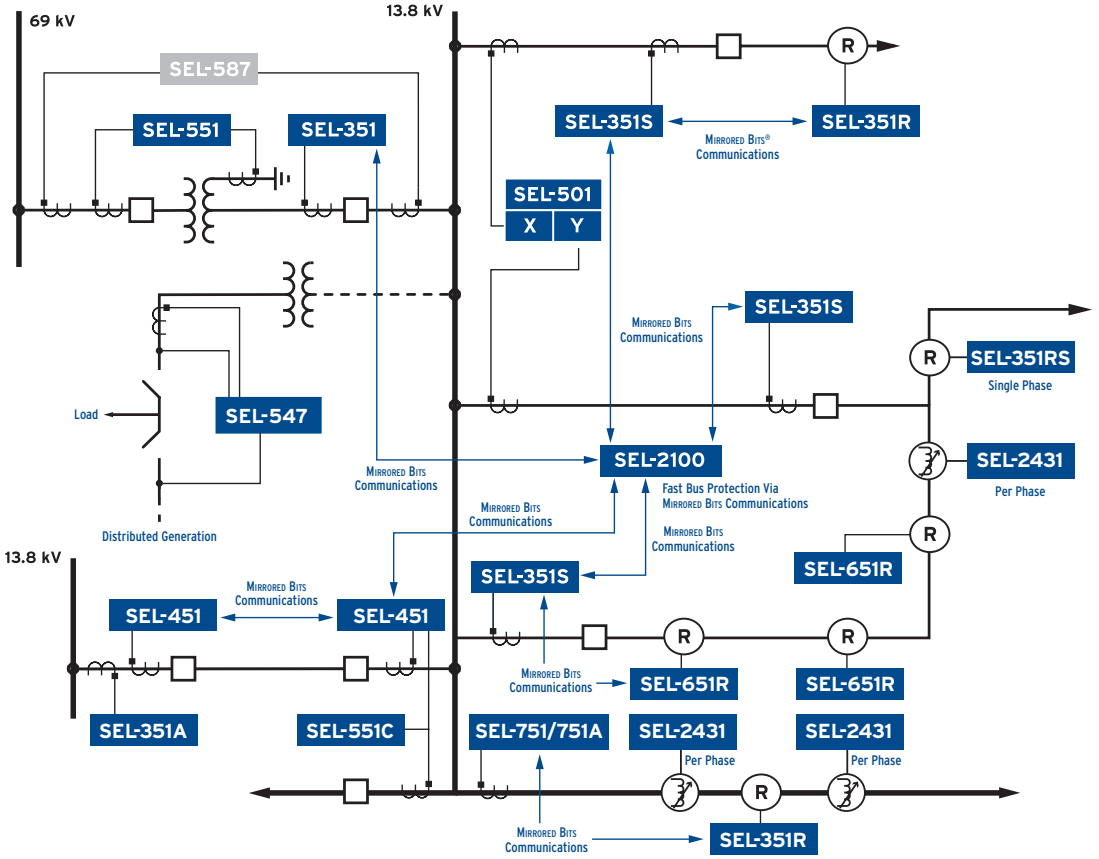


DIMENSION	ONE I/O BOARD (3U)	TWO I/O BOARD (4U)
A	5.22 (132.6)	6.97 (177.0)
B	2.25 (57.2)	4.00 (101.6)

i9013a

Visit www.selinc.com for more detailed information and configuration options.

Distribution Applications



Distribution Product Index

Distribution Features

Distribution Line Protection

	SEL-451	SEL-351	SEL-351A	SEL-351S	SEL-751	SEL-751A	SEL-501/501-2	SEL-551/551C	SEL-547	SEL-2431	SEL-351RS Kestrel	SEL-351R Falcon	SEL-351R	SEL-651R	SEL-632
APPLICATIONS															
Distribution Feeder Protection	•	•	•	•	•	•	•	•			•	•	•	•	
Breaker Failure Protection	•	*f*	*f*	*f*	•	•	*	*f*			*f*	*f*	*f*	*f*	
Automatic Reclosing	•	•	•	•	•	*		•			•	•	•	•	•
Generator Intertie Protection	•	•	•	•	•	*			•			•	•	•	
Recloser Control											•	•	•	•	
Synchronism Check	•	•	•	•	*	*			•			•	•	•	
Underfrequency Load Shedding	*f*	•	•	•	•	•			•		•	•	•	•	
Undervoltage Load Shedding	*f*	•	•	•	•	*			•		•	•	•	•	
32-Step Single-Phase Voltage Regulator										•					
PROTECTION															
27/59 Under-/Overvoltage	*f*	•	•	•	•	*			•		•	•	•	•	
32 Directional Power Elements	*f*	*		*	•	*			•					•	•
49 Thermal Overload	*f*														
50 Overcurrent Element (50P, N, G, Q)	•	•	•	•	•	•	•	•			•	•	•	•	
51 Time-Overcurrent Element (51P, N, G, Q)	•	•	•	•	•	•	•	•			•	•	•	•	
67 Directional Overcurrent (67P, N, Q)	•	•	•	•	*							•	•	•	
81 Over-/Underfrequency	*f*	•	•	•	•	•			•		•	•	•	•	
Separate Neutral Overcurrent	•	•	•	•	•	•		•				•	•	•	
Load-Encroachment Supervision	•	•	•	•	*							•	•	•	
MIRRORED BITS® Communications	•	*		*	•	•					•	•	*	•	
Sensitive Earth Fault Protection		*	*	*		*						•	•	•	
Directional Sensitive Earth Fault Protection		*	*	*								•	•	•	
Pilot Protection Logic	•	•		•								•	•	*f*	
Rate of Change of Frequency df/dt	*f*				•	*									
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	4/4	4/4	6/0	4/0	1/4	1/2	1/1	4/4	4/4	4/6	3/6
Complete Two-Breaker Control	•						•								
INSTRUMENTATION AND CONTROL															
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Fault Locating	•	•	•	•	•						•	•	•	•	
SELOGIC® Control Equations	•	•	•	•	•	•		•	•	•	•	•	•	•	
SELOGIC Counters	•				•	•				•	•	•	*	•	
Voltage Check on Closing	•	•	•	•	*	*			•		•	•	•	•	•
Operator Control Pushbuttons	•			•	•	•				•	•	•	•	•	
SELOGIC Nonvolatile Latch	•	•	•	•	•	•		*		•	•	•	•	•	
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Multiple Settings Groups	•	•	•	•	•	•			•	•	•	•	•	•	
Substation Battery Monitor	•	•	•	•	•	*									
Breaker/Recloser Wear Monitor	•	•	•	•	•	•					•	•	•	•	
Trip Coil Monitor	*f*	*f*	*f*	*f*	*f*	*f*		*f*			*f*	*f*	*f*	*f*	
Voltage Sag/Swell/Interrupt Recorder		*		*							•			•	
Load Profile Recorder		*		*	•	•				•	•	•	*		
Sequential Events Recorder	•	•	•	•	•	•		•	•	•	•	•	•	•	
Demand Meter	•	•	•	•	•	*	•	•		•	•	•	•	•	
DNP3 Level 2 Outstation	*	•	•	•	*	*				•	•	•	*	*	
Modbus® Slave		•	•	•	•	•	*	*	•		•				
Synchrophasors	•	•	•	•	•	•					•				
Bay Control	•														
Ethernet	*	•	•	•	*	*					•				
IEC 61850	*	*	*	*	*	*					*				
Independent Trip/Close Pushbuttons	*	*	*	*											
Harmonic Metering		•	•	•						•				•	
RMS Metering	•				•	•								•	•
MISCELLANEOUS FEATURES															
Accepts Delta Voltage Transformers		•	•	•	•	•				•					
Connectorized® (Quick Disconnect) Available	*							*		•			•		
Configurable Labels	•			*	*	*				•	*	*	*	*	
Vac/Vdc Power Supply	•	•	•	•	•	•	•	•			•	•			

• *Standard Feature* * *Model Option* *f* *This function may be created using settings*

SEL-451 Protection, Automation, and Bay Control System

Quickly integrate bay control for breakers and disconnect switches with full automation and protection in one device.

SEL IEC 61850

SEL Synchrophasors™

Key Features

Rapid Bay Control Commissioning

Choose among different bus configurations, including single- and dual-busbar, transfer bus, tie breaker, breaker-and-a-half, ring-bus, double-bus/double-breaker, and source transfer configurations. These bus arrangements allow easy status and control of as many as five disconnect switches and two breakers.

Panel Integration

Improve efficiency and simplify installation with more target LEDs and operator pushbuttons. The 4U and 5U chassis have options for an additional eight target LEDs and four operator pushbuttons. Optional breaker trip/close control switches and breaker status indicating lamps replace separately mounted control switches.

Synchrophasor Measurements to Increase Asset Utilization

Validate system load flow and fault models using instantaneous voltage angles. Use system-state measurements to increase stable system loading through reduced margin requirements. Synchrophasors meet IEEE C37.118 standards.

Advanced Mirrored Bits® Communications

Transmit digital, analog, and virtual terminal information over the same digital communications channel.

Arc Sense™ Technology (AST)

Detect many high-impedance faults, a common result of a downed conductor, with AST. Alarm or trip for faults that produce low fault current and are undetectable with conventional overcurrent relays.

Ethernet Access

Access all relay functions with optional Ethernet communications. Interconnect with automation systems directly using IEC 61850 or DNP3 protocols. Use File Transfer Protocol (FTP) for high-speed data collection.

Enhanced Security

Apply communications port settings to disable ports and restrict maximum port privileges for robust security. Enhanced password security also protects the relay from unauthorized access.

True Digital Fault Recorder (DFR) Functionality

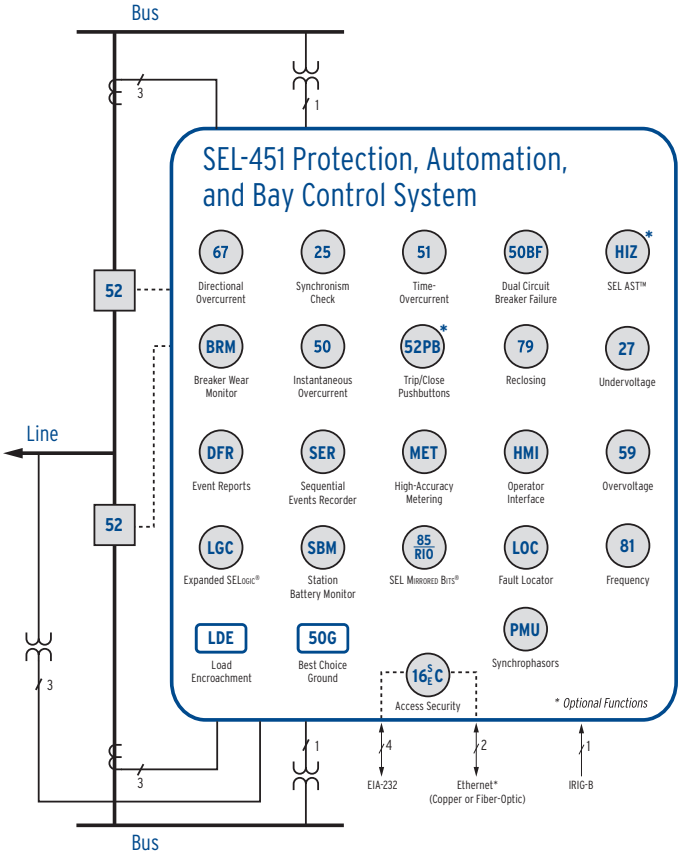
Use binary COMTRADE event reports sampled at 8 kHz direct from the relay without expensive auxiliary equipment.

Complete Overcurrent Protection

Use multiple instantaneous and time-overcurrent elements with SELogic® control equations to customize distribution protection. Best Choice Ground Directional Element® logic optimizes directional element performance and eliminates the need for many directional settings.

High-Speed Breaker Failure Detection for Two Breakers

Open-pole detection in less than 5/8 cycle allows the use of shorter breaker failure margin times. Independent current inputs provide protection for two circuit breakers.



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SEL-451 Protection, Automation, and Bay Control System

Applications

- Apply complete bay control, reclosing, and breaker failure protection for two breakers.
- Connect to Ethernet networks to simplify and speed information distribution.
- View synchronous phasors from any location via serial or Ethernet communications with an SEL-451 to measure the system state using IEEE C37.118 synchrophasor standard.
- Simplify the SEL-451 configuration process with the Graphical Logic Editor (GLE) in ACSELERATOR QuickSet Designer® SEL-5031 Software. The GLE lets you design your SELOGIC control equations graphically, so your settings files can be documented for easier validation and commissioning. Convert existing control equations to easy-to-read diagrams, and save with QuickSet settings.
- Monitor circuit breaker performance, including average and last tripping time, compressor run time, and contact-interrupting duty.
- Use expanded SELOGIC control equations for custom applications such as capacitor voltage differential, voltage-restrained overcurrent, or VAR-supervised undervoltage load shedding.
- Combine the digital fault recorder functions of the SEL-451 with ACSELERATOR Report Server® SEL-5040 Software to view system-wide events. High-accuracy timing makes report comparisons easy and accurate.
- Thermal overload protection.*

  * Connect to an SEL-2600 RTD Module using a fiber-optic transceiver.

Optional Features

- Vertical or horizontal, panel-mount or rack-mount hardware package.
- Additional inputs/outputs accommodate up to two additional I/O boards.
- Ethernet communications with fiber-optic* and copper options.
- IEC 61850 communications protocol.
- Connectorized® hardware configuration.
- Expanded targets and operator pushbuttons (4U and 5U only).
- Independent breaker trip/close control switches and indicating lamps (4U and 5U only).
- High-impedance fault detection.

  * Eye-safe, Class 1 LED product per EN 60825-1

Related Products

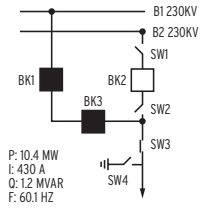
SEL-2401 Satellite-Synchronized Clock 316
SEL-3354 Embedded Automation Computing Platform 422
SEL-5077 SYNCHROWAVE® Server Software 332

GSA Schedule
Contract: GS-07F-0123N

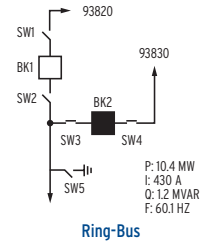
This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

One-Line Bay Diagrams

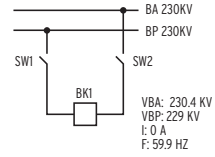
The SEL-451 offers a variety of preconfigured one-line diagrams for common bus configurations. The included diagrams demonstrate some of the preconfigured bay arrangements available in the SEL-451. Additional one-line diagrams will be created upon request for your application.



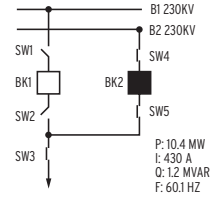
Breaker-and-a-Half



Ring-Bus



Tie Breaker



Double-Bus/Double-Breaker

Hardware Specifications

AC Voltage Inputs (6 total)

300 V_{L-N} continuous, 600 Vac for 10 seconds
Burden 0.03 A @ 67 V; 0.06 VA @ 120 V

AC Current Inputs (6 total)

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical, 1250 A for 1 cycle
Burden 0.27 VA @ 5 A; 2.51 VA @ 15 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical, 250 A for 1 cycle
Burden 0.13 VA @ 1 A; 1.31 VA @ 3 A

Power Supply

125/250 Vdc or Vac
Range 85–300 Vdc or 85–264 Vac
48/125 Vdc or 125 Vac
Range 38–140 Vdc or 85–140 Vac
24/48 Vdc
Range 18–60 Vdc

Standard Input/Output

3 high-interrupt outputs
2 standard-speed Form A outputs
3 standard-speed Form C outputs
7 settable assertion level inputs

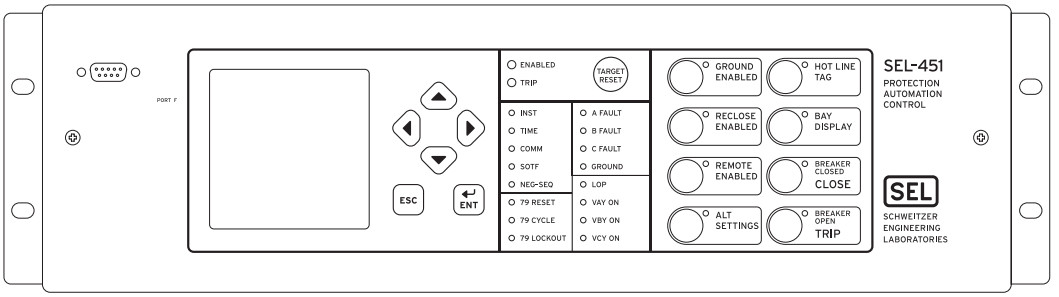
Price

Budgetary Retail, Quantity 1: $4,200

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

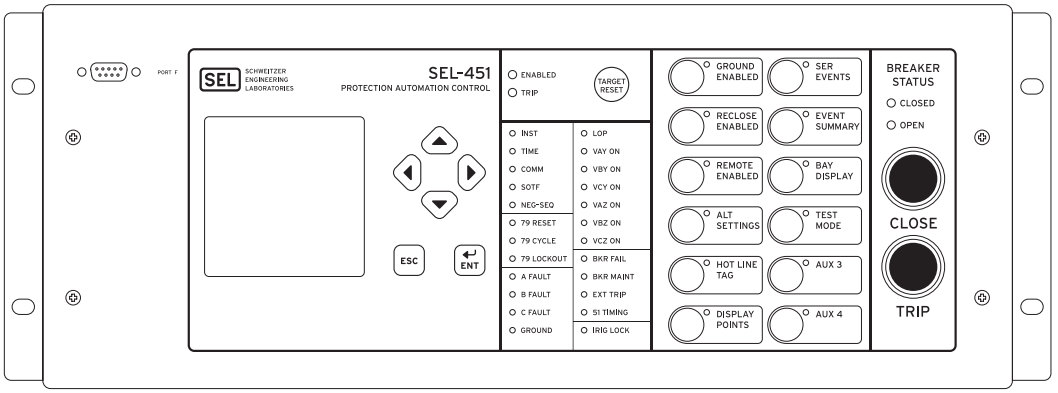
SEL-451 Protection, Automation, and Bay Control System

Front View - Rack-Mount (3U)



i4824a

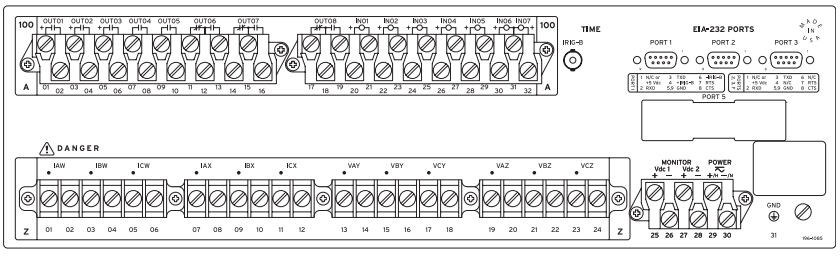
Front View - Rack-Mount (4U)



i4828a

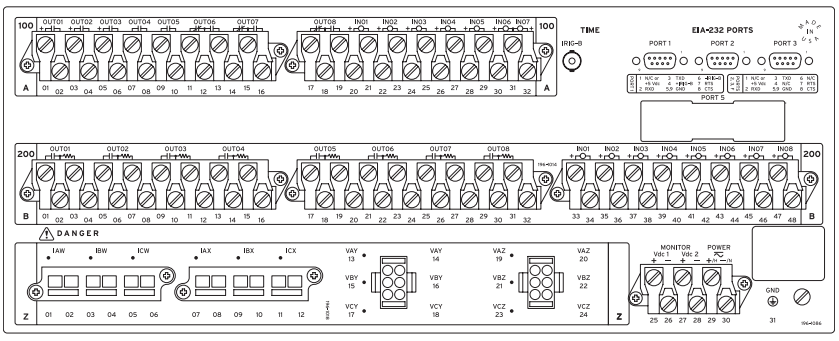
Shown with optional targets and operator pushbuttons (available on 4U and 5U only).

Rear View - Conventional Terminal Blocks (3U)



i3359d

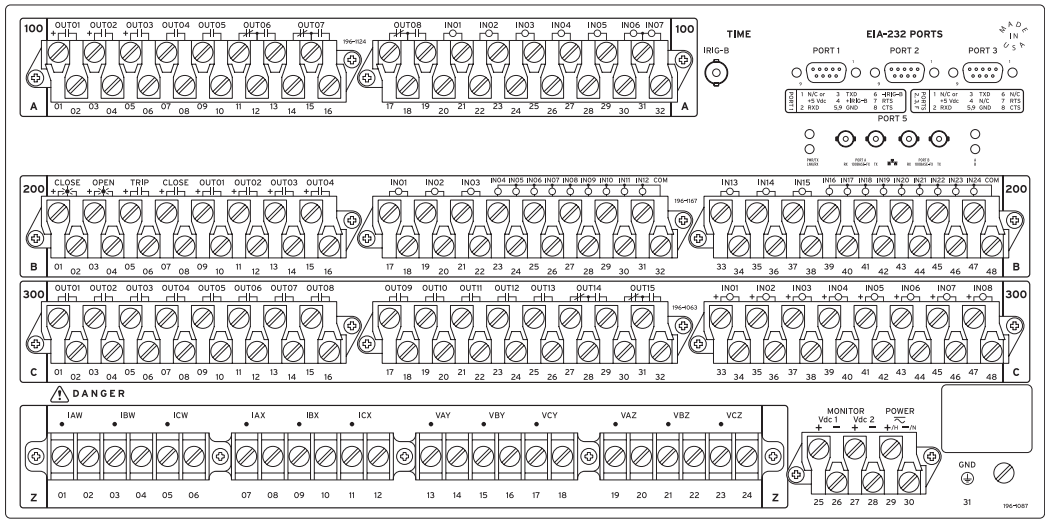
Rear View - Connectorized® - One Additional I/O (4U)



i3375c

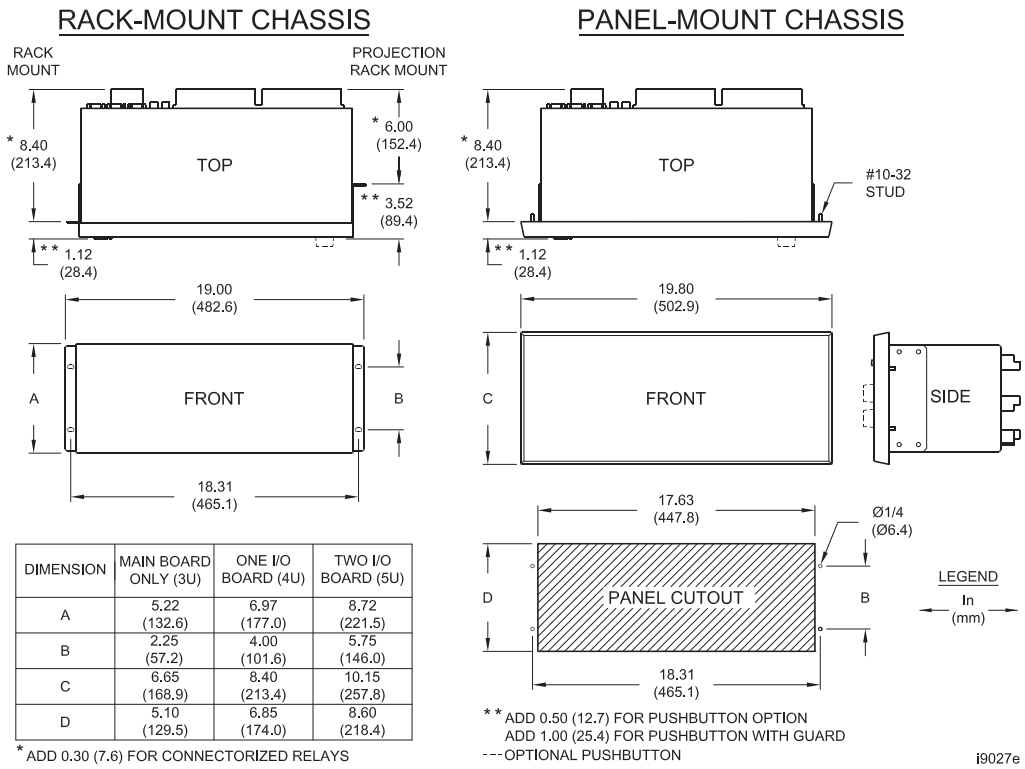
SEL-451 Protection, Automation, and Bay Control System

Rear View – Conventional Terminal Blocks - Two Additional I/O (5U)



i4149a

Dimensions



DIMENSION	MAIN BOARD ONLY (3U)	ONE I/O BOARD (4U)	TWO I/O BOARD (5U)
A	5.22 (132.6)	6.97 (177.0)	8.72 (221.5)
B	2.25 (57.2)	4.00 (101.6)	5.75 (146.0)
C	6.65 (168.9)	8.40 (213.4)	10.15 (257.8)
D	5.10 (129.5)	6.85 (174.0)	8.60 (218.4)

* ADD 0.30 (7.6) FOR CONNECTORIZED RELAYS

** ADD 0.50 (12.7) FOR PUSHBUTTON OPTION
ADD 1.00 (25.4) FOR PUSHBUTTON WITH GUARD
---OPTIONAL PUSHBUTTON

i9027e

Visit www.selinc.com for more detailed information and configuration options.

SEL-351 Protection System

Choose the SEL-351-5, -6, or -7 Relay for transmission or distribution overcurrent protection with optional load profile recording, Mirrored Bits® communications, and power quality monitoring capabilities.

Key Features

Complete and Flexible Protection

Multiple phase, negative-sequence, neutral, and residual instantaneous/definite-time overcurrent elements with independent pickup, time dial, curve, and reset emulation settings. Numerous phase and sequence under- and overvoltage elements. Six steps of frequency elements for multilevel under- and overfrequency trip and control.

Innovative Directional Element Polarization

Positive-sequence voltage-polarized phase directional element with memory for directional stability during phase faults. Best Choice Ground Directional Element® logic for secure ground directional element operation for all types of system grounding practices under varying system conditions.

Adaptive Overcurrent Element

The Adaptive Overcurrent Element performs reliably even with CT saturation, dc offset, and off-frequency harmonics.

Enhanced Security

Apply communications port settings to disable ports and restrict maximum privileges for robust security. Enhanced password security also protects the relay from unauthorized access.

Communications and Automation

Built-in Ethernet communications, EIA-232 serial ports, and available EIA-485 serial port provide easy local/remote access and system integration. The optional front-panel USB port simplifies local connection and speeds relay communication and event retrieval. Optional Mirrored Bits communications protocol for eight channels of secure relay-to-relay logic communications is available on both rear-panel EIA-232 serial ports. Programmable relay logic affords increased ability for user-defined automation requirements.

Pilot Communications-Assisted Trip Logic

Multiple pilot communications-assisted trip logic schemes are available for use with traditional pilot communications equipment or with optional Mirrored Bits communications.

Reclosing Control

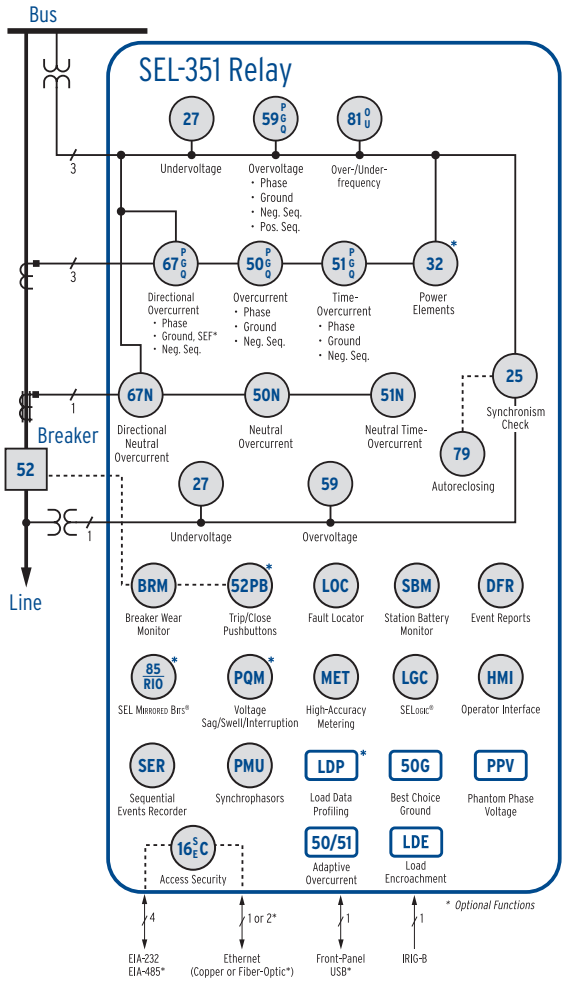
Programmable four-shot breaker autoreclosing function with synchronism and voltage check logic matches a variety of reclosing practices. Sequence coordination logic coordinates with downstream reclosers.

IEEE C37.118 Synchrophasors Increase Asset Utilization

Validate system load flow and fault models using instantaneous voltage angles. Use system-state measurements to increase stable system loading through reduced margin requirements.

Metering, Load Profiling, Power Quality Monitoring

Accurate metering eliminates the need for external meters (amps, volts, MW, MVAR, MWh, MVARh, PF, instantaneous/peak demand, frequency, dc volts, and harmonics to the 16th order). Optional load profiling periodically records up to 15 quantities for daily, weekly, and monthly trending information. Optional power quality monitoring records voltage sags, swells, and interruptions.



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SEL-351 Protection System

Applications

- Integrate easily into new or existing Ethernet networks with single or dual, copper or fiber-optic Ethernet communications ports.
- Connect to SCADA systems using DNP3 Level 2 Outstation and Modbus® serial and Ethernet communications protocols.
- Access basic relay information on a standard Ethernet network with the built-in web server. Securely view relay status, settings, and other read-only information within a local network.
- Protect and control radial or looped transmission, subtransmission, or distribution circuits.
- Use pilot protection on transmission, subtransmission, or distribution circuits, including three-terminal lines.
- Apply sensitive directional overcurrent protection for Petersen Coil grounded, ungrounded, and impedance-grounded power systems.
- Apply directional and nondirectional overcurrent protection for transformer/bus-main/bus-tie breaker.
- Protect and control capacitor banks.
- Apply breaker failure protection.
- Control autoreclosing with synchronism and voltage check logic.
- Protect small generators.
- View IEEE C37.118 synchronous phasors from any location to measure the system state.
- Protect distributed generation interconnections.
- Shed load using underfrequency elements.
- Dispatch line crews to quickly isolate overhead line problems and restore service faster using built-in fault locator.
- Schedule circuit breaker maintenance based on need as determined from breaker monitoring data and alarms.
- Analyze overcurrent protection system performance using built-in Sequential Events Recorder (SER).

Optional Features

- Single or dual fiber-optic Ethernet or dual copper Ethernet communications port.
- SafeLock™ trip/close pushbuttons.
- Front-panel USB communications port.
- Panel-mount, projection panel-mount, or rack-mount hardware package.
- Vertical panel-mount (3U) hardware package.
- Mirrored Bits communications and load profiling.
- Additional I/O board with contact-sensing inputs and standard or high-current interrupting contact outputs.
- Sensitive directional power elements.
- Voltage sag, swell, and interruption (VSSI) recording.
- Low-range neutral current input channel for nondirectional sensitive earth fault (SEF) applications (0.05 A nominal neutral).
- Sensitive directional earth fault protection for Petersen Coil grounded, ungrounded, and impedance-grounded power systems (0.2 A nominal neutral).
- IEC 61850 communications protocol.

Related Products

SEL-3530/3530-4 Real-Time Automation Controllers (RTACs) 338
SEL-5078 SYNCHROWAVE® Console Software 333

Hardware Specifications

AC Voltage Inputs

300 V_{L-N} or V_{L-L} continuous, 600 Vac for 10 seconds (wye or delta)

Burden 0.03 VA @ 67 V; 0.06 VA @ 120 V; 0.8 VA @ 300 V

AC Current Inputs

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical, 1250 A for 1 cycle

Burden 0.27 VA @ 5 A; 2.51 VA @ 15 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical, 250 A for 1 cycle

Burden 0.13 VA @ 1 A; 1.31 VA @ 3 A

Sensitive Earth Fault

0.2 A nominal channel IN current input: 15 A continuous, 500 A for 1 second, linear to 6.4 A symmetrical, 1250 A for 1 cycle

Burden 0.00009 VA @ 0.2 A; 0.54 VA @ 15 A

0.05 A nominal channel IN current input: 15 A continuous, 500 A for 1 second, linear to 6.4 A symmetrical, 1250 A for 1 cycle

Burden 0.000005 VA @ 0.05 A; 0.0054 VA @ 1.5 A

Power Supply Ratings

24/48 V supply	18–60 Vdc; <25 W
48/125 V supply	38–200 Vdc or 85–140 Vac; <25 W
125/250 V supply	85–350 Vdc or 85–264 Vac; <25 W

Standard Control Input and Output Ranges

24, 48, 110, 125, 220, or 250 Vdc, level sensitive (specify voltage at time of order)

Standard configuration provides 6 inputs and 8 outputs, <5 ms pickup/dropout times with 30 A make, 6 A continuous duty.

Additional I/O board may be selected with standard inputs and outputs or with a combination of standard inputs and high-current interrupting outputs.

Operating Temperature

–40° to +85°C (–40° to +185°F)

(Note: LCD contrast impaired for temperatures below –20°C)

Price

Budgetary Retail, Quantity 1:	SEL-351-5, -6	$2,380
	SEL-351-7	$3,010

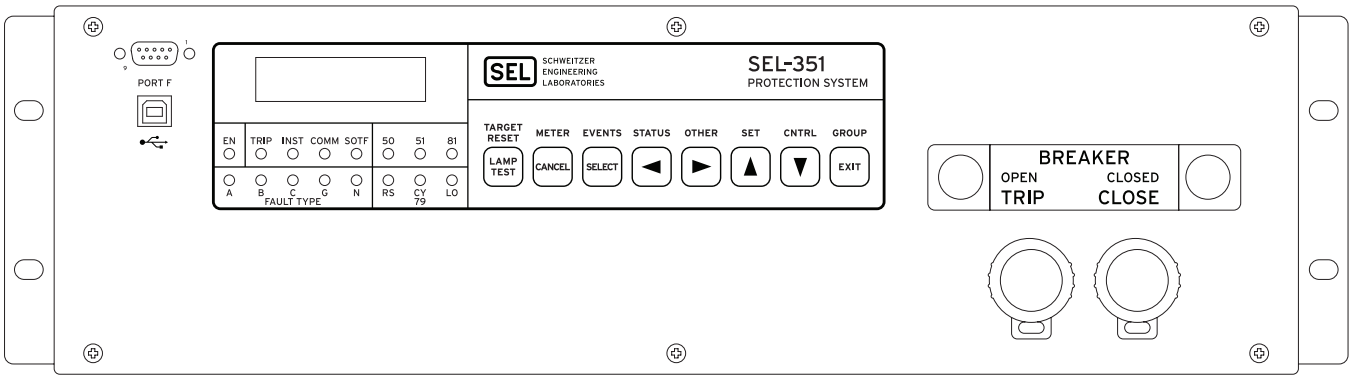
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

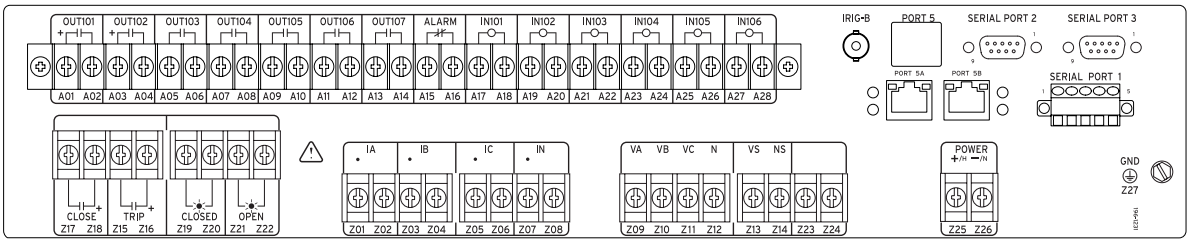
SEL-351 Protection System

Front View – Rack-Mount (vertical panel-mount also available)



i4289a

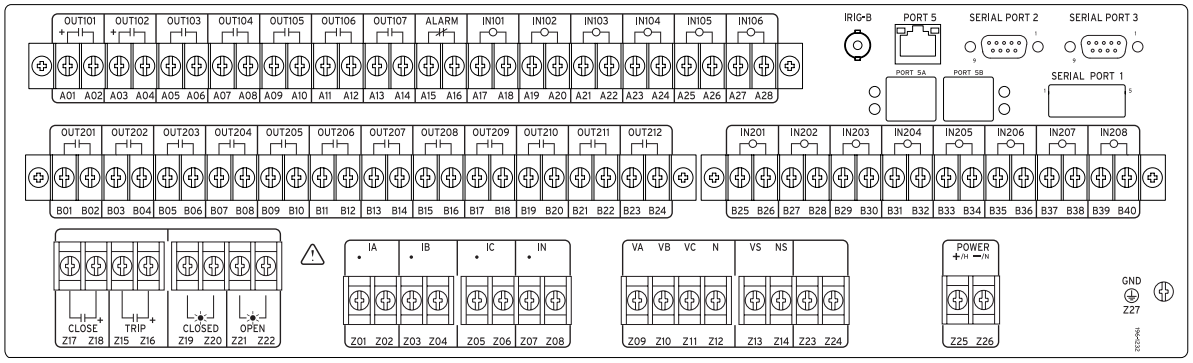
Rear View – Conventional Terminal Blocks (2U)



i4292b

2U chassis with optional dual Ethernet and EIA-485 serial ports.

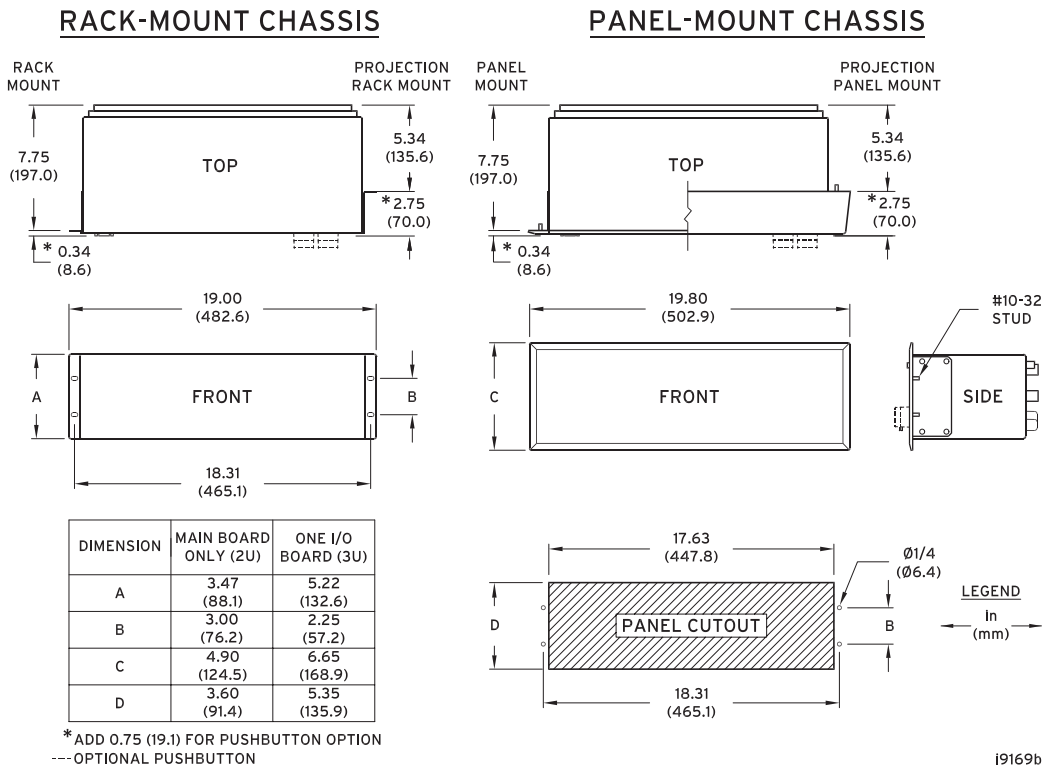
Rear View – Conventional Terminal Blocks – Additional I/O (3U)



i4293b

SEL-351 Protection System

Dimensions



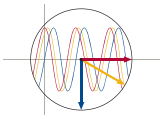
DIMENSION	MAIN BOARD ONLY (2U)	ONE I/O BOARD (3U)
A	3.47 (88.1)	5.22 (132.6)
B	3.00 (76.2)	2.25 (57.2)
C	4.90 (124.5)	6.65 (168.9)
D	3.60 (91.4)	5.35 (135.9)

*ADD 0.75 (19.1) FOR PUSHBUTTON OPTION
---OPTIONAL PUSHBUTTON

Visit www.selinc.com for more detailed information and configuration options.

SEL-351A Protection System

Select the SEL-351A Protection System for complete, economical distribution feeder protection, automation, monitoring, and control.



Key Features

Dependable Overcurrent Protection

Sensitive and secure mix of phase, negative-sequence, neutral, and residual overcurrent elements with available directional control for coordinated protection. Phase and ground directional elements with memory for directional stability and Best Choice Ground Directional Element® logic to optimize directional elements according to system conditions.

Enhanced Security on Heavily Loaded Feeders

Load-encroachment control of the four phase overcurrent elements for load security. Loss-of-potential logic used to disable voltage-polarized directional elements and associated overcurrent elements.

IEEE C37.118 Synchrophasors Increase Asset Utilization

Validate system load flow and fault models using instantaneous voltage angles. Use system-state measurements to increase stable system loading through reduced margin requirements.

Enhanced Security

Apply communications port settings to disable ports and restrict maximum privileges for robust security. Enhanced password security also protects the relay from unauthorized access.

Communications and Automation

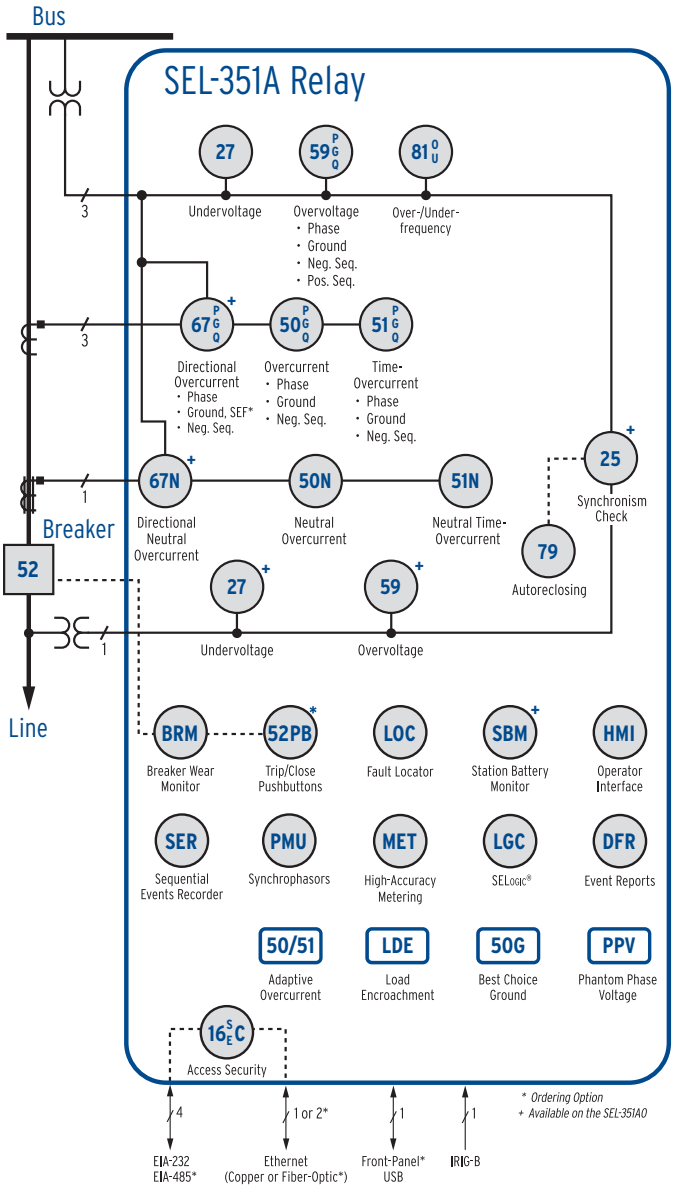
Built-in Ethernet communications, EIA-232 serial ports, and available EIA-485 serial port provide easy local/remote access and system integration. The optional front-panel USB port simplifies local connection and speeds relay communication and event retrieval. Programmable relay logic affords increased ability for user-defined automation requirements.

Metering and Monitoring

Accurate metering eliminates the need and associated installation costs for external meters (MW, MVAR, MWh, MVARh, PF, instantaneous/peak demand, and harmonics to the 16th order). Monitor substation battery voltage, alarm for excessive breaker wear, and capture detailed 1/128 cycle resolution oscillographic event reports. Sequential Events Recorder (SER) data have 1/4 cycle resolution of up to 72 relay elements.

Adaptive Overcurrent Element

The Adaptive Overcurrent Element performs reliably even with CT saturation, dc offset, and off-frequency harmonics.



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SEL-351A Protection System

Applications

- Integrate easily into new or existing Ethernet networks with single or dual, copper or fiber-optic Ethernet communications ports.
- Connect to SCADA systems using DNP3 Level 2 Outstation and Modbus® serial and Ethernet communications protocols.
- Access basic relay information on a standard Ethernet network with the built-in web server. Securely view relay status, settings, and other read-only information within a local network.
- Provide primary or backup overcurrent protection on distribution feeders with sensitive phase, negative-sequence, residual, and neutral overcurrent protection elements.
- Apply sensitive directional overcurrent protection for Petersen Coil grounded, ungrounded, and impedance-grounded power systems.
- Set the bus overcurrent backup relay close to maximum bus load current levels using load-encroachment logic for security.
- Apply in underfrequency load-shedding schemes to meet system operating requirements put forward by area system coordinating councils.
- View IEEE C37.118 synchronous phasors from any location to measure the system state.
- Use as multishot reclosing control for transmission breakers.
- Accurately estimate fault locations and reduce total costs by eliminating the need for expensive communications channels, special instrument transformers, prefault information, or line crews to travel the distance of the line for visual fault inspection.
- Use built-in SELOGIC® control equations for substation capacitor bank switching control.

Optional Features

- Single or dual fiber-optic Ethernet or dual copper Ethernet communications port.
- SafeLock™ trip/close pushbuttons.
- Front-panel USB communications port.
- Panel-mount, projection panel-mount, or rack-mount hardware package.
- Vertical panel-mount (2U) hardware package, without display.
- Low-range neutral current input channel for nondirectional sensitive earth fault (SEF) applications (0.05 A nominal neutral).
- Sensitive directional earth fault protection for Petersen Coil grounded, ungrounded, and impedance-grounded power systems (0.2 A nominal neutral).
- IEC 61850 communications protocol.

Related Products

SEL-2401 Satellite-Synchronized Clock 316
SEL-3530/3530-4 Real-Time Automation Controllers (RTACs) 338

Hardware Specifications

AC Voltage Inputs

300 V_{L-N} or V_{L-L} continuous, 600 Vac for 10 seconds (wye or delta)

Burden 0.03 VA @ 67 V; 0.06 VA @ 120 V; 0.8 VA @ 300 V

AC Current Inputs

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical, 1250 A for 1 cycle

Burden 0.27 VA @ 5 A; 2.51 VA @ 15 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical, 250 A for 1 cycle

Burden 0.13 VA @ 1 A; 1.31 VA @ 3 A

Sensitive Earth Fault

0.2 A nominal channel IN current input: 15 A continuous, 500 A for 1 second, linear to 6.4 A symmetrical, 1250 A for 1 cycle

Burden 0.00009 VA @ 0.2 A; 0.54 VA @ 15 A

0.05 A nominal channel IN current input: 15 A continuous, 500 A for 1 second, linear to 6.4 A symmetrical, 1250 A for 1 cycle

Burden 0.000005 VA @ 0.05 A; 0.0054 VA @ 1.5 A

Power Supply Ratings

24/48 V supply	18–60 Vdc; <25 W
48/125 V supply	38–200 Vdc or 85–140 Vac; <25 W
125/250 V supply	85–350 Vdc or 85–264 Vac; <25 W

Standard Control Input and Output Ranges

24, 48, 110, 125, 220, or 250 Vdc, level sensitive
(specify voltage at time of order)

Standard configuration provides 6 inputs and 8 outputs, <5 ms pickup/dropout times with 30 A make, 6 A continuous duty.

Operating Temperature

–40° to +85°C (–40° to +185°F)

(Note: LCD contrast impaired for temperatures below –20°C)

Price

Budgetary Retail, Quantity 1: $1,440

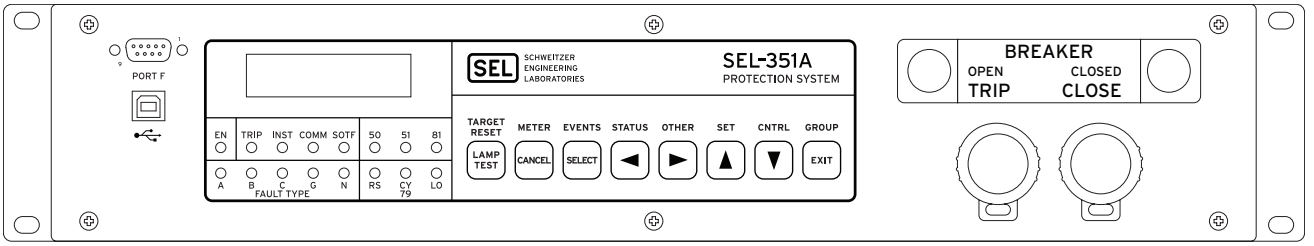
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

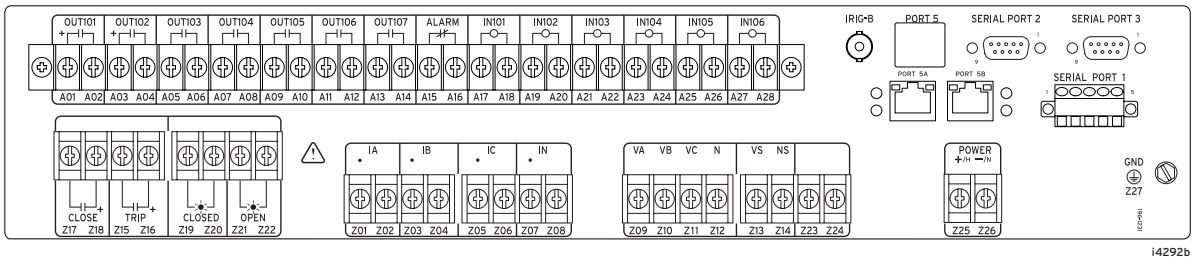
SEL-351A Protection System

Front View – Rack-Mount



i4410a

Rear View – Conventional Terminal Blocks (2U)

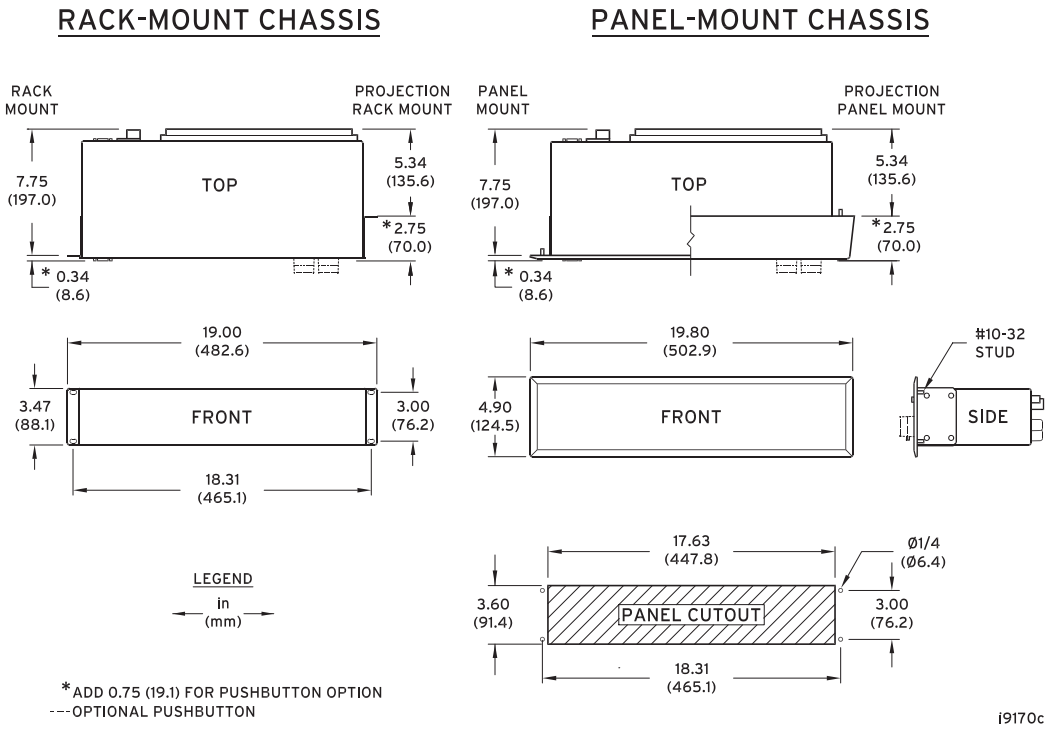


i4292b

2U chassis with optional dual Ethernet and EIA-485 serial ports.

SEL-351A Protection System

Dimensions



Visit www.selinc.com for more detailed information and configuration options.

SEL-351S Protection System

Simplify feeder protection and control with the SEL-351S Protection System, combining comprehensive protection, control, automation, and communication in one package.

SEL Synchrophasors®

Key Features

Complete and Flexible Protection

All of the protection you need, including instantaneous/definite-time overcurrent elements, time-overcurrent elements, voltage elements, and frequency elements plus all traditional recloser time-overcurrent (TOC) curves. Innovative directional element polarization for secure and stable directional operation, load-encroachment logic, and built-in pilot scheme logic for use with traditional communications equipment or with optional Mirrored Bits® communications. The Adaptive Overcurrent Element provides high-speed operation for severe faults, even with CT saturation.

Large Display and Operator Controls

Large front-panel display and programmable operator control interface pushbuttons replace conventional control switches, meters, and wiring at the breaker control panel. Pushbuttons are preprogrammed and labeled with popular control switch functions and can be reprogrammed and relabeled to meet your unique application requirements. Optional breaker trip/close control switches and indicating lamps replace separately mounted control switches.

Enhanced Security

Apply communications port settings to disable ports and restrict maximum privileges for robust security. Enhanced password security also protects the relay from unauthorized access.

Communications and Automation

Built-in Ethernet communications, EIA-232 serial ports, and available EIA-485 serial port provide easy local/remote access and system integration. The optional front-panel USB port simplifies local connection and speeds relay communication and event retrieval. Optional Mirrored Bits communications protocol for eight channels of secure relay-to-relay logic communications is available on both rear-panel EIA-232 serial ports. Programmable relay logic affords increased ability for user-defined automation requirements.

Reclosing Control

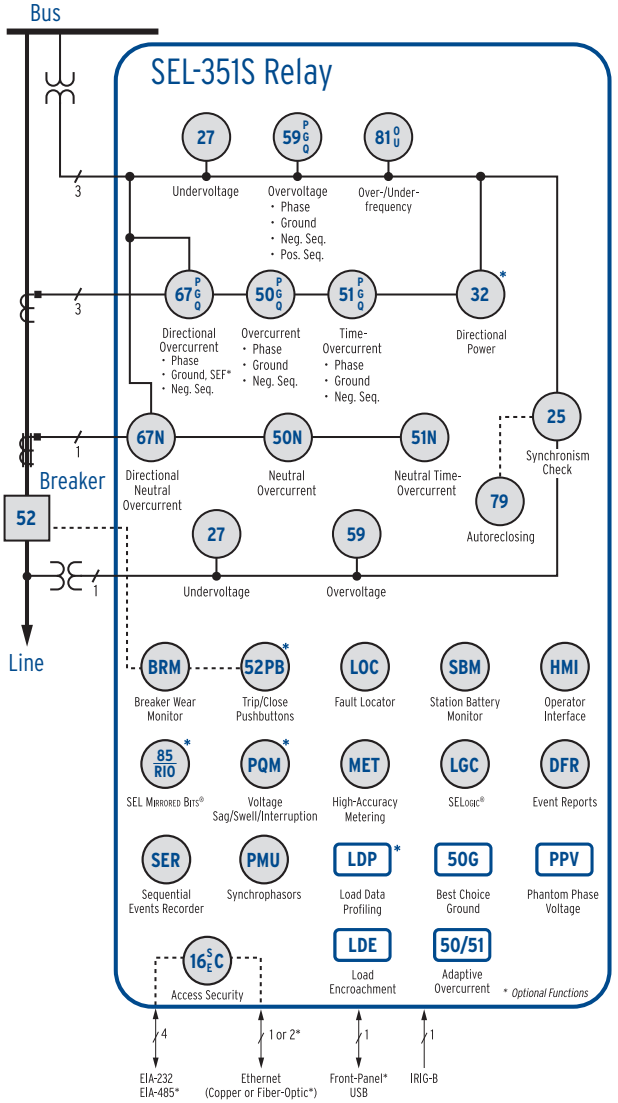
Programmable four-shot autoreclosing function with synchronism and voltage check logic matches a variety of reclosing practices. Sequence coordination logic coordinates with downstream reclosers.

IEEE C37.118 Synchrophasors Increase Asset Utilization

Validate system load flow and fault models using instantaneous voltage angles. Use system-state measurements to increase stable system loading through reduced margin requirements.

Metering, Load Profiling, and Power Quality Monitoring

Accurate metering eliminates the need for external meters (amps, volts, MW, MVAR, MWh, MVARh, PF, instantaneous/peak demand, frequency, dc volts, and harmonics to the 16th order). Optional load profiling periodically records up to 15 quantities for daily, weekly, and monthly trending information. Optional power quality monitoring records voltage sags, swells, and interruptions.



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SEL-351S Protection System

Applications

- Integrate easily into new or existing Ethernet networks with single or dual, copper or fiber-optic Ethernet communications ports.
- Connect to SCADA systems using DNP3 Level 2 Outstation and Modbus® serial and Ethernet communications protocols.
- Access basic relay information on a standard Ethernet network with the built-in web server. Securely view relay status, settings, and other read-only information within a local network.
- Protect and control radial or looped transmission, subtransmission, or distribution circuits.
- Use directional overcurrent comparison pilot protection on transmission or subtransmission circuits, including three-terminal lines.
- Apply directional and nondirectional overcurrent protection for transformer/bus-main/bus-tie breakers.
- Protect and control capacitor banks.
- Apply breaker failure protection.
- Control autoreclosing with synchronism and voltage check logic.
- Protect small generators.
- Protect distributed generation interconnections.
- Shed load using underfrequency and/or undervoltage elements.
- View IEEE C37.118 synchronous phasors from any location to measure the system state.
- Apply comprehensive mix of overcurrent functions for sensitive protection of phase-to-phase and phase-to-ground faults and fast operation for three-phase faults.
- Commission automatic substation restoration schemes using programmable user interface controls and Mirrored Bits communications in conjunction with the SEL-2100 Logic Processor.
- Use the programmable control logic and integration features with a communications link for control and protection of remote substations.
- Dispatch line crews to quickly isolate overhead line problems and restore service faster using built-in fault locator.

Optional Features

- Single or dual fiber-optic Ethernet or dual copper Ethernet communications port.
- SafeLock™ trip/close pushbuttons.
- Front-panel USB communications port.
- Panel-mount, projection panel-mount, or rack-mount hardware package.
- Vertical panel-mount hardware package.
- Mirrored Bits communications and load profiling.
- Additional interface I/O board with contact-sensing inputs and standard or high-current interrupting contact outputs.
- Sensitive directional power elements and voltage sag, swell, and interruption (VSSI) recording.
- Low-range neutral current input channel for nondirectional sensitive earth fault (SEF) applications (0.05 A nominal neutral).
- Sensitive directional earth fault protection for Petersen Coil grounded, ungrounded, and impedance-grounded power systems (0.2 A nominal neutral).
- User-configurable labels.
- IEC 61850 communications protocol.

Hardware Specifications

AC Voltage Inputs

300 V_{L-N} or V_{L-L} continuous 600 Vac for 10 seconds (wye or delta)

Burden 0.03 VA @ 67 V; 0.06 VA @ 120 V; 0.8 VA @ 300 V

AC Current Inputs

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical, 1250 A for 1 cycle

Burden 0.27 VA @ 5 A; 2.51 VA @ 15

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical, 250 A for 1 cycle

Burden 0.13 VA @ 1 A; 1.31 VA @ 3 A

Sensitive Earth Fault

0.2 A nominal channel IN current input: 15 A continuous, 500 A for 1 second, linear to 6.4 A symmetrical, 1250 A for 1 cycle

Burden 0.00009 VA @ 0.2 A; 0.54 VA @ 15 A

0.05 A nominal channel IN current input: 15 A continuous, 500 A for 1 second, linear to 6.4 A symmetrical, 1250 A for 1 cycle

Burden 0.000005 VA @ 0.05 A; 0.0054 VA @ 1.5 A

Power Supply Ratings

24/48 V supply	18–60 Vdc; <25 W
48/125 V supply	38–200 Vdc or 85–140 Vac; <25 W
125/250 V supply	85–350 Vdc or 85–264 Vac; <25 W

Standard Control Input and Output Ranges

24, 48, 110, 125, 220, or 250 Vdc, level sensitive (specify voltage at time of order)

Standard configuration provides 6 inputs and 8 outputs, <5 ms pickup/dropout times with 30 A make, 6 A continuous duty. Additional interface I/O board may be selected with standard inputs and outputs or with a combination of standard inputs and high-current interrupting outputs.

Operating Temperature

–40° to +85°C (–40° to +185°F)

(Note: LCD contrast impaired for temperatures below –20°C)

Related Products

SEL-2407® Satellite-Synchronized Clock 308

SEL-3530/3530-4 Real-Time Automation Controllers (RTACs) 338

SEL-5077 SYNCHROWAVE® Server Software 332

Price

Budgetary Retail, Quantity 1:	SEL-351S-5, -6	$2,550
	SEL-351S-7	$3,180

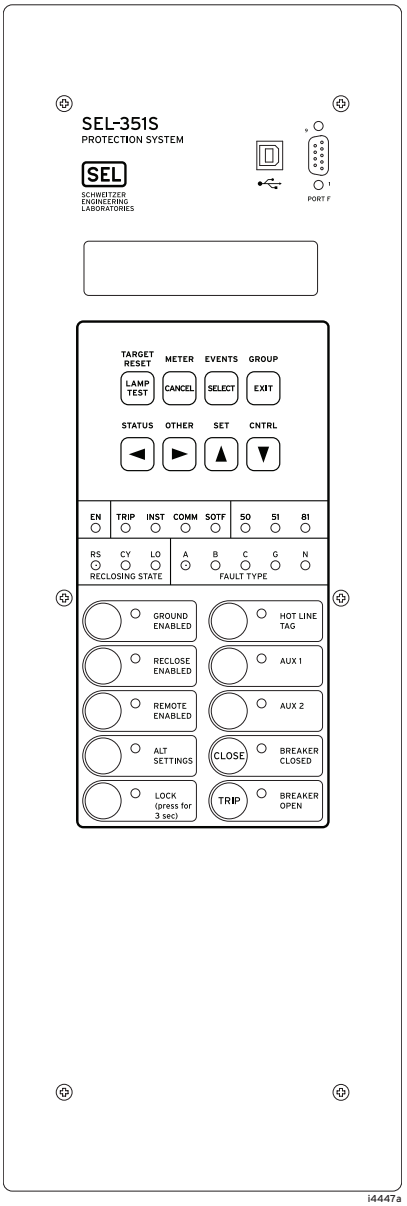
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

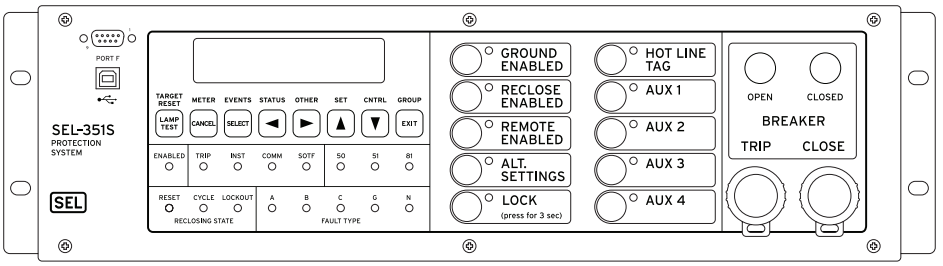
SEL-351S Protection System

Front View – Panel-Mount (Vertical)



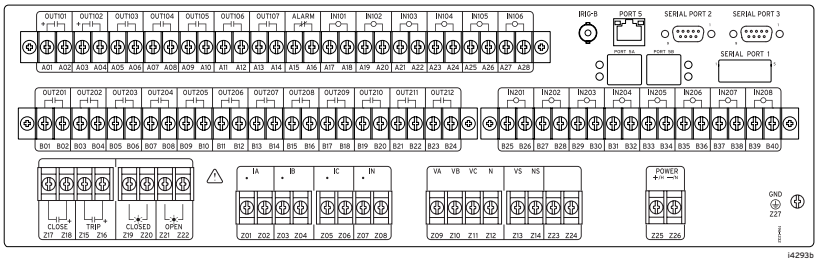
i4447a

Front View – Rack-Mount



i4291a

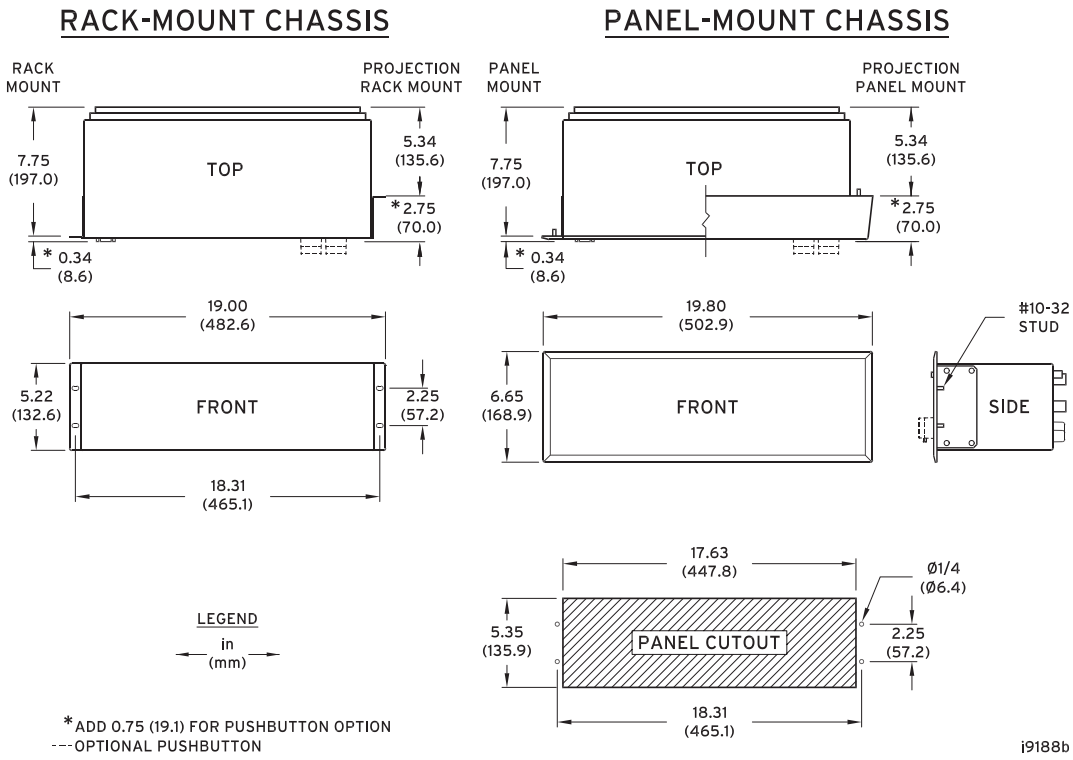
Rear View – Conventional Terminal Blocks



i4293b

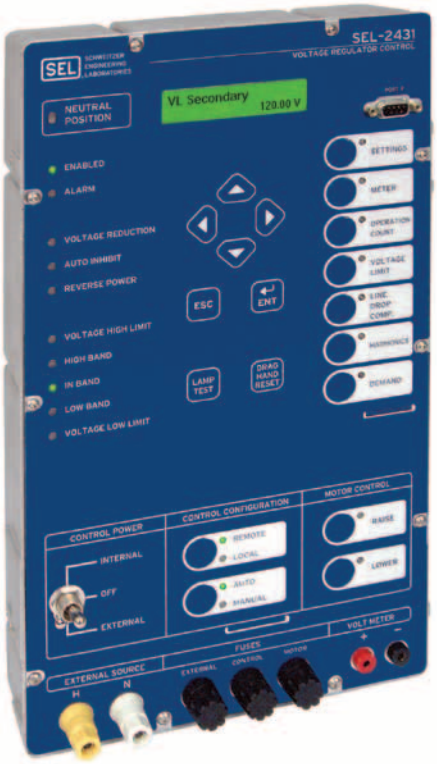
SEL-351S Protection System

Dimensions



Visit www.selinc.com for more detailed information and configuration options.

SEL-2431 Voltage Regulator Control



Optimize system voltage with the SEL-2431 Voltage Regulator Control, using directional voltage profiles and detailed tap-change event reports.

Key Features

Built-In Reliability, No-Questions-Asked Warranty

Reduce maintenance and repair costs with the industry's only voltage regulator control with a worldwide, ten-year, no-questions-asked warranty.

Plug-In Voltage Regulator Compatibility

Use simple hinge and wiring kits to mount the SEL-2431 Voltage Regulator Control directly into existing control cabinets for Cooper/McGraw-Edison, GE, Howard Industries, and Siemens/Allis-Chalmers 32-step, single-phase voltage regulators.

Easy Application Settings

Quickly commission new controls with a minimal number of simple, application-specific settings.

Rugged Design

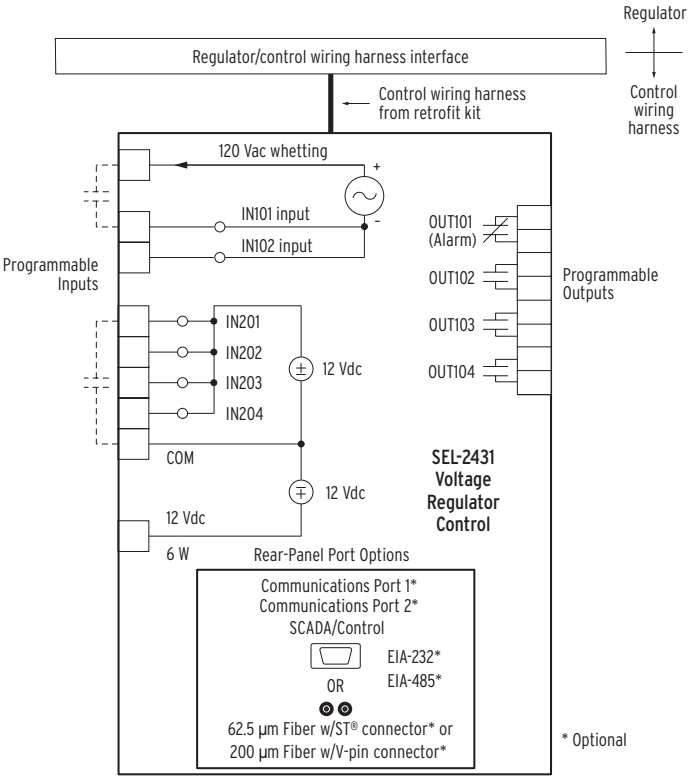
Rely on the only regulator control built to protective relay standards, with the industry's widest ambient operating temperature range, −40° to +85°C (−40° to +185°F), in a rugged, single-board design.

Large Display and Operator Controls

Use large front-panel display and programmable operator control interface pushbuttons for easy control.

Convenient Rotating Display Points

Define up to 32 analog display points on the rotating display to easily show key information. This allows users to gather periodic load, metering, and status information without even pushing a button.



SEL-2431 Voltage Regulator Control

Applications

- Supports the following modes of operation:
  - Locked forward
  - Locked reverse
  - Idle reverse
  - Bidirectional
  - Cogeneration
- Personalize LCD messages using event-driven display point settings.
- Create an integrated control system with a variety of I/O and communications options.
- Analyze system performance using built-in Sequential Events Recorder (SER) and waveform event reports.
- Use ACSELERATOR QuickSet® SEL-5030 Software to manage your voltage regulator control settings.
- Monitor load- and source-side voltage inputs for optimal reverse and bidirectional operation.
- Choose pushbutton or toggle switch raise/lower control.
- Use the built-in contact I/O (8 inputs, 7 outputs) to control accessories or for custom applications.

Optional Features

- Two communications port options, including any combination of:
  - EIA-232
  - EIA-485
  - Fiber-optic, 200 µm, multimode, V-pin connector
  - Fiber-optic, 62.5 µm, multimode, ST® connector

  Note: With optional communications ports, choose from SEL ASCII, SEL Compressed ASCII, Fast Meter and Fast Operate, and DNP3 Level 2 Outstation protocols.
- Conformally coated circuit board.

Related Products

SEL-2401 Satellite-Synchronized Clock 316
SEL-3022 Wireless Encrypting Transceiver 366

Available Retrofit Kits

Replace existing voltage regulator controls with SEL-2431 direct replacement mounting and wiring kits. These kits provide all the parts needed to easily replace existing controls with the SEL-2431.

Siemens/Allis-Chalmers: 10-position polarized disconnect switch (PDS) interface	9253002
Howard Industries: 10-position connector terminal strip (CTS) interface	9253003
Cooper/McGraw-Edison: 18/10-position fanning strip (traditional interface)	9253004
Cooper: 20-position connector (dead-front interface)	9253005
GE: Fork-terminal connections (traditional interface to cabinet NN terminals)	9253006
GE: 24-position connector (power disconnect interface)	9253007

Hardware Specifications

Power Supply

Range	88–132 Vac
Burden	≤35 VA

Raise/Lower Outputs

Carry	6 A continuous at 120 Vac

Voltage Control Accuracy—Steady State (V secondary)

Measured channels	±0.3% (–40° to +85°C, 108–132 Vac) (IEEE C57.15-1999)
Calculated values	±1.0% (–40° to +85°C, 108–132 Vac)
Load current	±0.3% ±500 µA (0.001–2.000 A) and ±0.5° (0.020–2.000 A)

Price

Budgetary Retail, Quantity 1: $1,095

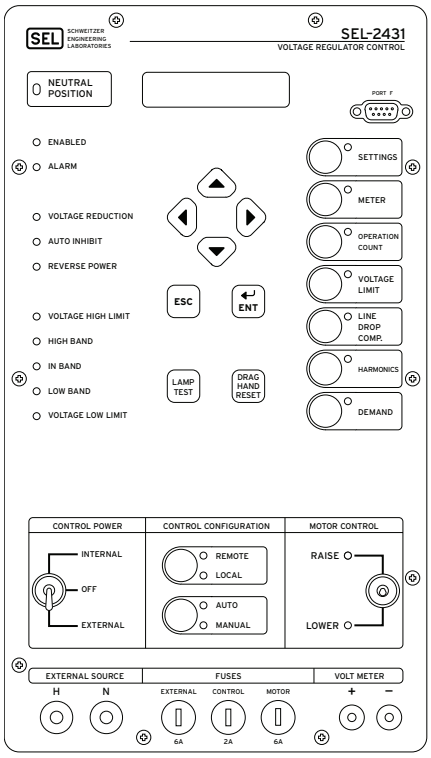
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

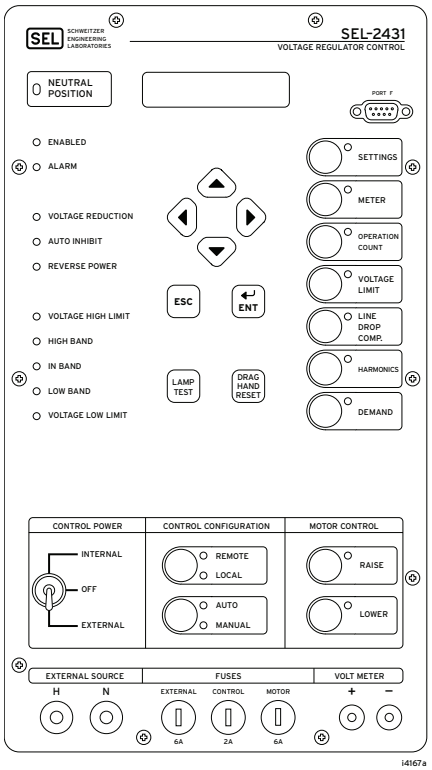
SEL-2431 Voltage Regulator Control

Front View



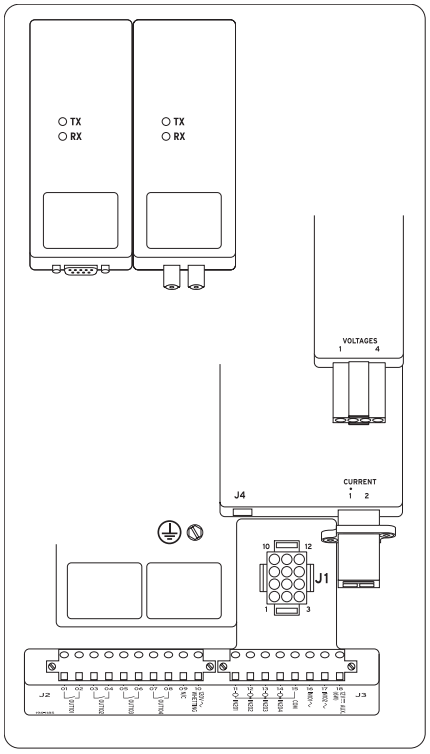
Front panel with raise/lower toggle switch option.

Front View



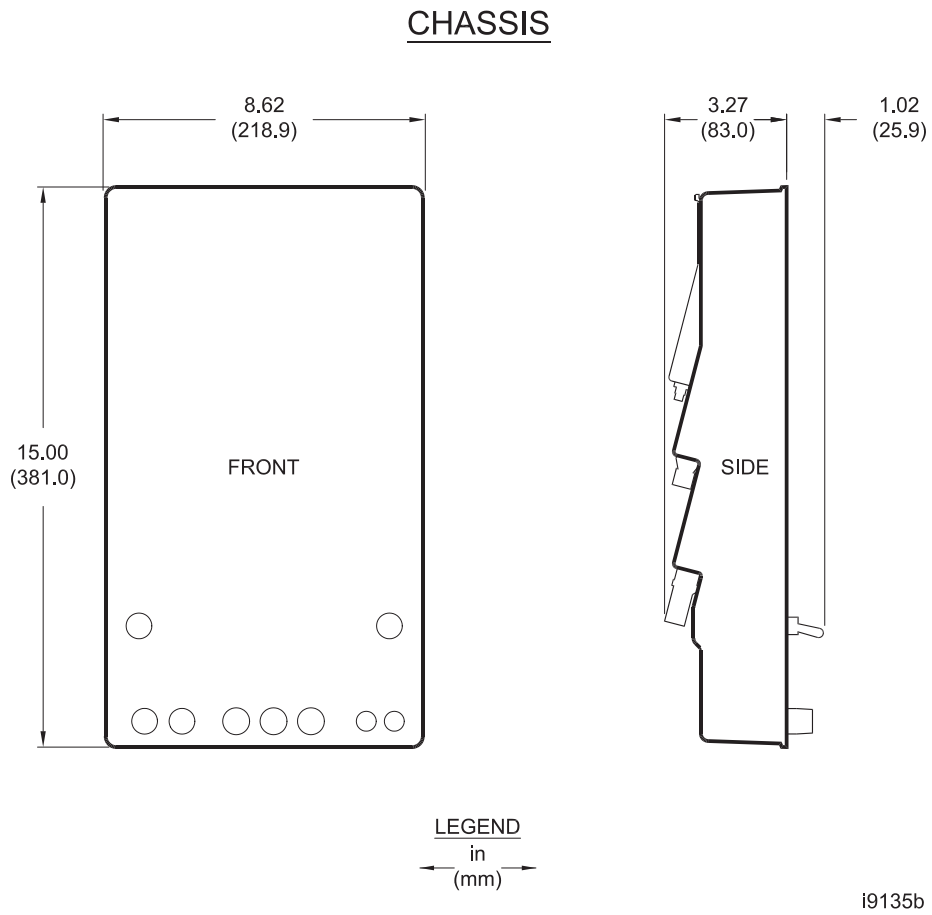
Front panel with raise/lower pushbutton option.

Rear View



SEL-2431 Voltage Regulator Control

Dimensions



Visit www.selinc.com for more detailed information and configuration options.

SEL-751 Feeder Protection Relay

Choose the SEL-751 for feeder overcurrent protection with optional directional overcurrent, auto reclosure, and Arc Sense™ Technology.

SEL IEC 61850

SEL Synchrophasors™

Key Features

Directional Overcurrent and Arc Sense Technology (AST)

The SEL-751 builds on the capabilities of the popular SEL-751A Feeder Protection Relay. The additional protection elements of the SEL-751 include directional overcurrent and AST.

Arc-Flash Detection

Reduce arc-flash incident energy with fast detection and tripping. Combine light-sensing technology with fast overcurrent protection to provide high speed without false tripping.

Additional Fault Detection With AST

Detect many high-impedance faults, a common result of a downed conductor, with AST. Alarm or trip for faults that produce low fault current and are undetectable with conventional overcurrent relays.

Convenient Controls

Use the eight programmable pushbuttons with two tricolor LEDs, each on the front, for quick, personalized control. Tricolor LEDs allow customized red, green, or yellow indication of protection, control, or equipment status.

Easy Communications

Choose from single or dual, copper or fiber-optic Ethernet or serial communications and several protocols, including MIRRORED BITS® communications and IEC 61850. Pick multiple Modbus® TCP or Modbus serial sessions for custom configuration of your application. Use DNP3 Serial or DNP3 LAN/WAN protocol.

Rugged Design

Rely on the industry's widest ambient operating temperature range, −40° to +85°C (−40° to +185°F).

Easy Installation

Easily install into existing locations using available retrofit kits and mounting adapters, with no cutting or drilling.

Flexible Design

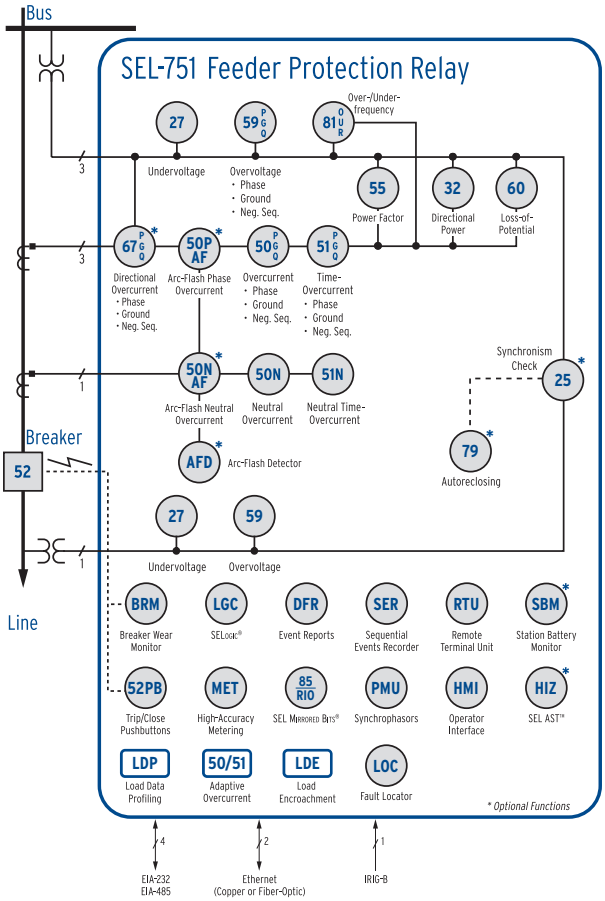
Choose from many installation and integration options, with a small form factor and slide-in expansion cards.

Reclosing Control

Apply the programmable four-shot autoreclosing function with synchronism and voltage check logic to match a variety of reclosing practices. Sequence coordination logic coordinates with downstream reclosers.

Increased Asset Utilization With IEEE C37.118 Synchrophasors

Validate system load flow and fault models via instantaneous voltage angles. Use system-state measurements to increase stable system loading through reduced margin requirements.



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SEL-751 Feeder Protection Relay

Applications

- Detect and trip arcing, downed conductors with AST.
- Customize front-panel pushbutton operation and LEDs, or use default breaker trip/close functions.
- Apply directional and nondirectional overcurrent protection for transformer/bus-main/bus-tie breaker.
- Personalize LCD messages using event-driven display point settings.
- Create an integrated control system with a variety of I/O and communications options.
- Use comprehensive reporting to understand events, schedule maintenance, detect unfavorable trends, modify loads, and satisfy information requirements of supervisory systems.
- Include RTD inputs as part of system integration or to bias protection.
- Mitigate arc-flash hazards in metal-clad switchgear.
- Analyze overcurrent protection system performance using built-in Sequential Events Recorder (SER).
- Accurately estimate fault locations and reduce total costs by eliminating the need for expensive communications channels, special instrument transformers, prefault information, or line crews to travel the distance of the line for visual fault inspection.
- Control autoreclosing with synchronism and voltage check logic.
- View synchronous phasors from any location to measure system state using IEEE C37.118 synchrophasor protocol.

Optional Features

- Communications.
  - DNP3, Modbus TCP, IEC 61850
  - Rear EIA-232 or EIA-485
  - DeviceNet™ communications card
  - Ethernet, single or dual port, copper or fiber-optic
- Vsync and Vbat input card with 4 arc-flash detection inputs.
- I/O expansion card.
  - 4 digital inputs (DI), 4 digital outputs (DO)
  - 4 DI, 4 DO with fast, high-current interrupting capability
  - 4 DI, 3 DO (2 Form C and 1 Form B)
  - 4 DO, 3 DI, and 1 analog output (AO)
  - 4 analog inputs (AI) and 4 AO
  - 8 AI
  - 8 DI
  - 8 DO
  - 10 RTD inputs
- Conformal coating.

Related Products

SEL-2725 Five-Port Ethernet Switch 372
SEL-3010 Event Messenger 384
SEL-4388 Mirrored Bits Tester 462

Price

Budgetary Retail, Quantity 1: $1,750

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

Hardware Specifications

Phase Current Inputs

Nominal Current I_{NOM}	1 A or 5 A
Burden	<0.01 VA @ 1 A; <0.10 VA @ 5 A
Continuous	3 • I_{NOM}
1 Second Thermal	100 • I_{NOM}

Neutral/Ground Current Input

Nominal Current IN_{NOM}	1 A or 5 A
Burden	<0.01 VA @ 1 A; <0.10 VA @ 5 A
Continuous	3 • IN_{NOM}
1 Second Thermal	100 • IN_{NOM}

Phase Voltage Input

Rated Operating Voltage	100–250 Vac
Rated Continuous Voltage	300 Vac
10 Second Thermal	600 Vac
Burden	<0.1 VA at 300 Vac

4-wire wye or open-delta voltage connections

Power Supply Ratings

110–250 Vdc, 110–240 Vac (–20% to +10%)
24/48 Vdc
<40 VA (ac) or 15 W (dc) total burden

Optoisolated Control Input Ranges

24, 48, 110, 125, 220, or 250 Vdc or Vac
Control inputs are externally wetted
2 inputs standard

Contact Outputs

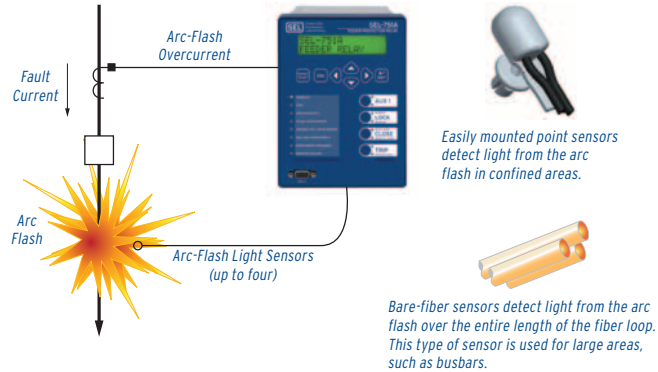
Operating Voltage	240 Vac/250 Vdc
Rated Insulation Voltage	300 Vac/300 Vdc

3 outputs standard

Operating Temperature

–40° to +85°C (–40° to +185°F)

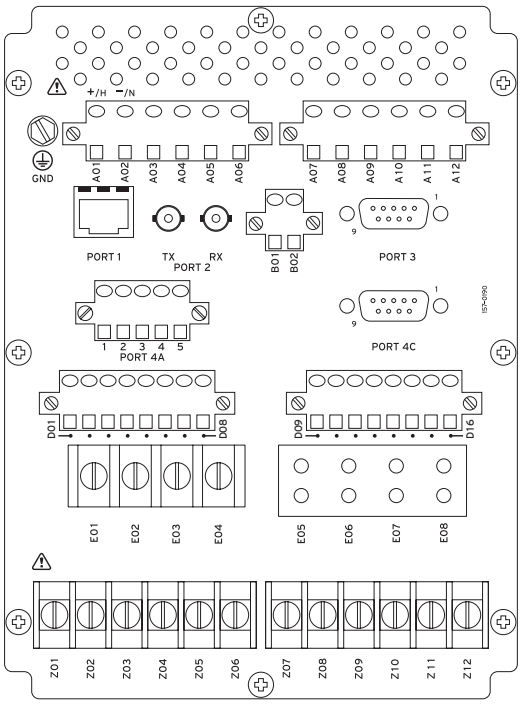
Arc-Flash Detection



Combined light-sensing technology with fast overcurrent protection provides high-speed, arc-flash detection without false tripping.

SEL-751 Feeder Protection Relay

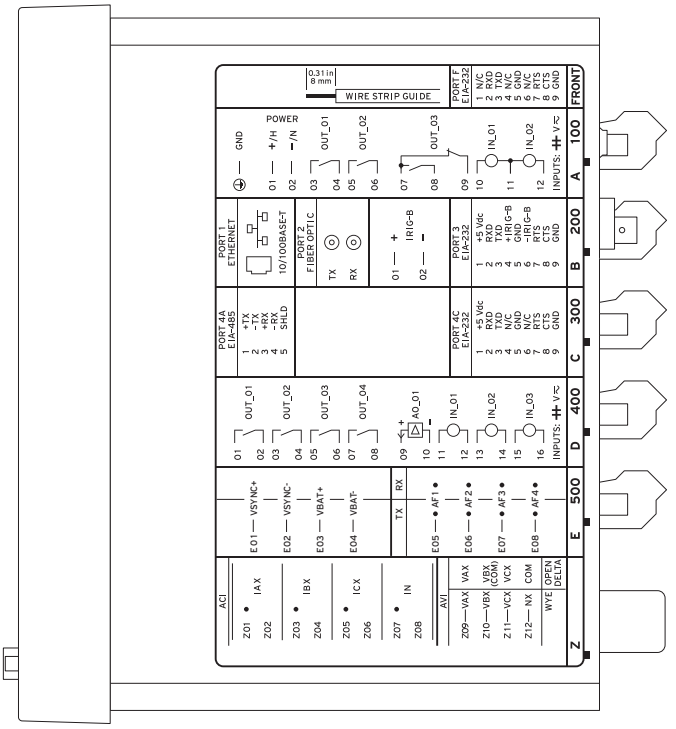
Rear View



i5016a

Ethernet, fiber serial, IRIG-B, EIA-232 communications, 4 DO/3 DI/1 AO, and Vsync and Vbat inputs with four arc-flash detection inputs.

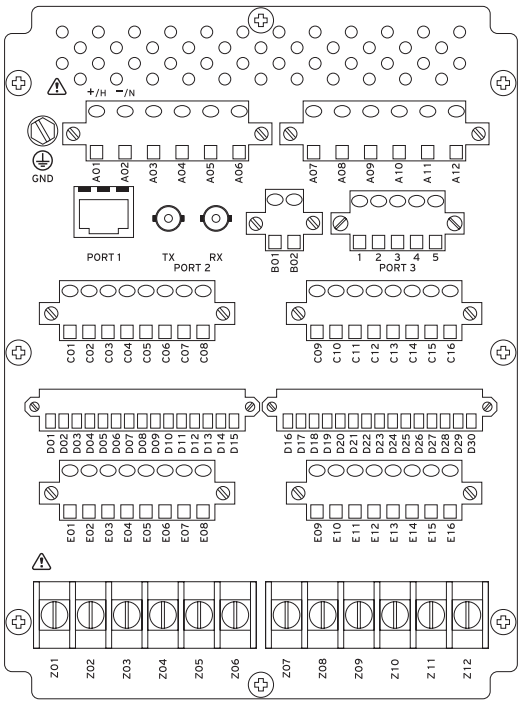
Side View



‡ SEE DOCUMENTATION FOR INPUT VOLTAGE RATING

i5015a

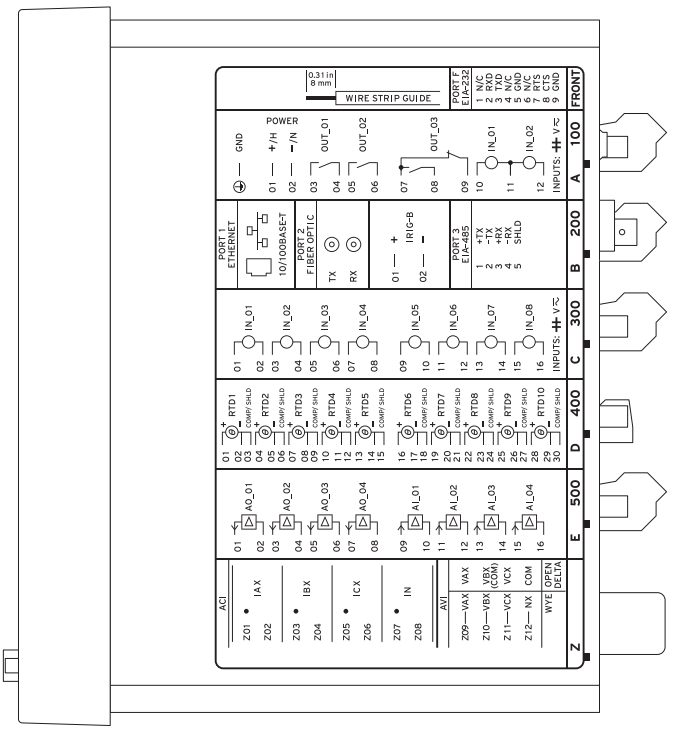
Rear View



i5017a

Ethernet, fiber serial, EIA-485 communications, 8 DI, RTD, and 4 AI/4 AO option.

Side View

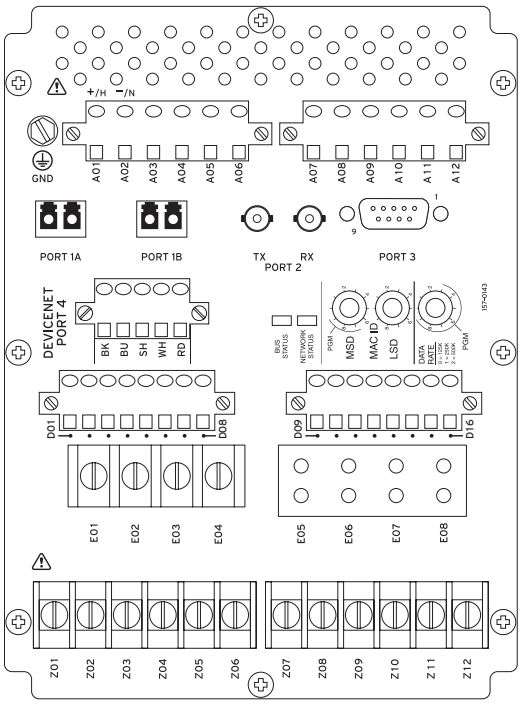


‡ SEE DOCUMENTATION FOR INPUT VOLTAGE RATING

i5012a

SEL-751 Feeder Protection Relay

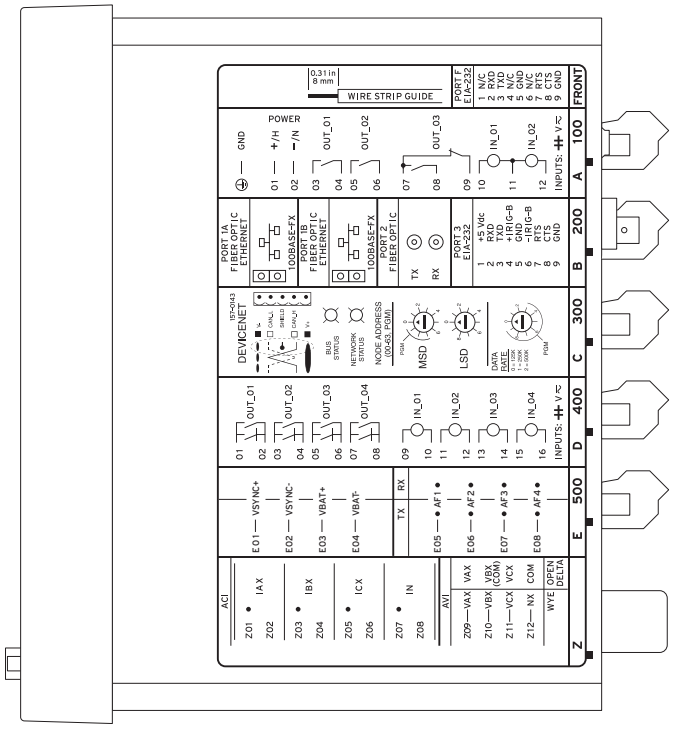
Rear View



i5010a

Dual-port, fiber-optic Ethernet, DeviceNet™, fast hybrid 4 DI/4 DO, and Vsync and Vbat inputs with four arc-flash detection inputs.

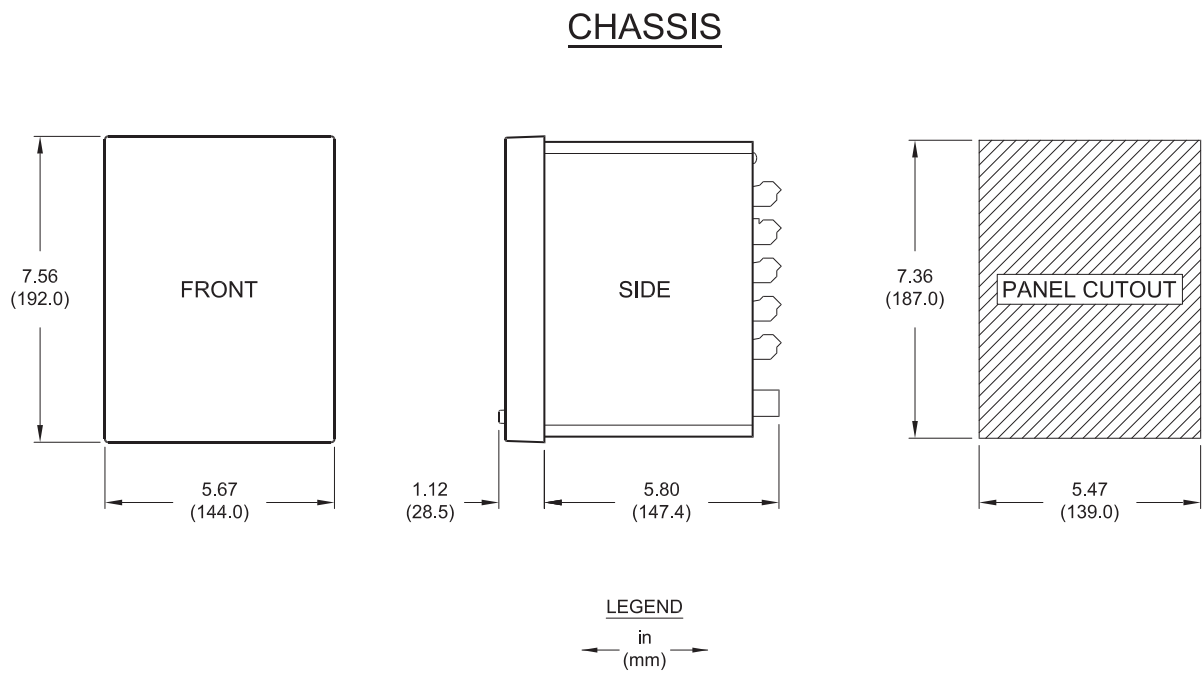
Side View



‡ SEE DOCUMENTATION FOR INPUT VOLTAGE RATING

i5018a

Dimensions



i9089b

Visit www.selinc.com for more detailed information and configuration options.

SEL-751A Feeder Protection Relay

The SEL-751A is the right solution for industrial and utility feeder protection, with arc-flash detection, flexible I/O, advanced communications, and easy mounting options.

SEL IEC 61850

Key Features

Complete Feeder Protection

Maximize control scheme flexibility with time- and instantaneous-overcurrent, reclosing control, synchronism check, overvoltage, undervoltage, and frequency elements.

Arc-Flash Detection

Reduce arc-flash incident energy with fast detection and tripping. Combine light-sensing technology with fast overcurrent protection to provide high speed without false tripping.

Convenient Controls

Use the four programmable pushbuttons on the front for quick, personalized control.

Easy Communications

Choose from single or dual, copper or fiber-optic Ethernet or serial communications and several protocols, including Mirrored Bits® and IEC 61850. Pick multiple Modbus® TCP or Modbus serial sessions for custom configuration of your application. Use DNP3 Serial or DNP3 LAN/WAN protocol.

Rugged Design

Rely on the industry's widest ambient operating temperature range, −40° to +85°C (−40° to +185°F).

Easy Installation

Easily install into existing locations using available retrofit kits and mounting adapters, with no cutting or drilling.

Flexible Design

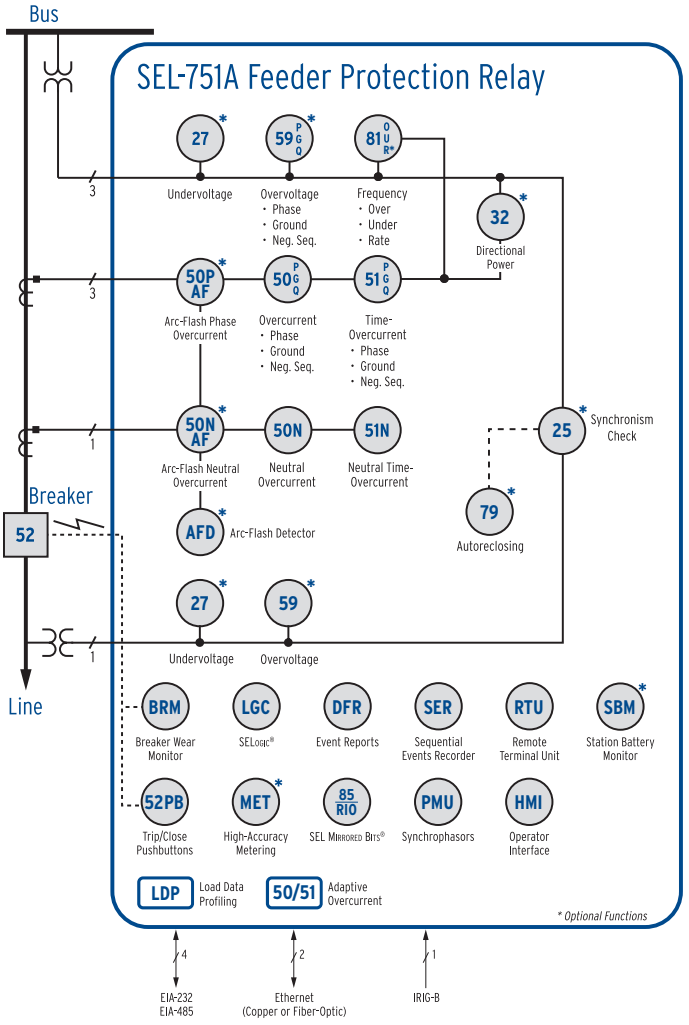
Choose from many installation and integration options, with a small form factor and slide-in expansion cards.

Reclosing Control

Apply the programmable four-shot autoreclosing function with synchronism and voltage check logic to match a variety of reclosing practices. Sequence coordination logic coordinates with downstream reclosers.

Synchrophasor Measurements to Increase Asset Utilization

Validate system load flow and fault models via instantaneous voltage angles. Use system-state measurements to increase stable system loading through reduced margin requirements.



Tel: +1.509.332.1890 | Fax: +1.509.332.7990 | www.selinc.com

SEL-751A Feeder Protection Relay

Applications

- Customize front-panel pushbutton operation and LEDs, or use default breaker trip/close functions.
- Personalize LCD messages using event-driven display point settings.
- Create an integrated control system with a variety of I/O and communications options.
- Use comprehensive reporting to understand events, schedule maintenance, detect unfavorable trends, modify loads, and satisfy information requirements of supervisory systems.
- Include RTD inputs as part of system integration or to bias protection.
- Mitigate arc-flash hazards in metal-clad switchgear.
- Analyze overcurrent protection system performance using built-in Sequential Events Recorder (SER).
- Control autoreclosing with synchronism and voltage check logic.
- Protect small generators, including distributed generation interconnections.
- View synchronous phasors from any location to measure system state using standard synchrophasor SEL Fast Messages.

Optional Features

- Communications.
  - DNP3, Modbus TCP, IEC 61850
  - Rear EIA-232 or EIA-485
  - DeviceNet™ communications card
  - Ethernet, single or dual port, copper or fiber-optic
  - Fiber-optic serial
- Voltage input card.
- Voltage input card with 4 arc-flash detection inputs.
- Enhanced voltage input card with monitoring package.
- I/O expansion card.
  - 4 digital inputs (DI), 4 digital outputs (DO)
  - 4 DI, 4 DO with fast, high-current interrupting capability
  - 4 DI, 3 DO (2 Form C and 1 Form B)
  - 4 DO, 3 DI, and 1 analog output (AO)
  - 4 analog inputs (AI), 4 AO
  - 8 AI
  - 8 DI
  - 3 ac voltage inputs or 5 ac voltage inputs
  - 10 RTD inputs
- Conformal coating.

Related Products

SEL-2725 Five-Port Ethernet Switch 372
SEL-3010 Event Messenger 384
SEL-4388 Mirrored Bits Tester 462

Price

Budgetary Retail, Quantity 1: $950

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Hardware Specifications

Phase Current Inputs

Nominal Current I_{NOM}	1 A or 5 A
Burden	<0.01 VA @ 1 A; <0.10 VA @ 5 A
Continuous	3 • I_{NOM}
1 Second Thermal	100 • I_{NOM}

Neutral/Ground Current Input

Nominal Current IN_{NOM}	2.5 mA, 50 mA, 1 A or 5 A
Burden	<0.01 VA @ 1 A; <0.10 VA @ 5 A
Continuous	3 • IN_{NOM}
1 Second Thermal	100 • IN_{NOM}

Optional Phase Voltage Input

Rated Operating Voltage	100–250 Vac
Rated Continuous Voltage	300 Vac
10 Second Thermal	600 Vac
Burden	<0.1 VA at 300 Vac

4-wire wye or open-delta voltage connections

Power Supply Ratings

110–250 Vdc, 110–240 Vac (–20% to +10%)
24/48 Vdc 20–60 Vdc
<40 VA (ac) or 15 W (dc) total burden

Hazardous Location Ratings

UL Class I, Zone 2 approved
ATEX
CSA

Class I Zone 2 Hazardous Location APPROVED

Optoisolated Control Input Ranges

24, 48, 110, 125, 220, or 250 Vdc or Vac
Control inputs are externally wetted
2 inputs standard

Contact Outputs

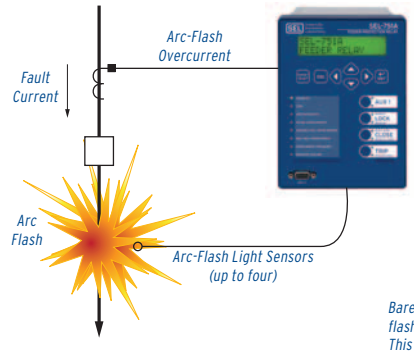
Operating Voltage	240 Vac/250 Vdc
Rated Insulation Voltage	300 Vac/300 Vdc

3 outputs standard

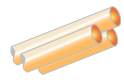
Operating Temperature

–40° to +85°C (–40° to +185°F)

Arc-Flash Detection



Easily mounted point sensors detect light from the arc flash in confined areas.

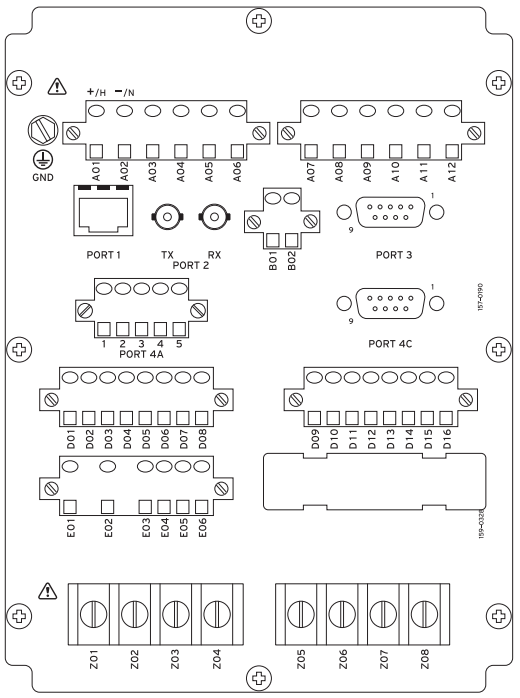


Bare-fiber sensors detect light from the arc flash over the entire length of the fiber loop. This type of sensor is used for large areas, such as busbars.

Combined light-sensing technology with fast overcurrent protection provides high-speed, arc-flash detection without false tripping.

SEL-751A Feeder Protection Relay

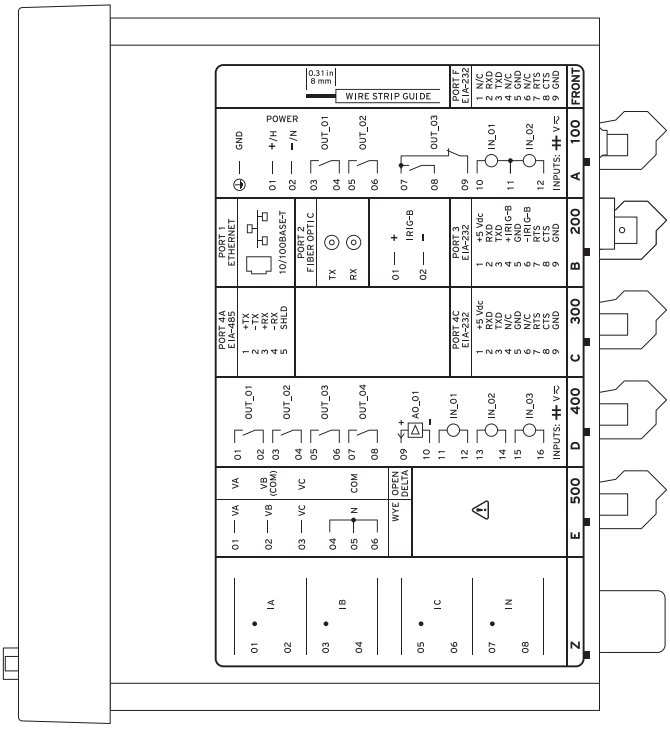
Rear View



i4160b

Ethernet, fiber serial, IRIG-B, EIA-232 communications, 4 DO/3 DI/1 AO, and voltage option.

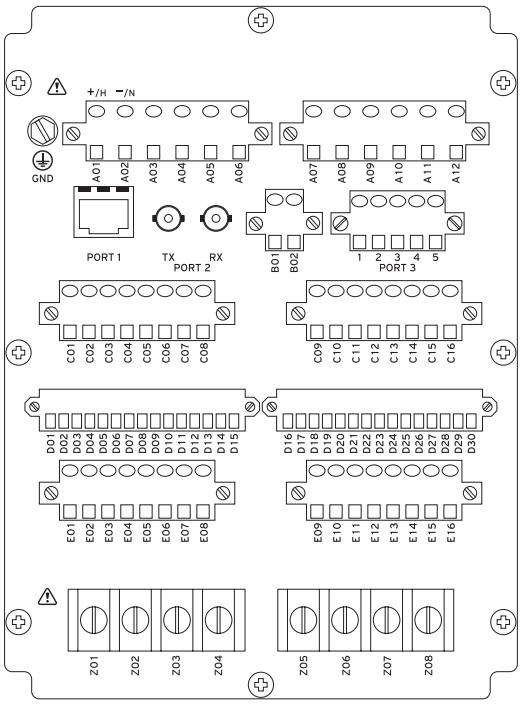
Side View



‡ SEE DOCUMENTATION FOR INPUT VOLTAGE RATING

i3970c

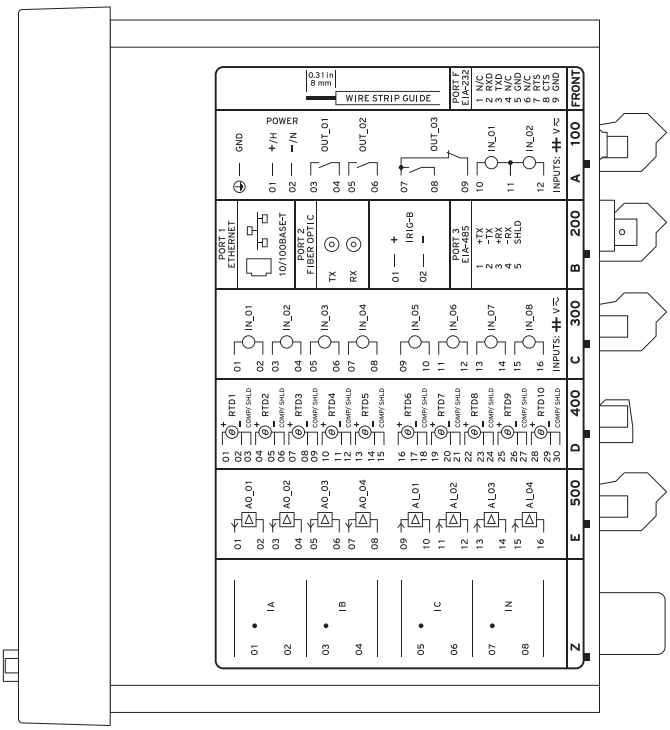
Rear View



i4162b

Ethernet, fiber serial, EIA-485 communications, 8 DI, RTD, and 4 AI/4 AO option.

Side View

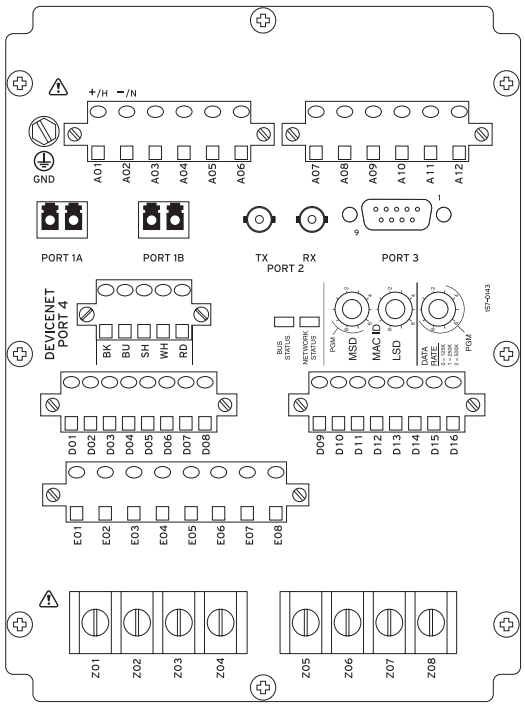


‡ SEE DOCUMENTATION FOR INPUT VOLTAGE RATING

i4159a

SEL-751A Feeder Protection Relay

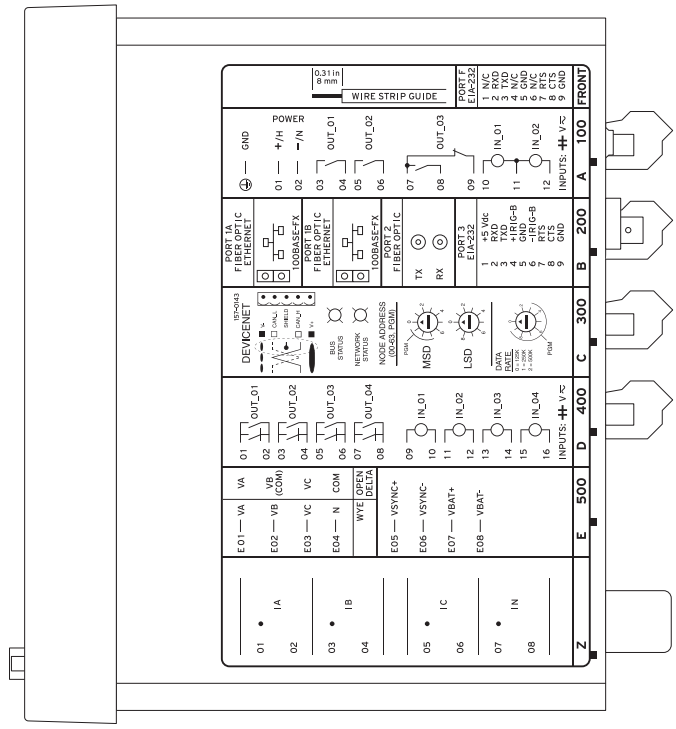
Rear View



i4247a

Dual-port, fiber-optic Ethernet, DeviceNet®, fast hybrid 4 DI/4 DO, and enhanced-voltage options with monitoring package.

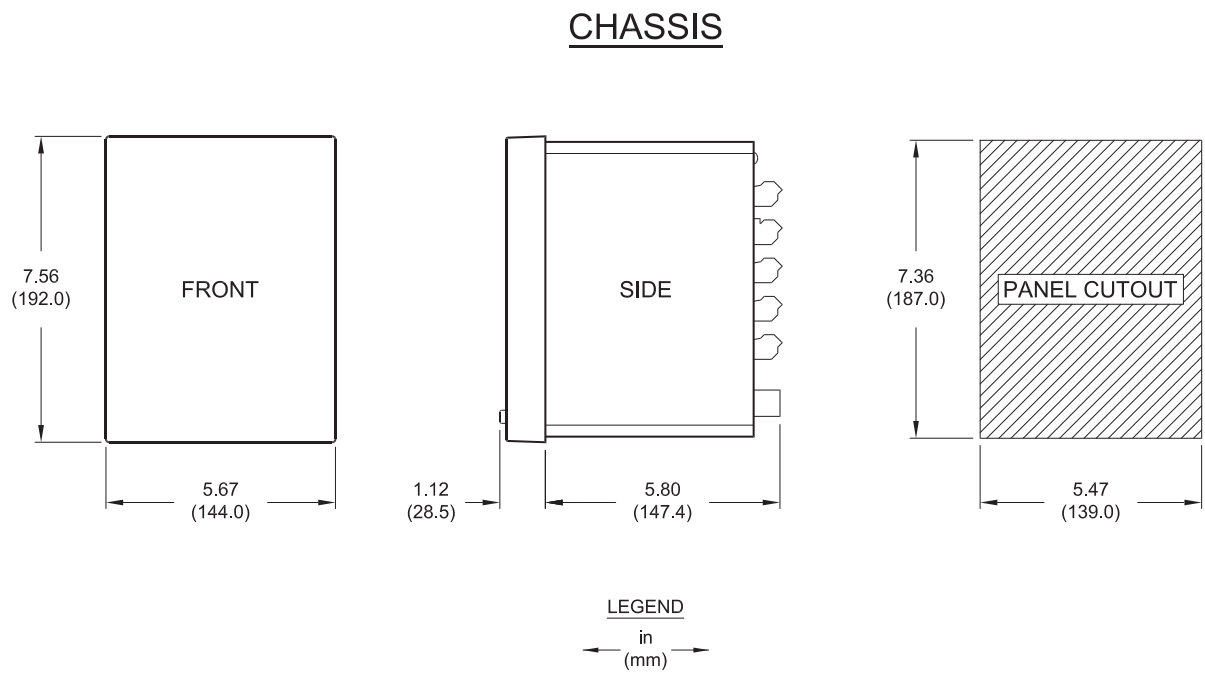
Side View



‡ SEE DOCUMENTATION FOR INPUT VOLTAGE RATING

i4246a

Dimensions



i9089b

Visit www.selinc.com for more detailed information and configuration options.

SEL-632 Network Protector Relay

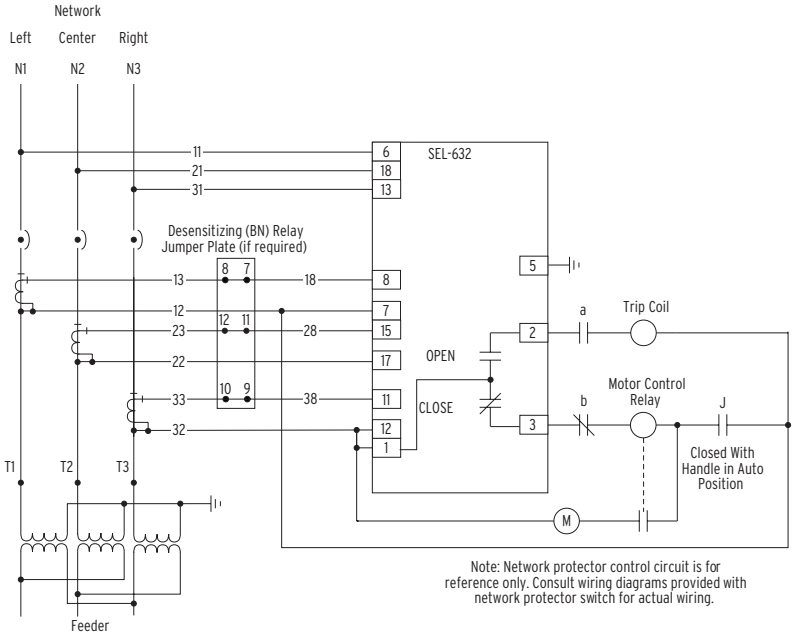
Reliable network protection engineered for the harshest environments.

Overview

The SEL-632 Network Protector Relay provides reverse-power and overcurrent protection for underground, secondary network systems and is compatible with most Westinghouse network protectors. Quickly retrofit relays on existing CM-22 and CMR-series network protectors, or install the SEL-632 in new network protector applications.

Key Features

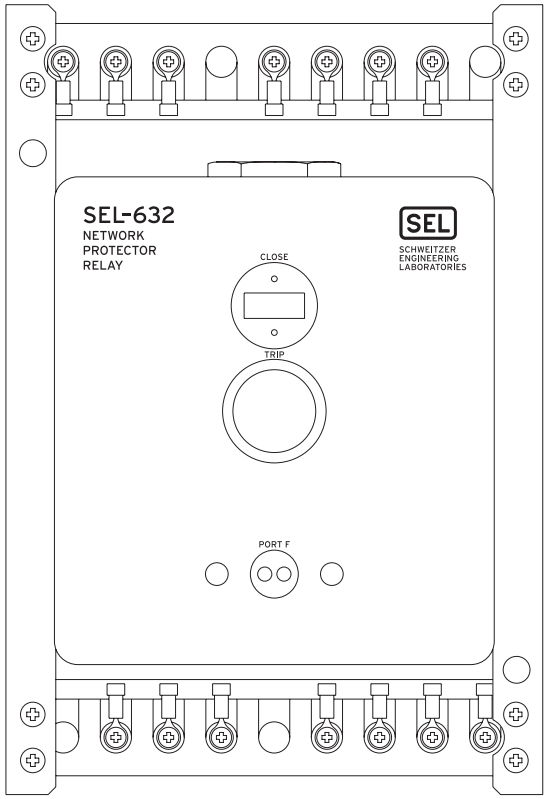
- Maintain high reliability, even in harsh environments, with an ambient temperature range of −40° to +125°C, submersibility to 25 feet, and a rugged chassis design.
- Quickly view relay status with the built-in scrolling display.
- Easily send and receive settings, and retrieve event information with the optical interface port.
- Reduce commissioning time with ASCII communications and convenient graphical software.
- Use the included SEL Express Software to modify settings, download and view oscillographic event data, and view relay status and metering information.
- Simplify root cause analysis with the 64-cycle event report, sampled at 256 samples per cycle, including voltage, current, and digital relay quantities.
- Replace CN-33 master and CN-J phasing electro-mechanical relays with this one device.



Note: For more information about the SEL-632 Network Protector Relay, including applications and compatibility, please contact your SEL representative.

SEL-632 Network Protector Relay

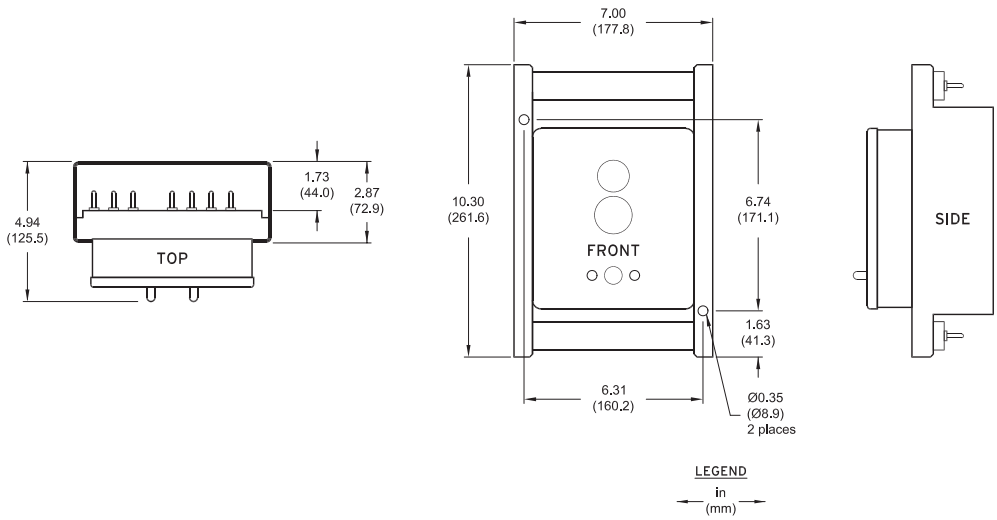
Front View



i4535a

Dimensions

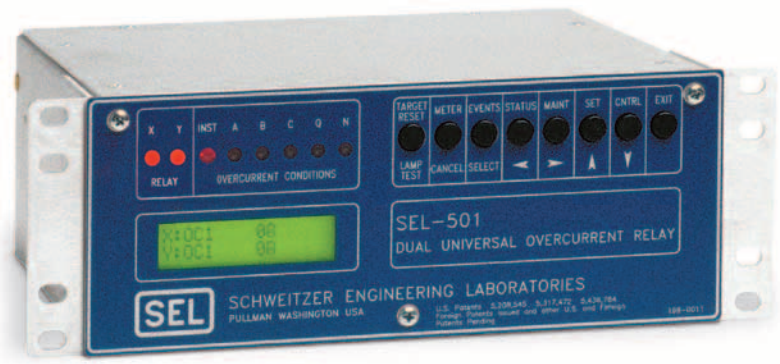
CHASSIS



i9199a

Visit www.selinc.com for more detailed information and configuration options.

SEL-501 Dual Universal Overcurrent Relay



Simplify protection in two-high switchgear with two independent sets of protection elements in one compact relay.

Key Features

Compact Package

Two independent three-phase relays (X and Y) in a single compact package simplify two-high switchgear installations with reduced wiring, enhanced protection, and simplified settings. Each relay is configurable for one of several relay applications.

Flexible Applications Eliminate Settings Complexity

Settings menu includes individual selections for Feeder (FDR), Overcurrent (OC1), Motor (MOT), Breaker Failure (BFR), and Timer (TMR) relay applications. Feeder and overcurrent applications include phase, negative-sequence, and residual ground protection with instantaneous, definite-time, and time-overcurrent elements. The breaker failure application includes initiate, retrip, and time-delayed operations. The timer relay application includes independent pickup and dropout settings for two outputs driven from a single control input.

Motor Protection Application

The motor relay application includes a patented motor thermal model for applications not requiring RTD (resistance temperature detector) inputs. The motor thermal model automatically switches between starting and running conditions and requires only basic information about the motor.

Event Reporting

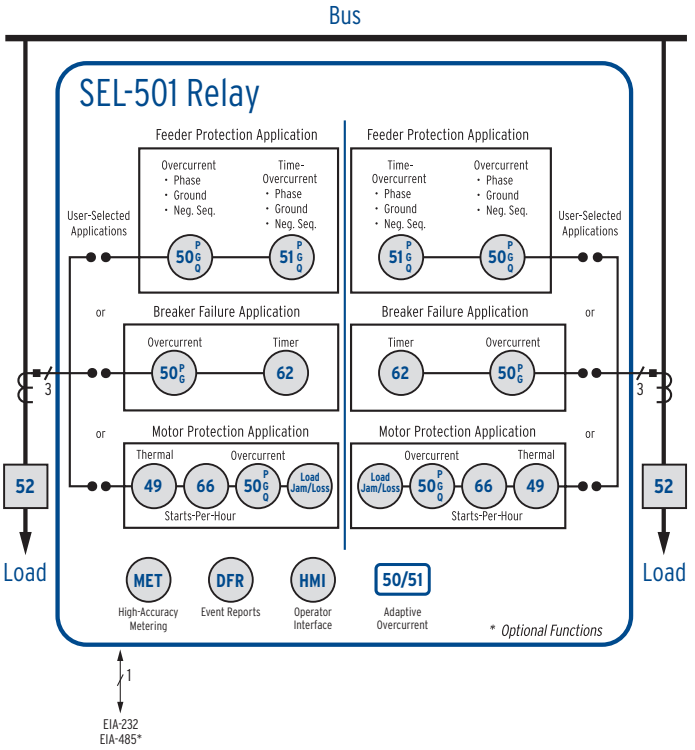
The relay stores 20 event report summaries and five 15-cycle event reports. The event summaries and the last two event reports are stored in nonvolatile memory.

Configuration and Control

Easily configured and controlled from local front panel or through the EIA-232 communications port ASCII/binary interface using off-the-shelf terminal emulation software.

Adaptive Overcurrent Element

The Adaptive Overcurrent Element performs reliably even with CT saturation, dc offset, and off-frequency harmonics.



Related Products

SEL-501 Dual Universal Overcurrent Relay

Applications

- Provide simple and economical protection for transformers, breakers, motors, capacitor banks, feeders, and other apparatus.
- Install the SEL-501 in two-high breaker switchgear to protect two separate feeders, providing primary or backup protection for each feeder.
- Set one side of the dual relay for a feeder application, and set the other side for a breaker failure application using the simple menu system.
- Connect one side of the dual relay to transformer high-side CTs for transformer overload and overcurrent protection. Connect the other side of the relay to the neutral CT on the wye side of a delta-wye transformer for sensitive internal ground fault protection and backup external fault protection.
- Apply both sets of overcurrent relay elements on the same feeder, and cover a wide range of fault currents, while maintaining accuracy of measured load and fault current magnitudes.
- Provide protection for two motors (using the SEL-patented thermal model) when RTDs are not required. (Note: For applications requiring RTD inputs, refer to the SEL-701 Motor Protection Relay on page 292.)
- Select the timer application in either or both relays to time-qualify external trips or conditions like underfrequency relay trips, overcurrent trips, and hot or dead voltage conditions. Timers are independent of the current inputs, so when the relays are set for timer applications, currents can remain connected for metering and event reporting.

Installation photography courtesy of Chelan County PUD.

Optional Features

- Modbus® RTU protocol.
- Panel-mount, projection panel-mount, or rack-mount hardware package.
- Connectorized® packaging includes high-current interrupting output contacts.
- EIA-232 or EIA-485 serial communications—either port includes a demodulated IRIG-B time-code input.
- Blank bracket to mount one relay in a 19-inch rack.
- Bracket with mounting hole for FT-1 switch (switch not included) to mount one SEL-500 series relay in a 19-inch rack.
- Conformal coating.

Hardware Specifications

AC Current Inputs

5 A nominal

15 A continuous, 250 A for 1 second, linear to 100 A symmetrical

Limiting Dynamic Value 625 A for 1 cycle (sinusoidal waveform)

Burden 0.16 VA @ 5 A; 1.15 VA @ 15 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical

Limiting Dynamic Value 250 A for 1 cycle (sinusoidal waveform)

Burden 0.06 VA @ 1 A; 1.18 VA @ 3 A

60/50 Hz system frequency and ABC/ACB phase rotation are ordering options

Power Supply Ratings

24 V (polarity sensitive)	16–36 Vdc
48/125 V	36–200 Vdc or 85–140 Vac
125/250 V	85–350 Vdc or 85–264 Vac

3.5 W nominal, 5.5 W maximum

Standard Control Input and Output Ranges

24, 48, 110, 125, or 250 Vdc

Standard configuration provides one input and two outputs for each relay in this two-relay package

Operating Temperature

–40° to +85°C (–40° to +185°F)

(Note: LCD contrast impaired for temperatures below –20°C)

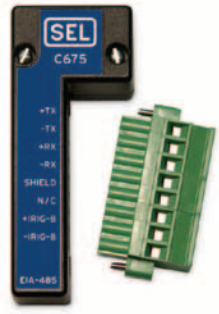
Price

Budgetary Retail, Quantity 1: $1,265

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

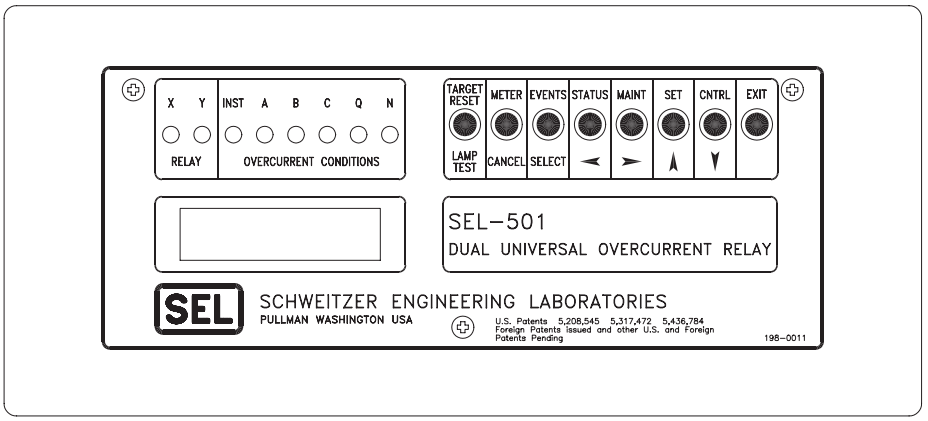


SEL Terminal Adapter

The SEL Terminal Adapter (C675) is included when ordering the SEL-501 with the EIA-485 rear-port option. The terminal adapter with the quick connector makes connecting EIA-485 communications fast and easy.

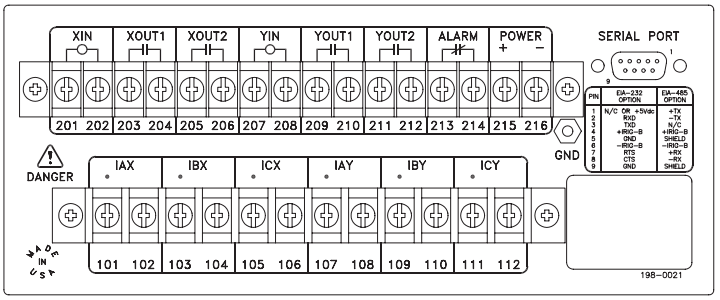
SEL-501 Dual Universal Overcurrent Relay

Front View – Panel-Mount



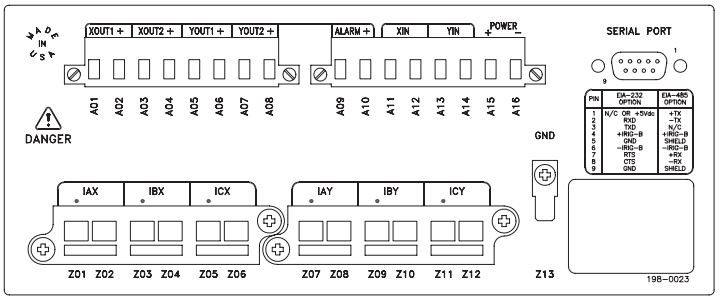
i3028a

Rear View – Conventional Terminal Blocks



i3031a

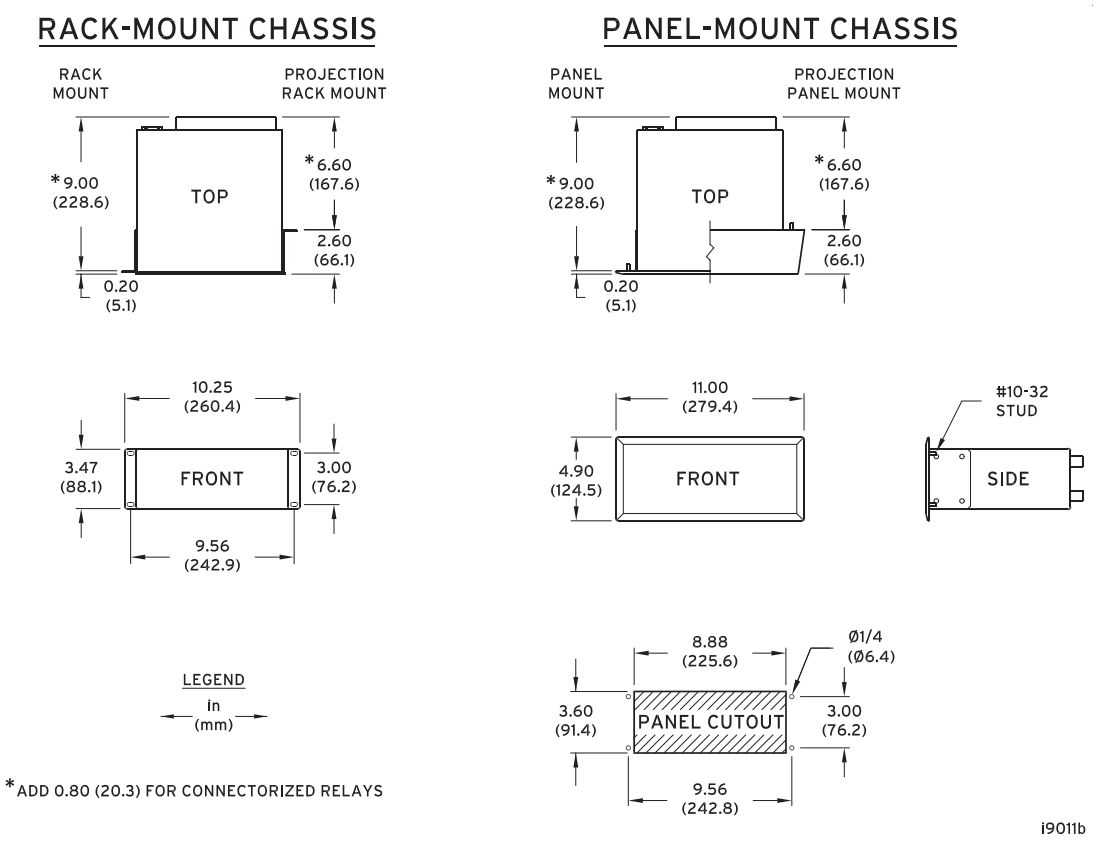
Rear View – Connectorized®



i3034a

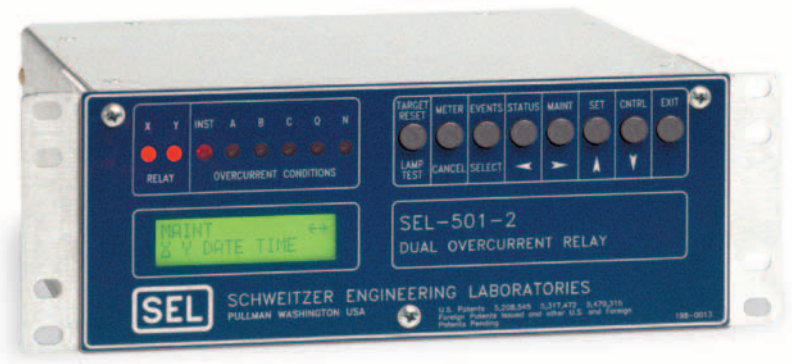
SEL-501 Dual Universal Overcurrent Relay

Dimensions



Visit www.selinc.com for more detailed information and configuration options.

SEL-501-2 Dual Overcurrent Relay



Simplify feeder protection in two-high switchgear with two independent sets of overcurrent elements in one compact relay.

Key Features

Compact Package

Two independent three-phase overcurrent relays (X and Y) in a single compact package simplify two-high switchgear installations with reduced wiring, enhanced protection, and simplified settings. The overcurrent functions are identical to the OC1 overcurrent relay application in the SEL-501 Dual Universal Overcurrent Relay.

Overcurrent Protection

Each overcurrent relay includes phase, negative-sequence, and residual ground protection with instantaneous, definite-time, and time-overcurrent elements. Torque control can be applied to the overcurrent functions by asserting a local control input or an internal control bit through remote communication. Individual overcurrent relay element output can be directed to either or both of the two trip contacts associated with an individual relay. Each output also includes a settable pickup delay timer, minimum trip duration timer, and latch function.

Event Reporting

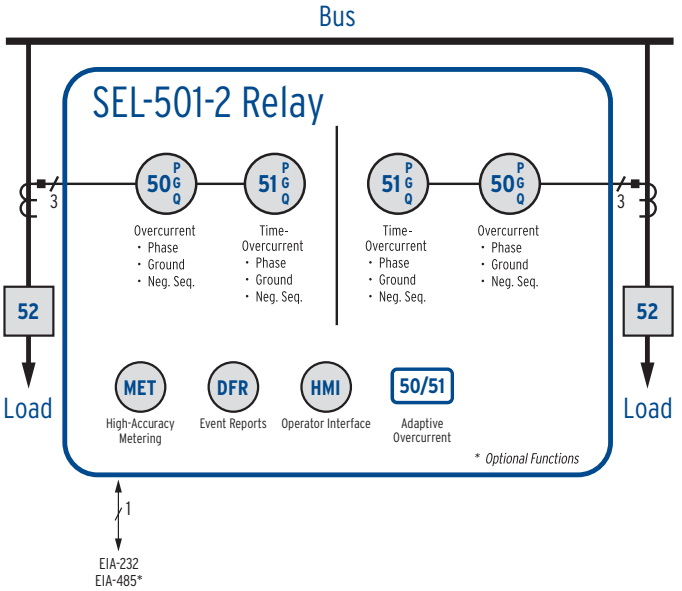
The relay stores 20 event report summaries and five 15-cycle event reports. The event summaries and the last two event reports are stored in nonvolatile memory.

Configuration and Control

Easily configured and controlled from local front panel or through the EIA-232 communications port ASCII/binary interface using off-the-shelf terminal emulation software.

Adaptive Overcurrent Element

The Adaptive Overcurrent Element performs reliably even with CT saturation, dc offset, and off-frequency harmonics.



SEL-501-2 Dual Overcurrent Relay

Applications

- Provide simple and economical protection for transformers, capacitor banks, feeders, and other apparatus.
- Install two SEL-501-2 Relays in two-high switchgear to protect two separate feeders, providing primary and backup protection for each feeder.
- Apply both sets of overcurrent relay elements on the same feeder, and cover a wide range of fault currents, while maintaining accuracy of measured load and fault current magnitudes.
- Connect one side of the dual relay to transformer high-side CTs for transformer overload and overcurrent protection. Connect the other side of the relay to the neutral CT on the wye side of a delta-wye transformer for sensitive internal ground fault protection and backup external fault protection.

Optional Features

- Modbus® RTU protocol.
- Panel-mount, projection panel-mount, or rack-mount hardware package.
- Connectorized® packaging includes high-current interrupting output contacts.
- EIA-232 or EIA-485 serial communications—either port includes a demodulated IRIG-B time-code input.
- Blank bracket to mount one relay in a 19-inch rack.
- Bracket with mounting hole for FT-1 switch (switch not included) to mount one SEL-500 series relay in a 19-inch rack.
- Conformal coating.

Related Products

SEL-501 Dual Universal Overcurrent Relay 140
SEL-2886 EIA-232 to EIA-485 Interface Converter 375
SEL-3094 Interface Converter 442

Hardware Specifications

AC Current Inputs

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical
Limiting Dynamic Value 1250 A for 1 cycle (sinusoidal waveform)
Burden 0.16 VA @ 5 A; 1.15 VA @ 15 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical
Limiting Dynamic Value 250 A for 1 cycle (sinusoidal waveform)
Burden 0.06 VA @ 1 A; 0.18 VA @ 3 A

60/50 Hz system frequency and ABC/ACB phase rotation are ordering options

Power Supply Ratings

24 V (polarity sensitive)	16–36 Vdc
48/125 V	36–200 Vdc or 85–140 Vac
125/250 V	85–350 Vdc or 85–264 Vac

3.5 W nominal, 5.5 W maximum

Standard Control Input and Output Ranges

24, 48, 110, 125, or 250 Vdc

Standard configuration provides one input and two outputs for each relay in this two-relay package

Operating Temperature

–40° to +85°C (–40° to +185°F)

(Note: LCD contrast impaired for temperatures below –20°C)

Price

Budgetary Retail, Quantity 1: $1,000

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

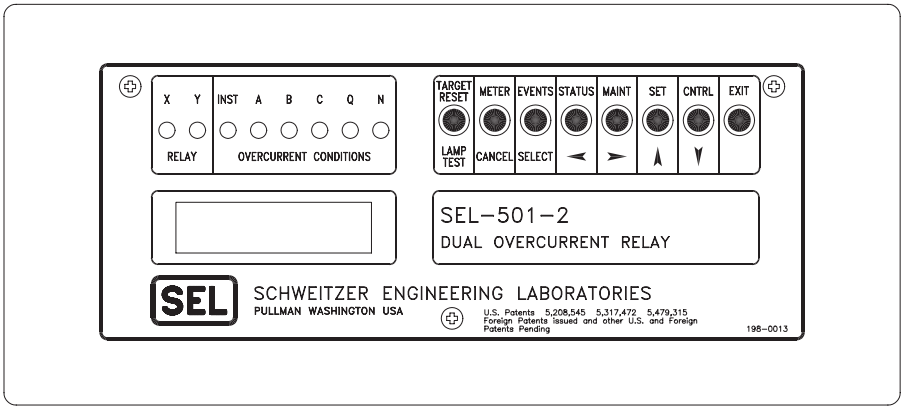
This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

SEL Terminal Adapter

The SEL Terminal Adapter (C675) is included when ordering the SEL-501-2 with the EIA-485 rear-port option. The terminal adapter with the quick connector makes connecting EIA-485 communications fast and easy.

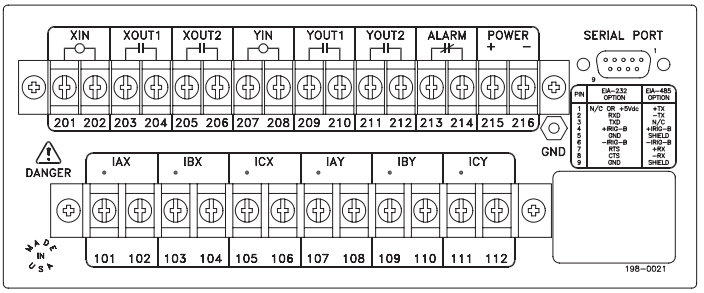
SEL-501-2 Dual Overcurrent Relay

Front View – Panel-Mount



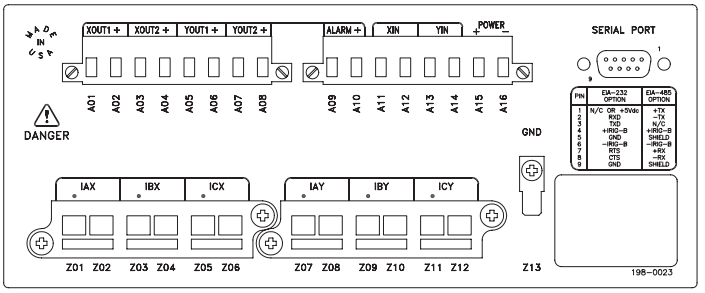
i3030a

Rear View – Conventional Terminal Blocks



i3031a

Rear View – Connectorized®

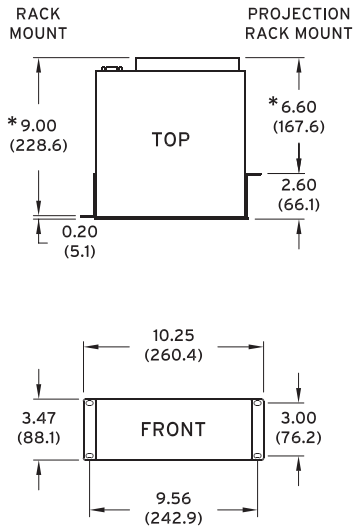


i3034a

SEL-501-2 Dual Overcurrent Relay

Dimensions

RACK-MOUNT CHASSIS

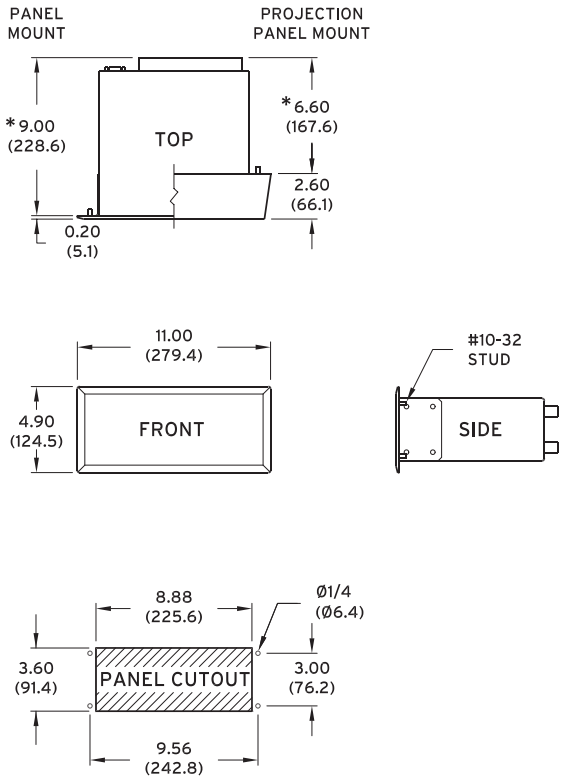


LEGEND

in
(mm)

*ADD 0.80 (20.3) FOR CONNECTORIZED RELAYS

PANEL-MOUNT CHASSIS



i9011b

Visit www.selinc.com for more detailed information and configuration options.

SEL-551/SEL-551C Overcurrent/Reclosing Relay

Comprehensive overcurrent protection, multiple-shot reclosing, robust I/O, and optional front and rear communications in one compact relay.

Key Features

Comprehensive Overcurrent Protection

Phase, negative-sequence, residual ground, and neutral overcurrent protection in a compact package. Complete set of instantaneous, definite-time, and time-overcurrent elements.

Reclosing

Program up to four shots of reclosing with sequence coordination logic for coordination with downstream reclosers.

Windows®-Based Graphical User Interface

Use ACSELERATOR QuickSet® SEL-5030 Software to develop settings offline with a menu-driven interface and completely documented help screens. Speed installation by copying existing settings files and modifying application-specific items.

Protection and Control Logic

SELOGIC® control equations with SELOGIC variables and timers allow traditional or advanced protection schemes. Programmable local control elements permit front-panel pushbutton control. Programmable text display points provide enhanced local operator information.

Monitoring and Reporting

Instantaneous, peak, and demand metering. The latest twenty 15-cycle oscillographic data event reports and the latest 512 Sequential Events Recorder (SER) reports are stored in nonvolatile memory.

Adaptive Overcurrent Element

The Adaptive Overcurrent Element performs reliably even with CT saturation, dc offset, and off-frequency harmonics.

Integration

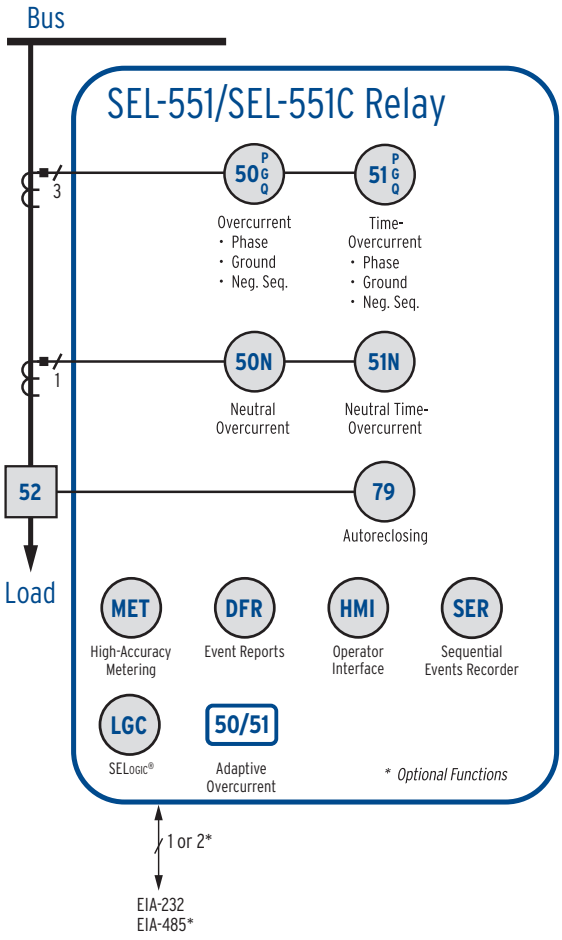
Integrate into industrial protection and control schemes with Modbus® RTU protocol. Order the rear serial communications port as either EIA-232 or EIA-485. Optional front EIA-232 port on the SEL-551C allows easy connection, even while communicating on the rear port.

Field-Proven Hardware With Robust I/O

Program inputs and outputs to meet your application needs using SELOGIC control equations. A wide operating temperature range (−40° to +85°C) allows for installation in a control house or outdoor enclosure.

Advanced Programmable Logic and Local/Remote Controls

Configure traditional or advanced protection and control schemes. Use edge triggers or latches within SELOGIC control equations for advanced control.



Tel: +1.509.332.1890 | Fax: +1.509.332.7990 | www.selinc.com

SEL-551/SEL-551C Overcurrent/Reclosing Relay

Applications

- Protect distribution feeders, distribution buses, transformers, capacitors, and circuit breakers.
- Select the "fast bus" trip scheme when protecting a distribution bus.
- Choose "fast" or "slow" curve operation to allow for cold-load pickup.
- Connect the separate neutral current input to accommodate core-balance current transformers, separate neutral current transformers, tertiary winding current transformers, or CT ground residual circuits.
- Front-port communication with EIA-232 on the SEL-551C even during rear-port EIA-485 communication.

Optional Features

- Panel-mount, projection panel-mount, or rack-mount hardware package.
- EIA-232 or EIA-485 serial communications—either port includes a demodulated IRIG-B time-code input.
- Bracket with mounting hole for FT-1 switch (switch not included) to mount one SEL-500 series relay in a 19-inch rack.
- EIA-232 front port on the SEL-551C.
- Conformal coating.
- Connectorized® packaging on the SEL-551 includes high-current interrupting output contacts.

Related Products

SEL-2032 Communications Processor.....348
SEL-2810 Fiber-Optic Transceivers With IRIG-B.....433
SEL-3021-1 Serial Encrypting Transceiver.....364

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Hardware Specifications

AC Current Inputs

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical
Limiting Dynamic Value 1250 A for 1 cycle (sinusoidal waveform)
Burden 0.16 VA @ 5 A; 1.15 VA @ 15 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical
Limiting Dynamic Value 250 A for 1 cycle (sinusoidal waveform)
Burden 0.06 VA @ 1 A; 0.18 VA @ 3 A

60/50 Hz system frequency and ABC/ACB phase rotation are user settable

Power Supply Ratings

24 V (polarity sensitive)	16–36 Vdc
48/125 V	36–200 Vdc or 85–140 Vac
125/250 V	85–350 Vdc or 85–264 Vac

3.5 W nominal, 5.5 W maximum

Standard Control Input and Output Ranges

24, 48, 110, 125, 220, or 250 Vdc level-sensitive inputs

SEL-551: Configuration provides 2 inputs and 4 outputs (plus alarm). Connectorized hardware package provides access to high-current interrupting output contacts.

SEL-551C: Configuration provides 6 inputs and 3 outputs.

Operating Temperature

–40° to +85°C (–40° to +185°F)

(Note: LCD contrast impaired for temperatures below –20°C)

Price

Budgetary Retail, Quantity 1: $840

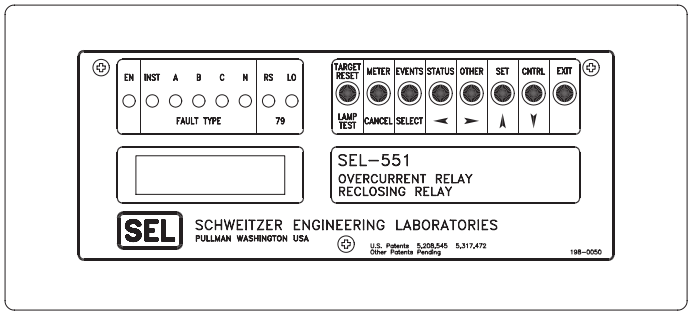
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

SEL Terminal Adapter

The SEL Terminal Adapter (C675) is included when ordering the SEL-551C with the EIA-485 rear-port option. The terminal adapter with the quick connector makes connecting EIA-485 communications fast and easy.

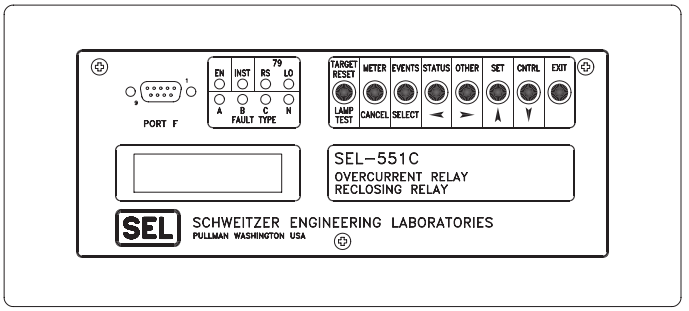
SEL-551/SEL-551C Overcurrent/Reclosing Relay

Front View – Panel-Mount - SEL-551



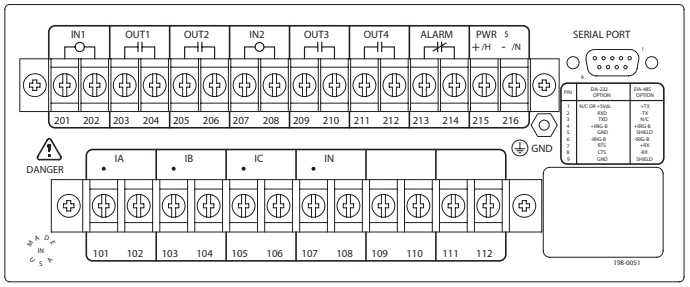
i3041a

Front View – Panel-Mount - SEL-551C



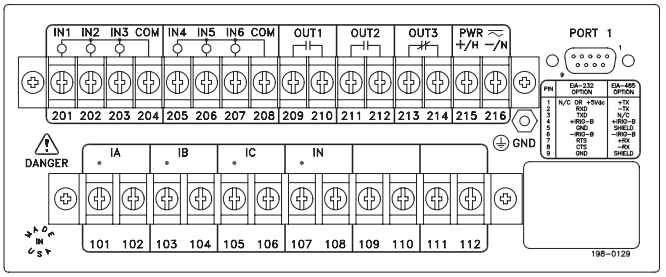
i3841a

Rear View – Conventional Terminal Blocks - SEL-551



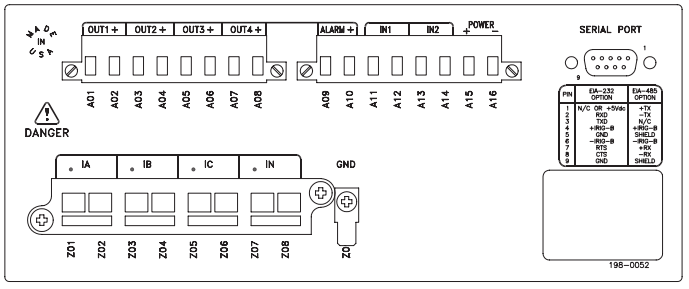
i3039b

Rear View – Conventional Terminal Blocks - SEL-551C



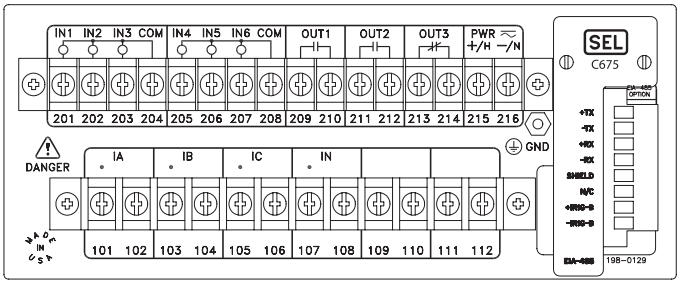
i3842a

Rear View – Connectorized® - SEL-551



i3042a

Rear View – Terminal Adapter - SEL-551C



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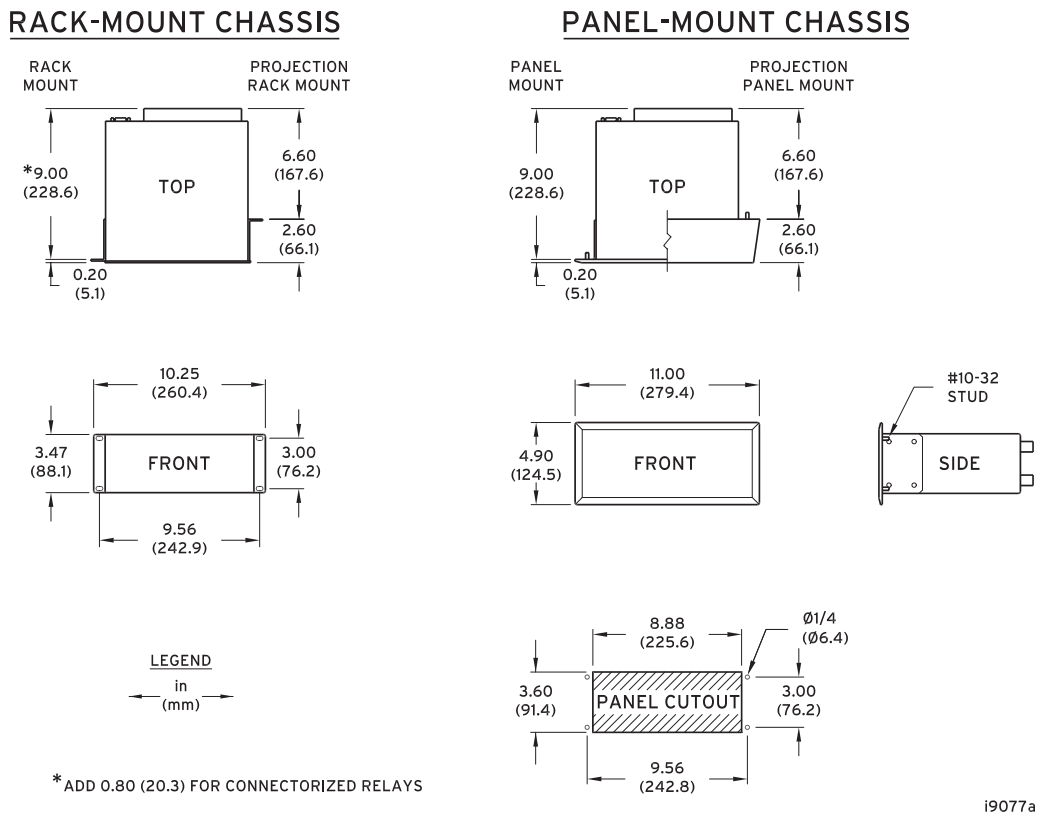
SEL-551/SEL-551C Overcurrent/Reclosing Relay

Dimensions



Visit www.selinc.com for more detailed information and configuration options.

SEL-547 Distributed Generator Interconnection Relay

Apply low-cost, compact package with essential protection and control elements for distributed generation.

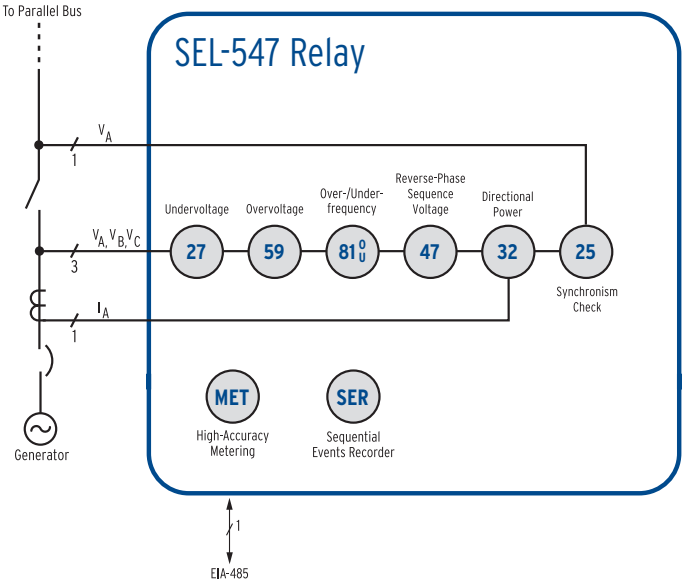
Key Features

Protection and Control

The SEL-547 is a voltage-based protective relay with over-/underfrequency and over-/undervoltage elements to trip for local system "islanding" or system-wide voltage or frequency disturbances. The directional power element trips for power export violations or generator "motoring." A synchronism check element detects healthy voltage, frequency, and angle, and supervises breaker/switch closing.

Communications

ASCII and Modbus® RTU protocols allow easy local and/or remote access for relay programming, data acquisition, or monitoring functions. Quickly interface to an SEL information processor for powerful data management, or connect direct to supervisory (SCADA) systems for integrated protection and control.



The SEL-547 is a great choice for backup power systems or IEEE 1547-compliant distributed generation interconnections.

SEL-547 Distributed Generator Interconnection Relay

Applications

- Use the over-/underfrequency or over-/undervoltage elements to quickly detect local system disturbances and trip the transfer switch to separate the utility supply from the load.
- Detect directional power flow problems, and quickly disconnect the utility supply from the load and the distributed resource.
- Apply the SEL-547 to small-scale wind generation installations at the interconnection point between the utility and the wind turbine.
- Protect both the generator and the grid from damage caused by a nonsynchronized close.

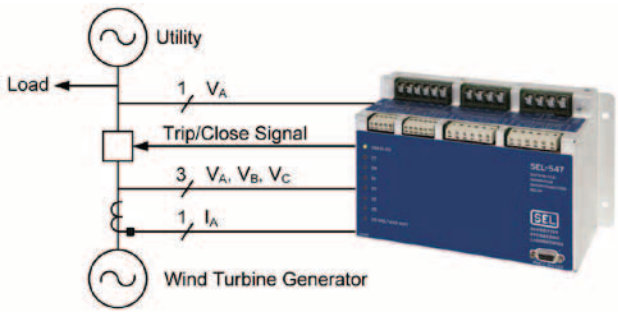
Price

Budgetary Retail, Quantity 1: $1,000

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.



Typical SEL-547 connections for a net-metered distributed generation application.

Hardware Specifications

AC Voltage Inputs (wye-connected)
208–480 V_{L-L} nominal (120–277 V_{L-N} nominal)
(additional input for synchronism check, 120–277 V_{L-N} nominal)

AC Current Input
5 A nominal

System Frequency and Phase Rotation
50 or 60 Hz; ABC or ACB rotation

Optoisolated Inputs (3)
Apply 6–32 Vdc wetting voltage

Power Ratings
6–32 Vdc input range; power consumption <10 W

Output Contacts (5 plus 1 alarm)
6 A continuous carry @ 70°C; 4 A continuous carry @ 85°C
30 A make per IEEE C37.90; 8 ms pickup time

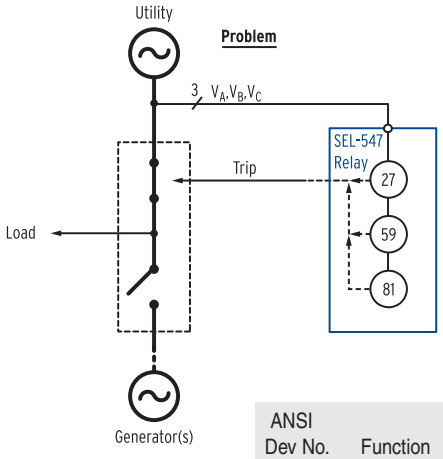
Serial Communications (300–19200 bps)
EIA-232 port (factory set: SEL ASCII protocol)
EIA-485 port (factory set: Modbus protocol)

Operating Temperature
–40° to +85°C (–40° to +185°F)

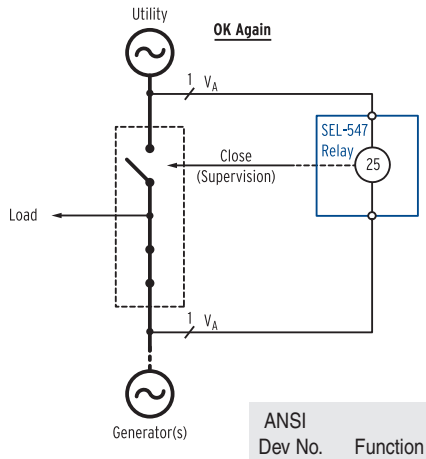
Distributed generators of all types can use the SEL-547 to provide interconnection protection. Use voltage, frequency, and power elements to disconnect generators under abnormal system conditions. Photo courtesy of Sustainable Energy Developments, Inc. (SED).

SEL-547 Distributed Generator Interconnection Relay

System Disturbance Detection and System Restoration



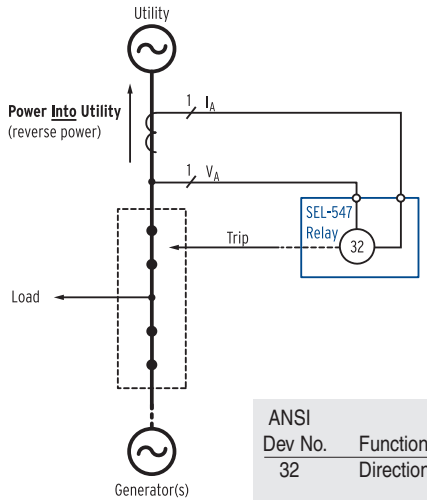
ANSI Dev No.	Function
27	Undervoltage
59	Overvoltage
81	Over-/underfrequency



ANSI Dev No.	Function
25	Synchronism check

These two figures show the operation of the SEL-547 and an emergency backup generator for a system disturbance. The emergency backup generator is normally offline. In the first figure, the over-/undervoltage or over-/underfrequency elements in the SEL-547 detect local system "islanding" or a system-wide problem and trip the transfer switch, separating the utility supply from the load. A separate control (not shown) brings the emergency backup generator online, and the generator then supplies part of or all of the load. Later, as shown in the second figure, the synchronism check element in the SEL-547 detects that the utility supply and generator are within normal bounds (voltage, frequency, and angle). The SEL-547 then issues a close (supervision) signal to a separate control (not shown) to close the transfer switch, reconnecting the utility supply to the load.

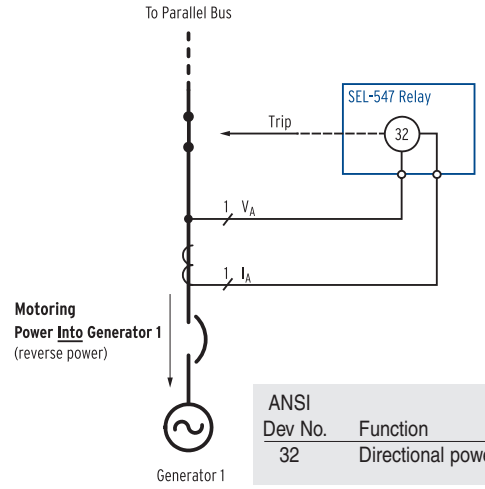
Reverse Power Flow Detection



ANSI Dev No.	Function
32	Directional power

In the figure above, the generator normally operates in a parallel mode, but with the restriction that no power can be exported to the utility. Due to reduced on-site demand or some other phenomenon, a net flow of power into the utility results. The directional power element in the SEL-547 detects this reverse power flow and trips the transfer switch, separating the utility supply from the load and generator.

Generator Motoring Detection

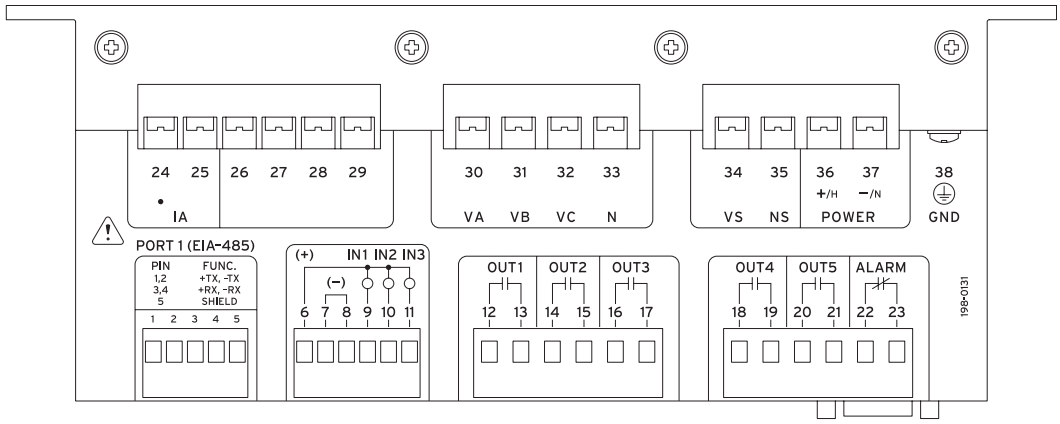


ANSI Dev No.	Function
32	Directional power

In the figure above, the generator normally operates in a parallel mode. For some reason (e.g., the generator loses its prime mover), power from the power system flows into the generator, "motoring" the generator. The directional power element in the SEL-547 detects this potentially damaging reverse power flow and trips the switch/breaker, breaking the parallel operation.

SEL-547 Distributed Generator Interconnection Relay

Top View



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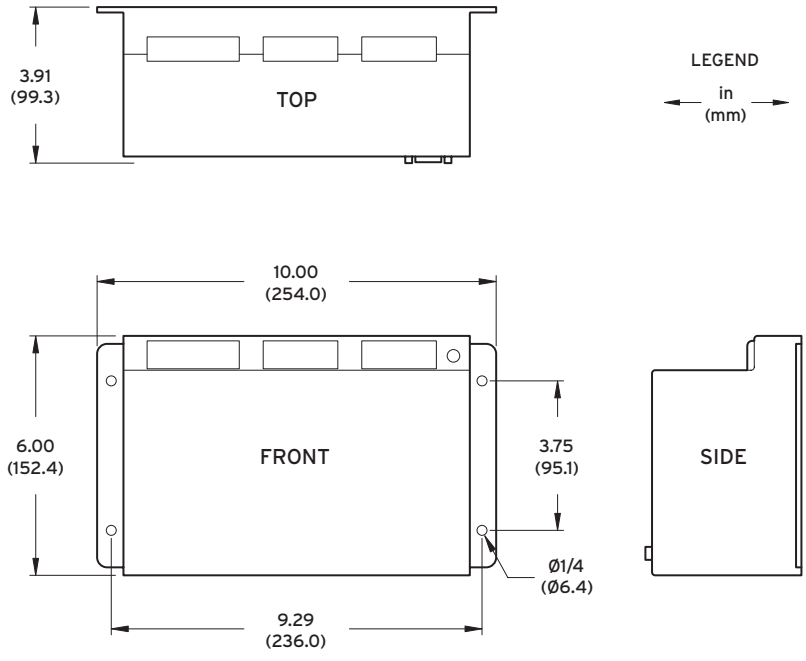
Dimensions



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Visit www.selinc.com for more detailed information and configuration options.

SEL-351R Recloser Control

Choose the SEL-351R for easy recloser control upgrades with advanced directional overcurrent and frequency elements, and communications-assisted protection schemes.

Key Features

Plug-In Recloser Compatibility

Plug-compatible replacement for Cooper Kyle® Form 3, 3A, 4, 4A, 4C, FXA, FXB, and other 14-pin recloser controls, including "EZ" recloser control settings for rapid installation. Also plug compatible with G&W Viper® Reclosers. Proven IEEE Standard C37.60-2003 compliance certified by an independent testing laboratory.

Windows®-Based ACSELERATOR QuickSet® SEL-5030 Software

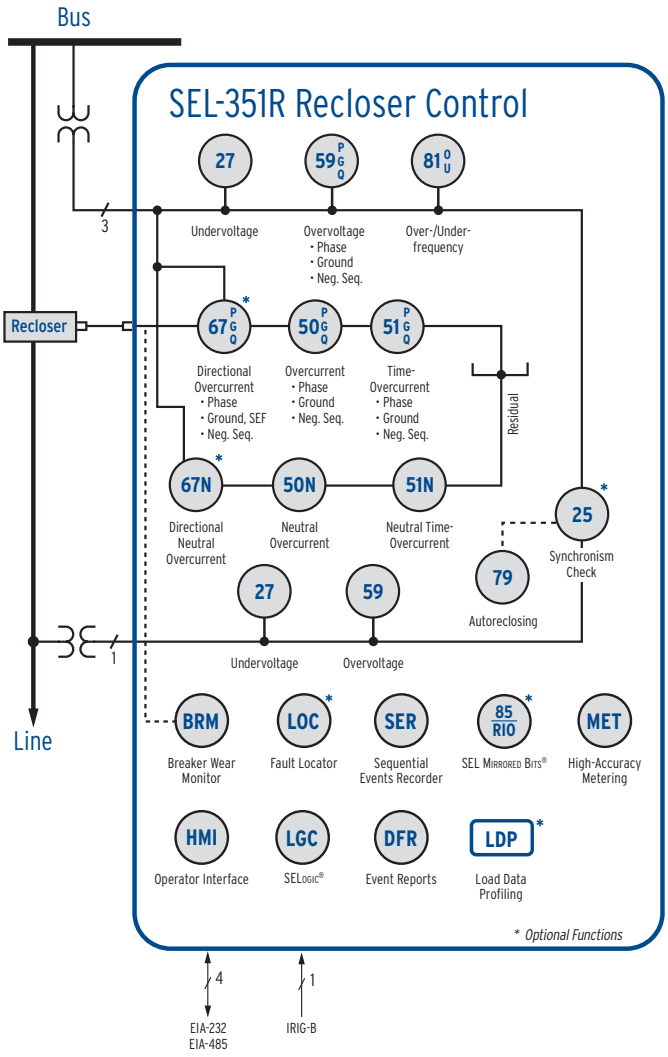
Use ACSELERATOR QuickSet Software to create and manage recloser control settings. Create settings offline for later deployment across your system. Facilitate monitoring, commissioning, and testing with the built-in HMI functions. Improve system reliability with system event analysis tools.

Large Display and Operator Controls

Large front-panel display and programmable operator control interface pushbuttons for easy recloser control. Control interface pushbuttons include "Lock" function to prevent inadvertent operation. Pushbuttons are preprogrammed and labeled with popular recloser control switch functions. Use optional configurable labels and programmable front panel to create custom applications. Simplify operator interface with programmable rotating display showing system status with numerical and text messages.

Advanced 24 Vdc Battery-Charging and Monitoring System

120 Vac powered battery-charging system monitors and tests the 24 Vdc battery. Maximize battery backup duration with automatic sleep and local/remote wake-up function. 12 Vdc available for powering modems and radio communications equipment (6 W continuous, 13 W for 1 second).



GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

SEL-351R Recloser Control

Applications

- Upgrade existing substation and pole-mounted Cooper recloser controls with plug-compatible SEL-351R Recloser Controls to improve protection, control, and monitoring functions.
- Integrate and automate new and existing recloser installations to provide remote control, remote communication, and automated data collection.
- Selectively control preferred and alternate source reclosers that serve critical customer loads using a Mirrored Bits® communications link.
- Selectively coordinate with upstream SEL-351 or SEL-351S Relays applied on feeder breakers using a Mirrored Bits communications link for secure, high-speed fault clearing on distribution circuits.
- Apply high-side transformer blown-fuse detection logic to protect customers from potentially damaging unbalanced voltages.
- Add underfrequency load shedding to individual feeder and subfeeder recloser installations.
- Use the built-in fault locator and fault type identification to efficiently dispatch line inspection and repair personnel, and identify recurring feeder trouble points to improve reliability.
- Program recloser failure logic with SELogic® control equations and SELogic counters.
- Use the oscillographic event report and Sequential Events Recorder (SER) data to measure and improve protection device coordination.
- Apply cold-load pickup scheme to prevent tripping on cold-load inrush current.
- Choose the optimal solution for Automatic Network Reconfiguration. Use a combination of Mirrored Bits communications, directional elements, voltage elements, and SELogic control equations.

Optional Features

- Three-phase and synchronism voltage input interface.
- EIA-485 communications port.
- DNP3 Level 2 Outstation communications protocol with point mapping.
- Mirrored Bits communications and load profiling.
- Overhead AutoRANGER® fault indicators.
- Configurable front-panel labels.
- SEL-3022 Wireless Encrypting Transceiver (see page 366).
- SEL-2401 Satellite-Synchronized Clock (see page 316).
- Accessory mounting bracket or plate.
- Additional 36-position terminal block.
- Additional 6-position shorting terminal block.
- 100 W heater.
- AC fuse option.
- DC fuse option.
- Low-voltage close cable.
- Recloser control cable.
- Two-pin receptacle.
- Security sleeve.

Related Products

Hardware Specifications

Power Supply Ratings

120 Vac nominal 106–140 Vac

Supply includes integral battery charger

Control Input and Output Ranges

24, 48, 125, or 250 Vdc

Standard configuration provides 6 inputs and 8 outputs, <5 ms pickup/dropout times with 30 A make, 6 A continuous duty

Operating Temperature

–40° to +85°C (–40° to +185°F) for relay module

–40° to +50°C (–40° to +122°F) for enclosure ambient

(Note: LCD contrast impaired for temperatures below –20°C)

For operating temperatures of accessories, including batteries, see manufacturers' specifications

Price

Budgetary Retail, Quantity 1: $3,440

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

Recloser Compatibility List

Cooper

CXE
NOVA™ Auxiliary Powered
RE
RVE
RXE
VSA
VSO
VWE
VWVE 27
VWVE 38X
WE
WVE 27
WVE 38X

G&W

Viper-G™
Viper-S®

Joslyn

TriMod™ 300R

FKI Whipp & Bourne

GVR*

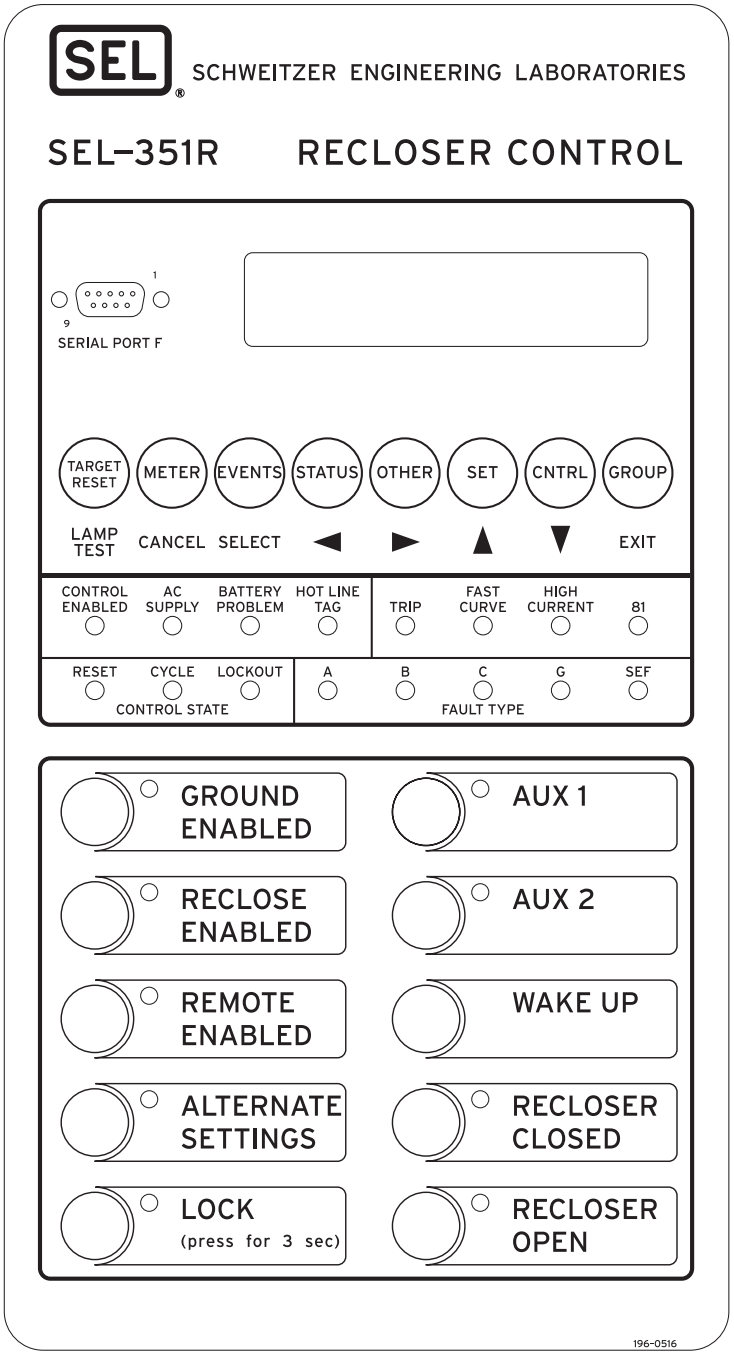
* When equipped with interface module

"We chose the SEL-351R because of our need for a single retrofit control with metering and control capabilities for SCADA as well as an underfrequency element for load shedding as mandated by our power pool."

Brad Truitt
Senior Engineer
Western Farmers Electric Cooperative

SEL-351R Recloser Control

Front View



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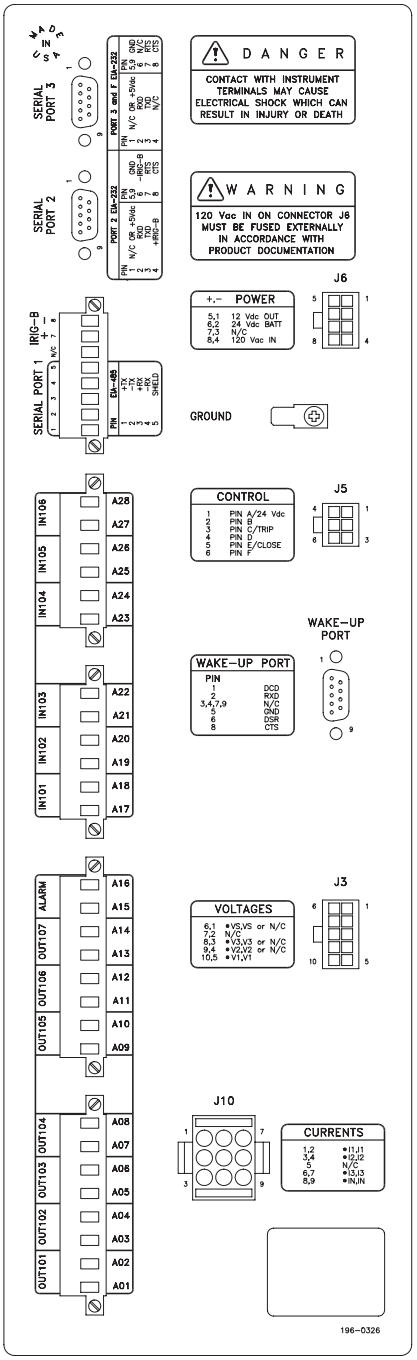
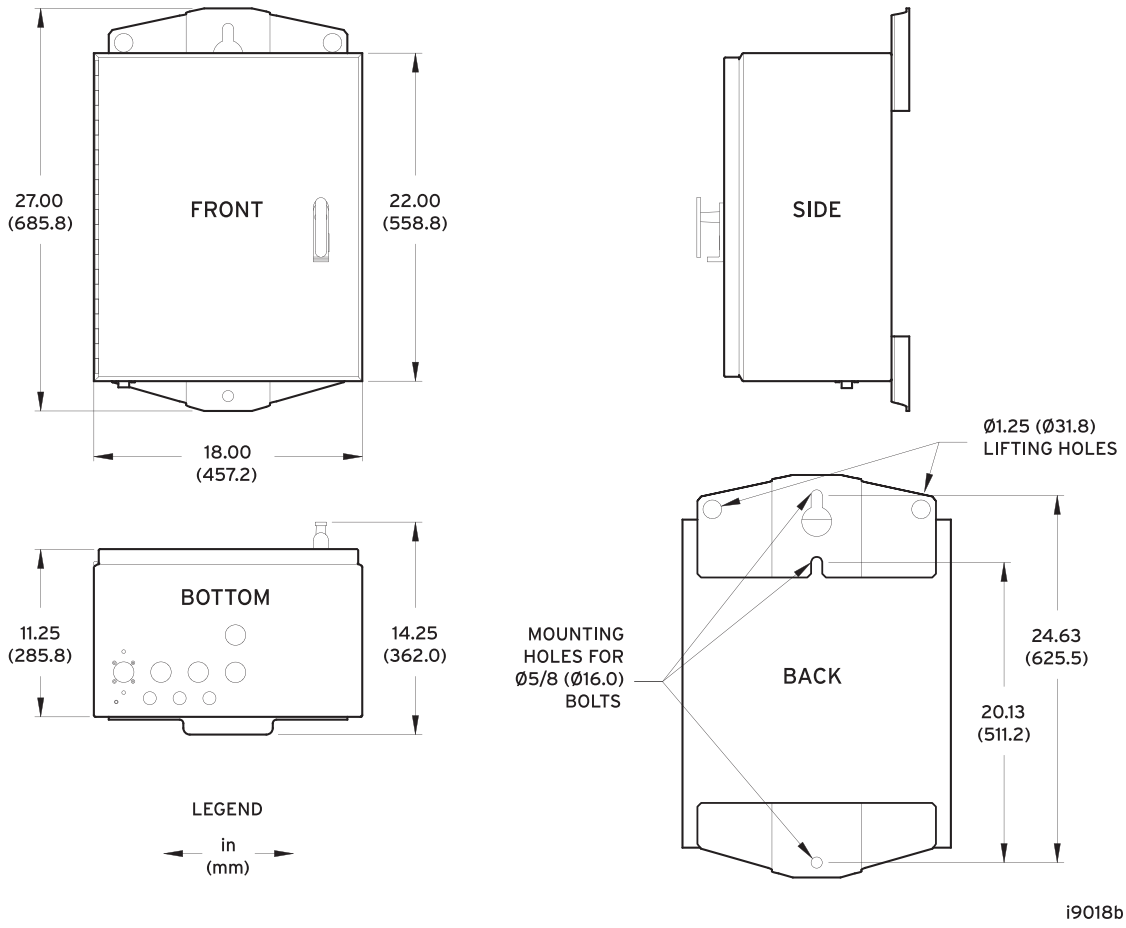
Side View



Dimensions

POLE-MOUNT ENCLOSURE



Visit www.selinc.com for more detailed information and configuration options.

SEL-351R Falcon™ Recloser Control

Apply the SEL-351R Falcon for simple recloser control upgrades. This small, lightweight control has advanced directional overcurrent and frequency elements, and Mirrored Bits® for communications-assisted protection schemes.

Key Features

Plug-In Recloser Control Compatibility

The SEL-351R Falcon Recloser Control, a plug-compatible replacement for Cooper Kyle® Form 3, 3A, 4, 4A, 4C, FXA, FXB, 5, and 6 recloser controls, is compatible with popular reclosers from Cooper, G&W, Joslyn, and FKI Whipp & Bourne. Familiar "EZ" recloser control settings expedite commissioning. The SEL-351R Falcon is independently certified to IEEE C37.60-2003 recloser standards.

Lightweight and Rugged Design

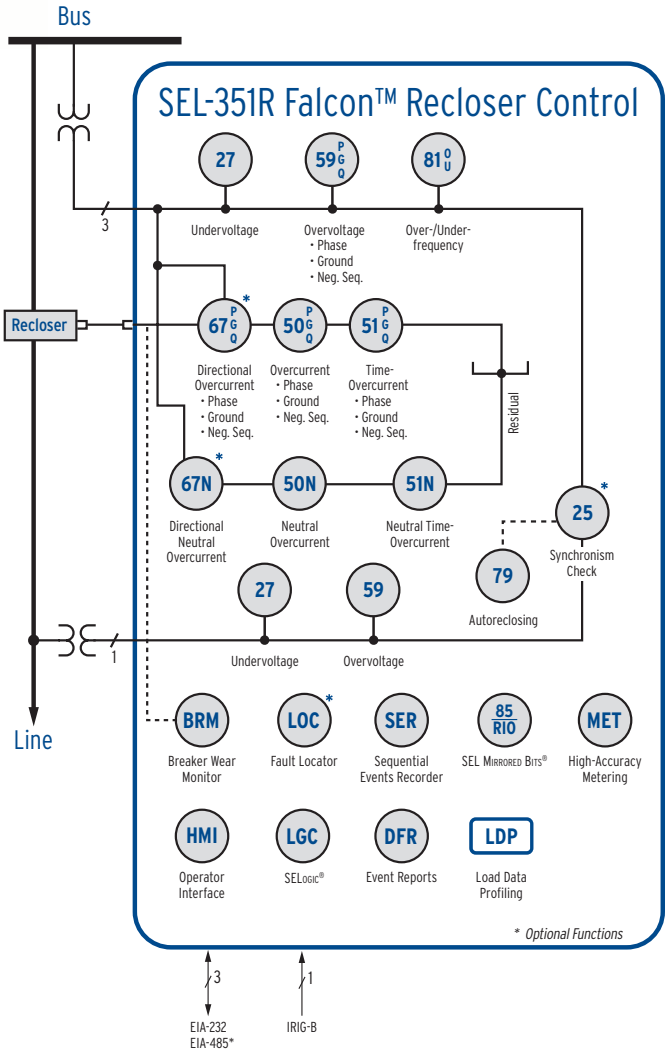
One person can easily lift and quickly install this lightweight recloser control. The durable, painted, aluminum enclosure will not rust and is rugged enough for line installation, and the gasketless enclosure carries a NEMA 3R rating to ensure reliable performance in all weather conditions. A swing-open NEMA 3R enclosure with a gasketed door is also available.

Improved Mirrored Bits Communications for Use With Spread-Spectrum Radios

Mirrored Bits communications simplifies high-speed, relay-to-relay logic communications schemes for improved feeder performance.

Advanced Battery-Charging and Monitoring System

The 120 Vac/Vdc-powered battery-charging system monitors and tests the 24 Vdc battery and includes automatic sleep and local wake-up function. The control also supplies 12 Vdc for powering modems, radios, and other equipment (6 W continuous, 13 W for 1 second).



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SEL-351R Falcon Recloser Control

Applications

- Upgrade existing substation and pole-mounted Cooper recloser controls with plug-compatible SEL-351R Falcon Recloser Controls to improve protection, control, and monitoring functions.
- Integrate and automate new and existing recloser installations to provide remote control, remote communication, and automated data collection.
- Selectively control preferred and alternate source reclosers that serve critical customer loads using a Mirrored Bits communications link.
- Selectively coordinate with upstream SEL-351 or SEL-351S Relays applied on feeder breakers using a Mirrored Bits communications link for secure, high-speed fault clearing on distribution circuits.
- Apply high-side transformer blown-fuse detection logic to protect customers from potentially damaging unbalanced voltages.
- Add underfrequency load shedding to individual feeder and subfeeder recloser installations.
- Use the built-in fault locator and fault type identification to efficiently dispatch line inspection and repair personnel, and identify recurring feeder trouble points to improve reliability.
- Program recloser failure logic with SELogic® control equations and SELogic counters.
- Use the oscillographic event report and Sequential Events Recorder (SER) data to measure and improve protection device coordination.
- Apply cold-load pickup scheme to prevent tripping on cold-load inrush current.
- Choose the optimal solution for Automatic Network Reconfiguration. Use a combination of Mirrored Bits communications, directional elements, voltage elements, and SELogic control equations.

Optional Features

- Three-phase and synchronism voltage input interface.
- EIA-485 communications port.
- Configurable front-panel labels.
- SEL-3022 Wireless Encrypting Transceiver (see page 366).
- SEL-2401 Satellite-Synchronized Clock (see page 316).
- Cabinet heater.
- Low-voltage close cable.
- Recloser control cable.
- Two-pin receptacle.
- Security sleeve.
- Additional inputs/outputs.
- Swing-open enclosure with gasketed door.

Related Products

Hardware Specifications

Power Supply Ratings

120 Vac nominal 106–140 Vac

Operating Temperature

–40° to +85°C (–40° to +185°F) for relay module

–40° to +50°C (–40° to +122°F) for enclosure ambient

(Note: LCD contrast impaired for temperatures below –20°C)
For operating temperatures of accessories, including batteries, see manufacturers' specifications

Weight

16.7 kg (37 lbs) with batteries

Recloser Compatibility List

Cooper
- CXE
- NOVA™ Auxiliary Powered
- RE
- RVE
- RXE
- VSA
- VSO
- VWE
- VWVE 27
- VWVE 38X
- WE
- WVE 27
- WVE 38X

G&W
- Viper-G™
- Viper-S®

Joslyn
- TriMod™ 300R

FKI Whipp & Bourne
- GVR*

* When equipped with interface module

Price

Budgetary Retail, Quantity 1: $2,600

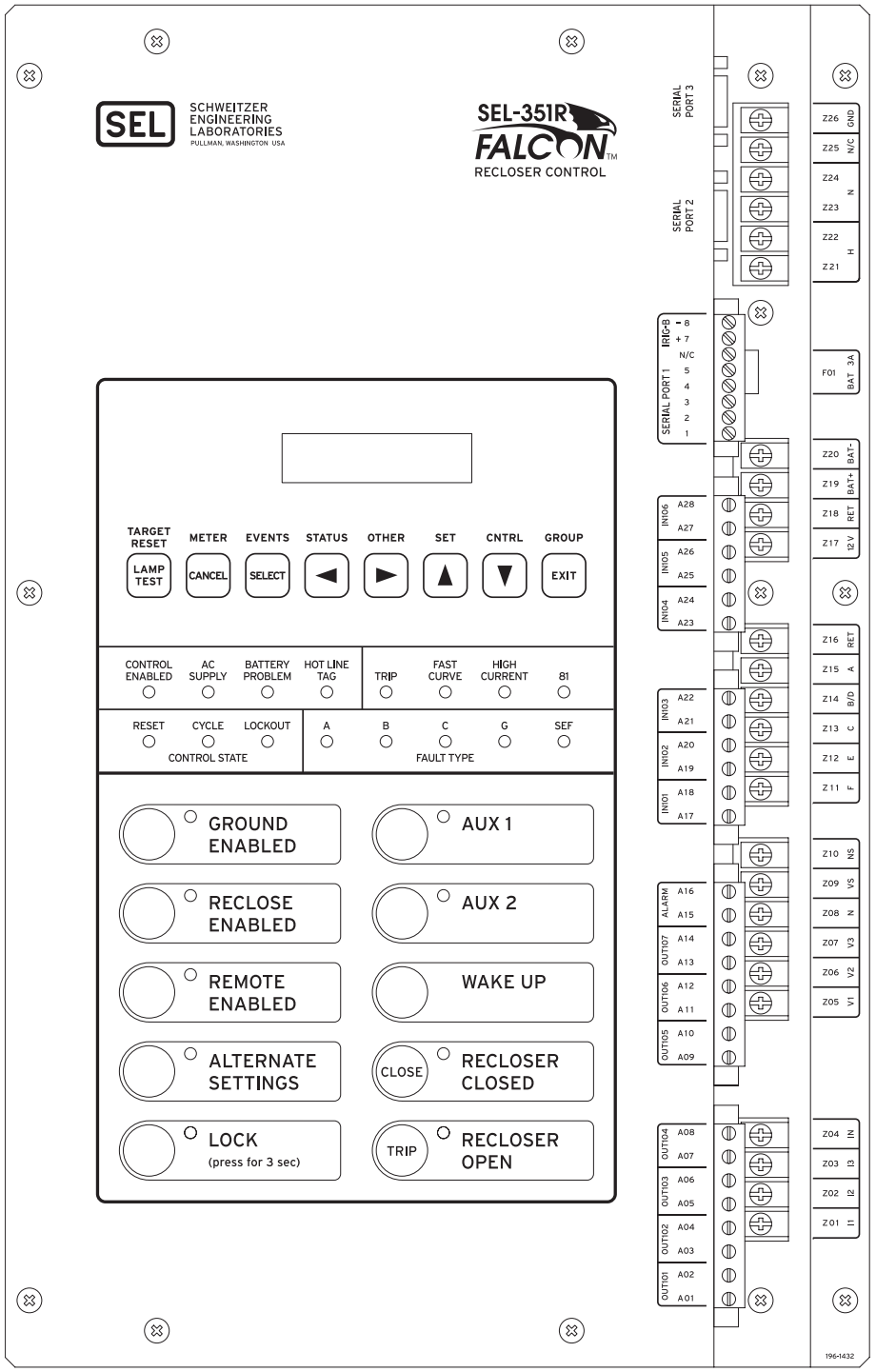
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

SEL-351R Falcon™ Recloser Control

Front View



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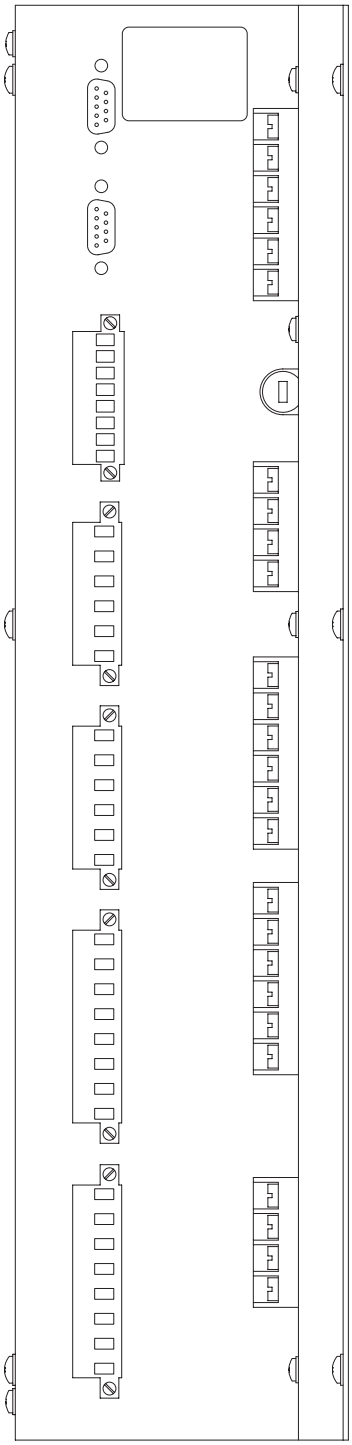
Side View



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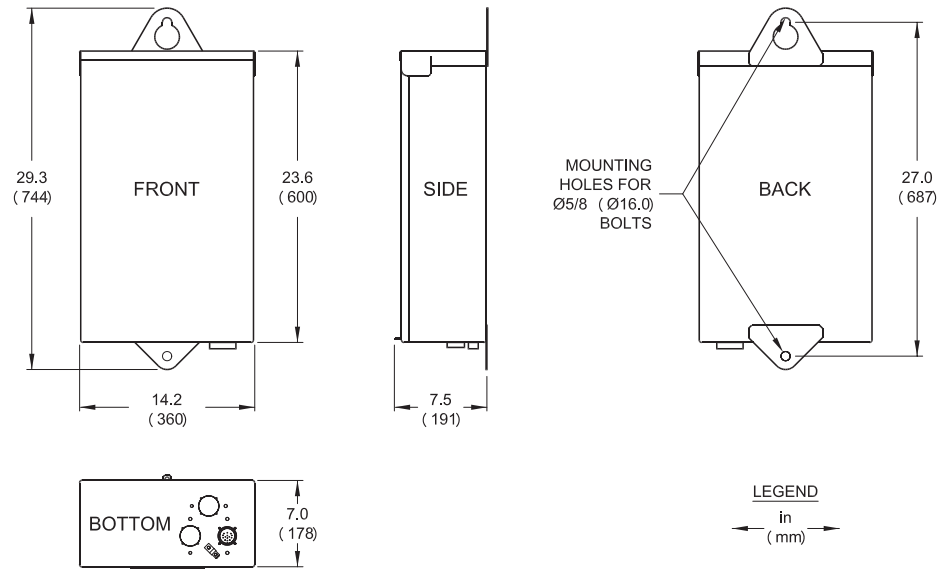
SEL-351R Falcon Recloser Control

Dimensions

POLE-MOUNT ENCLOSURE



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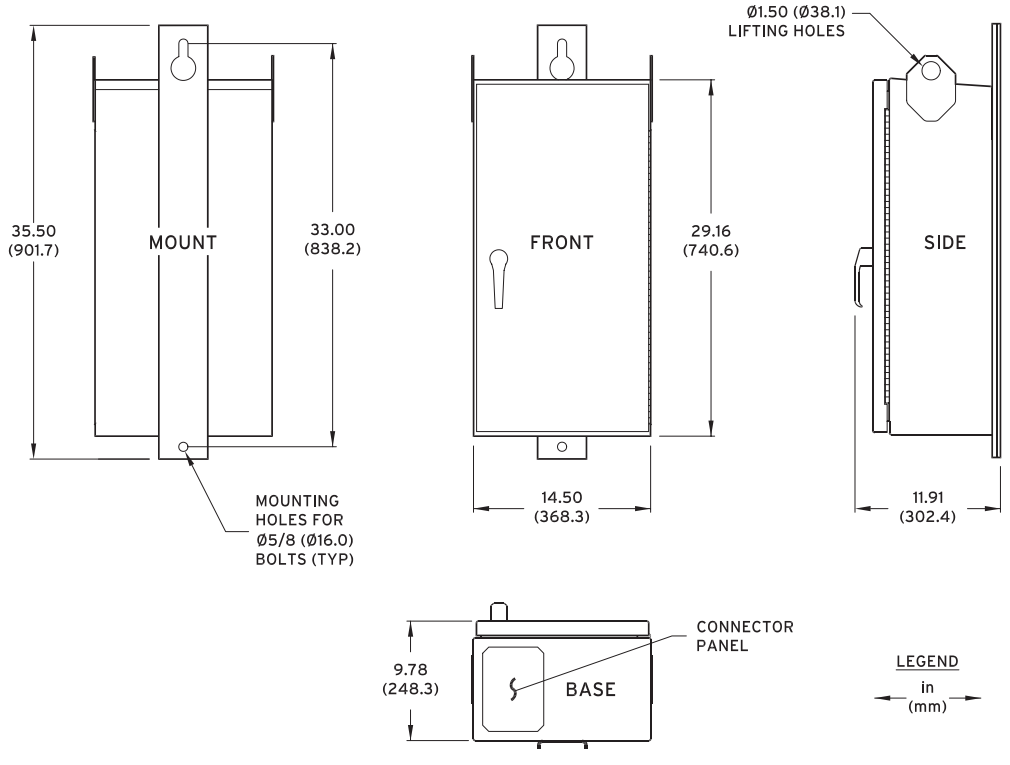
SWING OPEN POLE-MOUNT ENCLOSURE



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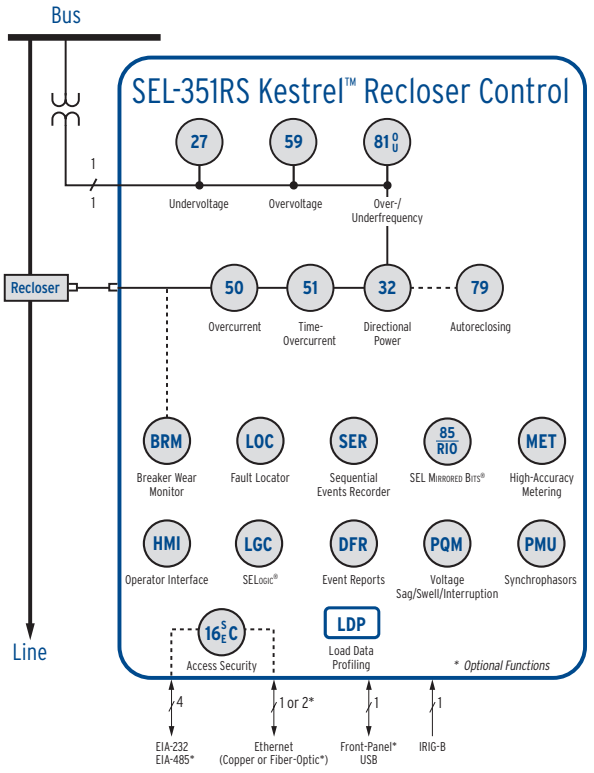
Visit www.selinc.com for more detailed information and configuration options.

SEL-351RS Kestrel™ Single-Phase Recloser Control

Add advanced recloser control capability to single-phase lines. Improve coordination and reliability with comprehensive protection, automation, communications, and control.



Key Features

Large Display and Operator Controls

Large front-panel display and programmable operator control interface pushbuttons allow easy recloser control. Control interface pushbuttons include "Lock" function to prevent inadvertent operation. Pushbuttons are preprogrammed and labeled with common recloser control switch functions. Use optional configurable labels and programmable front panel to create custom applications. Simplify operator interface with programmable rotating display showing system status with numerical and text messages.

IEEE C37.118 Synchrophasors

Identify the connected phase of single-phase devices by comparing synchronized data between substation and line equipment. Validate system load flow and fault models using instantaneous voltage angle. Use system-state measurements to increase stable system loading through reduced margin requirements.

Enhanced Security

Apply communications port settings to disable port and restrict maximum privileges for robust security. Enhanced password security also protects the relay from unauthorized access.

Windows®-Based acSELerator QuickSet® SEL-5030 Software

Use acSELerator QuickSet Software to create and manage recloser control settings. Create settings offline for later deployment across your system. Facilitate monitoring, commissioning, and testing with the built-in HMI functions. Improve system reliability with system event analysis tools.

Communications and Automation

Built-in Ethernet communications, EIA-232 serial ports, and available EIA-485 serial port provide easy local/remote access and system integration. The optional USB port simplifies local connection and speeds relay communication and event retrieval. Mirrored Bits communications protocol for eight channels of secure relay-to-relay logic communications is available on both side-panel EIA-232 serial ports. Programmable relay logic affords increased ability for user-defined automation requirements.

SEL-351RS Kestrel Single-Phase Recloser Control

Applications

- Selectively coordinate with upstream SEL-351 or SEL-351S Relays applied on feeder breakers using a Mirrored Bits communications link for secure, high-speed fault clearing on distribution circuits.
- Improve reliability and dispatch line inspection and repair personnel directly to trouble spots with the built-in fault locator and fault type identification.
- Program recloser failure logic with SELogic® control equations and SELogic counters.
- Measure and improve protection device coordination with the oscillographic event report and Sequential Events Recorder (SER) data.
- Apply cold-load pickup scheme to prevent tripping on cold-load inrush current.
- Integrate easily into new or existing Ethernet networks with single or dual, copper or fiber-optic Ethernet communications ports.
- View IEEE C37.118 synchronous phasors from any location to measure the system state. Identify the connected phase of single-phase devices by comparing synchronized data between substation and line equipment.
- Access status and metering information quickly and easily using the large front panel HMI.

Optional Features

- Swing-open painted aluminum enclosure.
- Conformal coating.
- User-configurable labels.
- Side-panel USB communications port.
- Additional interface I/O with 3 inputs and 4 outputs.
- Single or dual fiber-optic Ethernet or dual copper Ethernet communications port.
- IEC 61850 communications protocol.
- 40 Ah battery.
- SEL-3022 Wireless Encrypting Transceiver (see page 366).
- SEL-2401 Satellite-Synchonized Clock (see page 316).
- Security sleeve.
- EIA-485 communications port.
- Cabinet heater.
- Low-voltage close cable.

Related Products

Recloser Compatibility List

G&W

Viper-SP™

Hardware Specifications

AC Current Inputs

1 A nominal

3 A continuous, linear to 20 A symmetrical, 100 A for 1 second
Burden 0.13 VA @ 1 A; 1.31 VA @ 3 A

AC Voltage Inputs

300 V_{L-N} continuous (connect any voltage up to 300 Vac)
600 Vac for 10 seconds
Burden 0.03 VA @ 67 V; 0.06 VA @ 120 V; 0.8 VA @ 300 V

Power Supply

85–264 Vac, 120/230 Vac nominal
85–350 Vdc, 125/250 Vdc nominal

12 V Radio Supply

10.2–16 Vdc, 6 W continuous, 13 W for 1 second

Operating Temperature

Relay Module	–40° to +85°C (–40° to +185°F)
Entire SEL-351RS Kestrel Unit	–40° to +60°C (–40° to +122°F)

(Note: LCD contrast impaired for temperatures below –20°C (–4°F). The entire SEL-351RS Kestrel unit was operation tested up to +70°C (+158°F). The 20°C (36°F) difference in ratings allows for temperature rise due to sunlight.)

Weight

<18.1 kg (40 lbs) without battery

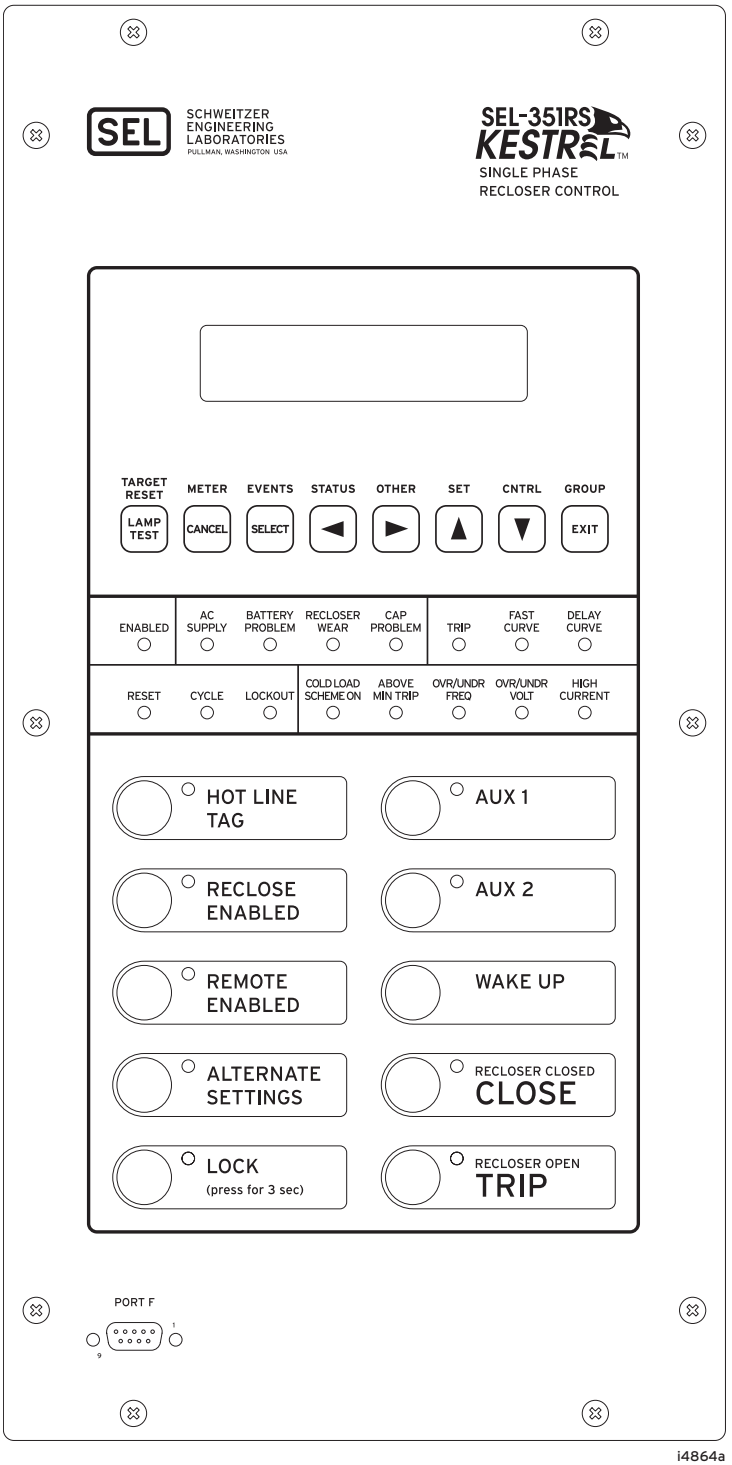
Price

Budgetary Retail, Quantity 1: $2,500

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

SEL-351RS Kestrel™ Single-Phase Recloser Control

Front View



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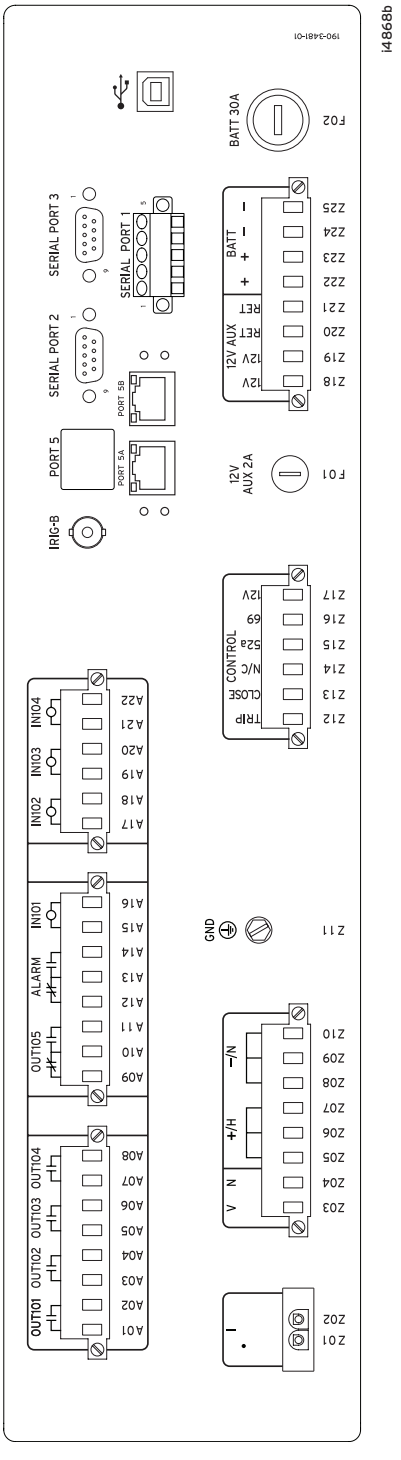
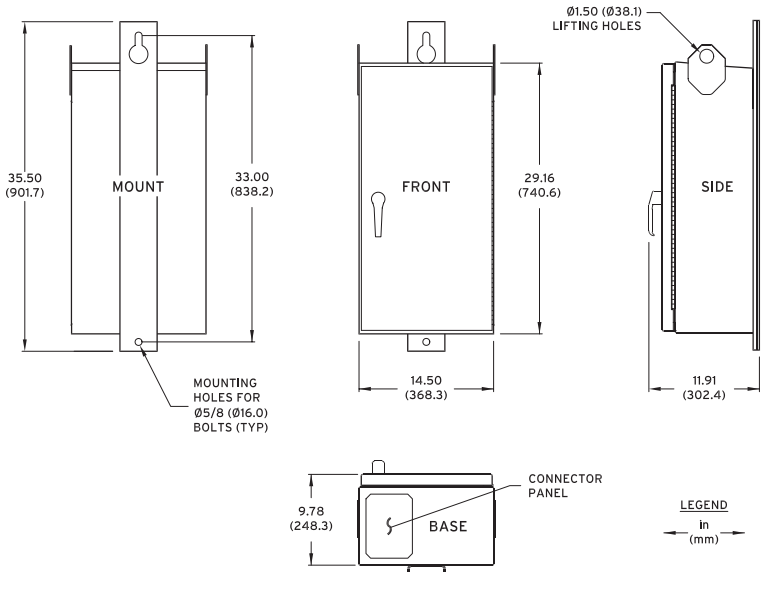
Side View

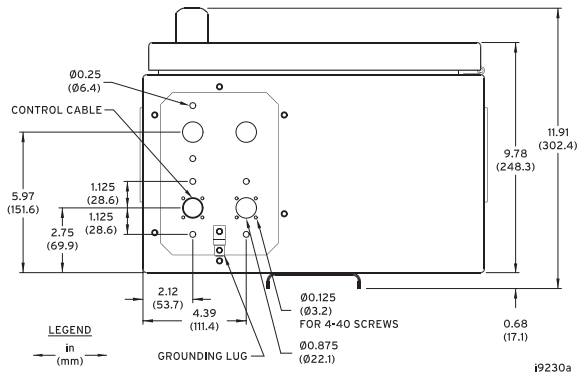


SEL-351RS Kestrel Single-Phase Recloser Control

Dimensions

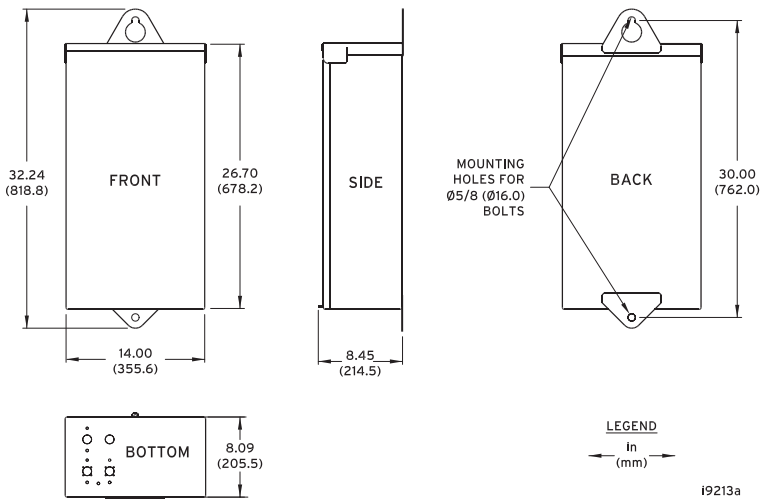
SWING-OPEN POLE-MOUNT ENCLOSURE

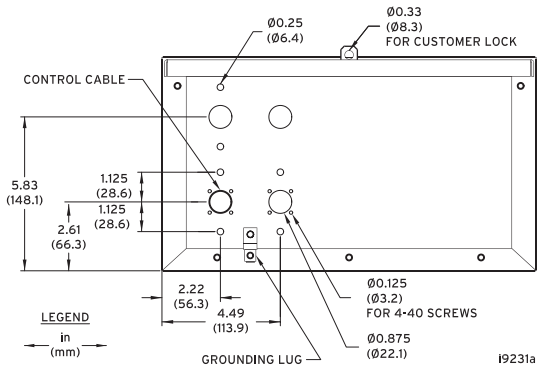




Swing-open enclosure dimensions and mounting.

LIFT-TO-OPEN POLE-MOUNT ENCLOSURE





Lift-to-open enclosure dimensions and mounting.

Visit www.selinc.com for more detailed information and configuration options.

SEL-651R Advanced Recloser Control

Apply the SEL-651R for advanced recloser control applications with Automatic Network Reconfiguration, single-phase tripping, and harmonics metering.

Key Features

Single-Phase Tripping

Single-phase tripping interrupts only the faulted phase, while maintaining service to unaffected customers and reducing system and customer impacts due to faults. Select single-pole or three-pole lockout, depending on connected loads.

Proven Compliance With IEEE C37.60-2003

Successfully passed all specified tests in accordance with IEEE C37.60 as certified by Powertech Labs, an independent testing laboratory.

40-Watt Auxiliary Power Supply

Auxiliary power supply rated at 40 W continuous and 60 W surge for 6 seconds every 60 seconds to power even the most demanding 12 V accessories.

Harmonics Metering

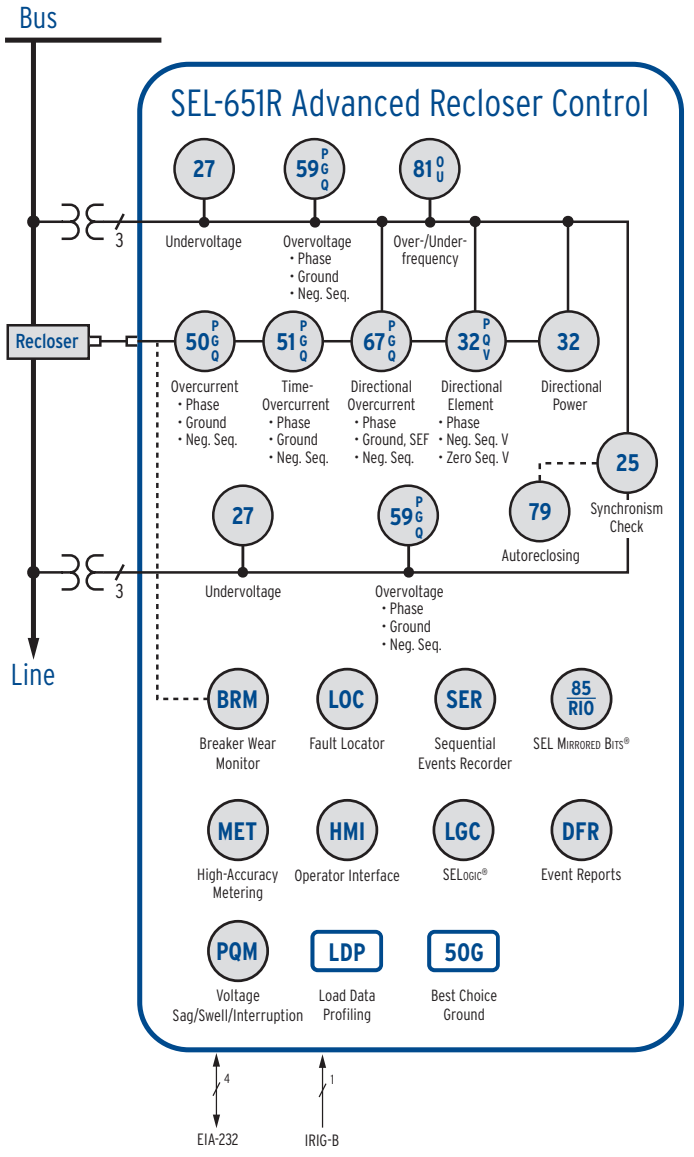
The SEL-651R Advanced Recloser Control meters harmonics from the second to the fifteenth as well as total harmonic distortion (THD). Improve power quality by tracking system harmonics levels. THD is also available for system control and protection decisions.

ACSELERATOR QuickSet® SEL-5030/ACSELERATOR QuickSet Designer® SEL-5031 Software

QuickSet Design Templates are easily customized to simplify control deployment across your system. Create designs that include the most commonly used control features and settings to reduce commissioning times. Templates are stored on the recloser control for easy access when making settings changes.

Automatic Network Reconfiguration (ANR)

ANR augments system reliability by automatically isolating faulted line segments and restoring service to the unaffected areas of the system. The SEL-651R includes six voltage inputs to monitor both source and load-side voltages, ensuring safe and secure reconfiguration.



Tel: +1.509.332.1890 | Fax: +1.509.332.7990 | www.selinc.com

SEL-651R Advanced Recloser Control

Applications

- Upgrade existing substation and pole-mounted recloser controls with plug-compatible SEL-651R Advanced Recloser Controls to improve protection, control, and monitoring functions.
- Integrate and automate new and existing recloser installations to provide advanced reclosing, such as ANR and single-phase tripping.
- Install at distributed generation interconnection point, and provide protection, control, metering, and automation all in one device.
- Interface with low-energy analog (LEA) voltage inputs such as those available on G&W Viper® reclosers, Cooper NOVA™ reclosers, and Lindsay voltage sensors.
- Selectively control preferred and alternate source reclosers that serve critical customer loads using a MIRRORED BITS® communications link.
- Selectively coordinate with upstream SEL-351 or SEL-351S Relays applied on feeder breakers using a MIRRORED BITS communications link for secure, high-speed fault clearing on distribution circuits.
- Apply high-side transformer blown-fuse detection logic to protect customers from potentially damaging unbalanced voltages.
- Add underfrequency load shedding to individual feeder and subfeeder recloser installations.
- Identify power quality issues using the harmonics and voltage sag/swell/interrupt recording and alarm capabilities.
- Program recloser failure logic with SELOGIC® control equations and SELOGIC counters.
- Use the oscillographic event report and Sequential Events Recorder (SER) data to measure and improve protection device coordination.
- Apply cold-load pickup scheme to prevent tripping on cold-load inrush current.
- Choose the optimal solution for ANR. Use a combination of MIRRORED BITS communications, directional elements, voltage elements, and SELOGIC control equations.

Optional Features

- Tricolored LEDs.
- 40 Ah battery.
- DNP3 Level 2 Outstation communications protocol with point mapping.
- Overhead AutoRANGER® fault indicators.
- Additional inputs/outputs.
- SEL-3022 Wireless Encrypting Transceiver (see page 366).
- SEL-2401 Satellite-Synchronized Clock (see page 316).
- Low-level voltage sensor inputs (analog).
- Smaller pole-mount enclosure.
- Stainless-steel enclosure.
- Accessory shelf.
- AC transfer switch.
- Voltage input fuse option.
- AC fuse option.
- Low-voltage close cable.
- Recloser control cable.
- Two-pin receptacle.
- Security sleeve.
- 125 Vdc power supply.

Related Products

Hardware Specifications

Power Supply Ratings

120 Vac*	85–132 Vac
230 Vac*	170–265 Vac
125 Vdc	100–137.5 Vdc

*Supply includes integral battery charger

Control Input and Output Ranges

12 Vdc

Optional configuration provides 7 inputs and 8 outputs, <5 ms pickup/dropout times with 30 A make, 6 A continuous duty

Operating Temperature

–40° to +85°C (–40° to +185°F) for relay module

–40° to +55°C (–40° to +131°F) for enclosure ambient

(Note: LCD contrast impaired for temperatures below –20°C)

For operating temperatures of accessories, including batteries, see manufacturers' specifications

Recloser Compatibility List

ABB
- OVR
- VR-3S

Cooper
- CXE
- NOVA Auxiliary Powered
- NOVA Control Powered
- NOVA-TS
- RE
- RVE
- RXE
- VSA
- VSO
- VWE
- VWVE 27
- VWVE 38X
- WE
- WVE 27
- WVE 38X

G&W
- Viper-G™
- Viper-S®
- Viper-ST®

Joslyn
- TriMod® 600R
- TriMod 300R

FKI Whipp & Bourne
- GVR*

* When equipped with interface module

Price

Budgetary Retail, Quantity 1: $5,750

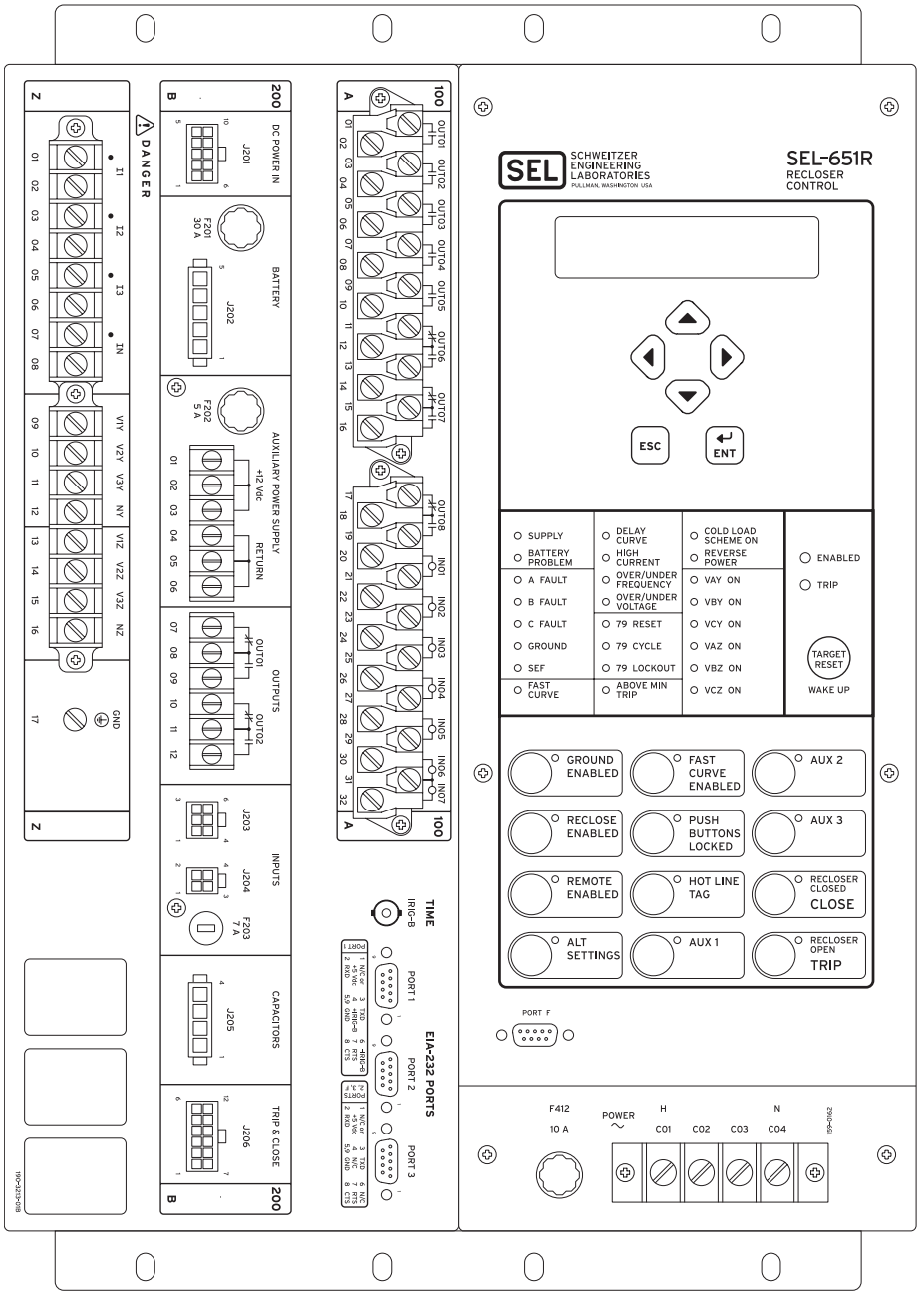
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

SEL-651R Advanced Recloser Control

Front View (Single Door)



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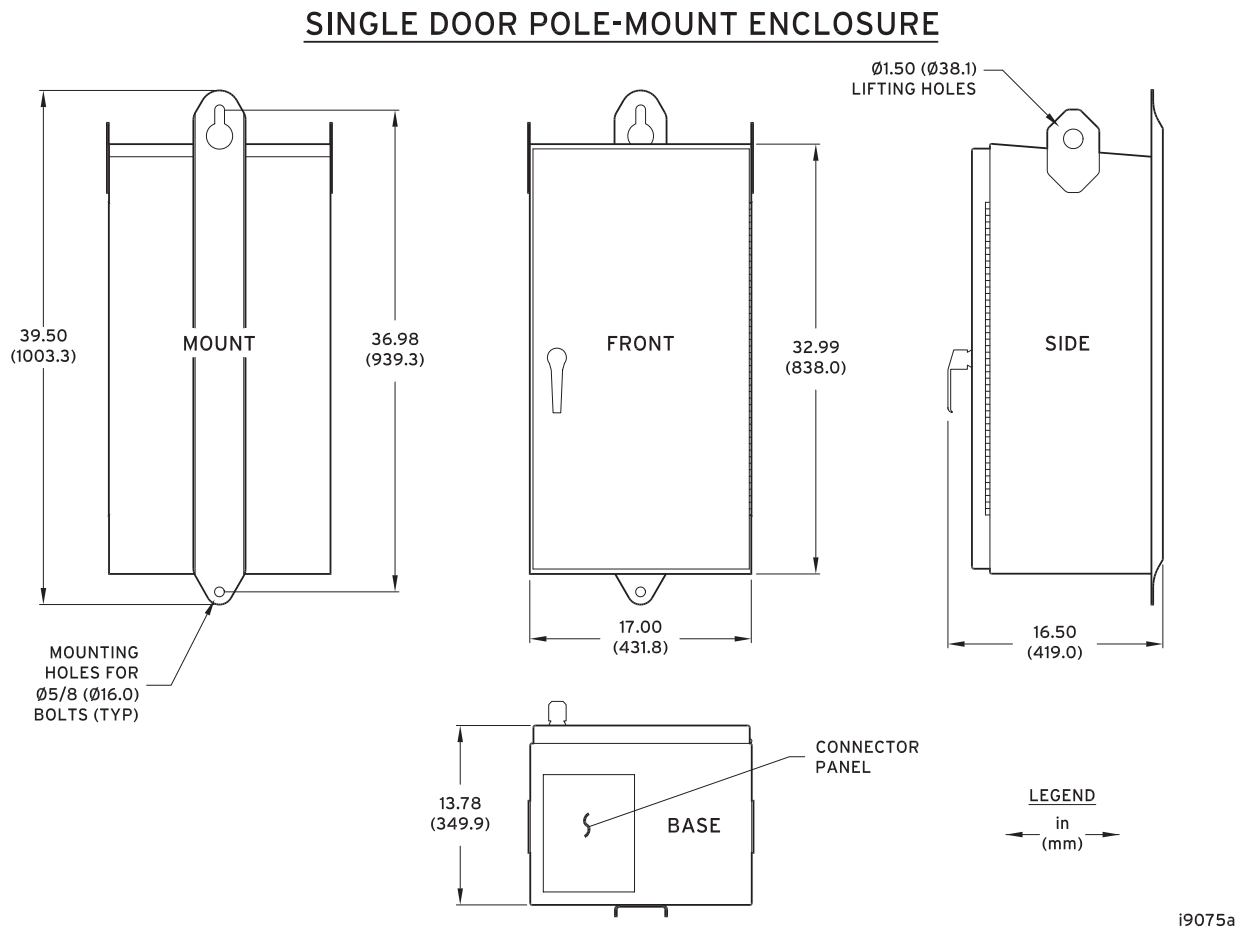
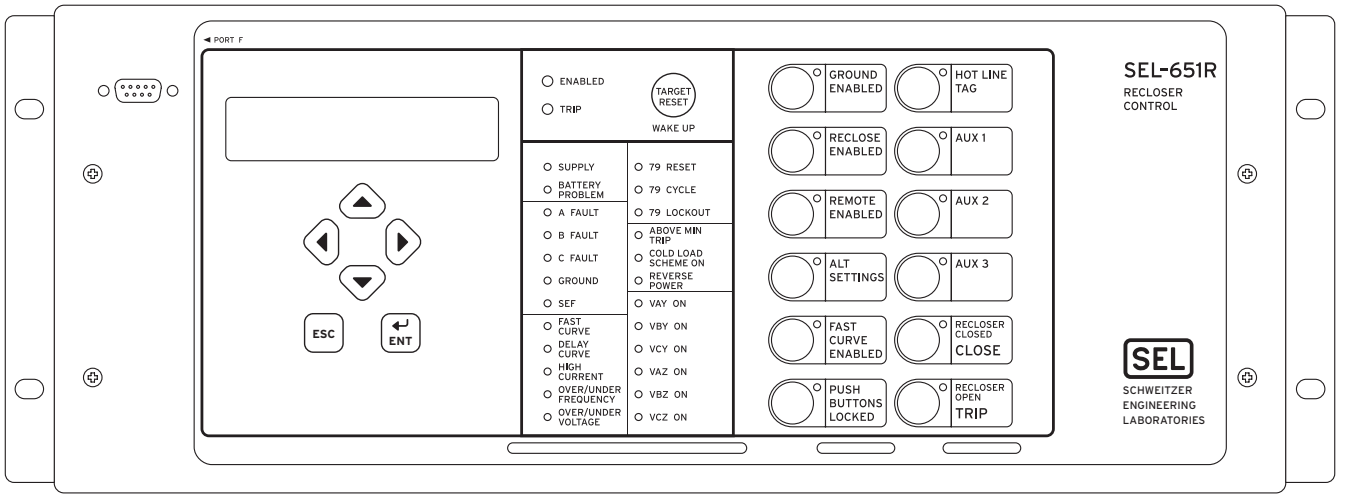
Dimensions (Single Door)



SEL-651R Advanced Recloser Control

Front View - Relay Module (Dual Door)



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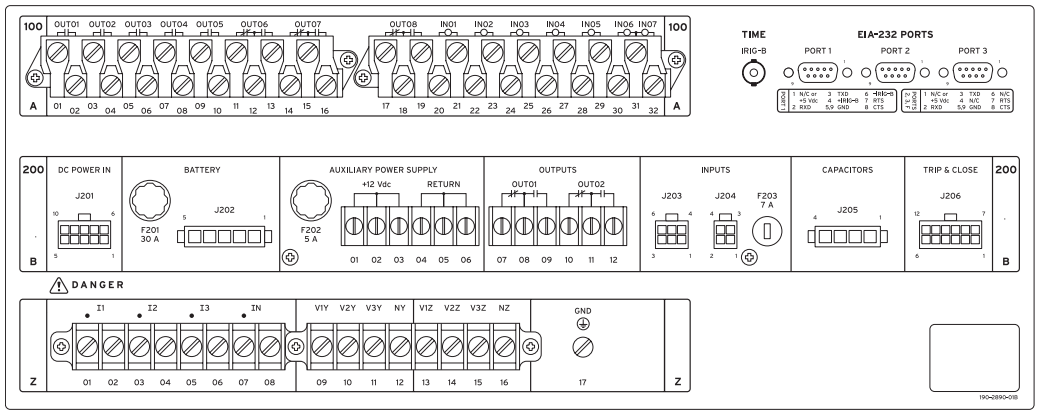
Rear View - Relay Module (Dual Door)



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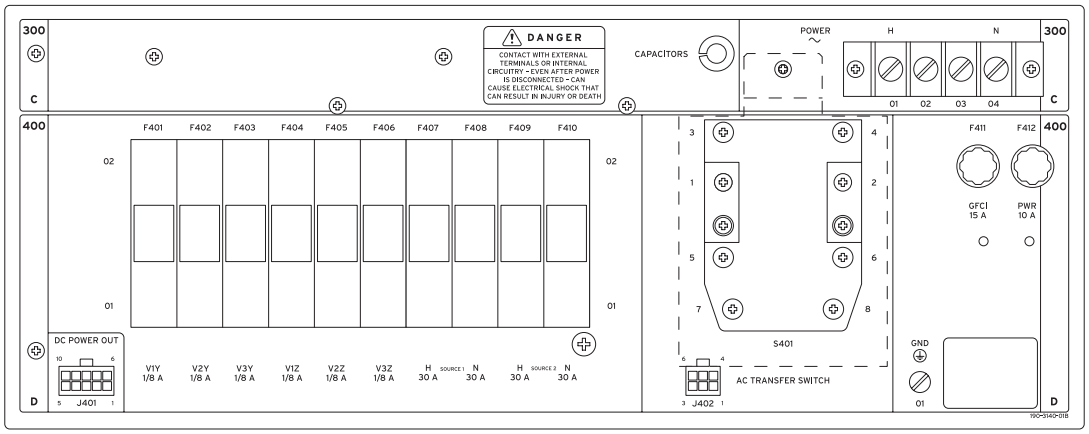
Rear View - Power Supply Module (Dual Door)



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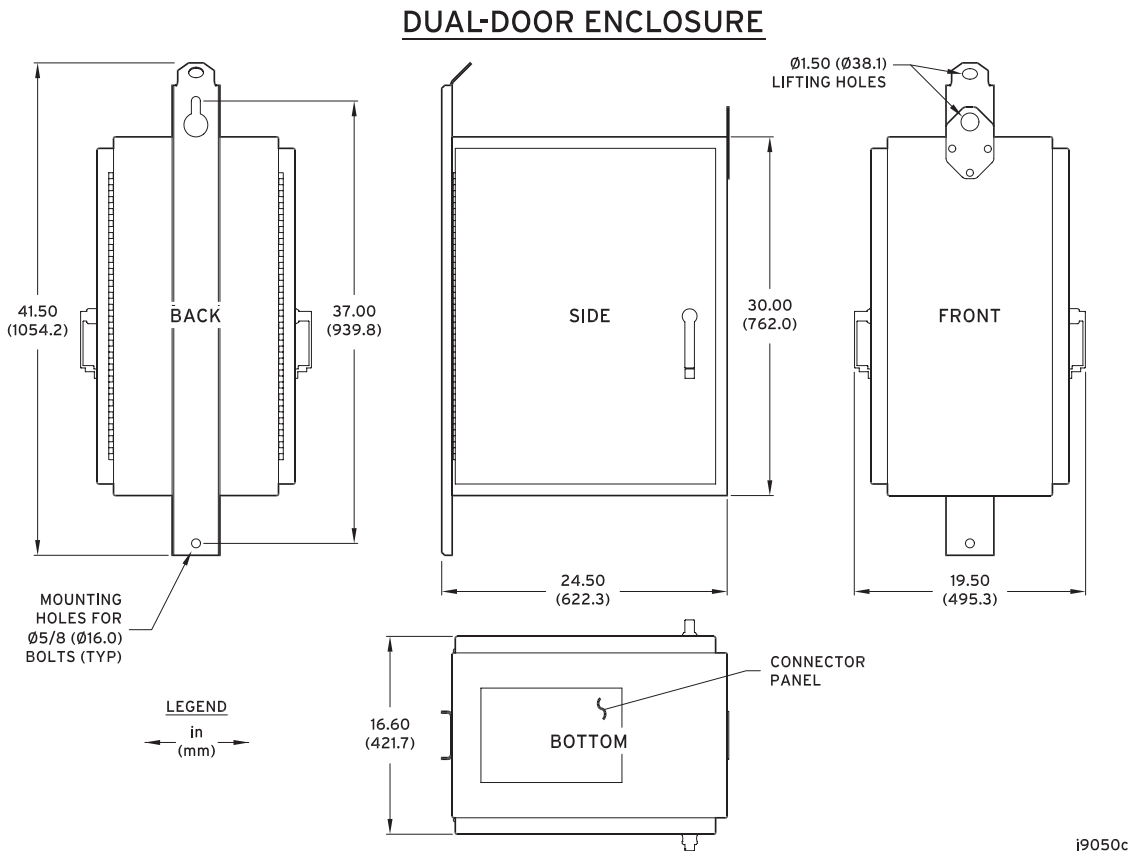
SEL-651R Advanced Recloser Control

Dimensions (Dual Door)



Visit www.selinc.com for more detailed information and configuration options.

Package Specials

Use our package specials with SEL-500 series relays for extra savings on mounting space and cost.

Key Features

- Two relays offered at a discount.
- Relays already fitted together.
- Fits in a 19-inch rack.
- Primary and backup protection in one package.
- Numerous applications.
- Available as Connectorized® models.

Package Model	Relays in Package	Budgetary Retail Package Price Quantity 1	Protection/Control Features				
			Overcurrent	Differential	Motor	Reclosing	Interface Conversion
SEL-99000	SEL-587 SEL-501	$3,010	•	•	•		
SEL-99002	SEL-587 SEL-501-2	$2,770	•	•			
SEL-99070	SEL-501 SEL-501	$2,270	•		•		
SEL-99072	SEL-501-2 SEL-501-2	$1,800	•				
SEL-9915	SEL-587 SEL-587	$3,740	•	•			
SEL-99180	SEL-551 SEL-501	$1,890	•		•	•	
SEL-99182	SEL-551 SEL-501-2	$1,660	•			•	
SEL-99190	SEL-587 SEL-551	$2,630	•	•		•	
SEL-99200	SEL-551 SEL-551	$1,510	•			•	
SEL-9921	SEL-3094 SEL-3094	$1,370					•
SEL-9924	SEL-551C SEL-551C	$1,510	•			•	

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Distribution Automation

Improve power system performance with SEL distribution automation solutions.

Distribution Automation Control System

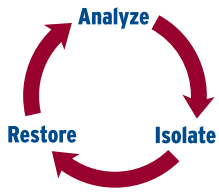
Automate feeder restoration and reduce outage times with the SEL Distribution Automation Control System. The system analyzes and detects fault conditions, isolates affected feeder sections, and restores power to unaffected sections. The system includes simple drag-and-drop IEC 61131 function block configuration software on an SEL information processor, with the ability to automate up to six sources and 100 devices.

Analyze

Analyze and detect permanent faults, broken jumpers, loss of substation source, and lockout due to miscoordinated protective devices.

Isolate

The distribution network is broken into zones, which are feeder sections that can be isolated or energized from one or more sources using fault-interrupting or switching devices.



Restore

Automatically restore unfaulted zones using alternative sources. Change settings groups to better coordinate the protective devices in the new network topology. Restore upstream zones that were de-energized due to miscoordination of the protective devices.

Capacitor Bank Control System

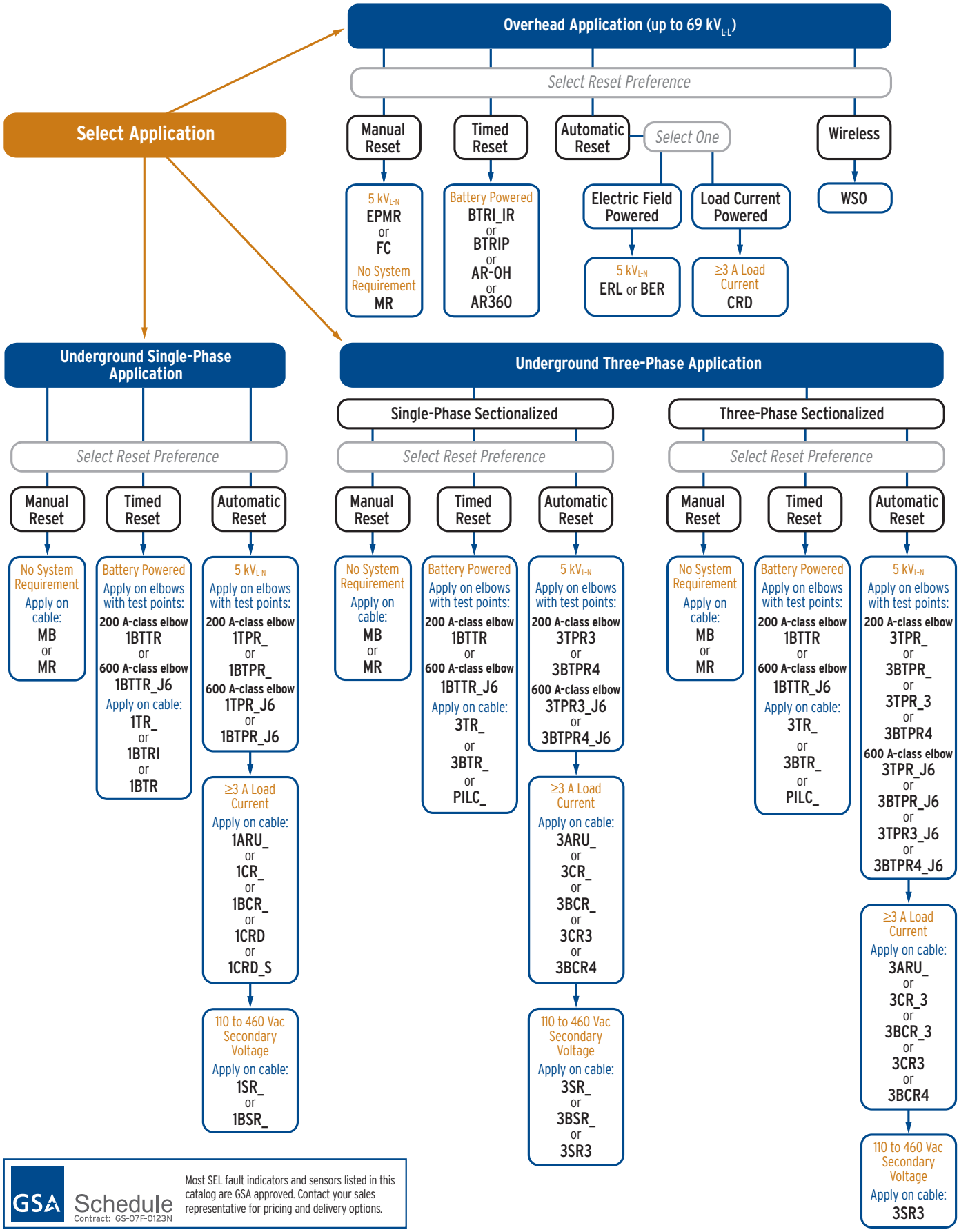
The SEL Capacitor Bank Control System uses a rugged computer and flexible communications to control capacitor banks down the feeder for better distribution and transmission system performance.

- Maintain distribution system power factor for reduced losses.
- Boost transmission VAR support during system contingencies.
- Measure bank effectiveness, and report problems for efficient maintenance.

Fault Indicating and Sensing

Product Index

SEL Fault Indicator Selection Guide



GSA Schedule
Contract: GS-07F-0123N

Most SEL fault indicators and sensors listed in this catalog are GSA approved. Contact your sales representative for pricing and delivery options.

SEL Fault Indicator Selection Guide

Overhead Fault Indicators

WSO—Wireless Sensor for Overhead Lines

AR360—360° Overhead AutoRANGER®

AR-OH—Overhead AutoRANGER

BTRIP—BEACON® Field-Programmable Timed Reset

BTRI_IR—BEACON Timed Reset

BER—BEACON Electrostatic Reset

ERL—Electrostatic Reset

CRD—Current Reset

Underground Fault Indicators

AR-URD—Underground AutoRANGER

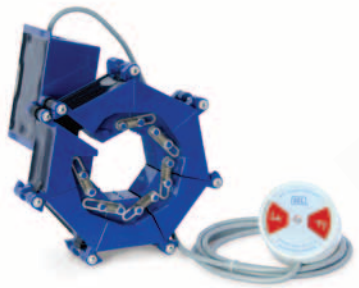
TPR—Test Point Reset

TR—Timed Reset

CR—Current Reset

MB—Manual Reset With Reset Button

MR—Manual Reset



PILC—Paper-Insulated Lead Cable Fault Indicator

SR—Secondary/ Low-Voltage Reset

GFD—Ground Fault Detector

RadioRANGER®—Wireless Fault Indication System

Overhead Fault Indicator Feature Table

Overhead Fault Indicators	Manual Reset		Electrostatic Reset		Current Reset	Timed Reset			Wireless
	MR	FC	ERL†	BER	CRD	BTRI_IR	AR-OH/AR360	BTRIP	WSO
APPLICATION									
Single-Phase	•	•	•	•	•	•	•	•	•
Three-Phase (Use 3 Single-Phase FCIs)	•	•	•	•	•	•	•	•	•
Troubleshooting	•	•				•	•	•	•
Also Applicable Underground	•		•		•				
RESET TYPE									
Manual Reset	•	•							
Electrostatic Reset			•	•					•
Current Reset					•				
Timed Reset						•	•	•	
DISPLAY OPTIONS									
Integral Target	•		•	•	•				•
Integral Pointer		•							
Integral LED(s)				•		•	•	•	
STANDARD FEATURES									
Inrush Restraint		•	•	•	•	•	•	•	•
Undelayed Trip (1 ms)		•	•	•	•	•			
Undelayed Trip (8 ms)	•								
Delayed Trip (24 ms)							•	•	•
Replaceable Lithium AA Cell				•		•			
Nonreplaceable Lithium C Cell							•	•	•
Daylight Restraint®				•					
AVAILABLE OPTIONS*									
Delayed Trip (24 ms)		•	•	•	•	•			
Nonreplaceable Lithium C Cell				•		•			
Constant Calibration			•	•					
TRIP RATINGS									
Self-Adjusting (50 to 1200 A)							•		•
Field-Programmable (50 to 1200 A)								•	
100 to 800 A	•								
50 to 1000 A		•							
50 to 1200 A			•	•		•			
100 to 1200 A					•				
POWER SOURCE									
Fault-Powered	•								
Line-Powered		•	•	•	•				
Battery				•		•	•	•	•
ARMING REQUIREMENTS (MAINTAIN READINESS TO TRIP)									
No Arming Requirement	•								
5 kV_{L-N} Continuous		•	•	•		•			
3 A Continuous					•				
2.4 kV_{L-N} and 10 A Continuous Load Current							•	•	•
RESET REQUIREMENTS									
Human Intervention	•	•							
5 kV_{L-N}			•	•					
3 A					•				
Time						•	•	•	•
OUTER DIAMETER CLAMPING RANGE (SPECIFY CABLE OUTER DIAMETER WHEN ORDERING)									
0.25" to 1.60"	•	•	•	•		•			
0.30" to 1.10"					•				
0.30" to 1.50"									
0.162" to 1.50"							•	•	•
SYSTEM VOLTAGE RANGE									
Up to 38 kV_{L-L}	•	•			•				•
8660 V_{L-L} to 69 kV_{L-L}			•	•					
4160 V_{L-L} to 69 kV_{L-L}							•	•	
8660 V_{L-L} to 38 kV_{L-L}						•			

* *Not all options are available on all models of a product family.*

† *Specify the snap-action clamp when applying the ERL on live-front switchgear lugs in underground applications. Snap-action clamping range from 1.0" to 2.3".*

WSO—Wireless Overhead Sensor

This distribution automation sensor stores load and temperature data, and monitors the distribution line for loss of voltage, loss of current, or fault events. Reports are transmitted to an access point on a communications network using an integrated radio.

Key Features

- Monitors average load current, ambient temperature, fault threshold, battery status, and history of outages and surge events.
- Allows more efficient maintenance scheduling using stored data profiles.
- Prevents false tripping with the inrush restraint feature, which allows for coordinated integration with automated reclosing schemes.
- Installs quickly using a standard hot stick.
- Displays visual target in addition to remote indication.
- Employs AutoRANGER® technology.
- Automatically adjusts fault threshold based on steady-state load.

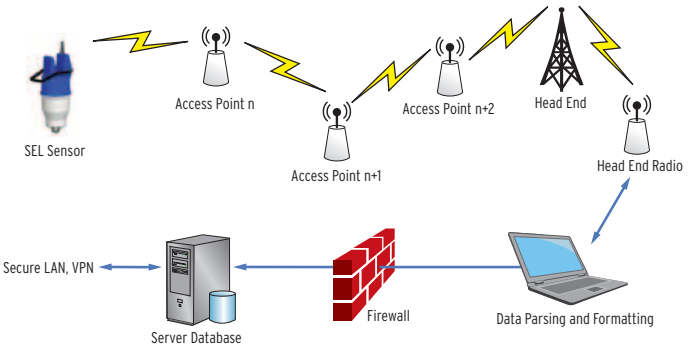
Note: Consult factory for available radio solution

Specifications	
Fault Sensing Range	50 A to 1200 A
System Voltage Range (L-L)	4.16 V to 34.5 kV
Maximum Fault Current	25 kA for 10 cycles
Battery	3.6 V high-capacity 19 Ah lithium battery with a 20-year shelf life
Temperature Range	–40° to +85°C
Approximate Weight	600 g (1.32 lbs)

Designed to meet IEEE 495 standards.

Applications

Reduce fault-finding time by communicating fault status back to a central location. Utilities are able to locate faults more quickly, thereby improving distribution reliability. Apply on overhead lines. The integrated radio operates in conjunction with a utility's existing communications infrastructure, such as a mesh or other radio network, as pictured in the example below:



As each application may vary, depending on the existing or planned communications system, its current use, and the desired reporting content and features, please consult SEL for additional information.

AR360—Overhead AutoRANGER®

360° visibility with intelligent display.

Key Features

- Intelligent display allows 360 degree visibility with six ultrabright, wide-angle LEDs that provide overlapping fields of light.
- Distinct temporary (amber) and permanent (red and amber) flashing patterns provide flexibility of locating cause of permanent and self-clearing faults.
- Auto-adjusting trip-level selection can detect faults with as little as 50 A of current when loads are light. Automatically steps up its trip threshold up to 1200 A for heavily loaded circuits.
- Inrush restraint feature allows coordinated integration with automatic reclosing schemes.
- The best battery-saving technology in the industry provides more than 1,800 flashing hours of operation.
- Patented Ramp-Down Restraint® feature prevents false activation after extended circuit lockout.
- Rugged construction ensures long product life.
- Quick, simple installation.
  - Installs with a single hot stick—no extra clamps or screws
  - Zero maintenance
  - Test and manually reset with the CRSRTT tool

Specifications	
Trip Value Range	50 to 1200 A
System Voltage Range (L-L)	4160 V to 34.5 kV
Maximum Fault Current	25 kA for 10 cycles
Trip Response Time	24 ms, nominal
Permanent Flash Clearing Times	
50 and 100 A Trip Levels	8 hours
200 to 1200 A Trip Levels	4 or 8 hours
Temporary Flash Clearing Times	0, 4, 8, 16, or 24 hours
Outer Diameter Clamping Range	0.162" to 1.50"
Battery	3.6 V high-capacity 17 Ah lithium battery with a 20-year shelf life
Flash Life	1800+ hours
Temperature Range	−40° to +85°C
Approximate Weight	825 g (1.82 lbs)

Applications

Overhead

- Provides clear visual indication of the fault path to line crews in the field.
- Reduces fault-locating time by guiding line crews to the faulted line section.
- Allows line crews to easily distinguish between temporary and permanent faults. Permanent faults are displayed with a red-amber flashing pattern that appears to rotate around the device. Temporary faults are displayed with an amber, nonrotating flash pattern.
- Provides a simple, economical way to improve utility reliability metrics by reducing outage durations.

Rural

- Automatic trip value selection as low as 50 A.
- TR(TV)™ feature (Timed Reset as a function of Trip Value) allows additional time for line crews to find faults on remote lines.

Troubleshooting

- Distinct temporary indication leads line crews to troubleshoot problematic sections of line.
- Allows line crews to investigate the cause of self-clearing faults and successful trip and reclose operations to improve circuit reliability.

Use the CRSRTT tool (sold separately) to field-test and manually reset the AR360 Overhead AutoRANGER®.

Flashing sequence rotates around the device indicating whether a fault is temporary or permanent.

AR-OH—Overhead AutoRANGER®

Self-adjusting fault indicator for system-wide application—one long-life product for all system loads.

Key Features

- Reduce engineering time, inventory, and misapplication with self-adjusting trip levels.
- Automatically adjusts its trip value based on the load current, eliminating the need to specify a trip value.
- Distinct temporary (amber) and permanent (red) fault indications provide the flexibility of tracking down self-clearing faults.
- The inrush restraint feature allows for coordinated integration with automatic reclosing schemes.
- Intelligent LED display provides the appropriate level of intensity for ambient lighting conditions.
- The best battery-saving technology in the industry provides more than 2,500 flashing hours of operation.
- Patented Ramp-Down Restraint® feature prevents false activation after extended circuit lockout.
- Rugged construction ensures long product life.
- Quick, simple installation.
  - Installs with a single hot stick—no extra clamps or screws
  - Zero maintenance
  - Test and manually reset with the CRSRTT tool

Specifications	
Trip Value Range	50 to 1200 A
System Voltage Range (L-L)	4160 V to 69 kV
Maximum Fault Current	25 kA for 10 cycles
Trip Response Time	24 ms
Permanent Flash Clearing Times	
50 and 100 A Trip Levels	8 hours
200 to 1200 A Trip Levels	4 or 8 hours
Temporary Flash Clearing Times	0, 4, 8, 16, or 24 hours
Outer Diameter Clamping Range	0.162" to 1.50"
Battery	3.6 V high-capacity 8.5 Ah lithium battery with a 20-year shelf life
Flash Life	2500+ hours (625 four-hour events*)
Temperature Range	−40° to +85°C
Approximate Weight	575 g (1.27 lbs)

** Based on AR4-8-OH. Others dependent on configuration.*

Applications

Overhead

- Provides clear visual indication of the fault path to line crews in the field.
- Reduces fault-locating time by guiding line crews to the faulted line section.
- Allows line crews to easily distinguish between temporary and permanent faults.
- Provides a simple, economical way to improve utility reliability metrics by reducing outage durations.

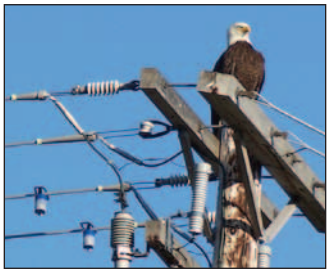
Rural

- Automatic trip value selection as low as 50 A.
- TR(TV)™ feature (Timed Reset as a function of Trip Value) allows additional time for line crews to find faults on remote lines.

Troubleshooting

- Distinct eight-hour temporary indication leads line crews to troubleshoot problematic sections of line.
- Allows line crews to investigate the cause of self-clearing faults and successful trip and reclose operations to improve circuit reliability.

Use the CRSRTT tool (sold separately) to field-test and manually reset the Overhead AutoRANGER®.



AutoRANGER® Fault Indicators providing fault indication in Kodiak, Alaska.

Install the AutoRANGER® with a single hot stick.

BTRIP—BEACON® Field-Programmable Timed Reset

Select your trip value in the field. Stock one fault indicator for a variety of system conditions.

Key Features

- Indicator's trip value is field-selectable based on circuit load and available fault current—stock one fault indicator for a variety of system conditions.
- Provides clear visual indication of the fault path to line crews in the field.
- Reduces fault-locating time by guiding line crews to the faulted line section.
- Provides a simple, economical way to improve utility reliability metrics by reducing outage durations.
- Inrush restraint feature allows for coordinated integration with automatic reclosing schemes, preventing false tripping.
- Rugged construction ensures long product life.
- Quick, simple installation.
  - Installs with a single hot stick—no extra clamps or screws
  - Zero maintenance
  - Test and manually reset with the CRSRTT tool

Specifications	
Trip Value Range	Select a set of four defined values between 50 A and 1200 A (see ordering table on page 188)
System Voltage Range (L-L)	4160 V to 69 kV
Maximum Fault Current	25 kA for 10 cycles
Trip Response Time	24 ms
Reset Time	4 or 8 hours (specify when ordering)
Outer Diameter Clamping Range	0.162" to 1.50"
Battery	3.6 V high-capacity 8.5 Ah lithium battery with a 20-year shelf life
Flash Life	2100+ hours
Temperature Range	−40° to +85°C
Approximate Weight	575 g (1.27 lbs)

Use the CRSRTT tool (included) to program, field-test, and manually reset the BTRIP.

BTRIP Fault Indicators provide the flexibility of field-selectable trip value.

The BTRIP's simple, strong clamp is easy to install on overhead lines.

BTRI_IR—BEACON® Timed Reset

Economical timed reset fault indicator eliminates false reset concerns.

Key Features

- Applicable on overhead taps, overhead-to-underground transitions, and at overhead midfeeder disconnects.
- No minimum load current necessary for reset.
- Permanently installed high-capacity lithium battery provides an average of 3,000 flashing hours (1,200 for models with a replaceable battery, shown in the photo above).
- Time delay between system restoration and reset makes the BTRI_IR a good choice for troubleshooting temporary faults.
- Inrush restraint feature allows for coordinated integration with automatic reclosing schemes, preventing false tripping.

Specifications	
Power Source	High-capacity 3.6 V lithium battery
Replaceable Battery	1200-hour flashing life (2.4 Ah cell)
Nonreplaceable Battery	3000-hour flashing life (8.5 Ah cell)
Nominal Trip Ratings	50 to 1200 A
Trip Tolerance	±10%
System Voltage Range (L-L)	8660 V to 38 kV
Maximum Fault Current	25 kA for 10 cycles at 60 Hz
Display	Flashing red LED with a 4- or 8-hour clearing time
Outer Diameter Clamping Range	0.25" to 1.6" (please specify clamping diameter or range when ordering)
Housing Material	UV-stabilized polycarbonate resin
Clamp Material	Stainless-steel clamp with a UV-stabilized rubber sleeve
Temperature Range	–40° to +85°C
Approximate Weight	400 g (0.88 lbs)

Use the CRSRTT tool (sold separately) to field-test and manually reset the BTRI_IR.

BTRI_IR Fault Indicators installed on an overhead system.

Install the BTRI_IR in applications susceptible to temporary faults.

ERL—Electrostatic Reset

Battery-free automatic reset fault indicator provides maintenance-free fault indication.

Key Features

- Automatically resets upon restoration of system voltage.
- Apply at strategic intervals along overhead conductors and at midfeeder disconnects to minimize fault-finding time and optimize reliability statistics.
- Inrush restraint feature prevents false tripping during recloser operations.
- The reflective red target (the largest display in the industry) is easy to spot both at night and during the day.
- Zero maintenance: no battery to replace or monitor.
- Models with the snap-action clamp option are applicable on live-front switchgear—simply install the ERL onto the barrel of the cable termination lug.

Specifications	
Power Source	Electric field potential gradient
Nominal Trip Ratings	50 to 1200 A
Trip Tolerance	±10%
System Voltage Range (L-L)	8660 V to 69 kV
Reset Time	Approximately 5 minutes at 5 kV_{L-N} (higher voltages result in quicker reset)
Display	Reflective red target
Maximum Fault Current	25 kA for 10 cycles at 60 Hz
Trip Response Time	1 ms
Inrush Restraint Response Time	300 ms
Outer Diameter Clamping Range	0.25" to 1.6" (please specify clamping diameter or range when ordering)
Housing Material	UV-stabilized polycarbonate resin
Clamp Material	Stainless-steel clamp with a UV-stabilized rubber sleeve
Temperature Range	−40° to +85°C
Approximate Weight	240 g (0.53 lbs)

Side view of the ERL.

The ERL, SEL's best-selling overhead fault indicator, automatically resets upon system restoration.

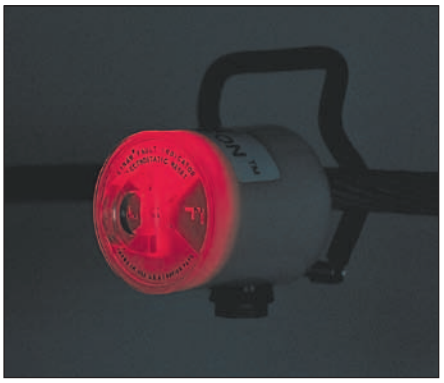
BER—BEACON® Electrostatic Reset

Combination LED and target display provides optimal night and day indications, and maximizes battery life.

Key Features

- Dual-display faulted circuit indicator (FCI) incorporates an LED with a reflective red mechanical target (the largest in the industry) to provide excellent visual indication, even in low light conditions.
- 1,200 flashing hours standard; 3,000 flashing hours with the non-replaceable battery.
- The mechanical target continues to provide indication regardless of battery status.
- Automatic reset upon restoration of system voltage.
- Daylight Restraint® conserves battery life by activating the LED only in reduced ambient light conditions.
- Apply at strategic intervals along overhead conductors and at midfeeder disconnects to minimize fault-finding time and optimize reliability statistics.
- Inrush restraint feature prevents false tripping during recloser operations.

Specifications	
Power Source	Electric field potential gradient
Nominal Trip Ratings	50 to 1200 A
Trip Tolerance	±10%
System Voltage Range (L-L)	8660 V to 69 kV
Reset Time	Approximately 5 minutes at 5 kV_{L-N} (higher voltages result in quicker reset)
Display	Reflective red target with LED
Maximum Fault Current	25 kA for 10 cycles at 60 Hz
Trip Response Time	1 ms
Inrush Restraint Response Time	300 ms
Outer Diameter Clamping Range	0.25" to 1.6" (please specify clamping diameter or range when ordering)
Battery	3.6 V high-capacity lithium battery with a 20-year shelf life
Flash Life	1200+ hours standard (replaceable 2.4 Ah cell); 3000+ hours (nonreplaceable 8.5 Ah cell)
Housing Material	UV-stabilized polycarbonate resin
Clamp Material	Stainless-steel clamp with a UV-stabilized rubber sleeve
Temperature Range	–40° to +85°C
Approximate Weight	390 g (0.86 lbs)



The BER Fault Indicator provides excellent fault indication at night because of its high-intensity LED display.

CRD — Current Reset

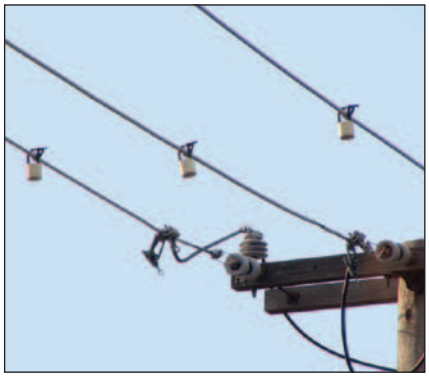
Load current-powered FCI with no minimum voltage requirement provides a solution for low-voltage applications.

Key Features

- Load current-powered—no battery necessary.
- No minimum voltage requirement.
- Automatically resets upon restoration of load current.
- Inrush restraint feature prevents false tripping during recloser operations.
- Maintains trip tolerance throughout the clamping range.
- Easy to install with a single hot stick.
- UV-stabilized materials provide excellent weatherability.

Specifications	
Power Source	Load current
Nominal Trip Ratings	100 to 1200 A
Trip Tolerance	±10%
System Voltage Range (L-L)	Up to 38 kV
Reset Time	25 seconds at 3 A
Reset Current	3 A
Maximum Fault Current	25 kA for 10 cycles
Trip Response Time	1 ms
Inrush Restraint Response Time	300 ms
Outer Diameter Clamping Range	0.3" to 1.1" (please specify clamping diameter or range when ordering)
Housing Material	UV-stabilized polycarbonate resin
Transformer Core	Silicon steel with vinyl coating
Temperature Range	−40° to +85°C
Approximate Weight	510 g (1.12 lbs)

The CRD Fault Indicator is easy to install on an overhead line using a single hot stick.



CRDs provide fault indication in a low-voltage application.

Overhead Fault Indicator Ordering Tables

Instructions for Creating Overhead Fault Indicator Part Numbers

1. Select one code (in bold) from each column (i.e., B, TRI, P3, etc.). For the Overhead BEACON® Timed Reset, both options can be selected from the Options column. List option codes in the order that they appear in the column.[1]
2. Follow your usual process to issue a purchase order, or complete a specification for standards.

Example Part Numbers

AR4–0H

BTRI0300IR4DT

Overhead AutoRANGER

AutoRANGER	Permanent Time-Out	Temporary Time-Out	Overhead Designation
AR	**4** 4 hrs	**–0** 0 hrs	**–0H**
	8 8 hrs	**–4** 4 hrs	
		–8 8 hrs	
		–16* 16 hrs	
		–24* 24 hrs	

Overhead AutoRANGER AR360 High Visibility

AutoRANGER	Permanent Time-Out	Temporary Time-Out
AR360	**–4** 4 hrs	**–0** 0 hrs
	–8 8 hrs	**–4** 4 hrs
		–8 8 hrs
		–16* 16 hrs
		–24* 24 hrs

* Extended time-out may affect battery life. Please consult factory.

Overhead BEACON Field-Programmable Timed Reset

BEACON LED	Timed Reset Designation	Programmable Trip Level Options	Trip Level Set at Shipment	Inrush Restraint	Time-Out Period
B	**TRI**	**P1** (100, 200, 400, 800 A)	**S1** Setting 1	**IR**	**4** 4 hrs
		P2 (200, 600, 800, 1200 A)	**S2** Setting 2		**8** 8 hrs
		P3 (400, 600, 800, 1000 A)	**S3** Setting 3		**16** 16 hrs
		P4 (600, 800, 1000, 1200 A)	**S4** Setting 4		**24** 24 hrs
		P5 (50, 100, 200, 400 A)			

Overhead BEACON Timed Reset

BEACON Timed Reset Designation	Trip Level	Inrush Restraint	Time-Out Period	Options
BTRI	**0050** 50 A	**IR**	**2** 2 hrs	**–** No options
	0100 100 A		**4** 4 hrs	**DT** Delayed trip (24 ms)
	0200 200 A		**8** 8 hrs	**N** Nonreplaceable battery
	0300 300 A		**M** Manual reset	
	0400 400 A			
	0600 600 A			
	0800 800 A			
	1000 1000 A			
	1200 1200 A			

Other time-out periods may be available for your application. For details, please call Customer Service at +1.847.362.8304.

Overhead Electrostatic Reset

Electrostatic Reset Designation	Trip Level	Inrush Restraint	Options
ERL	**0050** 50 A	**IR**	**–** No options
	0100 100 A		**DT** Delayed trip (24 ms)
	0200 200 A		
	0300 300 A		
	0400 400 A		
	0600 600 A		
	0800 800 A		
	1000 1000 A		
	1200 1200 A		

Overhead BEACON Electrostatic Reset

BEACON Electrostatic Reset Designation	Trip Level	Inrush Restraint	Options
BER	**0050** 50 A	**IR**	**–** No options
	0100 100 A		**DT** Delayed trip (24 ms)
	0200 200 A		**N** Nonreplaceable battery
	0300 300 A		
	0400 400 A		
	0600 600 A		
	0800 800 A		
	1000 1000 A		
	1200 1200 A		

Overhead Current Reset

Current Reset Designation	Large Integral Display	Trip Level	Inrush Restraint	Options
CR	**D**	**0100** 100 A	**IR**	**–** No options
		0200 200 A		**DT** Delayed trip (24 ms)
		0300 300 A		
		0400 400 A		
		0600 600 A		
		0800 800 A		
		1000 1000 A		
		1200 1200 A		

1 Consult Customer Service at +1.847.362.8304 if you are preparing to order a part number you have not ordered before.

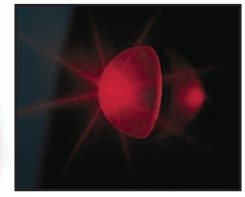
Underground Fault Indicating and Sensing

Advantages of SEL Underground Fault Indicators

- Compact, lightweight construction simplifies installation.
- All products manufactured by SEL Fault Indicator and Sensor Division come with a full, five-year product warranty; the RadioRANGER® Wireless Fault Indication System comes with a ten-year warranty.
- The RadioRANGER eliminates the need to open, enter, pump, or drain multiple underground vaults to find the location of a fault.
- Trip-value settings range from 50 A to 1200 A, and the AutoRANGER automatically adjusts its trip value based on the load current.
- Displays are easy to spot, easy to read, and require a minimal number of holes to be drilled in a transformer cabinet for installation.
- Any SEL fault indicator that uses batteries relies on patented technology, offering the longest cumulative flashing-hour life in the industry. As a result, SEL fault indicators require little, if any, maintenance.
- Auxiliary contact options available on most underground models enable SCADA compatibility.
- Magnetic cable guides keep remote display and sensor wiring neatly in place.
- The paper-insulated lead cable (PILC) fault indicator is a one-of-a-kind solution for fault finding on these cables.

Underground Display Options

Tamperproof Bolt Display



BEACON Bolt® Display

Standard "V" Display (BEACON® versions also available)

Three-Phase "3" Display (BEACON versions also available)

Large "L" Display (BEACON versions also available)

RadioRANGER® Remote Fault Reader (SEL-8310) Display

Fiber-Optic Display

Underground Fault Indicator Feature Table	Manual Reset Fault Indicators		Voltage Reset Faulted Circuit Indicators (FCIs)											PILC Family
				Test Point Voltage Reset Family					Secondary Voltage Reset Family					
	MR	MB	ERL†	TPRI	TPRV	TPRL	TPRB	TPR3	SRI	SRV	SRL	SRB	SR3	
APPLICATION														
Single-Phase	•	•	•	•	•	•	•		•	•	•	•		
Three-Phase	+	+	+	+	•	•	•	•	+	•	•	•	•	•
Troubleshooting	•	•												
Three-Phase Reset								•					•	
RESET TYPE														
Manual Reset	•	•												
Electrostatic Reset			•											
Test Point Voltage Reset				•	•	•	•	•						
Secondary Voltage Reset									•	•	•	•	•	
Current Reset														
Timed Reset														•
DISPLAY OPTIONS														
Integral Target	•	•	•	•					•					
Remote Target					•	•				•	•			•
Integral LED														
Remote LED, Hard-Wired							B					B		
Remote Target With LED					B	B				B	B			
Remote LED Fiber-Optic Display														
Three-Phase Target								•					•	
Three-Phase Target With LED								4						
Tamperproof Bolt Display							•					•		
RadioRANGER® Magnetic Probe														•
STANDARD FEATURES														
Undelayed Trip (1 ms)			•	•	•	•	•	•	•	•	•	•	•	
Undelayed Trip (8 ms)	•	•												
Delayed Trip Response Time														
Replaceable Lithium AA Cell														
Nonreplaceable Lithium C Cell														
Inrush Restraint			•											
Discrete Time-Current Curve														•
OPTIONAL FEATURES*														
Inrush Restraint				•	•	•	•	•	•	•	•	•	•	
Auxiliary Contact				•	•	•	•	•	•	•	•	•	•	
Window Mounting Kit						•					•			
Delayed Trip (24 ms)			•	•	•	•	•	•	•	•	•	•	•	
Snap-Action Clamp			•											
Nonreplaceable Lithium C Cell														
Junction Shield				•	•	•	•	•						
Constant Calibration			•											
Test Point Phase Sensor				•	•	•	•	•						
TRIP RATINGS														
25 to 800 A		•												
50 to 1000 A									•	•	•	•	•	
50 to 1200 A			•											
60 to 1200 A				•	•	•	•	•						
100 to 800 A	•													
100 to 1200 A														
600 to 1200 A														•
Self-Adjusting (50 A to 1200 A)														
POWER SOURCE														
Line-Powered			•	•	•	•	•	•						
Secondary Source									•	•	•	•	•	
Battery					B	B	B	B		B	B	B		•
ARMING REQUIREMENTS (MAINTAIN READINESS TO TRIP)														
No Arming Requirement	•	•												•
5000 V_{L-N}			•	•	•	•	•	•						
110 to 460 Vac									•	•	•	•	•	
3 A [LC]														
RESET REQUIREMENTS														
Human Intervention	•	•												
5000 V_{L-N} Continuous			•	•	•	•	•	•						
110 to 460 Vac									•	•	•	•	•	
3 A Continuous [LC]														
Time														•
OUTER DIAMETER CLAMPING RANGE (SPECIFY CABLE OUTER DIAMETER WHEN ORDERING)														
0.25" to 1.60"	•		•											
0.25" to 1.40"		•												
0.75" to 1.60"									•	•	•	•	•	
0.75" to 2.10"														
2.2" to 4.64"														•
Larger Clamp Options	C	C							C	C	C	C	C	
SYSTEM VOLTAGE RANGE														
Up to 35.5 kV_{L-L}	•	•												
Matches Shielded URD Cable Rating				•	•	•	•	•	•	•	•	•	•	•
8660 V_{L-L} to 34.5 kV_{L-L}			•											

3 *Option is available when selecting the 3 suffix (three-phase reset)*

4 *Reflective red targets with a center BEACON® LED*

B *Option is available when selecting the B prefix (BEACON LED) in model selection*

T *Test point phase sensor*

C *Please consult factory*

* *Not all options are available on all models of a product family*

Current Reset Faulted Circuit Indicators (FCIs)											Timed Reset Fault Indicators				
Current Reset Family					Underground AutoRANGER Family						Timed Reset Family				
CRI	CRV	CRL	CRB	CR3	1ARUI	1ARUV	1ARUL	1ARUB	3ARU3	1BARUZR	TRI	TRV	TRL	TRB	TR3
•	•	•	•		•	•	•	•		•	•	•	•	•	
+	•	•	•	•	+	+	+	+	•		+	•	•	•	•
											•	•	•	•	•
	3	3	3	•					•						•
					CATR	CATR	CATR	CATR	CATR		•	•	•	•	
•	•	•	•	•	•	•	•	•	•	•					
					CATR	CATR	CATR	CATR	CATR	•	•	•	•	•	•
•					•						•				
	•	•				•	•					•	•		
											B				
			B					B						B	
	B	B				B	B					B	B		
										•					
				•					•						•
				4											
			•					•						•	
•	•	•	•	•							•	•	•	•	•
					•	•	•	•	•	•					
											B	B	B	B	
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	B	B	B	B		B	B	B		•	•	•	•	•	•
											•	•	•	•	•
•	•	•	•	•	•	•	•	•	•	•					
•	•	•	•	•	•	•	•	•	•	•					
					CATR	CATR	CATR	CATR	CATR	•	•	•	•	•	•
											•	•	•	•	•
•	•	•	•	•	•	•	•	•	•	•					
C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•

† *ERLs can only be installed on live-front switchgear lugs for URD applications*

LC *1.5 A if a Low Current Reset (LC) option is selected*

\+ *Use three single-phase FCIs*

CATR *Optional time delay reset*

- All BEACON displays are battery powered
- BEACON products are not available with an auxiliary contact ("A" option)

RadioRANGER® Wireless Fault Indication System

RADIORANGER®
WIRELESS FAULT INDICATION SYSTEM

Let the RadioRANGER Wireless Fault Indication System point you to the underground fault location.

- Minimize fault-finding time and troubleshooting crew size. No need to open, enter, pump, or drain multiple vaults while blocking traffic.
- Improve line crew safety. Avoid leaving the truck and entering vaults in busy streets.
- Benefit from the proven reliability and quality record of SEL fault indicators.
- Choose from multiple SEL fault indicator types to match your applications and system requirements.
- Display fault-path information on the handheld Remote Fault Reader.
- Maximize application efficiency using the modular and scalable system in a variety of vault configurations.
- Choose the PILC Fault Indicator for hard-to-troubleshoot, paper-insulated lead cables.

Reduce fault-finding time in subsurface vault applications.

Communicate subsurface fault indicator status to street-level personnel.

Also Applicable in Pad-Mounted Enclosures

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RadioRANGER Wireless Fault Indication System

Fault Indicators Compatible With the Wireless Interface

RadioRANGER Interface Probe

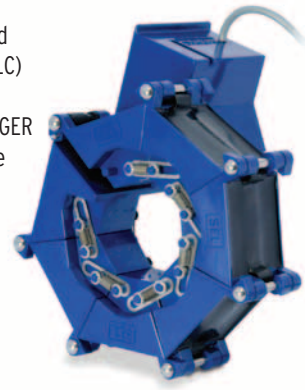
Underground AutoRANGER® With RadioRANGER Interface Probe

Current Reset With RadioRANGER Interface Probe

Test Point Reset With RadioRANGER Interface Probe

Timed Reset With RadioRANGER Interface Probe

Paper-Insulated Lead Cable (PILC) Fault Indicator With RadioRANGER Interface Probe



Key Features

- Simple street-level fault indicator status retrieval eliminates the need for fault-finding crews to remove utility access covers and enter vaults.
- Multiple IDs allow the crew to easily identify the vault, way, and phase on which the fault occurred.
- IP68-rated Wireless Interface and waterproof interconnection system (rated to 15 feet submersion) ensure environmental integrity required for vault applications.
- Remote Fault Reader displays Wireless Interface system health and fault indicator status.
- Vehicle accessory kit option maximizes the performance of the Remote Fault Reader in a vehicle.
- Two-way communications link prevents ambiguity by transmitting both tripped and reset fault indicator information. Users can retrieve Wireless Interface and fault indicator status at any time.

Tip From Ranger

For complete RadioRANGER features, applications, and specifications, visit **www.eosmfg.com/products/radio_ranger.html**

SEL fault indicators equipped with magnetic RadioRANGER® Interface Probes communicate their status to the Wireless Interface. Utility personnel can quickly retrieve subsurface FCI status at street level via the wireless communications link between the Wireless Interface and Remote Fault Reader. The RadioRANGER solution reduces the need to access vaults to retrieve FCI status, reducing fault-locating time and improving utility personnel safety.

RadioRANGER® Wireless Fault Indication System

Ordering Tables

Important: Please consult your independent sales representative or Customer Service (+1.847.362.8304) for assistance in selecting the best RadioRANGER model for your application.

Definitions

Option Abbreviation	Option
L	Large core
IR	Inrush restraint
DT	Delayed trip
J	Junction shield
J6	600 A-class junction shield

Specifications

Power Source	
Wireless Interface (8300)	3.6 V high-capacity lithium battery with 20-year shelf life
Remote Fault Reader (8310)	Three 1.5 V AA size cells
Wireless Interface Product Life	15-plus years
Certifications	
FCC	15.249
IEC	RSS-210
IP Rating	
Wireless Interface (8300)	IP68
Remote Fault Reader (8310)	IP54
Wireless Interface Submersibility	Up to 15 feet
Wireless Interface Temperature Range	−40° to +85°C (−40° to +185°F)
Fault Indicator Specifications	See individual fault indicator catalog pages

RadioRANGER Components

Remote Fault Reader

Style	Model Number
Remote Fault Reader with integral antenna	SEL-8310

Wireless Interface

Style	Model Number
Wireless Interface with integral antenna	SEL-8300
Wireless Interface with remote antenna	SEL-8300A

Fault Indicators

Underground AutoRANGER

Model Number	RadioRANGER Magnetic Probe Designation	Current Activated Timed Reset Duration		Options	Probe Lead Length Options		Factory Code
1ARU	M	0	0 hrs	No options (leave blank)	G	6 ft	Y2
		2	2 hrs	L	P	12 ft	
		4	4 hrs		Q	20 ft	
		8	8 hrs				
		12	12 hrs				

Test Point Reset

Model Number	RadioRANGER Magnetic Probe Designation	Nominal Trip Ratings		Options	Probe Lead Length Options	
1TPR	M	0080	80 A	No options (leave blank)	G	6 ft
		0100	100 A	IR	P	12 ft
		0160	160 A	DT	Q	20 ft
		0200	200 A	J*		
		0250	250 A	J6*		
		0300	300 A			
		0400	400 A			
		0600	600 A			
		0800	800 A			
		1000	1000 A			
		1200	1200 A			

* Required ≤200 A

RadioRANGER Wireless Fault Indication System

Fault Indicators (continued)

Timed Reset (Clamp Style)

Model Number	RadioRANGER Magnetic Probe Designation	Nominal Trip Ratings		Time-Out Period		Options	Nonreplaceable Lithium Cell	Probe Lead Length Options	
1TR	M	0100	100 A	2	2 hrs	No options (leave blank)	N	G	6 ft
		0200	200 A	4	4 hrs	DT		P	12 ft
		0300	300 A	8	8 hrs			Q	20 ft
		0400	400 A						
		0600	600 A						
		0800	800 A						
		1000	1000 A						
		1200	1200 A						

Underground Load Current With RadioRANGER Magnetic Probe

Number of Phases	Model Family Designation	RadioRANGER Magnetic Probe Designation	Nominal Trip Ratings		Options	Probe Lead Length Options	
1 - Single Phase	CR	M	0100	100 A	No options (leave blank)	G	6 ft
3 - Three Phase			0200	200 A	IR	P	12 ft
			0300	300 A	DT	Q	20 ft
			0400	400 A	L		
			0600	600 A			
			0800	800 A			
			1000	1000 A			
			1200	1200 A			

Paper-Insulated Lead Cable

Model Number	RadioRANGER Magnetic Probe Designation	Nominal Trip Ratings		Mounting Range	Time-Out Period		Probe Lead Length Options		Time-Current Curve Characteristic
PILC	M	06	600 A	D*	01	1 hr	G	6 ft	1
		08	800 A	E*	02	2 hrs	P	12 ft	2
		10	1000 A	F*	04	4 hrs	Q	20 ft	3
		12	1200 A		08	8 hrs			4
					12	12 hrs			
					24	24 hrs			

* See Paper-Insulated Lead Cable Mounting Range Cable Sizes table below

Paper-Insulated Lead Cable Mounting Range Cable Sizes

3 Conductor PILC Cable		Triplexed Single-Phase Cable			
3C Cable Diameter		Single Cable Diameter		Circumscribed Diameter	
D	2.2" to 3.1"	D	1.1" to 1.48"	D	2.38" to 3.2"
E	3.12" to 3.84"	E	1.5" to 1.85"	E	3.24" to 4.0"
F	4.0" to 4.44"	F	1.92" to 2.14"	F	4.16" to 4.64"

RadioRANGER Starter Kit

Product	Model Number
Starter Kit: 1 Wireless Interface, 1 Remote Fault Reader, 3 1ARUM Fault Indicators	RRKIT101

AR-URD—Underground AutoRANGER®

Now Available With Fiber-Optic BEACON® Display

Choose one low-maintenance fault indicator for your underground applications.

See page 192 for application with the RadioRANGER® Wireless Fault Indication System.

Key Features

System-Wide Adaptability

The Underground AutoRANGER's autoconfiguration features decrease the need for crew training, selection analysis, and inventory, resulting in fewer application errors.

Minimal Maintenance

The AutoRANGER's ability to adjust for load fluctuations results in a decreased need for field service. Choose a target-only (no LED) display option to eliminate the need for a battery. BEACON LED models have a 15-plus-year product life—minimize trips to the field to replace batteries.

Configuration Choices Optimize Performance

Ensure the best fault-indicating solution for your underground application by choosing from a wide variety of single- and three-phase display options, including remote displays that eliminate the need to open the enclosure to check the fault indicator's status.

Autoadjusting Trip-Level Selection

Automatic trip-level selection based on sampled load current makes the AR-URD suitable for applications with fault currents ranging from as low as 50 A to greater than 1200 A. This feature simplifies ordering and inventory, and reduces maintenance and application errors.

Line-Powered Functionality

Energy required to power the microprocessor comes from monitored load current rather than a battery, decreasing maintenance and cost of ownership.

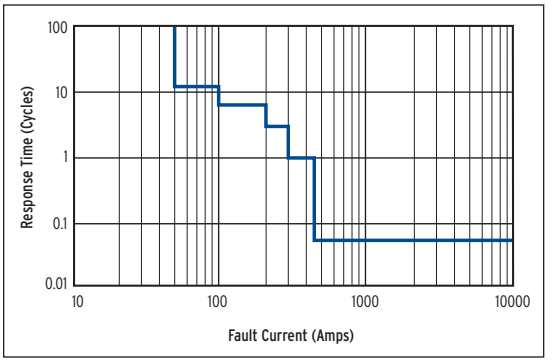
Dynamic Trip Response Times

By monitoring current, the AR-URD automatically adjusts its trip response time to better coordinate with upstream protection.

Current-Activated Timed Reset

Each AR-URD derives a normalization current as a function of measured circuit load. The AR-URD uses the normalization current to distinguish circuit restoration from backfeed current; it is this threshold that the AR-URD must detect before initiating the reset timer (0, 2, 4, or 8 hours).

Underground AutoRANGER® application.

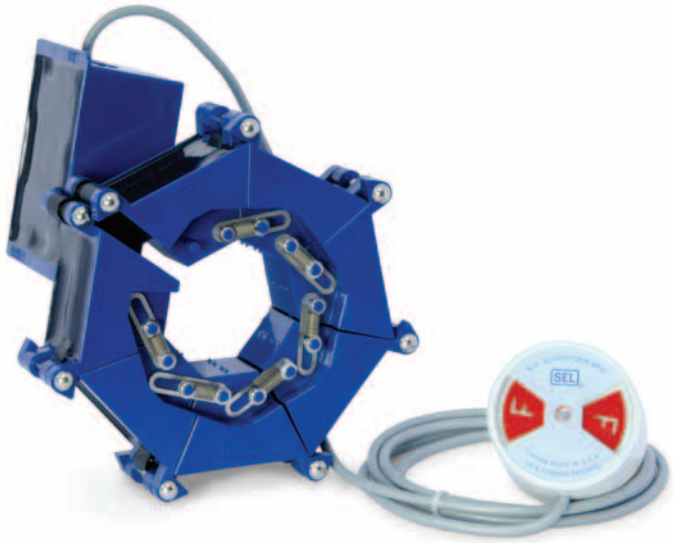


The Underground AutoRANGER's dynamic trip response time improves coordination with upstream protection, maximizing reliable performance.

Specifications	
Fault-Sensing Range	50 to 1200 A
Voltage Range	Equal to voltage class of shielded underground cable
Minimum Operating Current	3 A
Current-Activated Timed Reset	0, 2, 4, or 8 hours
Battery (for BEACON LED display only)	3.6 V high-capacity lithium battery with a 20-year shelf life
Dynamic Trip Response Time	Function of trip level (see graph above)
Inrush Restraint Response Time	5 cycles
Temperature Range	–40° to +85°C

Note: Selection of fiber-optic BEACON display option will change product functionality. Consult SEL for details.

PILC—Paper-Insulated Lead Cable



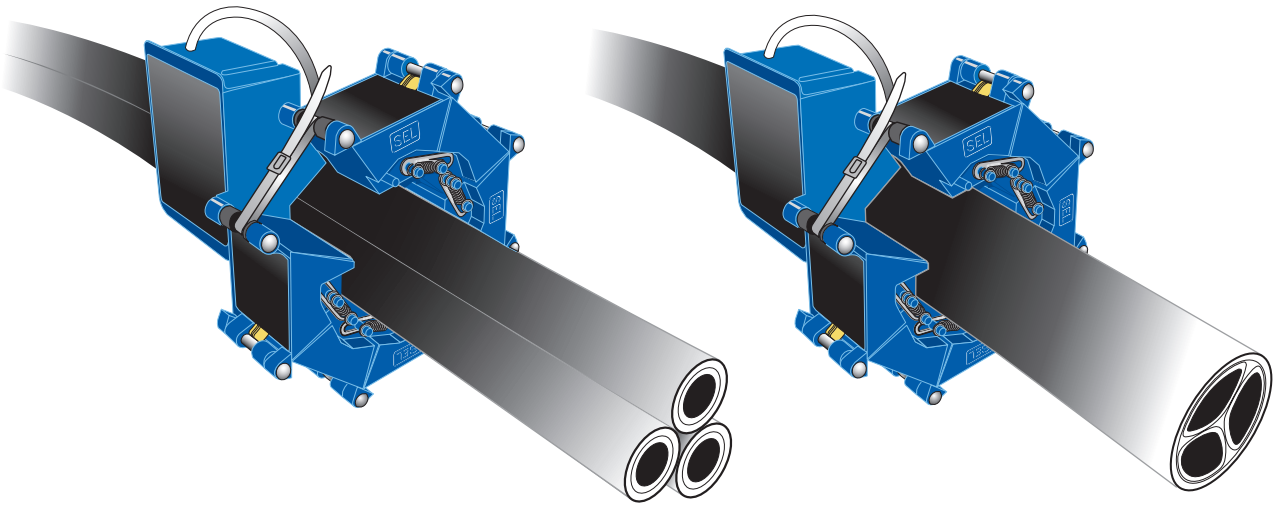
Find faults faster on urban systems with the PILC Fault Indicator.

See page 192 for application with the RadioRANGER® Wireless Fault Indication System.

Key Features

Simplify Fault Finding on PILC

- Narrows possible fault locations to one or two spans of cable.
- Choice of a remote target or RadioRANGER compatibility maximizes display options.
- Sensor design accommodates PILC diameters ranging from 2.2 to 4.64 inches.
- Four- and eight-hour timed reset options ensure sufficient fault-finding time.
- Split-cuff design makes installation simple.
- Fully encapsulated circuitry and stainless-steel parts withstand harsh underground environments.
- Durable construction, 3.6 V lithium battery, and reliable circuitry provide more than 15 years of maintenance-free operation.



Apply the PILC Fault Indicator on triplexed, single-phase PILC (left) and on three-phase sector (or round) PILC (right). It also provides fault indication on triplexed polycable.

For up-to-date specifications, ordering information, and application suggestions, please visit ***www.selinc.com/FCI/Underground/Paper-InsulatedLeadCable.***

TPR—Test Point Reset

The most economical fault-indicating solution for elbow test point applications.

Key Features

- The most economical solution for underground applications.
- Easy to install on most brands of 200 or 600 A-class elbows with capacitive test points.
- Automatic reset upon restoration of system voltage.
- Ideal for pad-mounted transformer and switchgear applications.
- Several remote display options eliminate the need to open an enclosure cabinet to determine the indicator's status.
- Available in single- and three-phase models.
- Simply remove the fault indicator to access the test point.
- Auxiliary contact option for SCADA compatibility.
- Junction shield option prevents false tripping due to adjacent phase effects. Please consult SEL.

Test Point Reset Fault Indicators are available with a variety of remote displays.

Specifications	
Power Source	Capacitive test point voltage
Nominal Trip Ratings	80 to 1200 A
Trip Tolerance	±10%
Reset Voltage (L-N)	≥5 kV
Reset	Automatic at minimum voltage
Reset Time	3 minutes typical, dependent on system voltage
Maximum Fault Current	25 kA for 10 cycles at 60 Hz
Trip Response Time	1 ms
Inrush Restraint Response Time	300 ms (add "IR" option)
Elbow Style	200 or 600 A-class with test point
Housing Material	Conductive EPDM rubber
Temperature Range	−40° to +85°C

A Test Point Reset Fault Indicator with junction shield provides indication in a switchgear cabinet.

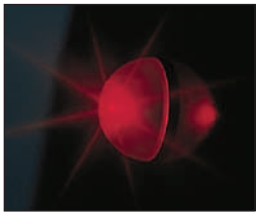
See page 192 for application with the RadioRANGER® Wireless Fault Indication System.

TR—Timed Reset

Automatic timed reset provides permanent and transient fault-finding capability.

Key Features

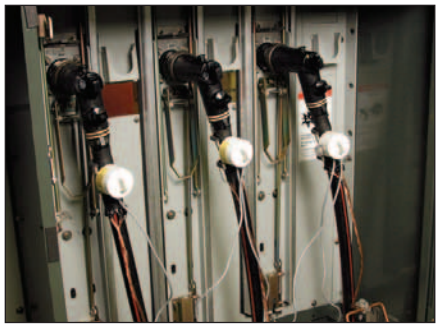
- Automatic reset at the end of a fixed reset period allows time for crews to locate permanent and transient faults.
- Ideal in locations where false reset because of feedback is a concern.
- Several remote display options eliminate the need to open an enclosure cabinet to determine the indicator's status.
- Available with test point or clamp-on sensors for single- and three-phase applications.
- Auxiliary contact option for SCADA compatibility.



Illuminated BEACON Bolt® Display.

Specifications (Single Phase)*	
Nominal Trip Ratings	50 to 1200 A
Trip Tolerance	±10%
Maximum Fault Current	25 kA for 10 cycles
Trip Response Time	1 ms
Housing Material	UV-stabilized polycarbonate resin and/or conductive EPDM rubber
Clamp Material	Rubber-sleeved stainless steel
Battery (on BEACON® models)	3.6 V lithium battery with a 20-year shelf life and 1200 flashing hours
Temperature Range	−40° to +85°C

* Please call for three-phase specifications



A three-phase Timed Reset Fault Indicator with a remote display (see page 189 for display options).

See page 192 for application with the RadioRANGER® Wireless Fault Indication System.

CR — Current Reset

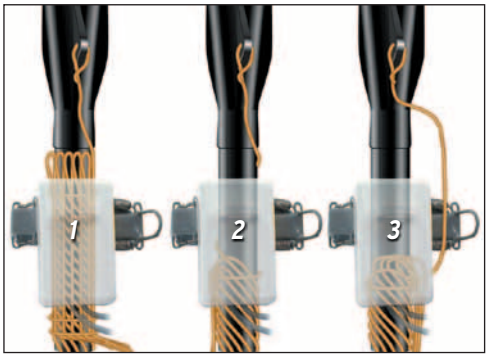
Line-powered fault indicator provides years of maintenance-free operation.

Key Features

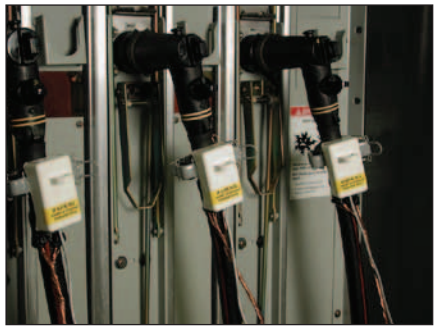
- Automatic reset upon restoration of load current.
- Closed-core design provides adjacent phase immunity.
- Available for single- and three-phase applications.
- Choose from BEACON® LED, target, and combination displays, depending on your application and operating practices.
- Ideal for installation in pad-mounted equipment without elbow test points; install the fault indicator outside of the influence of the ground return path of the cable's concentric neutral.
- Installation on low-voltage secondary lines is an ideal fault-finding solution in industrial environments.
- Choose the auxiliary contact option for SCADA compatibility.
- Fault-powered current reset models also available for low-load current applications. Please consult SEL.

Specifications	
Power Source	
Current Reset	Load current ≥3 A
Trip Value	
Current Reset	100 to 1200 A
Fault Powered	200 to 800 A
Maximum Fault Current	25 kA for 10 cycles
Trip Response Time	
Current Reset	1 ms
Fault Powered	8 ms nominal (function of current)
Outer Diameter Clamping Range	0.75" to 2.10" (please specify clamping diameter or range when ordering)
Reset Requirements	3 A
Housing Material	UV-stabilized polycarbonate resin
Clamp Material	Vinyl-coated silicon steel
Submersibility	Up to 15 feet
Temperature Range	–40° to +85°C

See page 192 for application with the RadioRANGER® Wireless Fault Indication System.



Double-back concentric neutral training is recommended (see 1 above). Examples 2 and 3 above indicate other acceptable neutral training methods.



A three-phase Current Reset Fault Indicator in a switchgear application.

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SR—Secondary/Low-Voltage Reset

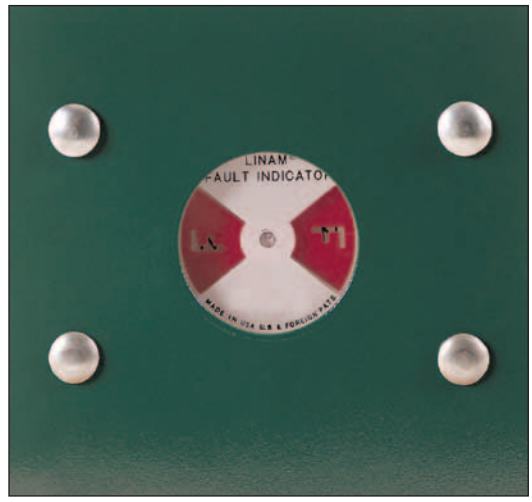
Arms and resets from transformer secondary voltage—no minimum load current necessary.

Key Features

- Line-powered arm and reset eliminate the need for a battery.
- The secondary voltage supplies the necessary arm and reset requirements in applications where there is insufficient load current to use a CR product.
- Available for single- and three-phase applications.
- Choose from BEACON® LED, target, and combination displays, depending on your application and operating practices.
- Reset restraint option prevents undesired reset from backfeed voltage. Please consult SEL.

Specifications	
Power Source	Secondary voltage
Secondary Voltage	110 to 460 Vac
Nominal Trip Ratings	50 to 1000 A
Trip Tolerance	±10%
Reset Time*	Approximately 30 seconds at 120 Vac
Maximum Fault Current	25 kA for 10 cycles
Trip Response Time	1 ms
Outer Diameter Clamping Range	0.75" to 1.6" (please specify clamping diameter or range when ordering)
Housing Material	UV-stabilized polycarbonate resin
Clamp Material	Stainless steel
Temperature Range	–40° to +85°C

*Product may vary depending on configuration



An SEL Type L large display indicates that a Secondary Reset Fault Indicator has tripped.

MR and MB—Manual Reset

MB—Manual Reset Fault Indicator with a reset button.

MR—Manual Reset Fault Indicator.

Economical troubleshooting device with 50-plus years of field-proven reliability.

Key Features

- After a fault occurs, use an MR or MB before reclosing for inexpensive, efficient fault location.
- Line-powered, battery-free.
- The built-in reset button in the MB model eliminates the need for a separate reset tool.
- The MR model is available in a convenient kit to keep on a truck—three MRs and a reset tool in a sturdy, lightweight carrying case.
- MR models are also applicable on overhead systems. MB models are only for underground applications.
- More than 50 years of field-proven reliability.

Specifications	
Nominal Trip Ratings	
MB	25 to 800 A
MR	100 to 800 A
Trip Tolerance	±10%
System Voltage Range	
Overhead (MR only)	Up to 38 kV_{L-L}
Underground	Matches the URD cable rating
Maximum Fault Current	25 kA for 10 cycles
Trip Response Time	8 ms
Outer Diameter Clamping Range	0.25" to 1.4" (please specify the clamping diameter or range when ordering)
Temperature Range	−40° to +85°C
Approximate Weight	
MB	170 g (0.37 lbs)
MR	140 g (0.31 lbs)

The Manual Reset Fault Indicator is an excellent troubleshooting tool for both overhead and underground applications.

Keep MR kits on a line truck as a convenient troubleshooting tool.

GFD — Ground Fault Detector

Reliable ground fault detection for three-conductor cable applications.

Key Features

- Detects ground faults by sensing the vector sum of the current flowing through a three-conductor cable.
- Choice of three reset options (secondary voltage, load current, or time) to meet various application needs.
- Install the split-core sensor on three-phase cables without opening the primary.
- Large reflective red target is easy to see both at night and during the day.
- Submersible vinyl-coated sensing core.
- Stainless-steel hardware and UV-stabilized materials ensure long product life.
- Thousands of SEL GFDs in service today help customers around the world quickly locate ground faults.

A Ground Fault Detector (Model GFD50SA) provides fault indication in the Middle East.

Specifications	
Power Source	Secondary voltage (120 to 240 Vac_{L-N} at 50 to 60 Hz); load current (≥3 A); or lithium battery for timed reset products
Reset Time (timed reset models only)	2, 4, or 8 hours
Nominal Trip Ratings	20, 40, 50, or 100 A
Trip Tolerance	±10%
Maximum Fault Current	25 kA for 10 cycles
Trip Response Time	1 ms
Outer Diameter Clamping Range	4" (6" optional)
Housing Materials	UV-stabilized polycarbonate resin
Submersibility	Up to 15 feet
Temperature Range	−40° to +85°C

Underground Fault Indicator Ordering Tables

Instructions for Creating Underground Fault Indicator Part Numbers

1. Select one code (in bold) from each column (i.e., 1, B, IR, etc.). It is possible to select more than one code from the Options column. List option codes in the order that they appear in the column. Please consult the factory if you are choosing more than one option from the options column. Consult E. O. Schweitzer Manufacturing if you are preparing to order a part number you have not ordered before.

2. Follow your usual process to issue a purchase order, or complete a specification for standards.

Example Part Numbers

1TPRV0200IRAJ

1BTPRB0600IR

1SRI0050DT

Underground AutoRANGER—Single-Phase

Single-Phase	BEACON LED Option	Underground AutoRANGER Designation	Display	Current Activated Timed Reset Duration	Options	Factory Code
1	**–** No BEACON **B** BEACON LED	**ARU**	**I** Integral **V** Standard remote **L** Large remote **B** Bolt	**0** 0 hrs **2** 2 hrs **4** 4 hrs **8** 8 hrs **12** 12 hrs	**–** No options **L** Large core 1.8" to 2.5" **W** Window-mounting kit for large remote display	**Y2**

Underground AutoRANGER—Three-Phase

Three-Phase	Underground AutoRANGER Designation	Display	Current Activated Timed Reset Duration	Options	Factory Code
3	**ARU**	3	**0** 0 hrs **2** 2 hrs **4** 4 hrs **8** 8 hrs **12** 12 hrs	**–** No options **L** Large core 1.8" to 2.5"	**Y2**

Underground AutoRANGER—Single-Phase, Fiber-Optic Display

Single-Phase	BEACON LED Option	Underground AutoRANGER Designation	Display Type Option	Timed Reset Period	Trip Value	Options	Display Lead Length	Factory Code
1	**B** BEACON LED	**ARUZ**	**R** Remote fiber-optic	**0** 0 hrs **2** 2 hrs **4** 4 hrs **8** 8 hrs	**–** Autoranging	**–** No options **L** Large core 1.6" to 2.5" (consult factory)	**G** 6 ft **P** 12 ft **Q** 20 ft	**Y2**

Underground Test Point Reset—Single-Phase

Single-Phase	BEACON LED Option	Test Point Reset Designation	Display	Trip Level	Options
1	**–** No BEACON **B** BEACON LED	**TPR**	**I** Integral **V** Standard remote **L** Large remote **B** Bolt	**0080** 80 A **0100** 100 A **0160** 160 A **0200** 200 A **0250** 250 A **0300** 300 A **0400** 400 A **0600** 600 A **0800** 800 A **1000** 1000 A **1200** 1200 A	**–** No options **IR** Inrush restraint **A** Auxiliary contact **DT** Delayed trip (24 ms) **J** Junction shields* **J6** 600 A-class junction shields* **W** Window-mounting kit for large remote display

* Required ≤200 A; suggested for junction enclosure applications or when phase distinction is required.

Underground Fault Indicator Ordering Tables

Underground Test Point Reset—Three-Phase

Three-Phase	BEACON LED Option	Test Point Reset Designation	Display	Trip Level	Options
3	– No BEACON	TPR	3 Three-phase	0080 80 A	– No options
	B BEACON LED		V Standard remote	0100 100 A	IR Inrush restraint
			L Large remote	0160 160 A	A Auxiliary contact
			B Bolt	0200 200 A	DT Delayed trip (24 ms)
			4 Three-phase target with single LED**	0250 250 A	J Junction shields*
				0300 300 A	J6 600 A-class junction shields*‡
				0400 400 A	W Window-mounting kit for large remote display
				0600 600 A	
				0800 800 A	
				1000 1000 A	
				1200 1200 A	

* Required for trip levels ≤200 A
‡ Required on 600 A-class elbows with "3" display
** Must select BEACON LED option in column 2

Underground Timed Reset— Clamp Style

Underground Phase Designation	BEACON LED Option	Clamp-Style Timed Reset	Display	Trip Level	Time-Out Period	Options
1 Single-phase	– No BEACON	TR	I Integral	0050 50 A	2 2 hrs	– No options
3 Three-phase	B BEACON LED		L Large remote	0100 100 A	4 4 hrs	A Auxiliary contact
			V Standard remote	0200 200 A	8 8 hrs	DT Delayed trip (24 ms)
			B Bolt	0300 300 A		N Nonreplaceable battery
				0400 400 A		S Snap-action clamp
				0600 600 A		W Window-mounting kit for large remote display
				0800 800 A		
				1000 1000 A		
				1200 1200 A		

Underground Timed Reset—Test Point Style

Underground Phase Designation	BEACON LED Option	Test Point-Style Timed Reset	Display	Trip Level	Time-Out Period	Options
1 Single-phase	– No BEACON	TTR	L Large remote	0080 80 A	2 2 hrs	– No options
3 Three-phase	B BEACON LED		V Standard remote	0100 100 A	4 4 hrs	A Auxiliary contact
			B Bolt	0160 160 A	8 8 hrs	DT Delayed trip (24 ms)
				0200 200 A		N Nonreplaceable battery
				0250 250 A		J Junction shields*
				0300 300 A		J6 600 A-class junction shields*
				0400 400 A		W Window-mounting kit for large remote display
				0600 600 A		
				0800 800 A		
				1000 1000 A		
				1200 1200 A		

* Required ≤200 A

Underground Current Reset

Underground Phase Designation	BEACON LED Option	Current Reset Designation	Display	Trip Level	Options
1 Single-phase	– No BEACON	CR	I Integral	0050 50 A	– No options
3 Three-phase	B BEACON LED		V Standard remote	0100 100 A	IR Inrush restraint
			L Large remote	0200 200 A	A Auxiliary contact
			B Bolt	0300 300 A	DT Delayed trip (24 ms)
			3 Three-phase	0400 400 A	3 Three-phase reset
			4 Three-phase target with single LED*	0600 600 A	L Large core 1.8" to 2.5"
				0800 800 A	W Window-mounting kit for large remote display
				1000 1000 A	
				1200 1200 A	

* Must select BEACON LED option in column 2

Underground Fault Indicator Ordering Tables

Underground Secondary/Low-Voltage Reset

Underground Phase Designation		BEACON LED Option		Secondary Reset Designation	Display		Trip Level		Options	
1	Single-phase	**–**	No BEACON	**SR**	**I**	Integral	**0050**	50 A	**–**	No options
3	Three-phase	**B**	BEACON LED		**V**	Standard remote	**0100**	100 A	**IR**	Inrush restraint
					L	Large remote	**0200**	200 A	**RR**	Reset restraint
					B	Bolt	**0300**	300 A	**A**	Auxiliary contact
					3	Three-phase	**0400**	400 A	**DT**	Delayed trip (24 ms)
							0600	600 A	**W**	Window-mounting kit for large remote display
							0800	800 A		
							1000	1000 A		
							1200	1200 A		

Paper-Insulated Lead Cable

Model Number	Display Version		Nominal Trip Ratings		Mounting Range	Time-Out Period		Display Lead Length		Time-Current Curve Characteristic	Options	
PILC	**L**	Large Remote	**06**	600 A	**D****	**01**	1 hr	**G**	6 ft	**1**	**A***	Auxiliary Contact
	M	RR Magnetic Probe (RadioRANGER® Only)	**08**	800 A	**E****	**02**	2 hrs	**P**	12 ft	**2**		
			10	1000 A	**F****	**04**	4 hrs	**Q**	20 ft	**3**		
			12	1200 A		**08**	8 hrs			**4**		
						12	12 hrs					
						24*	24 hrs					

* "L" display only

** See Paper-Insulated Lead Cable Mounting Range Cable Sizes table below

Paper-Insulated Lead Cable Mounting Range Cable Sizes

3 Conductor PILC Cable		Triplexed Single-Phase Cable			
3C Cable Diameter		Single Cable Diameter		Circumscribed Diameter	
D	2.2" to 3.1"	**D**	1.1" to 1.48"	**D**	2.38" to 3.2"
E	3.12" to 3.84"	**E**	1.5" to 1.85"	**E**	3.24" to 4.0"
F	4.0" to 4.44"	**F**	1.92" to 2.14"	**F**	4.16" to 4.64"

Manual Reset

Manual Reset Designation	Trip Level		Clamp Size	
MR	**0100**	100 A*	**–**	Standard size for up to 1.4" OD cables
	0200	200 A	**L**	Large size for 0.8" to 2.0" OD cables
	0400	400 A	**K**	Kit case (MR fault indicators and 1 MT reset tool in a hard-sided carrying case)
	0450	450 A		
	0800	800 A		

* MR0100 is appropriate for a 1.0" maximum cable diameter and is not available with the "L" option.

Manual Reset With Button

Manual Button Designation	Trip Level		Core Size	
MB	**0025**	25 A	**–**	Standard core size for 0.6" to 1.4" OD cables
	0050	50 A	**L**	Large core size for 1.2" to 2.3" OD cables
	0100	100 A		
	0200	200 A		
	0300	300 A		
	0400	400 A		
	0450	450 A		
	0800	800 A		

Ground Fault Detectors

Ground Fault Detector Designation	Auxiliary Contact		Trip Response		Display		Trip Level		Reset Type		Time-Out Period		Core Size	
GFD	**–**	No auxiliary contact	**–**	Standard 1 ms trip response time	**–**	Large remote	**20**	20 A	**–**	Secondary reset	**–**	Not a timed reset (TR) model	**–**	100 mm core, 4.0" ID
	A	Auxiliary contact	**DT**	Delayed trip (24 ms)	**I**	Integral	**40**	40 A	**CR**	Current reset	**2**	2 hrs	**L**	150 mm core, 6.0" ID
					V	Small remote	**50**	50 A	**TPR**	Test point reset	**4**	4 hrs		
					B	Bolt	**100**	100 A	**TR**	Timed reset	**8**	8 hrs		
									X	Factory-defined special	**16**	16 hrs		
											24	24 hrs		

Tools and Sensors Ordering Tables

Tools and sensors shown starting on page 208.

Voltage Indicators

Voltage Indicator Designation	Voltage Application	
VIN	200	Capacitive test point installation
	600	Basic insulation plug installation

Fault Counters

Fault Counter Designation	Trip Level		Inrush Restraint	Options	
FC	0050	50 A	IR	–	No options
	0100	100 A		DT	Delayed trip (24 ms)
	0200	200 A			
	0300	300 A			
	0400	400 A			
	0600	600 A			
	0800	800 A			
	1000	1000 A			

Split-Core Current Transformers

Secondary Output (amps)	Primary Current (amps)	Window Diameter (in)
5A	600	D35
5A	600	D45
5A	1000	D45
5A	1000	D60
5A	2000	D45
5A	2000	D60
5A	2000	D80
5A	3000	D45
5A	3000	D60
5A	3000	D80

Instructions for Creating Split-Core Current Transformer Part Numbers

Each row represents a complete part number.

Select the inner diameter of your Split-Core Current Transformer by choosing a code from the Window Diameter column. For example, D35 indicates a 3.5" inner diameter, D60 indicates a 6.0" inner diameter, etc.

Example Part Numbers

5A600D35
(5 A secondary output, 600 A primary current, 3.5" inner diameter)

5A2000D45
(5 A secondary output, 2000 A primary current, 4.5" inner diameter)

VIN—Voltage Indicators

Improve safety by indicating the presence of voltage.

Key Features

- Indicates the presence of system voltage to ensure safety.
- Flashing neon bulb indicates voltage is present. Faster flash rate indicates higher voltage.
- Install in pad-mounted transformers, switchgear, and other underground distribution enclosures with basic insulating plugs or capacitive test points.
- Applicable on most brands of test point elbows. Both 200 A and 600 A models available.
- Compact, lightweight, and durable design makes the voltage indicator easy to install.
- Three-phase version also available. Please consult SEL.

Specifications	
Power Source	Test point elbow terminator voltage
Primary Voltage (L-L)	2 kV to 35 kV
Flash Response Time	30 seconds at 2 kV_{L-L}
Flash Rate	Proportional to voltage
Elbow Style	200 or 600 A-class elbows with test points or basic insulating plugs
Housing Material	Conductive EPDM rubber
Temperature Range	−40° to +85°C
Approximate Weight	100 to 180 g (0.22 to 0.40 lbs)

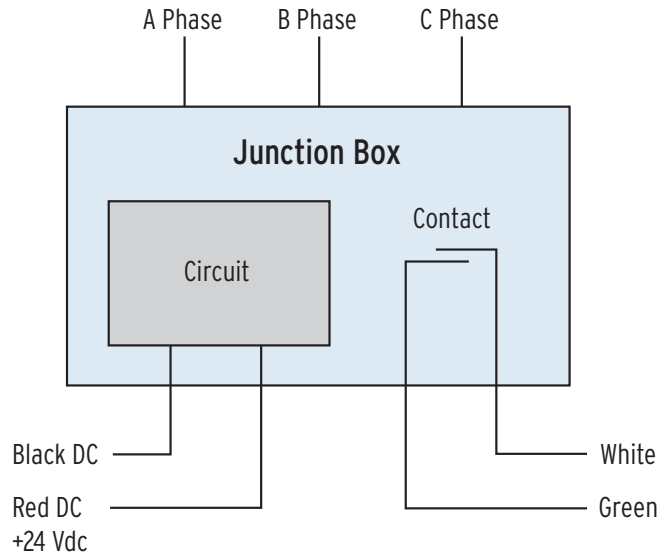
200 A Voltage Indicator alerts utility personnel to the presence of voltage.

VS—Voltage Sensors

Economically sense voltage, and eliminate the need for potential transformers or analog sensors.

Key Features

- Three-phase voltage sensors detect primary system voltage on main and alternate sources in pad-mounted automatic transfer schemes.
- Voltage sensors detect voltage via the test point of the separable connector component. The presence of system voltage is indicated by an electrically isolated contact.
- SEL makes and calibrates each voltage sensor as a complete custom solution for each application.
- Sensor circuitry monitors primary system voltage and controls contact status.
- Wye and ungrounded delta models allow you to match your system configuration.
- Contacts latch closed when system voltage on three phases is above 90 percent. Contacts latch open when system voltage on any phase drops below 75 percent. Delta units require voltage drop in two or more phases.



Specifications	
Isolated Power Supply	24 Vdc with a 50 mA maximum dc draw
Arming Requirement	24 Vdc nominal supply voltage
Voltage Pull-In	≥90% of system voltage
Voltage Dropout	≤75% of system voltage
Phase Sensor Material	Conductive EPDM rubber
Separable Connector Component	200 or 600 A-class connector with test points or basic insulating plugs
Voltage Class	15, 25, or 35 kV class
Contact Rating	40 VA, 1.0 A maximum, 200 Vdc maximum

FC—Fault Counters

Troubleshoot problematic sections of overhead systems.

Key Features

- Count the number of temporary and permanent faults on sections of line with problems caused by defective insulators, tree branches, etc.
- Clock-style face with a reflective red pointer counts up to ten faults.
- Manually reset with a hot-stick-mounted tool.
- Single hot-stick installation.
- Prevent false tripping during recloser operations with the inrush restraint feature.

Specifications	
Power Source	Electric field
Nominal Trip Ratings	50 to 1200 A
Trip Tolerance	±10%
System Voltage Range (L-N)	5 kV to 20 kV
Maximum Fault Current	25 kA for 10 cycles
Trip Response Time	1 ms
Inrush Restraint Response Time	300 ms
Outer Diameter Clamping Range	0.25" to 1.6" (please specify clamping diameter or range when ordering)
Housing Material	UV-stabilized polycarbonate resin
Clamp Material	Rubber-sleeved stainless steel
Temperature Range	−40° to +85°C
Approximate Weight	430 g (0.95 lbs)

Reset the Fault Counter with a battery-powered, hot-stick-held reset tool, model FCRT (sold separately).

Tel: +1.509.332.1890 | Fax: +1.509.332.7990 | www.selinc.com

CT—Split-Core Current Transformers

Install current monitoring sensors without interrupting service.

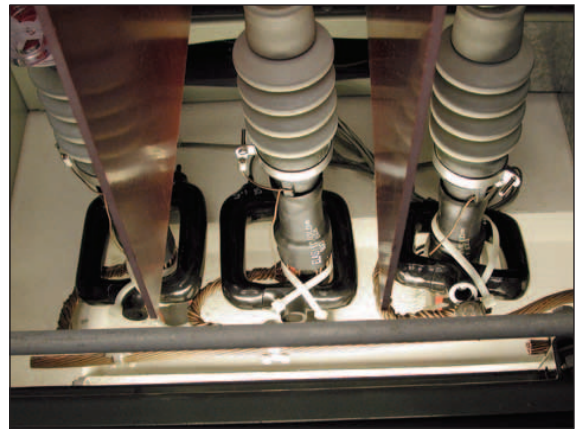
Key Features

- Split-core design eliminates the need to open the primary cable during installation over existing bushings or cable, resulting in lower installation cost and time than closed-core designs.
- Four window diameters available: 3.5", 4.5", 6.0", and 8.0".
- Flexible encapsulation provides 600 V class insulation and ensures long product life.
- Secondary terminals are protected with vinyl coating.
- One-piece design simplifies installation and use.
- Design allows for installation when secondary load is present.

Specifications	
Primary Current	600 to 3000 A
Secondary Current	5 A
Accuracy	±3% at rated burden
Metering Burden	B-0.2 (ANSI C57.13)
Nominal Window Diameters	3.5", 4.5", 6.0", and 8.0"
Core Design	Flexible split core
Core Material	Grain-oriented silicon steel
Insulation Class	600 V (can be used on higher voltage circuits when installed over insulated conductors)
Secondary Winding Material	Copper
Electrical Terminals	Nickel-plated brass threaded posts
Markings	Hot stamped for polarity, catalog number, and ratio
Operating Temperature	–40° to +85°C
Installation Temperature	–10° to +85°C

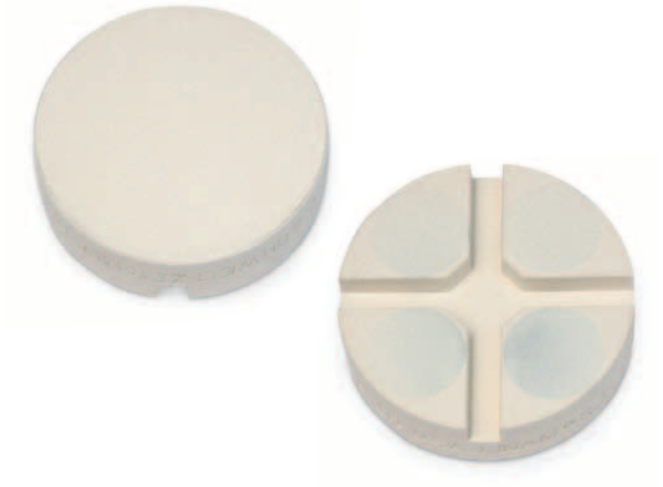
Applications

- Electrical load surveys.
- Industrial energy management systems.
- Submetering for department costing.
- In conjunction with:
  - Demand meters
  - Kilowatt-hour meters
  - Power factor meters
  - Current transducers
  - Watt transducers
  - Current-sensing relays



Split-Core Current Transformers provide current measuring for a variety of switchgear applications.

MCG—Magnetic Cable Guide



Keep remote display and sensor cables neat and secure.

Key Features

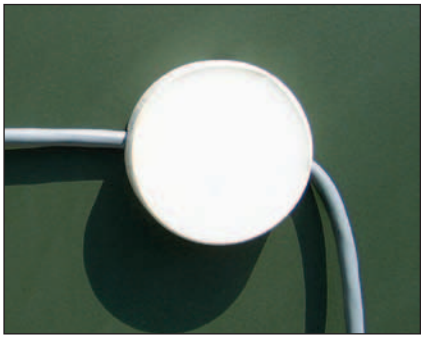
Designed to keep current sensor and remote display wiring in place against the inside of an enclosure, Magnetic Cable Guides (MCGs) are a favorite tool of customers who use fault indicators with remote displays. MCGs securely position cables against the cabinet wall, but are easy to reposition when pulling elbows, moving fault indicators, or working inside the enclosure. The magnetic strength is large enough to hold approximately 500 grams of weight when placed on a smooth surface.

Our creative customers use the MCGs in other ways that we never imagined!

- Use a cable tie to affix an MCG to a meter. Place the meter on the side of a voltage regulator or other cabinet for hands-free operation.
- Secure fiber-optic cables to racks.
- Keep wiring neat and secure underneath surface-mount technology machines.

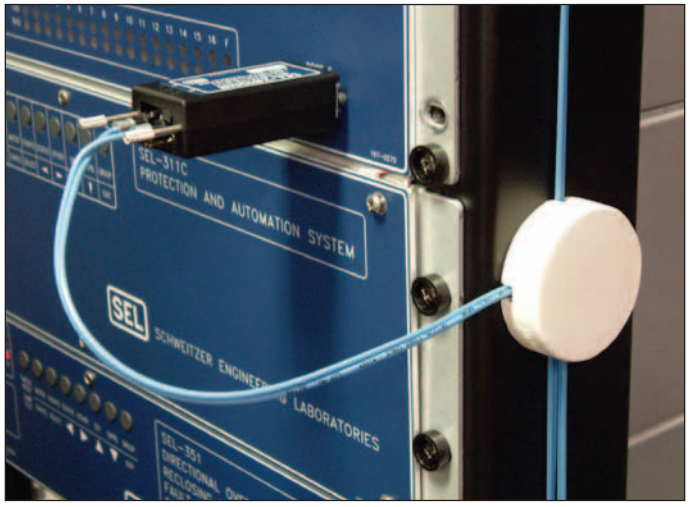
Purchase MCGs online at **www.sel-com.com/magnetic_cable_guides**.

Have a Creative Application for Magnetic Cable Guides?
Send a photograph to **sales@eosmfg.com**, and we'll send you two free MCGs.



MCGs keep cables neat inside of cabinets.

Use MCGs to hold meters to control cabinets for hands-free operation.



Hold fiber-optic cables against racks with MCGs.

Accessories and Tools

HHT
Silver Bolt Test Tool

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

Works like a compass; the red target built into its face comes into view to indicate a tripped fault indicator.

BTT
BEACON® Test Tool

Field-test fault indicators with BEACON Bolt® Displays.

TMRT
Gold Bolt Test and Reset Tool

Tests and resets fault-powered fault indicators with tamperproof bolt displays.

CRSRTT
Current and Secondary Reset Test Tool

Field-test and manually reset the AutoRANGER®, BTRIP, BTRI_IR, and other timed reset products.

ERLTT
Electric Field Reset Test Tool

Use in conjunction with a hot stick to field-test electrostatic reset ERL and BER fault indicators.

MT
Manual Reset Tool

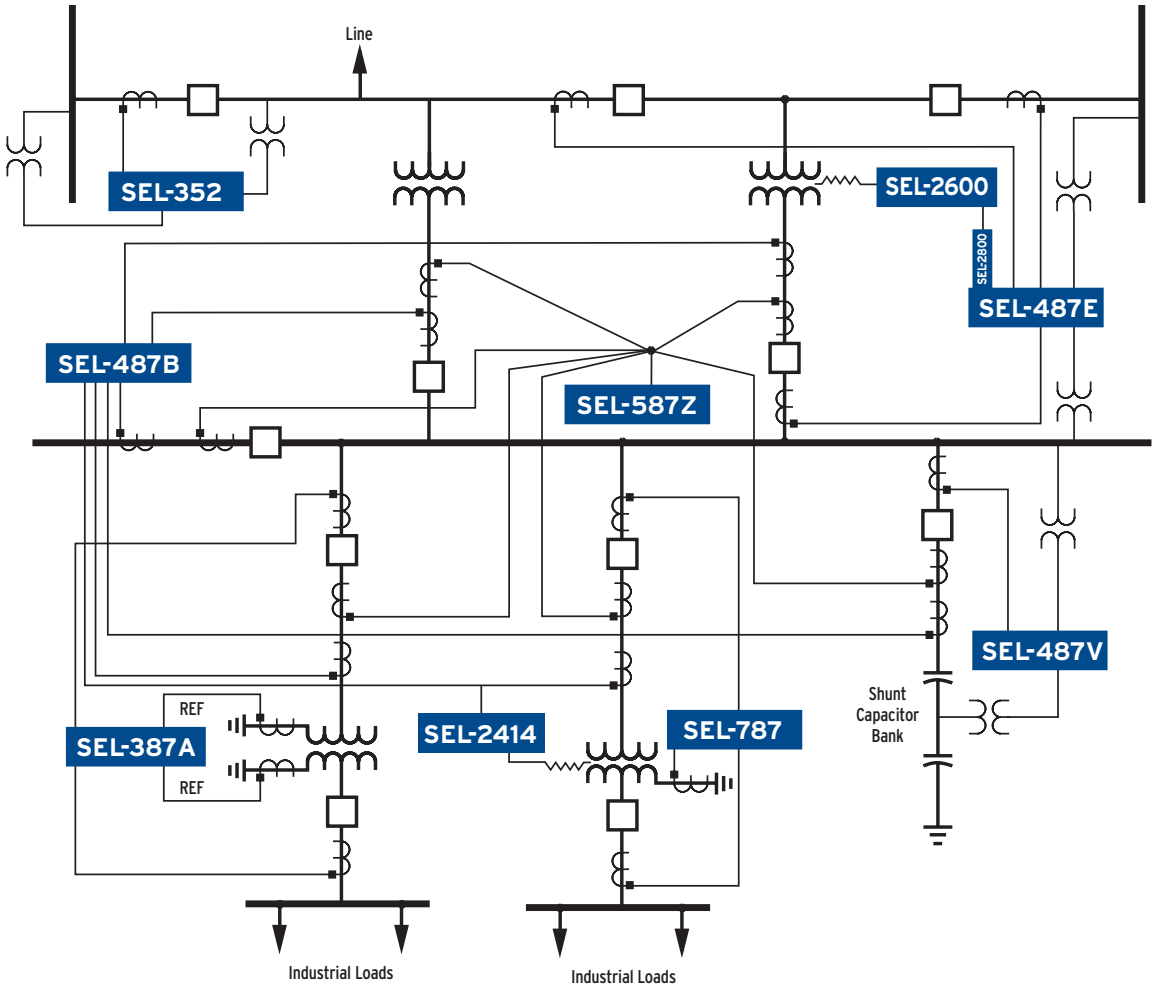
Manually reset the MR fault indicator.

FCRT
Fault Counter Reset Tool

Reset the Fault Counter with this battery-powered, hot-stick-held reset tool.

(tools sold separately)

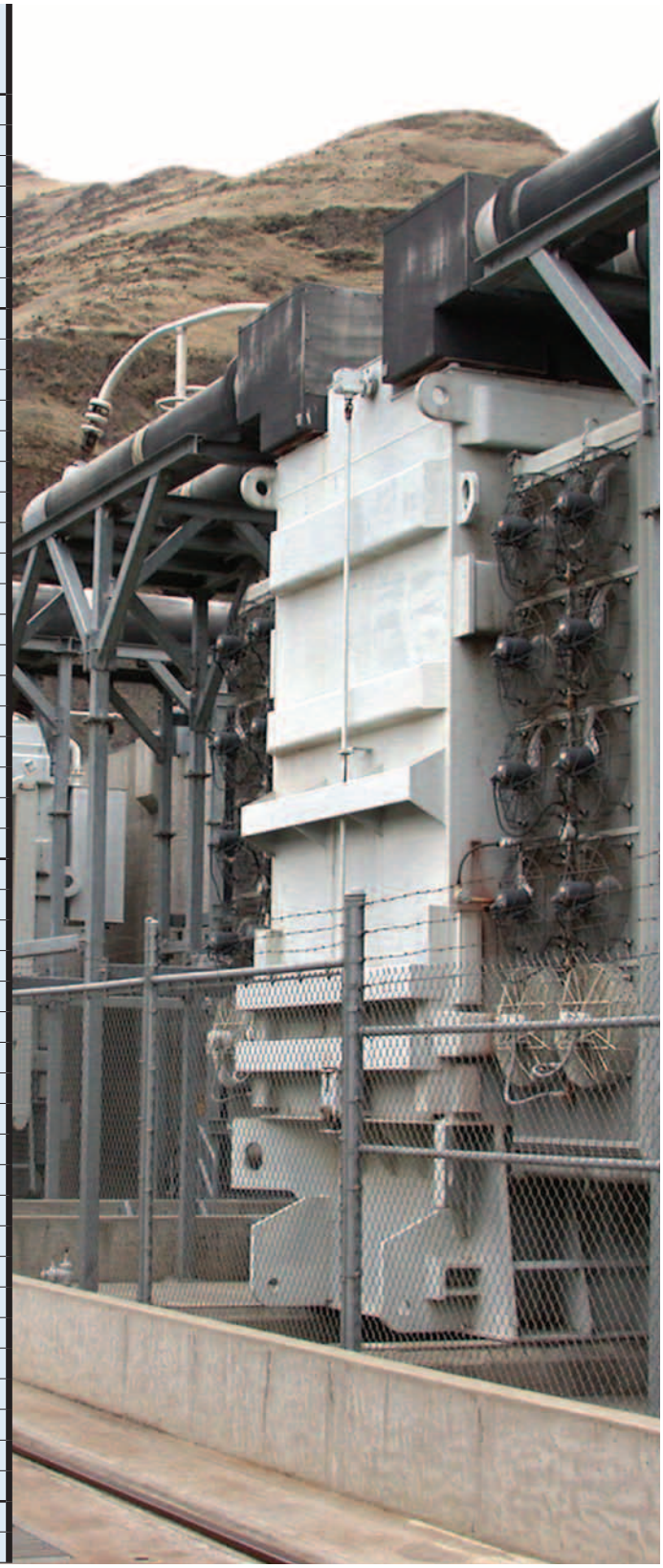
Transformer, Bus, Breaker, and Capacitor Applications



Transformer, Bus, Breaker, and Capacitor Protection Product Index

Transformer Protection and Monitoring Features

Transformer Protection and Monitoring	SEL-487E	SEL-387E	SEL-387	SEL-387A	SEL-787	SEL-587	SEL-2414
APPLICATIONS							
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	*
PROTECTION							
24 Overexcitation (Volts Per Hertz)	•	•			•		
27 Undervoltage	•	•			•		
32/37 Power Elements	•				•		
46 Current Unbalance	•						
49 Equipment Thermal Monitoring	ƒ		*	•	•		
50N/G Ground - O/C	•	•	•	•	•	•	
50P Phase - O/C	•	•	•	•	•	•	
50Q Negative-Sequence - O/C	•	•	•	•	•	•	
51N/G Ground Time - O/C	•	•	•	•	•	•	
51P Phase Time - O/C	•	•	•	•	•	•	
51Q Negative-Sequence Time - O/C	•	•	•	•	•	•	
59 Overvoltage	•	•			•		
81 Underfrequency/Overfrequency	•	•			•		
87 Current Differential	•	•	•	•	•	•	
87G Restricted Earth Fault	•	•	•	*	*		
67P Directional Overcurrent	•						
Flashover Protection	ƒ	ƒ			ƒ		
INSTRUMENTATION AND CONTROL							
SELogic® Control Equations	•	•	•	•	•	•	•
Voltage Check on Closing	ƒ	ƒ			ƒ		
Transformer Cooling Fan Control	ƒ				ƒ		ƒ
Nonvolatile Latch Control Switches	•	•	•	•	•		•
Remote Control Switches	•	•	•	•	•	•	•
Local Control Switches	•	•	•	•	•		•
Display Points	•	•	•	•	•		•
Multiple Settings Groups	•	•	•	•	•		
Substation Battery Monitor	•	•	•	•			ƒ
Breaker Wear Monitor	•	•	•	•			
Trip Coil Monitor	ƒ	ƒ	ƒ	ƒ	ƒ	ƒ	ƒ
Event Report (Multicycle Data)	•	•	•	•	•	•	•
Sequential Events Recorder	•	•	•	•	•		•
Instantaneous Meter		•	•	•	•	•	•
Demand Meter	•	•	•	•	•	•	•
Load and Temperature Profile Report	•				•		•
RTD (Resistance Temperature Detector) Inputs					*		*
Thermocouple Inputs							*
Through-Fault Monitor	•	•	*	•	•		•
Thermal Model/SEL-2600 RTD Module Communications	•		*	•	•		•
MISCELLANEOUS FEATURES							
Connectorized® (Quick Disconnect) Available		*	*			*	*



• *Standard Feature* * *Model Option* ƒ *This function may be created using relay elements, device word bits, analog quantities, and timers*

Bus Protection Features

Bus Protection

	SEL-387	SEL-487B	SEL-487E	SEL-587Z	SEL-311 or SEL-351S With SEL-2100
APPLICATIONS					
Breaker Failure Protection	*f*	•	•	*f*	*f*
Bus Differential	*f*	•	•	•	*f*
Transformer and Machine Current Differential	•		•		
High-Impedance Bus Differential				•	
Low-Impedance Bus Differential	•	•	•		*f*
Three-Phase Current Inputs	4	6/9/18	5	Common	15
PROTECTION					
27 Undervoltage		•	•		•
46 Current Unbalance		*f*	•		
47 Voltage Unbalance		•	*f*		
50N/G Ground - O/C	•		•	•	•
50P Phase - O/C	•	•	•	•	•
50Q Negative-Sequence - O/C	•		•	•	•
51N/G Ground Time - O/C	•		•	•	•
51P Phase Time - O/C	•	•	•	•	•
51Q Negative-Sequence Time - O/C	•		•	•	•
59 Overvoltage		•	•		•
87 Current Differential	•	•	•		
87Z High-Impedance Differential				•	
Single-Pole Trip/Close		•			
Directional Comparison			•		*f*
INSTRUMENTATION AND CONTROL					
79 Automatic Reclosing		*f*	*f*		*f*
SELogic® Control Equations	•	•	•	•	•
Nonvolatile Latch Control Switches	•	•	•		•
Remote Control Switches	•	•	•	•	•
Local Control Switches	•	•	•	•	*
Display Points	•	•	•	•	*
Multiple Settings Groups	•	•	•		•
Substation Battery Monitor	•	•	•		•
Breaker Wear Monitor	•		•		•
Trip Coil Monitor	*f*	*f*	*f*	*f*	*f*
Event Report (Multicycle Data)	•	•	•	•	•
Sequential Events Recorder	•	•	•	•	•
Instantaneous Meter	•	•	•	•	•
Demand Meter	•		•	•	•
Through-Fault Monitor	•		•		
Mirrored Bits® Communications		•	•		•
MISCELLANEOUS FEATURES					
Connectorized® (Quick Disconnect) Available	*				*
IEEE C37.118 Synchrophasors			•		
Synchrophasor Real-Time Control			•		
IEC 61850		•	•		

• *Standard Feature* * *Model Option* *f* *This function may be created using relay elements and timers*

Breaker Failure and Capacitor Bank Protection Features

Breaker Failure and Capacitor Bank Protection	SEL-352	SEL-451	SEL-487B	SEL-287V	SEL-487V
APPLICATIONS					
Breaker Failure Protection, Number of Breakers	1	2	6		1
Bus Differential			•		
Shunt Capacitor Bank Protection		*f*		•	•
Low-Impedance Bus Differential			•		
Synchronism Check	•	•			
Underfrequency Load Shedding		*f*			*f*
Undervoltage Load Shedding	*f*	*f*	*f*	•	*f*
PROTECTION					
27 Undervoltage	•	*f*	•	•	•
32/37 Power Elements			*f*		•
46 Current Unbalance	•	*f*	*f*		•
47 Voltage Unbalance	•	*f*	*f*		*f*
49 Equipment Thermal Monitoring		*f*			*f*
50N/G Ground - O/C	•	•			•
50P Phase - O/C	•	•	•		•
50Q Negative-Sequence - O/C		•			•
51N/G Ground Time - O/C		•			•
51P Phase Time - O/C		•	•		•
51Q Negative-Sequence Time - O/C		•			•
59 Overvoltage	•	*f*	•	•	•
81 Underfrequency/Overfrequency		*f*			•
87 Current Differential			•		
87V Voltage Differential	*f*	*f*		•	•
Single-Pole Trip	•		•		
Single-Pole Close	•				
Flashover Protection	•	•			•
INSTRUMENTATION AND CONTROL					
79 Automatic Reclosing	*f*	•	*f*		*f*
SELOGIC® Control Equations	•	•	•		•
25 Synchronism Check	•	•			
Voltage Check on Closing	•	•			
Nonvolatile Latch Control Switches	•	•	•		•
Remote Control Switches	•	•	•		•
Local Control Switches	•	•	•		•
Display Points	•	•	•		•
Multiple Settings Groups	•	•	•		•
Substation Battery Monitor	*	•	•		•
Breaker Wear Monitor	•	•			•
Trip Coil Monitor	*f*	*f*	*f*		*f*
Event Report (Multicycle Data)	•	•	•	•	•
Sequential Events Recorder	•	•	•		•
Instantaneous Meter	•	•	•	•	•
Demand Meter		•			•
SEL-2600 RTD Module Communications	*	•			•
MISCELLANEOUS FEATURES					
Connectorized® (Quick Disconnect) Available	*				•
IEEE C37.118 Synchrophasors		•			•
Synchrophasor Real-Time Control		•			•
IEC 61850		•	•		•

• *Standard Feature* * *Model Option* *f* *This function may be created using relay elements and timers*

SEL-487E Transformer Protection Relay

Apply the powerful SEL-487E with five 3-phase restraint current inputs, two 3-phase voltage inputs, three independent neutral current inputs, and restricted earth fault (REF) elements.

SEL IEC 61850

SEL Synchrophasors™

Key Features

Differential Protection With Two to Five Restraints

Implement a two-stage slope that adapts to internal or external fault conditions automatically, even with CT saturation and heavily distorted waveforms, for fast, sensitive, dependable, and secure differential protection.

Sensitive Turn-to-Turn Fault Detection

Detect turn-to-turn winding faults for as little as 2 percent of the total transformer winding with the negative-sequence differential element.

Monitoring, Metering, and Asset Management

Monitor transformer temperatures, through faults, substation battery voltage, and breaker wear. Eliminate external recorder and metering requirements with oscillographic event reports (up to 5 seconds of 8 kHz event data), Sequential Events Recorder (SER) reporting, and accurate three-phase power metering.

Synchrophasor Data

Send IEEE C37.118 synchrophasor messages over serial or Ethernet communications to easily detect reactive loop flows, turn state estimation into state measurement, and provide early warning of potential system instability. Receive synchrophasor messages from up to two phasor measurement units (PMUs). Use built-in time correlation, and take control actions based on combined local and remote messages. Apply control functions based on phase angles, currents, and voltages for basic or advanced applications.

Commissioning Assistant Software

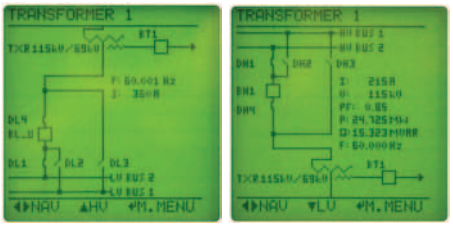
Minimize commissioning time with the first relay software that recommends matrix compensation settings after automatically identifying incorrect field wiring and improper CT configurations.

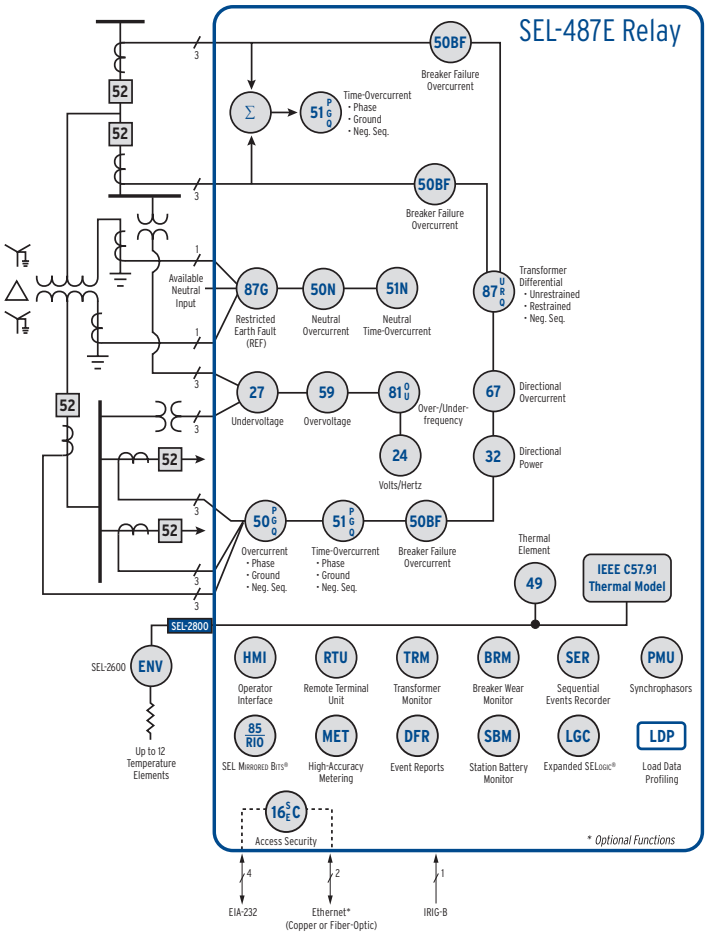
Graphical Logic Editor (GLE)

Simplify the SEL-487E configuration process with the GLE in ACSELERATOR QuickSet Designer® SEL-5031 Software. The GLE lets you design your SELOGIC® control equations graphically, so your settings files can be documented for easier validation and commissioning. Convert existing control equations to easy-to-read diagrams, and save with QuickSet settings.

Front-Panel One-Line Diagrams for Control and Monitoring

Select your own system bay configuration, and control as many as five breakers and eight disconnect switches using the built-in mimic diagrams that include up to six programmable analog quantities for readouts.





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SEL-487E Transformer Protection Relay

Applications

- Improve power system quality with SEL synchrophasors (IEEE C37.118) from all 24 analog channels (6 voltage and 18 current sources) in your relay. Synchrophasors over serial or Ethernet communication easily detect reactive loop flows, turn state estimation into state measurement, and provide early warning of potential system instability.
- Implement real-time control by receiving and time-aligning synchrophasor messages from up to two PMUs and taking control actions based on combined local and remote messages. Apply control functions based on phase angles, current, and voltages for basic or advanced applications.
- Configure the SEL-487E for transformer differential protection in transformer applications using up to five restraint currents. This includes single transformers with tertiary windings. Use three independent REF elements for protection of grounded wye windings.
- Protect large transformers with breaker-and-a-half high- and low-side connections.
- Protect a typical two-winding transformer application, and use the remaining three-phase current inputs for feeder backup protection.
- Protect generator step-up (GSU) transformers, and apply the built-in thermal elements for monitoring generator and transformer winding temperatures simultaneously.
- Set the directional power elements to detect forward and reverse power flow conditions for monitoring and protection of the GSU transformer in prime power, standby, base load, and peak-shaving applications.
- Provide backup protection with phase, negative-, and zero-sequence overcurrent elements. Set up breaker failure protection with subsidence detection to rapidly detect breaker failure and minimize system coordination times.
- Implement Mirrored Bits® communications for enhanced teleprotection and remote control.

Optional Features

- 6U or 7U chassis for one or two additional I/O boards.
- Additional inputs/outputs (settable or level-sensitive, optoisolated)
- Ethernet communications.*
- DNP3 LAN/WAN.
- DNP3 Level 2 Outstation communications protocol (serial).
- IEC 61850 communications.
- 5 A/1 A CT inputs.
- Conformal coating.

* Eye-safe, Class 1 LED product per EN 60825-1

Related Products

SEL Satellite-Synchronized Clocks 308–317
SEL-2600 RTD Module 296
SEL-3378 Synchrophasor Vector Processor 324
SEL-4391 Data Courier® 461

Hardware Specifications

AC Voltage Inputs (6 total)

300 V_{L-N} continuous, 600 Vac for 10 seconds

Burden 0.03 A @ 67 V; 0.06 VA @ 120 V

AC Current Inputs (18 total)

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical, 1250 A for 1 cycle

Burden 0.27 VA @ 5 A; 2.51 VA @ 15 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical, 250 A for 1 cycle

Burden 0.13 VA @ 1 A; 1.31 VA @ 3 A

Power Supply Ratings

125/250 Vdc or Vac

Range 85–300 Vdc or 85–264 Vac

48/125 Vdc or 125 Vac

Range 38–140 Vdc or 85–140 Vac

Standard Input/Output

3 high-interrupt outputs

2 standard speed Form A outputs

3 standard speed Form C outputs

5 level-sensitive, optoisolated digital inputs with independent commons

2 level-sensitive, optoisolated digital inputs with single shared common

Operating Temperature

–40° to +85°C (–40° to +185°F)

(Note: LCD contrast impaired for temperatures below –20°C)

Price

Budgetary Retail, Quantity 1: $6,750

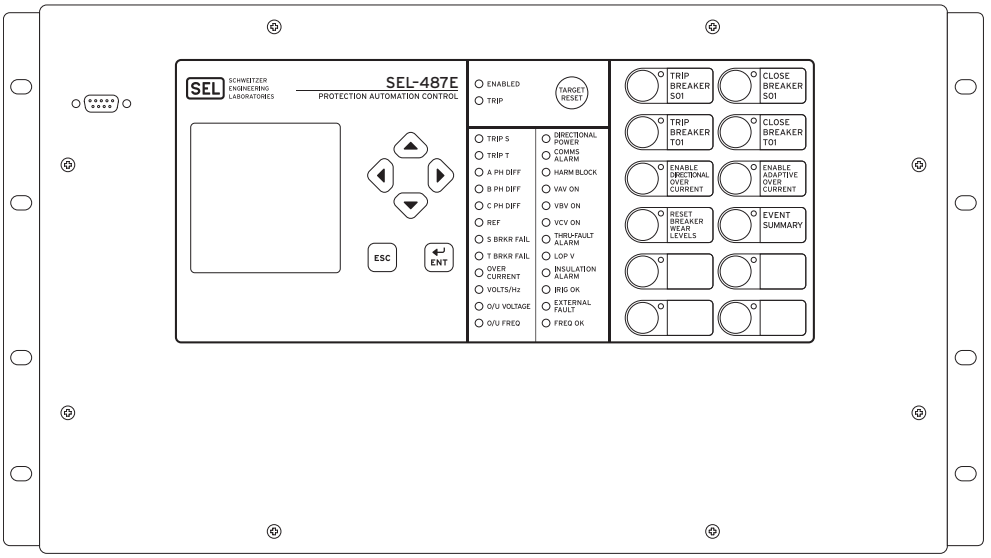
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

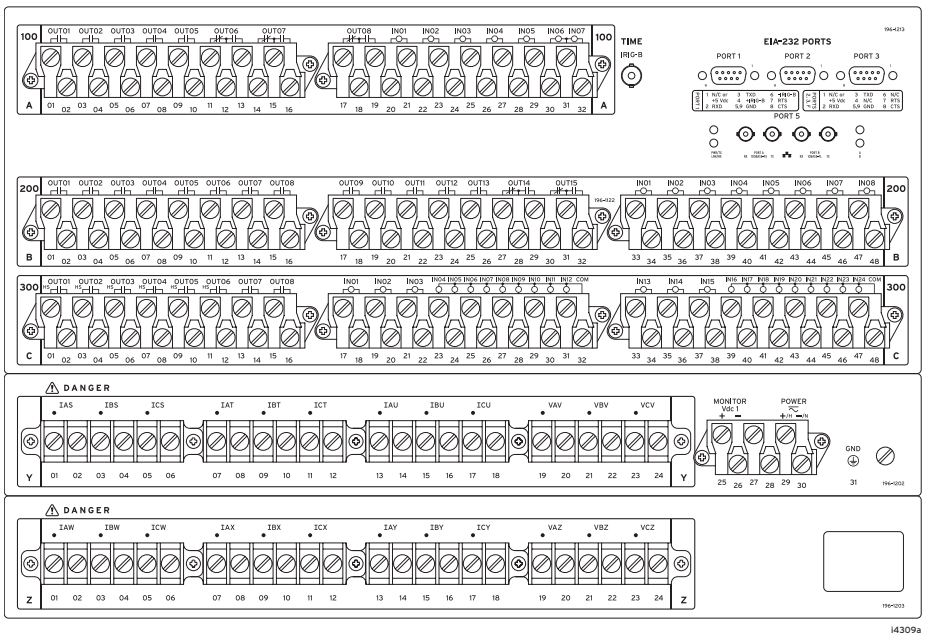
SEL-487E Transformer Protection Relay

Front View – Panel-Mount (7U) Enhanced Front-Panel HMI



I4222b

Rear View (7U)

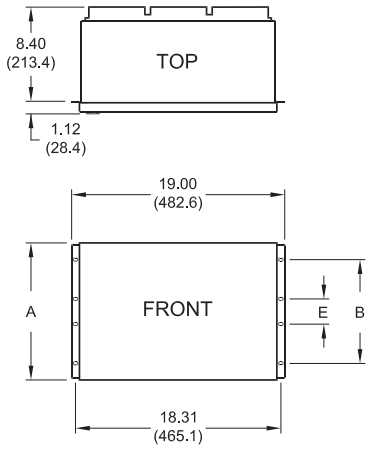


I4309a

SEL-487E Transformer Protection Relay

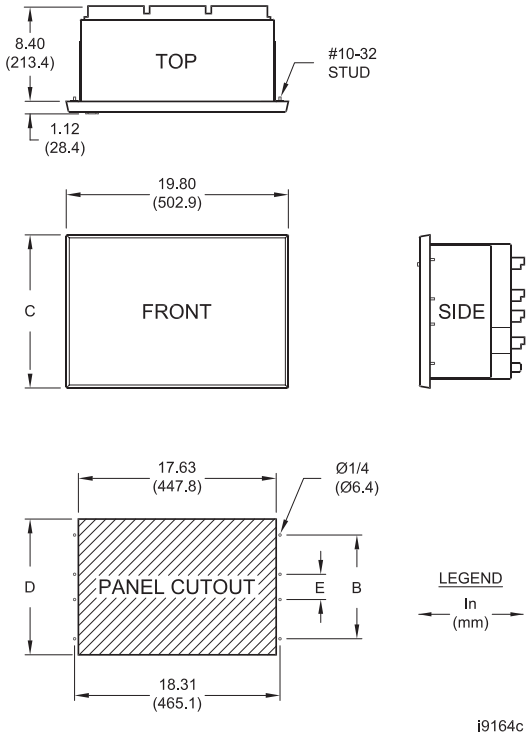
Dimensions

RACK-MOUNT CHASSIS



DIMENSION	TWO I/O BOARD (7U)	ONE I/O BOARD (6U)
A	12.22 (310.4)	10.63 (270.0)
B	9.25 (235.0)	7.50 (190.5)
C	13.65 (346.7)	12.10 (307.3)
D	12.10 (307.3)	10.55 (268.0)
E	2.25 (57.2)	3.00 (76.2)

PANEL-MOUNT CHASSIS



Visit www.selinc.com for more detailed information and configuration options.

SEL-787 Transformer Protection Relay

Apply advanced protection and monitoring with flexible communications to all two-winding transformer applications.

SEL IEC 61850

SEL Synchrophasors™

Key Features

Two-Winding Current Differential, Overcurrent, and Breaker Failure Protection

Apply two-winding, dual-slope differential protection with phase, negative-sequence, residual, and neutral-overcurrent elements for backup protection. Use breaker failure protection for two 3-pole breakers.

Secure and Dependable

Provide maximum security during external faults and transformer magnetizing inrush conditions with harmonic blocking. Detect internal faults quickly during energization or normal operating conditions using harmonic restraint. Both harmonic blocking and restraint can be used simultaneously for maximum security and dependability.

Transformer Monitoring

Record and accumulate through-fault duty for use in SELOGIC® control equations or manual monitoring. Monitor ambient, load tap changer (LTC) tank and transformer oil temperature with optional 4–20 mA analog inputs or RTD thermal inputs to extend the life of your transformers.

Operator Control

Use the four programmable front-panel pushbuttons, each with two programmable LEDs, for a wide variety of applications, including easy trip-and-close control and status indications for a breaker. Implement local and remote operator control schemes with 32 local and 32 remote control bits.

Metering and Reporting

Analyze Sequential Events Recorder (SER) reports and oscillographic event reports for rapid commissioning, testing, and post-fault diagnostics. Unsolicited SER protocol allows station-wide collection of binary SER messages.

Synchrophasor Data

Apply SEL synchrophasors (IEEE C37.118) to turn state estimation into state measurement and to provide early warning of potential system instability.

Retrofit Replacement Kits and Mounting Accessories

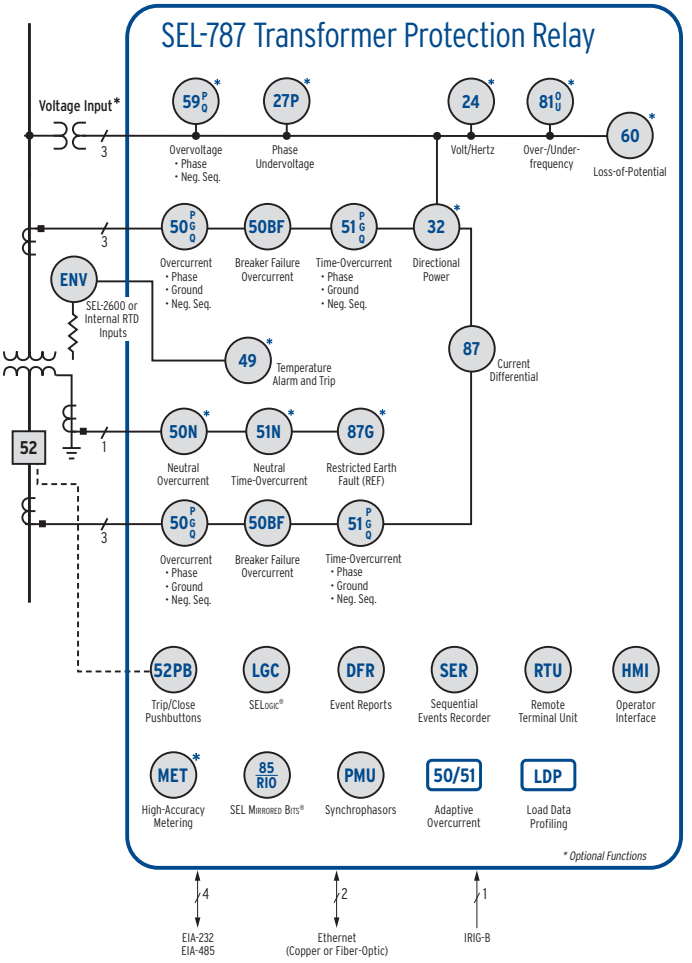
Replace existing transformer protection with SEL-787 direct-replacement kits.

Commissioning Assistant Software

Minimize commissioning time with the first relay software that recommends matrix compensation settings after automatically identifying incorrect field wiring and improper CT configurations.

ACSELERATOR QuickSet® SEL-5030 Software

Develop relay settings offline, program SELOGIC control equations, and analyze post-fault event reports.



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SEL-787 Transformer Protection Relay

Applications

- Provide differential and overcurrent protection for:
  - Power transformers
  - Generator step-up transformers
  - Autotransformers
- Apply the optional single-phase CT channel along with the RTD thermal elements to provide fan bank control and protection.
- Implement additional RTD thermal elements to monitor LTC tank temperatures and SELOGIC programming to indicate temperature differential alarms between transformer and LTC tank temperatures.
- Monitor the number of through faults, accumulated I^2t, and fault duration times to determine the frequency and impact of external faults on the transformer.
- Apply comprehensive reporting to diagnose events, schedule knowledge-based maintenance, detect unfavorable temperature trends, and satisfy information requirements of supervisory systems.
- Select an external SEL-2600 RTD Module to eliminate expensive wire pulls and reduce wiring terminations at the relay while acquiring clean RTD signals and an additional contact input.

Optional Features

- Neutral ac current input (1 ACI) with sensitive restricted earth fault (REF) element.
- Neutral ac current input with three-phase ac voltage inputs (1 ACI/3 AVI), includes volts/hertz protection, over- and underfrequency and over- and undervoltage elements, power, and loss-of-potential.
- Single or dual, copper or fiber Ethernet with DNP3 or IEC 61850.
- Fourth EIA-232 or EIA-485 serial port.
- DeviceNet™ communications.
- I/O expansion card.
  - 4 digital inputs (DI), 4 digital outputs (DO)
  - 4 DI, 4 DO with fast, high-current interrupting capability
  - 4 DI, 3 DO (2 Form C and 1 Form B)
  - 4 DO, 3 DI, 1 analog output (AO)
  - 4 analog inputs (AI), 4 AO
  - 8 DI
  - 3 ac voltage inputs or 5 voltage inputs
  - 10 RTD inputs
- 10 internal RTD inputs (or add 12 external RTD inputs with an SEL-2600 RTD Module).
- 5 A/1 A current transformer (CT) input.
- Conformal coating.

Related Products

SEL Satellite-Synchronized Clocks 308–317
SEL-2600 RTD Module 296
SEL-3378 Synchrophasor Vector Processor 324
SEL-4391 Data Courier® 461

Hardware Specifications

AC Voltage Inputs (3 total)

Rated Operating Voltage	100–250 Vac
Rated Continuous Voltage	300 Vac
10 Second Thermal	600 Vac
Burden	<0.1 VA at 300 Vac

4-wire wye or open-delta voltage connections

AC Current Inputs (7 maximum)

5 A nominal

15 A continuous, 500 A for 1 second

Burden	0.1 VA @ 5 A

1 A nominal

3 A continuous, 100 A for 1 second

Burden	0.01 VA @ 1 A

Power Supply Ratings

24–48 Vdc (19.2–52.8 Vdc)
110–250 Vdc (85–275 Vdc)
110–230 Vac (85–264 Vac)
<40 VA (ac) or 15 W (dc) total burden

Optoisolated Control Input Ranges

24, 48, 110, 125, 220, or 250 Vdc or Vac
Control inputs are externally wetted
2 inputs standard

Contact Outputs

Operating Voltage	240 Vac/250 Vdc
Rated Insulation Voltage	300 Vac/300 Vdc

3 outputs standard

Operating Temperature

–40° to +85°C (–40° to +185°F)

Price

Budgetary Retail, Quantity 1: $2,950

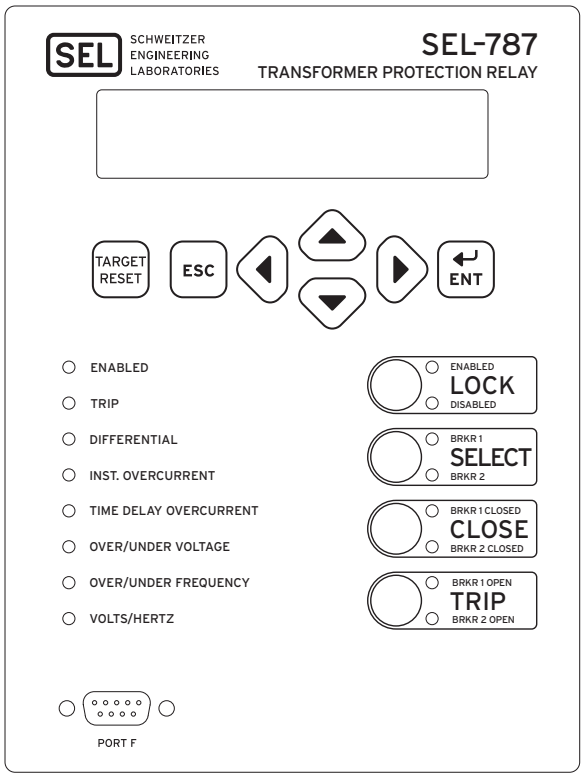
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

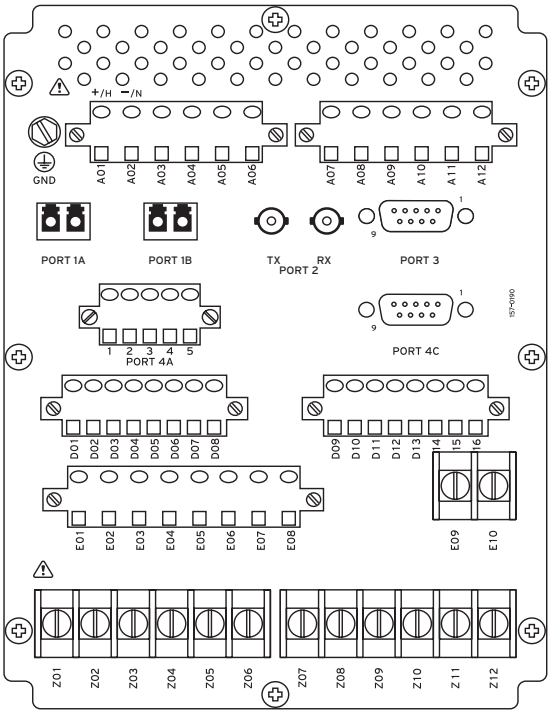
SEL-787 Transformer Protection Relay

Front View



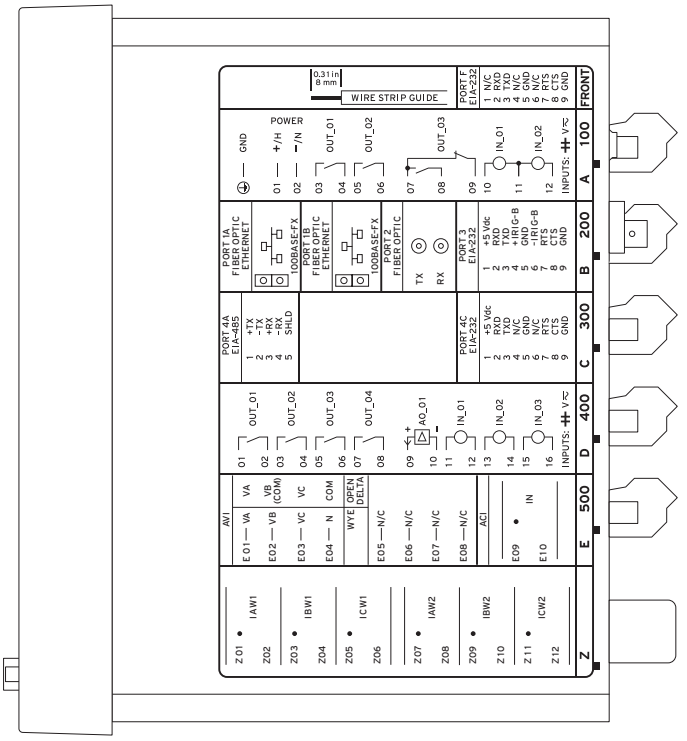
i4212a

Rear View



i4201a

Side View



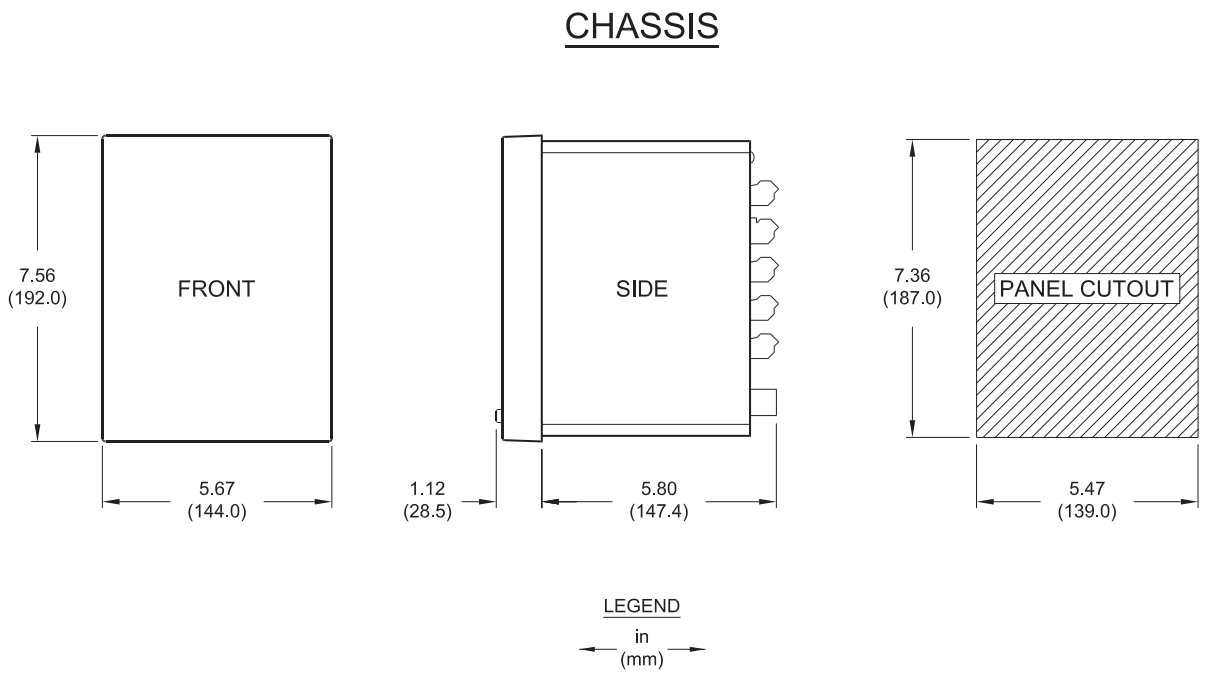
‡ SEE DOCUMENTATION FOR INPUT VOLTAGE RATING

i4202b

Dual fiber-optic Ethernet, EIA-232 communication, 3 DI/4 DO/1 AO, and current/voltage (1 ACI/3 AVI).

SEL-787 Transformer Protection Relay

Dimensions



Visit www.selinc.com for more detailed information and configuration options.

SEL-387 Current Differential and Overcurrent Relay

Apply the SEL-387 Relay for protection, monitoring, and automation of valuable substation assets, such as transformers, generators, and other power apparatus.

Key Features

Two-, Three-, and Four-Winding Current Differential Protection

Sensitive current differential protection with programmable single- or dual-slope percentage restraint, supervised by a choice of second- and fourth-harmonic blocking or restraint elements, plus fifth-harmonic and dc blocking elements, for secure protection of up to four windings. "Around the clock" phase angle compensation settings and automatic tap calculations simplify settings.

Individual Winding Overcurrent Protection

Torque-controllable overcurrent elements provide comprehensive overcurrent protection on each winding input. Combined current feature sums current from two CTs for ring-bus and breaker-and-a-half overcurrent applications.

Protection and Control Logic

SELOGIC® control equations with SELOGIC variables, timers, latch bits, and remote control elements for customizing advanced protection and control schemes. Local programmable control elements and programmable text display points for advanced local operator interface.

Metering and Reporting

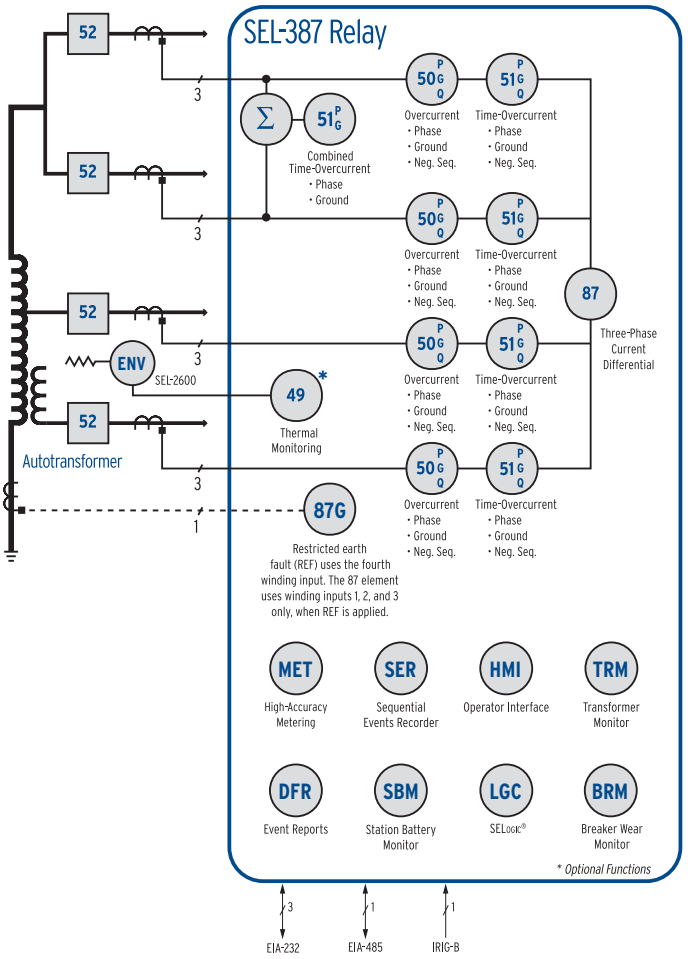
Oscillographic event reports (up to seven 60-cycle reports), Sequential Events Recorder (SER) reporting, and accurate metering eliminate or reduce external recorder and metering requirements. Use through-fault monitor, station battery voltage monitor, and circuit breaker contact wear monitor to provide data for reliability-centered maintenance (RCM) programs. Phase, ground, negative-sequence, differential, and harmonic metering is provided for EMS/SCADA applications.

Asset Optimization

Through-fault monitoring and optional thermal monitoring provide maintenance guidance. Accumulated loss-of-life gives indication of need for inspection or testing.

Settings and Analysis Software

ACSELERATOR QuickSet® SEL-5030 Software simplifies settings and expedites event analysis. Windows®-based menu screens provide error checking and real-time displays to reduce settings and connection errors. Supported protocols include ASCII, binary, and SEL Distributed Port Switch communications.



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SEL-387 Current Differential and Overcurrent Relay

Applications

- Apply one SEL-387 Relay to protect any two-, three-, or four-winding power transformer.
- Protect reactors, generators, large motors, and other multiterminal power apparatus.
- Install with any combination of delta- or wye-connected CT secondary circuits.
- Provide backup protection with built-in winding overcurrent elements.
- Detect ground faults through delta-wye transformer banks, or provide sensitive phase-to-phase protection, independent of load current, with negative-sequence overcurrent element.
- Provide backup distribution bus or feeder protection with low-side overcurrent elements.
- Quickly adapt the relay to different application scenarios with any one of six independent settings groups.
- Activate a warning or alarm with the optional thermal modeling element when the transformer overheats or is in danger of excessive insulation aging or loss-of-life. Capture present, hourly, or daily transformer data with the thermal event report.
- Schedule transformer inspections and maintenance based on cumulative through-fault duty. Set alarm points based on recorded total fault duty.

Optional Features

- Panel-mount or rack-mount hardware package.
- Chassis available for one additional I/O board.
- I/O board with contact-sensing inputs and standard control outputs or high-current interrupting outputs.
- Connectorized® packaging (with provision for additional I/O inputs and output contacts).
- Additional local and remote control switches and binary SER messaging.
- DNP3 Level 2 Outstation communications protocol.
- Thermal modeling element.
- Conformal coating.

Related Products

Price

Budgetary Retail, Quantity 1: $5,250

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Hardware Specifications

AC Current Inputs

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical, 1250 A for 1 cycle

Burden 0.27 VA @ 5 A; 2.51 VA @ 15 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical, 250 A for 1 cycle

Burden 0.13 VA @ 1 A; 1.31 VA @ 3 A

Power Supply Ratings

24/48 Vdc 18–60 Vdc

48/125 V 38–200 Vdc or 85–140 Vac

125/250 V 85–350 Vdc or 85–264 Vac

<25 W maximum for all supplies

Standard Control Input and Output Ranges

24, 48, 110, 125, 220, or 250 Vdc

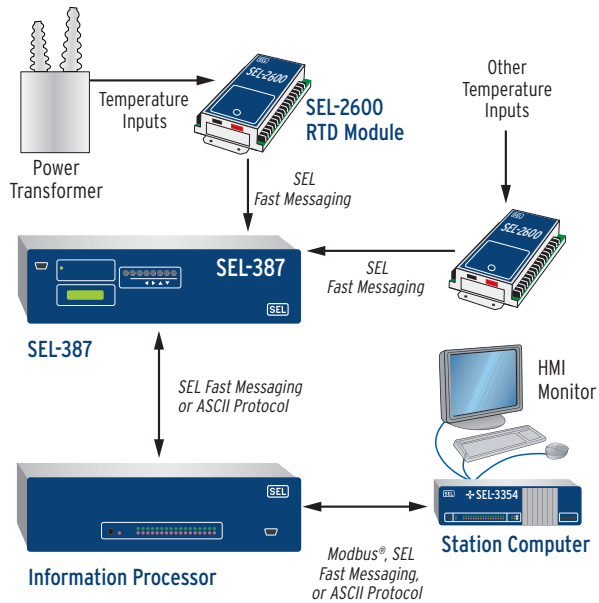
Standard configuration provides 6 inputs and 8 outputs, <5 ms pickup/dropout times with 30 A make, 6 A continuous duty. Additional I/O board may be selected with standard inputs and outputs, or with a combination of standard inputs and high-current interrupting outputs.

Operating Temperature

–40° to +85°C (–40° to +185°F)

(Note: LCD contrast impaired for temperatures below –20°C)

Transformer Thermal Monitoring

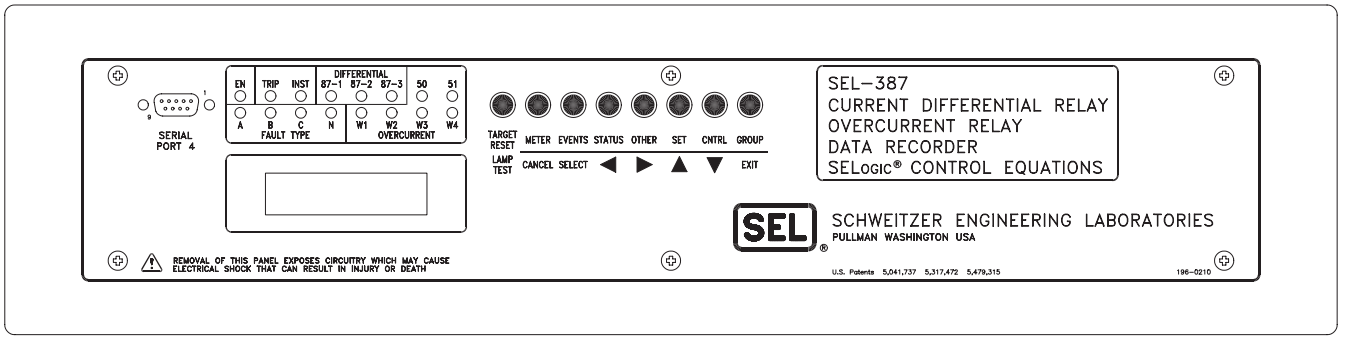


Typical functional diagram for collecting temperature data.

Specify the SEL-387-6 Relay to provide thermal modeling for monitoring and protection of a single three-phase transformer or three independent single-phase transformers.

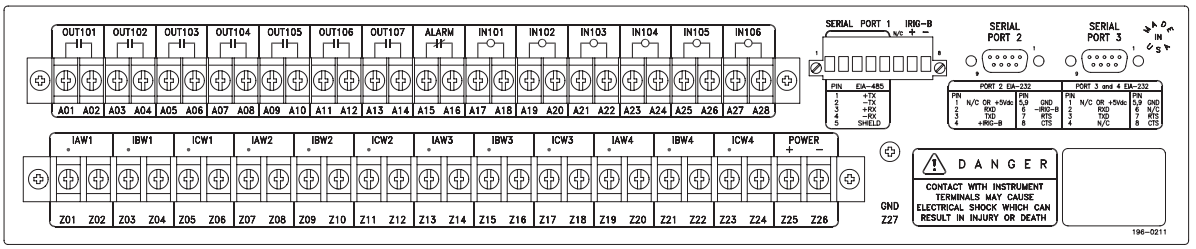
SEL-387 Current Differential and Overcurrent Relay

Front View – Panel-Mount (2U)



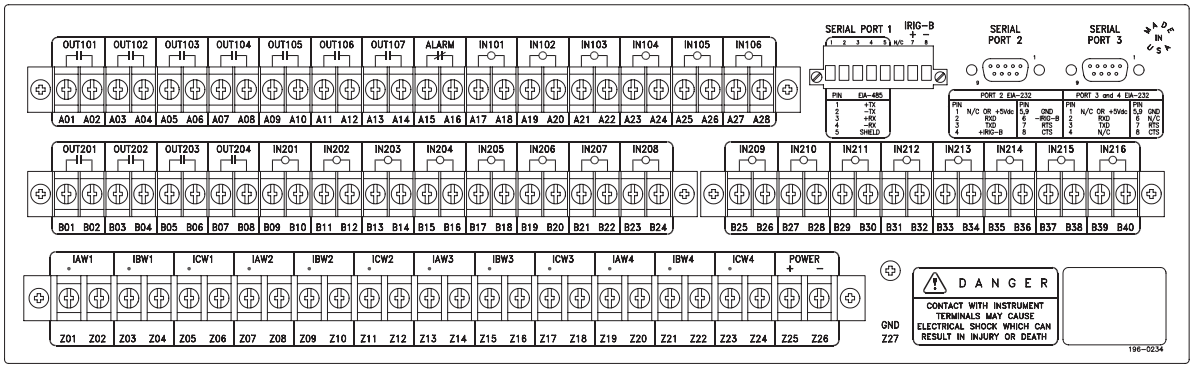
I3011a

Rear View – Conventional Terminal Blocks (2U)



I3009c

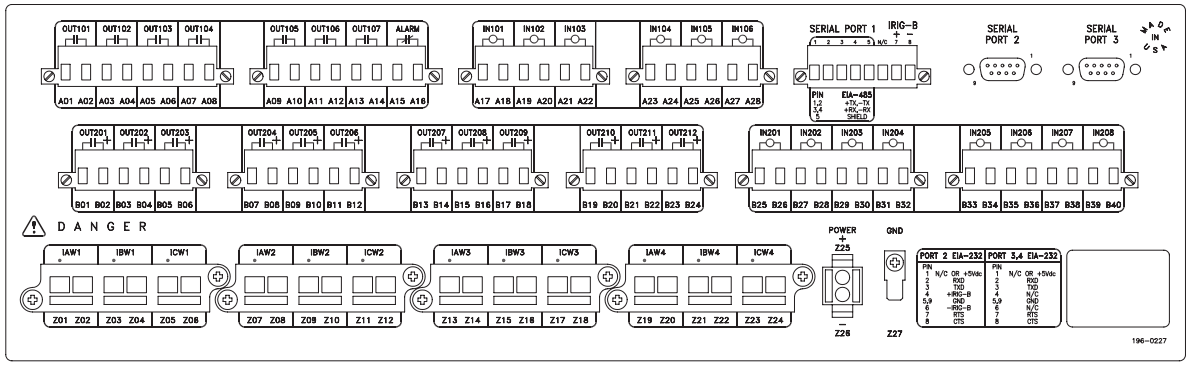
Rear View – Conventional Terminal Blocks – Additional I/O (3U)



I3151b

SEL-387 Current Differential and Overcurrent Relay

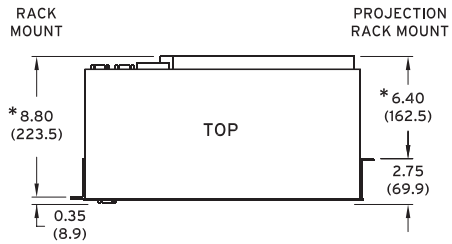
Rear View – Connectorized® – Additional I/O (3U)

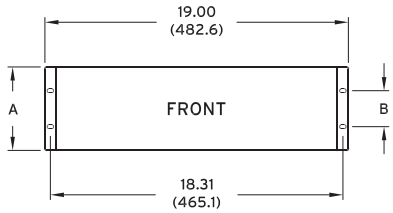


I3015b

Dimensions

RACK-MOUNT CHASSIS

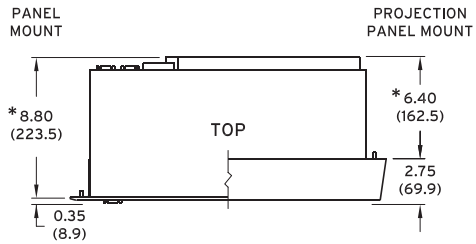


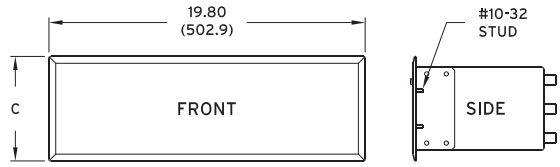


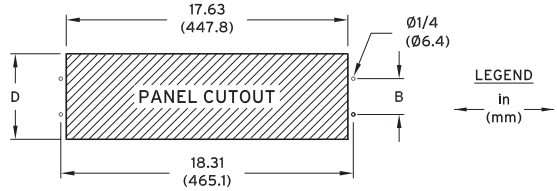
DIMENSION	MAIN BOARD ONLY (2U)	ONE I/O BOARD (3U)
A	3.47 (88.1)	5.22 (132.6)
B	3.00 (76.2)	2.25 (57.2)
C	4.90 (124.5)	6.65 (168.9)
D	3.60 (91.4)	5.35 (135.9)

*ADD 0.65 (16.5) FOR CONNECTORIZED RELAYS

PANEL-MOUNT CHASSIS







i9009b

Visit www.selinc.com for more detailed information and configuration options.

SEL-387A Current Differential and Overcurrent Relay

Apply the SEL-387A Relay for protection, monitoring, and automation of two-winding transformers and other power apparatus.

Key Features

Two-Winding Current Differential Protection

Sensitive current differential protection with programmable single- or dual-slope percentage restraint, supervised by a choice of second- and fourth-harmonic blocking elements, plus fifth-harmonic and dc blocking elements, for secure protection of two transformer windings. Choose common or independent phase current harmonic blocking. Unrestrained high-set differential elements provide fast operation for high-magnitude internal faults. "Around the clock" phase angle compensation settings and automatic tap calculations simplify settings.

Individual Winding Overcurrent Protection

Torque-controllable overcurrent elements, including one instantaneous, one definite-time, and one inverse-time element each for phase, negative-sequence, and residual ground currents, provide comprehensive overcurrent protection on each winding input.

Protection and Control Logic

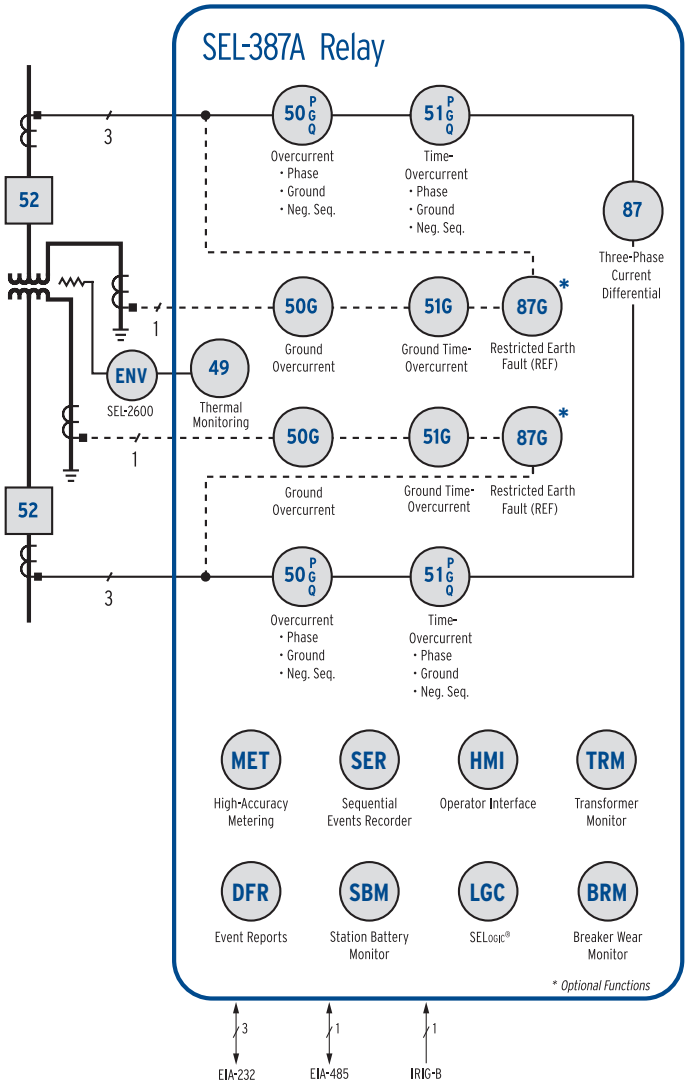
Two optional restricted earth fault (REF) elements provide sensitive grounded-wye winding ground fault protection. SELOGIC® control equations with SELOGIC variables, timers, latch bits, and remote control elements for customizing advanced protection and control schemes. Local programmable control elements and programmable text display points for advanced local operator interface.

Metering and Reporting

Oscillographic event reports (up to seven 60-cycle reports), Sequential Events Recorder (SER) reporting, and accurate metering eliminate or reduce external recorder and metering requirements. Station battery voltage monitor, through-fault monitor, and circuit breaker contact wear monitor provide important data for reliability-centered maintenance (RCM) programs. Phase, ground, negative-sequence, differential, and harmonic metering is provided for EMS/SCADA applications.

Settings and Analysis Software

ACSELERATOR QuickSet® SEL-5030 Software simplifies settings and expedites event analysis. Windows®-based menu screens provide error checking and real-time displays to reduce settings and connection errors. Supported protocols include ASCII, binary, and SEL Distributed Port Switch communications.



SEL-387A Current Differential and Overcurrent Relay

Applications

- Apply one SEL-387A to protect any two-winding power transformer.
- Protect reactors, generators, large motors, and other multiterminal power apparatus.
- Install with any combination of delta- or wye-connected CT secondary circuits.
- Provide backup protection with built-in winding overcurrent elements.
- Create breaker failure logic with SELOGIC control equations.
- Detect ground faults through delta-wye transformer banks, or provide sensitive phase-to-phase protection, independent of load current, with negative-sequence overcurrent element.
- Provide backup distribution bus or feeder protection with low-side overcurrent elements.
- Quickly adapt the relay to different application scenarios with any one of six independent settings groups.
- Schedule transformer inspections and maintenance based on cumulative through-fault duty. Set alarm points based on recorded total fault duty.

Optional Features

- Panel-mount, projection panel-mount, or rack-mount hardware package.
- Chassis available for one additional I/O board.
- I/O board with contact-sensing inputs and standard control outputs or high-current interrupting outputs.
- DNP3 Level 2 Outstation communications protocol.
- Two REF elements.
- Conformal coating.

Related Products

SEL Satellite-Synchronized Clocks 308–317
SEL-2600 RTD Module 296
SEL-9220 Fiber-Optic Adapter for SEL-300 Series Relays 440

Price

Budgetary Retail, Quantity 1: $3,680

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Hardware Specifications

AC Current Inputs

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical, 1250 A for 1 cycle

Burden 0.27 VA @ 5 A; 2.51 VA @ 15 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical, 250 A for 1 cycle

Burden 0.13 VA @ 1 A; 1.31 VA @ 3 A

Power Supply Ratings

24/48 Vdc 18–60 Vdc

48/125 V 38–200 Vdc or 85–140 Vac

125/250 V 85–350 Vdc or 85–264 Vac

<25 W maximum for all supplies

Standard Control Input and Output Ranges

24, 48, 110, 125, 220, or 250 Vdc

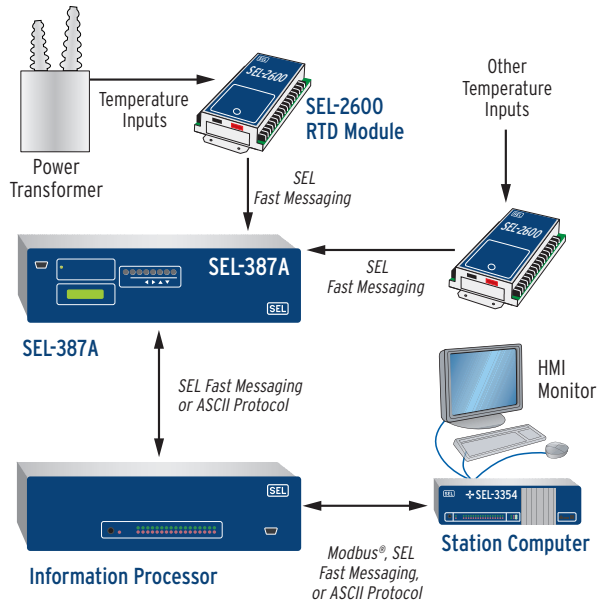
Standard configuration provides 6 inputs and 8 outputs, <5 ms pickup/dropout times with 30 A make, 6 A continuous duty. Additional I/O board may be selected with standard inputs and outputs, or with a combination of standard inputs and high-current interrupting outputs.

Operating Temperature

–40° to +85°C (–40° to +185°F)

(Note: LCD contrast impaired for temperatures below –20°C)

Transformer Temperature Metering

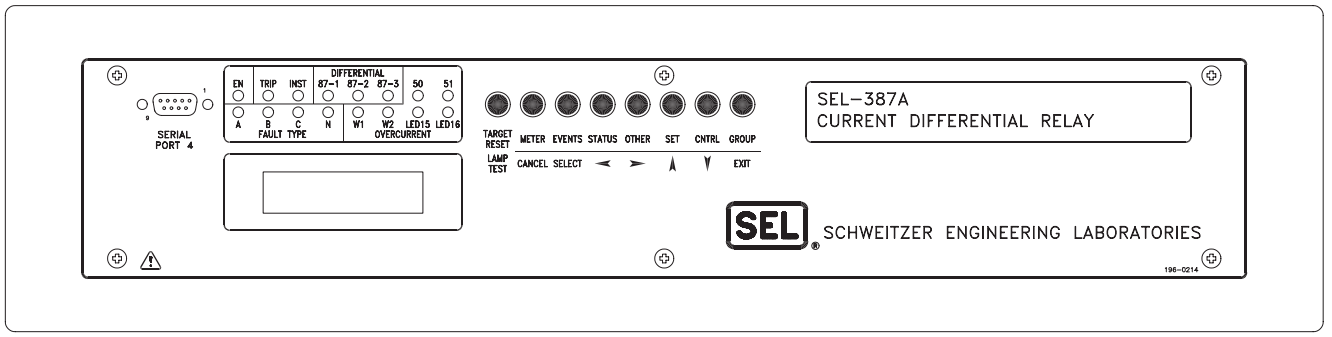


Typical functional diagram for collecting temperature data.

Specify the SEL-387A to provide thermal monitoring of a single three-phase transformer or three independent single-phase transformers using one or two SEL-2600 RTD Modules.

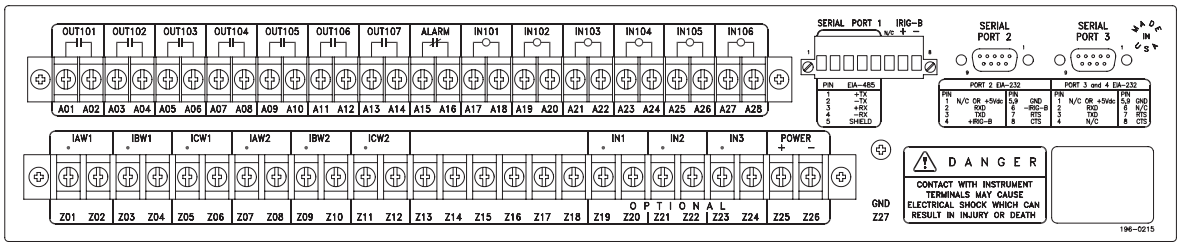
SEL-387A Current Differential and Overcurrent Relay

Front View – Panel-Mount (2U)



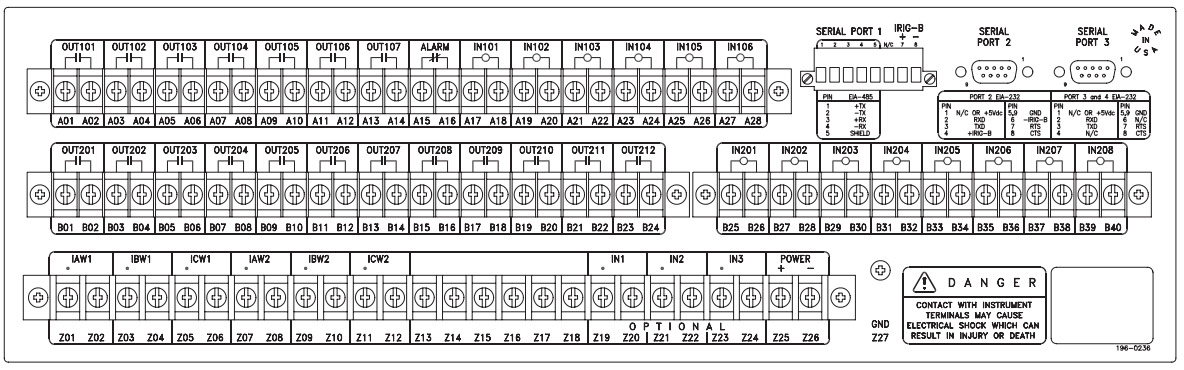
I3504a

Rear View – Conventional Terminal Blocks (2U)



I3507a

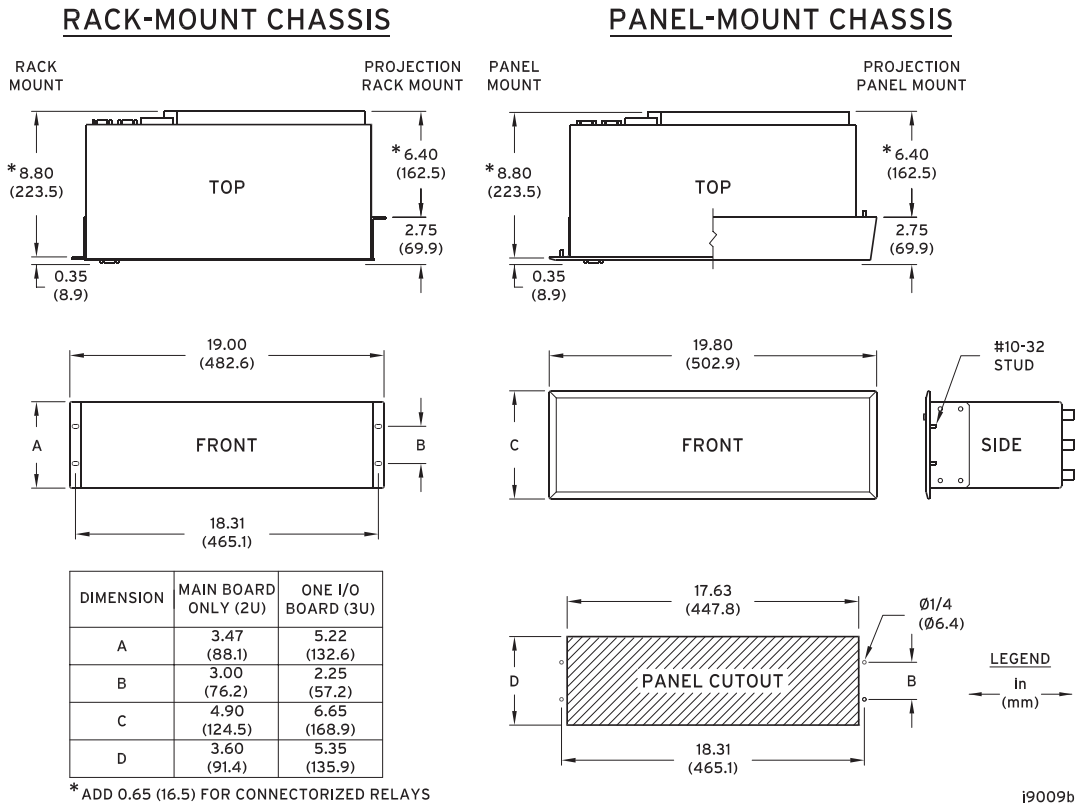
Rear View – Conventional Terminal Blocks – Additional I/O (3U)



I3508a

SEL-387A Current Differential and Overcurrent Relay

Dimensions



DIMENSION	MAIN BOARD ONLY (2U)	ONE I/O BOARD (3U)
A	3.47 (88.1)	5.22 (132.6)
B	3.00 (76.2)	2.25 (57.2)
C	4.90 (124.5)	6.65 (168.9)
D	3.60 (91.4)	5.35 (135.9)

*ADD 0.65 (16.5) FOR CONNECTORIZED RELAYS

Visit www.selinc.com for more detailed information and configuration options.

SEL-387E Current Differential and Voltage Relay

Apply the SEL-387E Relay to provide comprehensive protection, metering, monitoring, and automation of transformers, reactors, and other power apparatus.

SEL IEC 61850

Key Features

Two- and Three-Winding Current Differential Protection

Sensitive current differential protection with programmable single- or dual-slope percentage restraint, supervised by a choice of second- and fourth-harmonic blocking or restraint elements, plus fifth-harmonic and dc blocking elements, for secure protection of up to three windings. Unrestrained high-set differential elements provide fast operation for high-magnitude internal faults. "Around the clock" phase angle compensation settings and automatic tap calculations simplify settings.

Individual Winding Overcurrent Protection

Torque-controllable overcurrent elements for phase, negative-sequence, and residual ground currents provide comprehensive overcurrent protection on each winding input.

Under- and Overfrequency Protection

Six available frequency elements and associated timers for load-shedding and load-restoration schemes.

Protection and Control Logic

A restricted earth fault (REF) element provides sensitive grounded-wye winding ground fault protection. SELOGIC® control equations with SELOGIC variables, timers, latch bits, and remote control elements for customizing advanced protection and control schemes. Local control elements and programmable text display for advanced operator interface.

Metering and Reporting

Oscillographic event reports, Sequential Events Recorder (SER) reporting, and accurate three-phase power metering eliminate or reduce external recorder and metering requirements. Station battery voltage monitor, through-fault monitor, and circuit breaker contact wear monitor assist maintenance programs. Phase, ground, negative-sequence, differential, and harmonic metering is provided for EMS/SCADA applications.

Flexible Communications

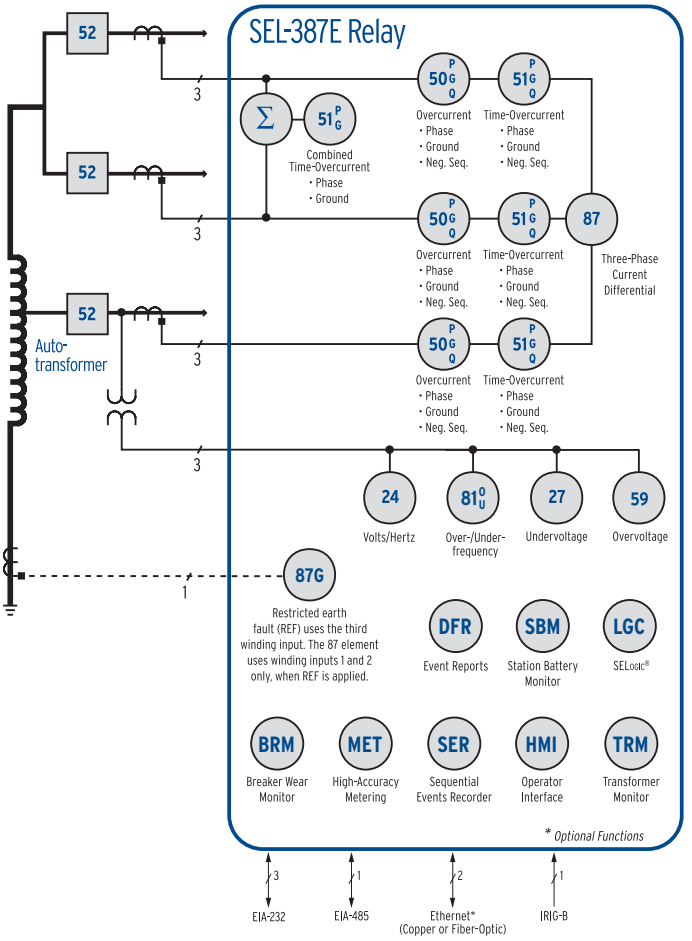
Serial and optional Ethernet communications provide complete integration. IEC 61850 communications, with a select-before-operate function for added operational security, give high-speed, relay-to-relay information exchange. Supported protocols include ASCII, binary, and SEL Distributed Port Switch communications.

Overexcitation (Volts-Per-Hertz) Protection

Volts-per-hertz elements detect overexcitation conditions in the protected apparatus. Choose definite-time elements, multiple curves, and custom programmable curves for alarm and tripping applications.

Settings and Analysis Software

ACSELERATOR QuickSet® SEL-5030 Software simplifies settings and expedites event analysis. Windows®-based menu screens provide error checking and real-time displays to reduce settings and connection errors.



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SEL-387E Current Differential and Voltage Relay

Applications

- Protect reactors, generators, large motors, and other multiterminal power apparatus.
- Install with any combination of delta- or wye-connected CT secondary circuits.
- Provide backup protection with built-in winding overcurrent elements.
- Apply load-shedding and/or load-restoration schemes with one or more of the six available frequency elements.
- Reduce or eliminate the need for panel-mounted metering devices with the accurate three-phase power metering capabilities of the relay.
- Create breaker failure logic with SELOGIC control equations.
- Detect ground faults through delta-wye transformer banks, or provide sensitive phase-to-phase protection, independent of load current, with negative-sequence overcurrent element.
- Provide backup distribution bus or feeder protection with low-side overcurrent elements.
- Apply the overexcitation elements for alarm and/or tripping functions.
- Schedule transformer inspections and maintenance based on cumulative through-fault duty. Set alarm points based on recorded total fault duty.

Optional Features

- Panel-mount, projection panel-mount, or rack-mount hardware package.
- Chassis available for one additional I/O board.
- I/O board with contact-sensing inputs and standard control outputs or high-current interrupting outputs.
- Connectorized® packaging (with provision for additional I/O inputs and output contacts).
- Ethernet with FTP/Telnet and webserver functionality.
- DNP3 Level 2 Outstation communications protocol.
- 10BASE-T or 100BASE-FX* Ethernet port with failover.
- IEC 61850 communications with a select-before-operate function.
- Conformal coating.

* Eye-safe, Class 1 LED product per EN 60825-1

Related Products

Hardware Specifications

AC Voltage Inputs

300 V_{L-N} three-phase, four-wire connection

300 V_{L-N} continuous (connect any voltage from 0 to 300 Vac)

600 Vac for 10 seconds

Burden 0.03 VA @ 67 V; 0.06 VA @ 120 V; 0.8 VA @ 300 V

AC Current Inputs

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical, 1250 A for 1 cycle

Burden 0.27 VA @ 5 A; 2.51 VA @ 15 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical, 250 A for 1 cycle

Burden 0.13 VA @ 1 A; 1.31 VA @ 3 A

Power Supply Ratings

24/48 Vdc 18–60 Vdc

48/125 V 38–200 Vdc or 85–140 Vac

125/250 V 85–350 Vdc or 85–264 Vac

<25 W maximum for all supplies

Standard Control Input and Output Ranges

24, 48, 110, 125, or 250 Vdc

Standard configuration provides 6 inputs and 8 outputs, <5 ms pickup/dropout times with 30 A make, 6 A continuous duty. Additional I/O board may be selected with standard inputs and outputs, or with a combination of standard inputs and high-current interrupting outputs.

Operating Temperature

–40° to +85°C (–40° to +185°F)

(Note: LCD contrast impaired for temperatures below –20°C)

Price

Budgetary Retail, Quantity 1: $5,780

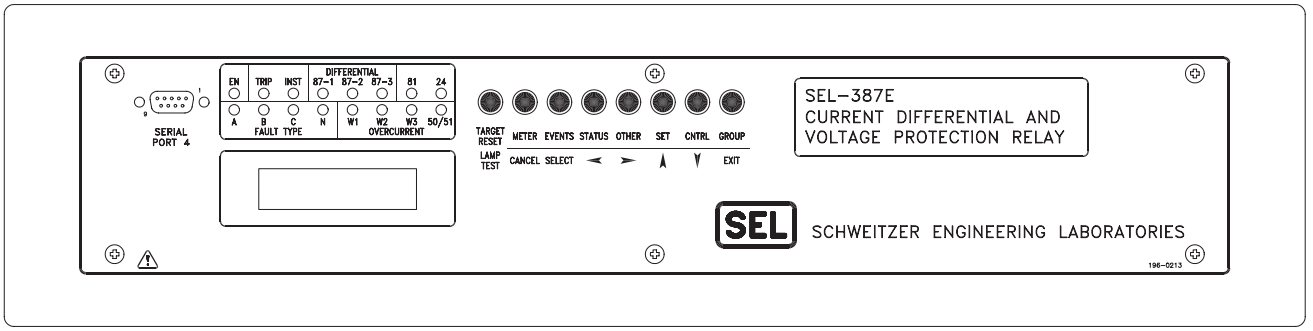
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

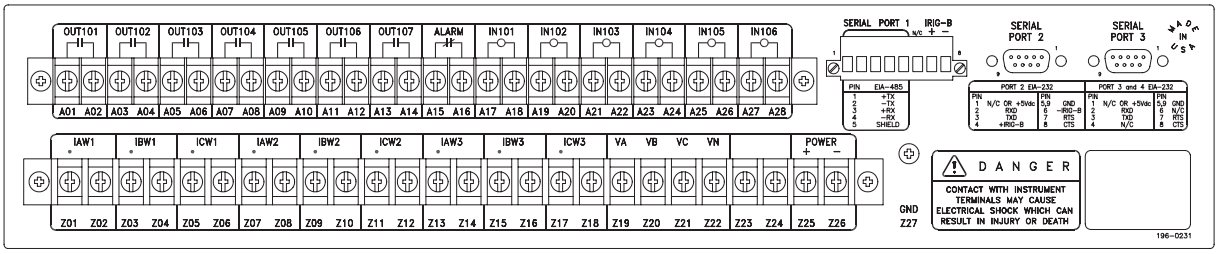
SEL-387E Current Differential and Voltage Relay

Front View – Panel-Mount (2U)



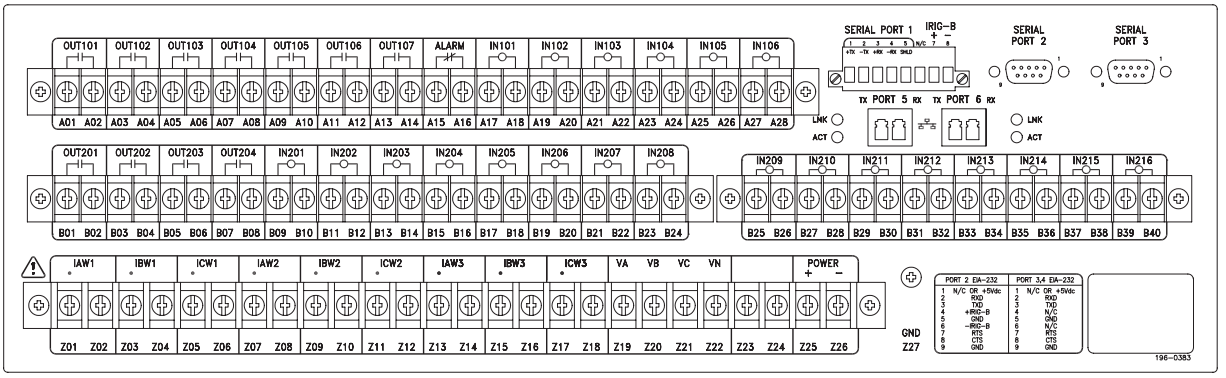
I3019b

Rear View – Conventional Terminal Blocks (2U)



I3018c

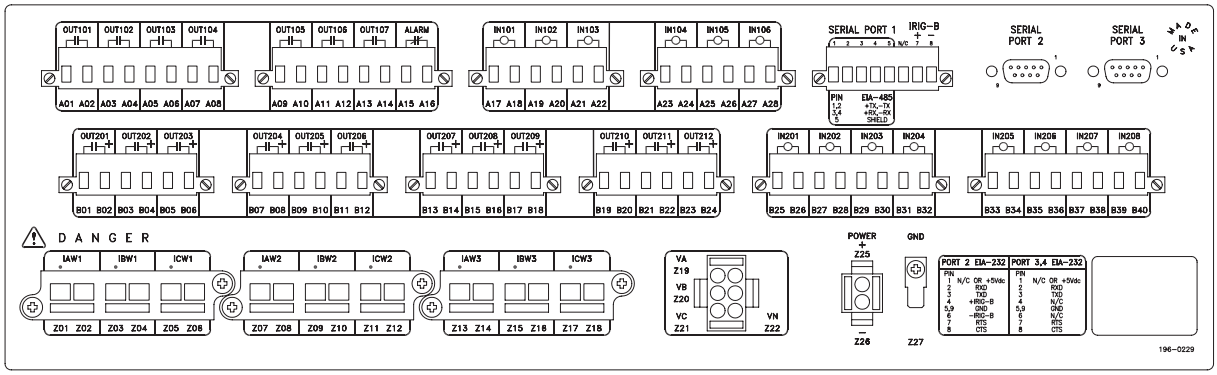
Rear View – Conventional Terminal Blocks – Additional I/O (3U) and Ethernet



I4035a

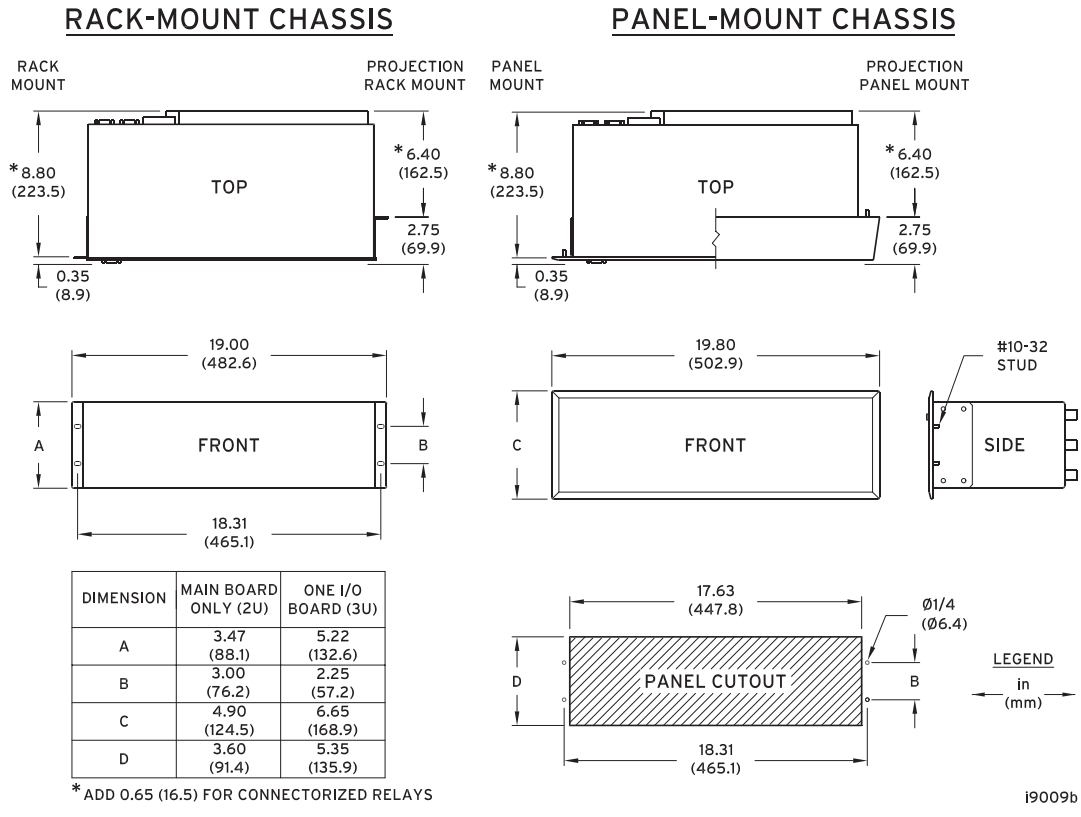
SEL-387E Current Differential and Voltage Relay

Rear View – Connectorized® – Additional I/O (3U)



i3027b

Dimensions



DIMENSION	MAIN BOARD ONLY (2U)	ONE I/O BOARD (3U)
A	3.47 (88.1)	5.22 (132.6)
B	3.00 (76.2)	2.25 (57.2)
C	4.90 (124.5)	6.65 (168.9)
D	3.60 (91.4)	5.35 (135.9)

*ADD 0.65 (16.5) FOR CONNECTORIZED RELAYS

i9009b

Visit www.selinc.com for more detailed information and configuration options.

SEL-587 Current Differential Relay

Provide economical differential protection for two-winding transformers or other two-terminal apparatus.

Key Features

Two-Winding Current Differential Protection

Sensitive current differential protection with programmable single- or dual-slope percentage restraint, supervised by a choice of second- and fourth-harmonic blocking or restraint elements, plus fifth-harmonic and dc blocking elements, for secure differential protection on two-winding apparatus. Choose common or independent harmonic blocking. Unrestrained differential elements provide fast operation for high-magnitude internal faults. Automatic tap calculations simplify settings.

Individual Winding Overcurrent Protection

Individual winding phase, residual, and negative-sequence overcurrent elements, including instantaneous, definite-time, and inverse time-overcurrent elements for comprehensive overcurrent protection.

Adaptive Overcurrent Element

High-speed operation for severe faults, even with CT saturation.

Protection and Control Logic

SELOGIC® control equations with SELOGIC variables and timers facilitate traditional or advanced protection schemes.

Metering and Reporting

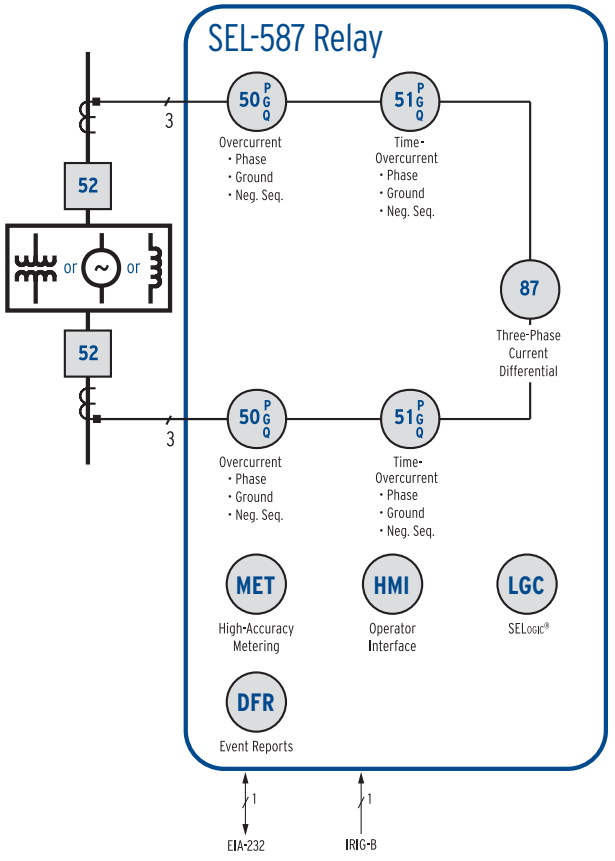
Oscillographic event reports (up to ten 15-cycle reports) and metering functions eliminate or reduce external recorder and metering requirements. Phase, ground, negative-sequence, differential, and harmonic metering is provided for EMS/SCADA applications.

Settings and Analysis Software

ACSELERATOR QuickSet® SEL-5030 Software simplifies settings and expedites event analysis. Windows®-based menu screens provide error checking and real-time displays to reduce settings and connection errors.

Flexible Communications

Supported protocols include ASCII, binary, Modbus® RTU, and SEL Distributed Port Switch communications.



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SEL-587 Current Differential Relay

Applications

- Protect any two-winding power transformer.
- Protect reactors, generators, large motors, and other two-terminal power apparatus.
- Install with any combination of delta- or wye-connected CT secondary circuits.
- Provide backup protection with built-in winding overcurrent elements.
- Detect ground faults through delta-wye transformer banks, or provide sensitive phase-to-phase protection, independent of load current, with negative-sequence overcurrent element.
- Provide backup distribution bus or feeder protection with low-side overcurrent elements.

Optional Features

- Panel-mount, projection panel-mount, or single and dual rack-mount hardware package.
- Connectorized® packaging includes high-current interrupting output contacts and level-sensitive, optoisolated inputs.
- Modbus RTU protocol.
- EIA-232 or EIA-485 serial communications—either port includes a demodulated IRIG-B time-code input.
- Bracket with mounting hole for FT-1 switch (switch not included) to mount one SEL-500 series relay in a 19-inch rack.
- Conformal coating.

Related Products

SEL Satellite-Synchronized Clocks 308–317

"We have applied SEL-587 transformer differential relays for over five years on our clients' systems. We are especially impressed with the relay's ability to confirm proper wiring and settings after it has been commissioned and load is initially placed on it. In many cases, the SEL-587 Relay, through its easy-to-use front-panel display, was able to demonstrate that a wiring error had occurred, which could then be fixed easily, instead of showing up later as misoperation.

"The relay displays metered quantities on the front-panel LCD screen, comprising phase current magnitude and phase angle, operate current, and restraint current. By making a few simple checks (which don't require sophisticated test equipment), it can easily be confirmed that the wiring is correct.

"We are very pleased with the SEL-587, and we specify it whenever the project calls for a transformer differential relay."

Blair A. Metsger, PE
DGR Engineers, Rock Rapids, IA

Hardware Specifications

AC Current Inputs

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical, 625 A for 1 cycle (sinusoidal waveform)

Burden 0.16 VA @ 5 A; 1.15 VA @ 15 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical, 250 A for 1 cycle (sinusoidal waveform)

Burden 0.06 VA @ 1 A; 0.18 VA @ 3 A

60/50 Hz system frequency and ABC/ACB phase rotation are user settable

Power Supply Ratings

24 V (polarity sensitive)	16–36 Vdc
48/125 V	36–200 Vdc or 85–140 Vac
125/250 V	85–350 Vdc or 85–264 Vac

5.5 W maximum

Standard Control Input and Output Ranges

24, 48, 125, or 250 Vdc

Configuration provides two inputs and four outputs (plus alarm). Connectorized hardware package provides access to high-current interrupting output contacts and level-sensitive inputs.

Operating Temperature

–40° to +85°C (–40° to +185°F)

(Note: LCD contrast impaired for temperatures below –20°C)

Price

Budgetary Retail, Quantity 1: $2,080

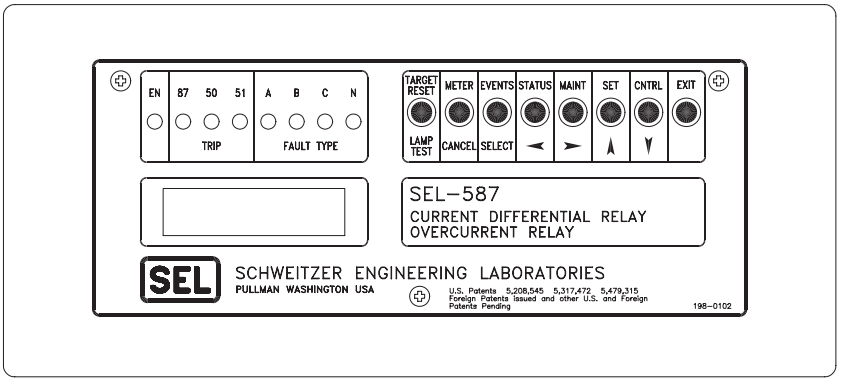
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

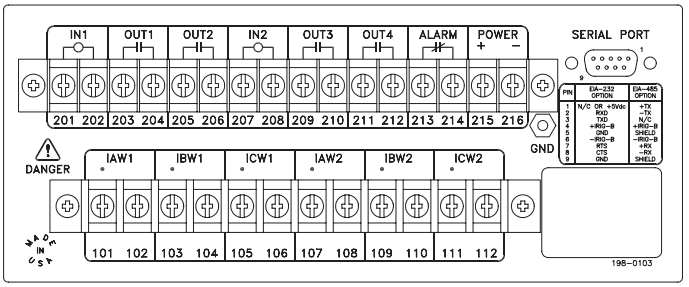
SEL-587 Current Differential Relay

Front View – Panel-Mount



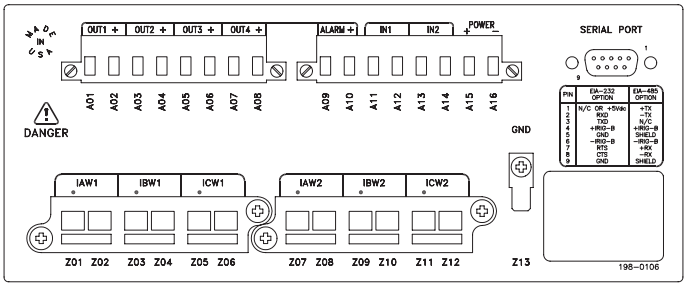
I3046a

Rear View – Conventional Terminal Blocks



I3043a

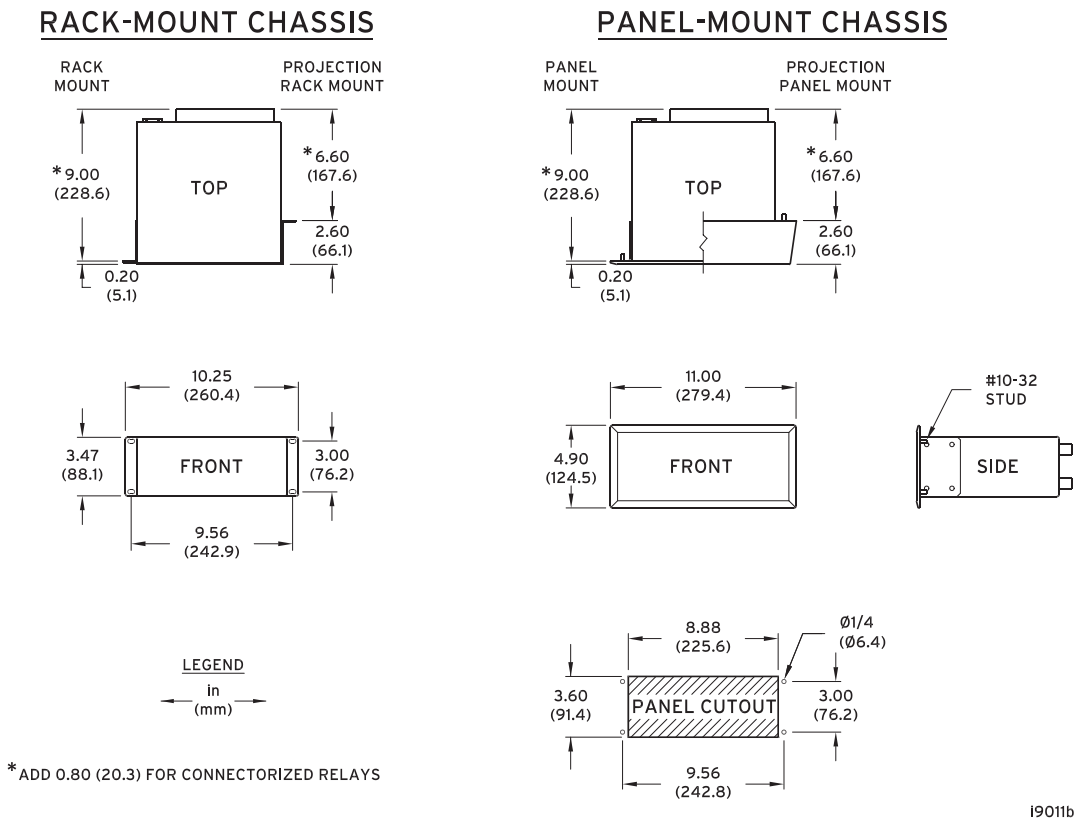
Rear View – Connectorized®



I3047a

SEL-587 Current Differential Relay

Dimensions



Visit www.selinc.com for more detailed information and configuration options.

SEL-487B Bus Differential and Breaker Failure Relay

Apply the SEL-487B for busbar and breaker failure protection, automation, and control in applications with up to six terminals per relay.

SEL IEC 61850

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Key Features

Busbar Differential Protection Operates in Less Than One Cycle

Sensitive and secure current differential protection provides fast detection of bus faults and security for external faults with heavy CT saturation to increase stability margins and reduce equipment damage.

Flexible, Dynamic Zone Configuration

The SEL-487B dynamically assigns the input currents to correct differential elements without the need for auxiliary relays. SELOGIC® control equations and patented zone selection logic will correctly assign the currents to the differential elements, even for complex bus arrangements. The dynamic differential protection zones simplify system wiring and switching logic.

Independent Check Zone

Independent check-zone element eliminates unintentional relay operations due to failed or misaligned disconnect auxiliary contacts and provides redundant verification of in-zone faults.

Advanced Open CT Detection

Patent-pending open CT detection logic assures current differential bus zones will not misoperate due to open or short CT terminals, improving the security of the current differential element.

Breaker Failure Detection for Each Terminal Integrates Bus and Breaker Failure Protection

Internal and external breaker failure detection is included in the SEL-487B. The integration of breaker failure detection reduces system components and wiring, improving the security and reliability of the protection system.

Metering, Monitoring, and Control

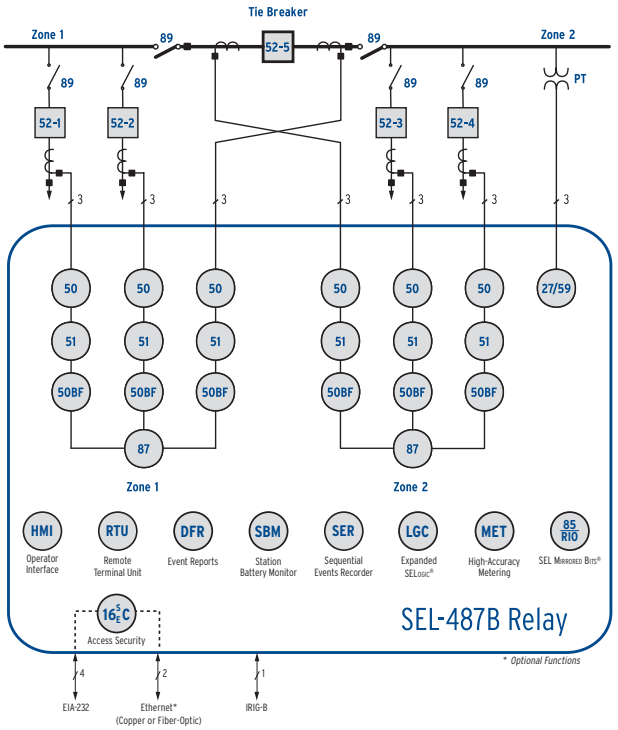
The SEL-487B meters and monitors the status of all breakers, disconnects, and ac signal inputs. It provides differential current, phase current, and voltage metering, and performs disconnect travel monitoring as well as disconnect status monitoring. Alias assignment of the SELOGIC variables allows custom display screen configuration for pertinent, easy-to-read information.

Sequential Events Recorder (SER) and Oscillographic Event Reporting

SER provides up to 250 monitoring points and 1,000 events. Oscillographic and event reporting stores up to 480 cycles (8 seconds), in either 15-, 30-, 60-, or 120-cycle event reports, at 24 samples per cycle in nonvolatile memory.

Graphical Logic Editor (GLE)

Simplify the SEL-487B configuration process with the GLE in ACSELERATOR QuickSet Designer® SEL-5031 Software. The GLE lets you design your SELOGIC® control equations graphically, so your settings files can be documented for easier validation and commissioning. Convert existing control equations to easy-to-read diagrams, and save with QuickSet settings.



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SEL-487B Bus Differential and Breaker Failure Relay

Applications

- Provide differential metering and protection on a per-phase basis.
- Apply one to three SEL-487B Relays for main bus differential protection in a wide variety of applications.
  - Single relay application for three-phase differential protection with up to 2 zones and 6 three-phase terminals.
  - Dual relay application with two phases (AØ, BØ) in one relay, the third phase (CØ) in the second relay. This application provides differential protection for up to 3 zones and 9 three-phase terminals.
  - Three relay application, where each relay provides single-phase differential protection with up to 6 zones and 18 three-phase terminals.
- Use the flexibility and scalability of the SEL-487B to protect a wide variety of bus configurations, including:
  - Single bus, multifeeder
  - Double bus sections with tie breaker
  - Two busbar, breaker-and-a-half configurations
  - Double busbar and transfer busbar
  - HV and LV busbar feeders
  - Check zone as trip criterion; configure any zone as an overall check zone

Optional Features

- Chassis supports multiple expansion I/O boards (4 max). Fully equipped option (1 main, 4 I/O boards)* includes:
  - 74 common inputs
  - 29 independent inputs
  - Up to 24 high-speed, high-current interrupting outputs
  - Up to 40 standard outputs
- Panel-mount or rack-mount chassis.
- 9 rack-unit version supports up to 4 expansion I/O boards; 7 rack-unit version supports up to 2 expansion I/O boards.
- Ethernet communications.**
- DNP3 Level 2 Outstation communications protocol.
- IEC 61850 communications.
- Conformal coating.
- Enhanced front-panel human-machine interface (HMI) provides 24 target LEDs and 12 operator pushbuttons.

* Standard main board: 7 inputs, 8 outputs
Optional I/O board: 2 groups of 9 common inputs, 6 independent inputs, 8 outputs
** Eye-safe, Class 1 LED product per EN 60825-1

Related Products

SEL Satellite-Synchronized Clocks 308–317
SEL-2815 Fiber-Optic Transceivers 436
SEL-4391 Data Courier® 461

Price

Budgetary Retail, Quantity 1: $6,830

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

Hardware Specifications

AC Voltage Inputs

For phase, negative-, and zero-sequence elements

300 V_{L-N} continuous (connect any voltage up to 300 Vac)
600 Vac for 10 seconds

Burden 0.03 VA @ 67 V; 0.06 VA @ 120 V; 0.8 VA @ 300 V

AC Current Inputs (secondary circuits)

10:1 CT mismatch

5 A nominal

15 A continuous, linear to 100 A symmetrical, 500 A for 1 second, 1250 A for 1 cycle

Burden 0.27 VA @ 5 A; 2.51 VA @ 15 A

1 A nominal

3 A continuous, linear to 20 A symmetrical, 100 A for 1 second, 250 A for 1 cycle

Burden 0.13 VA @ 1 A; 1.31 VA @ 3 A

Power Supply Ratings

125/250 Vdc or 120/240 Vac
Range 85–300 Vdc <35 W or 85–264 Vac (30–120 Hz)
Burden <120 VA

48/125 Vdc or 120 Vac
Range 38–140 Vdc <35 W or 85–140 Vac (30–120 Hz)
Burden <120 VA

24/48 Vdc
Range 18–60 Vdc
Burden <35 W

Standard Control Outputs

Main Board	5 Form A and 3 Form C
Interface Boards	2 standard Form A, 6 high-speed, high-current interrupting

High-Speed, High-Current Interrupting Outputs

Make	30 A
Carry	6 A continuous carry at 70°C 4 A continuous carry at 85°C
1 s Rating	50 A
MOV Protection (max voltage)	250 Vac, 330 Vdc
Pickup Time	10 µs, resistive load
Dropout Time	8 µs, resistive load
Update Rate	1/12 cycle

Break Capacity (10,000 operations)

48 V	10.0 A	L/R = 40 ms
125 V	10.0 A	L/R = 40 ms
250 V	10.0 A	L/R = 20 ms

Operating Temperature

–40° to +85°C (–40° to +185°F)

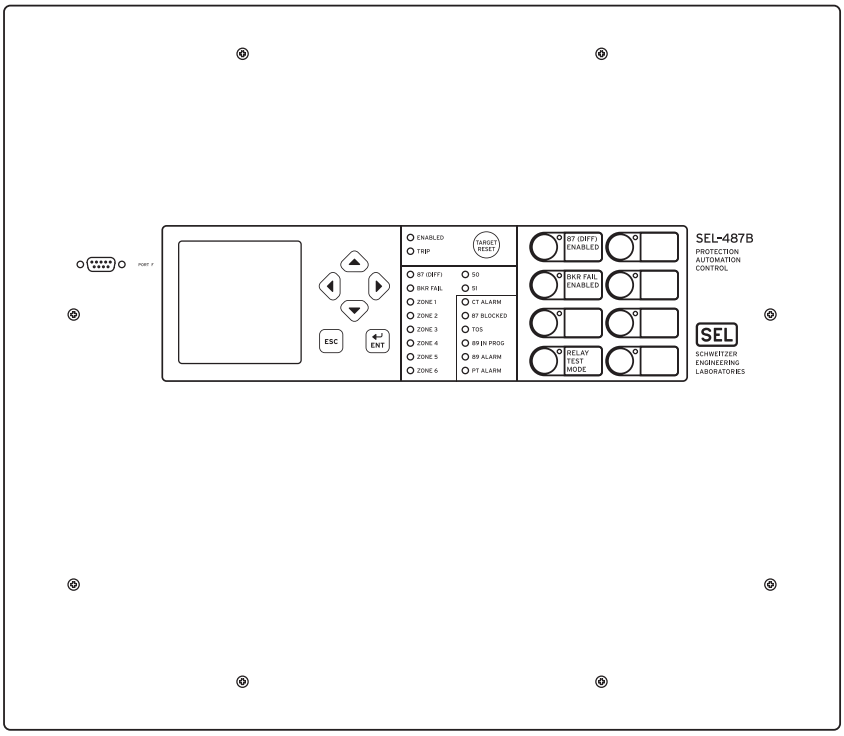
(Note: LCD contrast impaired for temperatures below –20° and above +70°C)

Weight (maximum)

9U Rack Unit	19.1 kg (42 lbs)
7U Rack Unit	15.9 kg (35 lbs)

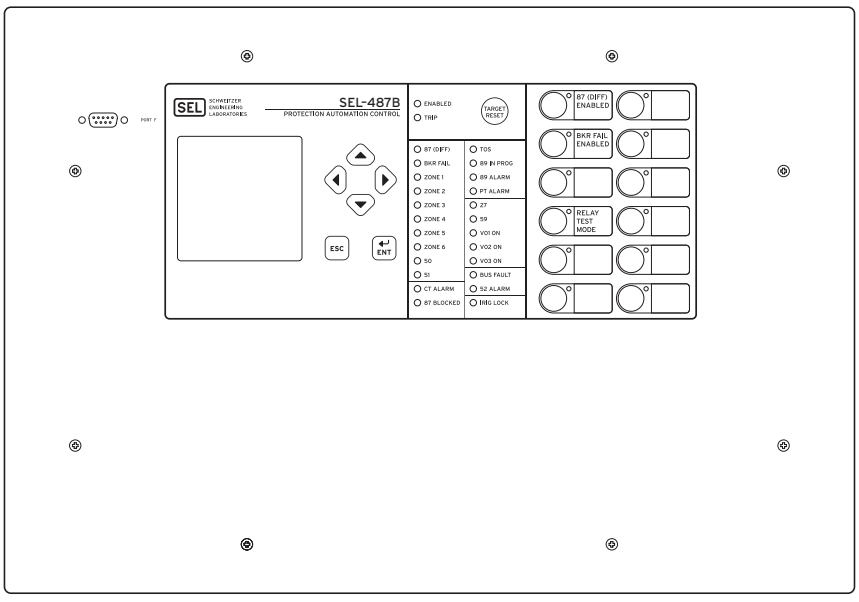
SEL-487B Bus Differential and Breaker Failure Relay

Front View – Panel-Mount (9U)



i3560d

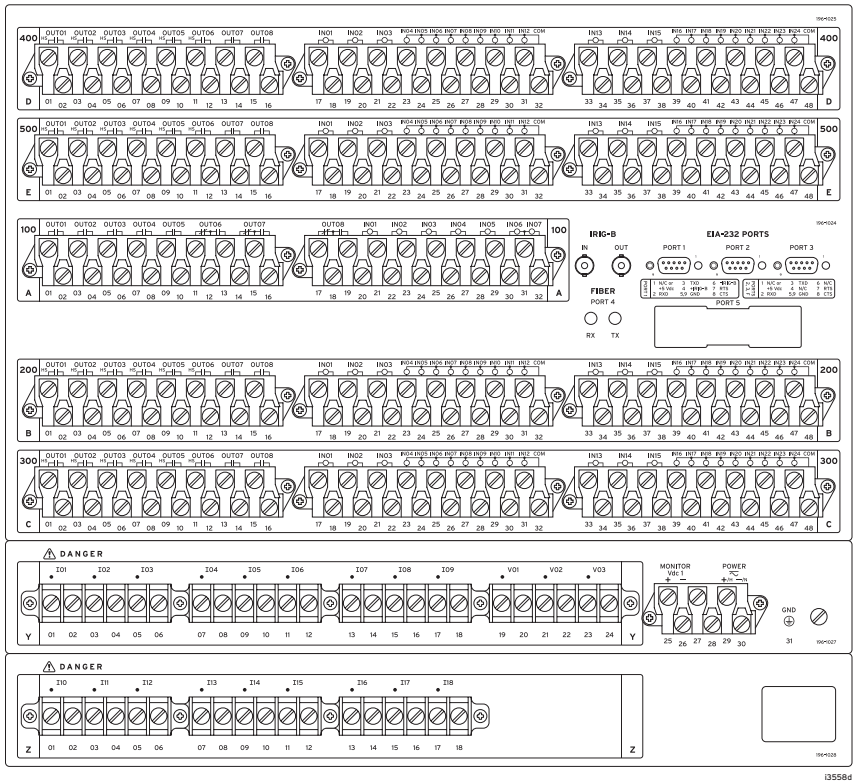
Front View – Panel-Mount (7U) Enhanced Front-Panel HMI



i4273a

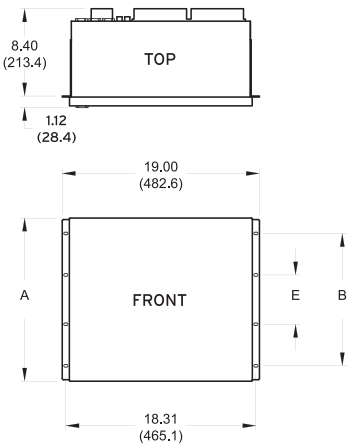
SEL-487B Bus Differential and Breaker Failure Relay

Rear View (9U, Four Additional I/O Boards)



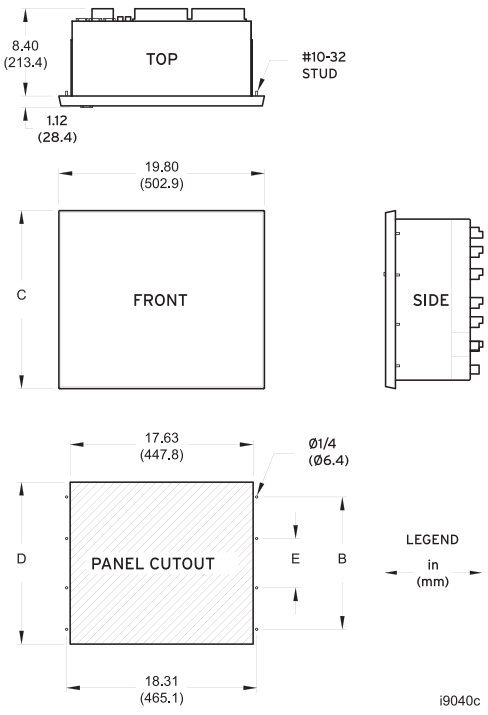
Dimensions

RACK-MOUNT CHASSIS



DIMENSION	TWO I/O BOARD (7U)	FOUR I/O BOARD (9U)
A	12.22 (310.4)	15.72 (399.3)
B	9.25 (235.0)	12.75 (323.9)
C	13.65 (346.7)	17.15 (435.6)
D	12.10 (307.3)	15.60 (396.2)
E	2.25 (57.2)	4.75 (120.6)

PANEL-MOUNT CHASSIS



Visit www.selinc.com for more detailed information and configuration options.

SEL-587Z High-Impedance Differential Relay

Apply the SEL-587Z for single-zone bus protection, reactor protection, or sensitive restricted earth fault protection on grounded, wye-connected power transformer windings.

Key Features

High-Impedance Differential Protection

High-impedance differential protection offers immunity against relay misoperation resulting from CT saturation. The SEL-587Z uses internal 2,000-ohm resistors to provide security against the effects of CT saturation for through-faults. Internally mounted metal oxide varistors (MOVs) are connected in parallel with the high-impedance element to clamp per-phase, secondary peak voltage to less than 2 kV.

Overcurrent Protection

Separate phase, neutral, and negative-sequence overcurrent elements, including instantaneous, definite-time, and inverse-time overcurrent elements, provide backup overcurrent protection.

Protection and Control Logic

SELOGIC® control equations with SELOGIC variables and timers facilitate traditional or advanced protection schemes.

Metering and Reporting

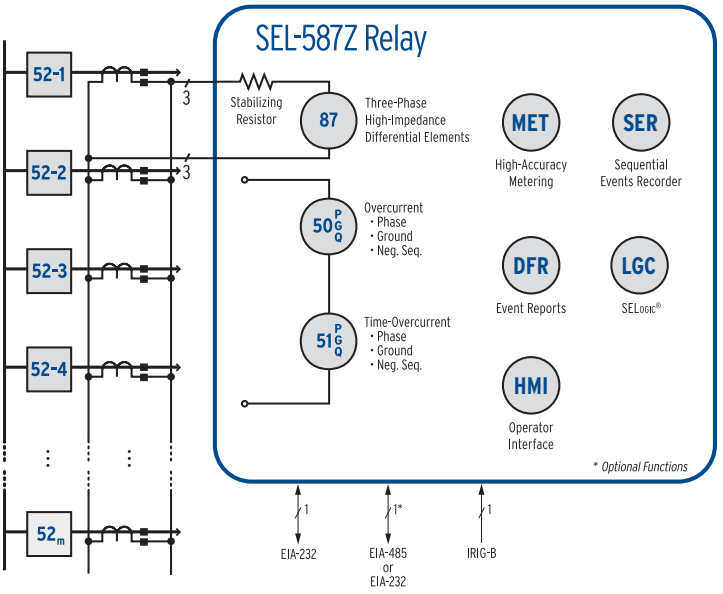
Oscillographic event reports (up to 15-cycle reports) and metering functions eliminate or reduce external recorder and metering requirements. Sequential Events Recorder (SER) stores the latest 512 entries in nonvolatile memory. Peak and demand metering, as well as phase, ground, negative-sequence, and differential metering, are provided for EMS/SCADA applications.

Serial Data Communication

Use both the front and rear serial ports for communicating with ASCII terminals, local HMI, SCADA, or distributed control systems. As an ordering option, select an EIA-232 or EIA-485 rear serial port. Select and configure ports for SEL ASCII and interleaved SEL Fast Messages, or Modbus® RTU protocol.

Settings and Analysis Software

ACSELERATOR QuickSet® SEL-5030 Software simplifies settings and expedites event analysis. Windows®-based menu screens provide error checking and real-time displays to reduce settings and connection errors.



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SEL-587Z High-Impedance Differential Relay

Applications

- Protect substation buses.
- Apply sensitive restricted earth fault protection on transformers with grounded-wye windings.
- Provide transformer bushing fault protection with built-in overcurrent elements.

Optional Features

- Panel-mount or rack-mount hardware package.
- EIA-232 front and EIA-232 or EIA-485 rear-mounted serial communications ports. Either rear-mounted port includes a demodulated IRIG-B time-code input.
- Low-energy or high-energy clamping MOVs. Use high-energy clamping MOVs for 5 A CT applications.
- Accessory external lockout relay.
- Conformal coating.

Related Products

SEL Satellite-Synchronized Clocks 308–317

Cutaway view showing stabilizing resistors and MOVs.

Hardware Specifications

High-Impedance Elements (87A, 87B, 87C)

120 V continuous, linear to 3000 V symmetrical

Burden	2000 Ω stabilizing resistor
Range	20–800 V

MOV clamping voltage: 1800 V (8 x 20 µs)

MOV maximum transient energy rating: 2500 J single or 5000 J double

MOV maximum continuous AC voltage rating 750 V

AC Current Inputs (IA, IB, IC)

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical, 625 A for 1 cycle (sinusoidal waveform)

Burden	<0.16 VA @ 5 A; <1.15 VA @ 15 A
Range	0.5–80 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical, 250 A for 1 cycle (sinusoidal waveform)

Burden	<0.06 VA @ 1 A; <0.18 VA @ 3 A
Range	0.1–16 A

Power Supply Ratings

24 V (polarity sensitive)	16–36 Vdc
48/125 V	36–200 Vdc or 85–140 Vac
125/250 V	85–350 Vdc or 85–264 Vac

5.5 W maximum

Standard Control Input and Output Ranges

24, 48, 125, or 250 Vdc

Configuration provides two inputs and four outputs (plus alarm)

Operating Temperature

–40° to +85°C (–40° to +185°F)

(Note: LCD contrast impaired for temperatures below –20°C)

Price

Budgetary Retail, Quantity 1: $3,940

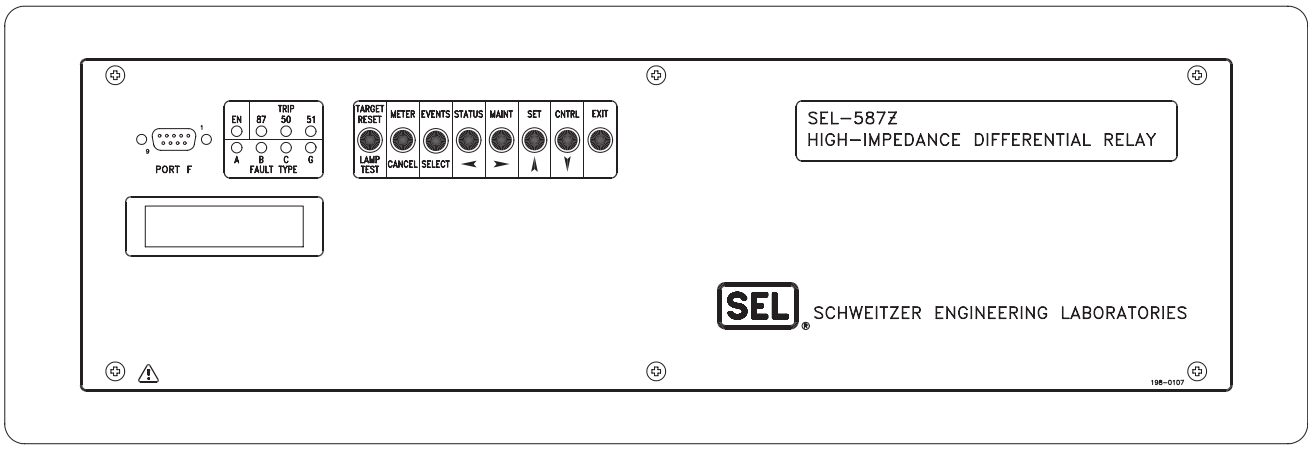
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

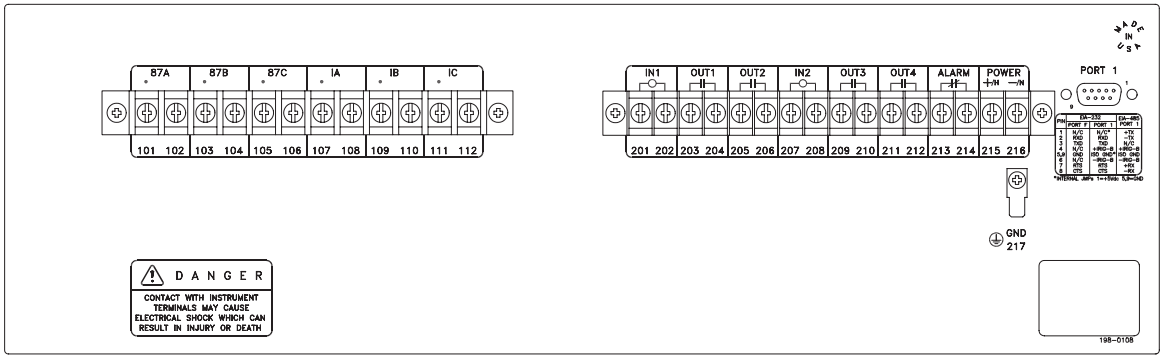
SEL-587Z High-Impedance Differential Relay

Front View – Panel-Mount (2U)



I3481b

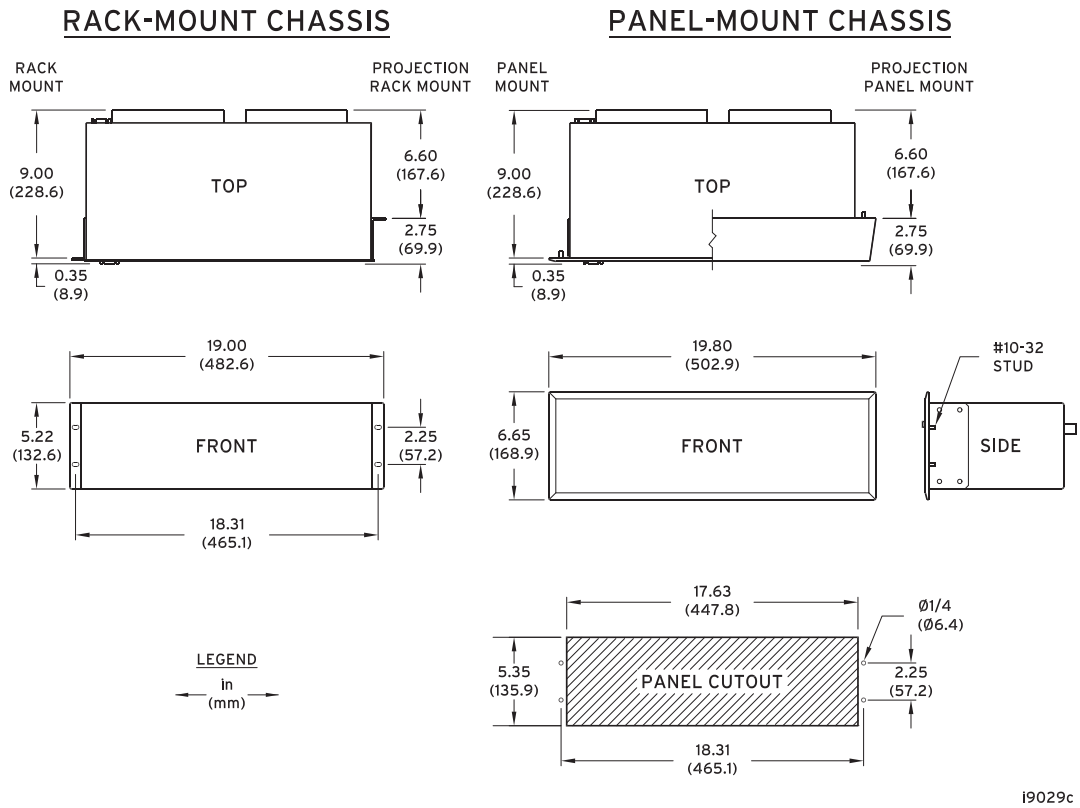
Rear View – Conventional Terminal Blocks (2U)



I3482b

SEL-587Z High-Impedance Differential Relay

Dimensions



Visit www.selinc.com for more detailed information and configuration options.

SEL-352 Breaker Failure Relay

Provide comprehensive protection and unparalleled flexibility for breaker failure applications using the SEL-352.

Key Features

Comprehensive Breaker Failure Protection

Circuit breaker failure protection, including failure to trip for fault or load conditions; failure to close, including pole disagreement; failure while open (flashover detection); failure to complete a trip or close due to stuck resistor switches; and loss of dielectric pressure. Five built-in schemes can be modified with SELOGIC® control equations for application flexibility. Trip failure schemes accommodate single and multiple breaker applications, single-pole closing, and three-pole tripping applications. Overcurrent fault detection element includes unique subsidence current detection logic to provide fast reset after the breaker opens. Point-on-wave opening will minimize restrike across opening breaker contacts and extend the life of the circuit breaker.

Complete Breaker Control

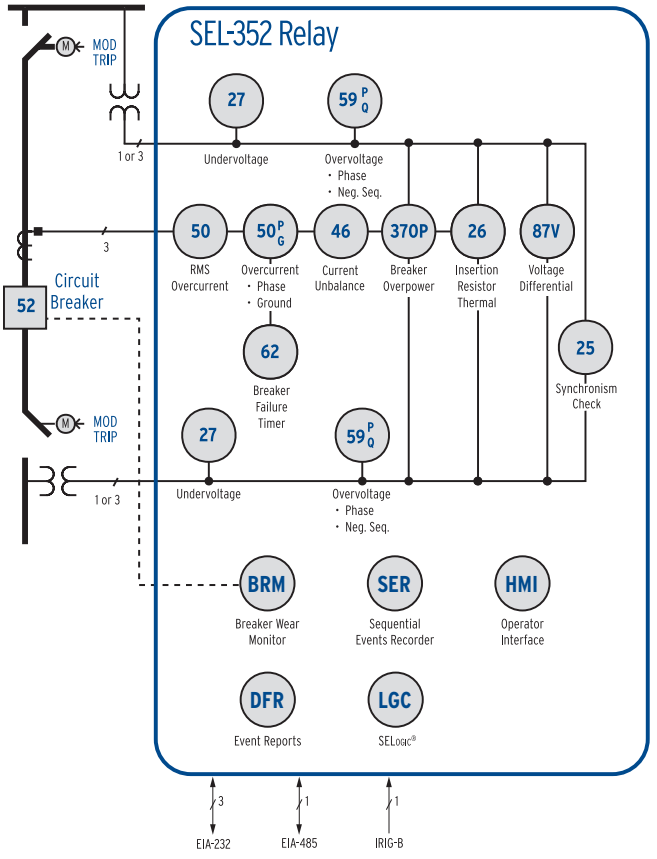
Circuit breaker control features, including Motor-Operated Disconnect (MOD) trip and power circuit breaker isolation security logic, retripping, point-on-wave and staggered phase closing and tripping, synchronism checking, and trapped-charge polarity detection for sophisticated breaker control. Extensive SELOGIC control equation tools enable custom automatic reclosing schemes.

Data Recording

Data recording features include ten seconds of oscillographic event reports (rates as great as 64 samples/cycle), 512 Sequential Events Recorder (SER) reports, breaker trip and close monitor details, and summary of electrical and mechanical operating times. Breaker contact wear monitor on per-phase basis. All data stored in nonvolatile memory.

Settings and Analysis Software

ACSELERATOR QuickSet® SEL-5030 Software simplifies settings and expedites event analysis. Windows®-based menu screens provide error checking and real-time displays to reduce settings and connection errors.



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SEL-352 Breaker Failure Relay

Applications

- Apply one SEL-352 per circuit breaker to detect breaker failure conditions for single-pole and three-pole tripping applications with any bus/breaker arrangement.
- Select one of five preconfigured breaker failure schemes for ring-bus, breaker-and-a-half, or double-bus configurations. In addition, you can build your own schemes for custom applications.
- Minimize total breaker failure fault-clearing time with reduced timing margins made possible by subsidence current detection logic and optional high-speed output contacts.
- Implement point-on-wave closing with trapped-charge polarity detection and synchronism checking to minimize system voltage transients when closing breaker.
- Minimize restrike across opening breaker contacts with point-on-wave opening for suitable breakers.
- Reduce transients with temperature and control voltage compensated point-on-wave tripping.
- Minimize breaker wear by using control logic to close at optimum times.
- Capture power system currents and voltages during fault conditions using the data recorder. Set the waveform sampling rate as great as 64 samples per cycle. The relay stores a total of ten seconds of event data in nonvolatile memory.

Optional Features

- Panel-mount, projection panel-mount, or rack-mount hardware package.
- Chassis available for one or two additional I/O boards.
- I/O boards with contact-sensing inputs and standard control outputs; high-current interrupting outputs; or high-speed, high-current interrupting outputs.
- Connectorized® (plug-in connectors).
- Breaker interrupting contact wear monitor, for each phase.
- DNP3 Level 2 Outstation communications protocol.
- Control dc voltage monitoring.
- Conformal coating.

Related Products

SEL Satellite-Synchronized Clocks 308–317
SEL-9220 Fiber-Optic Adapter for SEL-300 Series Relays 440

Hardware Specifications

AC Voltage Inputs

120 V_{L-N} three-phase, four-wire connection

150 V_{L-N} continuous (connect any voltage from 0 to 150 Vac)

365 Vac for 10 seconds

Burden 0.13 VA @ 67 V; 0.45 VA @ 120 V

AC Current Inputs

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical, 1250 A for 1 cycle

Burden 0.27 VA @ 5 A; 2.51 VA @ 15 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical, 250 A for 1 cycle

Burden 0.13 VA @ 1 A; 1.31 VA @ 3 A

Power Supply Ratings

24/48 V 18–60 Vdc

48/125 V 38–200 Vdc or 85–140 Vac

125/250 V 85–350 Vdc or 85–264 Vac

<25 W maximum for all supplies

Standard Control Input and Output Ranges

24, 48, 110, 125, or 250 Vdc

Standard configuration provides 6 inputs and 8 outputs, <5 ms pickup/dropout times with 30 A make, 6 A continuous duty. Additional I/O boards may be selected with standard inputs and outputs, a combination of standard inputs and high-current interrupting outputs, or a combination of standard inputs and high-speed, high-current interrupting outputs.

Operating Temperature

–40° to +85°C (–40° to +185°F)

(Note: LCD contrast impaired for temperatures below –20°C)

Price

Budgetary Retail, Quantity 1: $3,570

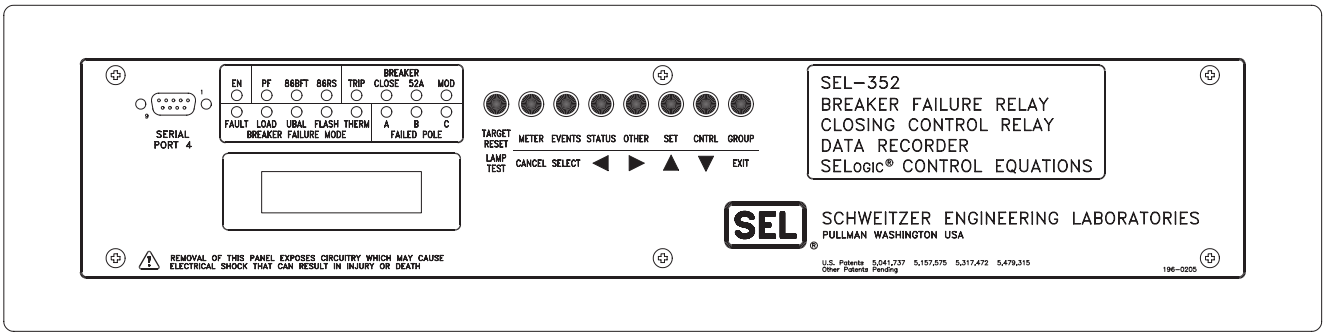
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

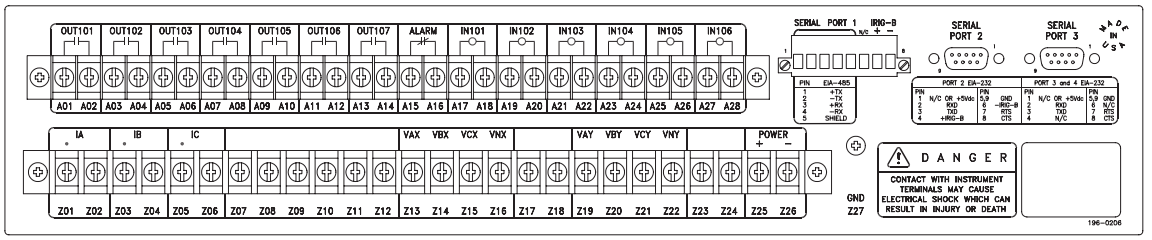
SEL-352 Breaker Failure Relay

Front View – Panel-Mount (2U)



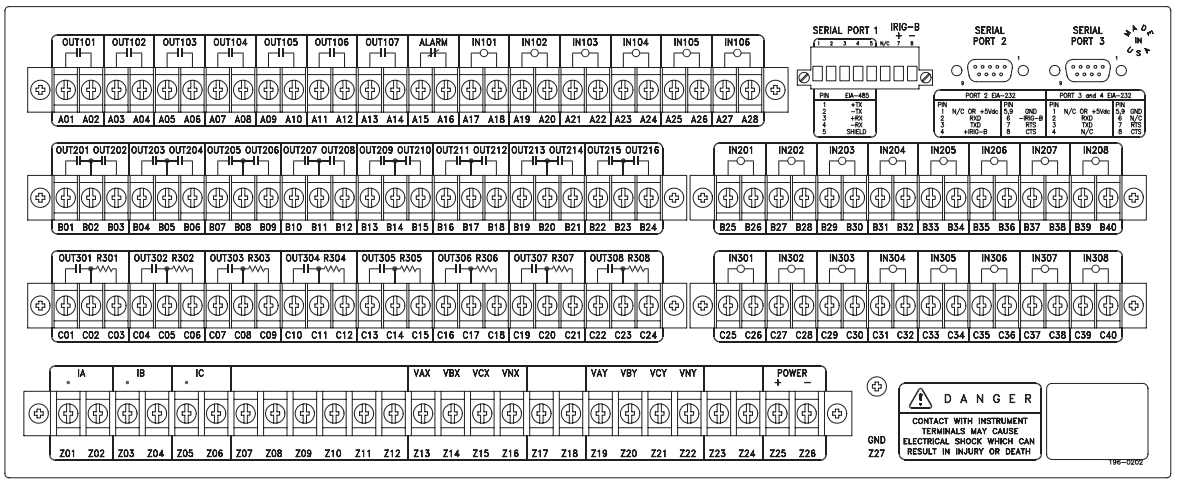
i3154b

Rear View – Conventional Terminal Blocks (2U)



i3153c

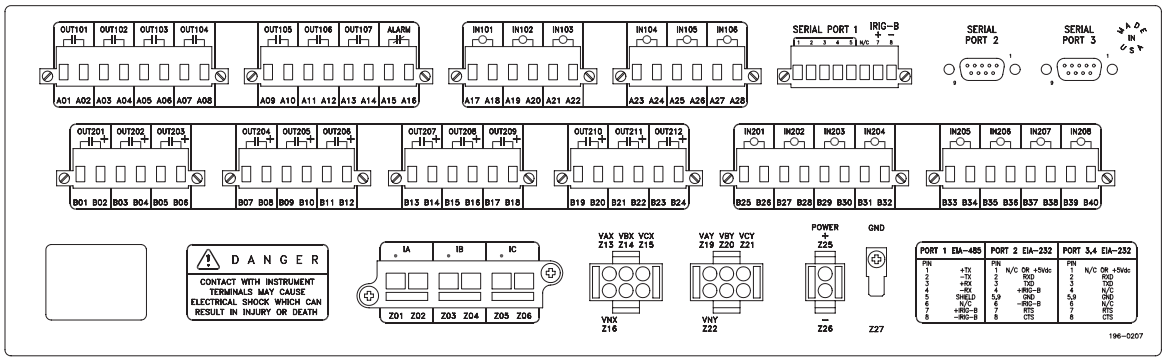
Rear View – Conventional Terminal Blocks – Additional I/O (4U)



i3158c

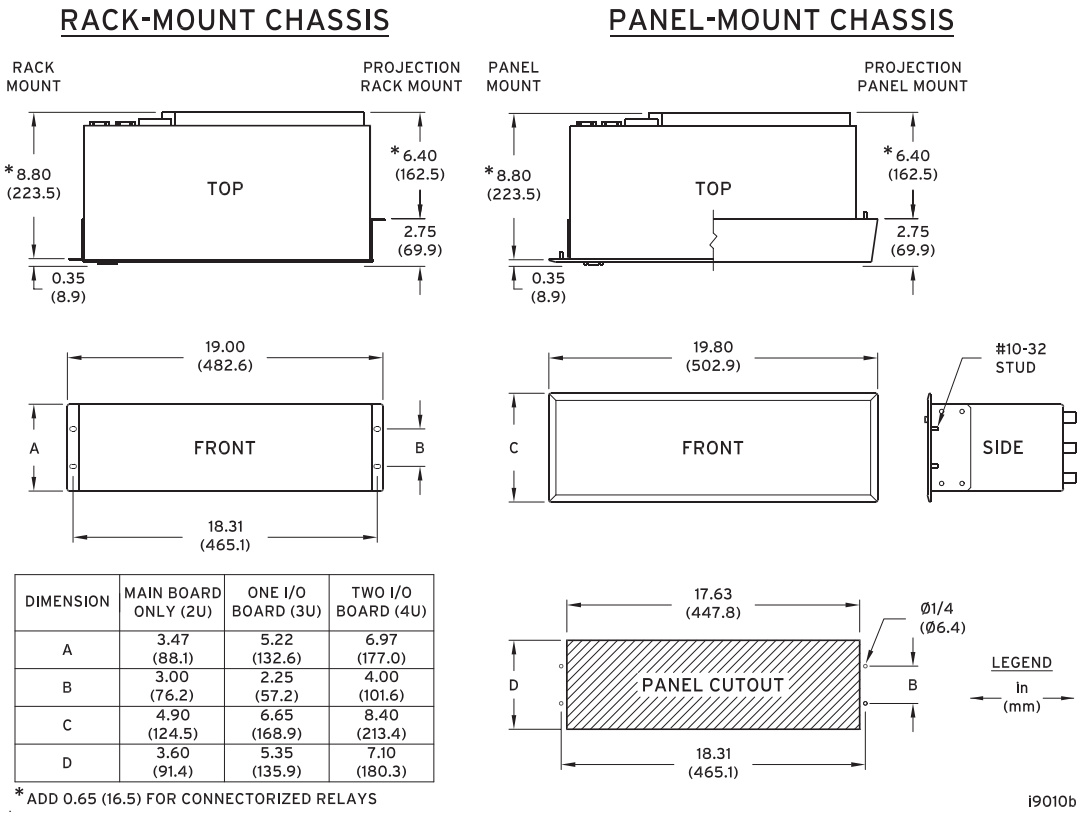
SEL-352 Breaker Failure Relay

Rear View – Connectorized® – Additional I/O (3U)



i3170b

Dimensions



DIMENSION	MAIN BOARD ONLY (2U)	ONE I/O BOARD (3U)	TWO I/O BOARD (4U)
A	3.47 (88.1)	5.22 (132.6)	6.97 (177.0)
B	3.00 (76.2)	2.25 (57.2)	4.00 (101.6)
C	4.90 (124.5)	6.65 (168.9)	8.40 (213.4)
D	3.60 (91.4)	5.35 (135.9)	7.10 (180.3)

* ADD 0.65 (16.5) FOR CONNECTORIZED RELAYS

i9010b

Visit www.selinc.com for more detailed information and configuration options.

SEL-487V Capacitor Protection and Control System

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

SEL IEC 61850

SEL Synchrophasors™

Key Features

Achieve Complete Capacitor Bank Protection and Control With One Relay

Easily protect and control grounded and ungrounded, single- and double-wye capacitor bank applications with a single relay. The SEL-487V includes both voltage differential and overcurrent elements for complete protection.

Provide Flexible Multibank Protection and Control

Apply sensitive capacitor failure detection with application-based settings that provide voltage and current unbalance elements. Select from voltage, power factor, VAR, or time-of-day/day-of-week control schemes. Prevent equipment damage to capacitor banks and switching apparatus using control instability (hunting) detection.

Simplify Settings Calculations

Automatically perform calculations for application-based settings with IEEE C37.99-specification settings assistant software.

Improve Power System Reliability and Stability With the Built-In Synchrophasor Measurement System

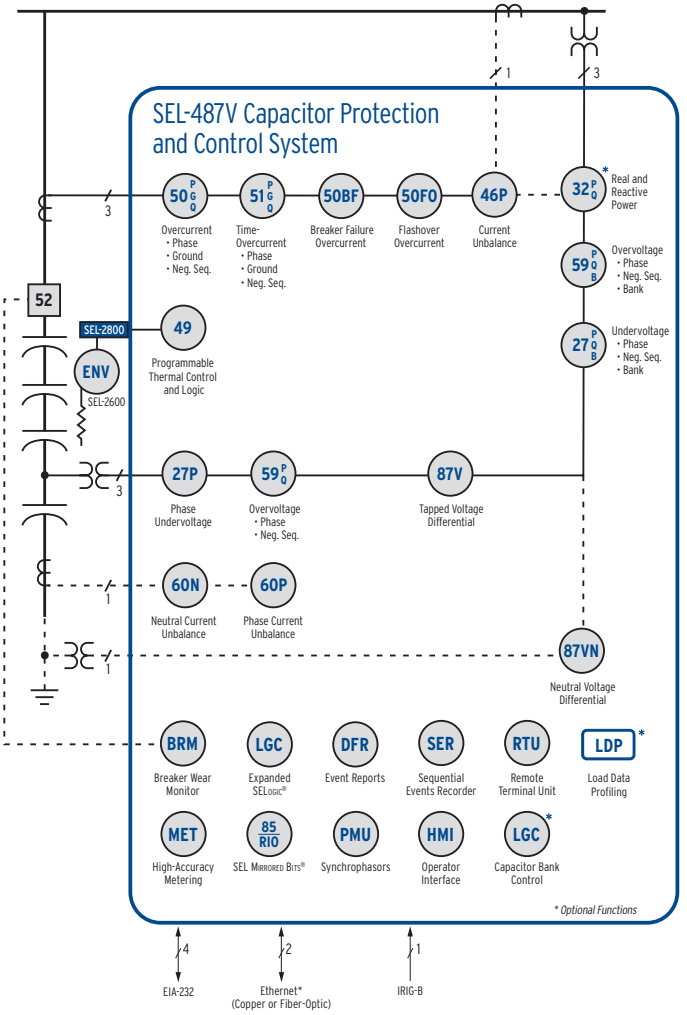
Obtain real-time measurements of electrical quantities. Provide local control based on wide-area measurements.

Save Time Identifying Faults

Find faulty capacitor units with the patent-pending advanced faulted phase and section identification logic.

Graphical Logic Editor (GLE)

Simplify the SEL-487V configuration process with the GLE in ACSELERATOR QuickSet Designer® SEL-5031 Software. The GLE lets you design your SELOGIC® control equations graphically, so your settings files can be documented for easier validation and commissioning. Convert existing control equations to easy-to-read diagrams, and save with QuickSet settings.



SEL-487V Capacitor Protection and Control System

Applications

- Measure voltage differences between bus or line phase voltages and the tapped voltage of the grounded-wye capacitor bank using three-phase voltage differential elements. The phase differential elements detect variations in capacitor bank impedance due to loss of individual capacitor elements, a single capacitor unit, or an entire group of capacitor units.
- Protect up to three ungrounded wye capacitor bank configurations with SEL-487V neutral voltage differential elements. Three neutral voltage differential elements calculate zero-sequence voltage from three-phase potential inputs provided from the line or bus. The calculated zero-sequence voltage is then compared to the zero-sequence voltage measured by a potential transformer connected between the capacitor bank neutral and ground.
- Provide protection for up to three ungrounded, double-wye capacitor banks with neutral current unbalance elements.
- Use phase current unbalance detection to protect both grounded and ungrounded, double-wye capacitor bank applications. The three-phase, phase current unbalance elements use the A-phase system voltage as a reference to enhance sensitivity and provide a directional indication.
- Apply automatic unbalance compensation for all protection methods.

Optional Features

- 4U or 5U chassis for one or two additional I/O boards.
- Vertical or horizontal, panel-mount or rack-mount hardware package.
- Additional inputs/outputs (settable or level-sensitive, optoisolated).
- Automatic voltage control (VAR, power factor, time of day).
- Voltage sag, swell, interruption (VSSI) reporting.
- Ethernet communications.*
- IEC 61850 communications.
- Conformal coating.
- Connectorized® hardware configuration.
- Auxiliary breaker control pushbuttons.

* Eye-safe, Class 1 LED product per EN 60825-1

Related Products

Hardware Specifications

AC Voltage Inputs (6 total)

300 V_{L-N} continuous, 600 Vac for 10 seconds

Burden 0.03 VA @ 67 V; 0.06 VA @ 120 V

AC Current Inputs (6 total)

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical, 1250 A for 1 cycle

Burden 0.27 VA @ 5 A; 2.51 VA @ 15 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical, 250 A for 1 cycle

Burden 0.13 VA @ 1 A; 1.31 VA @ 3 A

Power Supply Ratings

125/250 Vdc or 120/230 Vac

Range 85–300 Vdc or 85–264 Vac

48/125 Vdc or 120 Vac

Range 38–140 Vdc or 85–140 Vac

Standard Inputs/Outputs

3 high-interrupt outputs

2 standard speed Form A outputs

3 standard speed Form C outputs

5 level-sensitive, optoisolated digital inputs with independent commons

2 level-sensitive, optoisolated digital inputs with single shared common

Operating Temperature

–40° to +85°C (–40° to +185°F)

(Note: LCD contrast impaired for temperatures below –20° and above +70°C)

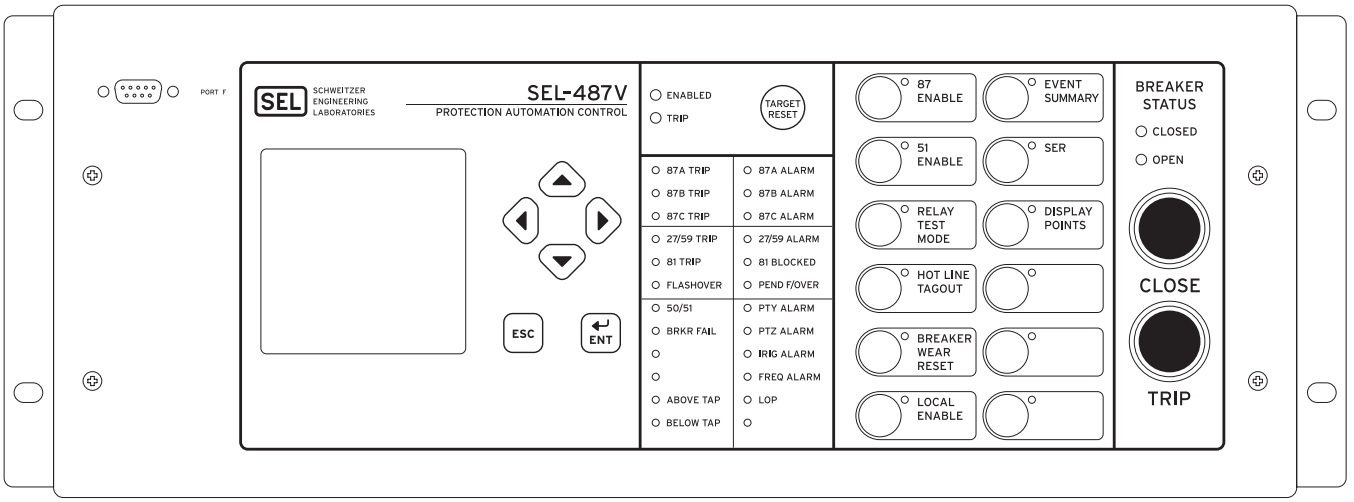
Price

Budgetary Retail, Quantity 1: $4,200

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

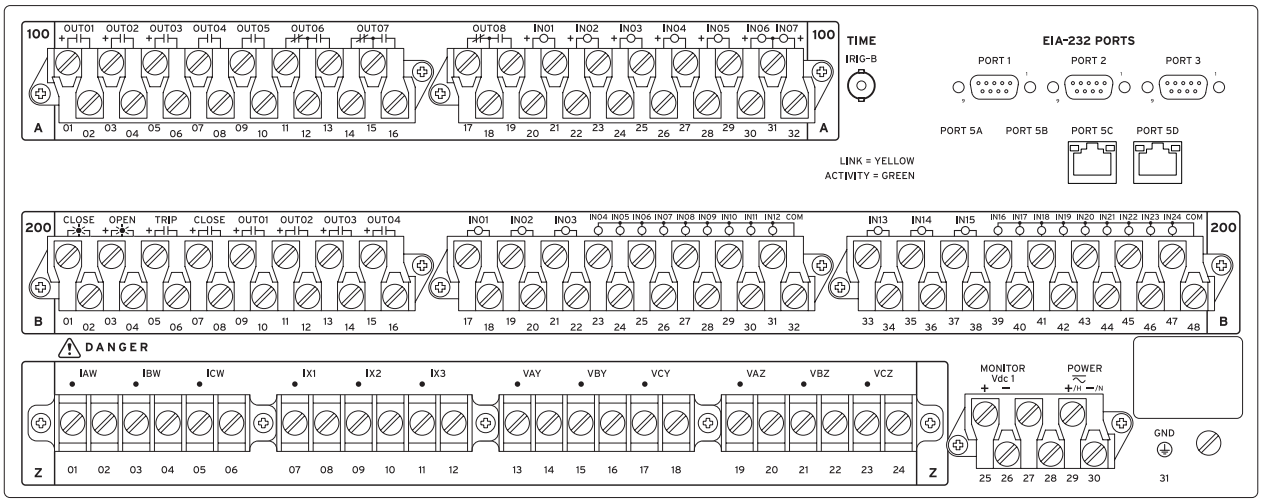
SEL-487V Capacitor Protection and Control System

Front View



i4453a

Rear View

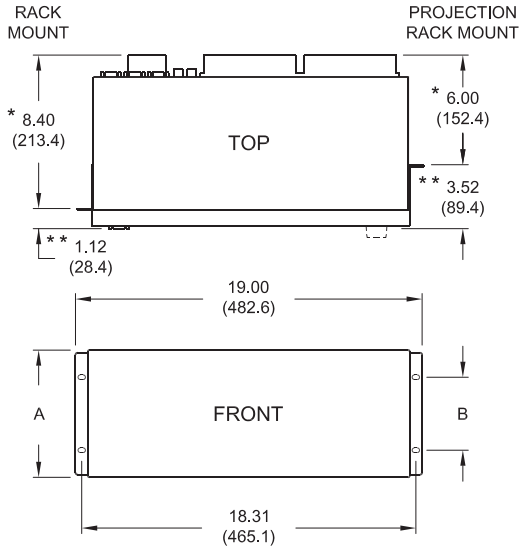


i4457a

SEL-487V Capacitor Protection and Control System

Dimensions

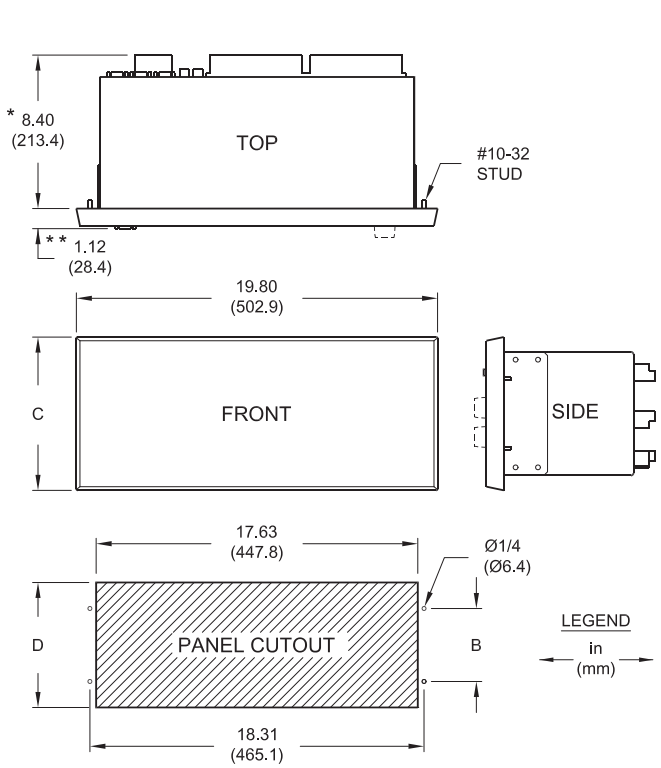
RACK-MOUNT CHASSIS



DIMENSION	MAIN BOARD ONLY (3U)	ONE I/O BOARD (4U)	TWO I/O BOARD (5U)
A	5.22 (132.6)	6.97 (177.0)	8.72 (221.5)
B	2.25 (57.2)	4.00 (101.6)	5.75 (146.0)
C	6.65 (168.9)	8.40 (213.4)	10.15 (257.8)
D	5.10 (129.5)	6.85 (174.0)	8.60 (218.4)

* ADD 0.30 (7.6) FOR CONNECTORIZED RELAYS

PANEL-MOUNT CHASSIS



** ADD 0.50 (12.7) FOR PUSHBUTTON OPTION
ADD 1.00 (25.4) FOR PUSHBUTTON WITH GUARD
---OPTIONAL PUSHBUTTON

i9027e

Visit www.selinc.com for more detailed information and configuration options.

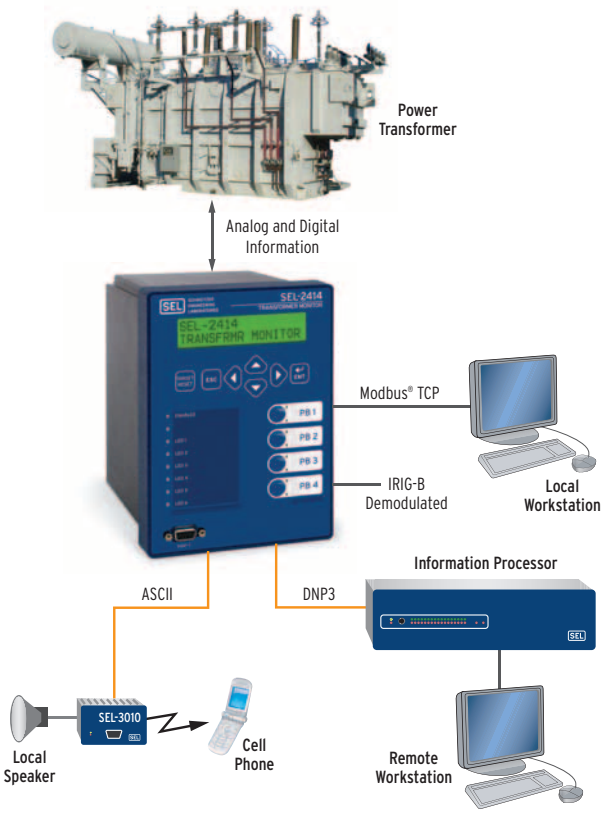
SEL-2414 Transformer Monitor

Complete system for monitoring and control of your new and existing transformers.

SEL IEC 61850

Now With

- *IEEE Thermal Model*
- *Through-Fault Monitor*
- *Thermocouples and RTDs*
- *Dual Ethernet Options*



Key Features

Reduce Transformer Downtime

Monitor and protect critical substation assets with comprehensive transformer thermal and through-fault monitoring. Monitor digital transformer alarms and status points. Measure pressure, oil level, temperatures, and process-level signals. Control cooling fans and other equipment.

Increase Reliability

Built to the same high standards as SEL protective relays, the SEL-2414 withstands vibration, electrical surges, fast transients, and extreme temperatures, meeting stringent industry standards. Compare our specification compliance, higher reliability, price, and worldwide, ten-year warranty to other transformer monitors.

Simplify Analysis

Record transformer events with the Sequential Events Recorder function, which supports up to 512 state changes for as many as 96 different digital points. Capture short-term transformer event waveforms with the event report (oscillography) function. Record transformer trend data with the analog signal profile function for up to 32 analog channels.

Easily Integrate With SCADA

Provide easy integration with SCADA systems using flexible communications options. Choose from Ethernet (Modbus® TCP, DNP3 LAN/WAN, IEC 61850, Telnet, FTP) and serial (Modbus and DNP3 RTU) protocols.

Match Flexible I/O and Logic to Your Needs

Easily program with powerful logic, math, timers, counters, and edge-trigger functions. I/O options include digital or analog outputs; digital, analog, RTD, thermocouple, and ac current inputs; and ac voltage inputs.

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Substation- and Plant-Grade Equipment

Designed, built, and tested with the same practices, processes, and standards that we use for our protective relays, information processors, and other products. This includes compliance with IEEE and IEC standards for electrostatic discharge, fast transients, radiated emissions, surge-withstand capability, dielectric strength, pulsed magnetic fields, and disturbances. Specifications and tests are per the IEEE C37.90-1989 and IEC 60255 protective relay standards and the IEEE 1613-2003 standard for communications and networking devices.

SEL-2414 Transformer Monitor

Applications

- Use the SEL-2414 to satisfy standalone or distributed monitoring and control of transformers, or choose from the flexible communications options to connect to a substation distributed SCADA or automation system.
- Monitor critical substation assets with comprehensive transformer thermal and through-fault monitoring. Calculate top oil, hot spot, insulation aging acceleration factor, and loss-of-life while generating hourly and daily data about your transformer. Capture through-fault current data that could lead to increased transformer wear.
- Apply flexible I/O options to meet the many needs of new or retrofit transformer installations. Use digital inputs (DI) to monitor critical transformer alarms and status points. Use analog inputs (AI) to measure pressure, oil level, temperatures, tap positions, and process-level signals from transducers. Operate cooling fans and alarms, or provide indication with digital outputs (DO) and analog outputs (AO).
- Select measured ambient, transformer top-oil, load tap changer, and other analog data (measured or calculated) for trending with the analog signal profile function.
- Provide extensive ac metering and monitoring capabilities. Voltage, current, power, energy, power factor, frequency; demand/peak demand metering; and maximum/minimum metering are measured and recorded.
- Exercise transformer cooling fans to eliminate maintenance surprises during critical load conditions. Separately control fan banks to balance cooling duty cycles to increase the life of the cooling systems.
- Design custom SELOGIC® applications and settings, and store them in the SEL-2414.
- Install on the transformer with confidence. The monitor operates from −40° to +85°C with as much as 95 percent relative humidity (noncondensing).

Related Products

Price

Budgetary Retail, Quantity 1: $1,150

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

Ordering Options

CPU Board

- Single- or dual-port Ethernet, 10/100BASE-T wired or 100BASE-FX fiber optic.
- EIA-232 rear port (standard).
- Fiber-optic serial port (62.5 µm core fiber, SEL-2812 compatible).

Optional Expansion Cards

- 8 digital inputs (DI).
- 8 digital outputs (DO) (electromechanical).
- 4 DI/4 DO (electromechanical and fast, high-current interrupting outputs).
- 4 DI/3 DO (2 Form C and 1 Form B).
- 8 analog inputs (AI).
- 4 AI/4 analog outputs (AO).
- EIA-232 or EIA-485 serial communication.
- 10 RTD/thermocouple inputs.
- 3 ac current/3-phase ac voltage inputs.
- 4 ac current inputs.
- Three-phase voltage inputs.

Note: Unless otherwise specified, all digital outputs are Form A. Base unit comes standard with 2 digital inputs and 3 digital outputs (electromechanical).

Protocol Options

- DNP3 and DNP3 LAN/WAN.
- IEC 61850 communications.
- Modbus TCP (included with Ethernet port option).

Conformal Coating

Hardware Specifications

Power Supply

Option	Range
24–48 Vdc	18–60 Vdc
110–250 Vdc, 110–240 Vac	85–264 Vac, 85–275 Vdc

Power Consumption

<40 VA (ac)
<15 W (dc)

Serial Communications Ports

Two EIA-232 ports, DB-9 connectors

Data rate (bps)	300 to 38400
Optional fiber-optic port	62.5 µm fiber, ST® connectors Eye-safe, Class 1 LED product per EN 60825-1

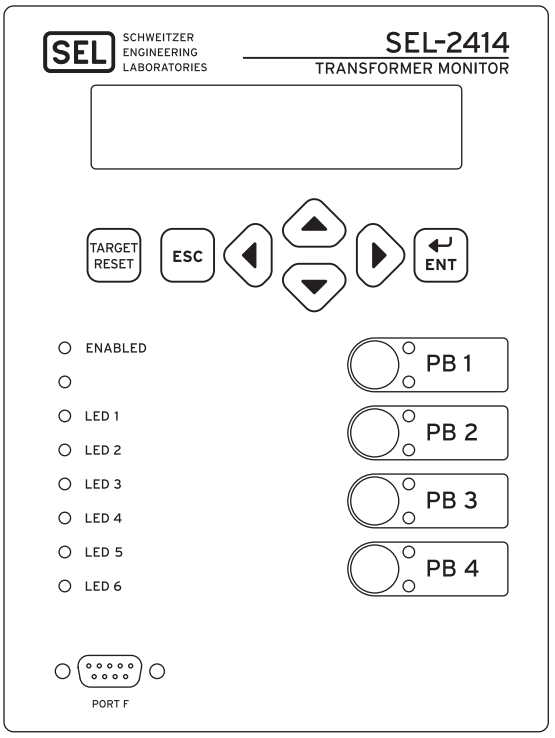
Operating Temperature

IEC performance rating of −40° to +85°C (−40° to +185°F)

Class I Zone 2
Hazardous Location
APPROVED

SEL-2414 Transformer Monitor

Front View – Panel-Mount



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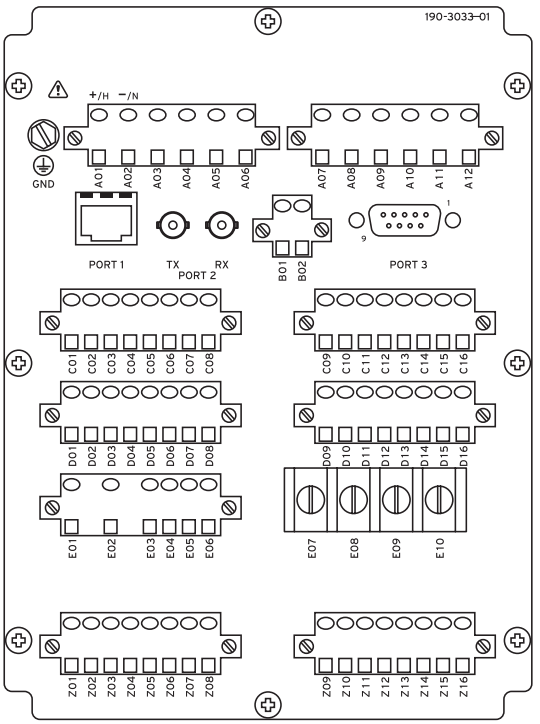
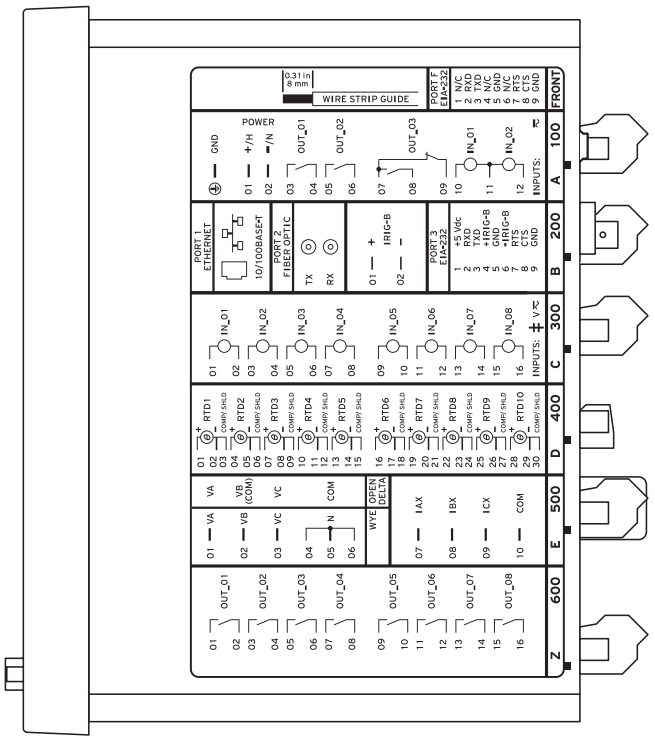
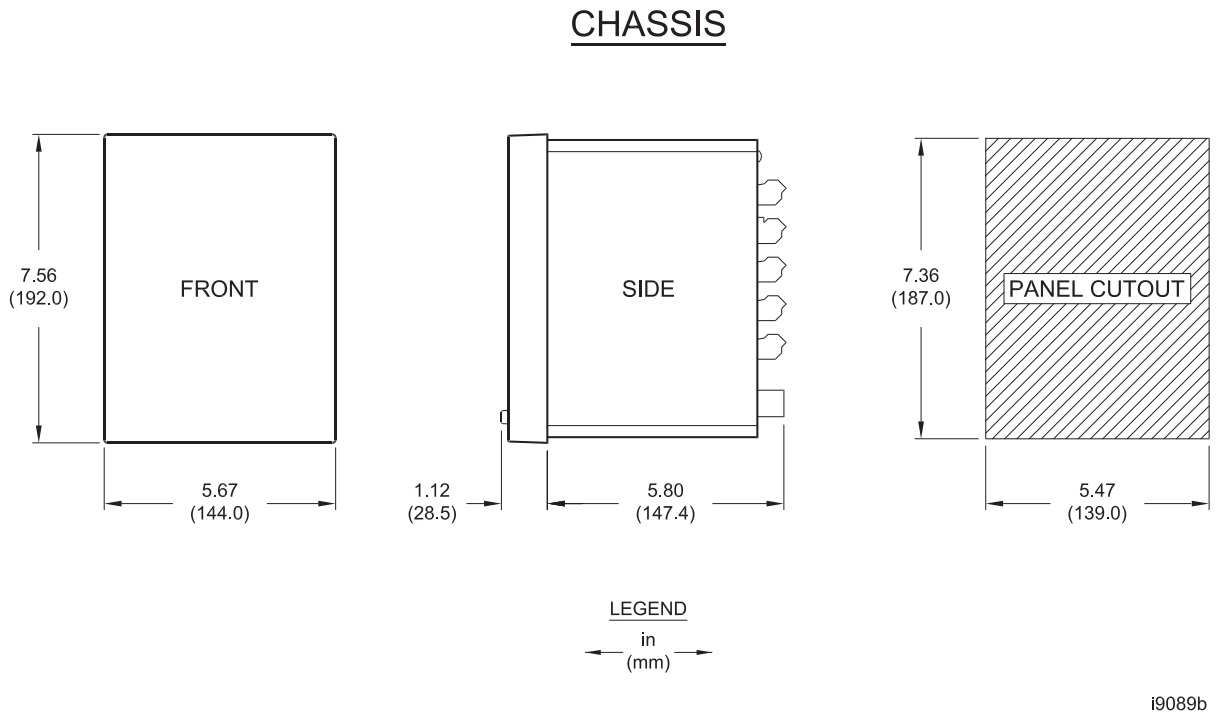
Rear View



Side View

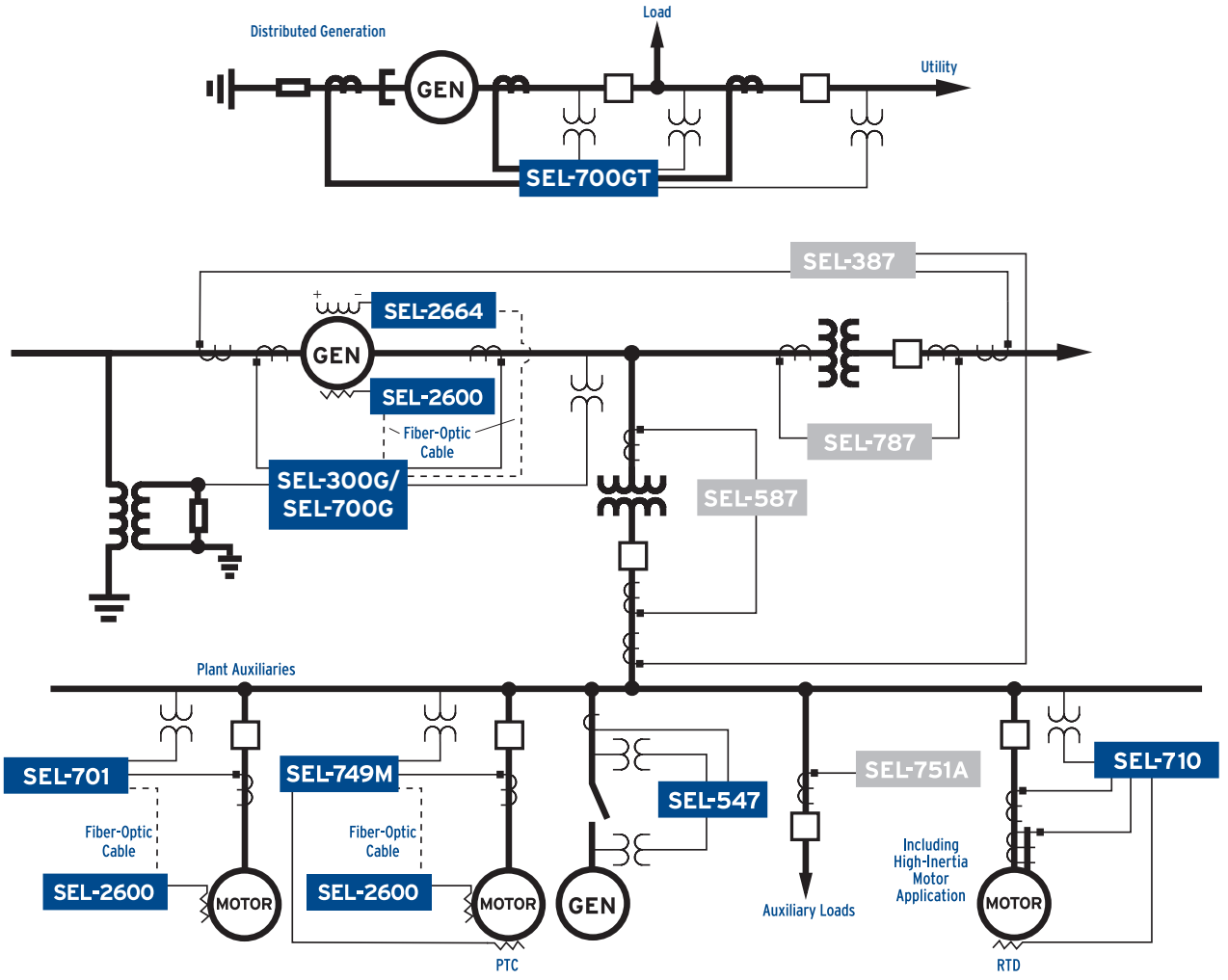


Dimensions



Visit www.selinc.com for more detailed information and configuration options.

Generator and Motor Applications



Generator and Motor Protection Product Index

Generator and Motor Features

Generator and Motor Protection	SEL-300G	SEL-700G	SEL-700GT	SEL-700GW	SEL-547	SEL-710	SEL-749M	SEL-701
APPLICATIONS								
Generator Protection	•	•	*					
Motor Protection	•				•	•	•	
Feeder Protection				•				
Breaker Failure Protection	*f*	•	•		*f*	•	*f*	*f*
Equipment Thermal Monitoring	*	*	*	*		*	*	*
Generator Intertie Protection			•		•			
Synchronism Check	*	*	•		•			
Integrated Synchronizer		*	*					
PROTECTION								
21P Phase Mho or Compensator Distance	•	*						
24 Overexcitation (Volts/Hertz)	•	•	•					
27 Undervoltage	•	•	•		•	*	*	*
32/37 Directional/Underpower Elements	•	•	•		•	*	*	*
40 Loss-of-Field	•	•	*					
46 Current Unbalance	•	•	*			•	•	•
47 Phase Reversal					•	•	•	•
49 Thermal		•	*			•	•	•
50N/G Neutral/Ground - O/C	•	•	•	•		•	•	•
50P Phase - O/C	•	•	•	•		•	•	•
50Q Negative-Sequence - O/C	•	•	•	•		•		•
51N/G Neutral/Ground Time - O/C	•	•	•	•		•		
51P Phase Time - O/C			•	•		•		
51Q Negative-Sequence Time - O/C			•	•		•		
59 Overvoltage	•	•	•		•	*	*	*
64G 100 Percent Stator Ground	•	*						
64F Field Ground	•	•	*					
67G Directional Ground Overcurrent		•	•					
78 Out-of-Step	•	•						
81 Over-/Underfrequency	•	•	•		•	•	•	*
87 Current Differential	*	*				*		
87G Restricted Earth Fault		•	*					
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Flashover Protection	*f*	*f*						
Zone/Level Timers	•	•	•	•	•	•	•	•
INSTRUMENTATION AND CONTROL								
SELogic® Control Equations	•	•	•	•	•	•	•	•
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Remote Control Switches	•	•	•	•	•	•	•	•
Local Control Switches	•	•	•	•		•		
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Multiple Settings Groups	•	•	•	•	•	•		
Station Battery Monitor	•							
Breaker Wear Monitor	•	•	•	•				
Event Report (Multicycle Data)	•	•	•	•	•	•	•	•
Sequential Events Recorder	•	•	•	•	•	•	•	•
Instantaneous Meter	•	•	•	•	•	•	•	•
Demand Meter	•	•	•	•				•
Load Profile Report		•	•	•		•		•
RTD (Resistance Temperature Detector) Inputs	*	*	*	*		*	*	*
Ethernet, Modbus® TCP, IEC 61850		*	*	*		*		
Modbus RTU Slave	*	•	•	•	•	•	•	•
Mirrored Bits® Communications		•	•	•		•		
DeviceNet™		*	*	*		*	*	
MISCELLANEOUS FEATURES								
Accepts Wye or Open-Delta Voltage Transformers	•	•	•		*	*	*	
Connectorized® (Quick Disconnect) Available	*				*			

• *Standard Feature* * *Model Option* *f* *This function may be created using relay elements and timers*

SEL-300G Generator Relay

Apply the SEL-300G for comprehensive primary and backup generator protection.

Key Features

Comprehensive Generator Protection

Numerous current, voltage, frequency, distance, and out-of-step elements provide comprehensive protection for large and small machines.

One Hundred Percent Stator Ground Fault Protection

One hundred percent stator ground fault protection using both fundamental frequency overvoltage and third-harmonic voltage differential elements to protect high-impedance grounded generators.

Current Differential Protection

Optional current differential elements to optimize protection for larger machines, yet economical enough for smaller machines. Phase shift and magnitude difference compensation for current differential applications that include generator step-up transformers. Current differential option includes individual phase overcurrent elements for split-phase differential protection applications.

Overexcitation Detection

Volts-per-hertz elements detect overexcitation in both the generator and step-up transformer. Choose from multiple curves and definite-time elements for alarm and tripping applications.

Directional Power Elements

Sensitive directional power elements protect against reverse power, overload conditions, or low forward power.

RTD-Based Protection

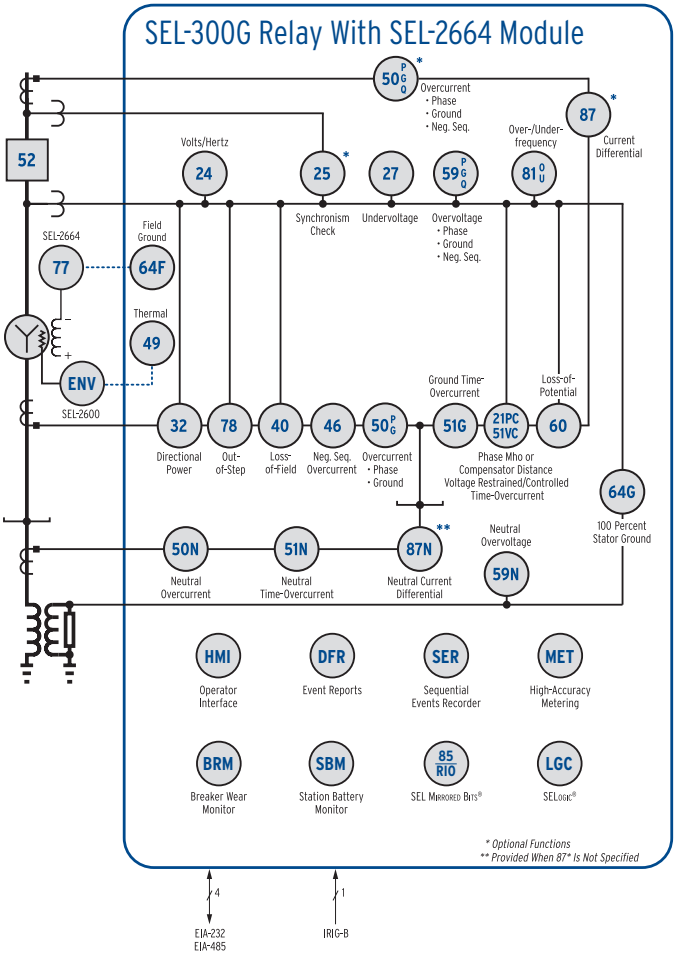
Use an SEL-2600 RTD Module to acquire thermal data for alarm and trip functions in the SEL-300G.

Metering and Reporting

Event reporting, Sequential Events Recorder (SER), Fast SER messages, and high-accuracy metering eliminate or reduce external metering requirements. Use 180-cycle oscillographic event reports to analyze unit shutdown or system faults. ACSELERATOR QuickSet® SEL-5030 Software simplifies event collection, real-time analog display, and relay settings.

Field Ground Protection

Use the SEL-2664 Field Ground Module to provide field ground protection using dc voltage injection.



Related Products

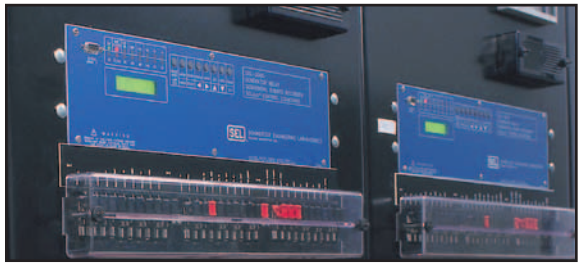
SEL-300G Generator Relay

Applications

- Connect the SEL-300G (with optional current differential elements) across large generators for complete primary and backup protection. 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.
- Apply sensitive percentage-restrained current differential elements and an unrestrained element, along with synchronism check and volts-per-hertz elements, across the entire unit to protect both the generator and the step-up transformer.
- Replace auxiliary meters at the generating station by taking advantage of accurate internal metering.
- Use the six-step frequency elements to trip for under- and overfrequency operation, while accumulating off-nominal frequency time in each 0.1 Hz band between 20 and 70 Hz. (Note: See IEEE guidelines for use of off-nominal frequency data to track accumulated mechanical stress in turbines.)
- Monitor and record generator utilization with internal hour meters that record stopped time, run time, and full load hours.
- Record accumulated breaker contact wear with the breaker monitor function, which uses manufacturer's specifications for defining breaker operation limits. The internal monitor tracks the total number of close/open operations and integrates interrupted current per phase. Set an alarm to alert operators when measured and accumulated quantities approach maintenance thresholds. This information facilitates proactive breaker maintenance and replacement without underutilizing resources.
- Monitor field ground resistance with state-of-the-art voltage injection. Protect generators from damage by responding to low field resistance warnings.

Optional Features

- Synchronism-checking element.
- Three-phase current differential or ground differential elements.
- Additional optoisolated inputs and standard or high-current interrupting output contacts.
- Rack-mount or panel-mount hardware.
- Connectorized® (plug-in connectors).
- Modbus® RTU protocol.
- Compatible with the SEL-2600 RTD Module.
- Field ground protection with the SEL-2664 Field Ground Module.
- Conformal coating.



Installation of SEL-300G Generator Relays protecting two 30 MVA generators at the Lake Chelan hydro facility. Photograph courtesy of Chelan County PUD.

Hardware Specifications

AC Voltage Inputs

80–208 V_{L-L} nominal, for 4-wire wye voltage input

80–140 V_{L-L} nominal, for 3-wire delta voltage input

300 V_{L-N} continuous limit for 3-phase, 4-wire wye connection

300 V_{L-L} continuous limit for 3-phase, 3-wire delta connection

300 V continuous, V_{N-NN} neutral voltage input

300 V continuous, V_{S-NS} synch voltage input

365 Vac for 10 seconds

Burden 0.13 VA @ 67 V; 0.45 VA @ 120 V; 0.80 VA @ 300 V

AC Current Inputs

5 A nominal

15 A continuous, 500 A for 1 second, linear to 100 A symmetrical, 1250 A for 1 cycle

Burden 0.27 VA @ 5 A; 2.51 VA @ 15 A

1 A nominal

3 A continuous, 100 A for 1 second, linear to 20 A symmetrical, 250 A for 1 cycle

Burden 0.13 VA @ 1 A; 1.31 VA @ 3 A

Power Supply Ratings

125/250 V 85–350 Vdc or 85–264 Vac

48/125 V 38–200 Vdc or 85–140 Vac

24/48 V 20–60 Vdc

<25 W total burden

Standard Control Input and Output Ranges

24, 48, 125, or 250 Vdc

Standard configuration provides 6 inputs and 8 outputs, <5 ms pickup/dropout times with 30 A make, 6 A continuous duty.

Additional interface I/O board may be selected with standard inputs and high-current interrupting outputs.

Operating Temperature

–40° to +85°C (–40° to +185°F)

(Note: LCD contrast impaired for temperatures below –20°C)

Price

Budgetary Retail, Quantity 1: $3,100

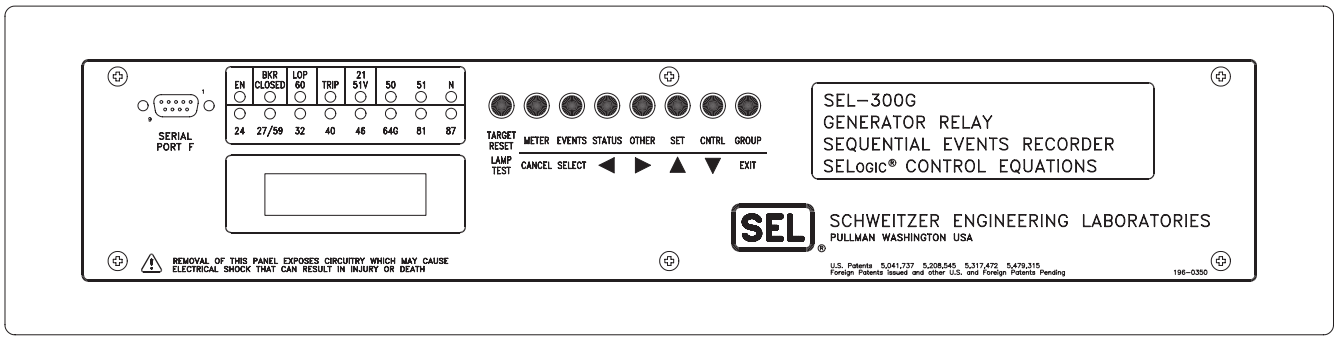
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

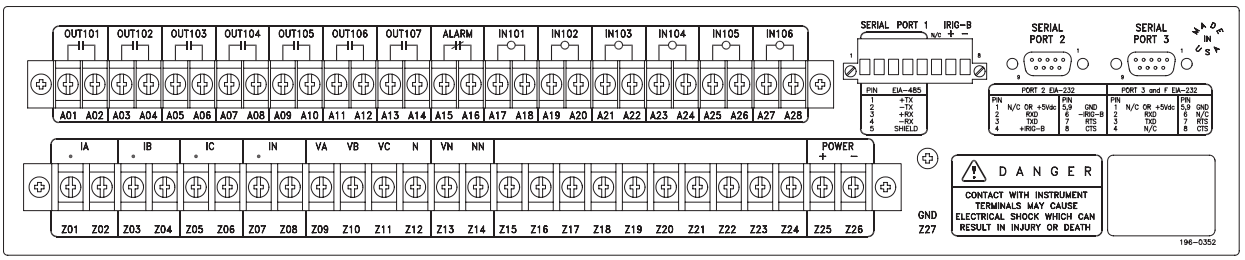
SEL-300G Generator Relay

Front View – Panel-Mount



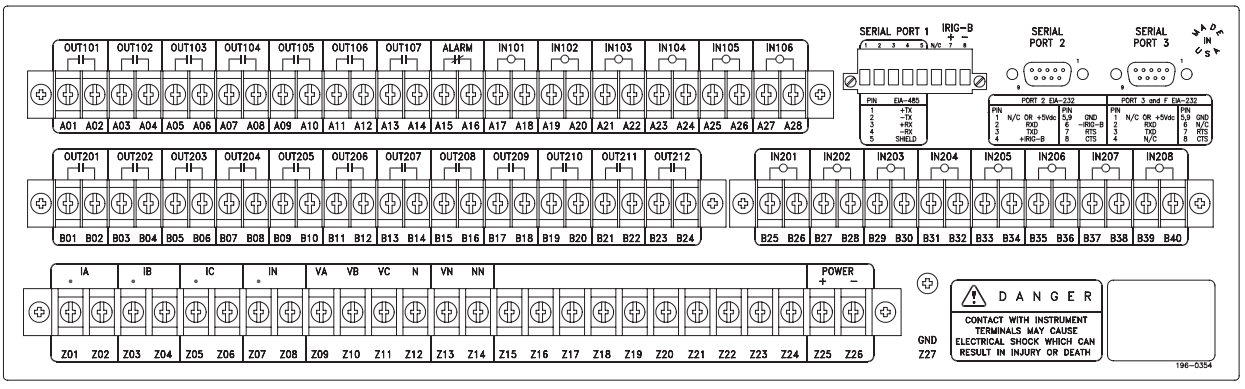
I3053a

Rear View – Conventional Terminal Blocks (2U)



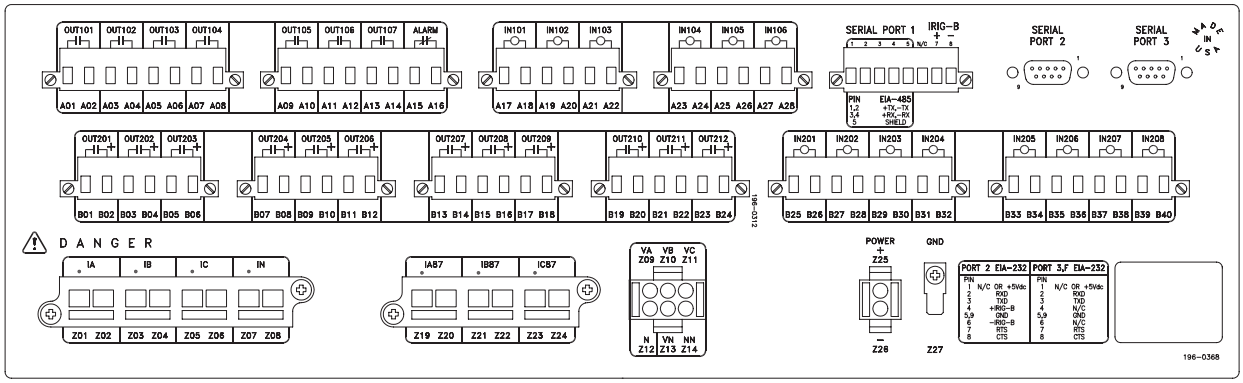
I3049b

Rear View – Conventional Terminal Blocks – Additional I/O (3U)



I3056b

Rear View – Connectorized® – Additional I/O (3U)



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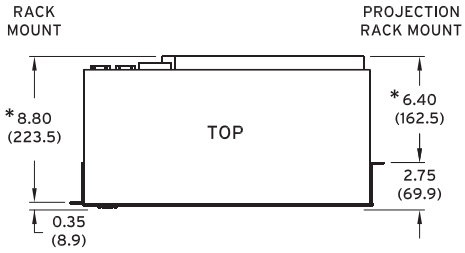
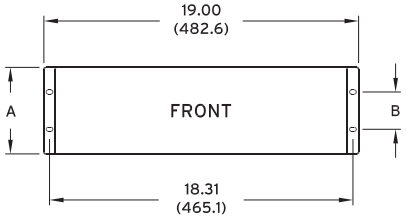
Dimensions

RACK-MOUNT CHASSIS

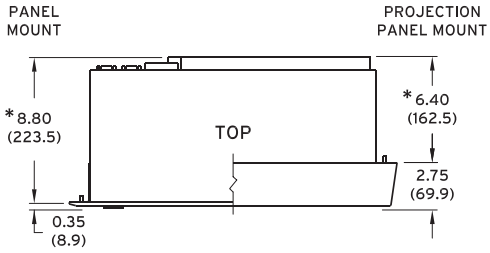


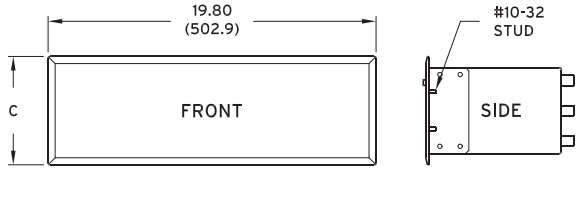


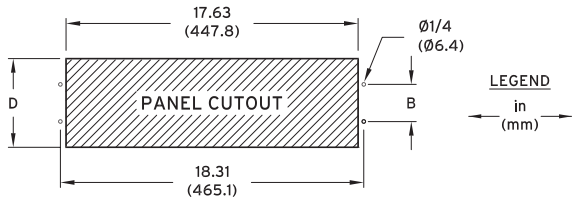
DIMENSION	MAIN BOARD ONLY (2U)	ONE I/O BOARD (3U)
A	3.47 (88.1)	5.22 (132.6)
B	3.00 (76.2)	2.25 (57.2)
C	4.90 (124.5)	6.65 (168.9)
D	3.60 (91.4)	5.35 (135.9)

*ADD 0.65 (16.5) FOR CONNECTORIZED RELAYS

PANEL-MOUNT CHASSIS







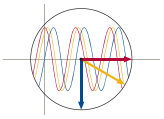
i9009b

Visit www.selinc.com for more detailed information and configuration options.

SEL-700G Generator Protection Relay

The SEL-700G is the right solution for industrial and utility generator protection, with autosynchronizer, flexible I/O, and advanced communications.

SEL IEC 61850



Key Features

Comprehensive Generator Protection

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

Autosynchronizer

The optional, built-in automatic synchronizer function eliminates the need for expensive external synchronizer equipment. Frequency, voltage, and phase control of the generator are automatically synchronized and connected to the power system.

Easy Communications

Choose from single or dual ports, copper or fiber-optic Ethernet or serial communications, and several protocols, including MIRRORED BITS® communications and IEC 61850. Pick multiple Modbus® TCP or Modbus serial sessions for custom configuration of your application. Use DNP3 Serial or DNP3 LAN/WAN protocol.

One Hundred Percent Stator Ground Detection

The SEL-700G detects stator ground faults on high-impedance grounded generators using a conventional neutral-overvoltage element with a third-harmonic voltage differential detection scheme for 100 percent stator winding coverage.

Current Differential Protection

Optional current differential elements detect stator faults using a secure, sensitive current differential function. Power transformer and CT connection compensation allows the unit step-up transformer to be included in the generator differential zone.

Power Elements

Sensitive power elements protect against reverse power, overload conditions, or low forward power.

RTD-Based Thermal Protection

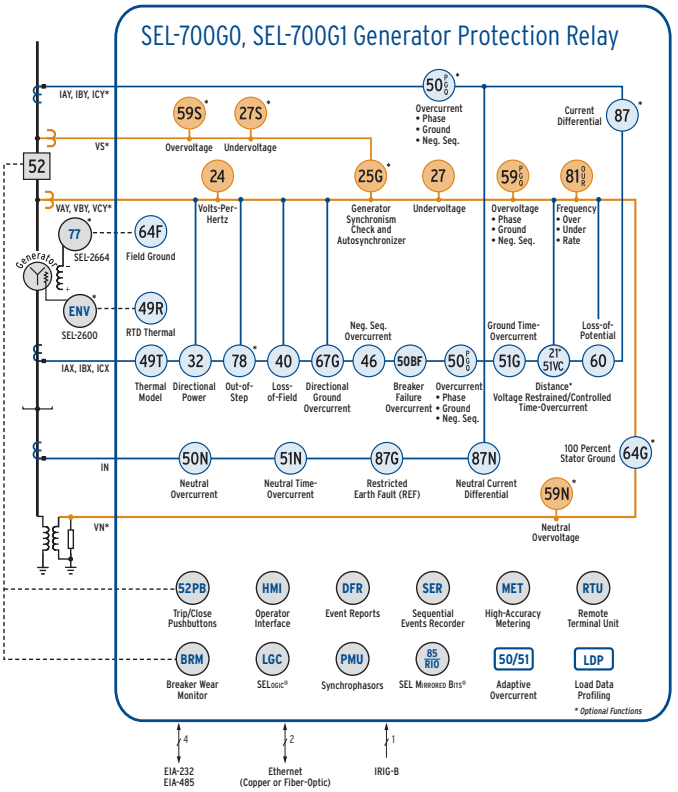
Use an internal 10 RTD input card or an external SEL-2600 RTD Module to acquire thermal data for alarm, monitoring, and trip functions in the SEL-700G.

Metering and Reporting

View generator autosynchronizer, Sequential Events Recorder (SER), and 180-cycle oscillographic event reports to analyze generator startup, shutdown, or system faults. Measure electrical, thermal, and generator run-time quantities.

Synchrophasor Data

Apply SEL synchrophasors (IEEE C37.118) to turn state estimation into state measurement and to provide early warning of potential system instability.



Tel: +1.509.332.1890 | Fax: +1.509.332.7990 | www.selinc.com

SEL-700G Generator Protection Relay

Applications

- Connect the SEL-700G (with optional current differential elements) across large generators for complete primary and backup protection. 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.
- Replace external generator control and synchronizer relays with the built-in automatic synchronizer function. Monitor the generator synchronization process using generator start reports and the PC-based synchroscope.
- Apply sensitive percentage-restrained current differential elements and an unrestrained element, along with synchronism check and volts-per-hertz elements, across the entire unit to protect both the generator and the step-up transformer.
- Use the high-accuracy, six-level frequency elements to trip for under- and overfrequency operation, while accumulating off-nominal frequency time in up to six frequency bands.
- Monitor and record generator utilization with internal meters that record stopped time, run time, full load hours, average power, and average power factor.
- Record accumulated breaker contact wear with the breaker monitor function, which uses manufacturer's specifications for defining breaker operation limits. The internal monitor tracks the total number of close/open operations and integrates interrupted current per phase. Set an alarm to alert operators when measured and accumulated quantities approach maintenance thresholds. This information facilitates proactive breaker maintenance and replacement without underutilizing resources.
- Monitor field ground resistance with state-of-the-art voltage injection. Protect generators from damage by responding to low field resistance warnings.

Optional Features

- Single or dual, copper or fiber-optic Ethernet port(s); Modbus TCP; DNP3 Serial and DNP3 LAN/WAN; FTP; Telnet.
- IEC 61850.
- DeviceNet™.
- EIA-232 or EIA-485 communications.
- Additional EIA-232 or EIA-485 port.
- Analog I/O (4 AI/4 AO, 8 AI).
- Digital I/O (4 DI/4 DO, 4 DI/3 DO, 8 DI, 8 DO, 3 DI/4 DO/1 AO).
- Voltage and current options.
- 10 RTDs.
- Conformal coating.

Related Products

Hardware Specifications

AC Phase and Neutral Current Inputs

Nominal Current I_{NOM}	1 A or 5 A
Burden	<0.01 VA @ 1 A; <0.10 VA @ 5 A
Continuous	3 • I_{NOM}
1 Second Thermal	100 • I_{NOM}

AC Voltage Inputs

Rated Operating Voltage	100–250 Vac
Rated Continuous Voltage	300 Vac
10 Second Thermal	600 Vac
Burden	<0.1 VA at 300 Vac

Power Supply Ratings

110–250 Vdc, 110–240 Vac (–22% to +10%)
24/48 Vdc
<40 VA (ac) or 20 W (dc) total burden

Optoisolated Control Input Ranges

24, 48, 110, 125, 220, or 250 Vdc or Vac
Control inputs are externally wetted
2 inputs standard

Contact Outputs

Operating Voltage	240 Vac/250 Vdc
Rated Insulation Voltage	300 Vac/300 Vdc

3 outputs standard

Operating Temperature

–40° to +85°C (–40° to +185°F)

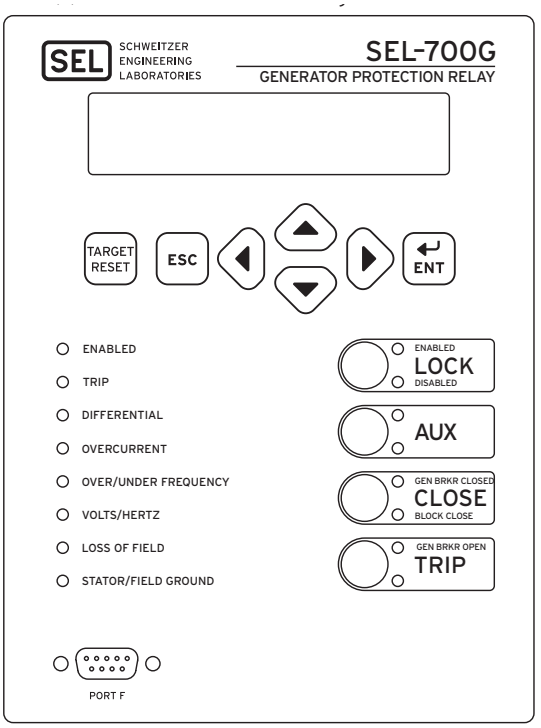
Price

Budgetary Retail, Quantity 1: $2,500

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

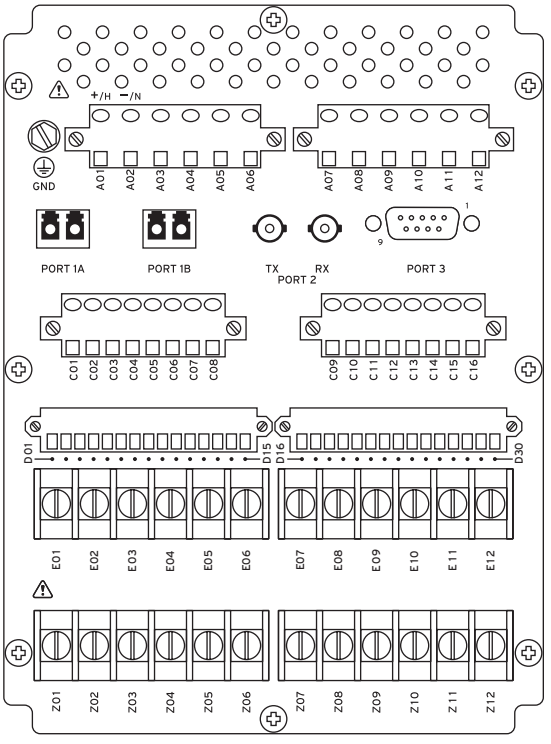
SEL-700G Generator Protection Relay

Front View



i4485a

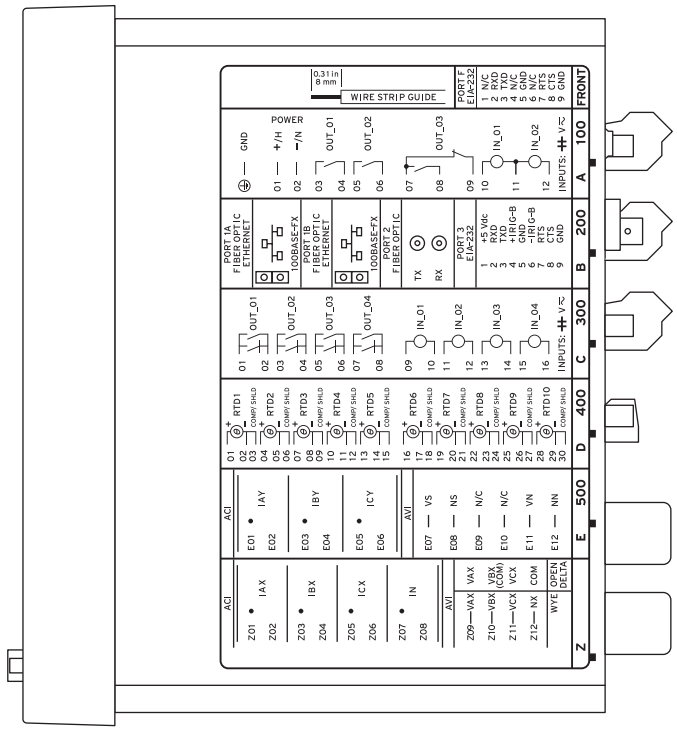
Rear View - Wire Terminal Legend



i4491a

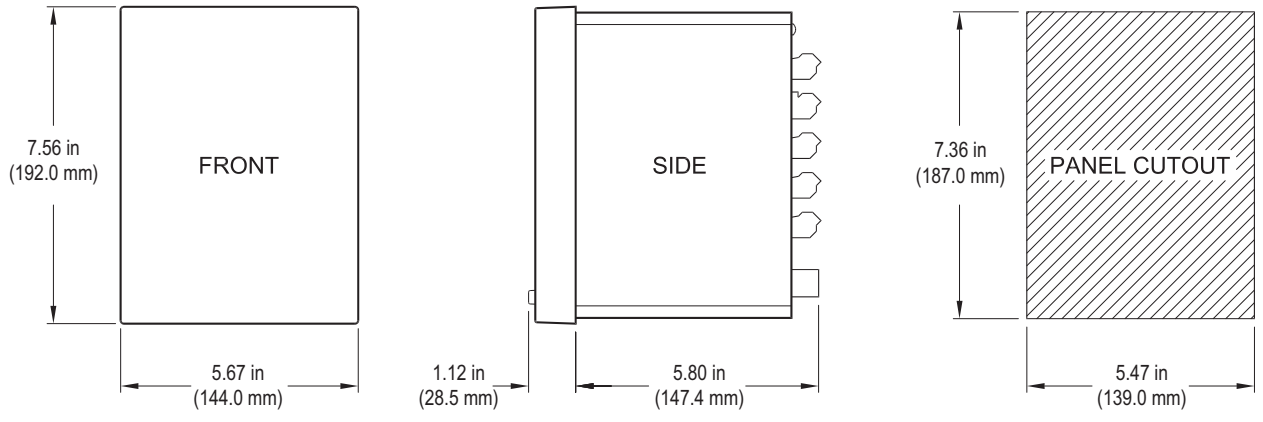
SEL-700G Generator Protection Relay

Side View



i4488a

Dimensions



i9089b

Visit www.selinc.com for more detailed information and configuration options.

SEL-700GT Intertie Protection Relay

Apply the SEL-700GT for comprehensive intertie and distributed generation protection.

SEL IEC 61850

SEL Synchrophasors™

Key Features

Complete Intertie and Generator Protection

The SEL-700GT provides an IEEE 1547-compliant intertie protection solution for distributed generation. Optional synchronous generator protection and automatic synchronization provide a complete generator and intertie protection system in one compact and economical package.

Intertie Synchronism Check

The SEL-700GT includes the tie synchronism check function, which provides the closing window for the tie breaker when connecting to the utility grid.

Distributed Generation and Utility Interconnection Protection

The SEL-700GT provides voltage-based protection for undervoltage, overvoltage, underfrequency, and overfrequency. Current-based protection functions include directional overcurrent, instantaneous overcurrent, and time-overcurrent.

Optional Generator Protection

Numerous current, voltage, frequency, distance, and power elements provide comprehensive protection for large, medium, and small generators.

Autosynchronizer

The optional, built-in automatic synchronizer function eliminates the need for expensive external synchronizer equipment. Frequency, voltage, and phase control of the generator are automatically synchronized and connected to the power system.

Easy Communications

Choose from single or dual ports, copper or fiber-optic Ethernet or serial communications, and several protocols, including MIRRORED BITS® communications and IEC 61850. Pick multiple Modbus® TCP or Modbus serial sessions for custom configuration of your application. Use DNP3 Serial or DNP3 LAN/WAN protocol.

Directional Power Elements

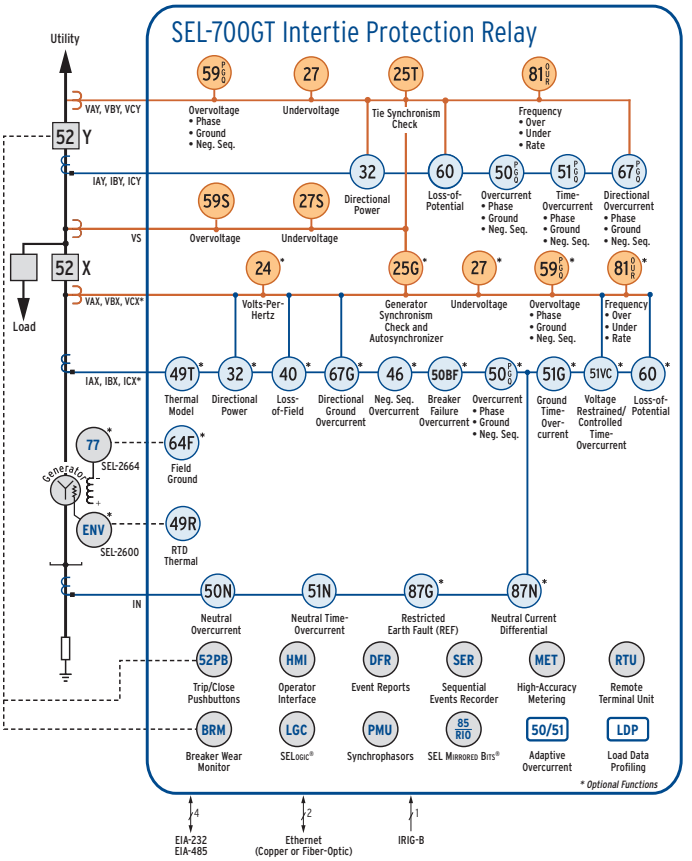
Sensitive power elements protect against reverse power, overload conditions, or low forward power.

Metering and Reporting

View generator autosynchronizer, Sequential Events Recorder (SER), and 180-cycle oscillographic event reports to analyze generator start up, shut down, or system faults. Measure electrical, thermal, and generator run-time quantities.

Synchrophasor Data

Apply SEL synchrophasors (IEEE C37.118) to turn state estimation into state measurement and to provide early warning of potential system instability.



SEL-700GT Intertie Protection Relay

Applications

- Use voltage, current, power, and directional elements to implement an IEEE 1547-compliant, distributed-interconnected generation system.
- Detect power flow problems, and quickly disconnect the utility supply from the load and the distributed resource.
- Use the SEL-700GT (with optional generator protection) to provide a one-device solution for generator protection, intertie protection, and automatic synchronization.
- Replace external generator control and synchronizer relays with the built-in automatic synchronizer function. Monitor the generator synchronization process using generator start reports and the PC-based synchroscope.
- Use the high-accuracy, six-level frequency elements to trip for under- and overfrequency operation, while accumulating off-nominal frequency time in up to six frequency bands.
- Monitor and record generator utilization with internal meters that record stopped time, run time, full load hours, average power, and average power factor.
- Record accumulated breaker contact wear with the breaker monitor function, which uses manufacturer's specifications for defining breaker operation limits. The internal monitor tracks the total number of close/open operations and integrates interrupted current per phase. Set an alarm to alert operators when measured and accumulated quantities approach maintenance thresholds. This information facilitates proactive breaker maintenance and replacement without underutilizing resources.
- Monitor field ground resistance with state-of-the-art voltage injection. Protect generators from damage by responding to low field resistance warnings.

Optional Features

- Single or dual, copper or fiber-optic Ethernet port(s); Modbus TCP; DNP3 Serial and DNP3 LAN/WAN; FTP; Telnet.
- IEC 61850.
- DeviceNet™.
- EIA-232 or EIA-485 communications.
- Additional EIA-232 or EIA-485 port.
- Analog I/O (4 AI/4 AO, 8 AI).
- Digital I/O (4 DI/4 DO, 4 DI/3 DO, 8 DI, 8 DO, 3 DI/4 DO/1 AO).
- Voltage and current options.
- 10 RTDs.
- Conformal coating.

Related Products

SEL Fiber-Optic Transceivers 432–439
SEL-300G Generator Relay 264
SEL-2600 RTD Module 296
SEL-2664 Field Ground Module 280
SEL-2725 Five-Port Ethernet Switch 372

Hardware Specifications

AC Phase and Neutral Current Inputs

Nominal Current I_{NOM}	1 A or 5 A
Burden	<0.01 VA @ 1 A; <0.10 VA @ 5 A
Continuous	3 • I_{NOM}
1 Second Thermal	100 • I_{NOM}

AC Voltage Inputs

Rated Operating Voltage	100–250 Vac
Rated Continuous Voltage	300 Vac
10 Second Thermal	600 Vac
Burden	<0.1 VA at 300 Vac

Power Supply Ratings

110–250 Vdc, 110–240 Vac (–22% to +10%)
24/48 Vdc
<40 VA (ac) or 20 W (dc) total burden

Optoisolated Control Input Ranges

24, 48, 110, 125, 220, or 250 Vdc or Vac
Control inputs are externally wetted
2 inputs standard

Contact Outputs

Operating Voltage	240 Vac/250 Vdc
Rated Insulation Voltage	300 Vac/300 Vdc

3 outputs standard

Operating Temperature

–40° to +85°C (–40° to +185°F)

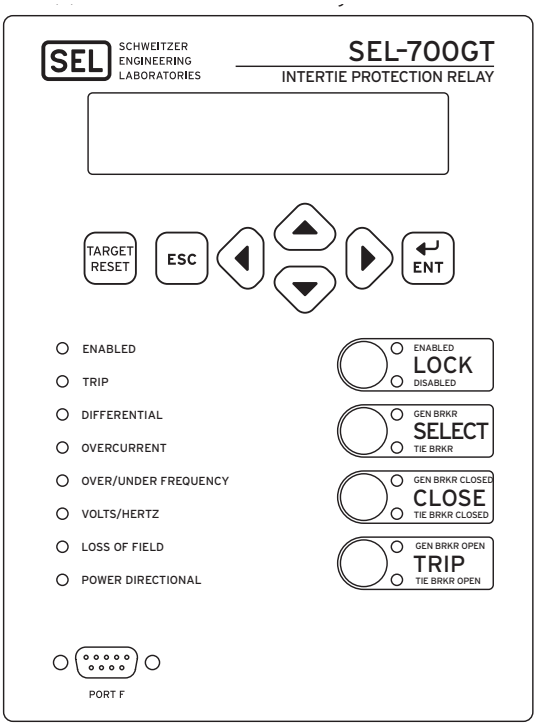
Price

Budgetary Retail, Quantity 1: $2,500

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

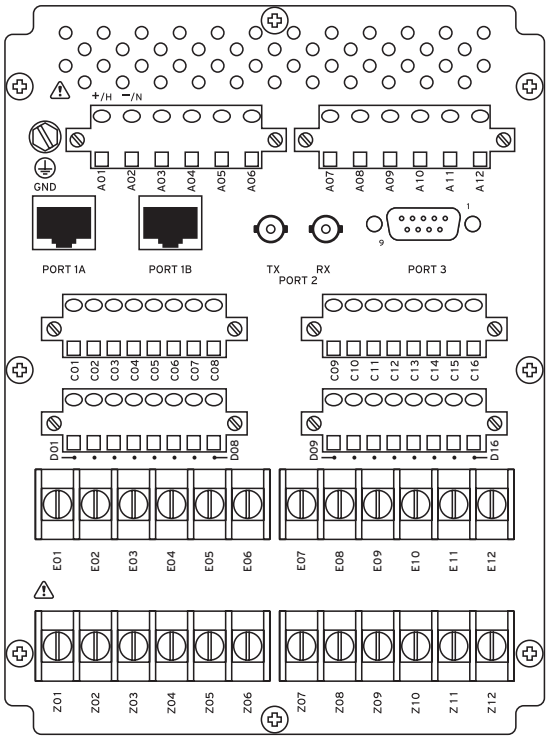
SEL-700GT Intertie Protection Relay

Front View



i4486a

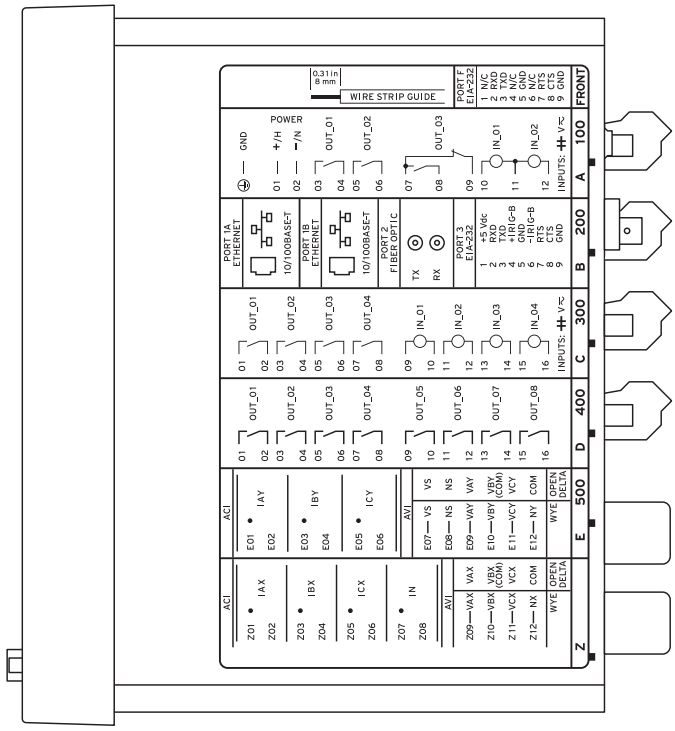
Rear View - Wire Terminal Legend



i4492a

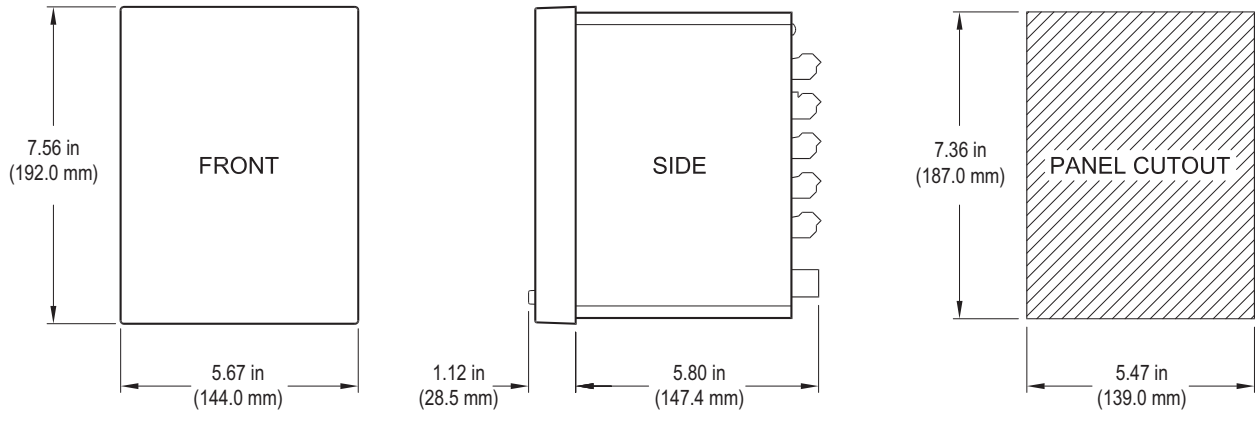
SEL-700GT Intertie Protection Relay

Side View



i4489a

Dimensions



i9089b

Visit www.selinc.com for more detailed information and configuration options.

SEL-700GW Wind Generator Relay

Apply the SEL-700GW to protect wind generation feeders.

SEL IEC 61850

Key Features

Wind Generator Dual Feeder Protection

The SEL-700GW maximizes wind turbine availability by isolating feeder faults. When a fault occurs, dual overcurrent elements isolate the fault on the affected feeders.

Convenient Controls

Use the four programmable pushbuttons on the front for quick, personalized control.

Easy Communications

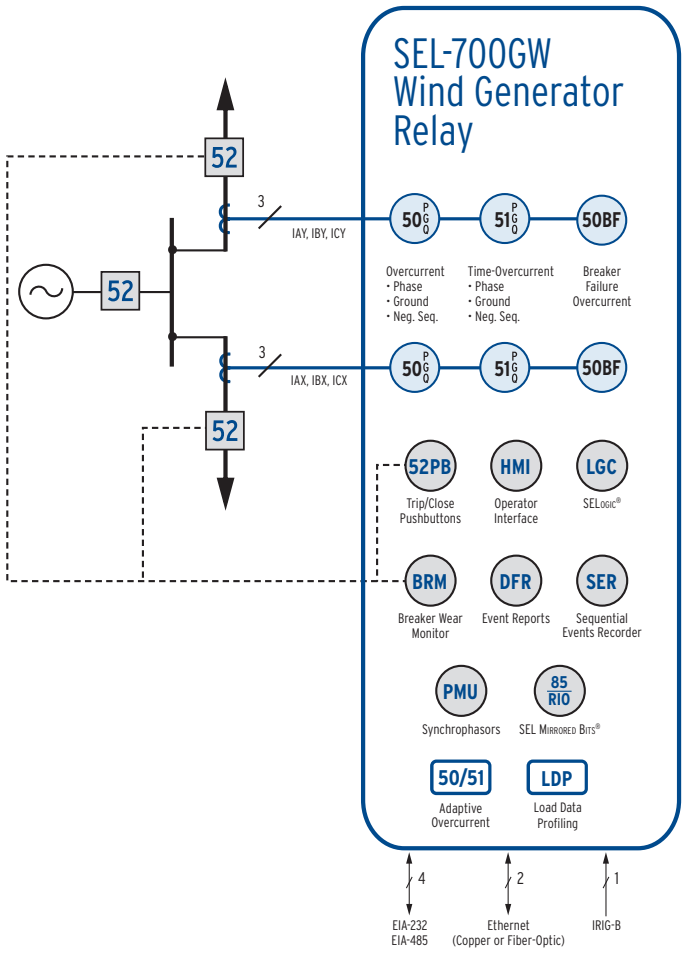
Choose from single or dual ports, copper or fiber-optic Ethernet or serial communications, and several protocols, including MIRRORED BITS® communications and IEC 61850. Pick multiple Modbus® TCP or Modbus serial sessions for custom configuration of your application. Use DNP3 Serial or DNP3 LAN/WAN protocol.

Rugged Design

Rely on the industry's widest ambient operating temperature range, –40° to +85°C (–40° to +185°F).

Synchrophasor Data

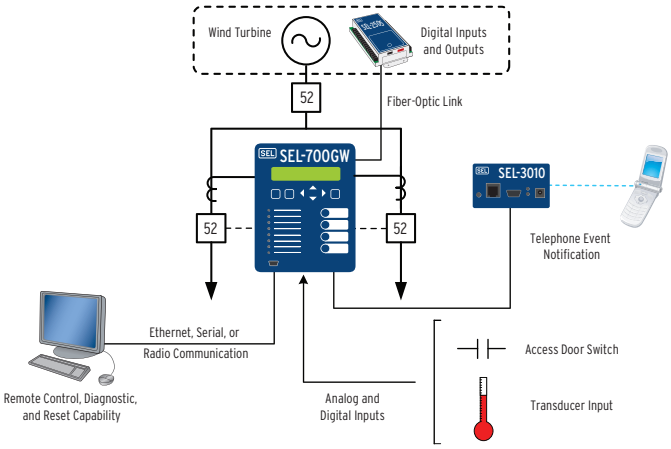
Apply SEL synchrophasors (IEEE C37.118) to turn state estimation into state measurement and to provide early warning of potential system instability.



SEL-700GW Wind Generator Relay

Applications

The SEL-700GW is a complete feeder protection solution for distributed generation. The SEL-700GW provides high system availability by using two sets of overcurrent elements (50/51) to detect and isolate a fault on either feeder. The SEL-700GW also provides many functions of a programmable logic controller (PLC). Multiple communications options, a variety of I/O choices, and programmable SELOGIC® control equations make the SEL-700GW a complete solution.



The application shown includes optional Ethernet and SELECT I/O cards for analog and digital I/O. The SEL-3010 Event Messenger and SEL-2505 Remote I/O Module are sold separately.

Optional Features

- Single or dual, copper or fiber-optic Ethernet port(s); Modbus TCP; DNP3 Serial and DNP3 LAN/WAN; FTP; Telnet.
- IEC 61850.
- DeviceNet™.
- EIA-232 or EIA-485 communications.
- Additional EIA-232 or EIA-485 port.
- Analog I/O (4 AI/4 AO, 8 AI).
- Digital I/O (4 DI/4 DO, 4 DI/3 DO, 8 DI, 8 DO, 3 DI/4 DO/1 AO).
- Voltage and current options.
- 10 RTDs.
- Conformal coating.

Related Products

Hardware Specifications

AC Phase and Neutral Current Inputs

Nominal Current, I_{NOM}	1 A or 5 A
Burden	<0.01 VA @ 1 A; <0.10 VA @ 5 A
Continuous	3 • I_{NOM}
1 Second Thermal	100 • I_{NOM}

AC Voltage Inputs

Rated Operating Voltage	100–250 Vac
Rated Continuous Voltage	300 Vac
10 Second Thermal	600 Vac
Burden	<0.1 VA at 300 Vac

Power Supply Ratings

110–250 Vdc, 110–240 Vac (–22% to +10%)
24/48 Vdc
<40 VA (ac) or 20 W (dc) total burden

Optoisolated Control Input Ranges

24, 48, 110, 125, 220, or 250 Vdc or Vac
Control inputs are externally wetted
2 inputs standard

Contact Outputs

Operating Voltage	240 Vac/250 Vdc
Rated Insulation Voltage	300 Vac/300 Vdc

3 outputs standard

Operating Temperature

–40° to +85°C (–40° to +185°F)

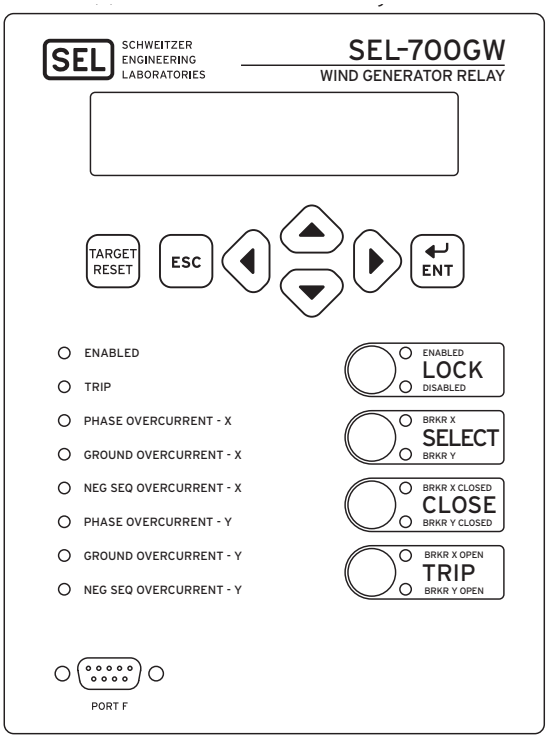
Price

Budgetary Retail, Quantity 1: $1,500

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

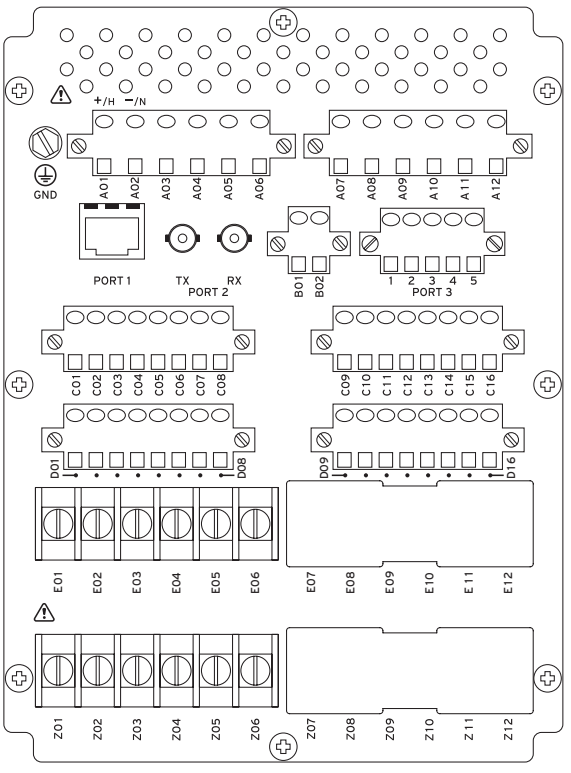
SEL-700GW Wind Generator Relay

Front View



i4487a

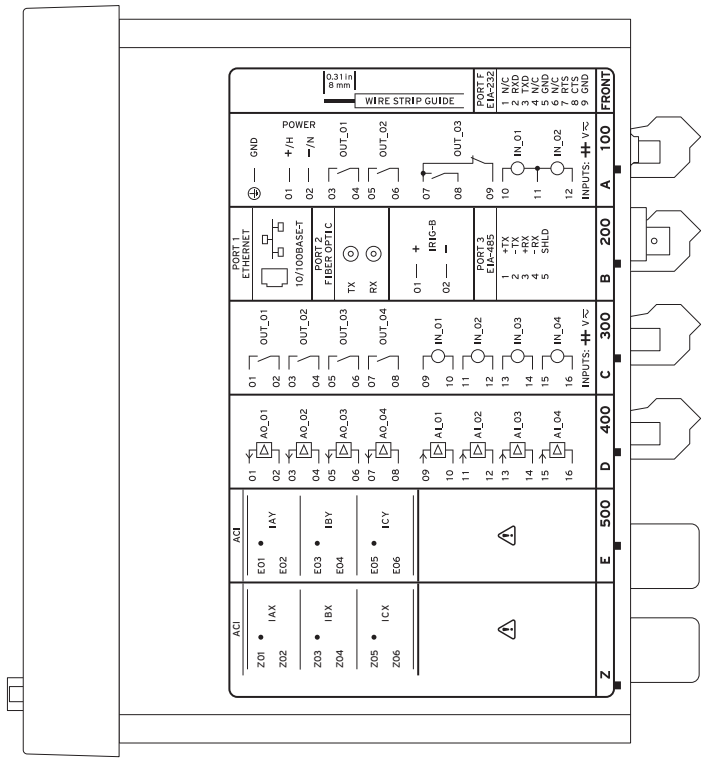
Rear View - Wire Terminal Legend



i4493b

SEL-700GW Wind Generator Relay

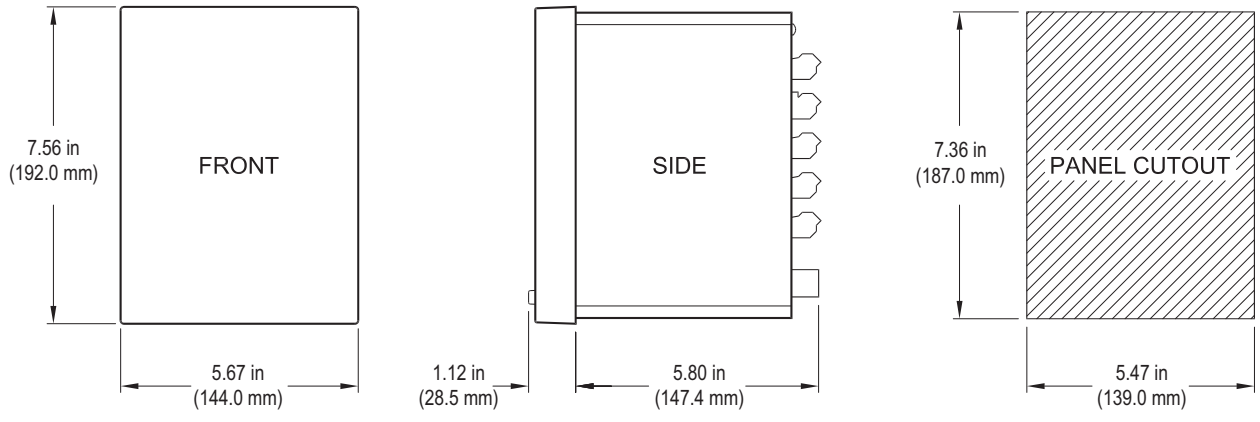
Side View



‡ SEE DOCUMENTATION FOR INPUT VOLTAGE RATING

i4490b

Dimensions



i9089b

Visit www.selinc.com for more detailed information and configuration options.

SEL-2664 Field Ground Module

Minimize generator damage with field ground monitoring.

Key Features

Plug-In Compatibility With SEL-300G, SEL-700G, and SEL-700GT+

Designed to work with the SEL generator relays to provide complete generator protection. Add the SEL-2664 Field Ground Module to the SEL-300G, SEL-700G, and SEL-700GT+ to protect all the critical components in your generator with one comprehensive relay.

Continuously Measure the Field-to-Ground Resistance

Protect your generator from excessive starting stress by detecting field-to-ground faults prior to startup. Continuously monitor resistance to ground during operation.

Eliminate Noise and Ground Potentials

Avoid potentially hazardous voltages from a high-voltage dc field to the relay or relay panel using digital fiber-optic communication. Eliminate tedious calibrations and variations common when using analog signals to the relay.

Wide Temperature Range

Benefit from accurate timing during any operating condition. The SEL-2664 is tested for operation from −40° to +85°C.

High Accuracy

Ensure maximum operation time with precise measurements and trip calculations. Benefit from best-in-class accuracy at 500 ohms, ±5 percent.

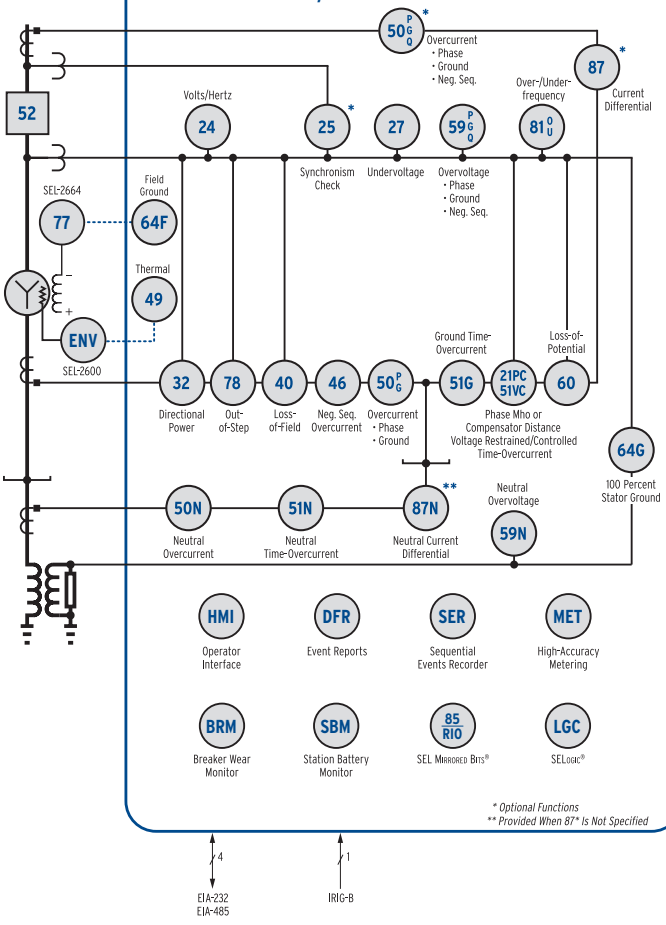
Easy Setup

The SEL-2664 is ready to connect to your generator field winding right out of the box. The SEL-300G, SEL-700G, and SEL-700GT+ automatically recognize the connection and configure the protection in the relay. Simply turn on the 64F element, and set the port, alarm, and trip values in the relay. ACSELERATOR QuickSet® SEL-5030 Software makes it quick and easy.

Wide-Range Power Supply

Operate at all power supply rating levels, with nominal voltage range of 24–250 Vdc or nominal ac power range of 110–240 Vac.

SEL-300G Relay With SEL-2664 Module



GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Tel: +1.509.332.1890 | Fax: +1.509.332.7990 | www.selinc.com

SEL-2664 Field Ground Module

Applications

- Works with most large or small generators.
- Integrated 64F protection with SEL-300G, SEL-700G, and SEL-700GT+ Relays.
- Configurable to trip, warn, or simply monitor field-to-ground resistance.
- Sensitive early detection of field-to-ground faults.
- Channel verification, module status, and noise immunity provided by fiber-optic communication.

SEL-2664 and SEL-300G with fiber-optic communications link.

Related Products

Hardware Specifications

DC Voltage Inputs

60–750 Vdc ±10% field circuit continuous operating range
1500 Vdc for 60 seconds, 0.5 A continuous

Steady-State Accuracy

Metering up to 20 MΩ
64F pickup range 500 Ω–200 kΩ
±5% ±500 Ω for 48 ≤VF ≤825 Vdc
±5% ±20 kΩ for 825 ≤VF ≤1500 Vdc

Power Supply Ratings

Nominal Input Voltage
24–250 Vdc
110–240 Vac (50/60 Hz)

Input Voltage Range
18–300 Vdc
85–264 Vac

Operating Temperature

Relay module −40° to +85°C (−40° to +185°F)

Conformal Coating

Standard

Fiber-Optic Port

One port consisting of a transmit (no receive) multimode fiber-optic interface with ST® connections

Transmission Distance	≤1000 m
Fiber-Optic Cable	50, 62.5, and 200 µm fiber
Wavelength	850 nm
Data Rate	≥2400 bps
Optical Source	850 nm VCSEL transmitter

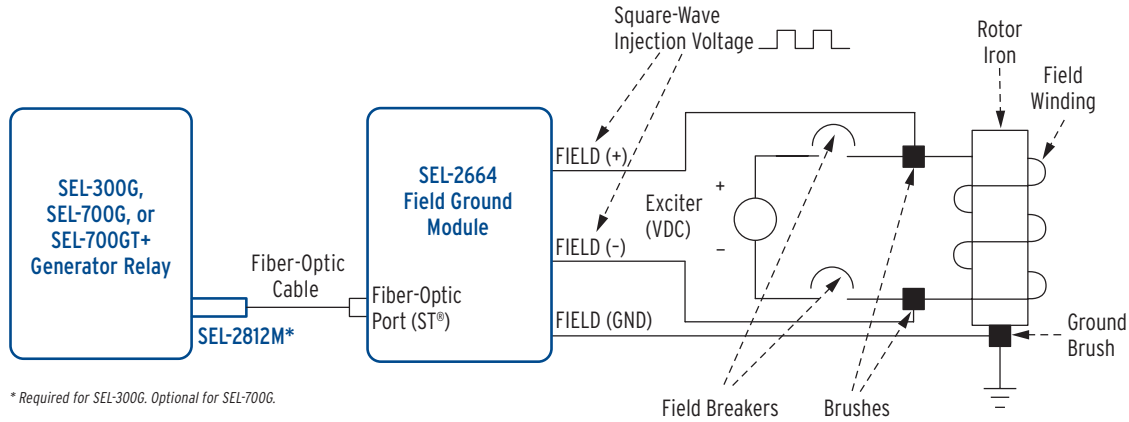
Eye-safe, Class 1 laser product per EN 60825-1

Price

Budgetary Retail, Quantity 1: $1,500

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

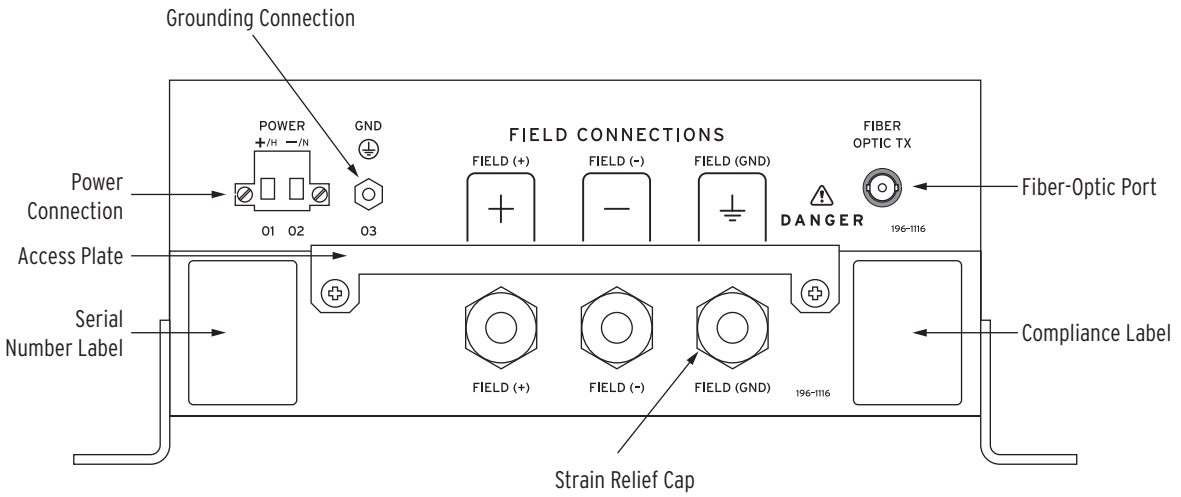
Generator Protection With SEL-300G or SEL-700G Relays



** Required for SEL-300G. Optional for SEL-700G.*

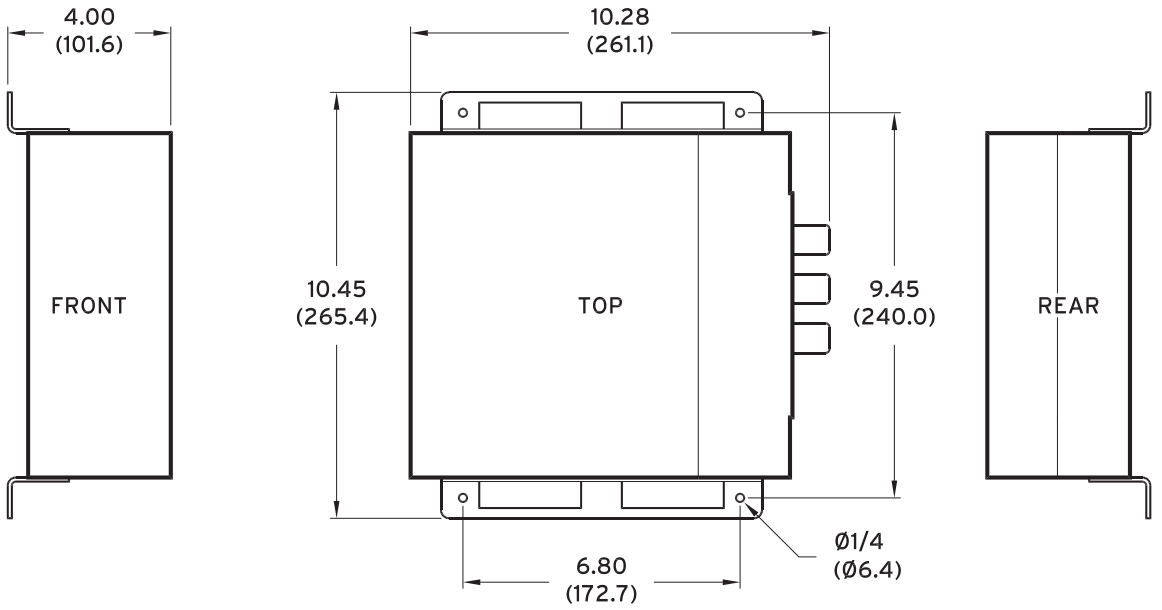
SEL-2664 Field Ground Module

Back View



Dimensions

WALL-MOUNT CHASSIS

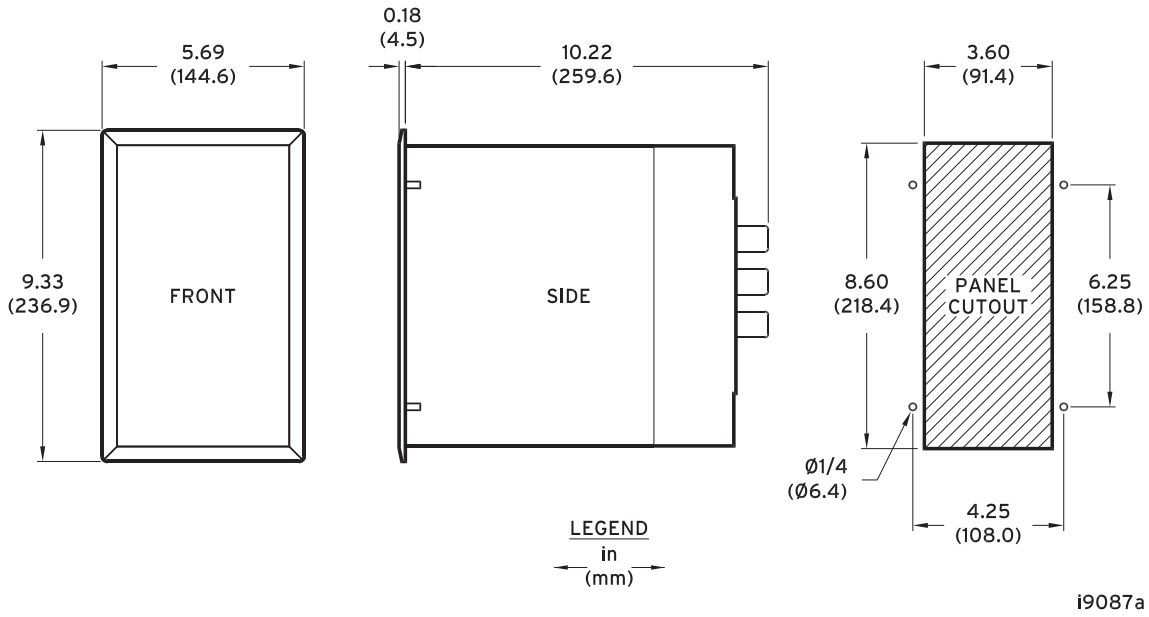


LEGEND
in
(mm)

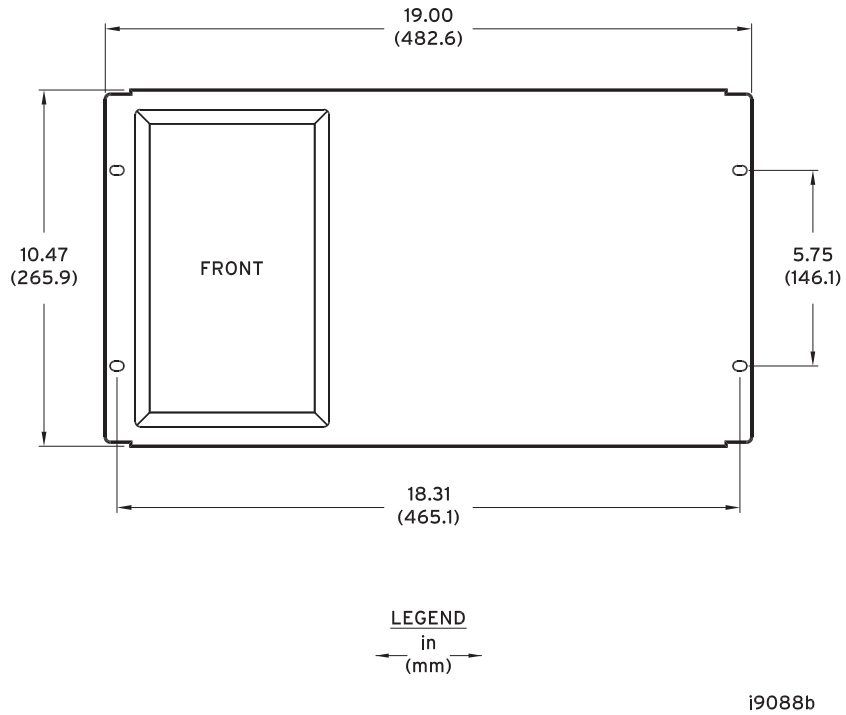
i9081b

Dimensions

PANEL-MOUNT CHASSIS



RACK-MOUNT CHASSIS



Visit www.selinc.com for more detailed information and configuration options.

SEL-710 Motor Protection Relay

Apply advanced motor protection for the industry's toughest applications.

SEL IEC 61850

Key Features

Keep the Motor Running and Improve Protection

The SEL-710 Motor Protection Relay features the industry's most accurate motor protection together with settings, mounting, and communications options designed for easy application. The SEL-710 with the AccuTrack™ Thermal Model determines the longest safe starting time and reduces wait time between motor starts up to 33 percent. Avoid unwanted trips, even during cyclic overloads, with patented SEL technology. Choose from many communications protocols for fast integration into control systems. SEL relays have the highest reliability in the industry to keep the process running.

Restart Sooner and Allow Longer Start Time

Accurate tracking of heating during startup can provide faster restart times for all motors and longer starting times for slow-starting motors. Real-time calculation of varying motor resistance during startup allows minimum waits between starts and maximum start time for slow-starting motors.

Easy Communications and Multiple Sessions

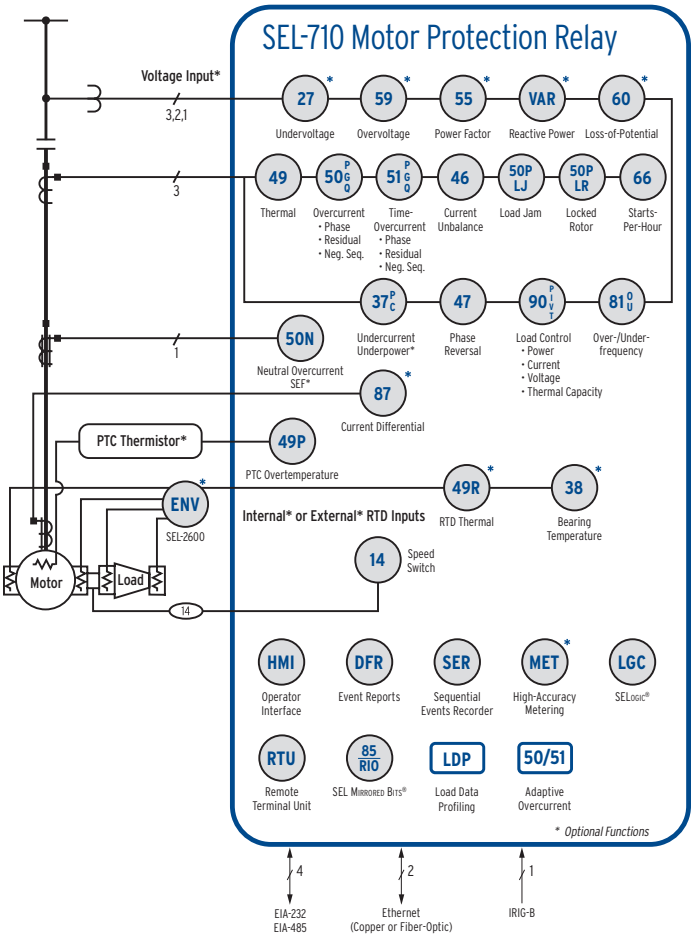
Choose from single or dual ports, copper or fiber-optic Ethernet, IEC 61850, Mirrored Bits® communications, Modbus® TCP, DeviceNet™, Modbus RTU, EIA-232, EIA-485, Telnet, and File Transfer Protocols. Pick one or multiple connections, including multiple communications sessions.

Rugged Design

Meet your demanding application needs with all-metal construction, −40° to +85°C operating temperature range, and testing and certification to power system relay standards for high reliability. The SEL-710 is approved by UL for use in tough Class I, Zone 2 hazardous locations.

Easy Setup Options

Easily set up with 12 basic nameplate settings, or use the advanced features with acSELerator QuickSet® SEL-5030 Software.

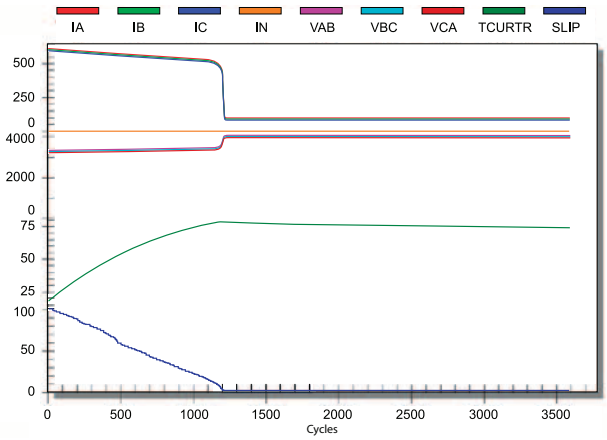


Tel: +1.509.332.1890 | Fax: +1.509.332.7990 | www.selinc.com

SEL-710 Motor Protection Relay

Monitoring Features

- Event summaries that contain relay ID, date and time, trip cause, and current/voltage magnitudes.
- Event reports, including filtered and raw analog data.
- Sequential Events Recorder (SER) keeps 1,024 events in memory.
- Motor start trend data for the past eighteen 30-day intervals.
- A complete suite of accurate metering functions.
- Graphical data and motor start reports, for as long as 60 seconds, for each of the last five starts.



Easily troubleshoot motor starting problems with the industry's only complete graphical motor start report included in ACSELERATOR QuickSet® for the SEL-710.

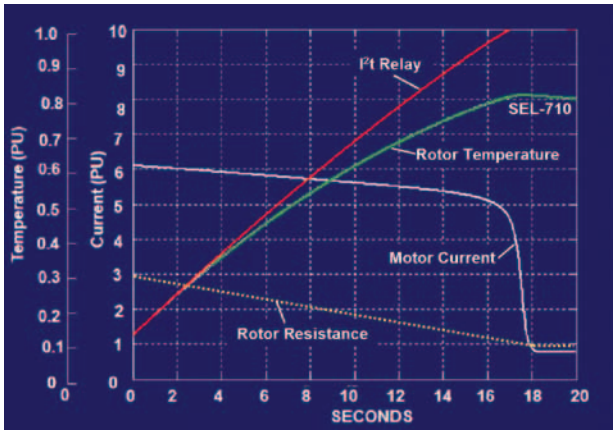
Communications and Control

- EIA-232 front-panel port.
- EIA-232, EIA-485, single or dual ports, copper or fiber-optic Ethernet, and fiber-optic* serial rear-panel ports.
- Redundant Ethernet ports with failover or switch mode.
- IRIG-B or PTC connection.
- Modbus RTU Slave, Modbus TCP, Ethernet, IEC 61850, Telnet, DeviceNet, and File Transfer Protocols.
- SEL ASCII, MIRRORED BITS communications, compressed ASCII, Fast Meter, Fast Operate, Fast SER, and Fast Message protocols.
- Programmable Boolean and math operators, logic functions, and analog comparison.
- Motor-operating statistics since the last reset.
  - Running and stopped times
  - Number of starts and emergency starts
  - Average and peak metering values during start and run periods
  - Load profiling
  - Number of various alarms and trips

* Eye-safe, Class 1 LED product per EN 60825-1

Best-in-Class Thermal Modeling

The SEL-710 provides locked rotor, running overload, and negative-sequence current unbalance protection and much more using a slip-based thermal model that maximizes motor horsepower. The relay accurately tracks the heating effects of load current and current unbalance while the motor is starting and running.



Accurate thermal modeling provides protection that maximizes motor horsepower while providing excellent protection from damage.

Protection Features

- Thermal overload (thermal model) (49).
- Undercurrent (load loss) (37).
- Current unbalance and phase loss (46).
- Overcurrent (load jam).
- Short circuit (50P).
- Ground fault (50G and 50N).
- Time-overcurrent (51P/51G/51Q).
- Current differential (87).
- Frequency (81).
- Breaker/contactor failure protection.
- PTC overtemperature (49).
- Undervoltage (27).
- Overvoltage (59).
- Phase reversal (47).
- Power factor (55).
- Underpower (37).
- Reactive power.
- Motor starting/running.
- Notching or jogging device (66).
- Rotor and stator TCU (thermal capacity utilization) start inhibit.
- Anti-backspin timer.
- Two-speed protection.
- Reduced-voltage starting (19).
- Stall-speed switch (14).
- Motor-slip calculation.
- Dynamic motor-resistance calculation.

SEL-710 Motor Protection Relay

Applications

- Slip-based resistance calculation provides the longest safe start times available for high-inertia motors.
- Accurate temperature tracking allows the soonest possible safe restart times.
- Quickly program using nameplate data.
- Protects all three-phase motors.
- Apply with reduced-voltage start (including wye-delta starting) and two-speed motors.
- Avoid misoperation during cyclic overloads (e.g., crushers and chippers).
- Use motor monitoring to confirm motor sizing, understand events, schedule maintenance, modify loads, and provide data to supervisory systems.
- Use optional RTD card for accurate temperature data to bias the thermal overload model.
- Apply built-in positive temperature coefficient (PTC) thermistor motor winding protection.
- Install in unfavorable environmental conditions. The relay operates from −40° to +85°C with as much as 95 percent relative humidity (noncondensing).
- Detect load loss from pump cavitation or coupling failure.

Optional Features

- Communications protocol card.
  - Rear EIA-232 or EIA-485 with optional single or dual ports, copper or fiber-optic Ethernet, and choice between IRIG-B and PTC input
  - DeviceNet communications card.
- Voltage inputs card.
  - Three-phase voltages for voltage, power, and power factor protection and measurement
  - Wye-connected Va, Vb, and Vc or open delta-connected Vab and Vbc (300 Vac maximum)
- Optional RTD inputs.
  - Connect to an internal card with 10 RTD inputs
  - Connect an external SEL-2600 RTD Module using fiber-optic communication
- I/O expansion cards.
  - AC voltage inputs
  - AC voltage inputs with current differential
  - 10 RTD inputs
  - 8 analog inputs (AI) or 4 AI/4 analog outputs (AO)
  - 4 digital inputs (DI), 4 digital outputs (DO)
  - 3 DI, 4 DO, 1 AO
  - 8 DI
  - 4 DI, 4 DO with fast, high-current interrupting capability
  - 4 DI, 3 DO (2 Form C and 1 Form B)
- Conformal coating.

Hardware Specifications

Phase Current Inputs

Nominal Current I_{NOM}	1 A or 5 A
Burden	<0.01 VA @ 1 A; <0.10 VA @ 5 A
Continuous	3 • I_{NOM}
1 Second Thermal	100 • I_{NOM}

Neutral/Ground Current Input

Nominal Current IN_{NOM}	2.5 mA, 1 A or 5 A
Burden	<0.01 VA @ 1 A; <0.10 VA @ 5 A
Continuous	3 • IN_{NOM}
1 Second Thermal	100 • IN_{NOM}

Optional Phase Voltage Input

Rated Operating Voltage	100–250 Vac
Rated Continuous Voltage	300 Vac
10 Second Thermal	600 Vac
Burden	<0.1 VA at 300 Vac

4-wire wye or open-delta voltage connections

Power Supply Ratings

110–250 Vdc (−20% to +10%)
110–240 Vac (−20% to +10%) 50/60 Hz
24/48 Vdc 20–60 Vdc
<40 VA (ac) or 15 W (dc) total burden

Hazardous Location Rating

UL Class I, Zone 2 approved
ATEX
CSA

Optoisolated Control Input Ranges

24, 48, 110, 125, 220, or 250 Vdc or Vac
Control inputs are externally wetted
2 inputs standard

Contact Outputs

Operating Voltage	240 Vac/250 Vdc
Rated Insulation Voltage	300 Vac/300 Vdc

3 outputs standard

Operating Temperature

−40° to +85°C (−40° to +185°F)

Price

Budgetary Retail, Quantity 1: $2,500

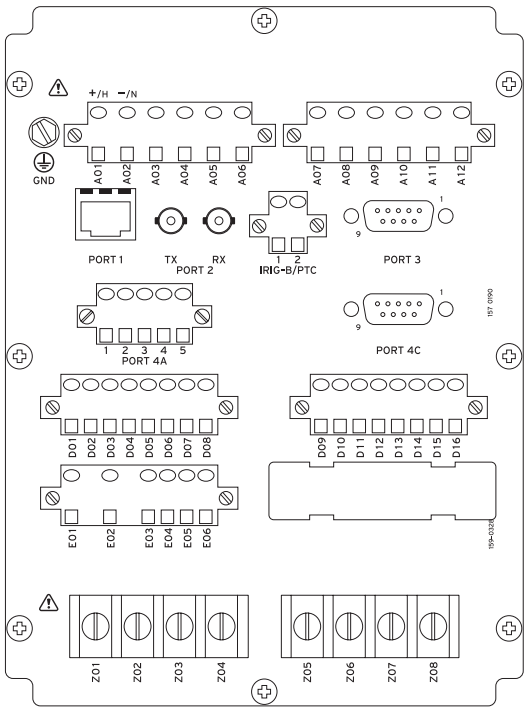
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

SEL-710 Motor Protection Relay

Rear View



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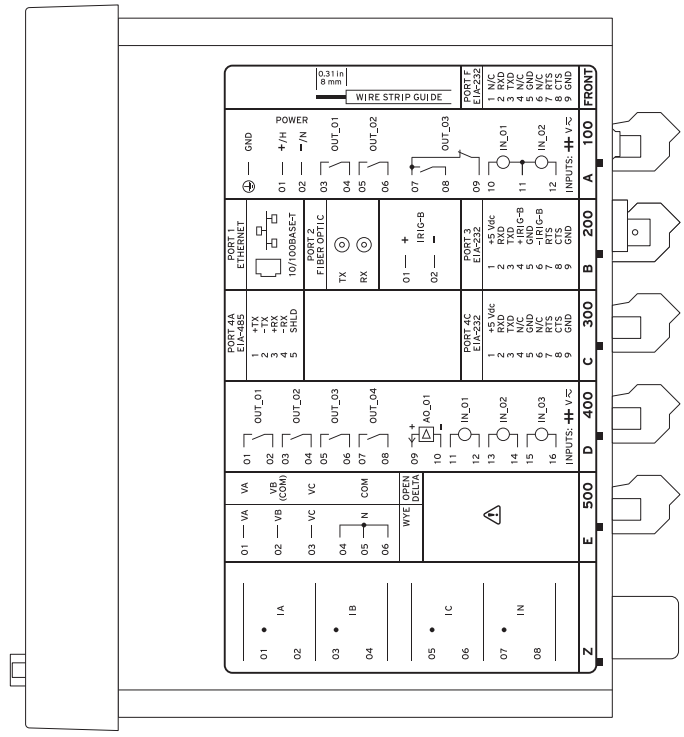
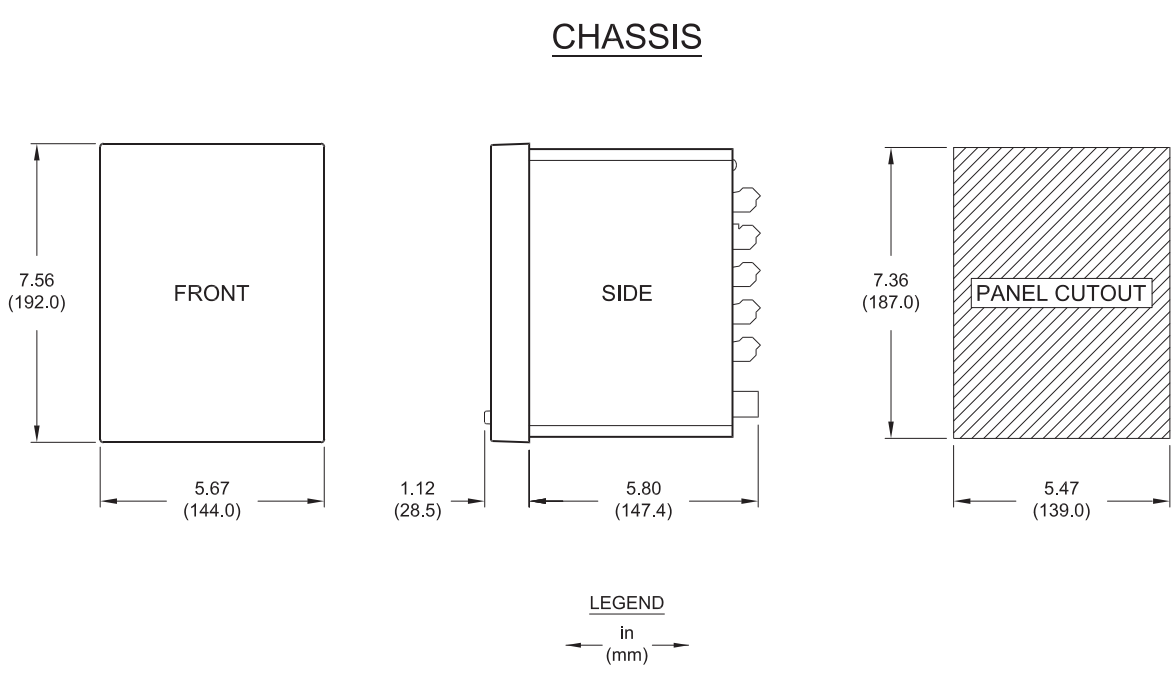
Side View



‡ SEE DOCUMENTATION FOR INPUT VOLTAGE RATING

i3970c

Dimensions



i9089b

Visit www.selinc.com for more detailed information and configuration options.

SEL-749M Motor Relay

Use the reliable and economical SEL-749M to protect three-phase motors, including two-speed and reduced-voltage start motors.

Key Features

Compact, Rugged Hardware

Mount in any motor control center with this UL/IEC switchgear-rated relay. Built to take temperatures from −40° to +85°C and provide years of trouble-free service.

Extensive Communications and Software

Communicate seamlessly with built-in SEL ASCII and optional Modbus® and DeviceNet™ protocols. Quickly and easily set the SEL-749M with the included, Windows®-based ACSELERATOR QuickSet® SEL-5030 Software. View start reports, motor trends, and real-time motor values with the complete meter and control features included in ACSELERATOR®.

Comprehensive Start Reports and Trends

Track motor performance during the critical starting period with complete motor start reports and 30-day average motor start trending. Only SEL offers this valuable tool for tracking motor performance.

Option Cards for Added Functionality

Customize the relay for your particular protection and control applications. Front-panel slide-in labels and programmable target LEDs customize operator interface. Field-install option cards into the base relay to obtain voltage-based protection/control, increased digital I/O with a 4–20 mA analog output, and expanded communications capabilities.

True Temperature-Based Thermal Overload Protection

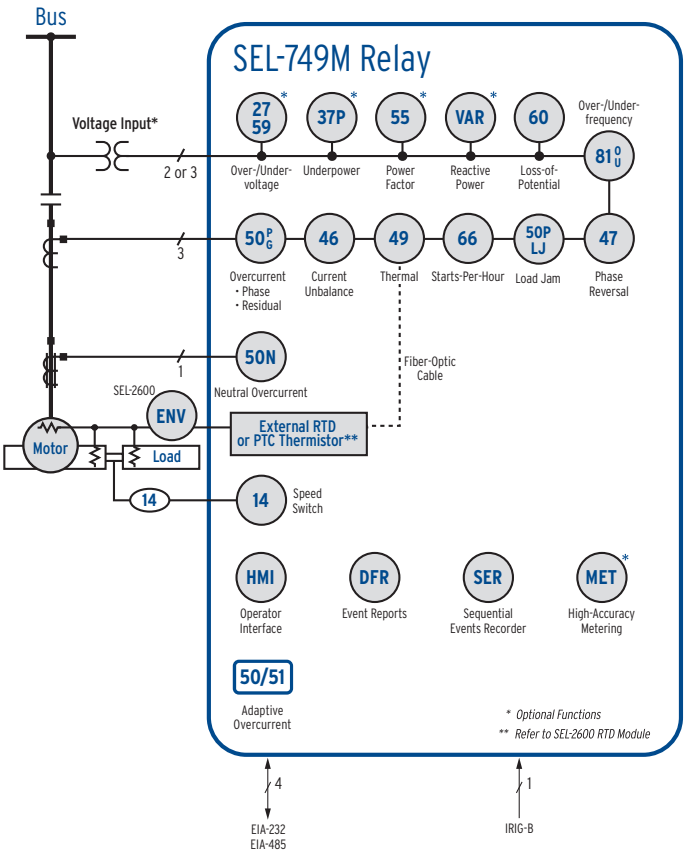
Eliminate false tripping, especially during cyclic overload operations. Release motor capability unavailable with traditional overload relays.

Complete Reporting for Increased Machine Availability

Troubleshoot motor/process problems using valuable, stored information about motors and processes from unique-in-the-industry motor start reports and start trending, motor statistics, oscillograms, event reports, and sequential events records.

Programmable RTDs (Optional)

Connect an SEL-2600 RTD Module for configurable temperature trips and alarms, thermal overload model and RTD biasing, and temperature measurement. Advanced logic detects open or shorted RTD leads, and RTD voting prevents inadvertent tripping caused by failed RTDs.



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SEL-749M Motor Relay

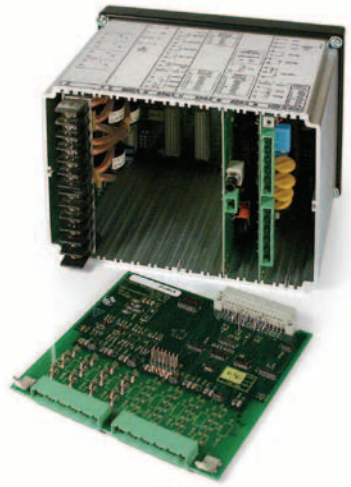
Applications

- Protect low-voltage and medium-voltage induction and synchronous motors.
- Apply with reduced-voltage start (including wye-delta starting) and two-speed motors.
- Avoid misoperations during cyclic overloads (e.g., crushers and chippers).
- Use motor monitoring to confirm motor sizing, understand events, schedule maintenance, modify loads, and provide data to supervisory systems.
- Use RTD temperature data to bias the thermal overload model, or warn and trip from RTD data via the fiber-optic connection to an SEL-2600 RTD Module (optional).
- Apply built-in positive temperature coefficient (PTC) thermistor motor winding protection.
- Install in unfavorable environmental conditions. The relay operates from −40° to +85°C with as much as 95 percent relative humidity (noncondensing).

Optional Features

- Communications protocol card.
  - Modbus RTU EIA-485/232
  - DeviceNet communications card
- Voltage inputs card.
  - Three-phase voltages for voltage, power, and power factor protection and measurement
  - Wye-connected Va, Vb, and Vc or delta-connected Vab and Vbc (300 Vac maximum)
- I/O expansion card.
  - Four additional contact outputs, three additional optoisolated control inputs, one 4–20 mA analog output
  - Control input voltages, 24, 48, 110, 125, 220, or 250 Vdc or Vac
  - Voltage inputs card, three-phase
  - Eight additional optoisolated control inputs
- Conformal coating.
- Optional RTD inputs.

  Link an SEL-2600 RTD Module to the SEL-749M using fiber-optic cable. Field-configurable by RTD type (Pt100, Ni100, Ni120, and Cu10) and location (winding, bearing, ambient, other).



Hardware Specifications

Phase Current Inputs

Nominal Current, I_{NOM}	1 A or 5 A
Burden	<0.01 VA @ 1 A; <0.10 VA @ 5 A
Continuous	3 • I_{NOM}
1 Second Thermal	100 • I_{NOM}

Neutral/Ground Current Input

Nominal Current, IN_{NOM}	1 A or 5 A
Burden	<0.01 VA @ 1 A; <0.10 VA @ 5 A
Continuous	3 • IN_{NOM}
1 Second Thermal	100 • IN_{NOM}

Optional Phase Voltage Inputs

Rated Operating Voltage	100–250 Vac
Rated Continuous Voltage	300 Vac
10 Second Thermal	600 Vac
Burden	<0.1 VA at 300 Vac

Four-wire wye or open-delta voltage connections

Power Supply Ratings

110–250 Vdc (−20% to +10%)
110–240 Vac (−20% to +10%), 50/60 Hz
24/48 Vdc (20–60 Vdc)
<40 VA (ac) or 15 W (dc) total burden

Optoisolated Control Input Ranges

24, 48, 110, 125, 220, or 250 Vdc or Vac
Control inputs are externally wetted
2 inputs standard

Contact Outputs (per IEC 60947-5-1)

Operating Voltage	240 Vac/250 Vdc
Rated Insulation Voltage	300 Vac/300 Vdc

3 outputs standard

Hazardous Location Rating

UL Class I, Zone 2 approved
ATEX
CSA

Class I Zone 2
Hazardous Location
APPROVED

Operating Temperature

−40° to +85°C (−40° to +185°F)

Price

Budgetary Retail, Quantity 1: $1,200

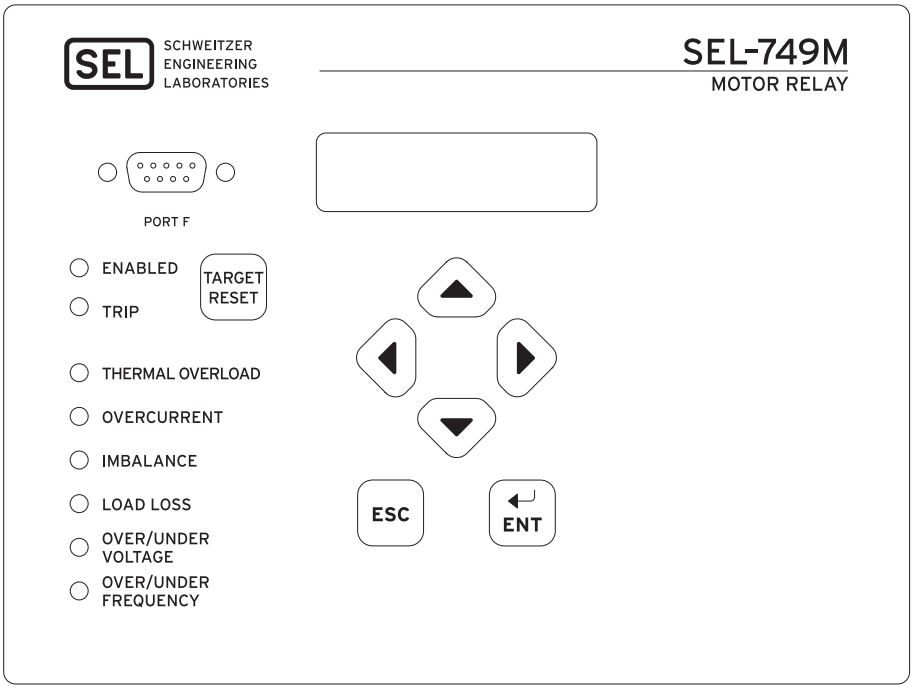
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

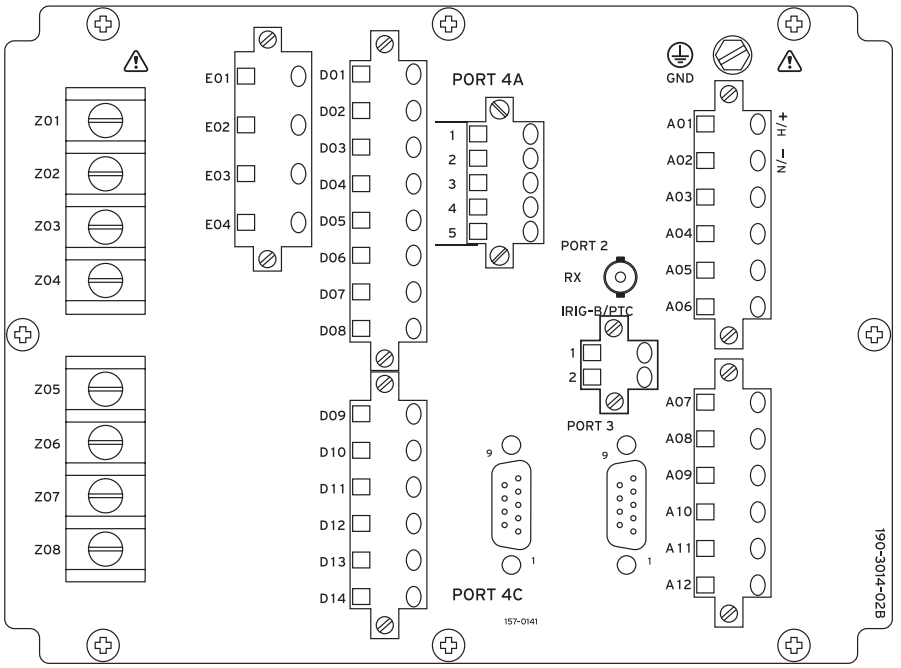
SEL-749M Motor Relay

Front View



i3662b

Rear View - Wire Terminal Legend



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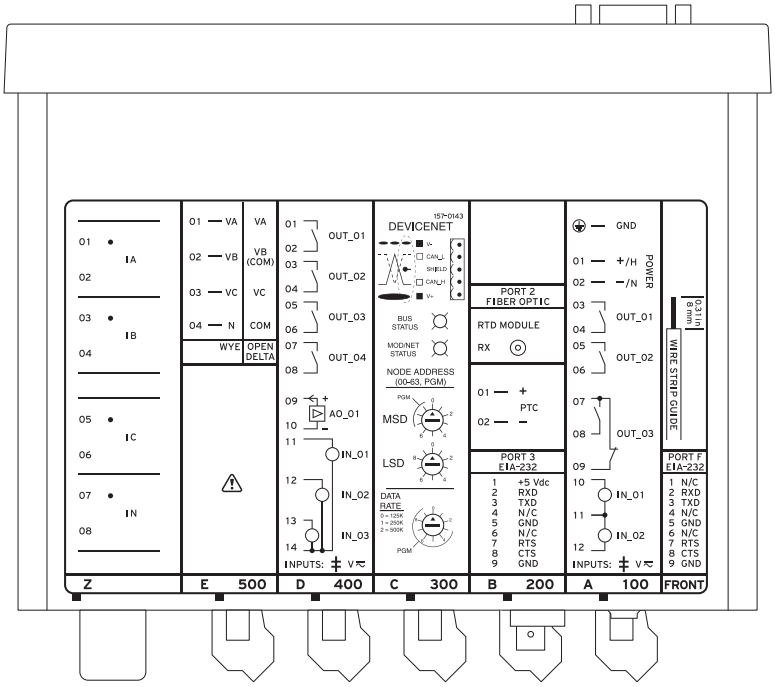
SEL-749M Motor Relay

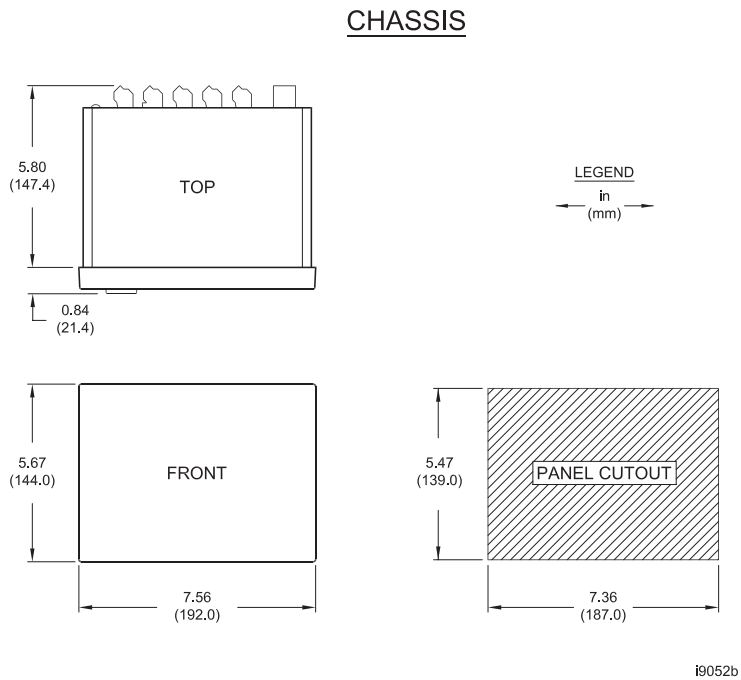
Top View



‡ SEE DOCUMENTATION FOR INPUT VOLTAGE RATING

i3702c

Dimensions



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Visit www.selinc.com for more detailed information and configuration options.

SEL-701 Motor Protection Relay

Reliable, flexible, advanced motor protection in a compact, economical package.

Key Features

Complete Motor Protection

The SEL-701 Motor Protection Relay provides locked rotor, running overload, and negative-sequence current unbalance protection using a patented thermal model. The thermal element accurately tracks the heating effects of load current and current unbalance while the motor is accelerating and running. Backup overcurrent protection provides fast relay response for severe faults. Adaptive overcurrent elements operate at high speed, even with severe CT saturation. You can choose from three easy settings methods: motor nameplate rating, generic curves, and custom curve fitting. Optional internal or external RTD monitoring inputs extend the thermal protection to include direct temperature measurements. The thermal element protection is integrated with short-circuit protection and a variety of current- and voltage-based protection and control features to provide complete motor protection.

Event Reports and Trends

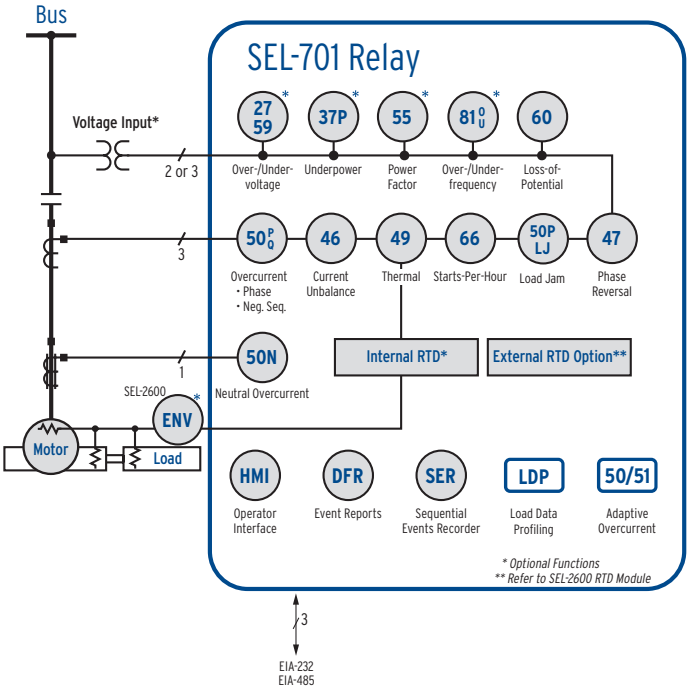
Comprehensive reports such as motor starts, motor start trends, load profile, Sequential Events Recorder (SER), and full event reports provide unprecedented analytical tools for motor applications and load profiling. Reports are retained in nonvolatile memory.

Programmable RTDs

Field-configurable RTDs accommodate a variety of RTD types and locations. Advanced logic detects open or shorted RTD leads and prevents inadvertent tripping caused by failed RTDs.

Simple Communication

One front-panel EIA-232 serial communications port supports ASCII communication using popular terminal emulation communications programs. One rear port, EIA-232 or EIA-485, supports either ASCII/binary serial communication on the EIA-232 port or Modbus® RTU protocol on the EIA-485 port. Use Windows®-based ACSELERATOR QuickSet® SEL-5030 Software to create, modify, send, receive, and save SEL-701 settings.



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SEL-701 Motor Protection Relay

Motor Thermal Element Design, Application, and Setting

The SEL-701 combines instantaneous and definite-time overcurrent elements with a patented thermal model element to provide continuous protection through motor starting and running conditions.

The top figure shows the starting current (dotted line) of an induction motor with the thermal and overcurrent protection characteristics of the SEL-701 (solid line). The locked rotor and overload characteristics are provided by a thermal element, defined by motor nameplate and thermal data, that accounts for the slip-dependent heating of both positive- and negative-sequence current. The element is a real-time mathematical model that calculates winding temperature. The element is simple to set and is determined by the following five settings:

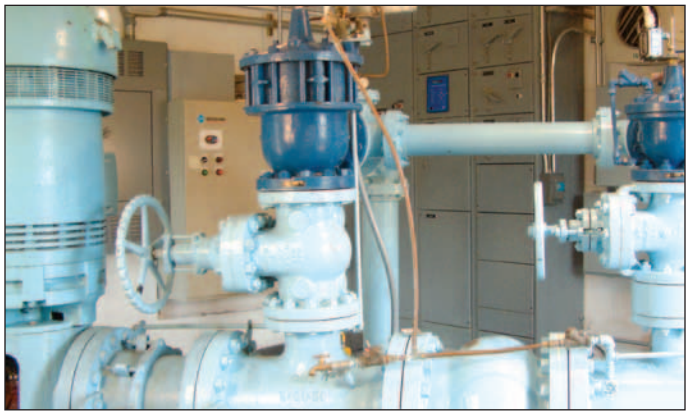
- FLA—Rated Full Load Current
- LRA—Rated Locked Rotor Current
- LRT—Thermal Limit Time at LRA
- TD—Time-Dial in Per Unit of LRA
- SF—Rated Service Factor

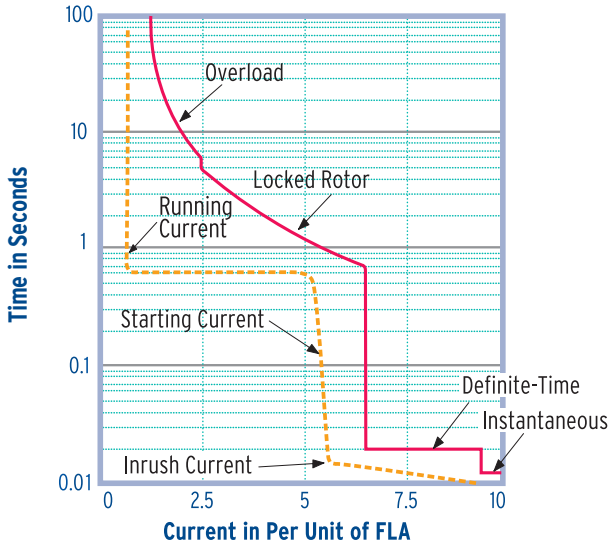
The model accounts for the thermal history and accurately tracks the winding temperature during starting and running conditions. The temperature is compared to alarm and trip thresholds. The thermal element trips to prevent overheating during overload, locked rotor, frequent or prolonged starts, or unbalanced current conditions.

The definite-time and instantaneous overcurrent elements provide protection for motor leads and internal faults. A definite-time setting of about six cycles allows the overcurrent element setting to be 1.2 to 1.5 times the locked rotor current. This setting is high enough to avoid tripping on the initial inrush current (shown amplified). The instantaneous overcurrent element is set at twice the locked rotor current for fast clearing of high-current faults.

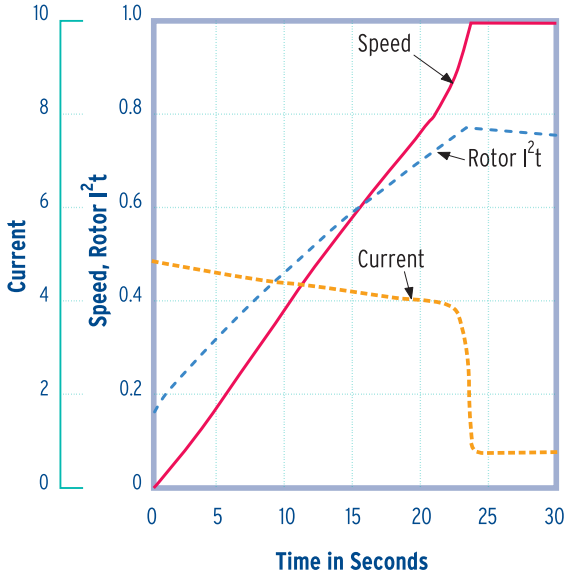
The bottom figure shows changes of motor speed, current, and the accumulated rotor thermal energy during an induction motor start. The current starts out at about five times of FLA and decreases to below FLA when the motor reaches full speed at around 23 seconds. The thermal energy starts to decrease as well after that time.

For more information on this subject, please refer to the paper, "Thermal Models in Power System Protection," by Stanley Zocholl and Armando Guzmán, available at **www.selinc.com**.





Motor characteristics plotted with motor starting current.



Motor speed, current, and the accumulated rotor thermal energy.

SEL-701 Motor Protection Relay

Applications

- Protect most medium-voltage induction motors, regardless of horsepower rating.
- Apply the integrated thermal protection model to retain "learned" motor thermal characteristics through transitional operating states (start, run, stop, restart).
- Use comprehensive reporting to confirm motor sizing, understand events, schedule maintenance, detect unfavorable trends, modify loads, and satisfy information requirements of supervisory systems.
- Select each RTD type and location, and then include RTD inputs as a part of the integrated thermal model to bias protection.
- Select an SEL-2600 RTD Module to eliminate expensive wire pulls, eliminate dangerous ground potential rise, and reduce wiring terminations at the relay, while acquiring clean RTD signals and an additional contact input.
- Apply the SEL-701 in unfavorable environmental conditions. Tested from −40° to +85°C and up to 95 percent relative humidity (noncondensing).

Optional Features

- Voltage inputs for complete metering and power information.
- Internal RTDs (11 RTD inputs for internal RTD card).
- External RTDs (12 RTD inputs and one contact input on an SEL-2600 RTD Module mounted near motor).
- Conformal coating.

Hardware Specifications

Phase Current Inputs

Nominal Current, I_{NOM}	1 A or 5 A
Range	0.05–20.00 • I_{NOM}
Burden	0.14 VA @ 5 A; 5 A tap
	0.06 VA @ 1 A; 1 A tap
Continuous	3 • I_{NOM}
1 Second Thermal	50 • I_{NOM}

Neutral/Ground Current Input

Nominal Current, IN_{NOM}	1 A or 5 A
Range	0.005–2.000 • IN_{NOM}
Burden	0.28 VA @ 5 A; 5 A tap
	0.19 VA @ 1 A; 1 A tap
Continuous	3 • IN_{NOM}
1 Second Thermal	50 • IN_{NOM}

Optional Phase Voltage Inputs

Nominal Voltage	0–300 Vac
Four-Wire Wye or Open-Delta Voltages	
Burden	<2 VA @ 300 V

Power Supply Ratings

20–250 ±20% Vdc

95–240 ±10% Vac, 50/60 Hz

<15 VA total burden

Standard Control Output Ranges

24, 48, 125, or 250 Vdc

Configuration provides six inputs and three outputs, with an additional trip contact and self-test alarm contact. Six contact inputs are powered internally (self-wetted) by the relay.

Optional RTD Inputs

Internal card (field-configurable by RTD type and location)

External module (Link an SEL-2600 RTD Module to the SEL-701 using fiber optics. Field-configurable by RTD type and location.)

Operating Temperature

−40° to +85°C (−40° to +185°F)

Price

Budgetary Retail, Quantity 1: $1,530

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

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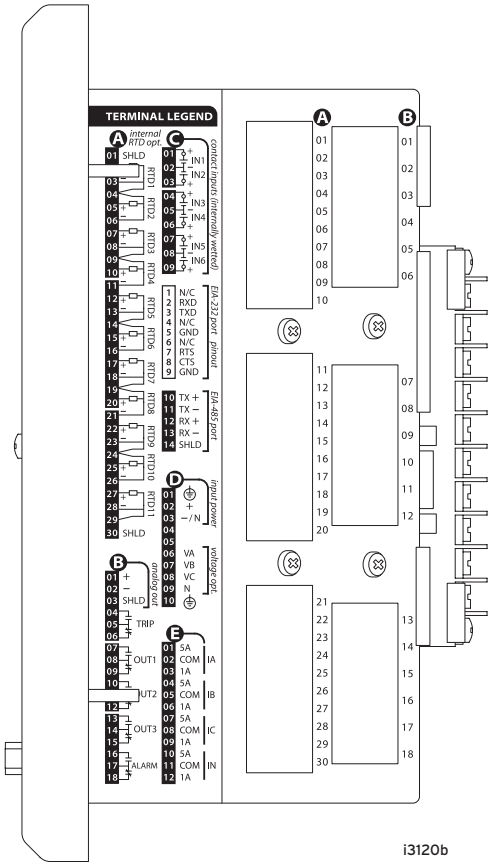
SEL-701 Motor Protection Relay

Side View - Wire Terminal Legend



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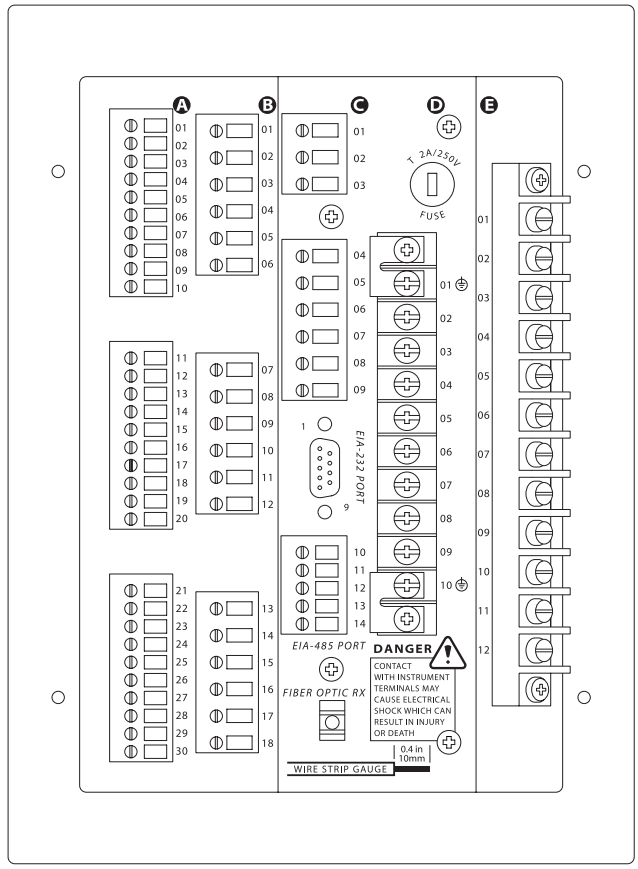
Rear View - Wire Terminal Legend



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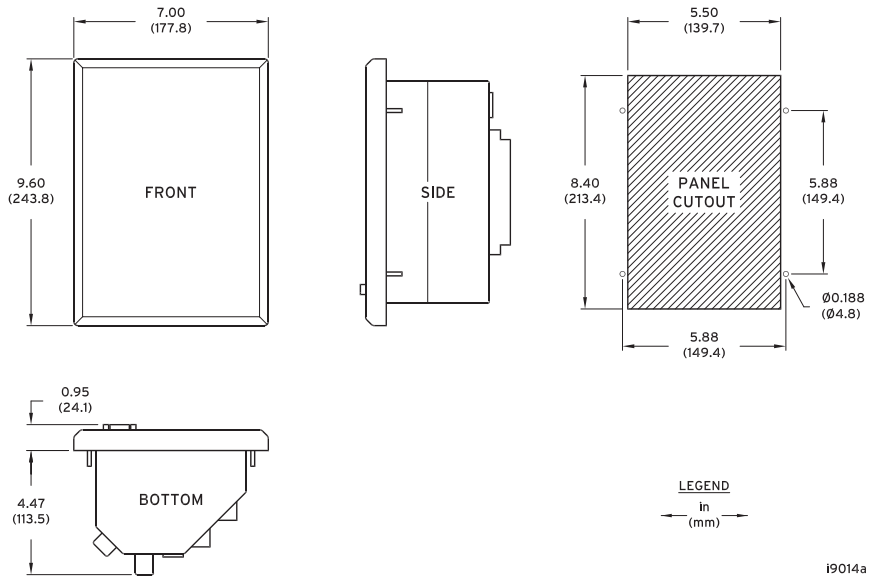
Dimensions

PANEL-MOUNT CHASSIS



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Visit www.selinc.com for more detailed information and configuration options.

SEL-2600 RTD Module

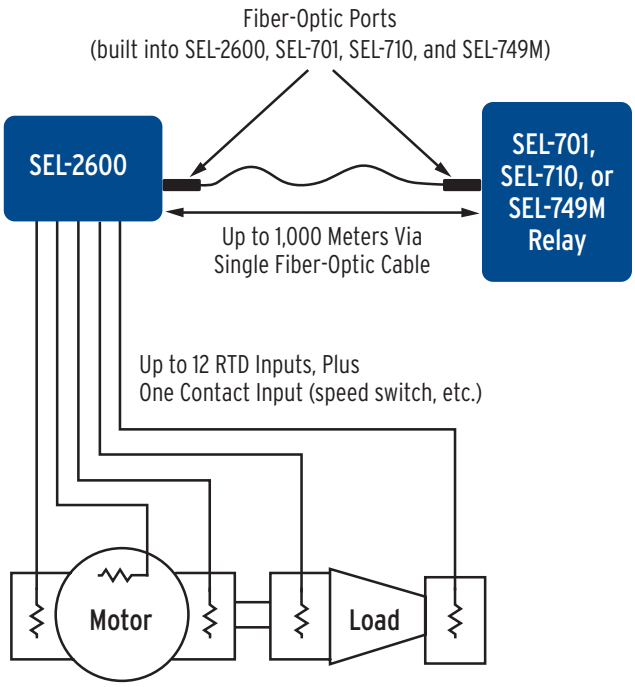
Acquire and transmit resistance temperature detector (RTD) thermal data from transformers, motors, generators, or other system apparatus.

Key Features

- Measures up to 12 RTD temperatures plus one contact input.
- Allows flexible mounting for locating near RTDs.
- Fiber link provides electrical noise immunity and ground isolation between devices.
- Advanced design provides superior noise rejection from RTD leads.
- SEL-2600A accepts 120 Vac or 240 Vac input power.
- SEL-2600D accepts 125 Vdc input power.
- Illuminates LEDs to indicate contact input status, data transmission, and product-enabled status.
- Operates in extreme ambient temperatures from −40° to +85°C.
- Conformally coated and rated at Pollution Degree 3 (PD3).
- UL/CSA/CE recognized.
- Class I, Zone 2 approved.
- Corrosion tested to ASTM B117-03 salt spray (fog).

Related Products

SEL Fiber-Optic Transceivers 432–439
SEL-9220 Fiber-Optic Adapter for SEL-300 Series Relays 440



Motor protection using the SEL-2600 RTD Module with the SEL-701, SEL-710, or SEL-749M Relay.

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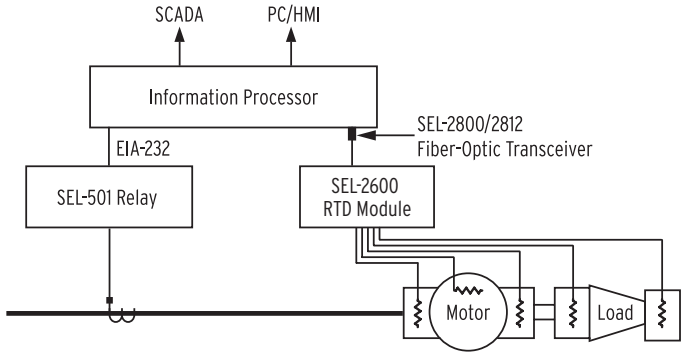
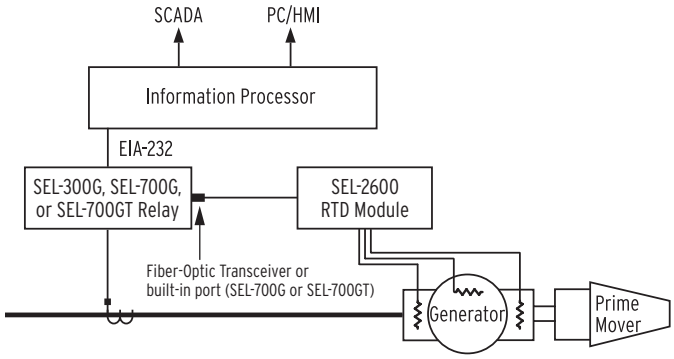
SEL-2600 RTD Module

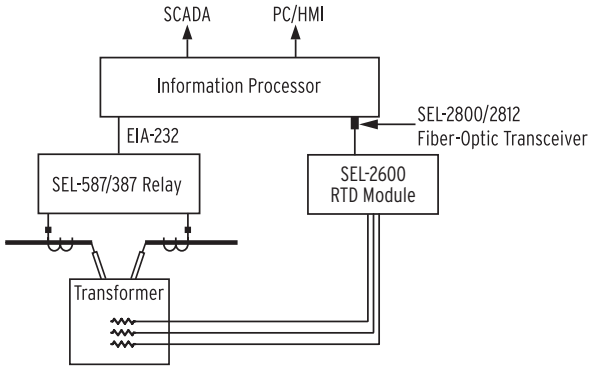
Motor Protection With the SEL-501 Relay



Generator Protection With the SEL-300G, SEL-700G, and SEL-700GT Relays



Transformer Protection With the SEL-587 or SEL-387 Relay



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

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Applications

- Connect any one of four different RTD types on each independent input:
  - 100 ohm platinum
  - 100 ohm nickel
  - 120 ohm nickel
  - 10 ohm copper
- Replace expensive RTD cable pulls using a single fiber-optic cable.
- Measure and transmit data from RTDs located in transformers, breakers, motors, generators, or other system apparatus in combination with SEL communications processors.

Optional Features

- Selectable fiber-optic* connection for V-pin (SEL-2800 or SEL-701) or ST® (SEL-710, SEL-700G, SEL-700GT, SEL-700GW, SEL-749M, SEL-751A, SEL-787, SEL-2411, SEL-2414, or SEL-2812).

  *Eye-safe, Class 1 LED product per EN 60825-1

Hardware Specifications

RTD Inputs

12 independent RTD inputs

Range −50° to +250°C

Accuracy ±2°C

Open- and short-circuit detection

Supports Pt100, Ni100, Ni120, and Cu10 RTD types

Contact Input

One dry contact input

Communication

Binary data packet transmits approximately every 0.6 seconds (0.75 seconds maximum) at 2400 bps

Data packet contains temperatures, contact status, and self-test results

Data secured using CRC-16

Power Supply

SEL-2600A	SEL-2600D
120 Vac, ±20%, 50/60 Hz	125 Vdc rated
240 Vac, ±20%, 50/60 Hz	90–140 Vdc range
5 VA maximum	5 VA maximum

Operating Temperature

−40° to +85°C (−40° to +185°F)

Pollution Degree

PD3

Class I, Zone 2 Approved

Class I Zone 2 Hazardous Location APPROVED

Corrosion

ASTM B117-03 salt spray (fog)

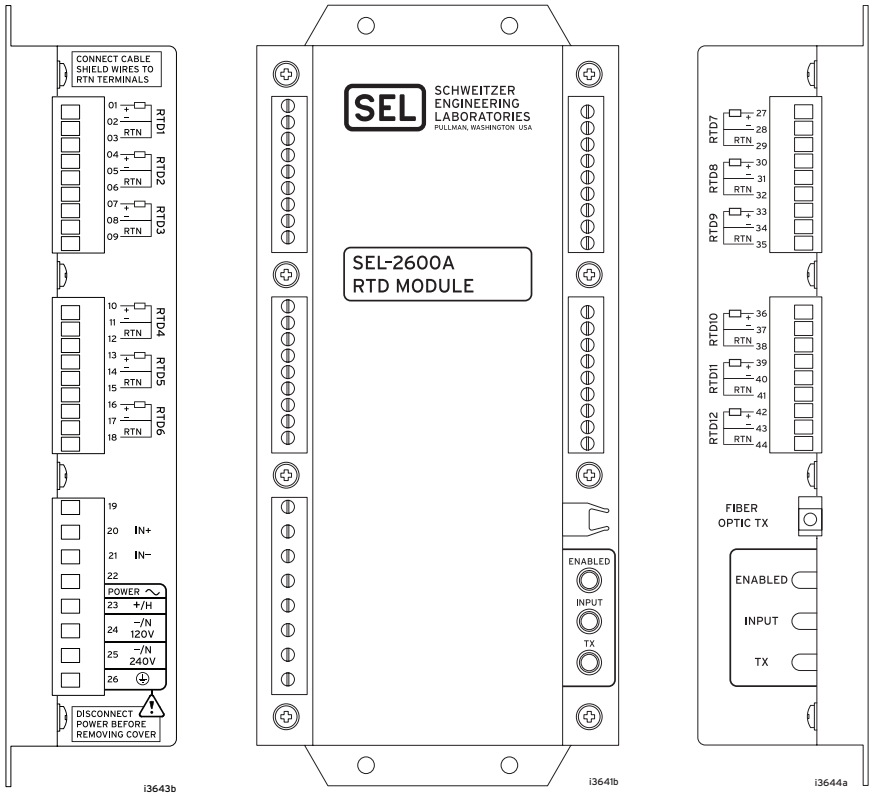
Price

Budgetary Retail, Quantity 1: $790

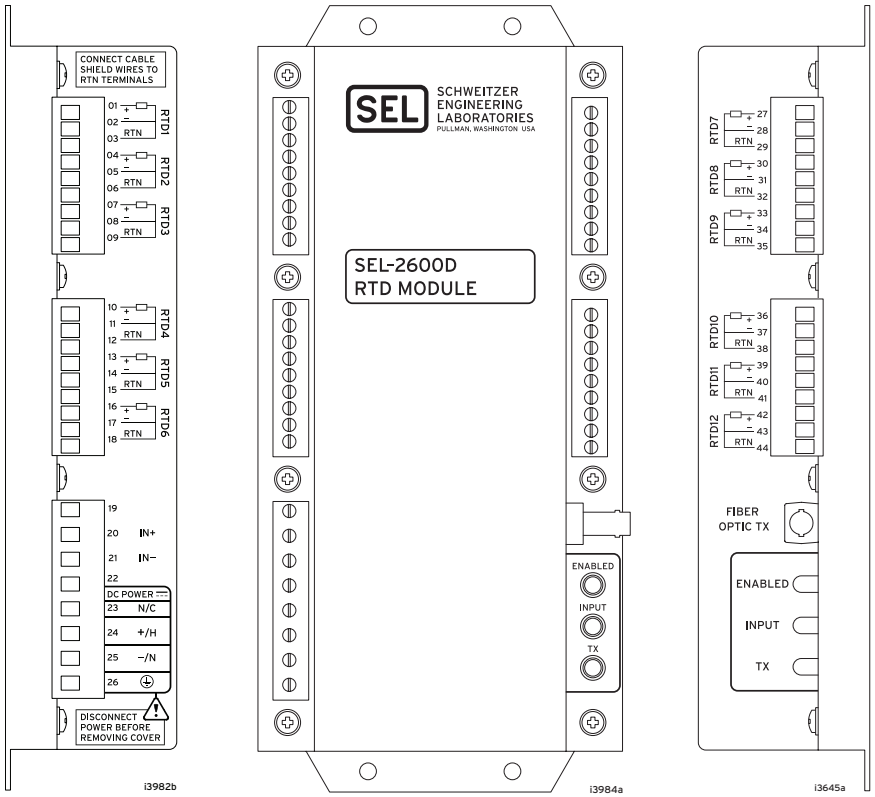
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

SEL-2600 RTD Module

Side View — Front View — Side View



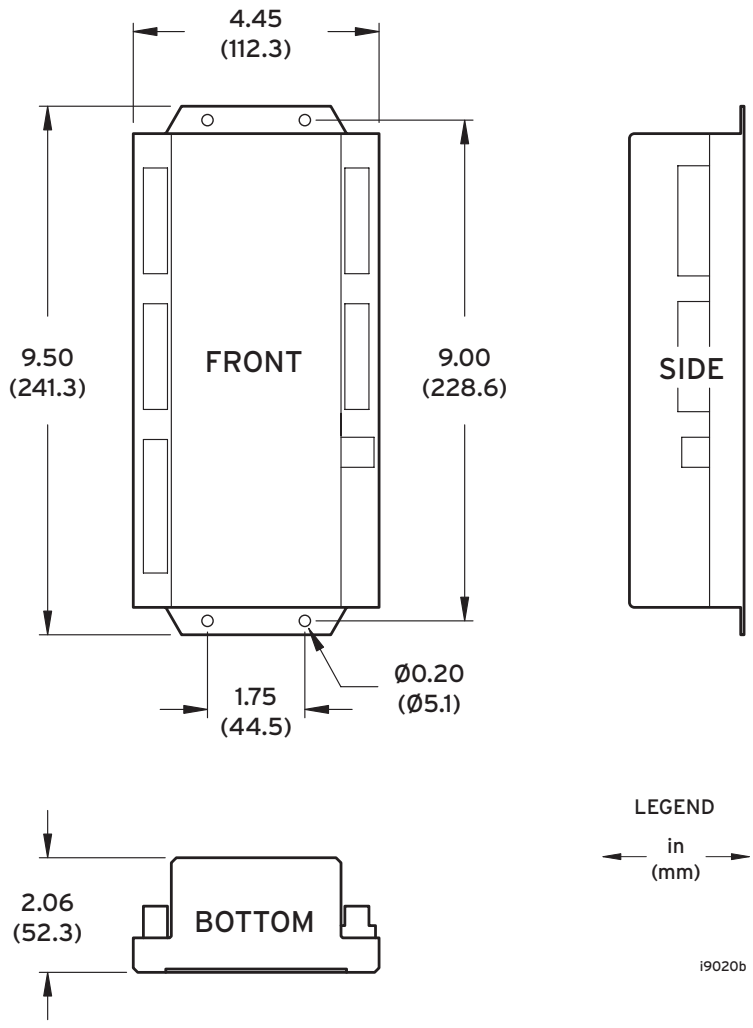
Side View — Front View — Side View



SEL-2600 RTD Module

Dimensions

CHASSIS



Visit www.selinc.com for more detailed information and configuration options.

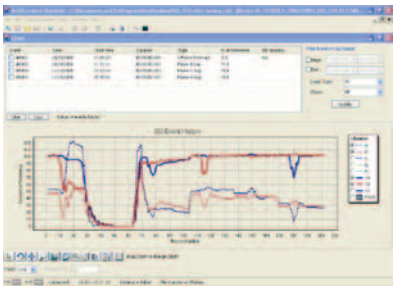
Meter Applications

Revenue Metering

Outdoor Metering

Easily Extractable Meter

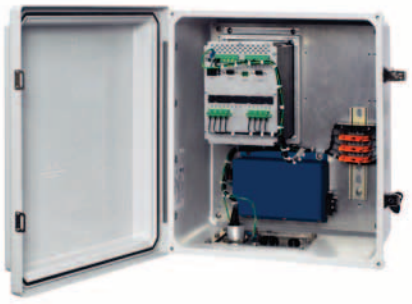
Power Quality Metering



Portable Power Quality

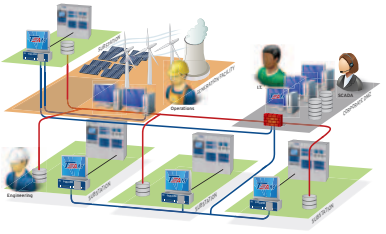
Capacitor Bank Control

Distribution Monitoring and Automation



Digital Transducer

ACSELERATOR TEAM™ Software



Metering Product Index

Meter Features

Metering	SEL-734H/V	SEL-734A/D	SEL-734E	SEL-734P/Q	SEL-734B	SEL-734T
APPLICATIONS						
Revenue Metering	•	•	•			
Basic Power Quality, 32 MB	•	•	•		•	•
Advanced Power Quality, 128 MB	*	*	*	•	*	*
Portable Power Quality				•		
Outdoor Metering		•			•	•
Monitor and Capacitor Bank Control	•	•	•		•	•
Distribution Feeder Monitoring		•			•	•
MOUNTING						
Rack, Panel, and Retrofits	•		•		•	
Outdoor Enclosure		•			*	*
Easily Extractable Meter			•			
Portable Case				•		
Surface Mount Transducer						•
INSTRUMENTATION AND CONTROL						
3 Electromechanical Outputs, 2 Inputs	•	•	•	•	*	*
4 Electromechanical Outputs, 4 Inputs	*	*	*	*	*	*
4 Solid-State Outputs, 4 Inputs	*	*	*	*	*	*
4 Solid-State Outputs, 4 Analog Outputs	*	*	*	*	*	*
4 Analog Outputs, 4 Analog Inputs	*	*	*	*	*	*
COMMUNICATIONS						
ANSI Type 2 Optical Port	1	1	1	1	0	0
EIA-232	2 (3)*	2 (3)*	2 (3)*	1	3	2 (3)*
EIA-485	2*	2*	2*	0	2*	2*
Telephone Modem	1*	1*	1*	0	1*	1*
Ethernet	1*	1*	1*	1	1*	1*
IRIG-B Time Input	1	1	1	1	1	1
SERIAL PROTOCOLS						
SEL Fast Messages	•	•	•	•	•	•
Mirrored Bits® Communications	•	•	•	•	•	•
SEL Distributed Port Switch	•	•	•	•	•	•
MV-90(xi) TIM	•	•	•	•	•	•
Modbus® RTU	•	•	•	•	•	•
DNP3 Level 2 Outstation	*	*	*	*	*	*
ETHERNET PROTOCOLS						
SEL	•	•	•	•	•	•
SEL Fast Messages	•	•	•	•	•	•
MV-90(xi) TIM	•	•	•	•	•	•
Modbus TCP Slave	•	•	•	•	•	•
TCP/IP, Telnet	•	•	•	•	•	•
DNP3 LAN/WAN	*	*	*	*	*	*

• *Standard Feature* * *Model Option*

SEL-734 Advanced Metering System

High-accuracy, bidirectional, four-quadrant metering system with power quality monitoring, time-of-use metering, load profile recording, and capacitor bank control.

Key Features

- Exceeds 0.2 Accuracy Class with 0.06 percent Wh accuracy.
- Select from CL2, CL10/CL20, or 0–10 Vac LEA current sense inputs.
- Apply time-of-use (TOU) rates with a 20-year programmable calendar.
- Utilize multiple load profile recorders to sample revenue and power quality data.
- Enter transformer and line information to automatically compensate for transformer or line losses and move the billing point.
- Record voltage sag/swell/interruption (VSSI), monitor harmonics, capture waveforms, and record sequential events.
- Configure advanced SELOGIC® control equations to customize alarms and control based on metered information.

Related Products

Price

Budgetary Retail, Quantity 1: $1,144 to $4,995

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

Applications

Revenue Metering, SEL-734H/V, A/D, EXM

- Collect and report billing, power quality (PQ), and phasor measurements.
- Replace obsolete transducers, and poll directly from SCADA with DNP3 or Modbus® protocols.
- Support complex tariffs with multiple load profile data recorders.
- Provide flexible time-of-use (TOU) metering with a 20-year calendar.
- Use predictive demand to initiate load control and reduce demand charges.

Power Quality, SEL-734P/Q

- Log and view VSSI events.
- Measure harmonic and interharmonic content through the 50th order.
- Monitor PQ anywhere with the SEL-734 Portable Power Quality Meter.

Monitor and Capacitor Control, SEL-734B

- Actively control capacitor banks by monitoring power factor, kVAR, or bus voltage.
- Use SELOGIC control equations to control multistage capacitor banks.

Digital Transducer, SEL-734T

- Integrate with Lindsey 0–10 Vac CVMI LEA inputs.
- Communicate data instantaneously to SCADA.
- Install virtually anywhere with economical outdoor enclosures.

SEL-734 Advanced Metering System

Standard Equipment

Revenue Metering

- Exceeds ANSI C12.20 0.2 Accuracy Class, with 0.06 percent accuracy.
- 4-quadrant kVARh metering.
- Block, rolling, thermal, and predictive demand.
- Transformer line-loss compensation.
- Load profile recorder with 12 channels for 770 days at 5-minute intervals.
- IRIG-B/GPS time synchronization provides highly accurate time stamps.
- Synchrophasor measurement.

Power Quality

- 32 MB of memory.
- VSSI logging with a minimum of 11,000 records.
- 64 event reports with waveform capture at 1 kHz sample rate.
- Harmonic monitoring with magnitude and angle through the 15th order.
- Sequential events report with a minimum of 21,000 time-stamped records.

TOU Metering

- 6 rates.
- 10 day types.
- 4 accumulation styles.
- 40 schedules.
- 20-year TOU calendar.
- 300 calendar entries.
- 15 self-reads.

I/O and Communications

- 3 electromechanical contact outputs and 2 contact inputs.
- Front ANSI Type 2 optical port.
- 2 rear EIA-232 ports.

Optional Equipment

SEL-734P Advanced Power Quality Features

- 128 MB of memory.
- Multiple load profile recorders with up to 192 channels.
- High-speed LDP recording.
- Flicker measurements per IEC 61000-4-15.
- Individual harmonic and interharmonic measurements to the 50th order.
- Store 16 to 3150 waveform captures at 1 or 8 kHz for 0.25–10 seconds.

General Options

- Additional inputs, solid-state, electromechanical, or analog outputs.
- Ethernet, copper, or fiber-optic.
- Telephone modem/EIA-232/EIA-485.
- DNP3 Level 2 protocol.
- External fiber-optic communications.
- External I/O using the SEL-2505 Remote I/O Module.

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Hardware Specifications

AC Voltage Inputs

120 V Option	50–150 V
240 V Option	150–300 V

AC Current Inputs

CL2 Option	0.01–6 A
CL10/20 Option	0.05–20 A
LEA Option	0.1–12 Vac

Power Supply

Low-Voltage	19–58 Vdc
High-Voltage	85–264 Vac, 85–275 Vdc
VA Rating	<40 VA/15 W

Certifications

- ISO: Meter is designed and manufactured using ISO 9001:2008 certified quality program.
- ANSI C12.20:2002; class 0.2, CL2, and CL10/CL20
  - Radiated Emissions: FCC Part 15, Class A
- IEC 62053-22/23:2003; class 0,2 S
- IEC 62052-11; rack-mounted meters
- CAN/CSA Certification: C22.2 No. 61010-04
- IEC 61010-1-2001
- UL 61010-1:2004 2nd edition
- ERCOT Compliant
- CFG G0000-48-1999 Compliant Per LAPEM
- CE: Mark-EMC Directive, Low-Voltage Directive

Note: Optional modem not CE compliant

Class I Zone 2
Hazardous Location
APPROVED

SEL-734 Advanced Metering System

Mounting Options and Retrofit Bezels

Mounting Option Kits

Use a mounting option kit to install meters into a variety of mounting services. Versatile options include rack-mount, panel-mount, hinged wall-mount, retrofit bezels, and indoor and outdoor cabinet configurations with internal DIN-rail mounting brackets. The outdoor enclosure is available with the meter and test switch prewired and tested. (Mounting kits shown do not include meters or accessories.)

Horizontal wall-mount bracket.

Vertical wall-mount bracket.

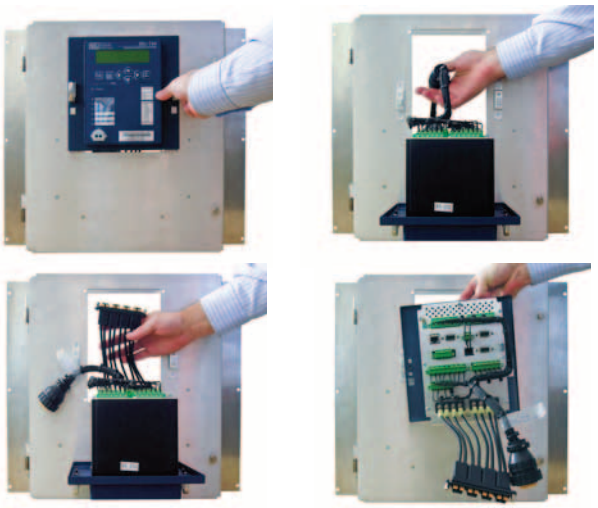
Outdoor enclosure (prewired options available).

Vertical Retrofit Bezels

Use a panel-mounting bezel to retrofit meters into existing panel cutouts.

Easily retrofit:

- JEM 1 SB
- JEM 1 Panel Mount
- GE kV
- JEMStar SB/TransData MK-5 SB
- Nexus 1260/1270 SB
- PML ION 8000 SB
- Schlumberger Q1000 SB
- Siemens Q4 Tall SB
- Siemens Q4 Short SB



The Easily Extractable Meter (EXM) option allows rapid removal while safely shorting connected CTs. This safe, economical, and flexible option easily retrofits legacy draw-out meters with a simple retrofit bezel.

Accessories

Advanced Power Quality and Recording Upgrade

Easily upgrade existing SEL-734 Meters by ordering an advanced power quality upgrade kit. Easy-to-use software automatically installs software and firmware upgrades. Refer to the SEL-734 Metering Accessories flyer for details.

Field-Upgradable Interface Boards

Provide increased integration capabilities and expand system flexibility by using an SEL-734 Advanced Metering System upgrade kit. Choose from communications, I/O, and power supply upgrade kits.

Optical Communications Probes

Connect any computer to the front optical port of the SEL-734 with an SEL-C660 or SEL-C661 optical probe. Seven-foot cable length provides convenient access for reading or programming the meter.

SEL-734 Accessories Flyer

Details of the wide variety of metering accessories are available in the SEL-734 Metering Accessories flyer, accessible on the SEL Metering website, **www.selinc.com/SEL-734**.

SEL-734 Advanced Metering System

Front View

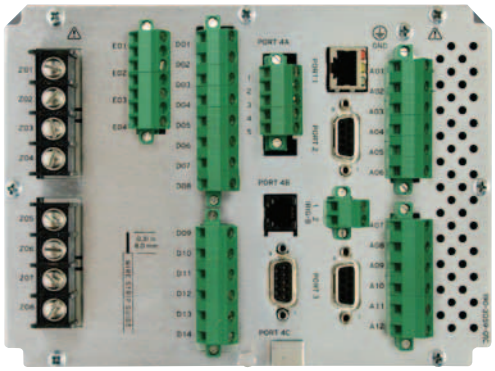
144 mm (5.67 in)

192 mm (7.56 in)

192 mm (7.56 in)

144 mm (5.67 in)

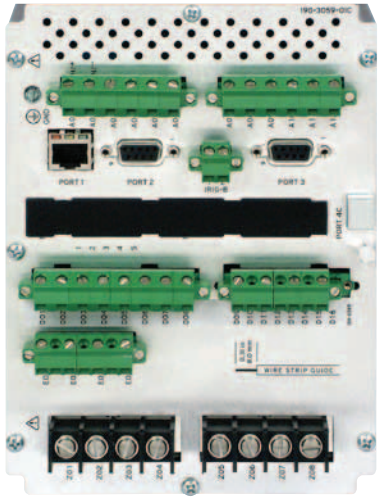
Rear View – Terminal Blocks



138 mm (5.43 in)

186 mm (7.32 in)

Cutout dimensions: 187 mm x 139 mm (7.36 in x 5.47 in)



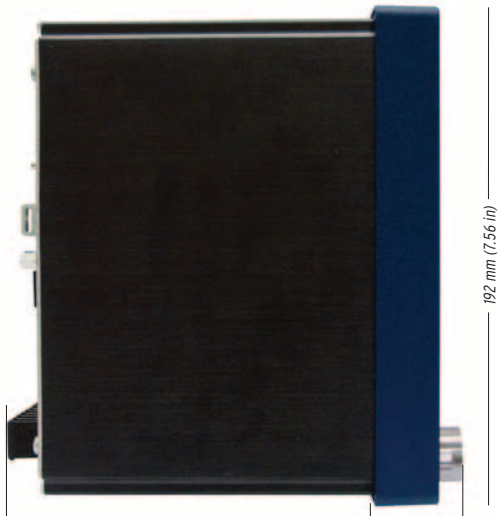
186 mm (7.32 in)

138 mm (5.43 in)

Side View

147.4 mm (5.8 in)

21.4 mm (.84 in)

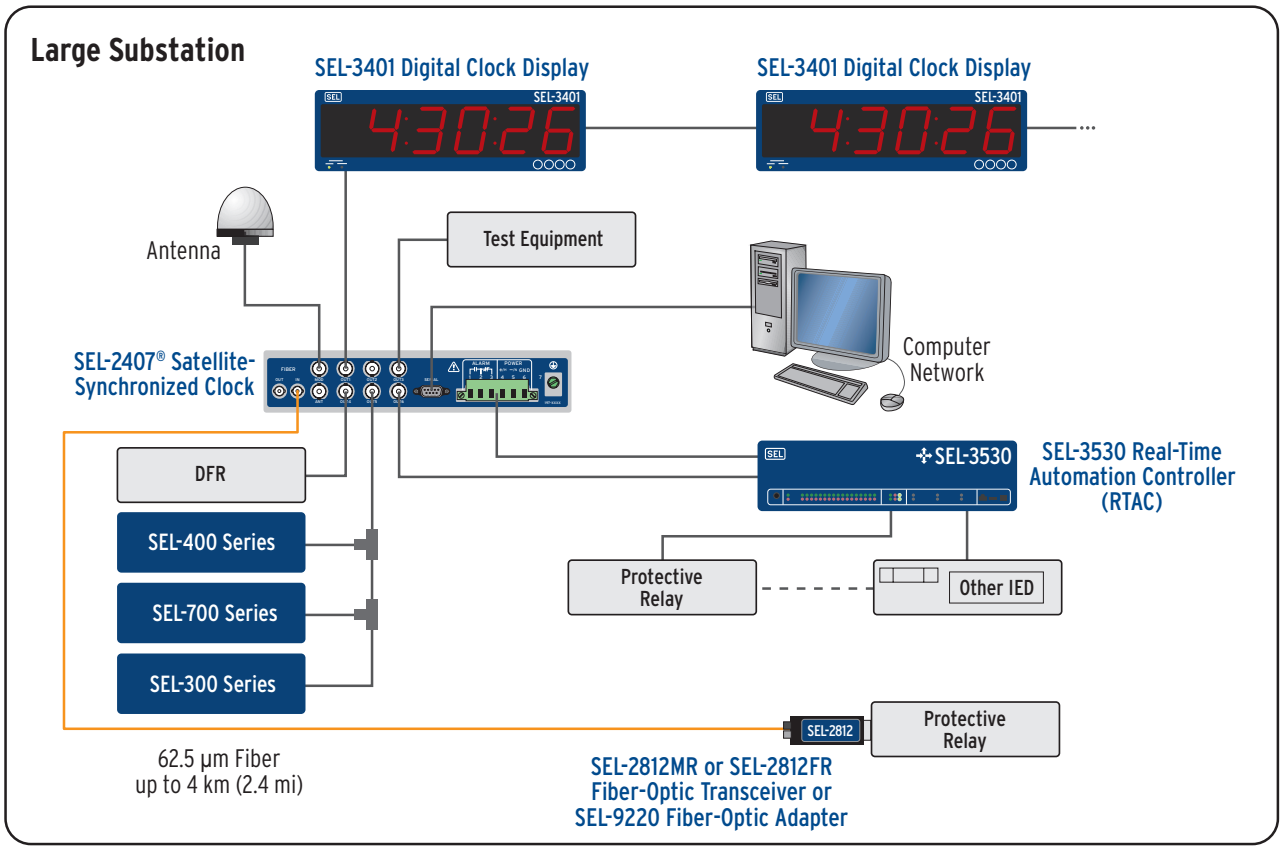


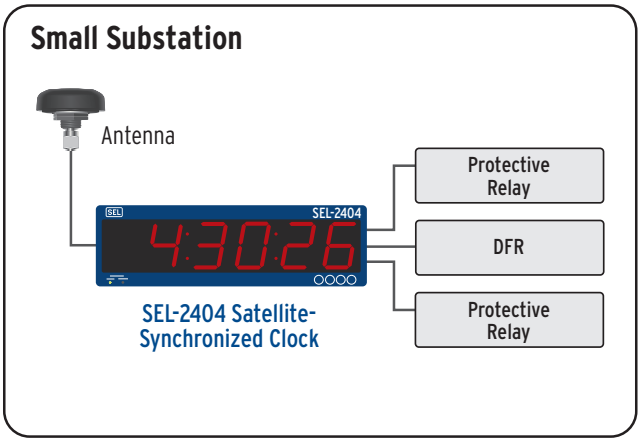
192 mm (7.56 in)

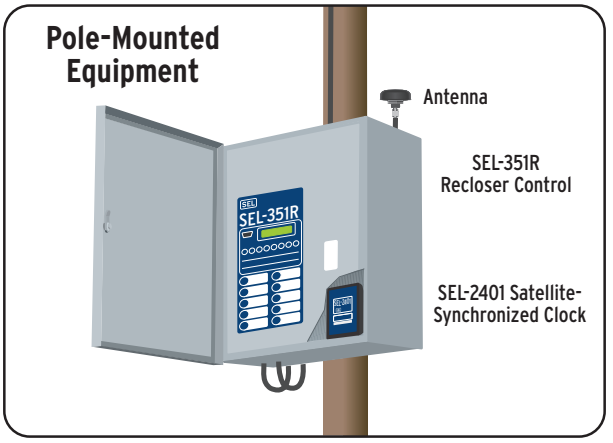
148.3 mm (5.84 in)

35 mm (1.38 in)

Clock Applications



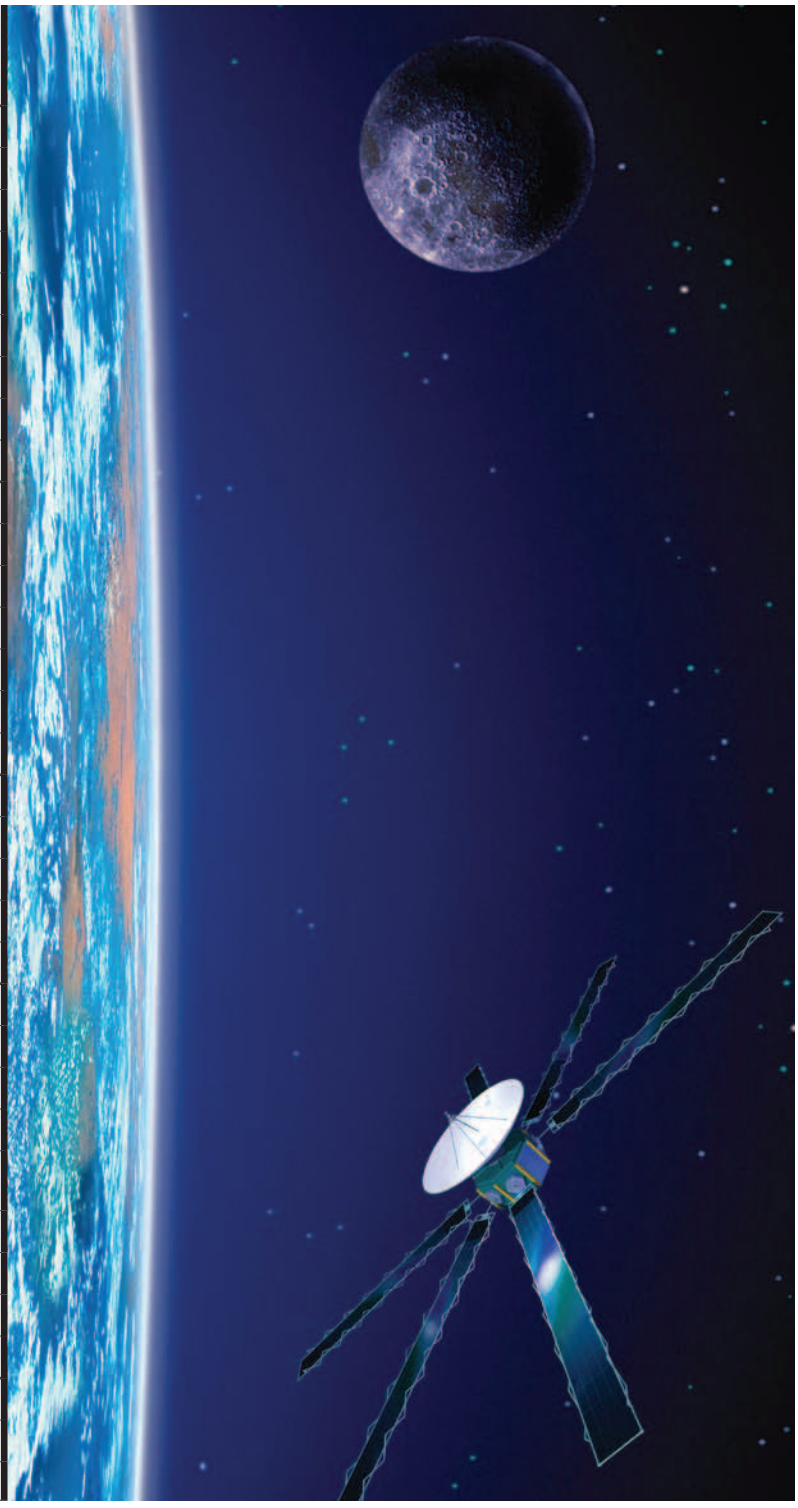




Precise Timing — Clocks Product Index

Clock Features

Clocks	SEL-2401	SEL-2404	SEL-2407	SEL-3401
APPLICATIONS				
Substation Time Automation	•	•	•	
Industrial Time Automation	•	•	•	
Synchrophasor Time Standard	•	•	•	
Control Room Viewing		•	•	•
Large-Area Viewing		•		•
Recloser Timing Source	•		•	
IEEE 1344/IEEE C37.118 Time-Quality Testing	•	•	•	
Synchronized Clock Systems	•	•	•	•
TIMEKEEPING AND DISTRIBUTION				
Accuracy ±100 ns (Average)	•	•	•	
Demodulated IRIG-B	•	•	•	•
Modulated IRIG-B			•	
GPS Satellite Tracking	•	•	•	
Multiple Channel Outputs		•	•	*
Single Channel Outputs	•			*
INSTRUMENTATION AND CONTROL				
Time-Synchronized Event Reporting	•	•	•	
Source for Time-Tagged SER	•	•	•	
Internal Battery Backup			•	•
Large-Distance Viewing 60.96 m (200 ft)		•		•
FEATURES				
High-Gain GPS Antenna and Feedline	•	•	•	
Large, 76.2 mm (3.0 in) LED Display		•		•
14 mm (0.56 in) LED Display			•	
Meets IEEE C37.90 and IEC 60255 Surge and Environmental Standards	•	•	•	•
Force-Time-Quality Mode (for Testing)			•	
Rack-Mount, Panel-Mount, or Wall-Mount Hardware	•	•	•	•
Synchronized Pulse Output	•	•	•	
Universal Power Supply			•	
SERIAL-PORT PROTOCOLS				
ASCII Commands and Reports	•	•	•	
Fiber Communications Port			*	



• *Standard Feature* * *Model Option*

SEL-2407® Satellite-Synchronized Clock

Apply the SEL-2407 Satellite-Synchronized Clock with relays, Sequential Events Recorders, information processors, and other devices for precise alignment of time-sensitive information.

Key Features

High Accuracy

Demodulated IRIG-B outputs with accuracy of ±100 ns average (±500 ns peak) meet requirements for existing and future timing applications such as synchrophasors, relay event report correlation, and sequential events recording.

Reliable Timing

Built to rigorous relay standards, the SEL-2407 operates in harsh substation environments. IEEE C37.90 and IEC 60255 design standards ensure accurate timing in the presence of electrical surges, extreme temperatures, and power supply variations.

Wide Temperature Range

To assure accurate timing during any operating condition, the SEL-2407 is fully rated over a temperature range of −40° to +80°C. Timing outputs and display function properly, even when the building air-conditioning is not functioning.

Flexible Output Choices

One modulated and six demodulated IRIG-B outputs on BNC connectors plus serial-port and optional fiber-port outputs provide time signals for most applications. All clock outputs are user-programmable for extended IEEE 1344/IEEE C37.118 IRIG-BXX0 format, standard IRIG-BXX2 format, 1 PPS, 1 kPPS, or alarm functionality. Outputs configured as alarms can be used for control applications, such as double-ended line tests. The alarm contact output can close for loss-of-timing/loss-of-satellite conditions or provide one pulse per 30 seconds, per minute, or per hour.

High-Power Outputs Are Standard

Every relay in the station can be time-synchronized with inputs direct from the SEL-2407 or through an SEL information processor. The SEL-2407 can drive 20 SEL-400 series or 10 SEL-300 series relay time inputs from each of the 6 output ports. No additional clocks or power-boost distribution options are required.

Practical, Useful Display and Diagnostics

Built-in, 14 mm (0.56 in), 7-segment LED display provides easy readability without high-priced options. Diagnostics and status reported by serial or fiber communications links provide operating data, position, configuration, and other important parameters.

Tel: +1.509.332.1890 | Fax: +1.509.332.7990 | www.selinc.com

SEL-2407 Satellite-Synchronized Clock

Applications

- Provide timing signals to phasor measurement and control units (PMCUs) as part of a synchronized phasor measurement and control (synchrophasor) system.
- Supply precise time to protective relays to assure event correlation to the absolute accuracy provided by the relay. Use SEL or third-party software to display time-locked event reports. For example, ACSELERATOR Analytic Assistant® SEL-5601 Software can display up to three reports on a single screen for easy analysis.
- Provide time signals to information processors for distribution to all connected devices in a station integration system such as the SEL-7000 Integrated Substation System.
- Test and confirm IEEE 1344/IEEE C37.118-compliant applications with the unique Force-Time Quality command. Set exact time-quality values in the IRIG-B control field extensions to simulate accuracy conditions and measure the response of downstream equipment (relays, recorders, PMCUs).
- Transmit time signals over fiber-optic cables for distances as far as 4 km (2.48 mi). Connect to other IEDs using an SEL-2812MR or SEL-2812FR Fiber-Optic Transceiver or SEL-9220 Fiber-Optic Adapter for SEL-300 Series Relays.
- Use the free SEL-5860 Time Service Software to provide Simple Network Time Protocol (SNTP) from a computer connected to the SEL-2407 serial port.
- FCC Part 15, Class A emissions-certified for nonsubstation applications.

Hardware Specifications

Power Supply Ratings

24, 48, 125, or 250 Vdc
Range 18–300 Vdc
120, 230 Vac 50/60 Hz
Range 85–264 Vac
Burden <10 W

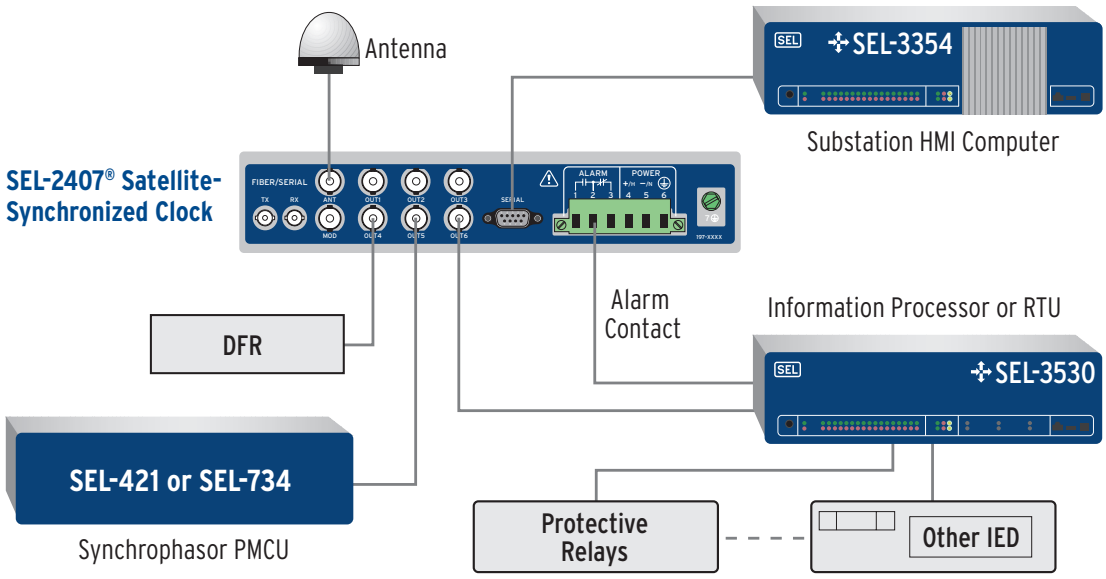
Price

Budgetary Retail, Quantity 1: $1,500 (includes cable and antenna)

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

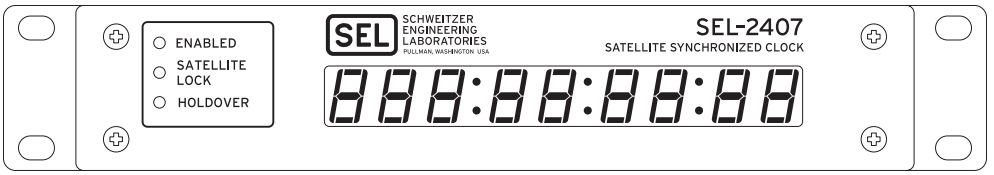
GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.



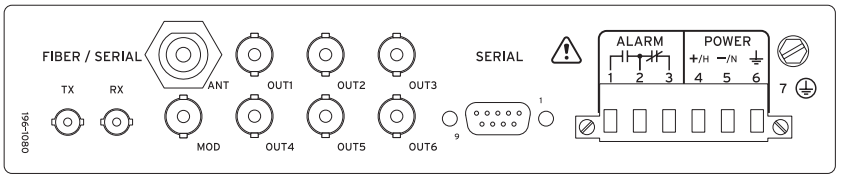
SEL-2407® Satellite-Synchronized Clock

Front View - Rack-Mount



i3858b

Rear View



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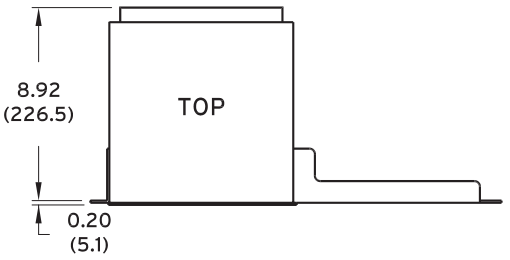
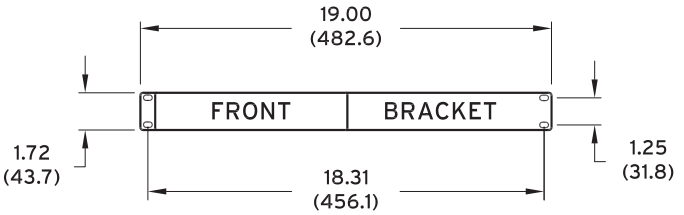
Dimensions

RACK-MOUNT CHASSIS





LEGEND

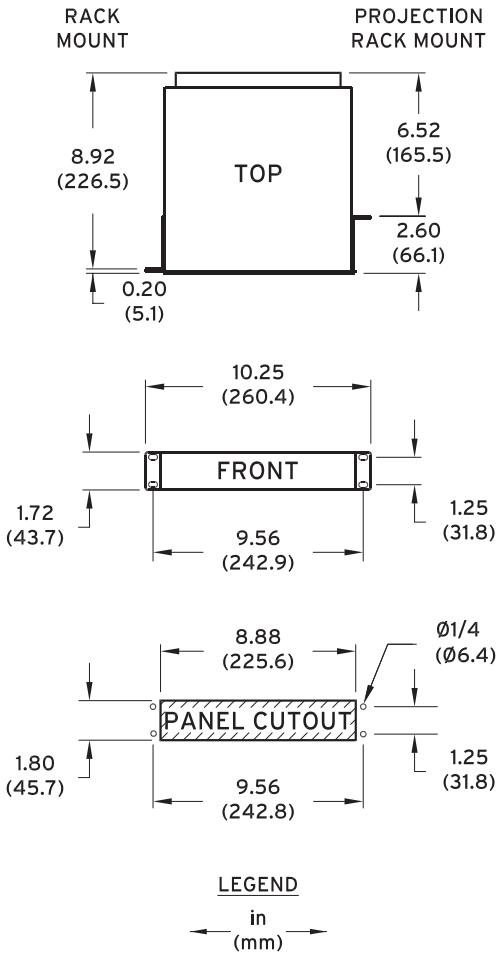
in
(mm)

i9035b

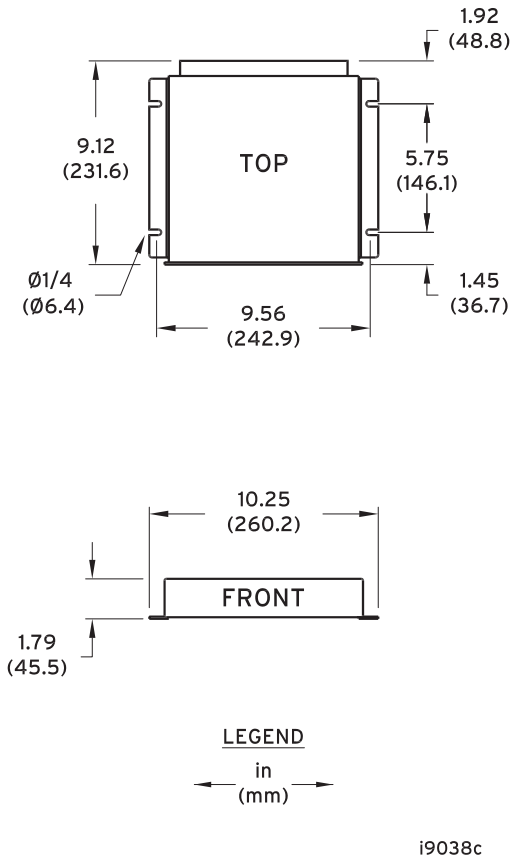
SEL-2407 Satellite-Synchronized Clock

Dimensions

RACK-MOUNT CHASSIS



SURFACE-MOUNT CHASSIS



Visit www.selinc.com for more detailed information and configuration options.

SEL-2404 Satellite-Synchronized Clock

Apply the SEL-2404 Satellite-Synchronized Clock with relays, event recorders, and information processors in applications requiring accurate time and highly visible time indication.

Key Features

High Visibility

The SEL-2404 Satellite-Synchronized Clock's large 76 mm (3.0 in) LED display is visible in all lighting conditions, including direct sunlight, from as far away as 61 m (200 ft) and is perfect for wide-area viewing.

High Accuracy

Four demodulated IRIG-B outputs with an accuracy of ±100 ns average (±500 ns peak) meet requirements for existing and future timing applications, such as synchrophasors, relay event report correlation, and sequential events recording.

Reliable Timing

Built to rigorous relay standards, the SEL-2404 operates in harsh substation environments. IEEE C37.90 and IEC 60255 design standards ensure accurate timing in the presence of electrical surges, extreme temperatures, and power supply variations.

Wide Temperature Range

To assure accurate timing during any operating condition, the SEL-2404 is fully rated over a temperature range of −40° to +80°C. Timing outputs and display function properly over the full temperature range.

Alarm Contact Output

The alarm contact output can be used for control applications, such as double-ended line tests or for satellite time-lock status.

High-Power Outputs Are Standard

Every station relay can be time-synchronized directly from the SEL-2404 or through an SEL information processor. The SEL-2404 can drive 20 SEL-400 series or 10 SEL-300 series relay time inputs from each of the four output ports. No additional clocks or power-boost distribution options are required.

SEL-2404 Satellite-Synchronized Clock

Applications

- Ensure accurate event logging for control rooms.
- Provide timing signals to phasor measurement and control units (PMCUs) as part of a synchronized phasor measurement and control (synchrophasor) system.
- Supply precise time to protective relays to assure event correlation to the absolute accuracy provided by the relay. Use SEL or third-party software to display time-locked event reports. For example, ACSELERATOR Analytic Assistant® SEL-5601 Software can display up to three reports on a single screen for easy analysis.
- Provide time signals to information processors for distribution to all connected devices in a station integration system, such as the SEL-7000 Integrated Substation System.
- Use the free SEL-5860 Time Service Software to provide Simple Network Time Protocol (SNTP) from a computer connected to the SEL-2404 serial port.
- FCC Part 15, Class A emissions-certified for nonsubstation applications.

Hardware Specifications

Power Supply Ratings

125 Vdc or Vac

Range	75–250 Vdc or Vac
Burden	<10 W

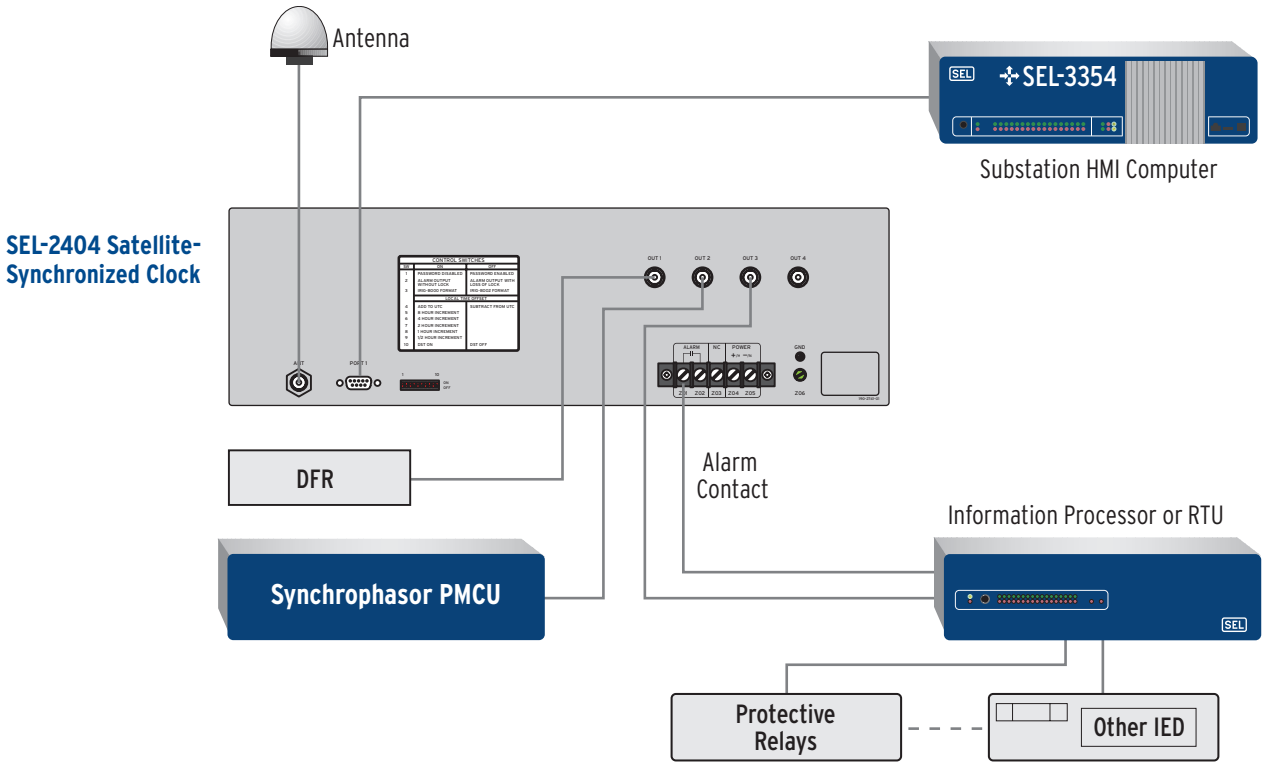
Price

Budgetary Retail, Quantity 1: $1,500 (includes cable and antenna)

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

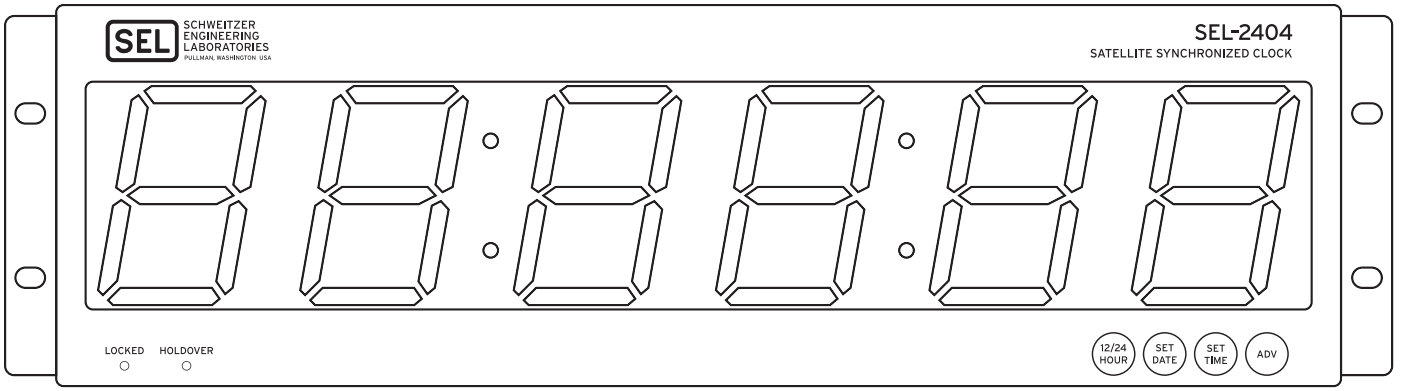
GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.



SEL-2404 Satellite-Synchronized Clock

Front View – Rack-Mount



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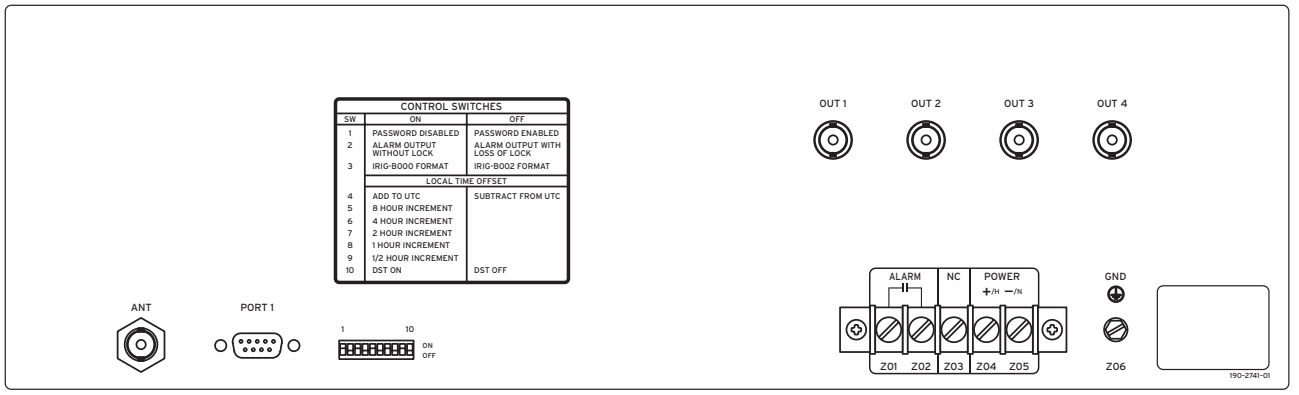
Rear View



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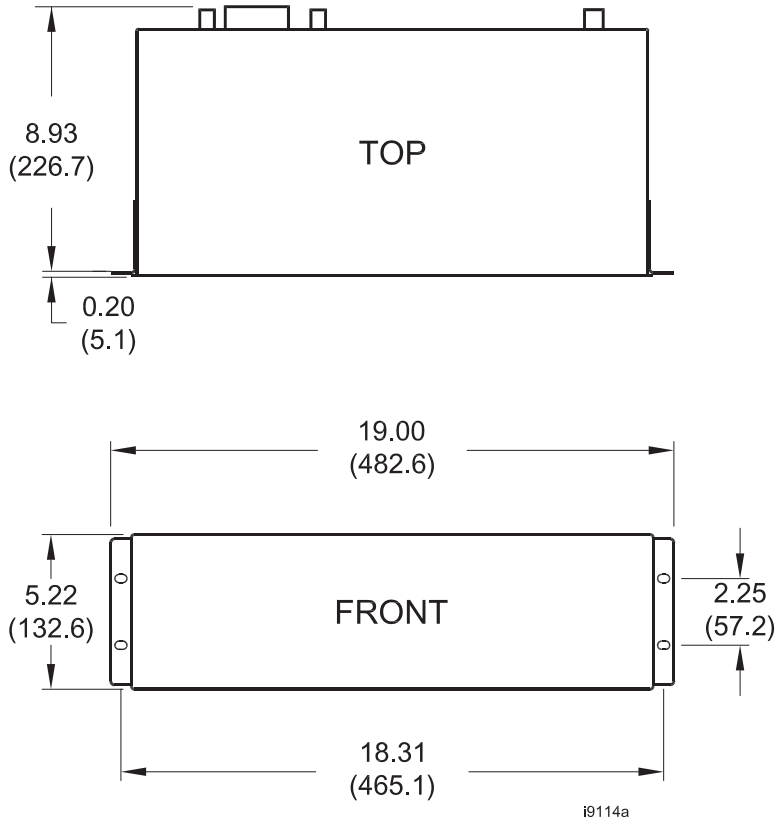
SEL-2404 Satellite-Synchronized Clock

Dimensions

RACK-MOUNT CHASSIS



LEGEND

in
(mm)

Visit www.selinc.com for more detailed information and configuration options.

SEL-2401 Satellite-Synchronized Clock

Compact enclosure and low power as well as included antenna and cable make the SEL-2401 easy to apply everywhere you need accurate time.

Key Features

High Accuracy

Apply for synchrophasor, relay event correlation, and other high-accuracy timing needs. A demodulated IRIG-B output with ±100 ns average accuracy meets requirements for existing and future timing applications, including IEEE C37.118 control function extensions for synchrophasors and other applications.

Reliable Timing

Install in harsh environments, including outdoor control enclosures. Exceeds IEEE C37.90 and IEC 60255 protective relay standards for robustness. Provides accurate time even in the presence of electrical surges.

Wide Temperature Range

Benefit from accurate timing during any operating condition. The SEL-2401 is tested to operate in temperatures ranging from −40° to +80°C.

Fast Troubleshooting

Reduce time and money spent testing for root cause of problems. Synchronized timing for relay sequential events records gives precise information on system events such as faults, outages, demand peaks, and others.

Alarm Contact Output

The alarm contact output can be used for control applications, such as double-ended line tests.

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

High-Powered Standard Output

Supply time-synchronized data to multiple SEL-400 series or SEL-300 series relay inputs from the single output. Connect multiple relays with simple BNC connectors.

Small Size, Large Features

Use a reliable time signal without paying a high cost for unused features. Apply the SEL-2401 for accurate timing in small or remote locations such as reclosers, control cabinets, and small substations.

Wide-Range Power Supply

Operate from 9–30 Vdc, or use the optional SEL-9321 Low-Voltage DC Power Supply, which provides a wide variety of ac and dc inputs. For ac-only operation, a wall-mount power supply is available.

Use the SEL-2401 inside recloser controls or other locations requiring small size and tough construction.

SEL-2401 Satellite-Synchronized Clock

Applications

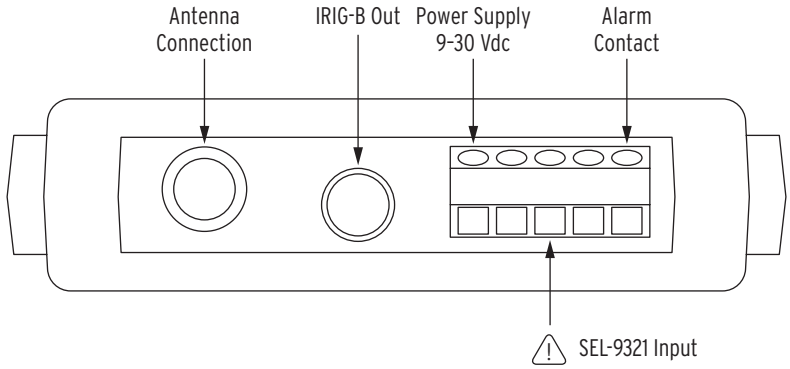
- Precise recloser controls with GPS-locked time source.
- Relays and digital fault recorders inside small substations.
- Cost-effective solution for remote control/monitoring.
- Synchronization time source for distributed generation stations.
- Use the free SEL-5860 Time Service Software to provide Simple Network Time Protocol (SNTP) from a computer connected to the SEL-2401 serial port.

Price

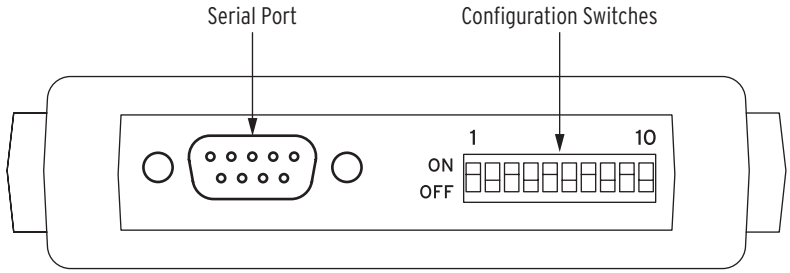
Budgetary Retail, Quantity 1: $548 (includes antenna and feedline)

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

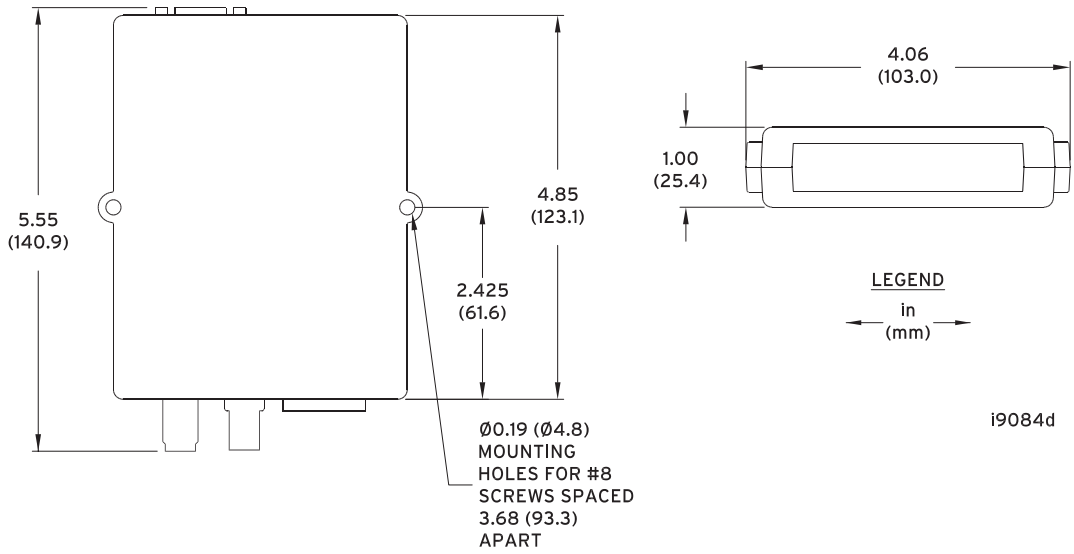
Front View



Rear View



Dimensions



Visit www.selinc.com for more detailed information and configuration options.

SEL-3401 Digital Clock Display

Improve productivity using a large time display in control rooms, factories, and other time-critical locations.

Key Features

High Visibility

Large 76 mm (3.0 in) LED display is visible in all lighting conditions, including direct sunlight, as far as 61 m (200 ft) and is perfect for wide-area viewing. Displays internal clock or demodulated IRIG-B time in 12- or 24-hour format.

Reliable Timing

Use the highly accurate internal clock, or display GPS satellite-synchronized IRIG-B demodulated time code to within ±100 ns (average) of UTC time.

Wide Temperature Range

View accurate time during any operating condition. The SEL-3401 is tested to operate in temperatures ranging from −40° to +80°C. SEL maintains an ISO 9001:2008 certified quality program.

High-Powered Optional Outputs

The wall/panel-mount digital clock display has an optional single output to drive downstream clocks and other devices with one high-drive demodulated IRIG-B output. The rack-mount version has an option for four high-drive demodulated IRIG-B outputs. TTL outputs provide 120 mA at 3.5 Vdc into 25 ohms, enough to drive 20 SEL-421 Relays or 10 SEL-351 Relays.

Easy to Use

Save money with simple mounting, minimal initial settings, and low installation cost. Purchase the SEL-3401, and increase productivity immediately.

Flexible Mounting Options

Choose a low-profile wall/panel-mount version or a 19-inch rack-mount version. Additional mounting brackets and antennas are available to fit any application need.

SEL-3401 Digital Clock Display

Applications

- Accurate event logging for control rooms.
- Tough time display for factory floors.
- Multiple, synchronized, and easy-to-read displays for busy travelers.
- Automatic timing reset after brief power failure.
- Increased productivity with on-time conference calls and web broadcasts in meeting rooms.
- Suitable for synchronized clock systems. Includes FCC Part 15, Class A emission certification for nonsubstation applications.

Note: See **www.selinc.com** for more application information

Hardware Specifications

Power Supply Ratings

Surface-Mount/Wall-Mount Version

Voltage	15 Vdc
Burden	8 W

(ac adaptor 230-0604 included; see page 491)

Rack-Mount Version

Voltage	125 Vdc or Vac
Range	75–250 Vdc or Vac
Burden	<10 W

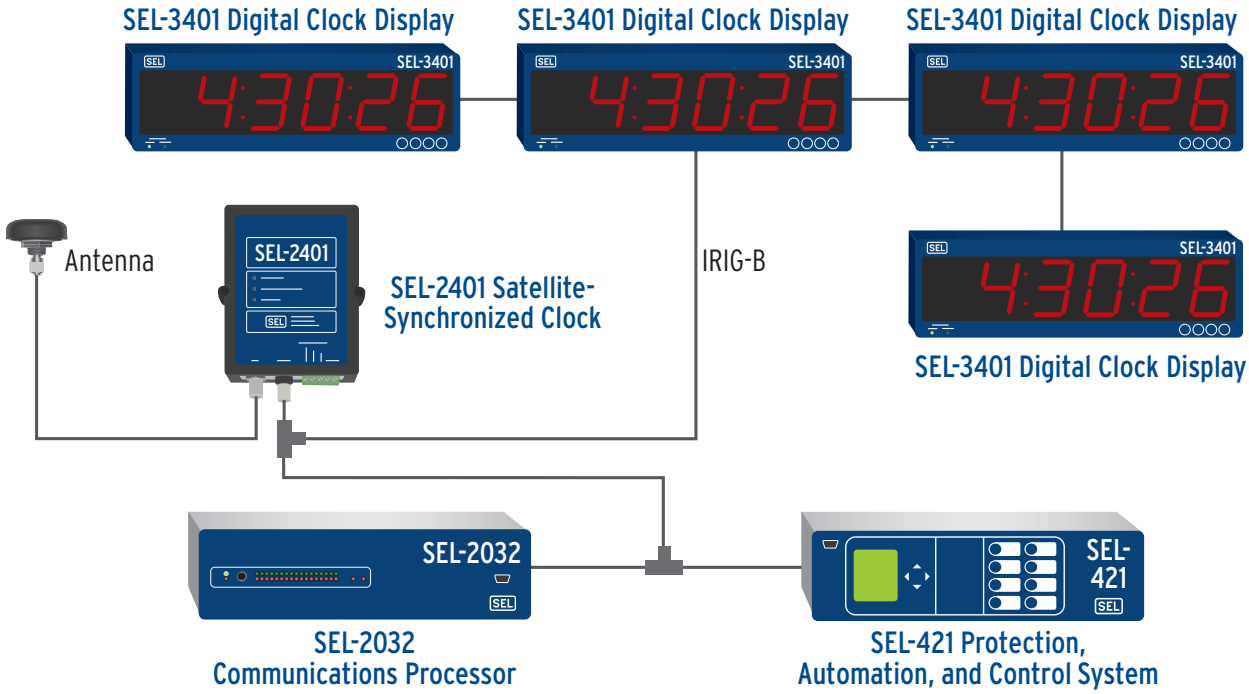
Price

Budgetary Retail, Quantity 1: $392

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

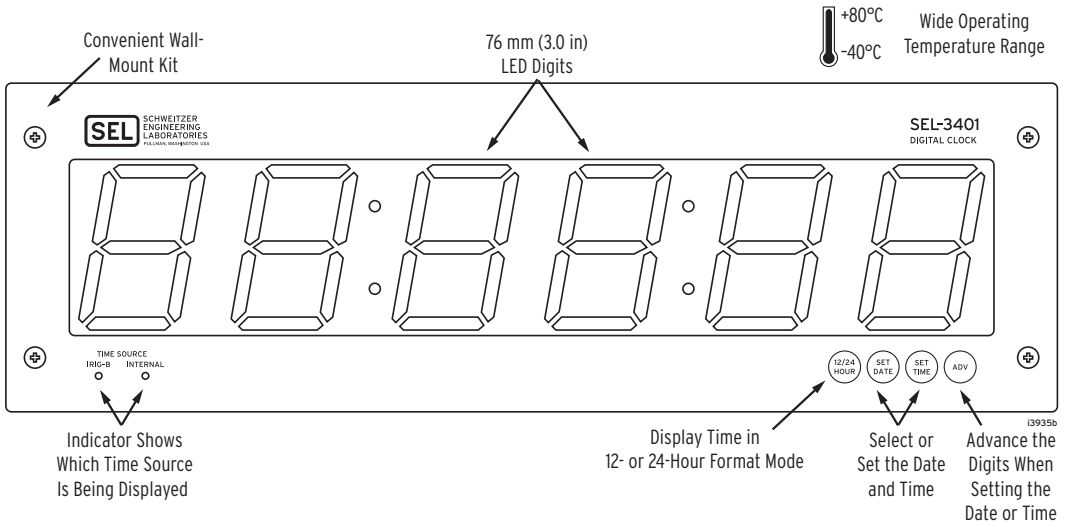
This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.



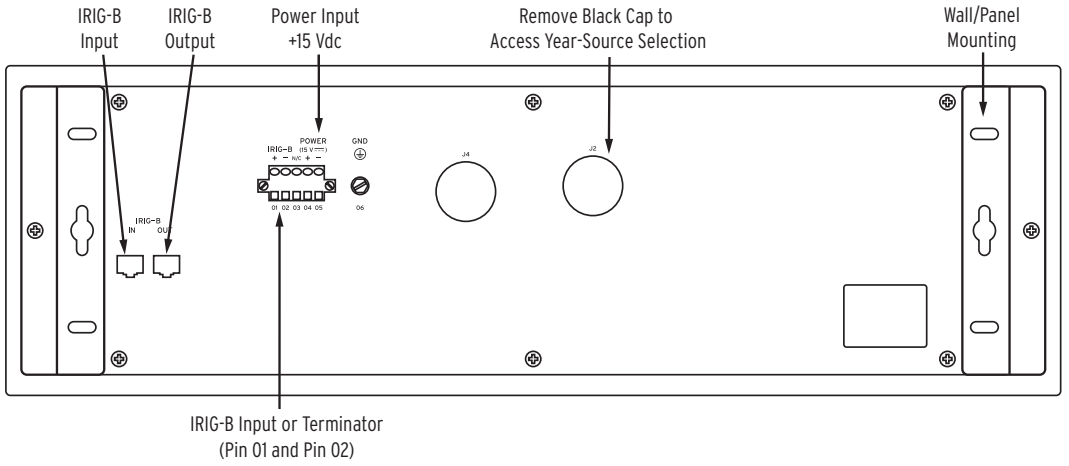
Use the SEL-3401 to display satellite-synchronized UTC time and distribute it to other IEDs.

SEL-3401 Digital Clock Display

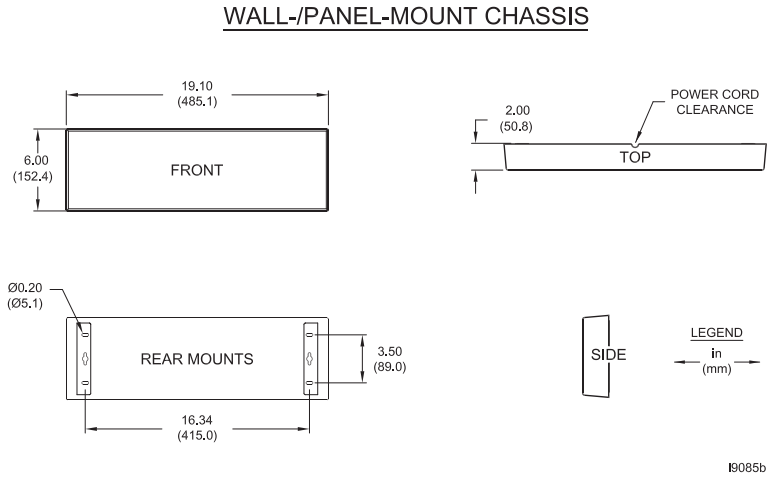
Front View



Rear View

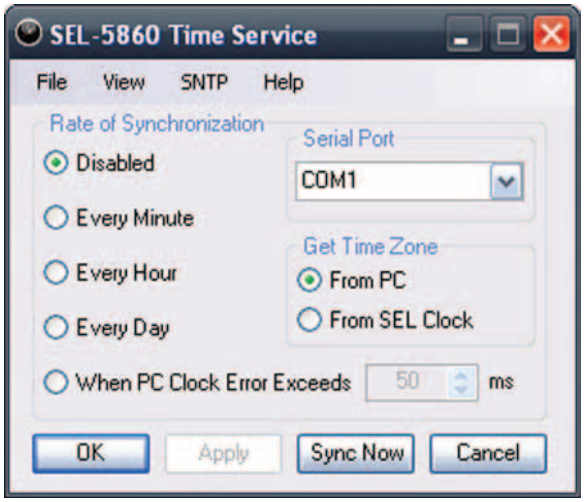


Dimensions



Visit www.selinc.com for more detailed information and configuration options.

SEL-5860 Time Service Software



Turn your SEL satellite-synchronized clock into a network time source.

Key Features

- Synchronize a Windows®-based PC system clock to GPS satellite time.*
- Allow a PC to serve as a Simple Network Time Protocol (SNTP) server.
- Allow a PC to act as an SNTP client.

* For Linux® or Mac OS® X, see application notes at **www.selinc.com**

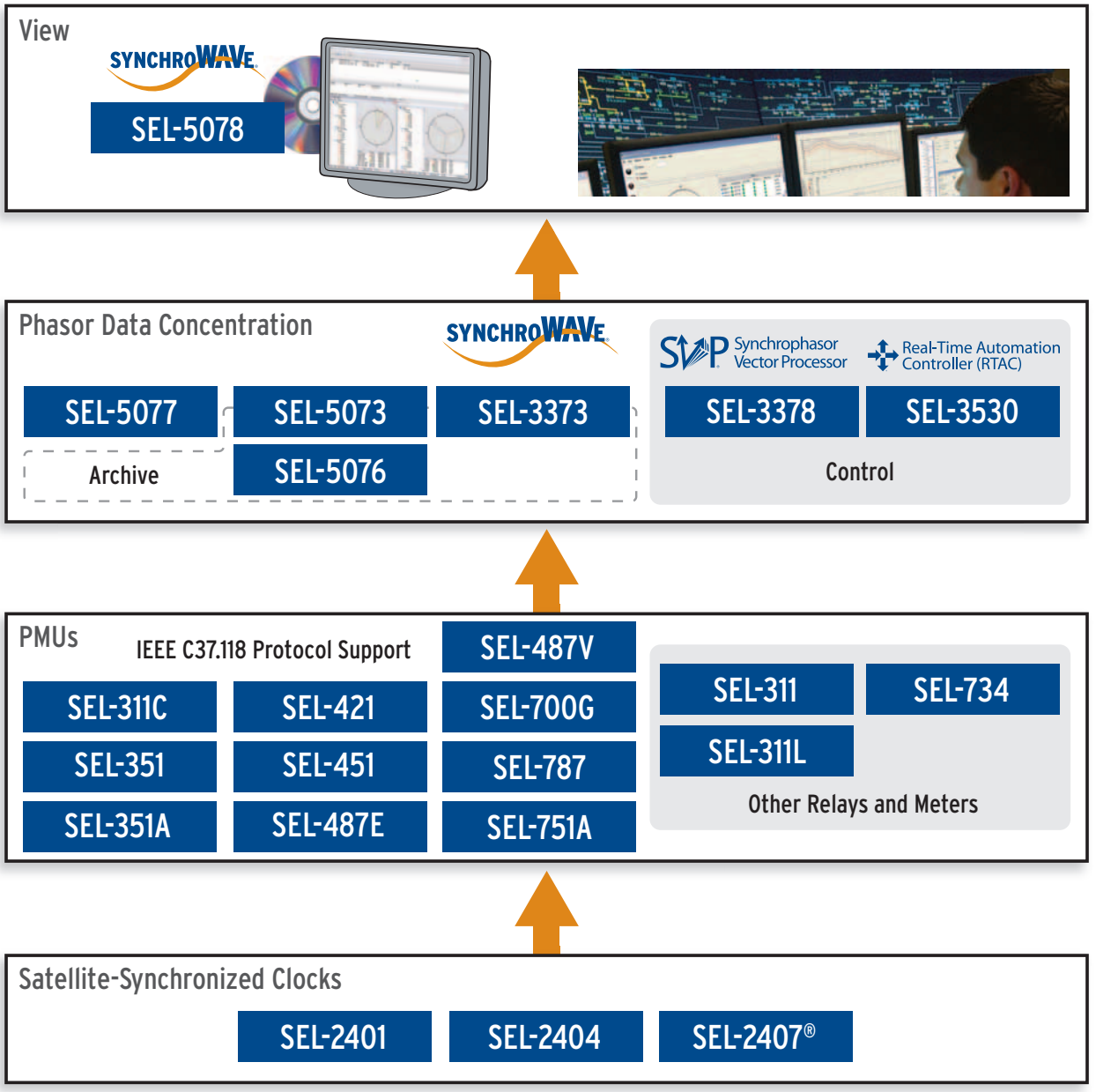
Price

Free download. Works with SEL-2401, SEL-2404, and SEL-2407 Satellite-Synchronized Clocks.

Related Products

SEL-2401 Satellite-Synchronized Clock 316
SEL-2404 Satellite-Synchronized Clock 312
SEL-2407® Satellite-Synchronized Clock 308

Synchrophasor Applications



Synchrophasor Product Index

Synchrophasor Features

Phasor Measurement Units

	SEL-311C/351/351A/351S	SEL-351RS	SEL-421/451	SEL-487E	SEL-487V	SEL-734	SEL-700G	SEL-751A	SEL-787	Legacy SEL-351/311/311L
IEEE C37.118 Compliant	•	•	•	•	•		•	•	•	
Maximum Data Rate (mps)	60	60	60	60	60	20	60	10	10	20
Fast Message	•	•	•	•	•	•				•
3 Ø Currents	1	1 phase	2	6	2	1	2	1	2	1
3 Ø Voltages	1	1 phase	2	2	2	1	2	1	1	1
Additional Analogs	0	0	8	16	16	0	4	4	4	0
Digitals	16	16	32	64	64	8	16	16	16	16
Ethernet	•	•	•	•	•	•	•			
Serial	•	•	•	•	•	•	•	•	•	•
IRIG-B Time Input	•	•	•	•	•	•	•	•	•	•
Settable Filter	•	•	•	•	•		•			
Synchrophasor Meter (MET PM)	•	•	•	•	•	•	•	•	•	•
Precise Time Event Report (EVE P)	•	•	•	•	•					•
Real-Time Control (RTC)			•	•	•					

Phasor Data Concentration

	SEL-5073	SEL-5076	SEL-5077	SEL-3373	SEL-3378	SEL-3530
Hardware PDC				•	•	•
IEEE C37.118 Format Input	•	•	•	•	•	•
Fast Message Input		•	•			•
Number of Inputs (Standard/Optional)	20/>100*	4	8	8/40*	20	16+
Number of Outputs	6	n/a	6	6	7	n/a
Control Outputs		n/a			•	•
IEC 61131 Programming		n/a			•	•
Archiving (Triggered or Continuous)	•*	•		•*		

Visualization

	SEL-5078
IEEE C37.118 Input	•
SEL Fast Message Input	•
Serial	•
Ethernet	•

• *Standard Feature* * *Model Option*

SEL-3378 Synchrophasor Vector Processor

Implement real-time, wide-area monitoring, protection, automation, and control schemes.

SEL Synchrophasors™

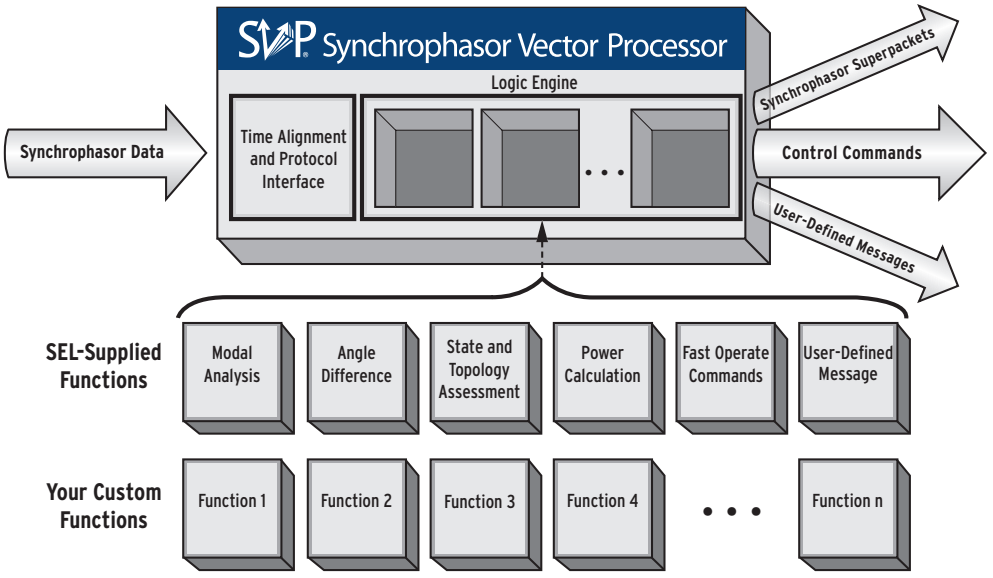
Key Features

Take Control Action Using Synchrophasor Measurements

Receive and correlate synchrophasor data from up to 20 phasor measurement units (PMUs). Produce control and data outputs by applying preconfigured logic and IEC 61131 logic equations to measurements (phase angles, voltage magnitudes, current magnitudes, real power, reactive power, and more).

Identify Oscillatory Conditions With Modal Analysis Function Block

Send a control command based on critical stability indicators, such as oscillatory frequency and damping ratio, to assess power system health. Create alarms for underdamped conditions. Analyze up to 15 different modes from up to six different signals (voltages, currents, or real/reactive power). Detect unstable operating conditions, and validate power system models. Send alarms based on mode amplitude, frequency, damping constant, and damping ratio.



Combine SEL-supplied functions with custom logic to create unique applications (e.g., islanding detection, voltage quality regulation, and load shedding).

SEL-3378 Synchrophasor Vector Processor

Applications

- Create real-time, wide-area monitoring, protection, automation, and control schemes.
- Improve overall system reliability with simplified system integrity protection schemes (SIPS).
- Identify and respond to inter-area power oscillations that compromise power system stability.
- Collect data, perform mathematical operations, and output results.
- Monitor measurements to detect wiring, CT, and PT problems.
- Refine measurements to improve system-state assessment.
- Eliminate redundant measurements to minimize communications channel requirements.
- Detect power swing oscillations and power system out-of-step conditions using phasor-angle measurements.
- Run custom IEC 61131-3 logic.

Price

Budgetary Retail, Quantity 1: $12,500

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Hardware Specifications

Operating Temperature

−40° to +75°C (−40° to +167°F)

Communications Ports

Serial Ports	16
Console Port	EIA-232 with DB-9 connectors
Serial Data Speed	9600 bps
Ports 1–15	EIA-232 with DB-9 connectors
Serial Data Speed	9600, 19200, 38400, 57600, and 115200 bps
Ethernet Ports	2
Ethernet Port 1	10/100BASE-T copper or 100BASE-FX fiber-optic
Ethernet Port 2	100BASE-FX fiber-optic

IRIG-B Ports

Time-Code Input	
Connector	Female BNC
Time Code	Demodulated IRIG-B TTL
Time-Code Output	
Connector	15 rear DB-9 port connectors
	Female BNC
Time Code	Demodulated IRIG-B TTL compatible

Synchrophasor Data Format

Input Data Formats	
IEEE C37.118-2005	Ethernet and serial
Output Data Formats	
IEEE C37.118-2005	Ethernet

Synchrophasor Input/Output Message Rates

60 Hz Nominal Data Rate	1, 2, 4, 5, 10, 12, 15, 20, 30, and 60 messages per second
50 Hz Nominal Data Rate	1, 2, 5, 10, 25, and 50 messages per second

Synchrophasor Data Ports

Serial	15
Ethernet	2

Synchrophasor Processing Capacity

Processing Capacity	Data from as many as 20 PMUs
Typical Message Size	354 bytes
Maximum Data Rate	60 messages per second

Output Commands

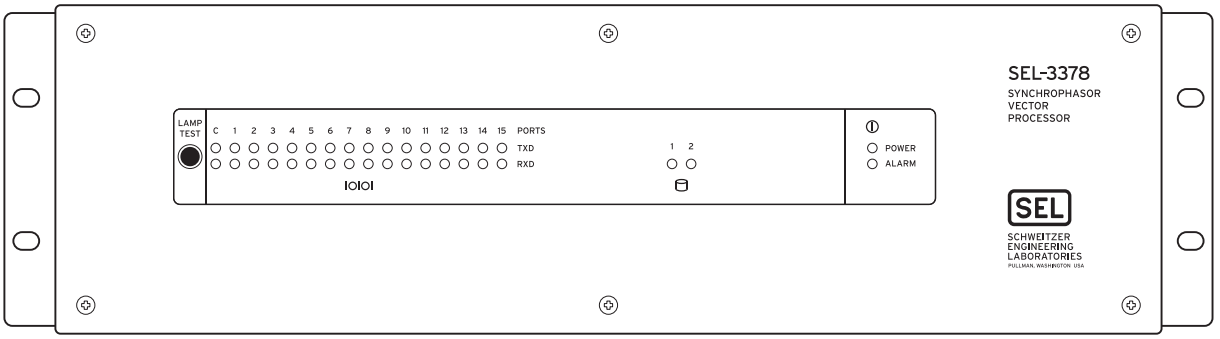
SEL Fast Operate
SEL Mirrored Bits® Communications
IEC 61850 GOOSE

Power Supply

125/250 Vdc or 120/230 Vac; 50/60 Hz
48/125 Vdc or 120 Vac; 50/60 Hz
24/48 Vdc

SEL-3378 Synchrophasor Vector Processor

Front View – Rack-Mount



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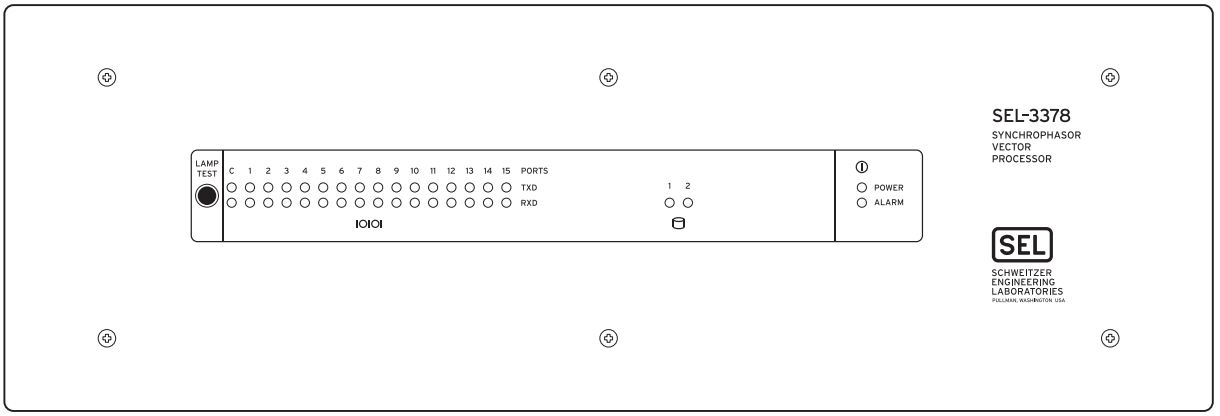
Front View – Panel-Mount



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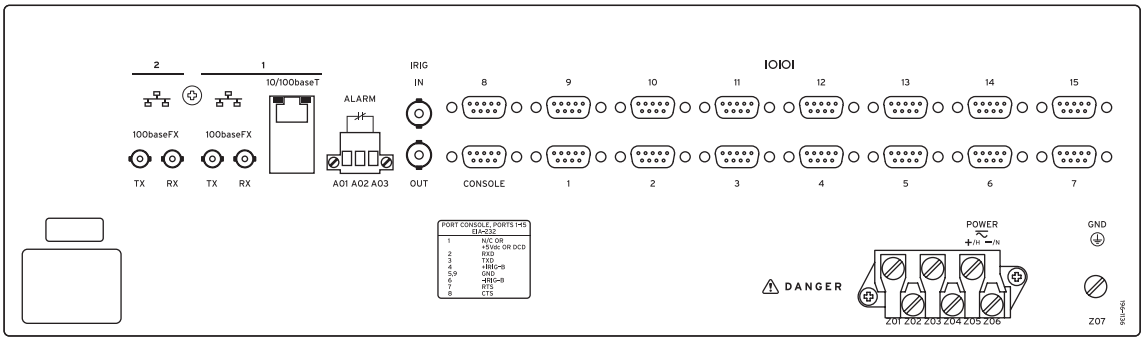
Rear View



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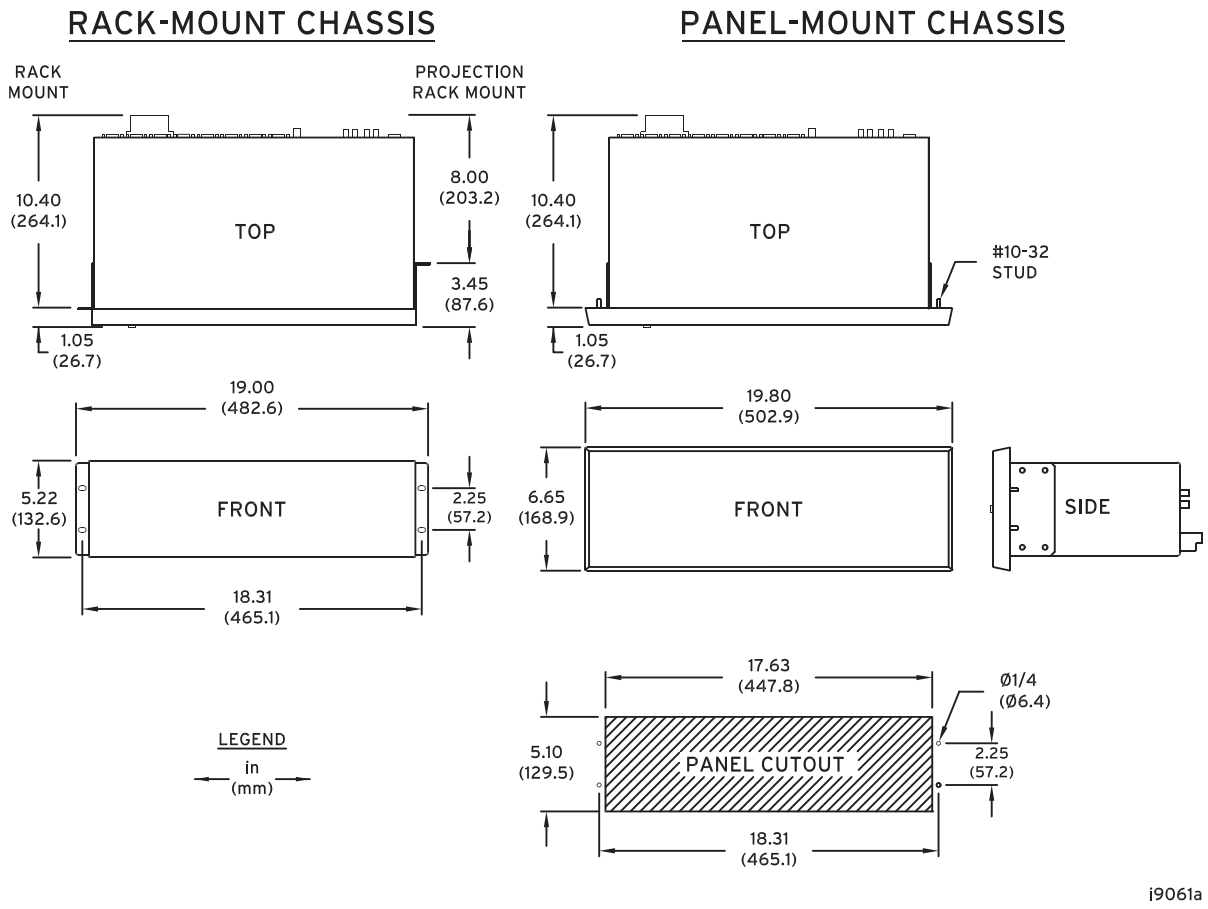
SEL-3378 Synchrophasor Vector Processor

Dimensions



Visit www.selinc.com for more detailed information and configuration options.

SEL-3373 Station Phasor Data Concentrator (PDC)

Substation-hardened, real-time performance PDC with archiving.

SEL Synchrophasors™

Key Features

High Performance

Connect the SEL-3373 Station PDC to 40 phasor measurement units (PMUs) or PDC inputs at rates up to 60 messages per second. Combine data from multiple input message rates into a single output stream. Control upstream data access with six individually configurable output streams. Configure outputs at variable message rates.

Powerful Database Archiving

Build a NERC PRC-002 disturbance recording system with the SEL-3373. Archive data locally at each substation. Select from several data-capturing options: continuous or triggered archiving, with pre- and postdisturbance data capture. Retrieve data in binary or ASCII COMTRADE, comma-separated values (CSV), and compressed CSV formats. Directly access the archived database using the included PDC Assistant application software. Easily access the archived data you are interested in with flexible data query.

Proven SEL Substation Reliability

Reduce your cost of ownership with years of reliable operation, even in tough substation environments. The Station PDC is designed and tested to meet or exceed protective relay specifications for harsh environments.

Easy Configuration and Commissioning

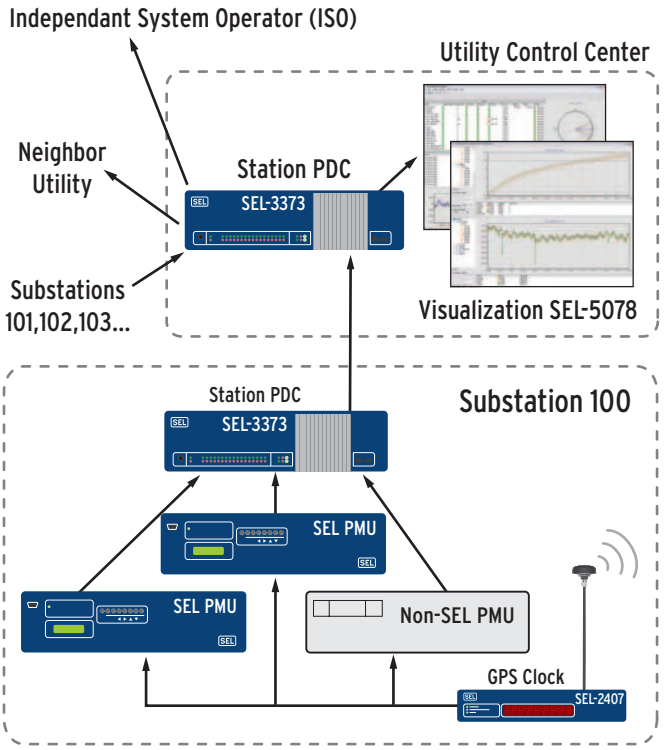
Quickly set up or add PMUs with the intuitive user interface. Select all PMU data or just a subset for concentration and archiving, and set event triggers and security options, all with the advanced and easy-to-use PDC Assistant.

Safe and Secure

Obtain NERC CIP compliance support with individual user- and role-based account authentication, strong passwords, access logs, and port control. Build a secure interutility synchrophasor data exchange network for wide-area situational awareness with the SEL-3373.

Applications

- Disturbance data recording and archiving. After a major power system event occurs, having synchronized, high-quality data dramatically reduces the time needed to understand the event. Additionally, observing trends and patterns in archived data helps in developing future power system design and control.
- Real-time wide-area monitoring. See up-to-the-second status of the entire power system. Using graphical results provided in the SEL-5078 SYNCHROWAVE® Console Software, observe the dynamically varying nature of the power system. This real-time information improves operator decision making.

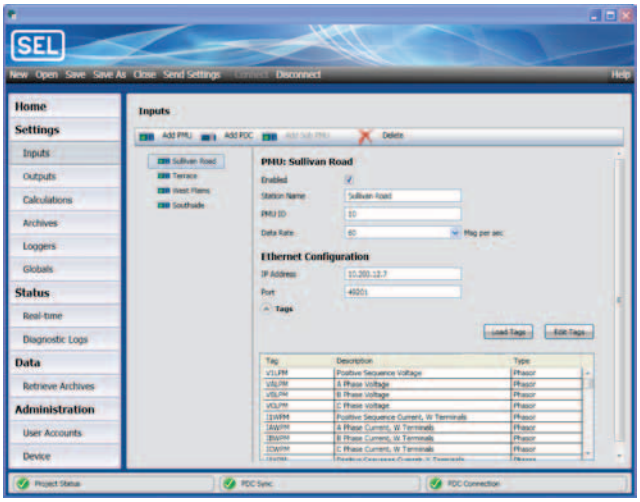


Tel: +1.509.332.1890 | Fax: +1.509.332.7990 | www.selinc.com

SEL-3373 Station Phasor Data Concentrator (PDC)

Optional Features

- Standard SEL-3373 supports 8 PMU inputs.
- Additional PMU inputs (~40).
- Local archiving on 16 GB CompactFlash® (CF), 60 GB or 120 GB solid-state drive (SSD).



Easily set up and configure the SEL-3373 with the PDC Assistant application software.

Hardware Specifications

Communications Ports

Ethernet Ports 3 (10/100BASE-T/FX)

2 rear panels RJ-45 (copper or fiber), 1 front panel RJ-45 copper

Serial Ports 16

Rear panel EIA-232 ports with DB9 connectors

Synchrophasor Data Format (input and output)

IEEE C37.118-2005

Operating Temperature Range

–20° to +60°C (–4° to +140°F)

Power Supply Ratings

48/125 Vdc or 120 Vac

125/250 Vdc or 120/240 Vac

Price

Budgetary Retail, Quantity 1: $7,500

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

Reliable Hardware

All SEL products are backed by our industry-leading, worldwide, ten-year warranty.

Built to operate reliably in harsh environments, the SEL-3373 conforms to IEEE C37.90 and IEC 60255 protective relay standards, and IEEE 1613 standard environmental and testing requirements for communications networking devices in electric power substations.

Built-in diagnostics continuously perform self-tests and send needed alerts.

LEDs provide visible indication of transmit/receive activity on the various I/O ports.

Solid-state design ensures high reliability—with no moving parts to wear out.

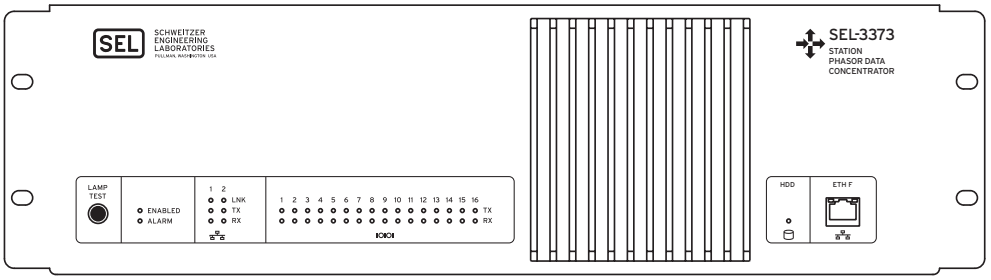
16 EIA-232 serial communications ports.

Wide-range ac or dc power supply.

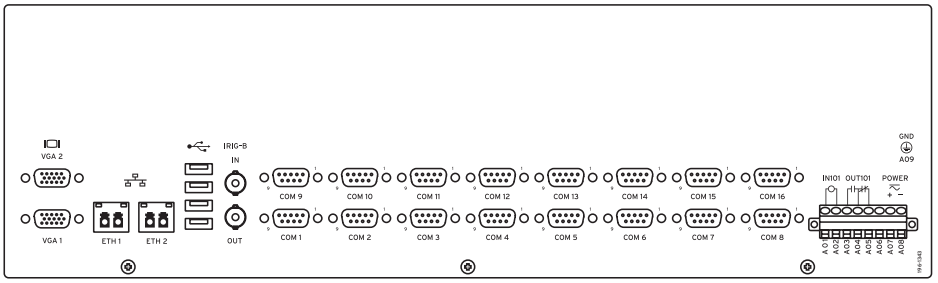
Alarm contacts indicate instrument failure.

SEL-3373 Station Phasor Data Concentrator (PDC)

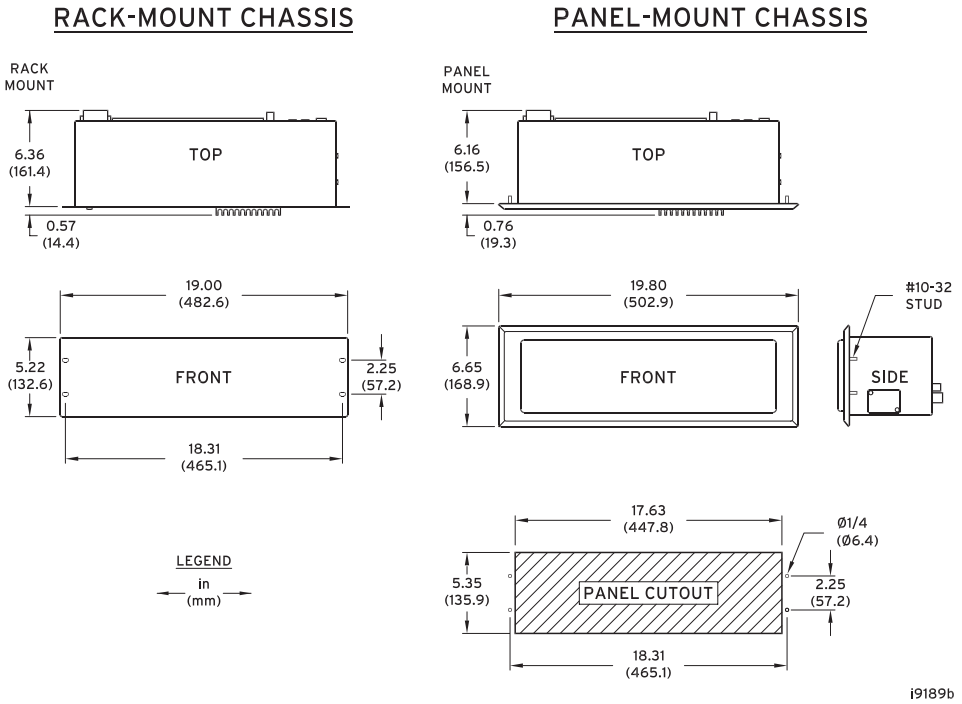
Front View – Rack-Mount



Rear View (3U)

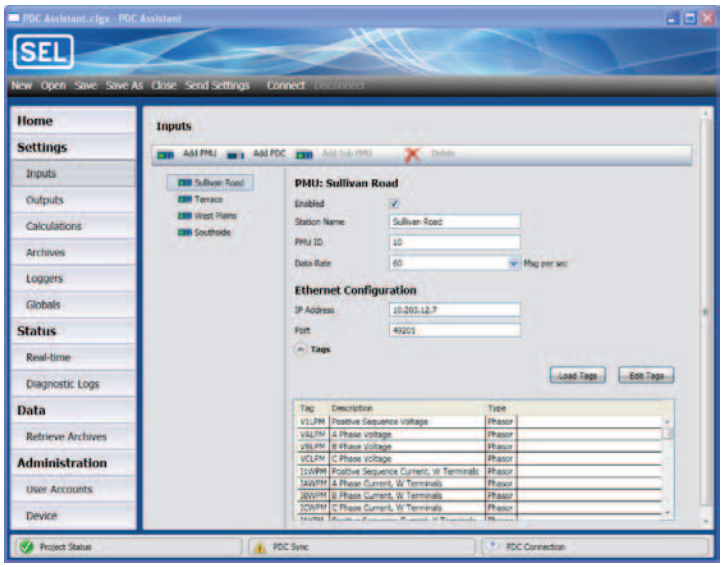


Dimensions



Visit www.selinc.com for more detailed information and configuration options.

SEL-5073 SYNCHROWAVE® Phasor Data Concentrator (PDC) Software



The included PDC Assistant makes setup and configuration of the Windows®-based PDC easy.

PDC system software with data archiving.

SEL Synchrophasors™

Key Features

High Performance

Install SYNCHROWAVE PDC Software on your PC, and connect more than 100 phasor measurement units (PMUs) or PDC inputs with rates of up to 60 messages per second. Combine data from multiple input message rates into a single output stream. Control upstream data access with six individually configurable output streams. Configure outputs at variable message rates.

Powerful Database Archiving

Build a NERC PRC-002 disturbance recording system with the SEL-5073. Archive data locally on the computer running SYNCHROWAVE. Select from several data-capturing options: continuous or triggered archiving with pre- and postdisturbance data capture. Retrieve data in binary or ASCII COMTRADE, comma-separated values (CSV), and compressed CSV formats. Directly access the archived database using the included PDC Assistant application software. Easily access the archived data you are interested in with flexible data query.

Reliable Operation on Your Computer

Run SYNCHROWAVE PDC Software on your Windows®-based computer hardware. The software is rigorously designed and tested for continuous and reliable operation, including autorestart after a computer reboot.

Easy Configuration and Commissioning

Quickly set up or add PMUs with the intuitive user interface. Select all PMU data or just a subset for concentration and archiving, and set event triggers and security options, all with the advanced and easy-to-use PDC Assistant.

Safe and Secure

Obtain NERC CIP compliance support with individual user- and role-based account authentication, strong passwords, and access logs. Build a secure interutility synchrophasor data exchange network for wide-area situational awareness with the SEL-5073.

Optional Features

Standard SEL-5073 supports 20 PMU inputs.

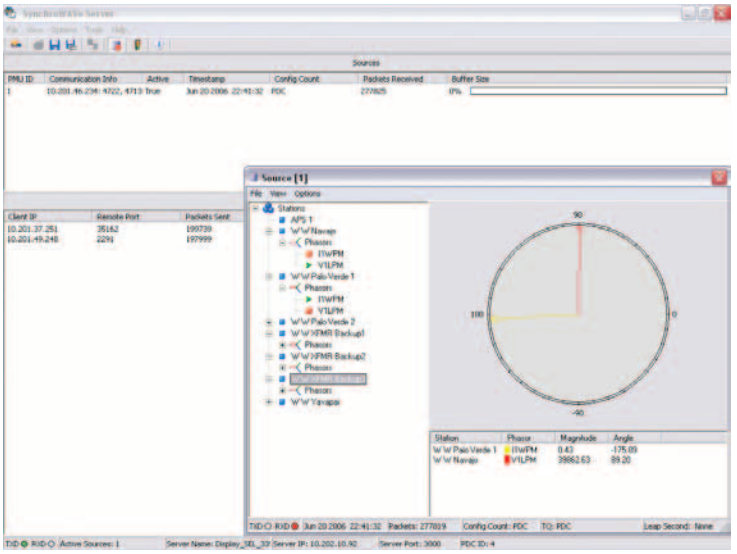
- Additional PMU inputs (~100).
- Local archiving.

Price

Budgetary Retail, Quantity 1: $4,000

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

SEL-5077 SYNCHROWAVE® Server Software



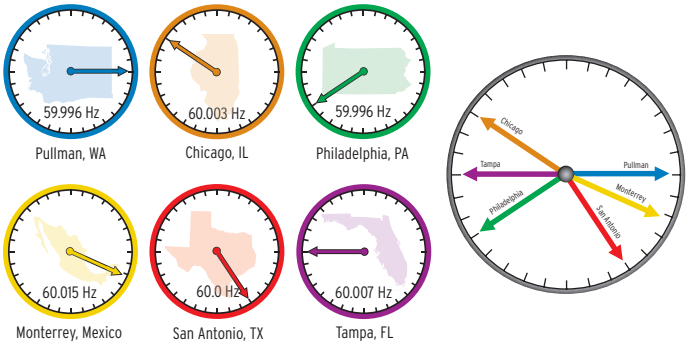
SEL-5077 SYNCHROWAVE® Server Software provides Windows® PC-compatible phasor data concentration (PDC) functionality. Simple configuration screen validates incoming data from each connected phasor measurement unit (PMU).

Collect, process, and communicate synchronized phasor measurements.

SYNCHROWAVE®

Key Features

- Collect and correlate synchrophasor data from multiple PMUs.
- Input data in IEEE C37.118 or SEL Fast Message format.
- Provide data to multiple clients for visualization, archiving, and analysis using IEEE C37.118 format.
- Support real-time viewing of power system conditions.
- Use where communication is limited, such as with dial-up or leased line as well as Ethernet and direct serial communications.
- Support Windows® 2000, XP, and Server 2003.
- Convert synchrophasor protocols (IEEE C37.118, SEL Fast Message) to Modbus® for easy transmission to SCADA/EMS systems.
- Calculate real and reactive power flow for system interconnections.



SEL synchrophasors provide real-time information on system swings, load shifts, and voltage stability.

Price

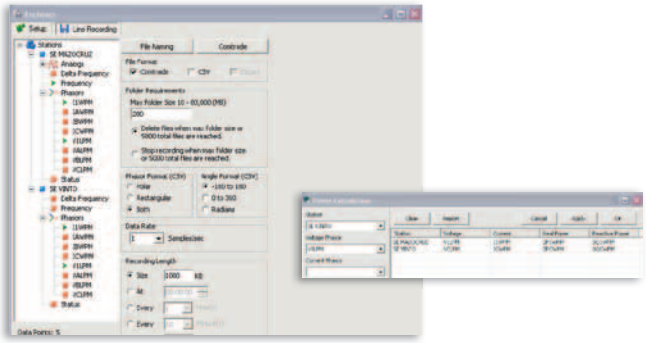
Budgetary Retail, Quantity 1: $7,500

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

SEL-5076 SYNCHROWAVE® Archiver Software



Flexible archiving accommodates varying data storage requirements.

Record system disturbances from a single station or an entire system.

SYNCHROWAVE

Key Features

- Archive power system operating conditions, continuously or based on event triggers, in CSV or COMTRADE format.
- Adjust length of storage to fit archiving needs by selecting quantities such as phasors, frequency, digitals, and analogs.
- Trigger-record any digital or analog signal from any or all PMUs.
- Use IEEE C37.118-defined triggers to capture system-wide events based on preprogrammed alarms.
- Select file size or time-based file length for continuous archiving.
- Support Windows® 2000, XP, and Server 2003.
- Apply subsample rate archiving to get low resolution during normal conditions, and maximum resolution during system events.
- Calculate real and reactive power flow for system interconnections.

Price

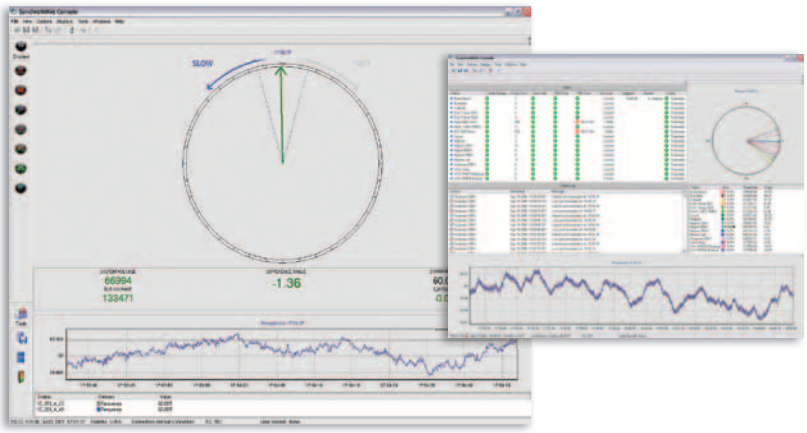
Budgetary Retail, Quantity 1: $5,500

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

SEL-5078 SYNCHROWAVE® Console Software



Synchroscope view facilitates remote control.

Improve situational awareness with real-time, wide-area displays.

SYNCHROWAVE

Key Features

- Display synchrophasor data.
- Improve situational awareness.
- Dock windows for customizable viewing of multiple displays.
- Optimize monitoring of power system conditions to meet operational requirements.
- Calculate real and reactive power flow for system interconnections.
- Support Windows® 2000, XP, and Server 2003.

Price

Budgetary Retail, Quantity 1: $5,500

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

SEL Phasor Measurement Units (PMUs)

Most SEL relays and meters include the capability of performing synchronized phasor measurement. Different devices offer protocols, data rates, and accuracies for wide-area measurement and control applications.

SEL-311C, SEL-351, SEL-351A, and SEL-351S Protection Systems

The SEL-311C, SEL-351, SEL-351A, and SEL-351S Protection Systems have identical synchrophasor characteristics and settings. The accuracy provides a total vector error (TVE) of less than 1 percent at ±5 Hz from nominal frequency. The filtering is settable for either fast response (for control applications) or high accuracy (for small signal and post-event analysis). Transmit synchrophasor data by either serial or Ethernet transmission paths. Use the EVE P command for high-accuracy timing of event reports. The SEL-351A is available as a standalone PMU.

Format
IEEE C37.118
SEL Fast Message

Data Rate
1–60 mps

Synchrophasor Data Elements
1 – 3 Ø Current, Positive Sequence
1 – 3 Ø Voltage, Positive Sequence
16 – Digitals

SEL-487V, SEL-421, and SEL-451 Protection, Automation, and Control Systems

The SEL-487V, SEL-421, and SEL-451 Protection, Automation, and Control Systems have identical synchrophasor characteristics and settings. The accuracy provides a TVE of less than 1 percent at ±5 Hz from nominal frequency. The filtering is settable for either fast response (for control applications) or high accuracy (for small signal and post-event analysis). Transmit synchrophasor data by either serial or Ethernet transmission paths. Binary COMTRADE event files are time-synchronized to a high-accuracy time source. These relays have real-time control capability for building relay-to-relay control schemes.

Format
IEEE C37.118 and
SEL Fast Message

Data Rate
1–60 mps

Synchrophasor Data Elements
2 – 3 Ø Currents
2 – 3 Ø Voltages
16 – Additional Analogs
64 – Digitals

SEL Phasor Measurement Units (PMUs)

SEL-487E Transformer Protection Relay

Apply the SEL-487E as a station PMU with high-accuracy, IEEE C37.118 synchrophasors from multiple voltage and current channels. Any or all connected voltage or current can be selected for inclusion in the synchrophasor message. Binary COMTRADE event files are time-synchronized to a high-accuracy time source. The SEL-487E has real-time control capability for building relay-to-relay control schemes. The SEL-487E is available as a standalone PMU.

Format
IEEE C37.118 and SEL Fast Message

Data Rate
1–60 mps

Synchrophasor Data Elements
6 – 3 Ø Currents
2 – 3 Ø Voltages
16 – Additional Analogs
64 – Digitals

SEL-751A Feeder Protection Relay, SEL-700G Generator Protection Relay, and SEL-787 Transformer Protection Relay

Synchrophasors are available from the SEL-787, SEL-700G, and SEL-751A with or without a voltage card. Ten messages per second support using the SEL-787 and SEL-751A in wide-area disturbance monitoring.

Format
IEEE C37.118

Data Rate
1–10 mps (SEL-751A, SEL-787)
1–60 mps (SEL-700G)

Synchrophasor Data Elements
1 – 3 Ø Current (SEL-751A)
2 – 3 Ø Currents (SEL-787, SEL-700G)
1 – 3 Ø Voltage
4 – Additional Analogs
16 – Digitals

SEL-311A and B, SEL-311L, and Legacy SEL-351 and SEL-311C Relays

Synchrophasors are provided in all new SEL-311A, B, C, SEL-311L, and SEL-351 Relays and available as a firmware retrofit in existing relays. Connect the Fast Message synchrophasor output to SEL information processors to check system angles and station connections. Use the EVE P command for high-accuracy timing of event reports.

Format
SEL Fast Message

Data Rate
1 mpm–1 mps

Synchrophasor Data Elements
1 – 3 Ø Current
1 – 3 Ø Voltage

SEL-734 Advanced Metering System

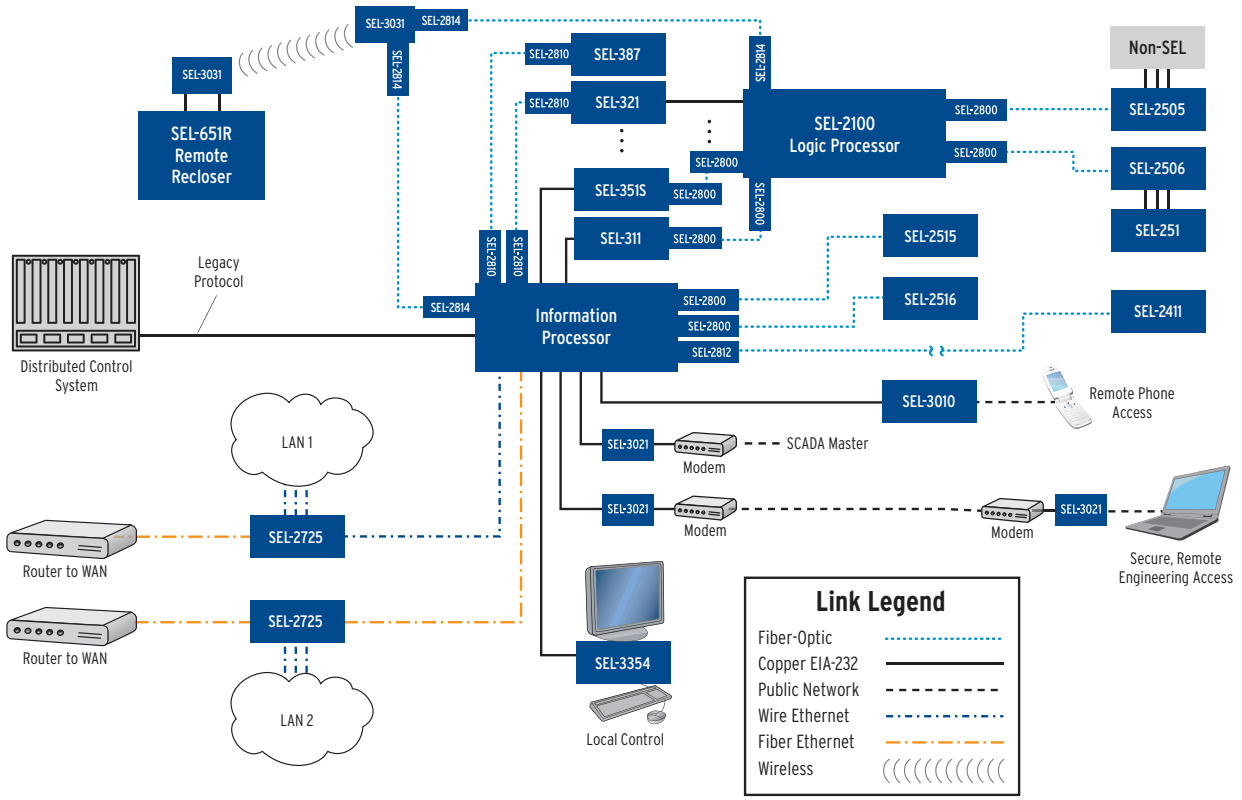
Send Fast Message synchrophasors from the SEL-734 to SEL phasor data concentrators for wide-area measurement or to SEL information processors for use in SCADA systems.

Format
SEL Fast Message

Data Rate
1–20 mps

Synchrophasor Data Elements
1 – 3 Ø Current
1 – 3 Ø Voltage

Information Processor Applications



Information Processor Product Index

Information Processor Features

Information Processors

	SEL-3530	SEL-3530-4	SEL-2032	SEL-3332	SEL-3354[4]	SEL-2020
APPLICATIONS						
Collect, Scale Meter Data	•	•	•	•	*	•
Collect Targets, Contact Input Status, Fault Location	•	•	•	•	*	•
Enable Fiber-Optic Links	•	•	•	•	•	•
Control Through IED Outputs	•	•	•	•	*	•
Extract Data From Non-SEL IEDs	•	•	•	•	*	•
Forward Information to Maintenance Databases	•	•	•	•	*	•
Accept IRIG-B Time Synchronization	•	•	•	•	•	•
Provide IRIG-B Time Synchronization	•	•	•	•	•	•
Concentrate IED Data for:						
Distributed Control System (DCS)	•	•	•	•	*	•
SCADA Master or RTU	•	•	•	•	*	•
Local or Remote HMI	•	•	•	•	*	•
Transparent "Port Switch"	•	•	•	•	*	•
Call Pager for Critical Conditions	•	•	•	•	*	•
Users Can Install Windows® Applications					•	
Web Server HMI	*	*			3	
FEATURES						
Primary and Standby LAN Support	•	•	1,2	•	•	
Programmable Logic Functions	•	•	•	•	*	•
Upgrade Firmware Through Port	•	•	•	•	•	
Optoisolated Inputs/Programmable Outputs	*	•	*			*
Telephone Connection Internal Modem						*
Rack-Mount or Panel-Mount Hardware	*	•	*	*	*	*
IEC 61131 Logic Engine	•	•			3	
Cybersecurity Management	•	•		•	•	
Real-Time Operating System	•	•	•			•
SERIAL PORT PROTOCOLS						
SEL Mirrored Bits® Communications	•	•				
Master						
DNP3	•	•		*	*	
Modbus® RTU	•	•		*	*	
Modbus Subset for IEDs			*f*			*f*
IEC 60870-5-103				*	*	
Harris 5000/6000				*	*	
LG 8979				*	*	
SES 92				*	*	
MV90 Master Subset for Meters	*f*	*f*	*f*			*f*
2179 for Tap-Changer Control	*f*	*f*	*f*			*f*
SEL Fast Messages, Interleaved With ASCII	•	•	•	•	*	•
SEL Synchrophasor	•	•	*			
Outstation						
DNP3	•	•	•	*	*	•
Modbus RTU Binary	•	•	•	*	*	•
IEC 60870-5-101/104				*	*	
Recon 1.1				*	*	
LG 8979				*	*	
Harris 5000/6000				*	*	
SES 92				*	*	
CDC Type 2 Byte				*	*	
GE-TAC/BE-TAC 7020				*	*	
Conitel 2020 Byte				*	*	
NETWORK PROTOCOLS						
Ethernet	•	•	1	•	•	
Telnet	•	•	1	•	•	
FTP	•	•	1	•	•	
DNP3 LAN/WAN	•	•	1	*	*	
Modbus TCP	•	•		•	*	
IEC 61850/UCA2			1	*	*	
IEC 61850				*	*	
IEC 61850 GOOSE	•	•		*	*	
OPC Client/Server				*	*	
IEEE C37.118 Client	•	•				
Modbus Plus®			2			
Lightweight Directory Access Protocol (LDAP)	•	•			3	

• *Standard Feature* * *Model Option* *f* *This function may be created using settings*

1 *With Ethernet Option* 2 *With Modbus Plus Option* 3 *Install and configure Windows applications* 4 *See page 421 for more tough computing platform features*

SEL-3530/3530-4 Real-Time Automation Controllers (RTACs)

Integrate station control, reporting, and logging through one reliable system.

SEL IEC 61850

SEL Synchrophasors™

Key Features

Integrated Security

Make the RTAC the secure access point into your substation or plant using Lightweight Directory Access Protocol (LDAP) central authentication and role-based user authentication, access logs, and secure engineering access. Map security tags into SCADA reports for industry-leading integration of security technologies.

Simple, Seamless Configuration

Quickly design an integrated substation system that includes protocol conversion, SCADA communications, synchrophasors, time synchronization, data management, and custom logic.

Complete System Control

Communicate with any device through built-in client and server protocols. Exchange data through DNP3, Modbus®, SEL Fast Messaging, Mirrored Bits® communications, and IEEE C37.118 for synchrophasors. Convert data between protocols, perform math and logic functions, and execute output logic for real-time control.

Unified Substation Logic

Create your logic solutions in the embedded IEC 61131 logic engine, standard with every RTAC. Build custom user logic, and access all system tags, including diagnostics, contact I/O, protocol data, and communications statistics to provide unparalleled control flexibility.

Renowned SEL Reliability

The RTAC is designed and tested to meet or exceed IEEE 1613 and protective relay specifications for harsh environments to withstand vibration, electrical surges, fast transients, and extreme temperatures.

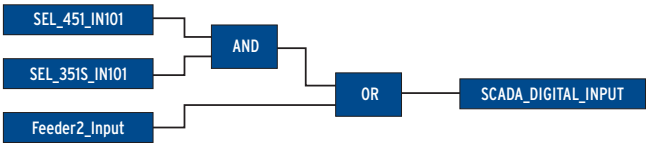
Setting	Value	Range
Client DNP Address	0	0-65519
Server DNP Address	1	0-65519
Issue Integrity Polling	true	true,false
Integrity Poll Period	60	0-100000
Issue Class 1,2,3 Polling	true	true,false
Issue Class 1,2,3 Polling	5	0-100000
Poll Timeout	7000	100-65535
Number of Poll Retries	1	0-255
Poll Timeout Restart Delay	30000	0-65535
Transport Protocol	TCP	TCP,UDP
Client TCP/IP Port	20000	23,1024-65534
Client TCP/IP Port	20000	23,1024-65534
Server IP Address	192.168.0.4	Valid IP Address
Server IP Port	20000	23,1024-65534
Broadcast Address	192.168.0.255	Valid IPV4 Broadcast Address

Quick and easy setting layouts.

Drag a column header here to group by that column

	Destination Tag Name	DT Data Type	Assignment Expression
	BREAKER1_POS	SPS	SEL421_SEL_IN101
	BREAKER2_POS	SPS	SEL321_SEL_IN102
	DOOR_SECURITY_ALARM	SPS	SEL2411_IN101 OR SEL2411_IN102
	POWER_FACTOR	MV	COS(ARCTAN(SEL421_SEL_Q/SEL421_SEL_P))
	ROOM_TEMPERATURE	MV	SEL2411_AI101
	FEEDER1_CURRENT_A	MV	SEL311L_SEL_IA
	FEEDER1_CURRENT_B	MV	SEL311L_SEL_IB
	FEEDER1_CURRENT_C	MV	SEL311L_SEL_IC

Intuitive tag management.



IEC 61131-3 graphical logic.

SEL-3530/3530-4 Real-Time Automation Controllers (RTACs)

Applications

- Concentrate data from relays and other IEDs with the RTAC. Configure the RTAC to collect and view station-wide event logs through industry-standard protocols.
- Remotely access and monitor the RTAC via built-in Ethernet connectivity and your favorite web browser.
- Easily integrate synchrophasor information into SCADA messages, allowing system-wide application of synchrophasor data.
- Perform complex math and logic calculations on protocol data within the RTAC using the built-in IEC 61131 logic engine.
- Eliminate costly equipment, breakers, interposing relays, and wiring as well as reduce engineering and labor costs by making the RTAC the system master controller and SCADA gateway.
- Apply integrated tools to scale values and create logic equations in a flexible IEC 61131 configuration environment.
- Secure your automation network with the RTAC and SEL accessories. Maintain system integrity by applying user security profiles and employing intrusion detection, notification, and logging.
- Integrate security options to ensure your system meets NERC CIP requirements for auditing, logging, port control, web authentication, and password restrictions.

Price

SEL-3530 Budgetary Retail, Quantity 1: $4,500

SEL-3530-4 Budgetary Retail, Quantity 1: $3,000

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Hardware Specifications

Processing Speed and Memory (SEL-3530)

Processor Speed	533 MHz
Memory	512 MB DDR2 ECC RAM
Storage	4 GB (2 GB reserved)

Processing Speed and Memory (SEL-3530-4)

Processor Speed	533 MHz
Memory	512 MB DDR2 ECC RAM
Storage	2 GB

Communications Ports (SEL-3530)

Ethernet	3 RJ-45 female (or LC fiber)
Serial	17 EIA-232/EIA-485 (software selectable)

Communications Ports (SEL-3530-4)

Ethernet	2 RJ-45 female (or LC fiber)
Serial	4 EIA-232/EIA-485 (software selectable)

Onboard I/O (SEL-3530/3530-4)

Contact Input	1 (programmable)
Contact Output	1 (programmable)
Expansion I/O Board	8 contact outputs, 24 contact inputs (N/A on SEL-3530-4)

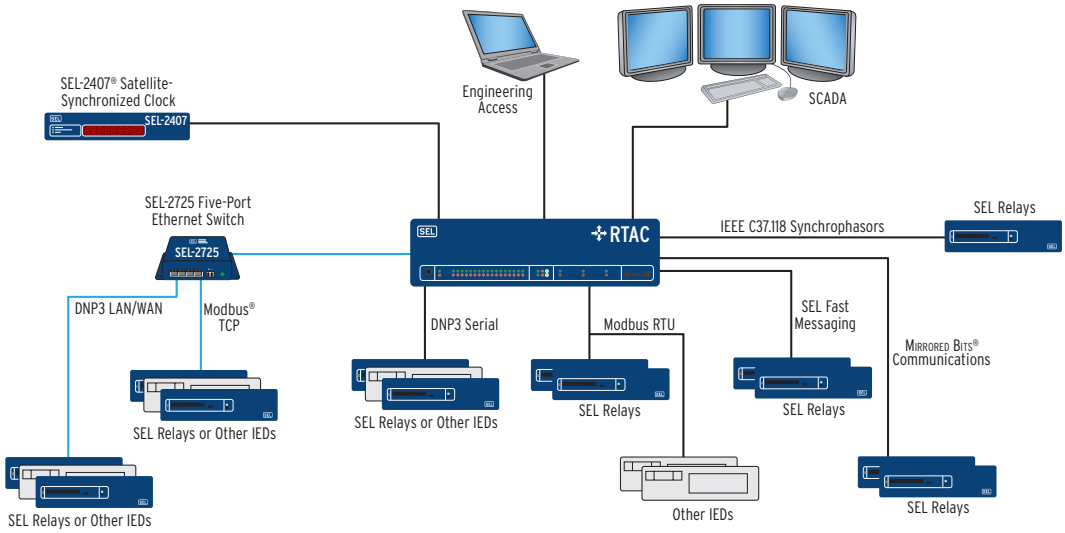
Power Supply Ratings (SEL-3530/3530-4)

Option 1	125/250 Vdc; 120/240 Vac
Option 2	48/125 Vdc; 120 Vac
Option 3	24/48 Vdc (SEL-3530-4 only)

Operating Temperature (SEL-3530/3530-4)

IEC Performance Rating	–40° to +85°C (–40° to +185°F)

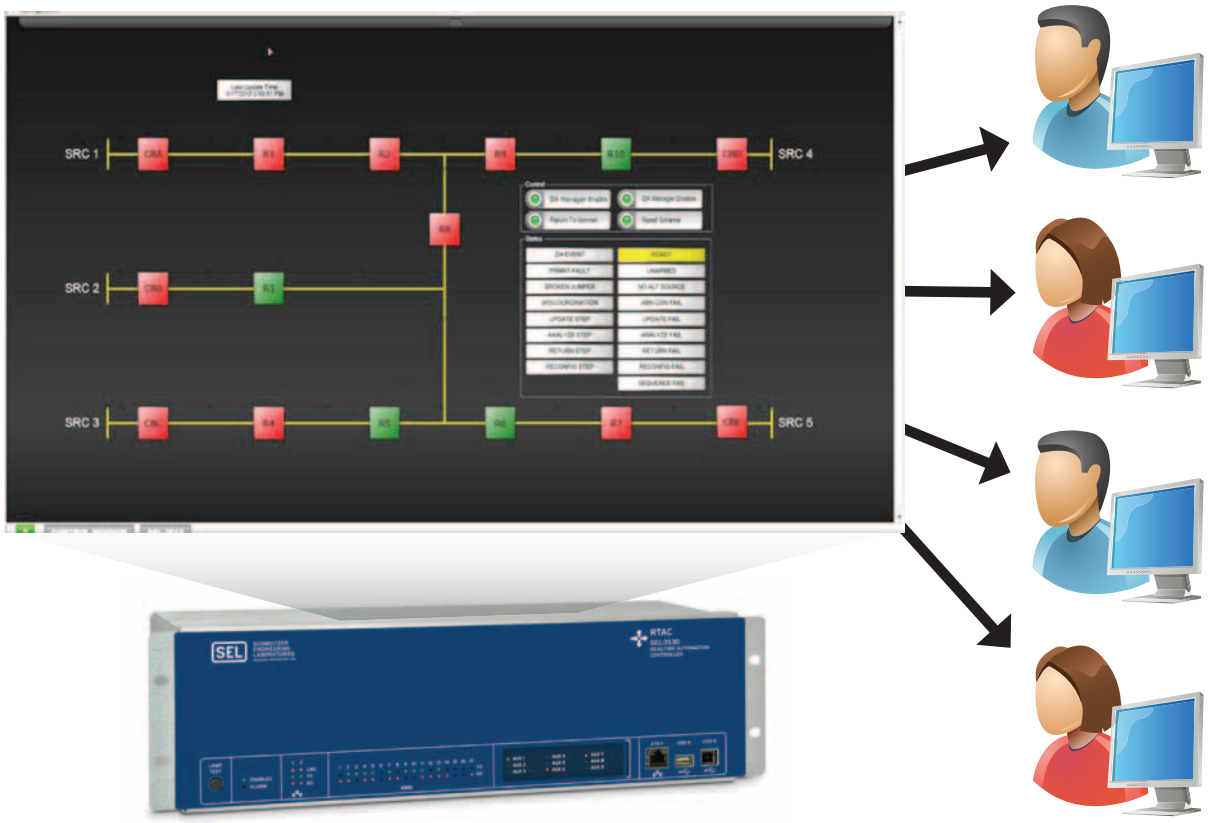
RTAC Example Application



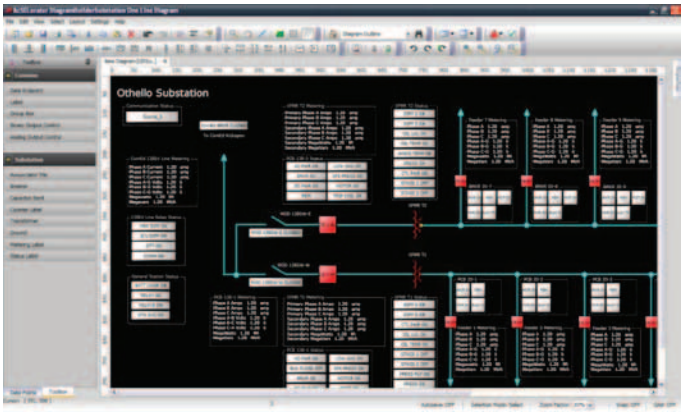
Data concentrator and substation controller.

SEL-3530/3530-4 Real-Time Automation Controllers (RTACs)

RTAC Integrated Human-Machine Interface (HMI)



Now with an intuitive, fully featured human-machine interface using an integrated web server.



HMI Diagram Builder.

Benefits

Web-Based User Interface

Allow one or multiple authenticated users to interface with customized HMI screens in a client-free environment.

Local and Remote HMI Access

Access the RTAC HMI locally or remotely with the built-in web server. The HMI utilizes Microsoft® Silverlight™ technology to provide fast and efficient information retrieval and display.

Simple and Powerful HMI Configuration

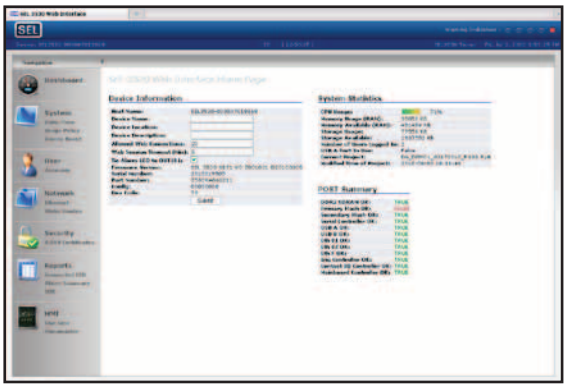
Quickly design an integration substation system using HMI Diagram Builder.

SEL-3530/3530-4 Real-Time Automation Controllers (RTACs)

Web-Based User Interface

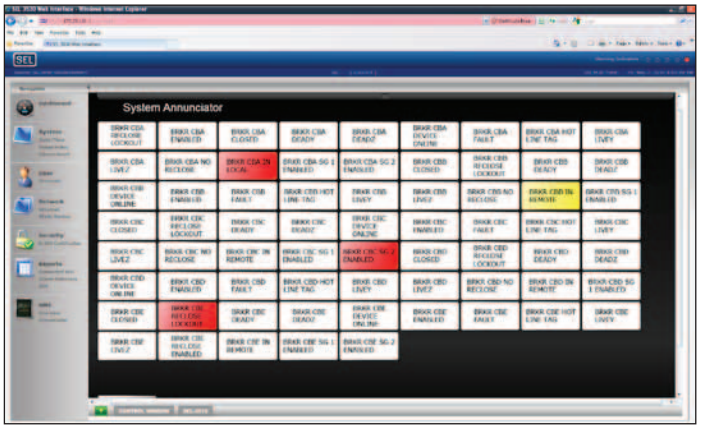
The embedded RTAC web interface gives you access to the following information:

- System
- Users
- Network
- Security
- Reports
- One-line diagrams
- Alarms
- Annunciation

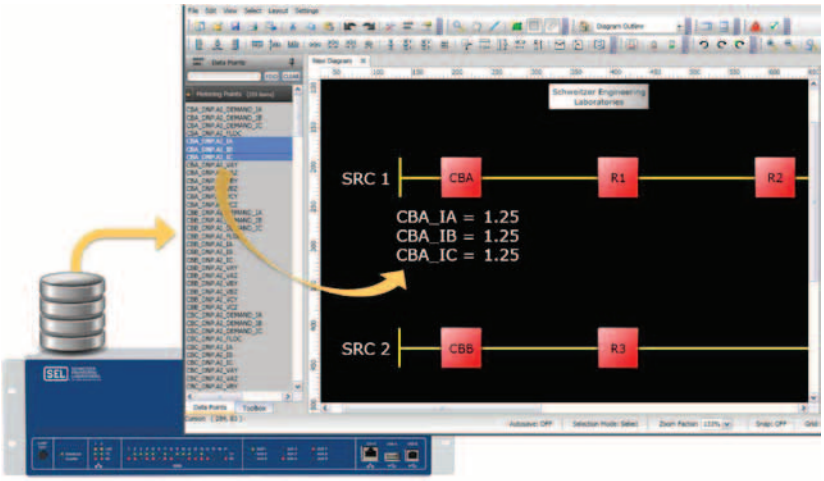


Features of the Web Interface HMI

- One-line diagrams
- Alarms/SER reports
- Layered annunciator
- Supervisory control
- Authentication
- ACSELERATOR® Diagram Builder
- RTAC database interface
- Low-cost solution



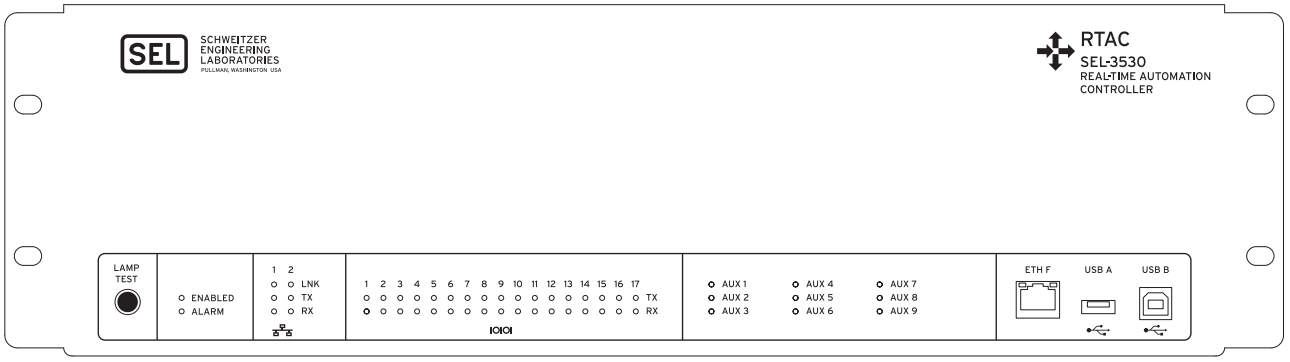
Create and use annunciator panel.



ACSELERATOR® Diagram Builder provides a complete list of all mapped points in the SEL RTAC database.

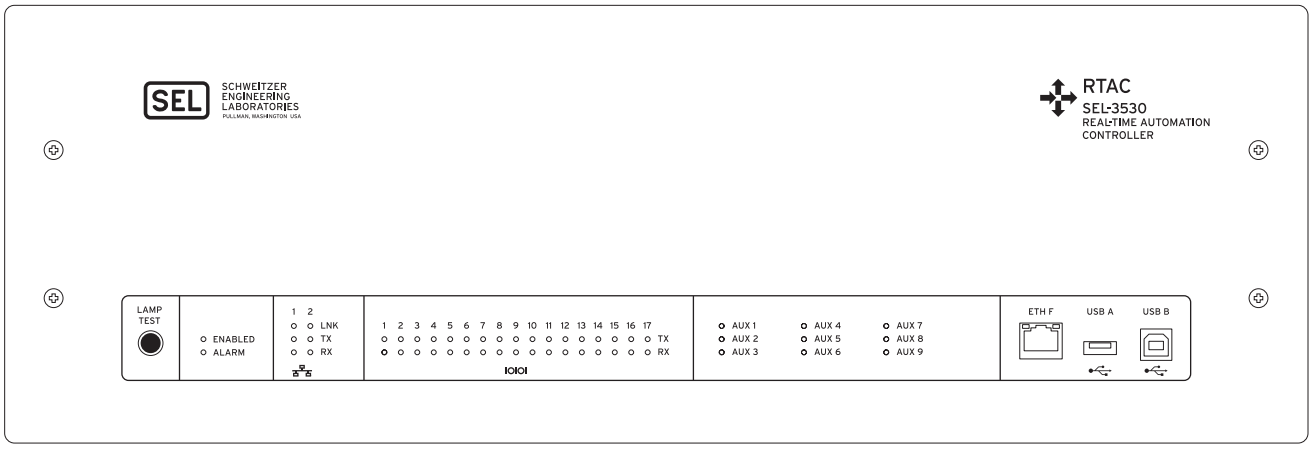
SEL-3530/3530-4 Real-Time Automation Controllers (RTACs)

Front View SEL-3530 – Rack-Mount



i4192c

Front View SEL-3530 – Panel-Mount



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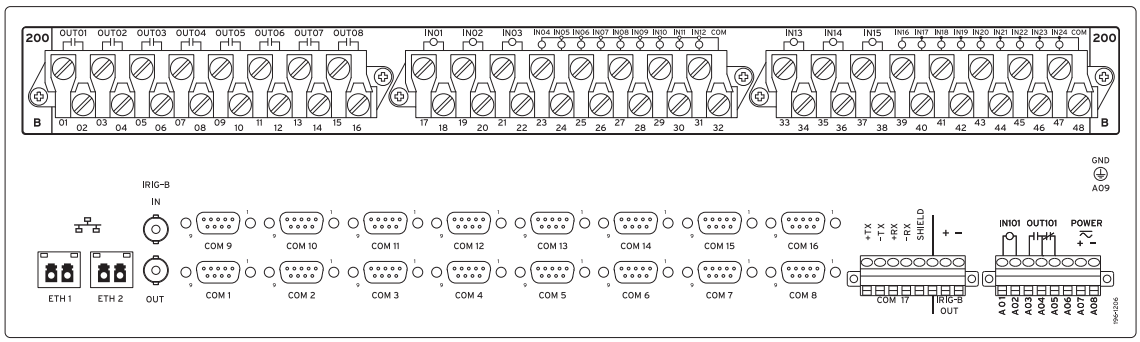
SEL-3530/3530-4 Real-Time Automation Controllers (RTACs)

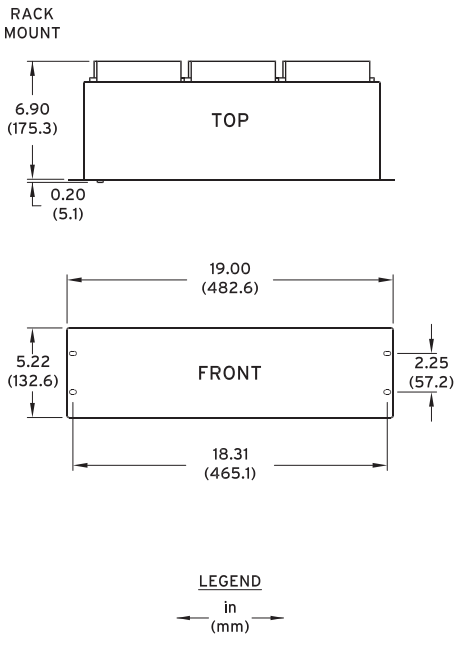
Rear View SEL-3530



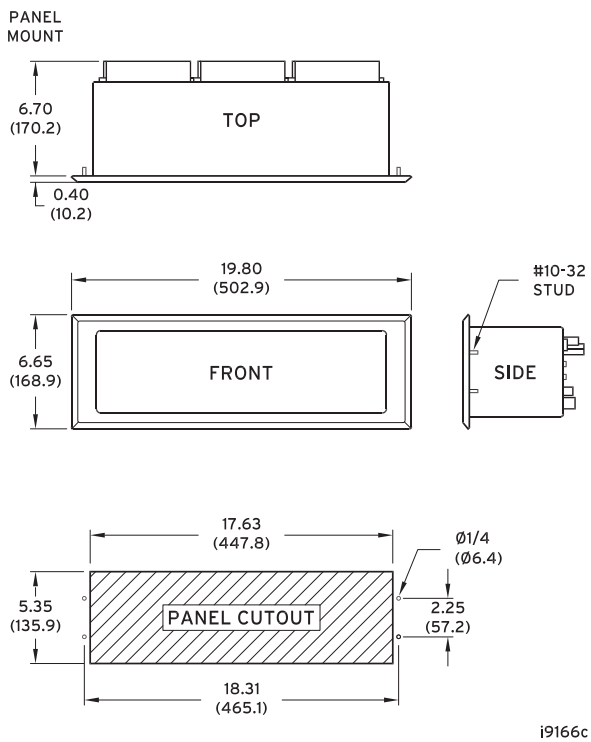
i4268a

Dimensions SEL-3530

RACK-MOUNT CHASSIS



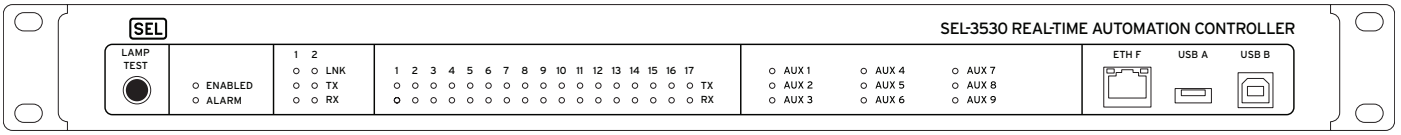
PANEL-MOUNT CHASSIS



i9166c

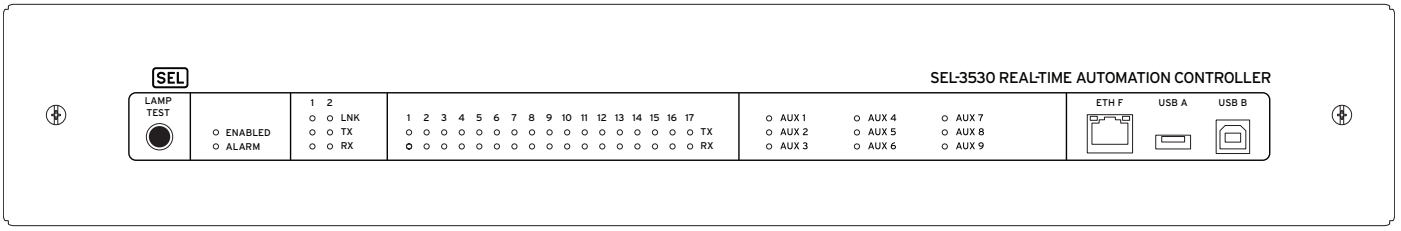
SEL-3530/3530-4 Real-Time Automation Controllers (RTACs)

Front View SEL-3530 – Rack-Mount (1U)



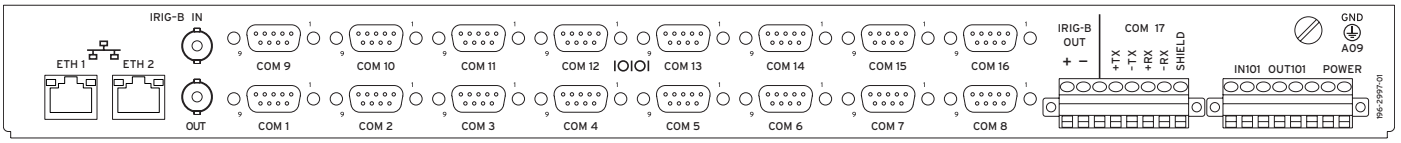
i4743a

Front View SEL-3530 – Panel-Mount (1U)



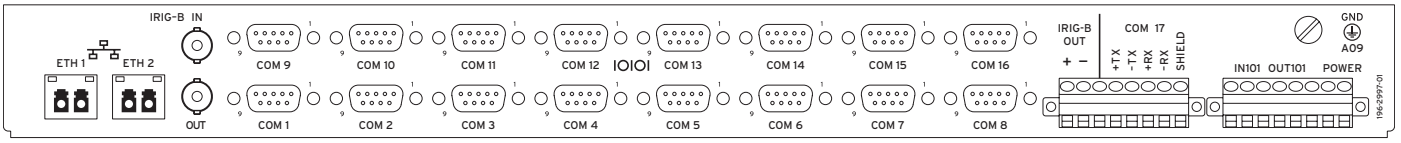
i4742a

Rear View SEL-3530 (1U) – Dual Copper Ethernet Option



i4696b

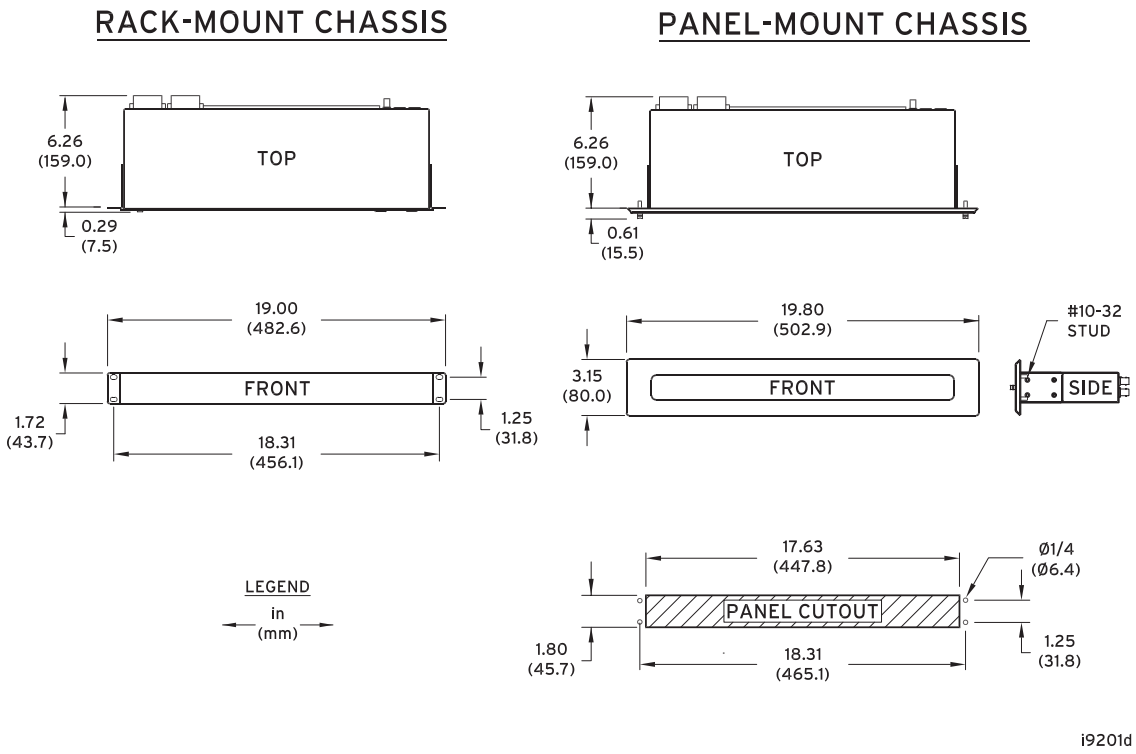
Rear View SEL-3530 (1U) – Dual Fiber-Optic Ethernet Option



i4730b

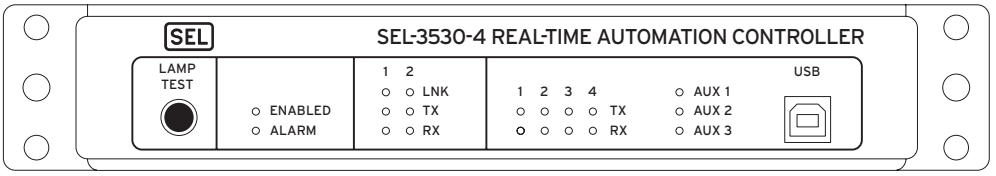
SEL-3530/3530-4 Real-Time Automation Controllers (RTACs)

Dimensions SEL-3530



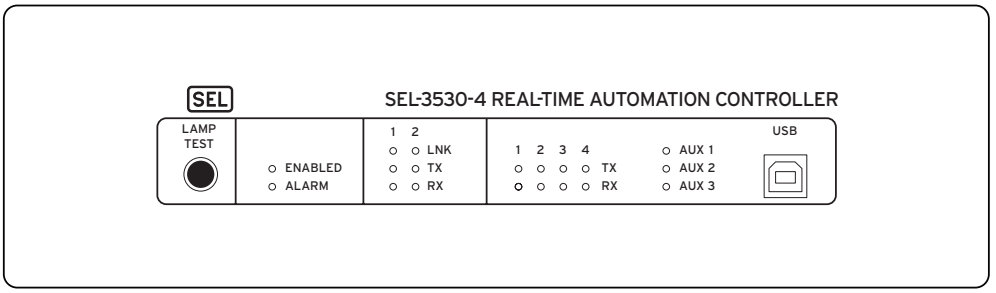
SEL-3530/3530-4 Real-Time Automation Controllers (RTACs)

Front View SEL-3530-4 – Rack-Mount



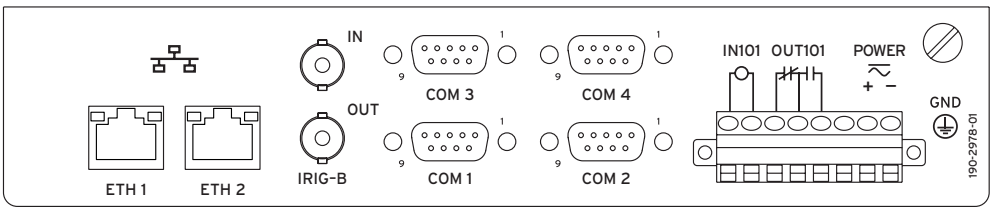
i5006b

Front View SEL-3530-4 – Panel-Mount



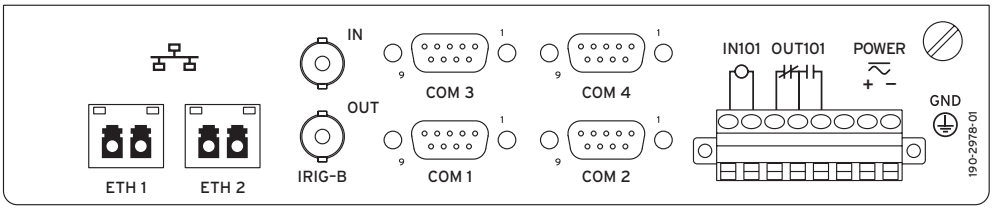
i5007b

Rear View SEL-3530-4 – Dual Copper Ethernet Option



i5008a

Rear View SEL-3530-4 – Dual Fiber-Optic Ethernet Option

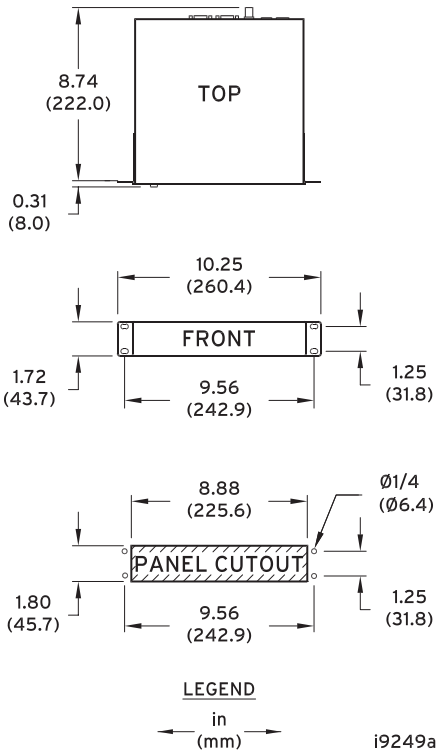


i5009a

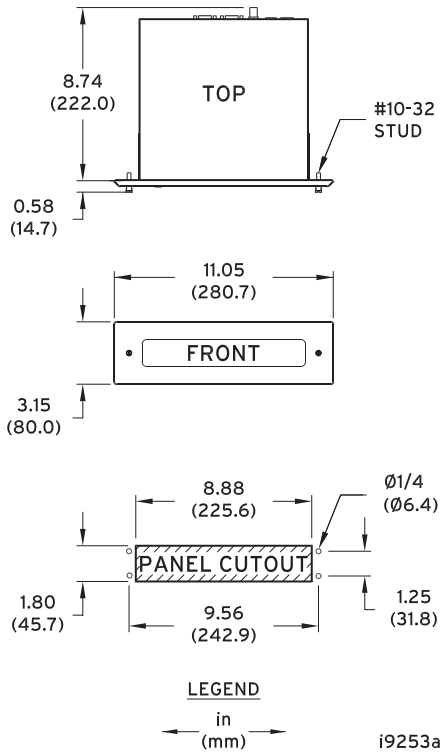
SEL-3530/3530-4 Real-Time Automation Controllers (RTACs)

Dimensions SEL-3530-4

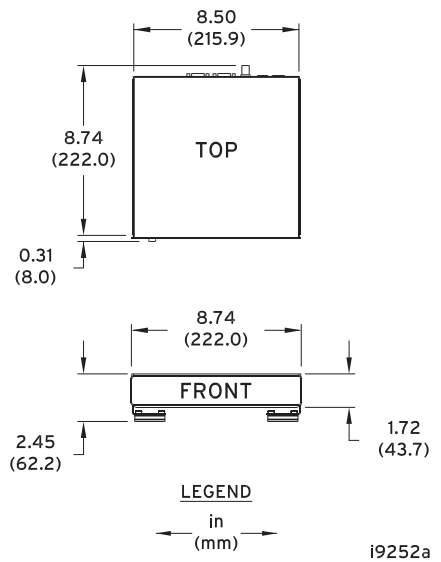
RACK-MOUNT CHASSIS



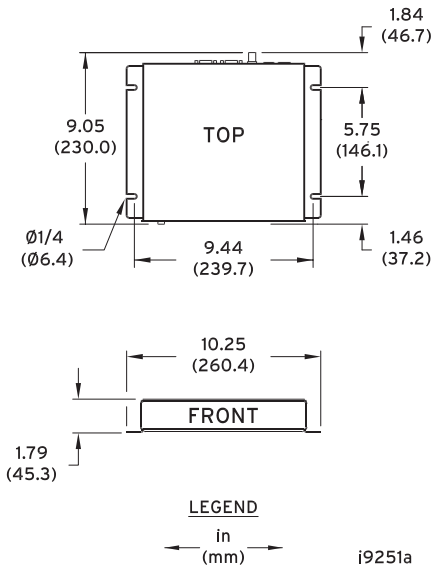
PANEL-MOUNT CHASSIS



DIN-MOUNT CHASSIS



SURFACE-MOUNT CHASSIS



Visit www.selinc.com for more detailed information and configuration options.

SEL-2032 Communications Processor

Provide SCADA RTU functions with higher reliability and lower cost.

Key Features

Simple, Complete Integration

Links all substation intelligent electronic devices (IEDs) into a single, low-cost, configurable contact point for SCADA, local human-machine interface (HMI), dial-in access, dial-out notification, and overall substation integration applications. Link multiple communications processors to provide redundant communications paths when necessary.

Consolidated Sequential Events Recorder (SER) Data

Uses SER data from SEL device Fast SER commands and local contact inputs and updates the local SER database. SER data also generate DNP3 event records and send Fast SER records to SEL I/O server software.

Increased Settings Capacity

Allows for increased integration and automation settings with increased SET M setting memory.

Nonvolatile User-Region Memory

Provides ten registers of nonvolatile user-region memory per port.

Serial Protocols: Modbus® Slave, DNP3 Level 2 Outstation, SEL Fast Messages, SEL ASCII Commands, and ASCII

Provides easy-to-configure support for these popular serial protocols. SCADA links, local HMI, and dial-in modems can access data from multiple IEDs or communicate directly with individual IEDs.

Network Protocols: DNP3 LAN/WAN, IEC 61850 GSSE, Telnet, FTP, and Modbus Plus®

Uses up to two optional plug-in cards to communicate with local- and wide-area networks. The Ethernet card interfaces with fiber-optic and wire Ethernet networks with Telnet, FTP, and options for DNP3 LAN/WAN. The Modbus Plus card connects with Modbus Plus networks.

Programmable Logic Functions

Uses Boolean and arithmetic operators to create logical schemes to produce and forward information or to perform control. Use IF-THEN-ELSE statements for easily understood control programs. Reduce overall system costs and improve system reliability by reducing the number of auxiliary devices.

SEL Binary Messages, Interleaved With ASCII Messages

A single, bidirectional communications port carries ASCII commands and responses, interleaved with SEL binary messages. An example use of these interleaved binary messages is that they allow an engineer to communicate with a relay in ASCII through a dial-in port without impacting the real-time updates from the relay to a SCADA system. SEL binary messages include SEL Fast Meter messages for analog and digital SCADA information, SEL Fast Operate messages to rapidly send control commands, and SEL Block Transfer messages for efficient communication between communications processors. SEL Fast SER messages provide precise, time-tagged sequential events records.

Time Synchronization

Accepts time-code input from IRIG-B time source and redistributes it to IEDs. Or, use the internal clock to generate IRIG-B formatted time to the IEDs.

IED Communication

Powerful parsing, conversion, checksum calculation, and command-response setting features allow fast development of IED information retrieval and control schemes. SEL provides Job Done® examples that show you how to communicate with many IEDs, using the native protocol commands and responses of each IED.

Automatic Database

Collects, stores, and forwards meter reports, targets, digital input status, event reports, demand meter reports, and more.

SEL-2032 Communications Processor

Applications

- Eliminate SCADA RTUs. Simplify, improve the reliability of, and reduce the total cost of SCADA systems by using the communications processor to collect and scale meter data, and to collect targets, contact input status, and fault location directly from relays. Use SEL-2515 or SEL-2516 Remote I/O Modules to extend the I/O of the communications processor with inexpensive fiber connections. Use the SEL-2411 Programmable Automation Controller to add process-level dc analog I/O, ac current and voltage inputs, and digital I/O. Use the contact outputs of relays and other IEDs for control. Directly support Modbus RTU and DNP3 protocols for links to RTUs or masters.
- Use plug-in cards in the communications processor to connect IEDs to Ethernet or Modbus Plus networks.
- Connect IEDs that do not support Modbus to a distributed control system (DCS). The communications processor provides faster updates to the DCS than would a multidrop system because it groups data for more efficient multiple-register or block access. Arithmetic functions can change scaling, calculate virtual analog inputs, and compare analog values to thresholds. Use SELOGIC® control equations to combine digital inputs to initiate and qualify automatic control or for interlocks.
- Support local HMI on an SEL-3354 Embedded Automation Computing Platform using the communications processor as a communications hub for gathering data from and directing control commands to IEDs in the substation. Local event report collection, settings management, and data archiving may also be included in the local HMI.
- Set the communications processor to detect critical conditions and dial a pager. Send an ASCII message to an alphanumeric pager or an SEL-3010 Event Messenger.
- Use the communications processor as a hub to enable low-cost, point-to-point fiber-optic links that isolate equipment from hazardous and damaging ground potential rise; eliminate RFI, EMI, and communications system ground loops; and allow longer signal paths than possible with EIA-232 copper connections.
- Acquire and forward information from relays and specialized equipment monitoring devices to maintenance databases and expert systems.

Optional Features

- Sixteen additional optoisolated digital inputs and four programmable digital output contacts.
- Two slots accept Ethernet* and Modbus Plus cards.
- Rack-mount or panel-mount hardware.

  * Eye-safe, Class 1 LED product per EN 60825-1

Hardware Specifications

Power Supply Ratings

125/250 V	85–350 Vdc
	85–264 Vac
48/125 V	38–200 Vdc
	85–140 Vac
24/48 V	20–60 Vdc

25 W maximum for all supplies

Standard Digital Input and Output Ranges

24, 48, 125, or 250 Vdc

Standard hardware provides one alarm output. Optional board provides 16 digital inputs and 4 digital outputs.

Operating Temperature

–40° to +85°C (–40° to +185°F)

Ethernet Option	–40° to +70°C (–40° to +158°F)
Modbus Plus Option	0° to +70°C (+32° to +158°F)

(Also reference the Ethernet and Modbus Plus card specifications.)

Price

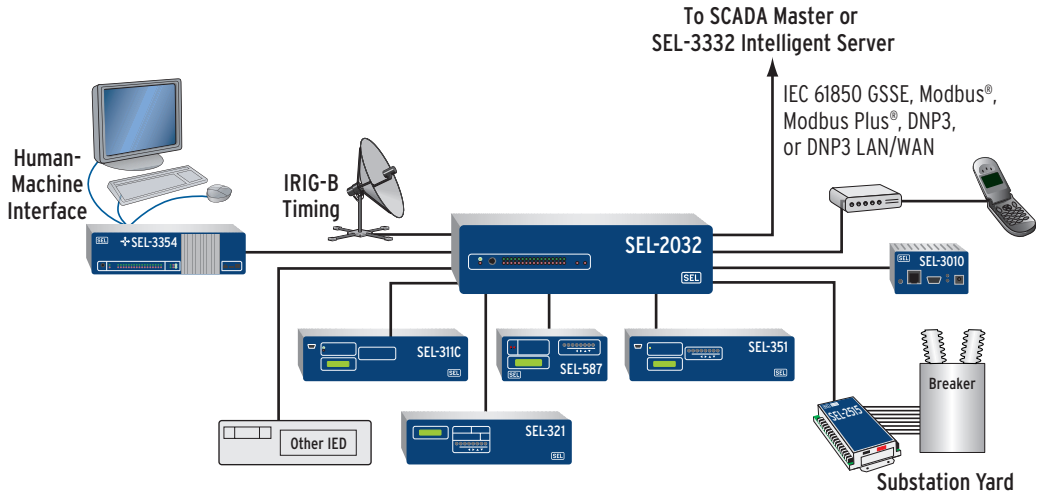
Budgetary Retail, Quantity 1: $2,840

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

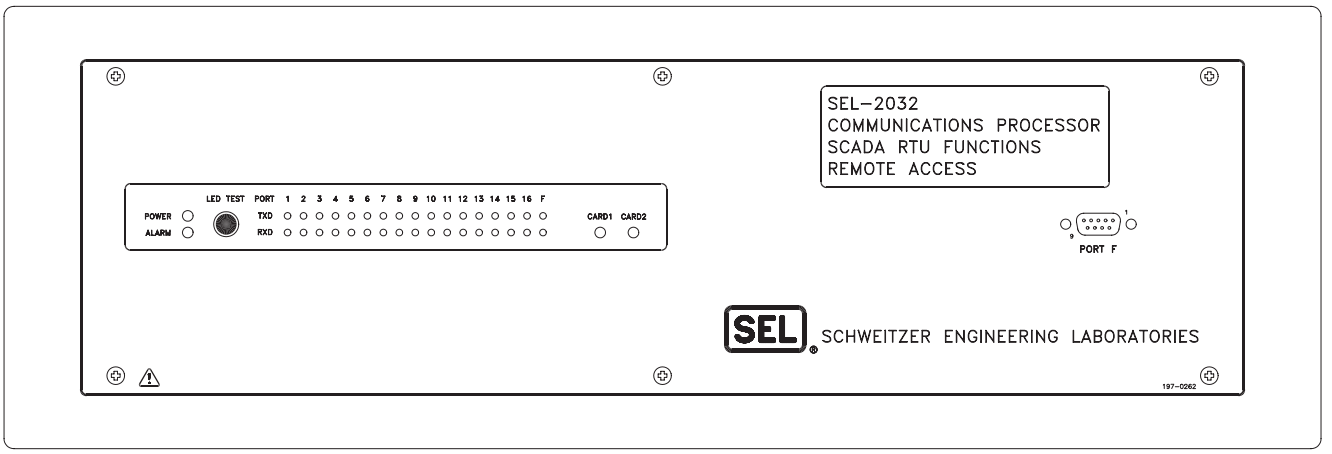
This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

SEL-2032 Application



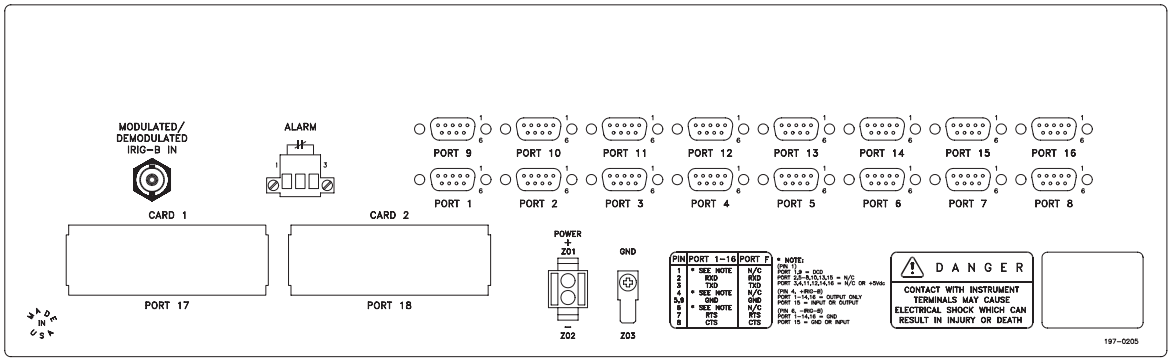
SEL-2032 Communications Processor

Front View – Panel-Mount



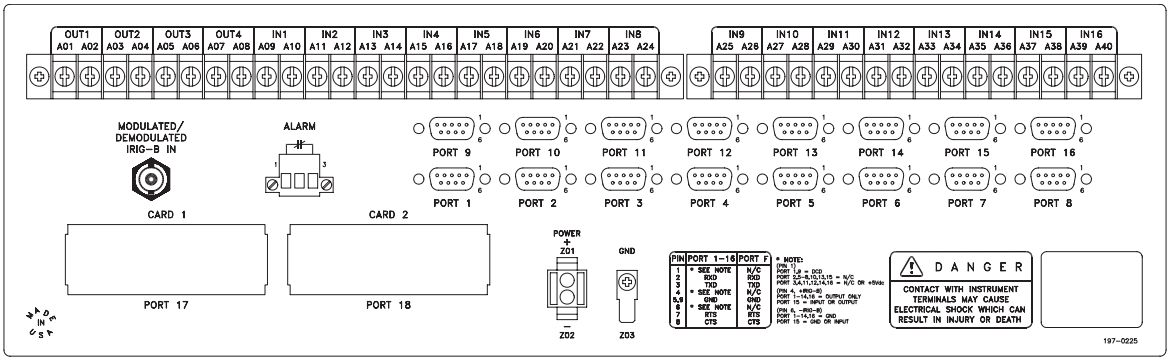
I3556a

Rear View (3U)



I3005b

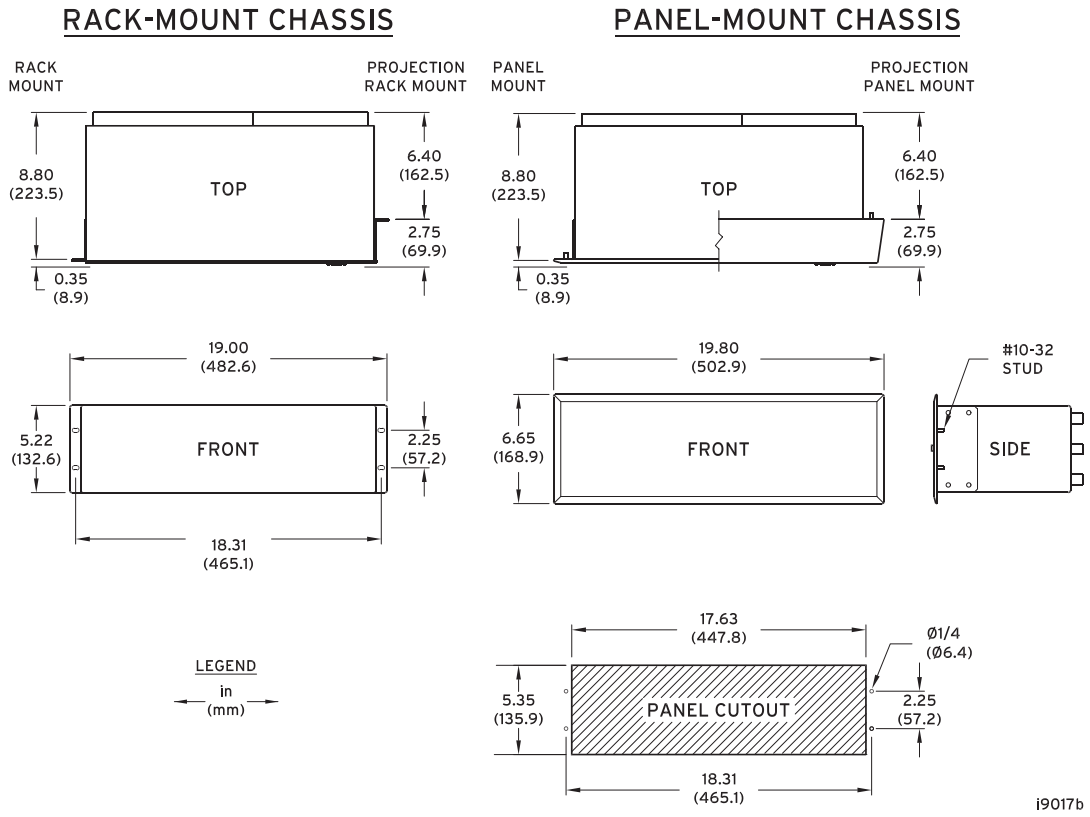
Rear View – Additional I/O (3U)



I3006b

SEL-2032 Communications Processor

Dimensions



Visit www.selinc.com for more detailed information and configuration options.

SEL-2100 Logic Processor

Implement low-cost, high-speed bus protection, automated bus sectionalizing, breaker failure protection, multiple terminal line protection, or other applications by interconnecting up to 15 protective devices using resident MIRRORED BITS® communications.

Key Features

Logic Processing

Use patented SELOGIC® control equation processing on 15 ports for advanced protection schemes at a very low cost.

MIRRORED BITS Communications

Facilitate rapid transfer of digital information between many devices using MIRRORED BITS communications on 15 ports.

Integration and Automation

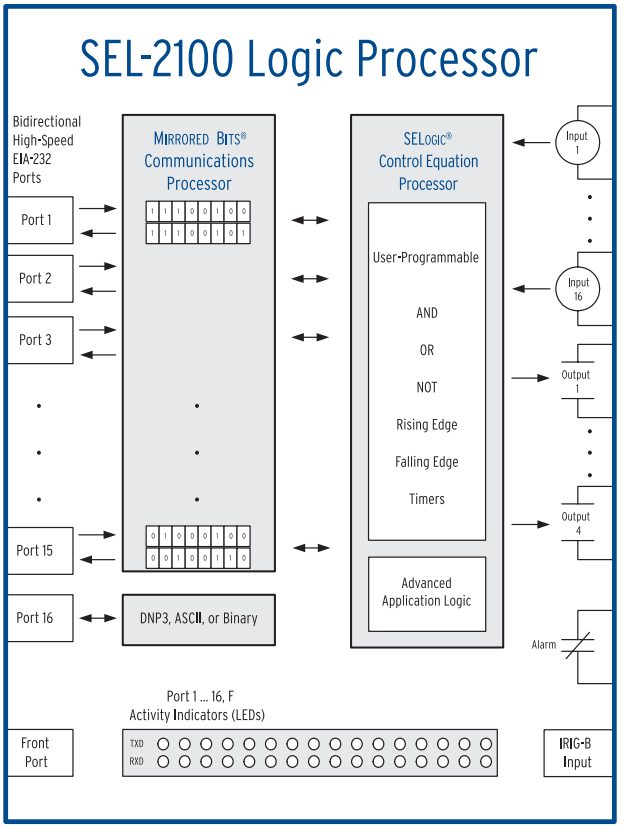
Apply 16 contact inputs, 4 contact outputs, 32 remote bits, 32 latch bits, and 32 SELOGIC variables, combined with Fast Operate and Fast Message commands, and DNP3 Level 2 Outstation communications protocol for powerful integration and automation configurations. Multiple settings groups are included.

Advanced Application Logic

Load Advanced Application Logic modules to achieve even more capability. For example, use the patented Crosspoint Switch Advanced Logic module to support high-speed control.

Reporting

Analyze events with a Sequential Events Recorder (SER) that stores status of up to 144 user-selected elements in over 36,000 nonvolatile records. The SEL-2100 supports either modulated or demodulated IRIG-B time-code inputs to automatically set the real-time clock/calendar. These features make the SEL-2100 a low-cost alternative to standalone SERs.

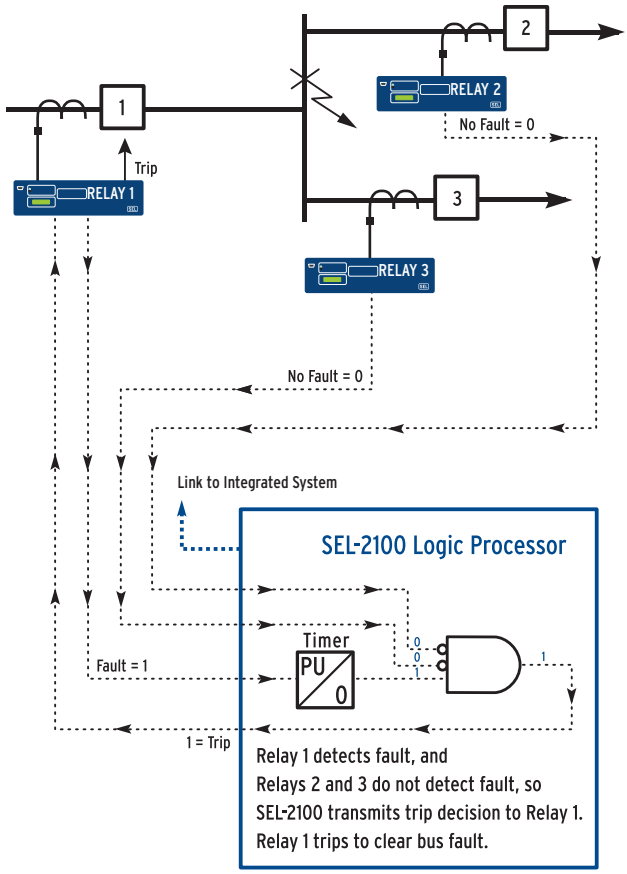


SEL-2100 Logic Processor

Applications

- Create three-terminal (communications-assisted) tripping/blocking protection, bus protection, breaker failure protection, and other applications.
- Transmit and receive Mirrored Bits communications at high speeds on up to 15 ports.
- Monitor data channel integrity and availability for each serial port to increase scheme reliability.
- Connect an external IRIG-B clock source to synchronize internal SER times and distribute IRIG-B on all rear EIA-232 ports.
- Create communications-assisted protection schemes using the SEL-2100 and compatible fiber-optic transceivers to eliminate ground potential rise, and reduce channel noise and costs associated with long pulls (and termination of) copper wire.
- Apply Advanced Application Logic to implement high-speed load-shedding or restoration schemes.
- Integrate remote I/O from several locations using SEL-2505 Remote I/O Modules.

Bus Protection Application



Optional Features

- Panel-mount, projection panel-mount, or rack-mount hardware.
- Sixteen additional optoisolated inputs and four programmable output contacts on a single I/O board.
- Advanced Application Logic.

Related Products

SEL Fiber-Optic Transceivers 432–439
SEL-2505 Remote I/O Module 396
SEL-2505PB Mirrored Bits Interface 463
SEL-2506 Rack-Mount Remote I/O Module 400
SEL-4388 Mirrored Bits Tester 462

Hardware Specifications

Power Supply Ratings

24/48 V	18–60 Vdc; <25 W
125/250 V	85–350 Vdc; <25 W
	85–264 Vac

Jumper selectable +5 Vdc out on Pin 1, Ports 1–16: up to 0.5 A total

Standard Control Input and Output Ranges

24, 48, 110, 125, or 250 Vdc

Standard provides one alarm output. Optional board provides 16 inputs and 4 outputs.

Operating Temperature

–40° to +85°C (–40° to +185°F)

Price

Budgetary Retail, Quantity 1: $2,100

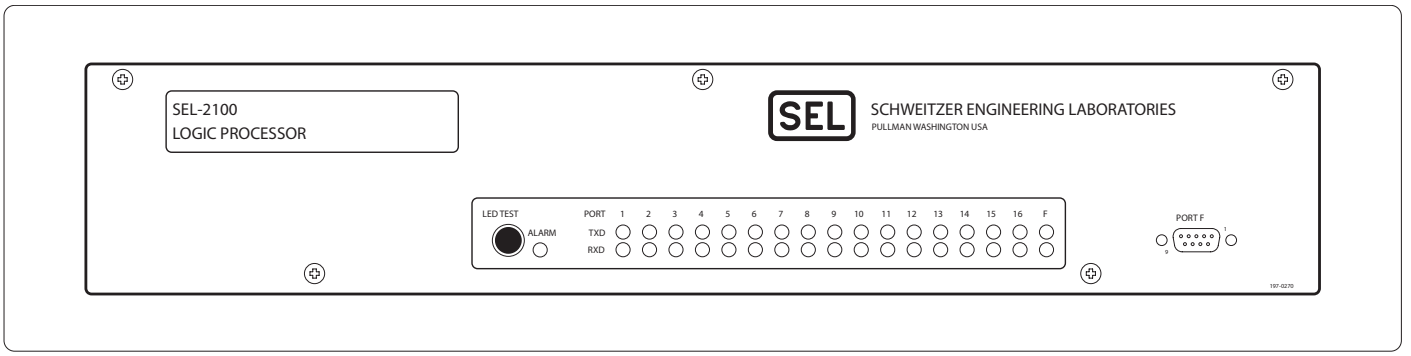
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

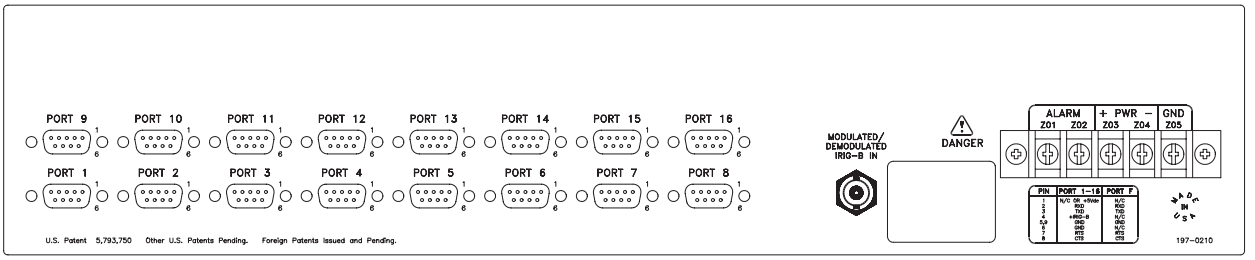
SEL-2100 Logic Processor

Front View – Panel-Mount



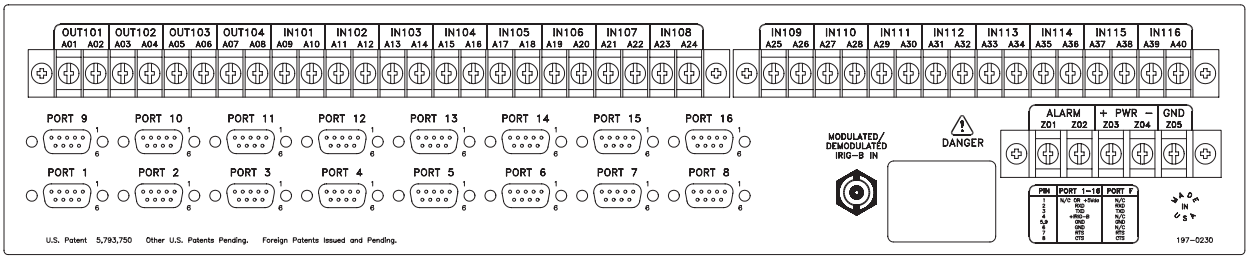
i3102b

Rear View (2U)



I3099a

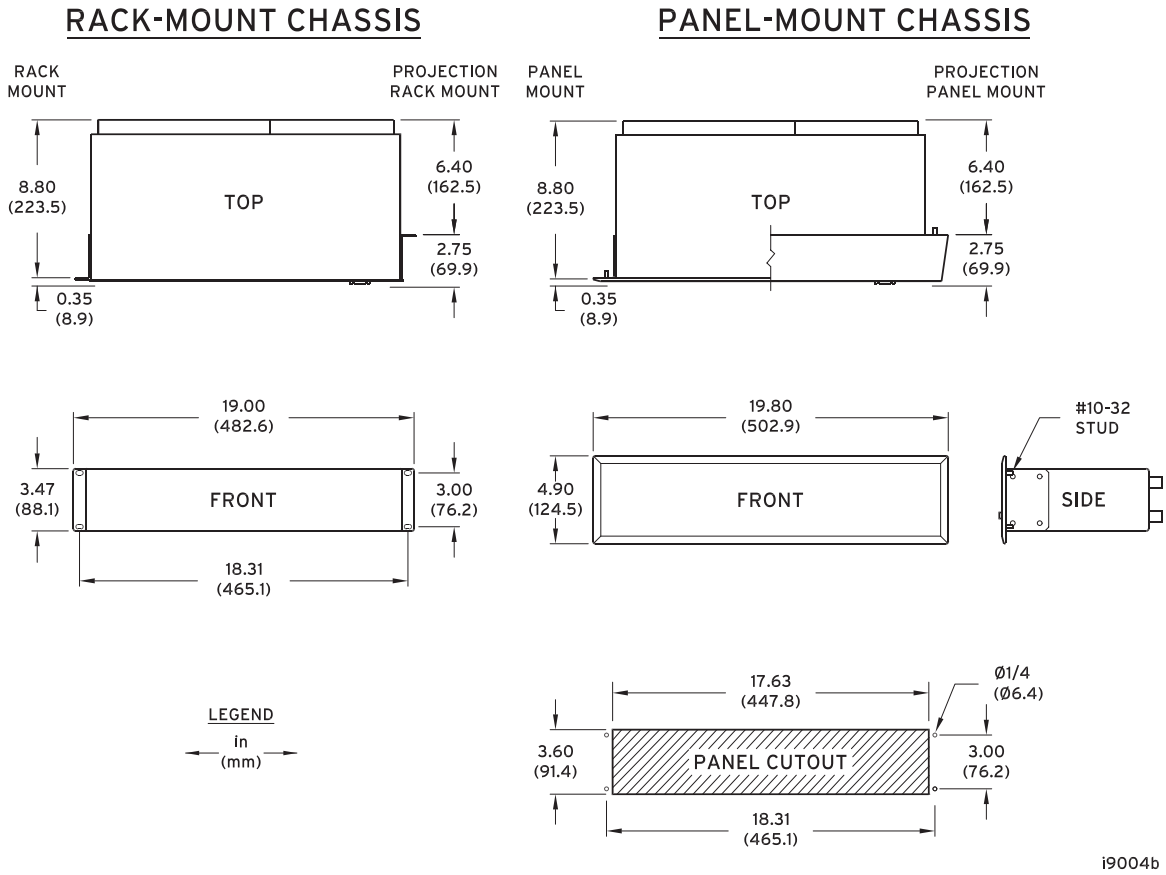
Rear View – Additional I/O (2U)



I3100a

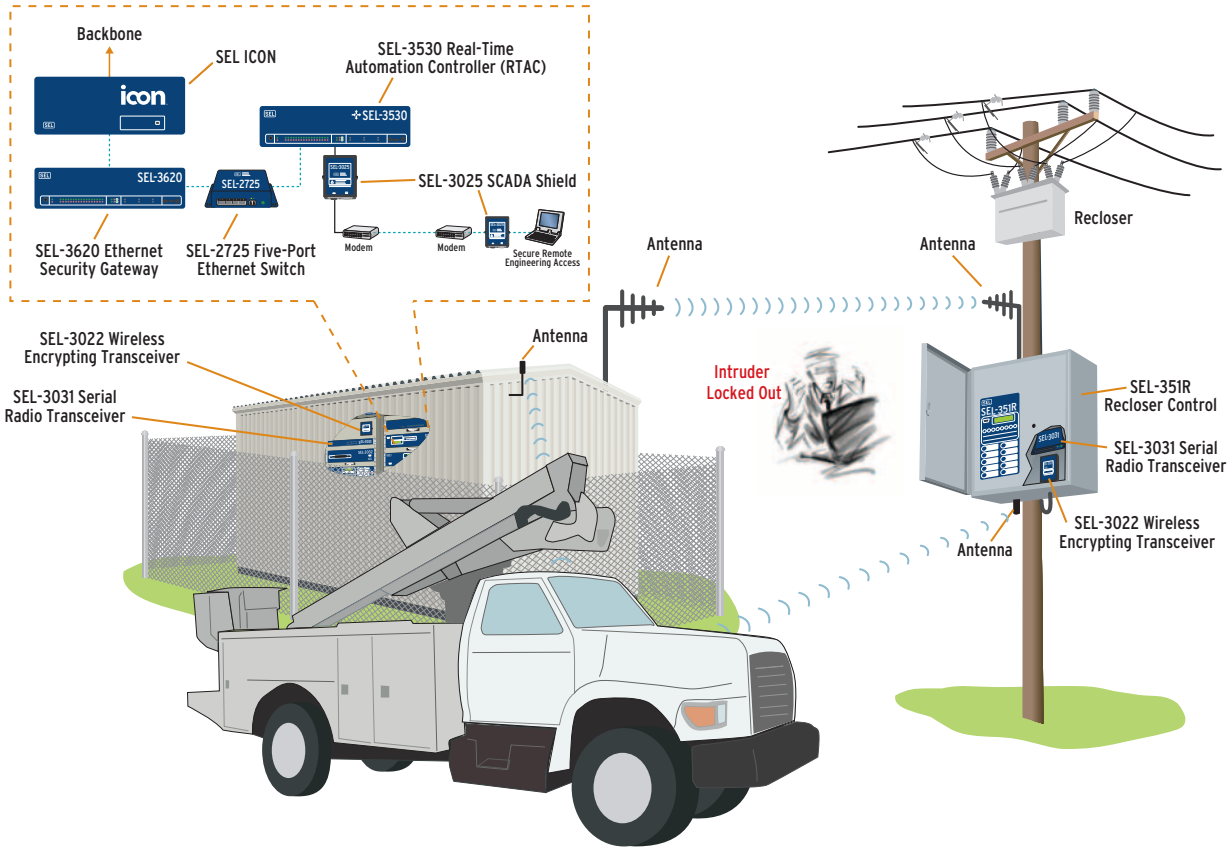
SEL-2100 Logic Processor

Dimensions



Visit www.selinc.com for more detailed information and configuration options.

Networking and Communications Applications



Networking and Communications Product Index

Networking and Communications Features

Networking and Communications	SEL-3021-1	SEL-3021-2	SEL-3022	SEL-3031	SEL-2725	SEL-2890	SEL-2886
APPLICATIONS							
Protect Wired, Radio, Fiber, Dial-Up Serial SCADA Data Links From Intrusion	•						
Protect Wired, Radio, Fiber, Dial-Up Engineering Access Links From Intrusion	•	•					
Provide Wireless Point-to-Point Serial Link, Protected From Intrusion			•	*			
Provide Three Point-to-Point Serial Links With One Radio Channel				•			
Provide Point-to-Multipoint Serial Radio Links				•			
Provide Encrypted and Authenticated Wireless Engineering Access Using Laptop Wi-Fi®, Protected From Intrusion			•				
Connect Multiple Wired-Ethernet Devices to Network					•		
Convert Wired 10/100BASE-T Ethernet Links to Fiber-Optic 100BASE-FX Ethernet Links					•		
Convert Serial EIA-232 Link to 10BASE-T Ethernet Link						•	
Multidrop	•	•				•	•
Mixed Mode		•					
Low Latency for SCADA Applications	•			•			
Convert EIA-232 Ports to EIA-485							•
Compatible With DNP, Modbus®, and Other Byte-Oriented Protocols	•	•	•	•		•	•
Combine to Convert and Protect Data for Ethernet		•				•	
FEATURES							
Encryption	•	•	•	*			
Session Authentication	•	•	•	*			
Message Authentication		•	•				
User-Based Accounts	•	•					
Logging		•					
FIPS 140-2 Level 2 Validated	•			*			
915 MHz ISM Band Radio (Unlicensed)				•			
Wired 10BASE-T Ethernet Port; RJ-45 Jack						•	
Wired 10/100BASE-T Ethernet Port; RJ-45 Jack (Quantity)					4 or 3		
Fiber-Optic 100BASE-FX Ethernet Port; LC Connectors (Quantity)					1 or 2		
Wired EIA-232 Port; 9-Pin Subminiature D Connector (Quantity)	2	2	2	3		1	1
Wired EIA-485 Port; Compression Terminal Block							•
SETUP METHOD							
Encrypted and Authenticated Wireless Link	•	•	•				
USB Port	*	*		•			
EIA-232 Port						•	
Ethernet Link						•	
Control Switches							•

• *Standard Feature* * *Model Option*

Integrated Communications Optical Network

Overview

The SEL ICON™ is designed and built to address demanding communications needs and operate in extreme environments, including utilities, light-rail and highway transportation, manufacturing, petrochemical plants, pipelines, or anywhere reliable communication is required to support critical applications.

The SEL ICON, with other SEL products, provides end-to-end solutions:

- Wide-area control using synchrophasors
- Time distribution
- Transmission line protection

The SEL ICON supports time-division multiplexing (TDM) and Ethernet traffic on a single product and can transport this traffic over SONET and/or Ethernet links. In addition to supporting flexible transport options, the SEL ICON can distribute time for a more fault-tolerant, robust time distribution network. The SEL ICON is easy to configure and manage with software that automatically reads the connected system and builds a visual network representation. The SEL ICON is available in a 19-inch, shelf-mount package and an 8-inch, DIN-rail or panel-mount package.

Economically Distribute Precise Time

Distribute time over a wide-area network with better than 1 µs accuracy, so that very accurate relative time is maintained in the event of a GPS failure.

Apply Flexible SONET and Ethernet Transport Options

Easily adapt your communications networks to meet current and future communications needs. Set the SEL ICON to operate as an:

- OC-48 SONET multiplexer
- Gigabit/Fast Ethernet multiplexer
- Gigabit/Fast Ethernet switch

Secure Internode SONET Links

Eliminate man-in-the-middle attacks by using the optional SONET cryptomodule on line ports. The cryptomodule supports AES-256 encryption with low latency.

Support Robust Network Architectures and Boost Network Reliability

Maintain critical services by quickly restoring traffic when an infrastructure disruption like fiber failure occurs. The SEL ICON supports single or multiple ring network topologies with single or dual interconnection ties between rings. If a fiber fails in a ring network, traffic switches in <5 ms. In addition to ring network topologies, point-to-point and linear configurations are also supported.

Easily and Securely Manage the SEL ICON Network

Tailor the network management solution to meet your needs using the SEL-5051 network management software or a commercially available SNMP-based (Simple Network Management Protocol) management software package. Features include a graphical network representation, remote provisioning, event reporting, performance monitoring, inventory management, and security management.

Select From a Wide Range of Interfaces

Manage time-sensitive, data-intense, and low-bandwidth applications with the same product. The SEL ICON supports TDM and packet applications. Interface modules include IEEE C37.94, asynchronous data, synchronous data, voice, transfer trip, Fast Ethernet, and Gigabit Ethernet.

Integrated Communications Optical Network

Flexible Mapping of Traffic Into TDM Streams or Ethernet Frames

Map traffic from the access modules into TDM streams for point-to-point communication or Ethernet frames for point-to-multipoint communication. This flexibility supports better network traffic management and customization to handle a wide range of applications.

Optimize Packet Delivery Times With Priority Queues

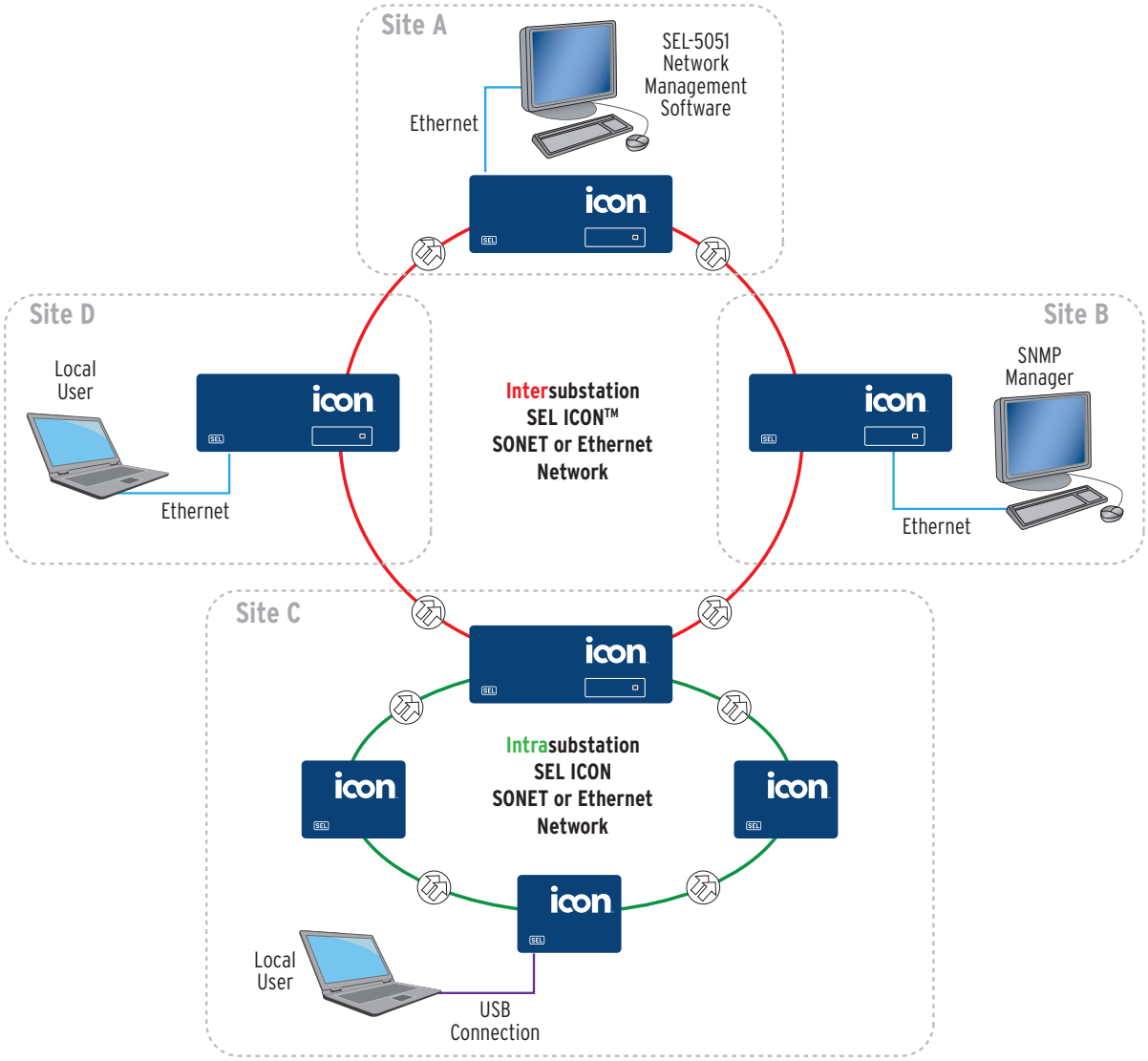
Manage latency on the Ethernet network with eight priority queues on the drop ports.

Isolate Application Traffic

Separate different traffic types using SONET pipes with STS-1 or VT granularity. The Ethernet interfaces support IEEE 802.1Q and port-based virtual local-area networks (VLANs).

Operate the SEL ICON in Harsh Environments

Withstands vibration, electrical surges, electrostatic discharge, fast transients, and extreme temperatures. Meets or exceeds IEEE 1613 and IEC 61850-3 standards for communications networking devices in electric power substations.



SEL ICON Integrated Communications Optical Network with network management.

Visit www.selinc.com for more detailed information and configuration options.

SEL-3620 Ethernet Security Gateway

Protect site-to-site Ethernet communications with IPsec VPN, and secure your private networks with a substation-tough stateful firewall.

Key Features

Ethernet Security Gateway

Interoperate with existing IT and control systems with vetted Internet Protocol Security (IPsec) and syslog protocols. Manage status and configuration with an intuitive, menu-driven web interface.

Protocol and Data Security

Secure routable protocols and data that cross an electronic security perimeter. The Ethernet Security Gateway provides up to 16 virtual private network (VPN) connections on 3 Ethernet ports.

Protective Firewall

Secure your private network from malicious traffic with a configurable ingress and egress stateful firewall.

Central Authentication With LDAP

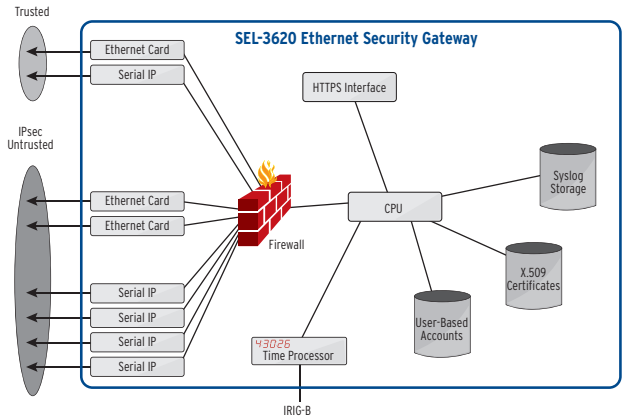
LDAP allows fast and secure lookup of user access controls from a central location and streamlines compliance with NERC CIP user access control requirements by allowing users "need-to-know" access to device settings and configurations.

Serial IP Protection

Use IPsec to encrypt and authenticate TCP/IP data over serial lines (e.g., those found on leased lines between network nodes) with Serial Line Internet Protocol (SLIP) connections.

Event Logs and Time Tagging

Centralize logging with Syslog protocol. Access up to 60,000 security event reports with the Syslog protocol, and apply an IRIG-B clock to synchronize the internal clock for precise time tagging of events.




Firewall


SEL Secure


Operating Temperature (−40° to +85°C)

Industry-Vetted Security and Interoperability


IPsec (RFC 4301, 4302, 4303) creates a secure VPN. **X.509 certificates** ensure strong authentication for incoming connection requests.


OCSP certificate revocation operates with standard certificate servers to centrally revoke certificates and prevent unwanted connections.


IRIG-B time synchronization receives and distributes IRIG-B signal to maintain time synchronization.

HTTPS web interface allows convenient, secure setup and management, and eliminates the need for extra PC software.


Cisco: Lemnos interoperability facilitates communication with Cisco routers and Lemnos-compliant devices.


Syslog logs events for consistency and compatibility, and enables centralized collection.

Price

Budgetary Retail, Quantity 1: $2,800

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

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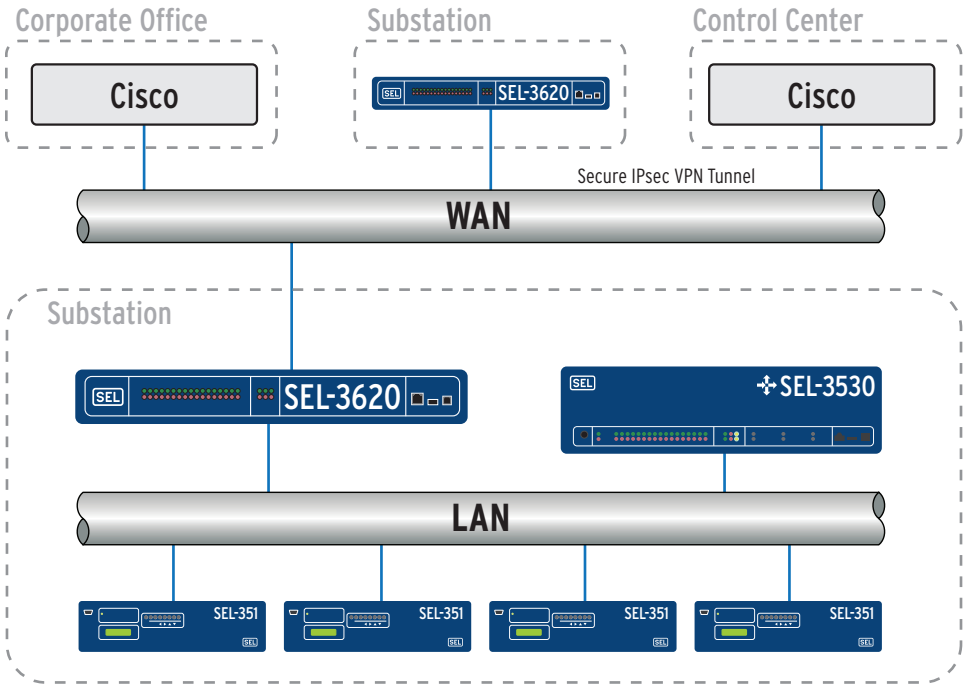
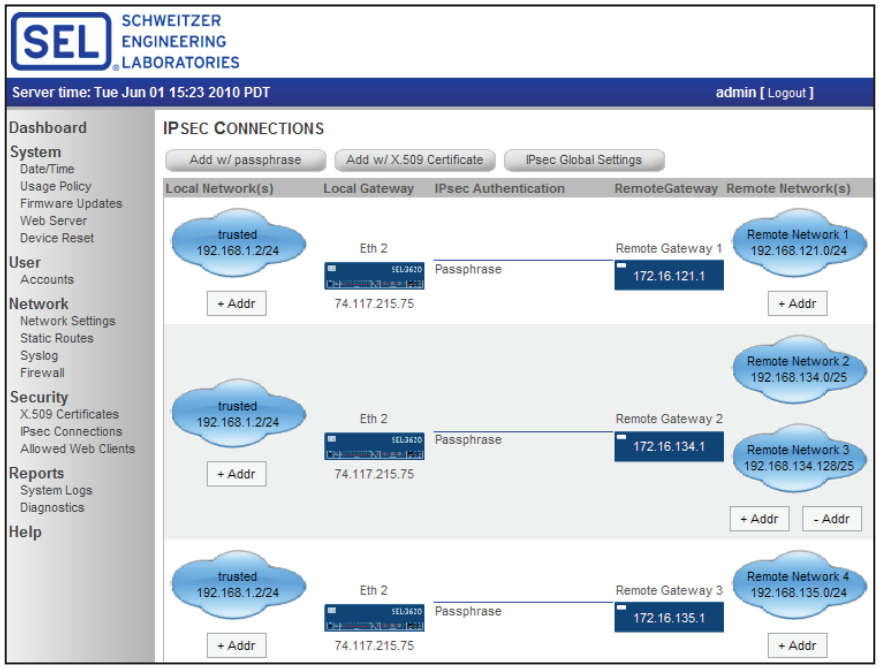
SEL-3620 Ethernet Security Gateway

Application

Centrally Revoke Access With the Open Standard Online Certificate Status Protocol (OCSP)

The SEL-3620 receives and logs a connection request, and polls the OCSP server to verify that the X.509 certificate is valid or invalid. If the SEL-3620 Ethernet Security Gateway receives an invalid status for the certificate, it denies the remote user the connection request.

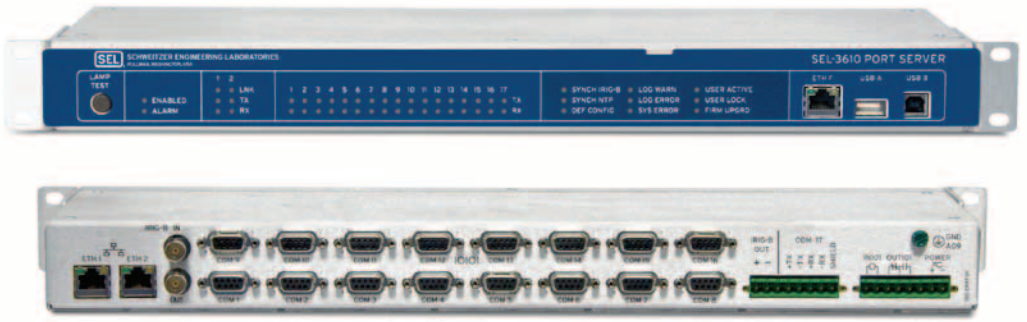




Easy-to-use, intuitive, and secure web interface reduces the time to set up and operate a security gateway.

Visit www.selinc.com for more detailed information and configuration options.

SEL-3610 Port Server



Add tough serial ports via Ethernet links.

Key Features

Serial Port Expansion

Add 17 remote serial ports to computers and SEL-3530 Real-Time Automation Controllers (RTACs) via Ethernet connections.

Secure Point-to-Point Communications

Securely communicate with serial devices via Ethernet networks for engineering access or data acquisition and control.

Seamless Modbus® RTU to Modbus TCP Conversion

Configure Port Server to act as a Modbus protocol transceiver and allow Modbus serial devices to communicate with Modbus TCP products. Modbus conversions are applicable in one-to-one and one-to-many architectures.

Ease of Use

Simplify configuration and maintenance from a secure web interface, eliminating PC configuration software. Easily configure and manage serial ports, IRIG-B time source, and security features.

Accurate Time

Benefit from time synchronization for event logs or for synchrophasor applications. Synchronize and source IRIG-B or NTP time information.

Logging

Track authenticated identity of users (user-based access), and log and store events either locally or to three remote servers with Syslog.

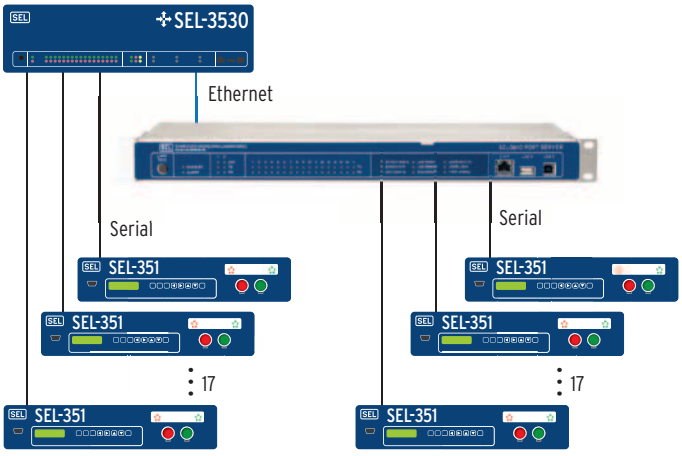
Related Products

SEL-3354 Embedded Automation Computing Platform.....422
SEL-3530/3530-4 Real-Time Automation Controllers (RTACs).....338
SEL-3620 Ethernet Security Gateway.....360

Price

Budgetary Retail, Quantity 1: $1,800

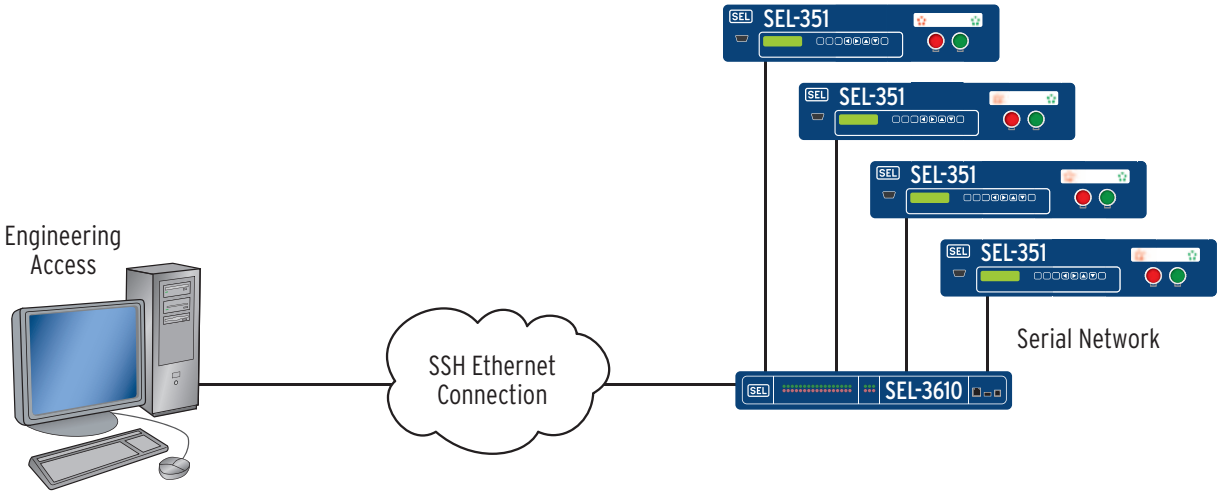
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)



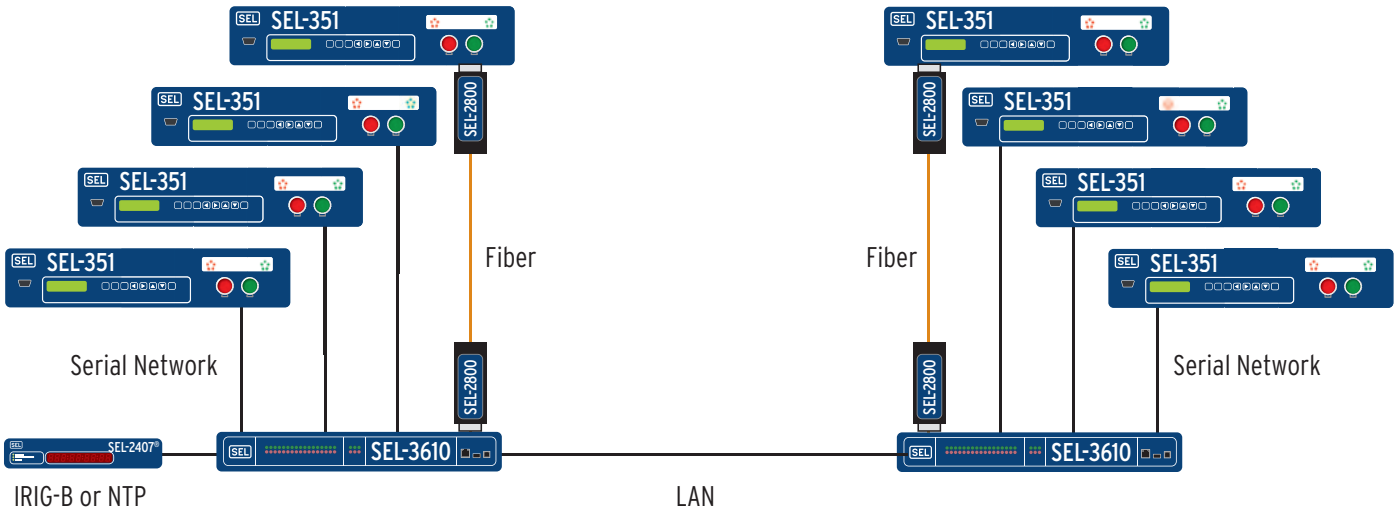
Add 17 serial ports with the SEL-3610 Port Server.

SEL-3610 Port Server

Applications



Secure shell (SSH) command mode example where the end user accesses an IED from a secure Ethernet connection.



Use the SEL-3610 to distribute time information and provide relay communications links over Ethernet.

Visit www.selinc.com for more detailed information and configuration options.

SEL-3021-1 Serial Encrypting Transceiver

Protect serial data links against unauthorized access.

Key Features

Secure Protection of Serial Communications

Use encryption and session authentication to protect point-to-point or multidrop data links from unauthorized attacks. Validated to FIPS 140-2 security requirements.

Easy Installation

Use surface or DIN rail mounting and options to power from ac, station dc, or low-level dc sources.

Secure, Nonintrusive Setting and Monitoring

Set and monitor through encrypted, authenticated wireless Ethernet link or USB port and PC software.

Applications

Optimal for SCADA Link Protection

- Point-to-point and multidrop links are supported.
- Low latency supports time-sensitive requirements.
- SCADA protocols factory-tested with the SEL-3021-1 include DNP3 and Modbus® RTU.

Protect Any EIA-232 Serial Link

Protect any serial link that carries important data and that is outside of your physical security perimeter. Do not expose sensitive financial, status, control, monitoring, or other data through unprotected serial links.

Related Products

Price

Budgetary Retail, Quantity 1: SEL-3021-1 $540

Budgetary Retail, Quantity 1: SEL-5809 $250

At least one installation of SEL-5809 Settings Software is required to set, operate, and test unit.

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

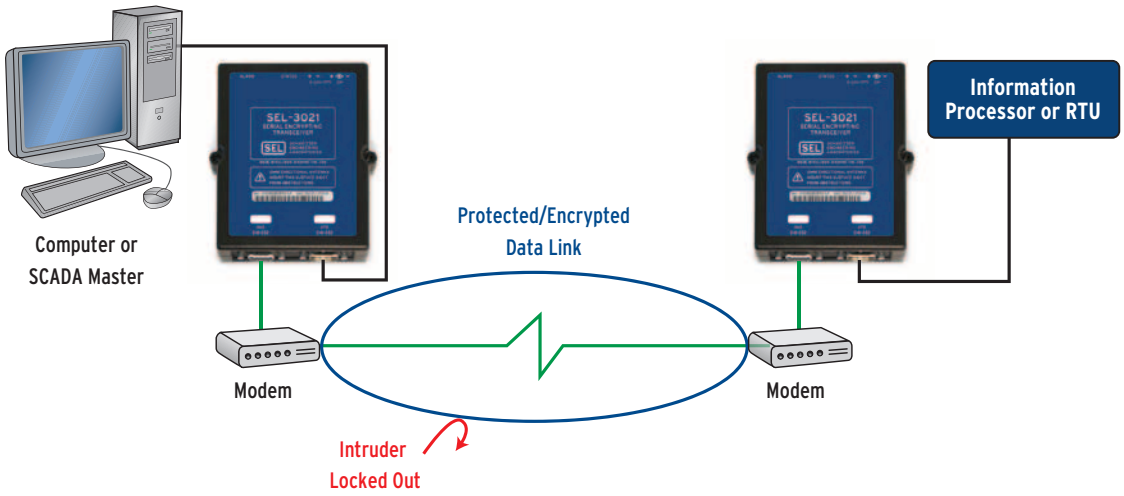
This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

SEL-3021-1 Serial Encrypting Transceiver

Product Selection Guide

SEL Product	SEL-3021-1	SEL-3025	SEL-3022
Application	Secure Serial SCADA and EMS Links	Secure SCADA and Remote Engineering Access	Convert Wired to Wireless Access
Real-Time Protection	Yes	No	No
Data Encryption	Yes	Yes	Yes
Data Authentication	No	Yes	Yes
Session Authentication	Yes	Yes	Yes
FIPS 140-2	Yes	Yes	No

Example Application



Lock intruders out of SCADA link.

Visit www.selinc.com for more detailed information and configuration options.

SEL-3022 Wireless Encrypting Transceiver

Deploy in situations where communication is required, but pulling cable is not cost effective or practical.

Key Features

Apply Easily With Low Impact and Cost

- Connect two IED serial ports via a secure wireless connection in point-to-point mode, or communicate from an SEL-3022 Wireless Encrypting Transceiver to the 802.11b wireless interface in your laptop.
- Connect to a Wi-Fi access point by configuring the SEL-3022 in infrastructure mode to seamlessly integrate with your Ethernet network.
- Install SEL-5810 Virtual Serial Software to add a virtual encrypted serial port for use with your existing application or communications software.
- Connect the SEL-3022 to an EIA-232 port on any device, with no change in the device firmware or software.

Designed to Meet FIPS 140-2 Security Requirements

Designed to satisfy network perimeter security requirements set by FERC and NERC.

Communicate using a secure wireless link between a remote serial port and your laptop.

Applications

Protect Personnel and Equipment

- Avoid exposing personnel to hazardous conditions by enabling them to control and monitor equipment from their trucks or other safe locations.
- Keep enclosure and control house doors shut to protect equipment from weather and contaminants.

Lock Out Intruders

- Locate equipment where vandals cannot reach it.
- Keep gates and control house doors locked.
- Lock out cyberintruders with communications links using National Institute of Standards and Technology (NIST)-approved encryption and authentication.

Related Products

SEL-351R Recloser Control 156
SEL-651R Advanced Recloser Control 168
SEL-2431 Voltage Regulator Control 126
SEL-3031 Serial Radio Transceiver 370

Price

Budgetary Retail, Quantity 1: $499

Includes SEL-3022, SEL-5810 Virtual Serial Software, and antenna

Budgetary Retail, Quantity 1: SEL-5809 $250

At least one installation of SEL-5809 Settings Software is required to set, operate, and test unit.

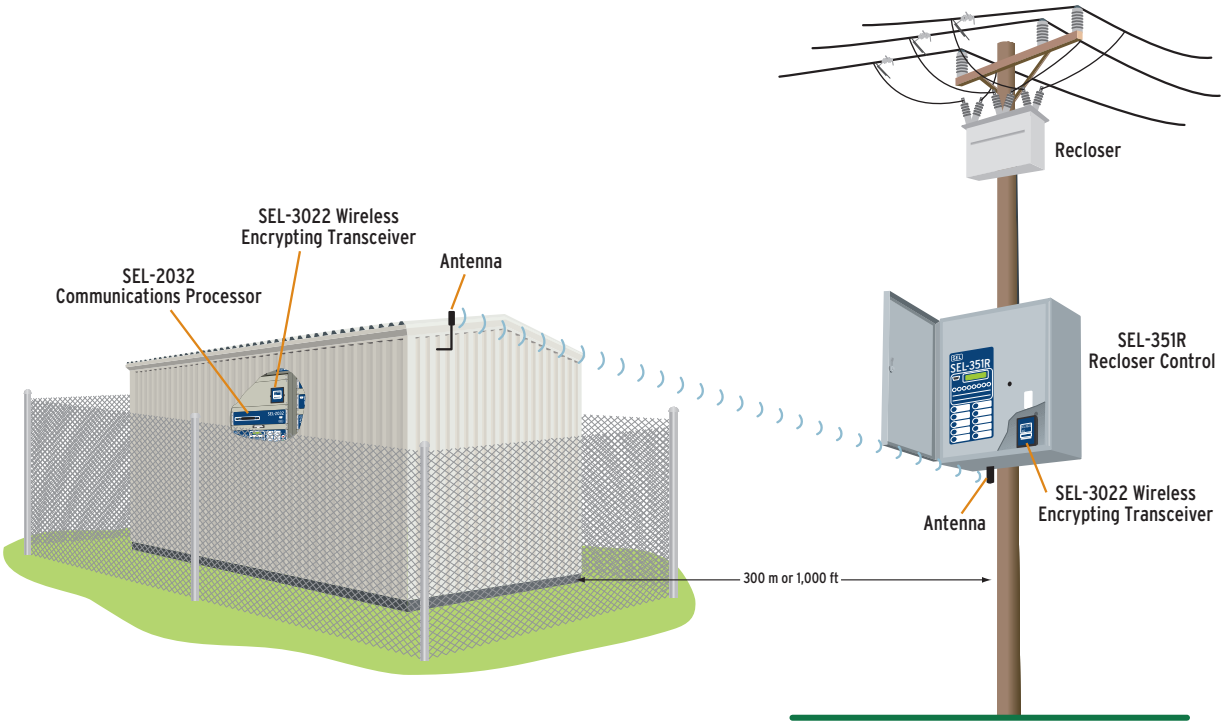
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

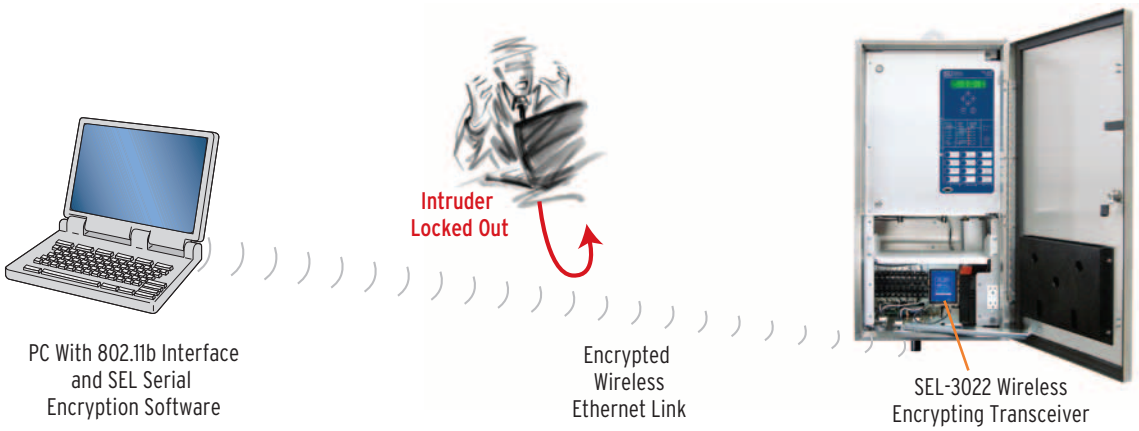
SEL-3022 Wireless Encrypting Transceiver

Point-to-Point Application Example



In point-to-point mode, the SEL-3022 connects two IED serial ports via a secure wireless connection.

Engineering Access Application Example



Connect the SEL-3022 serial port to a recloser control, substation communications processor, PLC, telemetry unit, or other device. Communicate using the wireless network interface card in your laptop or handheld computer, standard serial communications software, and SEL-5810 Virtual Serial Software.

Visit www.selinc.com for more detailed information and configuration options.

SEL-3025 SCADA Shield

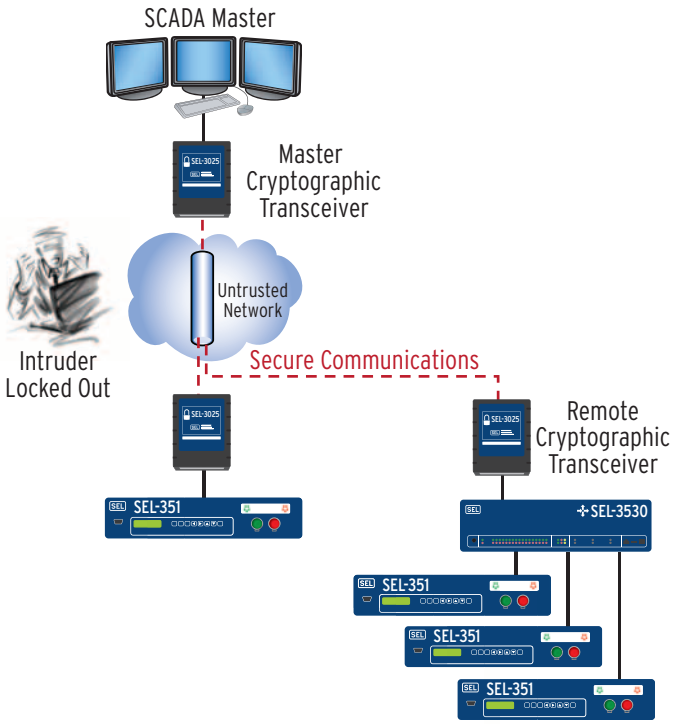
Protect engineering access and SCADA communications with strong, authenticated access controls.

Key Features

Protect Serial Data Communications With the DOE Sponsored SSCP

Cryptographically authenticate and optionally encrypt every data packet on the serial link. Available cryptographic methods include:

- AES-128/256 encryption
- SHA-1/256 authentication
- Diffie-Hellman key exchange
- X.509 server-side certificates
- HTTPS interface
- Pending FIPS 140-2 security validation



Remotely Manage, Monitor, and Configure

Access the SEL-3025 SCADA Shield from your web browser using Hypertext Transfer Protocol Secure (HTTPS) supporting X.509 server-side certificates through the Ethernet port, or manage remote units over the secured serial link. Reach your entire installed base from one central PC.

Establish Identity-Based Access Controls

Apply identity-based access controls to protect all point-to-point, point-to-multipoint, and many-to-many network topologies.

Centralize Event Report Collection

Collect event reports at a central location with Syslog protocol. Forward logs to two separate Syslog servers for redundancy and fast operator response.

Easily Integrate Into Existing Systems

Bump-in-the-wire installation ensures minimal equipment setting changes during SCADA Shield installation.

Minimize Latency

Use configurable frame sizes and Hash-Based Message Authentication Code (HMAC) trailers to minimize latency.

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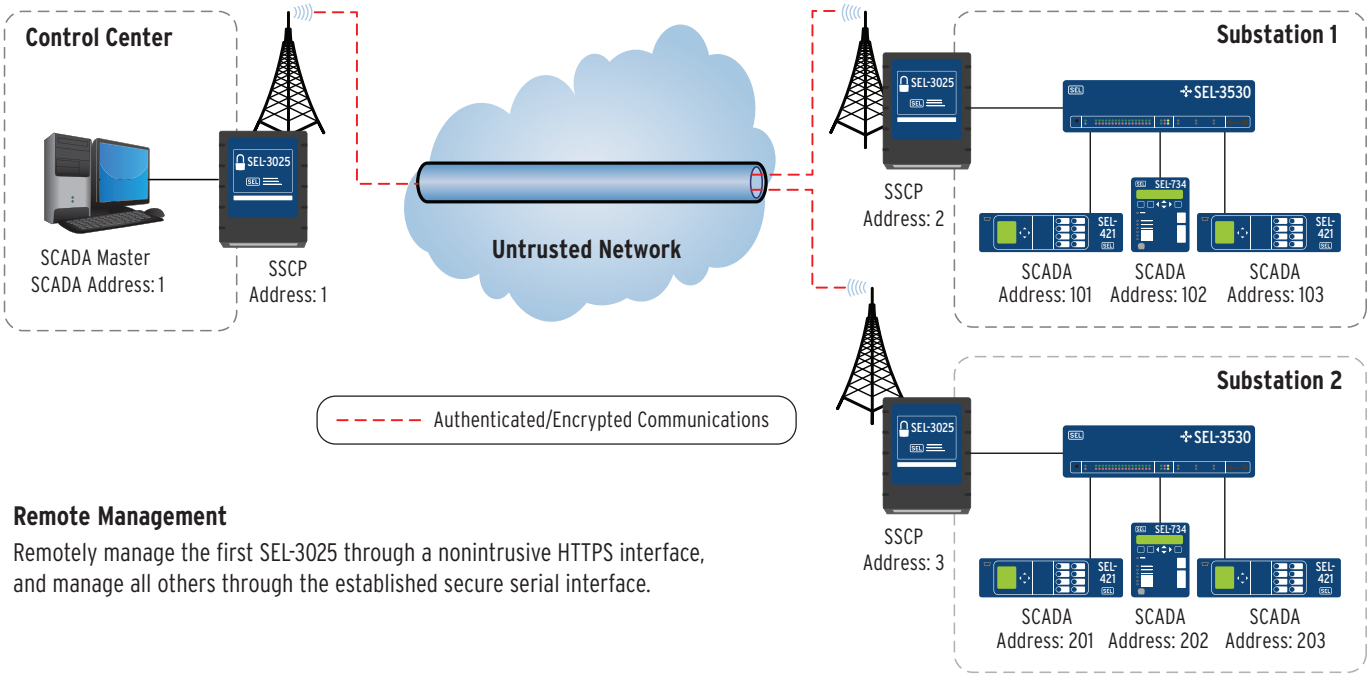
SEL-3025 SCADA Shield

Applications



Remote Management

Remotely manage the first SEL-3025 through a nonintrusive HTTPS interface, and manage all others through the established secure serial interface.

SSCP Data Packet Format

0-9	10	11	12	13	14	...	...	...	...
SSCP Header	Data Type	Sequence Number		Data (variable length)			HMAC (variable length)		

Related Products

Price

Budgetary Retail, Quantity 1: $900

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

Product Selection Guide

SEL Product	SEL-3021-1	SEL-3025	SEL-3022
Application	Secure Serial SCADA and EMS Links	Secure SCADA and Remote Engineering Access	Convert Wired to Wireless Access
Real-Time Protection	Yes	No	No
Data Encryption	Yes	Yes	Yes
Data Authentication	No	Yes	Yes
Session Authentication	Yes	Yes	Yes
FIPS 140-2	Yes	Yes	No

Visit www.selinc.com for more detailed information and configuration options.

SEL-3031 Serial Radio Transceiver

One radio.
Three secure links in point-to-point mode.

Cold (–40°C) *NERC CIP Secure* *Heat (+85°C)*

Key Features

Versatile

Operates in point-to-point or point-to-multipoint mode. In point-to-point mode, allows up to three different connections and protocols to operate simultaneously. For example, operate three MIRRORED BITS® communications channels at the same time or mix synchrophasor, DNP3, Modbus®, ASCII, and MIRRORED BITS data in any combination. In point-to-multipoint mode, a single master radio can communicate with multiple remote radios supporting SCADA data gathering. The radio transmits data in the license-free, 915 MHz ISM band up to 20 miles, providing an economical communications path or backup communications system.

Reliable and Secure

Protects critical data and thwarts malicious attacks with session authentication and strong 256-bit Advanced Encryption Standard (AES) encryption. Use logging and strong passwords to satisfy the requirements placed by NERC on electric utilities for critical infrastructure protection (CIP).

Rugged

Operates trouble-free in extreme environments and is tested in extreme conditions (temperature, RFI, shock, and vibration).

Flexible Installation and Easy Setup

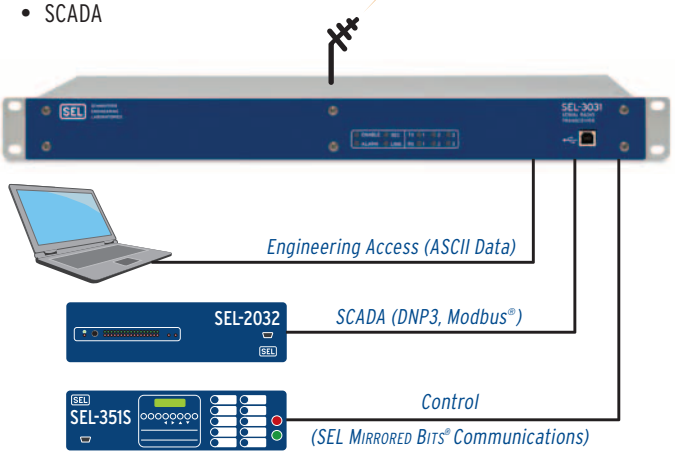
Select from multiple styles of cases and power supplies, including rack-mount, wall-mount, and NEMA 3R enclosures to meet specific applications. NEMA 3R cabinet versions may be customized to meet your needs. Quickly and easily set up the radio with minimum settings with ACSELERATOR QuickSet® SEL-5030 Software.

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Applications

- Step Distance Protection Enhancement
- Distributed Generation
- Distributed Automation
- Engineering Access
- SCADA
- Control
- Water and Wastewater
- Oil and Gas
- Transportation and Traffic Control



Related Products

SEL-351R Recloser Control 156
SEL-651R Advanced Recloser Control 168
SEL-2431 Voltage Regulator Control 126

Price

Budgetary Retail, Quantity 1: SEL-3031 Wall-Mount	$1,155
Budgetary Retail, Quantity 1: SEL-3031 Rack-Mount	$1,600
Budgetary Retail, Quantity 1: SEL-3044 Encryption Card Option	$500

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

SEL-3031 Serial Radio Transceiver

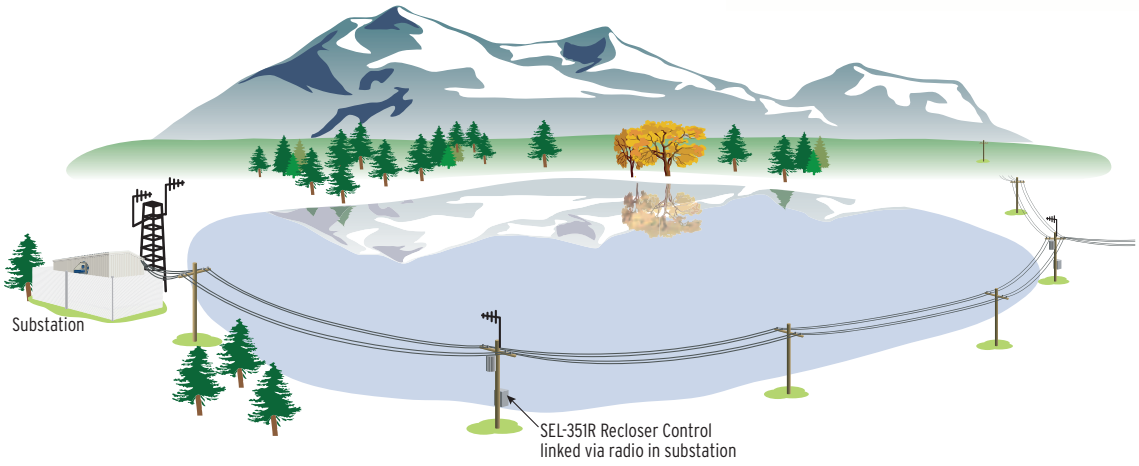
Point-to-Point Application Example

The SEL-3031 Serial Radio Transceiver allows up to three different connections and protocols to operate simultaneously over the spread-spectrum, 900 MHz ISM band. Operate three Mirrored Bits communications channels at the same time, or use one port for Mirrored Bits, the second for SCADA, and the third for engineering access. The radio provides an economical communications or backup communications system for applications including:

- Recloser controls
- Transmission
- Distribution
- Capacitor bank controls
- Remote relay access
- Voltage regulator controls

Optional SEL Encryption Card

Add the optional SEL encryption card to the radio system and cryptographically secure your valuable data with AES encryption.



Cost-effective wireless—use wireless connections in situations where communication is required, but pulling cable is not cost effective or practical.

Radio Accessories

- Weatherproof three- and five-element Yagi directional antennas, fully sealed for protection against humidity, rain, or even salt spray.
- A one-quarter-wavelength, omnidirectional, weatherproof, vertical antenna with 1.2 to 1 or less SWR over the entire band.
- Coaxial cable and TNC to Type N connectors and converters.
- Line surge suppressor and mounting bracket.

Visit www.selinc.com for more detailed information and configuration options.

SEL-2725 Five-Port Ethernet Switch

Easily connect devices to Ethernet networks with a tough, reliable switch.

SEL IEC 61850

Key Features

Easily Applied

Apply unmanaged "no-settings" switch/media converter. LED indicators simplify commissioning and solve network problems. Ports 1–4 automatically configure for crossover cables, speed, and half- or full-duplex operation.

Tough

Withstands vibration, electrical surges, electrostatic discharge, fast transients, and extreme temperatures. Meets or exceeds IEEE 1613 and IEC 61850-3 standards for communications networking devices in electric power substations.

Reliable

Compare our superior specification compliance, lower price, and worldwide, ten-year warranty to alternatives. Directly power from 24/48 Vdc or 125/250 Vdc or Vac; observed power supply mean time between failures (MTBF) exceeds 3,000 years.

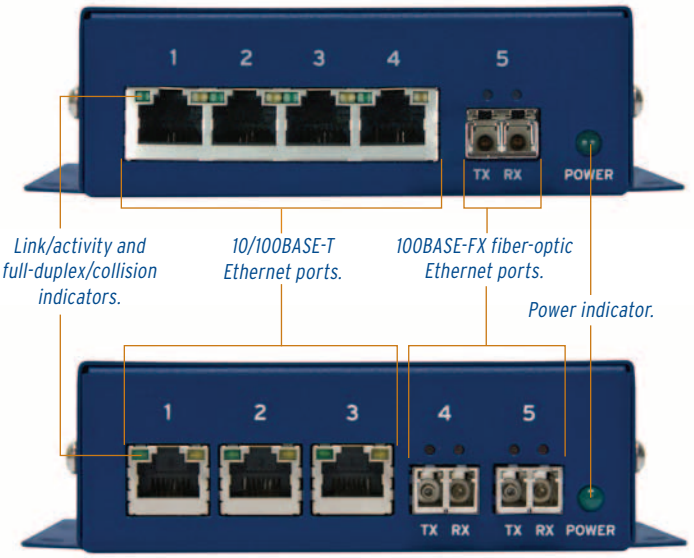
Safe

Convert Ethernet links to fiber-optic Ethernet link(s). Use fiber-optic Ethernet links outside of cabinets for increased safety and electrical noise immunity.

High Performance

Switch ports operate at wire speed. Undersubscribed, fully nonblocking switch fabric ensures that Ethernet traffic is never held up by the switch. Automatically adjusts maximum frame size when VLAN tags are present in the Ethernet traffic.

Single-Fiber Option



Dual-Fiber Option

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SEL-2725 Five-Port Ethernet Switch

Applications

- Integrate Ethernet devices in electrical substations; generating, process, and manufacturing plants; security systems; and commercial facilities.
- Apply on Ethernet networks located in harsh environments.
- Use shielded, twisted-pair (STP) Category 5 cable for short connections within the same cabinet, and convert to a fiber-optic link for connections to the station network.
- Connect multiple SEL-2411 Programmable Automation Controllers to exchange data using IEC 61850 GOOSE messages.
- Implement fiber-optic distribution for automatic schemes based on Ethernet communications.
- Wire high-speed field communications in photovoltaic (PV) solar and wind farm generating facilities.

Optional Features

- "D" option for three electrical ports and two fiber-optic ports.
- Single-mode fiber optics.

Related Products

SEL Category 5e Ethernet Cables 479
SEL-C807 Multimode 62.5 µm Core Fiber-Optic Cables 472
SEL-C809 Single-Mode 9 µm Core Fiber-Optic Cables 476

Hardware Specifications

Ethernet Ports

Ports 1–4 (1–3 with "D" option)

Data rate	10 or 100 Mbps
Connector	Metal RJ-45 female
Compatible cable	Category 5e Ethernet STP (SEL-C627)
Interface	10/100BASE-T
Maximum distance	100 m (328 ft)
Auto configuration	Crossover cable, speed, and half- or full-duplex operation

Port 5 (4, 5 with "D" option)

Data rate	100 Mbps
Connector	LC female
Interface	100BASE-FX
Safety	Eye-safe, Class 1 product per EN 60825-1

Option	Maximum Distance	Device Type
Multimode 1300 nm	2 km (1.24 mi)	LED
Single-mode 1300 nm	15 km (9.32 mi)	Laser

Power Supply

Power consumption	<5 W
Observed field MTBF	>3,000 years

Option	Range
12 Vdc	9–30 Vdc
24–48 Vdc	18–60 Vdc
110–250 Vdc, 110–240 Vac	85–275 Vdc, 85–264 Vac

Operating Temperature

IEC performance rating of –40° to +85°C (–40° to +185°F)

Price

Budgetary Retail, Quantity 1: $450

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Visit www.selinc.com for more detailed information and configuration options.

SEL-2890 Ethernet Transceiver

Use Ethernet infrastructure for direct device communications.

Key Features

EIA-232 to Ethernet Communications

Connect to your private Ethernet network. Telnet, webpage, email, and serial tunneling are included.

Port Powered

Powered from 5 Vdc in the host EIA-232 connector.

Compact

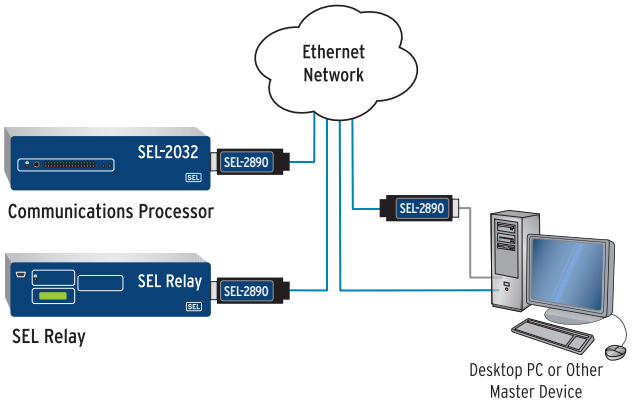
Plugs directly onto DB-9 connector.

Easy Application

Easily set with a PC. Upload, customize, and download webpage using FTP. Easily ground the shield of STP cables via metal RJ-45 connector.

Substation Quality

Operating temperature range of −40° to +85°C (−40° to +185°F).



Key Accessories

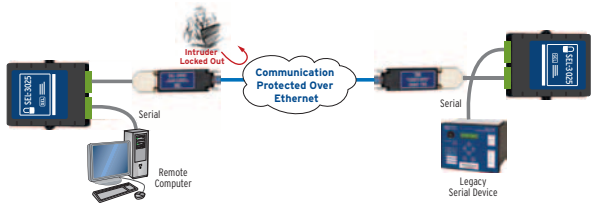
- SEL-C642 configuration cable provides power with an ac adapter. Use with PC or other non-SEL devices.
- SEL shielded, twisted-pair (STP) Ethernet jumper cables.

Applications

- Use an existing Ethernet network to replace leased or dial-up communications lines, or add communications to sites where other communications are prohibitive. Use serial tunneling for a virtual serial link through the network.
- Use standard Ethernet network and Internet protocols for access to devices with serial ports. Streamline terminal access and save engineering time by using Telnet for ASCII terminal dialogs. Simplify and control data access by using a webpage on your private network. Send email alerts based on automatic messages from the host device to improve customer service.

Related Product

Combine the SEL-2890 with the SEL-3025 SCADA Shield to secure communications over the Internet.



Price

Budgetary Retail, Quantity 1: $360

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

SEL-2886 EIA-232 to EIA-485 Interface Converter

Connect EIA-232 devices to an EIA-485 network.

Key Features

Flexible Power Options

Accepts 5 Vdc power from the SEL host device EIA-232 port or through 0.7 mm power jack.

Improved Safety

Isolation to 1500 Vrms.

Compact

Plugs directly onto DB-9 connector.

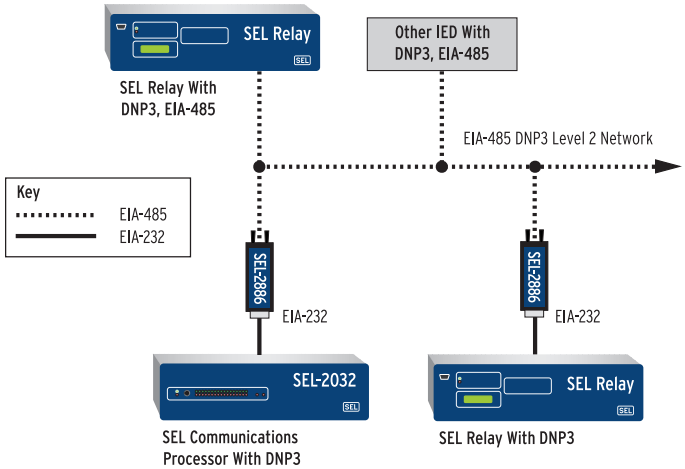
Easy Application

Use control (DIP) switches to select operating modes to key the transmitter on and off and to control the echo mode.

Substation Quality

Operating temperature range of −40° to +85°C (−40° to +185°F).

DNP3 Application



Applications

- Connect the DNP3 EIA-232 ports on SEL devices to an EIA-485 DNP3 network.
- Connect Modbus® port on an SEL device to an EIA-485 Modbus network.
- Use the EIA-485 port on a relay for engineering access or other EIA-232 communications. Order an SEL-2886 and an SEL-C671A Cable to communicate with the EIA-485 port of an SEL-500 series relay.

Related Products

SEL-C671A Cable for EIA-232 communications with SEL-500 series relays (includes SEL-2886 and 230-0601) 481
SEL-9321 Low-Voltage DC Power Supply 490
230-0601 AC Power Supply 491

Price

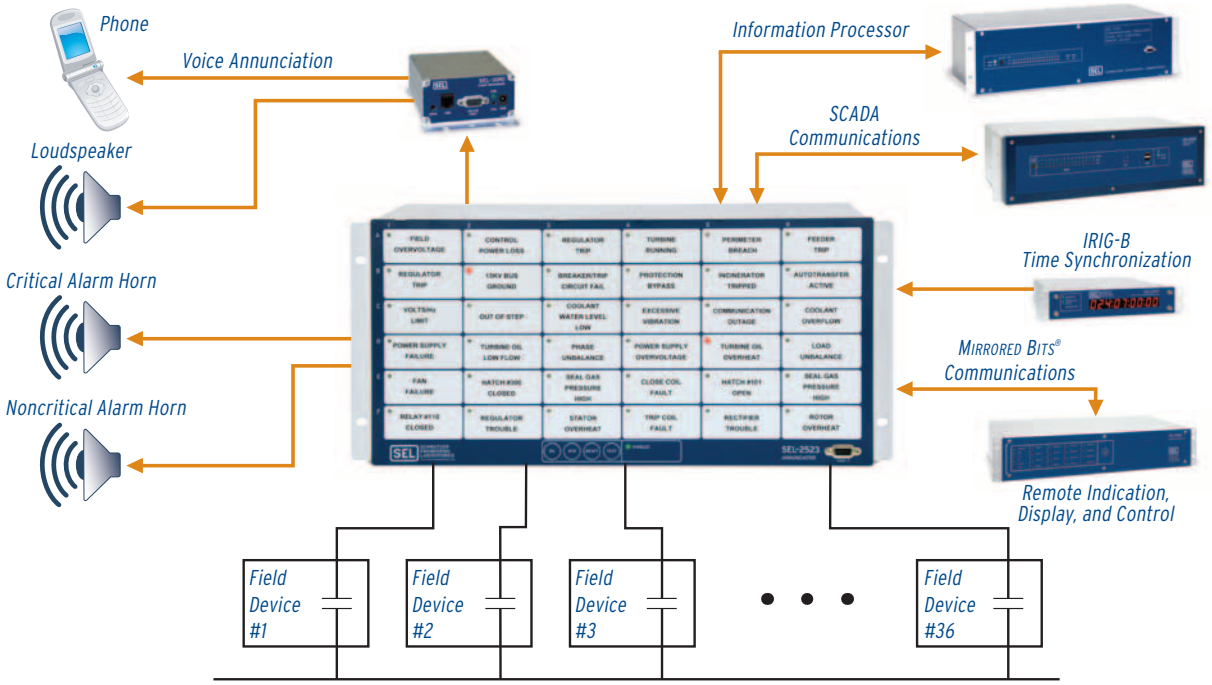
Budgetary Retail, Quantity 1: $130

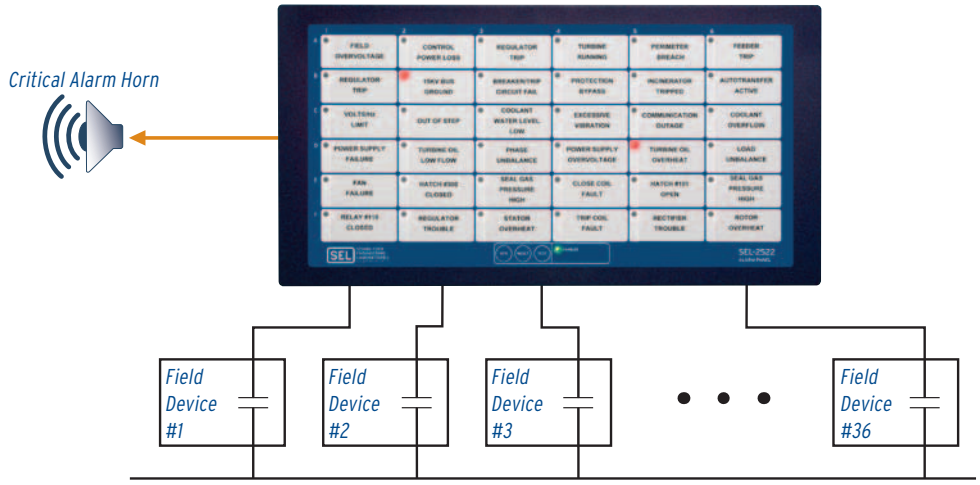
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Annunciation and Notification Applications





Annunciation and Notification Product Index

Annunciation and Notification Features

Annunciators, Alarm Panels, Indicators, and I/O Modules

	SEL-2522	SEL-2523	SEL-2533	SEL-2506†	SEL-2516†	SEL-2595†	SEL-3010
APPLICATIONS							
Local Visual Indication	•	•	•	•	•	•	
Remote Visual Indication		•	•	•	•	•	
Local Audible Indication	•	•	•				•
Remote Audible Indication	•	•	•				•
Loudspeaker Messages							•
Telephone Dial-Out Messages		•	•				•
Local SELOGIC® Control Equations and Time Tagging		•	•				
MOUNTING AND LABELING							
Surface/Wall Mount							•
Rack Mount	*	*		*	*	*	•
Panel Mount	*	*	•				
Projection Panel Mount				*	*	*	
User-Defined Slide-In Labels	•	•	•	•	•	•	
INPUTS, OUTPUTS, AND HMI							
General-Purpose Digital Inputs	36	42	14*	8	8	8	
Acknowledge, Reset, Test Digital Inputs	3	6	4*				
General-Purpose Digital Outputs	1	11	14*	8	8	8	
Alarm Digital Output	1	1	1	1	1	1	
General Display LEDs/Windows	36	36	10	8	8	8	
Enabled LED	1	1	1	1	1	1	1
Other Communication/Status LEDs				5	4	5	
Pushbuttons	3	4	4				
Base Serial Ports		3	3	1	1	1	1
Optional Additional EIA-232 or EIA-485 Port		1	1				
IRIG-B Time Input		1	1				
ISA Annunciation Alarm Sequence Choices	2	6	All				
SERIAL COMMUNICATIONS PROTOCOLS							
SEL MIRRORED BITS® Communications		•	•	•			
SEL Fast Messages		•	•		•		
Send SEL Messenger Points		•	•				
Receive SEL Messenger Points							•
Modbus® RTU		•	•				
DNP3 Level 2 Outstation		*	*				

• *Standard Feature* * *Model Option* † *See page 387 for more I/O module information*

SEL-2522 Alarm Panel

Easily view status of station alarms.

Key Features

Easy Installation

Save engineering time and effort with simple wiring and configuration. Control (DIP) switch selection provides for either N/O or N/C input.

Secure Alarms

View alarms even if there has been a power interruption. Alarms are sealed in until acknowledged.

Easy, Low-Cost Labeling

Print slide-in labels on any printer for easy initial installation or changes.

Substation- and Plant-Grade Equipment

Provide for secure operation in station environments. Wide temperature range (–40° to +85°C) and surge protection.

Acknowledge, Reset, and Test

Follows ISA-18.1 standard manual reset and ringback sequences for reliable and repeatable operation.

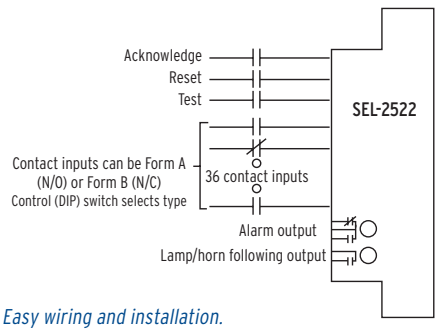
Applications

Manned Station Annunciator

Output contact can drive alarm horn or external light. Super-bright LED output provides easily visible indication of alarm points in any ambient lighting condition.

Unmanned Station Annunciator

Seal-in of momentary alarms provides a visual indication of event history.



Easy wiring and installation.

Hardware Specifications

Alarm Windows

36 display windows with slide-in labels
Window dimensions 32 mm H x 70 mm W (1.25 in x 2.75 in)

Front-Panel Pushbuttons

Acknowledge, reset, and test buttons, with logic following standard ISA-18.1-1979 (R1992), Sequence M, and Sequence R (ringback).

Contact-Sensing Inputs

36 optically isolated status inputs; user-configuration switches select open or closed contact as alarm state.

Acknowledge, reset, and test inputs, with same functions as corresponding front-panel pushbuttons.

Input range options 24, 48, 110, 125, or 250 Vdc

Contact Outputs

Alarm Output Form "C" contact indicates power supply and self-diagnostics status.

Lamp/horn output follows status of active alarm state.

Power Supply Ratings

48/125 V	36–200 Vdc or 85–140 Vac
125/250 V	85–350 Vdc or 85–264 Vac

Dimensions

Rack	222 mm H x 483 mm W x 54 mm D (8.72 in x 19 in x 2.10 in)
Panel	258 mm H x 503 mm W x 54 mm D (10.15 in x 19.8 in x 2.10 in)

Price

Budgetary Retail, Quantity 1: $2,100

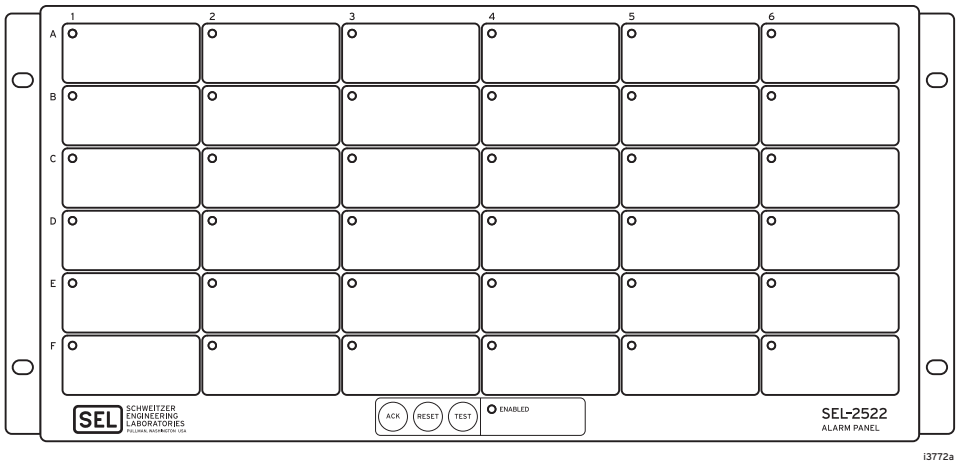
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

SEL-2522 Alarm Panel

Front View



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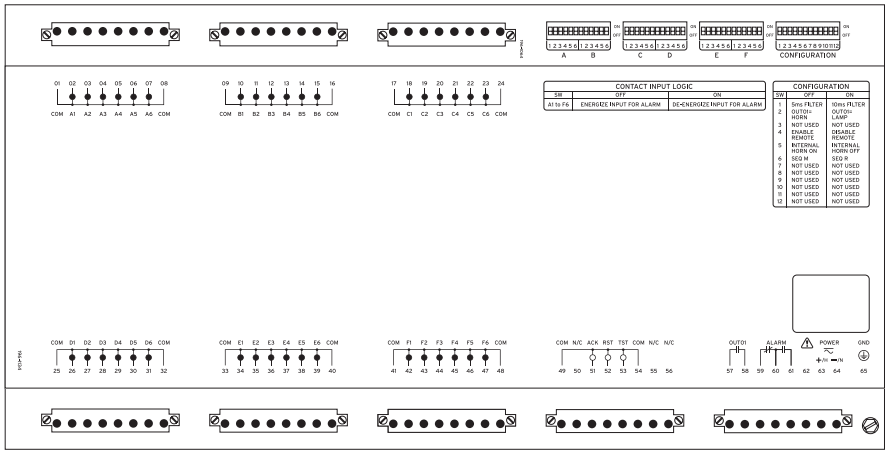
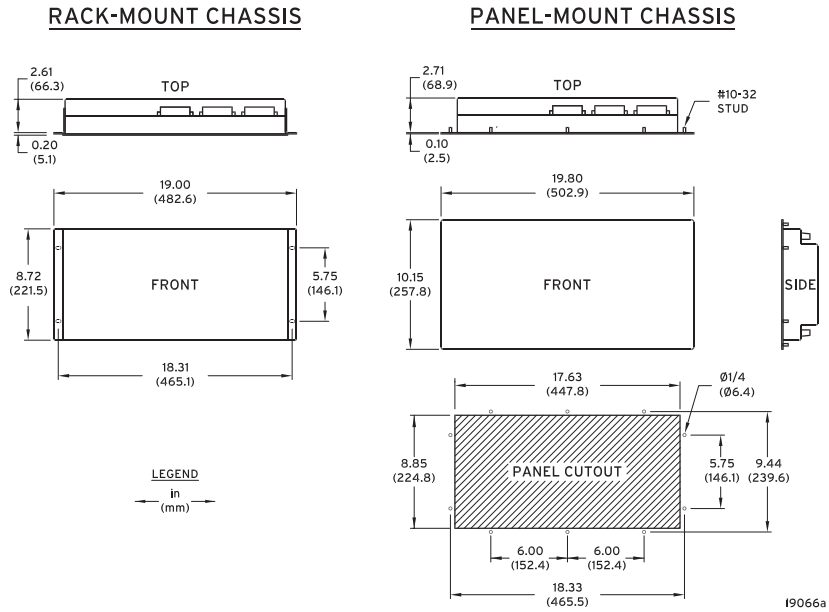
Back View



i3774c

Dimensions



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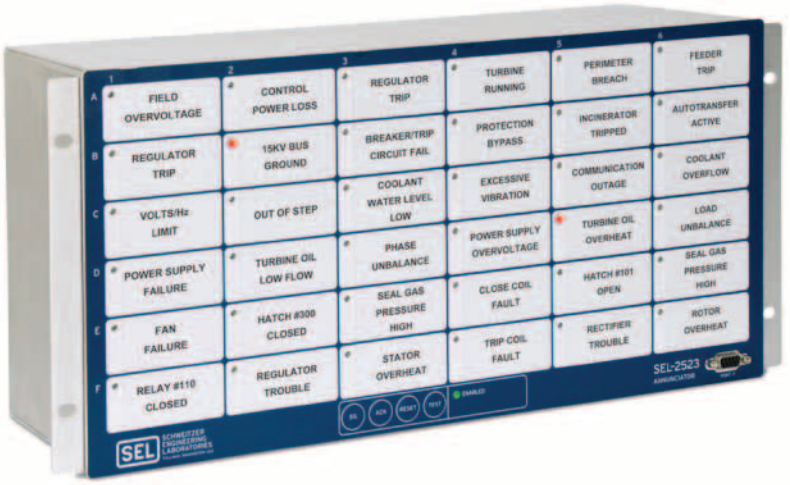
Visit www.selinc.com for more detailed information and configuration options.

SEL-2523 Annunciator Panel



Provide local and remote notification with the SEL-2523 Annunciator Panel.

Key Features

Comprehensive Annunciation

Select from six ISA-18.1 standard acknowledge sequences: Automatic Reset (A), Automatic Reset—First Out With No Subsequent Alarm State (F1A), Manual Reset—First Out With No Alarm Flashing and Silence Pushbutton (F2M-1), Automatic Reset—First Out With First Out Flashing and Reset Pushbutton (F3A), Manual Reset (M), and Ringback (R). Super-bright LEDs provide easily visible alarm indication in any lighting condition.

Flexible Communications

Use up to four high-speed serial ports to communicate with DNP3, Modbus®, or SEL protocols. Support multiple sessions for all protocols. Three EIA-232 ports are standard; one EIA-232 or EIA-485 port is optional. Mirrored Bits® communications protocol for two 8-bit channels of secure device-to-device logic communications is available on all rear-panel serial ports.

Programmable Logic

Create custom alarm conditions using programmable logic. Alarm conditions can be based on physical inputs, communications data, or a combination of both. Reduce or eliminate costly wiring by implementing purely communications-based annunciation.

Configurable Labels

Print custom alarm labels in the field using terminology to match your application. Easily reprint labels to accommodate expansions, system reconfigurations, or corrections.

Tough Design

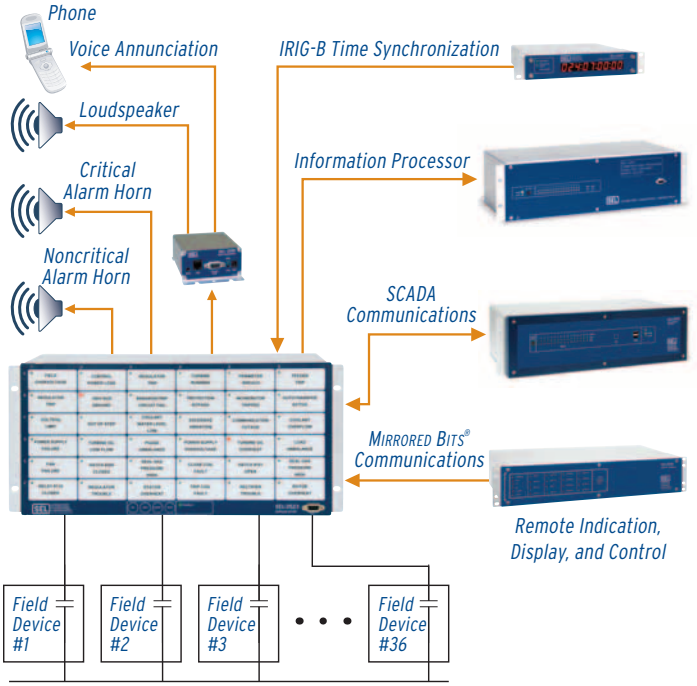
Meet the demands of your harshest environments. Designed to exceed stringent vibration, electrostatic discharge, electromagnetic interference, and temperature requirements, the SEL-2523 is backed by SEL's worldwide, ten-year product warranty.

PC Software

Easily set, commission, test, and troubleshoot with acSELerator QuickSet® SEL-5030 Software. Develop settings offline with the menu-driven interface and completely documented help screens. Quickly test and commission annunciator panels with live device-status information on the software HMI screen. Customize the software HMI screen for your application with changeable alarm labels and elements.

Time-Tagged Event Recording

Time-tag alarm events to the nearest millisecond. Improve operation analysis with time-stamped records of the last 1,024 operations of up to 96 different internal and external events. Report time-tagged messages with DNP3 or SEL Fast SER protocol.



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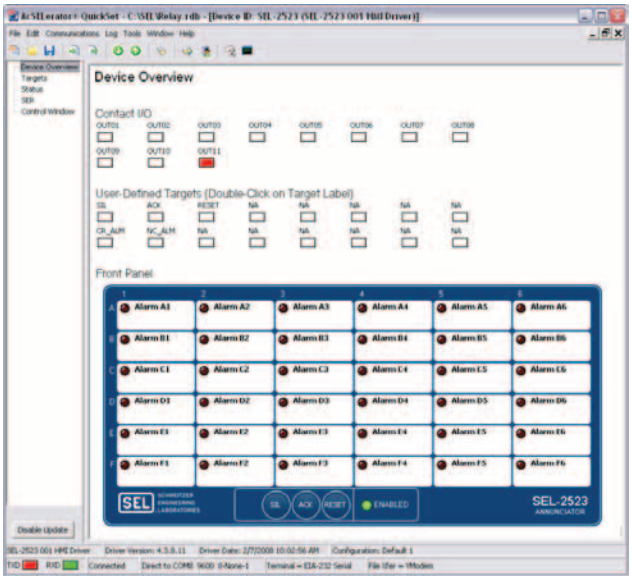
SEL-2523 Annunciator Panel

Applications

- Manned station annunciator.
- Unmanned station annunciator.
- Digital I/O RTU.



Configurable HMI screen aids commissioning, testing, and maintenance with live data from devices.

Optional Features

- Panel-mount or rack-mount hardware package.
- DNP3 Level 2 Outstation communications protocol.
- EIA-232 or EIA-485 serial communications card.
- Additional user-configurable labels.

Related Products

SEL-2401 Satellite-Synchronized Clock 316
SEL-2522 Alarm Panel 378
SEL-3010 Event Messenger 384

Hardware Specifications

Front-Panel Pushbuttons

Silence, acknowledge, reset, and test pushbuttons, with logic following standard ISA-18.1-1979 (R1992) sequences A, F1A, F2M-1, F3A, M, and R

Contact-Sensing Inputs

42 optically isolated status inputs

Input Range Options 24, 48, 110, 125, 220, or 250 Vdc

Contact Outputs

12 contacts, 6 A continuous carry

Serial Communications Ports

Two rear and one front EIA-232 ports

Optional rear EIA-232/EIA-485 port

Connectors	9-pin female
Data Rate (bps)	300 to 38400
Protocols	SEL Fast Meter, SEL Fast SER, SEL Fast Operate, SEL Mirrored Bits communications, SEL Messenger Points, SEL ASCII, Modbus RTU
Optional Protocol	DNP3 Level 2 Outstation

Environmental

–40° to +85°C (–40° to +185°F) operating temperature

IEEE C37.90 compliant

IEC 60255 compliant

Alarm Windows

36 display windows with slide-in labels

Window Dimensions 32 mm H x 70 mm W (1.25 in x 2.75 in)

Power Supply Options

Option	Range
48 Vdc	35–60 Vdc
110–250 Vdc, 110–240 Vac	85–275 Vdc, 85–264 Vac

Label Generation

Print slide-in labels on any printer, using included software template

Dimensions

Rack 222 mm H x 483 mm W x 160 mm D (8.72 in x 19 in x 6.29 in)

Panel 258 mm H x 503 mm W x 160 mm D (10.15 in x 19.8 in x 6.29 in)

Price

Budgetary Retail, Quantity 1: $3,700

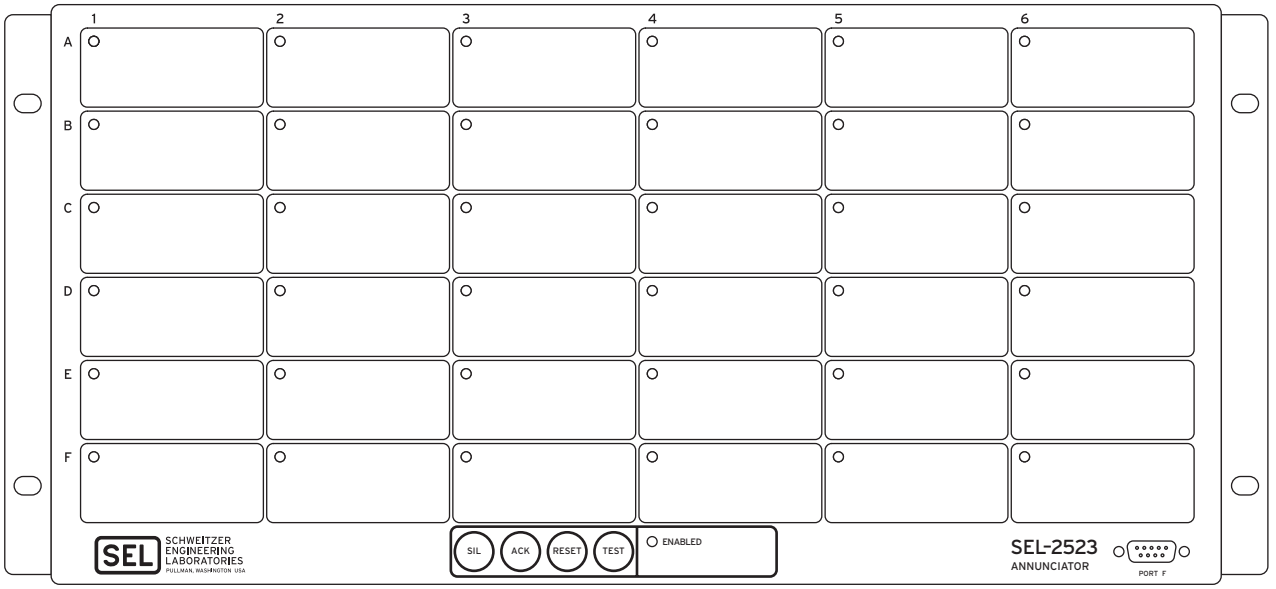
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

SEL-2523 Annunciator Panel

Front View – Rack Mount



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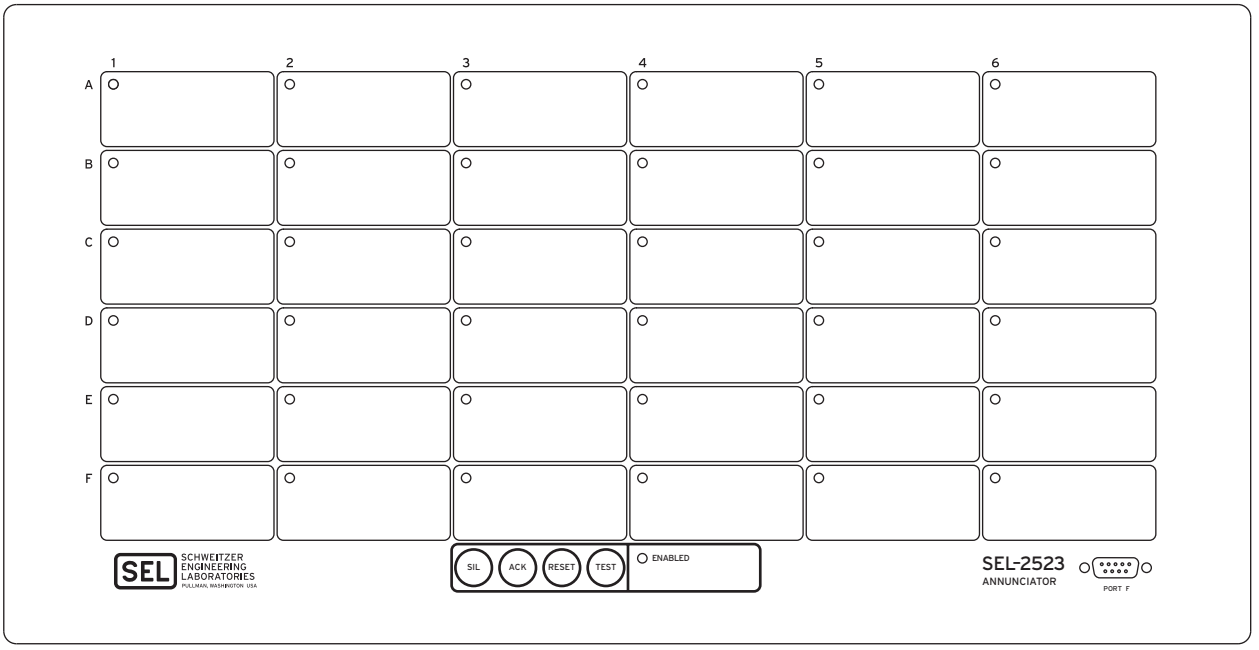
Front View – Panel Mount



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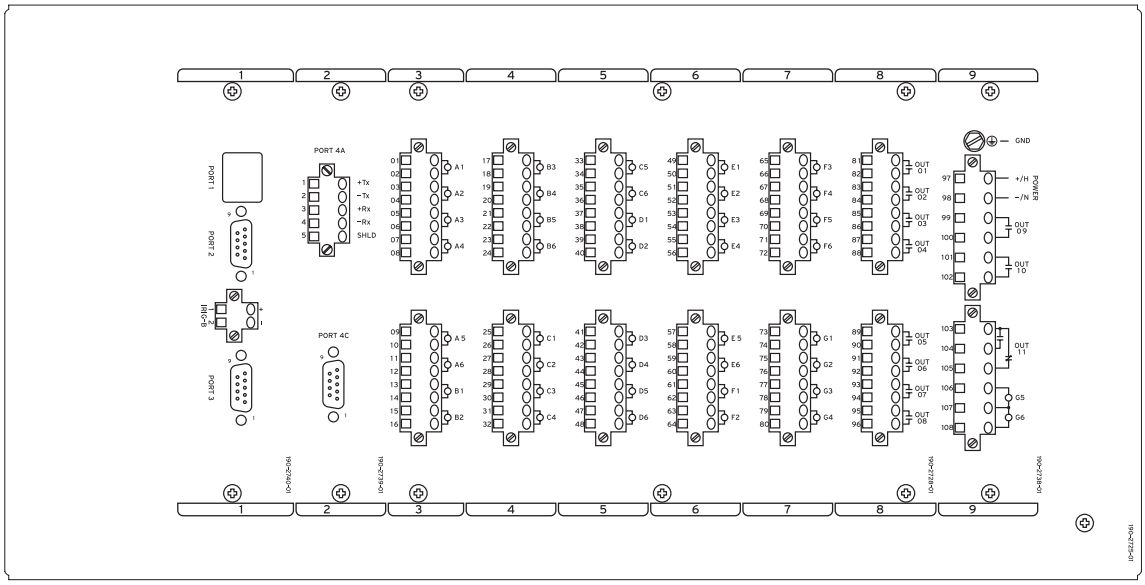
SEL-2523 Annunciator Panel

Rear View



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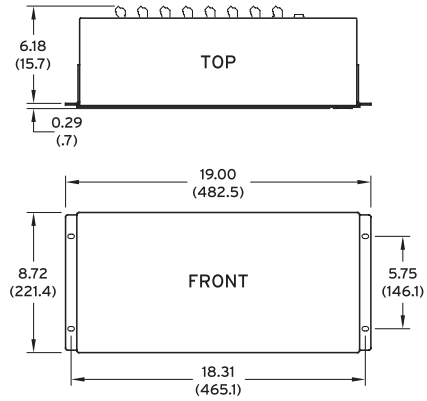
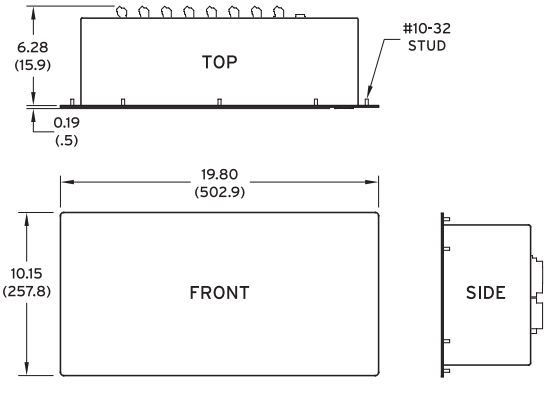
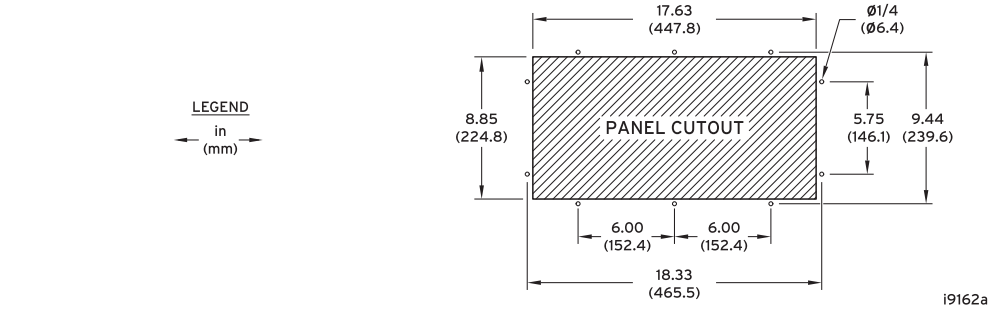
Dimensions

RACK-MOUNT CHASSIS



PANEL-MOUNT CHASSIS





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Visit www.selinc.com for more detailed information and configuration options.

SEL-3010 Event Messenger

Deliver station alarms and event notification by telephone.

Key Features

- Delivers ASCII text messages by telephone.
- Automatically retries until messages are delivered and accepted.
- Stores dialing list of up to four telephone numbers.
- Allows unlimited number of ASCII message types to be sent and delivered.
- Includes numeric values in messages.
- Stores and plays unique location header information.
- Connects to serial port of SEL information processor, programmable automation controller, annunciator panel, compatible relay, or non-SEL PLC, computer, or other device.
- Drives speaker for local public address alarm annunciation.
- Accepts power from SEL devices through serial connector; for non-SEL devices, use one of the accessory power supplies.
- Operates in extreme ambient temperatures from −40° to +85°C (−40° to +185°F).
- FCC and Industry Canada certified for use on public telephone networks.

Applications

Power Industry

Transmit fault location, time, and substation information directly to operations staff, eliminating the need to contact the operations center to confirm an alarm or obtain detailed alarm information.

Industrial Process Control

Transmit alarms and include process data that convey the severity of the alarm. For example, a process temperature out of tolerance by 1°C may be advisory, while a temperature out of tolerance by 10°C may require immediate attention.

Public Works Remote Site Monitoring

Use the SEL-3010 to provide alerts via telephone voice annunciation much more economically than with full-time SCADA monitoring and communication.

Commercial Property Management

Automatically transmit maintenance alerts, warnings, and alarms for HVAC, refrigeration, standby generation, or other important facility equipment directly to mobile maintenance and repair staff.

Off-Shift Alarm Notification

Send alarms to the SEL-3010 to be transmitted by telephone to on-call personnel when operators are off shift. This provides on-call response to critical alarms for municipal and industrial sites that are not staffed 24 hours a day.

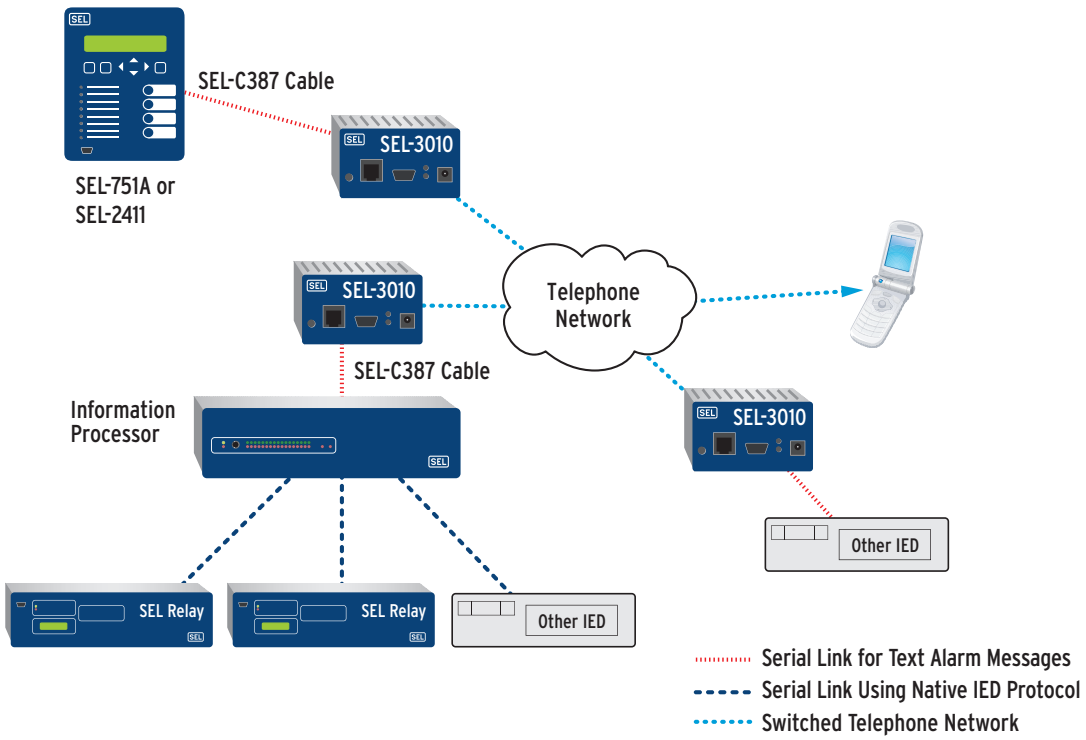
SEL-3010 Event Messenger

Compatible Devices

Accessories

- 230-0601 AC Power Supply
- SEL-C387 Cable
- SEL-245A Cable
- SEL-9321 Low-Voltage DC Power Supply

Application Example



Hardware Specifications

Power Supply

4.5–5.5 Vdc
330 mA maximum
Input power via serial connector or 2.5 mm jack

Communications Interfaces

EIA-232 9-pin serial port
RJ-11 telephone jack
3.5 mm (1/8 in) stereo plug speaker output, 100 mW into 8 ohms

Dimensions

Mounting Footprint	144.3 mm (5.68 in) x 131.6 mm (5.18 in)
Height	46.8 mm (1.84 in)

Operating Temperature

–40° to +85°C (–40° to +185°F)

Price

Budgetary Retail, Quantity 1: $675

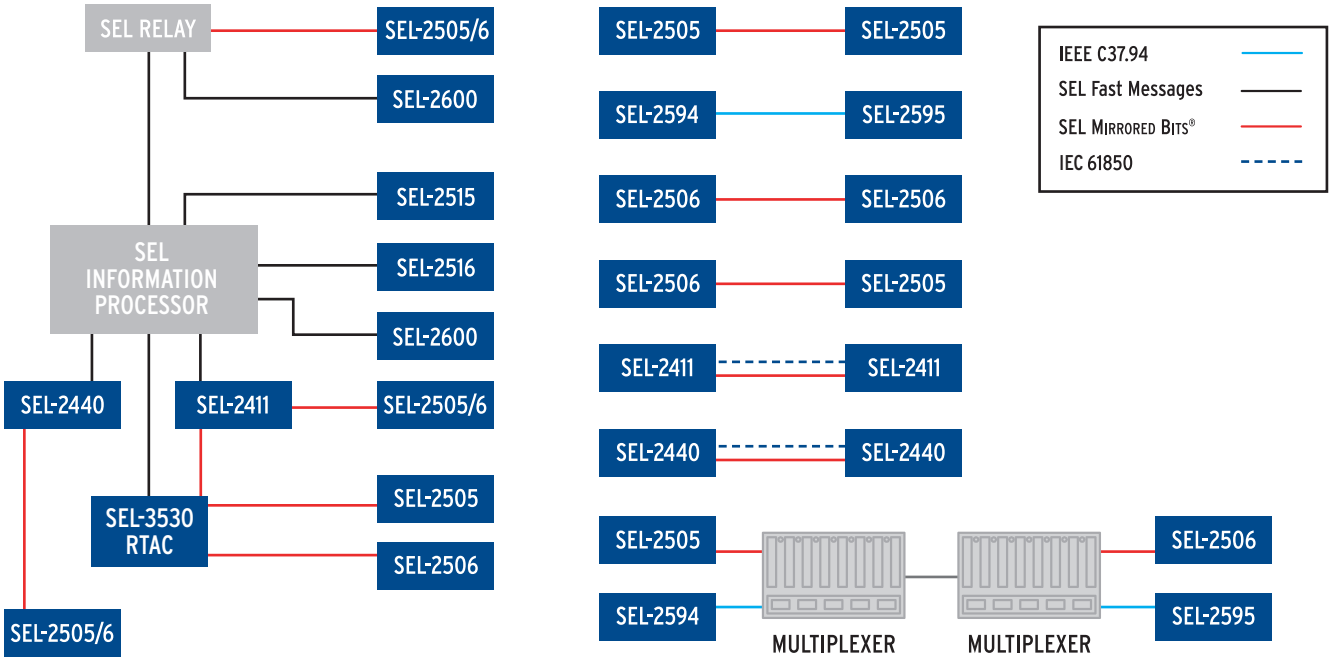
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Visit www.selinc.com for more detailed information and configuration options.

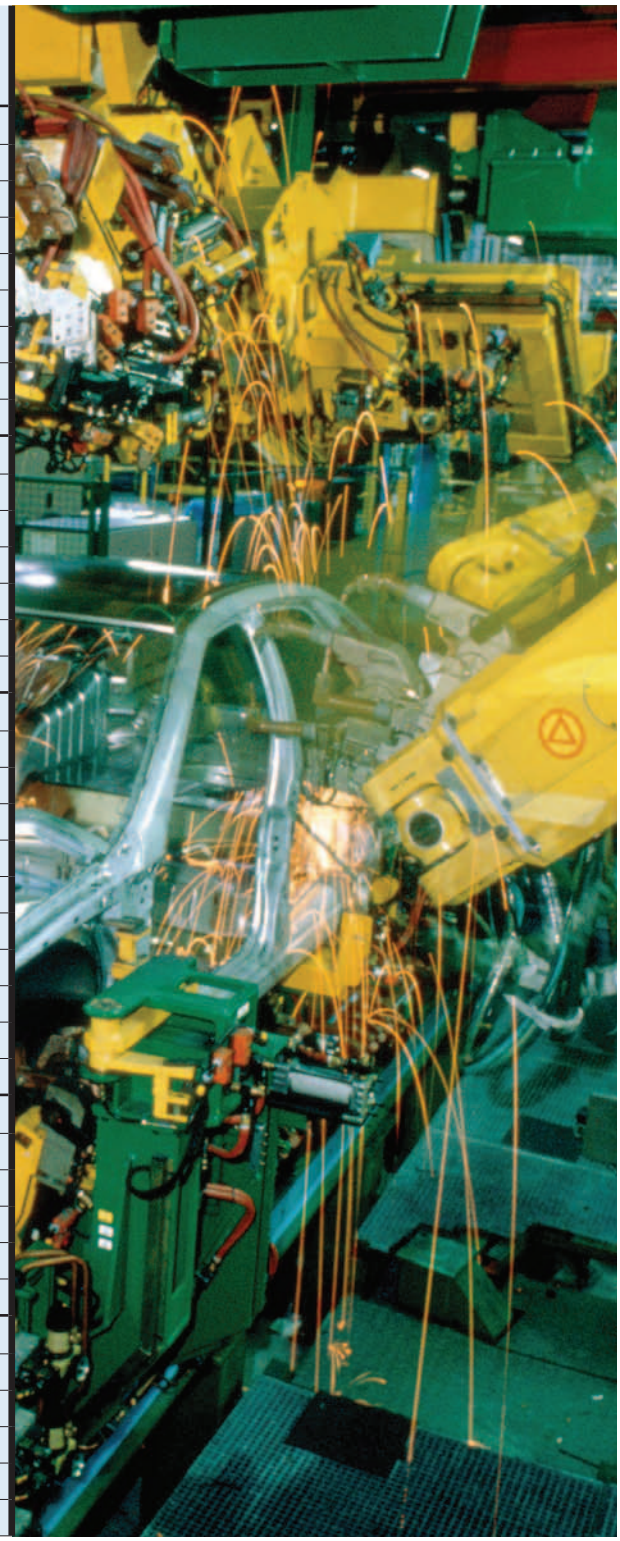
I/O Processor and Controller Applications



I/O Processor and Controller Product Index

I/O Processor and Controller Features

I/O Processors and Controllers	SEL-2411	SEL-2440	SEL-2505	SEL-2506	SEL-2515	SEL-2516	SEL-2594	SEL-2595	SEL-2600
APPLICATIONS									
Save Wiring Via I/O Multiplexing	•	•	•	•	•	•	•	•	•
I/O for SEL Relays/SEL-3530/SEL-2100	•	•	A	A					A
I/O for Information Processors	•	•			A	A			A
Transfer I/O to SEL-2505/2506	•	•	•	•					
Transfer I/O to SEL-2594/2595							•	•	
Teleprotection	•	•	•	•			•	•	
Automatic Local Control Logic	•	•							
Improve Safety With Optical Fiber	*	*	•	•	•	•	•	•	•
MOUNTING AND LABELING									
Surface/Wall-Mount	*	•	•		•		•		•
Rack-Mount	*	•		*		*		*	
Panel-Mount	*	•		*		*		*	
Projection Panel-Mount	*			*		*		*	
User-Configurable Labels	•			•		•		•	
Screw-Terminal Connectorized® Blocks				•		•		•	
NUMBER OF INPUT/OUTPUT CHANNELS									
Digital Inputs (DI) Base	2	32	8	8	8	8	8	8	1
DI Maximum	34	48	8	8	8	8	8	8	1
Digital Outputs (DO) Base	3	16	8	8	8	8	8	8	
DO Maximum	35	32	8	8	8	8	8	8	
DC Analog Inputs (AI) Maximum	32								
DC Analog Outputs (AO) Maximum	4								
AC Current Inputs/CT Maximum	7								
AC Voltages/VT Maximum	3								
DC Analog RTD Inputs Maximum	10								12
DC Analog Thermocouple Inputs Maximum	10								
SERIAL COMMUNICATIONS PROTOCOLS									
SEL Mirrored Bits®	•	•	•	•					
SEL Fast Messages	•	•			•	•			•
Modbus® RTU	•	•							
IEEE C37.94							•	•	
DNP3	*	•							
ETHERNET COMMUNICATIONS PROTOCOLS									
Modbus TCP	*	•							
DNP3 LAN/WAN	*	•							
Telnet	*	•							
FTP	*	•							
IEC 61850	*	*							



• *Standard Feature* * *Model Option* A *With compatible SEL fiber-optic transceiver or interface option at relay or processor*

SEL-2411 Programmable Automation Controller

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

SEL IEC 61850

Key Features

High Reliability, Robust Design, and Low Price

Apply in harsh physical and electrical environments; the SEL-2411 withstands vibration, electrical surges, fast transients, and extreme temperatures. Compare our superior specification compliance, higher reliability, lower price, and worldwide, ten-year warranty to alternatives.

Flexible Input, Output, and Logic Choices

Choose from digital or analog outputs, and digital, analog, RTD, thermocouple, ac current, and ac voltage inputs. Easily program with powerful logic, math, timer, counter, and edge-trigger functions.

Time-Tagged Sequential Events Recorder (SER)

Store up to 512 SER reports of digital input transitions, time-tagged to the nearest millisecond. Send the SER data to an information processor or computer for system analysis and troubleshooting.

Convenient Customizable Controls

Four programmable pushbuttons are provided on the front panel. Print labels for six front-panel LEDs to show channel activity, device status, critical I/O status, or logic calculation results. Label four pushbuttons and associated LEDs to simplify operator interaction.

Security Protection

Strengthen security through strong password support and multiple-level access control, including maximum access levels and port-enabling logic. Enhance security through SER reports, programmable onboard digital output for alarm contacts, optional external serial encrypting transceivers, and optional external text-to-speech conversion for event notification of problems or alarm conditions.

Flexible Mounting Options

Select from a wide range of mounting option kits to install the programmable automation controller into many mounting surfaces. Versatile options include a wide variety of mounting brackets for rack- or wall-mount, indoor enclosures, and outdoor enclosures. Select the SEL-2411-1 surface-mount option using the SEL-2411 and the surface-mounting bracket where remote control and access to the rear connection only are required.

Versatile Communications and Software

- Independent front and rear EIA-232 ports with 9-pin connectors.
- Optional card adds another EIA-232 port and an EIA-485 port.
- Full-duplex fiber-optic serial port option.
- Single- or dual-port Ethernet option with Modbus® TCP, DNP3 LAN/WAN, or IEC 61850.
- SEL Fast Messages for information processor compatibility.
- SEL Mirrored Bits® communications.
- Modbus RTU Binary serial.
- DNP3 Level 2 Outstation for SCADA communications.
- Supported by acSELerator QuickSet® SEL-5030, acSELerator QuickSet Designer® SEL-5031, and acSELerator Architect® SEL-5032 Software.

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Substation- and Plant-Grade Equipment

Designed, built, and tested with the same practices, processes, and standards that we use for our protective relays, information processors, and other products. This includes compliance with IEEE and IEC standards for electrostatic discharge, fast transients, radiated emissions, surge-withstand capability, dielectric strength, pulsed magnetic fields, and disturbances. Specifications and tests are per the IEEE C37.90-1989 and IEC 60255 protective relay standards and the IEEE 1613-2003 standard for communications and networking devices.

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SEL-2411 Programmable Automation Controller

Applications

- Automatically control or acquire data using high-speed, deterministic logic with a very reliable device, instead of with lower-reliability, slower PLCs.
- Sense up to eight pressures, temperatures, fluid levels, or other process values with each analog input card. Report these values to SCADA or distributed control systems, and use them in local automatic control equations.
- Apply in a system with SEL information processors, intelligent servers, relays, and other devices, instead of an RTU. An RTU provides only remote I/O for SCADA; therefore, you do not benefit from the other functions available through an SEL information processor-based system—protection settings management, power system report management, high-speed local logic, direct engineering access, and more.
- Interact with four front-panel pushbuttons and LED indicators. Use pushbuttons as inputs to logic to perform control, block, or initiate other actions.
- Accurately measure ac current and voltage, and calculate three-phase watts, VARs, watt-hours, VAR-hours, demand, and minimum/maximum for reporting or use in control logic. Single chassis supports up to seven current and three voltage inputs.

SELECT™ I/O Cards

Card Description	SELECT I/O Card Designation	Maximum Cards Per SEL-2411
8 Analog Inputs	8 AI	4
4 Analog Inputs/4 Analog Outputs	4 AI/4 AO	1
8 Digital Inputs	8 DI	4
8 Digital Outputs	8 DO	4
4 Digital Inputs/4 Digital Outputs	4 DI/4 DO	4
4 Digital Inputs/3 Digital Outputs (2 Form C and 1 Form B)	4 DI/3 DO	4
10 RTD/Thermocouple Inputs	10 RTD/TC	1
4 AC Current Inputs	4 ACI	1
3-Phase AC Voltage Input	3 AVI	1
3 AC Current/3-Phase AC Voltage Input	3 ACI/3 AVI	1
EIA-232 or EIA-485 Port	EIA-232/485	1

Note: Unless otherwise specified, all digital outputs are Form A. Base unit comes standard with 2 digital inputs and 3 digital outputs (electromechanical).

Related Products

SEL Category 5e Ethernet Cables 479
SEL Fiber-Optic Transceivers 432–439
SEL-C807 Multimode 62.5 µm Core Fiber-Optic Cables 472
SEL-2600 RTD Module 296
SEL-2725 Five-Port Ethernet Switch 372
SEL-3010 Event Messenger 384
SEL-3354 Embedded Automation Computing Platform 422
SEL-3530/3530-4 Real-Time Automation Controllers (RTACs) 338
SEL-4388 MIRRORED BITS Tester 462

Optional Features

- Single- or dual-port Ethernet, 10/100BASE-T wired or 100BASE-FX fiber optic.
- Fiber-optic serial port (62.5 µm core fiber, SEL-2812 compatible).
- DNP3 and DNP3 LAN/WAN protocols.
- IEC 61850.
- Conformal coating.

Hardware Specifications

Power Supply

Option	Range
24–48 Vdc	18–60 Vdc
110–250 Vdc, 110–240 Vac	85–264 Vac, 85–275 Vdc

Power Consumption

<40 VA (ac)
<15 W (dc)

Serial Communications Ports

Two EIA-232 ports, DB-9 connectors

Data rate (bps)	300 to 38400
Optional fiber-optic serial port	62.5 µm fiber, ST® connectors Eye-safe, Class 1 LED product per EN 60825-1

Operating Temperature

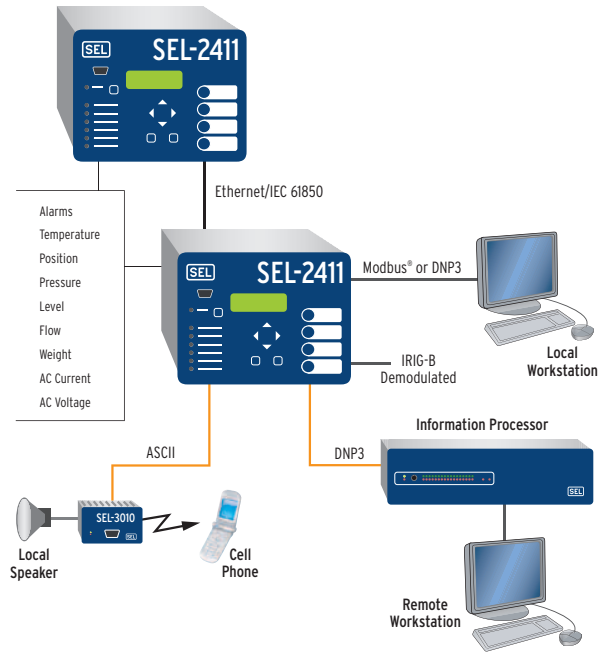
IEC performance rating of −40° to +85°C (−40° to +185°F)
Class I, Zone 2: −40° to +70°C (−40° to +158°F)

Class I Zone 2 Hazardous Location APPROVED

Price

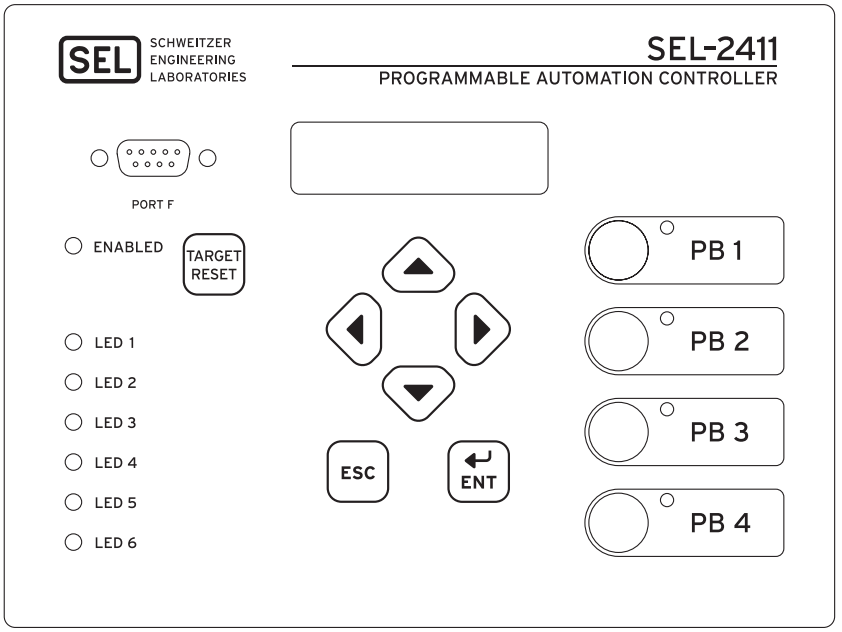
Budgetary Retail, Quantity 1: $950

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)



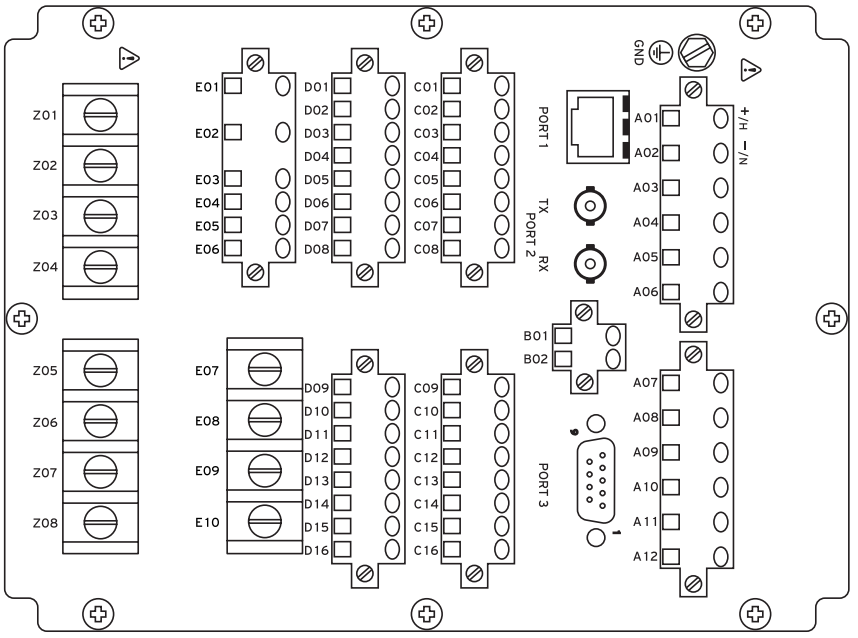
SEL-2411 Programmable Automation Controller

Front View – Panel-Mount



i3889c

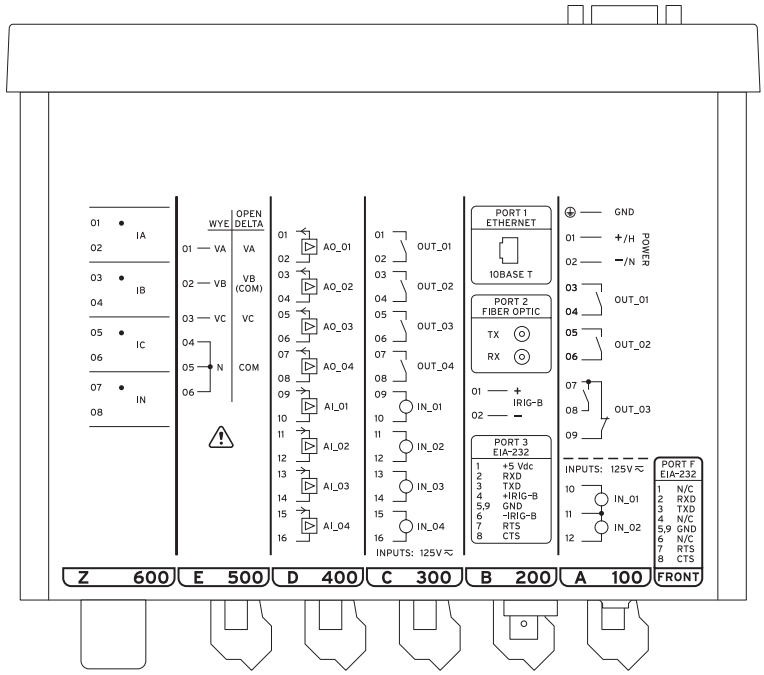
Rear View



i4174a

SEL-2411 Programmable Automation Controller

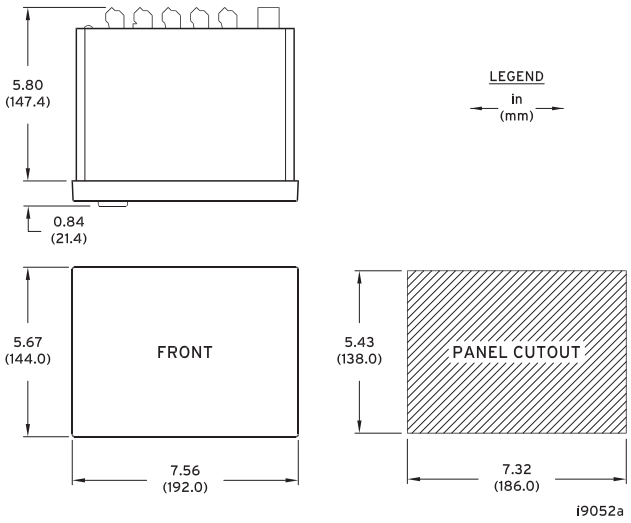
Top View



i3900a

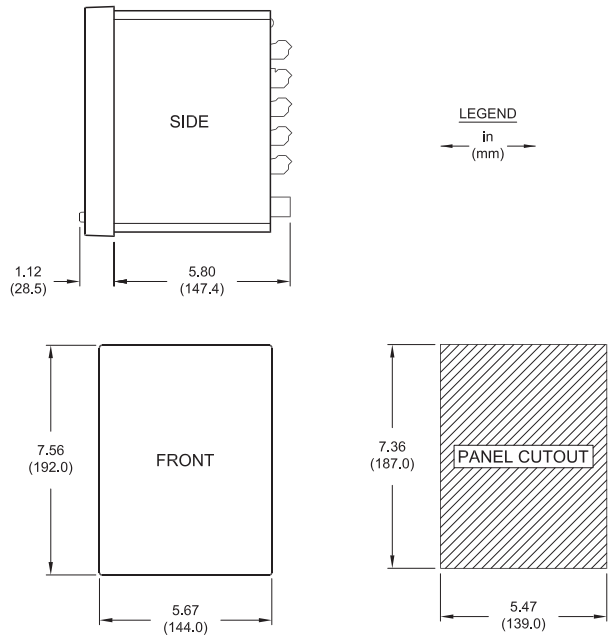
Dimensions

HORIZONTAL CHASSIS



i9052a

VERTICAL CHASSIS



i9089b

Visit www.selinc.com for more detailed information and configuration options.

SEL-2440 DPAC
Discrete Programmable Automation Controller

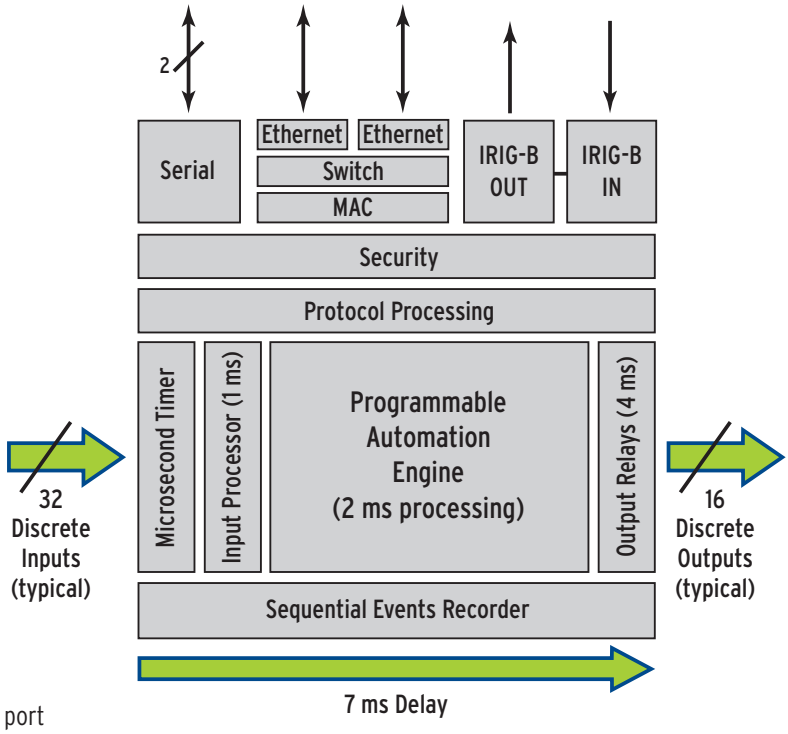
SEL-2440 rack- and DIN rail-mount chassis options.

- *Utility-grade I/O*
- *Powerful processing*
- *Flexible communications*
- *Microsecond timing*

SEL IEC 61850

- **$960 for 48 Points = $20 Per Point!**
- **Distributed I/O Right Out of the Box**
  - Preprogrammed register maps
  - Select protocol and address via switches behind front panel
- **Fast and Powerful**
  - 2 ms processing interval
  - 7 ms from input to output: auxiliary relay speed
  - Events timed to the microsecond
- **A Great Communicator and Interpreter**

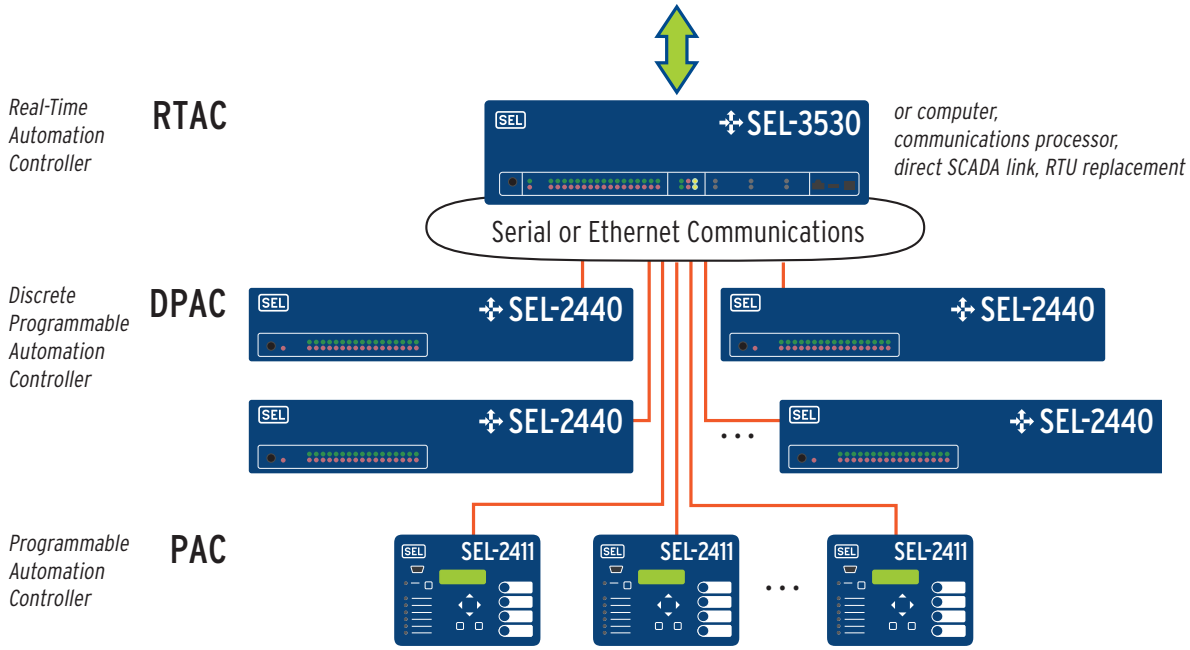
	Serial	Ethernet
DNP3	✔	✔
Modbus®	✔	✔
Mirrored Bits®	✔	
SEL Fast Message	✔	
IEC 61850		✔



- **Convenient Maintenance and Support**
  - Removable terminal blocks with positive retention
  - Continuous self-monitoring diagnostics
  - LEDs for system status, every I/O point, and communications port
  - Front-panel management port
  - Flexible mounting options include rack, panel, surface, and DIN rail
- **SEL Quality, Standards, and Global Support**
  - 2000 Vac/2500 Vdc HiPot
  - 8 kV contact/15 kV air ESD tested
  - IEEE C37.90-1989
  - ANSI/IEEE 1613-2003 standard
  - IEC 60255 protective relay standards

SEL-2440 DPAC
Discrete Programmable Automation Controller

Distributed I/O expandable to 1,000s of points



Applications

- Distributed I/O
- I/O expansion
- Remote terminal unit
- Programmable logic controller
- Microsecond Sequential Events Recorder
- Auxiliary relay and contact multiplier
- Controller for breakers, switches, security, and industrial processes

Related Products

SEL-2032 Communications Processor 348
SEL-2411 Programmable Automation Controller 388
SEL-2505 Remote I/O Module 396
SEL-2725 Five-Port Ethernet Switch 372
SEL-3010 Event Messenger 384
SEL-3354 Embedded Automation Computing Platform 422
SEL-3530/3530-4 Real-Time Automation Controllers (RTACs) 338

Price

Budgetary Base Price: $960 ($20 per point)
(Subject to change)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Hardware Specifications

Communications Ports

Ethernet: Dual Ethernet ports with integrated switch:
10/100BASE-T with RJ-45 connectors standard or
100BASE-FX with LC connector*

Serial

	Port 2	Port 3
Standard	EIA-232	EIA-232
Option 1	EIA-485	EIA-232
Option 2*	V-pin, 200 µm multimode (SEL-2810 compatible)	EIA-232
Option 3*	ST®, 62.5 µm multimode (SEL-2812 compatible)	EIA-232

USB: Management port

IRIG-B: Demodulated, input and output, BNC connectors

I/O Configurations	Inputs	Outputs
Standard Configuration	32	16
Option 1	16	32
Option 2	48	0
Option 3* (high-current interrupting outputs)	32	16

Universal Power Supply

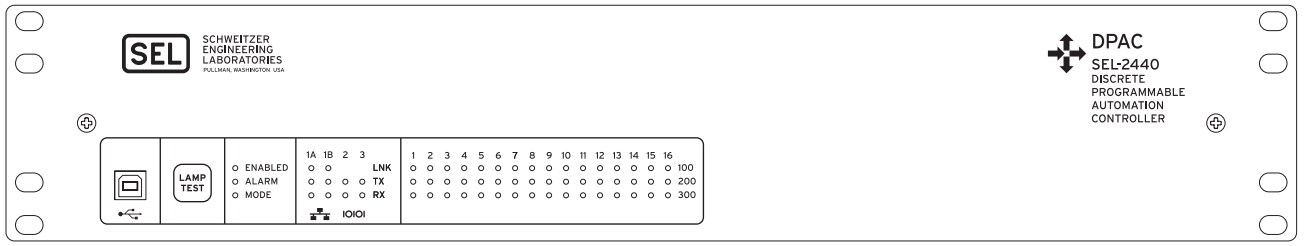
Ratings
120/230 Vac: 24/48/125/220/250 Vdc
Range: 19.2–275 Vdc

Operating Temperature –40° to +85°C (–40° to +185°F)

* Additional Cost

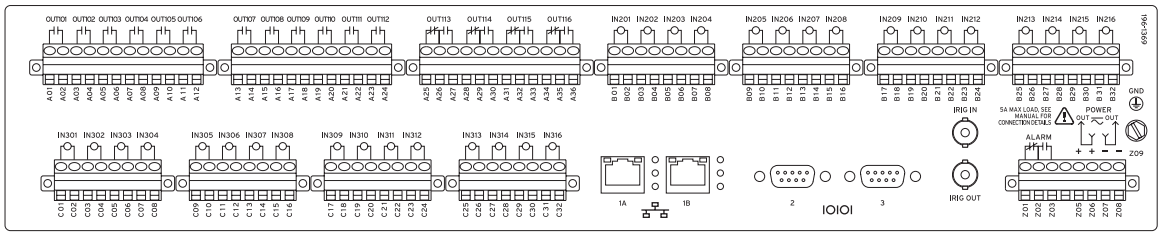
SEL-2440 DPAC
Discrete Programmable Automation Controller

Front View – Rack-Mount



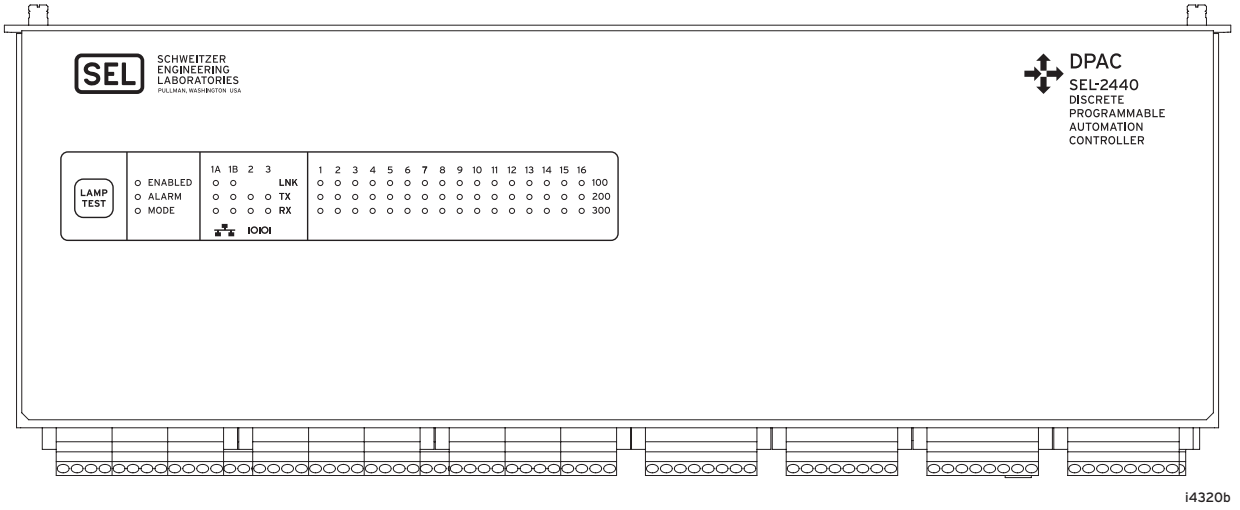
i4313b

Rear View



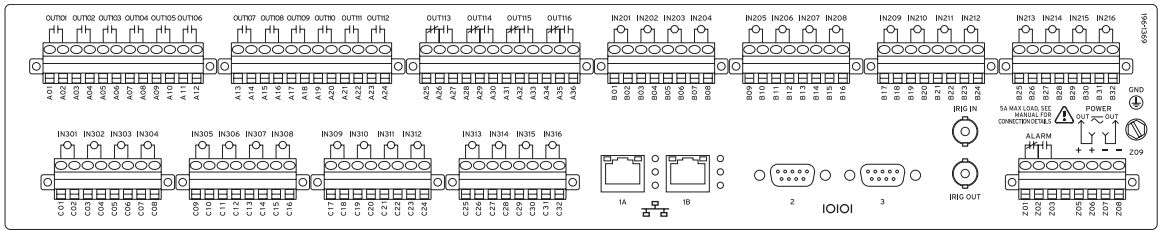
i4305e

Front View – DIN Rail-Mount



i4320b

Bottom View – DIN Rail-Mount

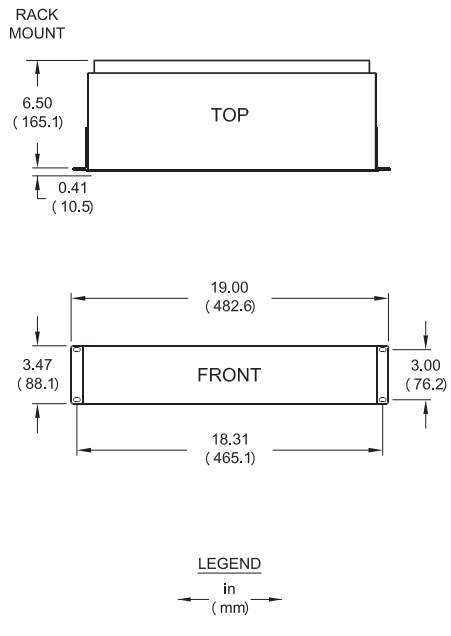


i4305e

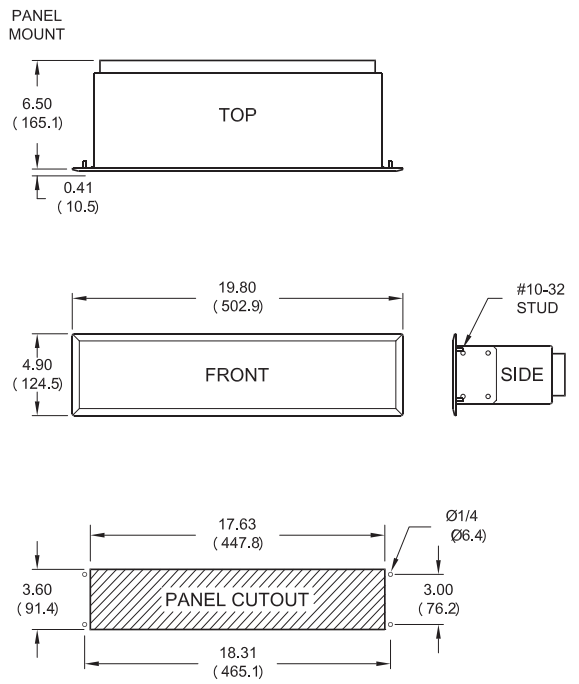
SEL-2440 DPAC
Discrete Programmable Automation Controller

Dimensions

RACK-MOUNT CHASSIS



PANEL-MOUNT CHASSIS



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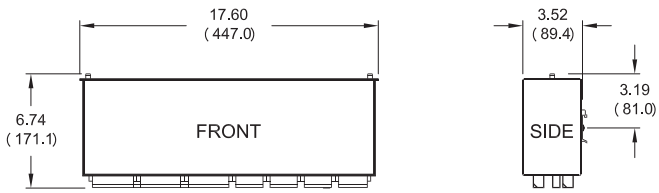
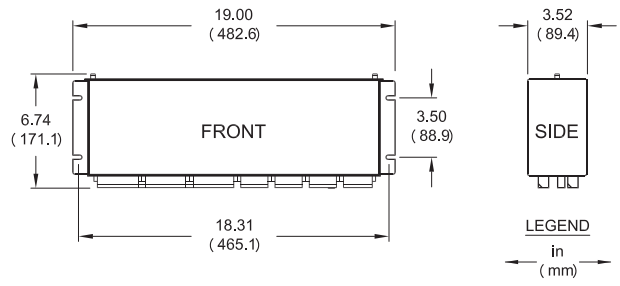
DIN RAIL-MOUNT CHASSIS



SURFACE-MOUNT CHASSIS



i9181a

Visit www.selinc.com for more detailed information and configuration options.

SEL-2505 Remote I/O Module

Reduce operating time, add self-testing, and simplify wiring for auxiliary inputs and outputs.

Key Features

Inputs/Outputs to Mirrored Bits® Communications

Directly convert device inputs/outputs to Mirrored Bits communications.

Visible Device Status

Monitor channel activity, alarm status, channel integrity, and loop-back detection mode with 22 status LEDs for immediate, visual feedback of product activity and status.

Flexible Communications

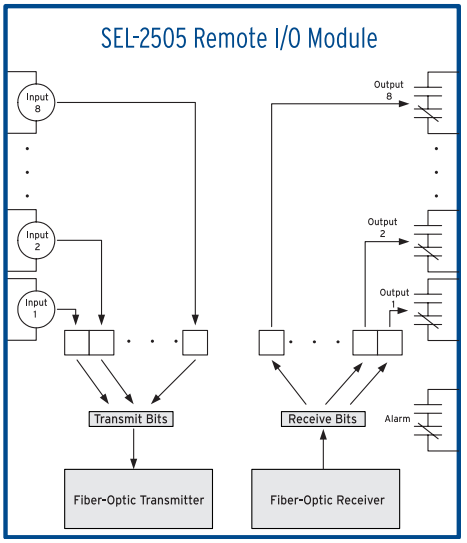
Choose either a V-pin or ST® connector configuration for a wide variety of fiber connection options, or use EIA-232 to add I/O to devices in the same cabinet.

Simple Settings

Configure security and communications rate on a single control (DIP) switch for easy operation.

High Reliability and Tough Design

Built to the same high standards as SEL protective relays, the SEL-2505 withstands vibration, electrical surges, fast transients, and extreme temperatures, meeting stringent industry standards. Conformal-coated printed circuit boards provide an additional barrier to airborne contaminants, such as hydrogen sulfide, chlorine, salt, and moisture.



Improve signal integrity, safety, and reliability, and lower costs by using two small optical fibers instead of 64 large-diameter copper wires. Photographs are from Kilometre 20 Substation, showing wires replaced by fiber-optic cables.

SEL-2505 Remote I/O Module

Applications

- Inexpensively extend contact I/O on SEL relays that are Mirrored Bits communications compatible.
- Add Mirrored Bits communications to any protective relay (digital or electromechanical) or other IED.
- Add I/O to an SEL-300 series relay through its eight-position EIA-485 port, using an SEL-9220 Fiber-Optic Adapter for SEL-300 series relays.
- Connect two SEL-2505 Modules together to share digital contact I/O information between any two IEDs.
- Monitor data channel integrity to increase reliability.
- Create simple bus protection using existing line relay contact I/O and the SEL-2505.
- Create simple pilot communications systems.
- Reduce or eliminate ground potential rise between IEDs with fiber-optic links.

Related Products

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Hardware Specifications

Power Supply Ratings

12/24 V	9–36 Vdc, 6.2 W
48/125 V	36–200 Vdc, 5 W
	85–140 Vac (50/60 Hz), 5 VA
125/250 V	85–264 Vac, 5 W
	85–350 Vdc, 5 VA

Standard Control Input and Output Ranges

24, 48, 110, 125, 220, or 250 Vdc
Provides 8 inputs and 8 outputs

Operating Temperature

–40° to +85°C (–40° to +185°F)

Communications Port Options

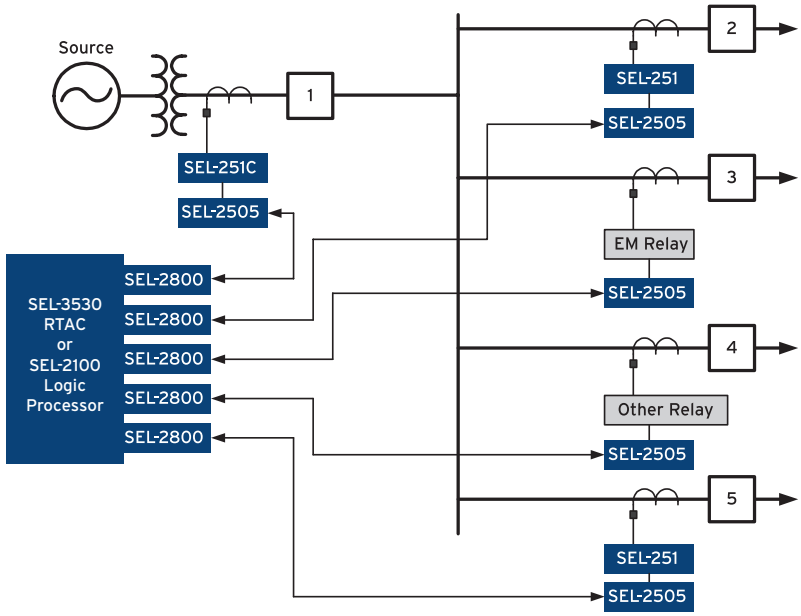
Connector	Optical Fiber or Wire	Compatible Transceiver	Maximum Recommended Distance (km)
V-pin	200 µm multimode[1]	SEL-2800	0.5
ST	50, 62.5, or 200 µm multimode[1]	SEL-2812, -2814, or -9220	4
ST	50, 62.5, or 200 µm multimode[2]	SEL-2815	15
ST	9, 10 µm single-mode[2]	SEL-2830	80
9-pin D	Copper wire	EIA-232	0.015

[1] Class 1 LED product complies with 21 CFR 1040.10 and EN 60825-1.
[2] Class 1 laser product complies with 21 CFR 1040.10 and EN 60825-1.

Price

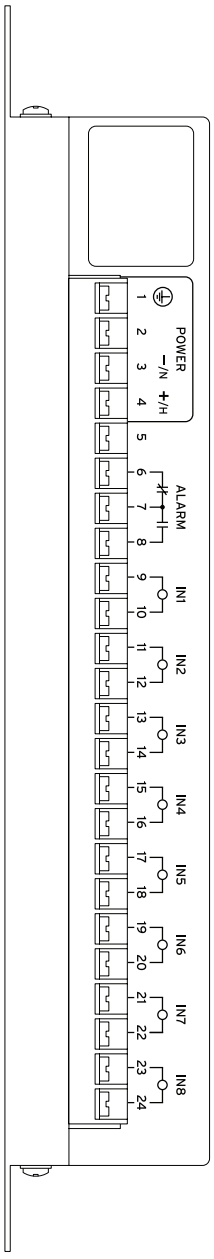
Budgetary Retail, Quantity 1: $525

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)



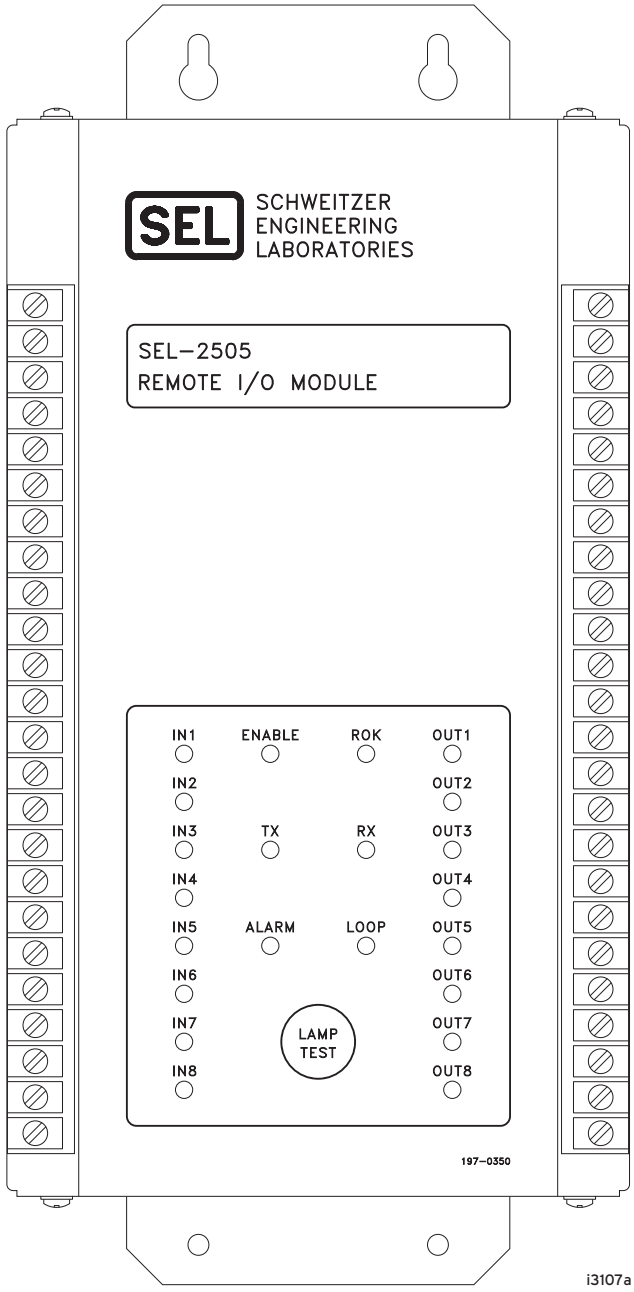
SEL-2505 Remote I/O Module

Side View



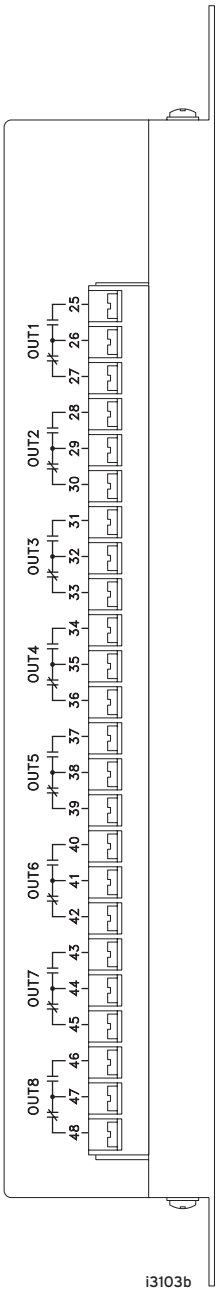
i3104d

Front View



i3107a

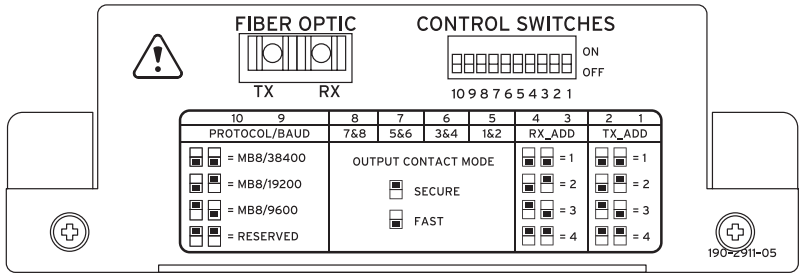
Side View



i3103b

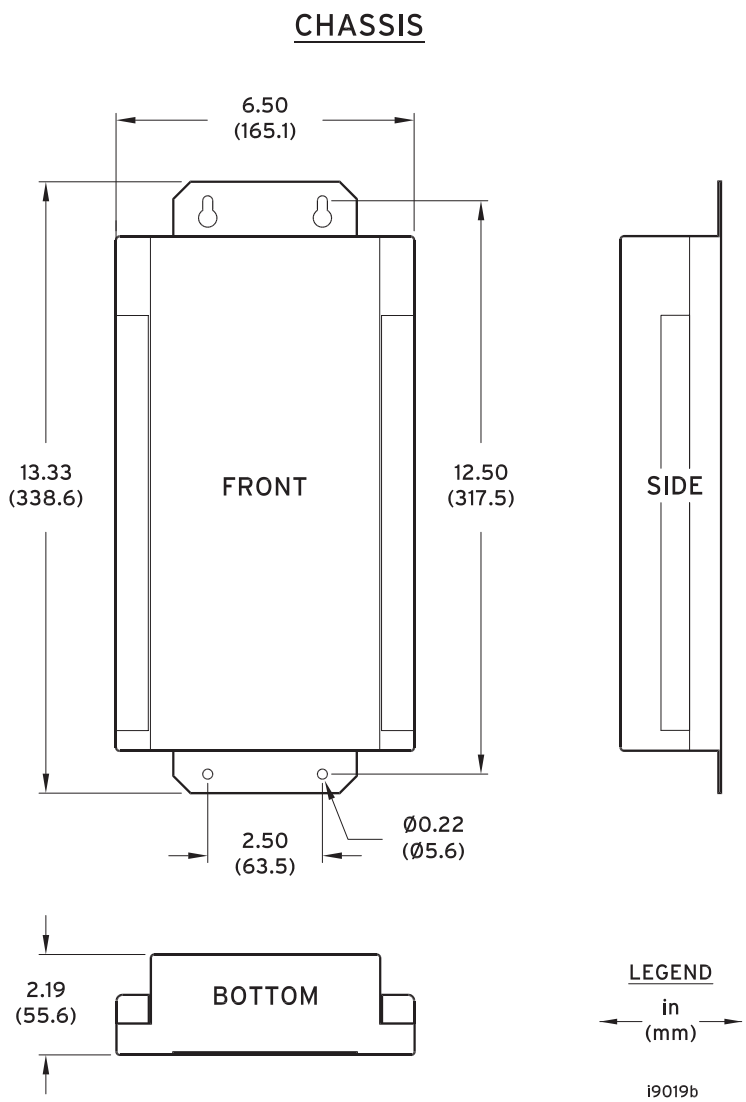
SEL-2505 Remote I/O Module

Bottom View



i3105b

Dimensions



i9019b

Visit www.selinc.com for more detailed information and configuration options.

SEL-2506 Rack-Mount Remote I/O Module

Add simple pilot communications, or provide annunciation of remote contacts.

Key Features

Inputs/Outputs to Mirrored Bits® Communications

Convert device inputs/outputs directly to Mirrored Bits communications.

Visible Device Status

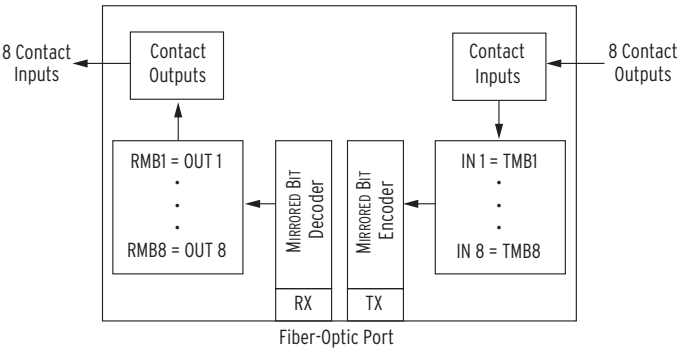
Monitor channel activity, alarm status, and channel integrity with 22 status LEDs. User-configurable labels allow clear indication of system status.

Connectorized® Terminal Blocks

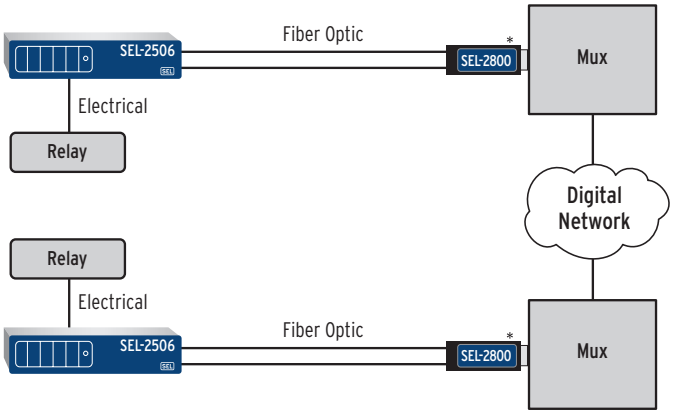
Connect standard ring terminals to convenient, patented Screw-Terminal Connectorized blocks.

Simple Settings

Configure security and communications rate on a single control (DIP) switch for easy operation.



TMBn = Transmit Mirrored Bit n, RMBn = Receive Mirrored Bit n



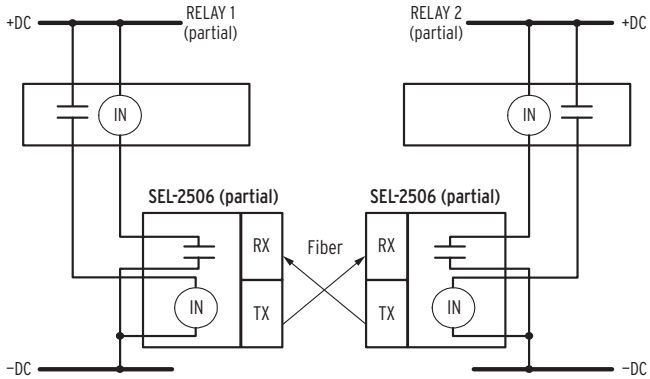
* Interfaces to SEL-2800, SEL-2815, SEL-2829, SEL-2830, and SEL-2831 Fiber-Optic Transceivers.

Provide communications-assisted tripping over existing digital communications networks.

SEL-2506 Rack-Mount Remote I/O Module

Applications

- Inexpensively extend contact I/O on SEL relays that are Mirrored Bits communications compatible.
- Add Mirrored Bits communications to any protective relay (digital or electromechanical) or other IED.
- Add I/O to an SEL-300 series relay through its eight-position EIA-485 port, using an SEL-9220 Fiber-Optic Adapter for SEL-300 series relays.
- Connect two SEL-2506 Modules together to share digital contact I/O information between any two IEDs.
- Monitor data channel integrity to increase reliability.
- Annunciate status of remote contacts.
- Create simple pilot communications systems.
- Reduce or eliminate ground potential rise between IEDs with the fiber-optic link.



Channel interface I/O for relays without native Mirrored Bits® protocol.

Hardware Specifications

Power Supply Ratings

48/125 V 36–200 Vdc
85–140 Vac (50/60 Hz)
125/250 V 85–264 Vac
85–350 Vdc
5 W/5 VA maximum for all supplies

Standard Control Input and Output Ranges

24, 48, 110, 125, 220, or 250 Vdc
Provides 8 inputs and 8 outputs

Operating Temperature

–40° to +85°C (–40° to +185°F)

Operate Time

End-to-End Operating Times	Operate Time	
Data Rate (bps)	Standard DO	High-Speed DO
38400	10 ms	4 ms
19200	12 ms	6 ms
9600	18 ms	12 ms

Communications Port Options

Connector	Optical Fiber	Compatibility	Maximum Recommended Distance (km)	Eye-Safe, Class 1 Product Per EN 60825-1
V-pin	200 µm multimode	SEL-2800	.5	LED
ST®	50, 62.5, or 200 µm multimode	SEL-2815	15	Laser
ST	9, 10 µm single-mode	SEL-2829	23	LED
ST	9, 10 µm single-mode	SEL-2830	80	Laser
ST	9, 10 µm single-mode	SEL-2831	110	Laser
9-pin D	Copper wire*	EIA-232	0.015	NA

* Wire recommended only within same cabinet

Related Products

Price

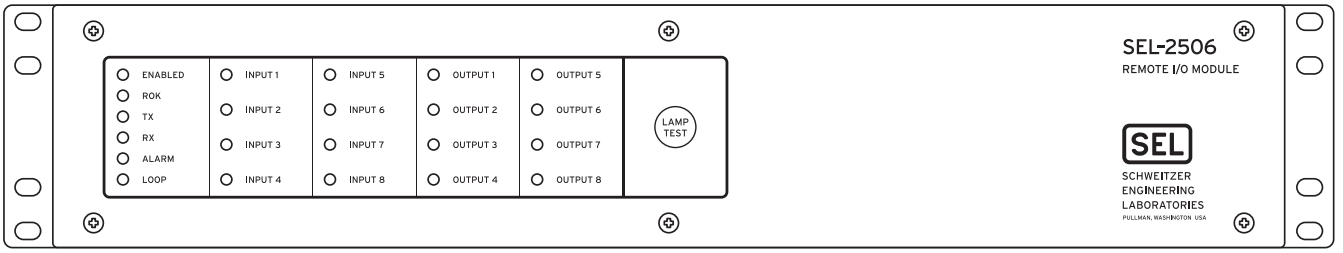
Budgetary Retail, Quantity 1: $990

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N
This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

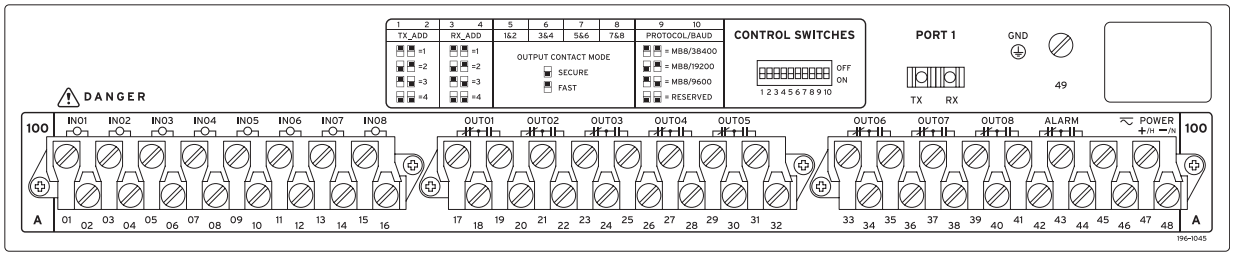
SEL-2506 Rack-Mount Remote I/O Module

Front View – Rack-Mount



i3617a

Rear View



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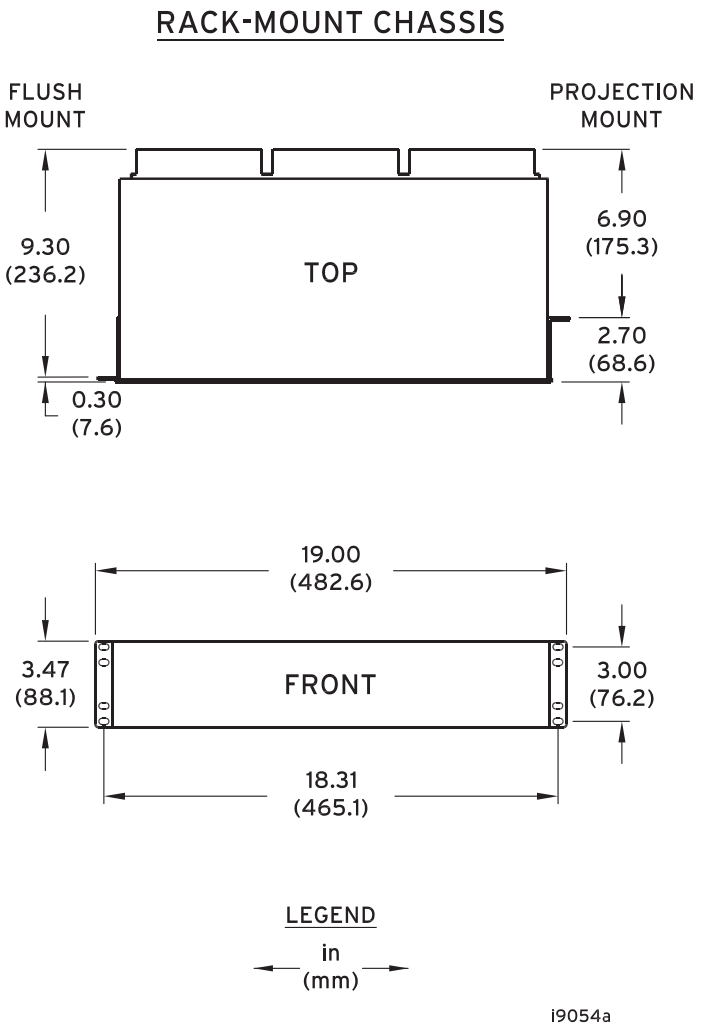
SEL-2506 Rack-Mount Remote I/O Module

Dimensions



Visit www.selinc.com for more detailed information and configuration options.

SEL-2515 Remote I/O Module

Remote I/O for SCADA and station integration.

Key Features

Additional Monitoring and Control

Eight digital inputs monitor the status of external contacts transmitted via SEL Fast Meter messages to an information processor. Control eight contact outputs using SEL Fast Operate commands.

Improved Safety

Eliminate exposure to ground potential rise and other dangerous voltages that can be present in a substation yard by using fiber-optic cable instead of control wiring to outside apparatus.

Easy Application

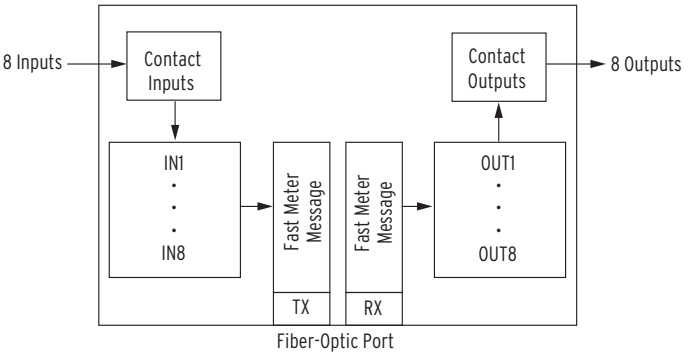
LEDs indicate the position of each contact output and the status of each sensed input. An "ENABLE" LED indicates that the unit is properly functioning. A "LAMP TEST" pushbutton illuminates all of the LEDs. Control (DIP) switches set basic operating parameters.

Dependability

Fiber-optic links reduce or eliminate data errors from electromagnetic interference. The SEL information processor monitors the fiber-optic connection to the SEL-2515 and creates alarms when the fiber-optic cabling is damaged, disturbed, or disconnected.

High Reliability and Tough Design

Built to the same high standards as SEL protective relays, the SEL-2515 withstands vibration, electrical surges, fast transients, and extreme temperatures, meeting stringent industry standards. Conformal-coated printed circuit boards provide an additional barrier to airborne contaminants, such as hydrogen sulfide, chlorine, salt, and moisture.



Improve signal integrity, safety, and reliability, and lower costs by using two small optical fibers instead of 64 large-diameter copper wires. Photographs are from Kilometre 20 Substation, showing wires replaced by fiber-optic cables.

Tel: +1.509.332.1890 | Fax: +1.509.332.7990 | www.selinc.com

SEL-2515 Remote I/O Module

Applications

- Inexpensively extend contact I/O on SEL information processors.
- Reduce wiring and improve safety. Locate each SEL-2515 close to a status panel, breaker, or other device with contact outputs to monitor as well as provide inputs to control. Use a fiber-optic link to an SEL information processor.
- Use in a system with SEL information processors, relays, and other devices to provide RTU functions, remote event report collection, engineering access, local logic, and more for lower cost and much higher reliability.

Related Products

SEL Fiber-Optic Transceivers 432–439
SEL Terminated Fiber-Optic Cables 470–476
SEL-2516 Rack-Mount Remote I/O Module 408
SEL-3530/3530-4 Real-Time Automation Controllers (RTACs) 338

Price

Budgetary Retail, Quantity 1: $525

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Hardware Specifications

Power Supply Ratings

24 V	16–36 Vdc
48/125 V	36–200 Vdc
	85–140 Vac (50/60 Hz)
125/250 V	85–350 Vdc
	85–264 Vac (50/60 Hz)

5 W/5 VA maximum for all supplies

Standard Control Input and Output Ranges

24, 48, 110, 125, 220, or 250 Vdc
Provides 8 inputs and 8 outputs

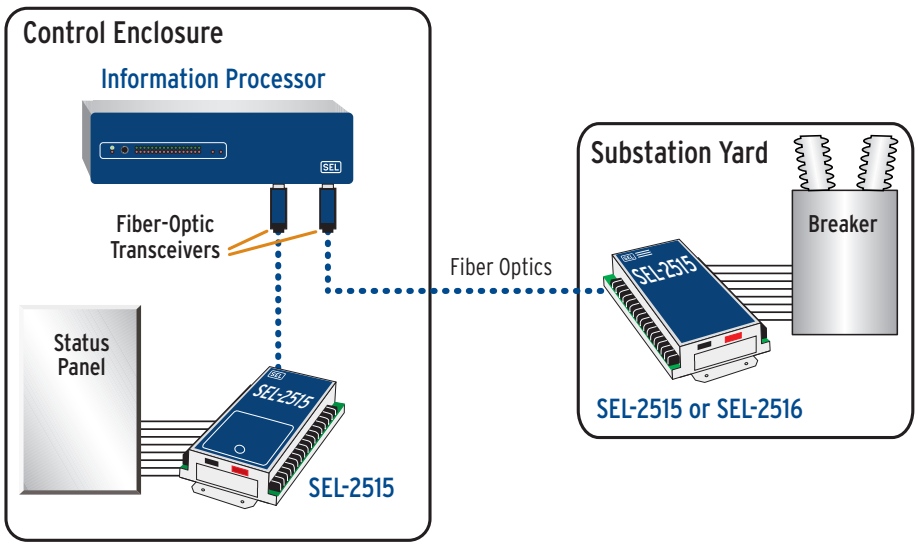
Operating Temperature

–40° to +85°C (–40° to +185°F)

Fiber Options/Compatibility

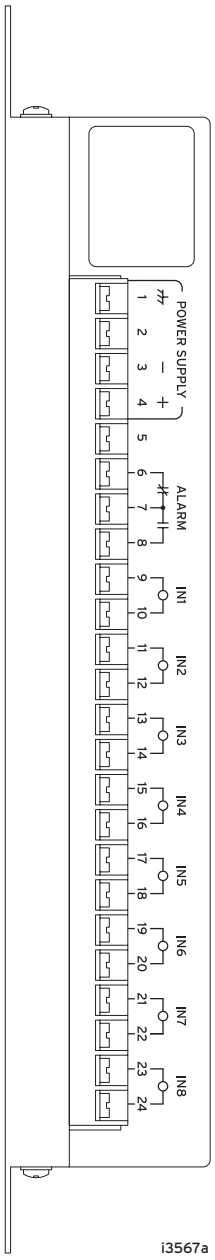
Connector	Optical Fiber	Compatible Transceiver	Maximum Recommended Distance (km)	Eye-Safe, Class 1 Product Per EN 60825-1
V-pin	200 µm multimode	SEL-2800	.5	LED
ST	50, 62.5, or 200 µm multimode	SEL-2812, -2414, -9220	4	LED
ST	50, 62.5, or 200 µm multimode	SEL-2815	15	Laser
ST	9, 10 µm single-mode	SEL-2830	80	Laser

Application Example

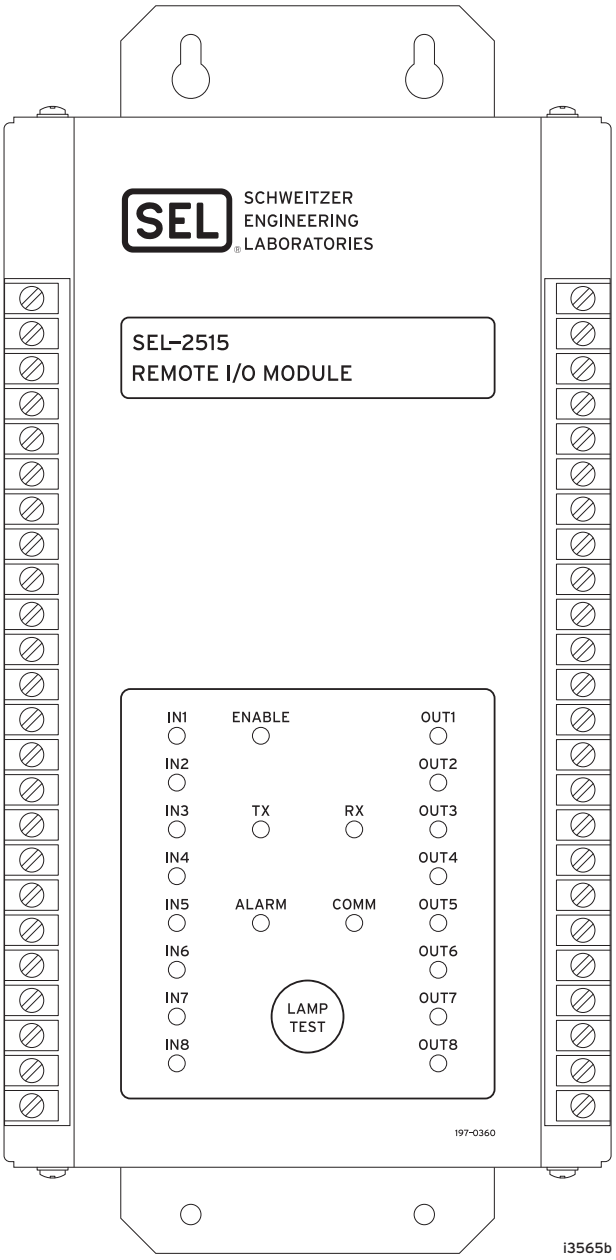


SEL-2515 Remote I/O Module

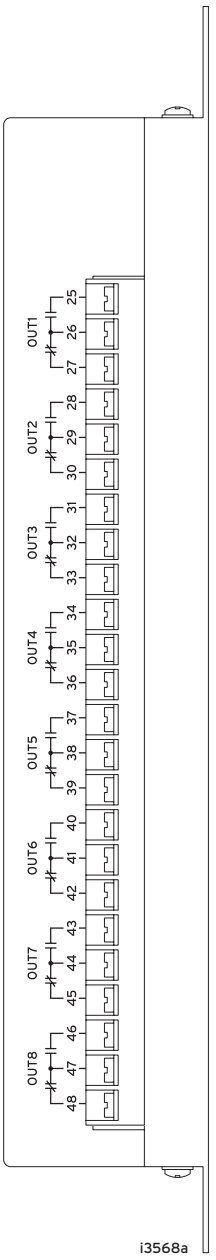
Side View



Front View

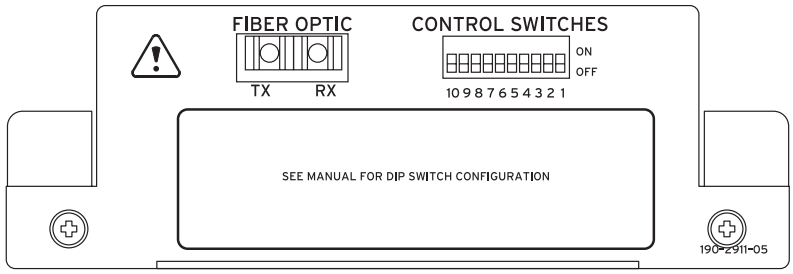


Side View



SEL-2515 Remote I/O Module

Bottom View



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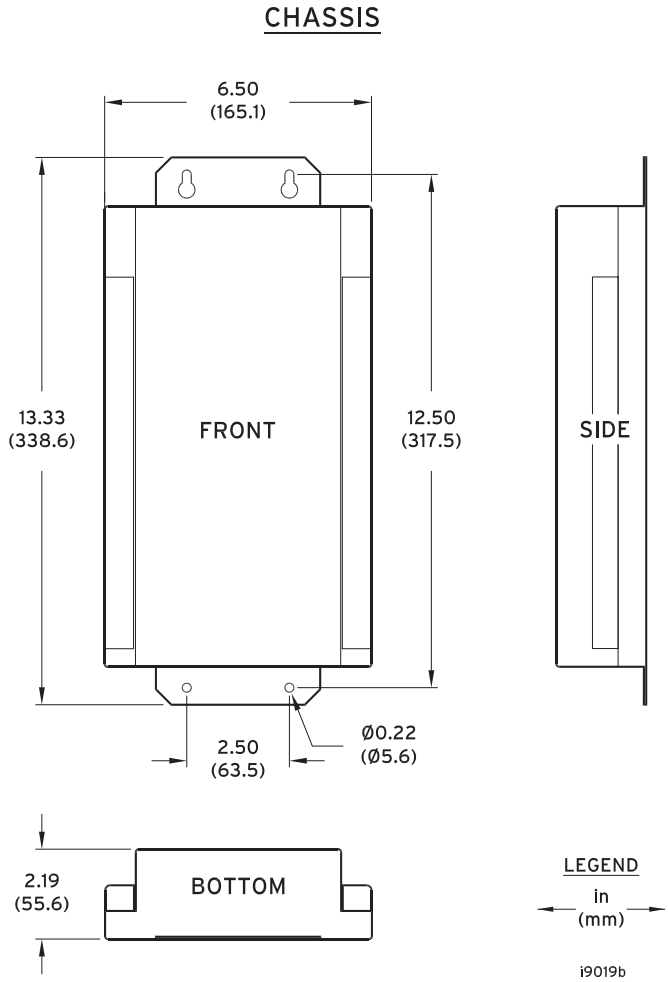
Dimensions



i9019b

Visit www.selinc.com for more detailed information and configuration options.

SEL-2516 Rack-Mount Remote I/O Module

Remote I/O for SCADA and station integration.

Key Features

Additional Monitoring and Control

Eight digital inputs monitor the status of external contacts transmitted via SEL Fast Meter messages to an information processor. Control eight contact outputs using SEL Fast Operate commands.

Improved Safety

Eliminate exposure to ground potential rise and other dangerous voltages that can be present in a substation yard by using fiber-optic cable instead of control wiring to outside apparatus.

Easy Application

LEDs indicate the position of each contact output and the status of each sensed input. An "ENABLE" LED indicates that the unit is properly functioning. A "LAMP TEST" pushbutton illuminates all of the LEDs. Control (DIP) switches set basic operating parameters. User-configurable labels allow clear indication of system status.

Dependability

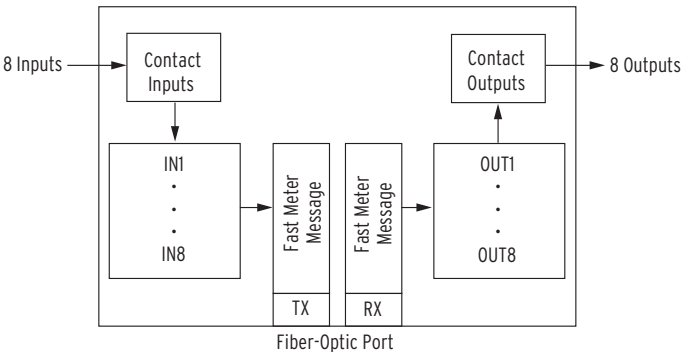
Fiber-optic links reduce or eliminate data errors from electromagnetic interference. The SEL information processor monitors the fiber-optic connection to the SEL-2516 and creates alarms when the fiber-optic cabling is damaged, disturbed, or disconnected.

Connectorized® Terminal Blocks

Connect standard ring terminals to convenient, patented Screw-Terminal Connectorized blocks.

High Reliability and Tough Design

Built to the same high standards as SEL protective relays, the SEL-2516 withstands vibration, electrical surges, fast transients, and extreme temperatures, meeting stringent industry standards.



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SEL-2516 Rack-Mount Remote I/O Module

Applications

- Inexpensively extend contact I/O on SEL information processors.
- Reduce wiring and improve safety. Locate each SEL-2516 close to a status panel, breaker, or other device with contact outputs to monitor as well as provide inputs to control. Use a fiber-optic link to an SEL information processor.
- Use in a system with SEL information processors, relays, and other devices to provide RTU functions, remote event report collection, engineering access, local logic, and more for lower cost and much higher reliability.
- Annunciate status of remote contacts with LEDs and user-configurable labels.

Related Products

Price

Budgetary Retail, Quantity 1: $990

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Hardware Specifications

Power Supply Ratings

48/125 V 36–200 Vdc
85–140 Vac (50/60 Hz)
125/250 V 85–350 Vdc
85–264 Vac (50/60 Hz)
5 W/5 VA maximum for all supplies

Standard Control Input and Output Ranges

24, 48, 110, 125, 220, or 250 Vdc
Provides 8 inputs and 8 outputs

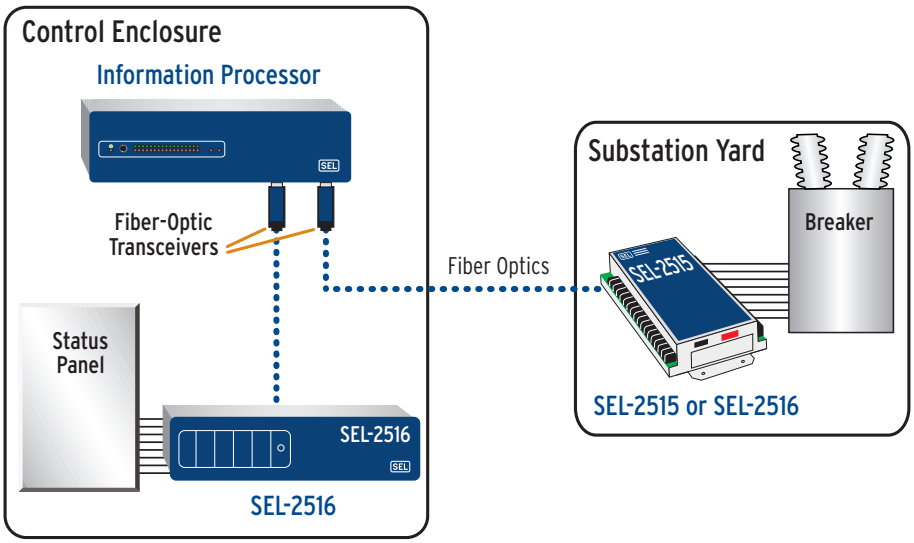
Operating Temperature

–40° to +85°C (–40° to +185°F)

Fiber Options/Compatibility

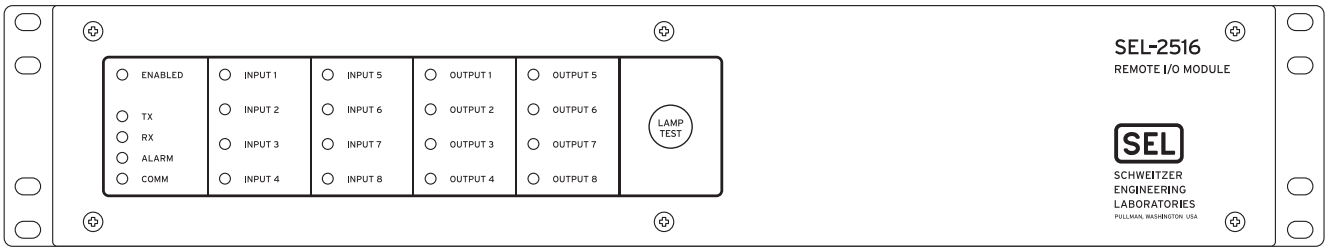
Connector	Optical Fiber	Compatible Transceiver	Maximum Recommended Distance (km)	Eye-Safe, Class 1 Product Per EN 60825-1
V-pin	200 µm multimode	SEL-2800	.5	LED
ST	50, 62.5, or 200 µm multimode	SEL-2815	15	Laser
ST	9, 10 µm single-mode	SEL-2829	23	LED
ST	9, 10 µm single-mode	SEL-2830	80	Laser

Application Example



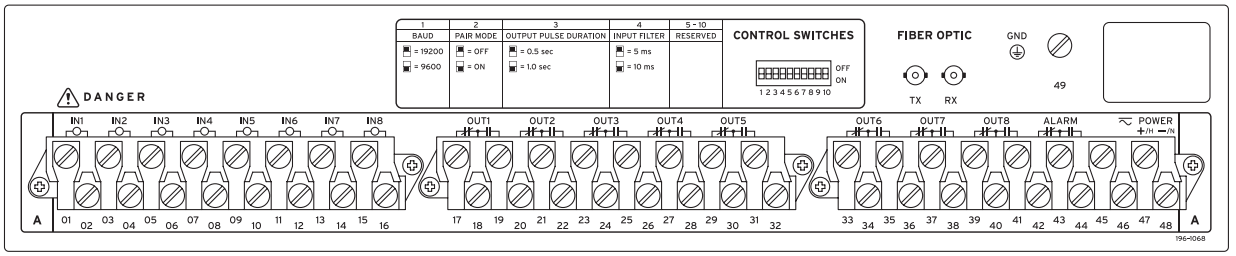
SEL-2516 Rack-Mount Remote I/O Module

Front View – Rack-Mount



i3769a

Rear View



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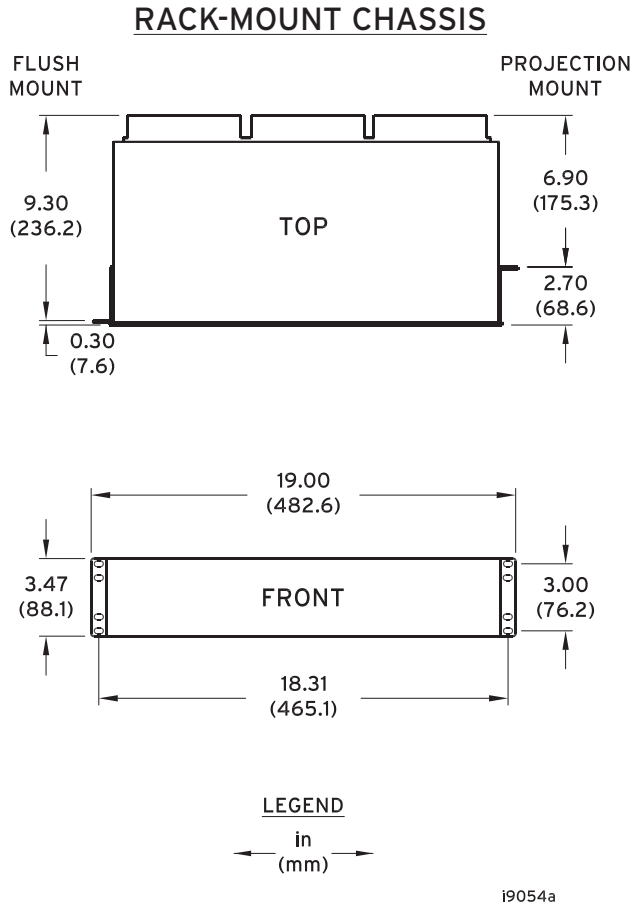
SEL-2516 Rack-Mount Remote I/O Module

Dimensions



Visit www.selinc.com for more detailed information and configuration options.

SEL-2594 Contact Transfer Module

Securely transfer contacts through high-speed IEEE C37.94 optical fiber interface.

Key Features

Use Compliant IEEE C37.94 Standard Fiber-Optic Interface

Complies with IEEE C37.94 standard for optical connection to communications multiplexers.

Apply Easily

All settings are made with control (DIP) switches. LEDs indicate the state of inputs, outputs, and the channel.

Operate at High Speed

Uses one 64 kbps time slot in a digital multiplexer with an end-to-end time of 8 ms.

Improve Security

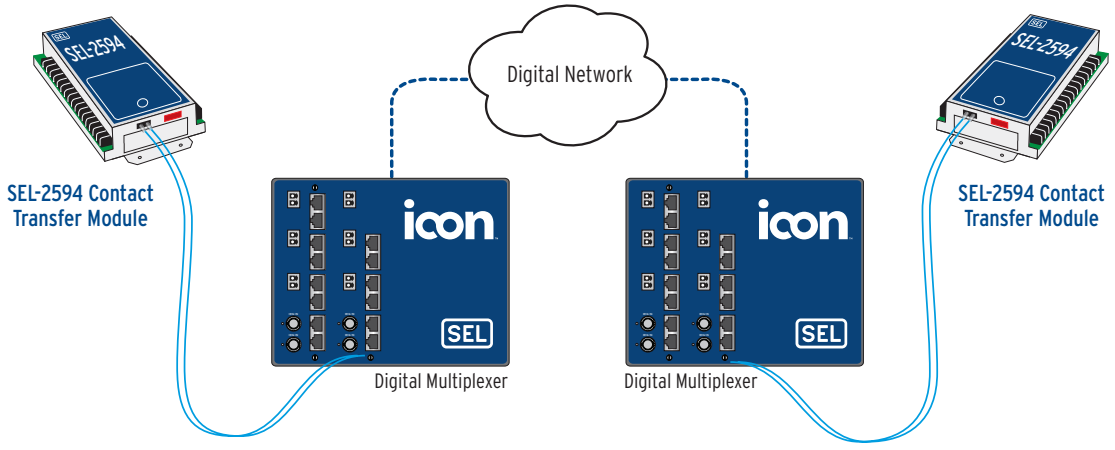
Digital error detection provides better security than audio tone equipment.

Improve Safety and Isolation

Fiber-optic connections provide isolation from dangerous ground potential rise, prevent induced electrical noise, and eliminate signal ground loops. Optoisolated inputs and contact outputs provide isolation for the field connections.

High Reliability and Tough Design

Built to the same high standards as SEL protective relays, the SEL-2594 withstands vibration, electrical surges, fast transients, and extreme temperatures, meeting stringent industry standards. Conformal-coated printed circuit boards provide an additional barrier to airborne contaminants, such as hydrogen sulfide, chlorine, salt, and moisture.



SEL-2594 Contact Transfer Module

Applications

- Use existing station communications paths with IEEE C37.94-compliant inputs to send permissive, blocking, and direct transfer trips between stations.
- Use the SEL-2594 to send transfer trips to and from electro-mechanical relays.
- Provide station alarm contacts to a central location for data acquisition, monitoring, or security systems.
- Transfer contact status or teleprotection signals through a multiplexed digital communications network using the IEEE C37.94 communications standard.
- Connect the SEL-2594 via optical fiber with the SEL-3094 Interface Converter to provide high-speed digital teleprotection through an ITU-T G.703, EIA-422, EIA-485, or EIA-232 electrical interface.
- Connect two SEL-2594 Modules together to share digital contact I/O information between any two IEDs. Use IEEE C37.90-specified multimode optical fiber for up to 2 km or optional single-mode optical fiber for up to 14 km. Or, use an SEL-2594 to communicate with a rack-mounted SEL-2595 Teleprotection Terminal.
- Monitor data channel integrity to increase reliability.
- Create simple, inexpensive pilot communications systems.
- Reduce or eliminate ground potential rise problems between IEDs with the fiber-optic link.

Related Products

SEL ICON™ Integrated Communications Optical Network 358
SEL ST®-Terminated Fiber-Optic Cables 472–476
SEL-2595 Teleprotection Terminal 416
SEL-2894 Interface Converter 441
SEL-3094 Interface Converter 442

Hardware Specifications

Power Supply Ratings

48/125 V 36–200 Vdc
85–140 Vac (50/60 Hz)
125/250 V 85–350 Vdc
85–264 Vac (50/60 Hz)
5 W/5 VA maximum for all supplies

Standard Control Input and Output Ranges

24, 48, 110, 125, 220, or 250 Vdc
Provides 8 inputs and 8 outputs

Operating Temperature

–40° to +85°C (–40° to +185°F)

Fiber-Optic Port Options

Connector	Fiber	Distance	Class 1 Device*	IEEE C37.94
ST	Multimode	≤2 km	Laser	Compliant
ST	Single-Mode	≤14 km	LED	Modulation Only

*Eye-safe, Class 1 product per EN 60825-1

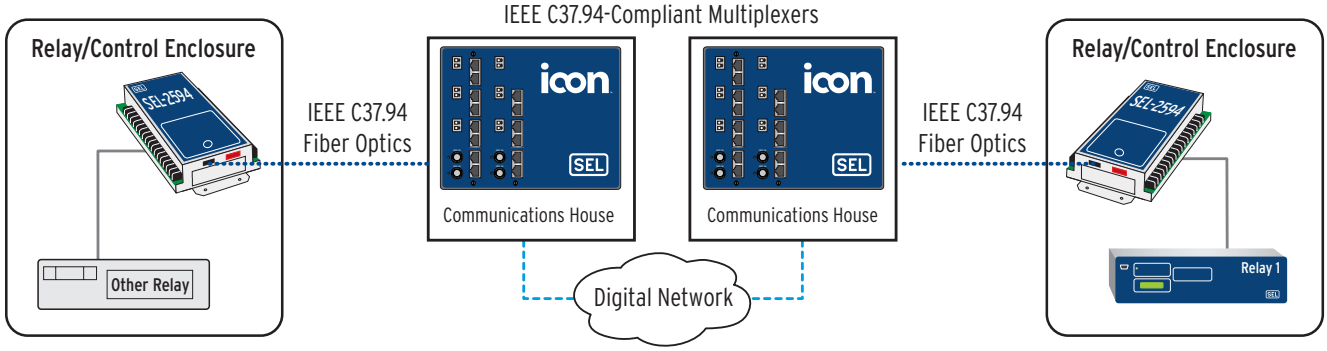
Price

Budgetary Retail, Quantity 1: $1,160

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N
This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

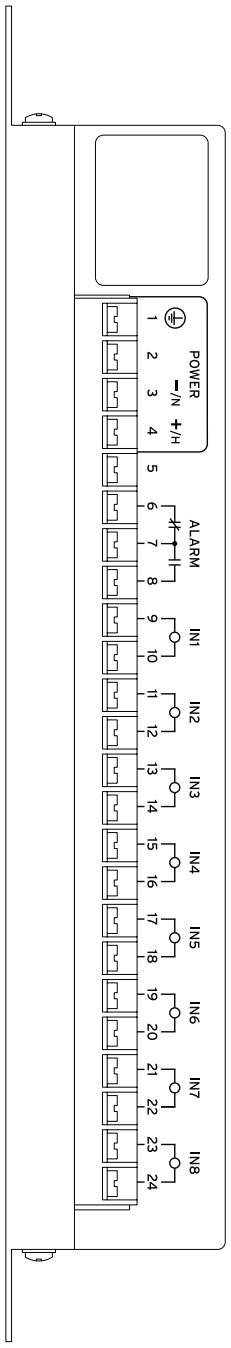
Application Example



Through a fiber-optic port, the SEL-2594 communicates through a multiplexer network using IEEE C37.94 protocol. Each contact input controls one remote output. Each of the eight receive bits controls an output contact. Use the transmitted contact input status for control and indication of the remote device. Use the remote device to control the SEL-2594 output contacts in trip, close, and other schemes.

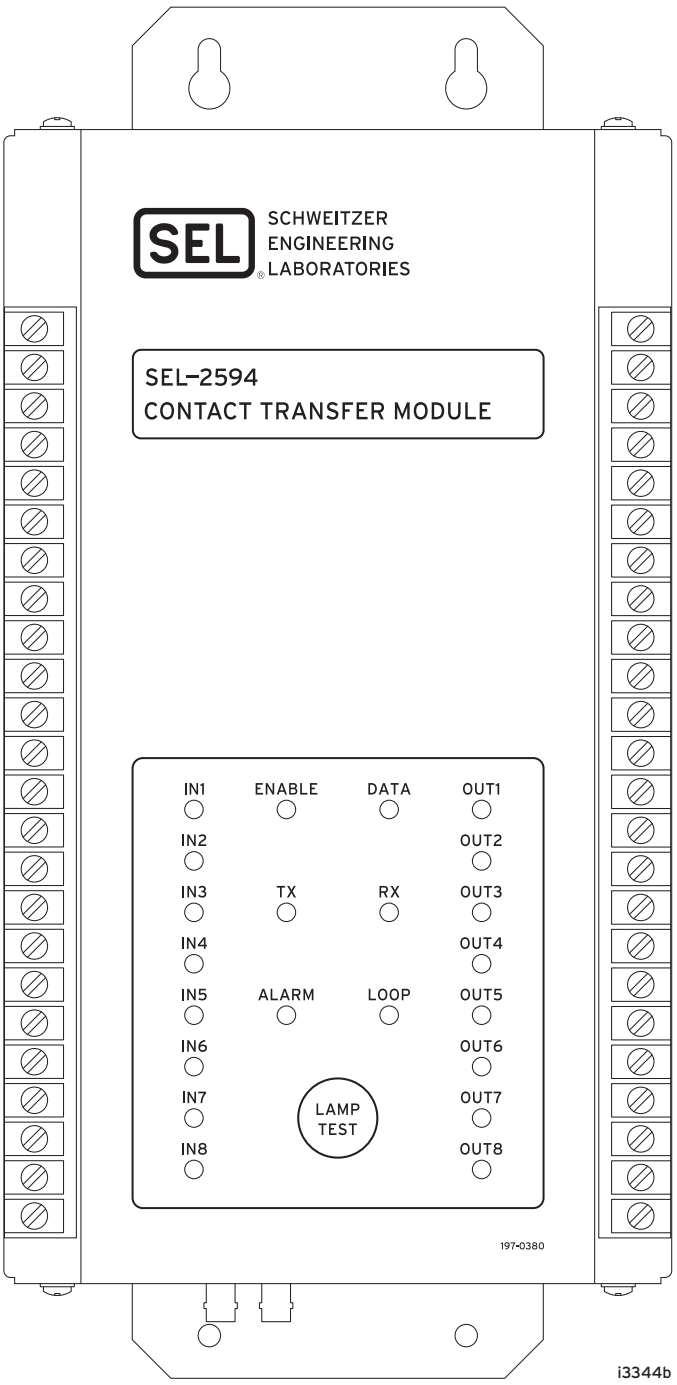
SEL-2594 Contact Transfer Module

Side View



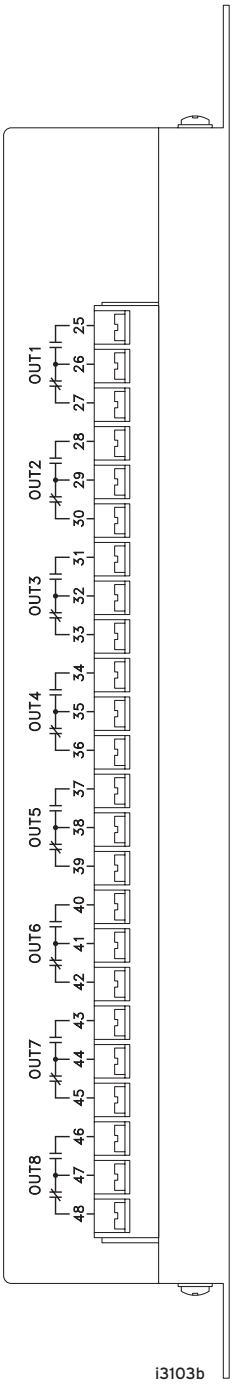
i3104d

Front View



i3344b

Side View



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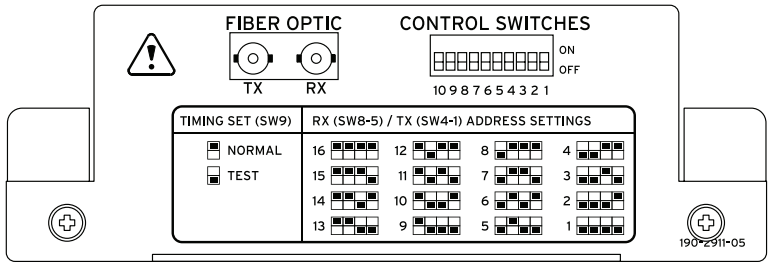
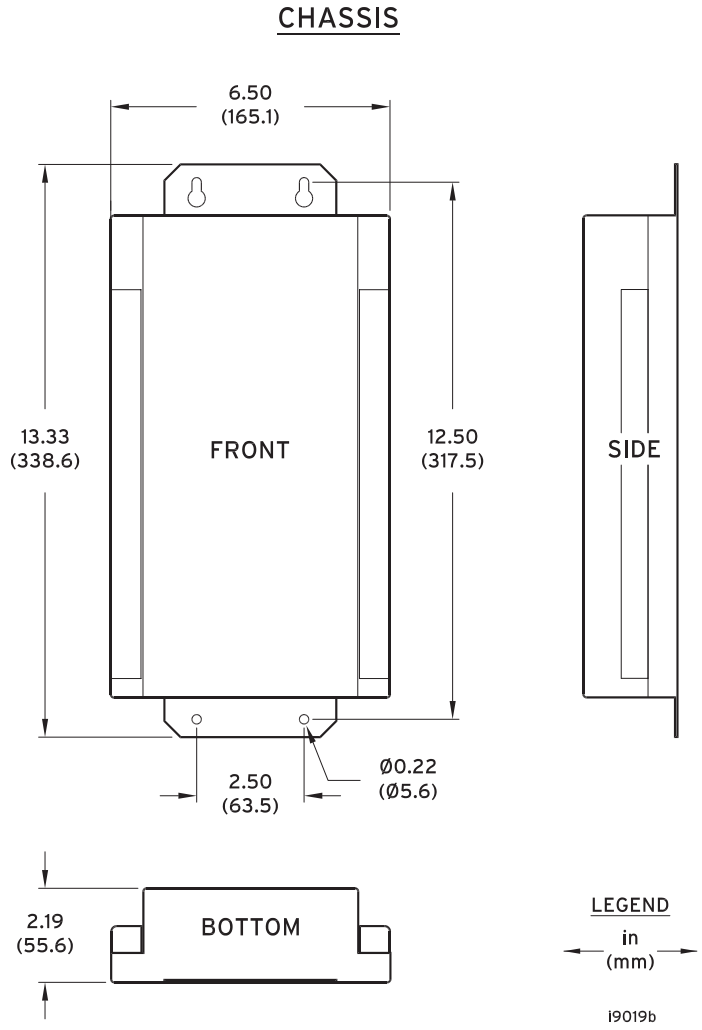
SEL-2594 Contact Transfer Module

Bottom View



i3345c

Dimensions



i9019b

Visit www.selinc.com for more detailed information and configuration options.

SEL-2595 Teleprotection Terminal

Securely transfer teleprotection signals through high-speed IEEE C37.94 optical fiber interface.

Key Features

Apply for High-Speed Teleprotection

Use existing station communications paths with IEEE C37.94-compliant inputs for electric power pilot protection schemes. Use the SEL-2595 to send permissive, blocking, and direct transfer trip signals securely and dependably between stations. Back-to-back operate time is under 5.5 ms.

Reduce Costs

Employ eight bidirectional channels per terminal to pass critical protection data for pilot protection schemes such as POTT, DCB, DCUB, and DTT (direct transfer trip).

Improve Safety and Data Reliability

Use fiber-optic cable between protection and telecommunications devices to avoid ground paths and induced noise interference. All wiring is behind the panel. Switchable contact dropout times provide output circuit notification reliability.

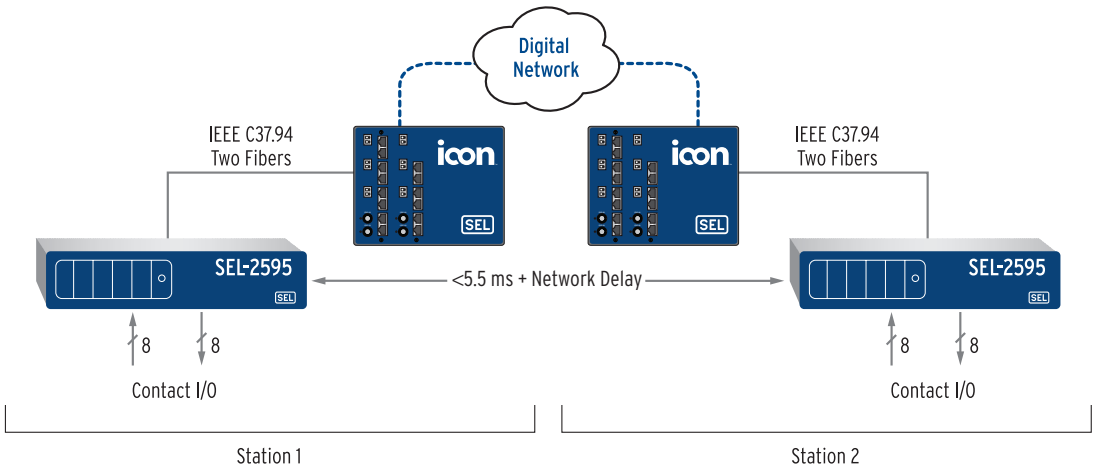
Indicate I/O Status

Print user-configurable labels (included) to clearly indicate I/O usage.

Install and Apply Easily

Set parameters with control (DIP) switches. Quickly install and remove using patented Screw-Terminal Connectorized® blocks, without disturbing wiring.

Teleprotection Signaling Application



An SEL-2595 at Station 1 communicates through a fiber-optic link to a multiplexer using the IEEE C37.94 protocol. The IEEE C37.94 standard defines an intrasubstation, point-to-point fiber-optic connection for synchronous, N • 64 kbps data transport between a protection device and a telecommunications multiplexer. The SEL-2595 uses a single 64 kbps channel. The multiplexer communicates through a network to a multiplexer and an SEL-2595 at Station 2. Each of the eight inputs at Station 1 controls an output at Station 2. Similarly, each input at Station 2 controls an output at Station 1.

SEL-2595 Teleprotection Terminal

Applications

- Use existing station communications paths with IEEE C37.94-compliant, synchronous interface to send permissive, blocking, and direct transfer trips between stations.
- Use the SEL-2595 to send transfer trips to and from electro-mechanical relays.
- Provide station alarm contacts to a central location for data acquisition, monitoring, or security systems.
- Transfer contact status or teleprotection signals through a multiplexed digital communications network using the IEEE C37.94 communications standard.
- Connect the SEL-2595 via optical fiber with the SEL-3094 Interface Converter to provide high-speed digital teleprotection with ITU-T G.703, EIA-422, EIA-485, or EIA-232 electrical interface.
- Connect two SEL-2595 terminals together to share digital contact I/O information between any two IEDs. Use IEEE C37.90-specified multimode optical fiber for up to 2 km or optional single-mode optical fiber for up to 14 km. Or, use an SEL-2595 with a surface-mounted SEL-2594 Contact Transfer Module.
- Monitor data channel integrity to increase protection scheme or I/O security above that of traditional configurations.
- Create simple, inexpensive pilot communications systems.
- Reduce or eliminate ground potential rise problems between IEDs with the fiber-optic link.

Related Products

Hardware Specifications

Power Supply Ratings

48/125 V 36–200 Vdc
85–140 Vac (50/60 Hz)
125/250 V 85–350 Vdc
85–264 Vac (50/60 Hz)
5 W/5 VA maximum for all supplies

Standard Control Input and Output Ranges

24, 48, 110, 125, 220, or 250 Vdc
8 inputs and 8 outputs

Operating Temperature

–40° to +85°C (–40° to +185°F)

Operate Time

Operate Times	Back-to-Back
Standard Contacts	11 ms
High-Speed Option	<5.5 ms

Fiber-Optic Port Options

Connector	Fiber	Distance	Class 1 Device*	IEEE C37.94
ST	Multimode	≤2 km	Laser	Compliant
ST	Single-Mode	≤14 km	LED	Modulation Only

*Eye-safe, Class 1 product per EN 60825-1

Price

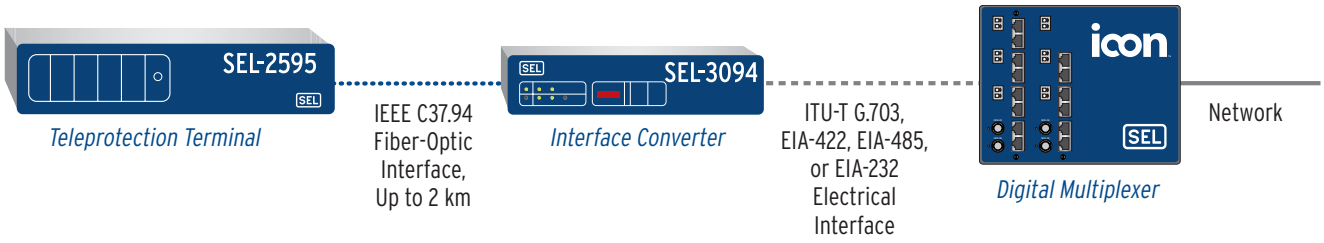
Budgetary Retail, Quantity 1: $1,680

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

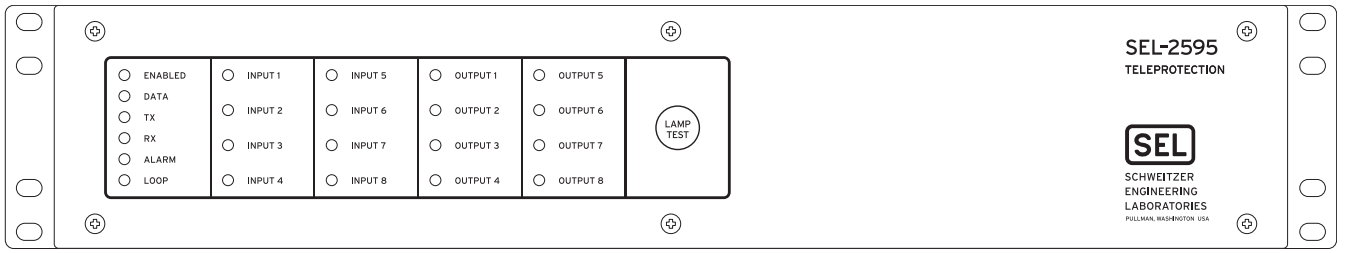
Application Example



Connect high-speed electrical interfaces: convert ITU-T G.703, EIA-422, EIA-485, or EIA-232 electrical links with an SEL-3094 Interface Converter.

SEL-2595 Teleprotection Terminal

Front View



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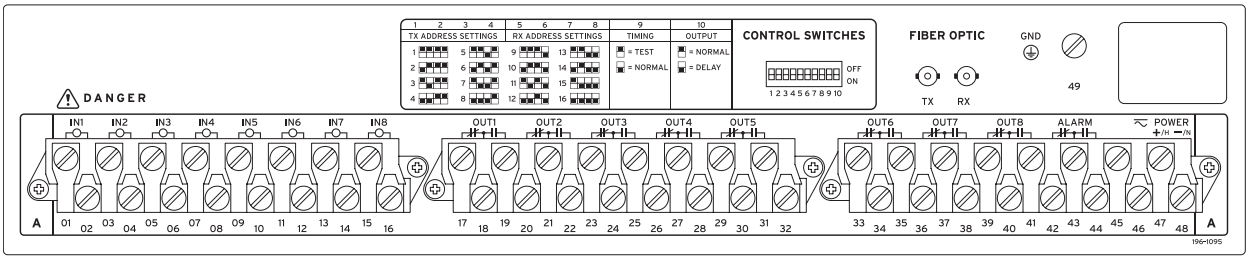
Rear View — Standard Outputs



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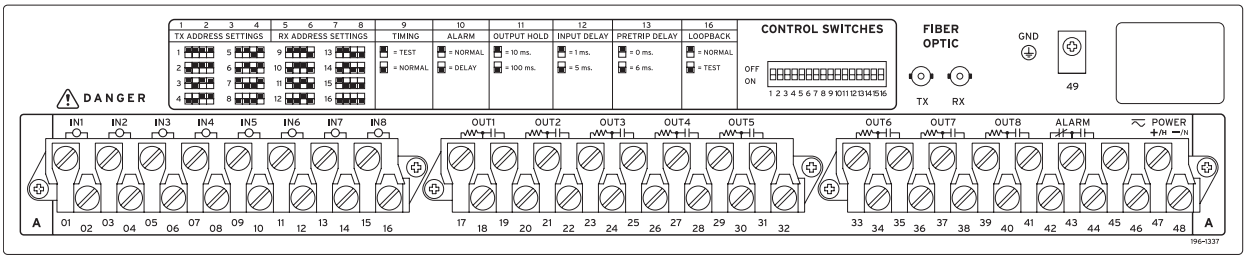
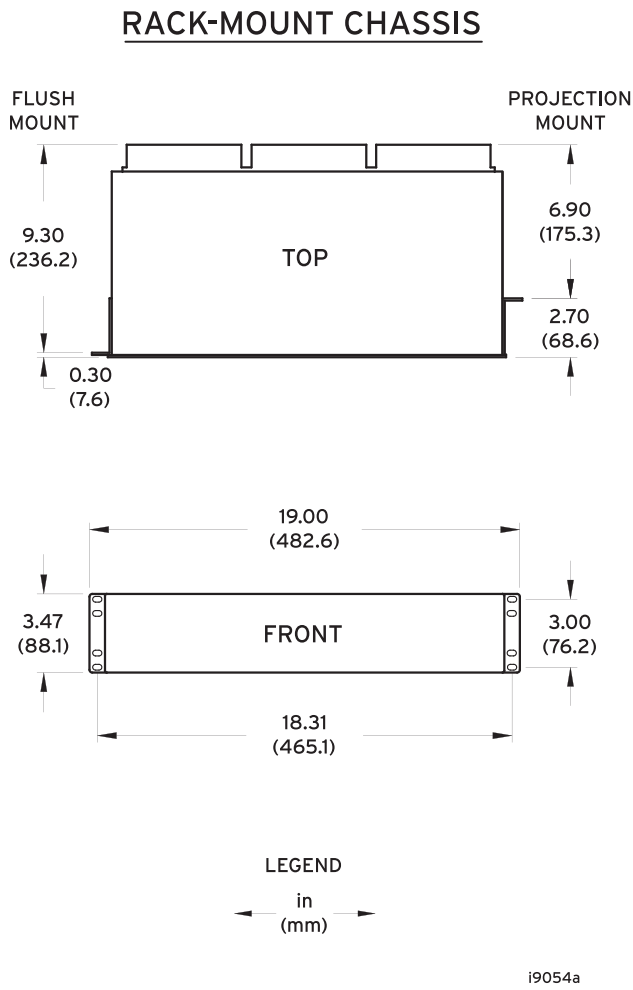
Rear View — High-Speed Outputs



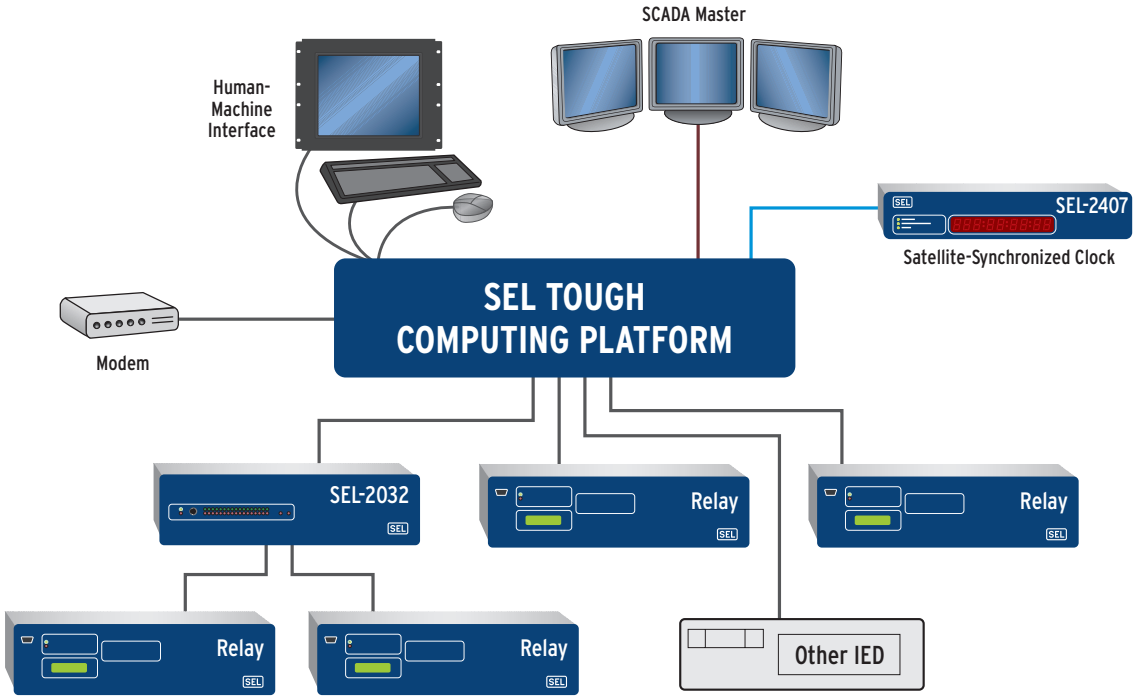
i4469b

Dimensions



Visit www.selinc.com for more detailed information and configuration options.

Computing Platform Applications



Computing Platform Product Index

Computing Platform Features

Computing Platforms

	SEL-3354
APPLICATIONS	
Use in Embedded Automation Systems	*
Collect, Scale Meter Data	*
Collect Targets, Contact Input Status, Fault Location	*
Run System in Harsh Environments	*
Control Through IED Outputs	*
Extract Data From Non-SEL IEDs	*
Forward Information to Maintenance Databases	*
Concentrate IED Data for:	
Distributed Control System (DCS)	*
SCADA Master or RTU	*
Local or Remote HMI	*
Convert SCADA Protocols	*
Configure System for Specific Application	•
Reseller/End User Adds Software	•
OPC Connectivity	*
Integrate With COTS Security Devices	*
Configure as Security Gateway to Help Satisfy NERC CIP Requirements	*
Create a Security Appliance by Loading Other Software	*
OPERATING SYSTEM	
Windows® Embedded Standard	*
Windows XP Professional	*
Windows 7	*
Windows 2008 Server	*
Linux®	*
None	•
SOFTWARE	
SEL Application Software	*
Other Third-Party Software	*
HARDWARE	
AMD Athlon™ 64 2600, 1.6 GHz, 64-Bit, 2 GB DDR2 SDRAM With ECC	•
Intel® Pentium® M, 1.4 GHz, 1 GB DDR SDRAM With ECC	*
Up to 16 EIA-232 Serial Ports (With IRIG-B and Configurable +5 V Source)	*
10/100 Mbps Independent Ethernet Ports	3
USB Ports (SEL-3354 is USB 2.0)	6
VGA Ports	2
Accept IRIG-B Time Synchronization	•
Provide IRIG-B Time Synchronization	•
Watchdog Processor	•
Dual CompactFlash® Slots	•
Solid-State Drive Mass Storage	*
IDE Interface Connector	
PC/104-*Plus*, PCI-104 Module Support	•
PCI Expansion Slot	•
Wide Power Supply Ranges	•
Alarm Contact and Alarm LED	•
No-Moving-Parts Design	•
Withstands Vibration, Shock, and Other Extreme Situations	•
–40° to +75°C Operating Temperature Range	*
–20° to +60°C Operating Temperature Range	•

• *Standard Feature* * *Model Option*

SEL-3354 Embedded Automation Computing Platform

SEL tough computers have over ten times the MTBF of typical industrial computers.

SEL IEC 61850

Key Features

Multiple Processor Options

Deliver high-performance computing power with the 64-bit AMD Athlon™ 64 2600 1.6 GHz processor. For wide temperature range requirements, choose the optional Intel® Pentium® M 1.4 GHz processor.

Robust Hardware Design—No Fans, No Moving Parts, and a Ten-Year Warranty

Improve reliability with SEL tough computers, which make use of error-correcting code (ECC) memory and other technologies to deliver a proven mean time between failures (MTBF) of at least ten times that of typical computers.

IRIG-B System Clock Updating, Decoding, and Generation

The SEL-3354 allows for high-precision synchronization to the system clock and shifts outgoing signal for daylight-saving time and time zone differences. Supports IEEE C37.118 IRIG-B extensions such as time quality. Optionally synchronize this system clock with a network time server. Demodulated IRIG-B is generated from the computer system clock when an external IRIG-B signal is absent.

Multiple I/O Ports: 6 USB 2.0, 3 Ethernet, and Up to 16 EIA-232/485

A choice of I/O ports allows direct connections to various local peripherals and high-speed network interfaces with three 10/100BASE-T Ethernet ports (fiber optional) and software-configurable serial ports.

Conforms to IEEE C37.90, IEEE 1613, and IEC 60255 Protective Relay Standards

Install the SEL-3354 in harsh environments, including –40° to +75°C, 15 kV electrostatic discharge, fast transients, radiated emissions, overcurrent, dielectric strength, and pulsed magnetic field disturbances.

Flexible Solution for Your Applications

Create embedded, integrated solutions for your application with 3 Ethernet ports, 6 USB ports, up to 16 serial ports, dual VGA, IRIG-B input/output, and I/O for alarming and control. An expansion slot is available to accept the large supply of expansion cards. With Windows® XP Professional, Windows XP Embedded, or Linux®, you have the options you demand for your applications.

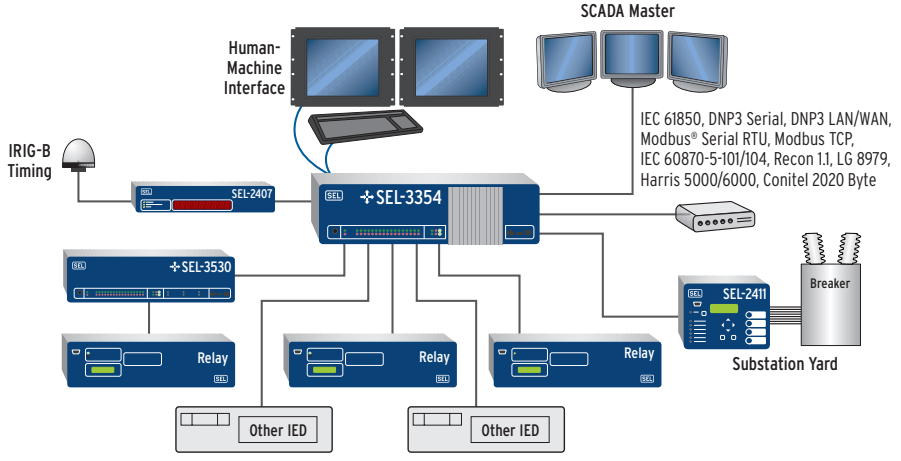
System Monitor and Watchdog Processor

A customizable, independent diagnostics watchdog processor improves system availability by detecting and alarming for problems, detecting system interruptions, and restarting the main processor.

Dual VGA Ports

Drive two independent displays for local HMI and SCADA. Drive one display for one-line diagrams and the other for event alarms.

SEL-3354 Application

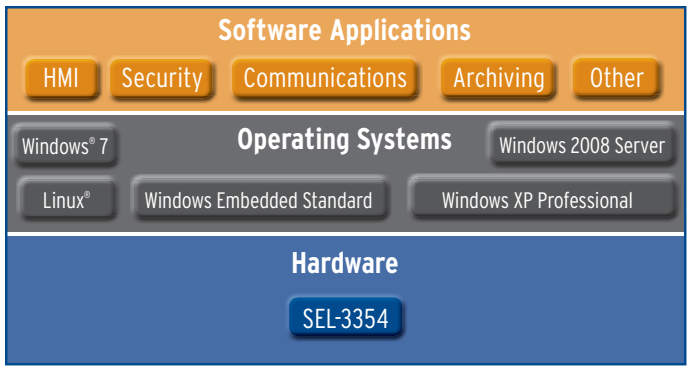


Use the SEL-3354 computing platform to develop an application-specific system for harsh environments in utility substations and commercial, industrial, or government systems.

SEL-3354 Embedded Automation Computing Platform

Applications

- Create an embedded, integrated computer system (EICS) with long product life for utility, industrial automation control, and instrumentation applications.
- Gather data from IEDs and operate on the information in a soft-PLC program for applications including load shedding, remedial action schemes, data grouping, industrial control, and more.
- Use the SEL-3354 to collect and format relay data for legacy remote terminal units (RTUs) and send directly to SCADA systems using legacy protocols.
- Include dual monitors, keyboard, pointing device, and software for a local HMI, providing local status indication, measurement display, and control.
- Access data through multiple paths. Different utility departments may be interested in different data and different rates. Use the SEL-3354 to collect real-time data at one rate and serve data to any client via any supported protocol.
- Synchronize the time clocks in attached devices, such as information processors, that accept a demodulated IRIG-B time signal. The demodulated IRIG-B signal is regenerated by the SEL-3354 from an external modulated or demodulated time source, such as a GPS satellite clock receiver. Network Time Protocol (NTP) is accepted by the SEL-3354 to set its internal clock.
- Eliminate the need for separate substation or communications units. Communications and information handling features make the SEL-3354 ideal for large and small substation integration projects. The ability to add protocols allows the use of high-speed networks and protocol changes in the future with minimal or no hardware impact.
- Configure to help satisfy NERC CIP compliance with standard Windows security features, such as Windows Firewall, Security Configuration Manager, and Internet Protocol Security (IPsec). Filter incoming traffic, set passwords on accounts, authenticate, and encrypt network sessions with Internet Protocol (IP). Load optional anti-virus software.
- Extend central authentication to the substation using enterprise credentials when logging in with the same account used throughout the enterprise.



Typical SEL-3354 solutions.

Optional Features

- Intel Pentium M 1.4 GHz processor with 1 GB ECC RAM (–40° to +75°C operating temperature).
- Windows XP Professional operating system.
- Windows Embedded Standard operating system.
- Windows 7 operating system.
- Windows 2008 Server operating system.
- Linux®.
- 16 serial ports with IRIG-B output.
- Two 100BASE-FX rear Ethernet ports.
- CompactFlash® storage.
- Solid-state drive storage.
- SEL and third-party software.
- Contact I/O.
- Rack-mount or panel-mount hardware.
- Power supply choices.

Related Products

SEL Category 5e Ethernet Cables 479
SEL-C807 Multimode 62.5 µm Core Fiber-Optic Cables 472
SEL-2725 Five-Port Ethernet Switch 372

Hardware Specifications

CPU

AMD Athlon 64 2600 1.6 GHz processor with 2 GB ECC RAM (–20° to +60°C operating temperature)

Ports

3 Ethernet ports

Front	One 10/100BASE-T
Rear	Two 10/100BASE-T

IRIG-B input and output (BNC connectors)
2 VGA monitor
6 USB 2.0

Price

Budgetary Retail, Quantity 1: $3,970

Includes high-performance AMD Athlon 64 2600 1.6 GHz processor with 2 GB ECC RAM, Windows XP Professional operating system, 8 GB CompactFlash storage, two serial ports, and three 10/100BASE-T Ethernet ports.

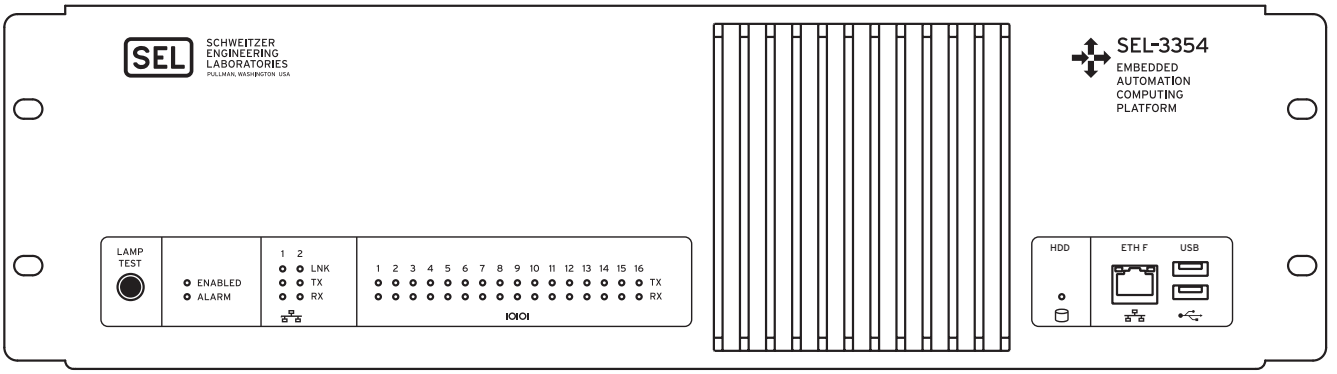
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

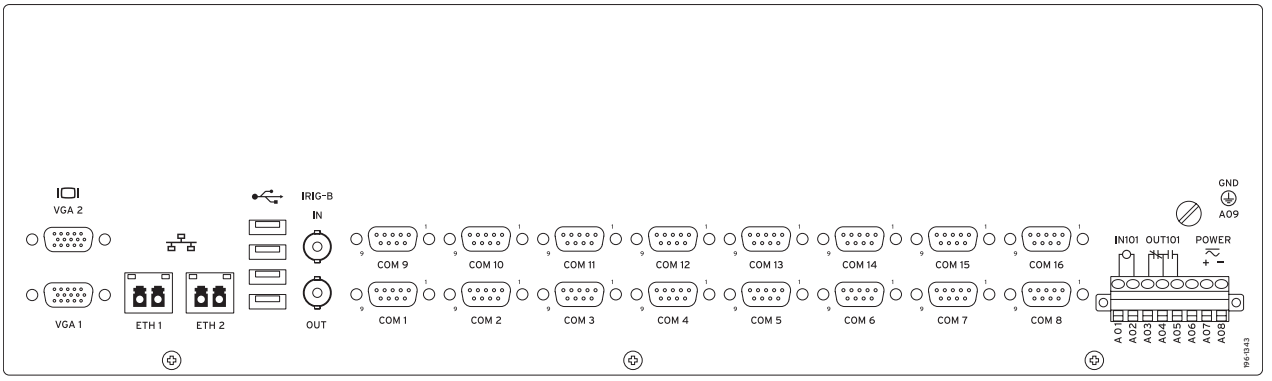
SEL-3354 Embedded Automation Computing Platform

Front View – Rack-Mount



i4267b

Rear View (3U)



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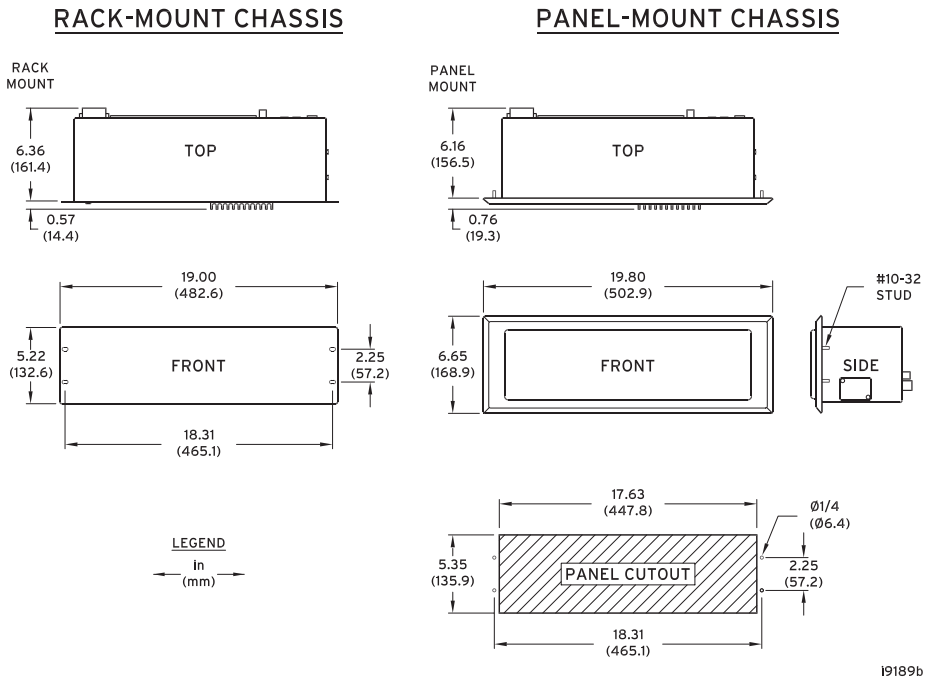
Dimensions



i9189b

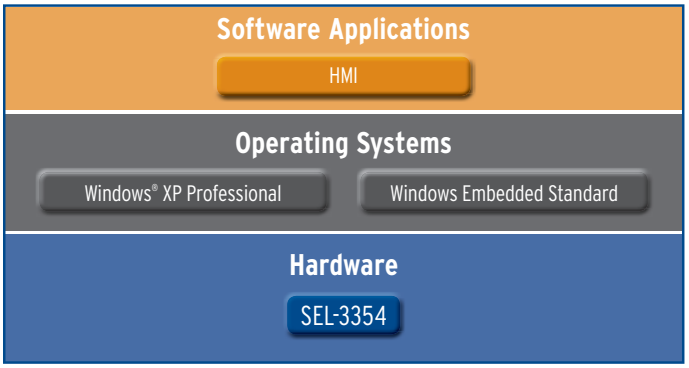
Visit www.selinc.com for more detailed information and configuration options.

HMI Visualization, Monitoring, and Control

Key Features

Create customized screens for viewing, monitoring, and control processes with Wonderware® InTouch® or ReLab ClearView.

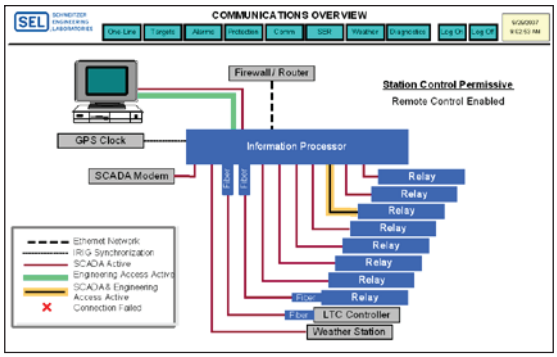
- Implement and set up with ease.
- Create customized visualizations.
- Improve situational awareness.
- Connect to RTUs, IEDs, PLCs, and historians.
- Implement advanced security policies.
- Use with central authentication for security requirements.
- Utilize open access to data.
- Easily set up alarms.
- Develop HMI with pre-existing objects.
- Configure with drag-and-drop capability.
- Create scripts to customize applications.
- Scale from single-node to enterprise-wide.

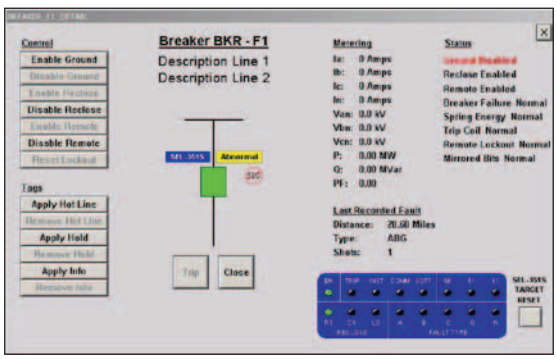


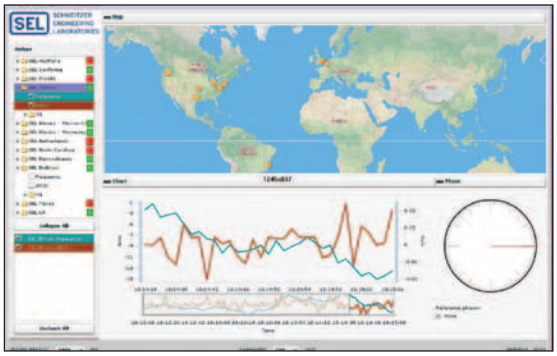
Choose the SEL-3354 as the platform for your HMI visualization, monitoring, and control system for a reliable and robust system suitable for in the harshest environments.

Applications

- Create customized local HMI with one-line diagrams, communications diagrams, alarm displays, and sequence-of-event charts.
- Connect to practically any automation system in use today, and display the configuration and status of the communications system.
- Monitor energy usage, and track with real-time trending. Determine affects of cogeneration and load shedding. Detect inefficiencies, and send usage reports to necessary systems.
- Set up to control IEDs from HMI with optional touchscreen, and create safe environments to control IEDs.
- Place monitoring and control system HMI based on SEL-3354 in environments with high humidity and extreme temperatures.
- Streamline access to valuable information and optimize engineering time through automatic event report collection, settings management, and event report analysis.
- Connect to SEL-3530 RTAC and other SEL devices to create a complete local monitoring and control visualization system.
- Use with synchrophasor software and systems to create wide-area monitoring and control applications.







Example screens.

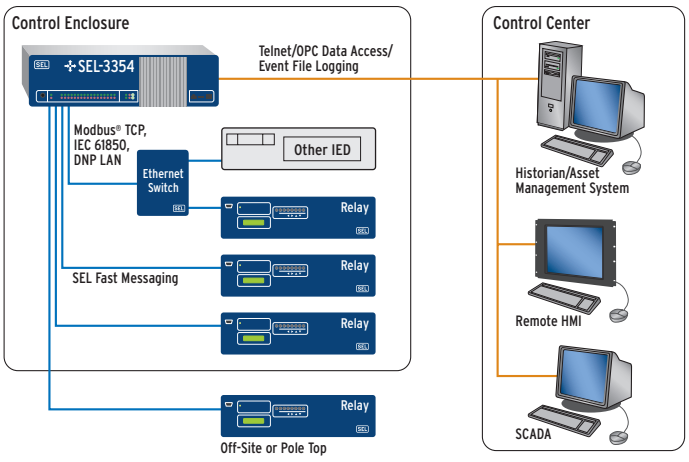
Information Processor Data Concentrator/Protocol Converter

Key Features

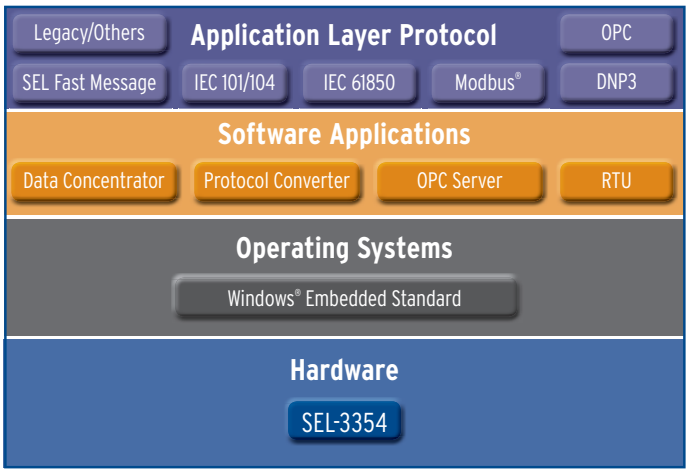
Concentrate data and convert protocols with SubstationSERVER.NET and Windows® Embedded Standard.

- Simple Setup
  - Automatically configure IEDs
  - Efficiently map and translate data with drag-and-drop interface
- Built-In Logic Processing Platform
  - Perform substation automation
  - Flexibly concentrate data
  - Easily perform scaling and Boolean logic
- Seamless Protocol Conversion
  - Connect to a wide variety of devices using IEC 61850 or other protocols
  - Use multiple protocols concurrently to communicate with multiple masters
- Data Archiving and Viewing
  - Log sequential events records and analog information
  - Automatically retrieve and store fault records locally and remotely
- Cybersecurity Management
  - Encrypt Ethernet-based engineering access and SCADA protocols with SSL/TLS
  - Protect VPN access with IPsec link security
  - Manage access via user accounts
  - Exceed NERC system security auditing and logging requirements
  - Enforce NERC password complexity requirements
  - Include NERC-compliant port control

By using Windows Embedded Standard with SubstationSERVER.NET, you get the latest generation Windows-embedded operating system. Designed for high reliability, Windows Embedded Standard also includes robust security features, remote access, and is customizable with the SEL Menu.



Protocol conversion and data concentration with remote enterprise connectivity.



Applications

The SEL-3354 with SubstationSERVER.NET, an advanced substation information processor software product from SUBNET Solutions, Inc., provides data concentration, protocol conversion, automatic logic, event file collection, and enterprise connectivity for electric utilities.

Protocol Conversion and Data Concentration With Local HMI

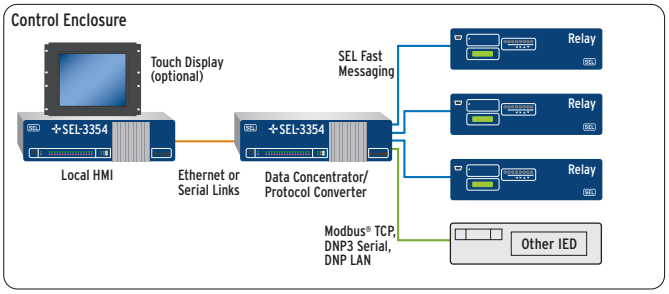
Convert protocols and concentrate data from multiple IEDs made by multiple manufacturers to achieve overall substation integration. Add optional HMI software and touch display to the SEL-3354 for local display and control of substation IEDs.

Connect to Enterprise

Interface directly to utility information systems, including historians and asset management systems. Relieve SCADA master stations from unnecessary substation information.

RTU Replacement

Use the SEL-3354 as an information processor with multiple relays, remote I/O modules, and SEL-2440 DPAC Discrete Programmable Automation Controllers for higher reliability, lower cost, and more functions instead of settling for an RTU. An RTU provides only remote I/O for SCADA, without the benefit of the other functions available in a distributed SEL system.



Example of protocol conversion and data concentration with local control.

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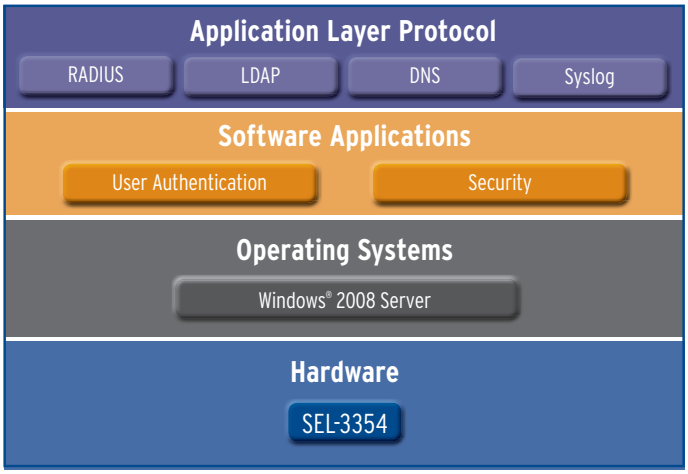
Centralized Authentication Server

With Active Directory Domain Services

Key Features

- Leverage Windows® 2008 Server.
- Use enterprise user credentials at substation.
- Extend enterprise central authentication to substation.
- Provide high-availability user credentials at substation independent of wide-area network (WAN) availability.
- Authorize and authenticate with RADIUS.
- Connect to Active Directory with Lightweight Directory Access Protocol (LDAP).
- Supports industry standards.
  - NERC CIP
  - NIST SP800 53/82
  - IEEE 1686
  - IEC 62351



Applications

Extend Central Authentication to Substation

Authenticate in the substation at the electronic security perimeter using a centrally managed, distributed Active Directory database.

Integrate Into Existing Enterprise IT Infrastructure

Reduce your costs by using current security policies, and minimize employee training. Integrate into existing Active Directory implementations, and leverage current existing investments.

Use Enterprise Credentials

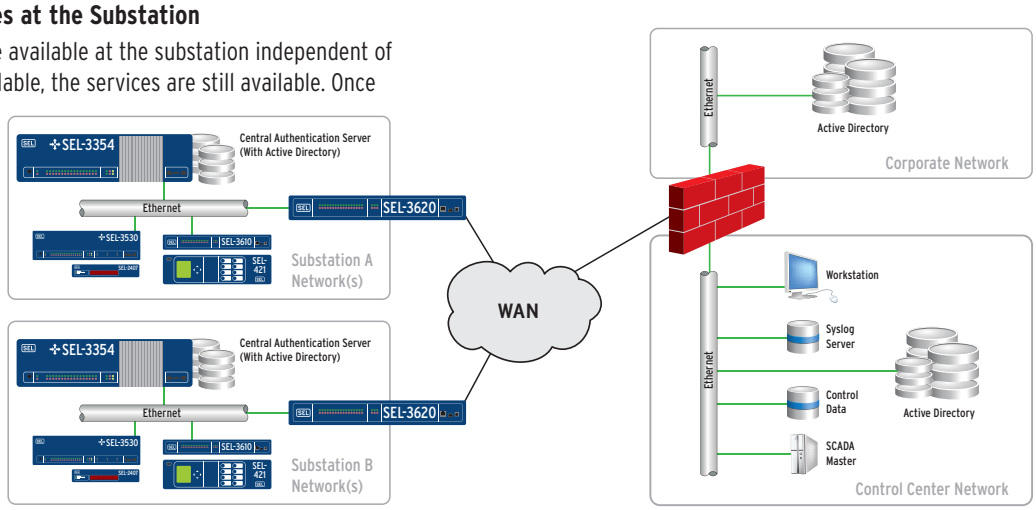
No need to remember multiple passwords. Log in to devices in the substation with the same individual user names and passwords used throughout the enterprise.

Audit, Log, and Manage With Typical IT Tools

Auditing support for resource access can be enforced by means of Group Policy on each server and can be configured for both run-time auditing and policy-change auditing. Collect, store, and forward event logs with Syslog. Use the rich set of IT tools for managing the system.

High-Availability Services at the Substation

Authentication services are available at the substation independent of WAN. When WAN is not available, the services are still available. Once the WAN is re-established, the substation centralized authentication server will resynchronize.



Set Up Role-Based Access Controls

Grant user access to line-of-business applications according to the users' role. Users can be assigned a role to perform a job function. The role defines the authorization permissions on a set of assets. Create roles such as relay test technician, security substation administrator, or power engineer, giving each role a different set of access controls based on authorization rules that allow you to apply fine-grained control over the mapping between access control and the structure, and tasks performed.

Combine With SEL-3620 Ethernet Security Gateway

Secure your private substation network from malicious traffic with a configurable ingress and egress stateful firewall. Use industry-vetted security and interoperability with IPsec VPNs using X.509 certificates or pre-shared keys.

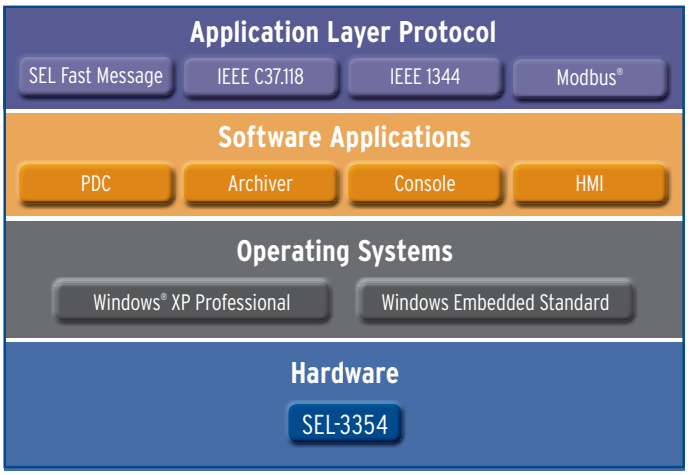
Synchrophasor Phasor Data Concentrator, Archiver, and Console

Key Features

Concentrate, archive, and display synchronized phasor measurements from a single station or a wide area with the SEL-3354 and SEL SYNCHROWAVE® Software.

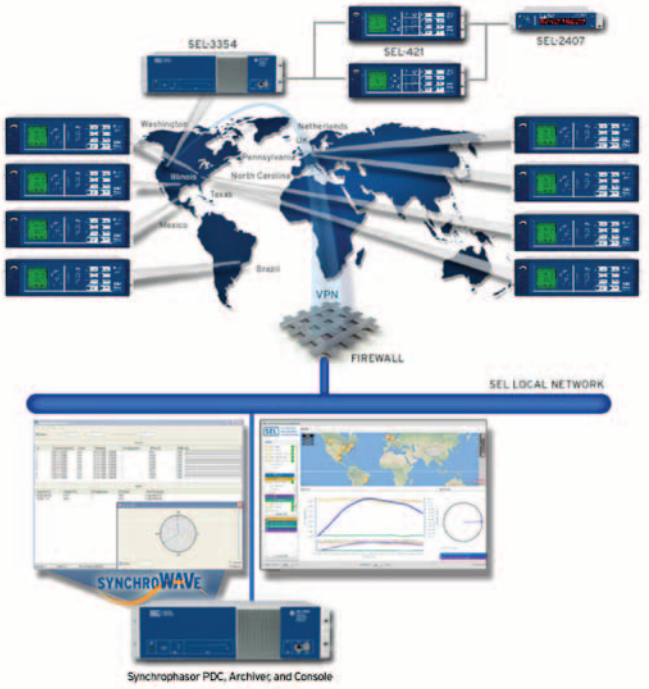
- Archive power system operating conditions continuously or based on event triggers.
- Trigger-record any digital or analog signal from any or all phasor measurement units (PMUs).
- Use IEEE C37.118-defined triggers to capture system-wide events based on preprogrammed alarms.
- Improve situational awareness.
- Calculate real and reactive power flow for system interconnections.
- Collect and correlate data from multiple PMUs.
- View data with dockable windows and multiple displays.
- Create customized visualizations.

By using Windows XP Professional or Windows Embedded Standard and loading your favorite HMI visualization software on the SEL-3354, you can create customized wide-area management synchrophasor systems.



Applications

- Collect streaming synchrophasor data from SEL relays, meters, and other protocol-compliant PMUs and data concentrators.
- Transmit streaming phasor measurement superpackets to unique clients for a number of applications ranging from real-time data visualization to archive historians for postdisturbance analysis.
- Improve power system model understanding with views of phase angle, magnitude, and trending of real-time data from multiple PMUs.
- Warn operators and engineers of impending instabilities and operating condition problems through the use of selectable quantities, alarms, and data sets.
- Send selected data to archiving systems for analysis of steady-state or abnormal conditions.



Synchrophasor PDC, Archiver, and Console

Visit www.selinc.com for more detailed information and configuration options.

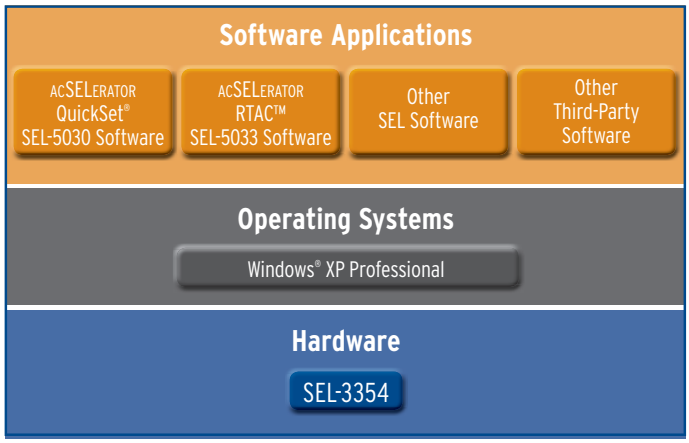
Engineering Workstation

Key Features

Loaded with all necessary software applications to manage substation assets.

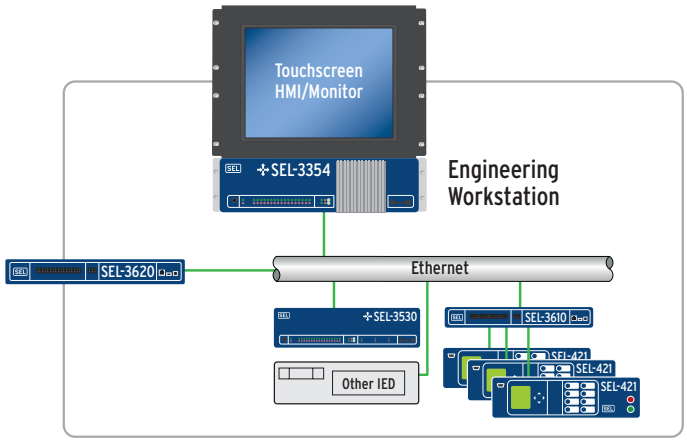
- Automatically collect event reports.
- View IED configurations and settings.
- View metering values and breaker status.
- Modify settings.
- Use built-in Event Waveform Viewer to display events as oscillograms.
- View sequence-of-events record files from many IEDs.
- Filter and sort data.
- View station diagram drawings and documents.
- Access the engineering workstation remotely and securely.

Choose the SEL-3354 as your engineering workstation platform, and get a reliable and robust system suitable for the harshest environments.



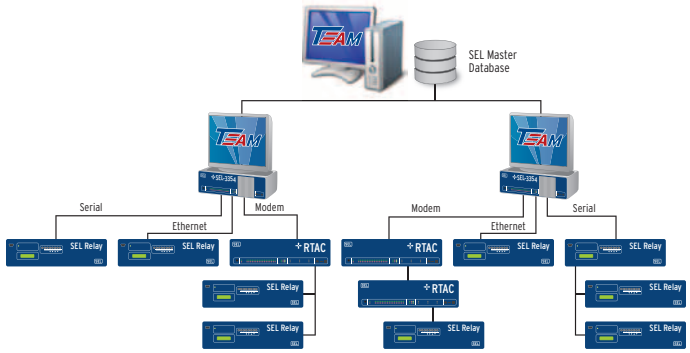
Applications

- Add touchscreen display and keyboard with mouse to view all IEDs and settings. Access SEL-3530 RTACs, SEL-3620 Ethernet Security Gateways, SEL relays, and any other IEDs in the substation.
- Gain engineering access at the substation to view and monitor system status and individual IEDs; access locally or remotely. Secure, remote access solutions are available with SEL's security products.
- View all IED status and settings, and modify as necessary from a central substation computer. Control IEDs from safe environments.
- Streamline access to valuable information, and optimize engineering time through automatic event report collection, settings management, and event report analysis. Install ACSELERATOR TEAM™ Software to easily gather event information.
- Load computer with your substation drawings and documents to get easy access while on-site. Install your favorite .pdf and .dwg viewers.
- Modify settings and control system during engineering acceptance testing and maintenance. Install Ethernet troubleshooting software.
- Display oscillograms with time-coordinated element assertions.
- Create, map, and view IEC 61850 messages and substation configuration language files.
- Display synchrophasor wide-area measurement data for situational awareness and analysis.



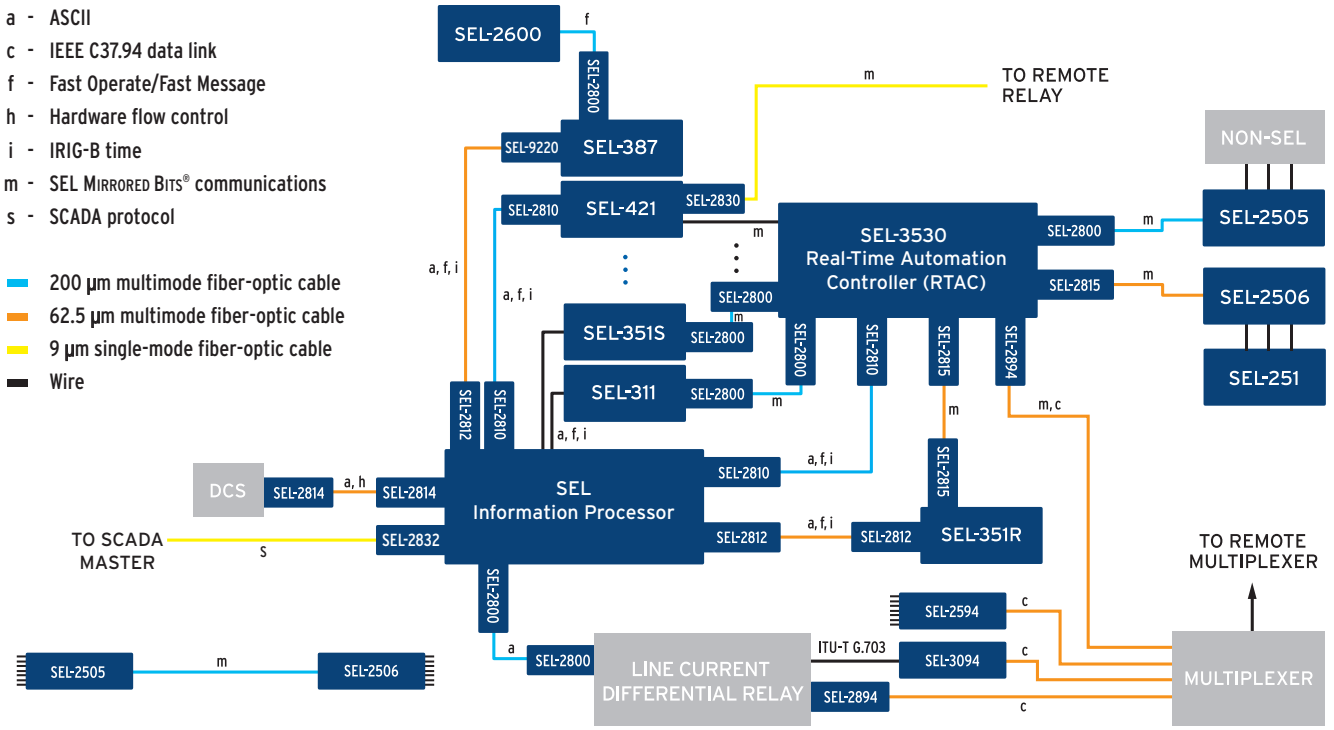
Engineering access to all IEDs in the substation.

SEL ACSELERATOR TEAM Software



Visit www.selinc.com for more detailed information and configuration options.

Fiber-Optic Applications



Fiber-Optic Product Index

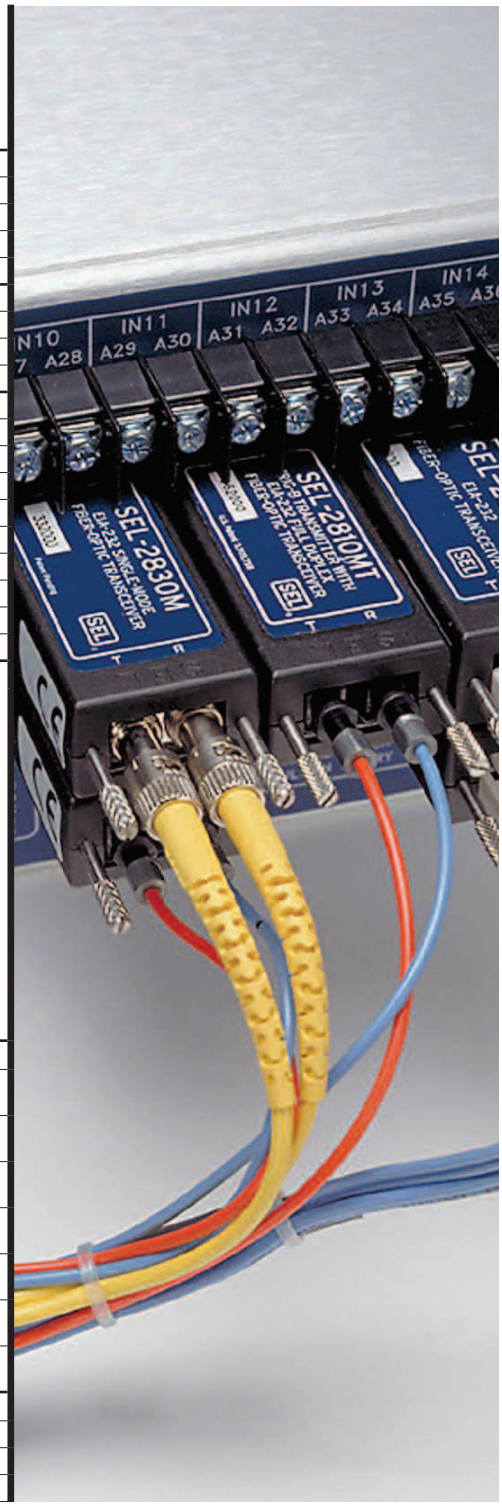
Fiber-Optic Features

Fiber-Optic Transceivers

	SEL-2800	SEL-2810	SEL-2812	SEL-9220	SEL-2814	SEL-2815	SEL-2829	SEL-2830	SEL-2831	SEL-2894	SEL-3094
CONNECTOR AND OPTICS											
V-System®, 650 nm Wavelength	•	•									
ST®, 850 nm Wavelength			•	•	•	•				•	•
ST, 1300 nm Wavelength							•	•			
ST, 1550 nm Wavelength									•		
FIBER COMPATIBILITY											
200 µm Core Multimode Fiber (SEL-C805)	•	•	•	•	•	•					
50 or 62.5 µm Core Multimode Fiber (SEL-C807, -C808)			•	•	•	•				•	•
9 µm Core Single-Mode Fiber (SEL-C809)							•	•	•		
ELECTRICAL											
EIA-232 Asynchronous Serial Data	•	•	•		•	•	•	•		•	*
EIA-485 Asynchronous Serial Data											*
EIA-422, EIA-485 Synchronous Serial Data											*
ITU-T G.703 Synchronous 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					•					•	•

Serial Fiber-Optic Devices

	SEL-2126	SEL-2505	SEL-2506	SEL-2515	SEL-2516	SEL-2594/2595	SEL-2431/2440/2600	SEL-2664	SEL-701	SEL-700G/710/751A/787/2411/2414 /2440	SEL-311L[8]/387L[8]	SEL-2407
CONNECTOR, OPTICS, AND ENCODING												
V-System Connector, 650 nm Wavelength Data: SEL-2800 Compatible		1	1	1	1		1		•			
ST Connector, 850 nm Wavelength Data Plus IRIG-B: SEL-2812/SEL-9220 Compatible		2		2			2	•		2		2
ST Connector, 850 nm Wavelength Data: SEL-2815 Compatible		3	3	3	3							
ST Connector, 1300 nm Wavelength Data: SEL-2829 Compatible			4		4							
ST Connector, 1300 nm Wavelength Data: SEL-2830 Compatible		5	5	5	5							
ST Connector, 1550 nm Wavelength Data: SEL-2831 Compatible			6									
ST Connector, 850 nm Wavelength Data: SEL-3094 Compatible	•					•					7	
FIBER COMPATIBILITY												
200 µm Core Multimode Fiber (SEL-C805)	2	1,3	1,3	1,3	1,3		1,2		•	•		2
50 or 62.5 µm Core Multimode Fiber (SEL-C807, -C808)	2	2,3	3	2,3	3	•	2			•	7,8	2
9 µm Core Single-Mode Fiber (SEL-C809)		5	4,5,6	5	4,5							

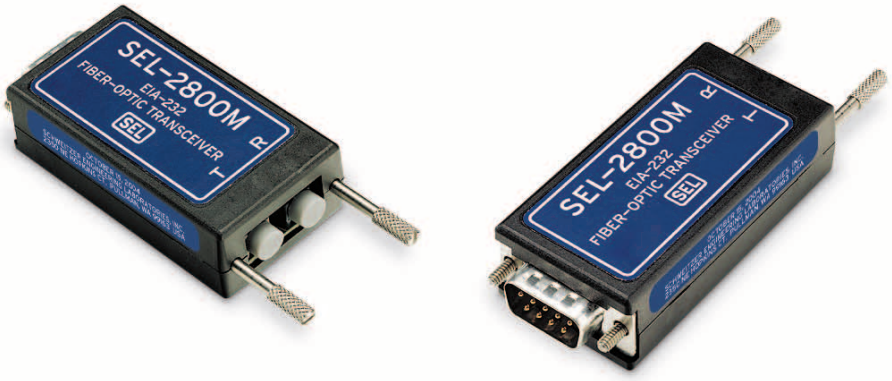


• *Standard Feature* * *Model Option*

Notes:

1 = With SEL-2800 Compatible Option
2 = With SEL-2812 Compatible Option
3 = With SEL-2815 Compatible Option
4 = With SEL-2829 Compatible Option
5 = With SEL-2830 Compatible Option
6 = With SEL-2831 Compatible Option
7 = With SEL-3094 Compatible Option
8 = Line Current Differential 1300 nm and 1550 nm Options Available

SEL-2800 Fiber-Optic Transceivers



Communicate 500 meters or more using two port-powered SEL-2800 Fiber-Optic Transceivers and fiber-optic cable.

Key Features

Improved Safety

Isolates communications devices from ground potential rise and EMI/RFI. Eye-safe, Class 1 LED product per EN 60825-1.

Reliable

Completely isolates communications; free from interference.

Economical

Low cost competes with metallic cables.

Compact

Plugs directly onto DB-9 connector.

Convenient

Serial-port powered; no separate power supplies.

Simple

Visible red light (650 nm) for easy inspection; no jumpers or settings.

Flexible

Up to 40 kbps; less than 15 µs delay.

Robust

Works with strong, economical OFS V-System® fiber-optic cables.

Cable Options

SEL provides assembled cables or bulk cable, connectors, and a termination kit. Cables are available for indoor trays, conduit, or outdoor cable ducts.

"We use the SEL-2800 Fiber-Optic Transceivers for both data acquisition and for high-speed relay protection, utilizing the SEL MIRRORED BITS® technology. We chose the SEL-2800 for its simple installation, needing no external power supply, and the price was competitive. They work well and have been very reliable."

Jim Maloney
Engineering Specialist
Power and Control Systems International, Inc.

The SEL-2800 Fiber-Optic Transceivers provide tremendous advantages in short- to medium-range EIA-232 communication. The SEL-2800 connects directly to the 9-pin serial port it serves. The transceiver receives power from the host device, so no external power connections are required. The high-strength, silica-based, fiber-optic cable is reliable and easy to use. Cable assemblies, built to your length specifications, are available from SEL. Or, you can build your own cable in minutes by installing ready-to-use terminations with simple hand tools. No epoxy or polishing is needed. For electrically isolated, noise-free EIA-232 communication up to 40 kbps, select the SEL-2800.

Related Products

Price

Budgetary Retail, Quantity 1: $102

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

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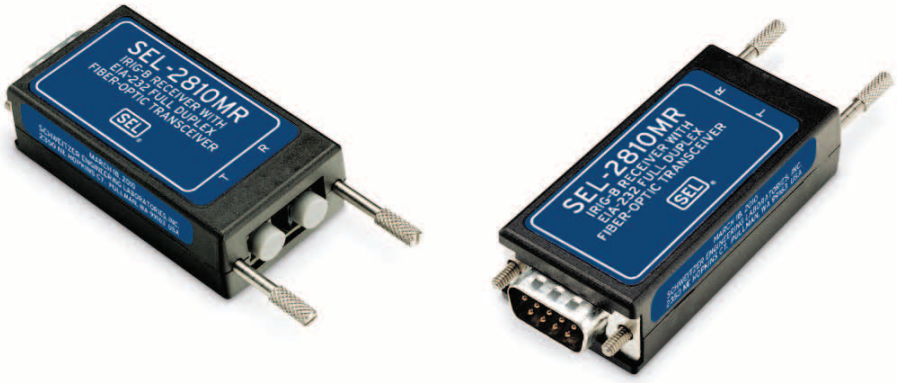
SEL-2810 Fiber-Optic Transceivers With IRIG-B



Communicate 500 meters or more and send time code using two port-powered SEL-2810 Fiber-Optic Transceivers and SEL fiber-optic cable.

Key Features

Innovative

Sends IRIG-B time code along with data.

Improved Safety

Isolates communications devices from ground potential rise and EMI/RFI. Eye-safe, Class 1 LED product per EN 60825-1.

Reliable

Completely isolates communications; free from interference.

Economical

Low cost competes with metallic cables.

Compact

Plugs directly onto DB-9 connector.

Convenient

Serial-port powered; no separate power supplies.

Simple

Visible red light (650 nm) for easy inspection; no jumpers or settings.

Flexible

Up to 20 kbps; less than 50 µs delay.

Robust

Works with strong, economical OFS V-System® fiber-optic cables.

Cable Options

SEL provides assembled cables or bulk cable, connectors, and a termination kit. Cables are available for indoor trays, conduit, or outdoor cable ducts.

The SEL-2810 Fiber-Optic Transceivers provide short- to medium-range EIA-232 communication and demodulated IRIG-B time-code transmission. Complementary SEL-2810MT and SEL-2810MR devices transmit and receive the time-code signal while simultaneously handling full-duplex EIA-232 communication. The SEL-2810 connects directly to the 9-pin serial port it serves. The transceiver receives power from the host device, so no external power connections are required. The high-strength, silica-based, fiber-optic cable is reliable and easy to use. Cable assemblies, built to your length specifications, are available from SEL. Or, you can build your own cable in minutes by installing ready-to-use terminations with simple hand tools. No epoxy or polishing is needed. For electrically isolated, noise-free, IRIG-B time-code support, along with EIA-232 communication up to 20 kbps, select the SEL-2810.

Related Products

SEL-2032 Communications Processor 348
SEL-2100 Logic Processor 352
SEL-3530/3530-4 Real-Time Automation Controllers (RTACs) 338
SEL-C650 IRIG-B Cable to SEL-100 Series ..... selinc.com
SEL-C651 IRIG-B Cable to Communications Processor ..... selinc.com
SEL-C652 IRIG-B Cable to SEL-200 Series or SEL-321 ..... selinc.com
SEL-C805 Multimode 200 µm Core Fiber-Optic Cables 470

Price

Budgetary Retail, Quantity 1: $132

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

SEL-2812 Fiber-Optic Transceivers With IRIG-B

Communicate 4 kilometers or more and send time code using two port-powered SEL-2812 Fiber-Optic Transceivers and SEL fiber-optic cable.

Key Features

Innovative

Sends IRIG-B time code along with data. Uses switch to provide IRIG-B signal via EIA-232 connector or mono jack.

Improved Safety

Isolates communications devices from ground potential rise and EMI/RFI. Eye-safe, Class 1 laser product per EN 60825-1.

Reliable

Completely isolates communications; free from interference.

Economical

Low cost competes with metallic cables.

Compact

Plugs directly onto DB-9 connector.

Convenient

Serial-port powered; no separate power supplies.

Flexible

Up to 115.2 kbps.

Fiber-Optic Cable Options

SEL provides assembled cables or bulk cable, connectors, and a termination kit. Cables are available for indoor trays, conduit, or outdoor cable ducts.

Simple Testing

Continuous light pulses issued for simple functional verification using an optical meter.

Related Products

SEL-C805 Multimode 200 µm Core Fiber-Optic Cables....470
SEL-C808 Multimode 62.5 µm Core Fiber-Optic Cables....474
SEL-700G Family of Relays....268–279
SEL-710 Motor Protection Relay....284
SEL-751A Feeder Protection Relay....134
SEL-787 Transformer Protection Relay....222
SEL-2411 Programmable Automation Controller....388
SEL-2600 RTD Module....296
SEL-2664 Field Ground Module....280
SEL-3530/3530-4 Real-Time Automation Controllers (RTACs)....338
SEL-9220 Fiber-Optic Adapter for SEL-300 Series Relays....440

IRIG-B adapter cables for devices that do not include the IRIG-B signal in the 9-pin connector: SEL-C654 mono plug to BNC, SEL-C655 mono plug to DB-9, and SEL-C656 mono plug to ring terminals.

The SEL-2812 Fiber-Optic Transceivers provide short- to medium-range (up to 4 km) EIA-232 communication and demodulated IRIG-B time-code transmission. Transmitters (SEL-2812MT and SEL-2812FT) send IRIG-B time code, and receivers (SEL-2812MR and SEL-2812FR) receive the time-code signal. Simultaneously, the transceivers provide full-duplex EIA-232 communication. The SEL-2812 connects directly to the 9-pin serial port it serves. The transceiver receives power from the host device, so no external power connections are required. Cable assemblies are available from SEL. For electrically isolated, noise-free, IRIG-B time-code support, along with EIA-232 communication up to 115.2 kbps, select the SEL-2812. The SEL-9220 Fiber-Optic Adapter is equivalent to an SEL-2812MR for the EIA-485 port of an SEL-300 series relay.

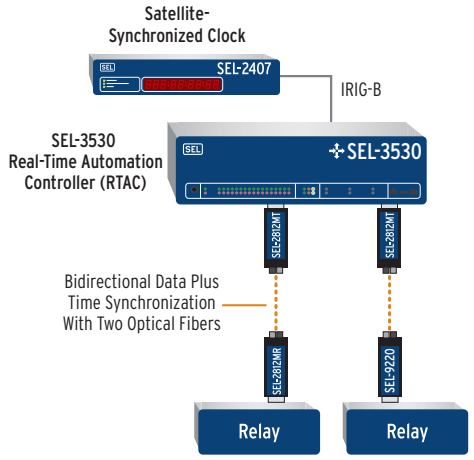
Price

Budgetary Retail, Quantity 1: $250

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.



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SEL-2814 Fiber-Optic Transceivers With Hardware Handshaking

Communicate 4 kilometers and transfer hardware-handshaking signals with SEL-2814 Fiber-Optic Transceivers and multimode fiber-optic cable.

Key Features

Control

Hardware-flow control on RTS and CTS pins.

Long Range

Serial communications distances of up to 4 km.

Fiber Choices

Multimode fiber core diameters from 50–200 µm using standard ST® connectors.

Flexible

Data rates up to 115.2 kbps; DCE/DTE switch selectable.

Improved Safety

Isolates communications devices from ground potential rise and EMI/RFI. Eye-safe, Class 1 laser product per EN 60825-1.

Convenient

Plugs directly onto DB-9 connector. Serial-port powered; no separate power supplies required. Or, use external power through 0.7 mm power jack.

Secure

Maximum bit error rate (BER) of 10^{-9}.

Simple Testing

Continuous light pulses issued for simple functional verification using an optical meter.

Send serial data up to 4 km with SEL-2814 Fiber-Optic Transceivers. These transceivers provide the best in component isolation, low power consumption, and simplicity of use. The transceiver can receive power from the host device, so no external power connections are required. Or, if the host cannot provide power, a power jack is provided. ST connectors provide the flexibility to select the fiber that best fits design requirements. The SEL-2814 is also DCE/DTE switch selectable, eliminating the need for adapters.

Related Products

230-0601 AC Power Supply 491
240-1525 Power Plug Cable With Tinned Leads ..... selinc.com
SEL-C805 Multimode 200 µm Core Fiber-Optic Cables 470
SEL-C808 Multimode 62.5 µm Core Fiber-Optic Cables 474
SEL-9220 Fiber-Optic Adapter for SEL-300 Series Relays 440
SEL-9321 Low-Voltage DC Power Supply 490

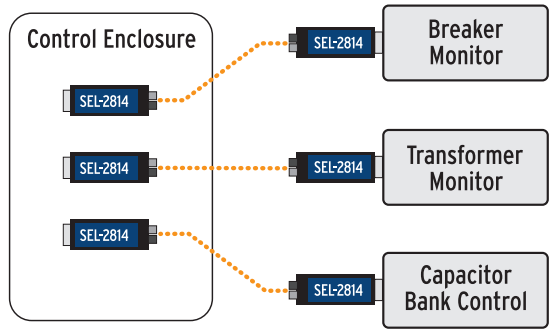
Price

Budgetary Retail, Quantity 1: $250

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.



SEL-2815 Fiber-Optic Transceivers

Communicate 15 kilometers using two port-powered SEL-2815 Fiber-Optic Transceivers and multimode fiber-optic cable.

Key Features

Long Range

Serial communications distances of up to 15 km.

Fiber Choices

Multimode fiber core diameters from 50–200 µm using standard ST® connectors.

Flexible

Data rates up to 40 kbps; transceiver conversion delay of 36 µs plus propagation delay; DCE/DTE switch selectable.

Improved Safety

Isolates communications devices from ground potential rise and EMI/RFI. Eye-safe, Class 1 laser product per EN 60825-1.

Compact

Plugs directly onto DB-9 connector.

Convenient

Serial-port powered; no separate power supplies.

Secure

Maximum bit error rate (BER) of 10^{-9}.

Simple Testing

Continuous light pulses issued for simple functional verification using an optical meter.

Send serial data up to 15 km with SEL-2815 Fiber-Optic Transceivers. These transceivers provide the best in component isolation, low power consumption, and simplicity of use. The transceiver receives power from the host device, so no external power connections are required.
ST connectors provide the flexibility to select the fiber that best fits the design requirements. The SEL-2815 is also DCE/DTE switch selectable, eliminating the need for adapters.

Related Products

Price

Budgetary Retail, Quantity 1: $362

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

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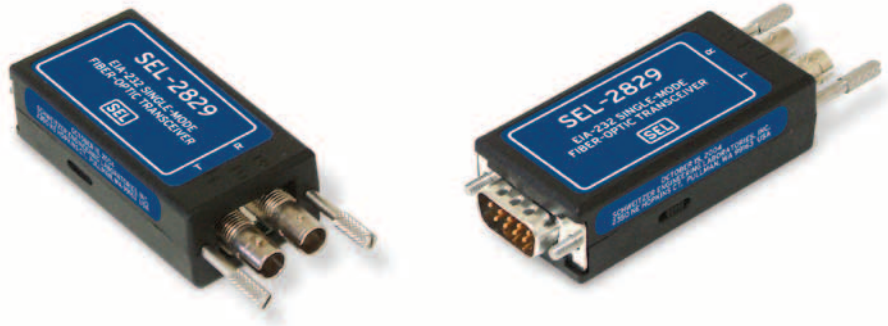
SEL-2829 Fiber-Optic Transceivers



Communicate 23 kilometers using two port-powered SEL-2829 Fiber-Optic Transceivers and single-mode fiber-optic cable.

Key Features

Long Range

Serial communications distances of up to 23 km.

Fiber Choices

Single-mode fiber with 9 or 10 µm core diameter using standard ST® connectors.

Flexible

Data rates up to 40 kbps; transceiver conversion delay of 36 µs plus propagation delay; DCE/DTE switch selectable.

Improved Safety

Isolates communications devices from ground potential rise and EMI/RFI. Eye-safe, Class 1 LED product per EN 60825-1.

Compact

Plugs directly onto DB-9 connector.

Convenient

Serial-port powered; no separate power supplies.

Secure

Maximum bit error rate (BER) of 10^{-9}.

Simple Testing

Continuous light pulses issued for simple functional verification using an optical meter.

Send serial data up to 23 km with SEL-2829 Fiber-Optic Transceivers. These transceivers provide the best in component isolation, low power consumption, and simplicity of use. The transceiver receives power from the host device, so no external power connections are required. The SEL-2829 is also DCE/DTE switch selectable, eliminating the need for adapters.

Related Products

SEL-C809 Single-Mode 9 µm Core Fiber-Optic Cables 476
SEL-2516 Rack-Mount Remote I/O Module 408

Price

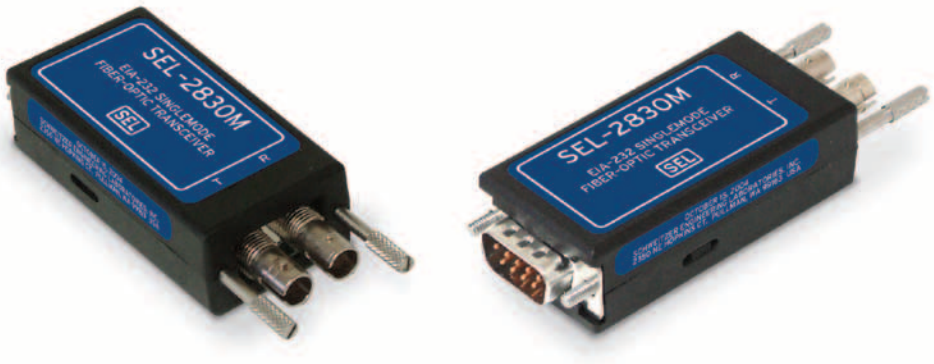
Budgetary Retail, Quantity 1: $700

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

SEL-2830 Fiber-Optic Transceivers



Communicate 80 kilometers using two port-powered SEL-2830 Fiber-Optic Transceivers and single-mode fiber-optic cable.

Key Features

Long Range

Serial communications distances of up to 80 km.

Fiber

Single-mode fiber with 9 or 10 µm core diameter using standard ST® connectors.

Flexible

Data rates up to 40 kbps; transceiver conversion delay of 36 µs plus propagation delay; DCE/DTE switch selectable.

Improved Safety

Isolates communications devices from ground potential rise and EMI/RFI. Eye-safe, Class 1 laser product per EN 60825-1.

Compact

Plugs directly onto DB-9 connector.

Convenient

Serial-port powered; no separate power supplies.

Secure

Maximum bit error rate (BER) of 10^{-9}.

Simple Testing

Continuous light pulses issued for simple functional verification using an optical meter.

Send serial data up to 80 km with SEL-2830 Fiber-Optic Transceivers. These transceivers provide the best in component isolation, low power consumption, and simplicity of use. The transceiver receives power from the host device, so no external power connections are required. The SEL-2830 is also DCE/DTE switch selectable, eliminating the need for adapters.

Related Products

Price

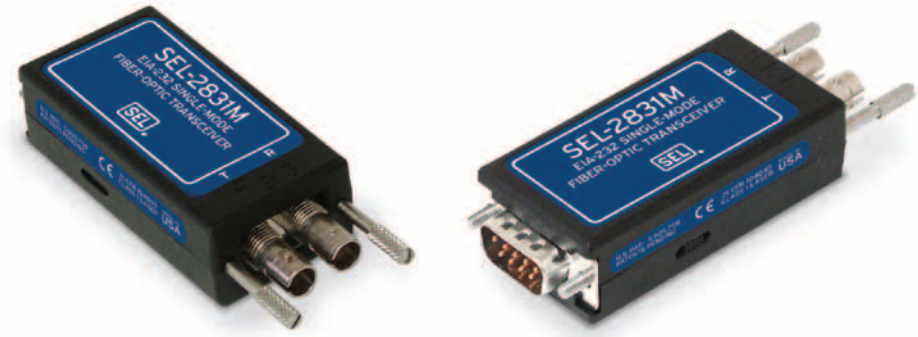
Budgetary Retail, Quantity 1: $980

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

SEL-2831 Fiber-Optic Transceivers



Communicate 110 kilometers using two port-powered SEL-2831 Fiber-Optic Transceivers and single-mode fiber-optic cable.

Key Features

Long Range

Serial communications distances of up to 110 km.

Fiber

Single-mode fiber with 9 or 10 µm core diameter using standard ST® connectors.

Flexible

Data rates up to 40 kbps; transceiver conversion delay of 36 µs plus propagation delay; DCE/DTE switch selectable.

Improved Safety

Isolates communications devices from ground potential rise and EMI/RFI. Eye-safe, Class 1 laser product per EN 60825-1.

Compact

Plugs directly onto DB-9 connector.

Convenient

Serial-port powered; no separate power supplies.

Secure

Maximum bit error rate (BER) of 10^{-9}.

Simple Testing

Continuous light pulses issued for simple functional verification using an optical meter.

Send serial data up to 110 km with SEL-2831 Fiber-Optic Transceivers. These transceivers provide the best in component isolation, low power consumption, and simplicity of use. The transceiver receives power from the host device, so no external power connections are required. The SEL-2831 is also DCE/DTE switch selectable, eliminating the need for adapters.

Related Products

SEL-C809 Single-Mode 9 µm Core Fiber-Optic Cables 476
SEL-2505 Remote I/O Module 396
SEL-2506 Rack-Mount Remote I/O Module 400
SEL-2516 Rack-Mount Remote I/O Module 408
SEL-91560 Attenuator Kit ..... selinc.com

Price

Budgetary Retail, Quantity 1: $1,500

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

SEL-9220 Fiber-Optic Adapter for SEL-300 Series Relays

Convert an EIA-485 port to a fiber-optic link for data and time synchronization by connecting to up to 4 km of fiber-optic cable.

Key Features

Accomplish More With a Third Serial Link

For applications that do not use an EIA-485 network, convert the eight-position EIA-485 port of an SEL-300 series relay to a fiber-optic port that is equivalent to an SEL-2812MR Fiber-Optic Transceiver. For example, connect an SEL-300G Generator Relay to an SEL-2600 RTD Module, an SEL-2664 Field Ground Module, and an SEL-3530 Real-Time Automation Controller (RTAC). Or, add I/O to an SEL distance or feeder relay via an SEL-2505 Remote I/O Module.

Easily Apply

Connects directly to the Port 1 connector with positive retention screws. Full-duplex serial data and IRIG-B time synchronization are provided via the connector. Attach with duplex SEL-C808 Fiber-Optic Cable to an SEL-2812MT Fiber-Optic Transceiver at the other end of the link.

Increase Safety and Signal Integrity

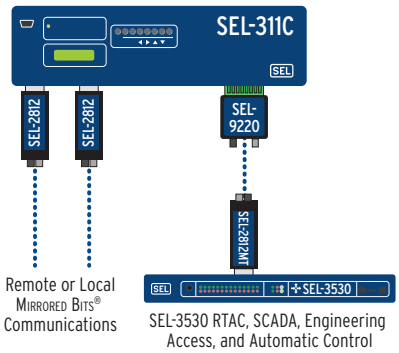
Isolate communications connections from ground potential rise and electrical interference using an eye-safe, Class 1 laser product per EN 60825-1.

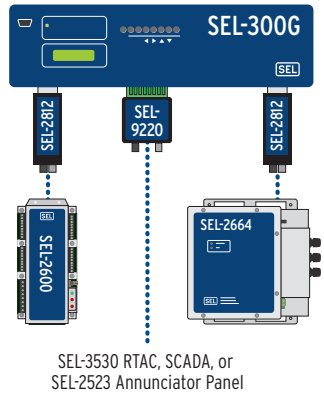
Related Products

Price

Budgetary Retail, Quantity 1: $320

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)





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SEL-2894 Interface Converter

Interface asynchronous communications devices to synchronous networks using the SEL-2894 Interface Converter and SEL fiber-optic cable.

Key Features

Innovative

Convert an asynchronous EIA-232 serial data interface (300 to 19200 bps) to a 64 kbps IEEE C37.94 synchronous fiber-optic interface.

Improved Safety

Completely isolate communications devices from ground potential rise and EMI/RFI. Eye-safe, Class 1 laser product per EN 60825-1.

Reliable

Provide low-noise and interference-free communication.

Fast

Support data rates from 300 to 19200 bps with less than 375 µs delay, back to back.

Compact Mounting

Plug directly onto EIA-232 port DB-9 connector.

TX/RX Indicators

Show incoming and outgoing fiber-optic states with TX and RX green LEDs.

IEEE C37.94 Yellow Alarm

A yellow LED indicates when a transmission problem occurred.

Convenient

Power interface converter from serial-port 5-Vdc power in SEL relays. Or, use external 0.7 mm power jack.

Flexible

Support IEEE C37.94 optical interface using ST® connectors and multimode fiber-optic cable. Works with SEL relays and other asynchronous EIA-232 devices and IEEE C37.94-compliant devices.

User Configurability

Select between internal and external timing for the IEEE C37.94 interface according to the specific application.

Use the SEL-2894 to interface asynchronous EIA-232 devices with synchronous networks for an efficient and reliable end-to-end connection. The SEL-2894 enables the SEL-2126 Fiber-Optic Transfer Switch to reroute Mirrored Bits® communications from EIA-232 interface relays. The SEL-2894 provides 2 km EIA-232 full-duplex communication over the IEEE C37.94 fiber-optic standard interface.

The converter connects directly to a standard 9-pin serial port and receives power directly on Pin 1, so no external power is required when used with SEL relays. However, the converter can also receive power from an external supply when connected to other devices. Cable assemblies are available from SEL.

Related Products

SEL ICON™ Integrated Communications Optical Network 358
SEL-C807 Multimode 62.5 µm Core Fiber-Optic Cables 472
SEL-2126 Fiber-Optic Transfer Switch 444
SEL-9321 Low-Voltage DC Power Supply 490
230-0601 AC Power Supply 491

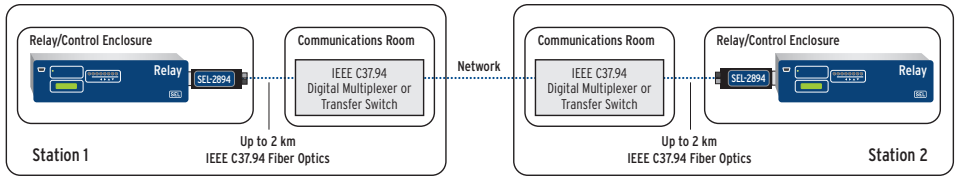
Price

Budgetary Retail, Quantity 1: $350

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.



Transfer SEL Mirrored Bits® communications between stations via IEEE C37.94 fiber-optic links and multiplexers.

SEL-3094 Interface Converter

Use the SEL-3094 Interface Converter to provide an IEEE C37.94 interface.

Key Features

IEEE C37.94 Standard Conversion

Convert older electrical teleprotection interfaces to the newer optical standard. The SEL-3094 Interface Converter links devices with ITU-T G.703, EIA-422, EIA-485, or EIA-232 electrical interfaces to IEEE C37.94 fiber-optic devices.

Easy Application

Configure all settings with ten control (DIP) switches. LEDs indicate the state of inputs, outputs, and the communications link.

High Speed

Use one 64 kbps time slot in a digital multiplexer.

Improved Safety and Isolation

Provide isolation from dangerous ground potential rise, prevent induced electrical noise, and eliminate signal ground loops with fiber-optic connections. Eye-safe, Class 1 laser product per EN 60825-1.

Universal Power

Power supply operates from 18 to 300 Vdc and 85 to 264 Vac.

Applications

- Convert ITU-T G.703, EIA-422, EIA-232, or EIA-485 electrical links to IEEE C37.94 fiber-optic standard.
- Apply the SEL-3094 at the electrical connection of a:
  - Noncompliant multiplexer
  - Noncompliant relay
  - Both noncompliant relay and multiplexer
- Use two SEL-3094 Interface Converters as a channel simulator for testing relays with an ITU-T G.703, EIA-422, EIA-232, or EIA-485 digital interface.

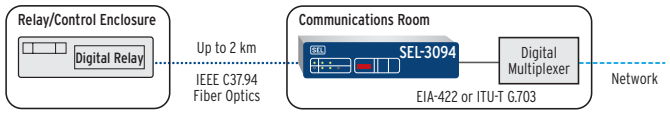
Related Products

Price

Budgetary Retail, Quantity 1: $685

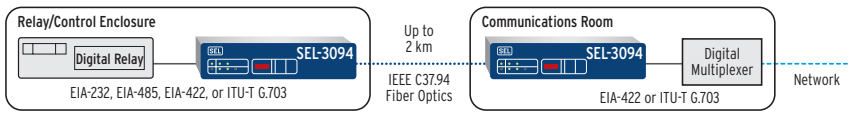
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

Application Examples



Link an IEEE C37.94-compliant relay (i.e., SEL-311L) to a noncompliant multiplexer.

Connect a relay using its electrical interface to an IEEE C37.94-compliant multiplexer or transfer switch (i.e., SEL-2126).



Use optical fiber between relays and multiplexers that have only electrical interfaces available.

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

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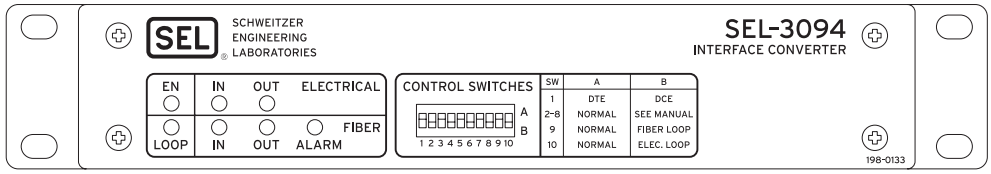
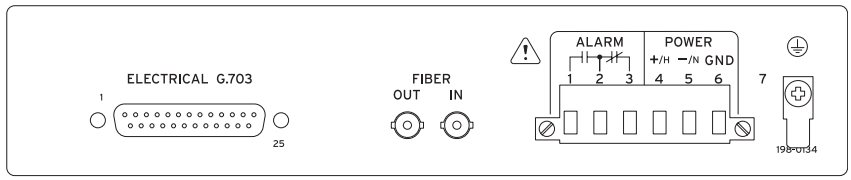
SEL-3094 Interface Converter

Front View – Rack-Mount

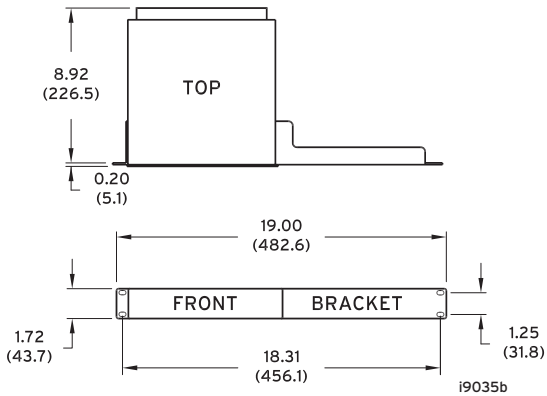


Rear View (30940CB_X)

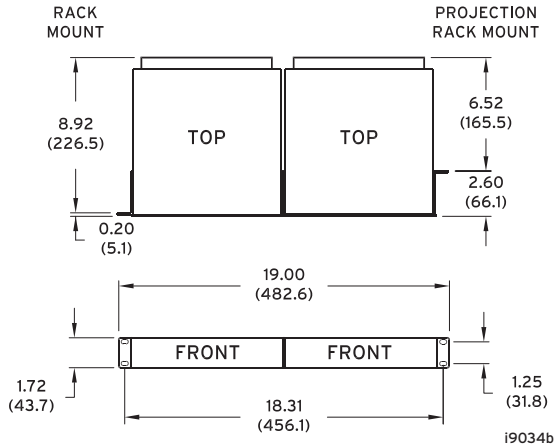


Dimensions

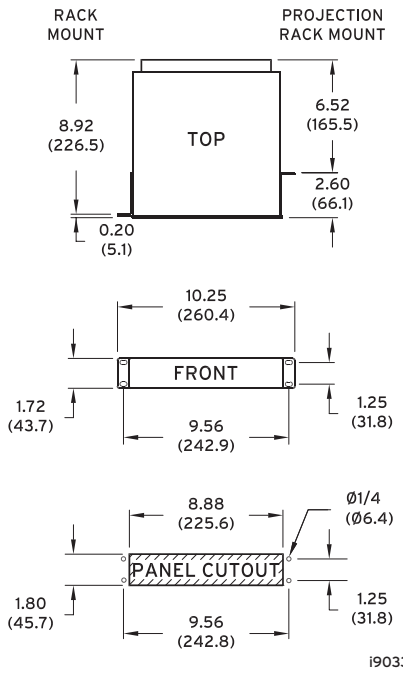
SINGLE RACK-MOUNT CHASSIS



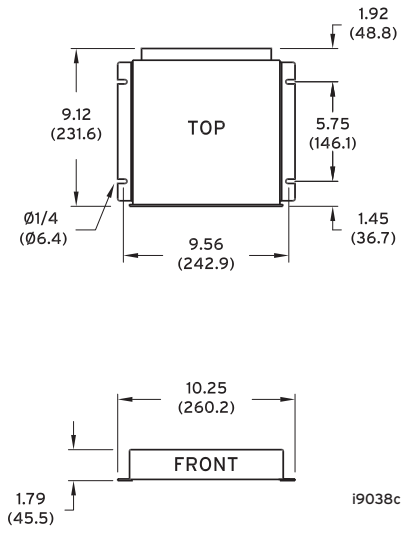
DUAL RACK-MOUNT CHASSIS



PANEL-MOUNT CHASSIS



SURFACE-MOUNT CHASSIS



SEL-2126 Fiber-Optic Transfer Switch

Reroute fiber-optic relay communications in main-bus/transfer-bus applications with the SEL-2126 Fiber-Optic Transfer Switch.

Key Features

IEEE C37.94 Compliant

Transfer multiple communications protocols carried on the IEEE C37.94 standard fiber-optic interface.

I/O Contacts

Apply 16 contact inputs to control fiber-port routing and two output contacts to report system status (ALARM or ACTIVE).

High Speed

Fiber through delay is <10 µs.

Easy Visualization

Quickly identify status with intuitive and easy-to-read, front-panel diagnostic LEDs.

Flexible

Reroute communications from as many as six pairs of line protection relays to either or both of two bus-tie relays.

Dependable

Improve protection scheme availability. Allow pilot tripping and current differential protection to remain in service during breaker or relay maintenance.

The SEL-2126 routes IEEE C37.94 synchronous communication to redirect protection data streams during circuit breaker or station bypass operations. The SEL-2126 maintains unit line protection even during breaker or relay maintenance by rerouting line protection communications to either or both of two bus-tie relays.

Quickly and cleanly reroute any communications protocol carried on the IEEE C37.94 fiber-optic interface standard without moving fiber connectors or changing communications equipment programming. Reroute current differential communications from SEL-311L Relays, Mirrored Bits® communications with the SEL-2894 Interface Converter, or any synchronous communications converted to the IEEE C37.94 interface standard with the SEL-3094 Interface Converter. For the only total fiber-optic rerouting solution in the industry, select the SEL-2126.

Related Technical Support Materials

Preserve High-Speed Protection During Bypass Operations
J. Gastón Ortega and Elijah Nelson

Using the SEL-2126 Fiber-Optic Transfer Switch and the SEL-321-1 in Bypass-Breaker Mirrored Bits Communications-Assisted Tripping Schemes (Application Guide AG2005-09)
Jacob Reidt and Brad Heilman

These documents and other related documents for this product are available from SEL. Visit **www.selinc.com** to download these as well as more than 600 other technical documents.

Tel: +1.509.332.1890 | Fax: +1.509.332.7990 | www.selinc.com

SEL-2126 Fiber-Optic Transfer Switch

Applications

- Preserve high-speed line protection by communications-assisted tripping schemes (POTT, DCB, 87L) during circuit breaker or substation bypass maintenance operations.
- Maintain primary and backup protection communications during circuit breaker operations on main-bus/transfer-bus or single-breaker double-bus configurations, or during substation bypass operations or three-terminal line applications.
- Perform local or remote relay testing, routing both local and remote relays to the transfer ports.
- Use the 16 contact inputs to control fiber-port routing, and use the two output contacts to report system status.
- Change group protection settings automatically on the transfer relay to match the bypassed-relay protection settings, or use an SEL-SSE, SEL-SSP, or any other selector switching scheme.

Optional Features

- Panel-mount or rack-mount hardware.

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Hardware Specifications

Power Supply Ratings

Range	18–300 Vdc or 85–264 Vac
Burden	<15 W

Standard Control Input Voltage Options

24, 48, 110, 125, 220, or 250 Vdc

Fiber-Optic Channels

Mode	Multimode
Wavelength	850 nm
Connector type	ST®
Typical TX power level	–23 to –11 dBm into 50 µm fiber
RX sensitivity	-32 dBm at 2.048 Mbps

Eye-safe, Class 1 laser product per EN 60825-1

Operating Temperature

–40° to +85°C (–40° to +185°F)

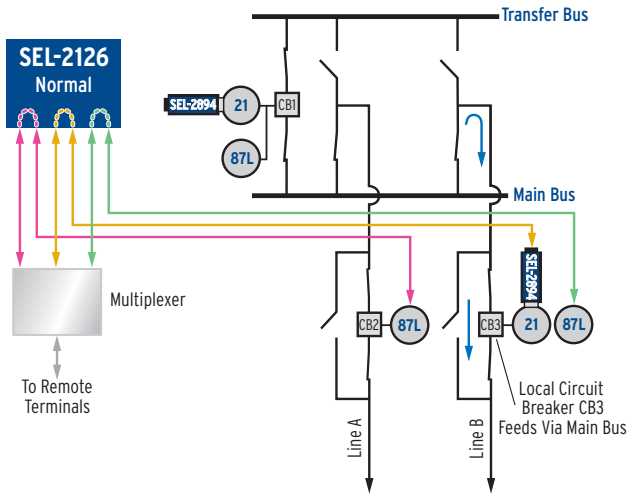
Price

Budgetary Retail, Quantity 1: $2,730

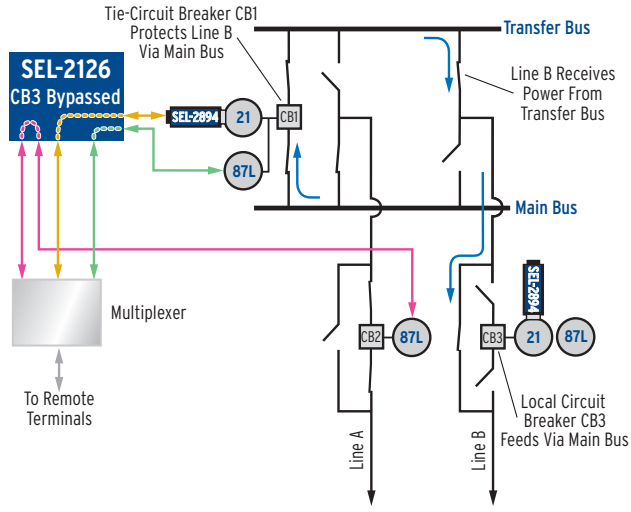
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

Main-Bus/Transfer-Bus Application Diagram

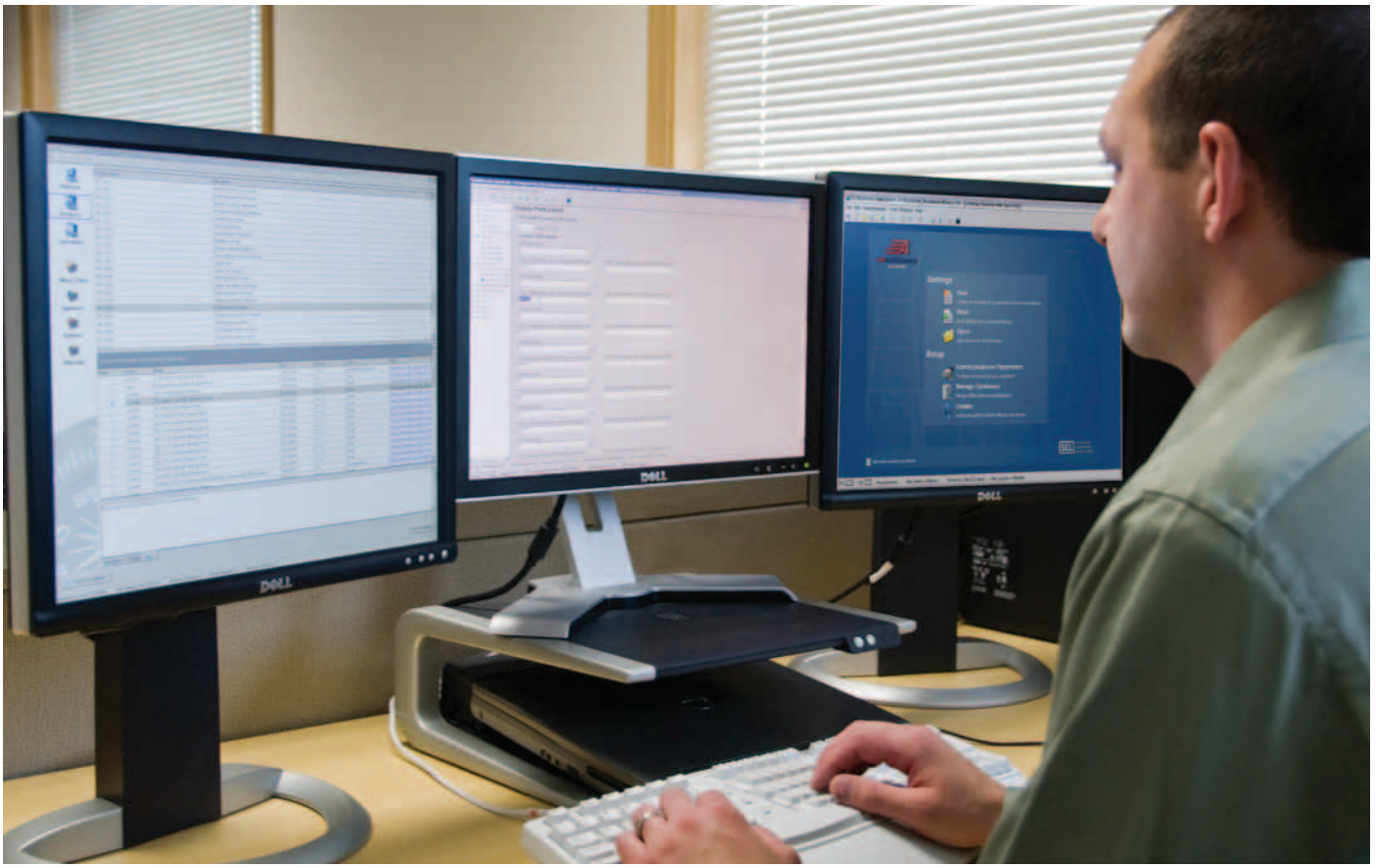
Normal Operation



Bypassed Operation



Software Solutions



Software Product Index

Software Category List

Design and Engineering

ACSELERATOR QuickSet Designer® SEL-5031
Create and edit QuickSet Design Templates for use by ACSELERATOR QuickSet® SEL-5030 Software.

SEL-5802 Motor Modeling Program
Model thermal behavior of induction motors.

SEL-5801 Cable Selector Program
Select cable to connect devices.

SEL-5804 Curve Designer
Design user-defined, time-overcurrent curves for SEL-351R Recloser Controls. Download from **www.selinc.com**.

SEL-5806 Curve Designer
Design user-defined, volts-per-hertz curves for SEL-387E Current Differential and Voltage Relays. Download from **www.selinc.com**.

ACSELERATOR Architect® SEL-5032
Design and commission IEC 61850 solutions that include SEL IEDs.

Settings and Configuration

ACSELERATOR QuickSet SEL-5030
Use Settings Editors or QuickSet Design Templates to create and edit device settings. Manage settings for multiple devices.

SEL-5020 Settings Assistant
Create and edit communications processor settings.

SEL-5809 Settings Software
Use settings software for SEL-3021-1 Serial Encrypting Transceivers and SEL-3022 Wireless Encrypting Transceivers (order with product, see pages 364–367).

SEL-5860 Time Service Software
Turn your SEL satellite-synchronized clock into a network time source. Free download, works with SEL-2401, SEL-2404, and SEL-2407® Satellite-Synchronized Clocks (see pages 308–317).

Data Retrieval and Analysis

ACSELERATOR Report Server® SEL-5040
Automatically retrieve, save, and summarize event reports from SEL devices.

ACSELERATOR Report Viewer® SEL-5042
View event reports and summary files remotely from computers on the same network as a PC executing ACSELERATOR Report Server.

Event Waveform Viewer
Built into SEL-5040, SEL-5030, and SEL-5031 to view event reports as oscillograms.

ACSELERATOR Analytic Assistant® SEL-5601
Display graphical event reports using many features and views.

SEL-5076 SYNCHROWAVE® Archiver Software
Store data in either COMTRADE or text format. Choose the number of channels, the data rate, and the length of storage to fit your needs.

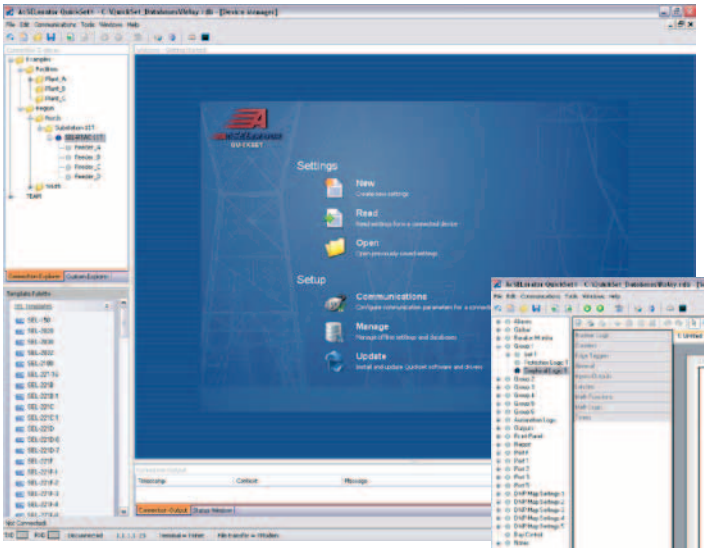
SEL-5077 SYNCHROWAVE Server Software
Automatically retrieve, concentrate, and publish synchronous phasor measurement data.

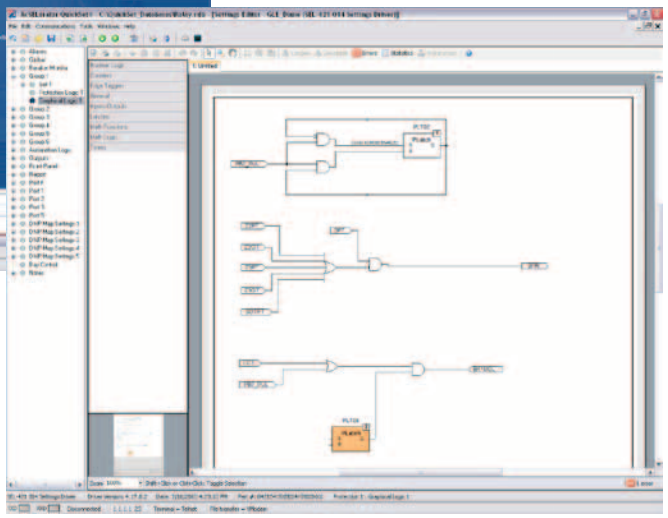
SEL-5078 SYNCHROWAVE Console Software
Visualize and archive synchronous phasor measurement data for wide-area system analysis.

SEL-5810 Virtual Serial Software
Encrypted serial port software for SEL-3022 Wireless Encrypting Transceivers (see pages 366–367).

SEL-5045 ACSELERATOR TEAM™ Software
Systematize and integrate your system data and assets using the TEAM Software solution.

ACSELERATOR QuickSet® SEL-5030 Software





Reduce the time required to program settings.

Key Features

- Support multiple device families, models, and versions.
- Create, edit, store, transfer, and manage SEL device settings.
- Develop programmable logic equations offline with easy-to-use configuration tools.
- Test and commission installations with display of line device measurements and status information.
- Use the configurable human-machine interface to obtain pertinent device data locally or from a remote location.
- Use the built-in waveform viewer to quickly analyze fault records and device element response.
- Obtain full integration with ACSELERATOR QuickSet Designer® SEL-5031 templates and logic drawings for creating custom views of settings to simplify commissioning of multiple SEL devices.
- Upgrade or downgrade device firmware while maintaining settings.
- Retrieve updates delivered to your computer on a schedule that you choose through SEL Compass® Software.

Visit **www.selinc.com/SEL-5030** for the current list of supported products.
For features supported for each device, consult device documentation.

Price

Included with supported products.

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

ACSELERATOR QuickSet SEL-5030 Software

Manage Performance

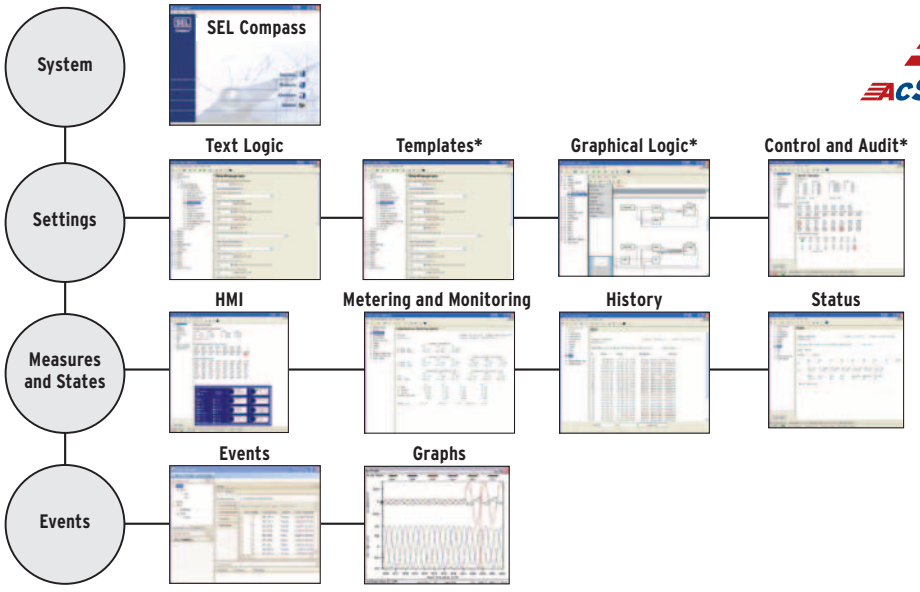
- Create, edit, store, transfer, and manage SEL device settings.
- Develop programmable logic equations offline with easy-to-use configuration tools.
- Obtain pertinent device data locally or remotely with the configurable HMI.
- Quickly graph load profile or other data using the built-in tools.

Analyze Performance

- Analyze fault records and device element response quickly with the built-in Event Waveform Viewer.
- Automatically check interrelated settings, and highlight out-of-range settings.
- Convert relay event reports to oscillography with time-coordinated element assertion and phasor/sequence element diagrams.
- Compare settings offline or online with ACSELERATOR QuickSet.

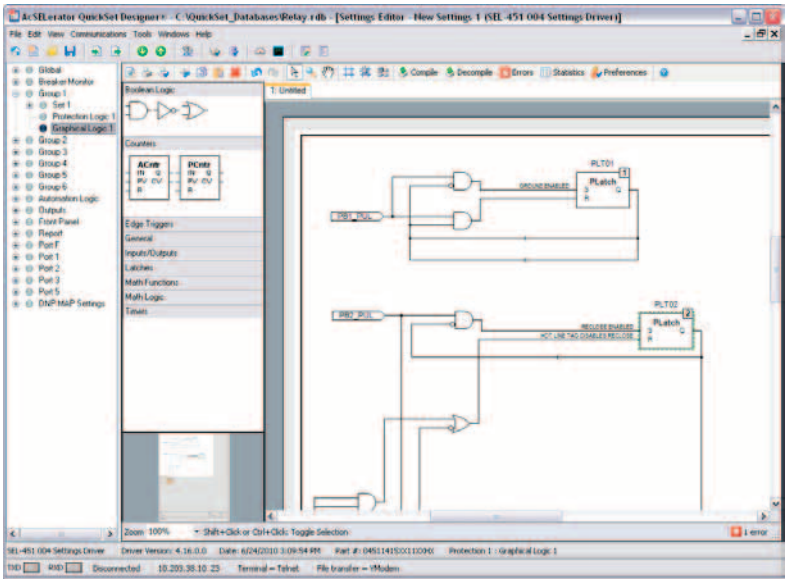
Implement Solutions

- Distribute QuickSet Design Templates to new and existing devices for quick, consistent setup.
- Download and implement firmware updates for installed devices.
- Easily move, cut, copy, and paste free-form logic equations and replicate them across multiple devices, reducing setup times.
- See changes as you make them, rather than relying on a traditional numerical input, with the graphical load-encroachment editor.
- Associate user comments with device settings.



*QuickSet supports viewing. Editing requires QuickSet Designer.

ACSELERATOR QuickSet Designer® SEL-5031 Software



Create custom templates for SEL products to streamline new device deployment and increase reliability.

Key Features

Build and Edit QuickSet Design Templates

Create custom views of settings, called QuickSet Design Templates, to lock settings to match your standards, or to lock and hide unused settings. This simplifies new installations and helps assure that new devices are applied according to your organization's standards.

Deploy Settings With QuickSet Design Templates

Import QuickSet Design Templates into ACSELERATOR QuickSet® SEL-5030 Software. Bring additional devices online quickly through application-specific settings.

Download Version Updates Via the Web

Receive updates to your computer on a schedule that you choose with SEL Compass® Software. Additionally, install new device-setting drivers directly from the web.

SEL-400, -700, -2400 Series Graphical Logic

Simplify the process of configuring your SEL-400, -700, -2400 series devices with the new graphical logic editor in QuickSet Designer. Design your SELOGIC® control equations with drag-and-drop ease of use, which allows you to document your settings files.

- Converts existing SELOGIC control equations to graphical logic.
- Saves diagrams with QuickSet settings.
- Produces automatic layouts.
- Fully supports drag-and-drop functions.
- Features full element palette.
- Supports aliases and comments.

Application Examples

QuickSet Design Templates streamline settings, reduce engineering time, and eliminate settings entry errors in various possible applications.

Protect a Line of Motors or Transformers

To install a new device, personnel enter only nameplate data and the ID. QuickSet then calculates settings from entered data, using protection, integration, and I/O assignment settings predetermined in the templates.

Protect and Automate a Feeder Network

Simply enter ID and load data for each recloser. A QuickSet Design Template then calculates protection and reclosing settings, using standard Automatic Network Reconfiguration and integration settings.

Apply Distance Protection

Create a QuickSet Design Template with QuickSet Designer that applies standards to calculate distance and load-encroachment settings. Personnel then enter only the ID, line parameters, and load size for each relay.

Price

Single-Seat License: $1,500

Five-Seat License: $3,500

Ten-Seat License: $5,000

Corporate License Package: $16,000

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

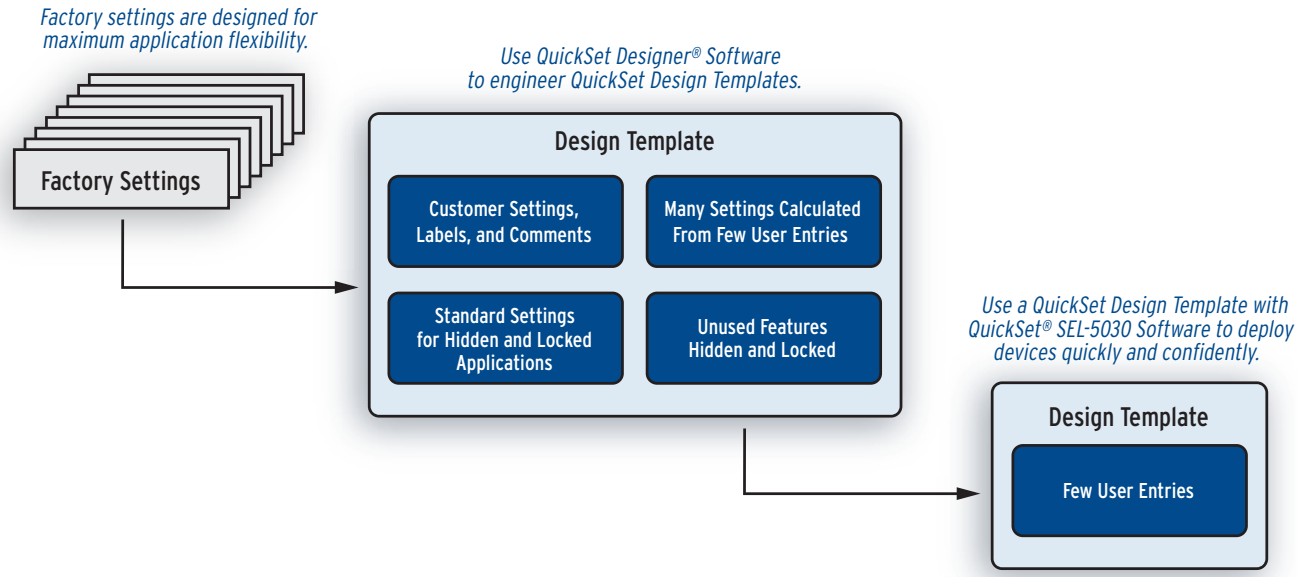
GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

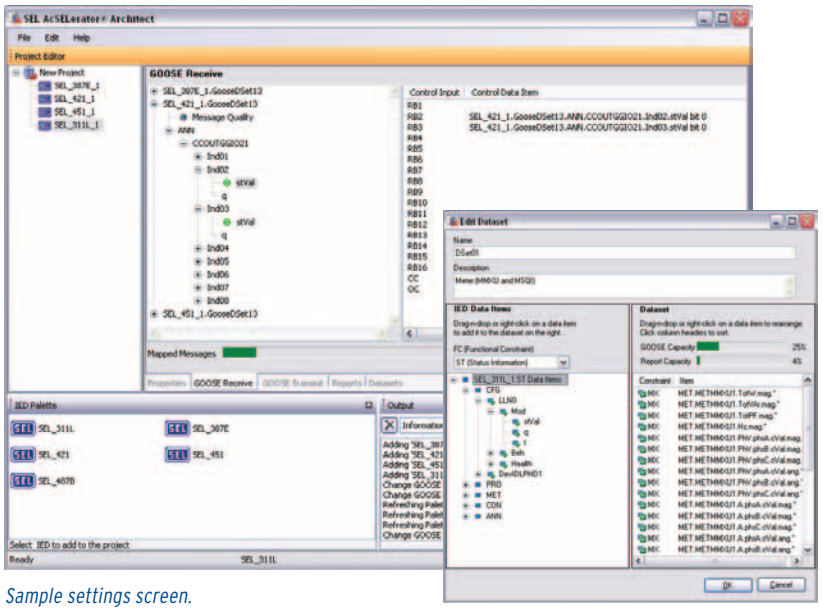
ACSELERATOR QuickSet Designer SEL-5031 Software

Develop and Deploy Settings in Five Simple Steps

1. Design a standard application for an SEL device. Select settings that will be hidden, fixed, calculated, and documented with names and comments.
2. Use QuickSet Designer to create, review, and test a QuickSet Design Template for standard SEL device applications.
3. Export the template, and deliver it to the technician responsible for SEL equipment deployment.
4. Import the template into QuickSet, and create installation settings for each device with a consistent setup.
5. Use QuickSet to transfer settings and commission devices.



ACSELERATOR Architect® SEL-5032 Software



Sample settings screen.

Easily edit data sets for GOOSE messages and reports.

Design and commission SEL IEDs in IEC 61850 substations.

SEL IEC 61850

Key Features

- Create and edit data sets.
- Create Generic Object Oriented Substation Event (GOOSE) transmit messages.
- Map GOOSE receive messages to IED's input bits from SEL and non-SEL relays.
- Utilize predefined reports.
- Create Configured IED Description (CID) files to send to SEL IEC 61850-compliant relays.
- Read, compare, and analyze CID files from all supported SEL devices.
- Export Substation Configuration Description (SCD) files to easily archive IEC 61850 substation configuration settings.
- Print to any connected printer for easy "offline" analysis.
- Utilize user-designed reports.

Price

Included with supported products.

Applications

Streamline System Design

Easily configure and document IEC 61850 communications between devices from several suppliers by using ACSELERATOR Architect.

- Import and export Substation Configuration Language (SCL) files to simplify system implementation.
- Detect and report errors by automatically comparing SCL files to the IEC 61850 requirements.
- SCL files include:
  - SCD—Substation Configuration Description
  - ICD—IED Capability Description
  - CID—Configured IED Description
- Easily use with these tools:
  - Drag-and-drop functionality
  - IED palette manager
  - Tab orientation
  - Diagnostic windows
  - Settings wizard

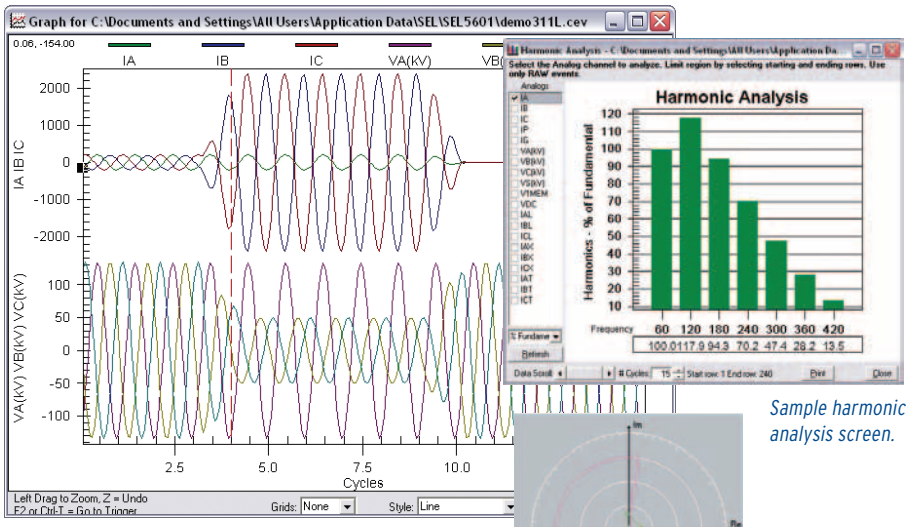
Reduce Engineering Effort With IEC 61850 Substation Configuration Language

Standardized and automated methods create and implement configuration information. Multiple suppliers use SCL files to report IED communications capabilities. Only SEL relays configure their communications based on received SCL files.

Visit **www.selinc.com/61850** for the current list of IEC 61850 products.
For features supported for each device, consult device documentation.

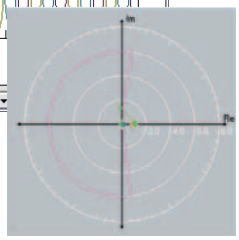
Note: Use SEL Compass® to receive updates

acSELerator Analytic Assistant® SEL-5601 Software



Sample oscillographic display.

Sample harmonic analysis screen.



Sample Alpha Plane plot.

Display oscillograms and vector diagrams to analyze event reports from SEL relays and COMTRADE files.

Key Features

- Use with SEL relay compressed event reports.
- Import COMTRADE 1991, COMTRADE 1999, and binary COMTRADE files.
- Display oscillograms with time-coordinated element assertion.
- Display phase and sequence phasors with manual or automatic advance.
- Display time-synchronized data from multiple event reports on a single plot. Use this feature to display event data from SEL-487B Bus Differential and Breaker Failure Relays.
- Simplify event analysis with point-and-click ease.
- Enhance clarity and versatility of synchronized analog and digital traces in standard SEL relay event reports.
- View all aspects of event reports with the click of a button:
  - Settings
  - Oscillographic display
  - Sequence and phasor display
  - Harmonics
  - Alpha Plane (SEL-311L, SEL-387L)
- Display multiple time-synchronized event reports on common time axis.
- View multiple events in a single file.
- Install on same PC to use with acSELerator QuickSet® SEL-5030, acSELerator QuickSet Designer® SEL-5031, and acSELerator Report Viewer® SEL-5042 Software.

acSELerator Analytic Assistant SEL-5601 Software accepts SEL relay event reports and COMTRADE files. You can view the records graphically, as oscillography with time-coordinated element assertion, or as phase and sequence phasors with manual or automatic advance. You can also view SEL relay settings and assign names to both analog and digital channels.

Price

Single-Seat License: $135

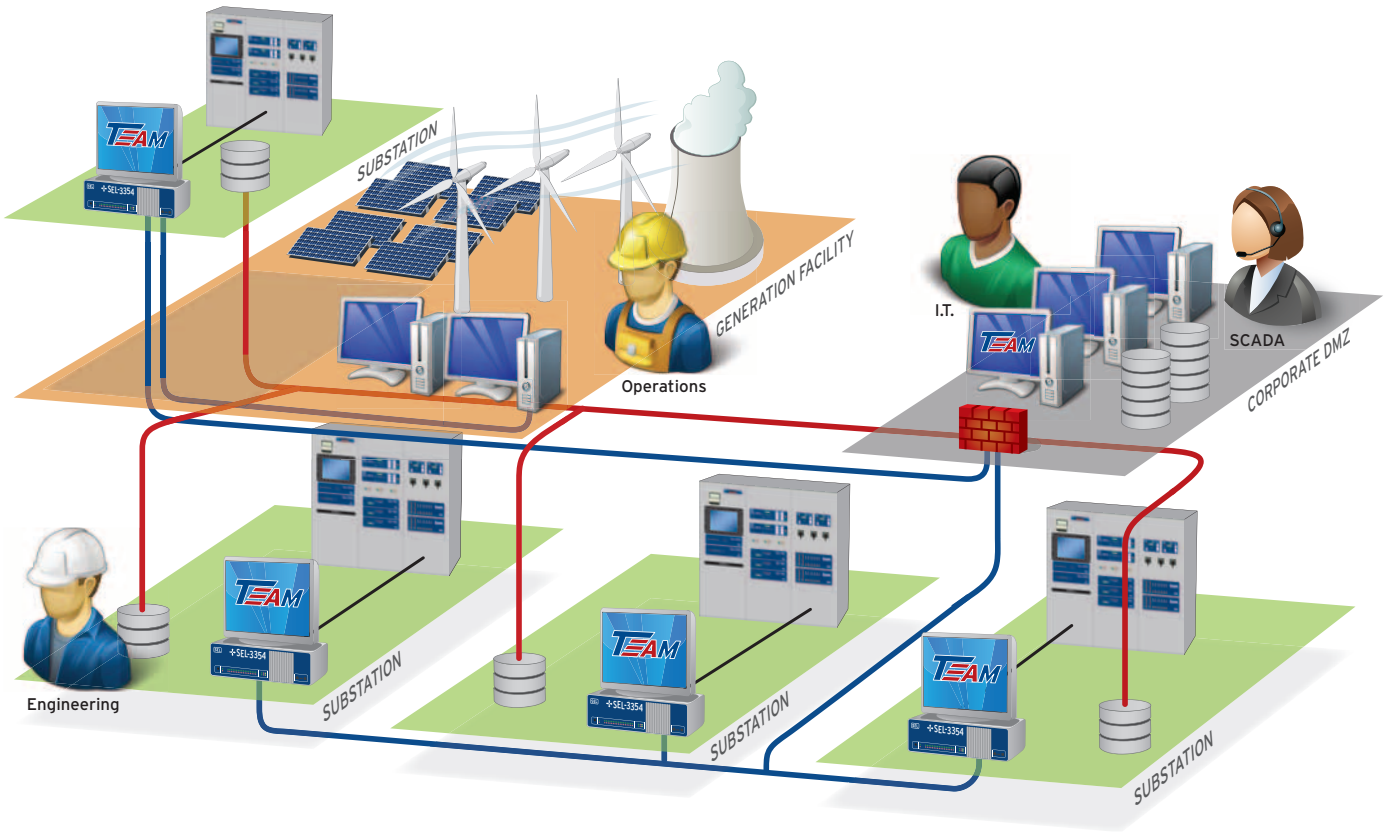
(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

Note: Use SEL Compass® to receive updates

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

ACSELERATOR TEAM™ SEL-5045 Software



TEAM SEL-5045 Software solutions offer a visual, highly intuitive interface, so individuals or groups can easily create, organize, and document assets and tasks across their entire system.

Key Features

The TEAM system provides the infrastructure necessary for most of your data collection needs. Our system provides tools such as communications, services, and SQL database, configuration, importing, and much more. These tools support communication with your devices; automatic collection of data on your equipment assets; and creation of reports, warnings, and alarms when necessary. The system is built on a flexible, multitiered architecture that supports distributed computing and parallel communications for fast and efficient data collection. It also supports the ability to create, edit, and modify customized data collection scripts.

Improve Productivity

Configure your system with drag-and-drop and other ease-of-use technologies. Reduce duplicated data. Create customized reports. Send notifications via email.

Manage Device Data

Organize devices by system hierarchy with the built-in device management tools. Create and manage data about these devices or locations. Information includes communications connections, physical locations, device associations, and more.

Support NERC Compliance

TEAM provides capabilities that simplify outage reports necessary for NERC disturbance reporting requirements.

Collect Data Quickly and Efficiently

Collect hundreds of event reports from multiple sites using information processors, modems, and Ethernet. Collect stranded data using built-in script capabilities. Collect and store data in the directory of your choice.

ACSELERATOR TEAM SEL-5045 Software

Manage Event Data

Event Collection

Using TEAM's Events feature, you can collect SEL event reports, and process and store data in a centralized SQL database. This feature also provides an intuitive event viewer to help you determine the events you want to analyze with the ACSELERATOR Analytic Assistant® SEL-5601 Software or other visualization applications. The TEAM Events feature dramatically outperforms previous event collection solutions.

Easy-to-Use Features

- Imports existing COMTRADE and SEL event report files.
- Exports events in COMTRADE format for further analysis.
- Exports event summaries in spreadsheet, HTML, and other formats.
- Integrates with event analysis tools like the ACSELERATOR Analytic Assistant Software.
- Provides predefined jobs and tasks for event report collection.
- Supports job assignment to one or more devices in a single step.
- Automatically tailors predefined jobs for SEL devices.
- Saves normalized event data in an SQL database.
- Includes an integrated event viewer with grouping and filtering options that simplify data access.
- Categorizes associated events into system incidents.
- Imports ACSELERATOR Report Server® SEL-5040 Software event data.

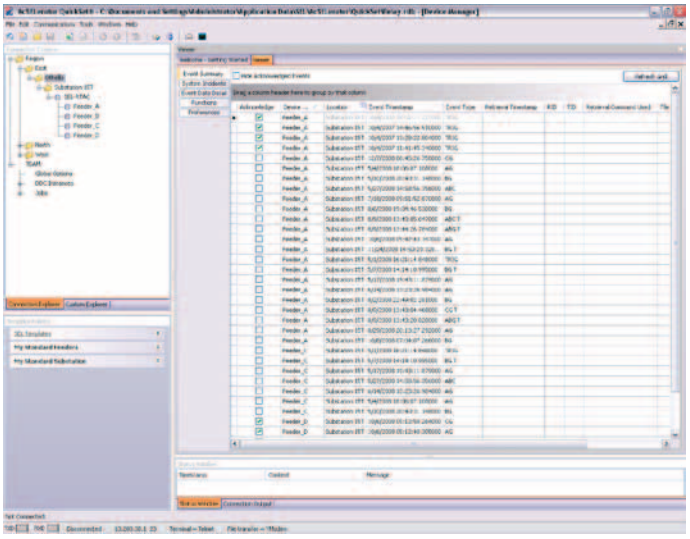
System Event Organization

Define and use system incidents to categorize and group associated events with a particular incident such as a tornado. Use this capability to easily find data and to help meet NERC audit requirements.

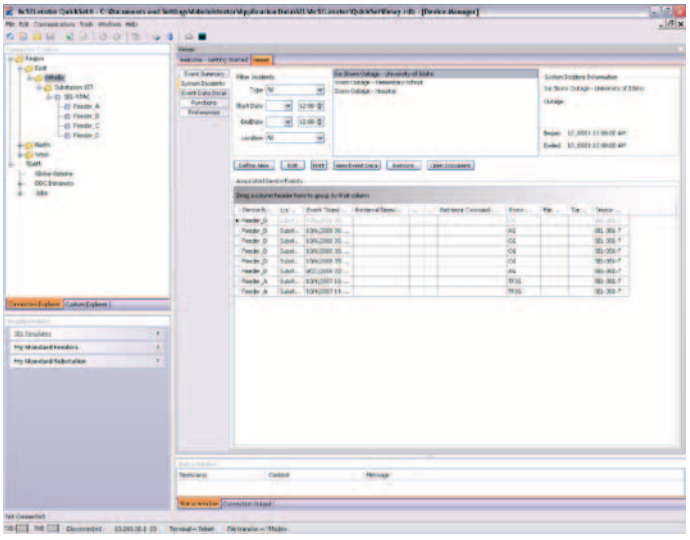
Event Summaries

Event Viewer presents event summaries of collected events in list form to facilitate finding a desired event.

- Automatically hide acknowledged events when desired.
- Order, group, sort, and filter summaries by location or device using the intuitive software interface instead of browsing through files and folders. For example, event summaries can be filtered to a specified time window.



Systematize events as they are collected throughout the system.



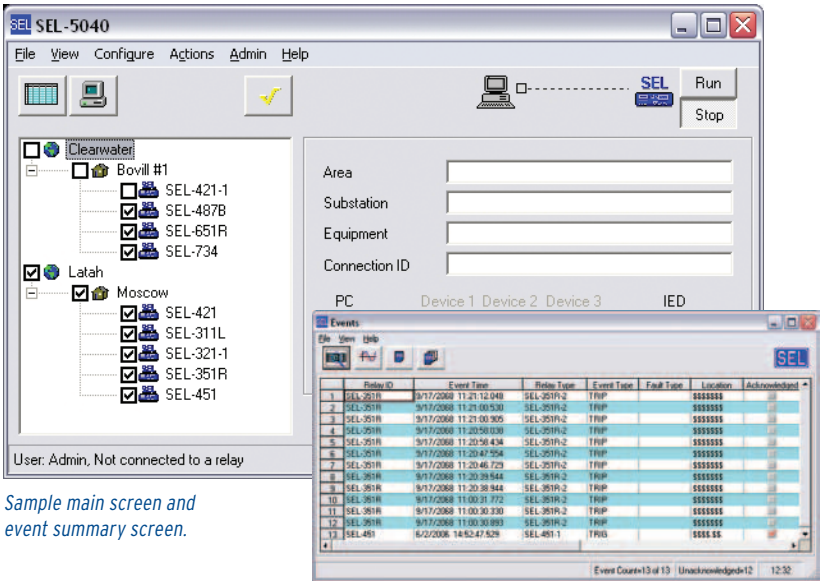
Assign events to system incidences for record keeping.

Price

Budgetary Retail, Quantity 25 Connected Devices: $2,500

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

ACSELERATOR Report Server® SEL-5040 Software



Sample main screen and event summary screen.

Reduce time retrieving reports and analyzing system events.

Key Features

- Save significant time compared to manually connecting to each relay, reviewing history reports, selecting files, and waiting for each file to upload.
- Automatically collect and file event reports.
- Create a Microsoft® Access® database record for each event.
- View oscillogram and vector diagrams for each event.
- Use summary screen to view records and select events, report text, display graphs, and manually upload long event reports.
- Set report retrieval method to poll, listen, or both.
- Communicate via dial-in, dial-out, and direct links, using modems and information processors in links between PC and relays.
- Use the Ethernet option to communicate with Ethernet-equipped SEL devices, SEL-2890 Ethernet Transceivers, or other Ethernet converters.
- Notify engineers automatically by setting the Report Server to send an email message with each new event report collected.
- Use SEL Application Guide AG2000-08 to set SEL information processors and relays to interact with the Report Server.

If you are responsible for outage analysis, outage management, or relay settings coordination, then fault information in relay event reports is important to you. The Report Server automatically collects and files the 1/4-cycle resolution event reports, so they are waiting on your computer when you need them.

The Report Server creates a Microsoft Access database record per event. Using criteria that you provide in advance, it selectively retrieves higher-resolution, long event reports.

The summary database lets you quickly select the short and long event reports of interest. You can then view and analyze the oscillograms.

Related Products

Use ACSELERATOR Analytic Assistant® SEL-5601 Software for more analysis options. This software is automatically used for graphical displays if loaded with the Report Server 453

Use ACSELERATOR Report Viewer® SEL-5042 Software for remote access of Report Server data 457

Price

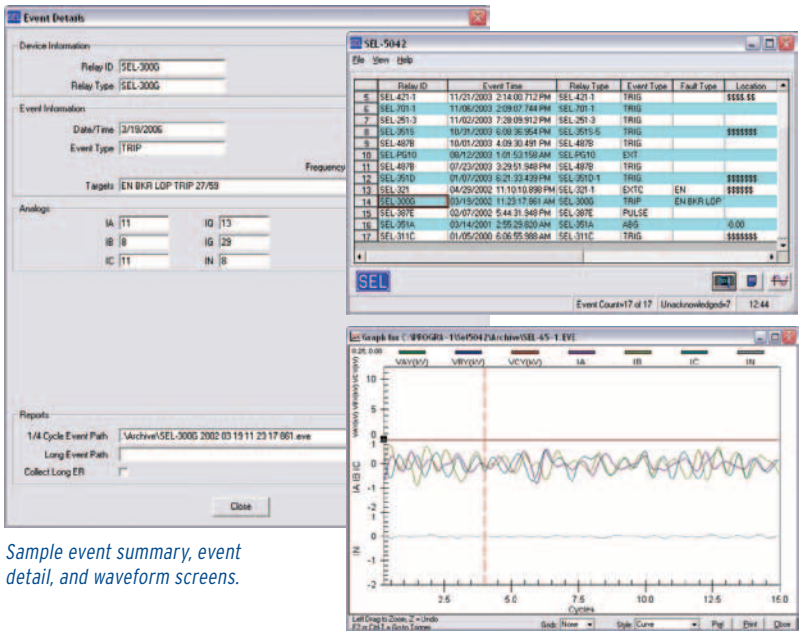
Budgetary Retail, Quantity 1: $1,175

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

ACSELERATOR Report Viewer® SEL-5042 Software

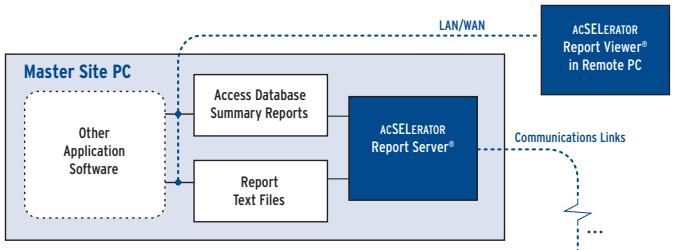


Sample event summary, event detail, and waveform screens.

Remotely view ACSELERATOR Report Server® SEL-5040 summary data and event reports for increased security and efficiency.

Key Features

- Remotely view summary and event report data collected by Report Server. Connect to Report Server through an Ethernet network.
- Increase security because only the Report Server communicates with the relays and uses access passwords. Use the Report Viewer to read information from the Report Server files.
- Increase engineering analysis efficiency by allowing each engineer with a Report Viewer license to access and analyze event report information from their workstation.
- Use ACSELERATOR Analytic Assistant® SEL-5601 Software to analyze event reports in the Report Viewer environment.



At an engineering or enterprise-wide master PC, the Report Server communicates with remote sites to collect and summarize reports, and select and collect long event reports. The software provides management and analysis tools to help you quickly analyze and use power system reports.

Report Server and Viewers.

Related Products

Use the ACSELERATOR Analytic Assistant SEL-5601 Software for more analysis options. This software is automatically used for graphical displays if loaded with the Report Viewer 453

Access ACSELERATOR Report Server SEL-5040 data 456

Price

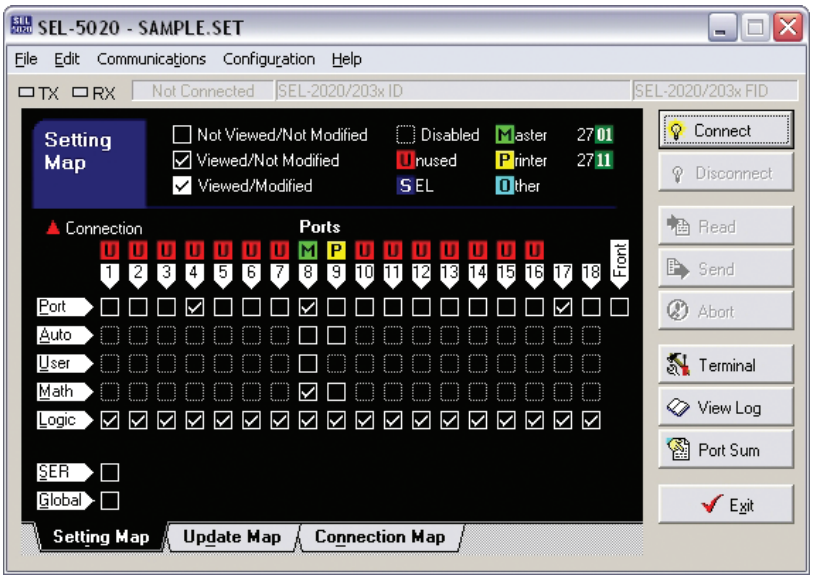
Included with supported products.

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

SEL-5020 Settings Assistant Software



Sample settings screen.

Enter settings to communicate with your SEL-2032 Communications Processors.

Key Features

- Create all SEL-2032 Communications Processor settings at your desk without the communications processor attached.
- Save and retrieve settings from your PC.
- Create complex strings and SELOGIC® control equations using string and expression builders.
- Retrieve communications processor settings with the Settings Assistant.
- Send settings from the Settings Assistant to the SEL-2032, with or without relays attached.
- Use the Ethernet option to configure the Ethernet-equipped SEL communications processor.
- Use online help for detailed information on the Settings Assistant, plus information from SEL-2032 instruction manuals.

The Settings Assistant is a graphical user interface that provides an intuitive Windows® environment for setting and communicating with SEL-2032 Communications Processors. The Settings Assistant helps you create or edit settings in the office and establish local or remote communication between the Settings Assistant on the PC and SEL communications processors. Once connected, you can send or read settings.

Price

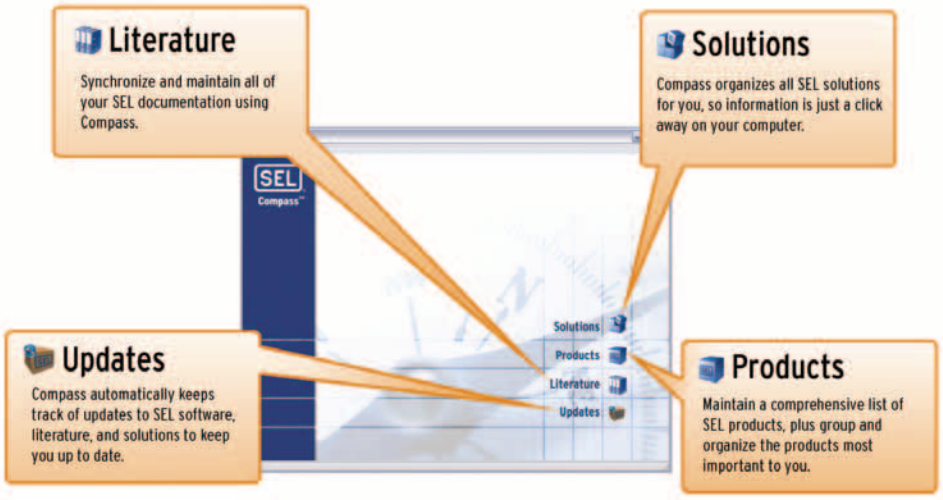
Included with supported products.

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

SEL Compass®



Navigating your way through SEL products has never been easier.

Key Features

SEL Compass offers a visual, highly intuitive interface for easy notification of product updates as well as downloads and sharing of the many products and information that SEL provides.

SEL Compass combines a local database with the ability to download new product updates, literature, and marketing materials according to your selections. Update when you want, automatically and on demand.

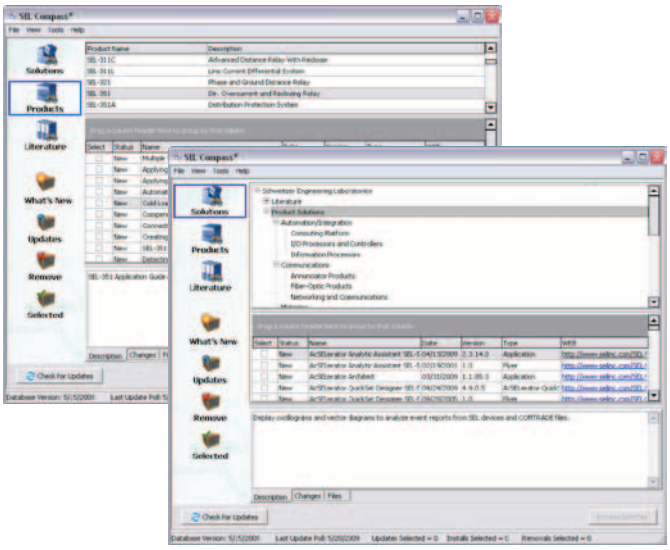
Download Version Updates Via the Web

- Receive updates to your computer on a schedule that you choose.
- Download and update literature directly to your computer with an easy-to-use interface for management.
- Install new device-setting drivers directly from the web.
- Share downloaded files internally throughout your company's network.

SEL Compass goes beyond basic software updates to provide, among other things, a rich selection of meaningful literature, application guides, and general software products. Use the enhanced sorting capabilities to facilitate product planning, organize and distribute information, and learn about the many products SEL provides.

Price

Download for free at **www.selinc.com/compass**.



Tools to Streamline Testing and Commissioning

Testing and Commissioning Product Index

SEL-4391 Data Courier®

Streamline commissioning, data retrieval, and product enhancements.

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Key Features

Save Time in the Field

Set the SEL-4391 Data Courier in the office so field personnel can easily accomplish tasks using pushbuttons, instead of navigating through a laptop operating system, file trees, and application software. Quickly load new firmware, send or retrieve settings, and gather reports. Start data transfers without waiting up to 7 minutes for a laptop to start up.

Apply Easily

Go everywhere with the portable, battery-powered device. At your desk, use SEL-5891 Data Courier Configuration Software to easily configure pushbuttons and store associated settings or firmware. In the field, complete tasks with simple button sequences.

Prevent Misuse

Lock out unauthorized use with a PIN in case of loss or theft. Device access passwords are protected in memory with encryption.

Increase Worker Safety

Operate breakers and contactors from a safer distance using the SEL-4391 and an appropriate cable. Workers can be up to 15 meters (50 feet) away from the control panel when manually opening and closing breakers or starting and stopping motors.

Applications

- Gather event reports from relays at sites that do not have remote communications links. Event reports provide important information to evaluate relay operations and analyze power system problems.
- Load new firmware into relays to activate new features (for example, synchrophasors) or to upgrade to the newest firmware version.
- Transfer new settings into relays to support expansion of the power system and to activate new capabilities. Retrieve settings to check that field device settings match approved settings files as a part of protection configuration control or audits.
- Carry an SEL-4391 and long cable in your tool kit to safely remove and test equipment.
- Consider the Data Courier as an integral part of such safety programs as those required by NFPA 70E: Standard for Electrical Safety in the Workplace®.

Price

Budgetary Retail, Quantity 1: $395

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

1. At Your Desk

Configure pushbuttons using SEL-5891 Software. Save to SD Memory Card.

2. In the Field

Upgrade firmware, send settings, retrieve settings and reports.

3. At Your Desk

View and store retrieved data.*

* Requires PC with SD card slot or external USB to SD card reader.

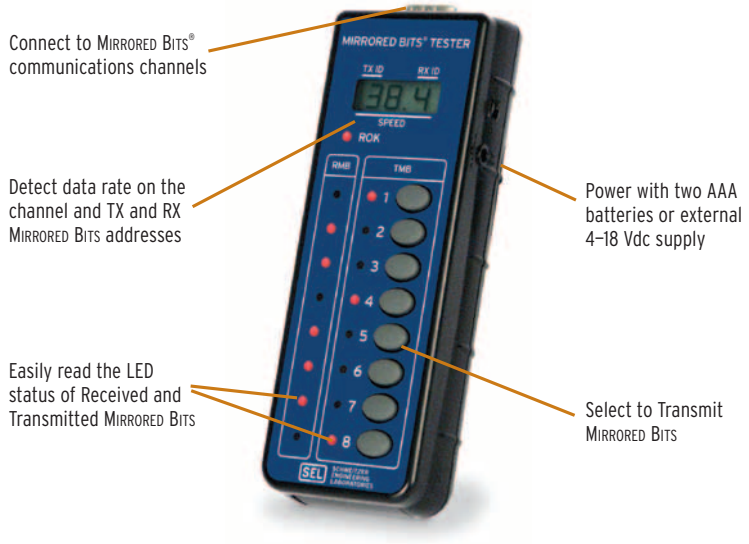
Included Accessories

Description	Part Number
• One EIA-232 extension cable	SEL-C602
• Two AAA batteries	
• 128 MB SD Memory Card	285-0033
• Data Courier Configuration Software	SEL-5891

Optional Accessories

Description	Part Number
• Long Serial Cable for Manual Operations	C245A
• AC Power Supply	230-0601
• USB to SD Card Reader	240-4050
• 128 MB SD Memory Card	285-0033

SEL-4388 Mirrored Bits® Tester



Easily test SEL Mirrored Bits communications links, and reduce commissioning and repair time.

Key Features

Save Time

Quickly test communications by automatically detecting and displaying SEL Mirrored Bits information, addresses, and data rate. Easily identify cable usage. Use pushbuttons to simulate inputs to force Transmit Mirrored Bits for testing.

Verify Settings

Streamline commissioning by easily verifying Mirrored Bits implementation and communications circuits.

Apply Easily

Portable battery-powered tester goes everywhere. Power from two AAA batteries or through the external 0.7 mm power jack.

Applications

- Connect the SEL-4388 to the serial cable or fiber-optic transceiver connected to an SEL relay or processor Mirrored Bits communications port.
- Verify addressing and communications parameters for the channel through the LCD.
- Observe the state of each transmitted (TMB) and received (RMB) bit on LEDs.
- Transmit test bits using the SEL-4388 pushbuttons.

Related Products

Price

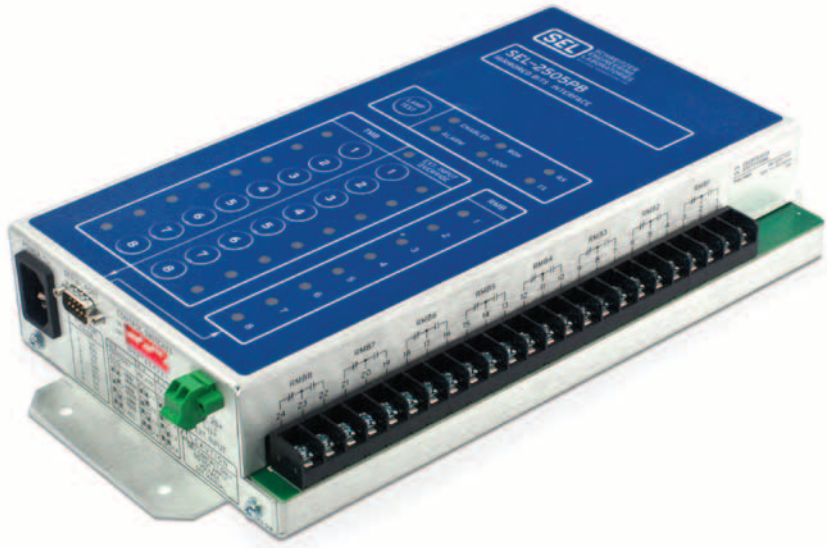
Budgetary Retail, Quantity 1: $295

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

SEL-2505PB Mirrored Bits® Interface



Easily test Mirrored Bits communications using push-buttons and monitoring LEDs.

Key Features

Received Data Monitor

Easily monitor the Received Mirrored Bits (RMB) with eight LEDs. Contact outputs follow the state of the RMB points. The received signal condition (ROK) is indicated with an LED.

Manual Data Transmission Tests

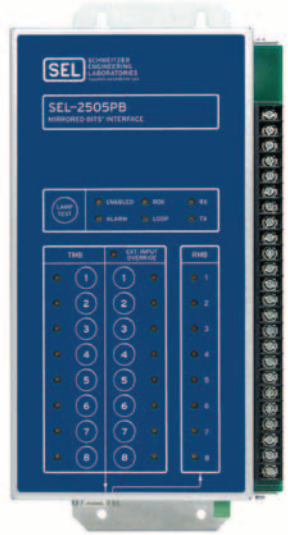
Use eight pushbuttons to set the state for Transmit Mirrored Bits (TMB) and illuminate corresponding LEDs.

Triggered Data Transmission Tests

Support automated tests by connecting a dry contact to the trigger input. Close the contact to trigger a change of state of the TMB points. A second column of eight pushbuttons programs the new state.

Easy Setup

Easily configure with control (DIP) switches for 9600, 19200, or 38400 bps, addresses, and output-contact security counts. Safely apply ac power with socketed line cord.



Applications

Test Pilot Schemes

Connect to the EIA-232 port of a relay using a pilot scheme. Use the TMB pushbuttons to manually set specific bits to simulate pilot or direct transfer trip signals from a remote relay.

Use the EXT pushbuttons to set the state that the TMB will take when the EXT input is asserted. Drive the EXT input with the output of a test set.

Test Remote I/O Modules

Connect an SEL-2800, -2810, -2812, -2814, -2815, -2829, -2830, or -2831 Fiber-Optic Transceiver to the SEL-2505PB, and connect via compatible fiber to an SEL-2505 or SEL-2506 Remote I/O Module to verify that the I/O points match the logic scheme specifications.

Test Logic Processors

Use one or multiple SEL-2505PB modules to test the SELogic® control equations programmed in an SEL-2100 Logic Processor or SEL-3530/3530-4 Real-Time Automation Controllers (RTACs). Simulate normal and transient conditions using the pushbuttons and EXT trigger.

Related Products

Price

Budgetary Retail, Quantity 1: $945

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

SEL-4000 Relay Test System

Test protective relays that have low-level test capabilities.

Key Features

- Test two complete line terminals back to back.
- Twelve analog outputs with 16-bit resolution.
- Six contact-sense inputs measure and sense relay outputs.
- Ten contact outputs simulate communications, control, and breaker status.
- Easy system testing with state-simulation software:
  - SEL-5401 Test System Software for Windows® 95 and Windows NT
  - Multistate capability supports simulating power system changes
  - Amplitude ramping permits relay element threshold tests
  - Programmable inputs and outputs simulate circuit breakers, communications, etc.
  - COMTRADE file support for signal definition, including EMTP simulations
  - System frequency ramping
- Data choices:
  - Enter state data manually
  - Import from Mathcad®
  - Construct analogs from COMTRADE files
- Drive powerful amplifiers, or use directly with SEL relays that have low-level test inputs (patented).
- Includes convenient 24/48/125/250 Vdc source for powering relays and I/O.
- The SEL-4000 Relay Test System supports a new direction in testing relays:
  - Avoid routine tests
  - Test to understand, train, and verify

Relays with low-level interface (most SEL-200 and -300 series and all -400 and -500 series relays) or with low-level input circuitry (such as inputs from MOCTs) can be directly tested with the SEL-4000. It provides 12 output channels, 6 sensing inputs, and 10 output contacts, which allow the user to replay waveforms or generate sinusoidal values with 16-bit precision. The SEL-4000 includes the SEL-AMS (Adaptive Multichannel Source) and SEL-5401, which have multistate capability and amplitude and frequency ramping. The SEL-4000 uses I/O to simulate breakers, communications channels, and other system devices.

SEL-5401 Test System Software

The SEL-5401 has an enhanced user interface and provides many features to make testing easier and more informative.

- Software front-panel window.
  - Provides real-time control of analog values and contact outputs
  - Synchronized analog controls allow multiple channels to be updated simultaneously
- Real-time test status window.
  - Provides an indication of the progress level of the test while it is running
- Thorough, integrated online help.
- COMTRADE conversion software included free.

Related Technical Support Materials

Assessing the Effectiveness of Self-Tests and Other Monitoring Means in Protective Relays

John Kumm, Daqing Hou, and Edmund O. Schweitzer, III

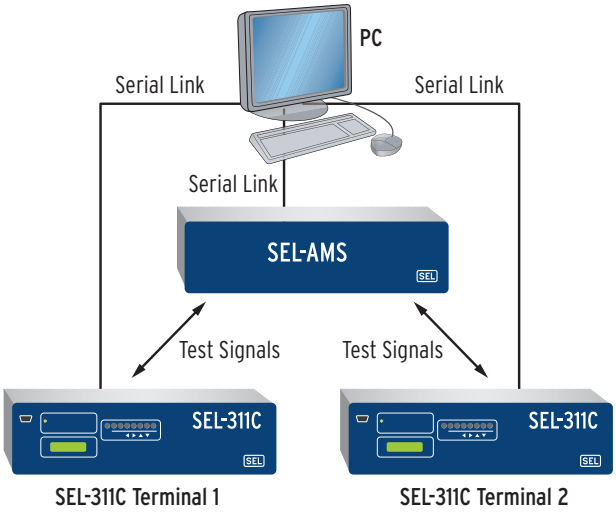
This document and other related documents for this product are available from SEL. Visit **www.selinc.com** to download this technical paper as well as more than 600 other technical documents.

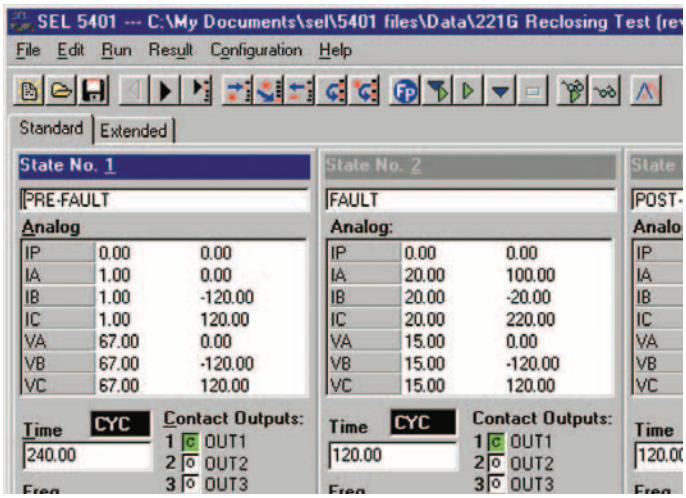
SEL-4000 Relay Test System

Application Example Connections

- Serial link from the PC to the SEL-AMS.
- Test signals to each relay include:
  - Three voltages to simulate line VTs
  - Three currents to simulate line CTs
  - Five contacts to simulate breaker status and communications equipment
- Test signals from each relay include three contacts to simulate trip and communications equipment.
- Serial link from each relay to the PC to collect event reports.

Block Diagram for a Two-Terminal Line Test





Standard test view.

Price

Budgetary Retail, Quantity 1: $4,730

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Cables and Cable Assemblies

Cable Product Index

Description

Fiber-Optic Cable Features

Fiber-Optic Cables

	C804	C805Z	C805D	C805G	C807Z	C807G	C808Z	C808G	C809Z
CONNECTOR									
V-Pin	•	•	•	•					
ST®		•	•	•	•	•	•	•	•
LC					•	•	•	•	•
FIBER DIAMETER									
1000 µm	•								
200 µm		•	•	•					
62.5/200 µm					•	•			
62.5/125 µm							•	•	
9/125 µm									•
WAVELENGTH									
650 nm (Multimode)		•							
850 nm (Multimode)		•	•	•	•	•	•	•	
1300 nm (Multimode)					•	•	•	•	
1300–1550 nm (Single-mode)									•
FIBER COUNT									
Simplex (1 Fiber)	•	•			•		•		
Duplex (2 Fibers)	•	•	•	•	•	•	•	•	•
Quad (4 Fibers)			•	•		•			
CABLE RATINGS									
Riser-Rated OFNR		•	•		•		•	•	•
Water-Blocked				•		•			
Waterproof								•	
JACKET MATERIAL									
None	•								
Polyvinyl Chloride (PVC)		•	•		•		•	•	•
Polyethylene (PE)	•			•		•			
TERMINATION KITS									
V-Pin Termination Kit		•	•	•					
ST Termination Kit		•	•	•	•	•	•	•	
LC Termination Kit							•	•	
OPTIONS									
Bulk (No Connectors)		•	•	•	•	•	•	•	
Pulling Loop Option			•	•		•			
SEL TRANSCEIVER COMPATIBILITY									
SEL-2800, -2810		•	•	•					
SEL-2812, -2814, -2815, -9220		•	•	•	•	•	•	•	
SEL-2829, -2830					•	•	•	•	•
SEL-2831									•
SEL-751A Arc-Flash Detection	•								

SEL-C804 Multimode Arc-Flash Detection Fiber-Optic Cables

Use arc-flash detection cables with SEL-751 and SEL-751A Relays to protect people and equipment from arc-flash events.

Key Features

- All cables are built with high-quality 1 mm-diameter plastic optical fiber (POF).
- Use point sensors to protect enclosed spaces, such as circuit breaker and instrument transformer compartments.
- Use bare-fiber sensors to protect large areas such as bus compartments.
- Order cables in one-meter increments.
- Purchase unterminated cable and use simple hand tools provided in the SEL Sensor Termination Tool Kit, part number 915900146, to build bare-fiber sensor assemblies on-site.

Applications

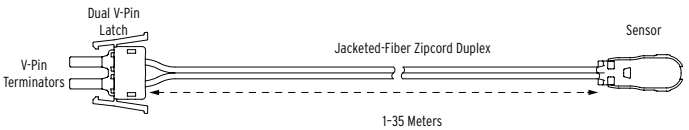
- Use with the SEL-751 or SEL-751A arc-flash detection option (required).
- Install in metal-clad and metal-enclosed switchgear.
- Detect arc-flash events in cable pull sections, circuit breaker, instrument transformer, and bus compartments.

Related Products

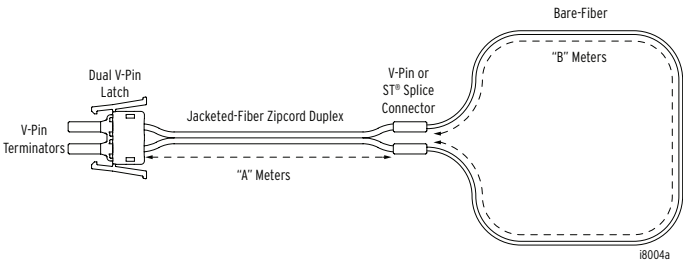
Price

Budgetary Retail, Quantity 1: $63–196 (terminated fiber-optic cable)

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)



Point sensor assembly.



Bare-fiber sensor assembly.

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

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Termination Accessories for SEL-C804 Fiber-Optic Cables

Termination Accessories

Purchase preterminated arc-flash sensor cable assemblies from SEL, or use the following items for connector termination of cables in the field.

Sensor Termination Tool Kit (V-Pin/ST®)

Includes C804 sensor cable assembly instructions

Part Number: 915900146
Price: $500

V-Pin Connectors (25 pack)

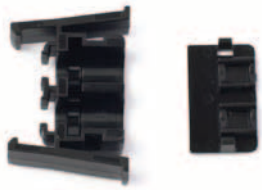
Part Number: 915900147
Price: $52

V-Pin Splice Bushing

Part Number: 915900148
Price: $6.30

Dual V-Pin Latching Kit (12 pack)

Part Number: 915900149
Price: $16



ST Connector

Part Number: 915900150
Price: $16

Bare-Fiber Transition Sleeve (25 pack)

Required for bare-fiber sensor assembly construction

Part Number: 915900152
Price: $25

ST-Connector Splice Bushing

Part Number: 915900151
Price: $21

Mounting Hardware Kit

For installation of sensor cables in switchgear

Part Number: 915900155
Price: $90

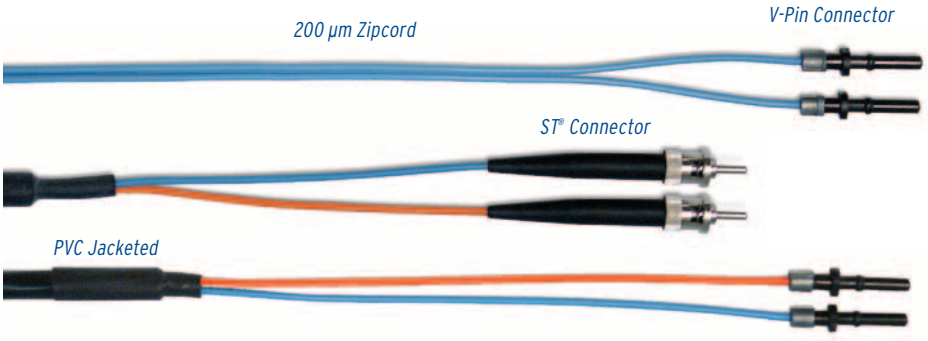
Kit contents from left to right:

Nylon Push Wing Cable Mount (100 pieces)

Nylon Cable Tie, 3.9" (100 pieces)

Point Sensor Grommet (25 pieces)

SEL-C805 Multimode 200 µm Core Fiber-Optic Cables



Safely connect your EIA-232 communications ports using SEL fiber-optic cables and SEL fiber-optic transceivers.

Key Features

- Order finished cables cut and terminated to your length specifications, with either V-pin or ST® connectors.
- Purchase unterminated cable and use simple hand tools provided in SEL fiber-optic termination kits to build your cables on-site. Terminate each connection in less than one minute, with no epoxy or polishing required.
- Terminate mechanically.
- All cables are built with OFS HCS® 200 µm, low-loss, silica-core fiber, clad with a high-strength polymer.

Applications

- Replace copper wire to provide isolation and noise immunity, improve reliability, and reduce costs.
- Apply for lengths of 500 meters or less in substations and plants.
- Install standard-duty zipcord (C805Z) in indoor risers.
- Apply heavy-duty, PVC-jacketed round cable (C805D) for applications requiring more strength and durability.
- Apply rugged, water-blocked cable (C805G) outdoors.

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Price

Budgetary Retail, Quantity 1: $47–205 (terminated fiber-optic cable)

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

Related Products

Termination Accessories for SEL-C805 Fiber-Optic Cables

Termination Accessories

Purchase preterminated cable assemblies from SEL, or use the following items for connector termination of cables in the field.

200 µm V-Pin Termination Tool Kit
Part Number: T800
Price: $1,000

200 µm ST® Termination Tool Kit
Part Number: 240-1501
Price: $1,420

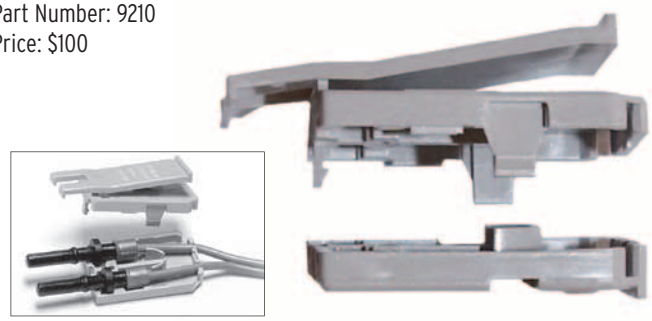
V-Pin Connectors (25 Pack)
Part Number: 915900067
Price: $52

ST Connector
Part Number: 090-5001
Price: $16

V-Pin Splice Bushing
Part Number: S800
Price: $6.30

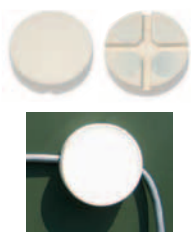
ST Splice Bushing
Part Number: 090-5011
Price: $21

V-Pin Latch Kit (10 Pack)
Part Number: 9210
Price: $100



GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.



Magnetic Cable Guide (MCG)
Keep cables neat and secure with MCGs. Securely position cables against any steel surface. See page 212 for more information.

SEL-C807 Multimode 62.5 µm Core Fiber-Optic Cables

Safely connect SEL fiber-optic transceivers, I/O modules, and Ethernet devices.

Key Features

- Order finished ST®-terminated cables built to your length specifications.
- Purchase unterminated cable and use simple hand tools provided in SEL fiber-optic termination kits to terminate your cables on-site without epoxy or polishing.
- Built with OFS 62.5/200 µm optical fiber.

Applications

- Apply for lengths of 15 kilometers or less for longer communications links and Ethernet networks.
- Install standard-duty simplex or zipcord (SEL-C807Z) in indoor risers.
- Apply rugged, water-blocked cable (SEL-C807G) outdoors.

Price

Budgetary Retail, Quantity 1: $50–205 (terminated fiber-optic cable)

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Related Products

Serial Fiber-Optic Transceivers and Converters With ST Connectors
SEL-2812 Fiber-Optic Transceivers With IRIG-B 434
SEL-2814 Fiber-Optic Transceivers With Hardware Handshaking 435
SEL-2815 Fiber-Optic Transceivers 436
SEL-2894 Interface Converter 441
SEL-3094 Interface Converter 442
SEL-9220 Fiber-Optic Adapter for SEL-300 Series Relays 440

Serial ST Ports
SEL ICON™ Integrated Communications Optical Network 358
SEL-710 Motor Protection Relay 284
SEL-751A Feeder Protection Relay 134
SEL-787 Transformer Protection Relay 222
SEL-2126 Fiber-Optic Transfer Switch 444
SEL-2407® Satellite-Synchronized Clock 308
SEL-2411 Programmable Automation Controller 388
SEL-2414 Transformer Monitor 258
SEL-2431 Voltage Regulator Control 126
SEL-2440 DPAC Discrete Programmable Automation Controller 392
SEL-2505 Remote I/O Module 396
SEL-2506 Rack-Mount Remote I/O Module 400
SEL-2515 Remote I/O Module 404
SEL-2516 Rack-Mount Remote I/O Module 408
SEL-2594 Contact Transfer Module 412
SEL-2595 Teleprotection Terminal 416
SEL-2600 RTD Module 296
SEL-2664 Field Ground Module 280

Line Current Differential ST Channel
SEL-311L Line Current Differential System 92
SEL-387L Line Current Differential Relay 100

Ethernet ST Ports
SEL-421-0, -1, -2, -3 Protection, Automation, and Control System 72
SEL-451-0, -2, -4 Protection, Automation, and Bay Control System 110
SEL-487B-0 Bus Differential and Breaker Failure Relay 242
SEL-487E-0, -2 Transformer Protection Relay 218
SEL-2032 Communications Processor 348

Termination Accessories for SEL-C807 Fiber-Optic Cables

Termination Accessories

Purchase preterminated cable assemblies from SEL, or use the following items for connector termination of cables in the field.

62.5 µm ST® Termination Tool Kit

Part Number: 240-1499
Price: $1,420

ST Connector

Part Number: 090-5001
Price: $16

ST Splice Bushing

Part Number: 090-5011
Price: $21

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Magnetic Cable Guide (MCG)

Keep cables neat and secure with MCGs. Securely position cables against any steel surface. See page 212 for more information.

SEL-C808 Multimode 62.5 µm Core Fiber-Optic Cables

Safely connect SEL fiber-optic transceivers, I/O modules, and Ethernet devices.

Key Features

- Order finished ST®-terminated cables built to your length specifications.
- Purchase unterminated cable, and use simple hand tools provided in SEL fiber-optic termination kits to terminate your cables on-site without epoxy or polishing.
- High-precision ceramic ferrule connectors guarantee a 0.1 dB typical/0.5 dB maximum insertion loss per connector pair for exceptional network performance.
- Built with Corning 62.5/125 µm optical fiber.

Applications

- Apply for lengths of 15 kilometers or less for longer communications links and Ethernet networks.
- Install standard-duty zipcord (SEL-C808Z) in indoor risers.
- Apply rugged, water-blocked cable (SEL-C808G) outdoors and in indoor risers.

Price

Budgetary Retail, Quantity 1: $50 (terminated fiber-optic cable)

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

Related Products

Serial Fiber-Optic Transceivers and Converters With ST Connectors

Serial ST Ports

Line Current Differential ST Channel

Ethernet ST Ports

Ethernet LC Ports

Termination Accessories for SEL-C808 Fiber-Optic Cables

Termination Accessories

Purchase preterminated cable assemblies from SEL, or use the following items for connector termination of cables in the field.

SEL-C808 Fiber Termination Tool Kit

Part Number: 240-1540
Price: $1,900

ST Connector

Part Number: 240-1541
Price: $18.50

LC Connector

Part Number: 240-1542
Price: $19

SEL-C809 Single-Mode 9 µm Core Fiber-Optic Cables

Safely connect your EIA-232 communications ports using SEL fiber-optic cables and SEL fiber-optic transceivers.

Key Features

- All cables are built with high-quality, 9 µm fiber with strain-relief boots at each end.
- Choose ST®-to-ST connectors, LC-to-LC connectors, or an ST connector on one end and an LC connector on the other end.
- Order finished patchcords in stock lengths of 5, 15, or 30 meters.

Applications

- Apply for lengths of 110 kilometers or less for very long hauls.
- Cables are available in standard-duty zipcord for indoor risers.

Price

Budgetary Retail, Quantity 1: $95–250 (terminated fiber-optic cable)

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

Related Products

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Electrical Data Cables

SEL provides a wide variety of quality manufactured cables for all your device connection needs.

Key Features

- Reliable connection between SEL products and other devices, including relays, information processors, computers, I/O modules and controllers, meters, DFRs, PLCs, RTUs, time clocks, multiplexers, phone switches, and modems.
- Each cable tested by SEL.
- Stock cables at discount prices for immediate delivery.
- Free cable selector software program.
  - SEL-5801 Cable Selector Program available for point-and-click selection of cables
  - Available for downloading on the SEL website or direct from SEL
- For isolation, noise immunity, and long-distance (>100 ft) communication, use our fiber-optic cables and transceivers.
- All cables built to IPC/WHMA-A-620 standards.

SEL manufactures high-quality cables for connecting a variety of devices. You can order cables to specific lengths to meet your needs, or you can choose from several stock cables at discount pricing. Each cable is quality tested to ensure reliability and proper operation.

Price

Budgetary Retail (Stock Cables): $26

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Popular Cables Available From SEL

C220	SEL-200/300/400 series products or SEL information processors to 5 Vdc powered external modem[1]
C222	SEL-200/300/400/500/700 series products or SEL information processors to externally powered external modem
C234A	SEL-200/300/400/500/700 series products or SEL information processors to computer, terminal, printer (DTE) 9-pin female[2] subminiature "D" connector
C245A	SEL-200/300/400/500/700 series products, SEL information processors, or SEL rugged computers to the SEL-3021 (data only)
C272A	SEL-200/300/400/500/700 series products (except SEL-321) to SEL information processors (data only)
C273A	SEL-300/400/500/700 series products (except SEL-321) to SEL information processors (data and IRIG-B)
C285	SEL-200/300/400/500/700 series products to SEL information processors or rugged computers to SEL-3022 or SEL-3031
C387	SEL-200/300/400/500/700 series products or SEL information processors (data only) to SEL-3021 Serial Encrypting Transceivers and SEL-3022 Wireless Encrypting Transceivers (9-pin male[2] subminiature "D" connector on both ends)

[1] Modems available from SEL—call for details.
[2] Male/female designation refers to cable termination.

NOTE: Cables listed above are available in standard lengths from stock for immediate shipment.

Coaxial Cables

SEL provides a wide variety of quality manufactured cables for efficient transmission of high-frequency signals.

Key Features

- SEL offers a wide variety of coaxial cables for antennas and clock signals.
- Each cable tested by SEL.
- Free SEL-5801 Cable Selector program with point-and-click cable selection, available for download on SEL website or direct from SEL.
- All cables built to IPC/WHMA-A-620 standards.

SEL manufactures high-quality cables for connecting a variety of radio frequency devices. You can order cables to specific lengths to meet your needs. Each cable is quality tested to ensure reliability and proper operation.

Price

Budgetary Retail, Quantity 1

SEL-C953: RG-58, BNC to BNC (8-ft length)	$11
SEL-C960: RG6, TNC to TNC (8-ft length)	$37
SEL-C962: RG-58, BNC to Tinned Wires (8-ft length)	$11
SEL-C961: LMR-400-UF, TNC to TNC (8-ft length)	$79
SEL-C654/SEL-C657: Mono Plug to BNC/Tinned Wires	$21

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

Tinned wires

N connector

BNC

TNC

Popular Cables Available From SEL

C953	SEL-400 series products or SEL information processors to SEL satellite-synchronized clocks (RG-58, BNC to BNC connector)
C654	SEL-400 series products or SEL information processors to SEL-2812 Transceiver (2.5 mm mono plug to BNC connector)
C657	SEL-300/700 series products or SEL-2523 Annunciator Panel to SEL-2812 Transceiver (2.5 mm mono plug to BNC connector)
C960	SEL satellite-synchronized clocks to GPS antenna (RG-6, TNC to TNC connector)
C961	SEL satellite-synchronized clocks or SEL radio to antenna or surge protector (LMR-400-UF, TNC to TNC connector)
C962	SEL-300/700 series products or SEL-2523 Annunciator Panel to SEL satellite-synchronized clocks (RG-58, BNC to tinned wires)
C964	SEL-3031 Serial Radio Transceiver to Yagi antenna (RG-8, TNC to N connector)
C966	SEL-3031 Serial Radio Transceiver to Yagi antenna (LMR-400-UF, TNC to N connector)
240-1800	BNC 50 Ohm terminating resistor
240-1801	BNC connector T (female-female-male)
240-1802	BNC connector T (female-female-female)

Category 5e Ethernet Cables

For wired Ethernet connections in the same cabinet or equipment lineup, use high-quality shielded, twisted-pair (STP) Category 5e Ethernet cables from SEL.

Key Features

- Complete shield coverage provided by the metal enclosure of the RJ-45 connectors plus the cable shield.
- Each cable tested by SEL.
- Custom cables available.
- Apply standard Ethernet cables terminated with shielded RJ-45 connectors (SEL-C627) for typical 10/100BASE-T Ethernet connections.
- Use an Ethernet crossover cable (SEL-C628) terminated with shielded RJ-45 connectors for a direct 10/100BASE-T Ethernet link without an intervening switch.
- For specialized applications, use adapter cable (SEL-C606A) terminated with shielded RJ-45 connector on one end, 9-pin male subminiature D connector on the other end, or SEL-C608 with shielded RJ-45 connector on one end, 9-pin female subminiature D connector on the other end.
- For compression terminal connections, apply adapter cable (SEL-C607) terminated with shielded RJ-45 connector on one end, wires on the other end.
- Between cabinets or in electrically noisy environments, use fiber-optic Ethernet links and SEL-C807 Multimode 62.5 µm Core Fiber-Optic Cables.

Magnetic Cable Guide (MCG)

Keep cables neat and secure with MCGs. Securely position cables against any steel surface. See page 212 for more information.

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Price

Budgetary Retail (stock cables):	Cable ≤8 ft (2.44 m)	$32
	Each additional foot (.30 m)	$0.31

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

Related Products

USB Cables and USB Conversion Cables

Easily adapt and connect USB ports using SEL cables and conversion cables.

Key Features and Applications

- USB port to EIA-232 9-pin male[1] (SEL-C662) or female[1] (SEL-C663) connector includes DTE/DCE switch. A second switch provides 5 Vdc on Pin 1 to power other converters or devices. Now available in a longer length; order either cable in a 15-foot version.
- USB A-type plug to B-type plug cable (SEL-C664) to connect a PC USB port to any device with a USB B-type communications port.
- USB A-type plug to ANSI Type 2 optical probe cable (SEL-C661) to connect a PC USB port to an SEL-734 optical port.
- USB A-type plug to female A-type plug active extension cable (SEL-C668) can be used to extend any SEL USB cable an additional 16 feet.

[1] Male/female designation refers to cable termination.

Magnetic Cable Guide (MCG)

Keep cables neat and secure with MCGs. Securely position cables against any steel surface. See page 212 for more information.

Price

Budgetary Retail, Quantity 1

SEL-C662: USB/EIA-232 9-pin male[1] (6-ft length)	$63
SEL-C662-15: USB/EIA-232 9-pin male[1] (15-ft length)	$73
SEL-C663: USB/EIA-232 9-pin female[1] (6-ft length)	$68
SEL-C663-15: USB/EIA-232 9-pin female[1] (15-ft length)	$78
SEL-C664: USB A-type to B-type (6-ft length)	$15
SEL-C661: USB A-type to optical probe (6-ft length)	$370
SEL-C668: USB active extension (16-ft length)	$22

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

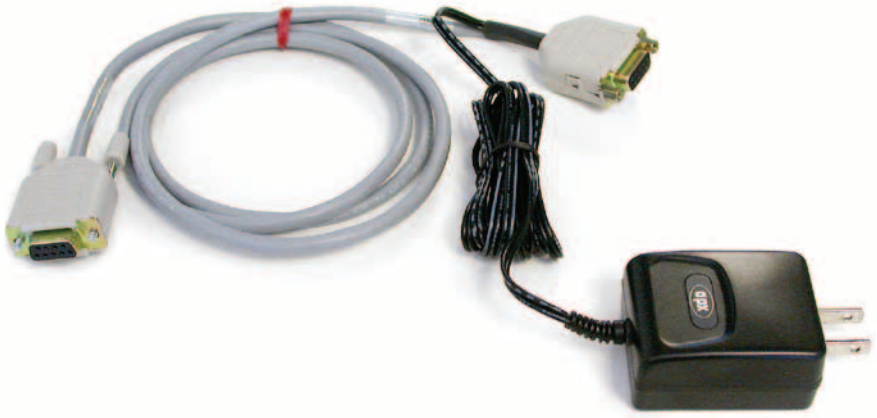
Related Products

SEL Fiber-Optic Transceivers 432–439
Magnetic Cable Guide (MCG) 212

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Data Cables With EIA-485 Converters or Power Supplies



Easily apply SEL cables with built-in level or power converters to simplify connections.

Key Features and Applications

- SEL-500 series relay EIA-485 port to EIA-232 port cable (SEL-C671A) includes an SEL-2886 EIA-232 to EIA-485 Interface Converter, ac power supply, cable to the relay, and cable to an EIA-232 device.
- EIA-232 9-pin female[1] connector to EIA-232 9-pin female[1] connector cable (SEL-C642) includes an ac power supply for devices that are powered from Pin 1, e.g., SEL-2890 Ethernet Transceiver, SEL-2810 Fiber-Optic Transceivers With IRIG-B, and SEL-2886.
- EIA-232 9-pin female[1] connector to EIA-232 9-pin female[1] connector cable (SEL-C643) includes an ac power supply for devices that are powered from Pin 7, e.g., SEL-2800, SEL-2812, SEL-2815, SEL-2829, SEL-2830, and SEL-2831 Fiber-Optic Transceivers.
- Convert from a serial fiber-optic link to a wired Ethernet link by using a cable (SEL-C644) that includes an ac power supply to connect an SEL-2890 to an SEL-2800, SEL-2812, SEL-2814, SEL-2815, SEL-2829, SEL-2830, or SEL-2831 Fiber-Optic Transceiver.

[1] Male/female designation refers to cable termination.

Price

Budgetary Retail, Quantity 1

SEL-C671A: SEL-500/EIA-485/EIA-232	$265
SEL-C642, -C643, -C644: EIA-232 with ac power supply	$74

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

Related Products

SEL Fiber-Optic Transceivers 432–439
SEL-2886 EIA-232 to EIA-485 Interface Converter 375
SEL-2890 Ethernet Transceiver 374
Magnetic Cable Guide (MCG) 212

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Magnetic Cable Guide (MCG)

Keep cables neat and secure with MCGs. Securely position cables against any steel surface. See page 212 for more information.

Accessories

Accessories Product Index

SEL-2652 Trip Coil Monitor

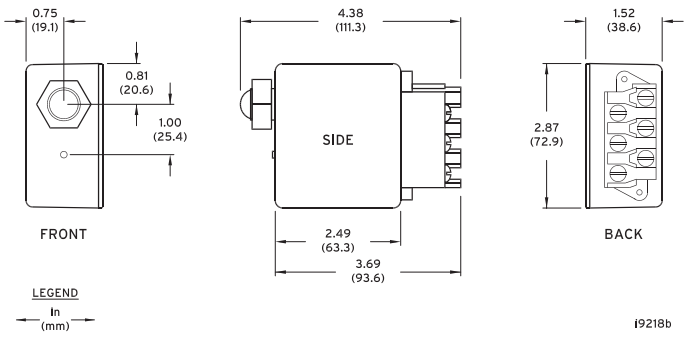
Apply the SEL-2652 Trip Coil Monitor to verify circuit breaker and lockout relay trip coil and trip circuit connections for continuity.

The SEL-2652 is self-powered, displays circuit breaker status with an external LED, and reports continuity status to SCADA with a Form C contact.

Key Features

- Eliminate the need to stock different trip coil monitors with the SEL-2652, which has a wide voltage range (48 to 125 Vdc).
- Quickly detect circuit breaker status (SEL-2652A) or continuity status (SEL-2652B) using clearly identifiable local indication LED, available in red and blue.
- Use convenient remote indication to easily monitor trip circuit health without nuisance alarms during normal circuit breaker operations.
- Reduce maintenance using this rugged device, designed and tested for substation environments.
- Install in minutes with panel-mount design and Connectorized® terminal block.

Side and Back Views



Measurements in inches.

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Hardware Specifications

Input Power

Self-powered from 48 Vdc or 125 Vdc systems

Range	30–150 Vdc
Current Draw	<10 mA dc

Contacts

Capable of switching up to 0.5 µF

Make/Break/Carry	1 A resistive up to 150 Vdc
Drop-Out Delay	>200 ms
MOV Protection	175 Vdc continuous

Connections

6 terminal connections support #10 ring

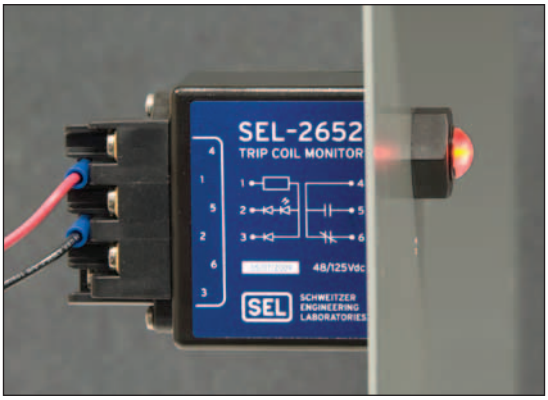
Operating Temperature Range

–40° to +85°C (–40° to +185°F)

Price

Budgetary Retail, Quantity 1: $200

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)



SEL-9510 Control Switch Module

The SEL-9510 easily adds independent local control and indication to any installation.

Key Features

High-Visibility Status Indication

See status from almost any angle and at a distance with large indicators.

Arc-Suppressed Contacts

Decrease contact wear with SEL's arc-suppression technology, field-tested and proven to reduce contact damage and provide years of reliable service.

Easy to Install

Quickly and easily install and commission the SEL-9510 with convenient panel-mount and several rack-mount options.

Rugged and Versatile

Apply the SEL-9510 in substations, industrial areas, and control centers, with its rugged housing, jumper-selectable indicator voltage, and ac/dc compatibility.

Independent, Local Operation

Use the SEL-9510 for applications that require local control, independent from protection and supervisory systems.

Applications

- Install independent breaker control in any panel or rack location.
- Add high-visibility status indication.
- Prevent contact damage with built-in arc suppression.
- Provide independent control for many switching applications, such as ground select, alternate settings, or motor-operated switches.

Optional Features

- Pushbutton cover kit.
- Configurable labels.
- Pushbutton colored lens kit.
- Mounting kits:
  - One-unit, 19-inch rack mount
  - Two-unit, 19-inch rack mount
  - Three-unit, 19-inch rack mount
  - One-unit, half 19-inch rack mount (for use next to an SEL-500 series relay)

Related Products

SEL-351 Protection System 114
SEL-487B Bus Differential and Breaker Failure Relay 242
SEL-551 Overcurrent/Reclosing Relay 148

Price

Budgetary Retail, Quantity 1: $300

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

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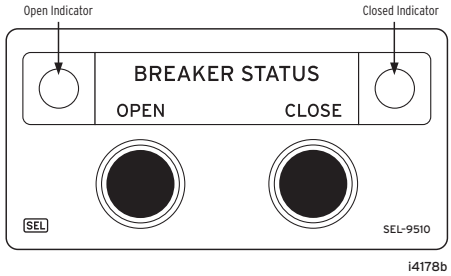
SEL-9510 Control Switch Module

Front View



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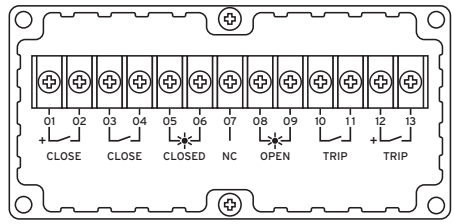
Rear View



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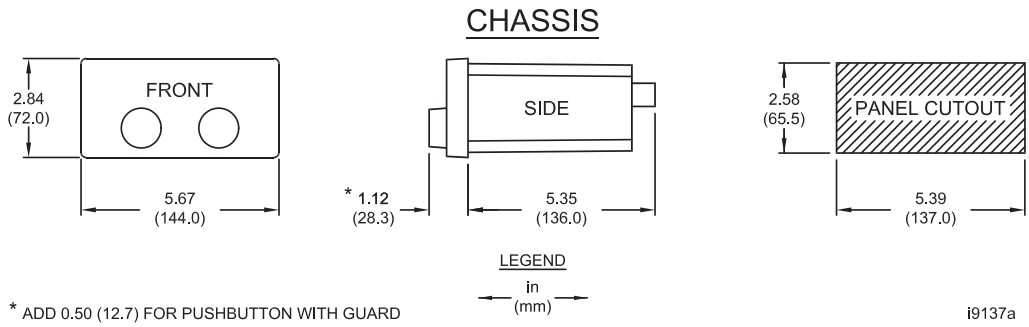
Dimensions



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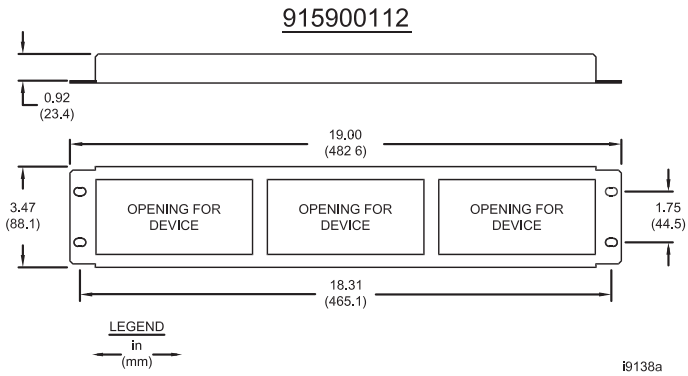
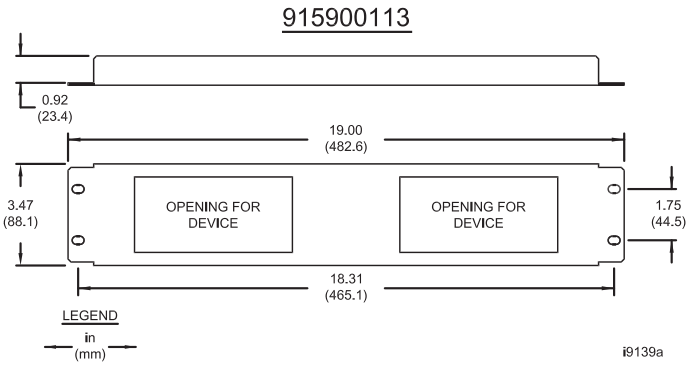
Optional Rack-Mount Cutout Bezels



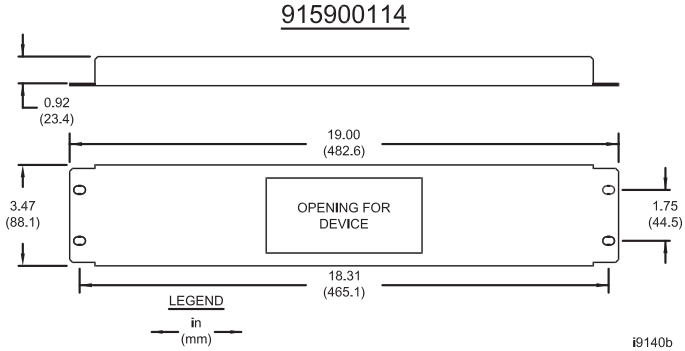
i9138a

SEL-9510 three-opening panel cutout.



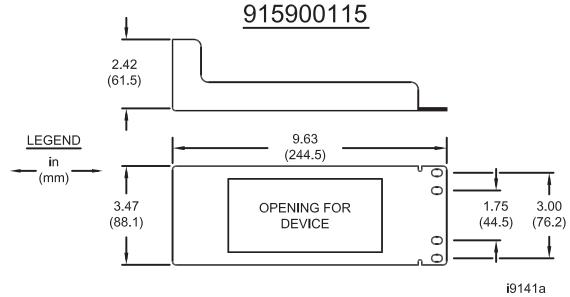
i9139a

SEL-9510 two-opening panel cutout.



i9140b

SEL-9510 single-opening panel cutout.



i9141a

SEL-9510 half-rack, single-opening panel cutout for mounting side by side with an SEL-500 series relay.

Visit www.selinc.com for more detailed information and configuration options.

SEL-2910 Port Isolator

Isolate EIA-232 and IRIG-B serial data links from electrical noise and hazards.

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Key Features

Port Powered
Powered from the host device EIA-232 transmit-data pin.

Improved Safety
Isolation to 2500 Vrms.

Compact
Plugs directly onto DB-9 connector.

Easy Application
There are no settings. Works with serial data rates up to 40 kbps.

Substation Quality
Operating temperature range of −40° to +85°C (−40° to +185°F).

Related Products

Apply two fiber-optic transceivers for even better isolation and safety.

Pages 432–439

Applications

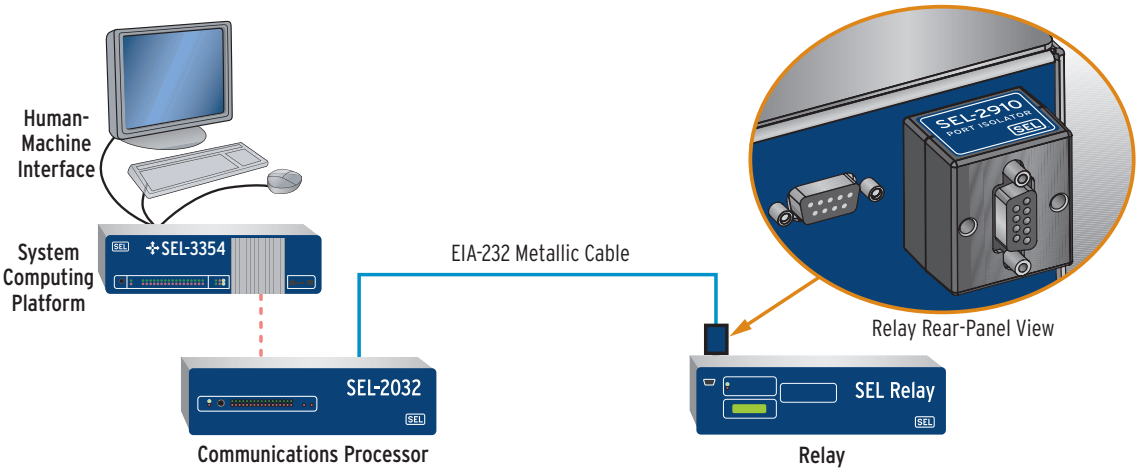
Use the SEL-2910 to isolate both EIA-232 and IRIG-B data channels where it is infeasible to use fiber-optic cable or to reroute cables to eliminate or minimize electrical interference. Reference SEL Application Guide AG2001-06.

Price

Budgetary Retail, Quantity 1: $86

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

Relay and Information Processor Application



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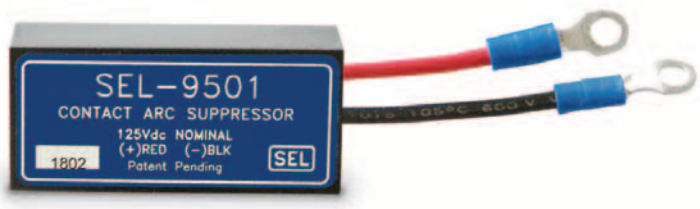
SEL-9501 Contact Arc Suppressor



Increase contact reliability, and significantly reduce maintenance costs.

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Key Features

- Increases existing contact-interrupt rating to 15 A for circuits with L/R ratio of 40 ms.
- Installs easily with simple connections.
- Withstands interrupting 10 A of trip coil current four times in three seconds.
- Protects many contact types, including 52a, 52b, auxiliary, and control switch. Not for use with reed relays.

Hardware Specifications

Voltage rating	160 Vdc
Let-through current time at dc turn-on	2000 microseconds
Leakage current	<150 microamps @ 125 Vdc

Eliminate the single largest failure mode of protective relays. Prevent contact welding caused by inadvertent interruption of tripping current by relay contacts not rated to do so. SEL contact arc suppressors increase the dc current-interrupt rating of most contacts (including SEL standard output contacts) to greater than 10 Adc in inductive circuits.

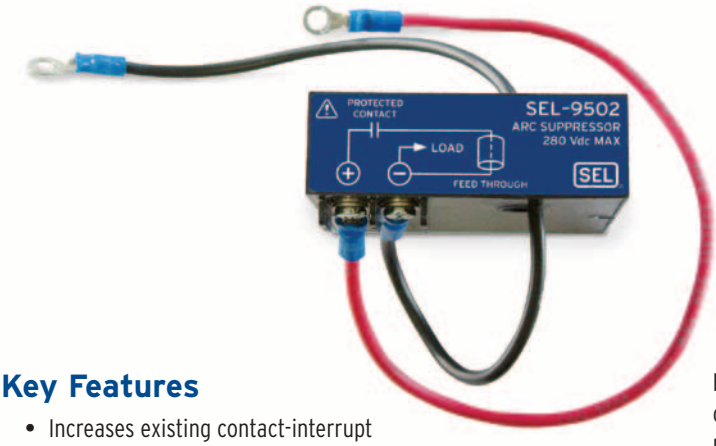
Arcing occurs when unprotected relay contacts interrupt current; this causes contacts to degrade or weld. SEL contact arc suppressors smoothly interrupt the current over a few milliseconds, absorbing the inductive energy of the circuit and dissipating this energy as heat.

Price

Budgetary Retail, Quantity 1: $84

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

SEL-9502 Contact Arc Suppressor



Increase contact reliability, and significantly reduce maintenance costs.

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Key Features

- Increases existing contact-interrupt rating to 15 A for circuits with L/R ratio of 40 ms.
- Installs easily with simple connections.
- Withstands interrupting 10 A of trip coil current four times in three seconds.
- Protects many contact types, including 52a, 52b, trip, close, lockout coil, auxiliary, and control switch. Not for use with reed relays.

Hardware Specifications

Voltage rating	280 Vdc
Let-through current time at dc turn-on	100 microseconds
Leakage current	<150 microamps @ 125 Vdc

Eliminate the single largest failure mode of protective relays. Prevent contact welding caused by inadvertent interruption of tripping current by relay contacts not rated to do so. SEL contact arc suppressors increase the dc current-interrupt rating of most contacts (including SEL standard output contacts) to greater than 10 Adc in inductive circuits.

Arcing occurs when unprotected relay contacts interrupt current; this causes contacts to degrade or weld. SEL contact arc suppressors smoothly interrupt the current over a few milliseconds, absorbing the inductive energy of the circuit and dissipating this energy as heat.

Price

Budgetary Retail, Quantity 1: $105

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

SEL-9310 Power Supply/Battery Charger

Apply the SEL-9310 to provide control power for protective relays and circuit breakers when the power is lost.

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Key Features

Power Supply

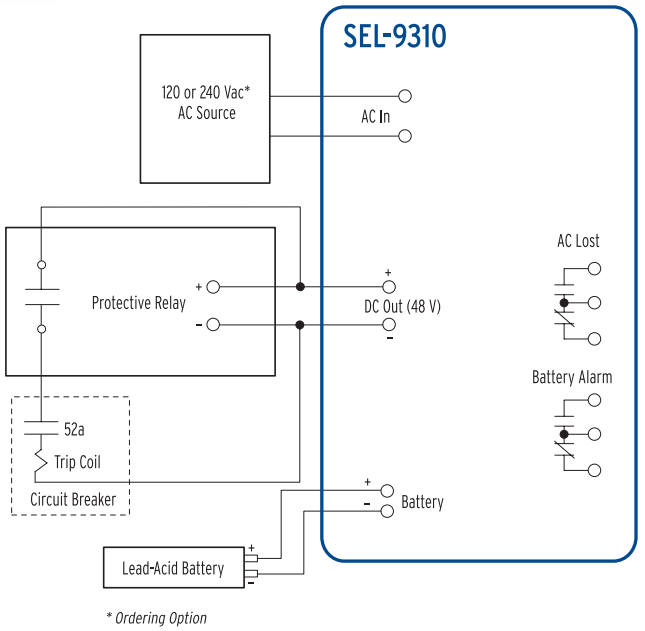
Provide a simple and economical source of auxiliary 48 Vdc power for protective relays, circuit breakers, or other loads.

Battery Charger

Apply temperature-compensated battery charging using a regulated taper-charge method. Use constant-voltage float charging to maintain lead-acid batteries at optimal capability. Support 48 Vdc batteries of up to 12 Ah capacity.

Monitor and Alarm

Constantly monitor ac/dc power with contact response during failure of either supply.



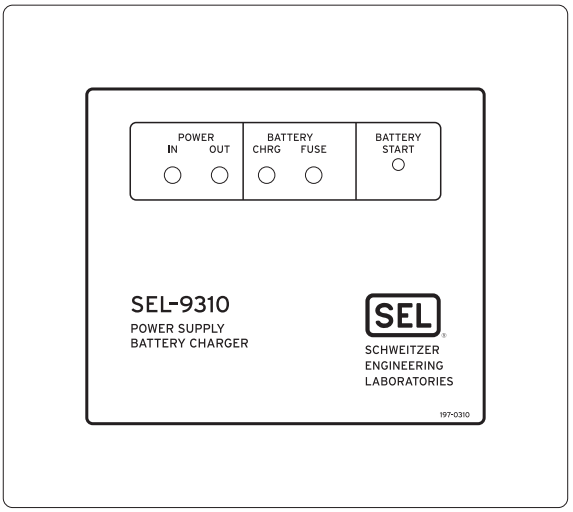
** Ordering Option*

Price

Budgetary Retail, Quantity 1: $515

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

Front View



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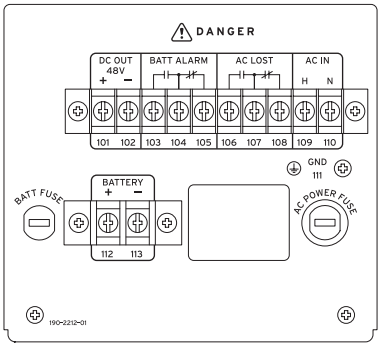
Rear View



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SEL-UPS Uninterruptible Power Supply

Choose the SEL-UPS to provide uninterruptible power to relays, circuit breakers, and other devices.

The SEL-UPS Uninterruptible Power Supply provides 48 Vdc power from an ac source and has a 48 Vdc lead-acid battery that will maintain operating power when the ac source fails. Intended to power one or two 48 Vdc SEL relays, the SEL-UPS can also be used to power other devices and has the short-time capacity to energize the trip coil of a circuit breaker.

Key Features

- Provide reliable, affordable dc power anywhere.
- Power relays and trip breakers and reclosers.
- Apply battery-supplied 48 Vdc output with 6 Ah capacity.
- Supply 0.6 A dc to a continuous 48 Vdc load while maintaining full battery charge.
- Support 30 A trip current for 200 ms.
- Charge from 120 or 240 Vac in less than 24 hours.
- Prevent deep discharge with automatic undervoltage shutdown of battery.
- Replace standard lead-acid batteries in convenient drawer without interrupting relay power.
- Show status with front-panel indicators.
- Apply battery alarm and contact outputs, rated to relay standards.

Applications

- Supply backup power for:
  - Pole-top equipment
  - Relay and cellular telephone at remote point
  - Communications equipment
  - Relays located in breakers
- Eliminate capacitive trip devices
- Isolate control enclosure dc from breaker cabinet dc

Price

Budgetary Retail, Quantity 1: $685

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

SEL-9321 Low-Voltage DC Power Supply

Provide reliable power for communications and instrumentation devices.

GSA Schedule Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Key Features

- Reliable and robust low-voltage dc power supply, backed by the SEL worldwide, ten-year product warranty.
- Meets IEEE and IEC standards for surge withstand, fast transient, and RFI immunity requirements in electric power substations.
- Provides flexible voltage input choices: 24 Vdc, 48/125 Vdc, or 125 Vac and 125/250 Vdc or Vac.
- Includes outputs up to 1 A at 5 Vdc, and a total of 100 mA for +10 Vdc and –10 Vdc.
- Easily mounts to any flat surface or DIN rail with the included mounting hardware. Optional cables are available for use with SEL products.

The SEL-9321 Low-Voltage DC Power Supply converts station battery power or ac power to low-voltage dc power. Optional cables include the proper plug or termination to provide power for the SEL-3021 Serial Encrypting Transceiver, SEL-3022 Wireless Encrypting Transceiver, SEL-3010 Event Messenger, SEL-2814 Fiber-Optic Transceiver, SEL-2886 EIA-232 to EIA-485 Interface Converter, and SEL-2401 Satellite-Synchronized Clock.

Price

Budgetary Retail, Quantity 1: $190

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

SEL-9322 15 Vdc Power Supply

Provide reliable power for communications and instrumentation devices.

Key Features

- Reliable and robust low-voltage power supply, backed by the SEL worldwide, ten-year product warranty.
- Meets IEEE and IEC standards for surge withstand, fast transient, and RFI immunity requirements in electric power substations.
- Provides flexible voltage input choices: 48 Vdc and 125/250 Vdc or Vac.
- Provides +15 Vdc nominal output voltage at up to 1 A for communications devices and accessories.
- Easily mounts to any flat surface or DIN rail with the included mounting hardware.
- Facilitates easy connection with terminal block contacts.

The SEL-9322 15 Vdc Power Supply converts ac power or station battery power to low-voltage dc power. The SEL-9322 can be used as a reliable power source for the wall-mount SEL-3031 Serial Radio Transceiver.

Price

Budgetary Retail, Quantity 1: $260

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

SEL-LPS Linear Power Supply

Provide auxiliary dc power to your protective relays in the classroom or lab.

GSA Schedule Contract: GS-07F-0123N
This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

Key Features

- Compact desk/benchtop power supply for protective relay auxiliary power.
- Four relay auxiliary power outputs.
  - Two 24 Vdc: connect in series for 48 Vdc
  - Two 125 Vdc: connect in series for 250 Vdc
  - Linear design provides "stiff" low-impedance outputs to start and serve high-surge loads
- Three regulated electronic-level outputs: +5 and ±15 Vdc.
- Safe solution to powering relays in laboratories, classrooms, and offices.

The SEL-LPS Linear Power Supply is a general-purpose dc power supply with two 24 Vdc and two 125 Vdc unregulated sources that can be combined to produce 24, 48, 125, or 250 Vdc at 50 VA. Low-voltage outputs supply +5 Vdc (500 mA), +15 Vdc (250 mA), and −15 Vdc (250 mA) of regulated power.

Price

Budgetary Retail, Quantity 1: $370

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

Other Power Accessories

230-0600 Wall AC to 5-Volt Power Supply

Input:	100 to 120 Vac, 47–63 Hz
Output:	5 Vdc ±5% @ 2.0 A max.
Operating Temperature:	0° to +40°C
Emissions:	Meets VCCI, FCC Part 15 Class B
Low-Voltage Connector:	0.7 female, right-angle barrel plug

230-0601 Wall AC to 5-Volt Power Supply

Input:	100 to 240 Vac, 47–63 Hz
Output:	5 Vdc ±5% @ 1.2 A max.
Operating Temperature:	0° to +40°C
Emissions:	Meets VCCI, FCC Part 15 Class B
Low-Voltage Connector:	0.7 female, right-angle barrel plug

230-0604 Wall AC to 15-Volt Power Supply

Input:	90 to 264 Vac, 47–63 Hz
Output:	15 Vdc ±5% @ 2.0 A max.
Operating Temperature:	0° to +40°C
Emissions:	Meets conduction FCC Part 15 Class B, CISPR-22 Class B
Low-Voltage Connector:	Stripped for connection to compression terminal blocks

240-1651 International Plug Adapter Kit (UK, EU, AUS)

The 230-0604 power supply has an interchangeable plug component. The standard supply comes with a US-style 2-pin plug installed. This kit contains interchangeable plug components for UK-style, EU-style ("Shuko"), or Australian-style connections.

SEL-9103/SEL-9104 Dust and Splash Protection

Protect your relays from damage caused by harmful splashes or dust.

Key Features

Dust and Splash Protection

The SEL-9103 and SEL-9104 provide liquid splash protection for equipment front panels. The degree of protection is IP54 as described by IEC 60529. These covers prevent harmful effects from liquids splashed from any direction. In addition, the covers provide sufficient dust penetration protection so that you can safely and satisfactorily operate the equipment. (Some insignificant dust penetration can occur.)

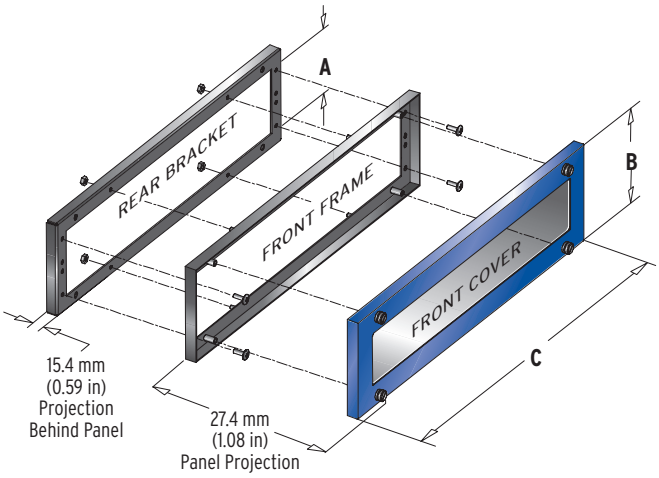
Front-Panel Access

Targets and the LCD are plainly visible through the cover. Access to pushbuttons and the front EIA-232 port can be obtained by disconnecting the four captive cover screws and removing the cover.

Mounting and Size

Width, height, and depth are minimized for uncluttered installation. The cover mounts to a flat panel. Relays and other equipment mount to the cover according to IEC 60297. The SEL-9103 cover fits most SEL-200 and SEL-300 series relays, the SEL-2032 Communications Processor, the SEL-587Z High-Impedance Differential Relay, and other 19-inch rack-mount equipment. The SEL-9104 cover fits most SEL-500 series relays. Covers fit only SEL relays ordered as rack-mount relays. After the covers are fitted, the relays can only be mounted in a panel. (The cover dimensions preclude mounting the relays in a rack.)

Covers are available to protect relay front panels against the ingress of water and dust. These covers come in various sizes to fit SEL relays as well as other products.



Cover Model	Rack Unit Height	Budgetary Retail Quantity 1	Dimensions		
			A	B	C
SEL-9103	2U	$210	88.9 mm (3.50 in)	132.1 mm (5.20 in)	492.8 mm (19.40 in)
SEL-9103	3U	$231	133.4 mm (5.25 in)	176.5 mm (6.95 in)	492.8 mm (19.40 in)
SEL-9104	2U	$189	88.9 mm (3.50 in)	132.1 mm (5.20 in)	270.5 mm (10.65 in)

GSA Schedule
Contract: GS-07F-0123N

This SEL product is GSA approved. Contact your sales representative for pricing and delivery options.

SEL-SSE Selector Switch

Select settings group from panel, rack, or switchboard.

Key Features

- Easily apply local or remote switching between settings groups for any SEL relay with multiple settings groups.
- Choose from panel-, rack-, or switchboard-mounting options.
- Select from five different versions.

Apply the SEL-SSE Escutcheon-Mounted Selector Switch for settings group selection.

Price

Budgetary Retail, Quantity 1: $210

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

SEL-SSP Selector Switch

Select settings group with rack-mounted switch.

Key Features

- Easily apply local or remote switching between settings groups for any SEL relay with multiple settings groups.
- Install horizontal mount design in a 19-inch rack.
- Select from five different versions.

Apply the SEL-SSP Rack-Mounted Selector Switch for settings group selection.

Price

Budgetary Retail, Quantity 1: $210

(Base price is shown for planning purposes and is subject to change. Contact your SEL sales representative today for a quote on configurations and quantities to meet your needs.)

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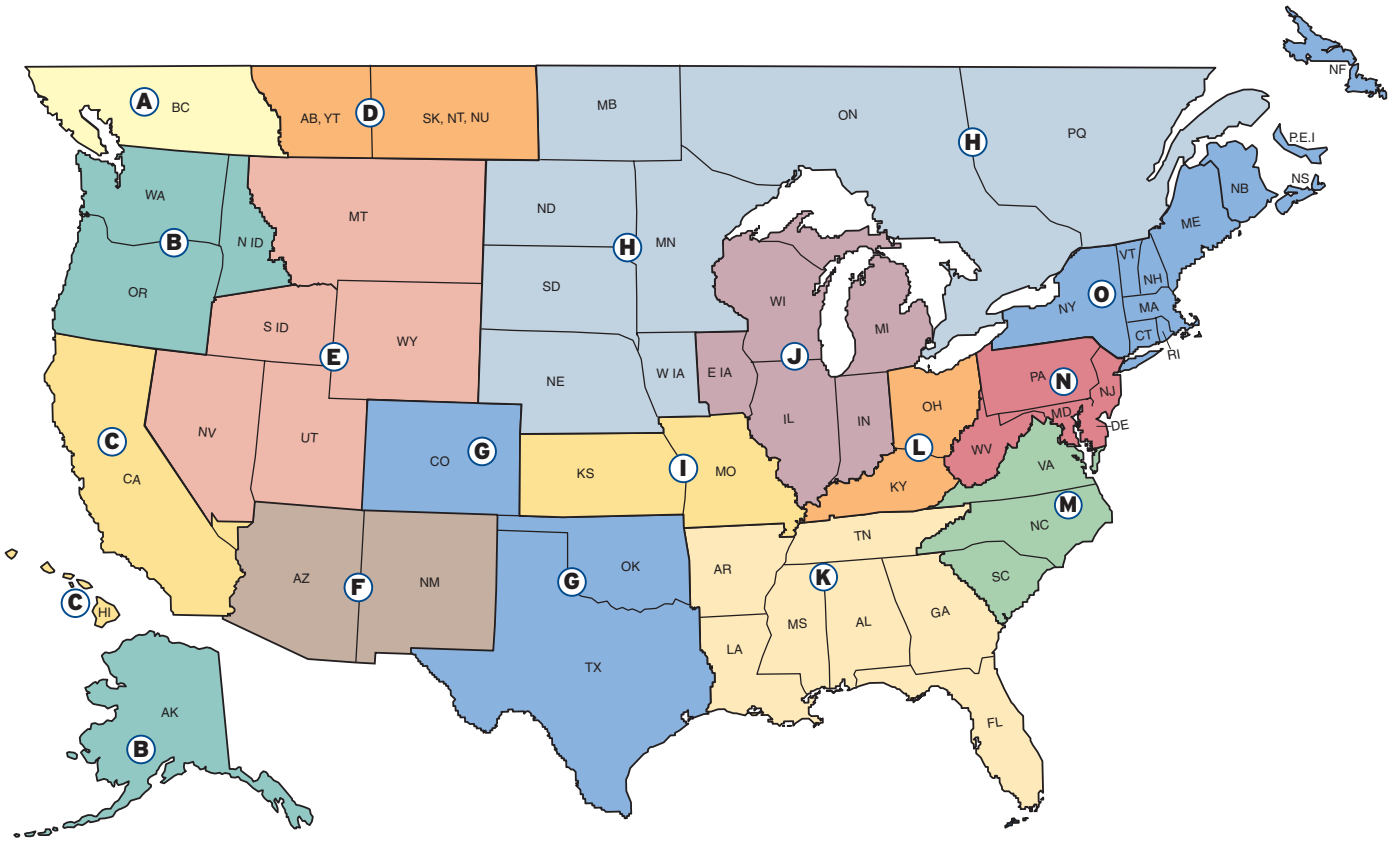

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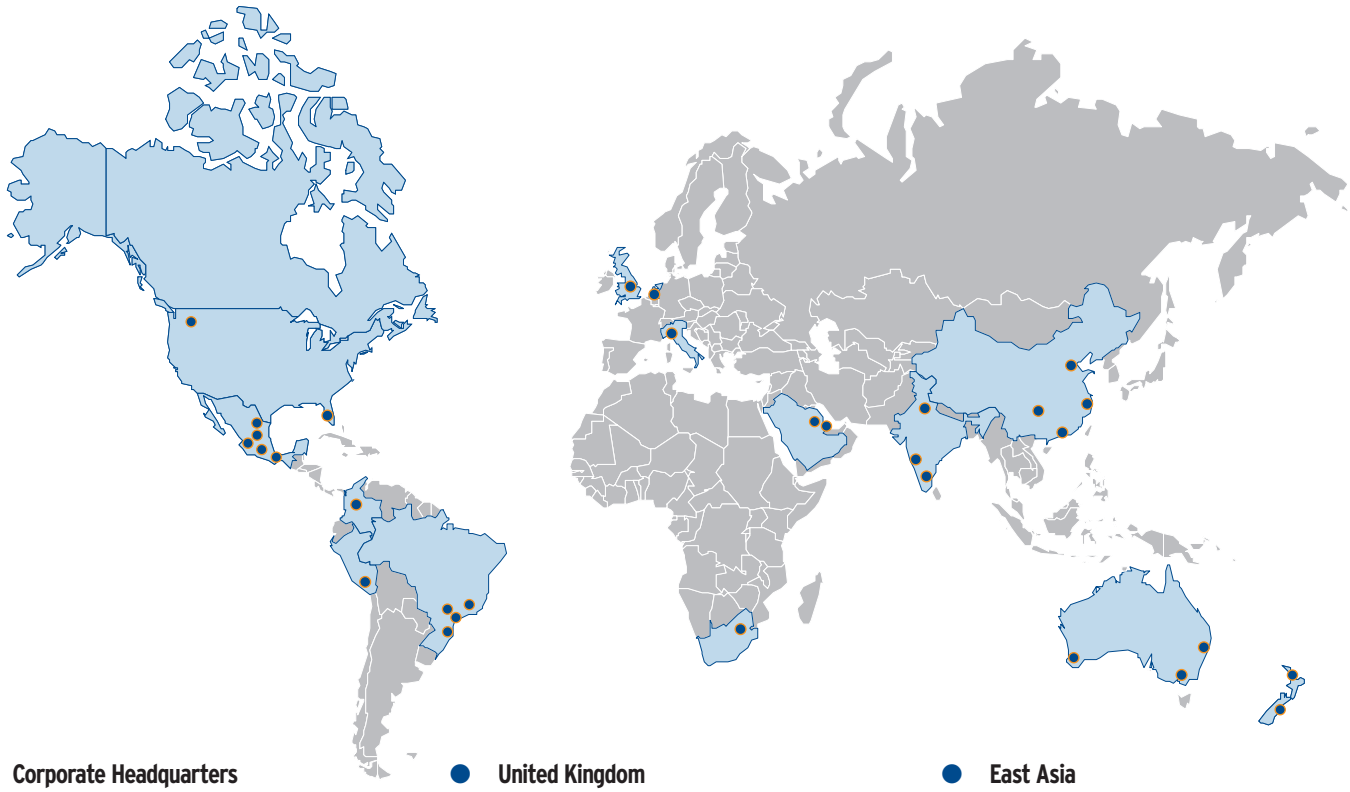

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