

SEL Power Solutions for **High-Speed Railroad Operations**



Proven power system solutions for high-speed rail applications.

- Complete traction power substation solution that delivers lower cost, improved power system reliability, and greater operational control.
- Industry-leading relays, meters, and controllers for optimum safety and performance.
- Ten-year worldwide warranty and local technical support provide peace of mind.
- Trusted supplier of power system solutions for rail transportation companies around the world.



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

For over 30 years, Schweitzer Engineering Laboratories, Inc. (SEL) has delivered solutions that make electric power systems safer, more reliable, and more economical. Rail operators worldwide deploy advanced power solutions from SEL and are supported by SEL engineers who know their industry and business. SEL products are engineered to exceed industry standards.

SEL products require practically no service and include a ten-year no-questions-asked warranty that substantially reduces the total cost of ownership. Railroad operations worldwide trust SEL to engineer, construct, monitor, meter, protect, and control their power systems for maximum safety, reliability, and cost efficiency.



SEL provides innovative, technologically advanced power management solutions and was chosen first among protective relay manufacturers across all categories in a recent study conducted by Newton-Evans Research Company. SEL power management and control solutions incorporate the full spectrum of technologies and services required for high-speed rail applications, including:

- Utility Grid Interconnection
- Revenue and Power Quality Metering
- Transformer Protection
- Breaker Protection
- Single- and Two-Phase Traction Protection
- Motor Protection
- Secure Data Communications
- Engineering and Consulting
- Automation and Control



Trusted Partners

SEL provides power protection, monitoring, and control solutions to transportation companies around the world, including:

- Amtrak
- BNSF
- Turkish State Railways
- ADIF
- BART (Bay Area Rapid Transit)
- New Jersey Transit
- Port Authority of NY & NJ
- MTA Metro-North
- Shanghai Metro
- Mumbai Monorail
- Metrolinx/GO Transit
- Taiwan High Speed Rail

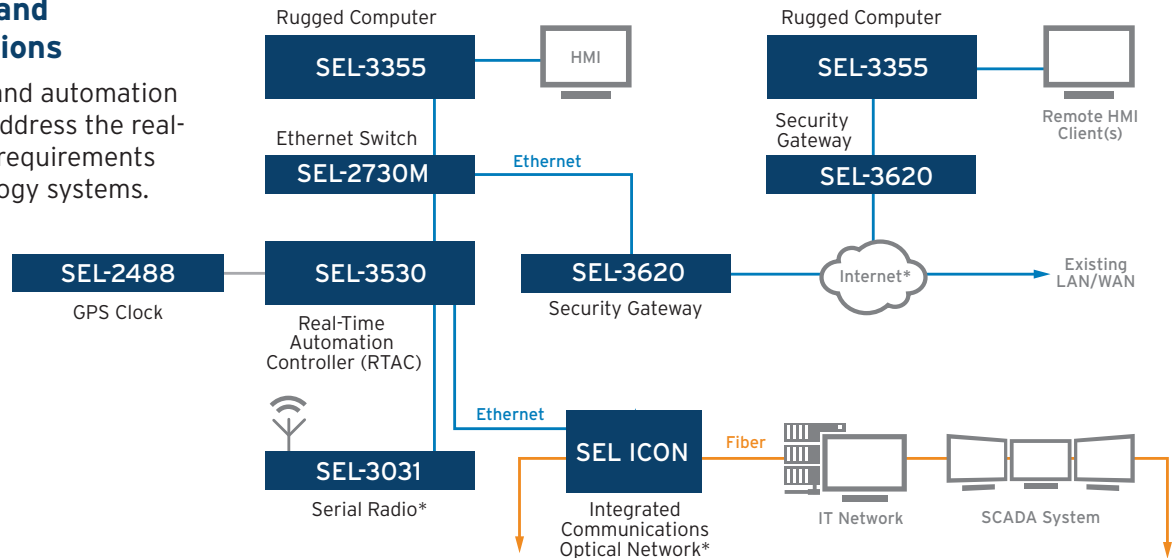
Learn more at www.selinc.com.



SEL Power Management and Control System Overview

Communications and Automation Solutions

SEL communications and automation solutions are built to address the real-time, minimal-latency requirements of operational technology systems.

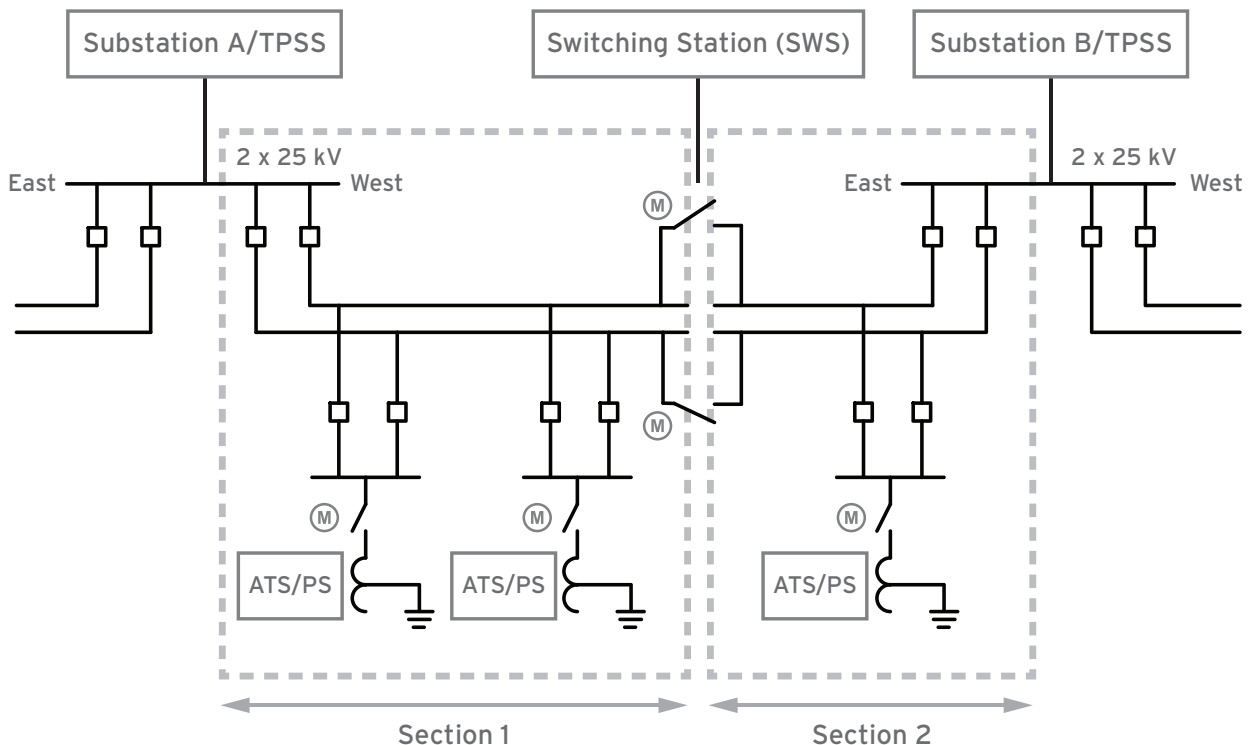


*Denotes network communications technologies that offer user-selectable options
Local- and Wide-Area Communications and Control System Using SEL Products

Typical AC Electrified 2 x 25 kV Autotransformer Traction Power System

Each section of an ac electrified traction power system is comprised of many different electrical devices: transformers, busbars, cables, switches, breakers, and many more. Each area of the traction power system needs to be properly designed for protection and automation

to ensure that catenary circuits do not falsely trip and that substation systems remain as reliable as possible for continued power delivery. Primary and backup protection systems need to operate flawlessly to keep trains and passengers moving.



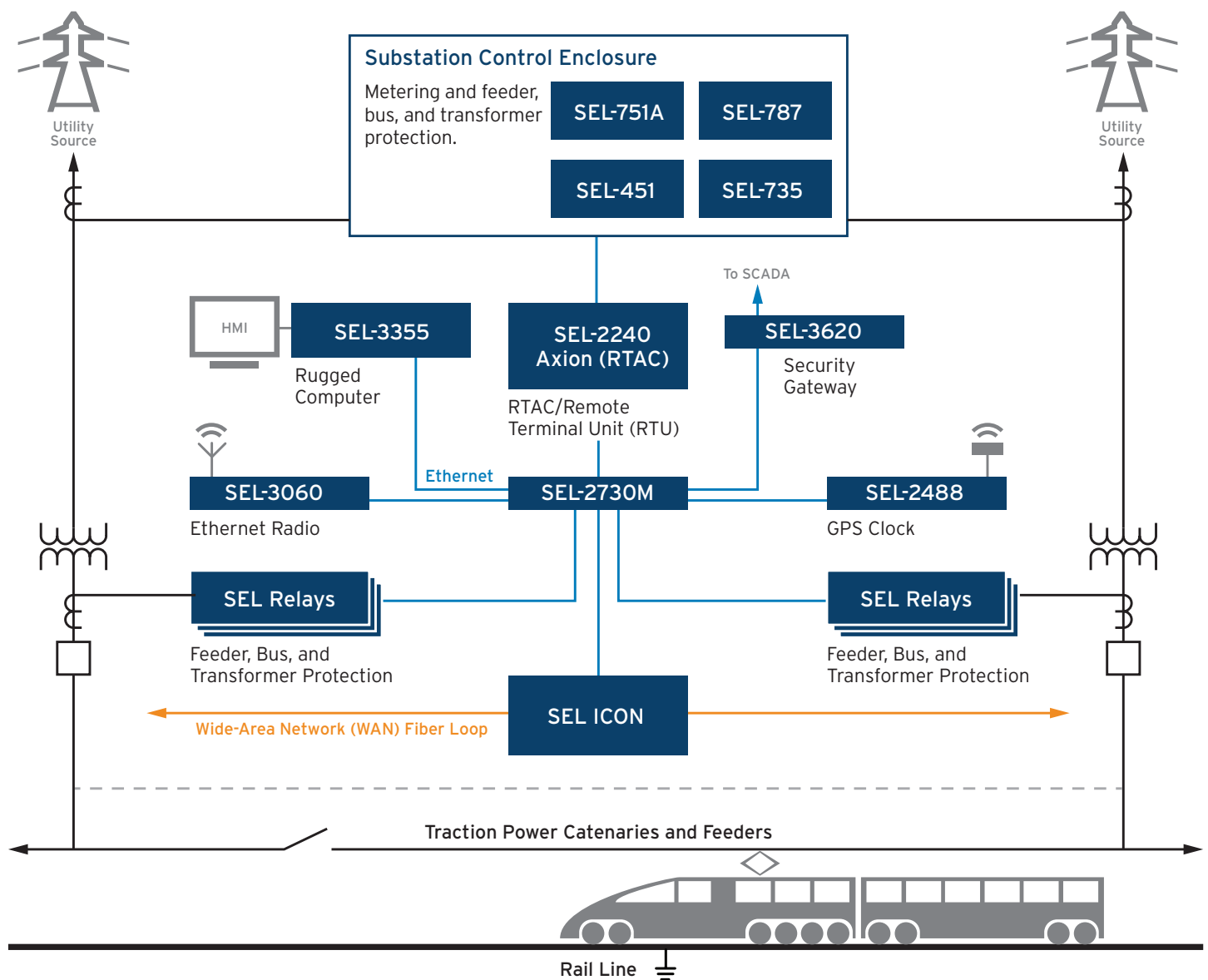
Traction Power Substation (TPSS)

SEL offers a complete TPSS solution, from the utility source to the catenary and feeders, including automation, control, protection, and communications.

Our flexible TPSS solutions enable multilevel power system coordination, including downstream and upstream stations and feeders, and multiple utility feeds. SEL's high-speed fault detection identifies the source and location, enabling you to quickly clear faults for reliable, continued high-speed rail operation. In addition, our high-speed, deterministic communications are essential in clearing faults quickly and enable secure coordination between stations and feeders.

SEL provides power system protection, including impedance, reclosing, under-/overvoltage, differential, time overcurrent, instantaneous overcurrent, breaker failure protection, and communications-assisted protection schemes. SEL metering solutions combine industry-leading power quality capabilities with exceptional revenue metering accuracy at an economical price.

SEL control enclosures and panels are integrated solutions for protection, control, and metering applications. We offer many pre-engineered, cost-effective solutions designed for typical rail applications. SEL also has the capability to design and manufacture custom solutions.



Typical Dual-Fed Traction Power Substation

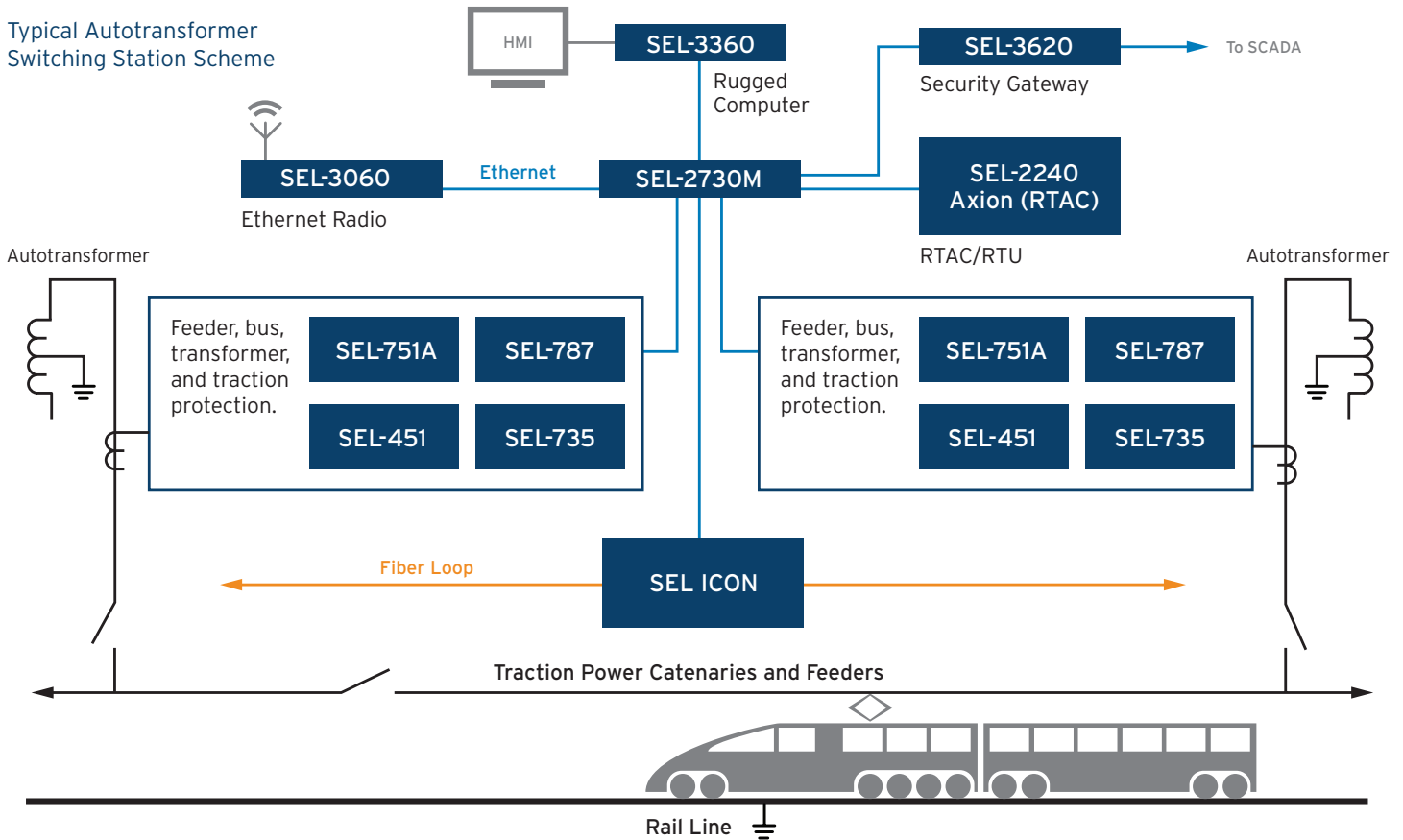
Switching Station (SWS)

An SWS acts as the breaking point between TPSSs. The switching station consists of two paralleling stations with a phase break in the middle to isolate each TPSS.

If a TPSS fails, the switching station closes the phase break, allowing one TPSS to power the entire stretch from one end.

SEL provides differential and time overcurrent power system protection. SEL's ICON® Integrated Communications Optical Network provides the ability to integrate security information from rail operations, including video and proximity inputs. The SEL-2240 Axion® provides dependable measurement and high-speed, deterministic control that is ideal for industrial environments, such as high-speed rail operations.

Typical Autotransformer Switching Station Scheme



SEL Power Management and Control System Components



SEL ICON Integrated Communications Optical Network

Wide-Area Data Communications

The SEL ICON is a wide-area-networking multiplexer optimized for industrial and utility applications. By combining time-division multiplexing (TDM) and Ethernet with a comprehensive range of data interfaces, the ICON makes it easy to migrate from legacy systems and meet the evolving needs of industrial and transportation system communications.



SEL-3620 Ethernet Security Gateway

Ethernet Security Gateway

Designed and built in conjunction with the U.S. Department of Energy, the SEL-3620 secures your control system communications with a stateful deny-by-default firewall, strong cryptographic protocols, and logs for system awareness. It also manages protected intelligent electronic device (IED) passwords, ensuring that passwords are changed regularly and conform to complexity rules. The SEL-3620 is ideal for mission-critical applications, including high-speed rail environments.



SEL-2730M Managed 24-Port Ethernet Switch

Managed Ethernet Switch

The SEL-2730M is designed for the harsh conditions found in industrial and utility environments. The switch supports communications infrastructure built for engineering access, SCADA, and real-time data communications.



SEL-3530 Real-Time Automation Controller (RTAC)

Communications Processors

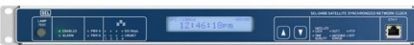
SEL information processors integrate power system protection, automation, communication, control, and monitoring with a variety of microprocessor-based devices. The SEL-3530 RTAC includes SEL's simple, intuitive acSELERATOR RTAC® SEL-5033 Software to simplify power system design and integration.



SEL-2240 Axion Distributed Control and Integration Platform

Automation Controllers

The SEL-2240 Axion is a fully integrated, modular I/O and control solution suitable for high-speed rail applications. It combines communications, built-in security, and real-time automation control with a durable suite of I/O modules that provide fast, deterministic control performance. The SEL-2411 Programmable Automation Controller easily integrates into SCADA systems to meet sequential events reporting, station integration, remote monitoring, ac metering, and plant control system needs.



SEL-2488 Satellite-Synchronized Network Clock

Satellite-Synchronized Timing

The SEL-2488 provides time signals to networked devices, with ± 100 nanosecond (average) Coordinated Universal Time (UTC) accuracy. The SEL-2488 distributes time via multiple output protocols, including IRIG-B, the Precision Time Protocol (PTP), and the Network Time Protocol (NTP).



SEL-3060 Ethernet Radio and SEL-3031 Serial Radio Transceivers

Radio Communication

The SEL-3060 and SEL-3031 are multipurpose radios for distribution automation wireless applications, including SCADA and engineering access. Both radios operate in the industrial, scientific, and medical (ISM) band, which is an unlicensed spectrum enabling fast deployment with minimal cost.



SEL-3355 Rack-Mount Rugged Computer and SEL-3360S Compact Industrial Computer

High-Reliability Computing

The tough SEL-3355 and SEL-3360S are built to withstand harsh environments. By eliminating all moving parts (including rotating hard drives and fans) and using error-correcting code (ECC) memory technology, SEL computers have over ten times the mean time between failures (MTBF) of typical industrial computers. Every SEL computer comes with an unprecedented ten-year worldwide warranty.



SEL-487E Transformer Protection Relay

Transformer and Bus Protection

Protect and monitor most transformer applications with the powerful SEL-487E Relay. The SEL-487E limits transformer damage by responding to internal fault conditions in fewer than 1.5 cycles, and it tracks wear with through-fault and thermal monitoring, enabling continued high-speed rail operation. The SEL-487B Bus Differential and Breaker Failure Relay provides current differential protection, circuit breaker failure protection, and backup overcurrent protection with an independent check zone, advanced open CT detection, an enhanced front-panel HMI, and 60- to 120-cycle event reports.



SEL-751A Feeder Protection Relay With Arc-Flash Detection

Feeder Protection, Including Arc-Flash Protection

SEL feeder protection solutions provide complete feeder protection, including overcurrent, overvoltage, undervoltage, and frequency elements with flexible input/output (I/O) options, easy mounting, and fast settings. The SEL-751A also provides full automatic protection against dangerous arc-flash events, insuring personnel safety and protecting equipment. Innovative fiber-optic communications, light-sensing technology, and overcurrent protection securely detect arc-flash hazards and send a trip signal to the breaker in as fast as 2 milliseconds.



SEL-451 Protection, Automation, and Bay Control System

Traction Feeder Protection

SEL catenary feeder protection solutions provide the fastest, most reliable fault-clearing time for radial and dual-feed power systems. The SEL-451 provides protection for single- and two-phase systems in an autotransformer or booster transformer scheme.



SEL-735 Power Quality and Revenue Meter

Power Quality and Revenue Metering

The SEL-735 Meter provides high-accuracy, four-quadrant metering and advanced load profile recording. The SEL-735 is indispensable for ensuring power quality, reliability, and accurate utility billing and submetering. Indoor mounting options and prewired outdoor enclosures enable high-accuracy metering at practically any location. In addition to revenue metering, the SEL-735 provides advanced power quality information to identify and mitigate harmonics, line imbalances, voltage sags and swells, flicker, and power factor problems.

SEL Engineering Services

Consulting Services

SEL consulting services range from the conceptual phase of the project, providing front-end engineering design, through project execution and commissioning.

Protection Studies

SEL can provide protection studies using a variety of tools to help protect against capital losses due to circuit failures or faults.

Automation Services

SEL offers robust automation 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 of your system.

Power System Modeling

Improve power system performance in critical applications, validate relay performance, and optimize settings using model power system testing. SEL creates a computer model of your power system, enabling endless possibilities for testing protection and control systems under realistic conditions using a Real Time Digital Simulator (RTDS®).

Condition-Based Monitoring and Asset Optimization

SEL's approach to condition-based monitoring gives rail operators and maintenance staff visibility to equipment health and helps identify potential problems early, enabling solutions to be proactively implemented, thus avoiding costly shutdowns.

Cybersecurity Solutions

Achieving success with cybersecurity requires a team approach. SEL believes that combining layered security protection with the efforts of protection engineers, information technology personnel, and compliance managers leads to a secure and compliant solution.

Design and Drafting Services

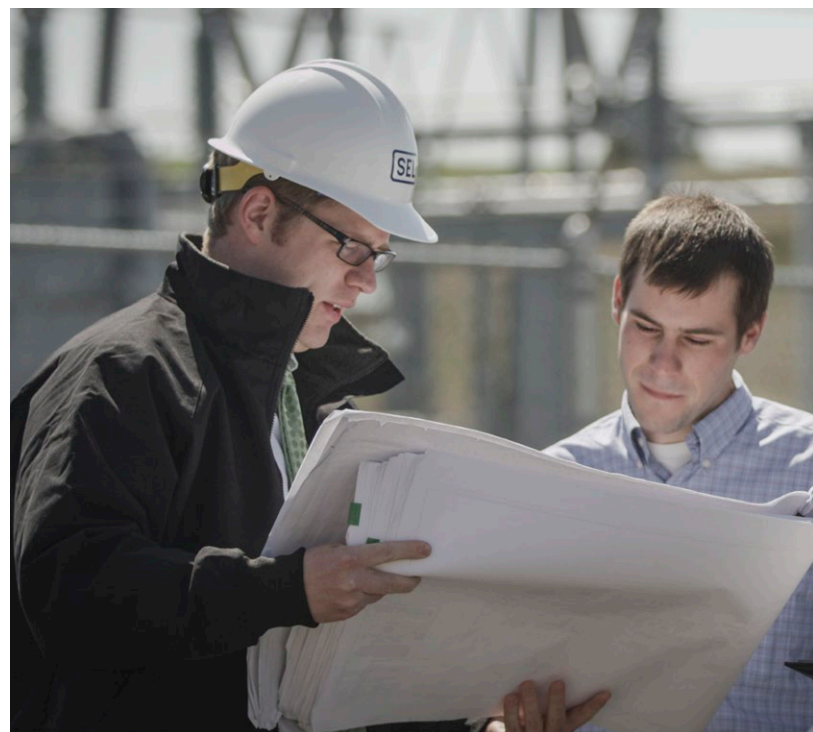
SEL offers full electrical packages. Electrical packages typically include ac and dc schematics, single-line diagrams, wiring diagrams, panel layout drawings, logic schematics, and communications and network drawings.

Enclosures and Panels

SEL provides integrated panel solutions and complete substation control enclosures for protection, control, and metering applications. Each SEL enclosure and panel is designed, manufactured, tested, and commissioned by highly skilled SEL employees and includes our no-questions-asked ten-year warranty.

Field Testing and Commissioning

SEL factory-trained technical staff can come onsite to support your testing and commissioning efforts and provide hands-on training for your personnel. This saves time, lowers costs, and improves your operational efficiency.



SEL Complete Solutions

Industry-Proven Interconnection Equipment

SEL interconnection equipment can substantially improve power system reliability by replacing commercial-grade data cables and transceivers that are poorly suited for the demanding operating conditions of high-speed rail environments. Our data transceivers, copper cables, and fiber-optic cables are produced in an SEL factory by employees who have the highest-quality training, production tools, and testing equipment available. SEL's attention to detail on these often-overlooked system components can eliminate significant system vulnerabilities and keep your power system operating properly.





SEL University

SEL University (SELU) training courses prepare you to efficiently manage and operate power management and control system components with confidence while earning continuing education units (CEUs). SELU offers convenient eLearning courses that fit your schedule and classroom-based courses that allow you to network with industry professionals. Choose an off-the-shelf option, or have SELU tailor materials for your company's specific solution. SELU instructors are industry thought leaders and experienced power engineers who understand the engineering applications and real-world operating requirements of modern power systems.

APP ICON: SEL ICON Integrated Communications Optical Network

APP 3620: Sensible Cybersecurity Using the Ethernet Security Gateway

APP 3530: SEL-3530 Real-Time Automation Controller

APP 487E: SEL-487E Transformer Protection Relay

APP 751: SEL-751/A Feeder Protection Relays

APP 451: SEL-451 Protection, Automation, and Bay Control System

APP 735: SEL-735 Power Quality and Revenue Meter

APP 2240: SEL-2240 Axion Distributed Control and Integration Platform

For a full list of SELU courses and to view the training calendar, visit selinc.com/selu.

Regional Technical Support

Worldwide SEL support teams provide our customers with local sales and technical service. 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 truly understand the importance of local support. SEL provides personalized, regional technical support to our customers from more than 85 offices.

Ten-Year Worldwide Warranty

The SEL ten-year worldwide product warranty is proof of our confidence in the high-quality products we design, manufacture, sell, and support. This stated warranty and our track record for never charging a customer to replace or repair a defective product are the best substantiation of true quality and durability.



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

Schweitzer Engineering Laboratories
Tel: +1.509.332.1890 | Email: info@selinc.com | Web: www.selinc.com

© 2016 by Schweitzer Engineering Laboratories, Inc.
PF00543 • 20160720

