POWER SOLUTIONS FOR MINING OPERATIONS

Power Protection, Monitoring, and Control

Generator Protection

Motor Protection

Arc-Flash Mitigation

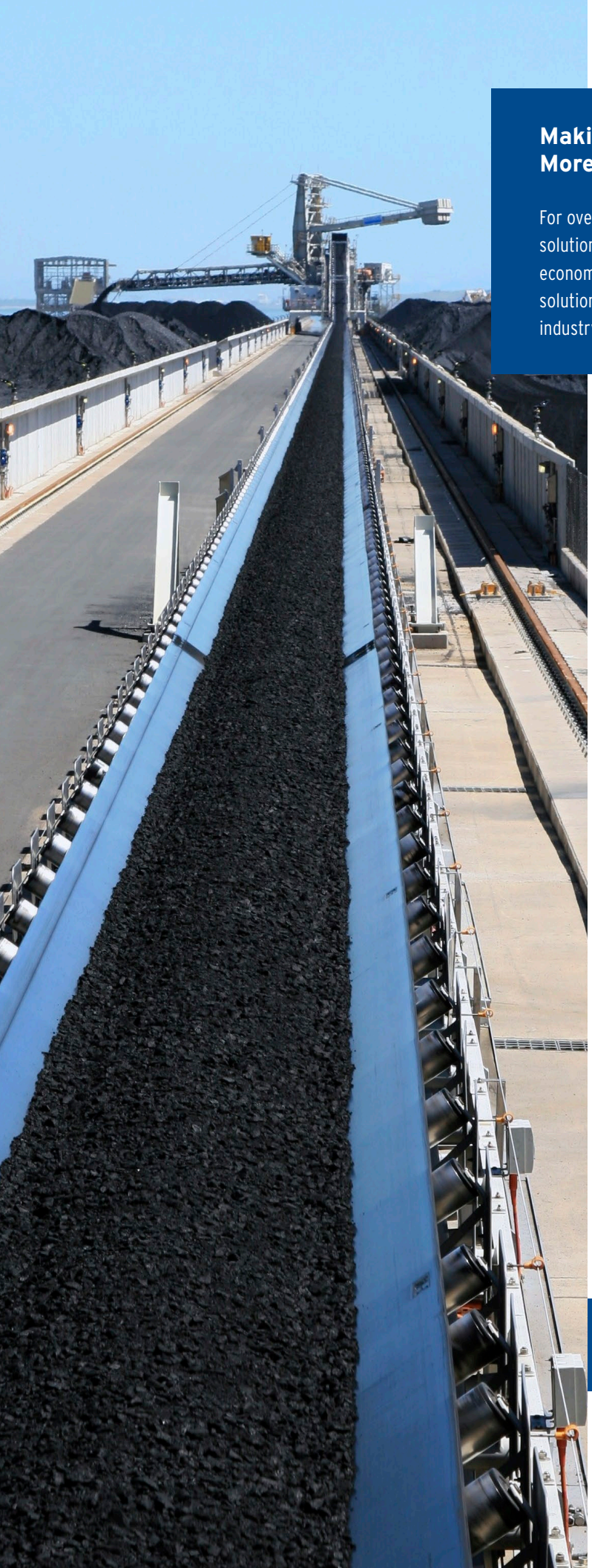
Power Quality Analysis

Secure Communications

Fault Indication

Metering

SEL



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

For over 25 years, Schweitzer Engineering Laboratories, Inc. (SEL) has delivered solutions that make electric power systems safer, more reliable, and more economical. Mine operators worldwide deploy advanced power management solutions from SEL and are supported by SEL engineers who know their industry and business.

SEL power management and control systems protect industrial facilities from blackouts, employee hazards, and lost production. SEL's advanced technology ensures uninterrupted electrical service under the most demanding environmental conditions.

SEL products are extraordinarily robust and exceed industry standards for temperature, dust, shock, and vibration. SEL products require practically no service and include a ten-year, no-questions-asked warranty that substantially reduces maintenance expenses.

Mining operations worldwide trust SEL to engineer, construct, monitor, meter, protect, and control their power systems for maximum safety, reliability, and cost efficiency.

Trusted Partners

SEL provides power protection, monitoring, and control solutions to respected businesses around the world, including:

- Alcoa Alumina of Australia
- ArcelorMittal Mines
- BHP Billiton
- CITIC Pacific Mining
- Kumba Resources
- Ma'aden–Saudi Arabian Mining Company
- Mexicana de Cobre, S.A. de C.V.
- Freeport-McMoRan Copper & Gold Inc.
- Potash Corporation of Saskatchewan
- Worsley Alumina

Learn more at **www.selinc.com**.

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

Utility Grid Interconnection

Revenue and Power Quality Metering

Capacitor Bank Control

Transformer Protection

Breaker Protection

Line Protection

Generator Protection

Motor Protection

Arc-Flash Detection

Annunciation and Control

Faulted Circuit Indication

Secure Data Communications

Engineering and Consulting

Custom Control Panels

SEL Power Management and Control Capabilities

SEL's Generation Control System regulates generator power outputs and manages utility interties to maximize system stability, minimize electrical disturbances, and mitigate load-shedding requirements.

Automatic Generation Control (AGC) regulates generator outputs to maintain the power interchange at the utility tie within user-defined set points. The powerMAX® AGC System can dynamically recalculate control set points under all system bus configurations and respond to load-shedding events within a few milliseconds.

Automatic MVAR and Voltage Control System utilizes load tap changers (TLCs), generator field and large synchronous motor exciters, synchronous and static condensers, and capacitor banks to maintain system bus voltages and MVAR flows on interties.

Automatic System Islanding Detection continuously monitors intertie points to determine if the power system has been islanded from one or more utility connections. SEL's islanding control system operates a selected generator in "isynchronous" mode to maintain frequency control during islanding events.

Automatic Decoupling System can quickly disconnect the power system from an unstable utility source and create a system island.

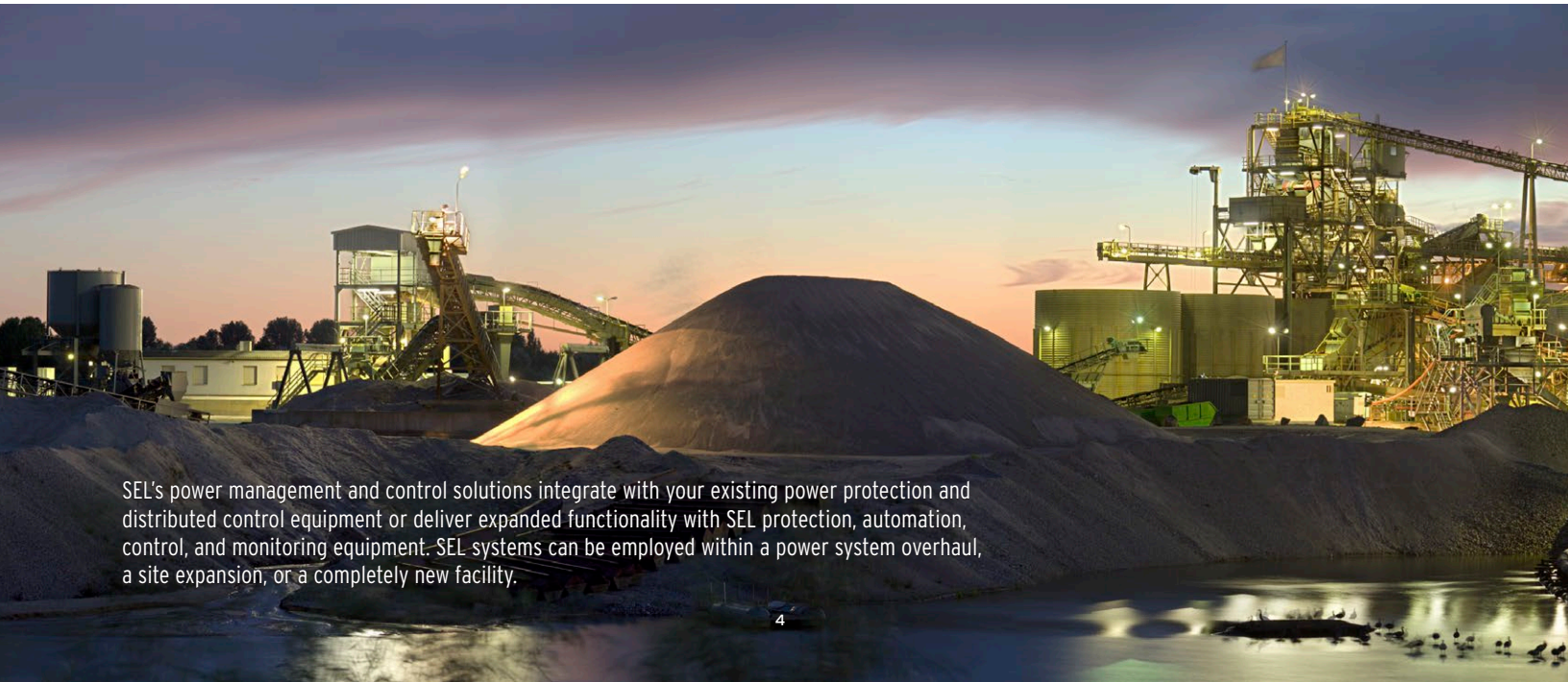
System Frequency Control automatically changes operational configuration to regulate system frequency upon detection of an islanded condition. The system's advanced algorithm adjusts set points within prescribed control modes for each generator.

Automatic Load Shedding compares generator and load data with predetermined load-shedding priorities to deliver fast, contingency-based load-shedding commands within a single power cycle.

Automatic Load Restoration will automatically close utility tie point breakers and resume real and reactive power flows once proper operating conditions are validated. This is coordinated through the generation control system to ensure all safety conditions are satisfied.

Synchronized Phasor Measurements (synchrophasors) enable a powerMAX System to monitor and control power systems with unprecedented accuracy and speed. SEL's modal analysis tools continuously calculate resonance and oscillation frequencies to optimize generator protection schemes.

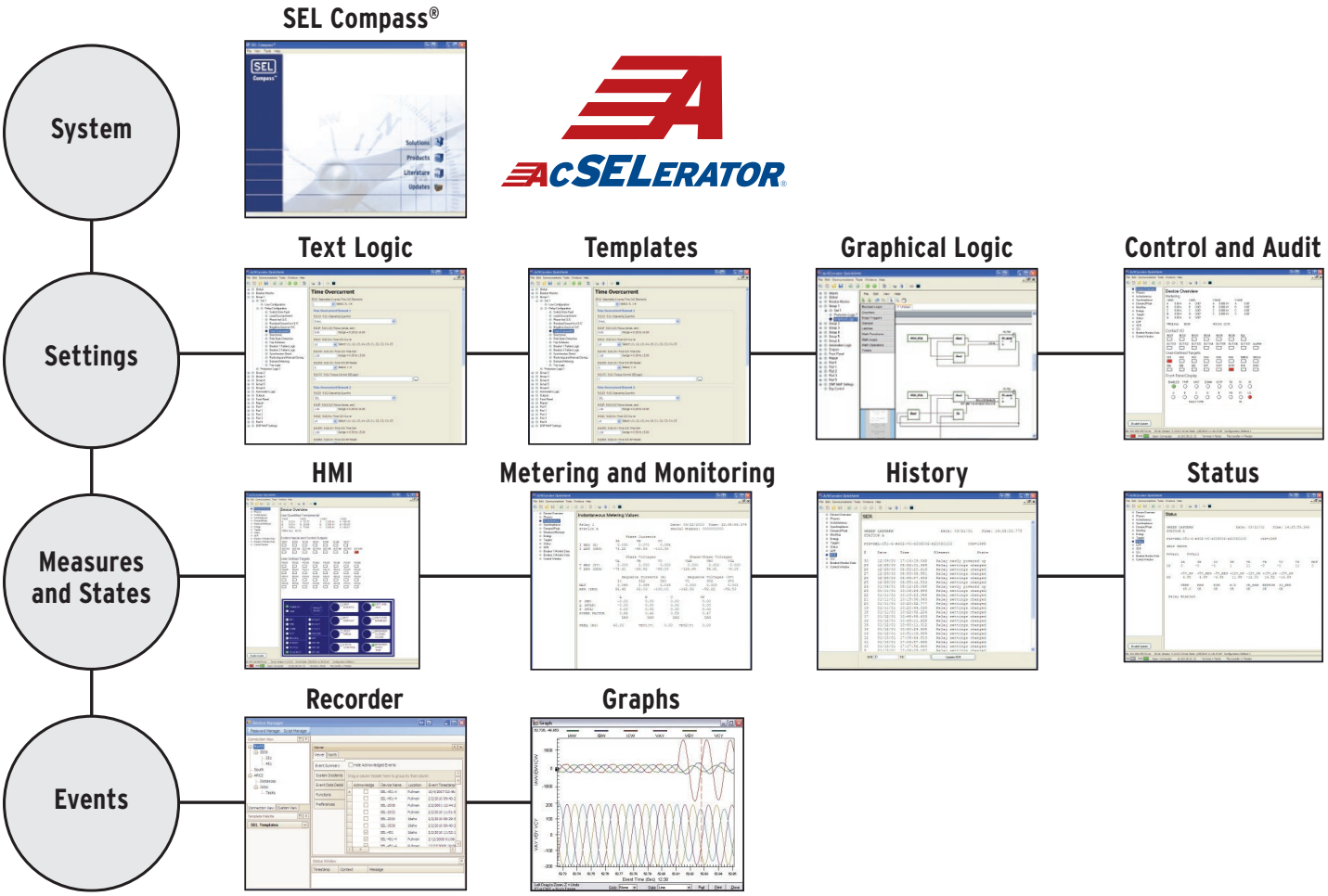
Advanced powerMAX Communications employ IEC 61850 GOOSE messaging or SEL Mirrored Bits® communications technology to transmit critical control commands every power cycle. powerMAX can also provide a secure communications platform for standard protocols, such as Modbus®, DNP3, and others.



SEL's power management and control solutions integrate with your existing power protection and distributed control equipment or deliver expanded functionality with SEL protection, automation, control, and monitoring equipment. SEL systems can be employed within a power system overhaul, a site expansion, or a completely new facility.

SEL Power Management and Control System Software

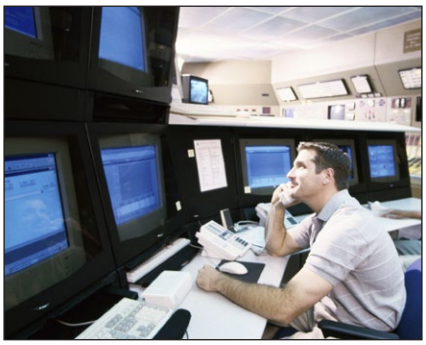
SEL's ACSELERATOR® Software products give engineers and operators incredible power to design, commission, manage, and control power systems within an easy-to-use graphical interface. SEL's graphical logic can simplify designs, and the preformatted templates enable quick and consistent implementation of equipment settings.



SEL Power Management and Control System Overview

Protect and Control

SEL protective relays, meters, and controllers ensure the power system is monitored and managed for optimum safety, performance, and reliability.

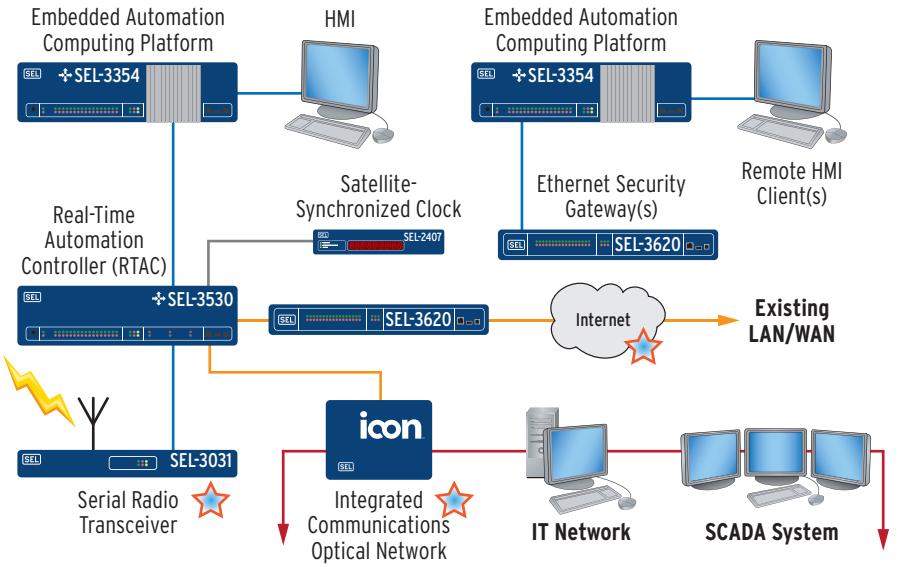


Integrate and Automate

Coordinate protection, utility feeds, on-site generation, and facility loads within a secure, high-speed control network that maintains power system stability and protects against blackouts under ever-changing conditions.

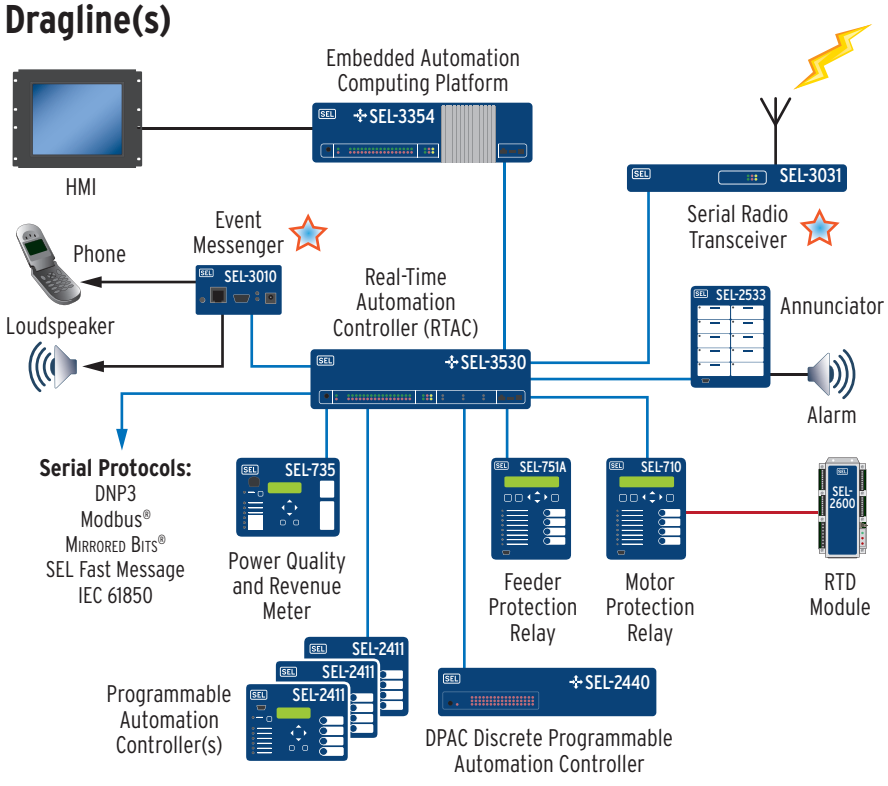
SEL

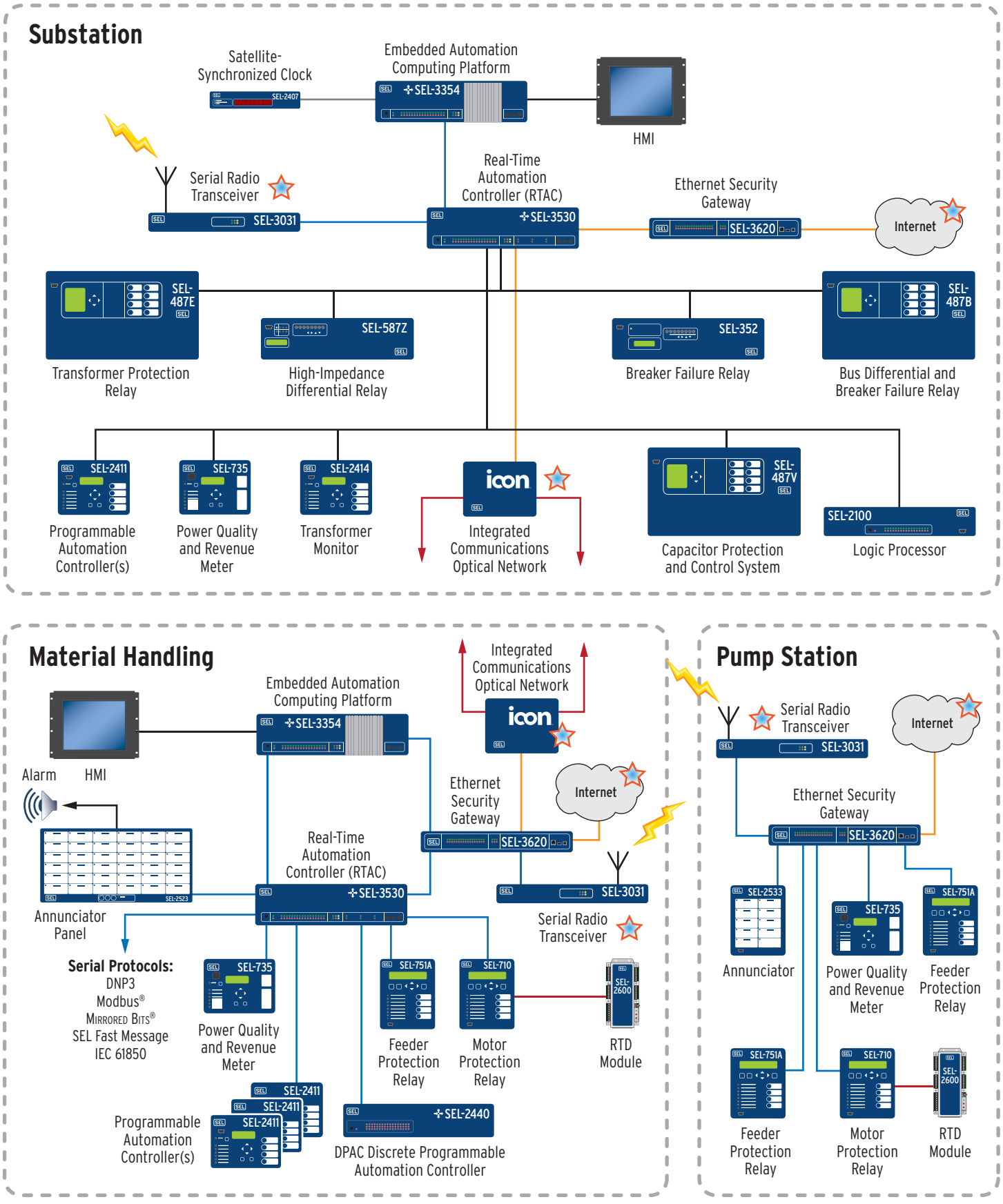
SEL Control Applications



SEL Fault Indicators for Overhead Power Lines

Dragline(s)




Substation
Satellite-Synchronized Clock
SEL-2407
Embedded Automation Computing Platform
SEL-3354
HMI
Serial Radio Transceiver
SEL-3031
Real-Time Automation Controller (RTAC)
SEL-3530
Ethernet Security Gateway
SEL-3620
Internet
SEL-487E
Transformer Protection Relay
SEL-587Z
High-Impedance Differential Relay
SEL-352
Breaker Failure Relay
SEL-487B
Bus Differential and Breaker Failure Relay
SEL-2411
Programmable Automation Controller(s)
SEL-735
Power Quality and Revenue Meter
SEL-2414
Transformer Monitor
icon
Integrated Communications Optical Network
SEL-487V
Capacitor Protection and Control System
SEL-2100
Logic Processor
Material Handling
Integrated Communications Optical Network
Embedded Automation Computing Platform
SEL-3354
Alarm
HMI
icon
Internet
Ethernet Security Gateway
SEL-3620
Real-Time Automation Controller (RTAC)
SEL-3530
SEL-3031
Serial Radio Transceiver
SEL-2523
Annunciator Panel
Serial Protocols:
DNP3
Modbus®
Mirrored Bits®
SEL Fast Message
IEC 61850
SEL-735
Power Quality and Revenue Meter
SEL-751A
Feeder Protection Relay
SEL-710
Motor Protection Relay
SEL-2600
RTD Module
SEL-2411
SEL-2411
SEL-2411
Programmable Automation Controller(s)
SEL-2440
DPAC Discrete Programmable Automation Controller
Pump Station
Serial Radio Transceiver
SEL-3031
Internet
Ethernet Security Gateway
SEL-3620
SEL-2533
Annunciator
SEL-735
Power Quality and Revenue Meter
SEL-751A
Feeder Protection Relay
SEL-751A
Feeder Protection Relay
SEL-710
Motor Protection Relay
SEL-2600
RTD Module

SEL Power Management and Control System Components

SEL ICON™ Integrated Communications Optical Network

Data Communications

The SEL ICON™ Integrated Communications Optical Network supports time-division multiplexing (TDM) and Ethernet traffic within single- or multiple-ring network topologies. This architecture and utility-grade reliability make the ICON ideal for system control and data acquisition (SCADA) applications. Additionally, the ICON includes data encryption and precise time distribution features to better manage power generation and distribution assets. If a fiber-optic line should fail, the ICON separates different traffic types and executes ring network traffic switches in fewer than five milliseconds.

SEL-3620 Ethernet Security Gateway

Ethernet and Security Gateway

Designed and built in conjunction with the U.S. Department of Energy National SCADA Test Bed, the SEL-3620 Ethernet Security Gateway easily secures site-to-site Ethernet communications and protects private networks. The SEL-3620 installs quickly and operates with an intuitive, menu-driven web interface, supports up to 16 VPN connections, provides up to 60,000 security event reports, and applies an IRIG-B clock signal for precise event time tagging.

SEL-3354 Embedded Automation Computing Platform

High-Reliability Computing

You can improve your power system reliability with a rugged computing solution from SEL. By eliminating all moving parts and using error-correcting code memory technology, SEL computers have over ten times the mean time between failures (MTBF) of typical industrial computers. Install an SEL computer and create embedded, integrated solutions with on-board Ethernet, USB, serial, and VGA ports. IRIG-B capability brings satellite-synchronized, precise-time capability to your power system, which is especially useful when troubleshooting power system anomalies. With Windows® 7 Ultimate, Windows Embedded Standard, and Linux® operating system choices, you have the tools you need for any application.

SEL-3530 Real-Time Automation Controller (RTAC)

Information Processors

SEL information processors integrate power system protection, automation, communication, control, and monitoring with a variety of microprocessor-based devices. The SEL-3530 Real-Time Automation Controller (RTAC) includes SEL's simple, intuitive ACSELERATOR RTAC® SEL-5033 Software to simplify power system design and integration. The embedded RTAC web interface speeds the setup and monitoring of critical data, such as network access, user accounts, and system performance.

SEL-487E Transformer Protection Relay

Substation Control

Protect and monitor most transformer applications with the powerful SEL-487E Transformer Protection Relay. The SEL-487E limits transformer damage by responding to internal fault conditions in fewer than 1.5 cycles and tracks wear with through-fault and thermal monitoring. The SEL-487B Bus Differential and Breaker Failure Relay provides current differential protection, circuit breaker failure protection, and backup overcurrent protection with independent check zone, advanced open CT detection, enhanced front-panel HMI, and 60- to 120-cycle event reports. You can simplify relay settings, applications, and inventory by using one relay for all of your capacitor bank needs. The SEL-487V Capacitor Protection and Control System can handle grounded and ungrounded, single- and double-wye capacitor bank controls.

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-751 Feeder Protection Relay also provides full automatic protection against dangerous arc-flash events. Innovative fiber-optic, light-sensing, and overcurrent protection detects arc-flash hazards and sends a trip signal to the breaker in as fast as 2 ms.

SEL-751 Feeder Protection Relay With Arc-Flash Detection

Motor Protection

SEL motor protection solutions provide complete protection for high-horsepower motors. The SEL-710 Motor Protection Relay features the industry's most accurate motor protection with settings, mounting, and communications options designed for easy application. This solution allows you to minimize wait periods between starts and extend start times for slow-starting motors to substantially reduce equipment wear and lower maintenance expenses.

SEL-710 Motor Protection Relay

Power Quality and Revenue Metering

The SEL-735 Power Quality and Revenue Meter provides high-accuracy, four-quadrant metering and advanced load profile recording. The SEL-735 is indispensable for ensuring accurate utility billing and submetering, power quality, and reliability. 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-735 Power Quality and Revenue Meter

Automation Controllers

Built and tested to meet mission-critical IEEE and IEC protective relay standards, SEL controllers employ fast and powerful control logic processors and communications capabilities for robust control system designs. 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. The SEL-2440 DPAC Discrete Programmable Automation Controller can be configured within scalable, encrypted, time-synchronized SEL networks that incorporate multiple facilities and high I/O counts. With flexible communications and I/O options, these highly reliable control and monitoring systems are ideally suited to replace slower PLCs to sense pressures, temperatures, fluid levels, and measure ac currents and voltages.

SEL-2440 DPAC and SEL-2411 Programmable Automation Controllers

Alarm and Annunciation

Make complex alarming simple with SEL's alarm and annunciation panels that include 42 inputs, 11 outputs, programmable logic, and up to 4 communications ports, which support DNP3, Modbus, and SEL protocols. You can simplify commissioning and troubleshooting with a built-in sequence of events recorder and full human-machine interface (HMI) software. Apply an SEL-3010 Event Messenger for telephone voice call-out of critical alarm conditions.

SEL-2523 Annunciator Panel
SEL-3010 Event Messenger

Satellite-Synchronized Timing

SEL-2407® Satellite-Synchronized Clocks provide IRIG-B time signals to the SEL-3401 Digital Clock Display and third-party devices with ±100 nanosecond (average) Coordinated Universal Time (UTC) accuracy. The compact, single-output SEL-2401 Satellite-Synchronized Clock is ideally suited for confined physical spaces. The SEL-2407 includes a bright, LED display and six IRIG-B outputs. SEL clocks automatically compensate for daylight saving time (DST), include alarm features, and are password-protected to maintain security.

SEL-3401 Digital Clock Display and SEL-2407® Satellite-Synchronized Clock

SEL Engineering Services

Power system studies from SEL assess existing power system infrastructure to profile both pre- and postproject power system configurations. SEL studies include arc-flash analysis, fault (short circuit) studies, protection and coordination studies, relay application studies, and cybersecurity assessments. If engineering analysis should reveal vulnerabilities, SEL can construct tests with SEL system modeling and simulation tools. These SEL tests often lead to design and configuration alterations that improve safety, lower costs, increase performance, validate regulatory compliance, and improve system reliability.

Project scope and specification services from SEL can assist both in-house engineering departments and consulting firms with conceptual planning, execution, and commissioning. SEL employs hundreds of power system engineers worldwide, who design complex power systems for surface and underground mining operations. SEL routinely provides field engineering support to switchgear OEMs, generator manufacturers, and electrical contractors as well as testing services to ensure everyone in the supply chain can deliver their products and services as expected.

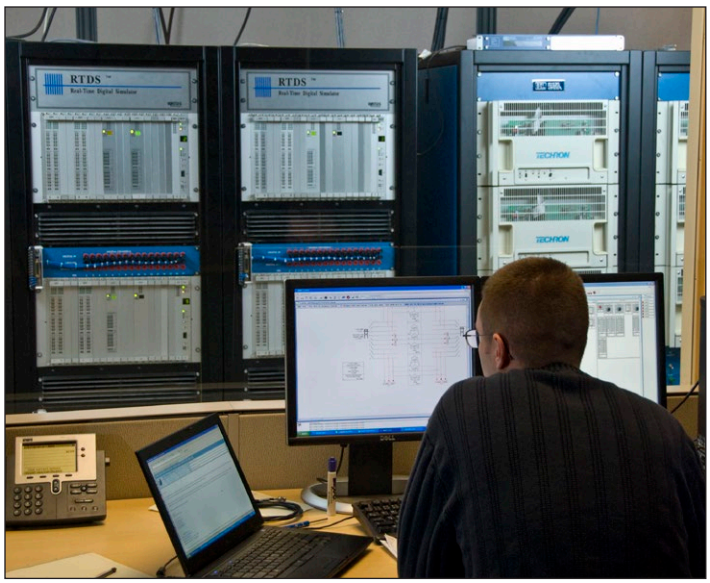
Design and documentation services from SEL ensure that design concepts, engineering studies, and product application recommendations are accurately represented within the project scope, engineering drawings, and cost estimates. SEL engineers ensure equipment capabilities are used to their full potential to reduce equipment counts, increase system reliability, and minimize expense.

HMI design services from SEL ensure power system engineers, operators, and electricians are working with HMIs that are intuitive, simple, fast, and informative. HMI design services include screen and settings programming, schematics, and connection diagrams. SEL can build screens that monitor the health of utility and local generation sources, display power system measurements (MW, MVAR, voltage, and current), and communicate system settings. SEL HMIs typically employ practical security features to ensure proper user access and event logging.

Engineering, procurement, and construction (EPC) services from SEL deliver turnkey solutions on time and on budget. SEL employs lean manufacturing techniques, strict quality management standards, highly qualified project managers, and experienced field service personnel to ensure that power system projects are successful.

Project implementation can be completed quickly and successfully when SEL engineers assist with relay settings and system commissioning. SEL engineers validate power system models, measure stability margins, validate stable system loading, and assist with load-shedding contingency planning.

Asset optimization solutions and services from SEL improve maintenance scheduling, track equipment life-cycle statistics, enhance system reliability programs, and improve power quality.



SEL Complete Solutions

SEL panels are designed, manufactured, tested, and commissioned by highly skilled SEL employees. SEL produces integrated panel solutions for protection, control, and metering applications, and stands behind both our equipment and workmanship with a no-questions-asked warranty. SEL offers pre-engineered solutions that deliver exceptional value and custom solutions designed to unique customer specifications.

SEL-7000 Integrated Substation Systems can substantially lower power system device counts and improve power system reliability by fully utilizing the automation and protection features in SEL relays. SEL integrated systems also reduce design requirements, training, documentation, operating, and maintenance expenses. SEL is uniquely qualified to deliver turnkey substation solutions within stated customer preferences.

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 utility and industrial power systems. Our data transceivers, copper cables, and fiber-optic cables are produced in an SEL factory by SEL 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 testing and commissioning equipment makes it easy for field personnel to load relay firmware, send or retrieve settings, test communications, and gather reports. SEL produces small, inexpensive handheld devices that operate independently of laptop computers, making them much faster and easier to operate for field service tasks. For more extensive testing, SEL produces a rack-mount relay test system that employs an adaptive multichannel source and an intuitive software interface. The SEL test system can test multiple relay signals, including voltages, currents, contacts, and serial links.

SEL University training courses ensure your engineers and system operators can manage and operate your POWERMAX System with confidence from the moment it is activated. SEL University courses are available in computer-based training (CBT) and web-based training (WBT) modules. SEL classroom and on-site learning sessions are designed for customer-specific learning requirements. SEL instructors are highly competent, experienced power engineers, who understand the engineering applications and real-world operating requirements of modern power systems.

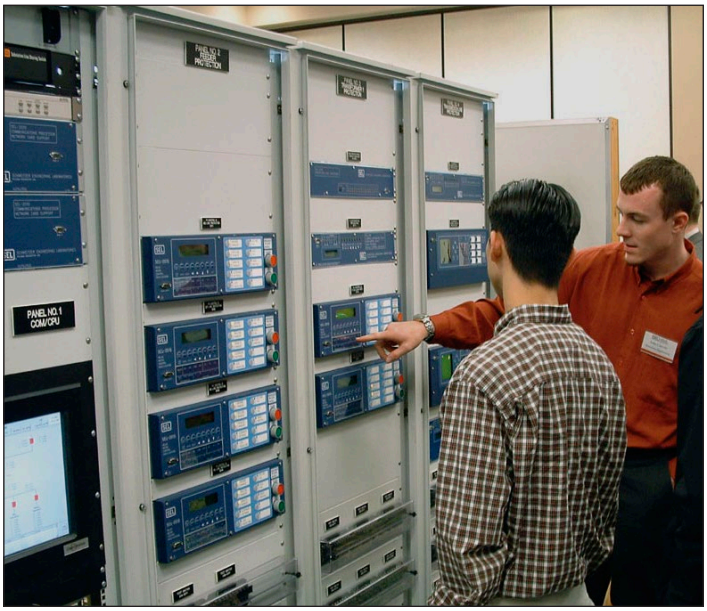
Services and Support

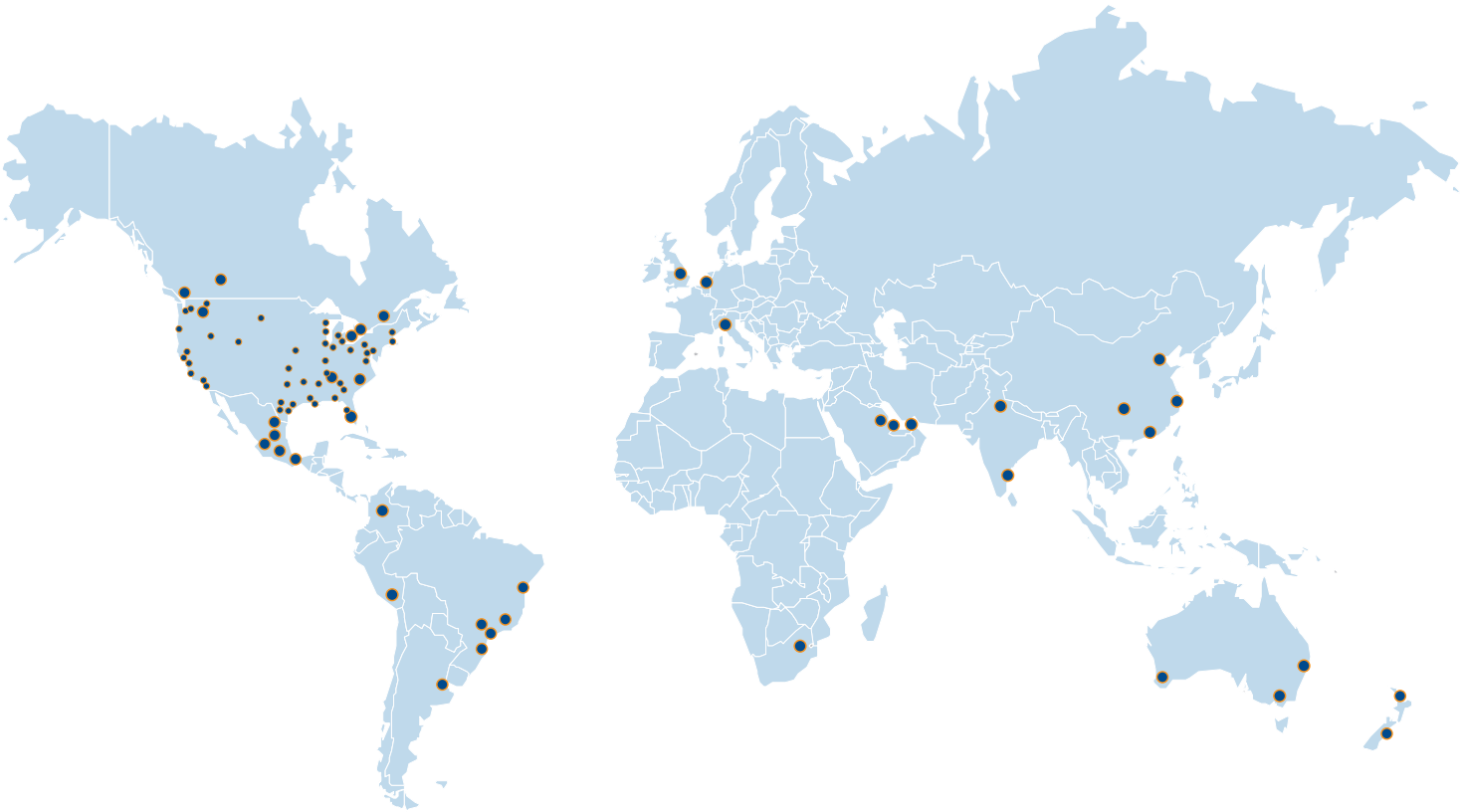
Ten-Year, Worldwide Warranty

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

Regional Technical Support

Teams in 18 countries worldwide provide local sales and technical service. With SEL solutions in more than 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 truly understand the importance of local support. SEL provides personalized, regional technical support to our customers from more than 85 offices.





www.selinc.com
info@selinc.com
+1.509.332.1890

PF00268 • 20111101