SEL POWERMAX® FOR OFFSHORE VESSELS

Advanced Generation Control
Communications and System Integration
Automatic Load Shedding
Total System Awareness

SEL®
SEL POWERMAX® Power Management, Protection, and Control System

The SEL POWERMAX Power Management and Control System protects against blackouts with advanced technology that revolutionizes protection and control for islanded power systems. This closed-loop system provides comprehensive generator protection and power system management, including harmonic analysis, advanced system visualization, and high-speed protection using synchrophasors. POWERMAX contains reliable, proven SEL hardware devices, IEC 61131 programming, and industry-standard communications protocols. SEL POWERMAX technology is uniquely qualified for onboard power plants used by offshore platforms and ocean-going vessels, including floating production storage and offloading vessels (FPSOs) and dynamic positioning vessels. SEL offers unmatched local and worldwide technical support and a ten-year product warranty.

Don’t jeopardize your revenue stream with anything less than SEL—we are the power experts.

“Vessels that use dynamic positioning (DP) rely on their power plant to maintain safe operations as well as to maintain the revenue stream. Also, large DP vessels are designed to spend more than 99 percent of their life at sea and, thus, are typically built with minimal capability to anchor the vessel. Even during periodic service, these ships usually remain on DP. For all of these reasons, power plant reliability is critical. Historically, power plant outages have been the single largest cause of revenue loss on DP vessels involved in the energy industry, representing about 40 percent of all failures.

“I am very impressed with SEL’s technology and their ability to provide comprehensive generator protection and power system management at each generator as well as from a supervisory level. I do not know of any other company that will warranty their products for ten years. During 28 years working on more than 30 DP power plants with 25 owners and every major power plant supplier, SEL’s system design is the most comprehensive, robust, and reliable protection philosophy and equipment that I have seen, particularly with respect to elimination of common-mode faults, which enables closed bus-tie operation.”

Lew Weingarth, BSEE
Technical Chairman
Marine Technology Society DP Conference

Total Power Management With Complete Protection and Control

SEL POWERMAX is designed to maximize generator performance and protect against blackouts with proactive safeguards against excess or reverse power, reactive power, loss of excitation, current/voltage imbalance, over- and undervoltage, and frequency.

POWERMAX is a complete power management system, designed to meet your specific protection and control requirements, whether the project is an overhaul to an existing power plant or a totally new vessel. The system provides generator running order selection, blackout start and recover, and diesel engine control. POWERMAX can be interfaced with existing systems and equipment, such as distributed control systems (DCSs), programmable logic controllers (PLCs), relays, governors, and exciters.

Protect Against Blackouts. Mitigate problems before you experience a blackout with real-time power system analysis and proactive generation protection and control.

Enhance Reliability With a Robust, Multifunctional System. Perform protection, control, automation, and management functions with the capability of integrating with existing DCS systems.

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

POWERMAX generation control features maximize generator performance and system stability using advanced power and voltage control at both local and supervisory levels. This is done with highly accurate, real-time acquisition of phasor measurements, or synchrophasors, for critically important power system data.

Power control features effectively alleviate common-mode power plant failures that lead to blackouts and regulate the MW power output of all system generators.

Generator voltage control features regulate the reactive power output of each generator through MVAR control and system voltage regulation. If there is a faulty exciter, POWERMAX instantly singles out the unreliable unit and takes immediate action with alarms and intervention.

Closed-Loop Generation Control

Precisely manage your onboard power plant, eliminating common-mode system faults such as governor faults, exciter faults, and other faults that affect the overall power system.

Mitigate voltage-induced blackouts using voltage and MVAR control.

Optimally control all voltage and MVAR—controlling components in your power system to maximize voltage stability margins.

With POWERMAX, full visibility of the system is provided with the ability to adjust set points and view alarms and generator MW and MVAR outputs. Reactive capability curves provide instant feedback on how each generator is performing in relation to its dynamic parameters.

Simplified POWERMAX Block Diagram
To provide comprehensive protection and management at both the individual generator level and the supervisory level, ultra-high-speed communications are required between the local and supervisory components.

**POWERMAX uses SEL Mirrored Bits** communications or IEC 61850 GOOSE messaging over fiber-optic cables to transmit critical control commands every power cycle. For redundancy, both protocols can be used. Additionally, **POWERMAX** can provide a secure communications gateway via standard protocols such as Modbus®, DNP3, and others.

SEL synchrophasor technology provides real-time measurement of electrical quantities. With SEL’s utility-hardened SEL-3378 Synchrophasor Vector Processor, **POWERMAX** can collect synchronous phasor measurements and compare, measure, and process real-time electrical quantities such as voltage, speed, MW, and MVAR. Using the C37.118-2005 protocol, microsecond GPS time-aligned measurements are transmitted between generators and system controls to provide highly advanced, reliable system protection and management.

**Synchrophasors**

Synchronized phasor measurements (synchrophasors) provide a real-time measurement of electrical quantities from across a power system. These measurements can be used for control and analysis of the power system.

SEL is a global leader in synchrophasor technology. Advanced SEL rugged synchrophasor vector processors and protective relays, coordinated with microsecond-accurate GPS clocks, are capable of transmitting and receiving synchronous phasor measurements in real time.

With synchrophasors, **POWERMAX** becomes a complete closed-loop system with the ability to monitor and control at unprecedented accuracy and speed. This is advantageous for islanded power plants found on offshore platforms, dynamic positioning vessels, and other ocean-going vessels with multiple medium-voltage generators. SEL synchrophasor technology allows you to:

- Protect against blackouts with automatic system correction and advanced warnings
- Perform modal analysis to calculate resonance and oscillation frequencies for enhanced generator and power system protection
- Provide comprehensive, managed power system startup
- Improve power system reliability by operating within measured stability limits

**Synchrophasor Vector Processor (SVP) Modal Analysis**

Unstable power system oscillations can cause blackouts. With SEL’s modal analysis tools, it is possible to calculate the resonance and oscillation frequencies on a continuous basis. This critical information can then be used to make necessary adjustments to the generator protection scheme.

**Ideal Time-Domain Waveforms**

SEL’s synchrophasor technology establishes a common reference waveform in every SEL device. This aligns the devices to the same standard reference. With a common reference for all locations, it is possible to compare voltages and currents from anywhere on a system.
Automatic Load Shedding

POWERMAX is a contingency-based system that continuously calculates precise load-shedding instructions.

To maintain overall system integrity and to protect assets, POWERMAX induces fault isolation and generator islanding. When a contingency arises, such as insufficient generation, POWERMAX can respond in less than one power cycle.

Because the POWERMAX system is always communicating with every individual load and every generator, it knows exactly what to do when a disturbance occurs. All sheddable loads are predetermined for every possible power system contingency and are shed only when that particular contingency arises.

Load Priority Table

SEL’s flexible, high-speed load-shedding system continuously calculates the amount of load necessary to shed for every possible supply loss. Using the load priority table, the operator is able to assign the priorities to the sheddable loads for different contingencies.

Source Contingency Summary

With proper security clearance, the operator has the ability to set the incremental reserve margin of each generator, which represents the extra generation available should a contingency occur. This directly impacts the amount of load that must be shed.

USS Makin Island

POWERMAX reduces analysis time with built-in tools and comprehensive self-diagnostics. All relays and protection functions are self-monitoring and record any system disturbance. Events are automatically archived for detailed analysis.

The human machine interface (HMI) continuously displays the operating parameters on custom screens with complete alarm details, allowing operators to optimize maintenance schedules and detect early signs of failure.

Reporting tools can be used in a primary or secondary capacity to the distributed control system (DCS) by providing additional system analysis and self-diagnostic tools.

Quickly and Easily Analyze Event Reports

With microsecond precision, POWERMAX retrieves sequence of events (SOE) records from all relays. In addition, SEL acSELeRator Report Server® Software retrieves event report oscillography from each relay. Based on the relay settings, the event report can contain analog inputs, control outputs, digital inputs, and relay logic variables that can be used for analysis of any system operation.

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: “Finally having legitimate data collection and reporting lets us focus on smart fixes. With just a handful of people to support power systems throughout the company . . . having the ability to remotely manage devices is a tremendous advantage.”
Example Offshore Platform One-Line Diagram Using SEL Products
SEL Power Management System Components

Maximize system uptime and mitigate problems before you experience an outage with proactive, high-speed load shedding, generation control, voltage control, and load management. SEL power management products provide total system awareness through graphical user interfaces, automatic waveform capture, report analysis software, and report generation tools. For more product options, visit www.selinc.com/ogp.

Protection

**SEL-700G Generator Protection Relay**
Achieve comprehensive primary and backup generator protection.

**SEL-710 Motor Protection Relay**
Dynamically calculate slip. This premiere motor protection scheme allows maximum start times. Best-in-class thermal modeling provides advanced protection beyond industry standards.

**SEL-749M Motor Relay**
Protect three-phase motors, including two-speed and reduced-voltage start motors.

**SEL-751A Feeder Protection Relay With Arc-Flash Detection**
Get the right solution for industrial feeder protection with flexible I/O, advanced communications, and easy mounting options. Protect personnel and minimize equipment damage with the industry’s fastest arc-flash detection system built into the SEL-751A.

**SEL-351S Protection System**
Simplify feeder protection and control.

**SEL-451 Protection, Automation, and Control System**
Combine directional overcurrent protection with complete control for a two-breaker bay.

**SEL-311L Line Current Differential System**
Apply for distance protection, reclosing, monitoring, and control.

**SEL-387L Line Current Differential Relay**
Install for economical, easy-to-apply line protection with zero settings.

**SEL-487B Bus Differential and Breaker Failure Relay**
Install for busbar and breaker failure protection, automation, and control in applications with up to six terminals per relay.
Computing, Automation, and Integration

SEL-3354 Embedded Automation Computing Platform
Built to withstand harsh environments with over ten times the MTBF of typical industrial computers.

SEL-2100 Logic Processor
Interconnect up to 15 devices. Add low-cost, high-speed bus protection, automated bus sectionalizing, breaker failure protection, and multiple terminal line protection.

SEL-3530 Real-Time Automation Controller (RTAC)
Integrate station control, reporting, and logging with one reliable system.

SEL-2664 Field Ground Module
Minimize generator damage with field ground monitoring.

SEL-2505 Remote I/O Module
Reduce operating time, add self-wiring, and simplify wiring for auxiliary inputs and outputs.

SEL-2600 RTD Module
Acquire and transmit resistance temperature detector (RTD) thermal data from transformers, motors, generators, and other system apparatus.

SEL-2440 DPAC Discrete Programmable Automation Controller
Achieve utility-grade I/O with powerful processing, flexible communications, and micro-second timing.

SEL-2411 Programmable Automation Controller
Use for automation control, SCADA, station integration, remote monitoring, and plant control systems.

SEL-3378 Synchrophasor Vector Processor
Implement real-time, wide-area monitoring, protection, automation, and control schemes.

Software and Accessories

acSELeRator Team™ Software
Use Team Software to apply predictive maintenance practices for electrical infrastructure.

SEL Synchrophasor Software
Synchrowave console, server, and archiver software are an important part of a complete synchrophasor system.

SEL-2407® Satellite-Synchronized Clock
Apply with relays, sequential events recorders, communications processors, and other devices for precise alignment of time-sensitive information.

SEL-2664 Field Ground Module
Minimize generator damage with field ground monitoring.

SEL-2505 Remote I/O Module
Reduce operating time, add self-wiring, and simplify wiring for auxiliary inputs and outputs.

SEL-2600 RTD Module
Acquire and transmit resistance temperature detector (RTD) thermal data from transformers, motors, generators, and other system apparatus.

SEL has received Product Type Approval from the American Bureau of Shipping (ABS). Over 35 SEL products have been Design Assessed to the ABS Rules and found suitable for use on vessels, Mobile Offshore Drilling Units (MODUs), and facilities certified by ABS. These include ocean oil platforms, drilling ships, oil tankers, and other ocean vessels.
Services and Support

Engineering Services
SEL’s team of engineers is ready to assist you in the following areas:
• Arc-flash hazard studies
• Engineering studies
• Security studies
• Power management system design
• Custom panel solutions
• Power system studies and relay settings
• Protection and automation scheme design
• Integration system design, testing, and settings
• HMI design and programming

Real Time Digital Simulator (RTDS®)
SEL’s RTDS allows complete dynamic modeling at the factory, significantly reducing on-site installation and commissioning costs.
• Closed-loop control and protection system testing
• Rotating and static-load modeling
• System and governor response time testing
• Load flow, short circuit, motor start, and governor and exciter operation testing and simulation

Regional Technical Support
SEL provides personalized, regional technical support to our customers in more than 130 countries from 75 regional technical service centers worldwide.