SEL powerMAX® Power Management Solutions

Power management solutions for energy systems of any size

- Provide energy assurance with reliable, resilient, and secure solutions for maintaining uninterrupted energy delivery.
- Maintain system stability with deterministic control that operates at subcycle speed to preserve load and generation balance.
- Seamlessly island and recouple managed grids with the bulk electric system.
- Integrate distributed energy resources (DERs).
- Manage power for projects ranging from small tactical microgrids (kilowatts) to country-level macrogrids (gigawatts).

OVERVIEW

An SEL POWERMAX Power Management and Control System is an integrated system composed of scalable relay and control hardware, software, and logic processing and designed by our engineering services experts. Ultra-high power system reliability and availability make POWERMAX ideal for locations with onsite generation and/or multiple utility power feeds.

SEL has designed, tested, and commissioned POWERMAX systems for utility and industrial customers across the globe. Our solutions are based on sound engineering principles, robust system architectures, and industry-leading protection, automation, computing, communications, and security products. POWERMAX systems provide relay-speed operation across wide areas.

SEL Protective Relays Are the Foundation

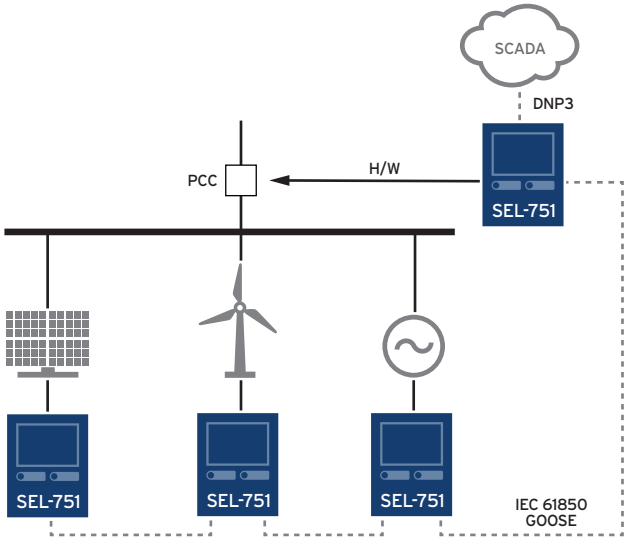
Protective relays are essential building blocks to any power management and control system. SEL relays are field-proven, multifunction devices that POWERMAX controls to protect people and equipment from faults and prevent blackouts.

SEL has a full selection of multifunction protective relays and control devices to meet any application or budget need. Our devices offer:

- Metering.
- Power quality monitoring.
- DC battery monitoring.
- IEC 61850 compliance.
- Whitelisting technology.
- High-speed communications.
- Continuous self-diagnostics.
- Environmental ratings that ensure continued operation in extreme conditions.
- Trip and close controls.
- HMI displays.
- No commercial operating system, which improves security.
- Remote I/O.
- Programmable logic controller capability.
- A Sequential Events Recorder (SER) function.
- Oscillography recorder.
- Load shedding.
- Short- and open-circuit protection.
- Interconnected contract compliance.
- IEEE 1547, 2030.7, and 2020.8 compliance.
- Power and power factor control.
- DER dispatch.
- Load sharing.
- Voltage and frequency regulation.

Relays provide multifunction capabilities in one device that no other solution can offer. By pairing an SEL relay with every DER, a POWERMAX system lets you efficiently meet control, protection, monitoring, and grid connection requirements.

Integrating DERs and novel topologies challenge protection schemes in microgrids, even more so than in conventional distribution systems. DERs in microgrids can modify fault currents, change fault current flow paths, result in bidirectional power flows, and affect protective device operations. POWERMAX seamlessly addresses these challenges with adaptive protection schemes, ensuring that personnel and equipment are always protected, regardless of the network configuration. The POWERMAX system uses adaptive protection to change relay settings, depending on the system needs and status.



The SEL Controller Is the Core of a POWERMAX System

At the core of every POWERMAX system is a powerful controller that responds to external data, such as real-time pricing signals and fast-changing system dynamics, to optimize the system's configuration.

Controlling the energy balance in the microgrid system is one of the most difficult challenges for reliable microgrid operation. By operating at relay speeds, the deterministic controller can reliably balance load with the available generation. This speed provides seamless islanding and resynchronizing, so processes stay online.

POWERMAX incorporates automated reconfiguration schemes that "self-heal," rerouting power around one or more faulted areas to maintain service elsewhere. This distribution automation control is combined with microgrid control in a single controller to provide multiple methods of dealing with faults for a low-risk, cost-effective solution. Integrated distribution automation allows network configuration within the microgrid because conditions that impact the utility grid can also impact the microgrid.

Maintaining Grid Stability—What Really Matters

A power management solution must maintain system stability while offering flexibility that reduces operating expenses and meets changing system demands. SEL POWERMAX meets these demands with comprehensive generation and load management made possible by its relays and control system.

Generation Control Functions

POWERMAX provides the following benefits for generation control:

- Automatic generation control that maintains balanced generation and nominal frequency under all scenarios.
- Dynamic capability curve calculation that constantly monitors the maximum capability of DERs.
- Voltage control that balances reactive power and maintains system voltage under all scenarios.

Load Management

POWERMAX provides the following benefits for load management:

- Prioritized high-speed contingency- and frequency-based load shedding that sheds the load based on system configuration and operation.
- Peak shaving that reduces the amount of energy purchased during peak hours when the charges are the highest.
- Load shifting that eliminates demand peaks by precharging energy management systems or precooling a building to offset anticipated charges.

POWERMAX Solutions

POWERMAX for Mobile Microgrids

POWERMAX ensures reliable power for microgrids that require mobility or rapid deployment, such as a military forward operating base (FOB) or a disaster relief effort.

For FOB military applications, you can parallel diesel generators instead of using the traditional setup of a dedicated generator per B-Hut or tent. Instead of sizing a generator to the peak demand of the respective function (e.g., tactical operations center, mess hall, or medical facility) and running it inefficiently most of the time, FOBs can now have parallel generators. This allows you to run a few diesel generators at high efficiency while resting the remaining generators. As loads increase, you can bring more generators online to meet the demand. This process increases operational efficiency by reducing wet stacking (and maintenance) and saving fuel, which prolongs mission operations and increases resiliency.

Additionally, the POWERMAX control system eliminates single points of failure by sharing the load between generators and can be located anywhere within the base, allowing you to be more strategic with the base layout. If a generator or communications are lost, the system reroutes power to keep the lights on. If the generation does not meet the load requirements, POWERMAX prioritizes loads and minimizes load shedding to maintain your critical loads.

SEL's TMS-MIL-STD-compliant microgrid is unique in that it works with all makes and models of generators, inverters, and loads. You can easily retrofit existing commercial off-the-shelf and tactical microgrid system (TMS) generators in the field with an SEL control system.

POWERMAX for Garrison Microgrids

POWERMAX uses dependable computing and communications, including adaptive relaying and cybersecurity, to provide high-performance control for garrison microgrids.

A microgrid has low inertia compared to the larger macrogrid, which is why the relay-speed POWERMAX system is ideal. Our control algorithms and demand response operate fast enough to preserve the load and generation energy balance, maintain system stability and, most importantly, make sure the base is operating at all times.

With POWERMAX, you can operate an independent power system that prevents blackouts, reduces DER operating costs, and protects people from injury and equipment from damage during faults. Even if closely timed faults occur, subcycle inertial-compensated control algorithms prevent blackouts. And if you want to connect to the bulk electric system, our point of common coupling (PCC) control methods can seamlessly reconnect or island the microgrid. SEL software-defined networking (SDN) ensures that all system communications happen as planned and with complete security.

For military installations that use backup diesel generation, POWERMAX can parallel existing diesel generators. The benefits of paralleling include wet-stacking correction and fuel savings, which prolong mission operations and increase resiliency.

The SEL solution is unique because it uses a TMS-MIL-STD-compliant microgrid controller that works with all makes and models of generators, inverters, and loads. If your device communicates, we can connect, control, and parallel it. Additionally, you do not have to procure the entire control system up front but can purchase and build your system in blocks over time as funding permits.

POWERMAX for Commercial Microgrids

SEL POWERMAX commercial microgrids keep the lights on, seamlessly islanding and reconnecting with the bulk electric system. POWERMAX microgrid control systems are efficient, reliable, and secure solutions for guaranteeing uninterrupted energy delivery to your facility and customers. They control and protect both renewable and conventional generation. SEL systems allow you to operate independently, ensuring a constant supply of energy after the loss of the utility PCC. POWERMAX also lets you manage energy storage to maximize renewable generation and reduce peak charges.

Every POWERMAX commercial microgrid control system includes a factory acceptance test (FAT) for you to attend. SEL owns and operates the largest for-lease controller hardware-in-the-loop (cHIL) testing facility in North America. This facility contains a large number of Real Time Digital Simulator (RTDS) racks used exclusively for cHIL testing of SEL protection and control systems under realistic conditions. During the FAT, you can observe and verify the full functionality of the system.

In 2018, the SEL POWERMAX won the National Renewable Energy Lab microgrid shootout, a rigorous, 21-week microgrid control and cybersecurity evaluation competition that pitted SEL microgrid controller technology against four competitors. SEL was also selected as the top microgrid provider by Navigant Research as part of their "Navigant Research Leaderboard: Microgrid Controls" report.

POWERMAX for Industrial Power Management

A POWERMAX system increases process uptime by protecting against blackouts with advanced high-speed protection and control technology. Any production facility with onsite generation will benefit from the stability and protection of a POWERMAX system. The SEL solution offers:

- Load-shedding systems.
- Steam controls.
- Generation-shedding and runback systems.
- Autosynchronization systems.
- Fast decoupling solutions.
- Generation control systems.
- Factory acceptance tests.
- Control system simulations.
- Cybersecurity.
- Synchrophasor monitoring and control.
- MOTORMAX® Low-Voltage Motor Management and Protection System.

POWERMAX improves personnel safety and reduces equipment damage with adaptive protection, advanced protection systems, and arc-flash mitigation. POWERMAX also improves total system awareness with time-synchronized condition monitoring systems, which keep track of equipment status, electrical metering, cyber attacks, network traffic, and more.

POWERMAX technology is proven to keep facilities running and is specifically engineered for industries with critical processes that need to stay online. These facilities include:

- Oil and petrochemical refining operations.
- Pulp and paper manufacturing facilities.
- Mining and metals processing facilities.
- Water and wastewater treatment plants.
- Data centers.

POWERMAX for Utilities

A POWERMAX system for utilities uses a remedial action scheme (RAS) in a control system for large geographic regions of interconnected transmission, generation, and loads. Distributed computing and communications provide smart transmission grid management for integrating renewable generation and DERs. This solution is commonly used for the wide-area monitoring, control, and integration of large wind power stations.

POWERMAX RAS integrates with existing relays, meters, and communications systems to minimize the footprint and complexity.

With a POWERMAX RAS, utilities can function closer to stability limits, operating transmission corridors at a higher capacity than ever before. In some cases, they can transmit over 50 percent more power across existing transmission lines. This increases daily revenues and frees up billions of dollars of capital to enhance existing transmission lines instead of building new lines.

Made in the U.S.A.

All SEL devices and POWERMAX systems are designed, tested, and manufactured in the U.S.A. SEL is the preferred protective relay supplier in the U.S.A., with 87 percent of electric utilities choosing SEL as their favorite provider in a 2019 Newton-Evans survey.

At SEL, we continually identify, monitor, and improve best practices to ensure your satisfaction. The SEL Engineering Services team follows rigorous engineering procedures for the design, development, testing, and commissioning of POWERMAX systems.

Our quality management system is certified to the ISO 9001 standard, *Quality Management System Requirements*. Our commitment to making electric power safer, more reliable, and more economical leads us to provide innovative products and solutions, outstanding customer support, and experienced engineers who are committed to your success.

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