SEL-451

Protection, Automation, and Bay Control System for High-Voltage AC Traction Railways

Shown with 5U chassis, expanded LEDs, operator buttons, and auxiliary trip/close buttons.

Reduce System Cost, Complexity, and Maintenance

- *Advanced reclosing functions. Individual breaker control for catenary and feeder breakers.*
- *Synch-check functions.*
- *Advanced oscillography at 8 kHz, allowing the user to visualize transients not filtered by the relay algorithm.*
- *Breaker failure.*
- *Several levels of overcurrent functions.*
- *IEC 61850 GOOSE—both analog and binary/DNP3*
- *Fully configurable LEDs.*
- *Fully configurable binary outputs and inputs.*
- *Six protection setting groups.*
- *Voltage functions (under/over and frequency measurements).*
- *Synchrophasors and time synchronization.*

SEL Synchrophasors

SEL IEC 61850

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

Features and Benefits

Maximize the Capability of Substation Equipment

Fully load equipment by monitoring power, including thermal or rolling interval demand as well as peak demand on positive-, negative-, and zero-sequence current. Use the full capacity of the equipment while maintaining SEL quality protection.

Improve Operation With Built-In Real-Time Synchrophasor Measurements

Help system operators understand the network status with real-time visual displays of system phase angles and frequency. High-accuracy synchronized phasor measurements provide information and control to match the frequency and phase angle for critical activities, such as switching, startup, and power transfer.

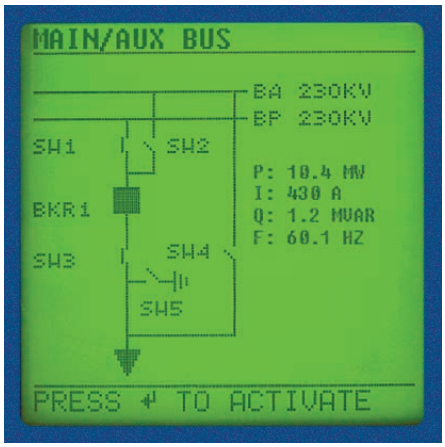
Provide Powerful Bay Control and High-Speed Breaker Protection

Complete two-breaker control and breaker failure protection complement the versatility of the SEL-451 Protection, Automation, and Bay Control System programmable logic to meet your bay control needs. Easily control motor-operated switches, capacitor banks, and field I/O from the front panel or remotely.

Advanced Power System Monitoring

Provide advanced power quality monitoring of system disturbance information with voltage sag, swell, and interruption (VSSI) monitoring.

Combine the control and protection of many substation devices into one fast, powerful, flexible, and economical system.

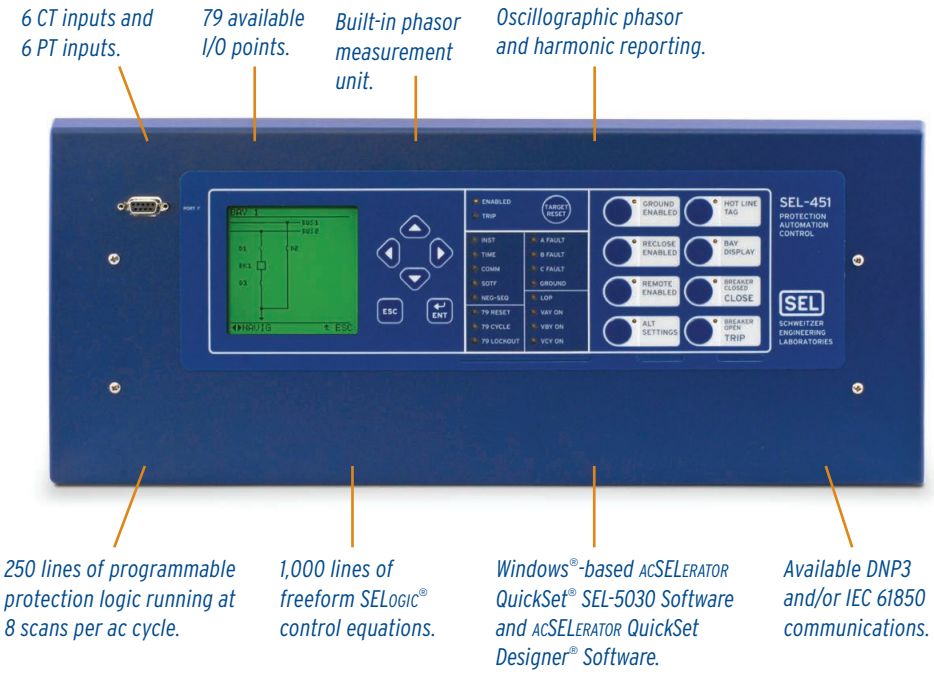


Dynamic one-line display.

High-Performance Features

The SEL-451 is a complete standalone protection, automation, and bay control system that includes synchrophasors. Use the SEL-451 as an integral part of a full station protection, control, and monitoring system. Connect each relay to a communications processor to integrate information with SCADA and automation systems. Combining advanced breaker control and monitoring with 79 I/O points enables the SEL-451 to economically provide powerful bay control and system automation features.

Analyze and use synchronized phasor measurements in the IEEE C37.118 standard format.



Overcurrent Features

Instantaneous and Time-Overcurrent Elements

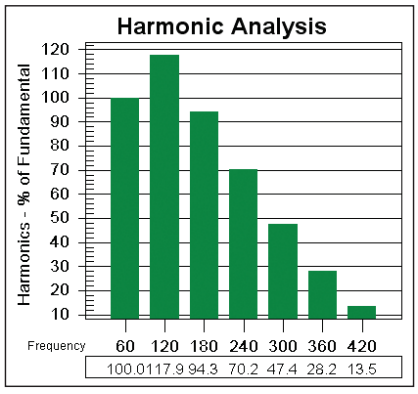
- Select from four phase, four negative-sequence, and four ground instantaneous overcurrent elements to best fit your application.
- Best Choice Ground Directional Element® logic optimizes directional element performance and eliminates the need for many directional settings.

Web Server

Access basic SEL-451 information on a standard Ethernet network with the built-in web server. View relay status, Sequential Events Recorder (SER) data, metering information, and settings through easy access within a local network. Web server access requires a relay password and is limited to read-only viewing of information.

Harmonic Monitoring

Apply the second-, fourth-, and fifth-harmonic elements with individual threshold settings to detect transformer energization and over-excitation conditions. The output from these harmonic detection elements can be used for a variety of functions, including modification of relay settings to improve security, and event reporting to make identification of transformer energization events fast and simple.



Transformer energization harmonic analysis.

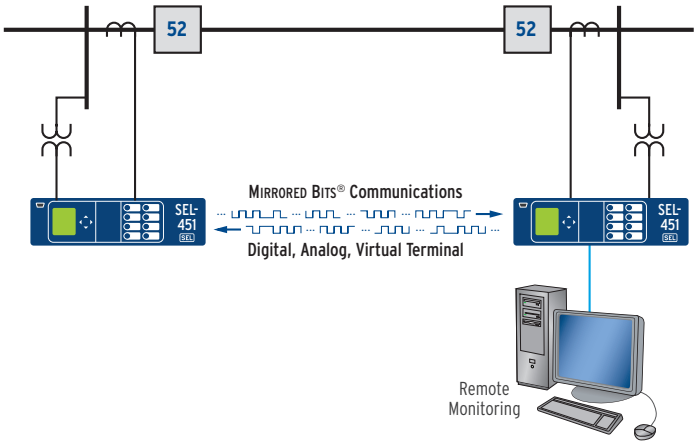
Breaker Failure

A full-function breaker failure system is incorporated into the SEL-451. Current can be individually monitored in two breakers. High-speed, open-phase detection logic allows you to set the pickup current below minimum load for sensitivity without sacrificing high-speed dropout. Even in cases with delayed zero crossing in the secondary of the CT caused by trapped flux, high-speed detection of circuit breaker opening is achieved. A reset of less than one cycle reduces coordination times, improving stability.

Enhanced Mirrored Bits Communications

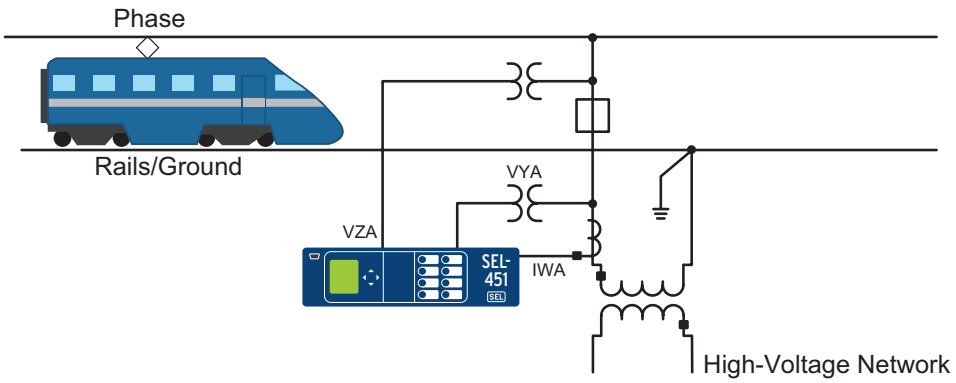
Transmit analog as well as digital information over high-speed serial communications paths:

- Use virtual terminal Mirrored Bits® communications to get complete information from a remote relay using a connection to the local relay.
- Send up to seven analog values or eight digital values on each Mirrored Bits communications channel.

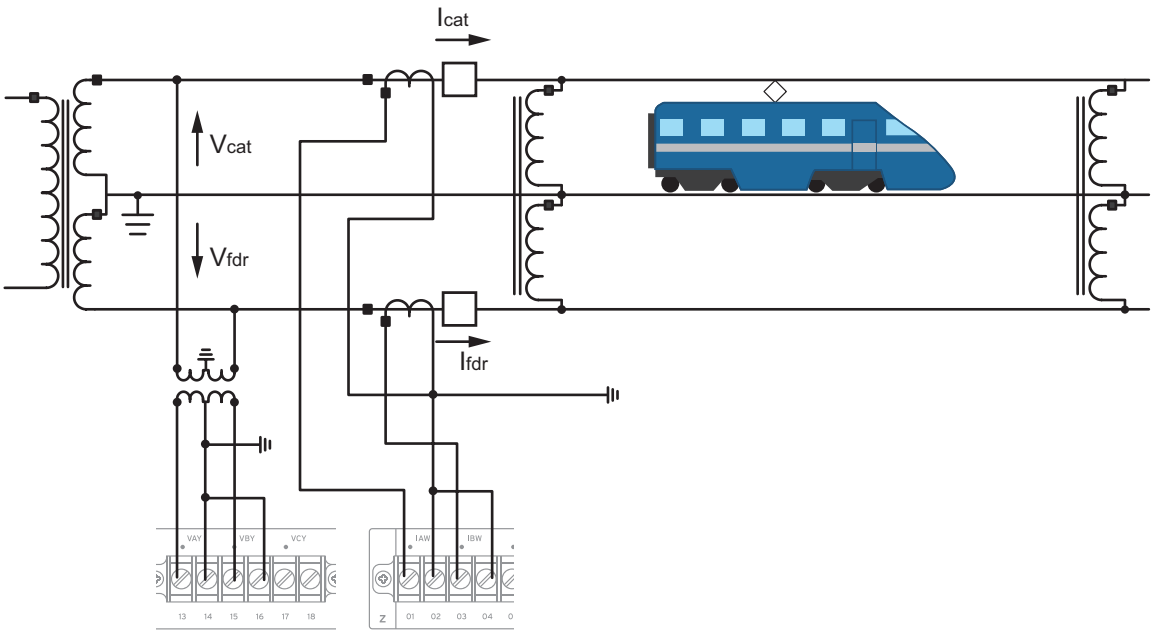


The patented Mirrored Bits communications technology is simple, powerful, and field-proven.

Applications

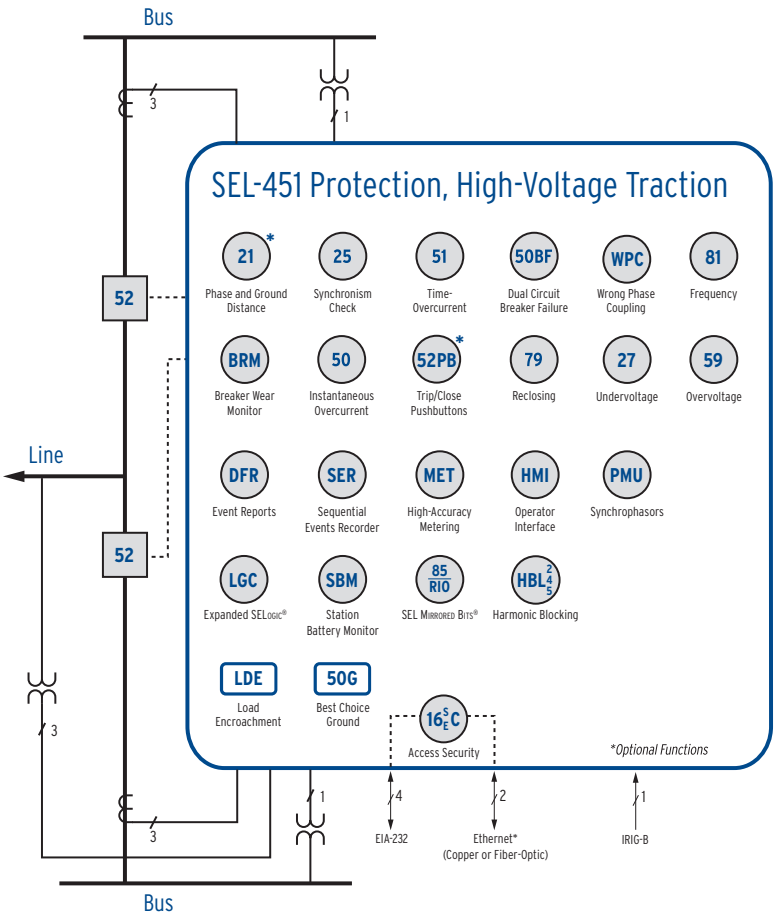


Single-phase system.



Two-phase system with autotransformers.

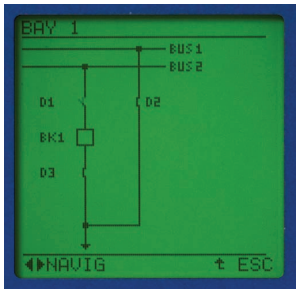
Functional Overview



Visualization Tools

The SEL-451 offers a configurable human-machine interface (HMI) for easy integration into your application or operating standards. HMI tools include:

- Custom metering and status displays, including user-defined labels and units.
- Direct pushbutton access to alarms, event reports, and metering.
- One-line bay diagram navigation to operate devices or view real-time data.
- Critical information alarms in chronological order.
- Rotating display that automatically scrolls between custom metering displays, alarms, and preconfigured fundamental line quantity displays.
- Time-stamped SER report.

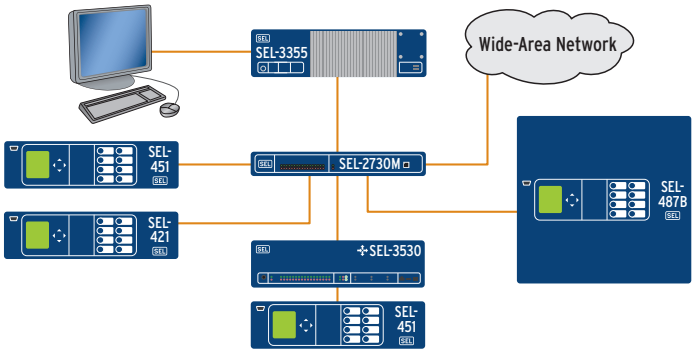


Custom metering and bay control display.

Integrate With Ethernet Networks

Connect the SEL-451 directly to a local network with the built-in Ethernet interface or through the SEL-2032 Communications Processor.

- Use DNP3 LAN/WAN and IEC 61850 to quickly send information through your networks.
- Provide seamless failover protection with the Parallel Redundancy Protocol (PRP).
- Increase communications reliability with separate and redundant communications ports.
- Transfer data at high speeds (10 Mbps or 100 Mbps) for fast HMI updates and file uploads.
- Use popular Telnet applications for easy terminal communication with SEL relays and other devices.
- Use popular FTP applications for easy transfer of settings, events, and history files.
- Transmit synchrophasor data to multiple clients using UDP and TCP formats.
- Simplify wiring and installation by receiving a time signal over existing Ethernet networks using the Simple Network Time Protocol (SNTP). SNTP makes a good backup to more accurate IRIG-B time synchronization.



SEL offers complete Ethernet direct-connect solutions.

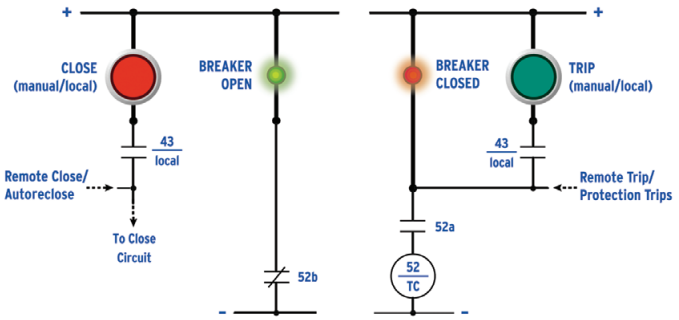
SEL-451 Ethernet port options.

Integration Reduces Substation Costs and Improves Information Flow

Panel Integration

Improve efficiency and simplify installation with more target LEDs and operator buttons. The 4U and 5U chassis have options for an additional eight target LEDs and four operator control buttons. Include arc-suppressed trip/close buttons for an enhanced solution.

- Display breaker status and control breaker position, even if the relay is not powered, with auxiliary breaker trip/close control buttons and indicating lamps.
- Indicate relay state and various trip conditions with 24 target LEDs, or configure them for specific applications.
- Meet operator control needs by modifying the 12 operator buttons to replace traditional panel switches.

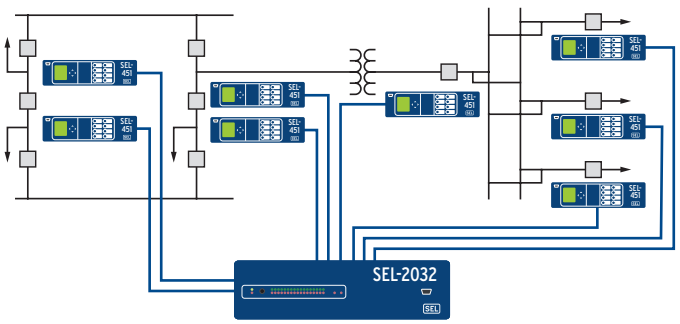


Suggested application.

Communications Integration

Reduce costs using a station-based protection system with all relaying located at the breaker and fiber communication to the station control building.

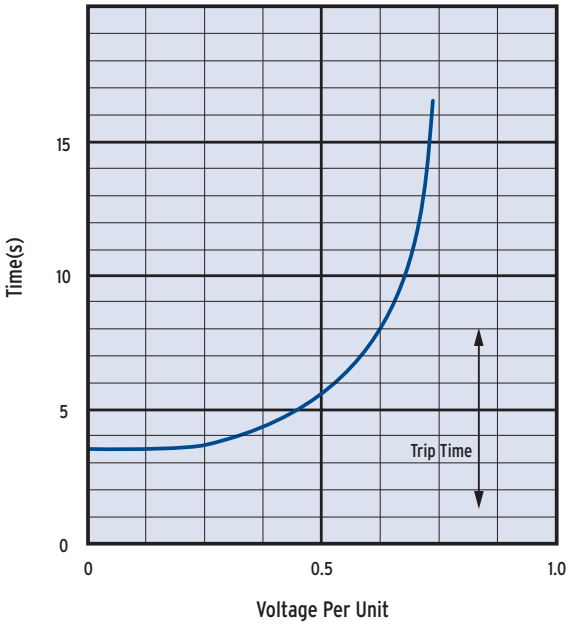
- Use Mirrored Bits communications between serial ports of SEL relays to allow functional integration between primary and backup protective relays.
- Communicate via Ethernet or serial port to the SEL-451 or Real-Time Automation Controller (RTAC).
- Apply the SEL-451 as bay control for a ring-bus, double-breaker, or breaker-and-a-half configuration.
- Optimize your substation maintenance with real-time operating data. The relay records circuit breaker mechanical and electrical operating times, comparing average and last trip times.



Substation integration example.

Custom Automation With SELogic Control Equations

Create your own custom applications with customized curves using powerful SELogic® control equations.



VAR-supervised, time-undervoltage characteristic.

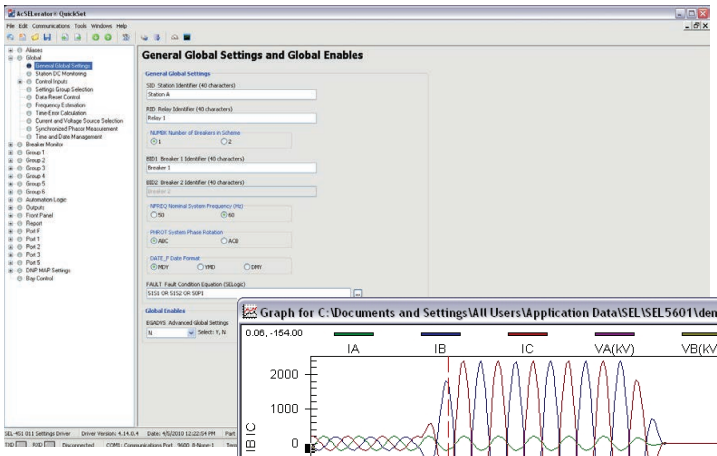
Easy-to-Use PC Software

Streamline Settings Engineering

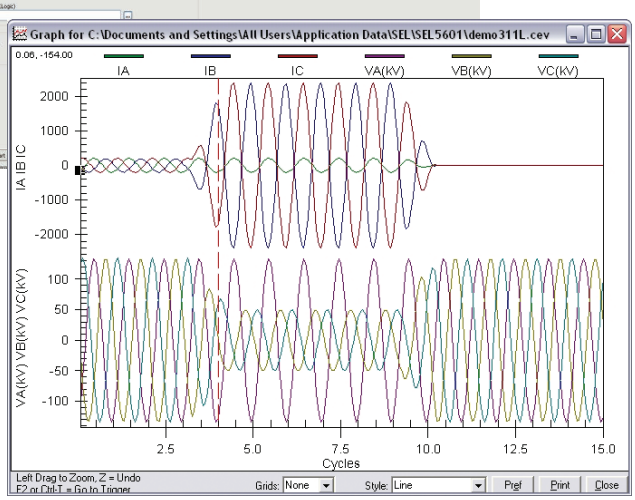
- Develop settings offline with a menu-driven interface and documented help screens in ACSELERATOR QuickSet® SEL-5030 Software.
- Automatically check and highlight out-of-range or conflicting settings using the rules-based architecture.
- Simplify configuration using the graphical logic editor (GLE) in ACSELERATOR QuickSet. The GLE displays SELOGIC control equations graphically so settings files can be documented for easier validation and commissioning. Convert existing SELOGIC control equations to easy-to-read diagrams, and save diagrams with ACSELERATOR QuickSet settings.

Enhanced Event Analysis Software

- Use the SEL-451 as a multichannel (six voltages, six currents) digital fault recorder.
- View COMTRADE files from the SEL-451 and other digital fault recorders with the included ACSELERATOR QuickSet Software.
- Select an event resolution from 1–8 kHz. Set the event report length from 0.25–24.00 seconds (1 kHz resolution).
- Perform harmonic analysis of any voltage or current. Select the portion of the event report to examine: prefault, fault, or postfault.



ACSELERATOR QuickSet settings form view.



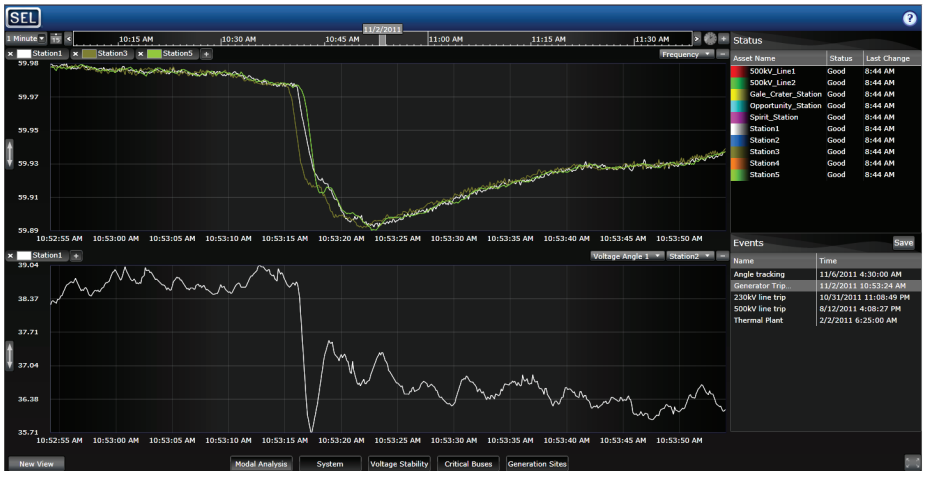
ACSELERATOR® event report.

Apply Synchrophasors to Your System

Improve System Performance With Synchrophasor Technology

SEL offers complete synchrophasor solutions, including hardware, communication, data collection, viewing and analysis software, and data archiving.

Users can add simple relay-to-relay control based on synchrophasor data with real-time control capability.



SEL-5078-2 SYNCHROWAVE® Central Software provides visualization and analysis of power system operating conditions.

General Specifications

AC Current Inputs (6 total)

1 A or 5 A I_{nom} (specify on order); 3 x I_{nom} continuous; 100 x I_{nom} one-second thermal rating; linear to 20 x I_{nom} symmetrical

Burden 0.27 VA @ I_{nom} for I_{nom} = 5 A; 0.13 VA @ I_{nom} for I_{nom} = 1 A

AC Voltage Inputs (6 total)

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

Output Contact Ratings (standard model)

30 A make per IEEE C37.90-1989 paragraph 6.7.2; 6 A continuous carry; MOV-protected

Optional high-speed and high-interrupting (10 A @ L/R = 40 ms) contacts available

Control Inputs

Range	15–265 Vdc
Accuracy	±5% plus ±3 Vdc
Maximum voltage	300 Vdc
Sampling rate	1/16 cycle
Typical burden	0.24 W @ 125 Vdc

Serial Communications Ports

Three rear-panel and one front-panel EIA-232 serial ports

SEL ASCII commands, SEL Mirrored Bits, SEL Fast Messages, DNP3

Serial data speed 300–57600 bps

Processing Specifications

AC voltage and current inputs: 8,000 samples per second, 3 dB low-pass analog filter cut-off frequency of 3000 Hz

Digital filtering: Full-cycle cosine and half-cycle Fourier filters, after low-pass analog and digital filtering

Protection and control processing: 8 times per power system cycle

Synchrophasors—IEEE C37.118 Standard

Up to 50 messages per second (50 Hz system)

Up to 60 messages per second (60 Hz system)

Power Supply

24/48 V	18–60 Vdc
48/125 V	38–140 Vdc or 85–140 Vac (30–120 Hz)
125/250 V	85–300 Vdc or 85–264 Vac (30–120 Hz)

Ethernet Communications Options

Provides IEC 61850, SNTP, DNP3 LAN/WAN, FTP, and Telnet protocols. Ethernet connection media options:

10/100BASE-T twisted-pair network

100BASE-FX fiber-optic network

Frequency and Phase Rotation

60/50 Hz system frequency and ABC/ACB phase rotation are user-settable

Operating Temperature

–40° to +85°C (–40° to +185°F)

–40° to +70°C with optional Ethernet

Note: LCD contrast impaired for temperatures below –20° and above +70°C

Humidity

5% to 95% without condensation

Weight (maximum)

3U rack mount	8.0 kg (17.5 lbs)
4U rack mount	9.8 kg (21.5 lbs)
5U rack mount	11.6 kg (25.5 lbs)

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