SEL-735 Power Quality and Revenue Meter

IEC 61000-4-30 Power Quality Compliant

The SEL-735 meter combines leading power quality capabilities with exceptional revenue metering accuracy at an economical price. Power quality reports with IEC 61000-4-30 compliance help identify and troubleshoot problems in power system equipment. Advanced communications deliver critical and historical information in real time to virtually any communications system. The SEL-735 is the essential meter for substation, power plant, and industrial metering.

Features and Benefits

- High Precision Revenue Metering Guarantee: 0.06%, 0.02% typical.
- Capture every power quality disturbance with preconfigured logs and triggers.
- Compare power quality measurements across the system with IEC 61000-4-30 power quality compliance.
- Perform statistical calculations while reporting only critical information to save system bandwidth.
- Standardize on one revenue meter for generation, transmission, distribution, intertie, main entrance, and submeter applications.
- Deliver complete billing data to Itron® MV-90® software over any communications port.
- Integrate into virtually any system with copper or fiber-optic Ethernet, serial, multidrop, infrared, or telephone modem communications.
- Simultaneously communicate with as many as ten other devices using industry standard protocols, including DNP, Modbus®, and IEC 61850.

One Package, Three Flexible Solutions

Three SEL-735 variants provide a meter for any application and any budget.

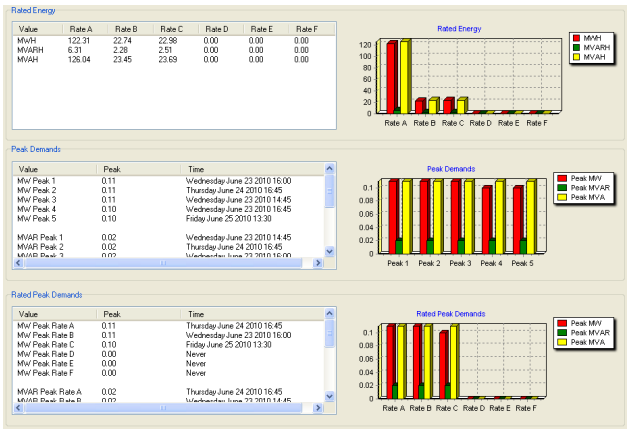
Metering, General	SEL-735 Basic PQ	SEL-735 Intermediate PQ	SEL-735 Advanced PQ
Stated list price	$1,500	$2,000	$2,500
Watt-hour Accuracy	0.06%	0.06%	0.06%
Voltage Range	5–300 V_{L-N}, 9–520 V_{L-L}	5–300 V_{L-N}, 9–520 V_{L-L}	5–300 V_{L-N}, 9–520 V_{L-L}
Current Range	0.001–22 A	0.001–22 A	0.001–22 A
Form Options (Elements)	5, 9, and 36 (2, 3, 2-1/2)	5, 9, and 36 (2, 3, 2-1/2)	5, 9, and 36 (2, 3, 2-1/2)
Load Profile Recorders x Channels	1 x 16	12 x 16	12 x 16
Memory	32 MB	128 MB	128 MB

IEC 61000-4-30 Power Quality	SEL-735 Basic PQ	SEL-735 Intermediate PQ	SEL-735 Advanced PQ
Measurement Aggregation			
10/12 Cycle Intervals	A	A	A
150/180 Cycles, 10 min., 120 min. Intervals	–	A	A
Voltage and Current	A	A	A
Voltage and Current Unbalance	A	A	A
Individual Voltage and Current Harmonics	S	S	S
Voltage and Current THD	A	A	A
Real, Reactive, and Apparent Power	A	A	A
Power Quality Parameters			
Real-Time Clock	S	S	S
Frequency	A	A	A
Flicker	–	S	S
Voltage Dips, Swells, and Interruptions	A	A	A
Voltage and Current Interharmonics	–	–	S
Harmonic Power	–	–	S
Harmonic Phase Angles	–	–	S
Maximum Harmonic Order	15th	63rd	63rd
Waveform Capture			
Samples-per-cycle	16	16 and 128	16, 128, and 512
Duration (cycles)	15	15, 30, 60, 120, 300, 600	15, 30, 60, 120, 300, 600
Number of Events	64	16–3155	4–3155
COMTRADE Reports	Y	Y	Y

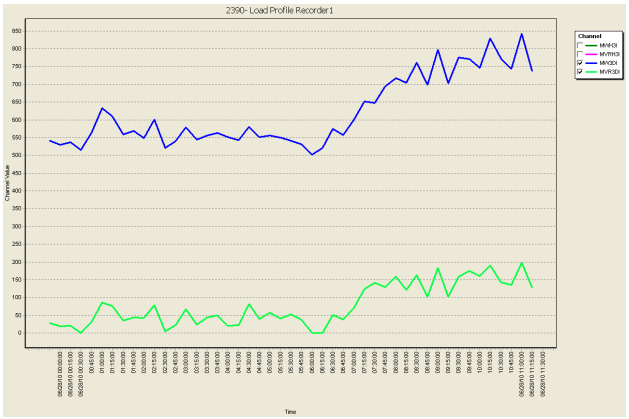
A = IEC 61000-4-30 Class A compliant.
S = IEC 61000-4-30 Class S compliant.

Power Dashboard

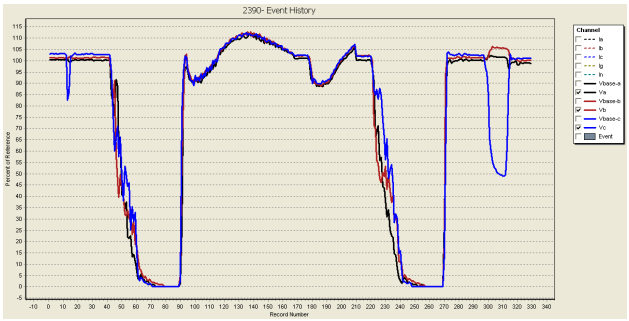
View the state of the power system using no-cost ACSELERATOR QuickSet® SEL-5030 Software. Quickly assemble an overview of the most important system parameters. Load profile trending displays voltage, current, power, and harmonic information. Record years of voltage, current, power, frequency, and harmonic information on a per-phase basis.



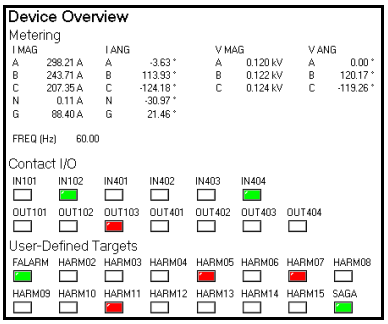
TOU stores and resets peak demand data



Load Profile trends power draw and energy consumption



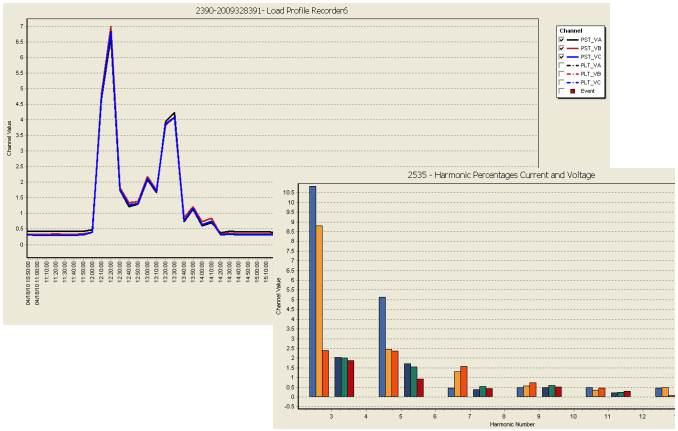
Voltage/Sag/Swell/Interruption reports system interruptions with 1 ms resolution



Meter monitoring software standard with the SEL-735

Power Quality Measurements

- IEC 61000-4-30 power quality compliant
- Statistical trending of virtually any parameter, including:
  - Voltage and current
  - Frequency
  - Harmonics up to the 63rd
  - Total harmonic distortion (THD)
  - Unbalance—symmetrical components
- Sags, swells, and interruptions
- Flicker measurement
- Waveform capture up to 512 samples/cycle

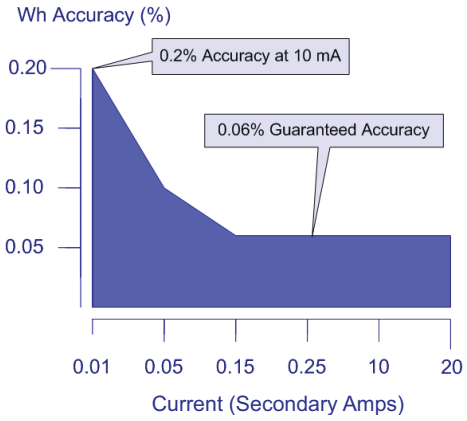


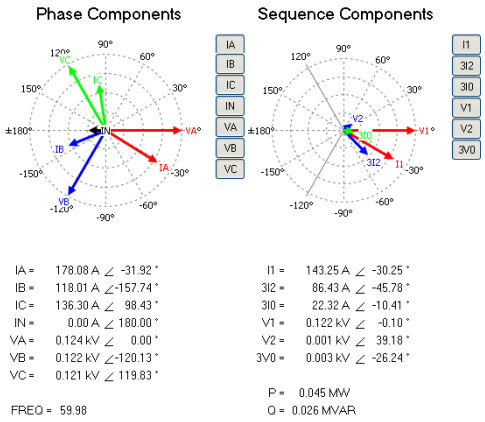
Flicker and harmonics reports help locate system disturbances

High-Function Metering for Substations, Power Generation, and Industrial Loads

Revenue metering applications require a diverse set of features to cover both new and legacy metering requirements. The SEL-735 supports a large feature set to cover a wide range of metering needs.

- 4-Quadrant Metering
- Multiple Load Profile Recorders
- Time-of-Use Metering
- Transformer/Line-Loss Compensation



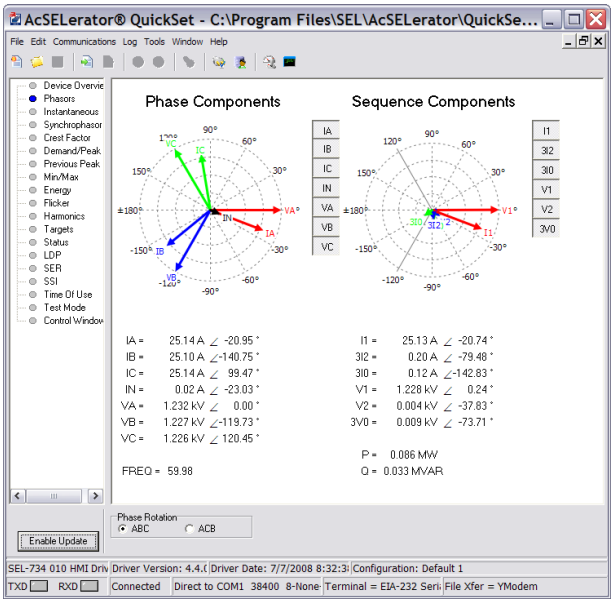


High Accuracy Metering for High Value Applications

Many new metering installations, such as distributed generation, operate over a very large current range. The SEL-735 provides high accuracy over an extended operating range with a 0.06% Wh guarantee. Typical Wh accuracy errors of 0.02% exceeds the accuracy of many measurement standards.

Simplified Setup and Troubleshooting

- Use ACSELERATOR QuickSet to customize your metering. Set and edit meter configuration, settings, and logic.
- View the HMI screens in ACSELERATOR QuickSet to check wiring connections, phase rotation, and power flow direction.
- Voltage and current sequence elements allow fast troubleshooting of miswired installations.



Feature Overview

- Form 5, 3-Wire Delta, Form 9, 4-Wire Wye, and Form 36, 4-Wire Wye metering connections
- ANSI C12.20 0.2 (Form 5 and Form 9), ANSI C12.1 (Form 36), and IEC 62053-22 0.2 S accuracy class leading
- Rack-mount, panel-mount, easily extractable meter (EXM), wall-mount, and NEMA enclosure options
- Simultaneous Ethernet, EIA-485, EIA-232, telephone modem, and optical probe communications
- Synchrophasor data with IEEE C37.118 accuracy (future release)
- Enhanced SELOGIC® control equations
- Communication protocols
  - SEL ASCII
  - Modbus RTU/TCP
  - SEL Fast Operate/Fast Meter
  - MIRRORED BITS® communications
  - SEL Distributed Port Switch (LMD)
  - DNP3 Serial and LAN/WAN
  - IEC 61850
  - SNTP
- Inputs/outputs
  - 2 digital inputs, 3 electromechanical outputs
  - 4 digital inputs, 4 KY outputs with programmable Ke
  - 4 digital inputs, 4 electromechanical outputs
  - 4 analog outputs, 4 KY outputs with programmable Ke

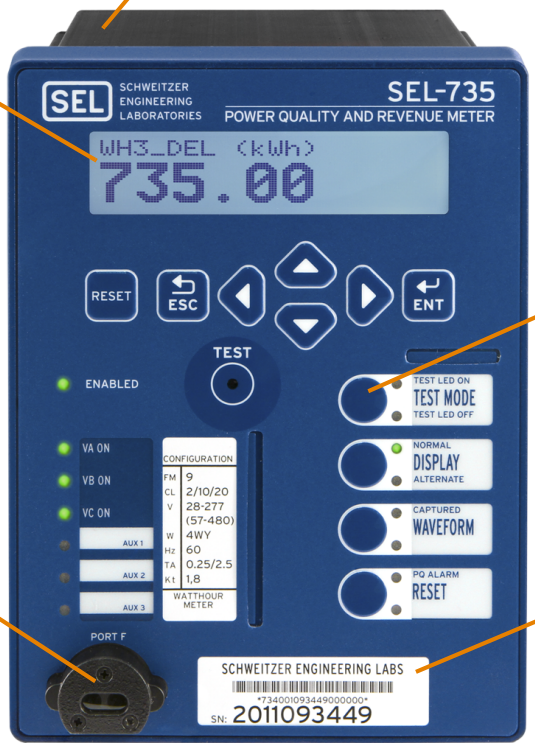
  See model option table for available configurations and options.

Product Overview

Advanced Display and Controls

SEL provides a worldwide, ten-year product warranty—no questions asked

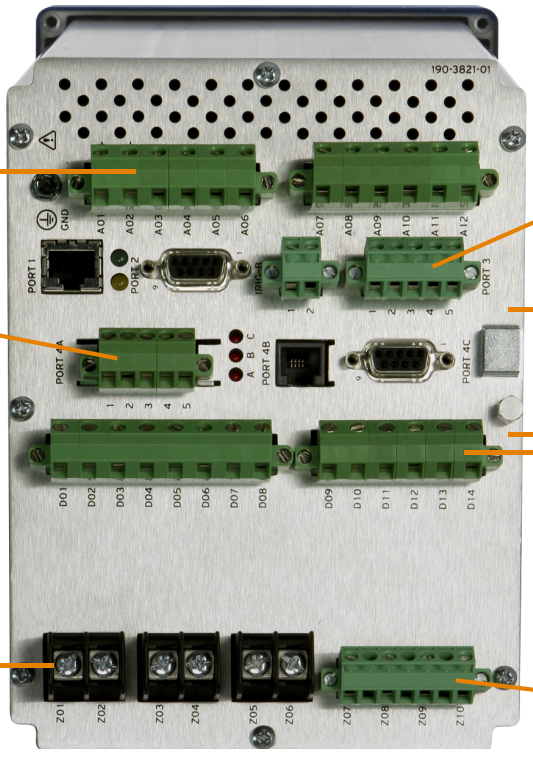
Simple front-panel navigation



Custom controls

Read, test, and program with ANSI Type II optical port

Custom nameplate, and bar code



Power Supply Board
2 Digital Inputs
3 Digital Outputs

Communications Board
(Expansion Slot #1)
EIA-485
Telephone Modem
EIA-232

CT Board
Ia, Ib, Ic

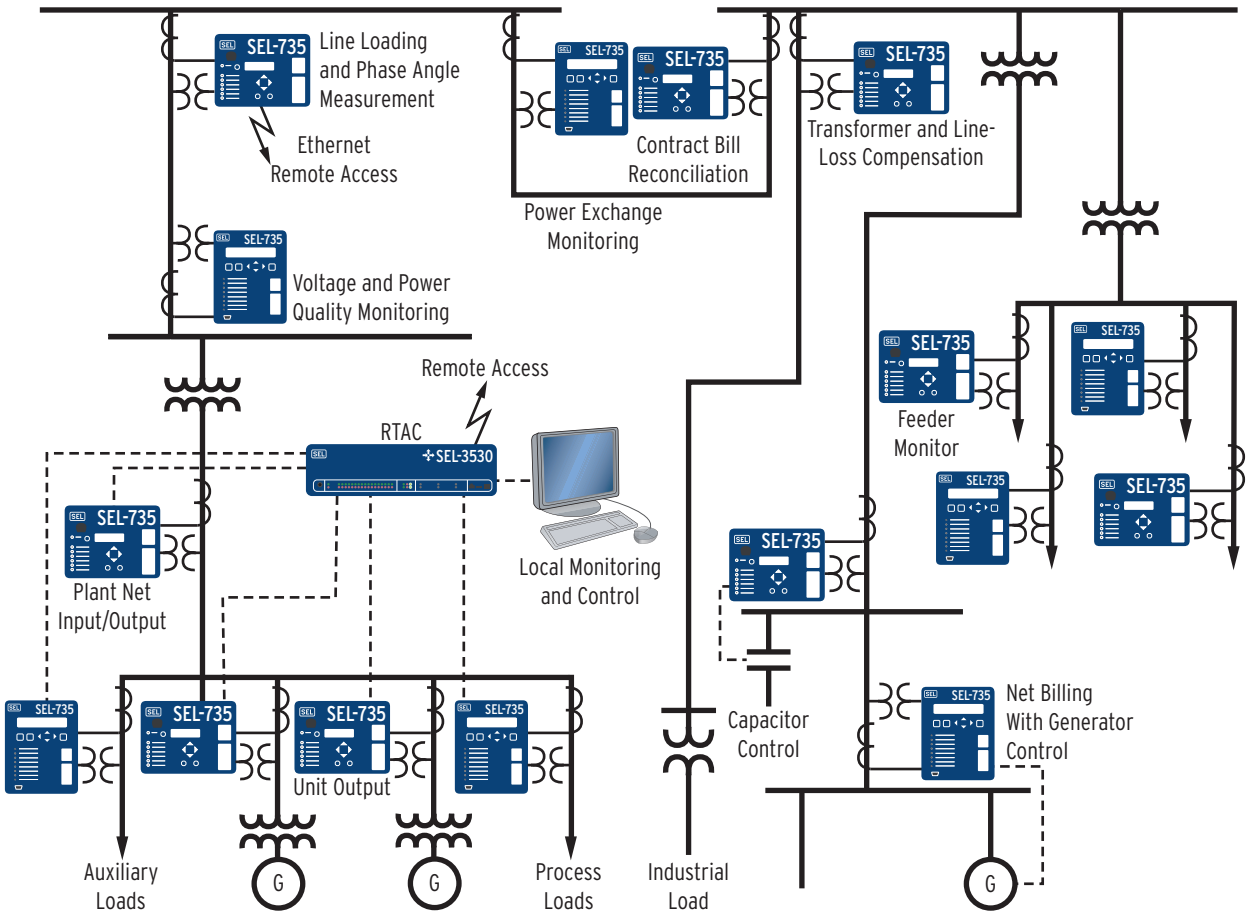
Main Board
Ethernet
EIA-232
IRIG-B
EIA-232/485

Sealing Provision

I/O Board
(Expansion Slot #2)
4 Digital Inputs
4 Digital Outputs (solid-state or electromechanical)
or
4 Analog Outputs
4 Digital Solid-State Outputs

PT Board
Va, Vb, Vc, Vn

Functional Overview



SEL-735 Capabilities

Accurate Revenue Metering

The SEL-735 exceeds ANSI C12.20 0.2 and IEC 62053-22 0.2 S accuracy class requirements. Transformer/line-loss compensation adds to meter accuracy when the meter location and billing points differ. Instrument transformer compensation removes the magnitude and phase error introduced by CTs and PTs. ACSELERATOR QuickSet provides a simple test mode interface to easily verify meter accuracy.

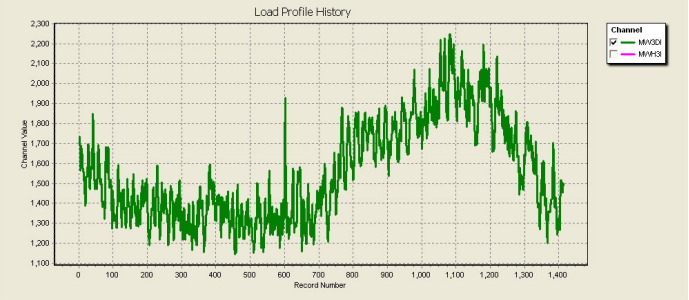
Load Profile Recorder

Independent load profile recorders in the SEL-735 allow simultaneous meter and power quality logging of up to 192 data channels. Trend averages, minimums, maximums, changes, and snapshots at a rate of once every three seconds.

ACSELERATOR QuickSet offers a fast and simple method to retrieve, plot, and export load profile data to .HHF or .CSV formats. Itron MV-90 meter reading software communicates to any SEL-735 communications port and automates meter reads for large-scale metering installations.

Communications and I/O

Select from six communications protocols and five physical communications interfaces, including 10/100BASE-T, 100BASE-LX10, or 100BASE-FX Ethernet. Advanced communications and protocols, such as IEC 61850 and DNP3, reduce the need for analog and digital outputs. When installations must communicate with legacy equipment, SEL offers digital and analog output options for the SEL-735. The SEL-2800 Fiber-Optic Transceivers provide electrically isolated communications paths between EIA-232 ports.



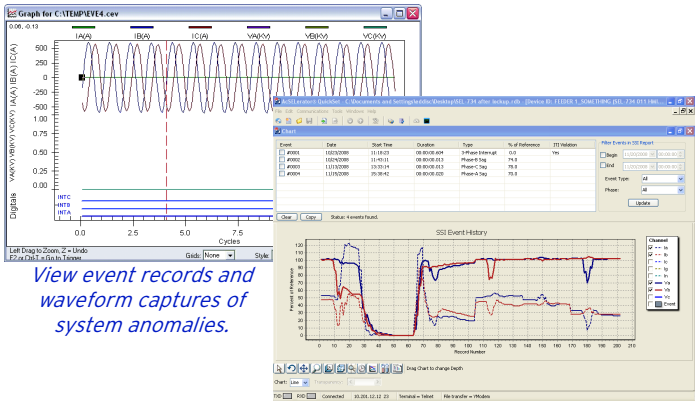
Save LDP data in .HHF or .CSV formats.

Power Quality Capabilities

Measure and Record the Following:

- IEC 61000-4-30 compliant current, voltage, power, energy, harmonic, flicker, and unbalance
- Measurement aggregation in 10/12 cycle, 3-second*, 10-minute*, and 120-minute intervals*
- Harmonic angles for voltage and current*
- High-resolution, 512 samples/cycle waveform capture*
- Total harmonic distortion (THD), crest factor, and K-factor metering with up to 63rd harmonic content
- High-speed load profile recording with three-second resolution*
- VSSI
- Symmetrical components (unbalance)

* Optional based on PQ variant.

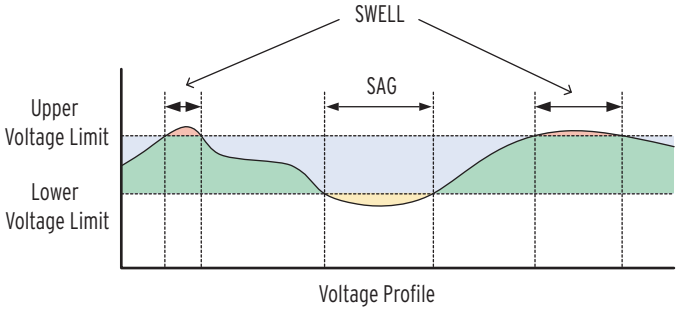


View event records and waveform captures of system anomalies.

VSSI reports detail system interruptions with 1 ms resolution.

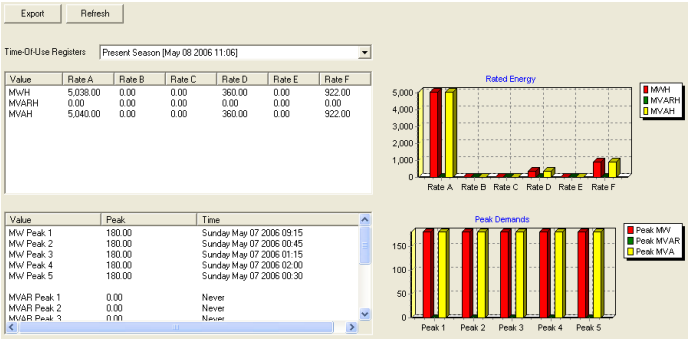
VSSI Recorder

Correlate system disturbances with the voltage sag/swell/interruptions (VSSI) recorder. Enabled from the factory, the VSSI recorder time-stamps voltage excursions with up to 1 ms resolution and records indefinitely using an adaptive sampling rate. The SEL-735 stores and reports residual voltage, duration, affected phases, CBEMA/ITIC reports, and time stamp of occurrence. The VSSI settings include trigger thresholds from ±3% to ±100% of the actual value and automatic recording duration dependent on the length of the voltage excursion. ACSELERATOR QuickSet automatically graphs and analyzes VSSI data and includes an export feature. Applications with SCADA systems can also retrieve these data using the DNP3 or IEC 61850 protocol.



Time-of-Use (TOU) Metering

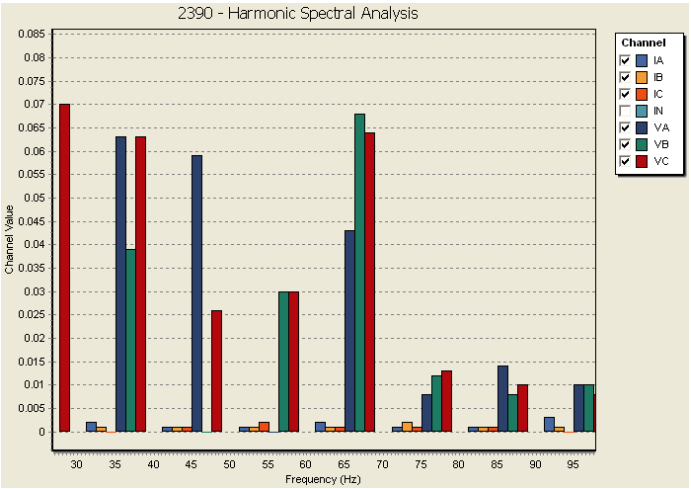
Record demand and energy consumption with a user-defined calendar; use TOU metering to bill consumption at different rates based on season, day type, and time of day. The program automatically self-reads and resets demand; there is no need to manually reset meters.



TOU stores and resets peak demand data.

Harmonic Metering

Monitor, record, and control using individual harmonic values, THD, and K-factor with resolution up to the 63rd harmonic.



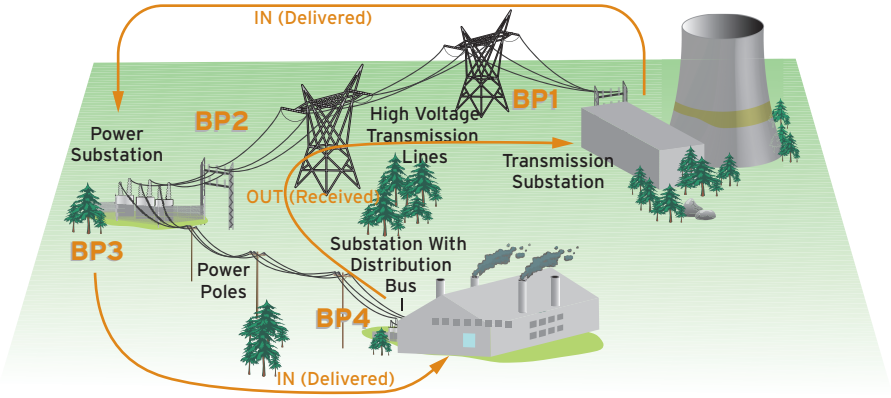
Interharmonic Metering

Measure, record, and control using Group THD. Measure interharmonics from 5 Hz to 3800 Hz in 5 Hz bins.

Advanced Capabilities

Transformer/Line-Loss Compensation

When the contractual billing point differs from the meter location, use transformer and line-loss compensation (TLLC) to optimize the metering location and reduce the instrument transformer costs. Both compensated and uncompensated values are stored in the meter to simplify site verification.



Choose from four billing and metering points with TLLC.

Instrument Transformer Compensation

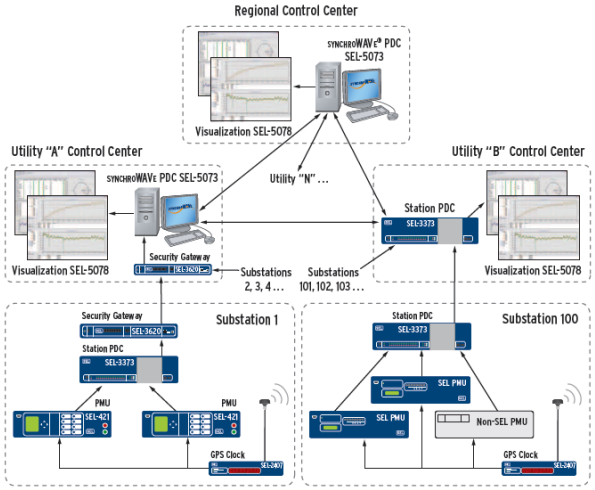
Use ITC to correct for ratio and phase shift that occurs in the secondary signal to provide improved measurement accuracy.

Synchronized Phasor Measurement (future release)

Provide the SEL-735 with an SEL IRIG-B time source to measure the system angle in real time with a performance that meets the IEEE C37.118-2011 requirements. Measure instantaneous voltage and current phase angles in real time to improve system operation with synchrophasor information. Use synchrophasor data for direct state measurement, study validation, or for tracking system stability.

Use the SEL-3373 Station Phasor Data Concentrator (PDC) or SEL-5073 SYNCHROWAVE® Server Software* PDC to combine and archive time-synchronized data from multiple measurement sources, such as the SEL-735.

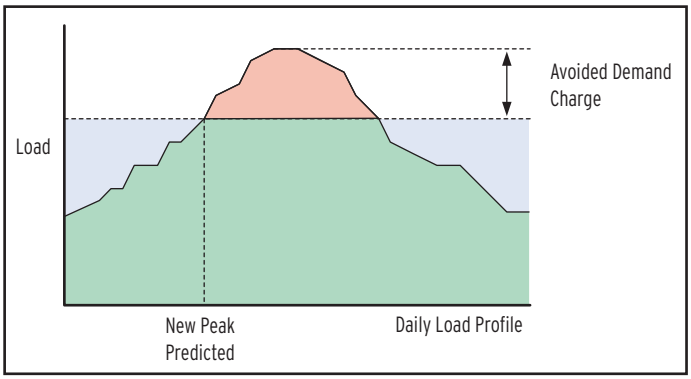
*Additional cost software.



View system angle at multiple locations.

Predictive Demand

The predictive demand function monitors accumulated demand and alarms when the demand exceeds a user-defined limit. The SEL-735 can then shut down loads or peak-shave with generation to avoid demand charges as shown to the right. The predictive demand alarm is available through IEC 61850, Modbus, DNP, MIRRORED BITS communications, or the front-panel LEDs.



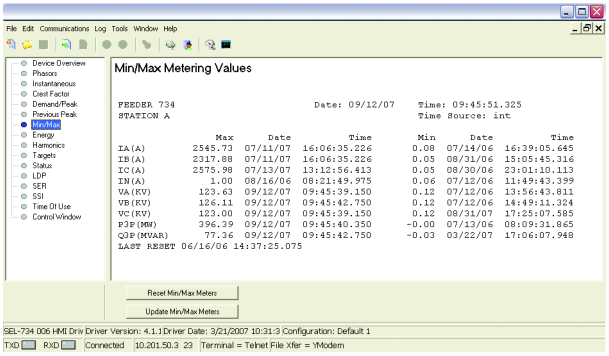
Reduce peak demand charges with the predictive demand alarm.

Frequency Recording

Measure frequency for local and remote indication or use in control and data acquisition. Use a load profile recorder for a "strip chart" record of the frequency as often as every three seconds.

Minimum/Maximum Metering

The SEL-735 automatically records the date and time of minimum and maximum voltage, current, and power measurements. Use this capability for equipment selection, troubleshooting, and diagnosis of any installation.



Capture minimum/maximum quantities with half-cycle resolution.

Advanced Capabilities (Continued)

Logging and Recording

Store up to 21,000 sequential events records capturing any power quality disturbance. Retrieve data using ACSELERATOR QuickSet, Modbus, DNP3, IEC 61850, or ASCII. Store and analyze waveform capture data using ACSELERATOR QuickSet.

Automatic Event Reporting

After recording an event report, the SEL-735 can automatically report event data through SEL, IEC 61850, or DNP3 protocols to a communications master. ACSELERATOR TEAM® SEL-5045 Software can automatically collect SEL-735 waveform data without the need for manual retrieval.

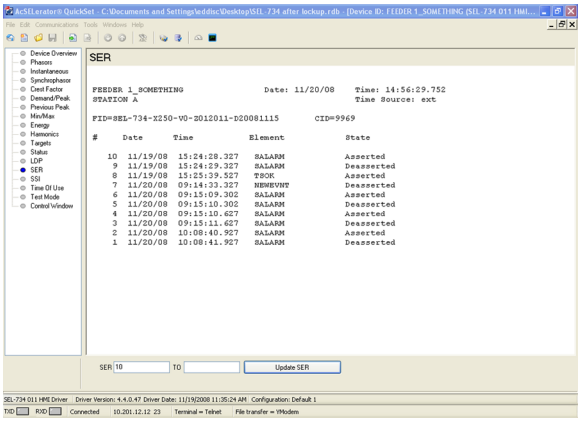
Password Protection

Three password levels ensure protection of critical meter configuration and billing data. Password levels include read only, limited read/write, and full read/write capabilities.

Programmable Logic (SELOGIC Control Equations)

The meter provides user-programmable logic to combine meter calculations, contact inputs, remote command inputs, and timers to control internal logic and contact outputs. The logic allows the following operations:

- Logic (OR, AND, NOT)
- Math (+, –, x, /)
- Analog compare (>, <, <>, =, >=, <=)
- Triggers (RISING EDGE, FALLING EDGE)
- Sixteen latches
- Sixteen remote-control logic units
- Sixteen programmable logic variables with pickup and dropout timers
- Sixteen programmable analog variables



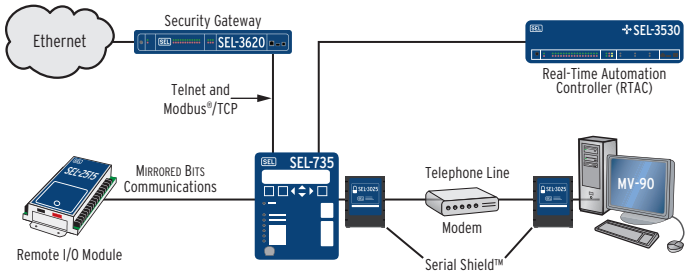
Monitor device and power system events with the Sequential Events Recorder (SER).

Metering Integration

Communication Integration and Security

Use the SEL-735 as part of a complete station integration package. Retrieve metering values with comprehensive security:

- Multitiered password protection
- Port security configuration
- Copper or fiber-optic Ethernet
- DNP3, IEC 61850, Modbus®, Fast Message, SEL, and MIRRORED BITS communications protocols
- Itron MV-90 compatible over serial, modem, and Ethernet



Integrate with many communications paths.

Test Block Integration

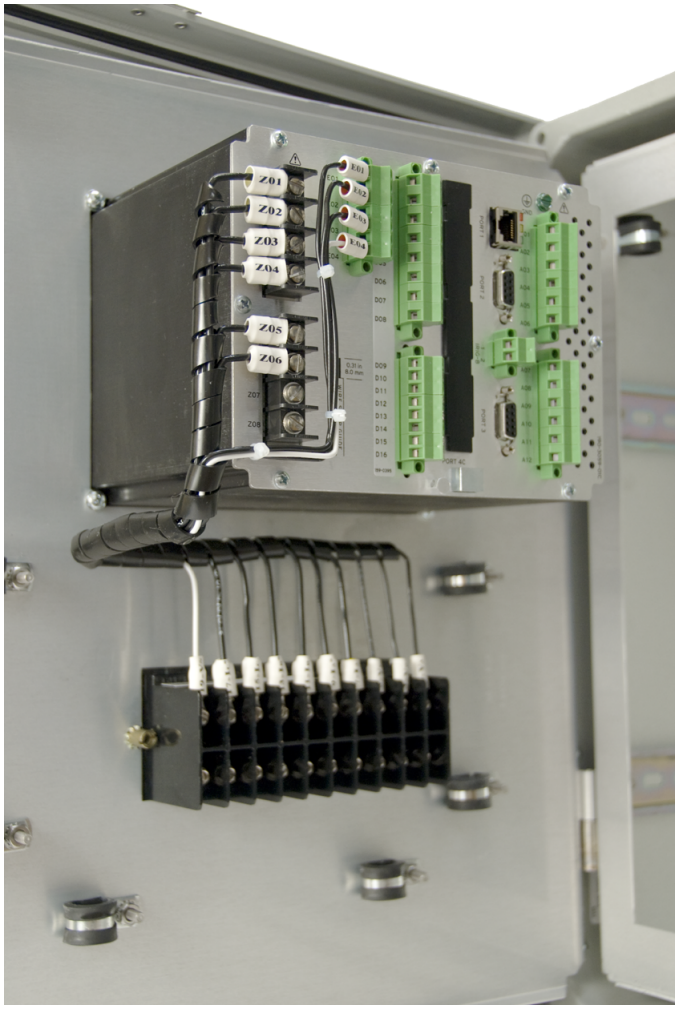
SEL supplies several types of test block as accessories for the SEL-735. The 4600 series test blocks and plugs ensure safety with current shorting and voltage isolation to protect the user and speed testing. Upon request, SEL will prewire the SEL-735 to a test switch installed in a rack-mount bracket, appearance bezel for panel mounting, indoor enclosures, and outdoor enclosures.

Metering Integration (Continued)

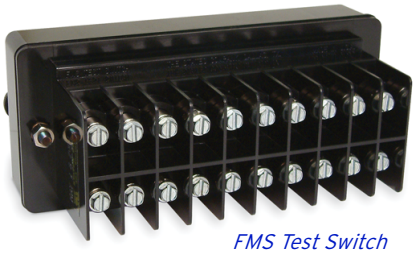
Self-Shorting Current Connector and FMS Test Switch

Use 4600 Series Test Blocks and Plugs to provide a complete test system interface for all electric apparatus. Safely disconnect live voltages and currents and easily service your meter with a self-shorting current connector or a test switch.

Self-Shorting Current Connector and FMS Test Switch	Part Number
10-Position Test Block	4610BTPxxHXXX
10-Position Test Plug	4610PSPxxHXXX
FMS Test Switch	240-1010
Self-Shorting Current Connector	915900048
4600 Retrofit Bezel for FT-1 Cutout	915900126



Test Block *Test Plug*



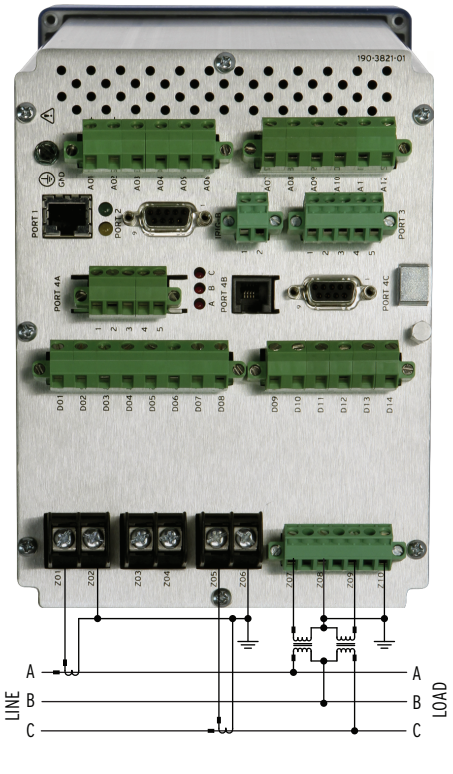
FMS Test Switch

Self-Shorting Current Connector

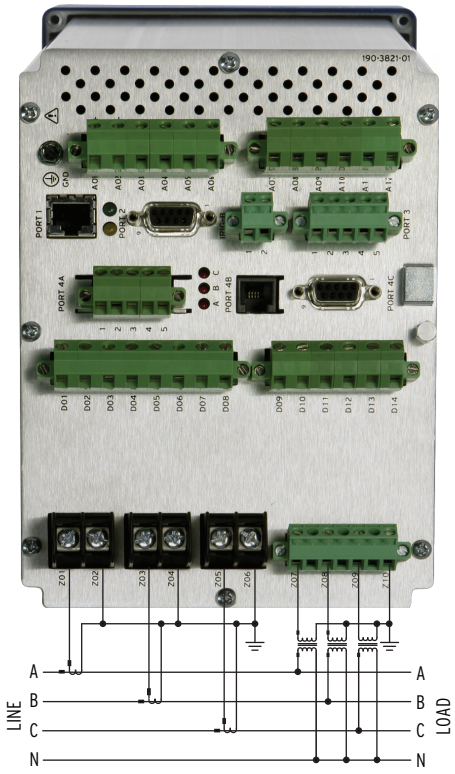
Metering Integration (Continued)

Wye or Open-Delta Integration

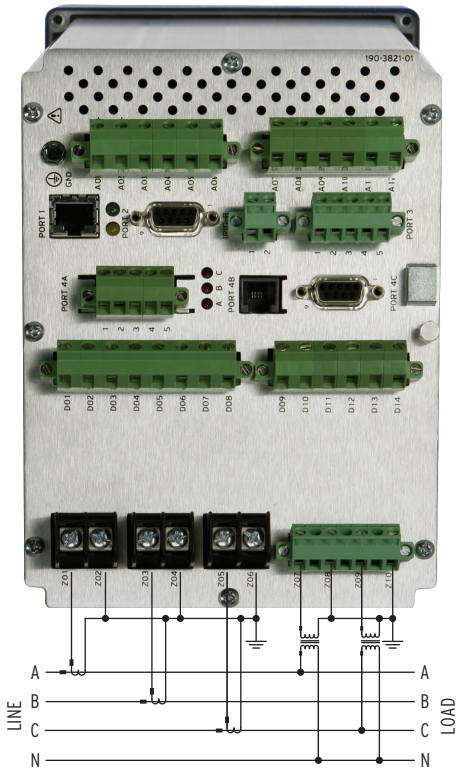
The SEL-735 supports four-wire wye-connected Form 9, three-wire open-delta connected Form 5, and four-wire wye-connected Form 36 configurations as shown below. The end user can select between Form 9, Form 5, and Form 36 metering options in the field by simply issuing a command to the meter.



Form 5, 2-Element, Three-Wire Delta



Form 9, 3-Element, Four-Wire Wye



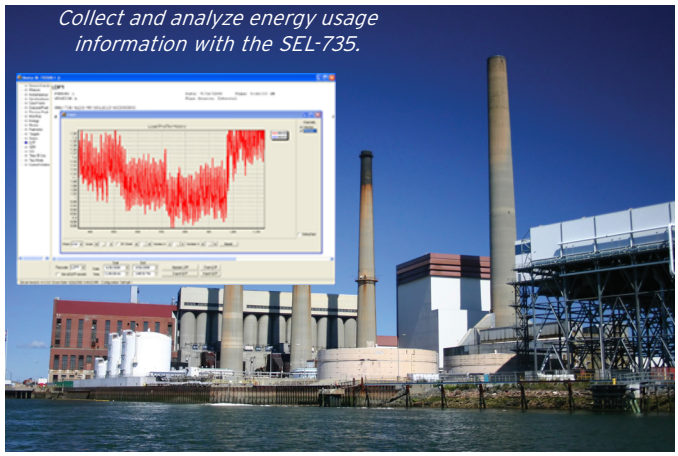
Form 36, 2 1/2-Element, Four-Wire Wye

Advanced Metering Applications

Industrial

- Support complex tariffs with a high-speed, 192-channel load profile data recorder in the SEL-735.
- Measure flicker induced by electric arc furnaces.
- Verify effectiveness of harmonic filters on large motor drives.
- Provide predictive demand for load control and energy usage information to the customer.
- Simplify troubleshooting by monitoring harmonics and interharmonics, triggering alarms, and capturing waveforms.

See the "Industrial Application of the SEL-734 Meter" white paper for the benefits of installing the SEL-735 into industrial applications. The paper can be found at www.selinc.com.



Collect and analyze energy usage information with the SEL-735.

Advanced Metering Applications (Continued)

Substation

- Integrate the SEL-735 into your substation, automation, and protection system.
- Collect metering, power quality, and phasor measurements from remote substations.
- Use the SEL-735 as a real-time feeder monitor to collect event logs, waveforms, and power quality information.

Submetering

- Allocate energy costs by applying SEL-735 meters as submeters.
- Use advanced SELOGIC control equations to manage load and energy costs.

Mini-SCADA or Transducer Replacement

- Use the SEL-735 to collect real-time voltage, current, and kVA information for direct SCADA interrogation via DNP3 or IEC 61850 protocol.
- Replace old, inaccurate, and maintenance-intensive transducers.
- Interface directly with auxiliary equipment and legacy devices, using status inputs and output relays.

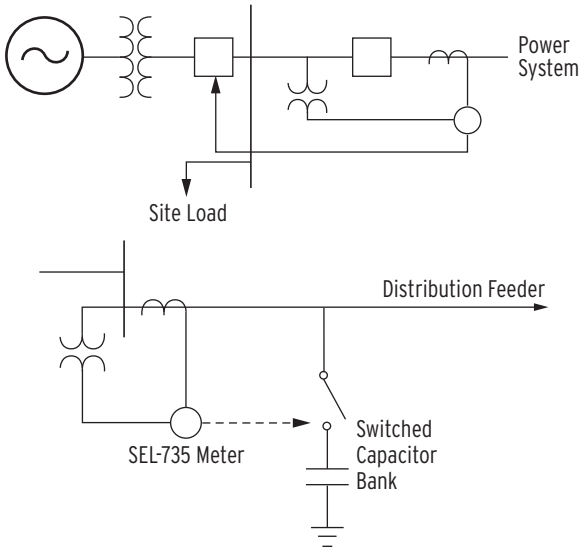
Improve substation monitoring, automation, and control with the SEL-735.

Distributed Generation Control

Use the SEL-735 to provide automatic start and remote control of distributed generation facilities. SELOGIC control equations support any logical or mathematical combination of measured quantities and set points to control a generator or load switch.

Capacitor Bank Control

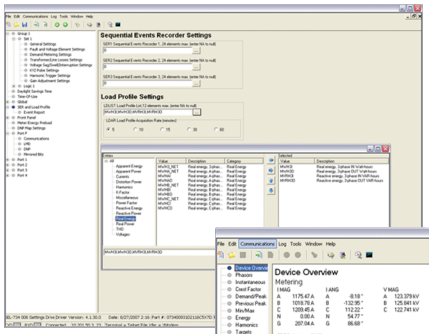
Use the SEL-735 to provide automatic control of switched capacitor banks in distribution feeder applications (as shown at right). The SELOGIC meter capabilities combine fixed pickup settings with metered quantities, such as VAR flow, voltage, time-of-day, and current flow on the feeder.



Simple Software Applications

Settings Editor

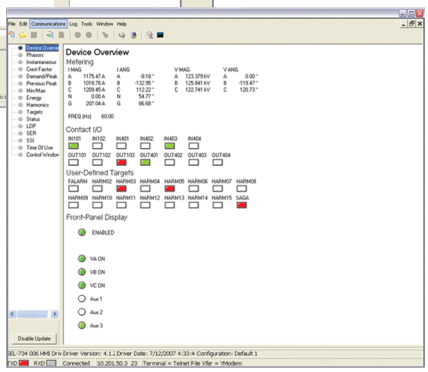
- Use the menu-driven graphical interface with detailed help screens.
- Speed installation by standardizing settings files and modifying application-specific items.
- Develop settings offline.



Simple settings software.

ACSELERATOR QuickSet HMI

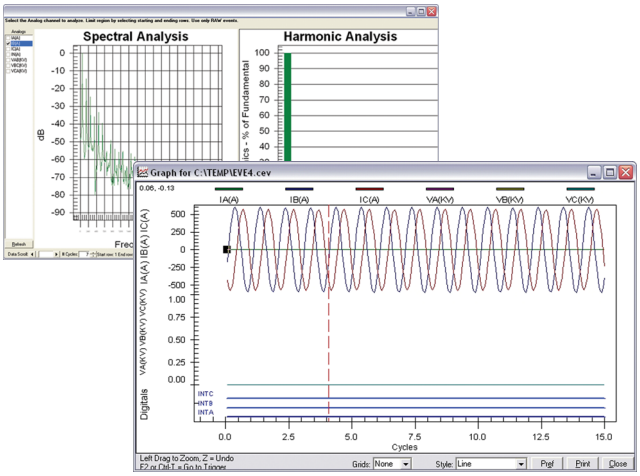
- Remotely monitor and reset real-time metering information, which includes:
  - Energy data
  - Demand and peak demand
  - Minimum/maximum records
  - Sequential Events Recorder (SER) data
- View load profile data.
- Monitor and control inputs and outputs.
- Read and save TOU data.
- Place meter into test mode and monitor test pulse output.



Meter monitoring software standard with the SEL-735.

Event Reports and Analysis

- Quickly analyze event records, status bits, spectral analysis, and harmonic content using the ACSELERATOR Waveform Viewer.
- Convert event reports to oscillography with time-coordinated Device Word bit assertion and phasor/sequence element diagrams.
- Use the SEL-735 modem dial-out capability to automatically transfer event files to ACSELERATOR TEAM software*.

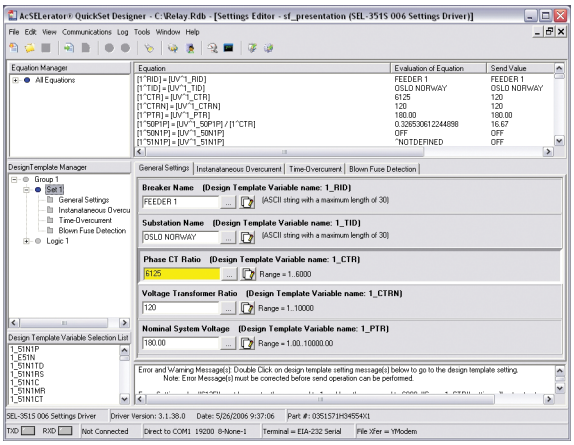


ACSELERATOR Architect

- Use ACSELERATOR Architect® SEL-5032 Software to manage the logical node data for all IEC 61850 devices on the network.
- Bind and identify IEC 61850 network data with this easy-to-use Microsoft Windows-based software.
- Get started faster with preconfigured configuration IED description (CID) files.

ACSELERATOR QuickSet Designer*

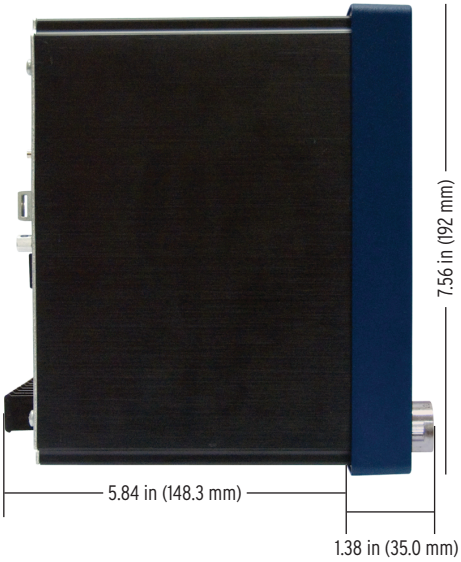
- Use ACSELERATOR QuickSet SEL-5030 Software with a template license to create custom views of settings, called QuickSet Design Templates. This makes installation of a new device simple and helps ensure that new devices are applied according to your organization's standards.
- Import and use QuickSet Design Templates with ACSELERATOR QuickSet. Each meter needs fewer settings because the template hides standardized and unused settings.

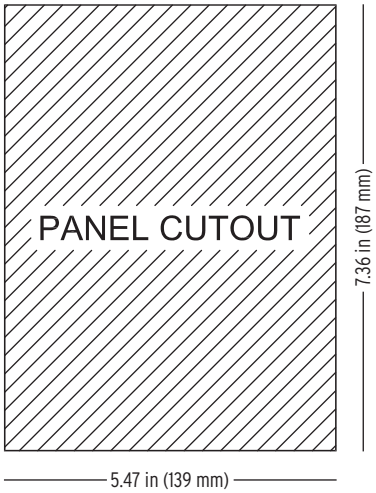


* Additional cost software

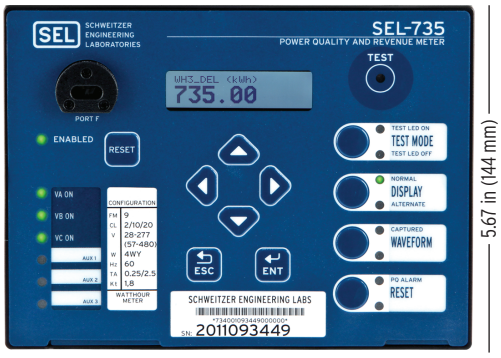
Dimensions and Mounting

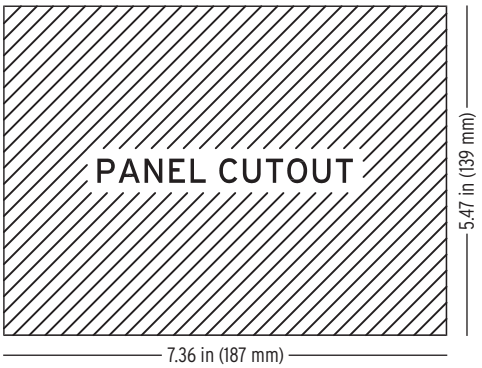
SEL-735 Vertical Dimensions





SEL-735 Horizontal Dimensions





Guideform Specification

The meter shall be 32-bit microprocessor-based with a combination of recording, automation, and communications capabilities. The meter shall include self-diagnostic functions to alarm upon detected failure. Specific requirements are as follows:

Accuracy. Accuracy shall exceed ANSI and IEC Class 0.2 with a ±0.06% Wh guarantee at unity power factor and a Class 0.2 accuracy guarantee for at least 10 years.

Power Quality. The meter shall meet IEC 61000-4-30 power quality accuracy for voltage, current, power, harmonics, and flicker.

True Four-Quadrant Metering. Energy and demand registers shall report delivered and received active power and energy as well as leading and lagging VARs for delivered and received reactive power and energy.

Load Profile Recording. The meter shall include at least 128 MB of nonvolatile memory for data storage and simultaneously record 192 channels for at least 140 days at 5-minute intervals. Statistical recording shall include minimum, maximum, average, changeover interval, and end-of-interval calculations. The recording rate shall be adjustable from 3 seconds to 2 hours. Recorded data shall be available via SEL, Modbus®, DNP3, MV-90, IEC 61850, and ASCII protocols.

Predictive Demand. A predictive demand calculation shall alarm when the demand for a fixed interval will pass a set value.

Transformer/Line-Loss Compensation. The meter shall compensate for meter locations remote from billing points. Bidirectional compensation shall include factors for excitation and loading losses in the transformer.

Human-Machine Interface. An integrated liquid crystal display (LCD) shall report all available analog quantities including power, energy, voltage, current, frequency, harmonics, phase angle, and maximum/minimum values. Customer-accessible programming shall support custom naming, alarming, scaling, and 1-line and 3-line display modes. The front panel shall include at least four programmable pushbuttons that can enter Test Mode, cycle to alternate display points, trigger waveform capture, and reset alarms. At least 14 programmable LEDs shall indicate status, alarms, and the presence of voltage.

Time-of-Use (TOU) Metering. The meter shall record demand and energy consumption during different time periods based on a user-defined calendar. Programming will allow for 4 seasons, 6 rates, 10 day types, 40 rate schedules, a 20-year calendar, and 15 self reads.

Instrument Transformer Compensation. The meter shall compensate for instrument transformer ratio and phase errors, and shall provide six calibration points for each transformer.

Minimum/Maximum Recording. Each phase voltage and current shall have the date and time of the last maximum and minimum value since resetting the maximum/minimum.

Sequential Events Recorder (SER). A chronological report shall record the most recent 16,000 events with 1 ms time-stamp accuracy.

Voltage Sag/Swell/Interruption Recording (VSSI). A VSSI recorder shall capture excursions with 1 ms time-stamp accuracy. At least 11,000 record samples shall adapt sampling rates from a quarter cycle to daily. VSSI summary and detailed reports shall be available less than 5 seconds after the event occurs.

Waveform Capture. The meter shall simultaneously capture 512 samples-per-cycle events for a total of 35 seconds from each phase. Available formats shall include filtered .CEV and full-bandwidth COMTRADE files, which are available 5 seconds after the event subsides. Waveform event reports shall contain data including the trigger bit, digital input, digital output, and device status.

Harmonic Metering. The meter shall report individual harmonics up to the 63rd order, including voltage, current, phase angles, and power magnitudes. The meter shall exceed IEC 61000-4-7 Class II accuracy. Interharmonic values shall encompass 5 Hz to 3800 Hz in 5 Hz bins.

K-Factor Calculation. The meter shall perform K-factor calculations for transformer loading, as defined by IEEE transformer loading guides.

Flicker. The meter shall report instantaneous, short-term, and long-term flicker measurement per IEC 61000-4-15.

Inputs and Outputs. The meter contains three electromechanical outputs and two digital inputs, standard. Optional inputs and outputs include combinations of electromechanical and solid-state outputs, analog outputs, and digital inputs.

Clock. The meter shall have an internal battery-backed clock with 20 ppm accuracy and retain time without power for at least 10 years.

Time Synchronization. Time synchronization shall include IRIG-B, DNP3, Modbus, MV-90, SNTP, ASCII, and front-panel inputs. Time stamps synchronized to an IRIG-B signal shall have a resolution of 10 µs.

Analog and Math Logic. The meter shall support programmable logic for remote terminal unit (RTU) control and automation. Binary and analog meter data shall be available for Boolean logic calculations and mathematical functions. Boolean logic shall include AND, OR, NOT, rising-edge detection, and falling-edge detection, as well as latches and counters. Mathematical functions shall include add, subtract, multiply, and divide as well as analog compare functions.

Communication. The meter shall support up to ten simultaneous communications sessions via EIA-232 serial, EIA 485/EIA-422 multidrop, infrared, 10/100BASE-T Ethernet, 100BASE-FX Ethernet, 100BASE-LX Ethernet, or telephone modem.

Protocols. The meter shall support simultaneous SEL-ASCII, Modbus, DNP3, IEC 61850 GOOSE and MMS, MV-90, MIRRORED BITS®, and binary interleaved communications protocols. The SEL ASCII, Modbus, DNP3, and IEC 61850 protocols shall support at least 2,000 simultaneous analog quantities with user-configurable mapping and scaling.

IEC 61850 Ethernet Communications. The meter shall incorporate IEC 61850 MMS and GOOSE with up to 24 GOOSE subscriptions and 6 simultaneous MMS sessions.

Software. The meter shall include no-charge settings configurations, data retrieval, and analysis software. The software shall retrieve, display, and store text and graphical reports including VSSI, Load Profile, TOU, and waveform event data without erasing stored meter data. Standard event analysis software shall support waveform event playback and harmonic reporting. The software shall export data in .CSV, .TXT, .HHF, COMTRADE, .CEV, and .BIN file formats.

Mechanical Construction. The meter case shall be aluminum with a front-panel International Protection (IP) rating of 65 when installed in a panel. Mounting provisions shall include rack-, panel-, and surface-mount options. An optional pre-wired outdoor enclosure shall include an FT-1 style test switch and include an IP rating of 66.

Compliance. The meter shall comply with ANSI C12.20, IEC 61000-4-30, IEC 62052-11, IEC 62053-22, IEC 62053-23, and ISO 9001 requirements.

Safety. The meter shall comply with UL 508, CAN/CSA C22/2 No. 142, and CE safety requirements.

Temperature. The meter shall function in ambient temperatures ranging from -40° to +85°C (-40° to +185°F).

Reliability. SEL shall supply the actual measured mean time between failures (MTBF) for the device upon request.

Service. The device shall include no-charge technical support for the life of the product.

Manufacturer. The manufacturer shall design and assemble all components including the printed circuit boards in a wholly owned manufacturing facility within the United States.

Conformal Coating. The device shall include optional conformal coating to protect the circuit boards from harsh environments.

Warranty Return. SEL shall support a 72-hour turnaround on all warranty repairs.

Warranty. The device shall include a ten-year, no-questions-asked warranty for all material and workmanship defects. In addition, the warranty shall cover accidental customer-induced damage.

Specifications

General

AC Voltage Inputs

Maximum Rating:	300 $V_{L–N}$, 520 $V_{L–L}$ continuous 600 $V_{L–N}$, 1039 $V_{L–L}$ for 10 seconds
Range:	
Revenue:	28–300$V_{L–N}$, 57–520 $V_{L–L}$
Measurement:	5–300 $V_{L–N}$, 9–520 $V_{L–L}$
Burden:	10 MΩ

AC Current Inputs

Maximum Rating:	22 A continuous 500 A for 1 second
Range:	
Current Class CL2/CL10/CL20, optimized for low-end accuracy:	
Revenue:	0.010–22 A
Measurement:	0.001–22 A continuous
Current Class CL10/CL20, optimized for 100 A fault recording:	
Revenue:	0.050–22 A
Measurement:	0.005–22 A continuous 22–100 A symmetrical for 25 seconds
Burden:	≤0.5 VA
Measurement Category:	II

Frequency and Rotation

60 or 50 Hz system frequency specified at time of order. User selectable ABC/ACB phase rotation.
Frequency tracking range: 40 to 70 Hz based on V_A or V_C.

Power Supply

Continuous Operating Limits

125/250 Volt Supply:	85–264 Vac (50/60 Hz) 85–275 Vdc
24/48 Volt Supply:	19–58 Vdc
12/24 Volt Supply:	9.6–30 Vdc
VA Rating:	<40 VA/15 W maximum <20 VA/7 W typical
Interruption (IEC 60255-11:1979)	50 ms at 125 Vac/Vdc 50 ms at 48 Vdc 10 ms at 24 Vdc 2 ms at 12 Vdc
Ripple (IEC 60255-11:1979)	12% for dc inputs
Terminal Voltage Dropout:	<40 V within 1 minute of power removal
Rated Insulation Voltage (IEC 60664-1:2002):	300 Vac
Dielectric Test Voltage:	3.1 kVdc

100BASE-FX Fast Ethernet Fiber-Optic Port

Fiber Type:	Multimode
Data Rate:	100 Mbps
Wavelength	1300 nm
Optical Connector Type:	LC
Link Budget:	11.8 dB
Min. TX Power:	–20 dBm
Min. RX Sensitivity:	–31.8 dBm
Fiber Size:	62.5/125 µm or 50/125 µm
Approximate Range:	2 km

100BASE-LX10 Fast Ethernet Fiber-Optic Port

Fiber Type:	Single-mode
Data Rate:	100 Mbps
Wavelength:	1310 nm
Optical Connector Type:	LC
Link Budget:	10 dB
Min. TX Power::	–15 dBm
Min. RX Sensitivity:	–25 dBm
Fiber Size:	9/125 µm or 8/125 µm
Approximate Range:	10 km

Communications Protocols

SEL ASCII/Compressed ASCII, SEL Fast Operate/Fast Meter, MIRRORED BITS, SEL Distributed Port Switch (LMD), Modbus RTU/TCP, DNP3 serial and LAN/WAN, FTP, TCP/IP, SNTP, IEC 61850, Telnet, MV-90, and C37.118 (future)

Output Contacts

Ratings determined by IEC 60255-23:1994.

Standard (Electromechanical)

Make:	30 A per IEEE C37.90-1989 3.6 kVA, Cos ϕ = 0.3
Break Rating:	360 VA, Cos ϕ = 0.3

Breaking Capacity (10000 operations):

12/24 Vdc	0.75 A	L/R = 40 ms
48 Vdc	0.50 A	L/R = 40 ms
125 Vdc	0.30 A	L/R = 40 ms
250 Vdc	0.20 A	L/R = 40 ms

Carry:	3 A at 120 Vac, 50/60 Hz 1.5 A at 240 Vac, 50/60 Hz 50 A for 1 second
Durability:	>10,000 cycles at rated conditions
Pickup/Dropout Time:	<16 ms
Maximum Operating Voltage (Ue):	250 V
Rated Insulation Voltage (Ui) (excluding EN 61010):	300 V

Optional (Solid State)

Voltage:	250 Vdc or Peak ac maximum	
Current:	100 mA maximum	
Capacity:	0.6 VA at 25°C, 0.2 VA at 85°C	
Pulse Rate:	20 pulses per second	
Maximum On Resistance:	Typical: Guaranteed:	50 Ω <100 Ω
Minimum Off Resistance:	10 MΩ	
Pickup/Dropout Time:	<25 ms	

Analog Outputs

±1 mA Output

Maximum Firmware Update Rate:	100 ms
Maximum Settling Time For Full Range Change to 0.1% Full-Scale:	500 ms
Bandwidth:	0 to 4 Hz

Range:	±1.2 mA
Minimum Output Impedance:	100 MΩ
Maximum Load:	10 kΩ,100 µH
Accuracy:	±0.15% ±2.0 µA at 25°C

4-20 mA Output

Range:	±24 mA
Minimum Output Impedance:	100 MΩ
Maximum Load:	500 Ω, 100 µH
Accuracy:	±0.20% ±10 µA at 25°C

Optoisolated Input Ratings

DC Control Signal

250 Vdc:	Pickup 200–275 Vdc Dropout 150 Vdc
220 Vdc:	Pickup 176–242 Vdc Dropout 132 Vdc
125 Vdc:	Pickup 100–137.5 Vdc Dropout 75 Vdc
110 Vdc:	Pickup 88–121 Vdc Dropout 66 Vdc
48 Vdc:	Pickup 38.4–52.8 Vdc Dropout 28.8 Vdc
24 Vdc:	Pickup 15–30 Vdc Dropout <5 Vdc
12 Vdc:	Pickup 9.6–13.2 Vdc Dropout <6 Vdc

AC Control Signal

250 Vac:	Pickup 170.6–300 Vac Dropout 106 Vac
220 Vac:	Pickup 150.3–264 Vac Dropout 93.2 Vac
125 Vac:	Pickup 85–150 Vac Dropout 53 Vac
110 Vac:	Pickup 75.1–132 Vac Dropout 46.6 Vac
48 Vac:	Pickup 32.8–57.6 Vac Dropout 20.3 Vac
24 Vac:	Pickup 14–27 Vac Dropout <5 Vac
Current Draw at Nominal DC Voltage:	2–6 mA

Time-Code Input

Meter accepts demodulated IRIG-B time-code input at EIA-232 Port 3, Port 2, or 2-pin Phoenix connector. Meter time is synchronized to within ±10 µs of time-source input.

Nominal Voltage:	5 Vdc
Maximum Voltage:	8 Vdc

Operating Temperature

IEC 60068-2-2:1993:	–40° to + 85°C (–40° to +185°F)

Note: Not applicable to UL applications.

LCD:	–20° to +70°C (–4° to +158°F)

Operating Environment

Pollution Degree:	2
Overvoltage Category:	II

Indoor Use

Maximum Altitude:	2000 M
Maximum Humidity:	95% RH

Weight

2.3 kg (5.0 lbs)

Dimensions

Refer to *Dimensions and Mounting on page 14* for meter dimensions.

Routine Dielectric Test

Current Inputs:	2.75 kVac for 1 s
Voltage Inputs:	2.2 kVac for 1 s
Inputs and Outputs:	2.2 kVac for 1 s
Power Supply:	3.11 kVdc for 1 s
EIA-485 Port:	1.5 kVdc for 1 s
IEC 60255-5:2000	2200 Vdc for 1 s on EIA-485 communications port
Dielectric tests performed on all units with the CE mark:	2000 Vac for 1 s on contact inputs, contact outputs, and analog inputs

Terminal Connections

Rear Screw-Terminal Tightening Torque

Current Input Terminal Block (ring terminals are recommended)

Minimum:	0.9 Nm (8 in-lb)
Maximum:	1.4 Nm (12 in-lb)

Connectorized®

Minimum:	0.5 Nm (4.4 in-lb)
Maximum:	1.0 Nm (8.8 in-lb)

Connectorized terminals accept wire size 12–24 AWG.

User terminals or stranded copper wire should be at a minimum temperature rating of 105°C (221°F).

Processing Specifications

AC Voltage and Current Inputs

512 samples per power system cycle.

Control Processing

1/2-cycle processing interval

SELOGIC Pickup and Accuracies

SELOGIC Timers:	±1/2 cycle
Analog Values:	±3%

Metering/Monitoring

Metering Accuracy (Form 5 and Form 9 only)

Voltage, Current, Power, and Energy

Unity Power Factor:	± 0.06% ± 0.02% typical
0.5 Power Factor:	± 0.16% ± 0.06% typical
Frequency:	±0.001 Hz
Power Quality:	IEC 61000-4-30:2008

Flicker

P_{ST}:	±5% over the range 0.5–25 P_{ST} (10-min. interval)
P_{LT}:	±5% over the range 0.5–25 P_{LT} (2-hour interval)

Type Tests

Electromagnetic Compatibility Immunity

Surge Withstand Capability:	IEC 60255-22-1:2007, Severity Level: 2.5 kV common mode, 1.0 kV differential mode 1.0 kV peak common mode on communications ports IEEE C37.90.1-2002 Severity Level: 2.5 kV oscillatory, 4 kV fast transient
Electrostatic Discharge Immunity:	IEC 60255-22-2:2008 Severity Level: 4 (both polarities at Levels 1, 2, 3, and 4) IEC 61000-4-2:2008 Severity Level: 4
Radiated Electromagnetic Field Immunity:	IEC 60255-22-3:2007 IEC 61000-4-3:2010, Severity Level: 10 V/m ANSI C12.20-1998, Severity Level: 15 V/m
Electrical Fast Transient Burst Immunity:	IEC 61000-4-4:2011, Severity Level: 4 kV
Surge Immunity:	IEC 62052-11:2003, 4 kV for Current, Voltage, and Power Supply Mains 1 kV for Auxiliary Circuits
Conducted Radio Frequency Immunity:	IEC 61000-4-6:2008, Severity Level: 10 Vrms
Power Frequency Magnetic Field Immunity:	IEC 61000-4-8:2009, Severity Level: 100 A/m for 60 seconds; 1000 A/m for 3 seconds, Level 5 excludes optional modem
Pulse Magnetic Field Immunity:	IEC 61000-4-9:2001, Severity Level: 1000 A/m, Level 5

Environmental

Cold:	IEC 60068-2-1:2007 Test Ad: 16 hours at –40°C IEEE 1613-2009 + A1-2011
Dry Heat:	IEC 60068-2-2:2007, Test Bd: 16 hours at +85°C IEEE 1613-2009 + A1-2011
Damp Heat, Cyclic:	IEC 60068-2-30:2005 Test Db: 5% RH, 25° to 55°C, 6 cycles (12 + 12 hour cycle)
Enclosure Protection:	IEC 60529:2001, IP65, enclosed in panel with available gasket (P/N: 915900097); IP41 without gasket; IP20 for rear panel

Vibration

Vibration Resistance:	IEC 60255-21-1:1988 Class 1 Vibration Endurance Class 2 Vibration Response
Shock Resistance:	IEC 60255-21-2:1988 Class 1 Shock Withstand Class 2 Shock Response Class 1 Bump Withstand
Seismic:	IEC 60255-21-3:1993 Class 2 Quake Response

Safety

Dielectric Strength/Impulse:	IEC 60255-5:2000 IEEE C37.90:2005 IEEE 1613-2009 + A1-2011 Severity Level: 2500 Vac for 1 minute, 3100 Vdc for 1 minute on power supply Severity Level: 0.5 Joules, 5 kV
High-Voltage Line Surges:	IEEE C62.41-1991 100 kHz Ring Wave for Location Category B3, Peak Voltage of 6 kV and Short-Circuit Peak Current of 3 kA 1.2/50 µs Combination Wave for Location Category B3, Peak Voltage of 6 kV and Short-Circuit Peak Current of 3 kA
Rated Impulse Withstand Voltage (U_{imp}):	IEC 60664-1:2007 4 kV on power supply, ac current inputs, and voltage inputs

Compliance

ISO 9001: This product was designed and manufactured under an ISO 9001 certified quality management system.

ANSI C12.20:2010 Accuracy; class 0.2, CL2, and CL10/CL20 (applies to Blondel-compliant Form 5 and Form 9 only)

ANSI C12.1 (Form 36)

IEC 62053-22:2003; class 0.2 S

IEC 62052-11; rack-mounted meters

IEC 62053-23:2003; class 2 S

C22.2 No. 61010-1-04

CAN/CSA C22.2 No. 142

UL 508

ERCOT Compliant
(applies to Blondel-compliant Form 5 and Form 9 only)

CAISO Compliant
(applies to Blondel-compliant Form 5 and Form 9 only)

CFG G0000-48-2010 Compliant per LAPEM

CE: Mark–EMC Directive, Low Voltage Directive

Note: Optional modem not CE compliant.

Notes

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