SEL-849 Motor Management Relay

Easy-to-Install Motor Control Center Relay

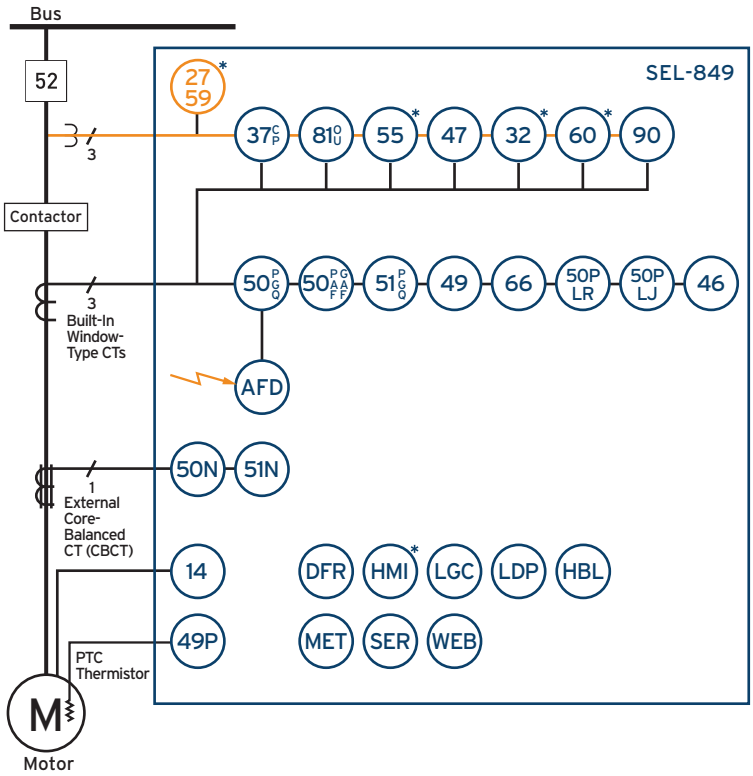
Key Features and Benefits

The SEL-849 Motor Management Relay provides an exceptional combination of protection, metering, monitoring, control, and communications in a compact industrial package. Built-in Rogowski coil-based window current transformers provide phase current measurement suitable for applications up to FLA = 256 A. You can connect external CTs to accommodate full load amperes (FLA) greater than 256 A, and you can configure the device as a motor, variable frequency drive (VFD) motor, or feeder protection relay. Connect an external core-balance current transformer (CBCT) to obtain sensitive ground-fault detection in a high-impedance grounded system.

- **Standard Motor Protection and Control Features.** Protect low- or medium-voltage three-phase motors, as well as VFD fed motors, with an enhanced thermal model that includes locked rotor starts, time between starts, starts-per-hour, antibackspin timer, load loss, current unbalance, load jam/stalled rotor, phase reversal, breaker/contactor failure, positive temperature coefficient (PTC) thermistor over temperature, phase, negative-sequence, residual-ground instantaneous and inverse-time overcurrent elements, and an external CBCT for sensitive ground-fault protection. Implement load control, star-delta starting, two-speed control, forward-reverse start control, and such other control schemes as undervoltage automatic restarting.
- **Arc-Flash Protection.** Use the SEL-849 with built-in fiber-optic arc-flash detector input to implement arc-flash protection. Settable arc-flash phase and residual overcurrent elements combined with the arc-flash light-detection element provide secure, reliable, and fast-acting arc-flash event protection.
- **Optional Protection Features.** Use the SEL-849 with voltage input option to provide over- and undervoltage, over- and underfrequency, directional power, loss-of-potential, and power factor elements.
- **Operator Controls.** Use a double-shielded, 600 V MCC-rated, SEL-C627M Category 5e Ethernet cable, as long as 7.62 meters (25 feet), to connect the SEL-849 Relay to an optional SEL-3421 Motor Relay human-machine interface (HMI) or SEL-3422 Motor Relay HMI module. Both HMI modules provide eight user-programmable tricolor LED targets, two fixed targets, and motor control and function keys. The SEL-3421 Motor Relay HMI module has a full graphical display and allows modification of the IP and router addresses using the navigation and soft keys. The soft keys are also programmable, providing up to eight additional pushbuttons.

- **Integrated Web Server.** Log on to the built-in web server to view metering and monitoring data and to download events, Sequential Events Recorder (SER), motor start reports, etc. Use the server also to view, edit, and save relay settings or to perform relay firmware upgrades.
- **Relay and Logic Settings Software.** ACSELERATOR QuickSet® SEL-5030 Software reduces engineering costs for relay settings and logic programming and simplifies development of SELOGIC® control equations.
- **Metering and Monitoring.** Use built-in metering functions to eliminate separately mounted metering devices. Analyze SER reports and oscillographic event reports for rapid commissioning, testing, and post-fault diagnostics. Additional monitoring functions include the following:
  - Motor start reports
  - Motor start trending
  - Load profile monitoring
  - Motor operating statistics
  - Demand metering
- **Direct Connect 690 Vac Voltage Inputs.** Optional voltage inputs allow for wye-connected, open-delta-connected, or single voltage inputs to the relay. Use potential transformers to connect higher voltages.
- **Control Inputs and Outputs.** Six or twelve (optional) internally wetted control inputs or six externally wetted to 24/48 Vdc/Vac or 110/125 Vdc/Vac control inputs and four contact outputs (one Form C and three Form A) are for control and status indication.
- **Analog Output (Optional).** Use an optional 0–20 mA programmable analog output to display any relay analog quantities on an external analog meter.
- **Communications Ports.**
  - Port 1 and an optional Port 3, EIA-232 or EIA-485 configurable serial ports
  - Port 2 single or dual (optional) 10/100BASE-T Ethernet port(s)
  - HMI Ethernet port
- **Communications Protocols.**
  - Modbus® RTU and TCP/IP
  - IEC 61850 (optional Ethernet-based protocol)
  - DNP3 serial, DNP3 LAN/WAN
  - Simple Network Time Protocol (SNTP)
  - EtherNet/IP
  - Parallel Redundancy Protocol (PRP)
  - File Transfer Protocol (FTP)
  - Telnet (SEL ASCII)
  - SEL protocols
- **Conformal Coating.**
  - Provides an additional barrier against contaminants in harsh environments; conformal coating is offered as an option for the SEL-849
  - All SEL-3421/3422 HMI electronic boards are conformally coated.
- **IEC 60947-4-1 Type 2 Coordination Compatible.** For short circuits, the relay withstands as much as 100 kA.

Functional Overview



ANSI Functions	
14	Speed switch
27	Undervoltage*
32	Directional power*
37 (C,P)	Undercurrent/Power load loss
46	Current Unbalance
47	Phase reversal
49	Thermal
50 (P,G,Q,N)	Instantaneous overcurrent
50PAF, 50GAF	Arc-flash instantaneous overcurrent
50P LR	Locked rotor
50P LJ	Load jam
51 (P,G,Q,N)	Time-overcurrent
55	Power factor*
59	Overvoltage*
60	Loss-of-potential*
66	Starts-per-hour*
81 (O,U)	Over- and underfrequency
90	Load control

* Optional feature

Additional Functions	
AFD	Arc-flash detection
DFR	Event reports
HBL	Harmonic blocking
HMI	Human-machine interface*
LDP	Load profile
LGC	SELOGIC control equations
MET	High-accuracy metering
SER	Sequential Events Recorder
WEB	Web server

* Optional feature

Figure 1 Functional Diagram

Protection and Control Features

Motor Thermal Protection

The SEL-849 uses a patented thermal model to provide locked rotor, running overload, and negative-sequence current unbalance protection. The thermal element accurately tracks the heating resulting from load current and current unbalance while the motor is accelerating and running. The relay expresses the present motor thermal estimate as a % Thermal Capacity Used for stator and for rotor. When either stator or rotor % Thermal Capacity reaches 100 percent, the relay trips.

You can choose from three easy setting methods:

- IEC or NEMA trip class (select from 5, 10, 20, 30)
- Motor nameplate ratings
- 45 standard thermal limit curves

For simple, effective protection, enter the IEC or NEMA trip class setting or the motor nameplate ratings for Full Load Current, Locked Rotor Current, Hot Stall Limit Time, and Motor Overload Pickup Level. To cause the relay to emulate existing motor protection, select the appropriate thermal limit curve from 45 standard curves.

Short-Circuit Tripping

The SEL-849 uses phase, negative-sequence, and residual overcurrent elements to detect cable and motor short-circuit faults. Relay elements include the following:

- Two phase overcurrent elements
- Two residual overcurrent elements
- One negative-sequence overcurrent element
- Two (2) CBCT instantaneous overcurrent elements for sensitive ground-fault detection

Set the relay to trip instantaneously or with a definite-time delay for short-circuit conditions. The relay also includes a phase element, negative-sequence element, and residual time-overcurrent element.

Load-Loss, Load-Jam, and Frequent-Starting Protection

The SEL-849 trips for load-jam and load-loss conditions. Load-loss detection causes an alarm and a trip when the relay detects such a condition. Load-jam protection trips the motor quickly to prevent overheating from stall conditions. The relay uses settable starts-per-hour and minimum time-between-starts protection functions to provide frequent-starting protection. The relay stores motor starting and thermal data in nonvolatile memory to prevent motor damage (caused by overheating resulting from frequent starts) from loss of relay power.

Current Unbalance and Phase Reversal Protection

In addition to the thermal element, the SEL-849 provides a current unbalance element, which trips for a motor single-phasing condition or for heavy current unbalance. Relay phase reversal protection detects motor phase rotation and trips after a delay if phase rotation is incorrect. The SEL-849 provides this protection even if phase voltages are not available.

Voltage-Based Protection Elements

The SEL-849 offers optional voltage inputs (direct connect to 690 Vac or with potential transformers for higher voltages) that you can configure in four different ways:

- One phase-to-phase voltage
- One phase-to-neutral voltage
- Open-delta voltages
- Four-wire wye voltages

When you have connected one or more voltages, the relay provides a number of added motor protection and metering functions.

- Over- and undervoltage
- Over- and underfrequency
- Directional power (+W, –W, +VAR, –VAR)
- Power factor
- Loss-of-potential

Start Monitoring/Incomplete Sequence

The relay produces a trip if motor starting is incomplete by START_T time and the start motor time-out has asserted the TRIP equation.

Starter Types and Automated Motor Starting Sequences

The relay automatically assigns appropriate inputs/outputs and supports a starting sequence based on the selected starter type, which includes the following:

- Full-voltage nonreversing
- Full-voltage reversing

- Two-speed
- Wye-delta

Undervoltage Automatic Restarting

The relay automatically restarts the motor if you have programmed the relay for an automatic restart and voltage has recovered following an undervoltage condition that stopped the motor. The restart sequences are tailored for short, medium, and long voltage dips.

Start Inhibit Protection

The SEL-849 provides start inhibit protection when the protected motor overheats (thermal lockout) or reaches a specific maximum number of starts-per-hour or minimum time between starts. Also, in certain pump applications, reverse flow through the pump can spin the pump motor for a short time after the motor stops. Any attempt to start the motor during this time can cause damage. The SEL-849 prevents motor starts during such backspin periods. The relay maintains the trip signal sufficiently long enough for you to restart the motor safely.

Speed Switch

When the motor has a speed switch, you can provide additional locked rotor protection by using the relay speed switch input. The relay can issue a warning or trip signal if the speed switch fails to close within the speed switch time delay after the motor start begins.

Arc-Flash Protection

An arcing short circuit or a ground fault in low or medium voltage switchgear can cause serious equipment damage and personal injury. An arc-flash event can also cause prolonged and expensive downtime.

The best way to minimize the impact of an arc-flash event is to reduce detection and circuit breaker tripping times. Conventional protection may need several cycles to detect the resulting overcurrent fault and trip the breaker. In some cases, there may not be sufficient current to detect an overcurrent fault. Sensitivity and selectivity can cause a tripping delay as long as a few hundred milliseconds in some applications.

The arc-flash detection-based (AFD) protection can act on the circuit breaker in as little as 8–12 milliseconds. This fast response can limit arc-flash energy, preventing injury to personnel and limiting or eliminating equipment damage. Settable arc-flash phase and residual overcurrent elements combined with the arc-flash light-detection element provide secure, reliable, and fast-acting arc-flash event protection.

Load Control Function

The SEL-849 provides the ability to control external devices based on the parameter load control selection. You can select the current, power, or stator thermal capacity for use in operating auxiliary outputs. Load control is active only when the motor is in the running state. You can use this feature to control the motor load within set limits.

Variable Frequency Detection (VFD)

When the VFD application is selected, the relay uses rms current magnitudes instead of fundamental for the phase/residual overcurrent elements and the motor thermal model.

If voltage inputs are used, make sure the inputs are nearly sinusoidal without any multiple zero crossings.

Exercise caution when using power and frequency elements.

Feeder Protection

When the feeder application is selected, the relay automatically disables motor protection elements.

Harmonic Blocking

For transformer applications, use the second- and fifth-harmonic blocking feature to detect inrush conditions or to block selected tripping elements until an inrush condition subsides.

Metering and Monitoring

Metering Functions

The SEL-849 provides accurate rms and fundamental frequency metering for input currents and optional voltages. Use the serial port, an SEL-3421, or the built-in web server to view phase, residual, CBCT, negative-sequence, and average and current unbalance

magnitudes. When equipped with voltage inputs, the relay provides additional meter quantities that include the following:

- Phase, residual, negative-sequence, average, and voltage unbalance magnitudes
- Real, reactive, and apparent power (kW, kVAR, kVA)
- Power factor
- Frequency and motor load in multiples of FLA

Other metered values include the following:

- Stator and rotor thermal capacity used in percent
- Time to reset in seconds after a lockout (thermal, time between starts, number of starts, or antibackspin timer)
- Maximum and minimum metering
- Energy metering
- Demand and peak demand metering
- Harmonics metering
- Math variables
- Remote analogs

Table 1 Metering Capabilities

Quantities	Description
Currents IA, IB, IC, IG (calculated 3I0), IN (CBCT), average, unbalance %, 3I2	Input currents, residual-ground current (IG = 3I0), CBCT current, current unbalance %, negative-sequence current
Voltages VA, VB, VC, 3V0 (calculated), unbalance %, 3V2	Wye-connected voltage inputs
Voltages VAB, VBC, VCA, unbalance %, 3V2	Delta-connected voltage inputs
xFLA	Motor load in multiples of full load amps
Power Quantities kW, kVAR, kVA	Three-phase kilowatts, kilovars, and kilovolt-amps
PF	Power factor (leading or lagging)
Energy MWh3P, MVARh3P-IN, MVARh3P-OUT, MVAh3P	Three-phase megawatt-hours, megavar-hours, and megavolt-amp-hours
Frequency (Hz)	Frequency in Hz
MV01–MV08	Math variables
RA001–RA032	Remote analogs
Stator TCU %	Stator thermal capacity used in percent
Rotor TCU %	Rotor thermal capacity used in percent
Thermal trip in (seconds)	Time to thermal trip in seconds
Time to reset (seconds)	Time to reset in seconds after a lockout (thermal, time between starts, number of starts, or antibackspin timer)

Motor Monitoring and Statistics

The SEL-849 records a variety of data for your motor maintenance program. Information the motor statistics function saves includes the following:

- Time running and stopped
- Number of starts
- Average and peak starting time and current
- Average and peak running current and power
- Protection element alarm and trip counts

Motor Start Report

The SEL-849 records motor start data for each motor start. The relay stores as many as five of the latest motor start reports in nonvolatile memory. The summary shows the following information:

- Date and time of the motor start
- Number of starts since last reset
- Motor start time
- Start % rotor thermal capacity used (% rotor TCU)
- Maximum start current
- Minimum start voltage (if voltage inputs option is installed)

The relay takes motor start data periodically after it detects starting current. The relay stores 720 sets of the data. The following data are stored:

- Magnitude of A-, B-, and C-phase currents
- Calculated magnitude of residual current, IG (3I0)
- % rotor thermal capacity used (% rotor TCU)
- Magnitude of AB, BC, and CA phase-to-phase voltages, if included

Motor Start Trending

For each motor start, the relay stores a motor start report and adds these data to the motor start trending buffer. Motor start trending tracks motor start data for the past eighteen 30-day periods. For each 30-day interval, the relay records the following information.

- The date the interval began
- The total number of starts in the interval
- The averages of the following quantities:
  - Motor start time
  - Start % rotor thermal capacity used
  - Maximum start current
  - Minimum start voltage, if voltage inputs option is installed

Load Profiling

Load-profile monitoring provides a periodic snap-shot (selectable rate of every 5, 10, 15, 30, or 60 minutes) of as many as 16 selectable analog quantities from the complete list of analog quantities the SEL-849 generates. Examples of analog quantities available include the following:

- Phase and residual current magnitudes
- Percent stator or rotor thermal capacity used
- Percent current unbalance
- System frequency
- Maximum and minimum values

When the voltage option is specified, the relay also records the following:

- Phase-to-phase voltage magnitudes
- Real power magnitude
- Reactive power magnitude
- Apparent power magnitude
- Energy values

The SEL-849 maintains load profile information in a nonvolatile buffer memory. The memory can hold data for 4,000 time-stamped entries. For example, if you chose to monitor 10 values at a rate of every 15 minutes, you could store 41.67 days' worth of data.

Analog Output

The SEL-849 offers an analog output for operating a remote panel meter or as an input to the distributed control system of your plant. Configure the output to operate in the range of 0–20 mA. The relay produces a dc signal proportional to your choice of a selected analog quantity available in the relay. Examples of such quantities include average current, percent of full load current, percent of stator or rotor thermal capacity used, etc.

Automation

Flexible Control Logic and Integration Features

The SEL-849 has as many as two independently operated serial ports, each of which you can configure as EIA-232 or EIA-485. Optionally, the relay supports single or dual copper Ethernet ports. The relay needs no special communications software. You can use any system with a web browser or terminal emulation software. Establish communication by connecting computers, modems, protocol converters, printers, an SEL real-time automation controller (RTAC), SEL communications processor, SEL computing platform, SCADA, and/or RTUs for local or remote communication. Refer to *Table 2* for a list of communications protocols available in the SEL-849.

Table 2 Communications Protocols[a,b]

Type	Description
Simple ASCII	Plain language commands for human and simple machine communication. Use for metering, setting, self-test status, event reporting, and other functions.
Compressed ASCII	Comma-delimited ASCII data reports. Allows external devices to obtain relay data in an appropriate format for direct import into spreadsheets and database programs. Data are checksum protected.
Extended Fast Meter and Fast Operate	Binary protocol for machine-to-machine communication. Quickly updates SEL communications processors, RTUs, and other substation devices with metering information, relay element, I/O status, time tags, start and stop commands, and summary event reports. Data are checksum protected. Binary and ASCII protocols operate simultaneously over the same communications lines, so there is no loss of control operator metering information while a technician transfers an event report.
Fast SER Protocol	Provides SER events to an automated data collection system.
DNP3	Serial or Ethernet-based DNP3 protocol. Provides default and mappable DNP3 objects that include access to metering data, protection elements, Relay Word bits, contact I/O, targets, SER, relay summary event reports, and settings group selection.
Modbus	Serial- or Ethernet-based Modbus with point remapping. Includes access to metering data, protection elements, contact I/O, targets, SER, relay summary event reports, and settings.
IEC 61850	Ethernet-based international standard for interoperability among intelligent devices in a substation. Operates remote bits and I/O. Monitors Relay Word bits and analog quantities.
PRP	Provides seamless recovery from any single Ethernet network failure and fast failover switching in a dual redundant Ethernet network, in accordance with IEC 62439-3.
SNTP	Ethernet-based protocol that provides time synchronization of the relay.
EtherNet/IP	Ethernet-based protocol that provides access to metering data, protection elements, targets, and contact I/O.

[a] Port 1 and Port 3 support SEL, Modbus RTU, or DNP3 protocol.

[b] Port 2 concurrently supports two Modbus TCP, five DNP3 LAN/WAN, two FTP, two Telnet, one SNTP, six IEC 61850 sessions, and one HTTP session for the web server, as well as two EIP I/O connections and six EIP message connections.

Apply an SEL communications processor as the hub of a star network, with point-to-point copper connection between the hub and the SEL-849 (see *Figure 2*).

The communications processor supports external communications links including the public switched telephone network for engineering access to dial-out alerts and private line connections of the SCADA system.

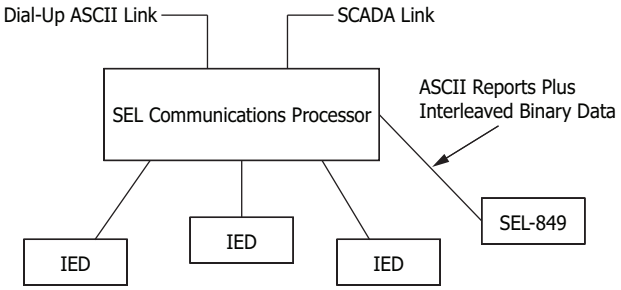


Figure 2 Example Communications System

SEL manufactures a variety of standard cables for connecting this and other relays to a variety of external devices. Consult your SEL representative for more information on cable availability.

SEL-849 control logic improves integration in the following ways.

- Eliminates RTU-to-relay wiring with eight remote bits.
- Set, clear, or pulse remote bits through the use of serial port commands. Program the remote bits into your control scheme with SELOGIC control equations. Use remote bits for SCADA-type control operations such as trip and close.
- Replaces traditional latching relays.
- Replace as many as eight traditional latching relays for such functions as “remote control enable” with latch bits. Program latch set and latch reset conditions with SELOGIC control equations. Use optoisolated inputs, remote bits, or any programmable logic condition to set or reset the nonvolatile latch bits. Each latch bit retains its state when the relay loses power.
- Replaces traditional indicating panel lights
- Replace traditional indicating panel lights with eight programmable displays. Define custom messages (e.g., `Breaker Open`, `Breaker Closed`) to report power system or relay conditions. Use advanced SELOGIC control equations to control which messages the external HMI displays.
- Eliminates external timers

➤ Replace external timers for custom protection or control schemes with eight general-purpose SELOGIC control equation timers. Each timer has independent time-delay pickup and dropout settings. Program each timer input with any element you need (e.g., time qualify a current element). Assign the timer output to trip logic, transfer trip communications, or other control scheme logic.

Fast SER Protocol

SEL Fast SER Protocol provides SER events to an automated data collection system. SEL Fast SER Protocol is available on any serial port. Devices with embedded processing capability can use these messages to enable and accept unsolicited binary SER messages from SEL-849 Relays.

SEL relays and communications processors have two separate data streams that share the same serial port. The normal serial interface consists of ASCII character commands and reports that are human readable through use of a terminal or terminal emulation package. The binary data streams can interrupt the ASCII data stream to obtain information, and then allow the ASCII data stream to continue. This mechanism allows use of a single communications channel for ASCII communications (e.g., transmission of a long event report) interleaved with short bursts of binary data to support fast acquisition of metering or SER data.

Ethernet Network Architectures

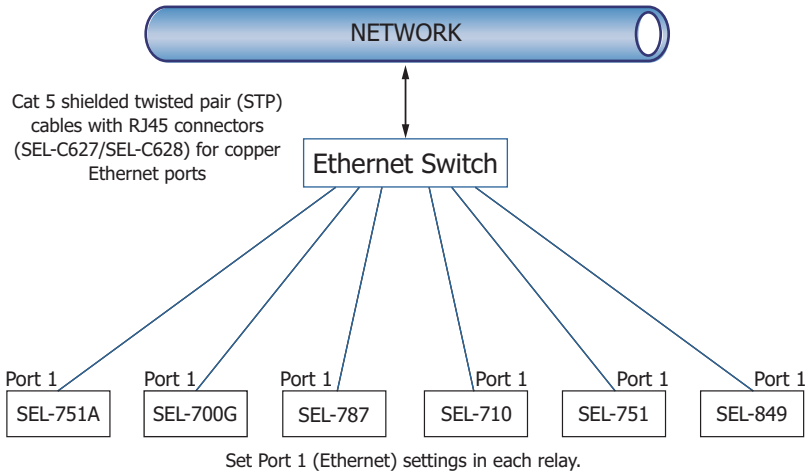


Figure 3 Sample Ethernet Network Configuration

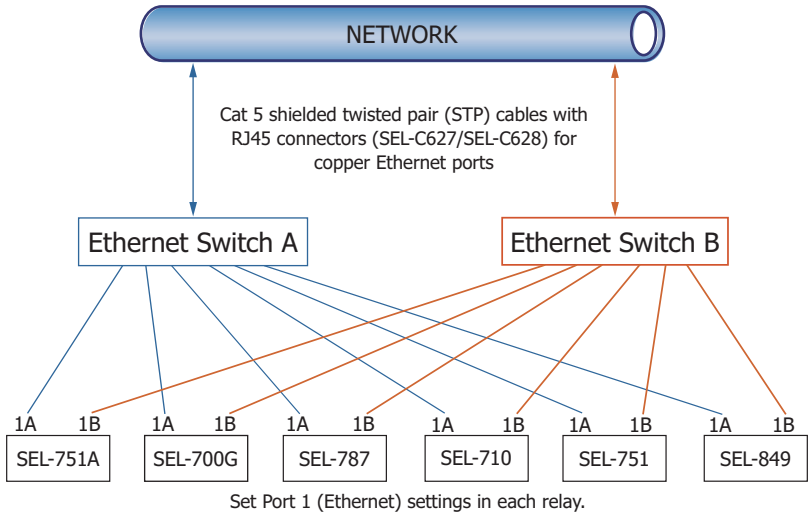


Figure 4 Simple Ethernet Network Configuration With Dual Redundant Connections (Failover Mode)

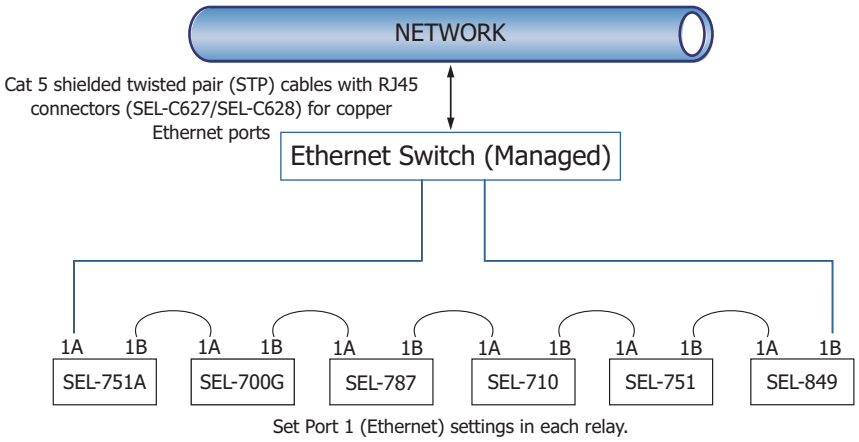


Figure 5 Simple Ethernet Network Configuration With Ring Structure (Switched Mode)

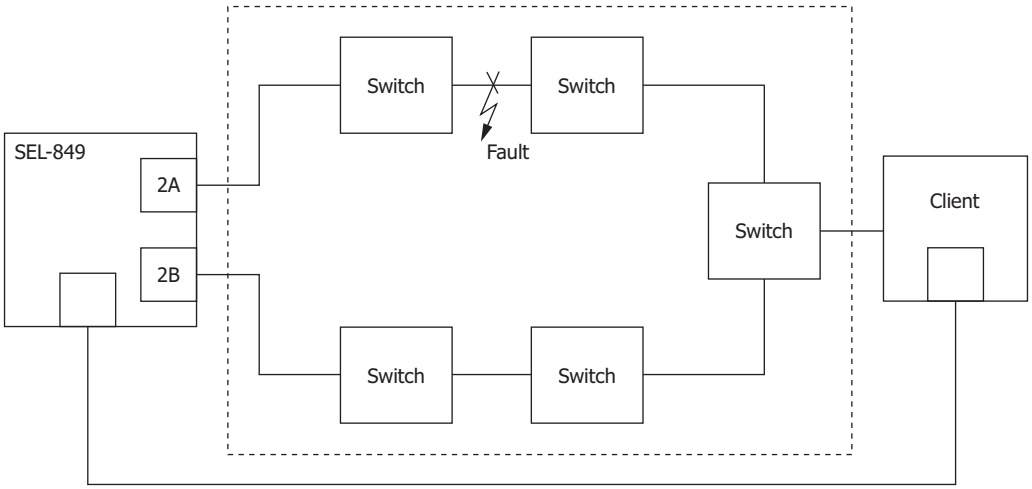
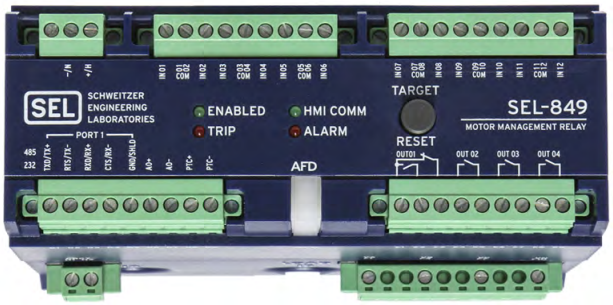


Figure 6 Dual Ethernet Configuration With NETMODE := FAILOVER and Using Network Link Failure (SELOGIC Equation) Setting to Force Switchover

There are multiple methods for accessing and using the operator interface of the relay.

Relay Top Panel

The top panel of the relay has four LEDS, including relay **ENABLED** status, **TRIP** status, **HMI COMM** communications status, and relay **ALARM** status. The panel also provides a **TARGET RESET** pushbutton for resetting the relay and the targets.



SEL-3421 Motor Relay HMI Module With LCD

The SEL-3421 connects to the HMI port on the relay and receives power from the relay, providing you the ability to control and monitor the relay. It is useful for commissioning and local control of the motor.

The module has ten tricolor LED targets (eight programmable) with configurable labels. It also has a graphical LCD with six pushbutton navigation keys and five function keys. Four control pushbuttons are provided for **START**, **STOP**, **LOCAL/REMOTE** selection, and **TARGET RESET**. The main menus consist of the following categories: Meter, Events, Monitor, Targets, Control, Status, and Info.

With the necessary logic credentials, the Info menu provides the ability to change the IP and router addresses. This allows the relay to be quickly connected to the system network without the need of a laptop.

SEL-3422 Motor Relay HMI Module

The SEL-3422 connects to the HMI port on the relay and receives power from the relay. It provides you the ability to control and monitor the relay. It is useful for commissioning and local control of the motor. It has no graphical LCD interface, so monitoring is limited to the target LEDs.

Remote Control Via Communications

The relay supports remote control and monitoring through the use of any of the supported communications. See *Automation* for a list of supported protocols.

Built-In Web Server

Every Ethernet-equipped SEL-849 includes a built-in web server. Interface to the relay with any standard web browser to perform any of the following functions:

- Log on with password protection.
- Safely read, edit, save, and download relay settings.
- Verify relay self-test status and read relay configuration.
- Inspect meter reports.
- Download SER, event history, and event reports from the relay.
- Download motor statistics report, motor start reports, and motor start trend reports.
- Display relay status, including target status, and allow control, including START/STOP control (if authorized) from the control page.
- Download the instruction manual and save it as a PDF file.
- Upload new relay firmware to the relay (firmware upgrade).

Figure 7–Figure 9 show examples of the Fundamental Metering screen, Control screen, and Protection Settings screen.

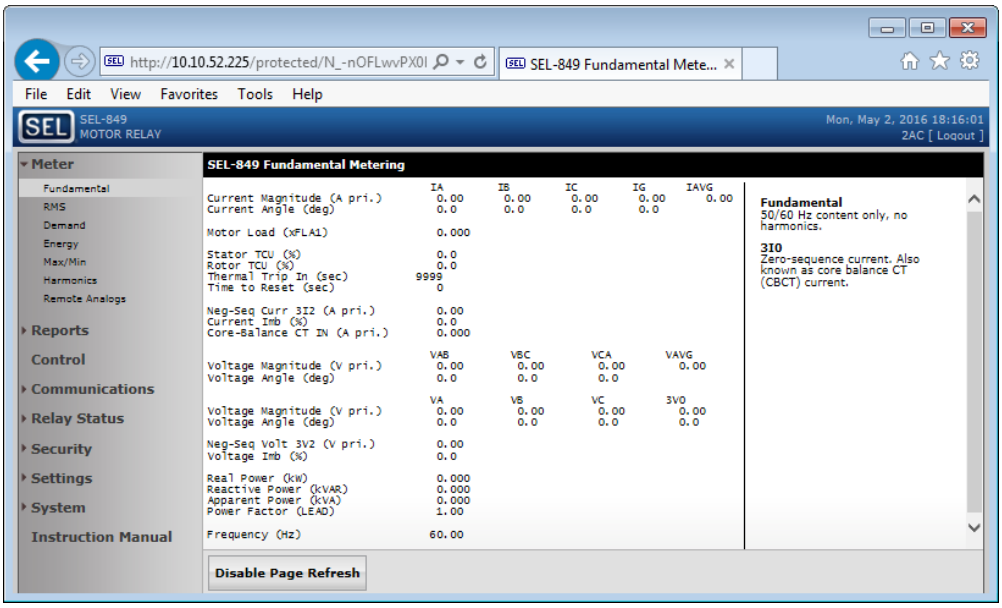


Figure 7 Web Server Fundamental Metering Screen

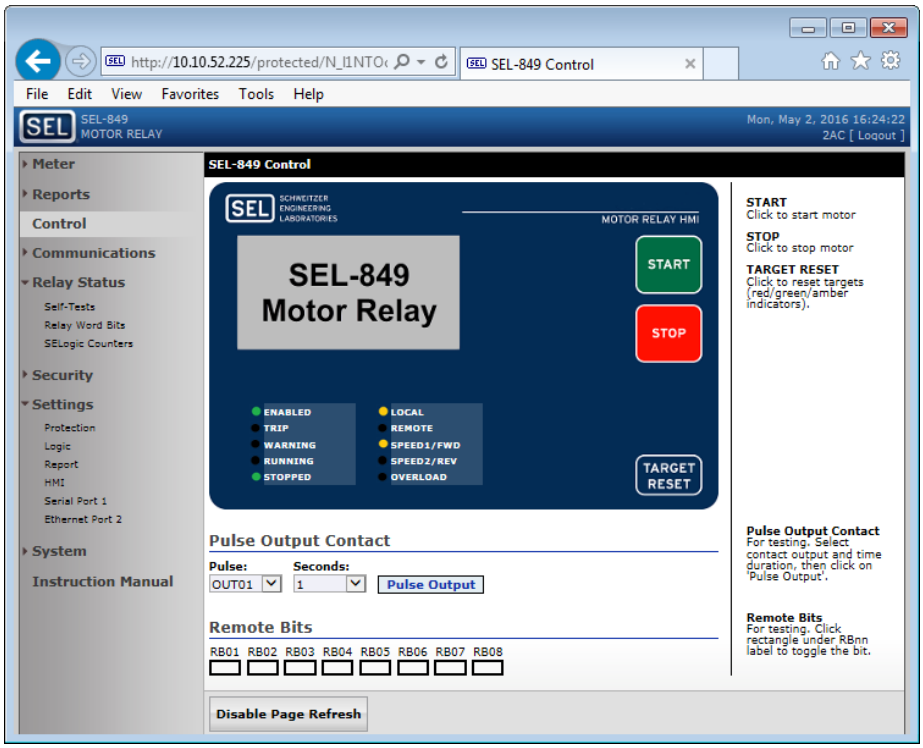


Figure 8 Web Server Control Screen

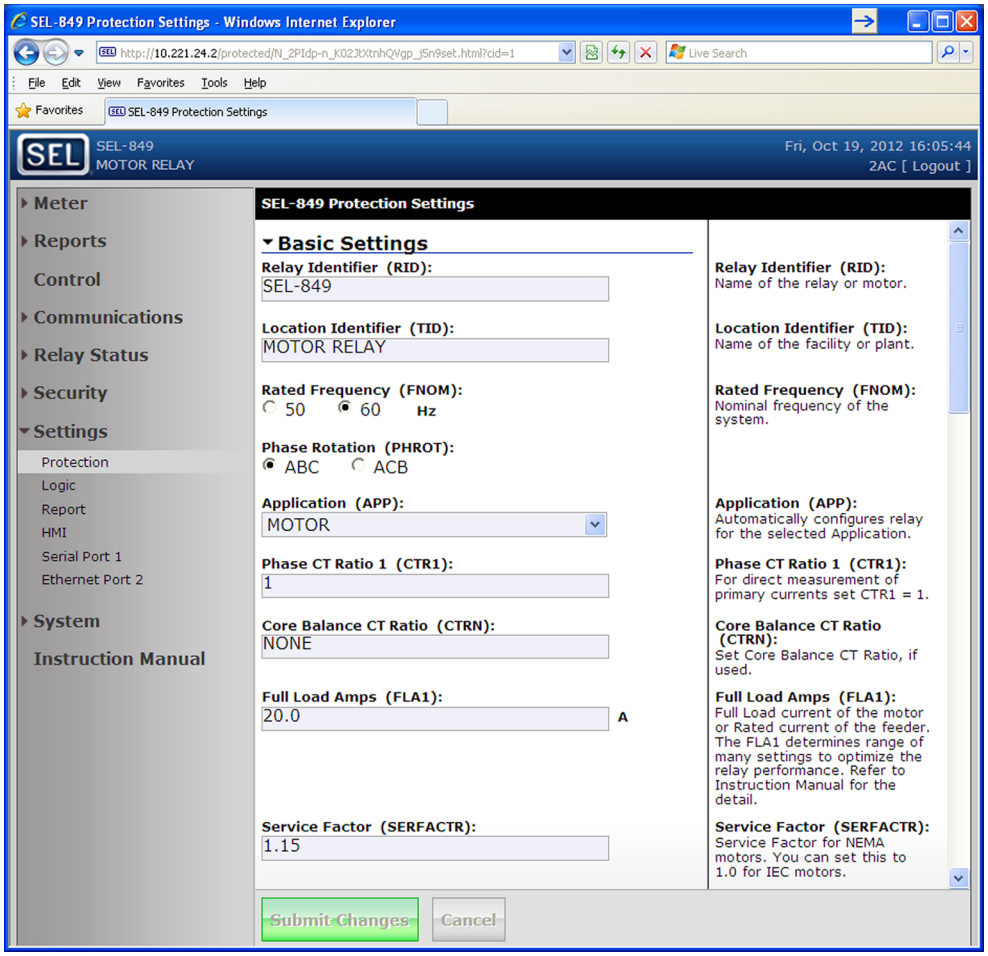


Figure 9 Web Server Protection Settings Screen (Partial)

Relay and Logic Settings Software

ACSELERATOR QuickSet Software simplifies settings and provides analysis support for the SEL-849. With ACSELERATOR QuickSet, you have several ways to create and manage relay settings:

- Develop settings offline with an intelligent settings editor that only allows valid settings.
- Create SELOGIC control equations with a drag-and-drop text editor.
- Configure proper settings through the use of online help.
- Organize settings with the relay database manager.
- Load and retrieve settings through use of a simple PC communications link.

With ACSELERATOR QuickSet, you can use integrated waveform and harmonic analysis to verify settings, analyze events, and analyze power system events.

Use the following features of ACSELERATOR QuickSet to monitor, commission, and test the SEL-849.

- The PC interface remotely retrieves power system data.
- The HMI monitors meter data, Relay Word bits, and output contacts status during testing. The control window allows resetting of metering quantities, start/stop control testing and diagnostics, and other control functions.
- Upgrade firmware through use of the Firmware Loader in the Tools menu.

Applications

Motor Control Centers

A primary application for the SEL-849 is overload and arc-flash protection for motor control centers (MCC). In this application, the SEL-849 operates the contactor, controlling motor start and stop. The SEL-849 receives start/stop commands through the use of IEC 61850, Modbus, contact inputs, or via the remote HMI **START/STOP** pushbuttons.

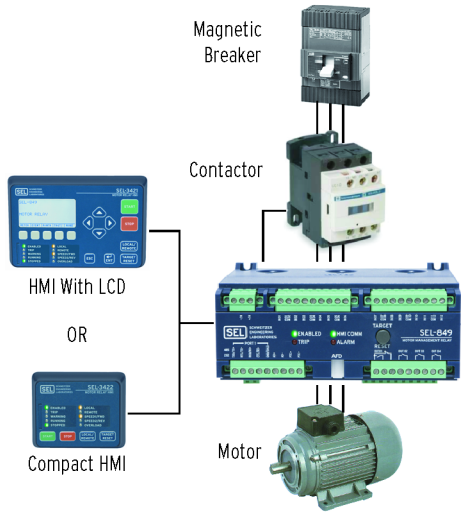


Figure 10 SEL-849 Relay Application in a Motor Control Center (MCC)

Complete Control System Integration

The SEL-849 also provides many of the same functions of a programmable logic controller (PLC). Multiple communications options, a variety of I/O, and programmable SELOGIC control equations make the SEL-849 a complete automation and protection solution.

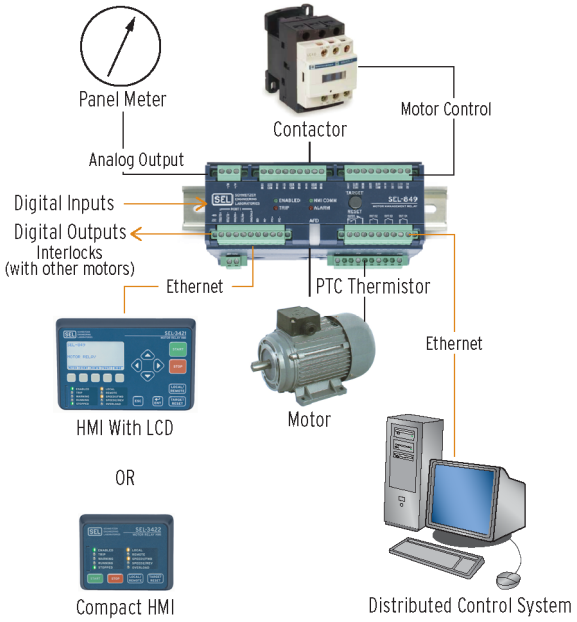
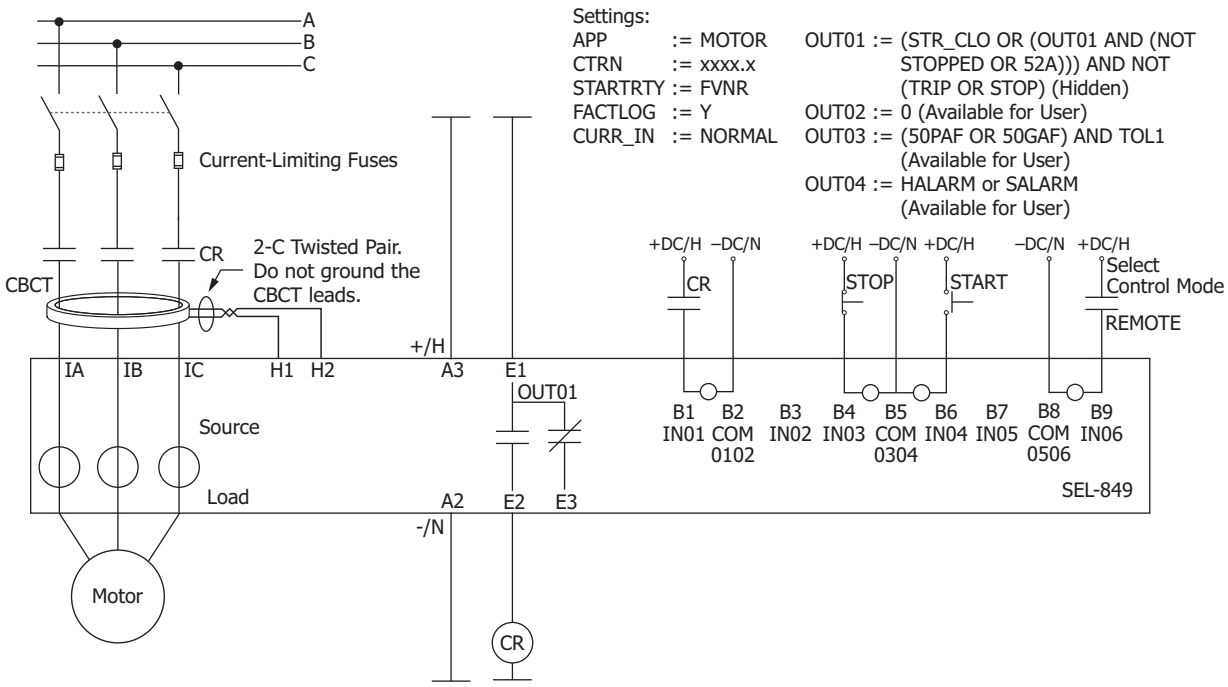


Figure 11 Control System Integration Example

Automatic Starter Sequence Configuration Example



Note: The CBCT input terminals H1–H2 allow you to connect a core-balance current transformer, which measures the ground fault current directly from the three-phase motor conductors and neutral (when used), passing through it.

Note: All contact inputs shown are externally wetted.

Figure 12 Connection Diagram for Factory-Default I/O Assignments Full-Voltage Nonreversing Starter (STARTRTY := FVNR)

Relay Features and Connections

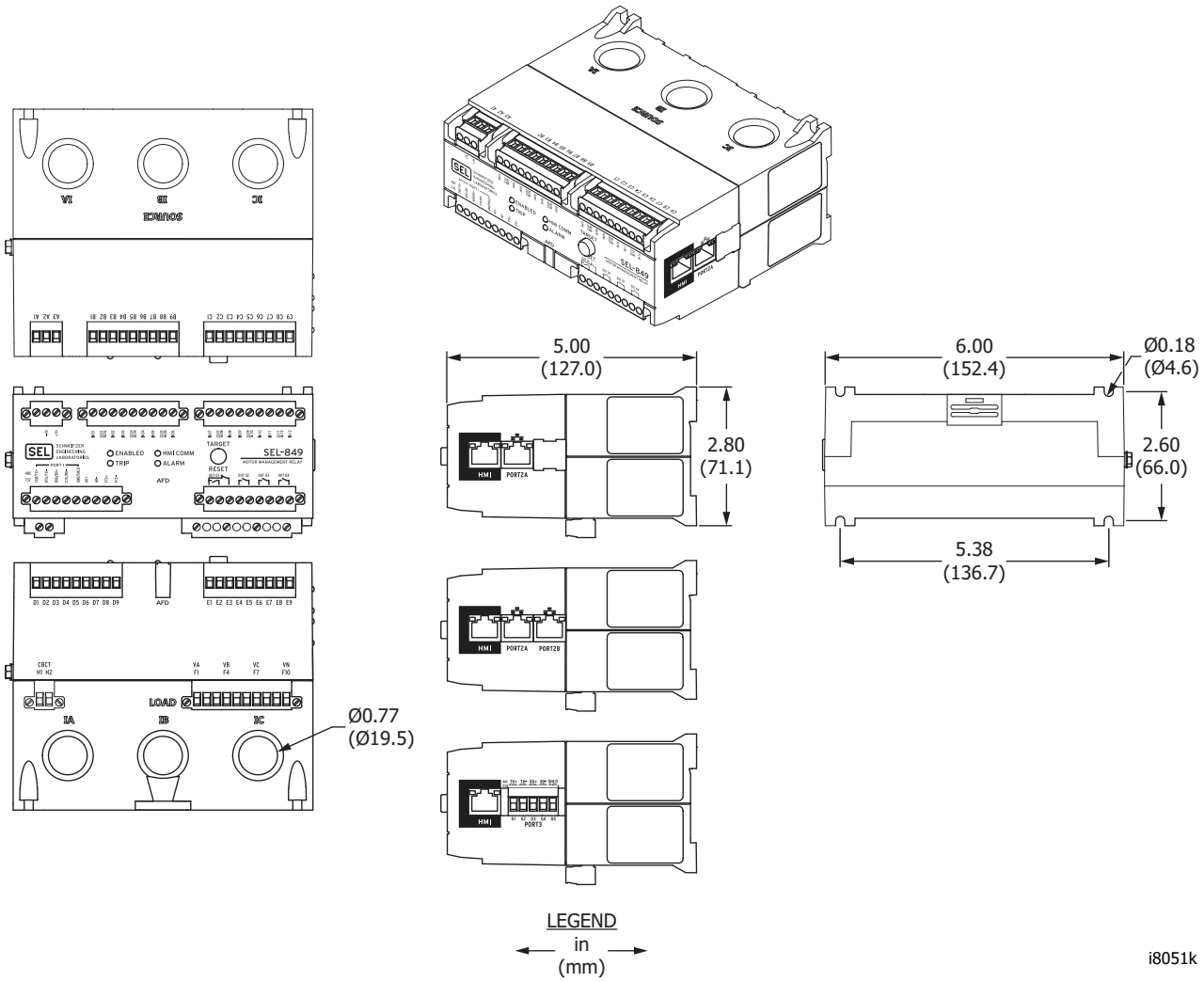


Figure 13 SEL-849 Motor Management Relay Installation Drawings

Motor Relay HMI Installations

Connection

- The RJ45 port on the rear of the SEL-3421/3422 connects to the HMI port on the SEL-849 Relay and receives power from the HMI port.
- Connection to the relay requires an RJ45 Ethernet cable, such as the SEL-C627M, double-shielded, 600 V, MCC-rated, Category 5e Ethernet cable, with a maximum length of 7.62 meters (25 feet).

Gasket Installation for Panel Mounting

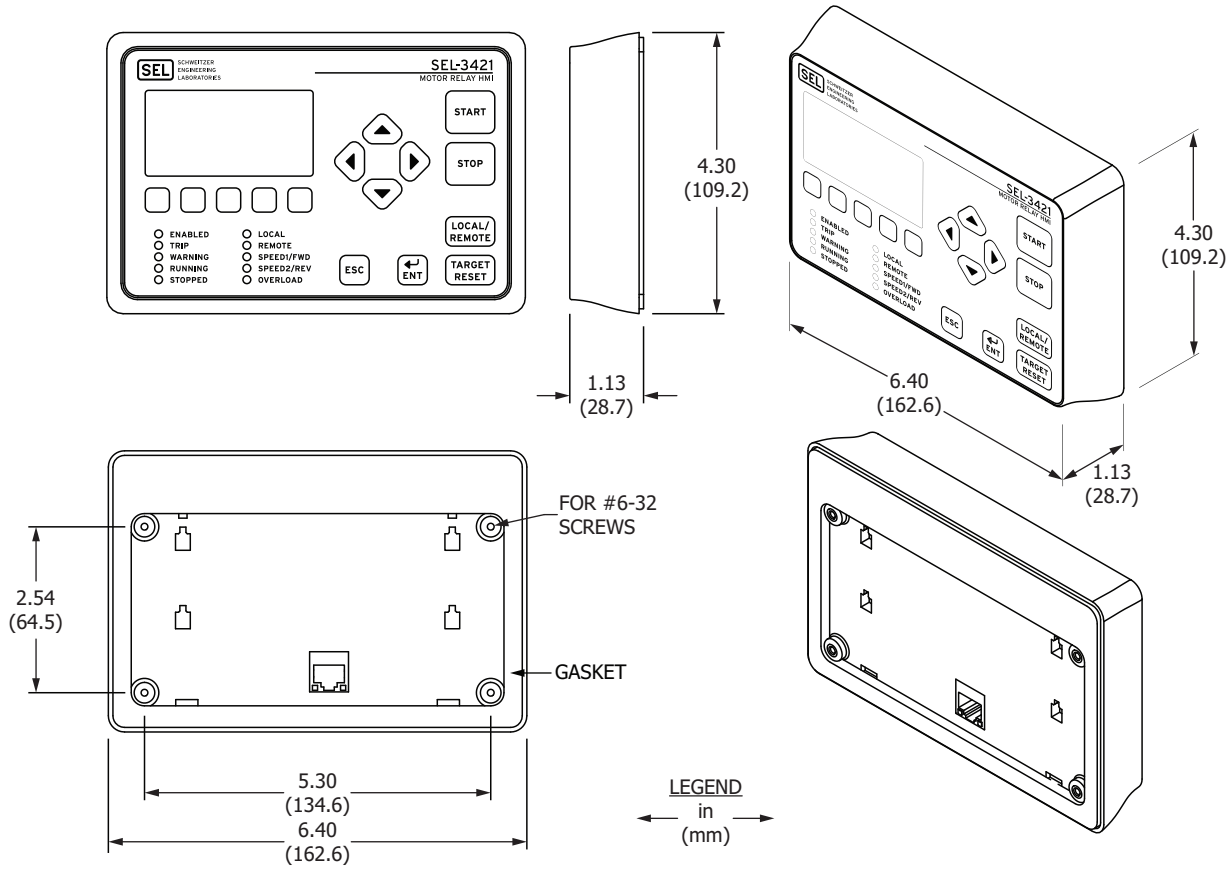
Step 1. Remove the inner rectangular section from the gasket.

Step 2. Peel off the paper to expose the adhesive.

Step 3. Position the gasket, with the adhesive side to the rear of the SEL-3421/3422, so that the gasket is inside the outer edge of the plastic casing and the four screw holes are inside the inner rectangle of the gasket.

Step 4. Press the gasket to the rear of the SEL-3421/3422 to create a seal around the edge of the SEL-3421/3422.

SEL-3421 Dimensions and Mounting Options



Note: To ensure that the electrical connections are completely enclosed, make sure the HMI is mounted with a gasket and that the enclosure has punch holes for the RJ45 connector and the screws.

Note: The SEL-3422 mounting drill templates show the location of the four screw holes (4.49 mm diameter) and the HMI communications port hole (25.4 mm diameter).

Figure 14 SEL-3421 Motor Relay HMI Installation Drawings (Panel Mount)

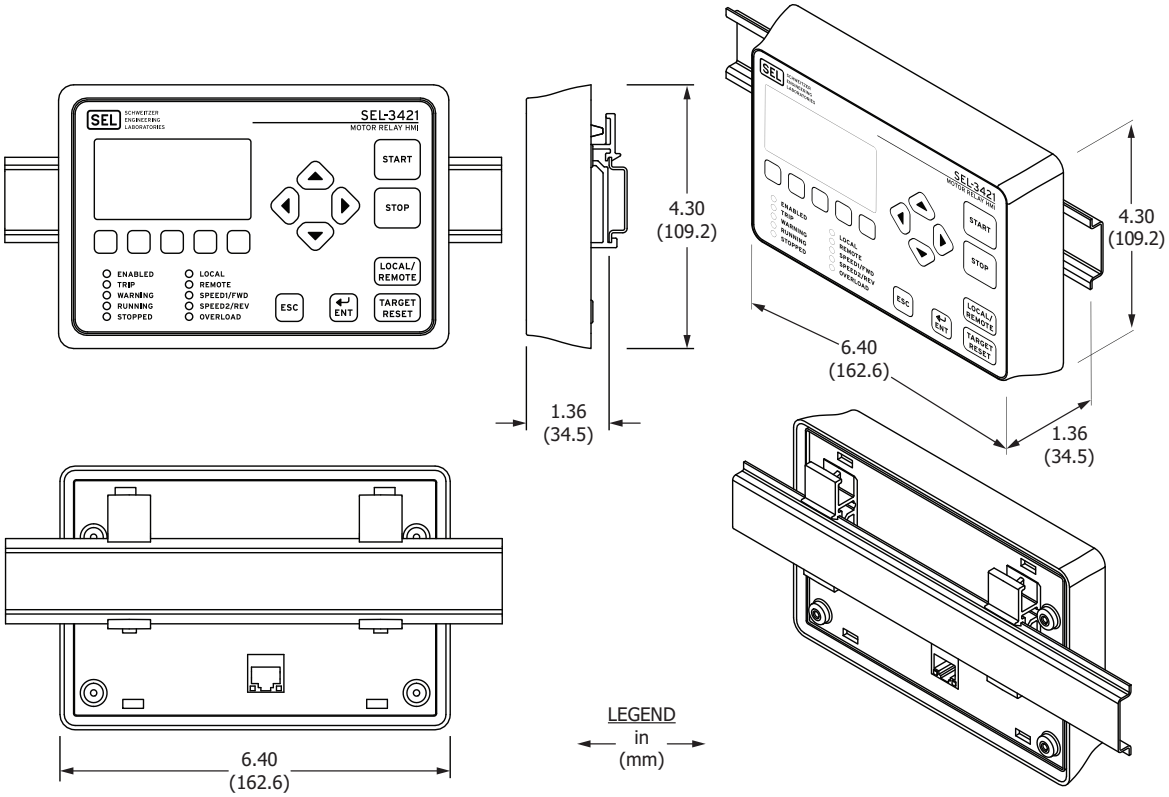
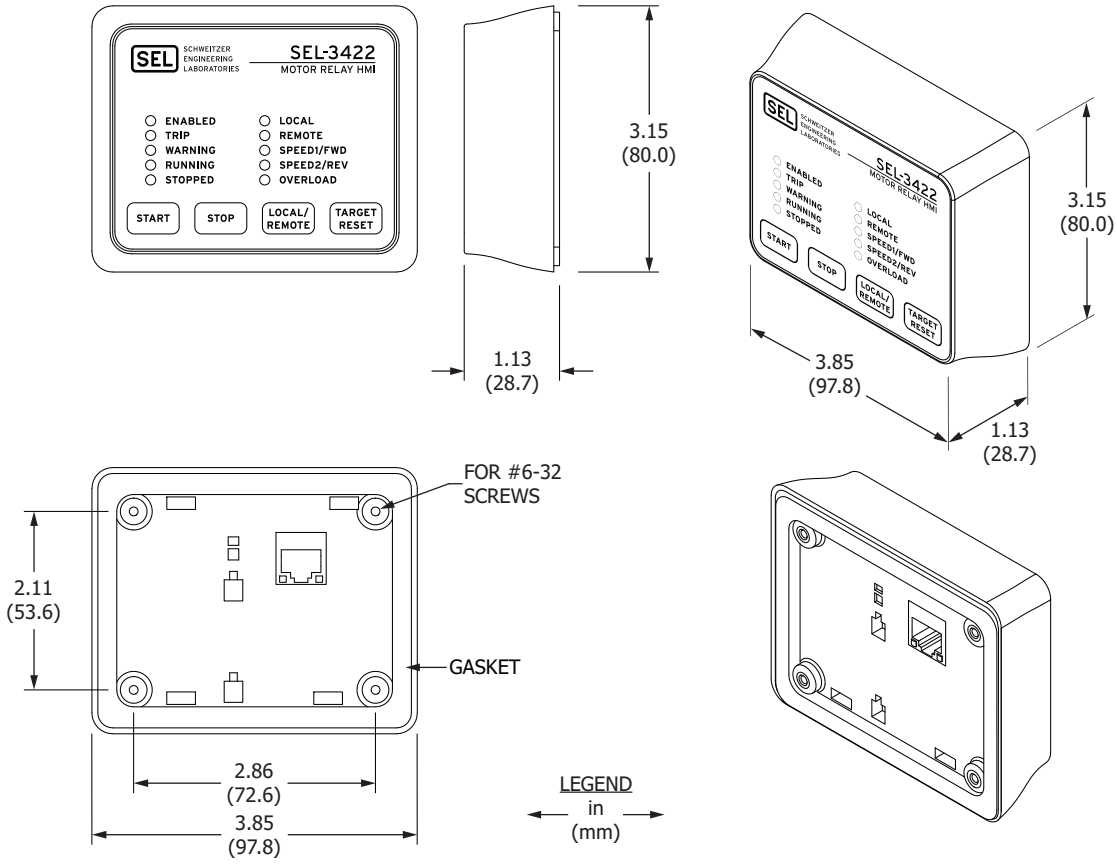


Figure 15 SEL-3421 Motor Relay HMI Installation Drawings (DIN-Rail Mount)

SEL-3422 Dimensions and Mounting Options



Note: To ensure that the electrical connections are completely enclosed, make sure the HMI is mounted with a gasket and that the enclosure has punch holes for the RJ45 connector and the screws.

Note: The SEL-3422 mounting drill templates show the location of the four screw holes (4.49 mm diameter) and the HMI communications port hole (25.4 mm diameter).

Figure 16 SEL-3422 Motor Relay HMI Installation Drawings (Panel Mount)

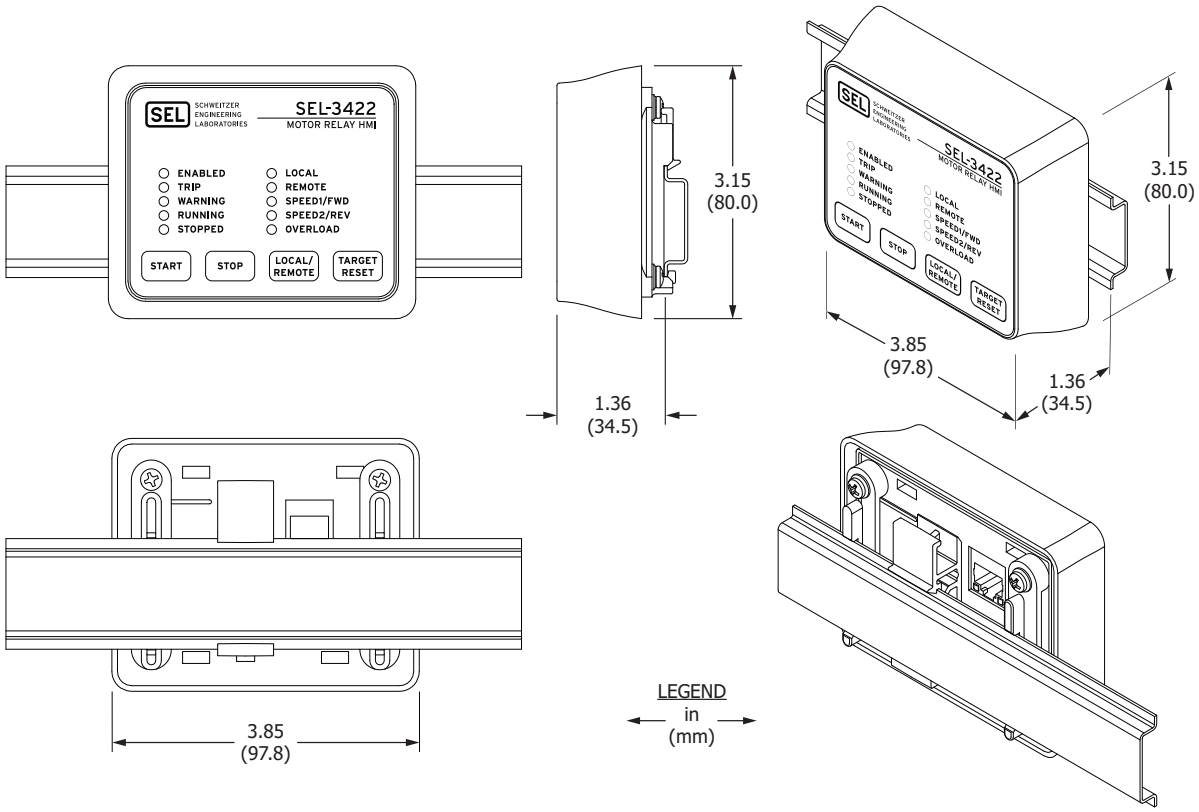


Figure 17 SEL-3422 Motor Relay HMI Installation Drawings (DIN-Rail Mount)

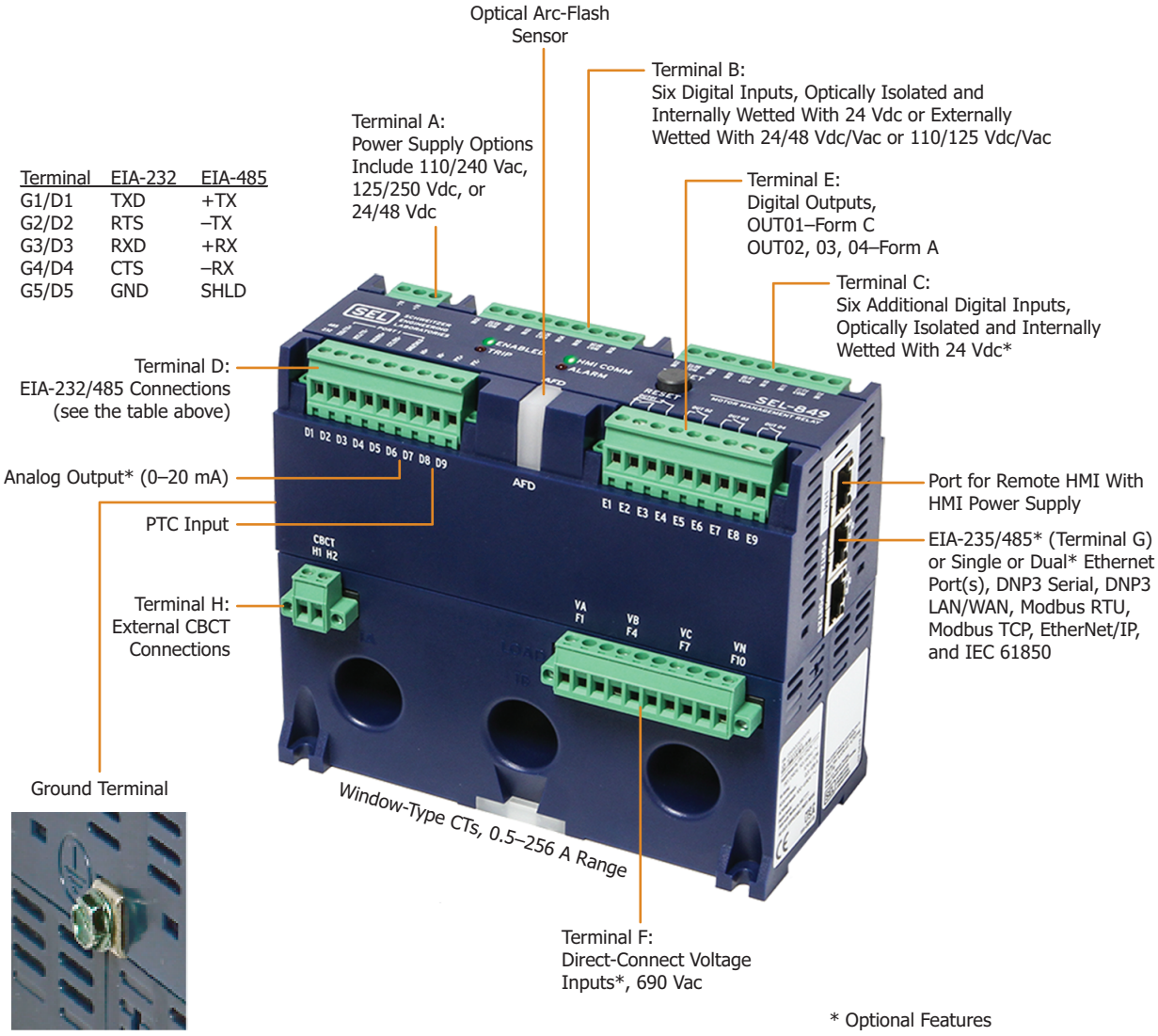


Figure 18 SEL-849 Relay Features and Options

Specifications

Compliance

Designed and manufactured under an ISO 9001 certified quality management system

47 CFR 15B, Class A

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

* UL has not yet developed requirements for products intended to detect and mitigate an arc flash; consequently, UL has not evaluated the performance of this feature. While UL is developing these requirements, it will place no restriction on the use of this product for arc-flash detection and mitigation. For test results performed by an independent laboratory and other information on the performance and verification of this feature, please contact SEL customer service.

UL Listed to U.S. and Canadian safety standards (File E212775, NRGU/7, KDAX, NKCR/7)

CE Mark

RCM Mark

UKCA Mark

Hazardous Locations

UL Listed for Hazardous Locations to U.S. and Canadian standards (File E470448; NRAK/NRAK7)

EU

II 3 G
Ex ec ic nC IIC T4 Gc
SEL 24 ATEX 0001X

IEC 60947-4-1 Type 2 Coordination Compatible. For short circuits, the relay withstands as much as 100 kA.

General

Rogowski Coil-Based AC Current Inputs—Phase

Rated Range:	0.5–256.0 A
Rated Frequency:	50/60 Hz
Burden (Per Phase):	Not applicable

Core-Balance CT Current (IN)

Rated Current Range:	0.010–40.000 mA
Rated Continuous Thermal Current:	1.0 A
1-Second Thermal Current:	10 A
Saturation Current Range:	7–48 mA (actual range will depend on the 50N1P setting)
Burden:	<0.012 VA at 40 mA

AC Voltage Inputs (Line-to-Line)

Rated Operating Voltage (Ue):	100–690 Vac
Rated Continuous Voltage:	800 Vac
10-Second Thermal:	1000 Vac
Rated Frequency:	50/60 Hz
Burden:	<0.2 VA
Input Impedance:	12 M Ω (phase-to-neutral) 12 M Ω (phase-to-phase)

Power Supply

Relay Start-Up Time:	Approximately 5 seconds (after power is applied until ENABLED LED turns on); approximately 2 seconds (after power is applied until ENABLED LED turns on) if Motor Restart feature is enabled and the Relay Word bit RSACTIVE is asserted before the relay powers down.

High-Voltage Supply

Rated Supply Voltage:	110–240 Vac, 50–60 Hz, 125–250 Vdc
Absolute Operating Range (Design Range):	85–264 Vac, 85 –275 Vdc
Power Consumption:	<30 VA (ac) <12 W (dc)
Interruptions:	20 ms minimum

Low-Voltage Supply

Rated Supply Voltage:	24–48 Vdc
Absolute Operating Range (Design Range):	19.2–57.6 Vdc
Power Consumption:	<12 W (dc)
Interruptions:	20 ms minimum

Fuse Ratings

LV Power Supply Fuse

Rating:	2.5 A
Maximum Rated Voltage:	125 Vdc, 125 Vac
Breaking Capacity:	50 A at 125 Vac
Type:	Time-lag T

HV Power Supply Fuse

Rating:	0.5 A
Maximum Rated Voltage:	600 Vac
Breaking Capacity:	75 A at 600 Vac
Type:	Time-lag T

Fuses are not serviceable.

Output Contacts

The relay supports Form A and C outputs.

Dielectric Test Voltages:	2500 Vac
Impulse Withstand Voltage (U_{IMP}):	4700 V
Mechanical Durability:	100,000 no-load operations

Standard Contacts (Electromechanical)

Pickup/Dropout Time:	<8 ms (coil energization to contact closure)

DC Output Ratings

OUT01 (Form C)

Rated Operational Voltage:	250 Vdc
Rated Voltage Range:	19.2–275 Vdc
Rated Insulation Voltage:	300 Vdc
Make:	30 A @ 250 Vdc per IEEE C37.90
Continuous Carry:	6 A @ 70°C 4 A @ 85°C
Thermal:	50 A for 1 s
Contact Protection:	385 Vdc, 9.6 J MOV protection across open contacts

Breaking Capacity (10,000 Operations) per IEC 60255-0-20:1974:

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

Cyclic (2.5 Cycles/Second) per IEC 60255-0-20:1974:

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

OUT02, 03, 04 (Form A)

Rated Operational Voltage:	30 Vdc
Rated Voltage Range:	19.2–275 Vdc
Rated Insulation Voltage:	300 Vdc
Make:	5 A @ 30 Vdc
Continuous Carry:	4 A @ 70°C 3 A @ 85°C
Thermal:	25 A for 1 s
Contact Protection:	385 Vdc, 9.6 J MOV protection across open contacts

Breaking Capacity (10,000 Operations) per IEC 60255-0-20:1974:

24 Vdc	0.2 A	L/R = 40 ms
48 Vdc	0.15 A	L/R = 40 ms
125 Vdc	0.1 A	L/R = 40 ms
250 Vdc	0.05 A	L/R = 40 ms

Cyclic (2.5 Cycles/Second) per IEC 60255-0-20:1974:

24 Vdc	0.2 A	L/R = 40 ms
48 Vdc	0.15 A	L/R = 40 ms
125 Vdc	0.1 A	L/R = 40 ms
250 Vdc	0.05 A	L/R = 40 ms

AC Output Ratings

Maximum Operational Voltage (U_e) Rating:	277 Vac
Insulation Voltage (U_i) Rating (excluding EN 61010-1):	300 Vac
1-Second Thermal:	50 A
Contact Rating Designation:	B300

B300 (5 A Thermal Current, 300 Vac Max)			
	Maximum Current		Max VA
Voltage	120 Vac	240 Vac	—
Make	30 A	15 A	3600
Break	3 A	1.5 A	360
PF < 0.35, 50–60 Hz			

Utilization Category: AC-15

AC-15		
Operational Voltage (Ue)	120 Vac	240 Vac
Operational Current (Ie)	3 A	1.5 A
Make Current	30 A	15 A
Break Current	3 A	1.5 A
Electromagnetic loads > 72 VA, PF < 0.3, 50–60 Hz		

Voltage Protection Across Open Contacts: 300 Vac, 9.6 J

Optoisolated Control Inputs (Internally Wetted to 24 Vdc)

Current Draw at Nominal dc Voltage:	2 mA (at 24 V)
Rated Impulse Withstand Voltage (U_{imp}):	4000 V
Pickup Time:	<60 ms
Dropout Time:	<40 ms

Optoisolated Control Inputs (Externally Wetted to 24/48 Vdc/Vac or 110/125 Vdc/Vac)

Minimum Current Draw:	1.5 mA
Rated Impulse Withstand Voltage (U_{imp}):	4000 V
Pickup Time:	<60 ms
Dropout Time:	<40 ms

When Used With DC Control Signals:

110/125 Vdc:	ON between 95 and 156.2 Vdc OFF below 70 Vdc
24/48 Vdc:	ON between 19.2 and 60 Vdc OFF below 14.4 Vdc

When Used With AC Control Signals:

110/125 Vac:	ON between 95 and 137.5 Vac OFF below 66 Vac
24/48 Vac:	ON between 19.2 and 60 Vac OFF below 14.4 Vac

Analog Output (Optional)

Current:	0–20 mA
Load at 20 mA:	0–300 ohms
Refresh Rate:	25 ms
% Error, Full Scale, at 25°C:	±1%
Select From:	Analog quantities available in the relay

Frequency and Phase Rotation

System Frequency:	50, 60 Hz
Phase Rotation:	ABC, ACB
Frequency Tracking:	12.5–72.5 Hz

Time-Code Input

Simple Network Time Protocol (SNTP) Accuracy

Internal Clock:	±5 ms
Unsynchronized Clock Drift Relay Powered:	10 minutes per year, typically

Communications Ports

EIA-232 (as many as 2 Ports)

Data Speed:	300–57600 bps

EIA-485 Port (as many as 2 Ports)

Data Speed:	300–57600 bps

Ethernet Port

Single/Dual, 10/100BASE-T copper (RJ45 connector)

Communications Protocols

SEL, Modbus RTU and TCP/IP, FTP, Telnet, EtherNet/IP, SNTP, DNP3 serial, DNP3 LAN/WAN, PRP, HTTP, HTTPS, IEC 61850 Edition 1 (optional)

Operating Temperature

SEL-849 Motor Relay/ 3422 Motor Relay HMI:	–40° to +85°C (–40° to +185°F)
SEL-3421 Motor Relay HMI:	–20° to +70°C (–4° to +158°F)

Note: The front-panel display is impaired for temperatures below –20° and above 70°C.

Not applicable to UL or ATEX hazardous locations applications

Operating Environment

Insulation Class:	1
Pollution Degree:	3
Overvoltage Category:	II
Atmospheric Pressure:	80–110 kPa
Relative Humidity:	5%–95%, noncondensing
Maximum Altitude Without Derating (Consult Factory for Higher Altitude Derating):	2000 m

Dimensions

71.1 mm (2.8 in) x 127.0 mm (5 in) x 152.4 mm (6 in)

Weight

1.0 kg (2.2 lb)

Terminal Connections

Compression Plug Tightening Torque

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

Compression Plug Mounting Ear Screw Tightening Torque

Minimum:	0.225 Nm (1.6 in-lb)
Maximum:	0.25 Nm (2.2 in-lb)

Product Standards

Electromagnetic Compatibility:	IEC 60255-26:2013
General Safety:	IEC 60255-27:2013
Hazardous Locations Standards:	UL 121201, Ninth Edition CSA C22.2 No. 213-17 EN 60079-0:2018/A11:2024 EN 60079-7:2015/A1:2018/A11:2024 EN 60079-11:2012 EN 60079-15:2019

Type Tests

Environmental Tests

Enclosure Protection:	IEC 60529:2001 + CRDG:2003 IP20 for SEL-849 IP65 for SEL-3421/3422
Vibration Resistance:	IEC 60255-21-1:1998 IEC 60255-27:2013; Section 10.6.2.1
Endurance:	Class 2 (panel mounted only) Class 1 (DIN-rail mounted only)
Response:	Class 2
Shock Resistance:	IEC 60255-21-2:1998 IEC 60255-27:2013; Section 10.6.2.2 IEC 60255-27:2013; Section 10.6.2.3
Withstand:	Class 1
Response:	Class 2
Bump:	Class 1
Seismic (Quake):	IEC 60255-21-3:1993 IEC 60255-27:2013; Section 10.6.2.4
Response:	Class 2
Cold:	IEC 60068-2-1:2007 IEC 60255-27:2013; Section 10.6.1.2 IEC 60255-27:2013; Section 10.6.1.4 –40°C, 16 hours
Dry Heat:	IEC 60068-2-2:2007 IEC 60255-27:2013; Section 10.6.1.1 IEC 60255-27:2013; Section 10.6.1.3 85°C, 16 hours
Damp Heat, Steady State:	IEC 60068-2-78:2001 IEC 60255-27:2013; Section 10.6.1.5 40°C, 93% relative humidity, 10 days
Damp Heat, Cyclic:	IEC 60068-2-30:2001 IEC 60255-27:2013: Section 10.6.1.6 25–55°C, 6 cycles, 95% relative humidity

Dielectric Strength and Impulse Tests

Dielectric (HiPot):	IEC 60255-27:2013; Section 10.6.4.3 IEEE C37.90-2005 2.5 kVac on current inputs, ac voltage inputs, and contact outputs 1.5 kVdc on PTC input and analog output 2.83 kVdc on power supply, contact inputs
Impulse:	IEC 60255-27:2013; Section 10.6.4.2 0.5 J, 5.0 kV on power supply, contact I/O, ac current, and voltage inputs 0.5 J, 2 kV on PTC input, analog output, serial port, and Ethernet port

RFI and Interference Tests

EMC Immunity

Electrostatic Discharge Immunity:	IEC 61000-4-2:2008 IEC 60255-26:2013; Section 7.2.3 Severity Level 3 6 kV contact discharge 8 kV air discharge
Radiated RF Immunity:	IEC 61000-4-3:2010 IEC 60255-26:2013; Section 7.2.4 10 V/m IEEE C37.90.2:2004 20 V/m
Fast Transient, Burst Immunity:	IEC 61000-4-4:2012 IEC 60255-26:2013; Section 7.2.5 4 kV @ 5.0 kHz 2 kV @ 5.0 kHz for comm. ports
Surge Immunity:	IEC 61000-4-5:2005 IEC 60255-26:2013; Section 7.2.7 1 kV line-to-line 2 kV line-to-earth
Surge Withstand Capability Immunity:	IEC 61000-4-18:2010 IEC 60255-26:2013; Section 7.2.6 2.5 kV common mode 1 kV differential mode 1 kV common mode on comm. ports IEEE C37.90.1:2012 2.5 kV oscillatory 4 kV fast transient
Conducted RF Immunity:	IEC 61000-4-6:2008 IEC 60255-26:2013; Section 7.2.8 10 Vrms
Magnetic Field Immunity:	IEC 61000-4-8:2009 IEC 60255-26:2013; Section 7.2.10 Severity Level 5 Class B 1000 A/m for 3 seconds 300 A/m for 1 minute IEC 61000-4-8:2009 IEC 60255-26:2013; Section 7.2.10 Severity Level 4 Class A 300 A/m for 3 seconds 30 A/m for 1 minute No binary input filtering IEC 61000-4-9:2001 300 A/m IEC 61000-4-10:2001 100 A/m (100 kHz and 1 Mhz)
Power Supply Immunity:	IEC 61000-4-11:2004 IEC 61000-4-17:1999 IEC 61000-4-29:2000 IEC 60255-26:2013; Section 7.2.11 IEC 60255-26:2013; Section 7.2.12 IEC 60255-26:2013; Section 7.2.13

EMC Emissions

Conducted Emissions:	IEC 60255-26:2013 Class A FCC 47 CFR Part 15.107 Class A CAN ICES-001(A) / NMB-001(A) EN 55011:2009 + A1:2010 Class A EN 55022:2010 + AC:2011 Class A EN 55032:2012 + AC:2013 Class A CISPR 11:2009 + A1:2010 Class A CISPR 22:2008 Class A CISPR 32:2015 Class A
Radiated Emissions:	IEC 60255-26:2013 Class A FCC 47 CFR Part 15.109 Class A CAN ICES-001(A) / NMB-001(A) EN 55011:2009 + A1:2010 Class A EN 55022:2010 + AC:2011 Class A EN 55032:2012 + AC:2013 Class A CISPR 11:2009 + A1:2010 Class A CISPR 22:2008 Class A CISPR 32:2015 Class A

Processing Specifications and Oscillography

AC Voltage and Current Inputs:	32 samples per power system cycle
Frequency Tracking Range:	12.5–72.5 Hz
Digital Filtering:	One-cycle cosine after low-pass analog filtering Net filtering (analog plus digital) rejects dc and all harmonics greater than the fundamental
Protection and Control Processing:	Four times per power system cycle (except for math variables and analog quantities which are processed every 25 ms)

Oscillography

Length:	15, 60, or 120 cycles
Sampling Rate:	1, 2, or 4 kHz sampling rate for raw (unfiltered) data and 4 samples per cycle for filtered data
Trigger:	Programmable with Boolean expression
Format:	ASCII and Compressed ASCII for filtered and unfiltered data and files in binary COMTRADE format (ANSI C37.111-1999) for raw data
Time-Stamp Resolution:	1 ms
Time-Stamp Accuracy:	±5 ms

Sequential Events Recorder

Time-Stamp Resolution:	1 ms
Time-Stamp Accuracy (With Respect to Time Source):	±5 ms

Relay Elements

Thermal Overload (49)

Full-Load Current (FLA) Limits:	0.5–256.0 A
Locked Rotor Current:	2.5–10.0 • FLA (if FLA ≤ 128 A) 2.5–6.0 • FLA (if FLA > 128 A)
Locked Rotor Time:	1–600 seconds
Overload Pickup:	1.01–1.50 • FLA
Accuracy:	5% ±25 ms at multiples of FLA > 2 (cold inverse curves)

PTC Overtemperature (49)

Type of Control Unit:	IEC34-11-2 Mark A
Max. Number of Thermistors:	6 in a series connection
Max. Cold Resistance:	1500 ohms
Trip Resistance:	3400 ±150 ohms
Reset Resistance:	1500–1650 ohms
Short-Circuit Trip Resistance:	25 ohms ±10 ohms

Undercurrent (Load Loss) (37)

Setting Range:	Off, 0.20–1.00 • FLA
Accuracy:	±5% of setting ±0.1 A
Maximum Pickup/Dropout Time:	1.5 cycles

Current Unbalance and Phase Loss (46)

Setting Range:	Off, 5%–80%
Accuracy:	±10% of setting
Maximum Pickup/Dropout Time:	1.5 cycles

Overcurrent (Load Jam) (48)

Setting Range:	Off, 1.00–6.00 • FLA
Accuracy:	±5% of setting
Maximum Pickup/Dropout Time:	1.5 cycles

Short Circuit (50P)[a]

Setting Range:	Off, 0.5–1280.0 A
Accuracy:	±5% of setting ±0.01 A
Maximum Pickup/Dropout Time:	1.5 cycles

Ground (Residual, 50G)[a]

Setting Range:	Off, 0.5–1280.0 A
Accuracy:	±5% of setting ±0.01 A
Maximum Pickup/Dropout Time:	1.5 cycles

Ground (Core-Balance, 50N)[a]

Setting Range:	Off, 0.010–40.000 mA
Accuracy:	±5% of setting ±0.005 mA
Maximum Pickup/Dropout Time:	1.5 cycles

Arc-Flash Instantaneous Overcurrent (50PAF)

Setting Range:	Off, 0.5–1280.0 A
Accuracy:	±5% of setting ±0.01 A
Typical Pickup/Dropout Time:	4 ms/1 cycle

(Does not include contact pickup time of 8 ms [maximum].)

Arc-Flash Instantaneous Overcurrent (50GAF)

Setting Range:	Off, 0.15–320.0 A
Accuracy:	±5% of setting ±0.01 A
Typical Pickup/Dropout Time:	4 ms/1 cycle

(Does not include contact pickup time of 8 ms (maximum).)

Negative-Sequence Overcurrent (50Q)[a]

Setting Range:	Off, 0.5–1280.0 A
Accuracy:	±5% of setting ±0.01 A
Maximum Pickup/Dropout Time:	1.5 cycles

Inverse-Time Overcurrent (51P, 51Q)[a]

Setting Range:	Off, 0.5–512.0 A
Accuracy:	±5% of setting ±0.1 A
Time Dial:	
U.S.:	0.50–15.00, 0.01 steps
IEC:	0.05–1.00, 0.01 steps
Accuracy:	±1.5 cycles, ±4% between 2 and 30 multiples of pickup (within the range of current measurement, see the current measurement table in *Metering* on page 26)

Inverse-Time Overcurrent (51G)[a]

Setting Range:	Off, 0.5–512.0 A
Accuracy:	±5% of setting ±0.01 A
Time Dial	
U.S.:	0.50–15.00, 0.01 steps
IEC:	0.05–1.00, 0.01 steps
Accuracy:	±1.5 cycles, ±4% between 2 and 30 multiples of pickup (within the range of current measurement, see the current measurement table in *Metering* on page 26)

Inverse-Time Overcurrent (51N)[a]

Setting Range:	Off, 0.010–4.800 mA
Accuracy:	±5% of setting ±0.005 mA
Time Dial	
U.S.:	0.50–15.00, 0.01 steps
IEC:	0.05–1.00, 0.01 steps
Accuracy:	±1.5 cycles, ±4% between 2 and 30 multiples of pickup (within rated range of current)

Phase-to-Phase Undervoltage (27)

Setting Range:	Off, 5.0–800.0 V
Accuracy:	±2% (±5% for transient) of setting ±2 V
Maximum Pickup/Dropout Time:	1.5 cycles

Phase-to-Phase Overvoltage (59)

Setting Range:	Off, 5.0–800.0 V
Accuracy:	±2% (±5% for transient) of setting ±2 V
Maximum Pickup/Dropout Time:	1.5 cycles

Harmonic Blocking

Pickup Range (% of Fundamental):	5.0%–100%, 1% steps
Pickup Accuracy:	±2.5 percentage points
Time Delay Range:	0.00–120.00 seconds, 0.01 second steps
Time Delay Accuracy:	±0.5% of setting plus ±0.25 cycle

Directional Power (32, 37)

Setting Range:	Off, 20.0%–200.0% VA (VA = 1.732 • VNOM • FLA1)
Accuracy:	±3% of setting ±5 VA
Pickup Types:	+WATTS, –WATTS, +VARS, –VARS
Maximum Pickup/Dropout Time:	10 cycles

Power Factor (55)

Setting Range:	Off, 0.05–0.99
Accuracy:	±5% of full scale for current > 0.2 • FLA at 120 V
Maximum Pickup/Dropout Time:	10 cycles

Phase Reversal (47)

No Settings, Except ENABLE	
Pickup Time:	Approximately 0.5 s

Frequency (81)

Setting Range:	Off, 15.00–70.00 Hz
Accuracy:	±0.01 Hz
Maximum Pickup/Dropout Time:	4 cycles

Timers

Setting Range:	Various
Accuracy:	±0.5% of setting ±1/4 cycle

Metering

Accuracies are specified at 20°C, 50 or 60 Hz nominal frequency (for VFD applications RMS accuracies apply), ac currents within the range shown in the following table, and ac voltages within 40–800 V unless otherwise noted.

Current Measurement Ranges Versus FLA[a]

FLA	Current Measurement Range
0.5–3.9 A	0.2 –74 A
4.0–15.9 A	0.8–295 A
16.0–47.9 A	3.2–1,178 A
48.0–256.0 A	6.4–2,357 A

[a] For the purpose of measurement accuracies

Phase Currents:	Magnitude ±1% of reading ±0.01 A; phase ±3°
IN (Core-Balance Ground Current):	Magnitude ±2%, ±0.005 mA
Average Current:	±2% of reading ±0.01 A
Average Motor Load:	(xFLA): ±2% of reading ±0.01 A
Current Unbalance (%):	±2% of reading or ±1% of full scale
IG (Residual Ground Current):	Magnitude ±2% of reading ±0.01 A; phase ±3°
3I2 Negative-Sequence Current:	±3% of reading ±0.01 A;
System Frequency:	±0.01 Hz of reading for frequencies within 12.5–72.5 Hz (V1 > 60 V)
Thermal Capacity:	±3% of TCU
Time to Trip:	±5% or ±1 second
Line-to-Line Voltages:	Magnitude ±1% of reading, phase ±3°
3-Phase Average Line-to-Line Voltage:	±2% of reading
Line-to-Ground Voltages:	Magnitude ±1% of reading, phase ±3°
3-Phase Average Line-to-Ground Voltages:	±2% of reading
Voltage Unbalance (%):	±2% of reading
3V2 Negative-Sequence Voltage:	Magnitude ±3% of reading
Real Power (kW):	±5% of reading for 0.10 < pf < 1.00
Reactive Power (kVAR):	±5% of reading for 0.00 < pf < 0.95
Apparent 3-Phase Power (kVA):	±2% of reading
Power Factor:	±2% of reading for 0.97 ≤ pf ≤ 1
PTC Temperatures:	±2°C

RMS Metering Accuracies

Phase and Residual (IG) Currents:	±2% of reading ±0.01 A; for current range 0.2 • FLA to 15 • FLA A (includes fundamental through 15th harmonic)
IN (Core-Balance Ground Current):	±2% of reading ±0.005 mA[a]
Voltages:	±2% of reading (includes fundamental through 15th harmonic)
Harmonic and THD Metering:	Range 0%–100%
Accuracy:	±5% of full scale

[a] Actual setting ranges will be restrictive depending on the FLA setting.

Technical Support

We appreciate your interest in SEL products and services. If you have questions or comments, please contact us at:

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