SEL-2240 Axion Bay Controller

Comprehensive Monitoring and Reliable Control for All Your Bay Control Applications

The SEL-2240 Axion Bay Controller combines modular I/O cards, advanced automation, a powerful logic engine, current and voltage measurement, a flexible color touchscreen HMI, and advanced communications protocols to provide comprehensive monitoring and reliable control for your bay control application. Choose from a variety of digital and analog modules to fit your application requirements. The advanced automation capability, combined with the diversity and flexibility of I/O modules, allows you to implement any blocking or interlocking scheme required by the switching devices in your substation. Use the Axion Controller as an economical yet powerful solution for monitoring and controlling one or more substation bays at the transmission or distribution level. Configure custom screens by using the Bay Screen Builder application in ACSELERATOR RTAC.

Major Features and Benefits

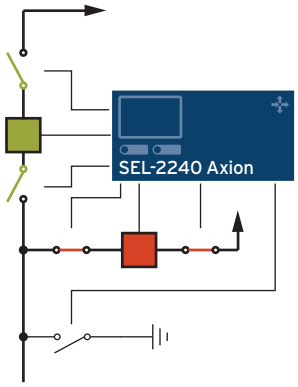
- **Switch Position Monitoring.** Monitor as many as four position states (open, close, alarm, and in-progress) of two-position switches, and as many as eight position states of three-position switches. Monitor as many switches as your application requires. Measure switch position directly by using digital input signals or indirectly by using other devices via communications protocols (e.g., IEC 61850).
- **Interlocking Control Logic.** Use the powerful IEC 61131-3 logic to program complex automation functions, interlocking schemes, or bypass logic. Create innovative logic solutions directly in ACSELERATOR RTAC by using any of the following editor tools: Tag Processor, Structured Text, Ladder Logic, or Continuous Function Chart.
- **Monitor and Control of Substation Equipment in Local or Remote Mode.** Perform local and remote control and monitoring of circuit breakers, disconnect switches, shunt reactors, and capacitor banks. The local touchscreen display makes the local control quick and efficient. Perform remote control and monitoring by using a variety of industry-standard protocols, such as IEC 61850, DNP3, Modbus, MIRRORED BITS communications, and IEC 60870-101/103/104.

- **Synchronism Check.** Use the SynchronismCheck function block to verify that the voltages on both sides of the breaker are within allowed phase and magnitude. The SynchronismCheck function block compensates for circuit breaker close time. Use selectable voltage sources as inputs for the synchronism check on each breaker.
- **Design Custom Screens to Meet Your System Needs.** Design bay screens, monitor screens, or meter screens by launching ACSELERATOR® Bay Screen Builder SEL-5036 Software for Axion Bay Controller. Display the bay configuration as a single-line diagram (SLD) on the touchscreen. Use ANSI and IEC symbols, along with analog and digital labels, for the SLD to indicate the status of breaker and disconnect switches, bus voltages, and power flow through the breaker. In addition to SLDs, design custom screens to show the status of any digital or analog tag of the RTAC logic. Design these custom screens with the help of ACSELERATOR Bay Screen Builder in conjunction with ACSELERATOR RTAC. You can create as many as 25 custom screens.
- **Programmable Pushbuttons and LED Status Indication.** Program six pushbuttons to quickly perform custom control commands. Each pushbutton (located on the Axion Bay Controller front panel) includes two programmable tricolor LEDs. Seven general-purpose tricolor LEDs are available for alarms or any other local indication. Use IEC 61131-3 logic to program custom operator control and LED status functions.
- **Control Multiple Bays.** Control and monitor circuit breakers, disconnect switches, and earthing switches for multiple bays with a single SEL-2240 Axion Bay Controller system.
- **Flexible I/O Selections for Your Application.** Include hundreds of digital and analog I/O points in a single panel.
- **Distributed I/O.** Improve safety and reduce copper conductor and installation time by installing the remote Axion ac analog input modules and digital I/O modules in the substation yard, near the circuit breaker, and control the breakers and monitor current, voltages, and status of contact points from the substation control building.
- **Deterministic I/O Performance.** Update connected I/O at a deterministic processing interval; all inputs provide 1 ms SER time stamps.
- **Redundant Power Supplies for Maximum Availability.** Apply redundant power support with two load-sharing SEL-2243 power couplers for applications requiring two independent power sources.
- **Synchronized Current and Voltage Measurements.** Retrieve high-accuracy current and voltage measurements with the advantage of synchronized measurements. Multiple AC Analog Input modules in an Axion system sample all measurements at the same time to ensure a common reference for all voltages and currents. This enables many time-deterministic control applications without performing additional processing to align the measurements to a reference. Use this capability to accomplish complex control schemes including load shedding, microgrid control, and synchronism check.
- **Create Historic Data Logs.** Leverage the Dynamic Disturbance Recording (DDR) library to continuously record fundamental, rms, synchrophasor quantities, or I/O status data.
- **Sensor Integration.** Use the SEL-2245-22 DC Analog Input modules to integrate gas pressure, oil level, tap position sensor, or any other voltage (–10 to +10 Vdc) or current (–20 mA to +20 mA) sensor. Use the SEL-2600 Resistance Temperature Detector (RTD) Module to integrate RTD sensors. Sensors can also be integrated via communications protocols.
- **Low-Energy Analog (LEA) Inputs.** Eliminate outage costs by using the SEL-2245-221 Low Voltage Monitoring Input module to connect external split-core current transformers.
- **Secure Operation.** Manage user accounts and permissions to only allow access to the touchscreen to approved users.

Applications

Control a Bay With Single or Dual Breakers

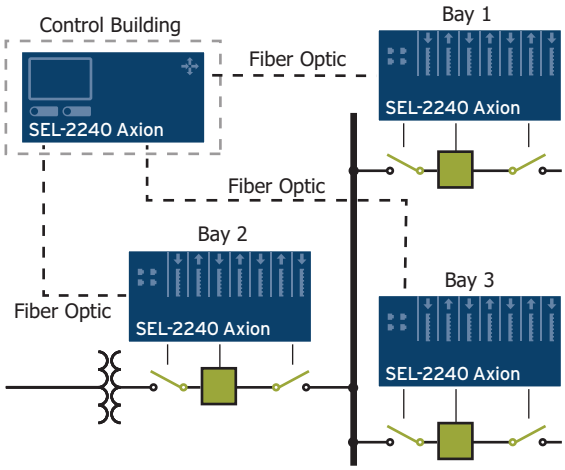
Use a single SEL-2240 Axion Bay Controller node to control a substation bay with as many as 3 breakers and 20 disconnect switches.



Use Distributed I/O to Control Multiple Bays

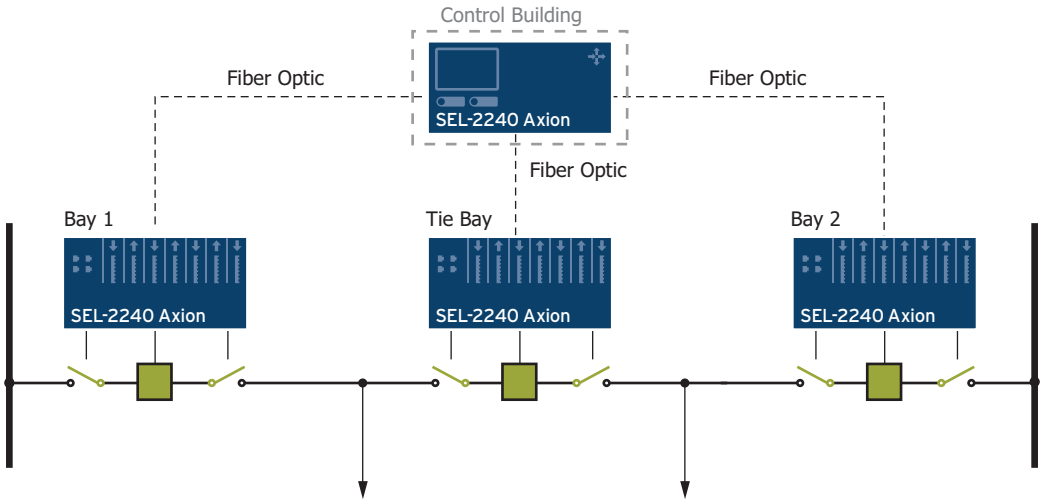
Use high-speed and deterministic fiber-optic communications from the control house in place of high-energy copper cables.

Install ac measurement modules and digital I/O modules near assets in the substation yard and perform bay control and monitoring from within the control house.



Control Breaker-and-a-Half Diameter

Monitor and control breakers and switches in a breaker-and-a-half scheme. Ensure safe connections by using synchronism check and automate control operations with the powerful logic engine in the RTAC.



Product Overview

Functional Diagram

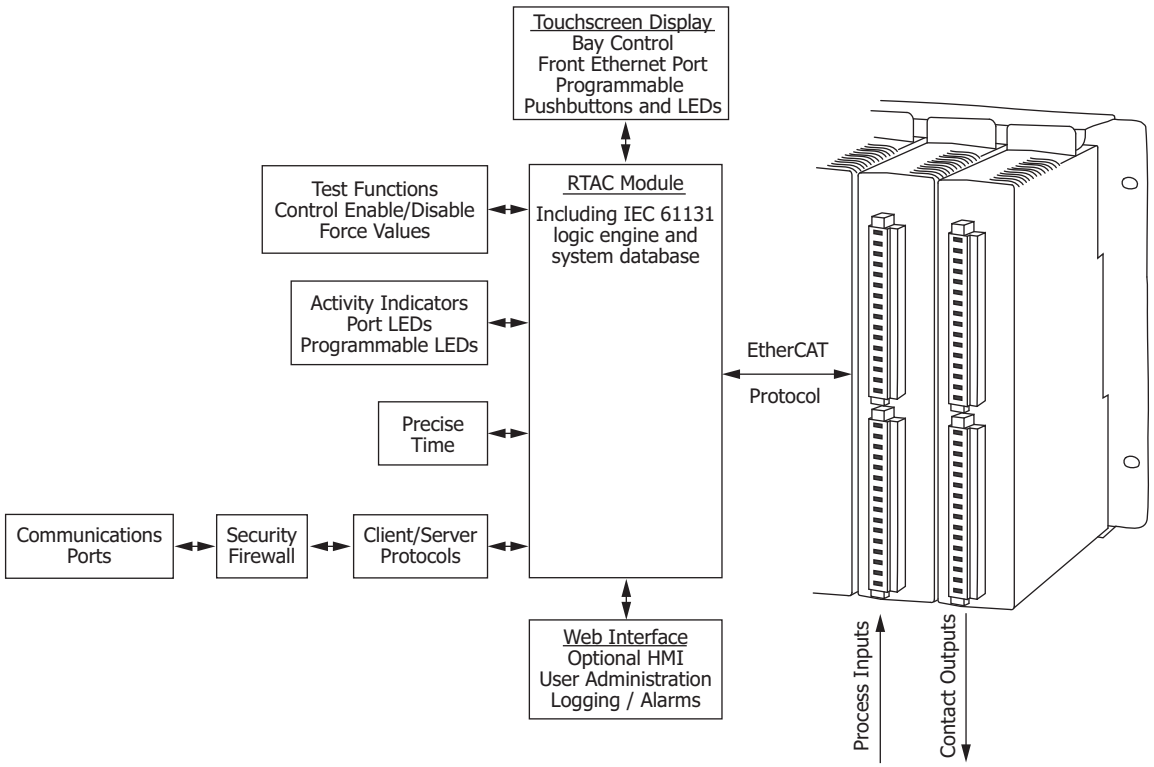


Figure 1 Functional Diagram

Flexible System Architecture

Today's monitoring and control applications need flexible system architectures and integrated security. The Axion Bay Controller meets these needs by using the RTAC module (SEL-2241 or SEL-2241-2) as the system CPU and providing modular and scalable I/O. SEL designs all Axion hardware to published standards (see *Specifications* on page 17) and performs tests to verify that each component exceeds standards by adequate margins. The SEL-2243 Power Coupler is a highly reliable device that uses the same power supply technology used in SEL protective relays. Configure the Axion to include single or redundant power couplers for critical applications. In redundant configurations, the pair of SEL-2243 modules actively share loads to supply power for the entire node. If one module should become unavailable, the remaining power coupler can accommodate the entire node with no loss of system capability. Employ dual power couplers for installations where you have dual power sources, one that is ac and one that is dc.

Figure 2 Modules Installed in Chassis/Backplane

Each Axion node is mounted in a chassis/backplane (model SEL-2242) that provides a means for each node to include a custom arrangement of modules. A single node can contain as many as nine modules. Use any combination, quantity, and sequence of modules that suits the application.

NOTE: The SEL-2242 backplane with 7-inch touchscreen display is compatible with the RTAC modules and does not support other RTAC variants.

The node does not need to be entirely full to function properly. Leave empty slots for future expansion as necessary. Many remote terminal unit (RTU) and control systems need more I/O points than will fit in a single Axion node. In those cases, use the EtherCAT protocol to connect multiple nodes together via a real-time Ethernet network. Through use of an Axion system EtherCAT network, you can use as many as 60 modules in a single network with no loss of speed or determinism. *Applications* on page 3 explores several possible network configurations. In each implementation, a single RTAC module provides logic functions and data concentration for the entire network.

Ordering Options

Table 1 RTAC Module

SEL-2241 Ethernet Communication Options	Two Ethernet ports: 10/100BASE-T copper (standard) 100BASE-FX fiber-optic (optional) 100BASE-LX single-mode fiber-optic (optional)
SEL-2241-2 Ethernet Communication Options[a]	Three Ethernet ports: Two 10/100/1000 Mbps RJ45 copper ports Two 100/1000 Mbps SFP fiber-optic ports
Web-Based HMI	Basic runtime license and diagram builder software
Peer-to-Peer Protocols	IEC 61850 GOOSE
Client Protocols	IEC 61850 MMS
Server Protocols	IEC 61850 MMS, Ethernet/IP
Environment	Conformal coating for chemically harsh and high-moisture environments

[a] Both SEL-2241-2 options include an additional 10/100/1000 Mbps RJ45 copper port.

Table 2 SEL-2242 Chassis/Backplane

Slot Configuration	10-slot, 4-slot, or dual 4-slot
Front Panel[a]	Bay Controller with 7-inch touchscreen display, 6 pushbuttons, and 19 programmable LEDs[b]
Mounting	Horizontal surface mount, 5U[c] Horizontal rack mount, 5U Horizontal panel mount, 5U (10-slot or dual 4-slot)
Environment	Conformal coating for chemically harsh and high-moisture environments

[a] Front-panel options are not supported if the SEL-2242 is configured for surface mount.

[b] Only available with the 10-slot SEL-2242. Only compatible with RTAC modules that are shipped with R149 firmware or later.

[c] For applications compliant with IEC 60255-27, surface-mount units must be installed in IP4X enclosures.

Table 3 SEL-2243 Power Coupler

Voltage Range	24/48 Vdc or 120/250 Vac/Vdc
EtherCAT Communication	Two ports: RJ45 Ethernet (standard) LC fiber-optic multimode or single-mode (optional)
Environment	Conformal coating for chemically harsh and high-moisture environments

Table 4 SEL-2244-2 24 Digital Input Module

Input Ratings	24 Vac/Vdc 48 Vac/Vdc 110 Vac/Vdc	125 Vac/Vdc 220 Vac/Vdc 250 Vac/Vdc
Environment	Conformal coating for chemically harsh and high-moisture environments	

Table 5 SEL-2244-4 32 Digital Input Module

Input Ratings	24 Vdc 48 Vdc	110 Vac/Vdc 125 Vac/Vdc
Environment	Conformal coating for chemically harsh and high-moisture environments	

Table 6 SEL-2244-3 Standard Current Digital Output Module

Output Types	16 Form A control outputs 8 Form A, 8 Form B control outputs 16 Form B control outputs
Environment	Conformal coating for chemically harsh and high-moisture environments

Table 7 SEL-2244-5 Fast High-Current Digital Output Module

Output Types	10 Form A control outputs 5 Form A, 5 Form B control outputs 10 Form B control outputs
Environment	Conformal coating for chemically harsh and high-moisture environments

Table 8 SEL-2245-2 DC Analog Input Module

Input Types	±20 mA, ±2 mA, ±10 V
Environment	Conformal coating for chemically harsh and high-moisture environments

Table 9 SEL-2245-22 DC Analog Input Extended Range Module

Input Types	5–400 V
Environment	Conformal coating for chemically harsh and high-moisture environments

Table 10 SEL-2245-221 Low-Voltage (LEA) Monitoring Module

Input Types	0.05–22 V
Environment	Conformal coating for chemically harsh and high-moisture environments

Table 11 SEL-2245-3 DC Analog Output Module

Output Types	±20 mA, ±10 V
Environment	Conformal coating for chemically harsh and high-moisture environments

Table 12 SEL-2245-4 AC Metering Module

Input Types	0.05–22 A, 5–400 V
Environment	Conformal coating for chemically harsh and high-moisture environments

Table 13 SEL-2245-42 AC Protection Module

Input Types	0.1–20 A, 6.7–300 V
Environment	Conformal coating for chemically harsh and high-moisture environments

Table 14 SEL-2245-411 Standard Current and Low-Voltage (LEA) Monitoring Module

Input Types	0.05–22 A, 0.05–22 V
Environment	Conformal coating for chemically harsh and high-moisture environments

Module Features

Front-Panel View

Rear-Panel View

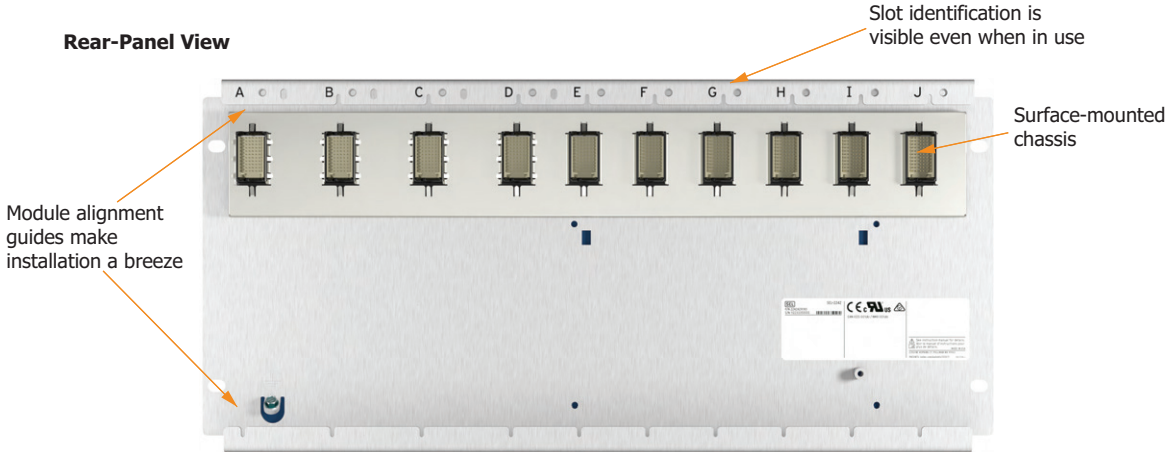


Figure 3 SEL-2242 10-Slot Chassis/Backplane

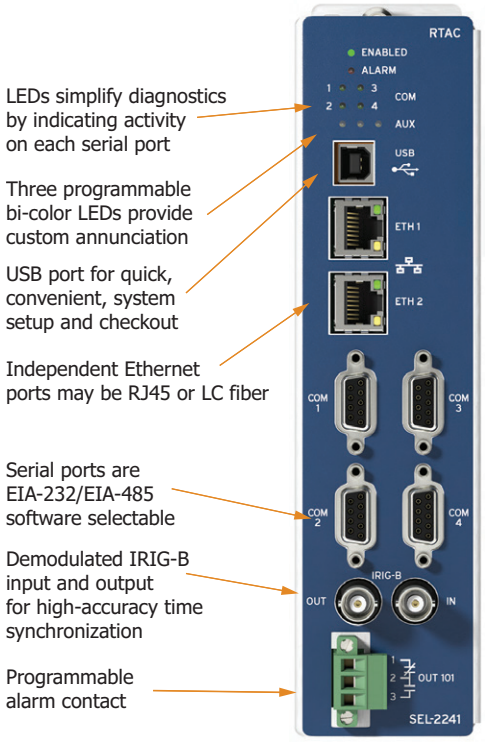


Figure 4 SEL-2241 RTAC Terminal-Side View

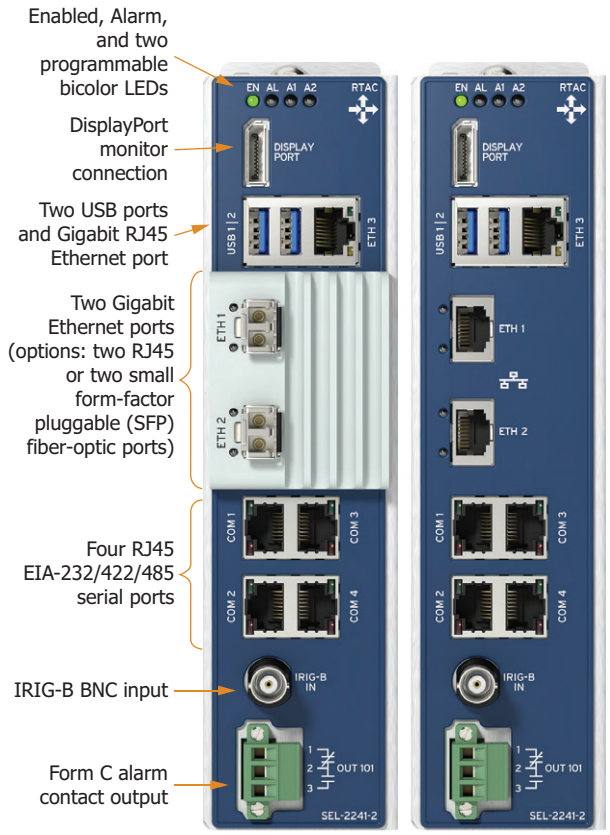


Figure 5 SEL-2241-2 RTAC Terminal-Side View

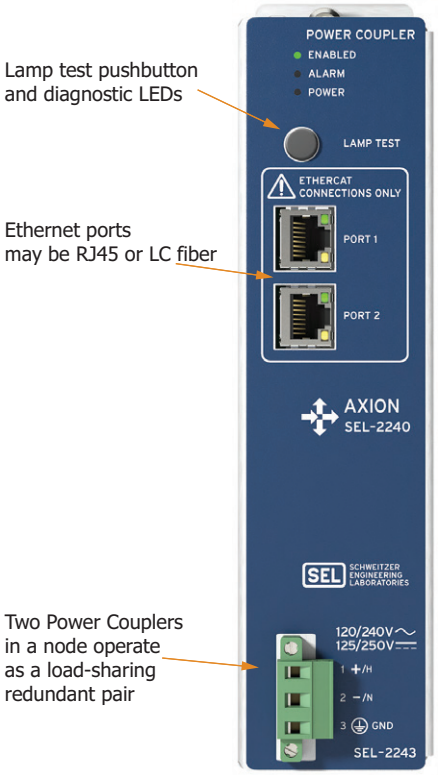


Figure 6 SEL-2243 Power Coupler Terminal-Side View

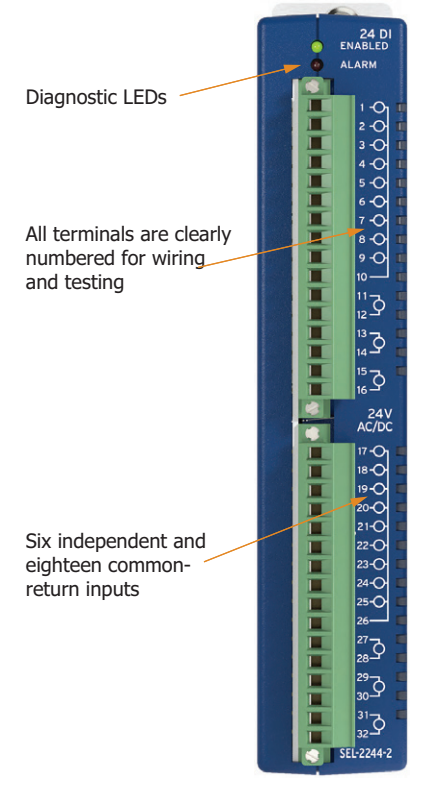


Figure 7 SEL-2244-2 Digital Input Module Terminal-Side View

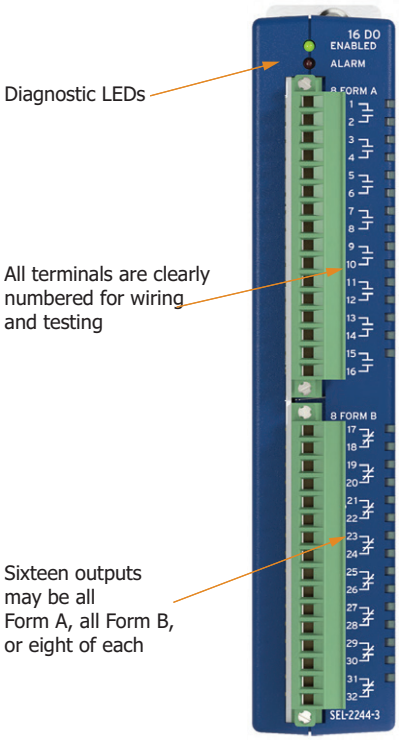


Figure 8 SEL-2244-3 Standard Current Digital Output Module Terminal-Side View

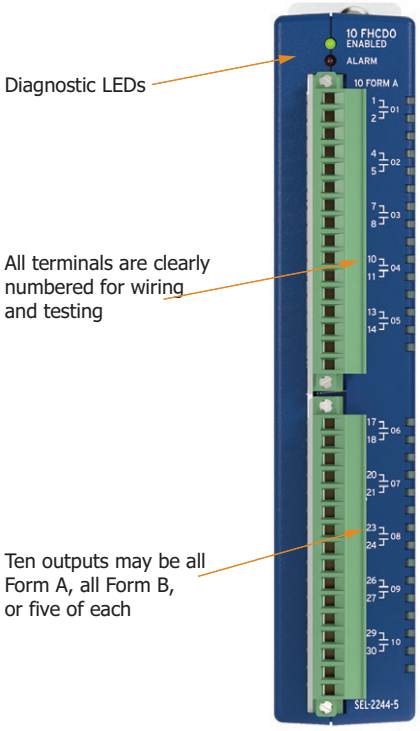


Figure 10 SEL-2244-5 Fast High-Current Digital Output Module Terminal-Side View

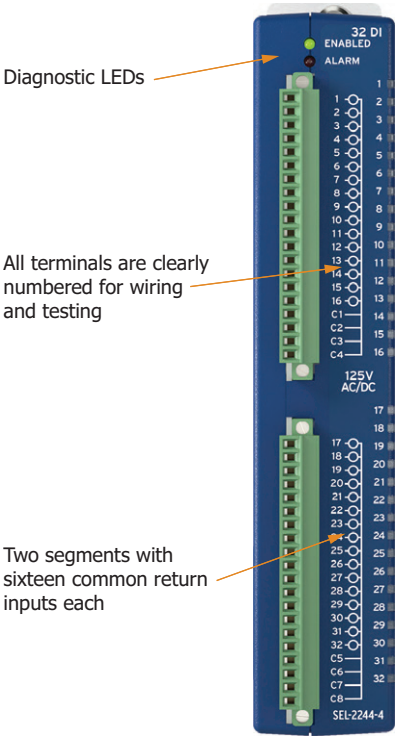


Figure 9 SEL-2244-4 32 Digital Input Module Terminal-Side View

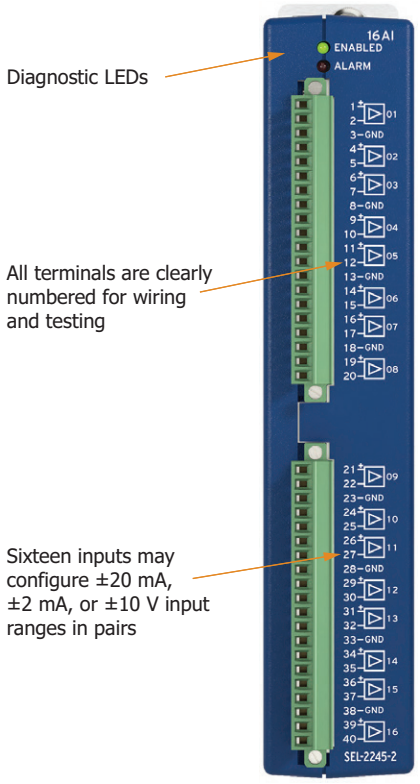


Figure 11 SEL-2245-2 DC Analog Input Module Terminal-Side View

Figure 12 SEL-2245-22 Analog Input Extended Range Module Terminal-Side View

Figure 13 SEL-2245-221 Low-Voltage (LEA) Monitoring Module

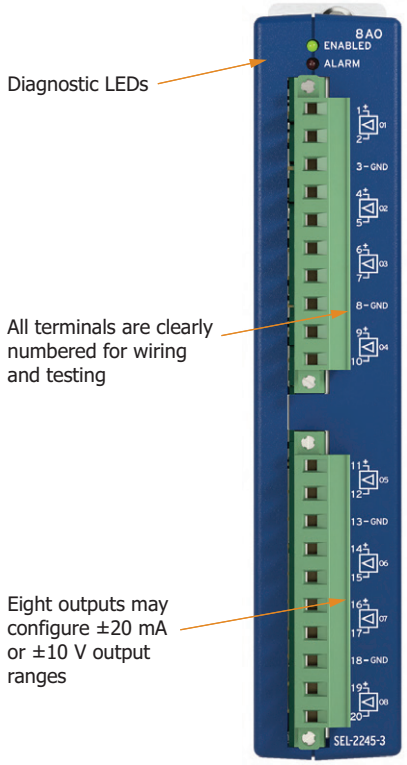


Figure 14 SEL-2245-3 DC Analog Output Module Terminal-Side View

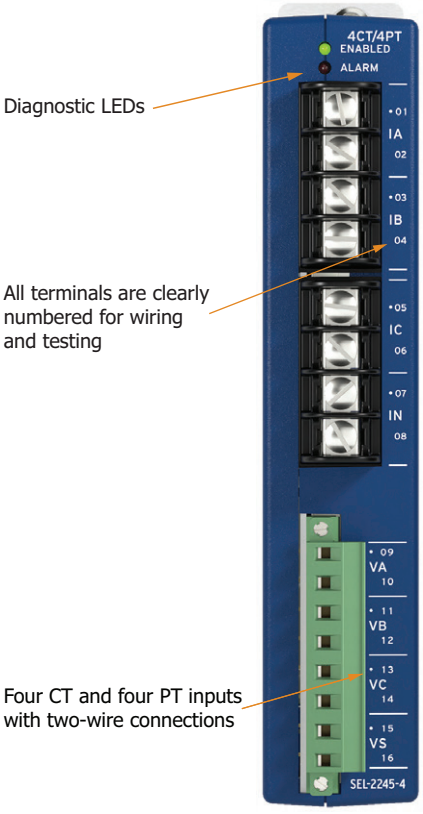


Figure 15 SEL-2245-4 AC Metering Module Terminal-Side View

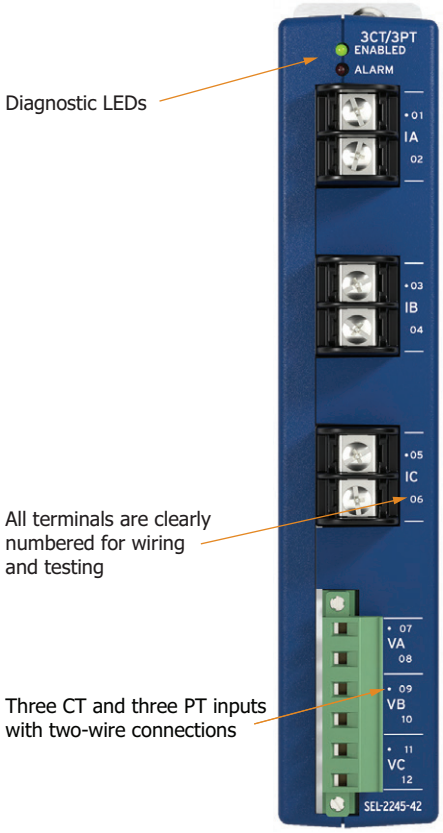


Figure 16 SEL-2245-42 AC Protection Module Terminal-Side View

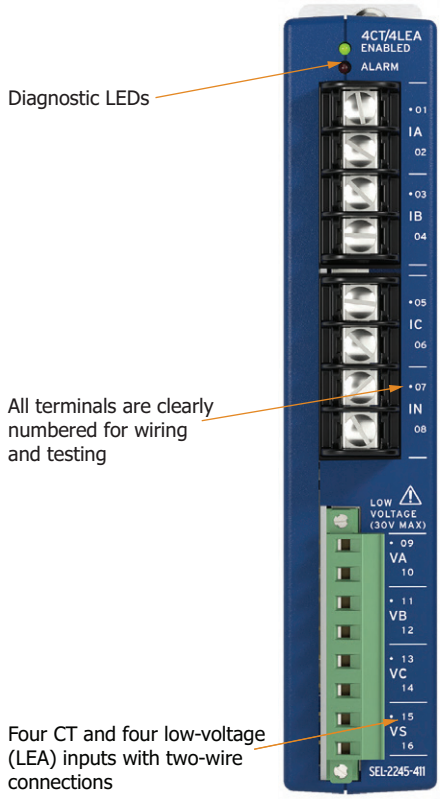


Figure 17 SEL-2245-411 Standard Current and Low-Voltage (LEA) Monitoring Module

Diagrams and Dimensions

NOTE: For applications compliant with IEC 60255-26, surface-mount units must be installed in IP4X enclosures.

You can mount the Axion in a sheltered indoor environment (a building or an enclosed cabinet) that does not exceed the temperature and humidity ratings for the modules. Equipment must be installed in an enclosure that protects against shock and fire to meet UL requirements. Configurations with an SEL-2245-42 as the rightmost module in a backplane should have the backplane installed in a metal enclosure to meet Radiated RF Immunity type test requirements. The Axion must be mounted such that modules are vertical and have at least 0.5 inches to the nearest solid surface above and below.

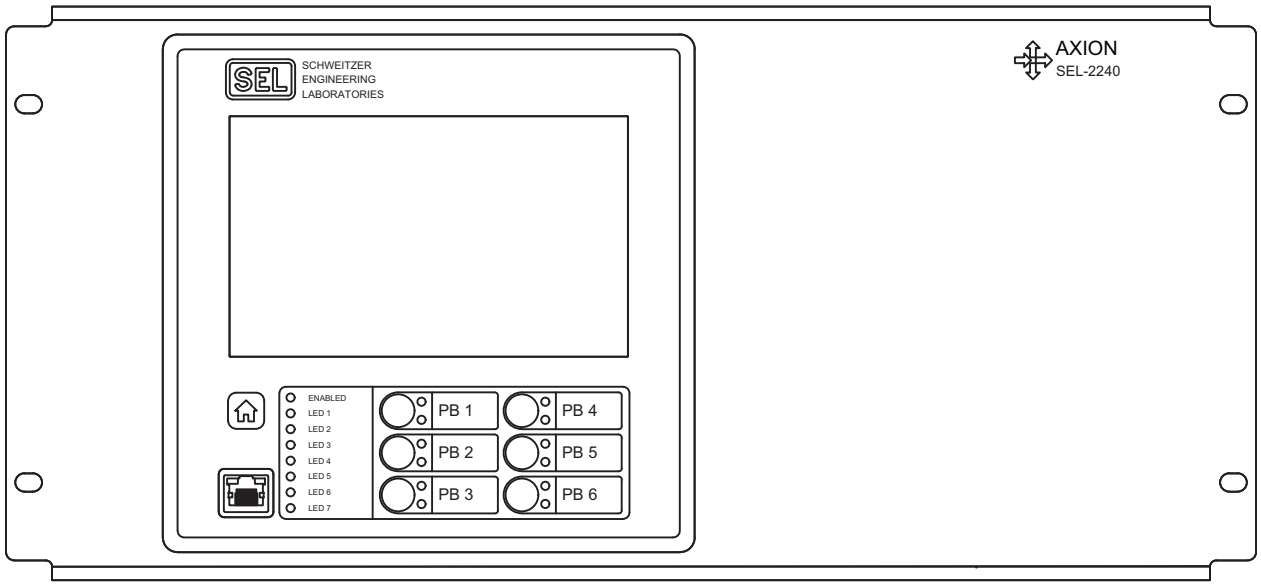


Figure 18 SEL-2240 10-Slot Front-Panel 7-Inch Touchscreen Display (Rack Mount)

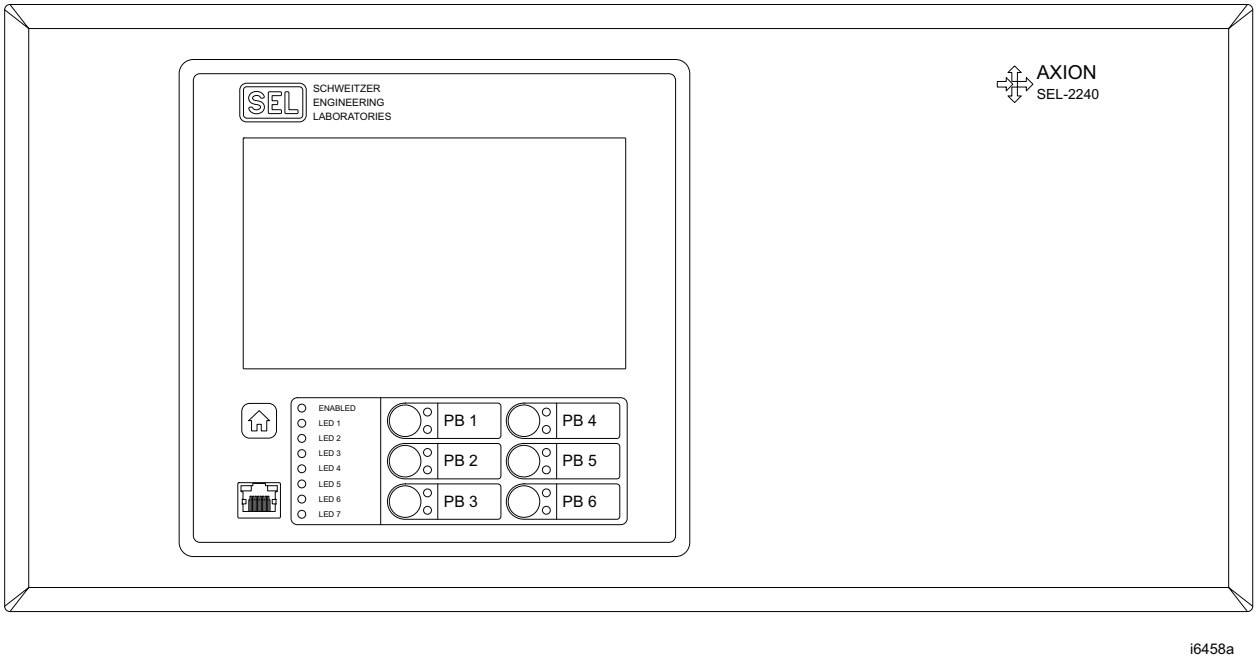


Figure 19 SEL-2240 10-Slot Front-Panel 7-Inch Touchscreen Display (Panel Mount)

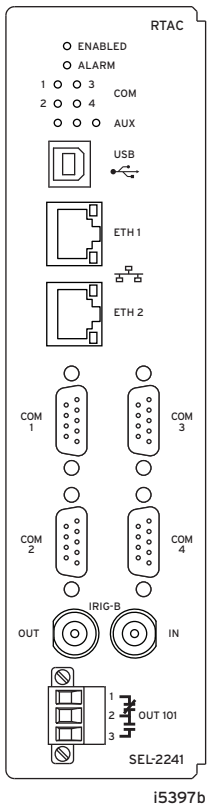


Figure 20 SEL-2241 Connections Diagram

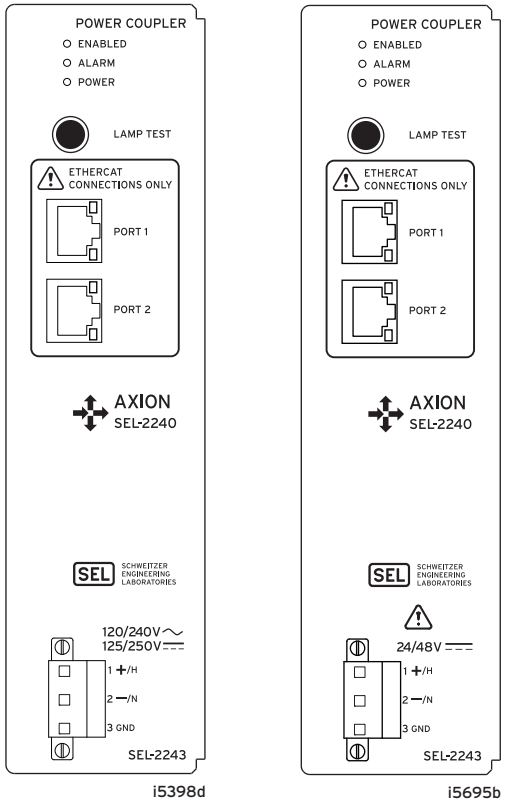


Figure 22 SEL-2243 Connections Diagrams

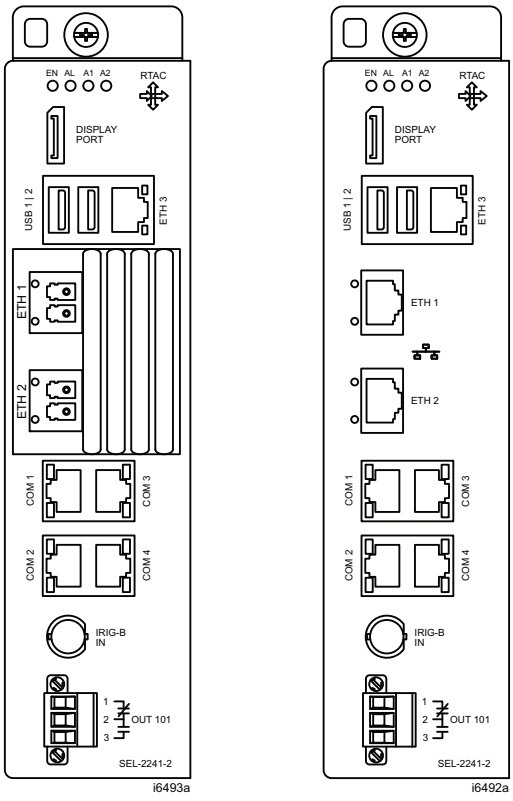


Figure 21 SEL-2241-2 Connections Diagrams

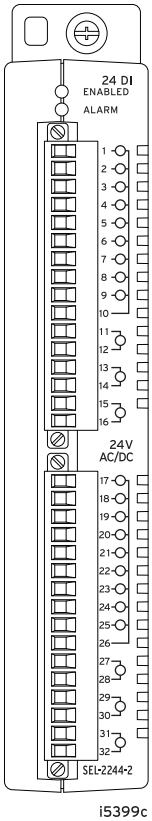


Figure 23 SEL-2244-2 Connections Diagram

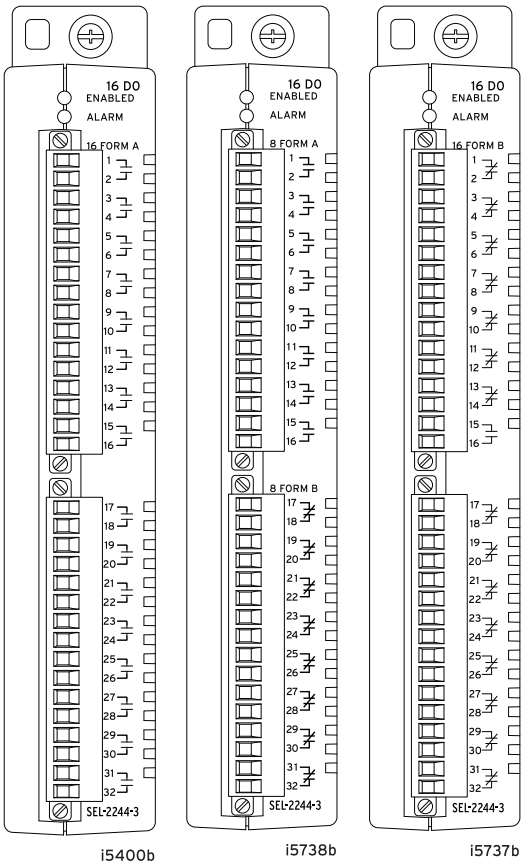


Figure 24 SEL-2244-3 Connections Diagrams

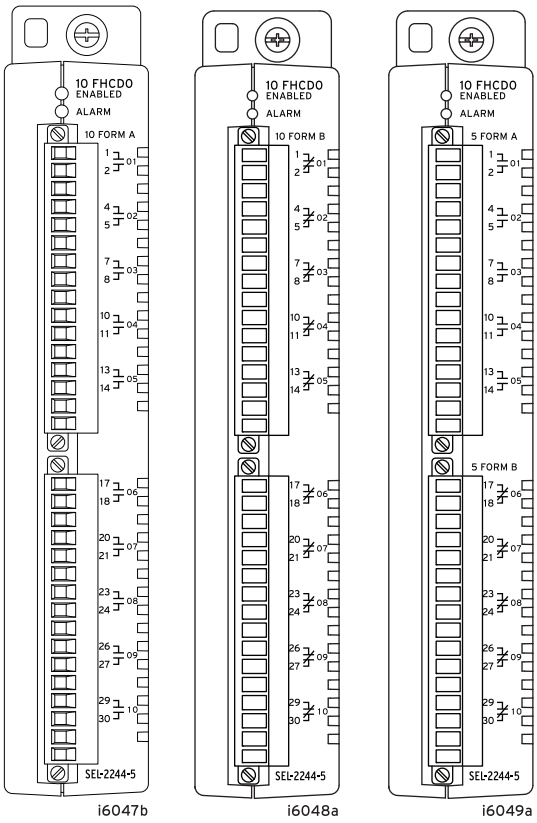


Figure 26 SEL-2244-5 Connections Diagrams

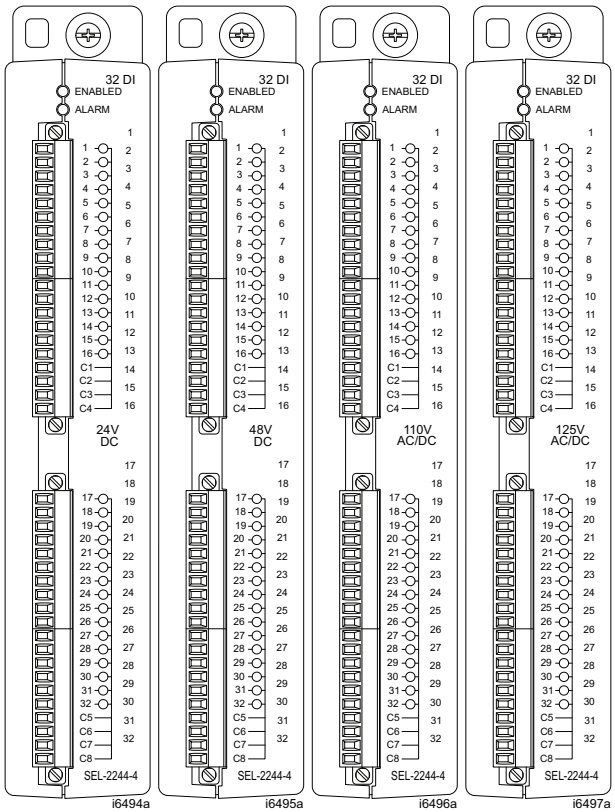


Figure 25 SEL-2244-4 Connections Diagrams

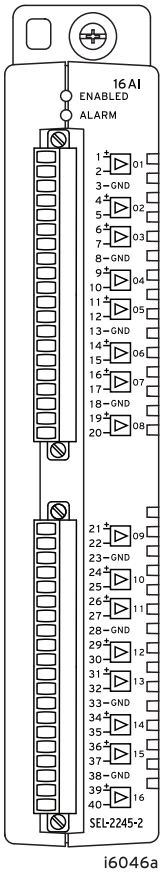


Figure 27 SEL-2245-2 Connections Diagram

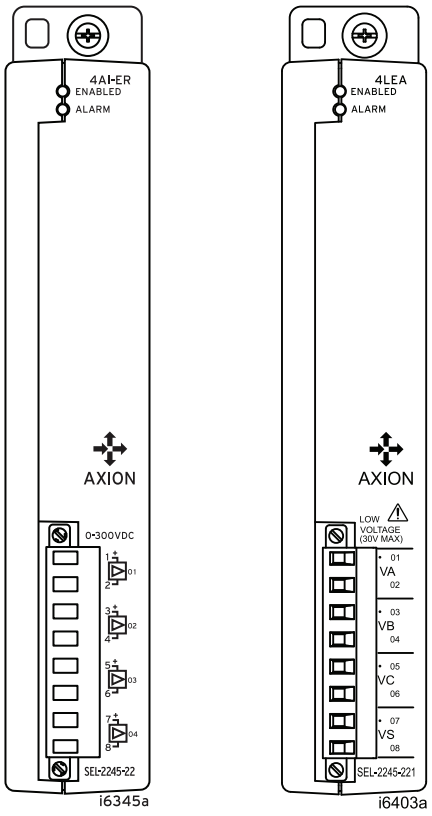


Figure 28 SEL-2245-22 and SEL-2245-221 Connections Diagrams

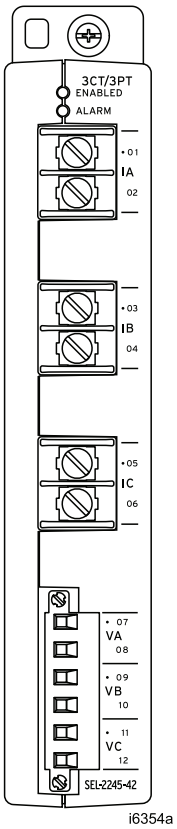


Figure 30 SEL-2245-42 Connections Diagram

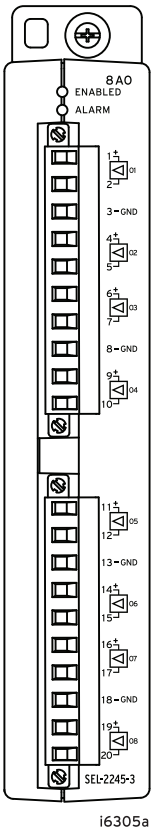


Figure 29 SEL-2245-3 Connections Diagram

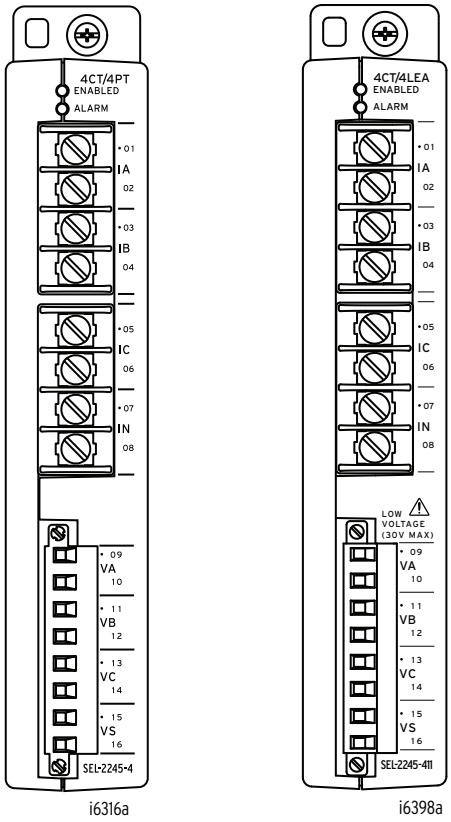


Figure 31 SEL-2245-4 and SEL-2245-411 Connections Diagrams

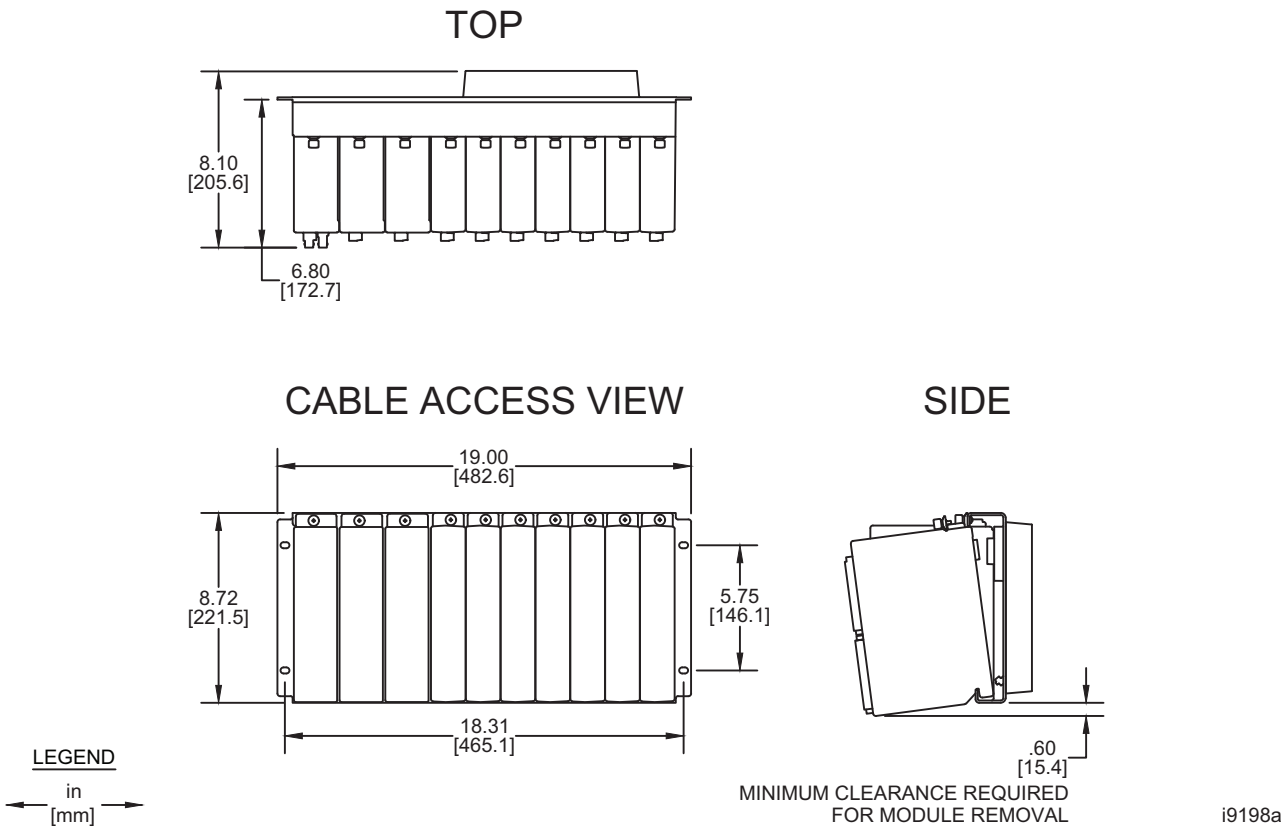


Figure 32 SEL-2240 Dimensions for 10-Slot Rack With 7-Inch, Color Touchscreen Display (Rack Mount)

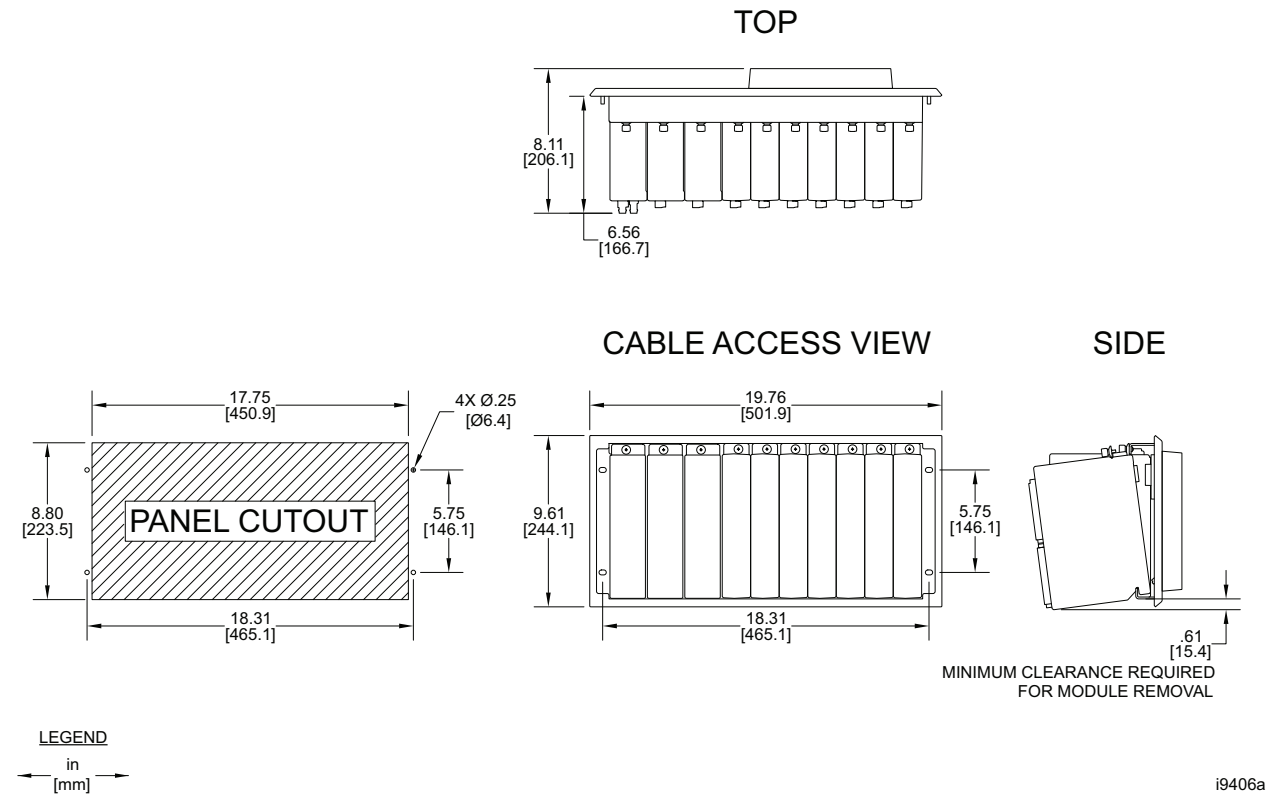


Figure 33 SEL-2240 Dimensions for 10-Slot Rack With 7-Inch, Color Touchscreen Display (Panel Mount)

Specifications

Compliance

Designed and manufactured under an ISO 9001 certified quality management system

SEL Axion operates at the specified limits on power up as soon as the device enables. Refer to the individual SEL Axion module datasheets for compliance and type test specifications.

UKCA Mark

IEC 60529 Enclosure Protection

IP4X Front
IP2X Product Without SEL-2245-4, SEL-2245-411, or SEL-2245-42
IP1X Product With SEL-2245-4, SEL-2245-411, or SEL-2245-42
Note: The product must be mounted in a locked IP4X enclosure or restricted area such that rear terminals are accessible by trained maintenance or operation personnel only.

Product Standards

IEC 60255-26:2013 - Relays and Protection Equipment: EMC
IEC 60255-27:2014 - Relays and Protection Equipment: Safety
IEC 60825-2:2004 + A1:2007 + A2:2010 for fiber-optic communications
IEC 61850-3:2013 Performance Class 1 - Comm Systems for Power Utility Automation

General

Operating System

SEL Linux® Yellowstone running Linux kernel 3.x with real-time preemption patches

Operating and Storage Temperature Range

–40° to +85°C (–40° to +185°F)
Units should be stored and transported in their original packaging.

Note: Operating temperature evaluated for UL ambient 0° to 40°C.
Note: The optional front-panel LCD is impaired for temperatures below –20°C and above +70°C.

Operating Environment

Pollution Degree:	2
Overvoltage Category:	II
Insulation Class:	1
Relative Humidity:	5%–95%, noncondensing
Maximum Altitude:	2000 m
Vibration, Earth Tremors:	Class 1

Dimensions

Refer to *Diagrams and Dimensions on page 11* for dimensions.

Weight

SEL-2241 RTAC:	0.67 kg (1.47 lb)
SEL-2241-2 RTAC (Copper):	1.29 kg (2.84 lb)
SEL-2241-2 RTAC (SFP):	1.42 kg (3.13 lb)
SEL-2242 19 in Backplane:	3.24 kg (7.13 lb)
Panel Mount Bezel:	0.28 kg (0.63 lb)
SEL-2242 10-Slot (19 in Rack Width) With 7 in Touchscreen Display:	4.0 kg (8.80 lb)
SEL-2243-1 HV Coupler:	0.85 kg (1.87 lb)
SEL-2243-2 LV Coupler:	0.89 kg (1.97 lb)
SEL-2244-2 24 DI:	0.45 kg (1.00 lb)
SEL-2244-3 16 DO:	0.59 kg (1.30 lb)
SEL-2244-4 32 DI:	0.40 kg (0.88 lb)
SEL-2244-5 10 FHCDO:	0.57 kg (1.26 lb)
SEL-2245-2 16 AI:	0.51 kg (1.12 lb)
SEL-2245-22 4 AI-ER:	0.42 kg (0.92 lb)
SEL-2245-221 4 LEA:	0.42 kg (0.92 lb)
SEL-2245-3 8 AO:	0.46 kg (1.01 lb)
SEL-2245-4 4 CT/4 PT:	0.54 kg (1.18 lb)
SEL-2245-411 4 CT/4 LEA:	0.54 kg (1.18 lb)
SEL-2245-42 3 CT/3 PT:	0.73 kg (1.60 lb)

Module Burden per Module for Each Node

Note: Total power consumption must not exceed 75 W. User must add burden values from the following table for their configuration to ensure this constraint is satisfied.

Module	Maximum Added Burden (W)[a]
SEL-2241 RTAC (Copper Ethernet)	12.5
SEL-2241 RTAC (Fiber Ethernet)	15
SEL-2241-2 RTAC (Copper Ethernet)	18
SEL-2241-2 RTAC (SFP Fiber Ethernet)	20
SEL-2242R Standard Rack-Mount Backplanes	1
SEL-2242 With Touchscreen Display	4
SEL-2243 Power Coupler (Fiber Ethernet)	5[b]
SEL-2243 Power Coupler (Copper Ethernet)	2.5[b]
SEL-2244-2 24 DI	2
SEL-2244-3 16 DO	8[c]
SEL-2244-4 32 DI	2
SEL-2244-5 10 FHCDO	6[c]
SEL-2245-2 16 AI	3
SEL-2245-22 4 AI-ER	2
SEL-2245-221 4 LEA	2
SEL-2245-3 8 AO	13
SEL-2245-4 4 CT/4 PT	3
SEL-2245-411 4 CT/4 LEA	3
SEL-2245-42 3 CT/3 PT	6
Feature Selections	**Typical Burden (W)**
No use of SEL-2241 serial port +5 Vdc	–3
No use of SEL-2241-2 serial port +5 Vdc	–1.5
No use of SEL-2241-2 USB port power	–1.5
Each DO port not energized (SEL-2241, SEL-2244-3, or SEL-2244-5 relay coil)	–0.3
Each AO port not energized (SEL-2245-2)	–0.7

[a] Values include worst-case real power consumption and do not include worst-case ac power factor correction (0.4). If the unit will not be used in wide temperature extremes, reduce power by up to 6%.
[b] Each SEL-2243 will draw a minimum of 11 W (quiescent) when the total burden of all other modules in the node is less than 11 W.
[c] All DO relay coils may be energized simultaneously and still meet specifications.

SEL-2241 RTAC

CPU Processing and Memory

Processor Speed:	533 MHz
Memory:	1024 MB DDR2 ECC RAM
Storage:	4 GB (2 GB reserved)

Time-Code Input (Modulated IRIG-B)

Input Impedance:	2 kΩ
Accuracy:	500 µs

Time-Code Input (Demodulated IRIG-B)

On (1) State:	V_{ih} > 2.2 V
Off (0) State:	V_{il} < 0.8 V
Input Impedance:	2 kΩ
Accuracy:	500 ns

Time-Code Output (IRIG-B)

On (1) State:	V_{oh} > 2.4 V
Off (0) State:	V_{ol} < 0.8 V
Load:	50 Ω

Communications Ports

Ethernet Ports (To Backplane)

Ports:	1
Data Rate:	Automatic
Protocols:	Dedicated EtherCAT port

Ethernet Ports (Terminal Side)

Ports:	2
Data Rate:	10 or 100 Mbps
Connector:	RJ45 Female or LC Fiber (Multimode or Single-Mode 100 Mbps only)

Fiber-Optic Ports (Class 1 LASER/LED)

Wavelength:	1300 nm
Optical Connector Type:	LC
Multimode Option	
Link Budget:	11 dB
Min. TX Power:	–20 dBm
Min. RX Sensitivity:	–31 dBm
Fiber Size:	50–200 µm
Approximate Range:	2 km
Data Rate:	100 Mbps
Typical Fiber Attenuation:	–2 dB/km
Single-Mode Option	
Link Budget:	10 dB
Min. TX Power:	–15 dBm
Min. RX Sensitivity:	–25 dBm
Fiber Size:	9 µm
Approximate Range:	15 km
Data Rate:	100 Mbps
Typical Fiber Attenuation:	–0.4 dB/km

Serial Ports

Ports:	4
Types:	EIA-232/EIA-485 (software selectable)
Data Rate:	300 to 115,200 bps
Connector:	DB-9 Female
Time Synchronization:	IRIG-B
Power:	+5 Vdc power on Pin 1 (500 mA maximum per SEL-2241)

USB Device Ports

1 Type B

Output

Mechanical Durability

10 M no-load operations

DC Output Ratings

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:	360 Vdc, 40 J MOV		
Operating Time (Coil Energization to Contact Closure, Resistive Load):	Pickup/Dropout time ≤8 ms typical		
Breaking Capacity (10,000 Operations) Per IEC 60255-0-20:1974:	24 Vdc 48 Vdc 125 Vdc 250 Vdc	0.75 A 0.50 A 0.30 A 0.20 A	L/R = 40 ms L/R = 40 ms L/R = 40 ms L/R = 40 ms
Cyclic Capacity (2.5 Cycles/Second) Per IEC 60255-0-20:1974:	24 Vdc 48 Vdc 125 Vdc 250 Vdc	0.75 A 0.50 A 0.30 A 0.20 A	L/R = 40 ms L/R = 40 ms L/R = 40 ms L/R = 40 ms

AC Output Ratings

Rated Operational Voltage:	240 Vac
Rated Insulation Voltage:	300 Vac
Utilization Category:	AC-15 (control of electromagnetic loads > 72 VA)
Contact Rating Designation:	B300 (B = 5 A, 300 = rated insulation voltage)
Contact Protection:	270 Vac, 40 J
Continuous Carry:	3 A @ 120 Vac 1.5 A @ 240 Vac
Conventional Enclosed Thermal Current (I_{the}) Rating:	5 A
Rated Frequency:	50/60 ± 5 Hz
Operating Time (Coil Energization to Contact Closure, Resistive Load):	Pickup/Dropout time <8 ms typical
Electrical Durability Make VA Rating:	3600 VA, cosø = 0.3
Electrical Durability Break VA Rating:	360 VA, cosø = 0.3

SEL-2241-2 RTAC

CPU Processing and Memory

Processor:	Intel Atom x5-E3940
Core/Threads:	4/4
Frequency:	1.6 GHz
Cache:	2 MB L2
Memory:	4 GB ECC SDRAM
Storage:	8 GB eMMC (2 GB reserved)

Time-Code Inputs

One BNC IRIG-B Input

Format:	IRIG-B002 or -B004 (demodulated)
On (1) State:	$V_{ih} \geq 2.2$ V
Off (0) State:	$V_{il} \leq 0.8$ V
Input Impedance:	≥1.2 kΩ at 5 V signal level
Constant Load:	≤4 mA

Note: IRIG-B004 control bits comply with IEEE C37.118.1-2011 (backward compatible with IRIG-B000 and IEEE C37.118-2005).

Time-Code Outputs

All RJ45 Serial Ports

Format:	IRIG-B004 (demodulated)
On (1) State:	Voh ≥ 2.4 V
Off (0) State:	Vol ≤ 0.8 V

Output Drive Capacity

Each Serial Port:	TTL 6 mA (>400 Ω)

Note: IRIG-B004 control bits comply with IEEE C37.118.1-2011 (backward compatible with IRIG-B000 and IEEE C37.118-2005).

Video and Audio

Intel HD Graphics 500 Controller

DisplayPort 2.1 output

Intel Display Audio digital audio output

Maximum Resolution*: 4096 x 2160 @ 60 Hz

Use DisplayPort cables that have ferrite chokes and are less than 2 m (6 ft) in length for Electromagnetic Compatibility Immunity compliance.

* High-resolution displays require high-quality cables. Ensure your display cables are as short as possible and rated for the required screen resolution.

USB

2 USB A ports

200 mA maximum combined current

Use USB cables that have ferrite chokes and are less than 2 m (6 ft) in length for Electromagnetic Compatibility Immunity compliance.

Communications Ports

Ethernet

SEL Gigabit Ethernet controllers

1 10/100/1000 Mbps port, RJ45 copper

Configurations: 2 RJ45 copper ports
2 SFP fiber-optic ports

Use RJ45 Ethernet cables that are less than 10 m (33 ft) in length for protection-level performance and for Surge Immunity Zone A compliance.

Serial

SEL multiport serial controller

EIA-232/422/485 Ports: 4 ports

RJ45 connectors

300–115,200 bps

256 byte TX and RX FIFOs each port

+5 Vdc port power

COM 1–4: 200 mA maximum combined current

IRIG-B output

Serial cables less than 10 m (33 ft) in length are required for Electromagnetic Compatibility Immunity compliance.

Standard Output Contact OUT101/Alarm

Output Type:	Relay Form C Break Before Make
Pilot Duty Ratings*:	B300 (UL), AC-15 (IEC) R300 (UL) DC-13 (IEC)
Rated Voltage†:	24–250 Vdc 110–240 Vrms

Note: The voltage across the contact output terminals must not exceed the operational voltage.

Operational Voltage†:	0–300 Vdc 0–264 Vrms
Contact Protection:	MOV protection across open contact 264 Vrms continuous voltage 300 Vdc continuous voltage
Continuous Carry†:	6 A @ 70°C, 4 A @ 85°C
Pickup/Dropout Time†:	≤6 ms (resistive load)
Power Supply Burden†:	≤1 W
Mechanical Endurance†:	10,000 no-load operations
Make (Short Duration Contact Current)†:	30 Adc 1,000 operations @ 250 Vdc 2,000 operations @ 125 Vdc

Note: 200 ms on, 15 ms off, current interrupted by independent means

Short-Time Thermal Withstand†:	50 A for 1 s
Limiting Making Capacity†:	1,000 W @ 250 Vdc (L/R = 40 ms)
Limiting Breaking Capacity/Electrical Endurance†:	10,000 operations 10 operations in 4 s, followed by 2 min idle

Rated Voltage	Resistive Break	Inductive Break L/R = 40 ms (DC) PF = 0.4 (AC)
24 Vdc	1.25 Adc	1.25 Adc
48 Vdc	0.63 Adc	0.63 Adc
125 Vdc	0.30 Adc	0.30 Adc
250 Vdc	0.20 Adc	0.20 Adc
110 Vrms	0.30 Arms	0.30 Arms
240 Vrms	0.20 Arms	0.20 Arms

* Per UL 508 and IEC 60947-5-1 for IEC 61010-2-201 compliance.
† Parameters verified by SEL per IEC 60255-1:2009 and IEEE C37.90-2005.

Network Time Protocol (NTP) Modes

NTP Client:	As many as three configurable servers

NTP Server

Simple Network Time Protocol (SNTP) Accuracy

±1 ms:	This does not take into account external factors such as network switches and topologies

Precision Time Protocol (PTP)

PTP Client:	Peer delay request and end-to-end path delay supported

Backplane (SEL-2242)

Ethernet Port

Ports:	1
Data Rate:	10/100 Mbps
Connector:	RJ45 Female
Protocols:	Engineering Access

Note: SEL-2242 Ethernet port is included with the optional touchscreen, 10-slot model only.

Fuse Rating

Non-Serviceable: 2.5 A, 125 V, time lag T

Power Coupler (SEL-2243)

EtherCAT Ports

Ports: 2

Data Rate: Automatic

Connector: RJ45 Female or LC Fiber

Protocols: Dedicated EtherCAT

RJ45 Ports

Cable Length: <3 m

Fiber-Optic Ports (Class 1 LASER/LED)

Wavelength: 1300 nm

Optical Connector Type: LC

Multimode Option

Link Budget: 11 dB

Min. TX Power: –20 dBm

Min. RX Sensitivity: –31 dBm

Fiber Size: 50–200 µm

Approximate Range: 2 km

Data Rate: 100 Mbps

Typical Fiber Attenuation: –2 dB/km

Single-Mode Option

Link Budget: 10 dB

Min. TX Power: –15 dBm

Min. RX Sensitivity: –25 dBm

Fiber Size: 9 µm

Approximate Range: 15 km

Data Rate: 100 Mbps

Typical Fiber Attenuation: –0.4 dB/km

Power Supply

AC Input Voltage (High-Voltage Model)

Note: Single phase.

Nominal Supply Voltage: 120–240 Vac, 50–60 Hz

Operational Voltage Range: 85–264 Vac, 40–70 Hz

DC Input Voltage (High-Voltage Model)

Nominal Supply Voltage: 125–250 Vdc

Operational Voltage Range: 85–300 Vdc

DC Input Voltage (Low-Voltage Model)

Nominal Supply Voltage: 24–48 Vdc

Operational Voltage Range: 19.1–57.6 Vdc polarity-dependent

Note: UL operational voltage range is equal to the nominal voltage range ±10 percent.

Fuse Rating

High-Voltage Model, F1: 3.15 A, high breaking capacity, time lag T, 250 V (5x20 mm, T3.15AH 250 V)

High-Voltage Model, F2 (Non-Serviceable): 8 A, high breaking capacity, time lag T, 60 Vdc (2.7x6.1 mm, T8A 60 Vdc)

Low-Voltage Model: 6.30 A, high breaking capacity, time lag T, 250 V (5x20 mm, T6.3AH 250 V)

Power Consumption: See *Module Burden per Module for Each Node* on page 17 for power per module.

Maximum AC Burden: 160 VA

Maximum DC Burden: 75 W

Interruptions: 30 ms @ 24 Vdc
130 ms @ 48 Vdc
50 ms @ 125 Vac/Vdc
100 ms @ 250 Vac/Vdc

The following exceptions for the IEC 61850-3 acceptance criteria for normal equipment functioning regarding ac power dips and interruptions and dc voltage dips are applicable (refer to IEC 61850-3 subclause 7.5.5, Equipment functioning, and 7.5.6, Exceptions).

Power Supply	Requirement	Exception[a]
125 Vac	5 cycles (83.33 ms @ 60 Hz, 100 ms @ 50 Hz)	50 ms
	50 cycles	Not applicable[b]

[a] Voltage interruptions that are longer than the specified interruption duration result in a device restart.

[b] Equipment is not intended to be connected to power supply ports that are directly connected to a public low-voltage power supply network.

Max Inrush: 17 A

Isolation: 3100 Vdc

Redundant Installation: Each node may have one or two SEL-2243 modules installed. When two are used, they operate in load-sharing mode.

Recommended External Overcurrent Protection

Breaker Type: Standard

Breaker Rating: 15 A or 20 A at 250 Vdc

Current Breaking Capacity: 10 kA

Grounded Neutral System: Device in series with the HOT or energized conductor

DC and Isolated Systems: Device in series with both conductors

Optoisolated Control Inputs (SEL-2244-2)

When Used With DC Control Signals:

250 V	ON for 200–275 Vdc	OFF below 150 Vdc
220 V	ON for 176–242 Vdc	OFF below 132 Vdc
125 V	ON for 100–135.5 Vdc	OFF below 75 Vdc
110 V	ON for 88–121 Vdc	OFF below 66 Vdc
48 V	ON for 38.4–52.8 Vdc	OFF below 28.8 Vdc
24 V	ON for 15–30 Vdc	OFF for <10 Vdc

When Used With AC Control Signals:

250 V	ON for 170.6–300 Vac	OFF below 106 Vac
220 V	ON for 150.3–264 Vac	OFF below 93.2 Vac
125 V	ON for 85–150 Vac	OFF below 53 Vac
110 V	ON for 75.1–132 Vac	OFF below 46.6 Vac
48 V	ON for 32.8–60 Vac	OFF below 20.3 Vac
24 V	ON for 14–27 Vac	OFF for <5 Vac

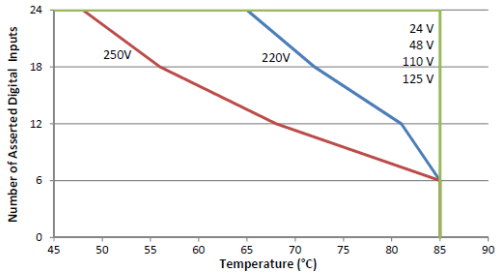
Burden/Current Draw at Nominal DC Voltage: 2–6 mA (Except for 24 V, 8 mA)

Rated Insulation Voltage: 300 Vac

Rated Impulse Withstand Voltage (U_{imp}): 5,000 V

Input Thermal Derating

SEL-2244-2 Digital Input Derating Curve



Control Outputs (SEL-2244-3 Standard Contacts)

Mechanical Durability

10 M no-load operations

DC Output Ratings

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		
Continuous Carry (UL/CSA Derating With All Outputs Asserted):	5 A @ <60°C; 2.5 A 60° to 70°C		
Thermal:	50 A for 1 s		
Contact Protection:	350 Vdc, 145 J MOV protection across open contacts		
Operating Time (Coil Energization to Contact Closure, Resistive Load):	Pickup/Dropout time ≤8 ms typical		
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 Capacity (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

AC Output Ratings

Rated Operational Voltage:	240 Vac
Rated Insulation Voltage (Excluding EN 61010-1):	300 Vac
Utilization Category:	AC-15 (control of electromagnetic loads > 72 VA)
Contact Rating Designation:	B300 (B = 5 A, 300 = rated insulation voltage)
Contact Protection:	250 Vac, 145 J
Continuous Carry:	3 A @ 120 Vac 1.5 A @ 240 Vac
Conventional Enclosed Thermal Current (I_{the}) Rating:	5 A
Rated Frequency:	50/60 ± 5 Hz
Operating Time (Coil Energization to Contact Closure, Resistive Load):	Pickup/Dropout time ≤8 ms typical
Electrical Durability Make VA Rating:	3600 VA, cosø = 0.3
Electrical Durability Break VA Rating:	360 VA, cosø = 0.3

Optoisolated Control Inputs (SEL-2244-4)

When Used With DC Control Signals:

125 V	ON for 100–135.5 Vdc	OFF below 75 Vdc
110 V	ON for 88–121 Vdc	OFF below 66 Vdc
48 V	ON for 38.4–52.8 Vdc	OFF below 28.8 Vdc
24 V	ON for 15–30 Vdc	OFF for <10 Vdc

When Used With AC Control Signals:

125 V	ON for 85–150 Vac	OFF below 53 Vac
110 V	ON for 75.1–132 Vac	OFF below 46.6 Vac

Burden/Current Draw at Nominal DC Voltage:	2–6 mA (Except for 24 V, 8 mA)
Rated Insulation Voltage:	300 Vac
Rated Impulse Withstand Voltage (U_{imp}):	5,000 V
Maximum Voltage Between Inputs That Share a Common Ground:	150 Vpeak

Use default timer values or greater (≥10 ms in DC mode) for EMC compliance.

Control Outputs (SEL-2244-5 Fast High-Current Contacts)

Mechanical Durability

10 M no-load operations

DC Output Ratings

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		
Continuous Carry (UL/CSA Derating With All Outputs Asserted):	5 A @ <60°C; 2.5 A 60° to 70°C		
Thermal:	50 A for 1 s		
Contact Protection:	330 Vdc, 145 J MOV protection across open contacts		
Operating Time (Coil Energization to Contact Closure, Resistive Load)			
Pickup Time:	≤12 µs at 250 Vdc, 16 µs at 125 Vdc, 65 µs at 19.2 Vdc typical (results with 100 kΩ resistive load)		
Dropout Time:	≤8 ms typical		
Inductive Breaking Capacity (10,000 Operations) Per IEC 60255-0-20:1974:	24 Vdc	10 A	L/R = 40 ms
	48 Vdc	10 A	L/R = 40 ms
	125 Vdc	10 A	L/R = 40 ms
	250 Vdc	10 A	L/R = 20 ms
Cyclic Capacity (4 Cycles/Second Followed by 2 Min Idle Thermal Dissipation) Per IEC 60255-0-20:1974:	24 Vdc	10 A	L/R = 40 ms
	48 Vdc	10 A	L/R = 40 ms
	125 Vdc	10 A	L/R = 40 ms
	250 Vdc	10 A	L/R = 20 ms

AC Output Ratings

Rated Operational Voltage:	110/120/220/240 Vac
Voltage Range:	19.2–250 Vac
Rated Insulation Voltage:	250 Vac
Make:	30 A @ 240 Vac
Continuous Carry:	6 A @ 70°C; 4 A @ 85°C
Continuous Carry (UL/CSA Derating With All Outputs Asserted):	5 A @ <60°C; 2.5 A @ 60° to 70°C
Thermal:	50 A for 1 s
Contact Protection:	250 Vac, 145 J MOV protection across open contacts

Operating Time (Coil Energization to Contact Closure, Resistive Load)

Pickup Time:	≤12 µs at 250 Vac, 16 µs at 125 Vac, 65 µs at 19.2 Vac typical (results with 100 kΩ resistive load)
Dropout Time:	≤8 ms typical

Note: Per IEC 60255-23:1994, using the simplified method of assessment.
Note: Make rating per IEEE C37.90-1989.

Fuse Rating

Non-Serviceable:	4 A, 450 V, medium time lag M

DC Transducer (Analog) Inputs (SEL-2245-2)

Input Impedance

Current Mode:	200 Ω for ±20 mA 5,000 Ω for ±2 mA
Voltage Mode:	10 MΩ

Input Range (Maximum)

±20 mA (transducers: 4–20 mA or 0–20 mA typical)
±2 mA (transducers: 0–1 mA or 0–2 mA typical)
±10 V (transducers: 0–5 V or 0–10 V typical)

Sampling Rate

1 ksps

Anti-Alias Filter

Corner Frequency:	330 Hz
Rolloff:	20 dBV per decade

Digital Filter

Corner Frequency:	Filter A: 16 Hz Filter B: 10 Hz Filter C: 0.2 Hz
50 Hz Rejection:	Filter A: >30 dB Filter B: >50 dB Filter C: >70 dB
60 Hz Rejection:	Filter A: >60 dB Filter B: >70 dB Filter C: >70 dB

Step Response

No Filter:	3 ms (10%–90% response)
Filter A:	23 ms (10%–90% response)
Filter B:	35 ms (10%–90% response)
Filter C:	700 ms (10%–90% response)

Common Mode Range

±35 Vdc between separate inputs
±250 Vdc all inputs to chassis

Isolation

500 Vac between inputs
2,000 Vac all inputs to chassis

Accuracy at 25°C

ADC:	16 bit
Voltage Inputs (±10 V):	0.25% of full-scale typical 0.05% with field calibration 2% of full-scale maximum
High Current Inputs (±20 mA):	0.5% of full-scale typical 0.1% with field calibration 2% of full-scale maximum
Low Current Inputs (±2 mA):	0.5% of full-scale typical 0.1% with field calibration 4% of full-scale maximum

Accuracy Variation With Temperature

Inputs:	±0.015% per °C of full scale (±20 mA, ±2 mA, or ±10 V)
ADC:	±0.004% per °C

Triggered Waveform Recording

Sampling Rate:	1 kHz
Record Duration:	0.1 second increments from 0.5 s to 144 s
Record Pre-Trigger:	0.05 s minimum to a maximum of (record length minus 0.05 s)
Waveform File Format:	COMTRADE (IEEE C37.111-1999 compliant)

DC Analog Inputs Extended Range (SEL-2245-22 in DC Mode)

Input Impedance

>7 MΩ

Input Range (Maximum)

0–300 V

Sampling Rate

24 ksps

Anti-Alias Filter

Corner Frequency:	5 kHz
Rolloff:	20 dB per decade

Digital Filter

Corner Frequency:	Filter A: 16 Hz Filter B: 10 Hz Filter C: 0.2 Hz
50 Hz Rejection:	Filter A: >30 dB Filter B: >50 dB Filter C: >70 dB
60 Hz Rejection:	Filter A: >60 dB Filter B: >70 dB Filter C: >70 dB

Step Response

Group Delay (Pre-Filter):	5.3 ms
No Filter:	3 ms (10%–90% response)
Filter A:	23 ms (10%–90% response)
Filter B:	35 ms (10%–90% response)
Filter C:	700 ms (10%–90% response)

Common Mode Range

±250 Vdc between separate inputs
±250 Vac all inputs to chassis

Isolation

2,500 Vrms between separate inputs
2,500 Vrms all inputs to chassis

Accuracy at 25°C

ADC:	16 bit
Inputs:	0.25% of full-scale typical 3% of full-scale worst case

Accuracy Variation With Temperature (Inputs)

±0.015% per °C of full scale

Triggered Waveform Recording

Sampling Rate:	1, 2, 4, 8, 24 kHz
Record Duration:	0.1 second increments from 0.5 s to 144 s
Record Pre-Trigger:	0.05 s minimum to a maximum of (record length minus 0.05 s)
Waveform File Format:	COMTRADE (IEEE C37.111-1999 compliant)

DC Analog Outputs (SEL-2245-3)

Current Mode

Output Range:	–20.48 to +20.48 mA
Load Impedance:	0–750 Ω @ 20 mA, 100 µH

Voltage Mode

Output Range:	–10.24 to +10.24 volts
Load Impedance:	>2,000 Ω, 1 µF

Step Response

1 ms (10%–90% response typical)

Isolation

2,000 Vdc between outputs or ground

Accuracy at 25°C (Outputs)

Current Mode:	±0.3% of full-scale typical ±3% of full-scale worst case (average during an EMI event over a 1-second period)
Voltage Mode:	±0.2% of full-scale typical ±2% of full-scale worst case (average during an EMI event over a 1-second period)

Accuracy Variation With Temperature (Outputs)

±0.01% of full-scale/°K (current or voltage mode)

AC Metering Inputs (SEL-2245-4, SEL-2245-411, SEL-2245-221, and SEL-2245-22 Voltage Inputs in AC Mode)

Frequency:	50/60 Hz
Range:	45–65 Hz
Typical Accuracy	
SEL-2245-4 and SEL-2245-22:	±0.005 Hz above 20 V
SEL-2245-411 and SEL-2245-221:	±0.005 Hz above 500 mV
Worst-Case Accuracy	
SEL-2245-4 and SEL-2245-22:	±0.01 Hz above 20 V
SEL-2245-411 and SEL-2245-221:	±0.01 Hz above 500 mV
Phase Rotation:	ABC, ACB
Input Configuration:	3-Wire Delta, 4-Wire Wye
Update Interval	
Fundamental Metering:	200 Hz
RMS Metering:	5 Hz

Current Inputs Phase and Neutral

I_{NOM}:	1 A or 5 A (no setting required)
Measurement Range:	0.050–22 A Continuous 22–100 A Symmetrical for 25 s
Thermal Withstand Limit:	500 A for 1 s
Typical Accuracy:	±0.1% fundamental @ f_{NOM} and > 0.6 A ±0.1% rms @ f_{NOM} and > 0.6 A
Worst-Case Accuracy:	±2% ± 0.005 A fundamental ±1% ± 0.005 A rms
Angle	
Range:	±180°
Typical Accuracy:	±0.1° fundamental @ f_{NOM} and > 0.6 A
Worst-Case Accuracy:	±2° @ f_{NOM}
Burden:	<0.1 VA @ I_{NOM}

Voltage Inputs (SEL-2245-4 and SEL-2245-22 in AC Mode)

V_{NOM}:	300 V
Measurement Range:	5–400 L-N, 9–693 L-L Vac fundamental/rms 5–300 L-N, 9–520 L-L Vac fundamental/rms (UL)
Maximum:	600 L-N, 1,039 L-L Vac fundamental/rms for 10 s
Typical Accuracy:	±0.1% fundamental @ f_{NOM} and > 20 V ±0.1% rms @ f_{NOM}
Worst-Case Accuracy:	±2% fundamental @ f_{NOM} ±1% rms plus ±0.05 V
Angle	
Range:	±180°
Typical Accuracy:	±0.1° @ f_{NOM} and > 20 V
Worst-Case Accuracy:	±2° @ f_{NOM}
Burden:	<0.1 VA

LEA Voltage Inputs (SEL-2245-411 and SEL-2245-221)

V_{NOM}:	1.5 V
Measurement Range:	30 Vac peak 0.05–22 Vac rms
Maximum:	300 V_{L-N} rms for 10 s (surge)
Typical Accuracy:	±0.1% rms @ f_{NOM} and > 50 mV ±0.1% fundamental @ f_{NOM} and > 50 mV
Worst-Case Accuracy:	±3% ±1 mV @ f_{NOM} fundamental/rms
Angle	
Range:	±180°
Typical Accuracy:	±0.1° @ f_{NOM} and > 50 mV
Worst-Case Accuracy:	±2° @ f_{NOM}
Burden:	<0.1 VA

Sequence Components (SEL-2245-4)

Values:	I0, I1, I2, V0, V1, V2
Typical Accuracy	
Magnitude:	±0.2% @ f_{NOM} and V > 6.7 V, I > 0.6 A
Angle:	±0.2° @ f_{NOM} and V > 6.7 V, I > 0.6 A
Worst-Case Accuracy	
Magnitude:	±3% @ f_{NOM} and V > 6.7 V, I > 0.6 A
Angle:	±0.2° @ f_{NOM} and V > 6.7 V, I > 0.6 A

Power and Power Factor Per Phase and Three-Phase (SEL-2245-4)

PA, PB, PC, 3P	
Typical Accuracy:	0.1% @ PF > 0.1
Worst-Case Accuracy:	2%
QA, QB, QC, 3Q	
Typical Accuracy:	0.1% @ PF < 0.9
Worst-Case Accuracy:	2%
SA, SB, SC, 3S	
Typical Accuracy:	0.1%
Worst-Case Accuracy:	2%
PFA, PFB, PFC, 3PF	
Typical Accuracy:	0.1% @ PF > 0.1
Worst-Case Accuracy:	2%

Power and Power Factor Per Phase and Three-Phase (SEL-2245-411)

PA, PB, PC, 3P	
Typical Accuracy:	0.1% @ PF ≥ 0.5
Worst-Case Accuracy:	2%

QA, QB, QC, 3Q

Typical Accuracy:	0.1% @ PF ≤ 0.98
Worst-Case Accuracy:	2%

SA, SB, SC, 3S

Typical Accuracy:	0.1%
Worst-Case Accuracy:	2%

PFA, PFB, PFC, 3PF

Typical Accuracy:	0.1% @ Unity PF
Worst-Case Accuracy:	2%

Synchrophasor

Conformance:	IEEE C37.118.1-2011 as amended by IEEE C37.118.1a-2014 IEEE C37.118.2-2011
Accuracy:	Level 1 as specified by IEEE C37.118
Measurements:	Software selectable (P or M class)
Voltage:	VA, VB, VC, VS
Current:	IA, IB, IC, IN
Positive-Sequence:	V1, I1
Periodic:	Frequency and df/dt
Processing Rate:	120 Hz
Frequency Resolution:	±1.25 mHz*
Calculated Power Resolution:	±0.1%*

* Resolution values tested on SEL-2245-4 with 69 V voltage inputs, 0.6 A to 1 A current inputs, and 49.5 to 50.5 Hz frequency range.

Message Rates (60 Hz nominal):	1, 2, 4, 5, 10, 12, 15, 20, 30, 60, and 120* (messages/second)
Message Rates (50 Hz nominal):	1, 2, 5, 10, 25, 50, and 100* (messages/second)

* This message rate is only supported on the SEL-2245-4, SEL-2245-42, and SEL-2245-411 Axion modules. Message rates are supported on the SEL-2241-2, SEL-3350, SEL-3555, and SEL-3560.

Triggered Waveform Recording (SEL-2245-4, SEL-2245-411, SEL-2245-22, and SEL-2245-221)

Sampling Rates:	1, 2, 4, 8, 24 kHz software selectable
Record Duration:	0.1 second increments from 0.5 s to specified maximum for each sample rate.
Maximum Record Duration:	6 s @ 24 kHz 18 s @ 8 kHz 36 s @ 4 kHz 72 s @ 2 kHz 144 s @ 1 kHz
Record Pre-Trigger:	0.05 s minimum to a maximum of (record length minus 0.05 s)
Waveform File Format:	COMTRADE (IEEE C37.111-1999 compliant)

AC Protection Inputs (SEL-2245-42)

Frequency

Rated:	50/60 Hz
Range:	40–90 Hz
Typical Accuracy:	±0.005 Hz above 20 V
Worst-Case Accuracy:	±0.01 Hz above 20 V (±0.1 Hz for <2.5 cycles during transients)
Phase Rotation:	ABC, ACB
Input Configuration:	3-Wire Delta, 4-Wire Wye

Update Interval

Fundamental Metering:	250 Hz
RMS:	250 Hz, 1 cycle window
THD (15th Harmonic Limited):	250 Hz, 1 cycle window
Harmonics and THD (63rd Harmonic Limited):	10/12 cycle for 50/60 Hz system frequency

AC Current Channels

Nominal Current:	1 A_{RMS} or 5 A_{RMS} (no setting required)
Current Range Rating (With DC Offset at X/R = 10, 1.5 Cycles):	0.1–91 A
Operational Range:	0.1–300 A_{RMS}
Measurement Range:	0.1–20 A_{RMS}
Thermal Withstand Limit:	15 A_{RMS} continuous 500 A_{RMS} for one second

Fundamental Measurement Accuracy

Magnitude:	±0.1%, typical, ±0.001 A ±2%, worst case, ±0.001 A
Phase:	±0.1°, typical at f_{NOM} and current > 0.4 A ±1°, over full rated temperature range ±2°, worst case

RMS Measurement Accuracy

Magnitude:	±0.1%, typical, ±0.001 A ±2%, worst case, ±0.001 A
Burden:	<0.1 VA @ 67 V Impedance >500 kΩ

THD Accuracy (15th Harmonic Limited):	±5% of measurement plus ±0.25%

AC Voltage Channels

Rated Range:	67–240 V_{L-N}

Note: Rated Range refers to the IEEE C37.118 rating system.

Operational Range:	0–300 V_{L-N}
Accuracy Range:	6.7–300 V_{L-N}
Rated Insulation Voltage:	300 V_{L-N} continuous 600 V_{L-N} for ten seconds

Galvanic Isolated Channels

Channel-to-Ground and Channel-to-Channel:	2.5 kV_{RMS} for one minute

Fundamental Measurement Accuracy

Magnitude:	±0.1%, typical, plus ±0.05 V ±3%, worst case, plus ±0.05 V
Phase:	±0.1° @ f_{NOM}, typical ±1° @ f_{NOM}, over full rated temperature range ±2° @ f_{NOM}, worst case

RMS Measurement Accuracy

Magnitude:	±0.1%, typical, plus ±0.05 V ±3%, worst case, plus ±0.05 V
Burden:	<0.01 VA @ 67 V Impedance >500 kΩ

THD Accuracy (15th Harmonic Limited):	±5% of measurement plus ±0.25%

Sequence Components

Values:	I0, I1, I2, V0, V1, V2

Note: Sequence components are of the fundamental frequency.

Accuracy

Magnitude:	±1%, typical
Angle:	±0.5°, typical

Power and Power Factor (Per-Phase and Three-Phase)

Values:	PA, PB, PC, PAB, PBC, PCA, QA, QB, QC, QAB, QAC, QCA, SA, SB, SC, SAB, SBC, SCA, PFA, PFB, PFC, P3, Q3, S3, PF3
Accuracy:	±1%, typical

Synchrophasors

Conformance:	IEEE C37.118.1-2011 as amended by IEEE C37.118.1a-2014 IEEE C37.118.2-2011
Accuracy:	Level 1 as specified by IEEE C37.118
Measurements:	Software selectable (P or M Class)
Voltage:	VA, VB, VC
Current:	IA, IB, IC
Positive-Sequence:	V1, I1
Periodic:	Frequency and df/dt
Processing Rate:	120 Hz
Frequency Resolution:	±1.25 mHz*
Calculated Power Resolution:	±0.1%*

* Resolution values tested with 69 V voltage inputs, 0.6 A to 1 A current inputs, and 49.5 to 50.5 Hz frequency range.

Message Rates (60 Hz nominal):	1, 2, 4, 5, 10, 12, 15, 20, 30, 60, and 120* (messages/second)
Message Rates (50 Hz nominal):	1, 2, 5, 10, 25, 50, and 100* (messages/second)

* Message rates are supported on the SEL-2241-2, SEL-3350, SEL-3555, and SEL-3560.

Triggered Waveform Recording

Sampling Rates:	1, 2, 4, 8, 24 kHz software selectable
Transient Fault Record Length	
Individual Records as Long as:	24 s for 24 kHz 72 s for 8 kHz 144 s for 4 kHz 288 s for 2 kHz 576 s for 1 kHz
Pre-Fault Time:	0.05 s to (max. event length – 0.05 s)
Data Format:	IEEE C37.111-2013 COMTRADE
File Naming:	IEEE C37.232 COMNAME

Harmonics

Processing Window:	10/12 cycle for 50/60 Hz system frequency
Measurement Bandwidth:	40–4,000 Hz (63rd harmonic)
Accuracy Range	
Fundamental Frequency:	40–70 Hz
Voltage (V_{fund}):	67–270 V
Current (I_{fund}):	0.5–18.0 A
Voltage Accuracy (40–3,000 Hz):	±5% for measurements ≥1% of V_{fund} ±0.05% of V_{fund} for measurements <1% of V_{fund}
Current Accuracy (40–3,000 Hz):	±5% for measurements ≥1% of I_{fund} ±0.15% of I_{fund} for measurements <1% of I_{fund}
THD Accuracy (63rd Harmonic Limited):	±5% typical

Note: Harmonic measurements are calculated as harmonic subgroups, representing the rms value of the spectral content within a 15 Hz band centered on the target harmonic frequency (7.5 Hz before and after). Interharmonic measurements are determined as interharmonic centered subgroups, which are the rms values of the spectral content between two harmonic subgroups. THD measurements are calculated as the ratio of the rms value of the harmonic subgroups, up to the 63rd harmonic, to the rms value of the subgroup associated with the fundamental frequency.

Technical Support

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

Schweitzer Engineering Laboratories, Inc.
2350 NE Hopkins Court
Pullman, WA 99163-5603 U.S.A.
Tel: +1.509.338.3838
Fax: +1.509.332.7990
Internet: selinc.com/support
Email: info@selinc.com

Notes

SCHWEITZER ENGINEERING LABORATORIES, INC.
2350 NE Hopkins Court • Pullman, WA 99163-5603 U.S.A.
Tel: +1.509.332.1890 • Fax: +1.509.332.7990
selinc.com • info@selinc.com

PDS2240-03