SEL-2240 Axion

Instruction Manual

20241025

SEL SCHWEITZER ENGINEERING LABORATORIES

Part Number: PM2240-01

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Preface

Safety Information

⚠CAUTION
To ensure proper safety and operation, the equipment ratings, installation instructions, and operating instructions must be checked before commissioning or maintenance of the equipment. The integrity of any protective conductor connection must be checked before carrying out any other actions. It is the responsibility of the user to ensure that the equipment is installed, operated, and used for its intended function in the manner specified in this manual. If misused, any safety protection provided by the equipment may be impaired.

Dangers, Warnings, and Cautions

This manual uses three kinds of hazard statements, defined as follows:

⚠DANGER
Indicates an imminently hazardous situation that, if not avoided, **will** result in death or serious injury.

⚠WARNING
Indicates a potentially hazardous situation that, if not avoided, **could** result in death or serious injury.

⚠CAUTION
Indicates a potentially hazardous situation that, if not avoided, **may** result in minor or moderate injury or equipment damage.

Safety Symbols

The following symbols are often marked on SEL products.

	**⚠CAUTION** Refer to accompanying documents.	**⚠ATTENTION** Se reporter à la documentation.
	Earth (ground)	Terre
	Protective earth (ground)	Terre de protection
	Direct current	Courant continu
	Alternating current	Courant alternatif
	Both direct and alternating current	Courant continu et alternatif
	Instruction manual	Manuel d'instructions

Safety Marks

The following statements apply to this device.

General Safety Marks

⚠CAUTION There is danger of explosion if the battery is incorrectly replaced. Replace only with Rayovac no. BR1632 or equivalent recommended by manufacturer. See Owner's Manual for safety instructions. The battery used in this device may present a fire or chemical burn hazard if mistreated. Do not recharge, disassemble, heat above 100°C or incinerate. Dispose of used batteries according to the manufacturer's instructions. Keep battery out of reach of children.	**⚠ATTENTION** Une pile remplacée incorrectement pose des risques d'explosion. Remplacez seulement avec un Rayovac no BR1632 ou un produit équivalent recommandé par le fabricant. Voir le guide d'utilisateur pour les instructions de sécurité. La pile utilisée dans cet appareil peut présenter un risque d'incendie ou de brûlure chimique si vous en faites mauvais usage. Ne pas recharger, démonter, chauffer à plus de 100°C ou incinérer. Éliminez les vieilles piles suivant les instructions du fabricant. Gardez la pile hors de la portée des enfants.
⚠CAUTION Use supply wires suitable for 60°C (140°F) above ambient.	**⚠ATTENTION** Utilisez des fils d'alimentation appropriés pour 60°C (140°F) au-dessus ambiante.
For use in Pollution Degree 2 environment.	Pour l'utilisation dans un environnement de Degré de Pollution 2.
Ambient air temperature shall not exceed 40°C (104°F).	La température de l'air ambiant ne doit pas dépasser 40°C (104°F).
Terminal Ratings Tightening Torque I/O and Power Terminal Blocks: 0.6 to 0.8 Nm (5 to 7 in-lb) Serial Ports: 0.6 to 0.8 Nm (5 to 7 in-lb) CT Terminal Blocks: 1.0 to 2.0 Nm (9 to 18 in-lb) Wire Type: Copper or Aluminum	Spécifications des bornes Couple de serrage Borniers d'entrée/sortie et de puissance: 0,6 à 0,8 Nm (5 à 7 livres-pouce) Ports série: 0,6 à 0,8 Nm (5 à 7 livres-pouce) CT borniers: 1,0 à 2,0 Nm (9 à 18 livres-pouce) Type de fil : cuivre ou aluminium

Other Safety Marks (Sheet 1 of 2)

⚠DANGER Contact with instrument terminals can cause electrical shock that can result in injury or death.	**⚠DANGER** Tout contact avec les bornes de l'appareil peut causer un choc électrique pouvant entraîner des blessures ou la mort.
⚠DANGER Disconnect or de-energize all external connections before opening this device. Contact with hazardous voltages and currents inside this device can cause electrical shock resulting in injury or death.	**⚠DANGER** Débrancher tous les raccordements externes avant d'ouvrir cet appareil. Tout contact avec des tensions ou courants internes à l'appareil peut causer un choc électrique pouvant entraîner des blessures ou la mort.
⚠WARNING Use of this equipment in a manner other than specified in this manual can impair operator safety safeguards provided by this equipment.	**⚠AVERTISSEMENT** L'utilisation de cet appareil suivant des procédures différentes de celles indiquées dans ce manuel peut désarmer les dispositifs de protection d'opérateur normalement actifs sur cet équipement.
⚠WARNING Have only qualified personnel service this equipment. If you are not qualified to service this equipment, you can injure yourself or others, or cause equipment damage.	**⚠AVERTISSEMENT** Seules des personnes qualifiées peuvent travailler sur cet appareil. Si vous n'êtes pas qualifiés pour ce travail, vous pourriez vous blesser avec d'autres personnes ou endommager l'équipement.
⚠WARNING Segregation between Class 1 (field, factory wiring, terminal, and uninsulated live parts) and Class 2 and Class 3 (wiring and uninsulated live parts) must be provided in the installation. Segregate by 1) using any combination of clamping, routing, or equivalent wire management method with a minimum of 6.0 mm of separation, 2) using insulation rated for the highest voltage on both wires and cables, or 3) adding an additional sleeving rated for the highest voltage on the Class 2 or Class 3 wiring (completely covering the wiring, end to end). Wiring class is defined per NFPA 70.	**⚠AVERTISSEMENT** La ségrégation entre la classe 1 (sur site, câblage d'usine, borne et pièces sous tension non isolées) et les classes 2 et 3 (câblage et pièces sous tension non isolées) doit être fournie avec l'installation. Séparer par 1) en utilisant toute combinaison de méthode de serrage, d'acheminement ou de gestion des câbles équivalente avec un minimum de 6,0 mm de séparation, 2) en utilisant une isolation évaluée pour la tension la plus élevée sur les fils et les câbles, ou 3) en ajoutant une gaine supplémentaire évaluée pour la tension la plus élevée sur le câblage de classe 2 ou de classe 3 (couvrant complètement le câblage, bout à bout). La classe de câblage est définie par NFPA 70.

Other Safety Marks (Sheet 2 of 2)

⚠CAUTION Equipment components are sensitive to electrostatic discharge (ESD). Undetectable permanent damage can result if you do not use proper ESD procedures. Ground yourself, your work surface, and this equipment before removing any cover from this equipment. If your facility is not equipped to work with these components, contact SEL about returning this device and related SEL equipment for service.	**⚠ATTENTION** Les composants de cet équipement sont sensibles aux décharges électrostatiques (DES). Des dommages permanents non-décelables peuvent résulter de l'absence de précautions contre les DES. Raccordez-vous correctement à la terre, ainsi que la surface de travail et l'appareil avant d'en retirer un panneau. Si vous n'êtes pas équipés pour travailler avec ce type de composants, contacter SEL afin de retourner l'appareil pour un service en usine.
⚠CAUTION The relay contains devices sensitive to Electrostatic Discharge (ESD). When working on the relay with the front panel removed, work surfaces and personnel must be properly grounded or equipment damage may result.	**⚠ATTENTION** Le relais contient des pièces sensibles aux décharges électrostatiques. Quand on travaille sur le relais avec les panneaux avant ou du dessus enlevés, toutes les surfaces et le personnel doivent être mis à la terre convenablement pour éviter les dommages à l'équipement.
⚠CAUTION Looking into optical connections, fiber ends, or bulkhead connections can result in hazardous radiation exposure.	**⚠ATTENTION** Regarder vers les connecteurs optiques, les extrémités des fibres oules connecteurs de cloison peut entraîner une exposition à des rayonnements dangereux
⚠CAUTION Use extreme caution when changing POU settings. Contact an SEL representative for assistance.	**⚠ATTENTION** Veuillez faire preuve d'une extrême prudence quand vous changez les réglages POU. Contactez un représentant de SEL pour de l'aide.

General Information

Environmental Conditions and Voltage Information

NOTE: For applications compliant with IEC-60255-27, surface-mount units must be installed in IP4X enclosures.

The following table lists important environmental and voltage information.

Condition	Range/Description
Indoor/outdoor use	Indoor
Altitude	As high as 2000 m
Relative humidity	5% to 95%
Overvoltage	Category II
Pollution	Degree 2
Vibration, earth tremors	Class 1
Atmospheric pressure	80 to 110 kPa

Laser/LED Emitter

The SEL-2240 is a Class 1 LED Product and complies with IEC 60825-1:1993 + A1:1997 + A2:2001.

The following table shows LED information specific to the SEL-2240 for **ETH 1** and **ETH 2**, the ports that optionally use LED transmitters.

SEL-2241 and SEL-2243 LED Information

Item	Detail
Mode	Multimode (62.5 µm fiber)
Wavelength	1300 nm
Source	LED
Connector type	LC
Output power	–14 to –19 dBm

Safety Warnings and Precautions

⚠CAUTION
Use of controls or adjustments, or performance of procedures other than those specified herein, may result in hazardous radiation exposure.

- Do not look into the end of an optical cable connected to an optical output.
- Do not look into the fiber ports/connectors.
- Do not perform any procedures or adjustments that are not described in this manual.
- During installation, maintenance, or testing of the optical ports only use test equipment classified as Class 1 laser products.
- Incorporated components such as transceivers and laser/LED emitters are not user serviceable. Units must be returned to SEL for repair or replacement.

Instructions for Cleaning and Decontamination

Use care when cleaning the SEL-2240. Use a mild soap or detergent solution and a damp cloth to clean the chassis. Clean the touchscreen display gently with a moist cotton cloth. Do not use abrasive materials, polishing compounds, or harsh chemical solvents (such as xylene or acetone) on any surface.

Copyrighted Software

The software included in this product may contain copyrighted software licensed under terms that give you the opportunity to receive source code. You may obtain the applicable source code from SEL by sending a request to:

Legal Department
GPL Compliance
Schweitzer Engineering Laboratories, Inc.
One Schweitzer Drive
Pullman, WA 99163

Please include your return address, product number, and firmware revision.

Technical Support

We appreciate your interest in SEL products and services. If you have questions or comments, or for test reports, or for information regarding safe disposal or recycling of the equipment, please contact us at:

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

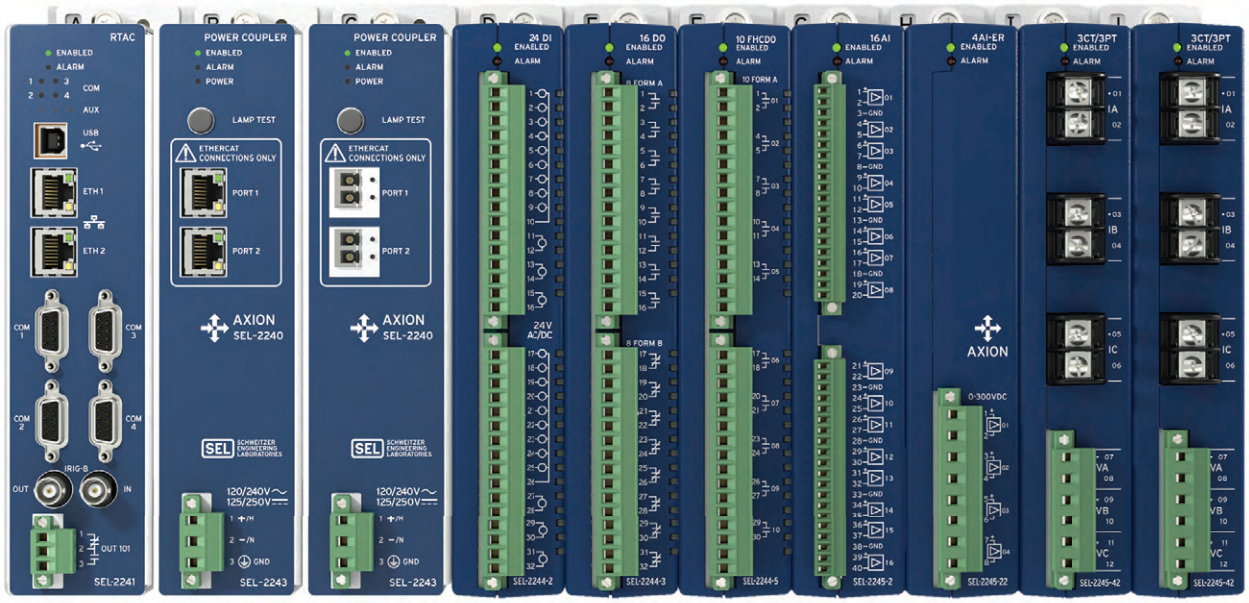
Section 1

Introduction and Specifications

Overview

The SEL-2240 Axion® is a fully integrated modular input and output (I/O) and control solution suitable for many utility and industrial applications. It combines the communications, built-in security, and IEC 61131 logic engine of the SEL Real-Time Automation Controller (RTAC) family with a durable suite of I/O modules that provide high-speed, deterministic, control performance over an Ethernet network. An Axion node consists of a 10-slot, 4-slot, or dual 4-slot chassis configurable to contain a CPU, one or two power supplies (called SEL-2243 Power Couplers), and as many as nine I/O modules. Power couplers operate in a fully redundant, load-sharing fashion. A single coupler module can accommodate the entire node for those applications that do not need redundant supplies.

For bay control applications, the optional 7-inch color touchscreen display (available on the 10-slot backplane only) provides a one-line diagram mimic display for comprehensive bay control and monitoring. Use this interface to operate breakers or switches and access Sequence of Events (SOE) logs, device information, module statuses, and more.



The SEL-2240 is designed to be easily scalable for larger projects. You can expand the system by connecting multiple nodes via Ethernet. EtherCAT® protocol creates a virtual Ethernet backplane between the I/O nodes without any loss of speed or determinism. Only a single central processing unit (CPU) module is necessary, even for a multinode network. Optionally, employ fiber-optic Ethernet cables between nodes to ensure excellent electrical isolation and enable greater distances between nodes. The CPU within the RTAC includes secure communications and user administration, advanced data concentration, high-speed logic processing, flexible engineering access, and protocol conversion capabilities between multiple built-in client/server protocols. The Axion gives an integrator the necessary tools to easily integrate and concentrate information from a wide variety of local I/O, remote I/O, and microprocessor-based devices in today's substations and plants. With the intuitive software in the device, you can quickly configure large automated systems.

Functional Concept

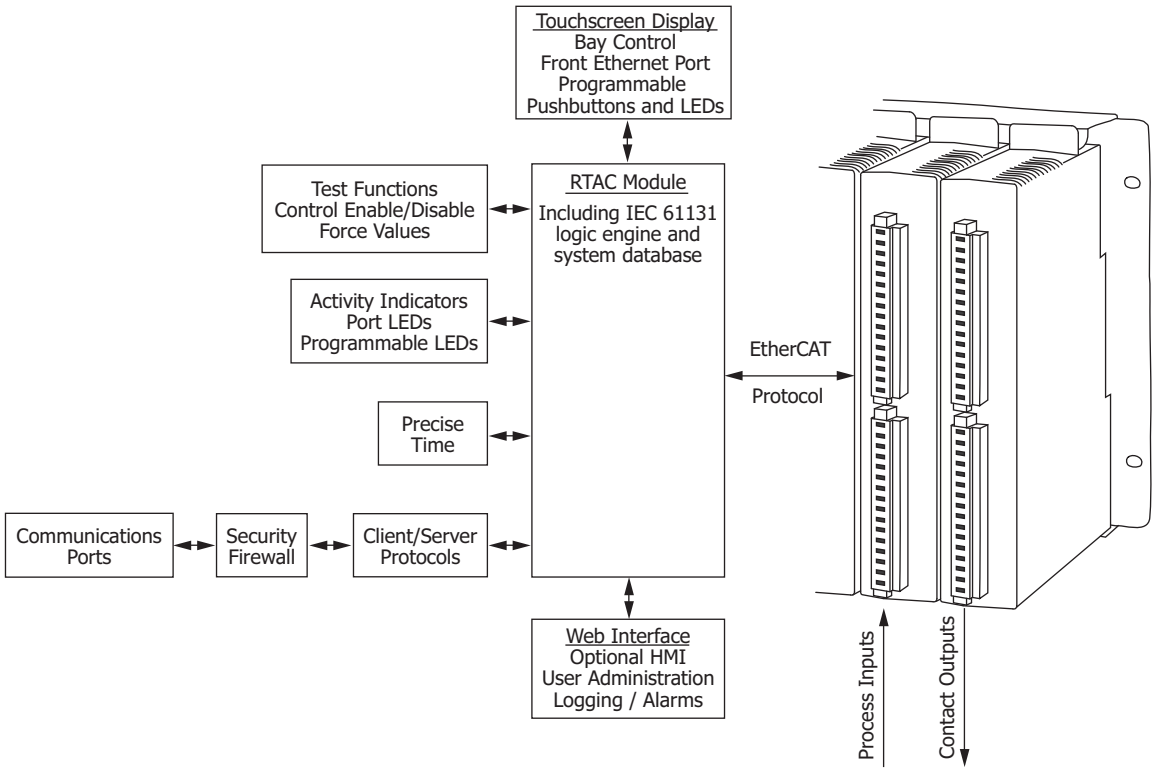


Figure 1.1 Functional Design Concept

Key Attributes

Today's monitoring and control applications need flexible system architectures and integrated security. The Axion meets these needs by using SEL RTAC modules as the system CPU. Two configurations are possible. There can be an SEL-2241 RTAC module installed directly in the Axion node, or there can be a standalone SEL-3530 or SEL-3555 RTAC installed separately from the node.

SEL designs all SEL-2240 hardware to published standards (see *Specifications*) and performs tests to verify that each component exceeds standards by adequate margins. The Power Coupler module (model SEL-2243) is a highly reliable device that uses the same power supply technology presently in use in SEL protective relays. You can also configure any node with redundant power couplers for critical applications needing redundant supplies. In such configurations, the SEL-2243 modules actively share loads to supply power needs 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.

Each SEL-2240 node is mounted in a chassis/backplane (model SEL-2242) that provides a means for each node to include a custom configuration of I/O modules. A single node can contain as many as nine I/O modules. Within a node, use any combination, quantity, and sequence of I/O modules that suits the application. The node does not need to be entirely full to function properly. Leave empty slots for future expansion as necessary.

Many RTU and control installation systems need more I/O points than will fit in a single node. In those cases, connect multiple nodes together via a real-time Ethernet network by using the EtherCAT protocol (see *Section 2: Communications* in the *ACSELERATOR RTAC SEL-5033 Instruction Manual*). Through use of the Axion

EtherCAT implementation, you can connect as many as 60 modules in a single network with no loss of speed or determinism. A single RTAC module provides logic functions and data concentration for the entire network.

Features

Physical

Table 1.1 Module Features (Sheet 1 of 2)

SEL-2240 Including Modules	
Height	5 rack units (22.15 cm (8.72 in))
Width	48.26 cm (19 in)
Depth	17.53 cm (6.9 in)
Weight	7.26 kg (16 lb)
Mounting	Surface mounting for control panels Rack mounting for relay panel or swing panels Panel mounting (10-slot and dual 4-slot)
SEL-2241 RTAC Module	
Ethernet	2 RJ45 ports (LC fiber multimode or single-mode option)
Host USB	1
EIA-232/EIA-422/EIA-485 Serial	4 (DB-9) ports
IRIG-B Input	1 (BNC) for modulated or demodulated IRIG-B
IRIG-B Output	1 (BNC) for demodulated IRIG-B
Digital Outputs	1 electromechanical, Form C
SEL-2242 Backplane	
Front Panel	Standard: **LAMP TEST** button and module status LEDs, includes standard overlay Bay Control: 7-inch touchscreen display, 6 programmable pushbuttons, and 19 LEDs (optional add-on, available with 10-slot, rack-mount model)
Ethernet	One RJ45 port for Engineering Access (included with touchscreen display)
SEL-2243 Power Coupler Module	
Ethernet	2 RJ45 ports (LC fiber multimode or single-mode option)
Incoming Power (High-Voltage Model)	120/240 Vac, 50/60 Hz, 125/250 Vdc
Incoming Power (Low-Voltage Model)	24/48 Vdc
SEL-2244-2 Digital Input Module	
Inputs	6 independent, eighteen common-return
Input Voltage (AC or DC)	24 V, 48 V, 110 V, 125 V, 220 V, 250 V
SEL-2244-3 Digital Output Module	
Outputs	16
Type	Form A or Form B
SEL-2244-5 Fast High-Current Digital Output Module	
Outputs	10
Type	Form A or Form B

NOTE: The SEL-2242 backplane with touchscreen display is only compatible with SEL-2241 RTACs that ship with R149 firmware or later.

Table 1.1 Module Features (Sheet 2 of 2)

SEL-2245-2 DC Analog Input Module	
Inputs	16
Input Range (DC)	±20 mA, ±2 mA, ±10 V
SEL-2245-22 DC Analog Input Extended Range Module	
Inputs	4
Input Range (DC)	0–300 V
SEL-2245-3 DC Analog Output Module	
Outputs	8
Output Range (DC)	±20 mA, ±10 V
SEL-2245-4 AC Metering Module	
Inputs	4 CT/4 PT
Input Range	0–22 A / 5–400 Vac: 45–65 Hz
SEL-2245-411 Standard Current and Low-Voltage (LEA) Monitoring Module	
Inputs	4 CT/4 LEA
Input Range	0–22 A / 0.05–30 Vac: 45–65 Hz
SEL-2245-221 Low-Voltage (LEA) Monitoring Module	
Inputs	4 LEA
Input Range	0.05–30 Vac: 45–65 Hz
SEL-2245-42 AC Protection Module	
Inputs	3 CT/3 PT
Input Range	0–20 A / 0–300 Vac: 40–70 Hz

Processing System

These features will be present for use of the SEL-2241 RTAC Module, SEL-3530 RTAC, or SEL-3555 RTAC.

Embedded Real-Time Operating System
The embedded SEL Linux® operating system provides exceptional speed, flexibility, and functionality along with increased security.
Watchdog Timer
A separate watchdog microcontroller system provides an extra level of computer system reliability. The microcontroller will activate an alarm and halt all input/output activity if there is a problem with the IEC 61131 logic engine.
Diagnostics and Logging
Manage users, view logs, and check report diagnostics via the built-in web server. Access the historical database for diagnostics and logging. Use open database connectivity (ODBC) to view security and diagnostics logs in off-the-shelf ODBC-compliant programs.

Human-Machine Interface (HMI)

Use ACSELERATOR Diagram Builder™ SEL-5035 Software to build HMI diagrams and load the pages into the RTAC for the optional web-based HMI. Use the HMI pages for annunciation, one-line diagrams, trending, and controls. Because the HMI is web-based, no software is needed besides a web browser. View the HMI through a web browser on a remote computer.

The RTAC will detect which web browser is used for viewing the HMI and render the images by using either HTML5 or Microsoft Silverlight technology, which is a browser plug-in used for graphical web content display. See *Table 1.2* for further requirements for viewing the HMI on a remote PC.

Table 1.2 HMI Browser Requirements

Requirement	HTML5	Silverlight
Operating System	Windows 7 SP1 Ubuntu 14.04+	Windows 7 SP1
Processor	Intel® Core™ Duo 2 GHz or higher processor	Intel Core Duo 2 GHz or higher processor
RAM	2 GB or greater	2 GB or greater
Web Browser	Google™ Chrome™ 40+ Opera 27+	Internet Explorer 8, 9, 11[a] Google Chrome 34+ Mozilla Firefox 35+

[a] Required Silverlight plug-in version is 5.1.30514.0.

Automation and Control

These features will be present for use of the SEL-2241 RTAC Module, SEL-3530 RTAC, or SEL-3555 RTAC.

Industry Standard (IEC 61131) Logic Processing

The RTAC includes the IEC 61131 programming environment with standard, custom, and Ethernet libraries for logic processing and scaling of collected data. Two configurable processing cycles give flexibility to run high-speed automation tasks at speeds as fast as one millisecond while SCADA and other lower-speed tasks can run at a slower rate.

Data Concentration and Protocol Conversion

Collect I/O and IED data from attached devices and store these data locally. Integrate with SCADA, HMI, and other SEL-2240 systems via popular industry-standard and SEL protocols, such as MIRRORED BITS® communications, Modbus® RTU, Modbus TCP, IEC 61850 GOOSE, IEC 61850 MMS client/server, LG 8979 client/server, SES-92 server, IEC 60870-5 101/104 client/server, EtherCAT fieldbus, DNP3 Level 3 Serial client/server, DNP3 LAN/WAN client/server, IEEE C37.118 client/server, CP2179 client, and SNMP client.

System Configuration and Maintenance

Configure the RTAC network interface, user account, and security settings over the network via the web interface. Configure I/O networks and protocol communications, program IEC 61131 logic, and send project settings with ACSELERATOR RTAC® SEL-5033 Software. After sending project settings, view and force data values to test user logic and data-mapping schemes. Create as many as 25 custom bay screen and modify settings for the 7-inch, color touchscreen display by using the embedded Bay Screen Builder application in ACSELERATOR RTAC.

System Security

These features will be present for use of the SEL-2241 RTAC Module, SEL-3530 RTAC, or SEL-3555 RTAC.

Malware Protection

exe-GUARD® anti-malware technology protects the RTAC in two ways:

1. Only authorized tasks are allowed to run on the system.
2. Mandatory Access Control restricts privileges of programs and services to the absolute minimum required to function on the system.

There is no need for virus definition files because only whitelisted or preapproved tasks are allowed to run on the RTAC. SEL Whitelist operates at the core of the RTAC operating system, where it intercepts every program before it is executed. Using advanced cryptographic algorithms, Whitelist inspects a program's binary image before it is allowed to execute, verifying its legitimacy and integrity against a known digital signature. As defined by user configuration, unauthorized changes to the system result in either an alarm indication or device reset to factory defaults. Similarly, any modification or replacement of an existing firmware binary is also revealed by the digital signature verification process and results in the same denial of execution and security response.

Mandatory Access Control fine-tunes the system security policy so that programs and services are constrained to the absolute minimum access privileges required to function. Defining this minimal privilege set at design time ensures firmware processes can be locked to their minimal scope of influence in the system.

User Account Management

Each user account has a unique username, password, and assigned permissions. You can configure accounts to use LDAP central authentication for user account management.

Logging and Auditing

Logged tag values and system events provide a system-wide Sequential Events Recorder report. View the logs online or use ODBC connectivity to download them to a central database.

Time Synchronization

These features will be present for use of the SEL-2241 RTAC Module, SEL-3530 RTAC, or SEL-3555 RTAC.

Time Synchronization for Connected Devices

The RTAC provides a modulated or demodulated coaxial IRIG-B output signal. The RTAC also provides a demodulated IRIG-B output signal to connected intelligent electronic devices (IEDs) via all EIA-232/EIA-422/EIA-485 ports. The RTAC also includes an NTP and SNTP server function for compatible Ethernet devices.

IRIG-B Generation

In the absence of an external IRIG-B signal, the RTAC generates a demodulated IRIG-B signal. If necessary, you can synchronize the system clock with a network time server (via SNTP, NTP, or PTP).

Communications Protocols

These features will be present for use of the SEL-2241 RTAC Module, SEL-3530 RTAC, or SEL-3555 RTAC.

Table 1.3 Communications Protocols (Sheet 1 of 2)

SEL Protocols	Connection	Serial	Ethernet
Encrypted Engineering Access	Pass-Through	Yes[a]	Yes
Transparent Connections	Pass-Through	Yes	Yes
SEL Fast Meter	Client	Yes	Tunneled Serial
SEL Fast Message	Client/Server	Yes	Tunneled Serial
SEL Compressed ASCII	Client	Yes	Tunneled Serial
SEL MIRRORED BITS communications	Peer-to-Peer	Yes	
Industry Protocols	**Connection**	**Serial**	**Ethernet**
DNP3	Client/Server	Yes	Yes
Telnet	Server		Yes
FTP	Client		Yes
Modbus	Client/Server	Yes (RTU)	Yes

Table 1.3 Communications Protocols (Sheet 2 of 2)

IEEE C37.118 Synchrophasors	Client/Server	Yes	Yes
IEC 61850 GOOSE	Peer-to-Peer		Yes
IEC 61850 MMS	Client/Server		Yes
EtherCAT	Client		Yes (Non-routable)
LG 8979	Client/Server		Tunneled Serial
SES-92	Server	Yes	Tunneled Serial
CP2179	Client	Yes	Tunneled Serial
IEC 60870-5-101 Server	Client/Server	Yes	Tunneled Serial
IEC 60870-5-104 Server	Client/Server		Yes
SNMP	Client		Yes
File Transfer Protocol	Server		Yes

[a] Using an accessory SEL encrypting transceiver module.

Models, Options, and Accessories

Models

This manual does not provide complete ordering information. For complete information, see the latest model option tables (MOT) at selinc.com/products/2240, and select Online Product Configuration under Ordering Information. The following modules comprise an SEL-2240 system.

Table 1.4 SEL-2240 Models

Part Number	Description
SEL-2241	Real-Time Automation Controller (RTAC)
SEL-2242	Chassis/Backplane
SEL-2243	Power Coupler
SEL-2244	Digital Input and Output Modules
SEL-2245	Analog Input and Output Modules

See *Section 2: Communications* in the *ACSELERATOR RTAC SEL-5033 Instruction Manual* for options for each module.

Options

The 10-slot SEL-2242 Chassis/Backplane includes three slots (Slot **A**, Slot **B**, and Slot **C**) that are wider than the rest, to accommodate the SEL-2241 RTAC and SEL-2243 Power Coupler. Slots **B** and **C** can also accommodate an SEL-2244 module. Slots **D**–**J** will only accept SEL-2244 modules (See *Section 2: Communications* in the *ACSELERATOR RTAC SEL-5033 Instruction Manual*). You can configure the 10-slot SEL-2242 with an optional LCD touchscreen for certain applications. When configured with an LCD, only rack-mount configurations are supported, and an SEL-2241 must be installed in Slot **A** for proper operation. The 4-slot SEL-2242 Chassis/Backplane contains only wider slots to accept any of the SEL-2240 modules. This allows redundant power coupler and redundant RTAC configurations or smaller IO configurations. There is no requirement that you install a predefined sequence or number of I/O modules in a node. You can, for instance, install modules to group together all inputs and outputs associated with a certain apparatus. Another method would be to install modules so that all inputs of a given voltage are together. Install

modules in each node consecutively, starting in Slot **A**. All empty slots must be to the right of the last module in the node. Refer to *Table 1.5* through *Table 1.9* for a summary of ordering options available for Axion modules.

Table 1.5 Slot Allocation Guidelines

Slot	Description
A	SEL-2241 RTAC (required for 10-slot SEL-2242 with optional touchscreen) SEL-2243 Power Coupler (when using standalone RTAC or multinode system)
B	SEL-2243 Power Coupler SEL-2244 I/O Modules SEL-2245 I/O Modules
C	SEL-2243 Power Coupler SEL-2244 I/O Modules SEL-2245 I/O Modules
D–J	SEL-2244 I/O Modules SEL-2245 I/O Modules

Table 1.6 SEL-2241 RTAC

Communications Options (Ethernet)
2 Ethernet ports, 10/100BASE-T copper Ethernet ports (standard)
2 Ethernet ports, 100BASE-FX or 100BASE-LX fiber-optic Ethernet ports
Applications and Protocols
IEC 61850 GOOSE protocol
IEC 61850 MMS Client protocol
IEC 61850 MMS Server protocol
Web-based HMI run time and ACSELERATOR Diagram Builder software
Environment
Conformal coating for chemically harsh and high-moisture environments

Table 1.7 SEL-2242 Chassis/Backplane

Mounting
Surface mounting for control panels
Rack mounting for relay panels or swing panels
Panel mounting (10-slot and dual 4-slot)
Environment
Conformal coating for chemically harsh and high-moisture environments

Table 1.8 SEL-2243 Power Coupler

Power Supply
120/240 Vac, 50/60 Hz, single or redundant supply 125/250 Vdc or 24/48 Vdc, single or redundant supply
Environment
Conformal coating for chemically harsh and high-moisture environments

Table 1.9 SEL-2244 Digital I/O Module

Inputs
24 dry contact inputs. Voltage options: 24 Vac/Vdc 125 Vac/Vdc 48 Vac/Vdc 220 Vac/Vdc 110 Vac/Vdc 250 Vac/Vdc
Standard Current Outputs
16 Form A output contacts
16 Form B output contacts
8 Form A, 8 Form B output contacts
Fast High-Current Outputs
10 Form A output contacts
10 Form B output contacts
5 Form A, 5 Form B output contacts
Environment
Conformal coating for chemically harsh and high-moisture environments

Table 1.10 SEL-2245 Analog I/O Module

Inputs
DC Analog Inputs
16 dc analog inputs. Range options: ±20 mA ±2 mA ±10 V
DC Analog Inputs Extended Range
4 dc analog inputs. Range options: 0–300 V
AC Analog Inputs
4 CT/4 PT ac metering inputs. Range Options: PT inputs 5–400 V CT inputs 0–22 A
4 CT/4 LEA standard current and low-voltage (LEA) inputs. Range Options: LEA inputs 0.05–30 V peak CT inputs 0–22 A
3 CT/3 PT ac protection inputs. Range Options: PT inputs 0–300 V CT inputs 0–20 A
Outputs
DC Analog Outputs
8 dc analog outputs. Range options: ±20 mA ±10 V
Environment
Conformal coating for chemically harsh and high-moisture environments

Accessories

For all SEL-2240 mounting and other accessories, visit selinc.com/products/accessories. Contact your Technical Service Center or the SEL factory for additional details and ordering information for all other accessories.

Table 1.11 Optional Accessories

Product	Description
SEL-2401	Precise Timing Source—Satellite-Synchronized Clock
SEL-3610	Expansion Serial Ports—Port Server
SEL-3620	Secure Communications—Ethernet Security Gateway
SEL-3010	Automatic Voice Notification—Event Messenger
SEL-3025	Secure Communications—Serial Shield
SEL-2925	BLUETOOTH Serial Adapter
SEL-3031	Radio Communications—Serial Radio Transceiver
SEL-2810	200 µm Fiber-Optic Transceiver With IRIG-B
SEL-2812	Multimode Fiber-Optic Transceiver With IRIG-B
SEL-2814	Multimode Fiber-Optic Transceiver With Hardware Handshaking
SEL-2815	Multimode Fiber-Optic Transceiver—15 km
SEL-2829	Single-Mode Fiber-Optic Transceiver—23 km
SEL-2830	Single-Mode Fiber-Optic Transceiver—80 km
SEL-2831	Single-Mode Fiber-Optic Transceiver—110 km
915900240	SEL-2244 Wetting Voltage Jumper Kit, 24 4-Prong Jumpers, 2 Jumpers per DI Module, Four per DO Module
915900241	Wetting Voltage Jumpers Bulk, 100 pack 4-Prong Jumpers
91590185	32 conductor panel wiring harness (16 AWG/1.3 mm^2) with pre-terminated SEL-2244 connectors on one end and partially stripped wires on the other—8 ft
91590186	32 conductor panel wiring harness (16 AWG/1.3 mm^2) with pre-terminated SEL-2244 connectors on one end and partially stripped wires on the other—12 ft
91590187	32 conductor panel wiring harness (16 AWG/1.3 mm^2) with pre-terminated SEL-2244 connectors on one end and partially stripped wires on the other—20 ft

Applications

The SEL-2240 Axion provides a robust automation platform capable of using IEC 61131 programming to perform a vast range of automated tasks. Implement programs in Structured Text, Function Block, or Ladder Logic to meet any logic requirements. Use the backplane I/O modules to acquire data or gather information securely from virtually any intelligent electronic device (IED) with the wide variety of protocols built into the RTAC. Use the optional web-based human-machine interface (HMI) on the RTAC to combine traditional remote terminal units (RTUs) and HMIs in the same platform.

SEL-2240 Application
Remote Terminal Unit (RTU)
SCADA Data Concentrator
Human-Machine Interface (HMI)
Remote I/O
Programmable Logic/Automation Controller (PLC/PAC)

SEL-2240 Application
GOOSE Integration
Synchrophasor Processor
Intelligent Port Switch
Network Gateway
Protocol Gateway
Time-Synchronization Source
Security Gateway
Bay Control

Bay Control

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 alternative 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 (see *Section 6: Bay Screen and Touchscreen Display* in the *ACSELERATOR RTAC SEL-5033 Instruction Manual*).

- **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

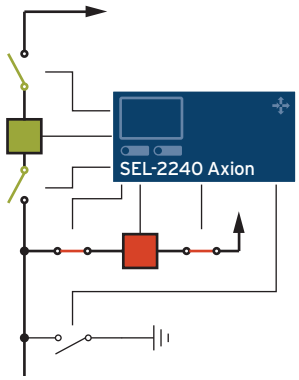
circuit breaker, and control the breakers and monitor current, voltages, and status of contact points from the substation control building.

- **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

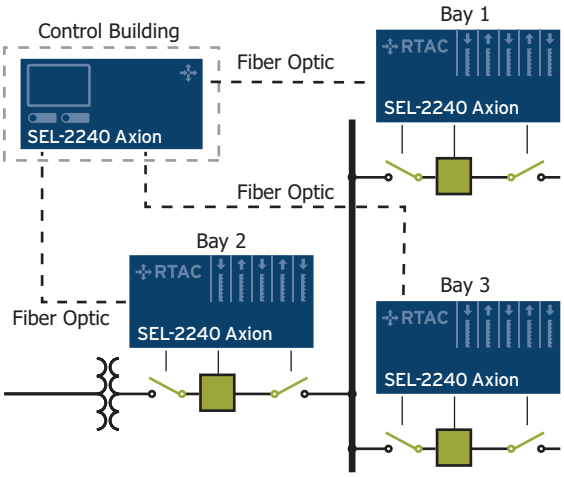
Control a Bay With Single or Dual Breaker

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



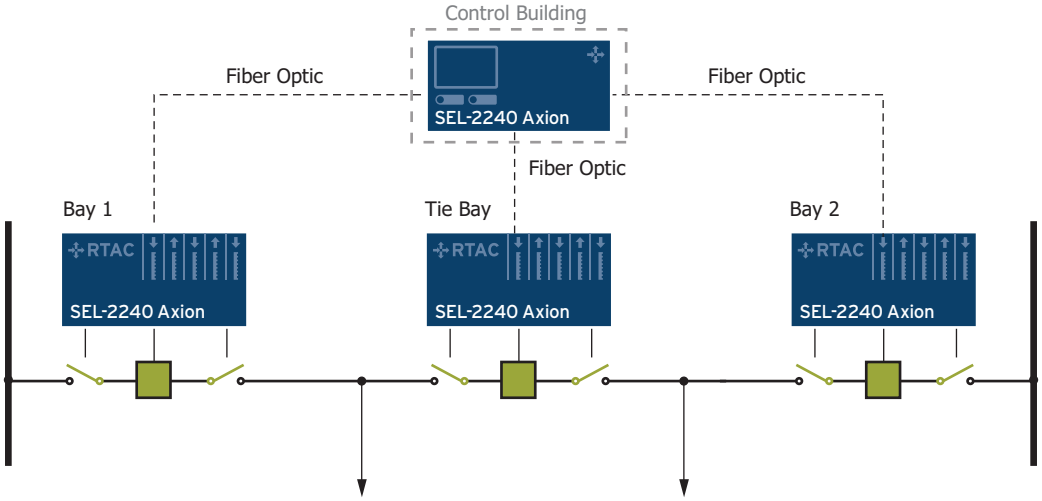
Use Distributed I/O to Control Multiple Bays

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.



Remote Terminal Unit (RTU)

Remote terminal units gather digital and analog signals at remote sites and supply these data over a variety of industry-standard protocols (DNP, Modbus, or IEC 61850) to a central supervisory control and data acquisition (SCADA) center or HMI. A master controller in the SCADA center can perform all logic or distribute logic to the RTU. The SEL-2244 I/O modules are available in a variety of types to gather many types of I/O at RTU locations. The SEL-2241 RTAC module has a variety of industry-standard protocols by which it can integrate seamlessly with any SCADA system. Additionally, the versatile IEC 61131 logic engine in the RTAC can meet the majority of logic requirements for small to large

automation projects. The modular design of the SEL-2240 provides it the ability to perform as an RTU in two ways: as a centralized master RTU or distributed in each substation.

Systems using distributed logic at the RTU use an SEL-2241 RTAC in each Axion node, thus providing all automation capabilities of the RTAC in each RTU. This architecture allows each RTU to function autonomously even if the central SCADA system is offline. Each RTAC module can communicate with the SCADA master over DNP, Modbus, IEC 61850 GOOSE, or SEL Fast Message. *Figure 1.2* illustrates use of the Axion as a distributed RTU communicating over DNP to a SCADA master.

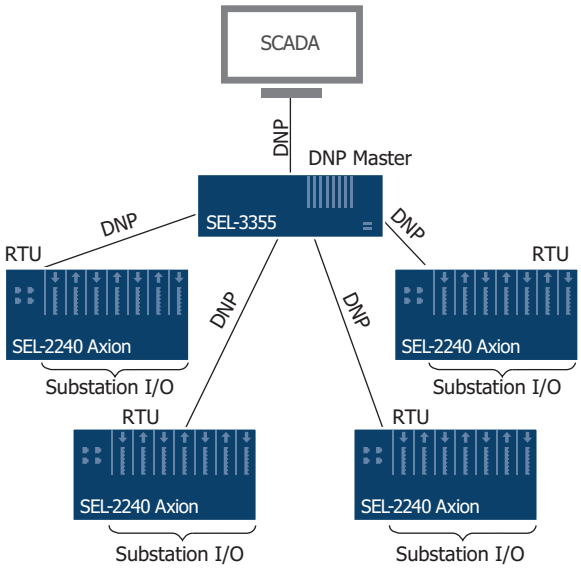


Figure 1.2 RTACs Distributed With RTUs

Systems that do not need autonomous operation at each RTU can use a central SEL-2241 and communicate to the remote nodes through the SEL-2243 Power Couplers. This architecture offers an economical solution to distributed I/O over EtherCAT at an extremely fast acquisition rate. The master SEL-2241 can host all data from remote nodes over DNP and interface directly with the SCADA system. The master Axion in *Figure 1.3* illustrates this functionality.

EtherCAT Network Topologies

The SEL-2243 Power Couplers provide not only hot-pluggable power supplies, but also fast EtherCAT connections to remote SEL-2240 nodes. The power couplers create EtherCAT links in star network topology, sequential network topology, or a combination of both. Star-configured topologies still use the sequential message format inherent to EtherCAT message design and offer greater flexibility than wired sequential network topologies in creating a network to match your physical system. Refer to *Section 2: Communications* in the *ACSELERATOR RTAC SEL-5033 Instruction Manual* for detailed information on EtherCAT.

Apply single or dual power couplers in each Axion node based on connection or redundancy requirements. *Figure 1.3* illustrates a star topology for four remote SEL-2240 nodes with single power couplers in the remote nodes and dual couplers in the RTAC master. Each remote node on the star has a corresponding slot on the EtherCAT message train.

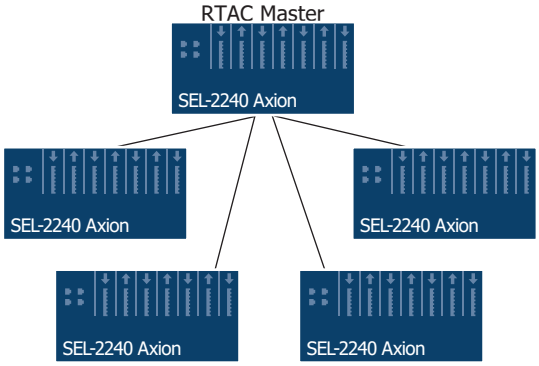


Figure 1.3 EtherCAT Star Network Topology

Figure 1.4 illustrates connections for an EtherCAT sequential topology with six Axion nodes. Each node uses a single SEL-2243 Power Coupler to provide connections to the previous and next node in the EtherCAT train.

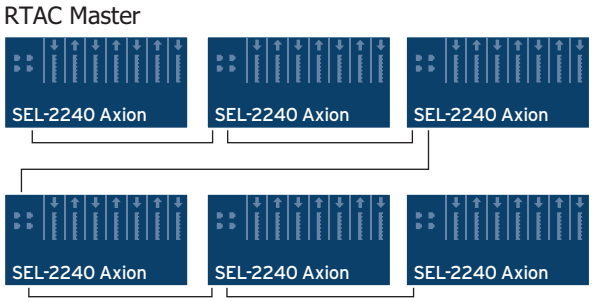


Figure 1.4 EtherCAT Sequential Network Topology

Figure 1.5 illustrates a combination of star and sequential connections with six Axion nodes.

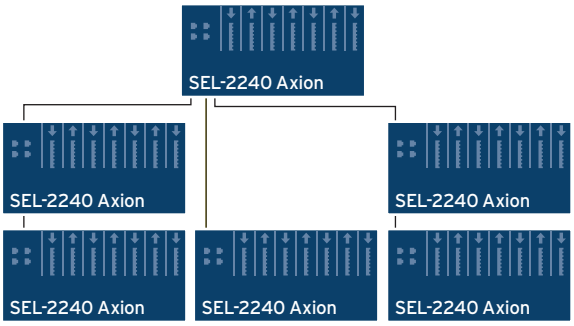


Figure 1.5 EtherCAT Combination Network Topology

SCADA Data Concentrator

Use the RTAC with your protective relays and other IEDs as the substation SCADA data concentrator. You can configure the RTAC to collect and view station-wide Sequential Events Recorder (SER) and event reports. Use MIRRORED BITS protocol to ensure compatibility with any SEL device. Retrieve asset optimization data from SEL or other IEDs to maintain the best possible system reliability. Take advantage of multiprotocol support to collect SCADA information, process control commands, and obtain SNTP/NTP time synchronization through a single communications link to each Ethernet device. Scale values and calculate logic in a familiar IEC 61131 configuration environment. Enjoy secure, encrypted communications to any device on the substation network or serial channel.

Remotely access the RTAC through the Ethernet connection, and use any web browser to manage users, view diagnostics, and access logs. Establish a remote connection with any IED connected to the RTAC through engineering access communications channels. Use the SEL Fast Message protocol to maintain SCADA control and metering updates throughout the engineering access connection. Use ACSELERATOR QuickSet® SEL-5030 Software to remotely manage protection and control settings in attached relays. See *Figure 1.6* for an example of this application.

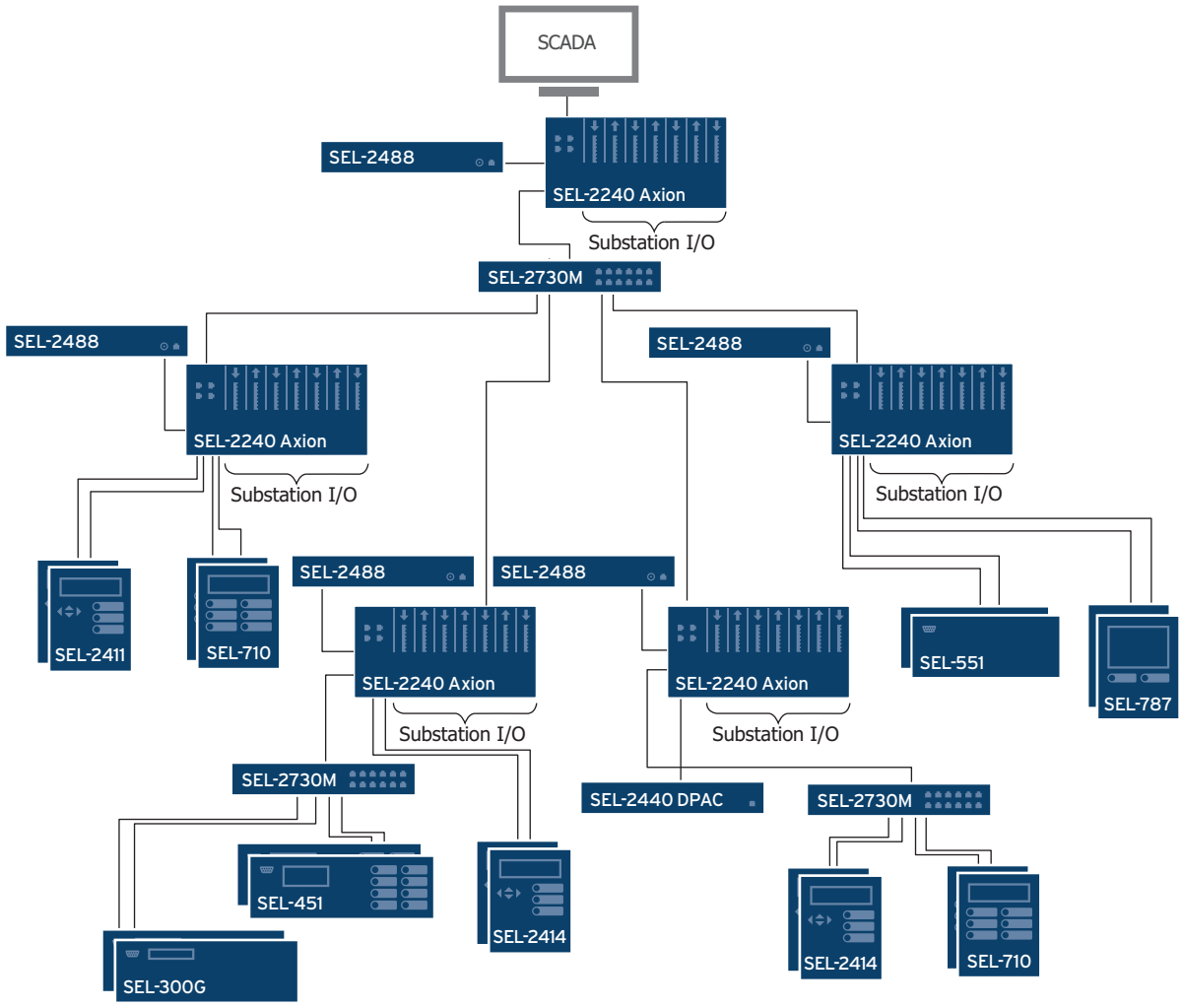


Figure 1.6 SCADA Data Concentrator and HMI

Human-Machine Interface (HMI)

Use the built-in web HMI in the RTAC for viewing and controlling any tags you configured in the RTAC. Use ACSELERATOR Diagram Builder to build custom HMI screens and load them into the RTAC. You can build one-line diagrams, annunciators, and graphical representations that contain control buttons, and you can then display any data in the RTAC, as shown in *Figure 1.7*. Once you have loaded the screens you built into the RTAC, you can view the screens in the RTAC web interface. The RTAC has a web-based HMI, so multiple users can view the HMI screens simultaneously.

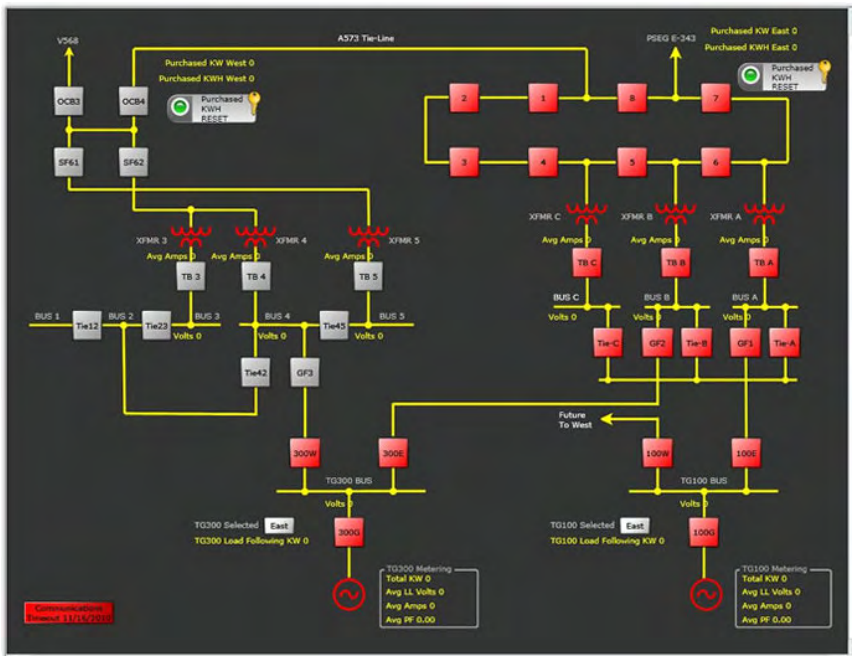


Figure 1.7 HMI One-Line Diagram

The logging system in the RTAC provides comprehensive logging for all variables in the RTAC, including those that connected IEDs provide. The logging system compensates for time-stamp differential among data from different IEDS, so all data are in sequence and on the same time-stamp reference. The RTAC can log data for changes in the state of Boolean values, changes in string values, and changes in Boolean, analog, or string time stamps. The RTAC can also alarm for analog values that cross defined thresholds. Assign variables for logging in the Tag Processor, or use one of the logger function blocks in IEC 61131 custom programs.

There are two user interfaces for viewing logged data. These include a secure HTML interface and an open database connectivity (ODBC) connection. Access the HTML interface through a web browser connection. Use the ODBC connection for standard data transfer between the logged data and database or spreadsheet software.

Remote I/O

When you use single or dual power couplers, the Axion serves as a low-cost remote I/O module. As many as 60 modules or six nodes can connect to one resident SEL-2241 RTAC or to a separate SEL-3530 or SEL-3555 RTAC. The Axion is an excellent teleprotection device that provides, through EtherCAT, a simple means for expanding the number of I/O points available in an automation system at rapid data acquisition rates.

Programmable Logic/ Automation Controller (PLC/PAC)

Use the Axion as a programmable logic controller to automate your real-time tasks based on a variety of input conditions and diagnostic information. Use the powerful IEC 61131 logic engine to write programs in Structured Text, Function Block, or Ladder Logic. Schedule periodic tasks or configure event-driven tasks with multiple preconditions. Create function blocks of complex tasks for simple configuration. Easily replace aging PLCs implemented in Ladder Logic by replicating the same logic or by using a conversion tool to translate logic to Structured Text. See *Figure 1.8* for an example of this application.

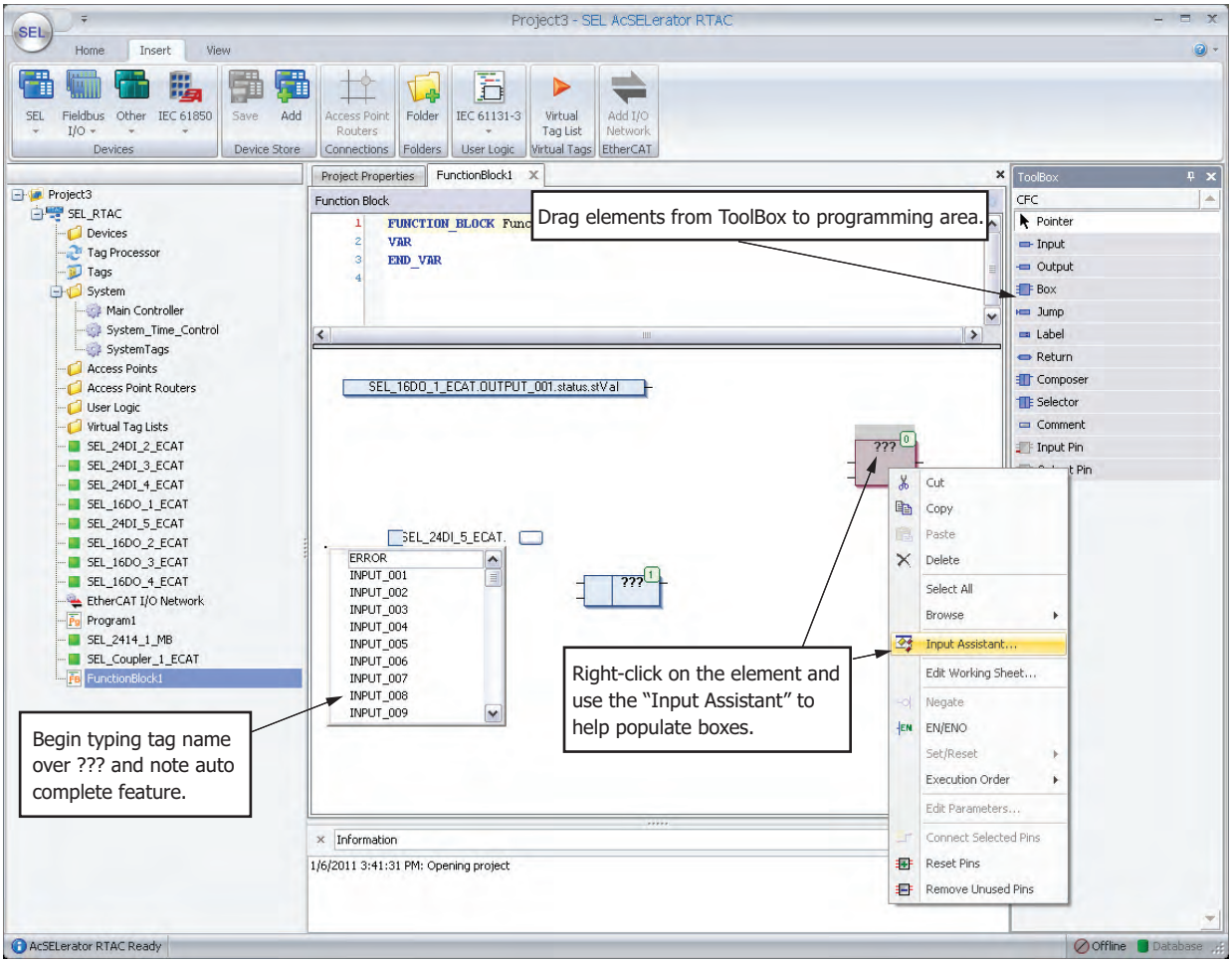


Figure 1.8 IEC 61131 Logic Example

IEC 61850 GOOSE Concentrator

Gather a variety of substation I/O with the SEL-2244 modules and share the data with IEC 61850 Generic Object-Oriented Substation Event (GOOSE) messages. Use the protocol flexibility of the RTAC to concentrate data from non-IEC 61850 relays and convert these data to GOOSE messages. See *Figure 1.9* for an example of this application.

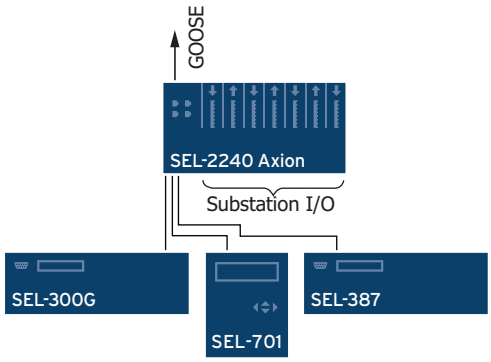


Figure 1.9 IEC 61850 GOOSE Concentrator

Synchrophasor Concentrator

Use standard protocols, such as DNP3, to move synchrophasor data to SCADA operation centers. Include time stamps and time quality in the SCADA message to allow for system-wide usage of synchrophasor data. Within the RTAC logic

engine, you can perform complex math and logic calculations on synchrophasor data you collect from SEL relays and other IEEE C37.118-compliant devices. See *Figure 1.10* for an example of this application.

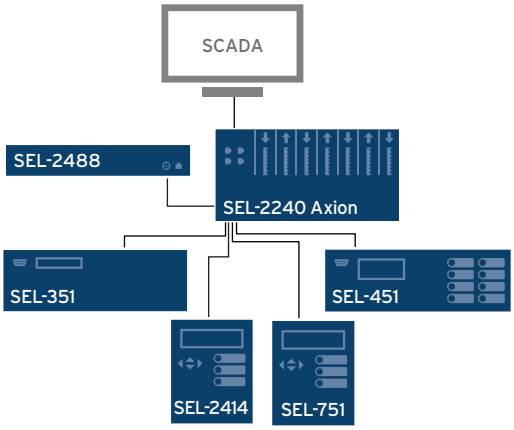


Figure 1.10 Synchrophasor Concentrator

Intelligent Port Switch

Flexible communications parameters make the RTAC a great choice for almost any port-switching application. Although RTAC multitasking/multiuser and data handling capabilities make it a very powerful remote automation platform, it is still an economical choice for port-switching applications. The time-synchronization capabilities of the RTAC add to its value in this application. See *Figure 1.11* for an example of this application.

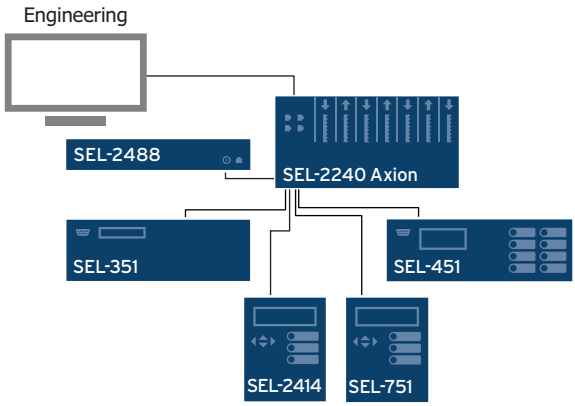


Figure 1.11 Intelligent Port Switch

Network Gateway

The SEL-2241 RTAC has two Ethernet ports through which it can make serially connected devices available to high-speed networks. The RTAC supports virtual terminal connections through the Ethernet ports. For example, Ethernet users can establish secure Telnet sessions and communicate with an IED connected to the RTAC. See *Figure 1.12* for an example of this application.

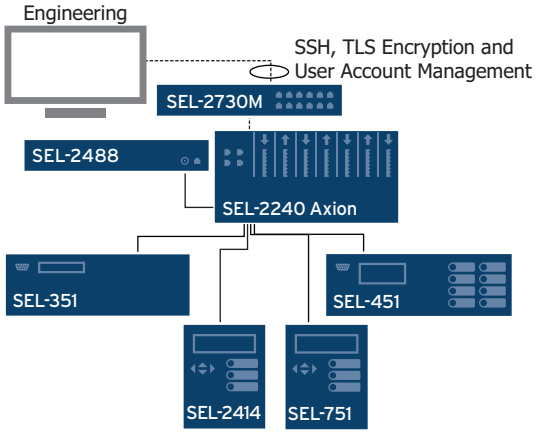


Figure 1.12 Network Gateway

Protocol Gateway

Collect downstream data with client or peer-to-peer protocols. Then send these data to your upstream HMI, RTU, or SCADA master with server protocols, converting the data from one protocol to another in the process. RTAC multitasking/multiuser and data handling capabilities make it a great choice for data concentration. See *Figure 1.13* for an example of this application.

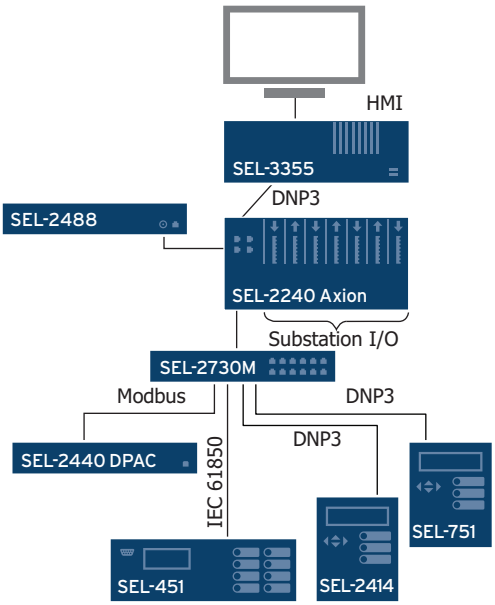


Figure 1.13 Protocol Converter

Time-Synchronization Source

Synchronize the time clocks in attached devices that accept a demodulated IRIG-B time signal. The RTAC regenerates the demodulated IRIG-B signal from an external modulated or demodulated source, such as a GPS satellite clock receiver, SNTP/NTP/PTP source, or serial or Ethernet protocol such as DNP3. If an external clock source is unavailable, the RTAC generates an IRIG-B signal from its internal clock, providing device synchronization to a common clock for improved SER data analysis. See *Figure 1.14* for an example of this application.

To determine how many devices an IRIG-B output is able to synchronize, a parallel resistance calculation is required because the input resistance of connected devices significantly affects this number. The Specifications section of

each RTAC product provides the output drive capability. If the RTAC output resistance is greater than or equal to the parallel resistance calculation of connected devices, all devices can be synchronized by the RTAC.

For example most SEL relays (excluding SEL-100 and SEL-200 Series Relays) have an IRIG-B input resistance of approximately 2500 ohms. For a BNC demodulated IRIG-B output that supports a drive capacity of 25 ohms, this allows approximately 20 SEL relays to be connected in parallel and be time-synchronized. For most serial port IRIG-B outputs, the drive resistance capability is approximately 500 ohms. This allows 5 SEL relays with IRIG-B input resistance of approximately 2500 ohms to be connected in parallel.

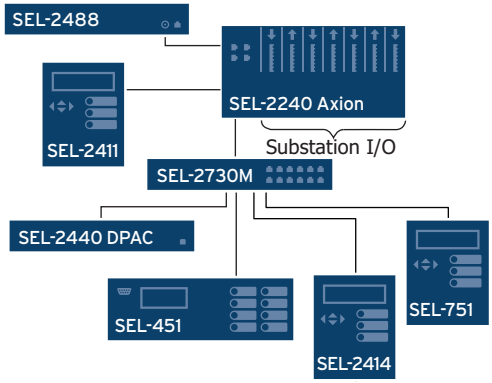


Figure 1.14 Time Synchronization

Security Gateway

Secure the automation network with the RTAC. Enable encryption for any engineering access channel or SCADA link. Implement system security auditing, logging, and password restrictions to enforce NERC standards. Comply with role-based requirements by implementing per-user security profiles. Optionally incorporate serial and wireless encrypting devices to further secure communications to any device. See *Figure 1.15* for an example of this application.

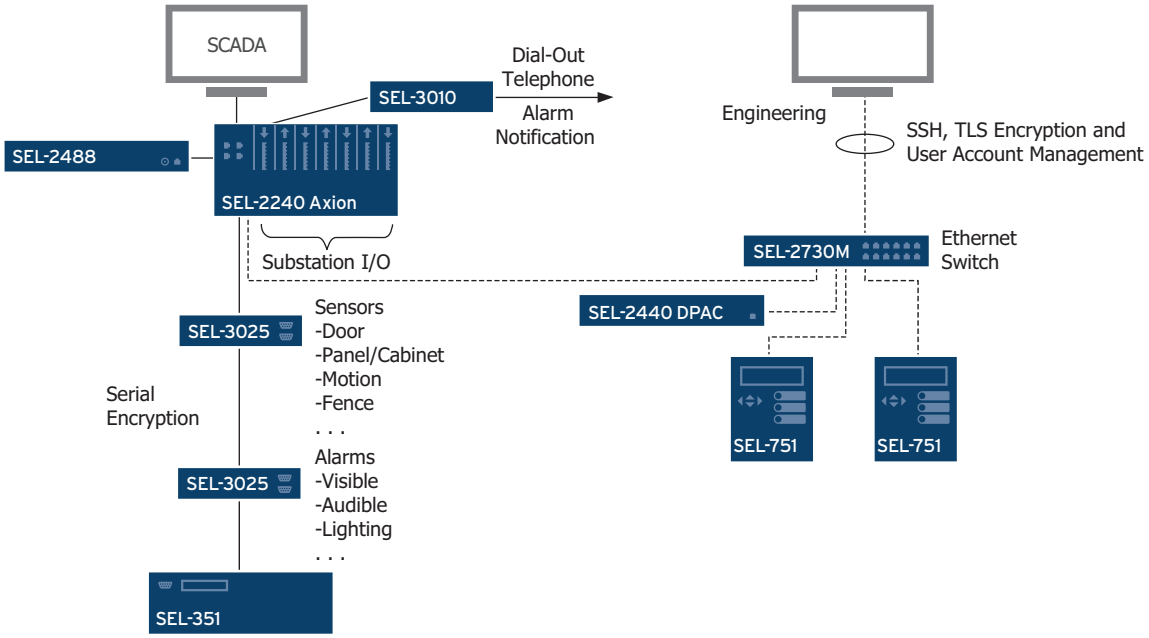


Figure 1.15 Security Gateway

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

Enclosure Protection

IP4X Front
IP2X Product Without SEL-2245-4, SEL-2245-411, and SEL-2245-42
IP1X Product With SEL-2245-4, SEL-2245-411, or SEL-2245-42
Note: If rear terminals are accessible during normal use, the product must be mounted in a locked enclosure or restricted area 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 - 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 *Section 2: Installation* for dimensions.

Weight

SEL-2241 RTAC:	0.670 kg (1.47 lb)
SEL-2242 19 in Backplane:	3.24 kg (7.13 lb)
Panel Mount Bezel:	0.283 kg (0.625 lb)
SEL-2242 10-Slot (19 in Rack Width) With 7 in Touchscreen Display:	3.999 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-2244-5 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

Table 1.12 Maximum Burden Per Module for Each Node

Module	Maximum Added Burden (W)[a]
SEL-2241 RTAC (Copper Ethernet)	12.5
SEL-2241 RTAC (Fiber Ethernet)	15
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-2244-5 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
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.

CPU Processing and Memory

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

Security Features

Account Management:	User Accounts User Roles LDAP Central Authentication RADIUS Central Authentication Strong Passwords Inactive Account Logouts
Intrusion Detection:	Access/Audit Logs Alarm LED Alarm Contact
Encrypted Communication:	SSL/TLS, SSH, HTTPS

Automation Features (Protocols)

Client:	DNP3 Serial, DNP3 LAN/WAN, Modbus RTU, Modbus TCP, SEL ASCII, SEL Fast Messaging, LG 8979, IEEE C37.118, IEC 61850 MMS, CP2179, IEC 60870-5-101/104, SNMP, SES-92, CDC Type II, Courier, IEC 60870-5-103, Ethernet/IP Explicit Message Client
Server:	DNP3 Serial, DNP3 LAN/WAN, Modbus RTU, Modbus TCP, SEL Fast Messaging, LG 8979, SES-92, IEEE C37.118, IEC 61850 MMS, IEC 60870-5-101/104, FTP, SFTP, CDC Type II, Ethernet/IP Implicit Message Adapter
Peer-to-Peer:	SEL MIRRORED BITS Communications, IEC 61850 GOOSE, Network Global Variables (NGVL), Parallel Redundancy Protocol
Fieldbus:	EtherCAT Client (in RTAC), EtherCAT Server (I/O modules)
Engineering Access	
Modes:	SEL Interleaved, Direct
Port Server:	Map Serial Ports to IP Ports
Secure Web Server:	Diagnostic and Communications Data

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

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

Precise Time Protocol (PTP)

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

Communications Ports (SEL-2241 RTAC)

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 (SEL-2241 RTAC)

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

Backplane (SEL-2242)

Ethernet Port

Port:	1
Data Rate:	10/100 Mbps
Connector:	RJ45 Female
Protocol:	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 *Table 1.12* 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 Vdc	ON for 200–275 Vdc	OFF below 150 Vdc
220 Vdc	ON for 176–242 Vdc	OFF below 132 Vdc
125 Vdc	ON for 100–135.5 Vdc	OFF below 75 Vdc
110 Vdc	ON for 88–121 Vdc	OFF below 66 Vdc
48 Vdc	ON for 38.4–52.8 Vdc	OFF below 28.8 Vdc
24 Vdc	ON for 15–30 Vdc	OFF for < 10 Vdc

When Used With AC Control Signals:

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

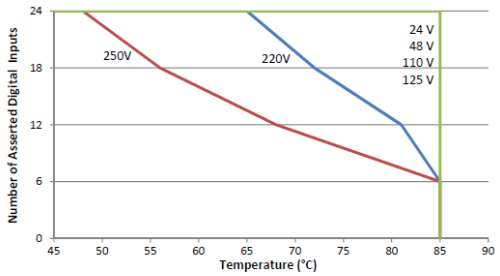
Burden/Current Draw at Nominal DC Voltage: 2–6 mA (Except for 24 V, 8 mA)

Rated Insulation Voltage: 300 Vac

Rated Impulse Withstand Voltage (U_{imp}): 4000 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

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 5000 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
2000 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

2500 Vrms between separate inputs
2500 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:	>2000 Ω, 1 µF

Step Response

1 ms (10%–90% response typical)

Isolation

2000 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, 1039 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 and SEL-2245-411 Axion modules. Message rates are supported on the 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 Metering:	250 Hz
RMS Window Size:	1 cycle

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

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

Isolation (Galvanic Isolated Channels)

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

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

THD and Noise (Accuracy)

±5% of measurement plus ±0.25%

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-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

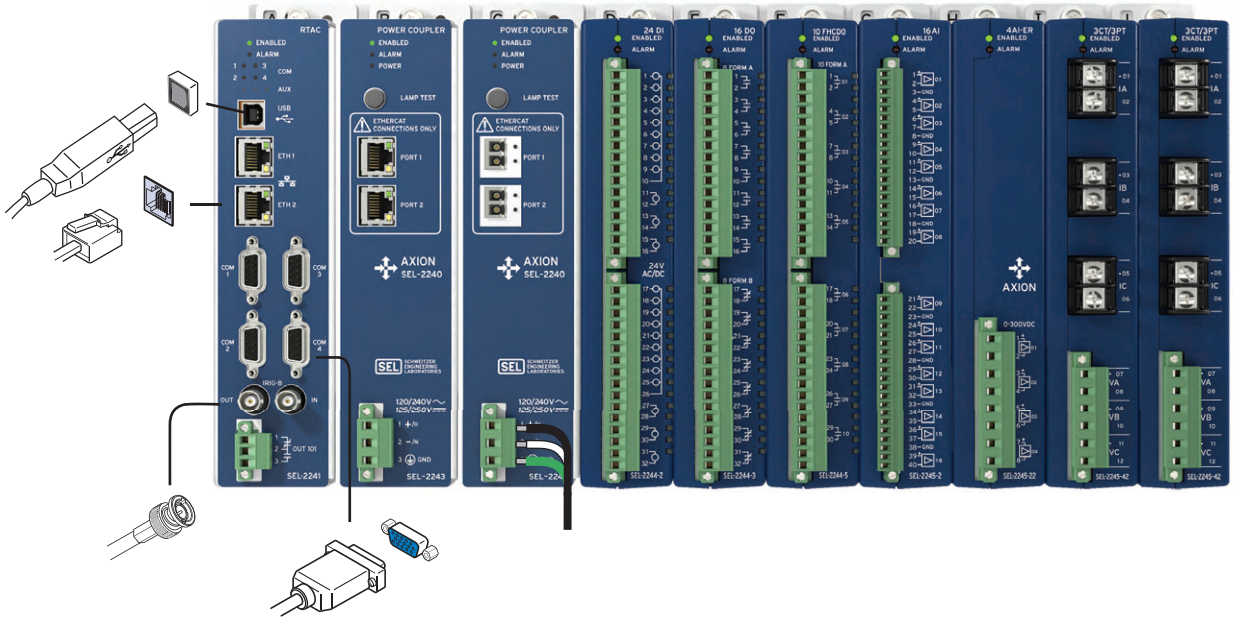
Fuse Rating

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

Section 2
Installation

Overview

The first steps in applying the SEL Axion® are mounting the chassis, installing modules into the chassis, and connecting the system. This section describes common installation features and requirements. To install and connect the Axion safely and effectively, you must be familiar with configuration features and options. You should carefully plan the placement, cable connections, and communication. Use the following drawings and information as a starting point for planning your particular application.



Device Placement

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.

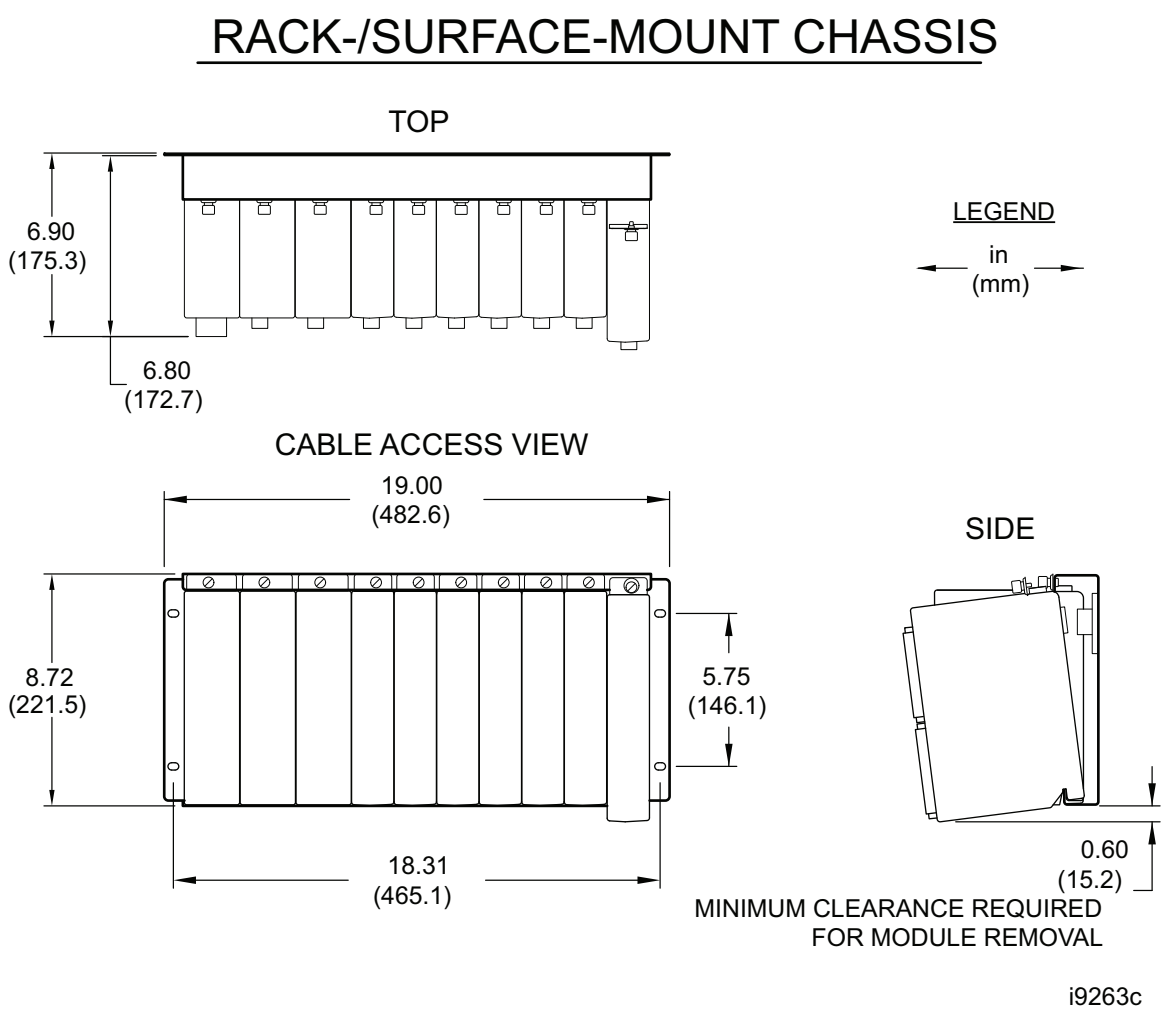


Figure 2.1 SEL-2240 Dimensions for 10-Slot Rack and Surface Mount

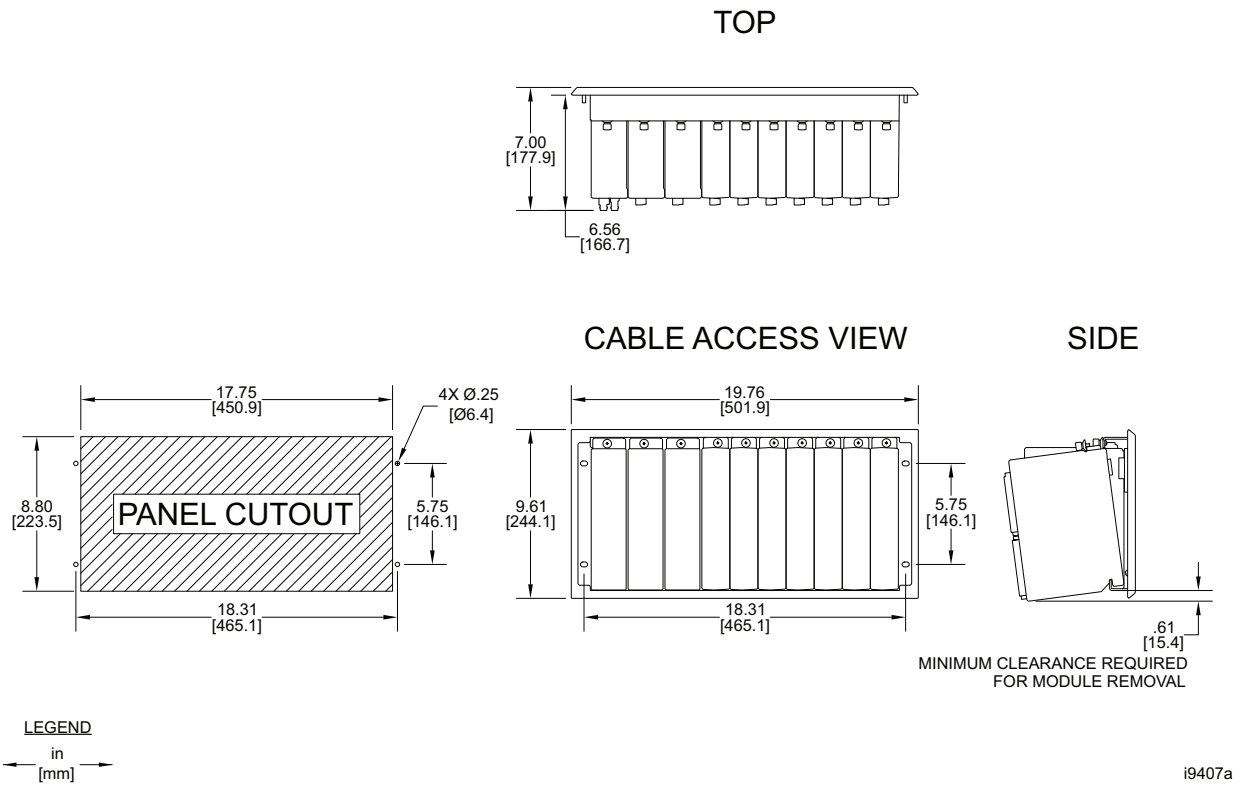


Figure 2.2 SEL-2240 Dimensions for 10-Slot Panel Mount

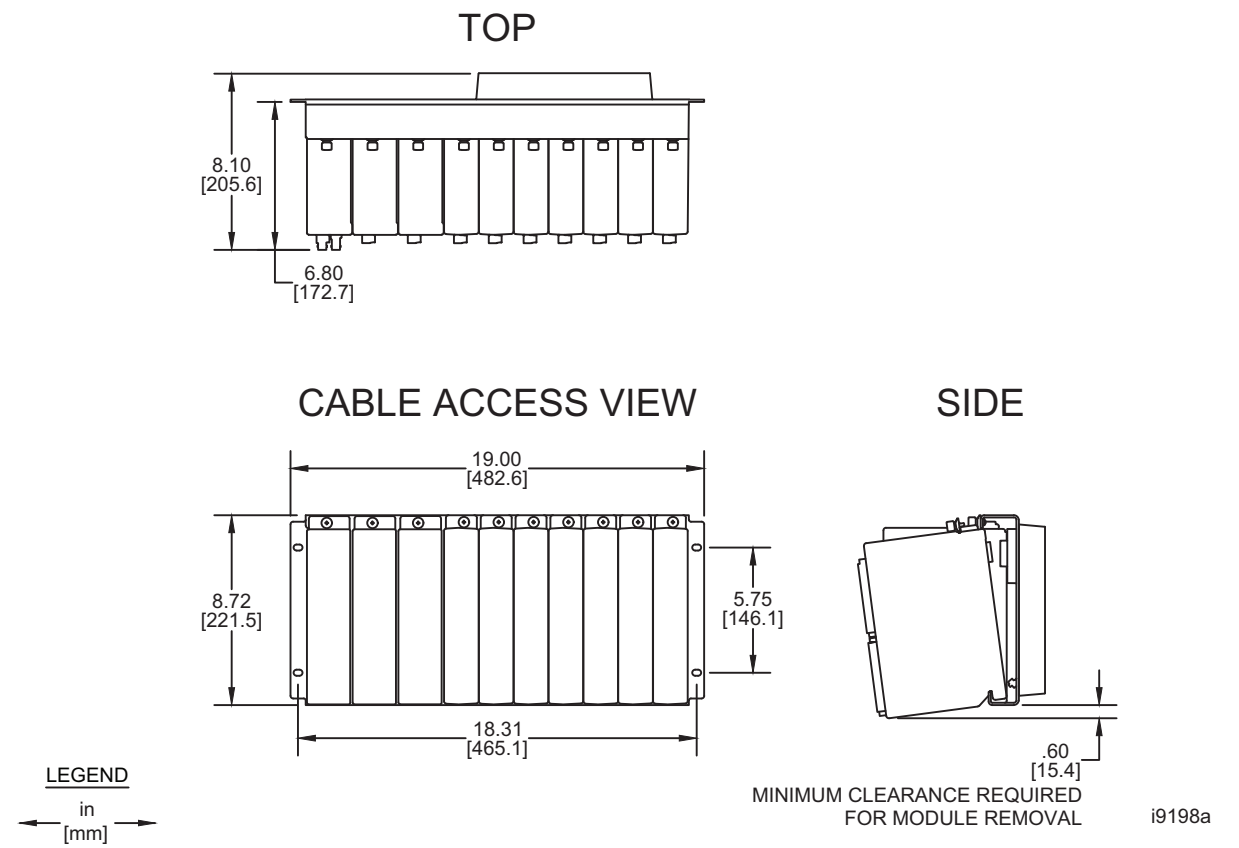


Figure 2.3 SEL-2240 Dimensions for 10-Slot Rack With 7-Inch, Color Touchscreen Display (Rack Mount)

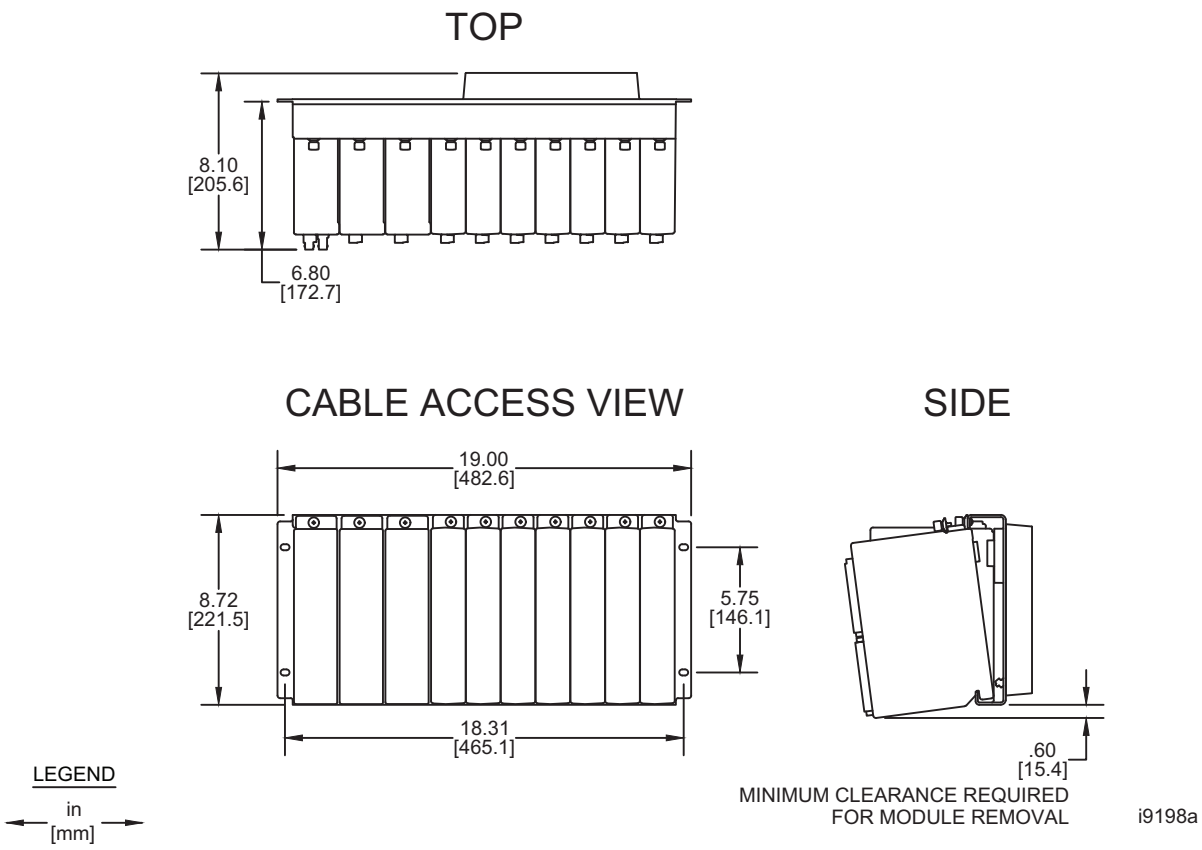


Figure 2.4 SEL-2240 Dimensions for 10-Slot Rack With 7-Inch, Color Touchscreen Display (Panel Mount)

RACK-/SURFACE-MOUNT CHASSIS

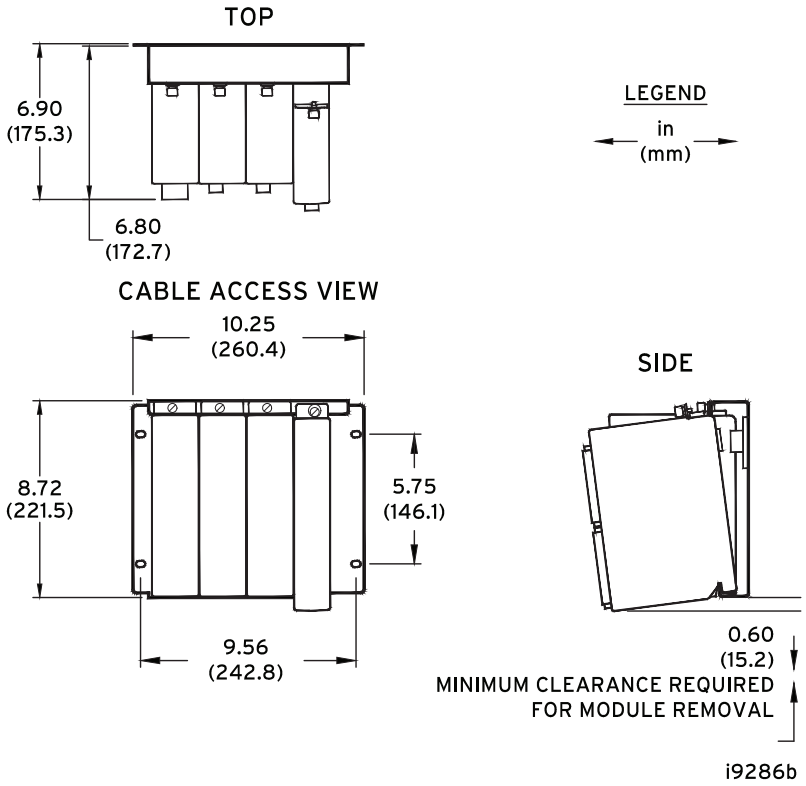


Figure 2.5 SEL-2240 Dimensions for 4-Slot Rack and Surface Mount

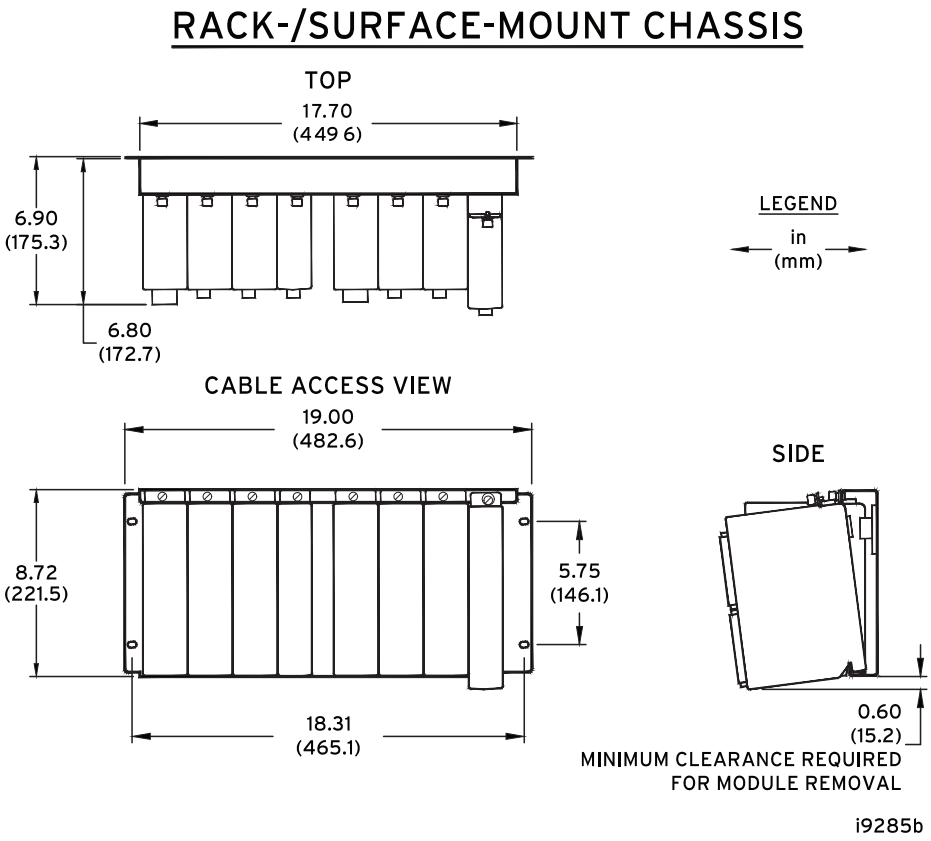


Figure 2.6 SEL-2240 Dimensions for Dual 4-Slot Rack and Surface Mount

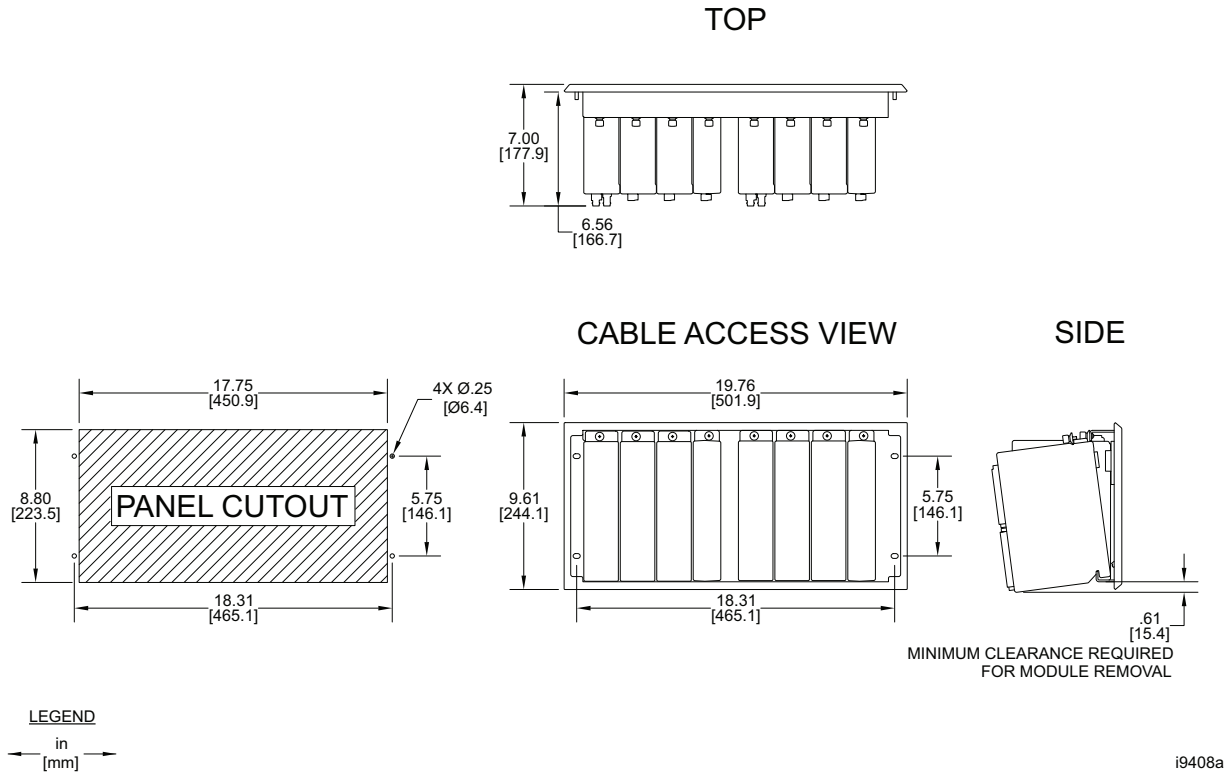


Figure 2.7 SEL-2240 Dimensions for Dual 4-Slot Panel Mount

SEL-2242 Front-Panel Drawings

Figure 2.8, *Figure 2.12*, and *Figure 2.13* show the front-panel status LEDs, which aid system troubleshooting. These figures also shows the location of the **LAMP TEST** pushbutton. *Figure 2.10* shows the front panel with the touchscreen display option.

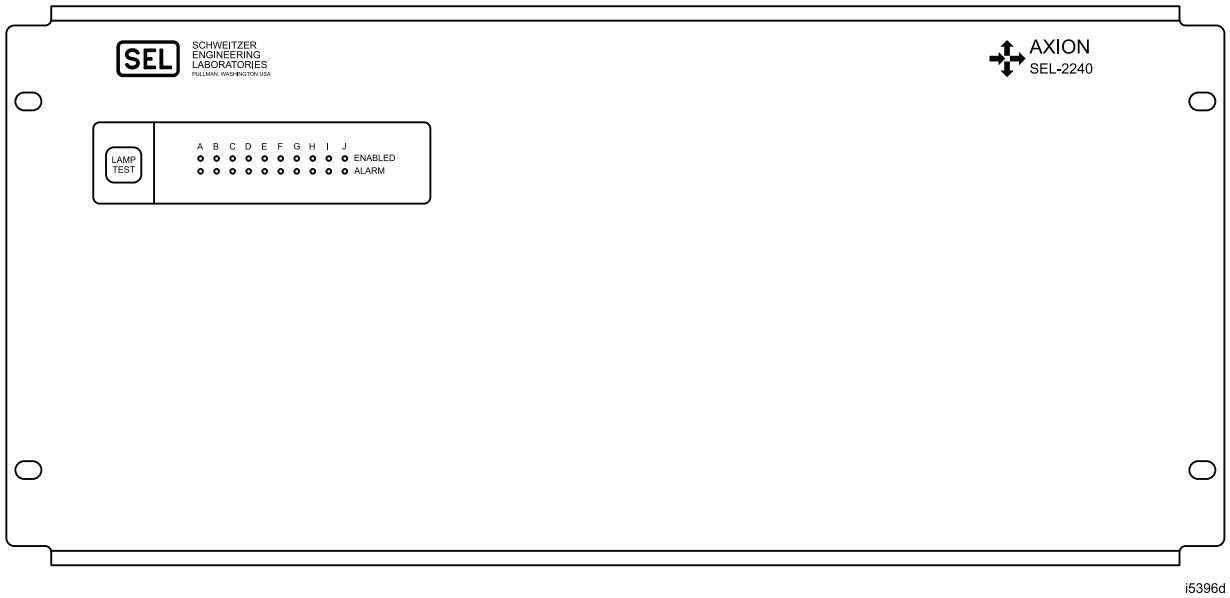


Figure 2.8 SEL-2242 10-Slot Front Panel (Rack Mount)

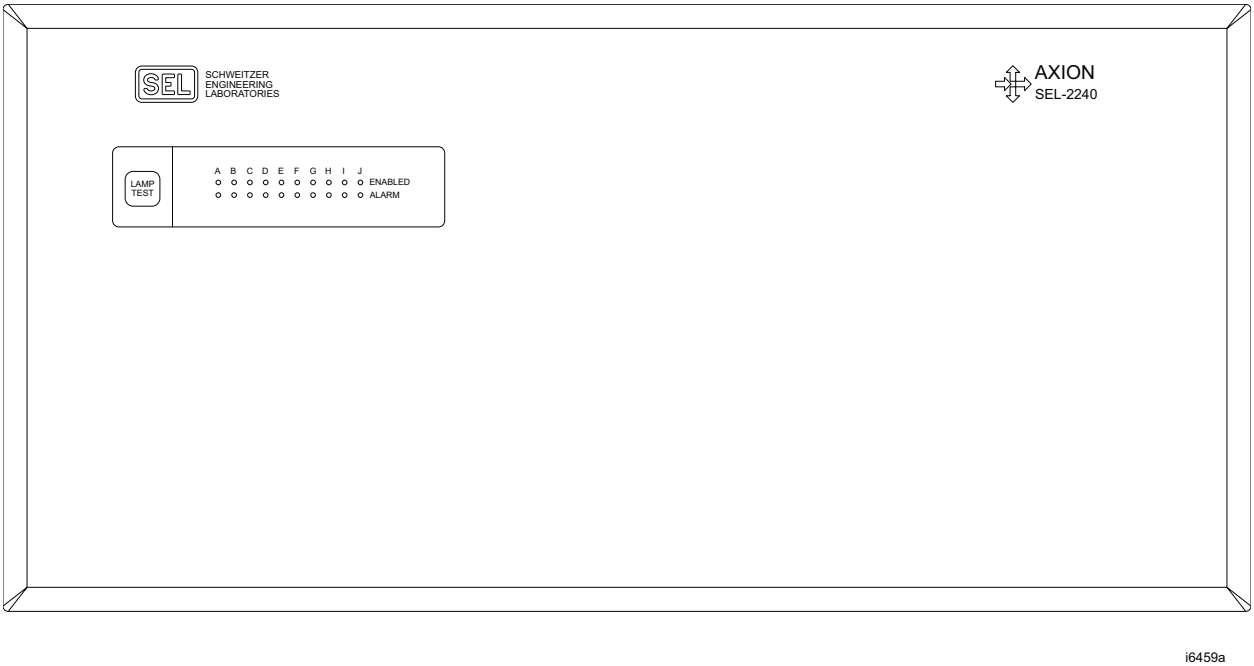


Figure 2.9 SEL-2240 10-Slot Front Panel (Panel Mount)

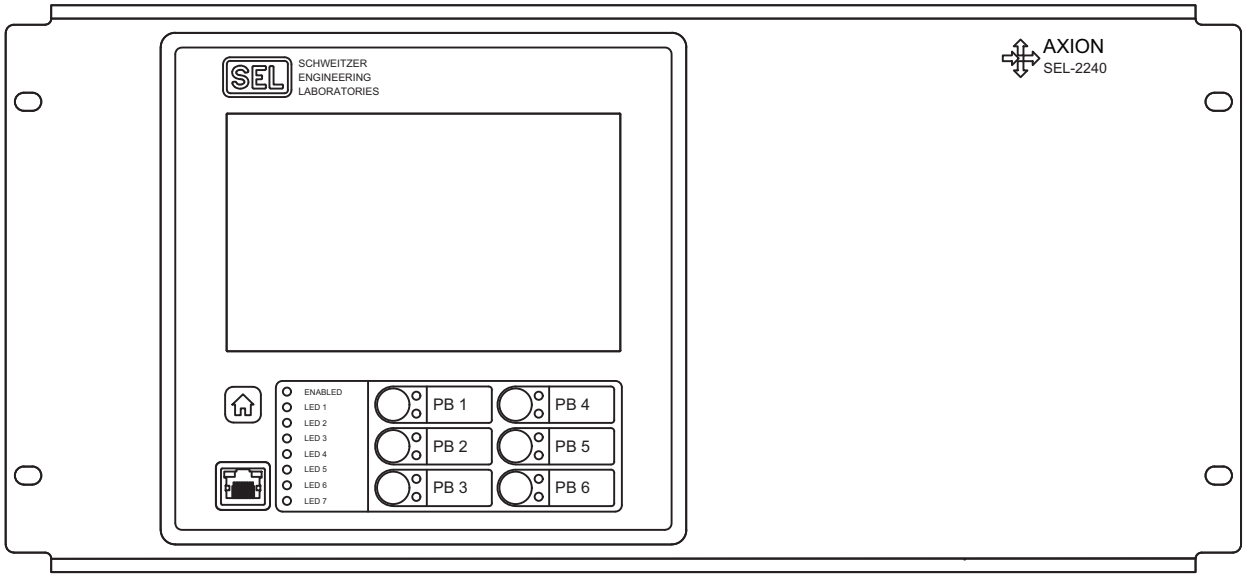


Figure 2.10 SEL-2242 10-Slot Front Panel With 7-Inch Touchscreen Display (Rack Mount)

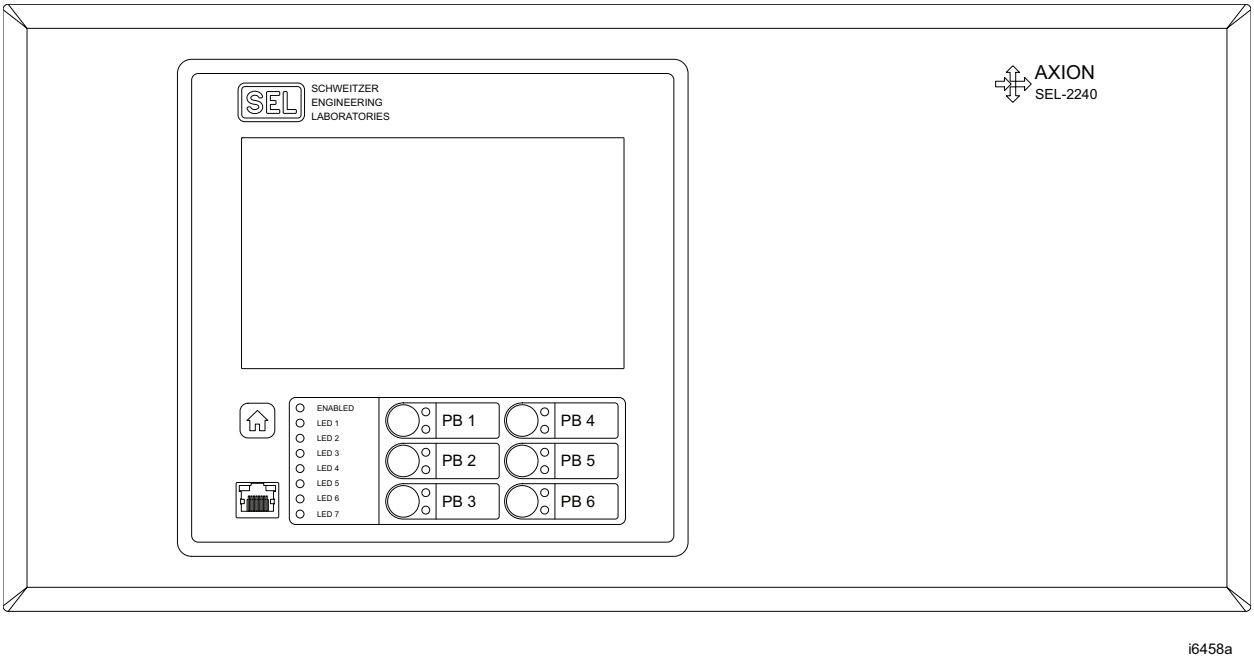


Figure 2.11 SEL-2240 10-Slot Front Panel With 7-Inch Touchscreen Display (Panel Mount)

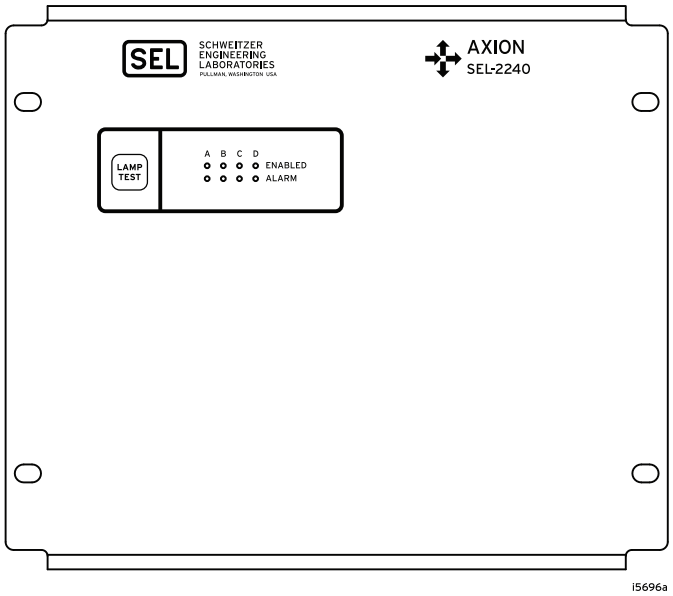


Figure 2.12 SEL-2240 4-Slot Front Panel

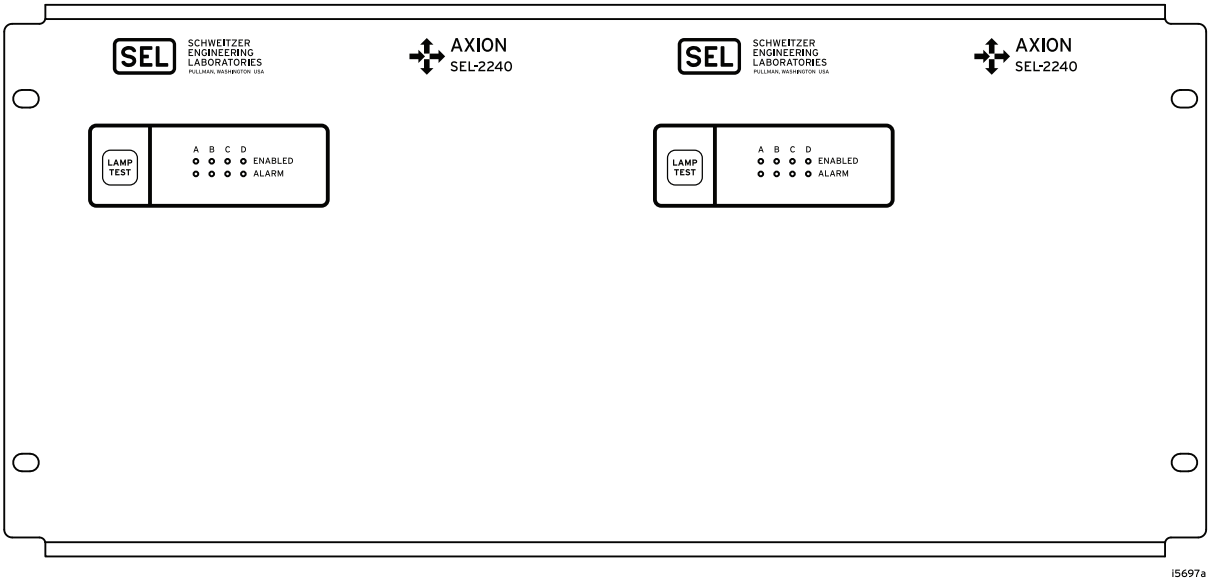
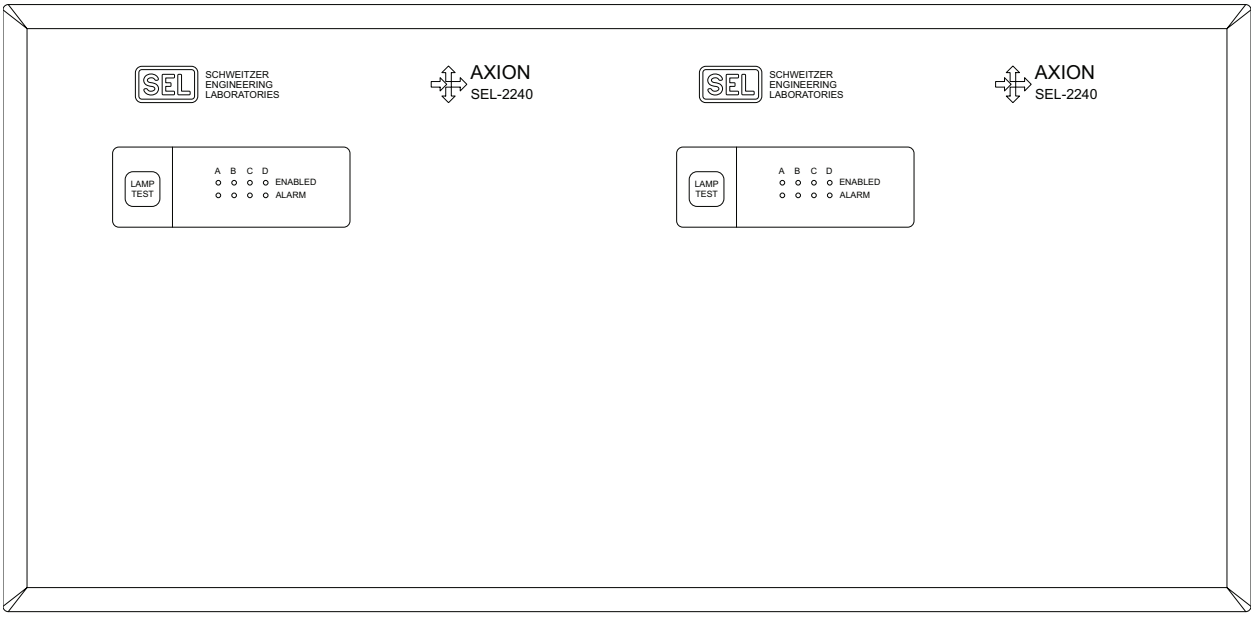


Figure 2.13 SEL-2240 Dual 4-Slot Front Panel (Rack Mount)



i6460a

Figure 2.14 SEL-2240 Dual 4-Slot Front Panel (Panel Mount)

Protective Connector Covers

The SEL-2242 is shipped with protective covers installed in each backplane connector. Prior to installing any Axion modules, grasp either side of the connector cover and pull it straight out of the connector. We suggest that you leave the covers inserted in any unused slots to provide dust and mechanical protection.

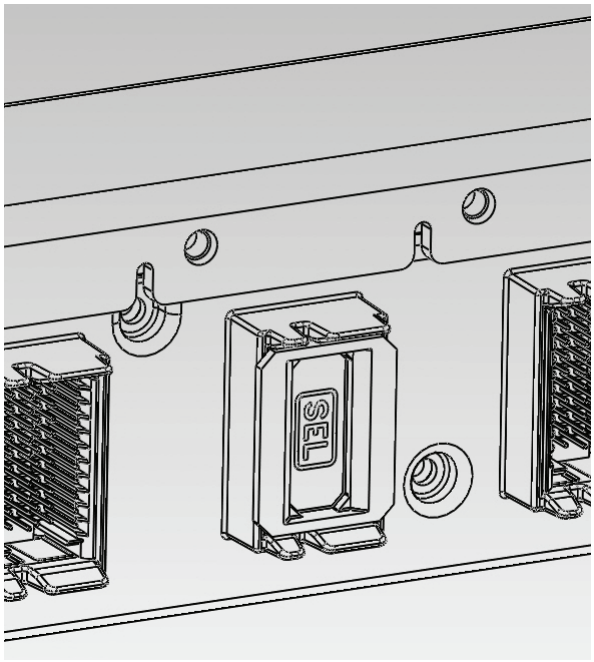


Figure 2.15 Protective Connector Cover

SEL-2241 Real-Time Automation Controller (RTAC)

For each Axion system, you have the option of using an external RTAC (SEL-3530 or SEL-3530-4) as the system controller or using the integrated SEL-2241 RTAC module. The SEL-2241 has all of the capabilities of the external RTAC units, but it receives power from the Axion backplane.

The SEL-2242 backplane chassis with touchscreen display requires an SEL-2241 RTAC in Slot **A**. The touchscreen is only compatible with SEL-2241 RTACs that ship with R149 firmware or later.

Front Panel

The following figure shows the RTAC status LEDs that aid system troubleshooting and the connectors for communications and wiring.

Figure 2.16 SEL-2241 RTAC Front Panel, Copper Ethernet

Mechanical Installation

Each SEL-2242 chassis/backplane has four or ten slots, labeled **A** through **J**. Only Slot **A** supports the SEL-2241 RTAC module.

To install the RTAC, tip the top of the module away from the chassis, align the notch on the bottom of the module with Slot **A** of the chassis, and place the module on the bottom lip of the chassis as *Figure 2.17* illustrates. The module is aligned properly when it rests entirely on the lip of the chassis.

Figure 2.17 Proper Module Placement

Carefully rotate the module into the chassis, making sure that the alignment pin fits into the corresponding slot at the top of the chassis (see *Figure 2.18*). Finally, press the module firmly into the chassis and tighten the chassis retaining screw.

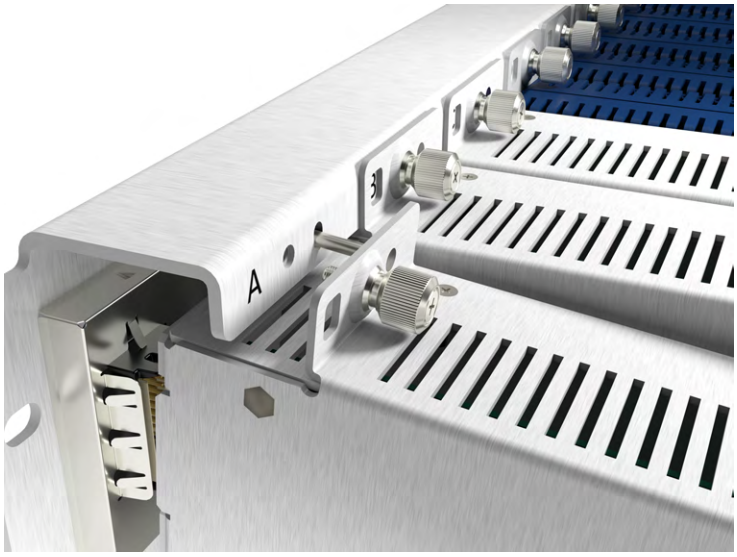


Figure 2.18 Final Module Alignment

Connections

Communications Ports

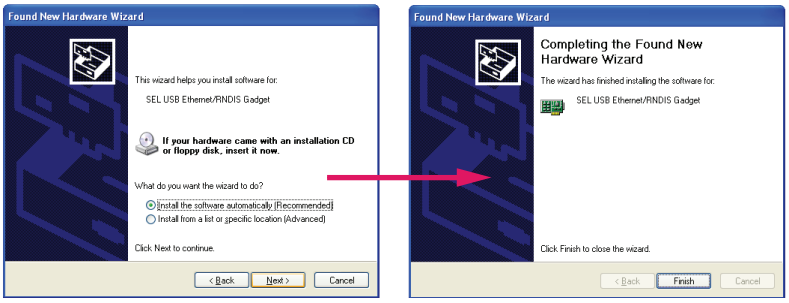
NOTE: Never connect two RTACs via USB to one PC.

NOTE: USB ports are intended for programming only, not continuous use.

NOTE: Do not use USB cables longer than three meters.

All web access, settings changes and ODBC connections use either the RTAC Ethernet ports or the front USB Type B port. Until you have configured the Ethernet interfaces on the RTAC, you will need to use the supplied USB Type B cable to access the RTAC web interface. The ACSELERATOR RTAC installation will place the required USB driver on your PC. Once Microsoft® Windows® detects the USB connection, the driver will be installed automatically. Plug the USB cable into the RTAC and into your PC. If you receive a prompt to connect to Windows Update, select **No, not at this time** and press **Next**. Then use the Windows Device Installation Wizard and follow the automatic install prompts to install the SEL USB driver.

After completing this step, you can use IP address 172.29.131.1 to access the RTAC web interface through the USB cable. See *Section 7: Security and Account Management* in the *ACSELERATOR RTAC SEL-5033 Instruction Manual* for RTAC web password setup.



The SEL-2241 has four nonisolated serial ports. You can select all RTAC serial ports through software to be either EIA-232 or EIA-485/EIA-422. You can configure any serial protocol on the RTAC to use any of these serial ports. See *Table 2.1* for the pinout of the RTAC serial ports.

Table 2.1 Nonisolated Female DB-9 Ports

EIA-232	EIA-485/EIA-422
Pin 1: N/C or +5 Vdc (also DCD input on COM 1 if +5 Vdc is disabled)	Pin 1: N/C or +5 Vdc (also DCD input on COM 1 if +5 Vdc is disabled)
Pin 2: RXD	Pin 2: -RXD
Pin 3: TXD	Pin 3: -TXD
Pin 4: +IRIG-B (DTR jumper option for COM 1)	Pin 4: +IRIG-B
Pin 5: GND	Pin 5: GND
Pin 6: -IRIG-B (DSR jumper option for COM 1)	Pin 6: –IRIG-B
Pin 7: RTS	Pin 7: +TXD
Pin 8: CTS	Pin 8: +RXD
Pin 9: GND	Pin 9: GND

Table 2.2 Port Characteristics

Port	Port Interface	Cables
USB-B	USB Type B to USB Type A	SEL-C664 (no longer than three meters)
ETH 1 and ETH 2	10/100BASE-T (RJ45 for Copper)	SEL-C627F (double shielded with a ferrite clamp)
COM 1–COM 4 (serial)	EIA-232 (Nonisolated)	SEL-C234A, SEL-C273A, and SEL-C387 are popular selections
IRIG-B INput	Female BNC	SEL-C953
IRIG-B OUTput	Female BNC	SEL-C953

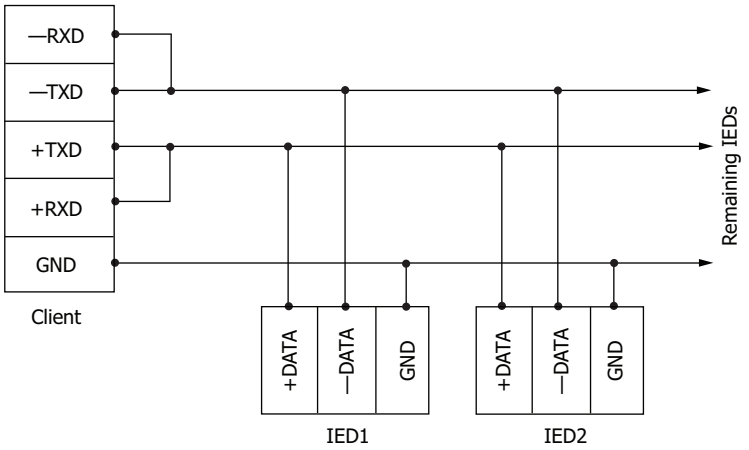


Figure 2.19 EIA-485 Typical Two-Wire Connection

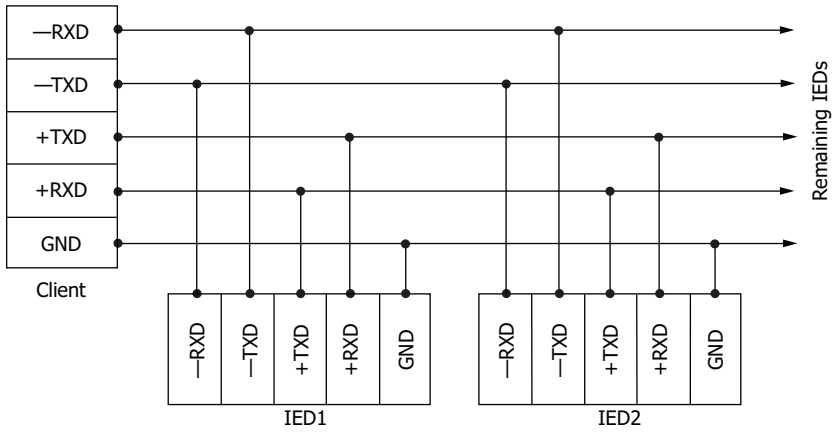


Figure 2.20 EIA-485 Typical Four-Wire Connection

Outputs

Refer to *Section 1: Introduction and Specifications* for output contact ratings and *Figure 2.17* for terminal assignments. Configure the contact output under SystemTags (Contact Outputs Tab) in ACSELERATOR RTAC. You can change the name of the point, create an alias tag name, and initialize status values. The RTAC will use the initialized value until run time, when it uses the actual value.

Figure 2.21 shows that a trip coil has a resistive and inductive component. After a trip output has been closed for a long time, the current settles to a steady-state value. When the trip output opens, it tries to interrupt the inductive current that wants to continue to flow (V = L di/dt). This attempted interruption of current causes a large voltage spike that can turn into an arc. When the contacts bounce during the arc, they often weld closed. SEL has designed, tested, and specified the outputs for this application to prevent any such welding (see the *Breaking Capacity (10,000 Operations) Per IEC 60255-0-20:1974: on page 1.26*).

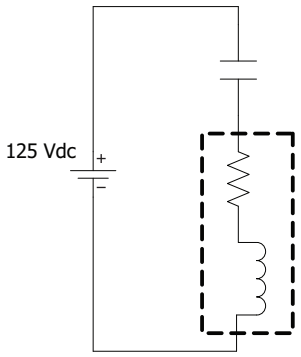


Figure 2.21 Inductive Interrupt of a Trip Output

LED Indicators

In addition to LEDs representing module status and communications activity, the SEL-2241 has three user-programmable bi-color LEDs. Configure these LEDs under SystemTags (LEDs Tab) in ACSELERATOR RTAC.

Field Serviceability

You can upgrade RTAC firmware and custom programming in the field or remotely over Ethernet. Self-tests provide status indication of errant conditions that can occur in the RTAC. You can map one or a combination of these or other status indications to the alarm contact to create a diagnostic alarm.

The real time clock battery and power coupler fuses are the only field-serviceable parts. Return all modules to SEL for any other servicing or maintenance.

The battery and fuses are only serviceable on units that are fully disconnected from any hazardous live voltage (such as connections to input power or OUT101).

Module Replacement

To replace the SEL-2241 RTAC, perform the following steps.

Step 1. Back up all RTAC settings. See *Section 1: Getting Started* of the *ACSELERATOR RTAC SEL-5033 Instruction Manual* for instructions on how to back up and restore RTAC projects.

Step 2. De-energize any power source connected to the power coupler(s) in the Axion node.

Step 3. Loosen retaining screws and remove the terminal strip for the alarm contact. Disconnect all communications cables.

Step 4. Loosen the chassis retaining screw at the top of the module.

Step 5. Tip the top of the module away from the chassis and lift it from the bottom lip.

Step 6. Install the new module according to the applicable mechanical installation instructions in this section.

Step 7. Make all necessary connections to the module according to the applicable connection instructions in this section.

Step 8. Apply power to the Axion node.

Step 9. Use IP address 172.29.131.1 to access the RTAC web interface through the supplied USB cable. See *Section 7: Security and Account Management* of the *ACSELERATOR RTAC SEL-5033 Instruction Manual* for RTAC web password setup. Also enable all necessary communications ports.

Step 10. Download the settings project from ACSELERATOR RTAC.

Real-Time Clock Battery Replacement

⚠DANGER
Disconnect or de-energize all external connections before opening this device. Contact with hazardous voltages and currents inside this device can cause electrical shock resulting in injury or death.

⚠CAUTION
The device contains devices sensitive to Electrostatic Discharge (ESD). When working on the device with the front panel removed, work surfaces and personnel must be properly grounded or equipment damage may result.

⚠CAUTION
There is danger of explosion if the battery is incorrectly replaced. Replace only with Rayovac no. BR1632 or equivalent recommended by manufacturer. See Owner's Manual for safety instructions. The battery used in this device may present a fire or chemical burn hazard if mistreated. Do not recharge, disassemble, heat above 100°C or incinerate. Dispose of used batteries according to the manufacturer's instructions. Keep battery out of reach of children.

The real-time clock battery is a field-replaceable component and cannot be recharged. A lithium battery powers the clock (date and time) during loss or removal of the external power source. The battery is a 3 V lithium coin cell, Rayovac BR1632 or equivalent. At room temperature (25°C), the battery will operate nominally for ten years. When the device receives power from an external source, the battery experiences a low self-discharge rate. Thus, battery life can extend well beyond ten years.

To replace the real-time clock battery, perform the following steps.

Step 1. Follow the *SEL-2241 Disassembly* instructions to expose the circuit board.

Step 2. Locate the battery clip (holder) on the board.

Step 3. Carefully remove the battery from beneath the clip. Properly dispose of the old battery.

Step 4. Install the new battery with the positive (+) side facing up.

Step 5. Follow the *SEL-2241 Reassembly* instructions.

Step 6. Set the device date and time.

Power Supply Fuse Replacement

⚠DANGER
Disconnect or de-energize all external connections before opening this device. Contact with hazardous voltages and currents inside this device can cause electrical shock resulting in injury or death.

⚠WARNING
Have only qualified personnel service this equipment. If you are not qualified to service this equipment, you can injure yourself or others, or cause equipment damage.

⚠CAUTION
Equipment components are sensitive to electrostatic discharge (ESD). Undetectable permanent damage can result if you do not use proper ESD procedures. Ground yourself, your work surface, and this equipment before removing any cover from this equipment. If your facility is not equipped to work with these components, contact SEL about returning this device and related SEL equipment for service.

You can replace a bad primary fuse in a power coupler, or you can return the power coupler to SEL for fuse replacement. If you decide to replace the fuse, perform the following steps:

Step 1. Follow your company standard to remove the whole Axion node from service.

Step 2. Disconnect power from all power couplers in the backplane.

Step 3. Remove all connections to the failed power coupler and remove it from the backplane.

Step 4. Ground the equipment to an ESD mat.

Step 5. Remove the six screws holding the lid on the chassis and remove the lid.

Step 6. While properly grounded to the ESD mat, remove the six screws holding the PCB in the chassis and remove the PCB from the chassis.

Step 7. Locate fuse F1 near the power supply input header.

Step 8. Examine the power supply for blackened marks or damage. If there is obvious damage, reassemble the power coupler and contact SEL to arrange for return of the module for repair.

Step 9. Remove the plastic fuse protector and remove the spent fuse from the fuse clips.

Step 10. Replace the fuse with an exact replacement (see *Power Coupler (SEL-2243) on page 1.26* for fuse ratings).

Step 11. Reinstall the PCB in the chassis and secure it with the six pan head screws.

Step 12. Replace the lid and secure it with the six flat head screws.

Step 13. Reinstall the power coupler in the unpowered backplane and reconnect all cables removed in the disassembly process.

Step 14. Follow your company standard procedure to return the Axion node to service.

Step 15. If the fuse opens while restoring service, return the power coupler to SEL for module replacement.

Jumpers

Table 2.3 shows the configurable jumper positions.

Table 2.3 Configurable Jumper Positions

Jumper	Position
JMP1	OPEN[a]
JMP2	OPEN[a]
JMP3	OPEN[a]
JMP4	1–2[a] Routes IRIG-B+ to COM 1 Pin 4 3–4 Routes DTR signal to COM 1 Pin 4 5–6[a] Routes IRIG-B ground to COM 1 Pin 6 7–8 Routes DSR signal to COM 1 Pin 6

[a] Factory-default position.

SEL-2241 Disassembly

To disassemble the SEL-2241 RTAC, perform the following steps.

Step 1. Disconnect any hazardous live voltage (such as connections to OUT101).

Step 2. Follow the SEL-2241 *Module Replacement* instructions.

Step 3. Remove the six retaining screws (two top, two rear, two bottom).

Step 4. Place the module on its side and lift the cover to expose the circuit board.

⚠DANGER
Disconnect or de-energize all external connections before opening this device. Contact with hazardous voltages and currents inside this device can cause electrical shock resulting in injury or death.

⚠CAUTION
The device contains devices sensitive to Electrostatic Discharge (ESD). When working on the device with the front panel removed, work surfaces and personnel must be properly grounded or equipment damage may result.

SEL-2241 Reassembly

To reassemble the SEL-2241 RTAC, perform the following steps.

Step 1. Gently close the cover until the retaining screw holes are aligned.

Step 2. Replace the six retaining screws.

Step 3. Follow the SEL-2241 *Mechanical Installation* instructions.

⚠DANGER
Disconnect or de-energize all external connections before opening this device. Contact with hazardous voltages and currents inside this device can cause electrical shock resulting in injury or death.

⚠CAUTION
The device contains devices sensitive to Electrostatic Discharge (ESD). When working on the device with the front panel removed, work surfaces and personnel must be properly grounded or equipment damage may result.

SEL-2243 Power Coupler

Every Axion node requires at least one SEL-2243 Power Coupler module. The SEL-2243 serves two purposes in an Axion system:

1. It is the power supply for all modules installed in the node, and;
2. It provides two dedicated EtherCAT® ports so that multiple Axion nodes can operate together.

Front Panel

Figure 2.22 SEL-2243 Front Panel, Copper and Fiber Connectors

Power Supply Operation

One SEL-2243 has sufficient power capacity to accommodate an entire Axion node. The terminal strip at the bottom of the unit, as seen in *Figure 2.22*, is the connection point for incoming power. All Axion modules have a 55-position IEC C-style connector that provides a communications and power interface to the backplane. The SEL-2243 provides power to the node via the backplane connector.

The power coupler module uses the same power supply design that you would find in SEL protective relays. The Axion provides test-proven superior performance and availability, while also allowing for redundant power couplers

in a node for applications that need these. If you install two power couplers in a node, both modules actively share load and provide the necessary power for node functions. If one SEL-2243 becomes unavailable, there is zero switching delay or power loss to the node.

CAUTION
Always ensure that power couplers are not connected to any Ethernet switches or other Ethernet devices, including RJ45-to-fiber-optic converters. The power coupler EtherCAT ports are only for direct connections between power couplers of the same type or to an RTAC EtherCAT port. Connecting a power coupler to any other Ethernet device can cause the EtherCAT network to stop communicating completely or behave unpredictably.

Each SEL-2243 provides two dedicated ports for EtherCAT networks. The ports will either be standard 10/100BASE-T or optional 100BASE-FX Ethernet ports. EtherCAT is a real-time fieldbus protocol (See *Appendix E of the ACSELERATOR RTAC® SEL-5033 Instruction Manual*) that we can use to connect an RTAC to I/O modules in an Axion system. If the installation has only one node, then the backplane transmits EtherCAT messages. Alternatively, if you use an SEL-3530 RTAC, or if you need more I/O than will fit in a node, then the ports on a power coupler module provide a mechanism for extending the EtherCAT network through the use of dedicated Ethernet wiring. Refer to the EtherCAT configuration section of the *ACSELERATOR RTAC SEL-5033 Instruction Manual* to learn more about configuring a network.

If an Axion node contains two SEL-2243 modules, then the EtherCAT ports in both power couplers will operate normally even if one power supply becomes unavailable. The remaining power supply will serve as the source for all I/O modules and communications needs.

Mechanical Installation

NOTE: For applications compliant with IEC 60255-27, surface-mount units must be installed in IP4X enclosures.

Slots **A**, **B**, and **C** support the SEL-2243 Power Coupler module. See *Mechanical Installation on page 2.11* for SEL-2243 module installation instructions.

Connections

General

Terminals are not intended for use with bare conductors. Solid or stranded wire can be used with ferrule or spade terminals. The customer is responsible for verifying that wire insulation and temperature ratings are sufficient for their application.

Power

DANGER
Contact with instrument terminals can cause electric shock that can result in injury or death.

CAUTION
Damage may occur from connecting a high-voltage source to a low-voltage power coupler.

The power terminals on the high-voltage power coupler (1 (+/H) and 2 (–/N)) must connect to 120–240 Vac with the proper polarity or to 125/250 Vdc. The power terminals on the low-voltage power coupler (1 (+/H) and 2 (–/N)) must connect to 24/48 Vdc. The power terminals are isolated from the chassis ground. Use 14 AWG (2.1 mm^2) wire with an external 15 A branch circuit protection device or 12 AWG (3.3 mm^2)wire with an external 20 A branch circuit protection device.

Grounding (Earthing)

Connect the ground terminal labeled ⏚ **GND (3)** on the power coupler to a rack frame or switchgear ground for proper safety and performance. Connect the ground terminal on the backplane behind the module in slot A to a rack frame or switchgear ground for proper safety and performance. Use less than 2 m

(6.6 feet) of 14 AWG (2.1 mm^2) wire of sufficient current capacity and insulation voltage ratings for the ground connection. Protective earth connections should not be removed when the equipment is energized.

EtherCAT Ports

⚠CAUTION
Do not connect the SEL-2243 Power Coupler to an Ethernet switch.

The SEL-2243 includes two 10/100BASE-T or 100BASE-FX Ethernet ports dedicated for EtherCAT protocol. Use a standard RJ45 connector for a copper port and an LC connector for a fiber-optic port to connect **PORT 1** or **PORT 2** of the module. Make each connection by using a direct cable to the next device. Use SEL cable SEL-C627F (double shielded with a ferrite cable clamp) on copper ports to shield against RF noise. Copper cables for EtherCAT connections should be less than 3 m (10 ft) in length.

Buttons and LEDs

Each power coupler includes a **LAMP TEST** button useful for system testing. When depressed, all module LEDs on the terminal side and front panel (rack mount only) will illuminate.

The green LED labeled **POWER** on the SEL-2243 will illuminate if incoming power is present and the power supply is operating normally. The LEDs labeled **ENABLED** and **ALARM** are related to EtherCAT network operation. The green **ENABLED** LED will illuminate when the module is operating normally on the network. The **ALARM** LED will illuminate during network initialization or when there is a problem with the network.

Module Replacement

Steps for replacing an Axion module will differ based on whether the module has failed or if you want different system functionality. The following steps apply to the SEL-2243 Power Coupler and SEL-2244 Digital I/O Modules for an Axion system that is configured and in operation. Refer to *Section 2: Communications* of the *ACSELERATOR RTAC SEL-5033 Instruction Manual* if you are configuring a new system.

Replacing a Module to Change System Functionality

The flexible design of the Axion allows you to modify system features by adding or replacing a module. For instance, replacing a digital output module with a digital input module.

Step 1. Open the ACSELERATOR RTAC project for the Axion system you want to modify. In the **Home** ribbon, click the **Go Online** button. Follow the software prompts to enter online mode.

Step 2. Select **EtherCAT I/O Network** from the project view pane. The EtherCAT I/O Network editor will display in the editing pane.

Step 3. Navigate to the **Connections** tab within the editor. As *Figure 2.23* shows, right-click on the module you want to replace and select **Decommission**. Decommissioning removes all network settings from the module so that you can use it as a spare for another system at a later date.

NOTE: Failure to decommission a module can cause network configuration errors if the subject module is placed in another Axion system at a later date.

Step 4. (Only applies if you are replacing an SEL-2243 Power Coupler) De-energize any power source connected to the power coupler. Remove the incoming power plug-in connector and all network

cables. If the Axion node has only one power coupler, the entire node will shut down and connected nodes will lose network connectivity.

Step 5. (Only applies if you are replacing an SEL-2244 Digital I/O Module) Loosen terminal strip retaining screws and remove I/O terminal strips.

Step 6. Loosen the chassis retaining screw at the top of the module.

NOTE: Do not decommission any modules in an Axion system while network errors exist on the system. The decommission function depends on a fully functioning network to complete properly.

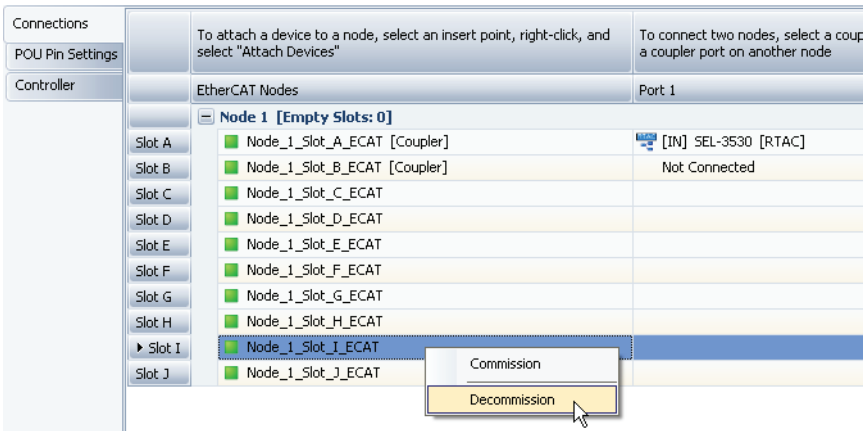


Figure 2.23 Decommissioning a Module

Step 7. Tip the top of the module away from the chassis and lift it from the bottom lip. By default, the RTAC asserts an EtherCAT network error and stops all EtherCAT messages. All output modules will deassert. See EtherCAT portion of *Section 2: Communications* of the *ACSELERATOR RTAC SEL-5033 Instruction Manual* to learn how to use a POU pin setting to disable this behavior.

Step 8. Install the new module according to the applicable mechanical installation instructions in this section.

Step 9. Make all needed connections to the module according to the applicable connection instructions in this section.

Step 10. You are installing a different module type, so you will need an updated settings project to take advantage of the new module. Click **Go Offline** and edit the ACSELERATOR RTAC project to include the new module. Use the downloading instructions in *Section 1: Getting Started* of the *ACSELERATOR RTAC SEL-5033 Instruction Manual* to save and download the new project. The EtherCAT network will automatically configure and enable once you have installed the new project.

Replacing a Failed Module

The default behavior of the Axion will be to disable the EtherCAT network if there are any module errors. In case of an error, such as a hardware fault, the RTAC will identify the network error and shut down all network traffic. For such an occurrence, all output modules will deassert. If you alter the EtherCAT POU setting "Disable_On_Network_Error" to a value of FALSE, then the network will continue to operate with the remaining modules even if an error occurs (See the EtherCAT portion of *Section 2: Communications* of the *ACSELERATOR RTAC SEL-5033 Instruction Manual* to learn about EtherCAT POU settings).

⚠CAUTION
Use extreme caution when changing POU settings. Contact an SEL representative for assistance.

Replacing a Failed Module With Disabled Network (Disable_On_Network_Error = TRUE)

If you have determined that an Axion module has failed and the EtherCAT network is disabled, use the following steps to install a replacement.

Step 1. (Only applies if you are replacing an SEL-2243 Power Coupler) De-energize any power source connected to the power coupler. Remove the incoming power plug-in connector and all network cables. If the Axion node has only one power coupler, the entire node will shut down.

Step 2. (Only applies if you are replacing an SEL-2244 Digital I/O Module) Loosen terminal strip retaining screws and remove I/O terminal strips.

Step 3. Loosen the chassis retaining screw at the top of the module.

Step 4. Tip the top of the module away from the chassis and lift it from the bottom lip.

Step 5. Install the new module according to the applicable mechanical installation instructions in this section.

Step 6. Make all needed connections to the module according to the applicable connection instructions in this section.

Step 7. Open the ACSELERATOR RTAC project for the Axion system. In the **Home** ribbon, click the **Go Online** button. Follow the software prompts to enter online mode.

Step 8. Select **EtherCAT I/O Network** from the project view pane. The EtherCAT I/O Network editor will display in the editing pane.

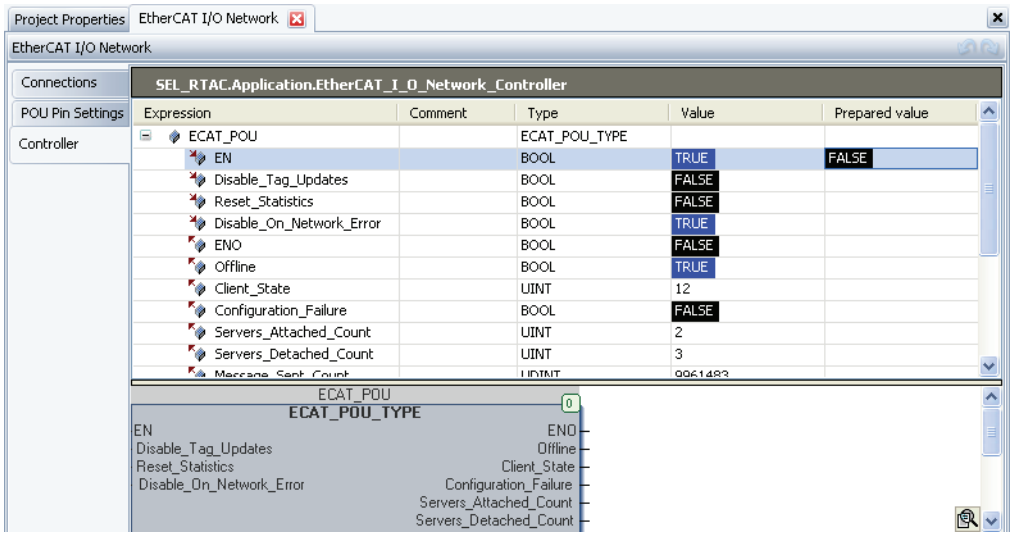


Figure 2.24 Manually Enabling the EtherCAT Network

Step 9. Navigate to the **Controller** tab within the editor. As *Figure 2.24* shows, enter a **Prepared value** of **FALSE** for the **EN** (enable) pin for the EtherCAT POU. In the **Home** ribbon, select **Tools** and click **Force Values** (press **<F6>** on your keyboard as a shortcut).

Step 10. Select **Tools** and click **Unforce and Restore Values** (press **<Shift+F6>** on your keyboard as a shortcut) to release the forced value and restart the EtherCAT network.

Replacing a Failed Module With Enabled Network (Disable_On_Network_Error = FALSE)

If you have determined that an Axion module has failed and that the EtherCAT network is still enabled, use the following steps to install a replacement.

Step 1. (Only applies if you are replacing an SEL-2243 Power Coupler) De-energize any power source connected to the power coupler. Remove the incoming power plug-in connector and all network cables. If the Axion node has only one power coupler, the entire node will shut down.

Step 2. (Only applies if you are replacing an SEL-2244 Digital I/O Module) Loosen terminal strip retaining screws and remove I/O terminal strips.

Step 3. Loosen the chassis retaining screw at the top of the module.

Step 4. Tip the top of the module away from the chassis and lift it from the bottom lip.

Step 5. Install the new module according to the applicable mechanical installation instructions in this section. *Do not tighten the chassis retaining screw.*

Step 6. Make all necessary connections to the module according to the applicable connection instructions in this section.

Step 7. Open the ACSELERATOR RTAC project for Axion system. In the **Home** ribbon, click the **Go Online** button. Follow the software prompts to enter online mode.

Step 8. The EtherCAT network is still enabled; you need to commission the replacement module so that it will join the network. During the commissioning process, the RTAC will download all of the necessary settings to the new module. Select **EtherCAT I/O Network** from the project view pane. The EtherCAT I/O Network editor will display in the editing pane.

Step 9. Navigate to the **Connections** tab within the editor. As *Figure 2.25* shows, right-click on the entry for the new module and select **Commission**.

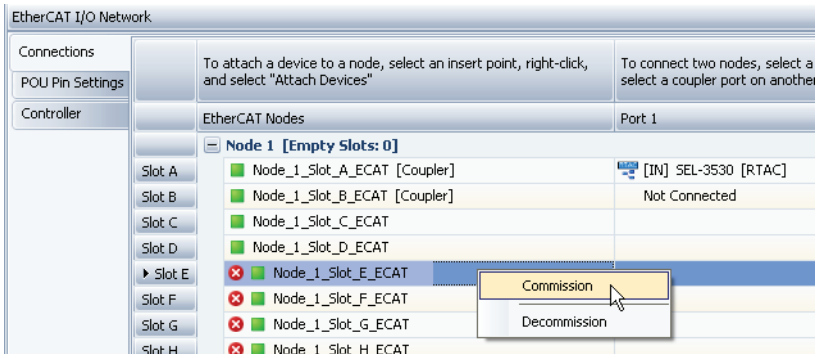


Figure 2.25 Commissioning a Module

Step 10. ACSELERATOR RTAC will display a dialog box instructing you to cycle power to the new module. This is necessary for the new settings to take effect. Tip the top of the module away from the chassis far enough that all LEDs on the module extinguish. Press the module back into place and tighten the chassis retaining screw. The module will join the network automatically.

SEL-2244 Digital Input/Output Module

The SEL-2244 provides contact input and outputs for the Axion. Within an Axion node, install any combination of SEL-2244 modules you want.

Front Panel

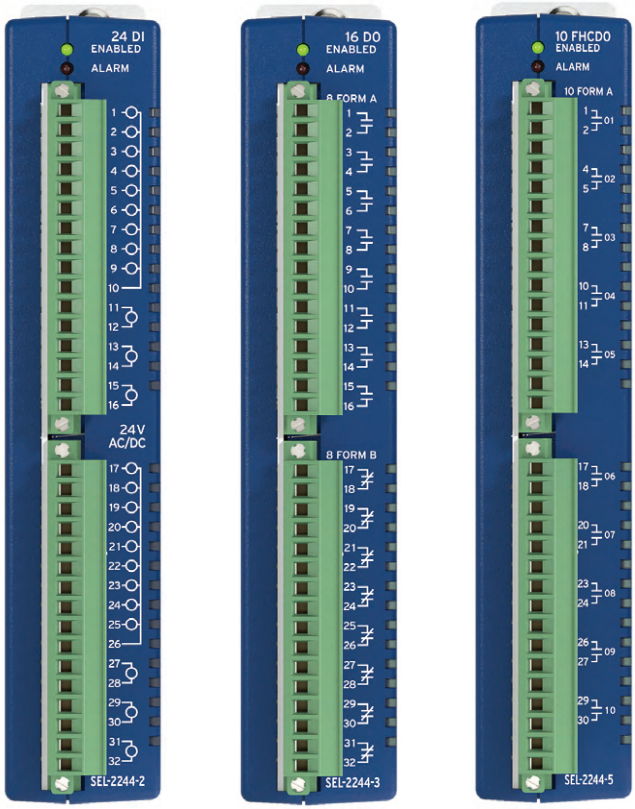


Figure 2.26 SEL-2244 Digital Input and Output Modules

Mechanical Installation

Each SEL-2242 chassis/backplane has four or ten slots, labeled **A** through **J**. Slots **B**–**J** support the SEL-2244 Digital Input and Digital Output modules.

To install an SEL-2244 module, tip the top of the module away from the chassis, align the notch on the bottom of the module with the slot you want on the chassis, and place the module on the bottom lip of the chassis as *Figure 2.27* illustrates. The module is aligned properly when it rests entirely on the lip of the chassis.

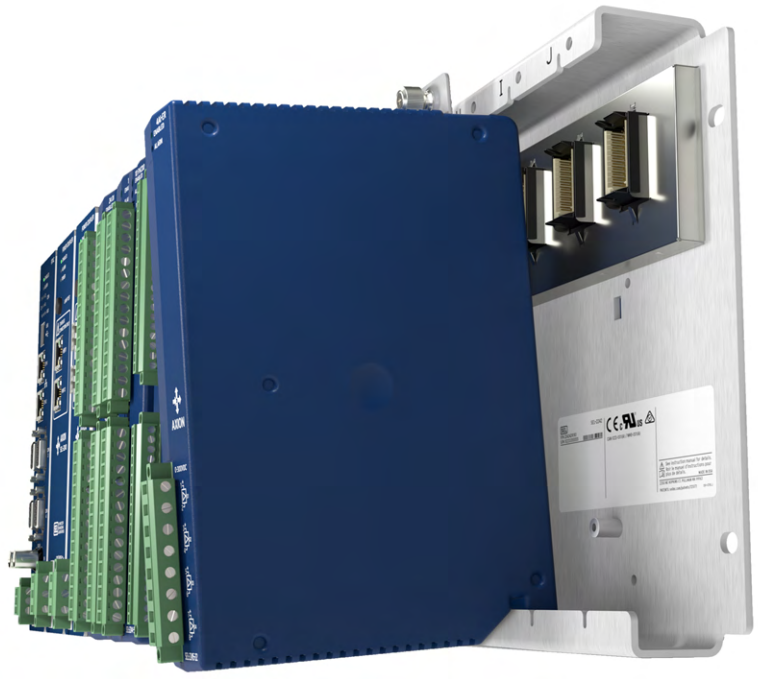


Figure 2.27 Proper Module Placement

Next, carefully rotate the module into the chassis, making sure that the alignment tab fits into the corresponding slot at the top of the chassis (refer to *Figure 2.28*). Finally, press the module firmly into the chassis and tighten the chassis retaining screw.

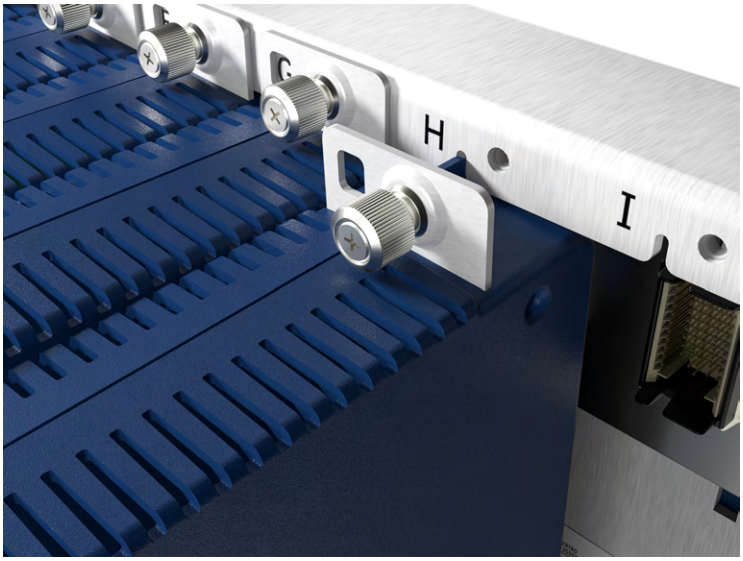


Figure 2.28 Final Module Alignment

Connections

Digital Inputs

The SEL-2244 optoisolated inputs are not polarity-dependent. Refer to *Section 1: Introduction and Specifications* for optoisolated input ratings and *Figure 2.26* for terminal assignments. You can configure inputs to respond to ac or dc control signals. Configure contact inputs by adding a Fieldbus I/O connection for each

module in ACSELERATOR RTAC. See the EtherCAT portion of *Section 2: Communications* of the *ACSELERATOR RTAC SEL-5033 Instruction Manual* for details. Use 0.2–3.3 mm^2 (24–12 AWG) wire of sufficient current capacity and insulation voltage ratings to connect to the digital input terminals for your application.

NOTE: Ensure that when you are applying ac power to inputs with common returns that ac neutral is connected to the common terminal.

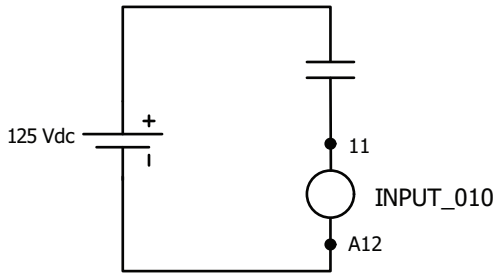


Figure 2.29 Digital Inputs

Digital Outputs

Refer to *Section 1: Introduction and Specifications* for output contact ratings and *Figure 2.26* for terminal assignments. Depending on which module type you ordered, the module will have all Form A, all Form B, or some of each contact type. Configure contact outputs by adding a Fieldbus I/O connection for each module in ACSELERATOR RTAC. See the EtherCAT portion of *Section 2: Communications* of the *ACSELERATOR RTAC SEL-5033 Instruction Manual* for details. Use 0.2–3.3 mm^2 (24–12 AWG) wire of sufficient current capacity and insulation voltage ratings to connect to the digital output terminals for your application.

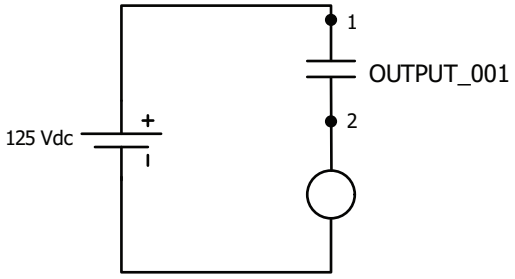


Figure 2.30 Digital Outputs

LED Indicators

Each input and output is associated with a red LED on the right edge of the module. The LED will be illuminated when you assert the point or depress the lamp test button.

The LEDs labeled **ENABLED** and **ALARM** are related to EtherCAT network operation. The green **ENABLED** LED will illuminate when the module is operating normally on the network. The **ALARM** LED will illuminate during network initialization or when there is a problem with the network.

Replacing Modules

Refer to *Module Replacement* for the SEL-2243.

SEL-2245 Analog Input/Output Modules

The SEL-2245 provides analog inputs and outputs for the Axion. Install as many as 16 modules of each type of analog module in an Axion system. Only three dc analog output modules can be installed in a standard backplane. Furthermore, only two dc analog output modules can be installed in a backplane with the 7-inch color touchscreen display.

Front Panels

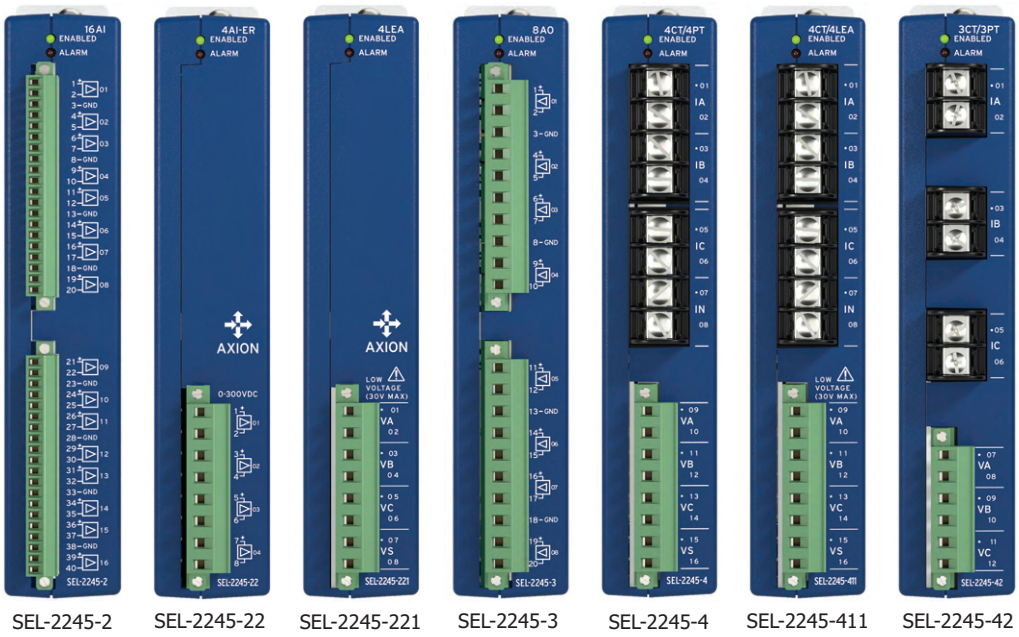


Figure 2.31 SEL-2245 Modules

Mechanical Installation

Slots B–J support the SEL-2245 Analog Input and Output modules. See *Mechanical Installation on page 2.24* for SEL-2245 module installation instructions.

DC Analog Inputs

The SEL-2245-2 dc analog inputs include a plus sign to indicate the positive convention. Refer to *Section 1: Introduction and Specifications* for analog input ratings and *Figure 2.32* for terminal assignments. You can configure inputs to measure ±20 mA, ±2 mA, or ±10 V signals. Configure inputs by adding a Fieldbus I/O connection for each module in ACSELERATOR RTAC® SEL-5033 Software. See *EtherCAT* in *Section 2: Communications* of the *ACSELERATOR RTAC SEL-5033 Instruction Manual* for details. Use 0.1–1.3 mm^2 (28–16 AWG) wire of sufficient current capacity and insulation voltage ratings to connect to the analog input terminals for your application.

The return terminal for all inputs, including unused inputs, must be connected together to ensure measurement errors stay within the maximum limits during transient events. This is required when using the SEL-2245-2 in a command and control system. The inputs may be isolated from each other for measurement

only applications. Accuracy returns to typical values within 100 ms of the end of a transient when using Filter A. Filter B and Filter C extend recovery time but reduce the magnitude of erroneous readings during transient events.

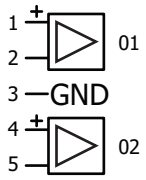


Figure 2.32 DC Analog Inputs

DC Analog Inputs Extended Range

The SEL-2245-22 extended range dc analog inputs include a plus sign to indicate the positive convention. Refer to *Section 1: Introduction and Specifications* for analog input ratings and *Figure 2.33* for terminal assignments. Extended range inputs are for measuring 0–300 Vdc signals. Configure inputs by adding a Fieldbus I/O connection for each module in ACSELERATOR RTAC. See *EtherCAT* in *Section 2: Communications* of the *ACSELERATOR RTAC SEL-5033 Instruction Manual* for details. Use 0.2–3.3 mm^2 (24–12 AWG) wire of sufficient current capacity and insulation voltage ratings to connect to the analog input terminals for your application.

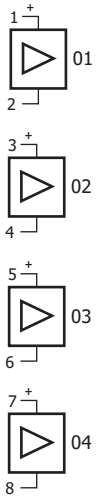


Figure 2.33 DC Analog Inputs Extended Range

DC Analog Outputs

The SEL-2245-3 dc analog outputs include a plus sign to indicate the positive convention. Refer to *Section 1: Introduction and Specifications* for analog output ratings and *Figure 2.34* for terminal assignments. You can configure outputs to produce ±20 mA or ±10 V signals. Configure outputs by adding a Fieldbus I/O connection for each module in ACSELERATOR RTAC. See *EtherCAT* in *Section 2: Communications* of the *ACSELERATOR RTAC SEL-5033 Instruction Manual* for details. Use 24–12 AWG (0.2–3.3 mm^2) wire of sufficient current capacity and insulation voltage ratings to connect to the analog output terminals for your application.

NOTE: You cannot install more than two dc analog outputs on the same node if the device is configured with an LCD touchscreen. Otherwise, you cannot install more than three outputs on the same node.

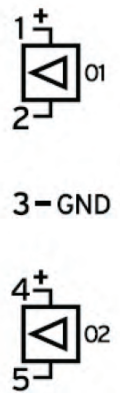


Figure 2.34 DC Analog Outputs

AC Metering Inputs

⚠CAUTION
If CT inputs are connected to external CTs, ensure that the external CTs are shorted prior to removing CT connections.

The SEL-2245-4 inputs use a dot by the terminal numbers to indicate the polarity connection of the CTs and PTs. Refer to *Section 1: Introduction and Specifications* for CT/PT analog input ratings and *Figure 2.35* for terminal assignments. Configure inputs by adding a Field-bus I/O connection for each module in ACSELERATOR RTAC. See *EtherCAT* in *Section 2: Communications* of the *ACSELERATOR RTAC SEL-5033 Instruction Manual* for details. Use 24–12 AWG (0.2–3.3 mm^2) wire of sufficient current capacity and insulation voltage ratings to connect to the analog input terminals for your application. Use #8 ring or spade terminals for CT connections.

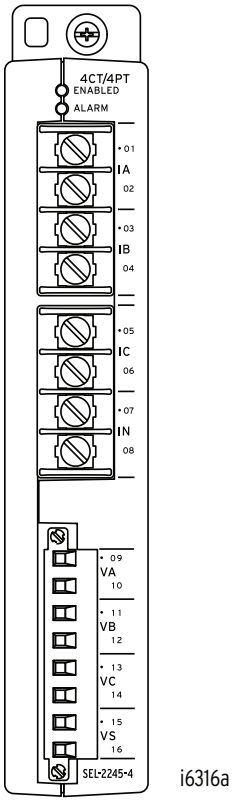


Figure 2.35 AC Metering Inputs

Low-Voltage (LEA) Monitoring Inputs

The SEL-2245-411 and SEL-2245-221 inputs use a dot by the terminal numbers to indicate the polarity connection of the CTs and low-voltage (LEA) inputs. Refer to *Section 1: Introduction and Specifications* for CT/LEA analog input

ratings and *Figure 2.36* for terminal assignments. Configure inputs by adding a field-bus I/O connection for each module in ACSELERATOR RTAC. See *EtherCAT* in *Section 2: Communications* of the *ACSELERATOR RTAC SEL-5033 Instruction Manual* for details. Use 24–12 AWG (0.2–3.3 mm^2) wire of sufficient current capacity and insulation voltage ratings to connect to the analog input terminals for your application. Use #8 ring or spade terminals for CT connections.

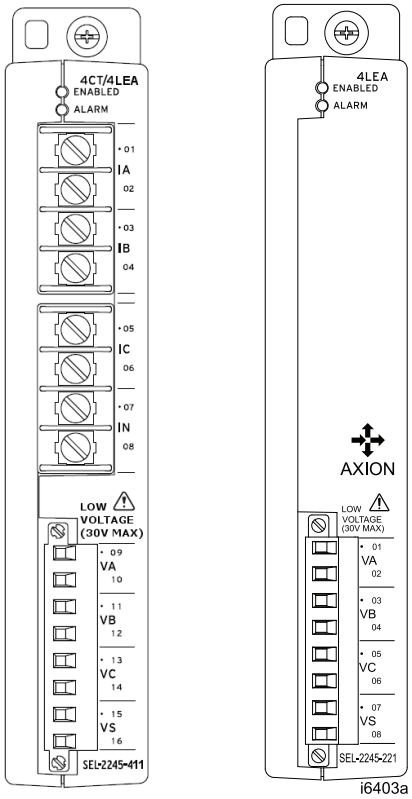


Figure 2.36 Low-Voltage (LEA) Monitoring Inputs

AC Protection Inputs

⚠CAUTION
If CT inputs are connected to external CTs, ensure that the external CTs are shorted prior to removing CT connections.

The SEL-2245-42 inputs use a dot by the terminal numbers to indicate the polarity connection of the CTs and PTs. Refer to *Section 1: Introduction and Specifications* for CT/PT analog input ratings and *Figure 2.35* for terminal assignments. Configure inputs by adding a Field-bus I/O connection for each module in ACSELERATOR RTAC. See *EtherCAT* in *Section 2: Communications* of the *ACSELERATOR RTAC SEL-5033 Instruction Manual* for details. Use 24–12 AWG (0.2–3.3 mm^2) wire of sufficient current capacity and insulation voltage ratings to connect to the analog input terminals for your application. Use #8 ring or spade terminals for CT connections.

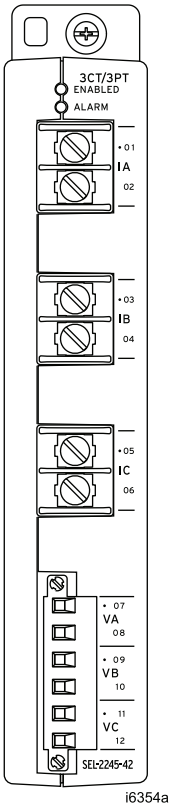


Figure 2.37 AC Protection Inputs

Wye-Connected Voltage Inputs

To connect wye-configuration voltage inputs on the SEL-2245-4 or SEL-2245-42 voltage inputs, directly connect each input (i.e., phase VA is connected to input VA on the module) as shown in *Figure 2.38*.

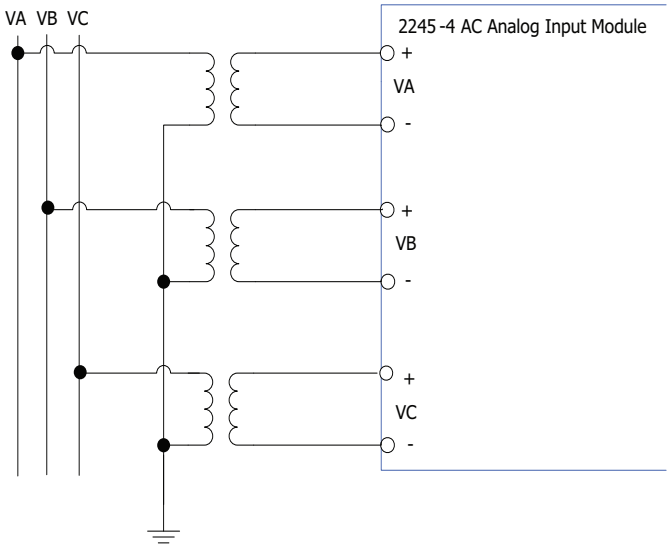


Figure 2.38 PT Wye-Connected Voltage Inputs

With wye voltages, the following tag assignments provide the individual voltages:

- VA = VA phase voltage
- VB = VB phase voltage
- VC = VC phase voltage

Delta-Connected Voltage Inputs

To connect delta voltage inputs on the SEL-2245-4 or SEL-2245-42, connect the open-delta inputs as shown in *Figure 2.39*.

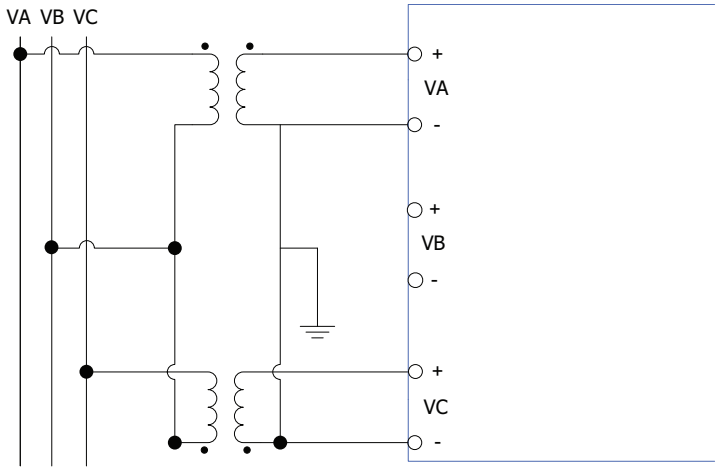


Figure 2.39 Open-Delta Voltage Inputs

With delta voltages, the following tag assignments provide the individual voltages:

- VAB = VA
- VBC = –VC
- VCA = VC – VA

LED Indicators

The LEDs labeled **ENABLED** and **ALARM** are related to EtherCAT network operation. The green **ENABLED** LED will illuminate when the module is operating normally on the network. The **ALARM** LED will illuminate during network initialization or when there is a problem with the network.

Replacing Modules

Refer to *Module Replacement* for the SEL-2243.

Section 3
Factory Reset

Override Login

The RTAC has a jumper that allows you to override the requirement to use a user password. SEL recommends using this jumper only when necessary to restore a unit when the administrative password is forgotten. For security reasons, you should not operate the RTAC without a password.

NOTE: ODBC and other tools may still prompt you for a password when the RTAC password override is enabled. You can enter any text for a password in those situations.

The following pages include information about changing specific jumper positions on the RTAC circuit board. Referring to *Figure 3.1*, you will notice that each jumper has one corner with wider silkscreen than the remaining portions of the jumper. This will indicate the location of Pin 1 and Position A of the jumper.

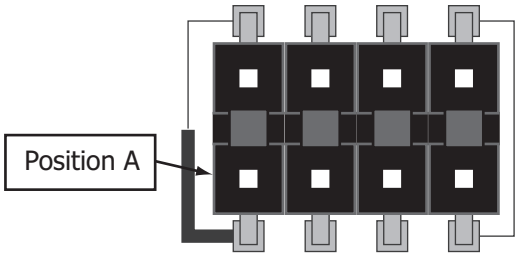


Figure 3.1 Connections Status for an Individual Module Failure

To override log in username/password verification, perform the following steps:

DANGER
Disconnect or de-energize all external connections before opening this device. Contact with hazardous voltages and currents inside this device can cause electrical shock resulting in injury or death.

Step 1. Follow *SEL-2241 Disassembly on page 2.17* to expose the main circuit board.

Step 2. Locate the reset jumper:

SEL-3530: **JMP6**
SEL-3530-4: **JMP4**
SEL-2241: **JMP3**

Step 3. Place a jumper across the **C** position in the jumper block.

Step 4. (Only applies to the SEL-2241) Follow *SEL-2241 Reassembly on page 2.17*, and reinstall all connectors.

CAUTION
The device contains devices sensitive to Electrostatic Discharge (ESD). When working on the device with the front panel removed, work surfaces and personnel must be properly grounded or equipment damage may result.

Step 5. Apply power to the unit. Wait until the **ENABLED** LED is on.

Step 6. Log in to the RTAC via the web interface with username **Edison** and no password. Edison is an administrative account that is only active when a jumper is in the **C** position. Previously configured user accounts will remain intact.

Step 7. Make any user account changes you need to make.

Step 8. Turn off the RTAC and remove the jumper.

Step 9. Follow *SEL-2241 Reassembly on page 2.17*, reinstall all connectors and energize the unit.

Reset to Factory Settings

You can reset the RTAC to factory-default settings via the web interface or by using a hardware jumper. All programming, user accounts, logs, etc., will be lost and the procedure is not reversible.

Perform the following steps to reset the RTAC to factory-default settings via the web interface.

Step 1. Log in to the web interface.

Step 2. Click on **Device Reset**.

Step 3. Check **Reset To Factory Default Settings** (see *Figure 3.2*).

Step 4. Click **Submit**.

Figure 3.2 Factory Reset Via Web Interface

DANGER
Disconnect or de-energize all external connections before opening this device. Contact with hazardous voltages and currents inside this device can cause electrical shock resulting in injury or death.

Perform the following steps to reset the RTAC to factory defaults by using the internal jumper only as a last attempt to recover from a failed state.

Step 1. Follow *SEL-2241 Disassembly on page 2.17* to expose the main circuit board.

Step 2. Locate the reset jumper:

SEL-3530: **JMP6**
SEL-3530-4: **JMP4**
SEL-2241: **JMP3**

CAUTION
The device contains devices sensitive to Electrostatic Discharge (ESD). When working on the device with the front panel removed, work surfaces and personnel must be properly grounded or equipment damage may result.

Step 3. Place a jumper across the **A** position in the jumper block.

Step 4. (Only applies to the SEL-2241) Follow *SEL-2241 Reassembly on page 2.17*, reinstall all connectors.

Step 5. Apply power to the unit. Wait until the **ENABLED** LED is on before proceeding to the next step.

Step 6. Turn off the RTAC and remove the jumper.

NOTE: Do not perform a firmware upgrade while the factory reset jumper is set.

Step 7. Follow *SEL-2241 Reassembly on page 2.17*, reinstall all connectors and energize the unit.

Appendix A

Firmware and Manual Versions

Firmware

Determining the Firmware Version in Your Device

Appendix A in the *ACSELERATOR RTAC® SEL-5033 Software Instruction Manual* lists the firmware versions, a description of modifications, and the instruction manual date code that corresponds to firmware versions.

Instruction Manual

The date code at the bottom of each page of this manual reflects the creation or revision date. *Table A.1* lists the instruction manual release dates and a description of modifications. The most recent instruction manual revisions are listed at the top.

Table A.1 Instruction Manual Revision History (Sheet 1 of 5)

Revision Date	Summary of Revisions
20241025	**Section 1** ➤ Updated *Specifications*.
20240716	**Section 2** ➤ Updated *Figure 2.16: SEL-2241 RTAC Front Panel, Copper Ethernet*, *Figure 2.18: Final Module Alignment*, *Figure 2.22: SEL-2243 Front Panel, Copper and Fiber Connectors*, *Figure 2.26: SEL-2244 Digital Input and Output Modules*, *Figure 2.27: Proper Module Placement*, *Figure 2.28: Final Module Alignment*, and *Figure 2.31: SEL-2245 Modules*.
20240419	**Section 1** ➤ Updated Message Rates in *Specifications*.
20240320	**Section 1** ➤ Updated *Specifications*.
20230712	**Section 1** ➤ Updated *Table 1.1: Module Features* and *Table 1.7: SEL-2242 Chassis/Backplane*. ➤ Updated *Specifications*. **Section 2** ➤ Added *Figure 2.2: SEL-2240 Dimensions for 10-Slot Panel Mount*, *Figure 2.3: SEL-2240 Dimensions for 10-Slot Rack With 7-Inch, Color Touchscreen Display (Rack Mount)*, *Figure 2.4: SEL-2240 Dimensions for 10-Slot Rack With 7-Inch, Color Touchscreen Display (Panel Mount)*, *Figure 2.7: SEL-2240 Dimensions for Dual 4-Slot Panel Mount*, *Figure 2.9: SEL-2240 10-Slot Front Panel (Panel Mount)*, *Figure 2.11: SEL-2240 10-Slot Front Panel 7-Inch Touchscreen Display (Panel Mount)*, and *Figure 2.14: SEL-2240 Dual 4-Slot Front Panel (Panel Mount)*.
20230119	**Section 1** ➤ Updated *Accuracy at 25°C* in *Specifications*. ➤ Updated *Synchrophasor* in *Specifications*. ➤ Updated *Synchrophasor* under *AC Protection Inputs (SEL-2245-42)* in *Specifications*.

Table A.1 Instruction Manual Revision History (Sheet 2 of 5)

Revision Date	Summary of Revisions
	Section 2 ➤ Added note under *Device Placement*. ➤ Updated *DC Analog Inputs* in *SEL-2245 Analog Input/Output Modules*.
20221221	**Section 1** ➤ Added UKCA Mark to *Specifications*.
20220902	**Section 1** ➤ Updated *Burden/Current Draw at Nominal DC Voltage* under *Optoisolated Control Inputs (SEL-2244-2)* in *Specifications*.
20220729	**Section 1** ➤ Added *Simple Network Time Protocol (SNTP) Accuracy* under *General* in *Specifications*.
20220225	**Section 1** ➤ Updated *Specifications* to include additional details. **Section 2** ➤ Updated *Field Serviceability*.
20211105	**Section 1** ➤ Updated product photos. **Section 2** ➤ Updated product and module photos.
20210921	**Preface** ➤ Updated *Safety Marks* and *Instructions for Cleaning and Decontamination*. **Section 1** ➤ Updated *Overview*. ➤ Updated *Figure 1.1: Functional Design Concept*. ➤ Updated *Table 1.1: Module Features*. ➤ Added *Bay Control*. ➤ Updated *Automation and Control, Options,* and *Specifications*. **Section 2** ➤ Updated *Figure 2.1: SEL-2240 10-Slot Rack- and Surface-Mount Dimensions*. ➤ Added *Figure 2.5: SEL-2242 10-Slot Front Panel With LCD Panel.* ➤ Updated *Figure 2.16: SEL-2241 RTAC Front Panel, Copper Ethernet*.
20210219	**Section 1** ➤ Updated *Specifications*. **Section 2** ➤ Updated *Power*. ➤ Updated *Grounding (Earthing)*. ➤ Updated *EtherCAT Ports*. ➤ Updated *Field Serviceability*. ➤ Added *Power Supply Fuse Replacement*.
20200224	**Section 1** ➤ Updated *Specifications*.
20190216	**Section 1** ➤ Updated *Specifications*. **Section 2** ➤ Updated *Figure 2.4: SEL-2242 10-Slot Front Panel, Rack-Mount*.
20181207	**Section 1** ➤ Added SEL-2245-221 Low-Voltage (LEA) Monitoring Module. ➤ Updated *Specifications*.

Table A.1 Instruction Manual Revision History (Sheet 3 of 5)

Revision Date	Summary of Revisions
	Section 2 ➤ Added SEL-2245-221 Low-Voltage (LEA) Monitoring Module.
20180629	Section 1 ➤ Updated Time-Synchronization Source to include additional PTP configuration information. ➤ Updated *Specifications*. Section 2 ➤ Added Low-Voltage (LEA) Monitoring Inputs.
20180330	Section 1 ➤ Updated *Specifications*.
20171107	Section 1 ➤ Updated *Specifications*.
20170728	Preface ➤ Updated *Copyrighted Software.* Section 2 ➤ Updated *Figure 2.28: SEL-2245 Modules.*
20170505	Section 1 ➤ Updated *Specifications*. Section 2 ➤ Updated *Figure 2.28: SEL-2245 Modules*. ➤ Added *AC Protection Inputs*. Appendix B ➤ Added *RTAC Web Upgrade Procedure*.
20170109	Section 1 ➤ Updated *Automation and Control*. ➤ Updated *Communications Protocols*. ➤ Updated *Specifications*.
20160624	Section 1 ➤ Updated *Features* and *Applications* for client/server and PTP information. Appendix B ➤ Added point-release information.
20160325	Preface ➤ Updated *Safety Information*. Section 1 ➤ Updated *Specifications*.
20151029	Section 2 ➤ Added recommended wire size and connection details.
20150904	Section 1 ➤ Revised for the addition of IEC 61850 MMS server.
20150807	Preface ➤ Updated *General Safety Marks* in *Safety Marks*. Section 1 ➤ Updated *Specifications*. Section 2 ➤ Updated *Figure 2.37: Open-Delta Voltage Inputs*.

Table A.1 Instruction Manual Revision History (Sheet 4 of 5)

Revision Date	Summary of Revisions
20150417	**Section 1** ➤ Added a reference to exe-GUARD® security feature. ➤ Updated *Features* and added subsection, *Human-Machine Interface*. ➤ Added figure references in *Applications*. ➤ Updated *Specifications*. **Section 2** ➤ Added *Wye-Connected Voltage Inputs* and *Delta-Connected Voltage Inputs*. **Section 3** ➤ Removed note from *User Sessions* and updated *Table 3.1: Self-Test System Tags*. ➤ Updated *Self-Test* and added subsection, *Power Source Scale*. ➤ Updated *Using Online Debug,* added subsection, *Tag Cross References* and *Figure 3.5: Create a Watch Window*. ➤ Updated *Watchdog*. **Appendix B** ➤ Added Chrome™ to the browsers in *Step 11* of *Upgrade Procedure*.
20150123	**Preface** ➤ Updated Tightening Torque values in *Safety Marks*. **Section 1** ➤ Updated *Table 1.7: Optional Accessories*.
20141230	**Preface** ➤ Changed *Safety and General Information* to *Safety Information*. ➤ Updated *Safety Information*. ➤ Added *General Information* subsection.
20141006	**Section 1** ➤ Revised *Physical Features* for addition of SEL-2245-22 4AI-ER module. ➤ Updated *Table 1.6: SEL-2245 Analog I/O Module*. ➤ Revised *Specifications* for addition of SEL-2245-22 4AI-ER module. **Section 2** ➤ Added DC Analog Inputs Extended Range to *SEL-2245 Analog Input/Output Module*. ➤ Added *Figure 2.33: DC Analog Inputs Extended Range*.
20140714	**Section 1** ➤ Updated *Specifications*. **Section 2** ➤ Added notes about correct usage of power coupler EtherCAT ports. ➤ Added notes about correct usage of USB ports. ➤ Clarified number of dc analog output modules that can be installed in a node.
20140428	**Section 1** ➤ Revised *Physical Features* for addition of SEL-2245-3 AO module. ➤ Updated *Table 1.6: SEL-2245 Analog I/O Module*. ➤ Revised *Specifications* for addition of SEL-2245-3 AO module. **Section 2** ➤ Updated *Figure 2.1: SEL-2240 10-Slot Rack- and Surface-Mount Dimensions*, *Figure 2.2: SEL-2240 4-Slot Rack- and Surface-Mount Dimensions*, and *Figure 2.3: SEL-2240 Dimensions for Dual 4-Slot Rack- and Surface-Mount*. ➤ Added *DC Analog Outputs* to *SEL-2245 Analog Input/Output Module*. ➤ Added *Figure 2.33: DC Analog Outputs*.
20130827	**Section 1** ➤ Added SES-92, IEC 60870-5-101, and -104 Server to *Communications Protocols*. ➤ Revised *Specifications* for addition of SEL-2245-4 CT/PT Module. **Section 2** ➤ Added *AC Analog Inputs* to *Installation*.

Table A.1 Instruction Manual Revision History (Sheet 5 of 5)

Revision Date	Summary of Revisions
	Section 3 ➤ Updated *Table 3.1: Self-Test System Tags*.
20130531	Section 1 ➤ Added protocol to *Data Concentration and Protocol Conversion* in *Automation and Control* in *Features*. ➤ Updated C*ommunications Protocols* table in *Features*. ➤ Updated *Table 1.7: Optional Accessories*; *Figure 1.6: SCADA Data Concentrator and HMI*; *Figure 1.12: Intelligent Port Switch*; *Figure 1.13: Network Gateway*; *Figure 1.14: Protocol Converter*; *Figure 1.15: Time Synchronization*; and *Figure 1.16: Security Gateway*. ➤ Updated *Specifications*. Section 3 ➤ Added note in *Force Tags* in *Using Online Debug*. ➤ Added watchdog task in *Watchdog*. ➤ Updated *Troubleshooting* table. ➤ Updated *Figure 3.8: Factory Reset via Web Interface*.
20121121	General ➤ Updated manual throughout for greater clarity in text and figures.
20120713	Section 1 ➤ Revised *Specifications* for FHC digital output release.
20120427	Section 1 ➤ Revised for addition of 16 analog inputs and 10 FHC digital output modules. Section 2 ➤ Revised for addition of 16 analog inputs and 10 FHC digital output modules. Appendix B ➤ Revised for addition of module firmware upgrades.
20120208	Section 1 ➤ Revised for addition of IEC 61850 MMS Client.
20111125	Section 2 ➤ Revised for addition of low-voltage power coupler, 4-slot backplane, and dual 4-slot backplane.
20110721	➤ Initial version.

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