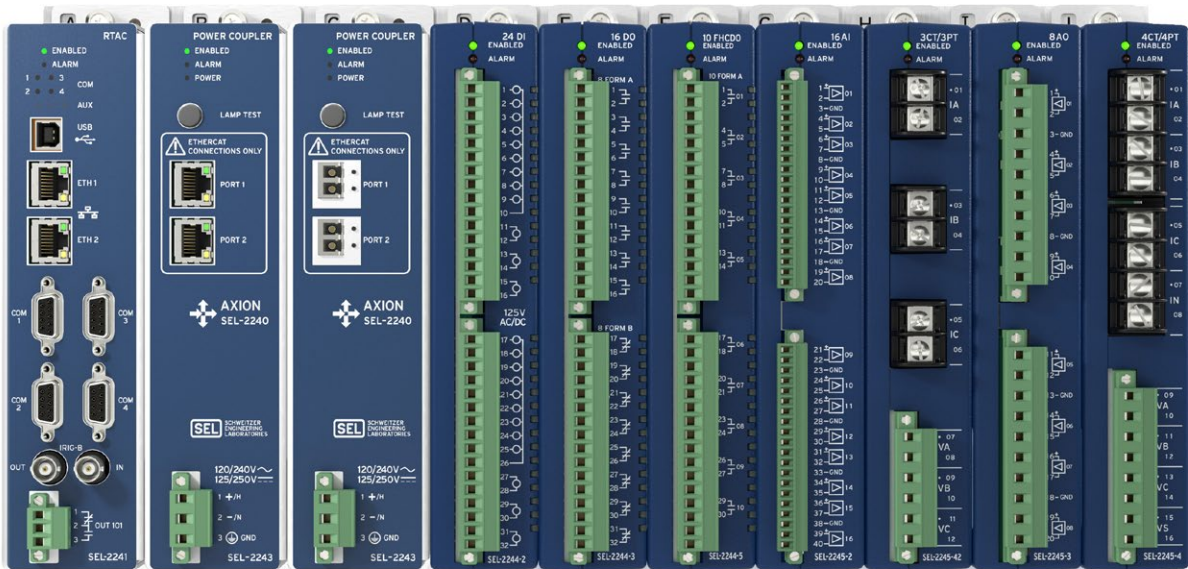


# SEL-2240 Axion<sup>®</sup>

## Modular Real-Time Automation Controller



Dependable control for harsh environments  
in a fully integrated, flexible platform

- Real-Time Automation Controller (RTAC) provides high-speed, deterministic control and performance.
- Modular design supports custom configuration of analog and digital I/O options.
- Hardware and components meet or exceed IEEE 1613 specifications for harsh conditions.
- Exe-GUARD<sup>®</sup> allowlist antivirus technology permits only authorized applications to run.
- Web-based HMI provides system-wide visualization and control.





## SEL-2240 Axion

### Features and Capabilities

- Digital fault recorder (DFR)
- Programmable logic controller (PLC)
- Remote terminal unit (RTU)
- Web-based HMI
- Communications integration
- Built-in security
- Scalable solution
- Redundant power supplies
- Ultrarugged I/O
- Phasor measurement unit (PMU)

### Industries Served

- Transportation
- Metals and mining
- Wastewater
- Energy
- Marine and offshore
- Paper production

# SEL-2241 RTAC Module

## Test Functions

- Control enable/disable
- Force values

## Activity Indicators

- Port LEDs
- Programmable LEDs

## Precise Time

- IRIG-B
- Network Time Protocol (NTP)

## Web Interface

- Optional HMI
- User administration
- Logging and alarms



## Client/Server Protocols

## Security Firewall

## Communications Ports

# Chassis Options

## 4-Slot Axion Chassis

Apply the 4-slot chassis for small I/O control applications.



## Dual 4-Slot Axion Chassis

Employ the dual 4-slot chassis for small I/O or dual RTAC with I/O applications.



## 10-Slot Axion Chassis

Apply the 10-slot chassis for large I/O control and monitoring applications.



# Product Overview

Lamp test pushbutton.

Diagnostic LEDs.

No fans or moving parts.

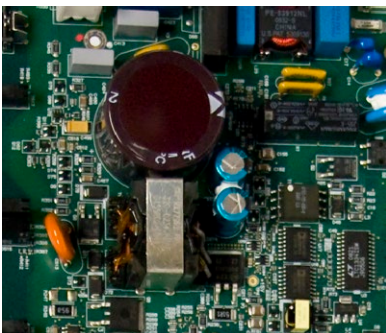
Wide operating temperature range  
(-40° to +85°C) for use indoors  
and in outdoor cabinets.



A powerful 32-bit microprocessor supports I/O, logic, security, and communications.



The Axion power coupler employs the same field-proven reliable design found in SEL protective relays, providing years of trouble-free operation.



## Client Protocols

CDC Type II  
 Courier  
 CP 2179  
 DNP3 Serial, DNP3 LAN/WAN  
 EtherNet/IP—Explicit Message Client\*  
 File Transfer Protocol (FTP)/Secure FTP (SFTP)\*  
 Flex Parse  
 IEC 60870-5-101/104  
 IEC 60870-5-103  
 IEC 61850 MMS and MMS Client File Services\*  
 IEEE C37.118 Synchrophasors  
 LG 8979  
 Modbus RTU, Modbus TCP  
 SEL Protocols  
 SES-92  
 Simple Network Management Protocol (SNMP)

## Server (Outstation) Protocols

CDC Type II  
 DNP3 Modbus  
 DNP3 Serial, DNP3 LAN/WAN  
 EtherNet/IP—Implicit Message Adapter\*  
 FTP/SFTP  
 IEC 60870-5-101/104  
 IEC 61850 MMS and MMS Server File Services\*  
 IEEE C37.118 Synchrophasors  
 LG 8979  
 Modbus RTU, Modbus TCP  
 SEL Protocols  
 SES-92



#### **Peer-to-Peer Protocols**

IEC 61850 GOOSE\*

Network Global Variable List (NGVL)

SEL MIRRORING BITS Communications

#### **Fieldbus Protocols**

EtherCAT to SEL Axion I/O Modules

#### **Ethernet Redundancy**

Parallel Redundancy Protocol (PRP)

#### **Maximum Supported Modules and I/O**

60 modules

Digital inputs: 1,296 (all digital input system)

Digital outputs: 864 (all digital output system)

DC analog inputs: 256 (16 analog input modules allowed per system)

Extended-range dc analog inputs: 64  
(16 analog input modules allowed per system)

DC analog outputs: 128 (16 analog output modules allowed per system, maximum of 3 analog output modules per node)

AC metering inputs: 128 (16 CT/PT modules allowed per system)

AC protection inputs: 96 (16 CT/PT modules allowed per system)

\*Optional feature

# Product Overview

The SEL-2241 RTAC Module is a dedicated RTAC. You can use one (or more) in a system to integrate I/O, substation intelligent electronic devices (IEDs), SCADA communications, and security applications all in one device.

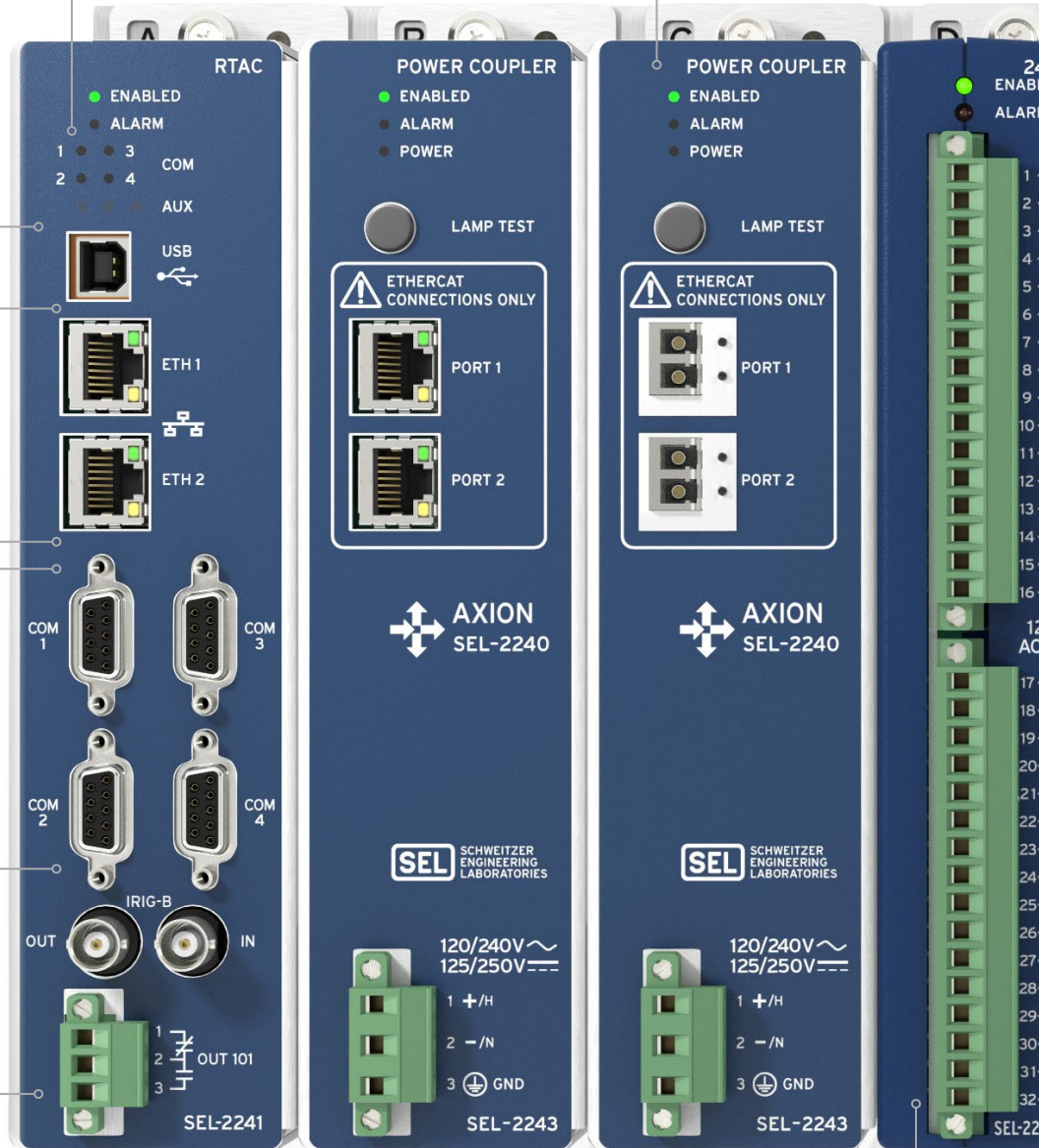
Two independent Ethernet ports, available in either copper or LC fiber, are capable of operating on separate subnets.

Four serial ports, software-selectable for EIA-232/EIA-485.

Panel wiring harnesses are available to simplify field termination. Choose between 8', 16', and 20' lengths.

Serial activity and user-programmable LEDs.

Optional redundant power supply.



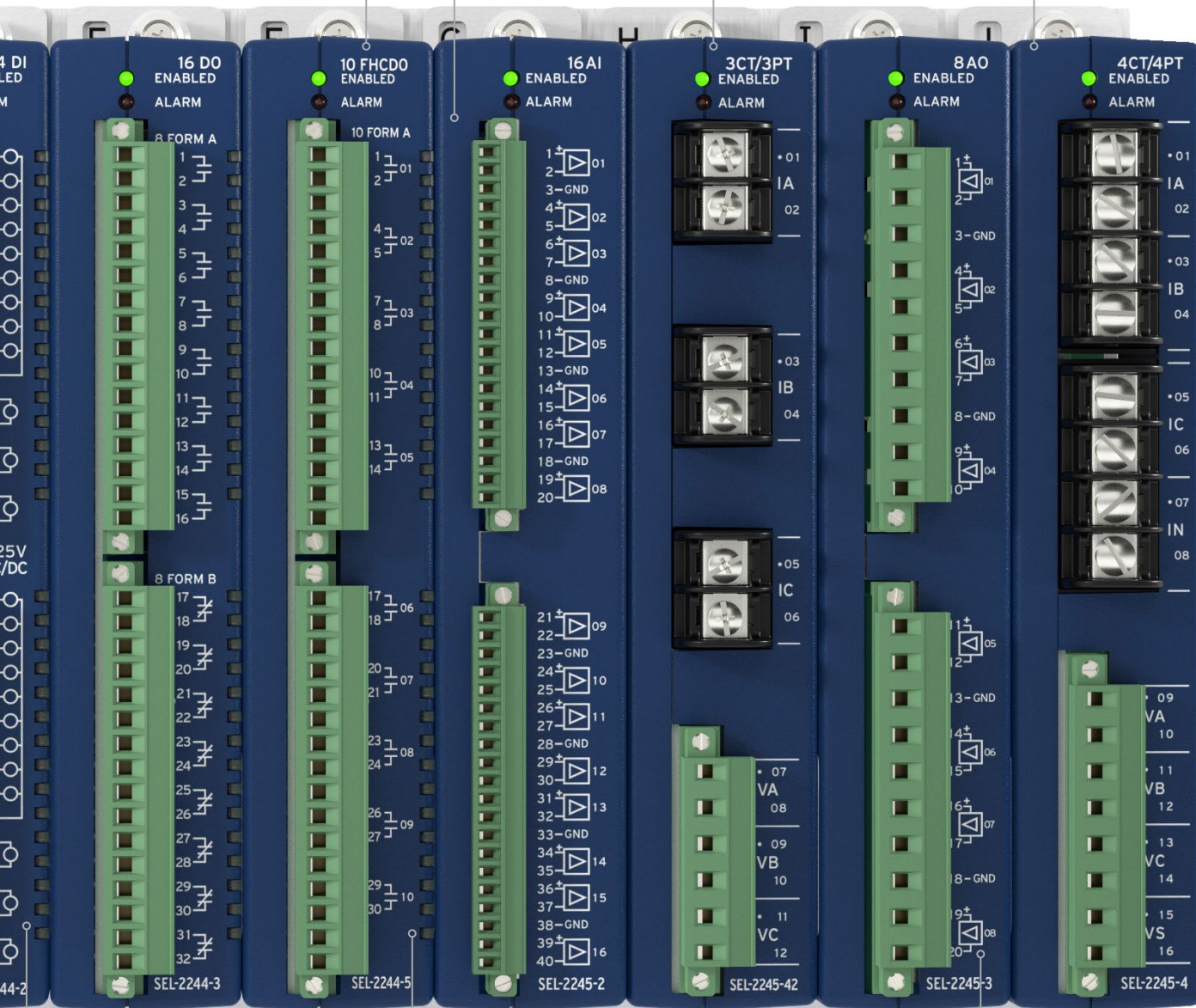
All digital inputs are rated for ac and dc operation and time-stamped to 1 ms accuracy.

Choose fast, high-current digital outputs for applications requiring fast action ( $<50 \mu\text{s}$ ) or interrupting high current (up to 10 A).

DC analog inputs are software-selectable for  $\pm 20 \text{ mA}$ ,  $\pm 2 \text{ mA}$ , or  $\pm 10 \text{ V}$  input ranges.

Measure ac signals with three current and three voltage inputs for recording or protection functions.

Collect synchronized ac measurements (5–400 V, 0–22 A) with an accuracy of 0.1 percent on the SEL-2245-4 AC Metering Module.



All terminals are clearly numbered for wiring and testing.

Indicating LED for each input and output.

Self-sourcing dc analog outputs are software-selectable for  $\pm 20 \text{ mA}$  or  $\pm 10 \text{ V}$ .

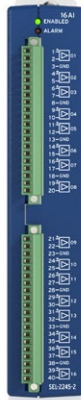
# Powerful Modular Design



**SEL-2245-4**  
AC Metering Module



**SEL-2245-3 DC**  
Analog Output  
Module



**SEL-2245-2 DC**  
Analog Input Module  
With Event Recording



**SEL-2245-22 DC**  
Analog Input Extended-  
Range Module



**SEL-2245-42 AC**  
Protection Module

## SEL-2245-4 AC Metering Module

### Synchronized Current and Voltage Measurements

Employ the AC Metering Module to provide high-accuracy current and voltage measurements with the advantage of synchronized sampling. Multiple modules in an Axion system sample all measurements at the same time to ensure a common reference for all voltage, current, and power values. You can create time-deterministic power control applications without performing additional processing to align the measurements to a reference.

### Remote Location of AC Metering Modules

Remotely locate AC Metering Modules in four-slot chassis with fiber-optic-connected power couplers to maintain electrical isolation. By locating the modules at the source CTs and PTs, you can reduce copper expenses. The Axion deterministic EtherCAT network allows you to use fiber-optic-connected power couplers to locate chassis up to 5 km apart without adding any latency and while maintaining synchronized sampling in all locations. You can replace aging transducers by directly measuring CT and PT inputs with a higher-accuracy measurement device with a smaller physical footprint.

## SEL-2245-3 DC Analog Output Module

The DC Analog Output Module includes eight software-settable current or voltage outputs, which can be sampled from  $-20$  to  $+20$  mA or  $-10$  to  $+10$  V. This module supports a ramp feature, allowing you to set a target value and a time to reach it. One SEL-2242 chassis can include up to three DC Analog Output Modules. These modules are ideal for transducer outputs or control set points for proportional integral derivative (PID) blocks.

## SEL-2245-2 DC Analog Input Module With Event Recording

The DC Analog Input Module includes 16 inputs for measuring low-level dc signals. The inputs are user-configurable in pairs to measure signals within  $\pm 20$  mA,  $\pm 2$  mA, or  $\pm 10$  V ranges. You can capture COMTRADE event reports of dc analog signals at a rate of 1 kHz for analysis.

## SEL-2245-22 DC Analog Input Extended-Range Module

The DC Analog Input Extended-Range Module includes four inputs for measuring 0–300 Vdc signals. This makes it ideal for monitoring battery voltage or trip coil currents. You can capture COMTRADE event reports of the signals at a rate of 1 kHz for analysis.



## Axion Module Components

SEL-2241 RTAC Module

SEL-2242 Chassis/Backplane

SEL-2243 Power Coupler

SEL-2244-2 Digital Input Module

SEL-2244-3 Digital Output Module

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

SEL-2245-2 DC Analog Input Module

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

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

SEL-2245-3 DC Analog Output Module

SEL-2245-4 AC Metering Module

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

SEL-2245-42 AC Protection Module

### SEL-2245-42 AC Protection Module

The AC Protection Module includes three CTs with isolated returns and three PTs for measuring ac signals. This module has galvanically isolated inputs and can sample events at user-software-selectable rates of 1, 2, 4, 8, and 24 kHz. You can use up to 16 AC Protection Modules in one Axion system and realize synchronized measurements throughout all the modules. This enables time-deterministic control algorithms to take advantage of the common reference for all measurements, even those in distributed locations. You can collect IEEE C37.118.1a-2014-compliant synchrophasor data from up to 64 phasor quantities with an SEL-2241 RTAC Module. By using the SEL-3555 RTAC with the SEL-2245-42 Module, you can create advanced recording systems, including built-in SSD storage of recorded data.

### Substation- and Plant-Grade Equipment

We designed, built, and tested the Axion chassis and modules with the same practices, processes, and standards that we use for our protective relays, information processors, and other products. This includes compliance with IEEE and IEC standards for electrostatic discharge, fast transients, radiated emissions, surge-withstand capability, dielectric strength, pulsed magnetic fields, disturbances, vibration, temperature, shock, and humidity. Specifications and tests are per the ANSI/IEEE C37.90, IEEE 1613, and IEC 60255 standards.



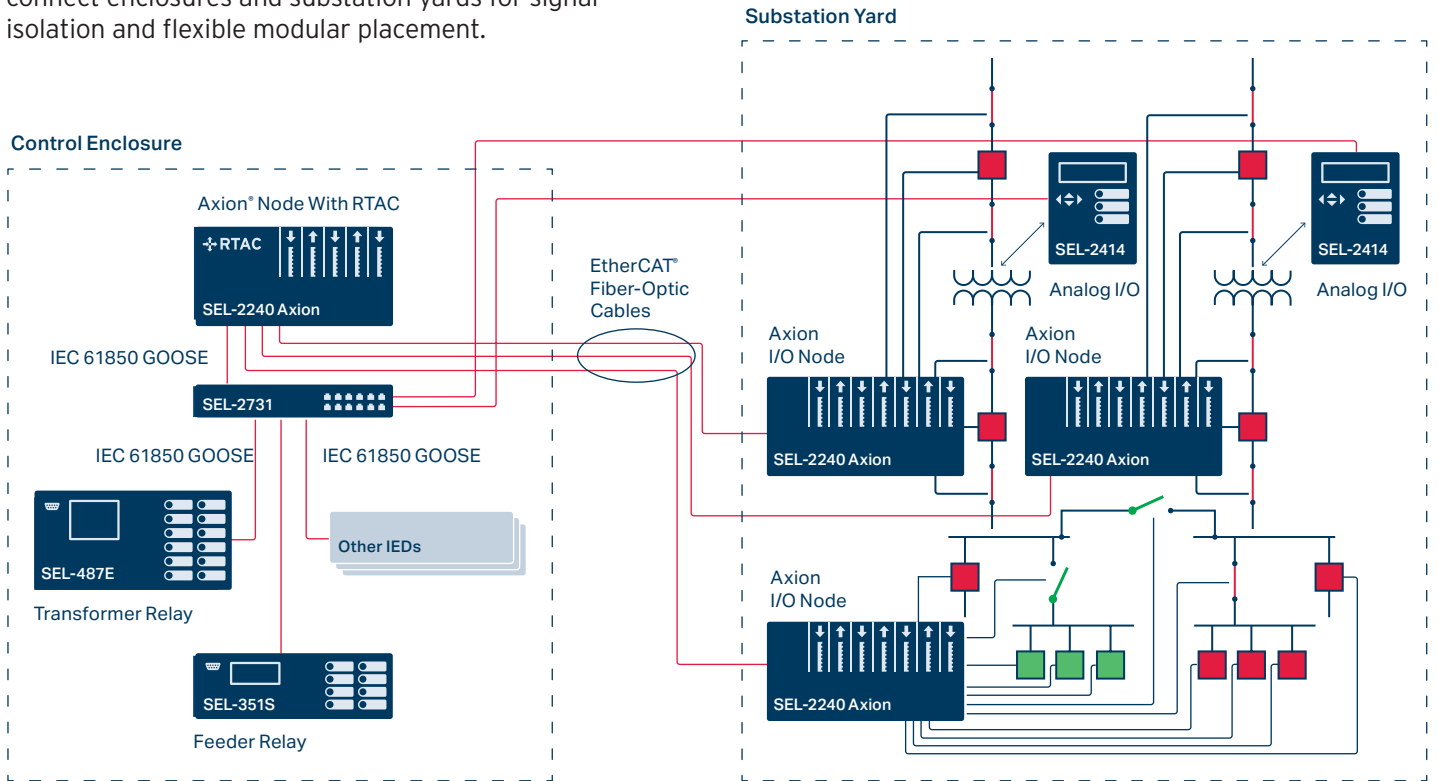
Visit [selinc.com/SEL-2240](https://selinc.com/SEL-2240) to access product configurators for the SEL Axion.



# Electric Utility Applications

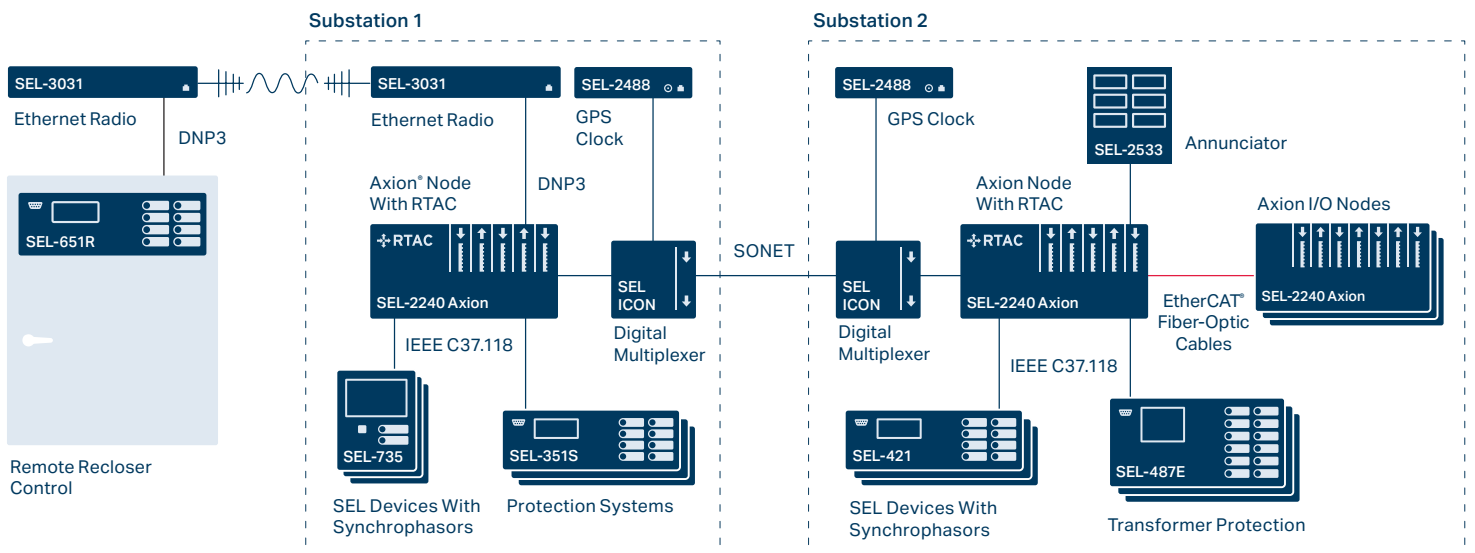
## Substation Automation

Integrate substation I/O into a comprehensive substation control scheme that includes IEC 61850 GOOSE messaging. EtherCAT fiber-optic cables connect enclosures and substation yards for signal isolation and flexible modular placement.



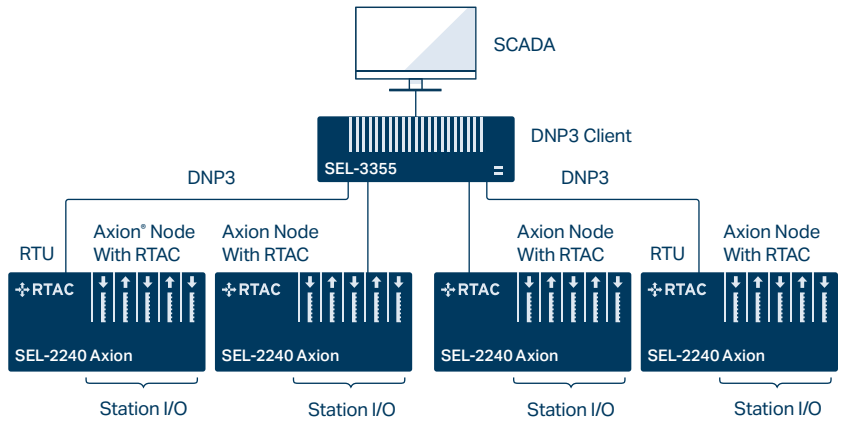
## Smart Grid

Apply the SEL Axion as part of a wide-area power system monitoring and automation strategy.



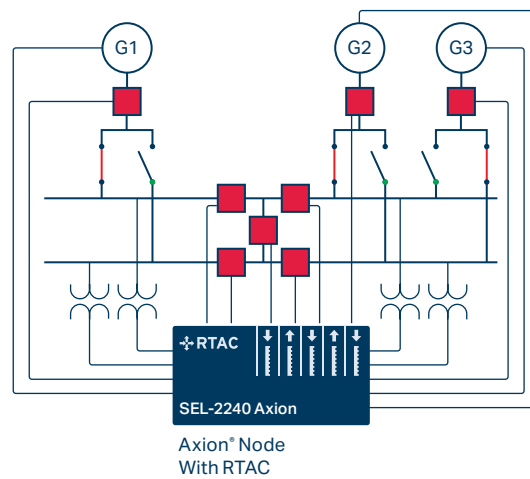
### Substation RTU

Gather digital and analog signals from remote sites, and distribute the data over a variety of industry-standard protocols to a central SCADA system or HMI.



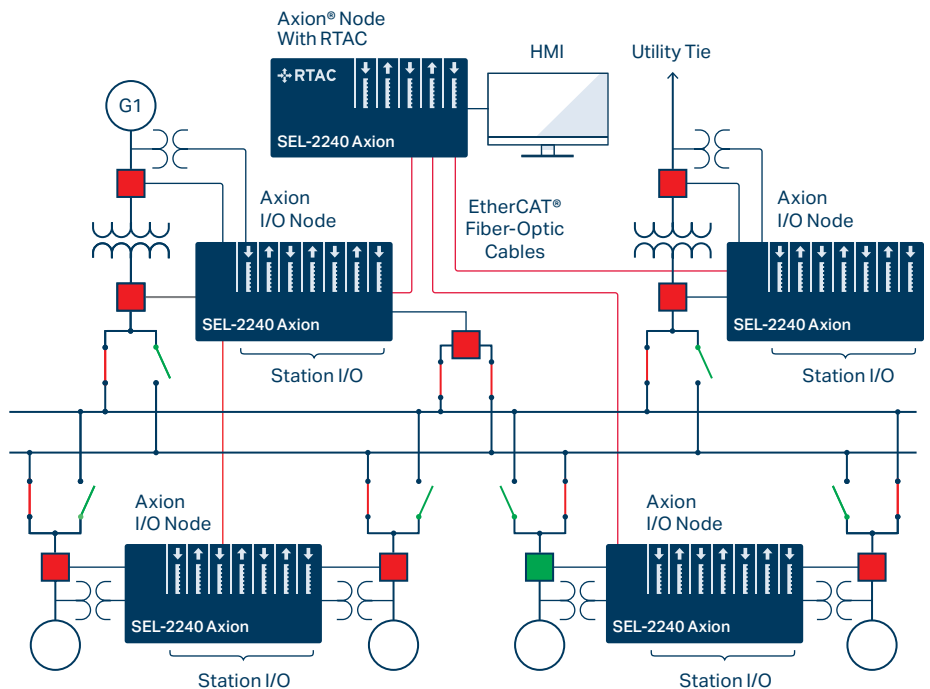
### Autosynchronization

Use multiple AC Metering Modules and I/O modules to create advanced and highly scalable autosynchronization systems. You can automatically adjust the governor exciter controls as necessary to provide safe, secure, and unattended synchronization of generation onto the power system. With synchronized sampling from multiple CT/PT modules, the control algorithms for multiple governor exciters have access to all necessary time-aligned PT measurements in the same Axion system.



### Load Shedding

Eliminate the need for separate input, output, and control devices for industrial and microgrid load-shedding schemes. Combining system frequency and power measurements with the ability to add hundreds of binary inputs and outputs, the Axion consolidates the measurement, logic engine, and mitigation equipment into a single unit. Employing the AC Metering Module frequency and power elements, the deterministic logic engine in the Axion incorporates system variables into fast-acting control logic for underfrequency or demand control load shedding.

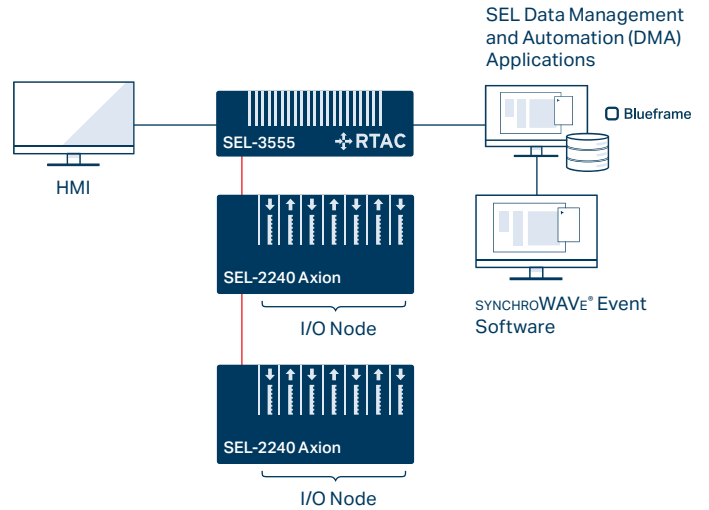


## Digital Fault Recorder

Use the SEL-3555 or SEL-3350 RTAC with Axion modules, including the SEL-2245-42 AC Protection Module, to implement DFR solutions that exceed the requirements of NERC PRC-002.

SEL DFR solutions:

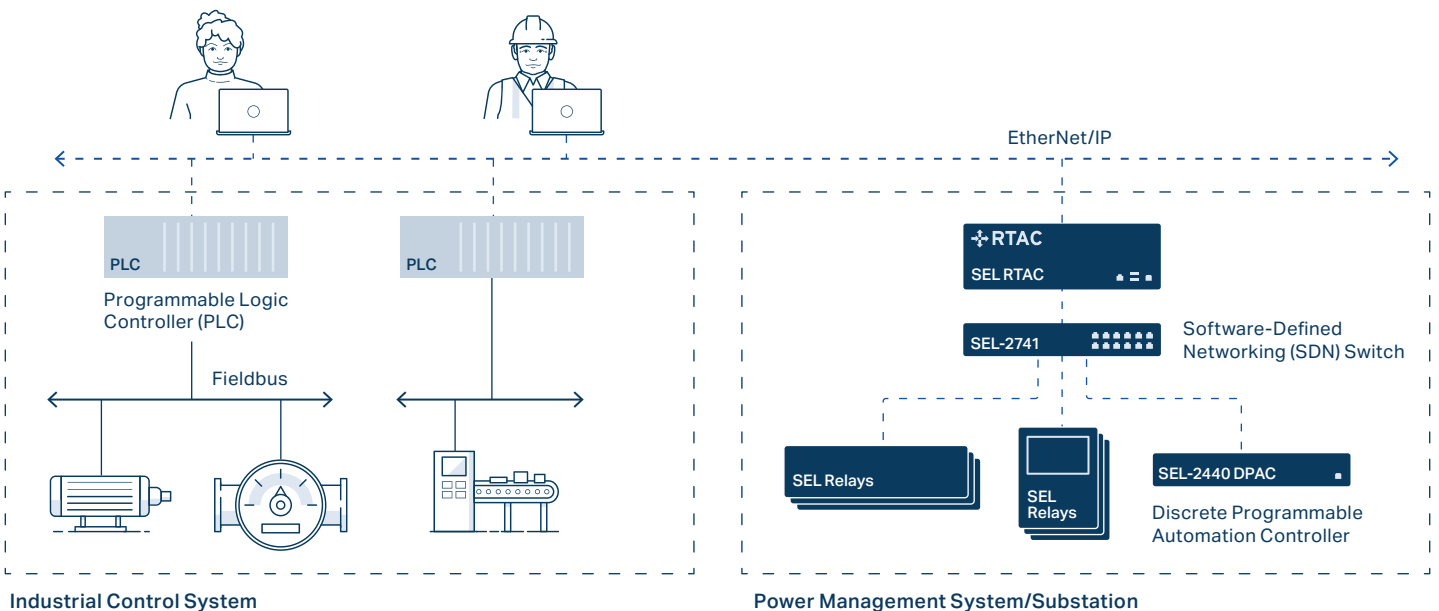
- Record at 24 kHz with recording group configuration for combining multiple module event reports, including digital values, into a single COMTRADE file.
- Stream and record continuous oscillography at 3 kHz, providing significantly more visibility into power system behavior than intermittent event reports.
- Support recording applications that need to maintain more than the minimum ten-day storage requirement for all fault records, dynamic disturbance records, and Sequence of Events records in the substation.



## Industrial Applications

### Integrate Power Management With Industrial Control

The RTAC provides a powerful gateway between the substation and the factory using EtherNet/IP. This popular industrial protocol facilitates reliable communication between electronic devices in industrial automation systems. You can use the RTAC EtherNet/IP adapter to exchange critical data for real-time monitoring, process control, and power system integration.



## Process Control

Easily implement sequential control for critical processes, and apply IEC 61131 ladder programming to simplify control documentation and troubleshooting.

## Distributed I/O Monitoring

Measure currents, voltages, or the status of contact points. You can use the data locally within the device, send the information to another device within the substation, or send the information to one or more databases for application by operators, engineers, planners, and administrators.

# Other Applications

## Axion Wave Server

Stream up to 96 channels of point-on-wave, ac analog samples from SEL-2245-42 protection modules at 3,000 samples per second. The Axion Wave Server provides the sample stream using an IEEE C37.118 TCP/IP connection to SEL-5702 Synchrowave® Operations.

## Impedance-Based Fault Location

Use the fault location library to automatically analyze Axion COMTRADE events from the SEL-2245-42, and perform impedance-based fault location on event recordings.

## Synchronized CT/PT Measurements for Advanced Control

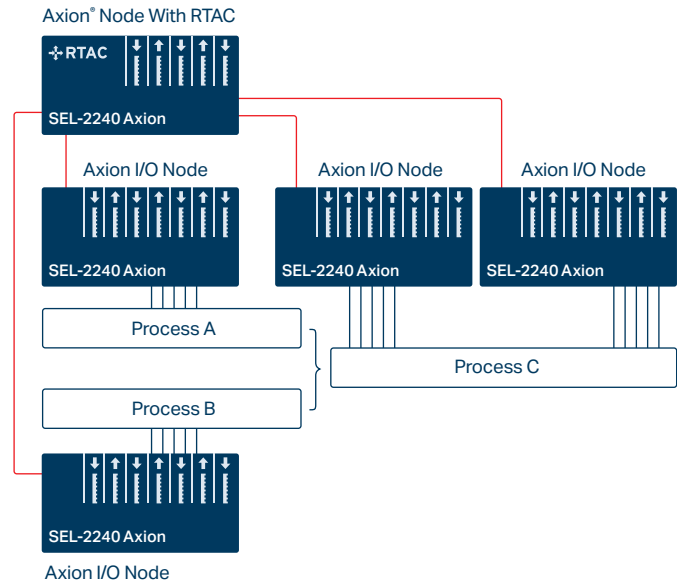
Employ synchronized CT/PT measurements from multiple Axion systems distributed across a substation and in other locations for advanced time-deterministic control applications, including load shedding and microgrid control.

## System Security

Enable encryption for any engineering access channel or SCADA link. System security auditing, logging, and password management help you enforce government standards.

## Flexible Synchrophasor Measurement Unit

Apply the Axion as a scalable and distributable PMU. The Axion was the first PMU in the world to fully comply with the IEEE Synchrophasor Measurement Test Suite Specification—Version 2. A single RTAC Module in the primary Axion node serves IEEE C37.118.1a-2014 synchrophasor data from remote Axion PMU nodes. Remote Axion nodes use the AC Metering Module at the measurement points.



## IEC 61850 GOOSE Concentrator

Gather a variety of substation I/O with the Digital I/O Modules, and share the data with IEC 61850 GOOSE messages. The protocol flexibility of the RTAC allows you to concentrate data from non-IEC 61850 relays and convert these data to GOOSE messages.

## Industrial Control System and PID Control

Create an ultrarugged PLC system by combining the standard IEC 61131-3 logic engine, integrated database, and flexible I/O. You can use ladder logic, structured text, or function chart programming for custom control strategies. In addition, advanced process control strategies are possible by implementing control function blocks, such as PID.

## Remote I/O Expansion

Increase the number of I/O points with as many as 60 modules or six nodes connected to one resident SEL-2241 RTAC. Through EtherCAT connectivity, you can provide rapid, time-synchronized data acquisition rates to the expanded I/O points within your automation system.

## Automatic Trip Coil Monitoring

Assess the health of a circuit breaker by capturing trip coil performance in real time. You can record trip coil dynamics, including current, voltage, and temperature during operations, and run automatic diagnostics to issue alerts for scheduling preventative maintenance.

## Recording Groups (COMTRADE and Axion I/O Combining)

Combine data from the AC Protection, DI, and DO modules into a single COMTRADE file using the recording group functionality. You can record at rates of 1, 2, 4, 8, or 24 kHz, with up to 576 seconds of recording length at 1 kHz, allowing you to automatically collect events via MMS File Services or SFTP.



# SEL-2240 Axion Specifications

## Hardware

### SEL-2241 RTAC Processor Module

Processor speed: 533 MHz  
Memory: 512 MB DDR2 error-correcting code (ECC) RAM  
User storage: 2 GB

### I/O Modules

Digital input: 24 contact inputs (24, 48, 110, 125, 220, or 250 Vac/Vdc)  
Standard digital output: 16 standard control outputs (all Form A, all Form B, or half and half)  
Fast high-current (FHC) digital output: 10 fast, high-current control outputs (all Form A, all Form B, or half and half)  
DC analog input: 16 transducer inputs ( $\pm 20$  mA,  $\pm 2$  mA, or  $\pm 10$  V software-selectable)  
DC analog input extended range: 4 inputs (0–300 Vdc or 6.7–300.0 VL-N in ac mode)  
DC analog output: 8 self-sourcing outputs ( $\pm 20$  mA or  $\pm 10$  V software-selectable)  
**AC Metering Inputs**  
4 current transformer inputs (0–22 A)  
4 potential transformer inputs (5–400 V<sub>L-N</sub>)  
**AC Protection Inputs**  
3 current transformer inputs (0.1–20.0 A)  
3 potential transformer inputs (6.7–300.0 V<sub>L-N</sub>)  
Maximum modules per network: 60

### Power Coupler

**Power Supply**  
120/240 Vac, 50/60 Hz; 125/250 Vdc; or 24/48 Vdc  
Single or redundant supplies  
**EtherCAT Ports**  
Ports: 2  
Connectors: RJ45 female or LC  
Protocol: EtherCAT

### EtherCAT I/O Network

Data rate: Automatic

### Operating Temperature

IEC performance rating:  $-40^{\circ}$  to  $+85^{\circ}\text{C}$  ( $-40^{\circ}$  to  $+185^{\circ}\text{F}$ )

## Security

### Account Management

Lightweight Directory Access Protocol (LDAP) and Microsoft Active Directory user accounts  
User roles  
Strong passwords

### Intrusion Detection

Access/audit logs  
Syslog  
Alarm LED  
Alarm contact

### Secure Encrypted Communications

Transport Layer Security (TLS)/Secure Shell (SSH)  
HTTPS

# SEL-2240 Axion Specifications Continued

## Automation

**Engineering Access** SEL interleaved and direct transparent modes

**Programmable Control** IEC 61131-3 logic engine

**Programming Languages**  
Ladder diagram  
Structured text  
Continuous function chart  
Tag processor

**Ethernet Redundancy**  
PRP

## Time Modes

**IRIG-B** Inputs modulated or demodulated; outputs demodulated

**Time Protocols** NTP Client  
NTP Server (up to three configurable servers)  
Accepts time via PTP

\*Optional feature

EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

## Protocols

### Client

CDC Type II  
Courier  
CP 2179  
DNP3 Serial, DNP3 LAN/WAN  
EtherNet/IP—Explicit Message Client\*  
FTP/SFTP\*  
Flex Parse  
IEC 60870-5-101/104  
IEC 60870-5-103  
IEC 61850 MMS and MMS Client File Services\*  
IEEE C37.118 Synchrophasors  
LG 8979  
Modbus RTU, Modbus TCP  
SEL Protocols  
SES-92  
SNMP

### Server

CDC Type II  
DNP3 Serial, DNP3 LAN/WAN  
EtherNet/IP—Implicit Message Adapter\*  
FTP/SFTP  
IEC 60870-5-101/104  
IEC 61850 MMS and MMS Server File Services\*  
IEEE C37.118 Synchrophasors  
LG 8979  
Modbus RTU, Modbus TCP  
SEL Protocols  
SES-92  
SNMP Agent

### Peer-to-Peer

IEC 61850 GOOSE\*  
NGVL  
SEL MIRRORING BITS Communications

### Field Bus Protocol

EtherCAT to SEL Axion I/O Modules



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