SEL-2240 Axion®

Modular Real-Time Automation Controller

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

- Automate power system operations with high performance and deterministic control.
- Monitor grid conditions and substation assets by using hundreds of measurement inputs and control outputs.
- Control substation bays through a 7-inch touchscreen display with customizable screens.
- Capture every disturbance with 24 kilosamples-per-second (ksps) fault recording and 3 ksps continuous waveform streaming.
- Ensure new installations are ready for the future, or seamlessly retrofit existing installations with a modular design and a wide range of protocols.

SEL-2240 Axion

Features and Capabilities

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

Industries Served

- Electric utilities
- Renewable energy
- Data centers
- Transportation
- Metals and mining
- Wastewater
- Oil and gas
- Marine and offshore
- Paper production

SEL-2241-2 RTAC Module

The SEL-2241-2 is the next generation of automation and control for the SEL-2240 Axion platform. Its rugged hardware enables you to deploy fully customized automation solutions in the harshest environments and has enough power to simultaneously support applications like bay control, digital fault recording, and continuous waveform streaming. The module includes either two RJ45 ports or two small form-factor pluggable (SFP) fiber-optic Ethernet ports.

Front-Panel Options

Standard Overlay

Includes the standard lamp test pushbutton and diagnostic LEDs.

Front-Panel With Touchscreen Display

Includes a local HMI with programmable buttons and a 7" full-color touchscreen display (only available with a 10-slot chassis).

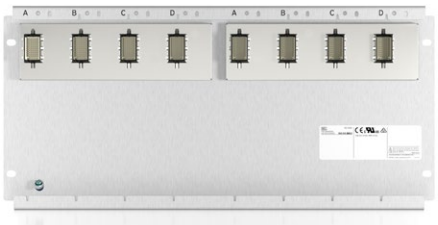
Chassis Options

4-Slot Axion Chassis

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

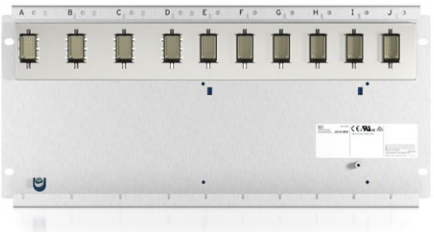
Dual 4-Slot Axion Chassis

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.



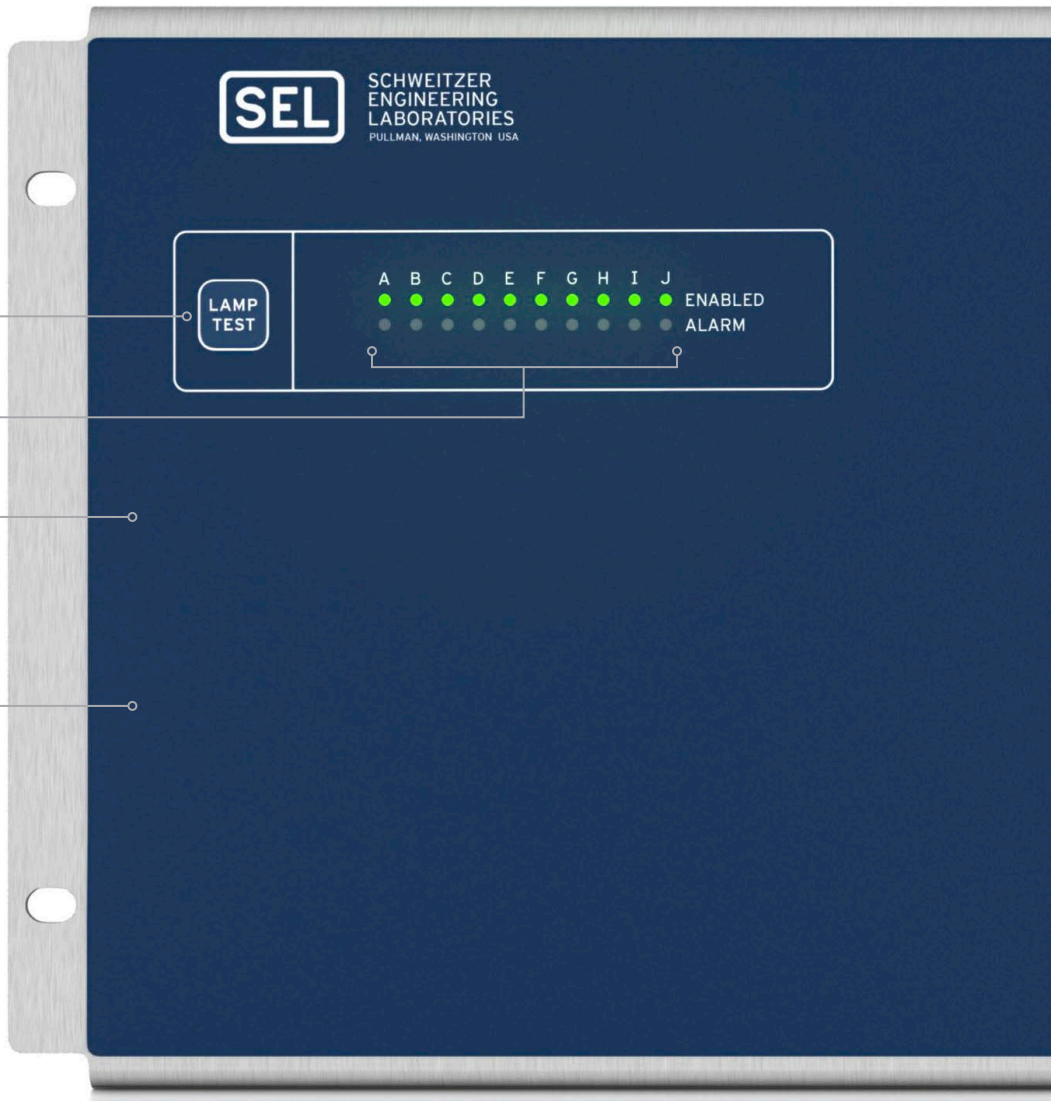
Product Overview

Lamp test pushbutton.

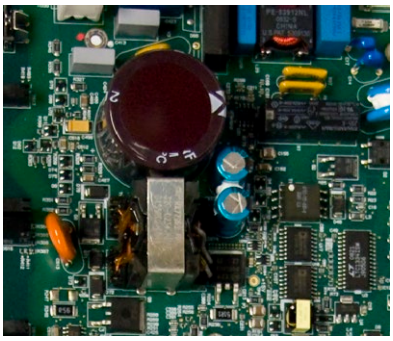
Diagnostic LEDs.

No fans or moving parts.

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



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
OPC UA
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
OPC UA
SEL Protocols
SES-92

Peer-to-Peer Protocols

IEC 61850 GOOSE*

Network Global Variable List (NGVL)

SEL MIRRORED BITS® Communications

Fieldbus Protocols

EtherCAT to SEL Axion I/O Modules

Ethernet Redundancy

Parallel Redundancy Protocol (PRP)

*Optional feature

Maximum Supported Modules and I/O

60 modules

Digital inputs: 1,728 (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)

Product Overview

The SEL-2241-2 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.

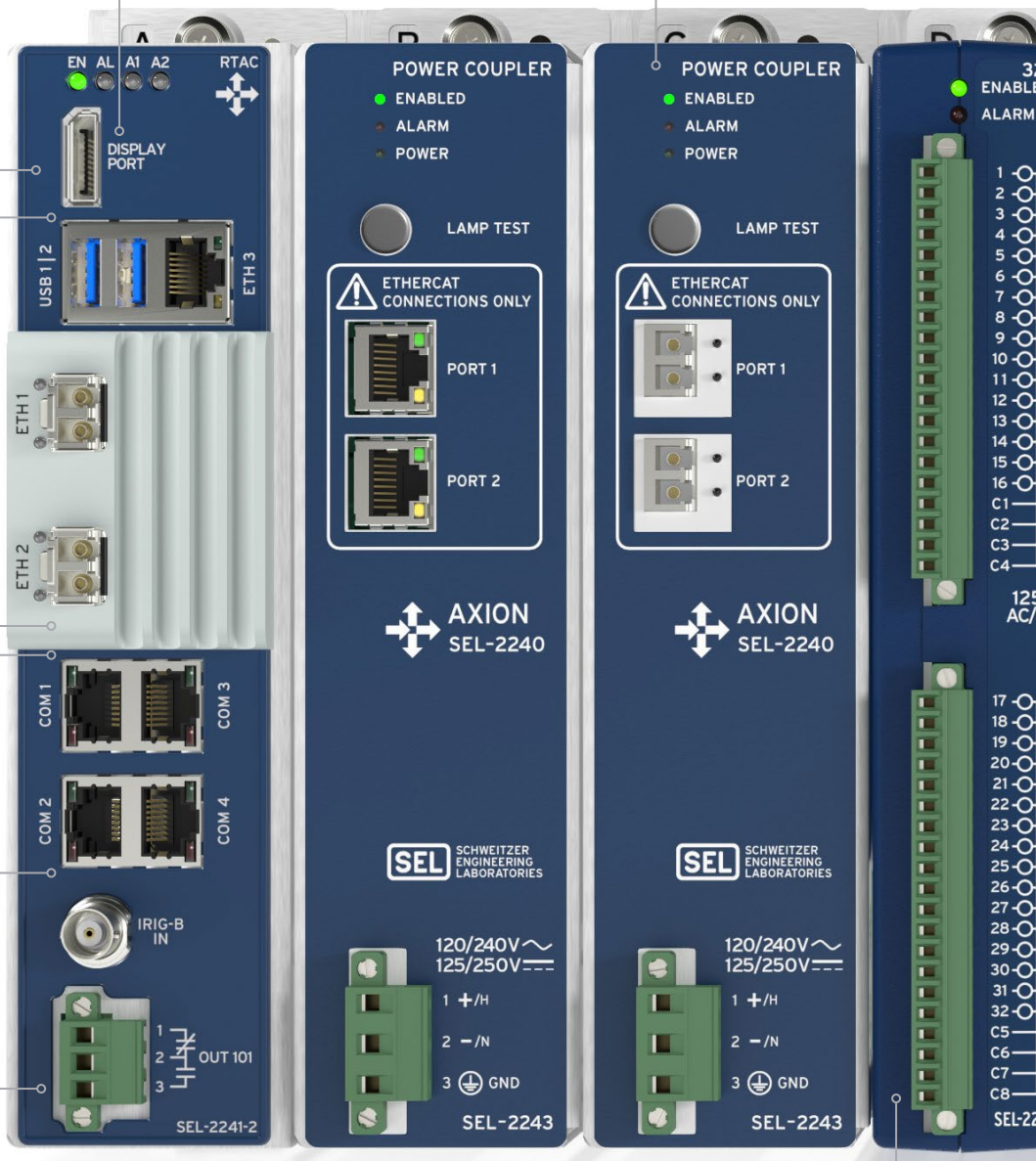
Three independent Ethernet ports capable of operating on separate subnets: one copper port and two copper or high-speed SFP fiber ports.

Four RJ45 serial ports, software-selectable for EIA-232 or EIA-485/422.

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

DisplayPort and USB ports enable system operations on a local HMI by using a monitor, mouse, and keyboard.

Optional redundant power supply.



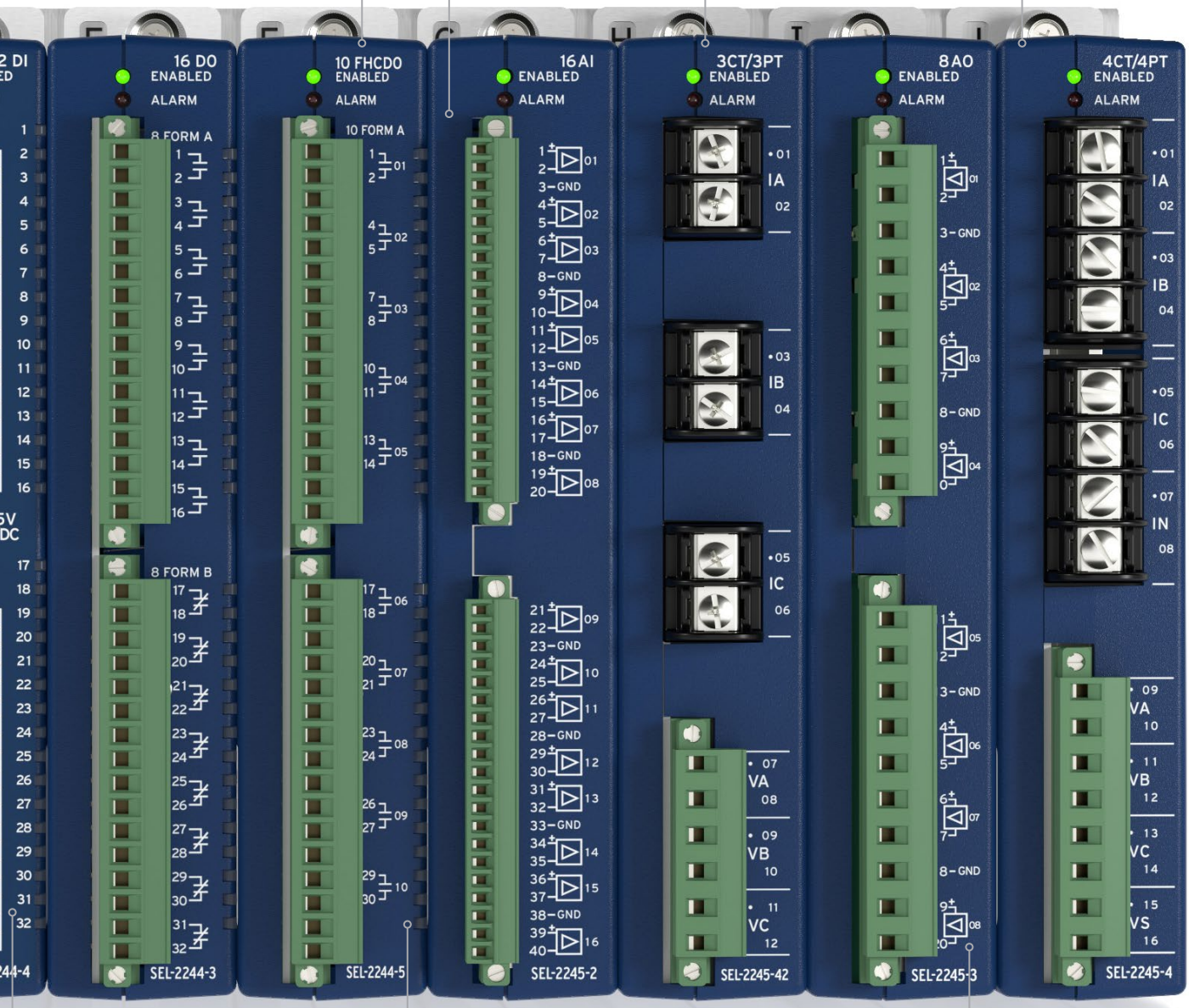
All digital inputs are rated for ac and dc operation and time-stamped to 1 ms accuracy.

Choose fast, high-current digital outputs for applications requiring fast action (<50 µs) or interrupting high current (up to 10 A).

DC analog inputs are software-selectable for ±20 mA, ±2 mA, or ±10 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.

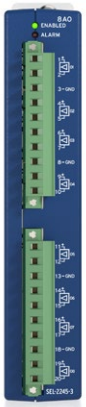
Indicating LED for each input and output.

Self-sourcing dc analog outputs are software-selectable for ±20 mA or ±10 V.

Powerful Modular Design

SEL-2245-4
AC Metering Module

SEL-2244-4
Digital Input 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. 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-2244-4 Digital Input Module

The 32 digital input module includes more input capacity than any other module, allowing the Axion even more flexibility to connect with a wide range of equipment. Use this module to monitor status signals from numerous types of devices, including circuit breakers, switches, protective relays, uninterruptible power supply systems, and communications health indicators.

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 ±20 mA, ±2 mA, or ±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-2241-2 RTAC Module	SEL-2245-22 DC Analog Input Extended-Range Module
SEL-2242 Chassis/Backplane	SEL-2245-221 Low-Voltage (LEA) Monitoring Module
SEL-2243 Power Coupler	SEL-2245-3 DC Analog Output Module
SEL-2244-2 Digital Input Module	SEL-2245-4 AC Metering Module
SEL-2244-3 Digital Output Module	SEL-2245-411 Standard Current and Low-Voltage (LEA) Monitoring Module
SEL-2244-5 Fast High-Current Digital Output Module	SEL-2245-42 AC Protection Module
SEL-2245-2 DC Analog Input Module	

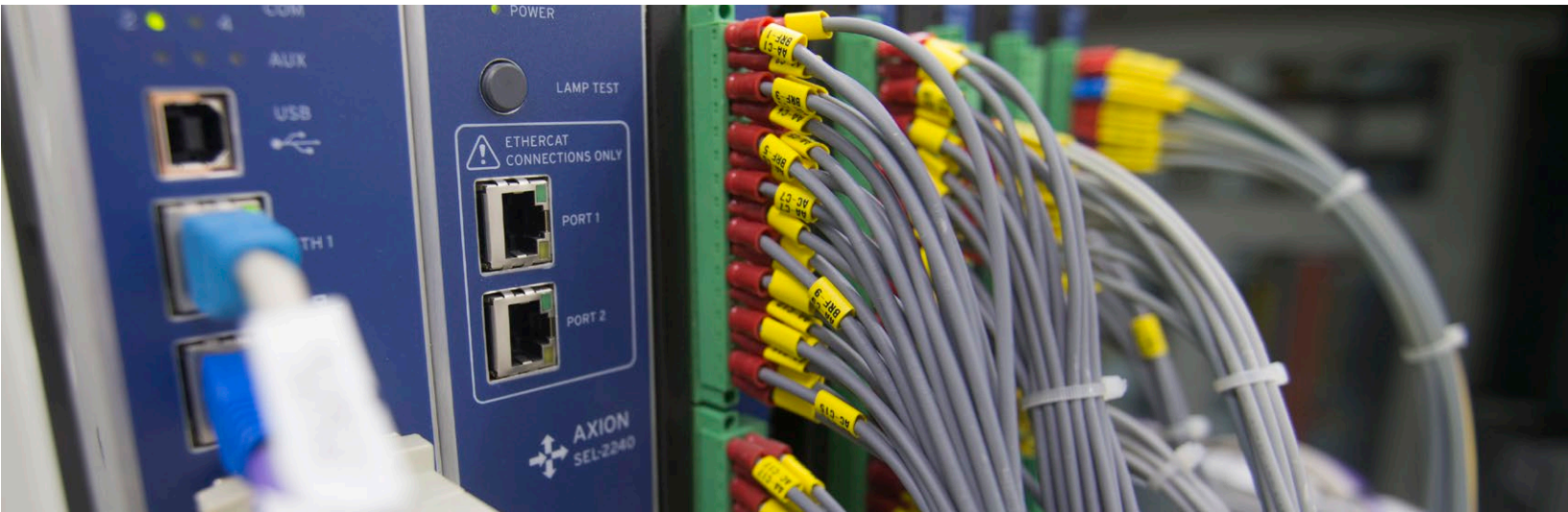
SEL-2245-42 AC Protection Module

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.

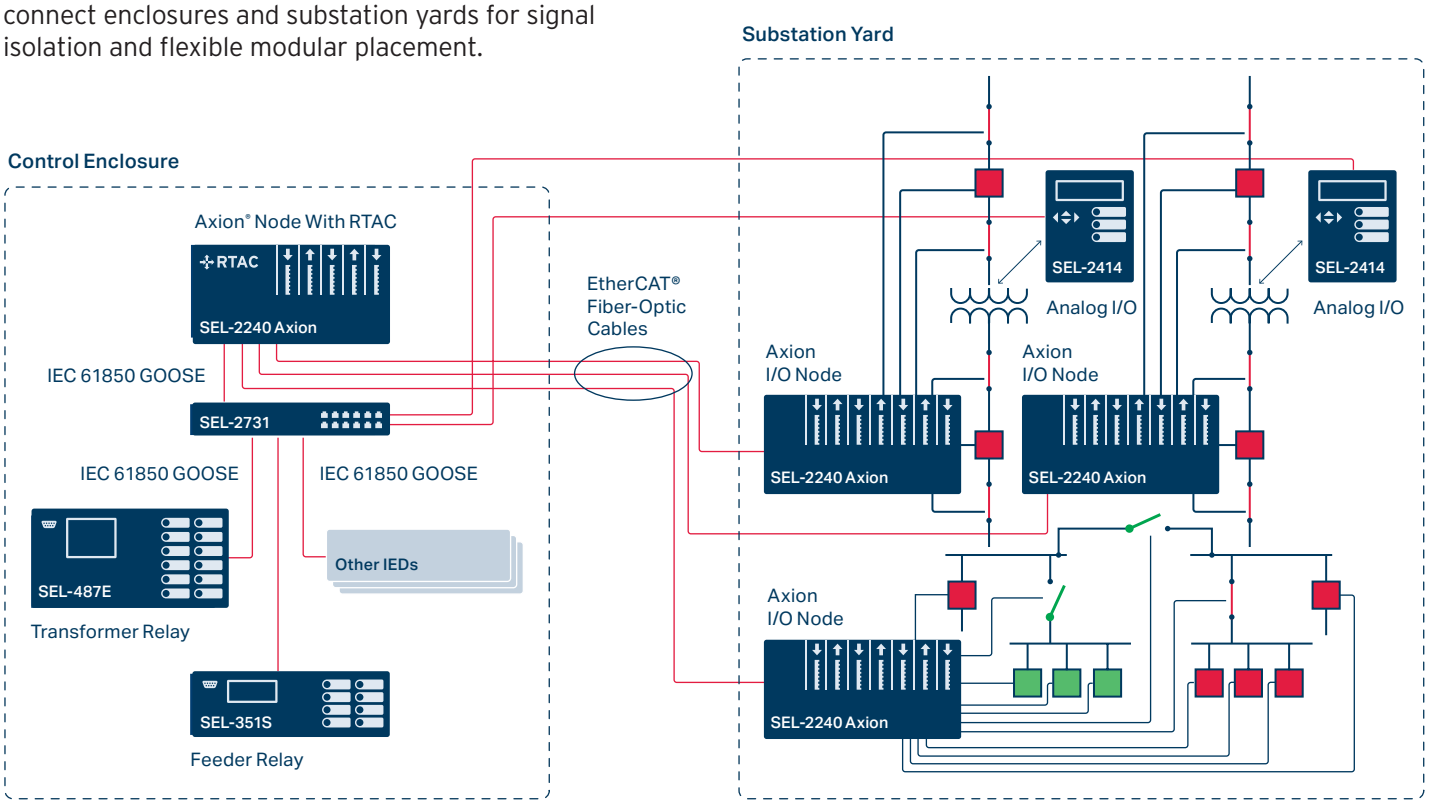
Visit **selinc.com/SEL-2240** to access product configurators for the SEL Axion.



Electric Utility Applications

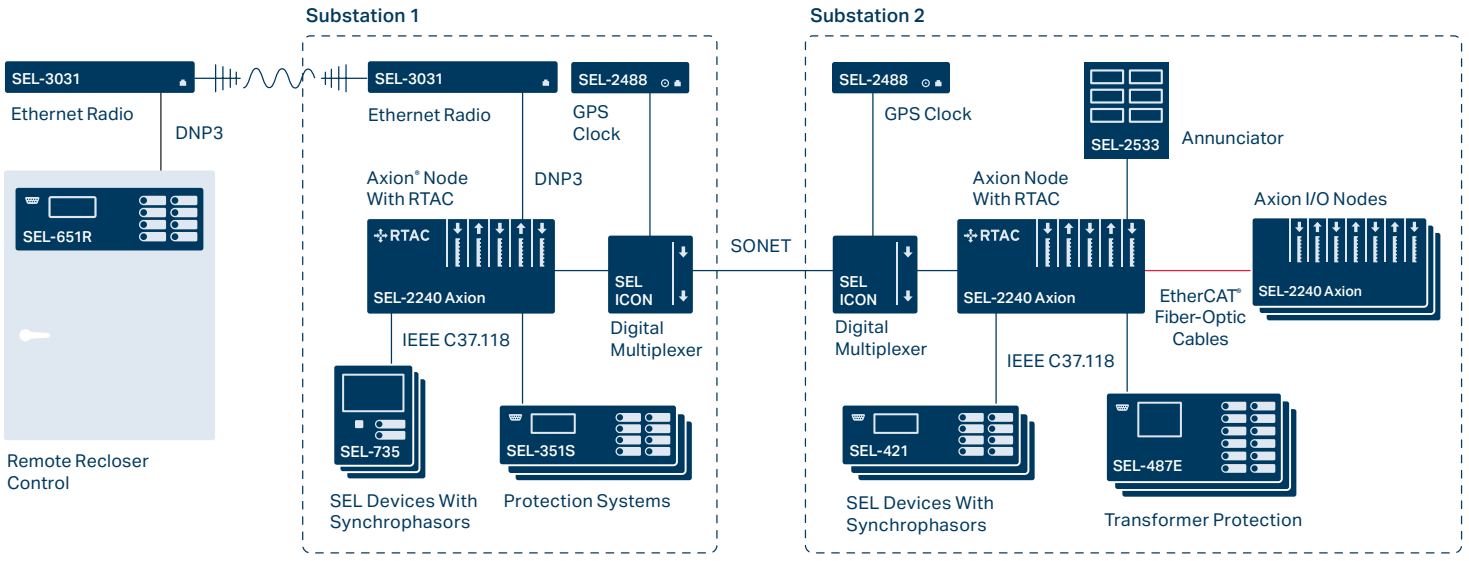
Substation Automation

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.



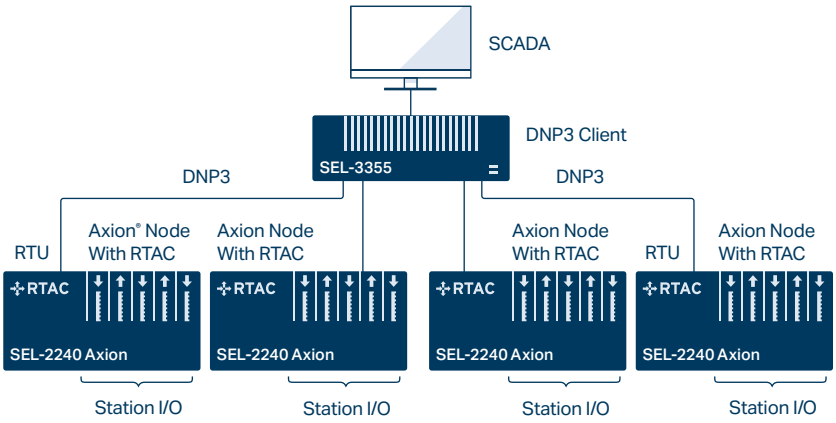
Smart Grid

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



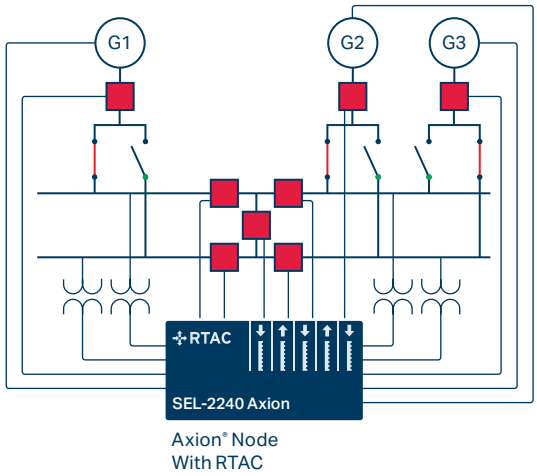
Substation RTU

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.



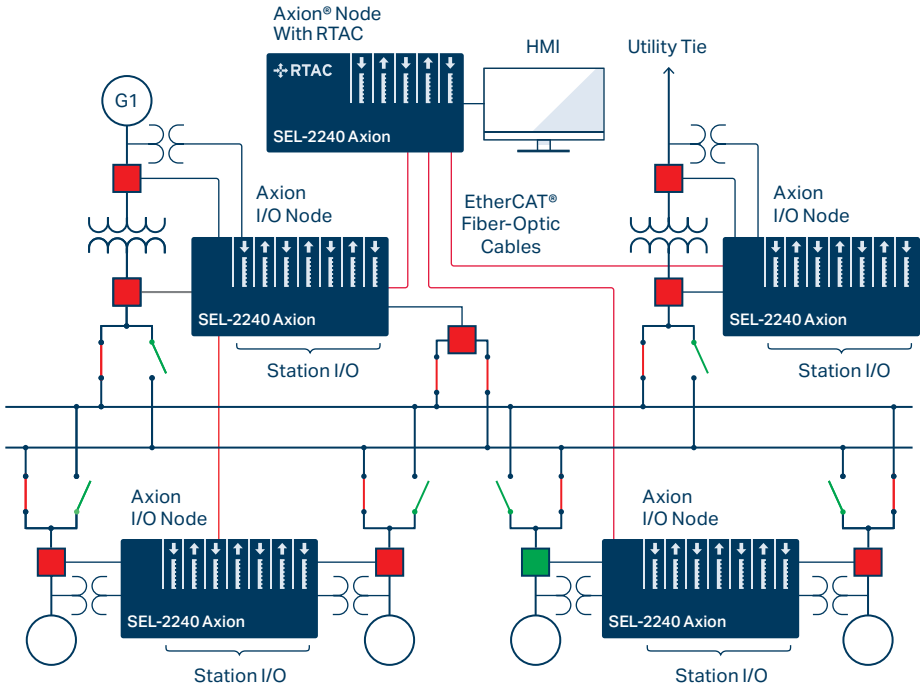
Autosynchronization

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.

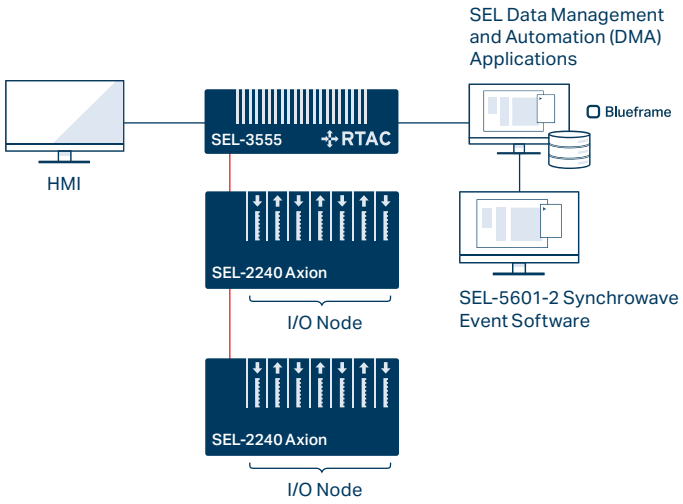


Digital Fault Recorder

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:

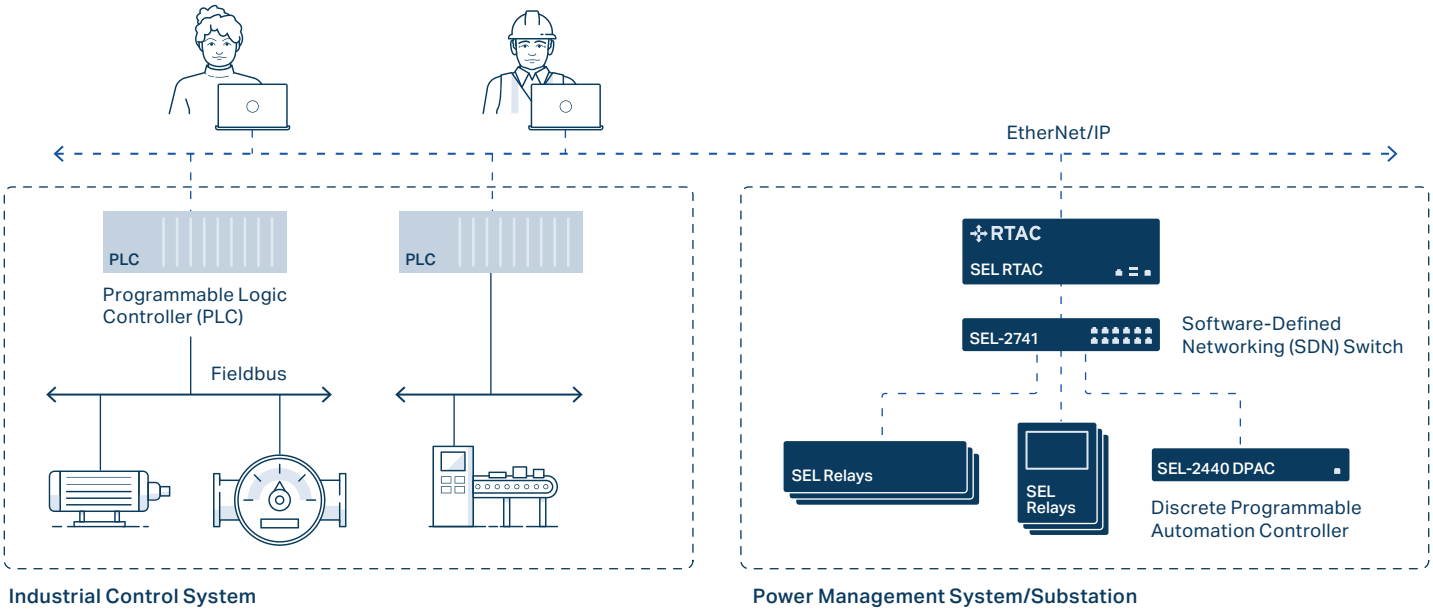
- Record at 24 kHz with recording group configuration for combining multiple module event reports, including digital values, into a single COMTRADE file.
- Stream and record continuous oscillography at 3 kHz, providing significantly more visibility into power system behavior than intermittent event reports.
- 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.

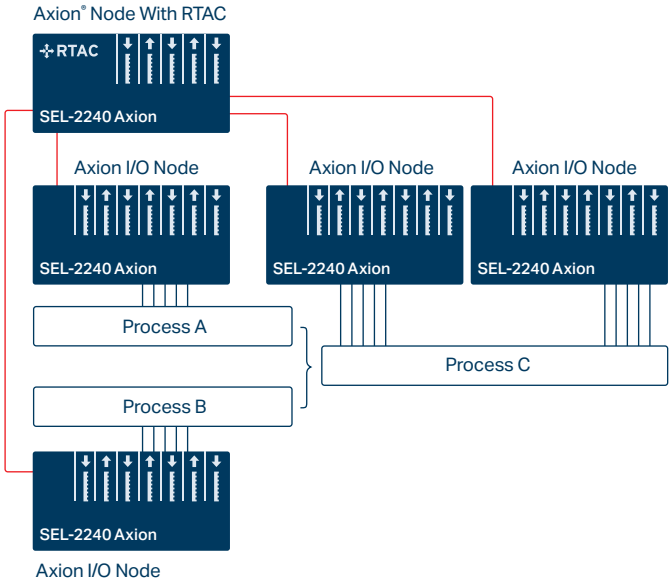


Process Control

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

Bay Control

Control multiple or individual substation bays with the Axion platform. Oversee your substation yard from within the control house via a touchscreen-equipped Axion linked to additional Axion nodes near yard assets to supply distributed I/O. Ensure safe connections by using the powerful logic engine in the Axion RTAC module to perform synchronism checks and automate control operations.

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

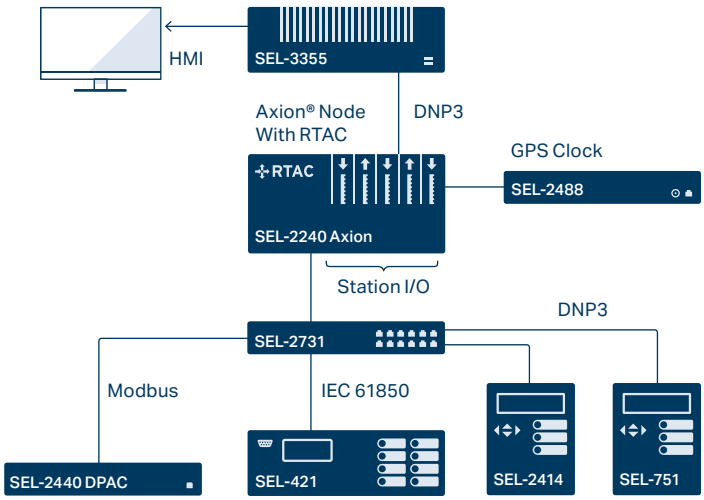
Increase the number of I/O points with as many as 60 modules or six nodes connected to one resident SEL-2241 RTAC. Through EtherCAT connectivity, you can provide rapid, time-synchronized data acquisition rates to the expanded I/O points within your automation system.

EtherCAT Network Topologies

SEL-2243 Power Couplers provide not only hot-pluggable power supplies, but also fast, time-synchronized EtherCAT connections to remote Axion nodes. The Power Couplers create EtherCAT links in a star network topology, sequential network topology, or a combination of both. You can apply single or dual power couplers in each Axion node based on connection or redundancy requirements.

Protocol Gateway

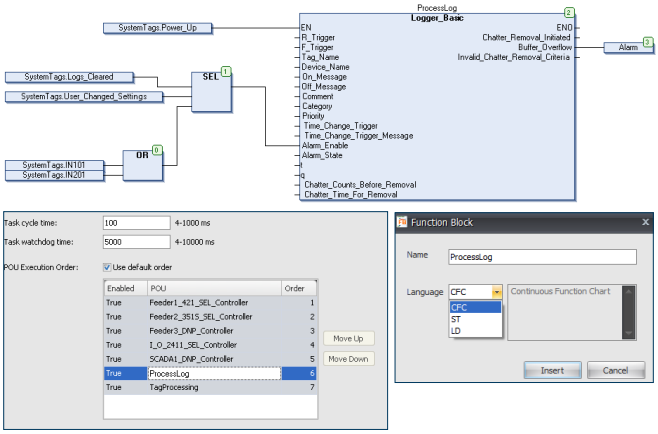
Collect downstream data with client protocols. Then, send these data to an upstream HMI, RTU, or SCADA controller with server protocols, converting the data from one protocol to another in the process.



Flexible Software

Implement Custom Logic Solutions

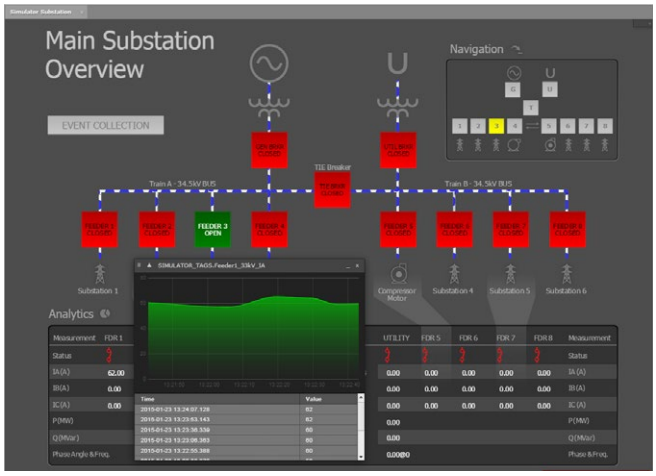
Design custom automation logic to control your system with ACSELERATOR RTAC® SEL-5033 Software, or monitor system performance using the prepopulated device tags. A flexible IEC 61131 configuration environment allows you to scale values and create logic equations by applying integrated tools. You can perform complex math and logic calculations on any data within the RTAC using the built-in IEC 61131 logic engine with continuous function chart (CFC), structured text (ST), or ladder diagram (LD) programming.



ACSELERATOR Diagram Builder™ SEL-5035 Software

Build custom HMI displays quickly and easily without the need for mapping data tags. Because the interface is web-based, you do not need special software to view HMI displays. Just enter the IP address of the Axion RTAC Module, and Diagram Builder imports all tags from the currently loaded ACSELERATOR RTAC project. The software lets you design custom HMI screens and then load the new HMI file into the RTAC to instantly view the HMI from any web browser on the network. With Diagram Builder, you can:

- Allow one or multiple authenticated users to interface with customized HMI screens.
- Access the RTAC HMI locally or remotely.
- Apply HMI trending and alarming.
- Quickly and easily visualize the data values over a definite period of time, both at design time and at run time.



SEL-2240 Axion Specifications

Hardware

SEL-2241 RTAC Processor Module	Processor speed: 1.6 GHz Memory: 4 GB error-correcting code (ECC) SDRAM User storage: 4 GB
I/O Modules	Digital input: 24 contact inputs (24, 48, 110, 125, 220, or 250 Vac/Vdc) Digital input: 32 contact inputs (24 Vdc, 48 Vdc, 110 Vac/Vdc, 125 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 (±20 mA, ±2 mA, or ±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 (±20 mA or ±10 V software-selectable) **AC Metering Inputs** 4 CT inputs (0—22 A) 4 PT inputs (5—400 V_{L-N}) **AC Protection Inputs** 3 CT inputs (0.1—20.0 A) 3 PT inputs (6.7—300.0 V_{L-N}) Maximum modules per network: 60 **Low-Voltage Monitoring** 4 LEA input module: 4 inputs for 0—30 V peak measurements 4 CT and 4 LEA input module: 4 CT inputs and 4 low-voltage inputs with 2 fiber connections
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
Operating Temperature	IEC performance rating: —40° to +85°C (—40° to +185°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 **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
OPC UA
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
OPC UA
SEL Protocols
SES-92
SNMP Agent

Peer-to-Peer

IEC 61850 GOOSE*
NGVL
SEL Mirrored Bits Communications

Field Bus Protocol

EtherCAT to SEL Axion I/O Modules

SEL SCHWEITZER ENGINEERING LABORATORIES

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