SEL

icon
INTEGRATED
COMMUNICATIONS
OPTICAL
® NETWORK

Dependable Communications for Critical Infrastructure®

The versatile SEL Integrated Communications Optical Network (ICON®) is purpose-built for mission-critical communications, providing either SONET, DS1/E1, and/or Ethernet transport. The ICON is a wide-area-networking multiplexer optimized for industrial and utility applications. The deterministic packet transport technology in the ICON preserves the performance characteristics of time-division multiplexing (TDM) with no performance degradation when converting to Ethernet as a transport protocol. By combining TDM and Ethernet transport options with a comprehensive range of data interfaces, the ICON makes it easy to migrate legacy network technologies to a packet-based solution. The ICON interoperates with Multiprotocol Label Switching (MPLS) or Carrier Ethernet-based core networks to provide a hardened edge device for mission-critical applications. The ICON is available in both a full 19" rack-mounted version and a half-width ICON Cube for compact applications.

Major Features and Benefits

➤ **Deterministic Packet Transport.** Provides an innovative solution for maintaining the performance of a TDM network for transporting teleprotection traffic over any Ethernet-based core network. ICON Virtual Synchronous Networking (VSN) provides a solution for migrating legacy interfaces to an MPLS or Carrier Ethernet network and enables the performance of critical protection circuits to be maintained.

➤ **Flexible Transport Bandwidth Options.** The ICON supports DS1/E1, OC-3, OC-12, and OC-48 data rates when configured as SONET and 1 Gbps when operating in Ethernet transport mode. Support for different Ethernet and SONET line rates enables the ICON to address a wide range of network topologies and connectivity requirements.

➤ **Analog to Ethernet Leased Line Migration.** Combine ICON deterministic transport with dedicated analog drop interfaces that include 2-wire FXO/ FXS, 4-wire analog voice frequency, and DTT to provide a migration solution from analog to Ethernet-based leased line services. Ethernet transport data rates can be reduced to 10 Mbps to support economical leased service rates.

➤ **Robust Universal Platform.** The ICON platform can operate as a SONET or Ethernet multiplexer with a built-in Ethernet switch. The ICON enables the operator to easily upgrade network backbone bandwidth to support new applications. Because the ICON supports TDM and Ethernet applications, your legacy equipment investments are protected.

➤ **Reliable and Economical Distribution of Precise Time.** Receive and distribute precise GPS time over the ICON wide-area network with better than 1 µs accuracy. The ICON network also features a robust terrestrial time distribution solution that overcomes vulnerabilities of isolated GPS-only local timing solutions. When operating in Ethernet transport (VSN) mode, the ICON can use the IEEE 1588 PTP telecom profile from a centralized grandmaster timing reference delivered over an MPLS or Carrier Ethernet transport network in addition to local GPS or IRIG-B sources. Time is available at each network node in IRIG-B or IEEE 1588 PTP (power and default profiles) for locally connected devices.

➤ **Security and Critical Infrastructure Protection.** The ICON helps users achieve NERC-CIP compliance by providing the following:

  ➢ Report generation

  ➢ Logging of all setting changes and firmware and hardware changes

  ➢ Logging of authorized and unauthorized user access and unauthorized access attempts

  ➢ Tools for baselining ICON network configuration

➤ **Easy and Secure Network Management.** Use SEL-5051 Network Management System (NMS) Client software and SEL-5052 NMS Server software or third-party SNMPv3-based NMS to monitor and manage your network. SEL-5052 provides Lightweight Directory Access Protocol (LDAP) and Single Sign-On (SSO) support to allow use of a centralized corporate directory to manage usernames and passwords to authenticate user access to the ICON network.

➤ **Channel Latency Monitoring in Real Time.** The ICON can measure and report latency at the individual DS0/E0 level. Mission- and time-critical network traffic can now be monitored, with results reported in real time.

➤ **TDM Bandwidth ePipes for Mission-Critical Ethernet Traffic.** The SONET payload can be divided into separate TDM pipes to isolate various Ethernet traffic over the wide-area network (WAN). This technology provides guaranteed bandwidth to support high-priority data such as IEC 61850 GOOSE traffic.
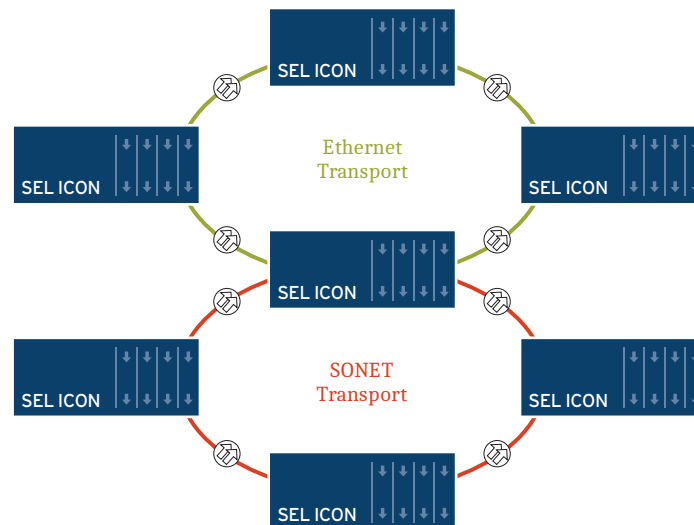

Figure 1   ICON Mixed SONET and Ethernet Transport

Ethernet Transport Features

VSN Features

➤ Small form-factor pluggable (SFP) 1 Gbps optical transceivers with a reach as far as 200 km

➤ Unidirectional Path Switched Ring for VSN traffic with <5 ms switching time

➤ Path direction selection and "switch on yellow" to eliminate asymmetrical delays

➤ User-selectable packetization bandwidths for VSN data. Three, eight, and twenty-five virtual tributaries (VTs) or from 1 to 12 synchronous transport signals (STSs).

➤ MAC and VLAN filtering

➤ Packet Delay Variation compensation

➤ Ethernet packet monitoring

➤ Support for Ethernet Jumbo frames

Layer 2 802.1Q Ethernet Features

➤ Optical transmit and receive level monitors

➤ Laser current output monitor

➤ RSTP and MSTP support for Ethernet loop mitigation for non-VSN Ethernet traffic

➤ Support for the IEEE 1588 PTP telecom profile (ITU-T G.8275.1) for time synchronization from a centralized grandmaster reference over an MPLS or Carrier Ethernet transport network

An ICON network equipped with EPLM line modules and 1 GigE line ports now supports native layer 2 Ethernet traffic. This feature reduces or eliminates the need to install core network switches and routers in the harsh substation environment. An ICON used as an edge device can aggregate the local substation Ethernet traffic and provide it to the core network.

Managed Layer 2 802.1Q Ethernet and VSN Traffic

An ICON network equipped with EPLM line modules, 1 GigE Ethernet line ports, and an EBAM now supports native layer 2 802.1Q managed Ethernet traffic. This feature reduces or eliminates the need to install core network switches and routers in the harsh substation environment. An ICON used as an edge device can aggregate the local substation Ethernet traffic and provide it to the core network.

Layer 2 Bridging and VSN Traffic

ICON VSN transport provides a mechanism for encapsulating services within a TDM container for deterministic transport over Ethernet. ICON also supports the capability to transport non-critical Ethernet services outside of the VSN container in regular Ethernet bandwidth.

Layer 2 Bridging (L2B) is a feature of the ICON system that enables ordinary Ethernet traffic to traverse an ICON network. In L2B, the ICON functions as a layer-2 bridge, interoperating with other bridges (including other L2B ICONs) and edge devices.

This enhanced capability allows non-critical services such as video or SCADA to be placed in standard layer 2 802.1Q Ethernet bandwidth outside of VSN. This enables the ICON to more efficiently utilize bandwidth for native Ethernet services and provides a simpler mechanism for the ICON to transport these services across MPLS or Carrier Ethernet transport networks.

Loop mitigation for the VSN traffic is provided by the VSN protocol. Layer 2 Ethernet traffic can use RSTP or MSTP for loop mitigation.

Figure 2 shows how layer 2 802.1Q traffic is mapped to bandwidth outside of the VSN deterministic traffic.
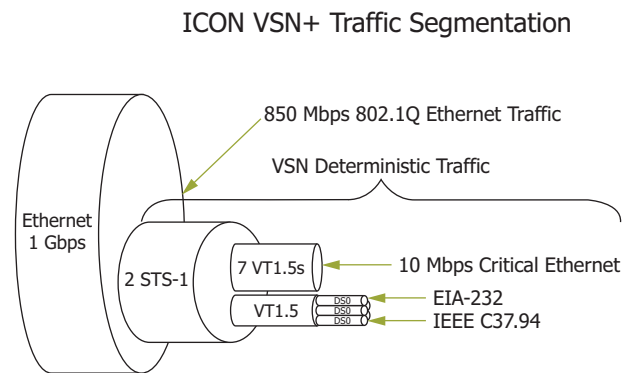
ICON VSN+ Traffic Segmentation

Figure 2   VSN and Layer 1 802.1Q Ethernet Traffic Segmentation

Network Implementation Using VSN With Layer 2 802.1Q Ethernet

VSN traffic can be applied in a ring topology through tunnels configured in the core network. These tunnels are set up to accept only VSN packets. All other Ethernet traffic is passed into the core network where it is managed by the core network.

The ICON is able to use its line ports to carry both VSN and ordinary Ethernet traffic to the core network when Layer 2 Bridging is enabled. Layer 2 Bridging increases the usable bandwidth on a line port link beyond that dedicated to VSN, up to the maximum line rate of 1 Gbps. For example, if the VSN bandwidth is set to 1 STS (100 Mbps), the remaining 900 Mbps capacity can be used for ordinary Layer 2 Ethernet traffic.
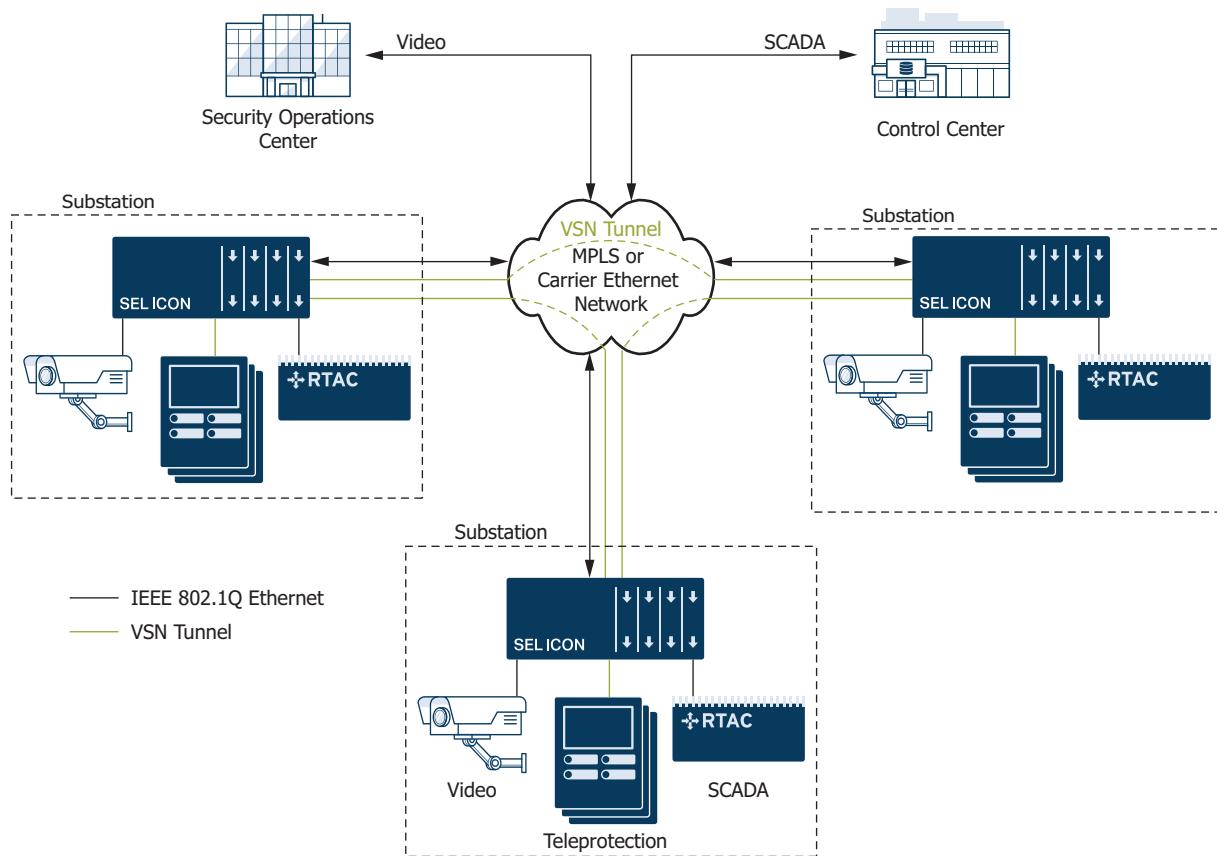
Figure 3 Network Design Using VSN With Layer 2 8O2.1Q Ethernet

EBAM—Ethernet Bridged Access Module

The ICON offers a dedicated 8 port Ethernet module for LAN facing traffic.

The EBAM provides four copper ports capable of 10, 100, 1000 Mbps and four SFP drop ports capable of 100 or 1000 Mbps operation.

With the release of the Layer 2 Bridging functionality, the EBAM now supports loop mitigation using RSTP or MSTP.

The ICON network can be used as a PTP grand master and IEEE 1588 power system profile timing can be optionally equipped providing high accuracy time distribution through the drop ports.

SONET Features

➤ Small form-factor pluggable (SFP) OC-3, OC-12, and OC-48 optical transceivers with a reach of up to 240 km

➤ Unidirectional Path Switched Ring with <5 ms switching time

➤ Path direction selection and "switch on yellow" to eliminate asymmetrical delays

➤ STS-12c, STS-3c, STS-1 (synchronous transport signal), and VT (virtual tributary) granular internal cross-connect for seamless interring traffic between networks

➤ Error monitoring for individual STS-1 and VTs at predetermined and user-defined intervals

➤ Optical transmit and receive level monitors

➤ Laser current output monitor

➤ Ethernet mapping using generic framing procedure (GFP-F)

➤ Built-in test capabilities

   ➢ Force AIS XMT and RCV

   ➢ Line loopback

   ➢ Section trace

   ➢ PRBS/test bytes

➢ STS-1 payload monitor

➢ VT payload monitor

➢ Channel latency

➤ Support for point-to-point, linear, ring, and multiple ring topologies. Internal cross-connect provides seamless operation between rings. Support for single or dual-ring interconnect ties, linear spurs, and subtended rings.

SONET standards supported:

➤ Telcordia GR.253-CORE

➤ ITU-T G.7041

DS0/E0 and DS1/E1 TDM Features

➤ Connect and synchronize non-ICON DS1 and E1 equipment for system-wide interoperability

➤ Groom incoming DS1/E1 subrate (DS0/E0) signals onto any ICON network-wide DS0/E0 channel

➤ Add/Drop any DS0/E0/DS1/E1 signal from higher-level STS-1 signals

➤ Aggregate DS1/E1 circuits onto the SONET WAN and individually extract them at any node

Local Area Network Ethernet Features

➤ Port statistics counters for frame length and type (unicast, multicast, broadcast) exiting and entering the Ethernet ports

➤ MAC table key functions and features:

➢ "Learn and Lock"—user-configurable capability to learn MAC addresses

➢ "No Learn"—user-entered MAC addresses

➢ "Aging field"

➢ "Learn and Age"

➢ Content-addressable RAM (avoids "fail-to-learn" problems when using HASH technology)

➤ Port-based VLANs (transparent traffic transport)

➤ 802.1Q VLANs

➤ Nested VLANs (802.1Q VLANs in port-based VLANs)

➤ Support for eight priority queues per port

➤ VLAN filtering per port—list of allowed or blocked VLANs, ingress and egress (SEL-8036-01/-02 Ethernet Bridging Access Module [EBAM])

➤ BPDU filtering and Ethernet Virtual Wire support to manage how ICON Ethernet LAN ports interact with spanning tree protocols from LAN switches

➤ Loop mitigation using RSTP and MSTP

Ethernet standards supported:

➤ 802.1d   Ethernet bridge

➤ 802.1Q   VLAN tagging, priority queues

➤ 802.3ab   1000BASE-T (RJ45 Cu)

➤ 802.3ac   Frame format extensions for VLAN tagging

➤ 802.3i   10BASE-T (RJ45 Cu)

➤ 802.3u   100BASE-T (RJ45 Cu), 100BASE-BX/EX/FX/LX/ZX

➤ 802.3z   1000BASE-BX/LX/SX/XD/ZX

➤ DSCP   DiffServ to 802.1Q priority mapping

Features Supported on Fiber Ethernet Ports

➤ Remote Fault Indicator

➢ 1000 Mbps Ethernet

➢ 100 Mbps Ethernet

➤ Monitor of fiber-optic transceiver parameters

➢ Optic receive level

➢ Optic transmit power

➢ Temperature

➤ IEEE 1588 PTP (SEL-8036-02 EBAM)

➢ IEEE/IEC 61850-9-3

➢ IEEE C37.238-2017

➢ IEEE 1588-2008 Annex F

Features Supported on Copper Ethernet Ports

➤ Autonegotiation (bit rate mode)

➤ Auto-MDIX (crossover cables not required)

➤ Port enabling and disabling

➤ IEEE 1588 PTP (SEL-8036-02 EBAM)

   ➢ IEEE/IEC 61850-9-3

   ➢ IEEE C37.238-2017

   ➢ IEEE 1588-2008 Annex F

ICON System Description

The ICON combines both SONET and Ethernet transport technologies on a single platform. To provide the equivalent functionality of the ICON through traditional methods, as many as four discrete pieces of hardware would be necessary. *Figure 4* is a comparison of the ICON functionality to that of traditional methods.
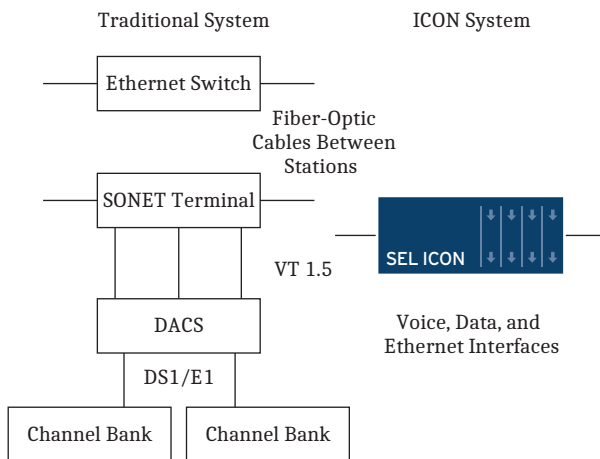

Figure 4   Traditional Communications System Versus the ICON

The ICON provides all the functionality of a traditional communications system, including the following components:

➤ Support for 155 Mbps (OC-3), 622 Mbps (OC-12), and 2.4 Gbps (OC-48) line speeds.

➤ Support for 1 Gb Ethernet transport.

➤ An Ethernet switch module to provide local Ethernet connectivity.

➤ Drop ports for voice and data circuits. To do this using traditional approaches would require a separate channel bank or E1/T1 terminal.

➤ Integrated Digital Access Cross-Connect Switch (DACS). This provides the cross-connection between the voice and data circuit traffic on DS0/E0 channels and the SONET multiplexer. DS0/E0 signals from incoming DS1/E1 tributaries can also be individually groomed and routed to any other network-wide DS0/E0 egress location. In legacy systems, this functionality was typically performed using separate hardware.

The ICON combines both TDM and packet technology while offering interfaces to the lowest bandwidth applications, including serial data and voice communication. This consolidation of functionality provides economy of scale, central management of the network, and a versatile system that will provide a communications platform for many years.

Applications

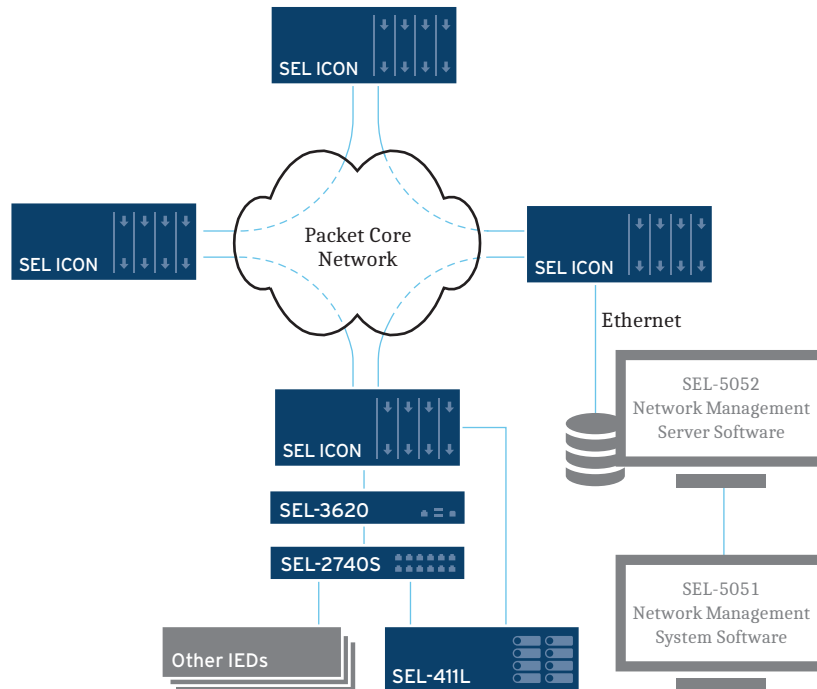## Flexible Interoperation With Packet Core Network

Figure 5   Packet Core Network

The SEL ICON is designed to provide low-latency services for substation and operational technology (OT) applications. With the ICON, you can provision time-division multiplexing (TDM) and TDM-encapsulated services across substation facilities while allowing native Ethernet services to transit through core network infrastructure. By complying with Ethernet standards for the Virtual Synchronous Network (VSN) transport technology for the ICON, you can pass Ethernet services across

core network infrastructure, enabling the ICON to interoperate with Multiprotocol Label Switching (MPLS) or Carrier Ethernet-based core networks.

ICON VSN technology provides the innovative approach of delivering mission-critical traffic with low and deterministic latency over an Ethernet transport network. The implementation preserves the performance characteristics of TDM with minimal performance degradation when converting to Ethernet as a transport protocol.
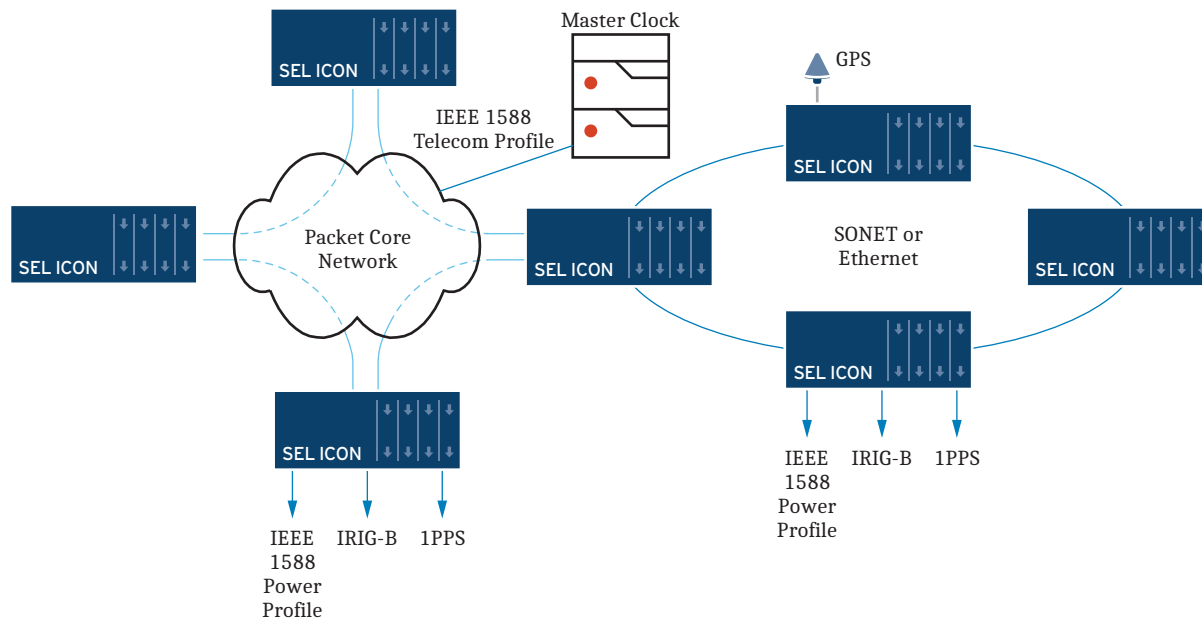
Time Distribution

Figure 6   Time-Distribution Network

The ICON can distribute time over wide-area networks (WANs) with an accuracy of 1 μs. High-accuracy time is a critical requirement in power utility protection and monitoring schemes for use in applications such as the following:

➤ Power system disturbance recording devices

➤ Synchrophasor measurement

➤ Sequential Events Recorders (SER)

➤ Line current differential and traveling-wave protection

The ICON has the ability to obtain time using a built-in GPS receiver or via IRIG-B. In addition, when operating in Ethernet transport (VSN) mode, the ICON can use the IEEE 1588 PTP telecom profile from a centralized grandmaster timing reference delivered over an Ethernet transport network (Ethernet, SDN, MPLS, or Carrier Ethernet).

Each ICON node has a built-in GPS receiver. When enabled, the local GPS receiver provides the local real-time clock and network stratum 1 clock. In the event of a local GPS receiver failure, other clock sources in the network will continue to provide high-accuracy timing over

the network. In the event that all clock sources in an ICON network are lost, the network will fall back to a holdover oscillator and continue to maintain 1 μs relative accuracy across the network.

Each node also has an IRIG-B input port to allow a collocated high-stability (OCXO, Rubidium, or Cesium) clock, such as the SEL-2488 Satellite-Synchronized Network Clock, to improve the holdover drift.

Mitigation for malicious time spoofing attacks is provided when multiple time sources are enabled on the network. Internode time source comparisons are performed to monitor timing source integrity. GPS antenna location is monitored and alarms are issued for location changes.

Time signals to local intelligent electronic devices (IEDs) (e.g., SEL-411L) are available from two BNC ports on each Enhanced Protected Line Module (EPLM), the EIA-232/EIA-422 ports on the Async Submodule, and the Ethernet drop ports on the SEL-8036-02 Ethernet Bridging Access Module (EBAM).

An EBAM can also provide IEEE 1588 PTP timing over all Ethernet ports via an ordering option.
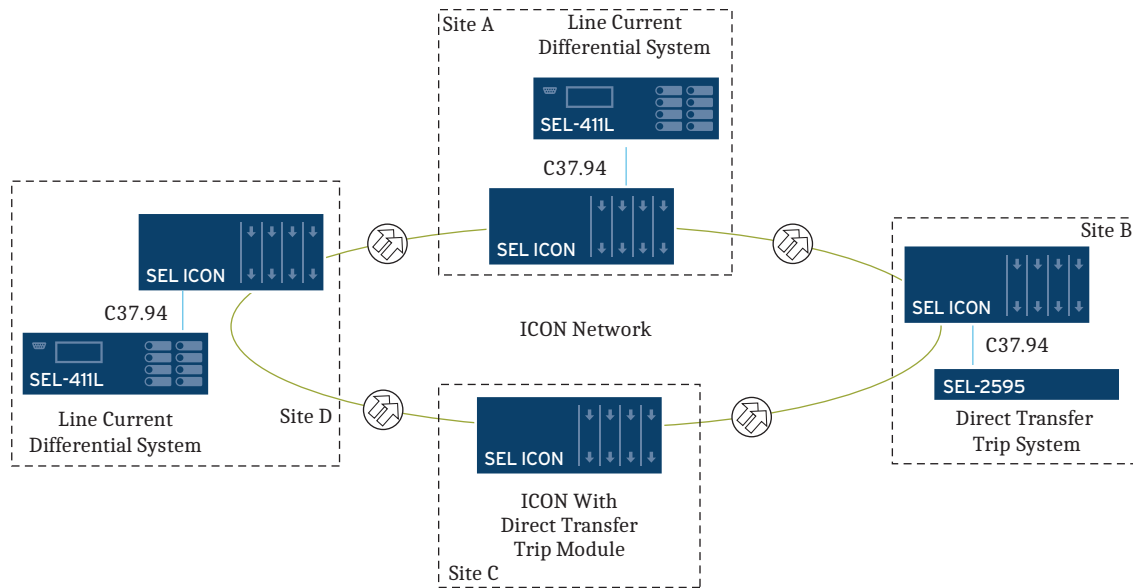
Transmission Line Protection

Figure 7   Teleprotection–Transmission Line Protection

Transmission line protection is an important application to an electric utility. *Figure 7* shows two types of protection: line current differential protection and direct transfer trip protection.

For line current differential protection, an SEL-411L Relay with an IEEE C37.94 interface connects to an Nx64F Data Submodule on the ICON at Site D. A similar connection is established at Site A. For the SEL-411L Relay with an EIA-422 interface, the 422 Sync Submodule on the ICON can be used at Site D with a similar connection at Site A.

For direct transfer trip protection, an SEL-2595 with an IEEE C37.94 interface connects to an Nx64F data submodule on the ICON at Site B. A similar connection is established at Site C using the Transfer Trip Module (TTM) available on the ICON. The ICON network monitors and reports the channel latency in real time. You can select the shortest path between terminals as the primary path. This ensures that the system always reverts to this configuration in the event of a path failure and subsequent restoration. The ICON TTM is a four-function transfer trip module that can plug into the ICON shelf for an integrated solution. These features combined with robust environmental operating specifications make the ICON ideal for critical power system applications.
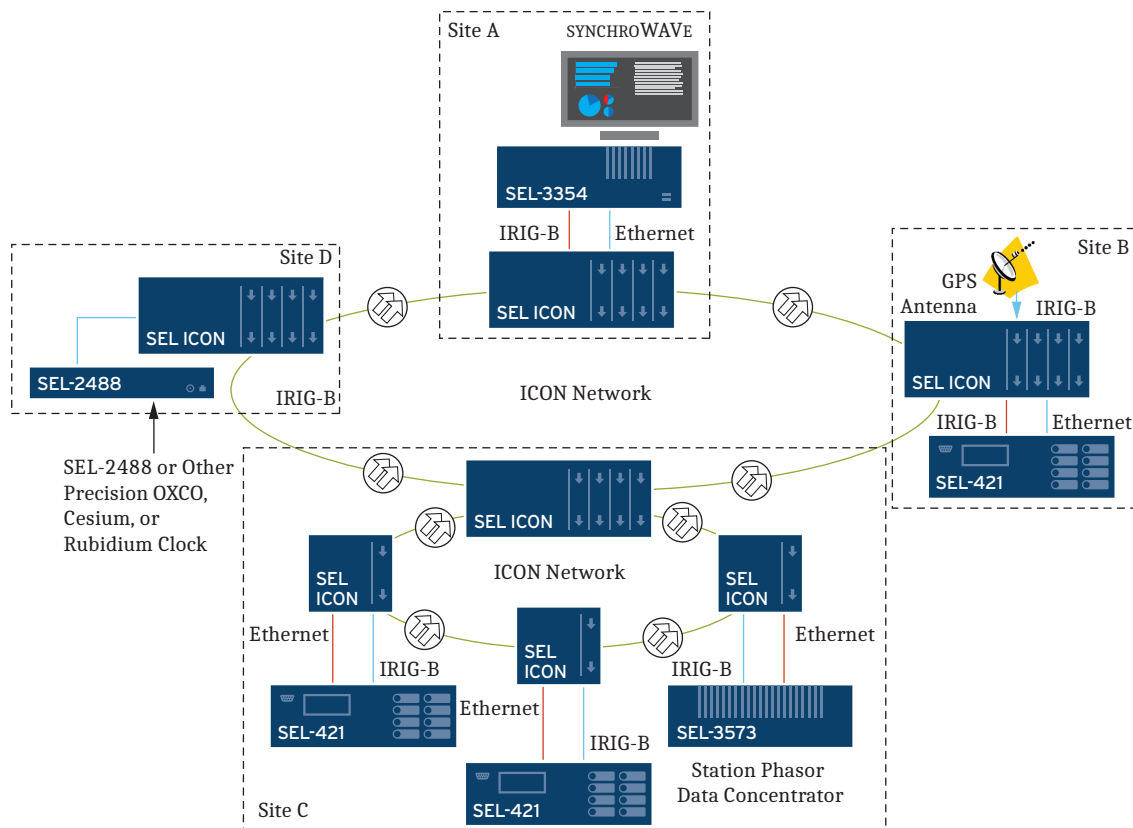
Synchrophasors

Figure 8   Wide-Area Control Using Synchrophasors

Synchronized phasor measurements (synchrophasors) provide a real-time measurement of electrical quantities across a power system. If they are synchronized correctly, you can use these measurements for analysis and control of the power system. The ICON provides communication necessary for synchrophasors. Ethernet is the preferred method to communicate synchrophasor data between power system substations and control locations. A key component of a synchrophasor system is the availability of precise time. The ICON distributes time across the network and can maintain better than 1 µs accuracy among all terminals in the network. This allows synchrophasor systems to continue to operate accurately even in the event of a local or system-wide timing source failure.

Migrating Analog Leased Services to Ethernet
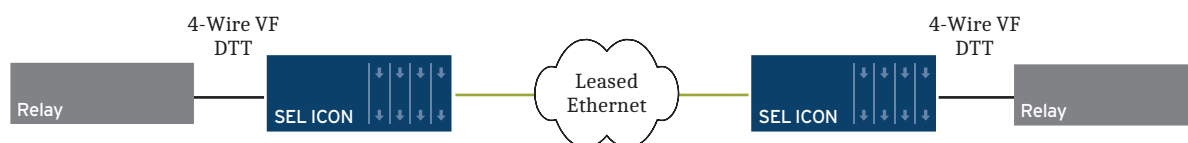
Figure 9   Transporting an Analog DTT Circuit Over a Leased Ethernet Network

With the major carriers announcing the end of service for leased analog services, many utilities are facing a forced migration to leased Ethernet circuits. This creates the challenge of maintaining adequate latency and asymmetry performance for critical analog circuits.

With ICON deterministic packet transport combined with dedicated analog drop interfaces that include 2-wire FXO/FXS, 4-wire analog voice frequency, and DTT, it is possible to migrate from an analog leased service to Ethernet.

These interfaces allow you to preserve existing analog end equipment and create a low-latency circuit through your leased service provider to maintain end-to-end

communications channel performance for critical applications. Using the ICON, you can achieve the same, or better, end-to-end latency.

DS0/E0 Grooming

Use the DS0/E0 grooming ability (DACS 2016 DS0) of the ICON to route low-speed DS0/E0 circuits from byte synchronous DS1/E1 inputs onto any DS0/E0 drop on the ICON network.
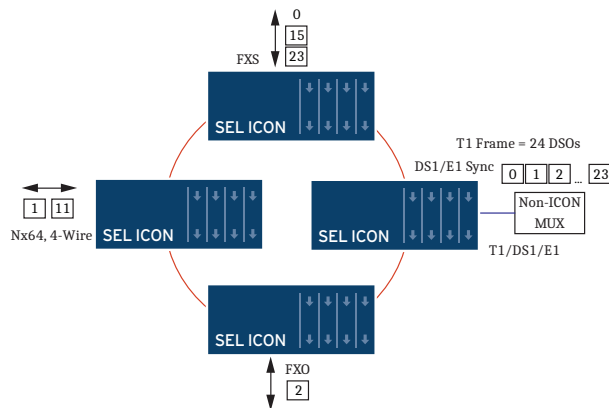
Figure 10   Route Low-Speed DSO/EO Circuits

Extend the reach of your corporate PBX into each ICON location by connecting it to the ICON DS1/E1 Sync Submodule. Then use ICON FXS Submodules throughout the network to distribute and terminate two-wire analog circuits for telephones and faxes.
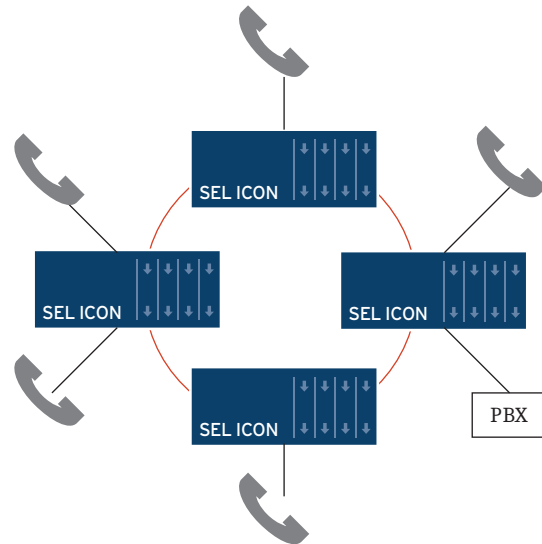
Figure 11   Distribute and Terminate Two-Wire Analog Circuits

DS1 PSync 1x1 Protected DS1
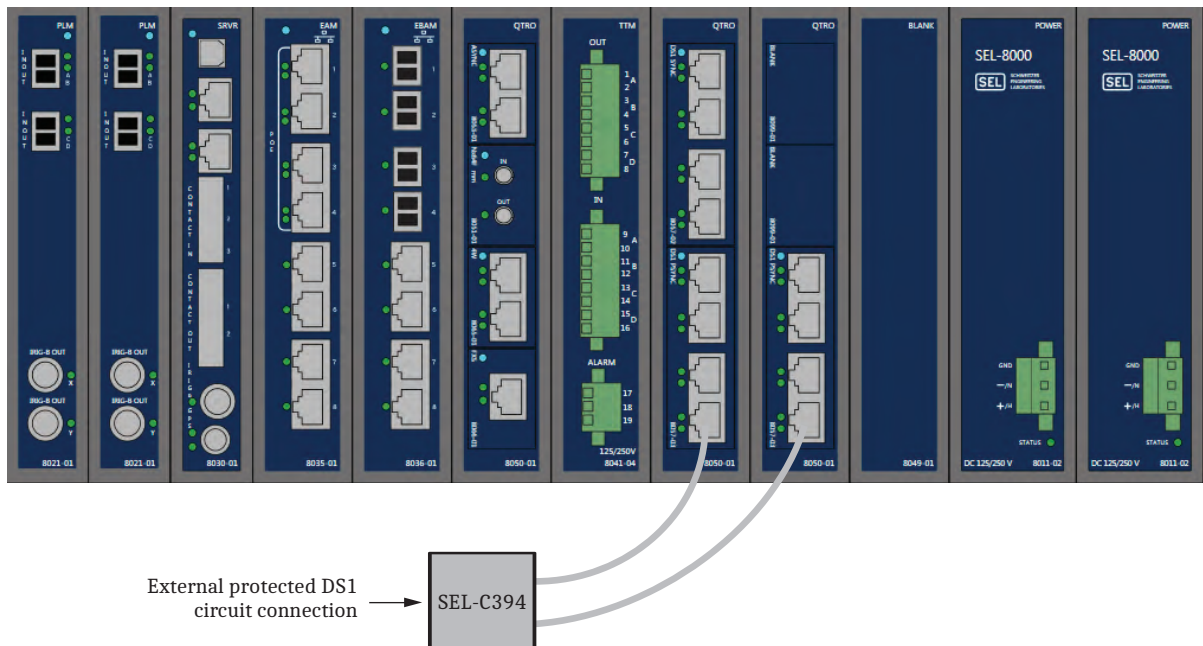
Figure 12   Redundant DS1 Interface

The DS1 PSync Submodule provides four 1-by-1 protected DS1 interfaces. The DS1 PSync Submodules are used in pairs, and DS1 connections are made using an SEL-C394 cable as shown in *Figure 12*. The DS1 PSync must be used with the Enhanced Protected Line Module

(SEL-8022-01), which supports the ability to groom network traffic at the DS0 level from SONET virtual tributaries (VT1.5). Local TDM drop ports can also be terminated (hairpinned) without requiring a SONET termination.

Network Management
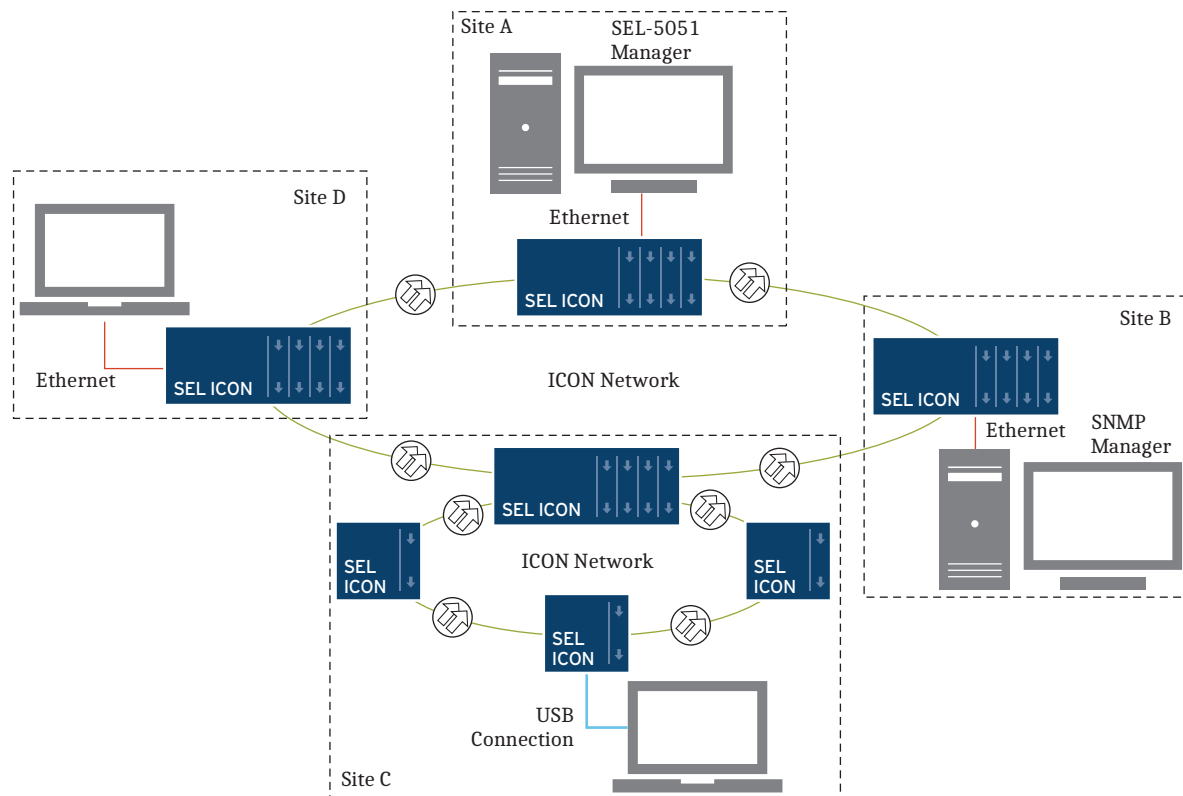
Figure 13   ICON Integrated Communications Network With Network Management

Use industry-standard SNMPv3 or SEL-5051 to manage an ICON network. These network management sessions can occur either locally or remotely via Ethernet, or locally via USB. NMS provides:

➤ Graphical network representation

➤ Remote provisioning

➤ Event recording/reporting

➤ Performance monitoring

➤ Inventory management

➤ Remote firmware upgrade

➤ Email notifications

➤ Management of multiple role-based users

➤ Circuit tracing

➤ Automatic network backups

NMS detects the network and topology, then presents it graphically as shown in *Figure 14*. The configuration of each network element can be viewed and modified as shown in *Figure 15*. The graphical views allow the status of every network element and subnetwork to be verified, with the ability to perform system-wide monitoring and event logging.

ICON also supports a client-server architecture for network management. In the client-server model, the SEL-5051 will connect to SEL-5052, as shown in *Figure 5*. In this network management model, SEL-5052 is responsible for centrally managing user accounts (i.e., multiuser security) and managing the ICON network, and SEL-5051 polls SEL-5052 for user accounts and ICON network information.

Figure 14   SEL-5051 Network and Topology (Overview Tab)
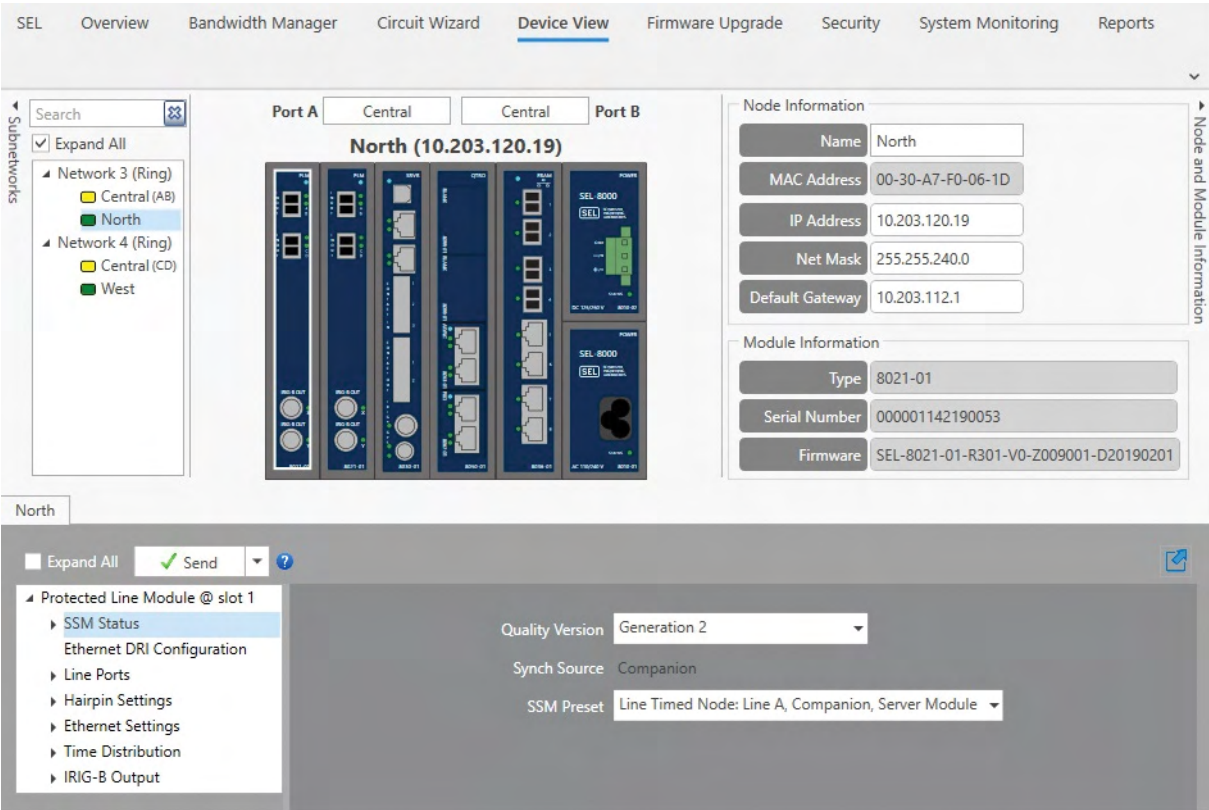
Figure 15   SEL-5051 Device View Tab (For Configuring and Monitoring Modules)

Table 1   Network Management Features (Sheet 1 of 2)

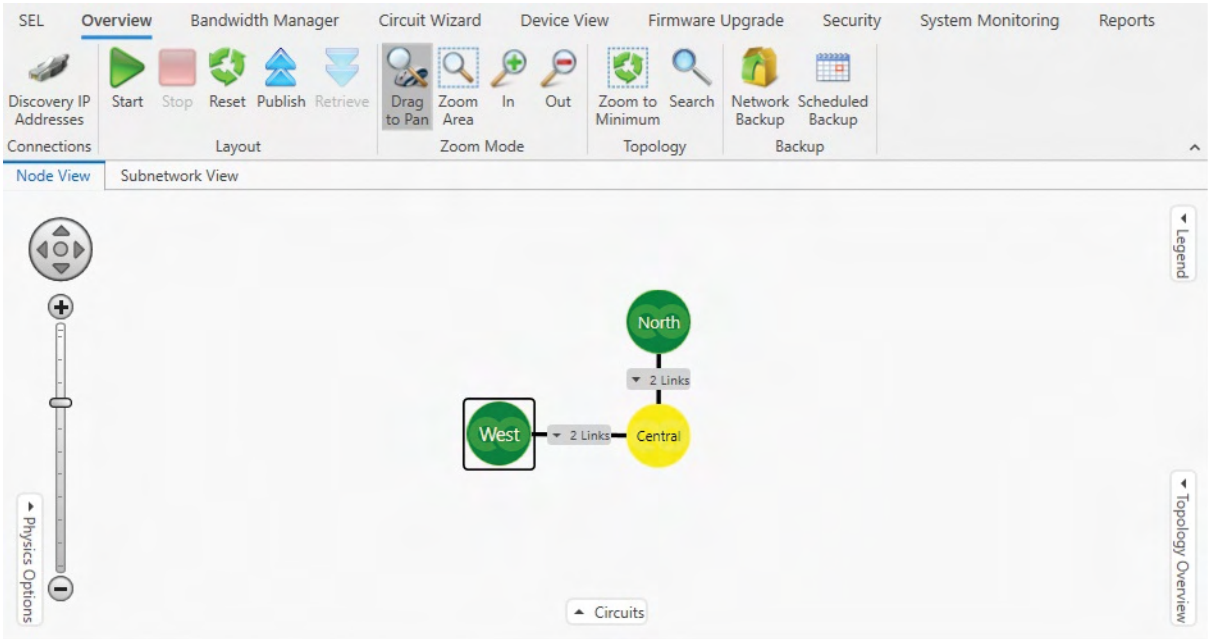| Feature	Description
Graphical Network Representation	➤ Represent ICON network element with a node icon ➤ Organize and arrange node icons ➤ Distribute common view to multiple users ➤ Display type and status of internode line links
Event Management	➤ Track user access at each node ➤ Monitor valid and invalid login attempts ➤ Session statistics—login and logout times ➤ Configuration history ➤ Filtering and sorting of event log parameters/columns ➤ Event log electronic file storage or paper record ➤ Alarms for users exceeding allowable invalid counts for specific events

Alarm Management	➤ Alarms are recorded in an alarm engine that supports three views
	  ➢ Current alarms
	  ➢ New alarms
	  ➢ Acknowledged alarms
	➤ Alarms are time-stamped and stored on the local node
	➤ An alarm log file is stored on the host computer
	➤ Alarms are filtered and sorted
	➤ SNMP traps are available

Inventory Management	➤ Inventory by network, ring, node
	  ➢ Total number of modules
	  ➢ Number of specific modules
	➤ Inventory information
	  ➢ Module serial numbers
	  ➢ Module firmware
	  ➢ Specific parameters
	➤ Remote firmware upgrade of all units

Configuration Management	➤ Circuit provisioning wizards (Pipes, STS-1, VT) ➤ Circuit trace ➤ Circuit report ➤ System health check ➤ Settings backup and restore ➤ Circuit aliases ➤ Node aliases ➤ Ring aliases ➤ Port aliases

Performance Management	➤ Analytics
	➤ SONET performance monitoring
	  ➢ Section
	  ➢ Line
	  ➢ Path
	  ➢ VT: Code violations
	  ➢ Errored seconds
	  ➢ Severely errored seconds
	➤ Ethernet frame counters
	  ➢ Input and output frame counters
	  ➢ Error frame counters

Table 1   Network Management Features (Sheet 2 of 2)

Feature	Description
Cybersecurity—Systems Security Management	➤ Capable of enabling NERC-CIP compliance ➤ Generates network topology maps and configuration ➤ Role-based user access controls, reports, and file encryption ➤ LDAP and SSO support ➤ Centralized user account and password management ➤ Event reporting ➤ GPS spoofing detection and mitigation ➤ Logs all changes to system settings, firmware, and hardware modules ➤ Communications ports disabled by default ➤ Authenticates and monitors all user access ➤ Logs all authorized and unauthorized access attempts ➤ Alarm management ➤ Logs physical removal of hardware modules and attempts to access disabled Ethernet ports ➤ Configure and forward event data to target Syslog servers or as email notifications

ICON Architecture

Chassis Options

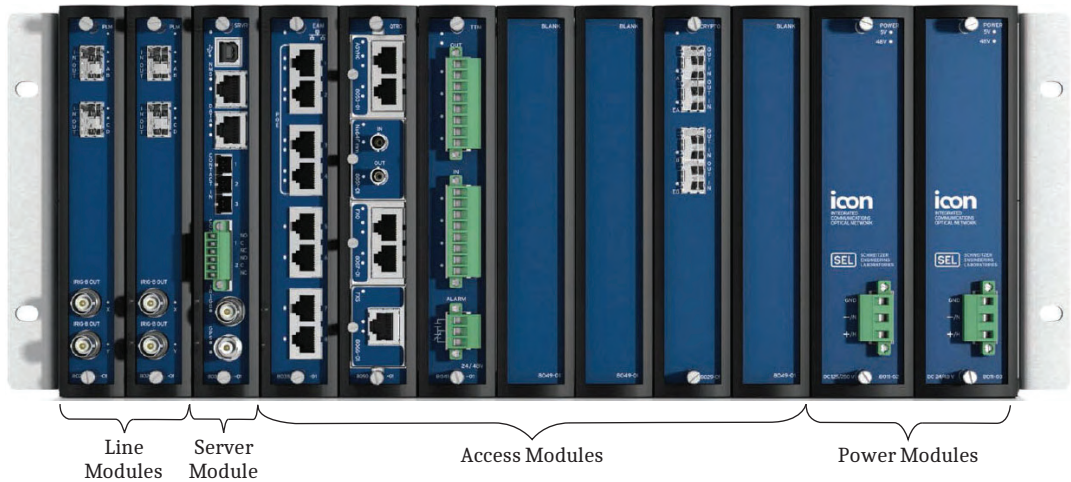**Figure 16   19-Inch Rack-Mount Chassis (Front Cable Access Shown)**

The ICON is available in a 19-inch rack-mount chassis as shown in *Figure 16*. The 19-inch rack-mount chassis has seven access module slots, which are available for the various interfaces.

For installations in which space may be limited, the ICON is available in the ICON Cube chassis shown in *Figure 17*. The ICON Cube has two access module slots.
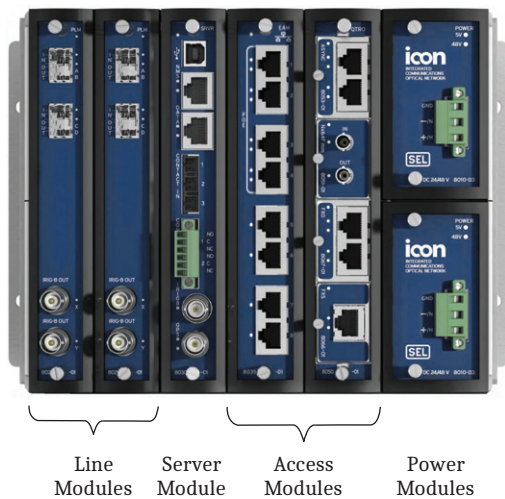
Figure 17   ICON Cube Chassis (Front Cable Access Shown)

Access module slots are the physical locations for the various accessory drop interfaces chosen by the user. Each ICON slot can accommodate one full-height module or a Quattro adapter that can support four Quattro access submodules. The full-height and the Quattro submodules are shown in *Figure 17*. Use the Quattro Module to divide the access module slot into four parts called submodule slots. The Quattro Module concept allows more efficient use of an access module slot. For example, if only one voice or data circuit is necessary, the Quattro Module can support various combinations of data and voice submodules in the four available submodule slots.

Enhanced Protected Line Module

The Enhanced Protected Line Module (EPLM) provides a redundant SONET or Gigabit Ethernet line interface. The Enhanced Protected Line Module provides added reliability by ensuring that line communications are maintained in the event of a module failure or replacement. The Enhanced Protected Line Module provides the following functionality:

➤ Internode communications links using SONET OC-3/OC-12/OC-48/1 Gigabit Ethernet line ports. Any combination of transport line rates are available on any port pair.

➤ Cross-connect with STS-1, VT, DS0, or E0 granularity.

➤ Timing output (IRIG-B) signals

➤ LAN Ethernet support provided by a separate Ethernet Bridging Access Module

➤ IEEE 1588 PTP telecom profile support when operating in Ethernet transport mode
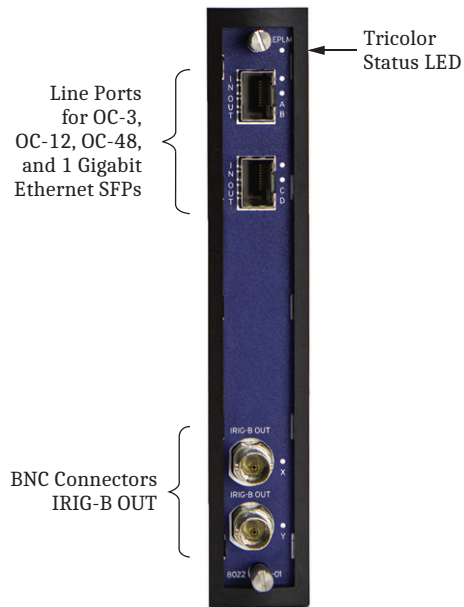
Figure 18   Enhanced Protected Line Module

Server Module

The Server Module provides the following functionality:

➤ Timing input (GPS and IRIG-B) signals

➤ RJ45 connector supporting 100 Mbps Ethernet for NMS local or remote connection

➤ USB management port

➤ Three internally wetted contact inputs for network management system (NMS) alarm information

➤ Two Form C Solid State Relay contact outputs for major and minor alarms
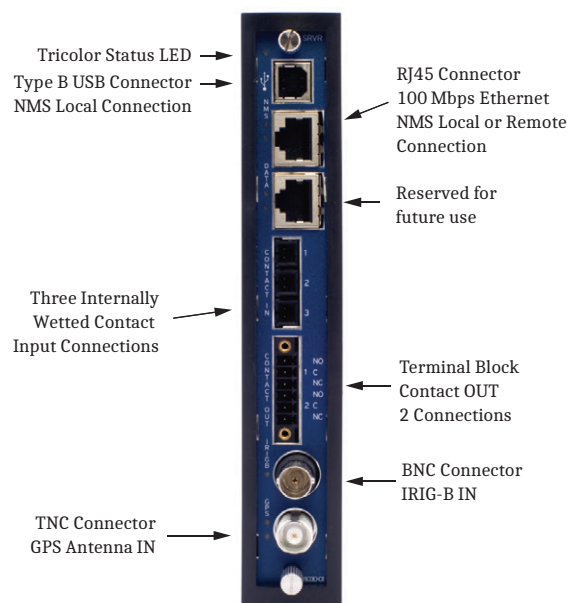
Figure 19   Server Module

Access Modules

Access modules are the full height of the chassis. The 19-inch rack-mount chassis has seven access module slots. The ICON Cube has two access module slots available.

The access modules and submodules all support the following test and monitoring features:

➤ Circuit addressing

➤ Real-time latency monitoring

➤ PRBS generation and monitoring

➤ Local and line loopback

This feature set consumes an additional 64 kbps time slot per module.

Ethernet Bridging Access Module

The Ethernet Bridging Access Module (EBAM) is an eight-port, full-height module providing four RJ45 copper ports for 10/100/1000 Mbps links, and four SFP-based fiber-optic links at 100/1000 Mbps.

All eight ports can also provide time as a PTP Master-Only Clock (via an ordering option). This supports IEDs and LANs with the following IEEE 1588 profiles:

➤ IEEE/IEC 61850-9-3 Base Power Profile

➤ IEEE C37.238-2017 Extended Power Profile

➤ IEEE 1588-2008 Annex F (default profile for transport of PTP over IEEE 802.2/Ethernet)

Transfer Trip Module
Inputs

Number of command inputs: 4
Input voltage options: 24, 48, 125, 250 Vdc
Connector: Terminal block

Outputs

Number of command outputs: 4
Output type: SEL Fast Hybrid
Output ratings
Make: 30 A per IEEE C37.90
Interrupting: 48 Vdc 10 A L/R = 40 ms
125 Vdc 10 A L/R = 40 ms
250 Vdc 10 A L/R = 20 ms
Pickup time: 10 µs
Dropout time: 8 ms
Connector type: Terminal block

Quattro Module

The Quattro Module provides the interface for as many as four access submodules. The various submodules available are described in *Access Submodules* on page 17.

Access Submodules

Data
Nx64F

Number of ports: 1
Interface: IEEE C37.94
Data rate: 64 kbps to 768 kbps
Connector: ST fiber-optic
Wavelength: 850 nm multimode or 1310 nm single-mode (ordering option)

Async

Number of ports: 2

Note: As many as six EIA-232 circuits can be supplied if handshake signals are not necessary.

Interface:

➤ EIA-232

➤ EIA-422

➤ EIA-485

Data rate: 110 bps to 115.2 kbps
Connector: Two RJ45
Time output: IRIG-B

Async-CB

The Async Data Channel Bank Submodule is intended for operation with a DS1 Sync or E1 Sync Submodule to support transport of EIA-232, EIA-422, and EIA-485 circuits over the DS1/E1 interface between ICONs.

Number of ports: 2

Note: As many as six EIA-232 circuits can be supplied if handshake signals are not necessary.

Interface:
➤ EIA-232
➤ EIA-422
➤ EIA-485

Data rate: 110 bps to 115.2 kbps
Connector: Two RJ45

422 Sync

Number of ports: 1
Connector: RJ45
Nominal data rate: 64 kbps

G.703

Number of ports: 1
Connector: One RJ48C
Data rate: 64 kbps

DS1 Async

Number of ports: 4
Connector: Four RJ48C
Line coding schemes: AMI, B8ZS
Nominal data rate: 1.544 Mbps

DS1 Sync

Number of ports: 4
Connector: Four RJ48C
Line coding schemes: AMI, B8ZS
Nominal data rate: 1.544 Mbps

DS1 PSync

Number of ports: 4 (1x1 protected)
Connector: Four RJ48C
Line coding schemes: AMI, B8ZS
Nominal data rate: 1.544 Mbps

E1 Async

Number of ports: 4
Connector: Four RJ48C
Line coding schemes: AMI, HDB3
Nominal data rate: 2.048 Mbps

E1 Sync

Number of ports: 4
Connector: Four RJ48C
Line coding schemes: AMI, HDB3
Nominal data rate: 2.048 Mbps

Voice
Voice 4-Wire

Number of circuits: 2
Signaling: Type I, II, III, V, or Transmission Only (TO)
Connector: Two RJ45

Voice 4-Wire Bridging

Number of circuits: 1
Connector: Two RJ45 (duplicate)

Voice 2-Wire FXS

Number of circuits: 1
Signaling: Loop start, PLAR
Connector: One RJ11

Voice 2-Wire FXO

Number of circuits: 2
Signaling: Loop start
Connector: Two RJ11

Network Management System PC Requirements

SEL-5051 requires a computer and operating system which meet the specifications listed in *Table 2*.

Table 2 Network Management System Requirements (Sheet 1 of 2)

Processor Speed:	2 GHz or faster
Operating System:	Microsoft Windows 10 with 4 GB RAM Microsoft Windows 11 with 4 GB RAM

Table 2   Network Management System Requirements (Sheet 2 of 2)

Disk Space:	1 GB
Monitor:	1280 x 1024 or higher resolution
Input Device:	Mouse or other pointing device
Networking:	Ethernet adapter

Table 3   SEL-5052 Network Management System Server Minimum Requirements

Processor:	Intel Core i3 or later
Operating System:	Microsoft Windows Server 2019 with 2 GB RAM Microsoft Windows Server 2022 with 2 GB RAM Microsoft Windows 10 64-bit with 2 GB RAM Microsoft Windows 11 64-bit with 2 GB RAM
Disk Space:	128 GB

SEL-5052 requires a computer and operating system that meets the specifications listed in *Table 3*.

Table 4   SEL-5052 NMS Server Host Recommendations for ICON Network Size

Number of ICONs	Processor Speed (GHz)	Number of Processor Cores	RAM (GB)	Storage Space (GB)
<25	2.4	1	4	1
26–75	3.0	2	4	2[a]
76–250	3.4	4	8	4[a]
>250	3.7	6+	16	6[a]

[a] A solid-state hard drive (SSD) is highly recommended to improve storage access speed when managing more than 25 ICONs.

ICON Dimensions

RACK-MOUNT CHASSIS

TOP

MOUNT OPTION 1

17.50
(444.4)

MOUNT OPTION 2

5.88
(149.3)

7.10
(180.3)

1.1
(27.9)

CABLE ACCESS VIEW

19.00
(482.6)

6.97
(177.0)

4.00
(101.6)

18.31
(465.1)

LEGEND
in
(mm)

i9246b
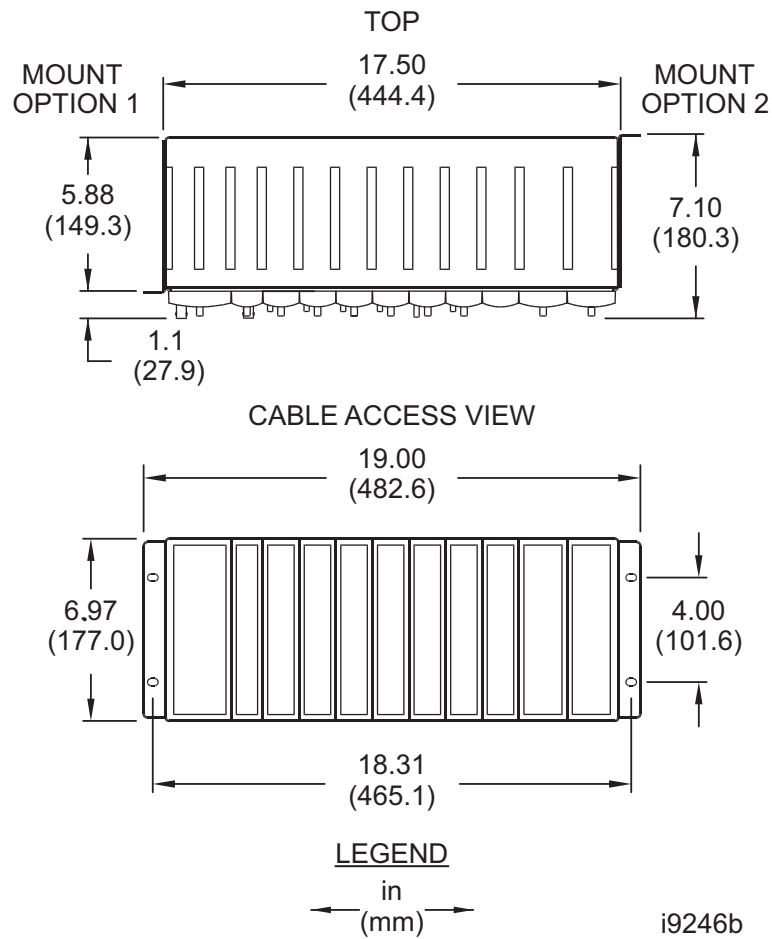
Figure 20   19-Inch ICON Dimension Diagram

TOP

0.10
(2.5)

7.00
(177.8)

8.75
(222.3)

10.25
(260.4)

6.97
(177.0)

4.00
(101.6)

9.55
(242.6)

BACK
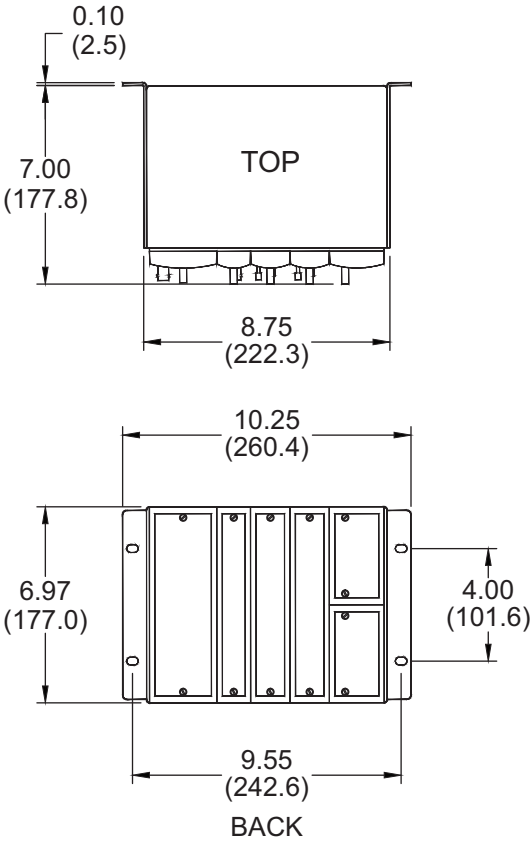
LEGEND

in
(mm)

i9335c

Figure 21   Half-Width ICON Cube Dimension Diagram

Specifications

Enhanced Protected Line Module (SEL-8022-01)

Line Ports

A/B:	OC-3, OC-12, OC-48, or 1 GigE
C/D:	OC-3, OC-12, OC-48, or 1 GigE

Small Form-Factor Pluggables (SFPs)

See selinc.com/products/sfp.

Other Ports

IRIG-B Out Connector:	BNC

Server Module (SEL-8030-01)

GPS Antenna Connector:	TNC
Supply for GPS Antenna:	5 V or 3 V
GPS Cable:	SEL-C965
Required GPS Surge Protector:	SEL Surge Protector (part number 915900139) or equivalent (not included with SEL-C965)
IRIG-B In Connectors:	BNC
IRIG-B Cable:	SEL-C953 (<10 m)
IRIG-B Format:	IRIG-B00X signal format, DCLS equivalent TTL IEEE C37.118 extended IRIG-B format

Network Management Ports

Connector:	B-type USB or RJ45 Ethernet
Quantity:	3 (2 USB, 1 Ethernet)
Cable:	<3 m for USB SEL-CA605R Ethernet
Data Ports Connector:	RJ45 reserved for future use

Contact In

Connector:	Molex 70551 connector
Quantity:	3
Cable:	SEL-C575 only (<3 m)
Burden Per Input:	0.0 W (internally wetted)

Contact Out

Connector:	Terminal block
Quantity:	2
Cable:	Insulated 24 AWG, 0.6 A long-distance (3.5 A short <0.9 m)
Type:	Form C Solid State Relay
Rated Voltage Range:	<50 V
Open Contact Voltage Withstand:	50 V
Total Burden:	1.5 W @ 50 V
Limited Making Capacity (Off Current):	1 μA
Contact Current:	150 mA (continuous); 350 mA (max)
Limited Breaking Capacity (On Resistance):	35 Ω
Endurance:	>10,000 cycles for make or break unloaded

Power Modules

Half-Height Power Module for ICON Cube Chassis

SEL-8010-01

Rated Voltage Range:	120–240 Vac, 50/60 Hz
Min/Max Voltage:	102–264 Vac, 50/60 Hz
Wiring Interface:	IEC C6 Connector
Cable:	SEL 030-1002
Minimum Wire Gauge:	16 AWG (10 A)
Maximum Burden:	163 VA (65 W)
Fuse Rating:	2.0 A, Time-lag T, 60 A @ 250 Vac, 24 I^2t

Note: Fuses are not user-serviceable. Return units to manufacturer for servicing.

SEL-8010-02

Rated Voltage Range:	125–250 Vdc 120–240 Vac, 50/60 Hz
Min/Max Voltage:	88–300 Vdc; 102–264 Vac
Wiring Interface:	Terminal Block Connector
Cable:	SEL-C5006
Minimum Wire Gauge:	16 AWG (10 A)
Maximum Burden	
AC:	163 VA
DC:	65 W
Fuse Rating:	2.0 A, Time-lag T, 60 A @ 250 Vac, 24 I^2t 2.0 A, Time-lag T, 50 A @ 250 Vdc, 24 I^2t 2.0 A, Time-lag T, 100 A @ 125 Vdc, 24 I^2t

Note: Fuses are not user-serviceable. Return units to manufacturer for servicing.

SEL-8010-13

Rated Voltage Range:	24–48 Vdc
Min/Max Voltage:	19.2–60.0 Vdc
Wiring Interface:	Terminal Block Connector
Minimum Wire Gauge:	16 AWG (10 A)

Maximum Burden:	78 W
Fuse Rating:	10.0 A, Time-lag T

Note: Fuses are not user-serviceable. Return units to manufacturer for servicing.

Full-Height Power Module for 19" Chassis

SEL-8011-01

Rated Voltage Range:	120–240 Vac, 50/60 Hz
Min/Max Voltage:	102–264 Vac, 50/60 Hz
Wiring Interface:	IEC C6 Connector
Cable:	SEL 030-1002
Maximum Burden:	92 W

SEL-8011-02

Rated Voltage Range:	125–250 Vdc 120–240 Vac, 50/60 Hz
Min/Max Voltage:	88–300 Vdc; 102–264 Vac
Wiring Interface:	Terminal Block Connector
Cable:	SEL-C5006
Maximum Burden:	92 W

SEL-8011-03

Rated Voltage Range:	24–48 Vdc
Min/Max Voltage:	19–58 Vdc
Wiring Interface:	Terminal Block Connector
Maximum Burden:	92 W

Access Modules

Ethernet Bridging Access Module (SEL-8036-01, SEL-8036-02)

Connector:	RJ45 and SFP
10/100/1000 Copper Ethernet Ports:	4
100/1000 Fiber-Optic Ports:	4
Precision Time Protocol Support:	IEEE 1588pp (SEL-8036-02 only)

Transfer Trip Module (SEL-8041-01, SEL-8041-04)

Rated Voltages (SEL-8041-01):	24 Vdc, 48 Vdc
Rated Voltages (SEL-8041-04):	125 Vdc, 250 Vdc
Connector:	Terminal Block
Conductor Size:	12–28 AWG
Maximum Carrying Current:	5 A
Number of Commands:	4
Channel Bandwidth:	64 kbps

Nx64F Submodule (Multimode) (SEL-8051-21)

Data Standard:	C37.94
Fiber:	Multimode
Connector:	ST
Quantity:	1 Rx, 1 Tx
Data Rate:	64 kbps–768 kbps

Nx64F Submodule (Single-Mode) (SEL-8051-22)

Data Standard:	C37.94
Fiber:	Single-mode
Connector:	ST

Quantity:	1 Rx, 1 Tx
Data Rate:	64 kbps–768 kbps

Async Data Submodule (SEL-8053-11)

Connector:	RJ45
Quantity:	2 ports supporting as many as 6 circuits
Data Standards:	EIA-232, EIA-422, EIA-485 with IRIG support
Data Rates:	110 bps–115.2 kbps

Async Data CB Submodule (SEL-8053-12)

Connector:	RJ45
Quantity:	2 ports supporting as many as 6 circuits
Data Standards:	EIA-232, EIA-422, EIA-485
Data Rates:	110 bps–115.2 kbps

422 Sync Submodule (SEL-8055-01)

Connector:	RJ45
Quantity:	1
Data Standard:	EIA-422
Data Rate:	64 kbps

G.703 Submodule (SEL-8056-01)

Connector:	RJ48C
Quantity:	1
Data Rate:	64 kbps

DS1 Async Submodule (SEL-8057-11)

Connector:	RJ48C
Quantity:	4

DS1 Sync Submodule (SEL-8057-12)

Connector:	RJ48C
Quantity:	4

DS1 PSync Submodule (SEL-8057-03)

Connector:	RJ48C
Quantity:	4 (1x1 protected)

E1 Async Submodule (SEL-8057-14)

Connector:	RJ48C
Quantity:	4

E1 Sync Submodule (SEL-8057-15)

Connector:	RJ48C
Quantity:	4

4W VF Submodule (SEL-8065-11)

Connector:	RJ45
Quantity:	2

4W Bridging VF Submodule (SEL-8065-12)

Connector:	RJ45
Quantity:	2
Circuits:	1

2W FXS Submodule (SEL-8066-01)

Connector:	RJ11
Quantity:	1

2W FXO Submodule (SEL-8067-01)

Connector:	RJ11
Quantity:	2

System Specifications

Network Topologies:	Point-to-point, linear, ring, multiple rings with single or dual interconnected nodes
Path Switching Time:	<5 ms per ring for Ethernet; <5 ms end-to-end for TDM
Convection Cooled:	No fans

Environmental Requirements

Note: To meet published IEEE 1613 vibration specifications, all ICON full-height modules should be firmly secured in the chassis by tightening the captive screws to a torque of 14 in-lb (1.6 Nm). All submodules should be firmly secured in the chassis by tightening the captive screws to a torque of 6 in-lb (0.7 Nm).

Operating Requirements

Operating Temperature:	–20° to +65°C (–4° to +149°F) ambient[a]
Storage Temperature:	–40° to +85°C (–40° to +185°F)
Relative Humidity:	5%–95%, noncondensing

Operating Environment

Enclosure Type:	NEMA Type 1 (indoor)
Pollution Degree:	2
Overvoltage Category:	II
Insulation Class:	I
Maximum Altitude:	2000 m
Atmospheric Pressure:	80–110 kPa

Enclosure Protection

Terminal Blocks (Contact Out, Power, and TTM):	IP2X
All Other Locations:	IP4X

[a] ICONs equipped with CWDM SFPs are rated −20°C to +50°C (−4° to +122°F).

Compliance and Type Tests

Designed and manufactured under an ISO 9001 certified quality management system

47 CFR 15B Class A

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

Emissions for Canada ICES-001 (A) / NMB-001 (A)

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to ICES-001, Issue 5.

Class 1 Laser

Modules and SFPs comply with 21 CFR 1040.10 and 1040.11 except for conformance with IEC 60825-1 Ed. 3, as described in Laser Notice No. 56, dated May 8, 2019.

Refer to the following matrix for module-specific FCC, CAN ICES-001, CE, RCM, RoHS, and UKCA compliance information:

Compliance Specs	8001	8002	8010	8011	8022	8030	8036	8041	8050	8051	8053	8055	8056	8057	8065	8066	8067
FCC PART 15	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
CAN ICES-001	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
CE		■	■		■	■	■		■	■	■	■	■	■	■		
RCM		■	■		■	■	■		■	■	■	■	■	■	■		
RoHS	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
UKCA		■	■		■	■	■		■	■	■	■	■	■	■		

Communications Product Testing

NOTE: These standards apply to SEL-8002-01, SEL-8010-01, SEL-8010-02, SEL-8010-13, SEL-8022-01, SEL-8030-01, SEL-8036-01, SEL-8036-02, SEL-8050-01, SEL-8051-21, SEL-8051-22, SEL-8053-11, SEL-8053-12, SEL-8055-01, SEL-8056-01, SEL-8057-03, SEL-8057-11, SEL-8057-12, SEL-8057-14, SEL-8057-15, and SEL-8065-11 when tested at Communication Profile 3 (IEEE 1613)/Profile 2 (IEC 61850-3) with double-shielded cables.

IEC 61850-3 Performance Class 1
IEEE 1613-2009 + A1:2011 Performance Class 1

Electromagnetic Compatibility (EMC)

NOTE: These standards apply to SEL-8002-01, SEL-8010-01, SEL-8010-02, SEL-8010-13, SEL-8022-01, SEL-8030-01, SEL-8036-01, SEL-8036-02, SEL-8050-01, SEL-8051-21, SEL-8051-22, SEL-8053-11, SEL-8053-12, SEL-8055-01, SEL-8056-01, SEL-8057-03, SEL-8057-11, SEL-8057-12, SEL-8057-14, SEL-8057-15, and SEL-8065-11 when tested at Communication Profile 3 (IEEE 1613)/Profile 2 (IEC 61850-3) with double-shielded cables.

Product Standards	ETSI EN 303 413 ETSI EN 301 489-1 V2.2.0: 2017-03 ETSI EN 301 489-19 V2.1.0: 2017-03 ICES-001, Issue 5 IEC 60255-26:2013 IEC 61850-3:2013 IEEE 1613-2009 IEEE C37.90-2005		
Test	**Methodology**	**Level**	
Emissions	ANSI C63.4 CISPR 11/22/32 EN 55011 EN 55022 EN 55032 KN 32	Class A	
Harmonics	IEC 61000-3-2	Class A	
Flicker	IEC 61000-3-3	Class A	
Radiated RF Immunity	ETSI 301 489-19 IEC 61000-4-3	**Frequency (MHz)** / **Field Strength** / **Modulation**	

Radiated RF Immunity (cont.)		Frequency (MHz)	Field Strength	Modulation
		80–6000	3 V/m	AM 80% 1 kHz sine
		80–6000	20 V/m	AM 80% 1 kHz sine

Conducted RF Immunity	IEC 61000-4-6	150 kHz–80 MHz, 1 kHz 80% AM 10 Vrms Spot Frequencies: 27 MHz and 68 MHz
Electrostatic Discharge	IEC 61000-4-2	Contact Discharge: ±2, 4, 6, 8 kV Indirect Discharge: ±2, 4, 6, 8 kV Air Discharge: ±2, 4, 8, 15 kV

	ETSI EN 303 413
Product Standards	ETSI EN 301 489-1 V2.2.0: 2017-03
	ETSI EN 301 489-19 V2.1.0: 2017-03
	ICES-001, Issue 5
	IEC 60255-26:2013
	IEC 61850-3:2013
	IEEE 1613-2009
	IEEE C37.90-2005

Test	Methodology	Level	
Electrical Fast Transient Burst	IEC 61000-4-4	**Port Type**	**Level**
		Power, Input/Output	±4 kV @ 5 kHz (Zone A)
		Communication Ports	±4 kV @ 5 kHz (Zone A)
		Note: For USB ports, use cable lengths ≤3 m.	
Surge Immunity	IEC 61000-4-5	**Port Type**	**Level**
		Power	±0.5, 1 kV line-to-line (Zone B) ±0.5, 1, 2 kV line-to-earth (Zone B)
		Communication Ports	±0.5, 1, 2 kV line-to-earth (Zone B)
		Note: For USB ports, use cable lengths ≤3 m. For the Server IRIG-B port, use cable lengths ≤10 m. For the Server GPS port, use an SEL Surge Protector (part number 915900139) or equivalent.	
Damped Oscillatory Wave Immunity	IEC 61000-4-18	**Port Type**	**Level**
		Power	±2.5 kV Common ±1 kV Differential
		Contact I/O	±2.5 kV Common ±1 kV Differential
		Communication Ports	±1 kV Common
		GPS	±1 kV Common
		IRIG-B	±1 kV Common
		Note: For USB ports, use cable lengths ≤3 m.	
Power Frequency Immunity/Conducted Common Mode Disturbances	IEC 60255-26 IEC 61000-4-16	Exempt. For binary input ports, use cable lengths ≤10 m.	
Power Frequency Magnetic Field Immunity	IEC 61000-4-8	100 A/m for 60 Seconds 1000 A/m for 1–3 Seconds	
Pulse Magnetic Field Immunity	IEC 61000-4-9	1000 A/m, Level 5	
Damped Oscillatory Magnetic Field Immunity	IEC 61000-4-10	100 A/m, Level 5	
AC Dips and Interruptions	IEC 61000-4-11	10 Cycles	
Ripple on DC Power Input	IEC 61000-4-17	15% of Rated DC Value	
DC Dips and Interruptions	IEC 61000-4-29	200 ms	
Burden	IEC 60255-1	Meets applicable requirements	
Surge Withstand Capability	IEEE C37.90.1	**Damped Oscillatory (1 MHz)**	
		Port Type	**Level**
		Power, Input/Output	±2.5 kV Common ±2.5 kV Differential
		Communication Ports	±2.5 kV Common
		Fast Transient (5 kHz)	
		Port Type	**Level**
		Power, Input/Output	±4.0 kV Common ±4.0 kV Differential
		Communication Ports	±4.0 kV Common
		Note: For USB ports, use cable lengths ≤3 m.	
Radiated Immunity	IEEE C37.90.2	**Frequency (MHz)**	**Field Strength**	**Modulation**
		80–6000	20 V/m	AM 80% 1 kHz sine
Electrostatic Discharge	IEEE C37.90.3	Contact Discharge: ±2, 4, 6, 8 kV Indirect Discharge: ±2, 4, 6, 8 kV Air Discharge: ±2, 4, 8, 15 kV	

Environmental

NOTE: These standards apply to SEL-8002-01, SEL-8010-01, SEL-8010-02, SEL-8010-13, SEL-8022-01, SEL-8030-01, SEL-8036-01, SEL-8036-02, SEL-8050-01, SEL-8051-21, SEL-8051-22, SEL-8053-11, SEL-8053-12, SEL-8055-01, SEL-8056-01, SEL-8057-03, SEL-8057-11, SEL-8057-12, SEL-8057-14, SEL-8057-15, and SEL-8065-11 when tested at Communication Profile 3 (IEEE 1613)/Profile 2 (IEC 61850-3) with double-shielded cables.

Product Standards	IEC 60255-27:2014 IEC 61850-3:2013 IEEE 1613-2009		
Test	**Methodology**	**Level**	
Cold	IEC 60255-1 IEC 60068-2-1	**Test Type**	**Level**
		Operational	Test Ad: 16 hours at –20°C
		Storage	Test Ab: 16 hours at –40°C
Dry Heat	IEC 60255-1 IEC 60068-2-2	**Test Type**	**Level**
		Operational	Test Bd: 16 hours at +65°C
		Storage	Test Bb: 16 hours at +85°C
Cyclic Temperature	IEC 60255-1 IEC 60068-2-14	Test Db: –20°C to +65°C, 5 cycles	
Damp Heat	IEC 60255-1 IEC 60068-2-78 IEC 60068-2-30	**Test Type**	**Level**
		Steady State	Test Cab: 93% RH, +40°C, 10 days
		Cyclic	Test Db: +25°C to +55°C, 6 cycles, (12+12-hour cycle), 95% RH
Vibration	IEC 60255-21-1	Class 2 Endurance, Class 2 Response	
Shock/Bump	IEC 60255-21-2	**Test Type**	**Level**
		Shock	Class 1 Withstand, Class 2 Response
		Bump	Class 1 Withstand
Seismic	IEC 60255-21-3	Class 2 Quake Response	
Shock Phenomena	IEEE 1613	**Test Type**	**Level**
		Normal Handling	100 mm Drop
		Note: Excluding cable access face.	

Safety

NOTE: These standards apply to SEL-8002-01, SEL-8010-01, SEL-8010-02, SEL-8010-13, SEL-8022-01, SEL-8030-01, SEL-8036-01, SEL-8036-02, SEL-8050-01, SEL-8051-21, SEL-8051-22, SEL-8053-11, SEL-8053-12, SEL-8055-01, SEL-8056-01, SEL-8057-03, SEL-8057-11, SEL-8057-12, SEL-8057-14, SEL-8057-15, and SEL-8065-11 when tested at Communication Profile 3 (IEEE 1613)/Profile 2 (IEC 61850-3) with double-shielded cables.

Product Standards	IEC 60255-27:2013 IEC 61850-3:2013 IEEE 1613-2009 IEEE C37.90-2005	
Test	**Methodology**	**Level**
Dielectric Strength	IEC 60255-27	**Port Type** / **Level** Power — ±3.6 kVdc Alarm Contacts — ±2.5 kVac Ethernet Ports — ±1.5 kVac Other Communication Ports — ±500 Vac
Impulse	IEC 60255-27	**Port Type** / **Level** Power — ±5 kV All Other Ports — ±1 kV
Insulation Resistance	IEC 60255-27	Meets applicable levels
Flammability of Insulating Materials	IEC 60255-27	Meets applicable levels
Maximum Temperature of Parts and Materials	IEC 60255-27	Meets applicable levels, Normal use
Protective Bonding/Continuity	IEC 60255-27	Meets applicable levels
Object Penetration	IEC 60529	**Location** / **Level** Terminal Blocks — IP2X All Other Locations — IP4X
Laser Safety	IEC 60825-1 IEC 60825-2 21 CFR 1040.10 and 1040.11	Class 1
Line Leakage	IEC 60255-27 IEC 60990	Meets applicable levels
Insulation Coordination	IEEE C37.90	**Dielectric Strength** **Port Type** / **Level** Power — ±3.6 kVdc Alarm Contacts — ±2.5 kVac Ethernet Ports — ±1.5 kVac Other Communication Ports — ±500 Vac **Impulse** **Port Type** / **Level** Power — ±5.0 kV All Other Ports — ±1.0 kV **Insulation Resistance** Meets applicable levels

Technical Support

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

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