The versatile SEL Integrated Communications Optical Network (ICON®) provides both intrastation and interstation communications on one easy-to-manage platform. 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 utilities looking to migrate to an MPLS or Carrier Ethernet network and enables the performance of critical protection circuits to be maintained.

- **Flexible Transport Bandwidth Options.** ICON line ports support OC-3, OC-12, and OC-48 data rates when configured as SONET and 1 Gbps when operating in Ethernet transport mode. Support for 10 Gbps will be added in a future release. Support for different Ethernet and SONET line rates will enable 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 GPS only solutions. Time is available at each network node in IRIG-B, with IEEE 1588 power profile available in a future release.
Fat Security and Critical Infrastructure Protection. The ICON helps users achieve NERC-CIP compliance by providing the following:

➢ Report generation
➢ Logging of all system setting changes and firmware and hardware changes
➢ Logging of authorized and unauthorized user access

The optional crypto module encrypts data in transit between ICON nodes. This module provides 256-bit AES encryption with a negligible 1 ms latency.

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 version 3.2.0.0 and later provides Lightweight Directory Access Protocol (LDAP) 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 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

➢ Small form-factor pluggable (SFP) 1 Gbps optical transceivers with a reach as far as 200 km. Support for 10 Gbps will be added in a future release.
➢ 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
➢ Optical transmit and receive level monitors
➢ Laser current output monitor
➢ Support for point-to-point, linear, ring, and multiple ring topologies. Support for single- or dual-ring interconnected ties with rings being all Ethernet or mixed Ethernet/SONET transport.
➢ Support for ITU-T G.8032 Ethernet Ring Protection Switching for non-VSN Ethernet traffic will be available in a future release.
SONET Features

➤ Small form-factor pluggable (SFP) OC-3, OC-12, and OC-48 optical transceivers with a reach of up to 160 km
➤ Optional line port encryption
➤ 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 and DS1 TDM Features

➤ Connect and synchronize non-ICON DS1 equipment for system-wide interoperability
➤ Groom incoming DS1 subrate (DS0) signals onto any ICON network-wide DS0 channel
➤ Add/Drop any DS0/DS1 signal from higher-level STS-1 signals
➤ Aggregate DS1 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)
➤ Four Power over Ethernet (PoE) ports per Ethernet Access Module [8035-01 Ethernet Access Module (EAM) only]
➤ Support for eight priority queues per port
➤ VLAN filtering per port—list of allowed or blocked VLANs, ingress and egress (EBAM only)
➤ BPDU filtering and Ethernet Virtual Wire support to manage how ICON Ethernet LAN ports interact with spanning tree protocols from LAN switches

Ethernet standards supported:
➤ 802.1d Ethernet bridge
➤ 802.1Q VLAN tagging, priority queues
➤ 802.3i 10BASE-T (RJ45 Cu)
➤ 802.3ac Frame format extensions for VLAN tagging
➤ 802.3af Power over Ethernet (PoE)
➤ 802.3u 100BASE-TX (RJ45 Cu)
➤ 802.3z 1000BASE-LX/ZX/BX
➤ DSCP DiffServ to 802.1Q priority mapping
Features Supported on Fiber Ethernet Ports

➤ Remote Fault Indicator (8036-01 EBAM module only)
➤ 1000 Mbps Ethernet
➤ 100 Mbps Ethernet
➤ Monitor of fiber-optic transceiver parameters
  ➤ Optic receive level
  ➤ Optic transmit power
  ➤ Temperature

Features Supported on Copper Ethernet Ports

➤ Autonegotiation (bit rate mode)
➤ Auto-MDIX (crossover cables not required)
➤ Port enabling and disabling

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 2 is a comparison of the ICON functionality to that of traditional methods.

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 with 10 Gbps available in a future release.
➤ 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 T1 terminal.
➤ Integrated Digital Access Cross-Connect Switch (DACS). This provides the cross-connection between the voice and data circuit traffic on DS0 channels and the SONET multiplexer. DS0 signals from incoming DS1 tributaries can also be individually groomed and routed to any other network-wide DS0 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

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

The ICON can distribute time over wide-area networks (WANs) with an accuracy of 1 ms. (Supporting 1 µs timing accuracy requires ICON line ports to be operating in SONET transport mode. A time accuracy of 1 µs cannot be achieved when operating in VSN transport mode.) High-accuracy time is quickly becoming 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)

Each ICON terminal has a global positioning system (GPS) receiver. When enabled, the local GPS receiver provides the local real-time clock and network stratum one 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 GPS clock sources in an ICON network are lost, the network will continue to maintain relative time with an accuracy of 1 ms.

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 GPS spoofing attacks is provided when multiple GPS receivers and IRIG-B time sources are enabled on the network. Internode time source comparisons are performed to monitor timing source integrity. Antenna location is monitored and alarms are issued for location changes.

Time signals to local intelligent electronic devices (IEDs) (e.g., SEL-311) are available from two BNC ports on the Line Module, and the EIA-232/EIA-422 ports on the Async Submodule.

Timing over the Ethernet ports (IEEE 1588pp) will be supported in a future release.
Transmission line protection is an important application to an electric utility. Figure 5 shows two types of protection: line current differential protection and direct transfer trip protection.

For line current differential protection, an SEL-311L 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-311L 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

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. When operating in SONET transport mode, the ICON distributes time across the network and can maintain better than 1 ms 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 GPS failure.

Migrating Analog Leased Services to Ethernet

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.

Figure 6  Wide-Area Control Using Synchrophasors

Figure 7  Transporting an Analog DTT Circuit Over a Leased Ethernet Network
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 an end-to-end latency of less than 5 ms for a contact transfer across leased Ethernet service.

**DS0 Distribution**

Use the DS0 grooming ability of the ICON to route low-speed DS0 circuits from byte synchronous DS1 inputs onto any DS0 drop on the ICON network.

![Figure 8 Route Low-Speed DS0 Circuits](image)

Extend the reach of your corporate PBX into each ICON location by connecting it to the ICON DS1 Sync Module. Then use ICON FXS modules throughout the network to distribute and terminate two-wire analog circuits for telephones and faxes.

![Figure 9 Distribute and Terminate Two-Wire Analog Circuits](image)
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 a 240-0010 combiner cable as shown in Figure 10. The DS1 PSync must be used with the Protected Line Module (SEL-8021-01), 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

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 reporting
- Performance monitoring
- Inventory management
- Remote firmware upgrade of ICON units
- Monitoring of contact closures
- Capability to manage multiple users
- Capability to configure and forward event data to target Syslog servers

NMS detects the network and topology, then presents it graphically as shown in Figure 12. The configuration of each network element can be viewed and modified as shown in Figure 13. 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. To simplify locating specific nodes or subnetworks, enter the appropriate alias into a search box, as shown in Figure 14.

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 3. 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 12  SEL-5051 Network and Topology (Overview Tab)

Figure 13  SEL-5051 Device View Tab (For Configuring and Monitoring Modules)
Table 1  Network Management Features (Sheet 1 of 2)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graphical Network Representation</td>
<td>➤ Represent ICON network element with a node icon</td>
</tr>
<tr>
<td></td>
<td>➤ Organize and arrange node icons</td>
</tr>
<tr>
<td></td>
<td>➤ Distribute common view to multiple users</td>
</tr>
<tr>
<td></td>
<td>➤ Display type and status of internode line links</td>
</tr>
<tr>
<td>Event Management</td>
<td>➤ Track user access at each node</td>
</tr>
<tr>
<td></td>
<td>➤ Monitor valid and invalid login attempts</td>
</tr>
<tr>
<td></td>
<td>➤ Session statistics—login and logout times</td>
</tr>
<tr>
<td></td>
<td>➤ Configuration history</td>
</tr>
<tr>
<td></td>
<td>➤ Filtering and sorting of event log parameters/columns</td>
</tr>
<tr>
<td></td>
<td>➤ Event log electronic file storage or paper record</td>
</tr>
<tr>
<td></td>
<td>➤ Alarms for users exceeding allowable invalid counts for specific events</td>
</tr>
<tr>
<td>Alarm Management</td>
<td>➤ Alarms are recorded in an alarm engine that supports three views</td>
</tr>
<tr>
<td></td>
<td>➤ Current alarms</td>
</tr>
<tr>
<td></td>
<td>➤ New alarms</td>
</tr>
<tr>
<td></td>
<td>➤ Acknowledged alarms</td>
</tr>
<tr>
<td></td>
<td>➤ Alarms are time-stamped and stored on the local node</td>
</tr>
<tr>
<td></td>
<td>➤ An alarm log file is stored on the host computer</td>
</tr>
<tr>
<td></td>
<td>➤ Alarms are filtered and sorted</td>
</tr>
<tr>
<td></td>
<td>➤ SNMP traps are available</td>
</tr>
<tr>
<td>Inventory Management</td>
<td>➤ Inventory by network, ring, node</td>
</tr>
<tr>
<td></td>
<td>➤ Total number of modules</td>
</tr>
<tr>
<td></td>
<td>➤ Number of specific modules</td>
</tr>
<tr>
<td></td>
<td>➤ Inventory information</td>
</tr>
<tr>
<td></td>
<td>➤ Module serial numbers</td>
</tr>
<tr>
<td></td>
<td>➤ Module firmware</td>
</tr>
<tr>
<td></td>
<td>➤ Specific parameters</td>
</tr>
<tr>
<td></td>
<td>➤ Remote firmware upgrade of all units</td>
</tr>
<tr>
<td>Configuration Management</td>
<td>➤ Circuit provisioning wizards (Pipes, STS-1, VT)</td>
</tr>
<tr>
<td></td>
<td>➤ Circuit trace</td>
</tr>
<tr>
<td></td>
<td>➤ Circuit aliases</td>
</tr>
<tr>
<td></td>
<td>➤ Node aliases</td>
</tr>
<tr>
<td></td>
<td>➤ Ring aliases</td>
</tr>
<tr>
<td></td>
<td>➤ Port aliases</td>
</tr>
</tbody>
</table>


**ICON Architecture**

**Chassis Options**

The ICON is available in a 19-inch rack-mount chassis as shown in *Figure 15*. 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 16*. The ICON Cube has two access module slots.

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**Table 1  Network Management Features (Sheet 2 of 2)**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Management</td>
<td>➢ SONET performance monitoring</td>
</tr>
<tr>
<td></td>
<td>➢ Section</td>
</tr>
<tr>
<td></td>
<td>➢ Line</td>
</tr>
<tr>
<td></td>
<td>➢ Path</td>
</tr>
<tr>
<td></td>
<td>➢ VT: Code violations</td>
</tr>
<tr>
<td></td>
<td>➢Errored seconds</td>
</tr>
<tr>
<td></td>
<td>➢ Severely errored seconds</td>
</tr>
<tr>
<td></td>
<td>➢ Ethernet frame counters</td>
</tr>
<tr>
<td></td>
<td>➢ Input and output frame counters</td>
</tr>
<tr>
<td></td>
<td>➢ Error frame counters</td>
</tr>
<tr>
<td>Cybersecurity—Systems Security Management</td>
<td>➢ Capable of enabling NERC-CIP compliance</td>
</tr>
<tr>
<td></td>
<td>➢ Generates network topology maps and configuration</td>
</tr>
<tr>
<td></td>
<td>➢ Role-based user access controls, reports, and file encryption</td>
</tr>
<tr>
<td></td>
<td>➢ LDAP support</td>
</tr>
<tr>
<td></td>
<td>➢ Centralized user account and password management</td>
</tr>
<tr>
<td></td>
<td>➢ Event reporting</td>
</tr>
<tr>
<td></td>
<td>➢ GPS spoofing detection and mitigation</td>
</tr>
<tr>
<td></td>
<td>➢ Logs all changes to system settings, firmware, and hardware modules</td>
</tr>
<tr>
<td></td>
<td>➢ Communications ports disabled by default</td>
</tr>
<tr>
<td></td>
<td>➢ Authenticates and monitors all user access</td>
</tr>
<tr>
<td></td>
<td>➢ Logs all authorized and unauthorized access attempts</td>
</tr>
<tr>
<td></td>
<td>➢ Alarm management</td>
</tr>
<tr>
<td></td>
<td>➢ Logs physical removal of hardware modules and attempts to access disabled Ethernet ports</td>
</tr>
<tr>
<td></td>
<td>➢ Configure and forward event data to target Syslog servers</td>
</tr>
</tbody>
</table>

*Protected Line Modules shown*

**Figure 15  19-Inch Rack-Mount 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 Modules. The full-height and the Quattro modules are shown in Figure 16. 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.

**Line Module**

The Line Module provides the following functionality:

- Internode communications links using SONET OC-48 line ports
- Eight 10/100 Mbps copper drop ports for Ethernet traffic
- Two 1000 Mbps fiber drop ports for Ethernet traffic
- Cross-connect with synchronous transport signal level 1 (STS-1) or virtual tributary (VT) granularity
- Timing output (IRIG-B) signals
- PoE on four ports

![Figure 16 ICON Cube Chassis (Front Cable Access Shown)](Image)

* Protected Line Modules shown

![Figure 17 Line Module](Image)
Protected Line Module

The Protected Line Module provides a redundant SONET or Gigabit Ethernet line interface. Users have the option to install two Protected Line Modules in place of the single Line Module. The Protected Line Module provides added reliability by ensuring line communications are maintained in the event of a module failure or replacement.

The Protected Line Module provides the following functionality:

- Internode communications links using SONET OC-3/OC-12/OC-48/1 Gigabit Ethernet line ports
- Cross-connect with STS-1, VT, or DS0 granularity
- Timing output (IRIG-B) signals
- Ethernet support provided by separate Ethernet Access 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 contact outputs for major and minor alarms
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.

Quattro Module

The Quattro Module provides the interface for as many as four Access submodules. The various submodules available are described in Access Submodules.

Ethernet Access Module

The Ethernet Access Module (EAM) provides eight 10/100 Mbps Ethernet ports on a full-height access module. The EAM is supported by the SEL-8021-01 Protected Line Module, but it cannot be used in conjunction with the SEL-8020-01 Line Module.

➤ 10/100 Mbps copper drop ports for Ethernet traffic
➤ PoE on ports 1–4 (to power video cameras, etc.)

Ethernet Bridging Access Module

The Ethernet Bridging Access Module (EBAM) is an 8 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.

Transfer Trip Module

Inputs

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

Crypto Module

Number of circuits encrypted: 2
Encryption line rate: OC-48
Encryption: AES-128, AES-256
Latency: <1 ms
Interface: Four small form-factor pluggable (SFP) fiber-optic transceivers

The Crypto Module cannot be used with the ICON Cube chassis.
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 1300 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: 300 bps to 115.2 kbps
- Connector: Two RJ45
- Time output: IRIG-B

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 (1 x 1 protected)
- Connector: Four RJ48C
- Line coding schemes: AMI, B8ZS
- Nominal data rate: 1.544 Mbps

G.703

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

422 Sync

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

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

Line Module (SONET) SFPs

The SONET SFP fiber-optic specifications are listed below and are for use in the SEL 8020-01 Line Module and SEL-8021-01 Protected Line Module in ports A, B, C and D.

**Note:** The Line Module (8020-01) only supports the OC-48 SFPs in Table 2 and Table 4. The Protected Line Module (8021-01) supports all of the OC-48, OC-12, and OC-3 SFPs that are listed.

**Note:** To meet SEL ICON published performance and environmental specifications, the ICON only supports SEL SFPs.
Table 2  Standard Single-Mode SONET SFPs

<table>
<thead>
<tr>
<th>SEL Part Number</th>
<th>SONET Rate</th>
<th>Distance (km)</th>
<th>Distance (mi)</th>
<th>Wavelength (nm)</th>
<th>TX Power (dBm)</th>
<th>RX Sens. MAX (dBm)</th>
<th>RX Sens. MIN (dBm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8120</td>
<td>OC-48</td>
<td>2</td>
<td>1.2</td>
<td>1310</td>
<td>–3 to –9.5</td>
<td>–3</td>
<td>–18</td>
</tr>
<tr>
<td>8121</td>
<td>OC-48</td>
<td>15</td>
<td>9.3</td>
<td>1310</td>
<td>0 to –5</td>
<td>0</td>
<td>–18</td>
</tr>
<tr>
<td>8122</td>
<td>OC-48</td>
<td>40</td>
<td>25</td>
<td>1310</td>
<td>3 to –2</td>
<td>–9</td>
<td>–28</td>
</tr>
<tr>
<td>8123</td>
<td>OC-48</td>
<td>80</td>
<td>50</td>
<td>1550</td>
<td>3 to –2</td>
<td>–9</td>
<td>–28</td>
</tr>
<tr>
<td>8124</td>
<td>OC-48</td>
<td>100</td>
<td>62</td>
<td>1550</td>
<td>5 to 0</td>
<td>–9</td>
<td>–28</td>
</tr>
<tr>
<td>8125-01</td>
<td>OC-48</td>
<td>120</td>
<td>75</td>
<td>1550</td>
<td>1 to 5</td>
<td>–9</td>
<td>–30</td>
</tr>
<tr>
<td>8125-02</td>
<td>OC-48</td>
<td>160</td>
<td>100</td>
<td>1550</td>
<td>5 to 8</td>
<td>–9</td>
<td>–30</td>
</tr>
<tr>
<td>8110-01</td>
<td>OC-12</td>
<td>20</td>
<td>12.4</td>
<td>1310</td>
<td>–8 to –14</td>
<td>–5</td>
<td>–28</td>
</tr>
<tr>
<td>8110-02</td>
<td>OC-12</td>
<td>40</td>
<td>25</td>
<td>1310</td>
<td>2 to –3</td>
<td>–8</td>
<td>–28</td>
</tr>
<tr>
<td>8110-03</td>
<td>OC-12</td>
<td>80</td>
<td>50</td>
<td>1550</td>
<td>2 to –3</td>
<td>–8</td>
<td>–29</td>
</tr>
<tr>
<td>8110-04</td>
<td>OC-12</td>
<td>120</td>
<td>74.5</td>
<td>1550</td>
<td>5 to 0</td>
<td>–9</td>
<td>–34</td>
</tr>
<tr>
<td>8110-05</td>
<td>OC-12</td>
<td>160</td>
<td>99.4</td>
<td>1550</td>
<td>5 to 1</td>
<td>–9</td>
<td>–37</td>
</tr>
<tr>
<td>8110-06</td>
<td>OC-12</td>
<td>200</td>
<td>124.2</td>
<td>1550</td>
<td>6 to 3</td>
<td>–9</td>
<td>–38</td>
</tr>
<tr>
<td>8105-01</td>
<td>OC-3</td>
<td>20</td>
<td>12.4</td>
<td>1310</td>
<td>–8 to –14</td>
<td>–8</td>
<td>–31</td>
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<tr>
<td>8105-02</td>
<td>OC-3</td>
<td>50</td>
<td>31</td>
<td>1310</td>
<td>0 to –5</td>
<td>–8</td>
<td>–34</td>
</tr>
<tr>
<td>8105-03</td>
<td>OC-3</td>
<td>80</td>
<td>50</td>
<td>1550</td>
<td>0 to –5</td>
<td>–8</td>
<td>–34</td>
</tr>
<tr>
<td>8105-04</td>
<td>OC-3</td>
<td>120</td>
<td>74.5</td>
<td>1550</td>
<td>5 to 0</td>
<td>–8</td>
<td>–34</td>
</tr>
<tr>
<td>8105-05</td>
<td>OC-3</td>
<td>160</td>
<td>99.4</td>
<td>1550</td>
<td>5 to 2</td>
<td>–10</td>
<td>–35</td>
</tr>
<tr>
<td>8105-07</td>
<td>OC-3</td>
<td>240</td>
<td>149</td>
<td>1550</td>
<td>5 to 10</td>
<td>–10</td>
<td>–45</td>
</tr>
</tbody>
</table>

* These single-mode transceivers are Class 1 laser products. They comply with IEC 60825 and FDA 21 CFR 1040.10 and 1040.11. The transceivers must be operated within the specified temperature and voltage limits. The optical ports of the module are terminated with an optical connector or with a dust plug.

Table 3  Standard Multimode SONET SFPs

<table>
<thead>
<tr>
<th>SEL Part Number</th>
<th>SONET Rate</th>
<th>Distance (km)</th>
<th>Distance (mi)</th>
<th>Wavelength (nm)</th>
<th>TX Power (dBm)</th>
<th>RX Sens. MAX (dBm)</th>
<th>RX Sens. MIN (dBm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8111-01</td>
<td>OC-12</td>
<td>1</td>
<td>0.62</td>
<td>1310</td>
<td>–12 to –19</td>
<td>–8</td>
<td>–26</td>
</tr>
<tr>
<td>8106-01</td>
<td>OC-3</td>
<td>2</td>
<td>1.24</td>
<td>1310</td>
<td>–12 to –19</td>
<td>–8</td>
<td>–30</td>
</tr>
</tbody>
</table>

* These multimode transceivers are Class 1 laser products. They comply with IEC 60825 and FDA 21 CFR 1040.10 and 1040.11. The transceivers must be operated within the specified temperature and voltage limits. The optical ports of the module are terminated with an optical connector or with a dust plug.

Table 4  Single-Fiber Single-Mode SONET SFPs (Sheet 1 of 2)

<table>
<thead>
<tr>
<th>SEL Part Number</th>
<th>SONET Rate</th>
<th>Distance (km)</th>
<th>Distance (mi)</th>
<th>Wavelength (nm)</th>
<th>TX Power (dBm)</th>
<th>RX Sens. MAX (dBm)</th>
<th>RX Sens. MIN (dBm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8127-01</td>
<td>OC-48</td>
<td>5</td>
<td>3.1</td>
<td>1310/1550</td>
<td>–3 to –10</td>
<td>–3</td>
<td>–18</td>
</tr>
<tr>
<td>8127-11</td>
<td>OC-48</td>
<td>5</td>
<td>3.1</td>
<td>1550/1310</td>
<td>–3 to –10</td>
<td>–3</td>
<td>–18</td>
</tr>
<tr>
<td>8127-02</td>
<td>OC-48</td>
<td>20</td>
<td>12.4</td>
<td>1310/1550</td>
<td>0 to –5</td>
<td>0</td>
<td>–18</td>
</tr>
<tr>
<td>8127-12</td>
<td>OC-48</td>
<td>20</td>
<td>12.4</td>
<td>1550/1310</td>
<td>0 to –5</td>
<td>0</td>
<td>–18</td>
</tr>
<tr>
<td>8127-04</td>
<td>OC-48</td>
<td>80</td>
<td>50</td>
<td>1510/1590</td>
<td>3 to –2</td>
<td>–9</td>
<td>–28</td>
</tr>
<tr>
<td>8127-14</td>
<td>OC-48</td>
<td>80</td>
<td>50</td>
<td>1590/1510</td>
<td>3 to –2</td>
<td>–9</td>
<td>–28</td>
</tr>
</tbody>
</table>
Table 4  Single-Fiber Single-Mode SONET SFPs<sup>a</sup> (Sheet 2 of 2)

<table>
<thead>
<tr>
<th>SEL Part Number</th>
<th>SONET Rate</th>
<th>Distance (km)</th>
<th>Distance (mi)</th>
<th>Wavelength (nm) TX/RX</th>
<th>TX Power (dBm)</th>
<th>RX Sens. MAX (dBm)</th>
<th>RX Sens. MIN (dBm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8107-02</td>
<td>OC-3</td>
<td>20</td>
<td>12.4</td>
<td>1310/1550</td>
<td>–8 to –14</td>
<td>–8</td>
<td>–33</td>
</tr>
<tr>
<td>8107-12</td>
<td>OC-3</td>
<td>20</td>
<td>12.4</td>
<td>1550/1310</td>
<td>–8 to –14</td>
<td>–8</td>
<td>–33</td>
</tr>
</tbody>
</table>

<sup>a</sup> These single-mode transceivers are Class 1 laser products. They comply with IEC 60825 and FDA 21 CFR 1040.10 and 1040.11. The transceivers must be operated within the specified temperature and voltage limits. The optical ports of the module are terminated with an optical connector or with a dust plug.

Table 5  Single-Fiber Multimode SONET SFPs<sup>a</sup>

<table>
<thead>
<tr>
<th>SEL Part Number</th>
<th>SONET Rate</th>
<th>Distance</th>
<th>Distance (m)</th>
<th>Wavelength (nm) TX/RX</th>
<th>TX Power (dBm)</th>
<th>RX Sens. MAX (dBm)</th>
<th>RX Sens. MIN (dBm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8128-01</td>
<td>OC-48</td>
<td>30</td>
<td>984</td>
<td>1310/1550</td>
<td>0 to –9</td>
<td>–3</td>
<td>–15</td>
</tr>
<tr>
<td>8128-11</td>
<td>OC-48</td>
<td>30</td>
<td>984</td>
<td>1550/1310</td>
<td>0 to –9</td>
<td>–3</td>
<td>–15</td>
</tr>
</tbody>
</table>

<sup>a</sup> These multimode transceivers are Class 1 laser products. They comply with IEC 60825 and FDA 21 CFR 1040.10 and 1040.11. The transceivers must be operated within the specified temperature and voltage limits. The optical ports of the module are terminated with an optical connector or with a dust plug.

Table 6  Dual-Fiber CWDM Single-Mode SONET SFPs<sup>a, b</sup>

<table>
<thead>
<tr>
<th>SEL Part Number</th>
<th>SONET Rate</th>
<th>Distance (km)</th>
<th>Distance (mi)</th>
<th>Wavelength (nm) TX/RX</th>
<th>TX Power (dBm)</th>
<th>RX Sens. MAX (dBm)</th>
<th>RX Sens. MIN (dBm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8129-11</td>
<td>OC-48</td>
<td>40</td>
<td>24.8</td>
<td>1470</td>
<td>3 to –2</td>
<td>0</td>
<td>–20</td>
</tr>
<tr>
<td>8129-15</td>
<td>OC-48</td>
<td>50</td>
<td>31</td>
<td>1550</td>
<td>3 to –2</td>
<td>0</td>
<td>–20</td>
</tr>
</tbody>
</table>

<sup>a</sup> These single-mode transceivers are Class 1 laser products. They comply with IEC 60825 and FDA 21 CFR 1040.10 and 1040.11. The transceivers must be operated within the specified temperature and voltage limits. The optical ports of the module are terminated with an optical connector or with a dust plug.

<sup>b</sup> CWDM SFPs have wide-band receivers, and they require a CWDM splitter on the receive path to properly filter the signal so only the relevant wavelength is passed to the ICON CWDM SFP receiver.

## Ethernet SFPs

Not all Ethernet SFPs are supported by all modules. Please see Table 13 for compatibility information.

**Note:** To meet SEL ICON published performance and environmental specifications, the ICON only supports SEL SFPs.

Table 7  Standard Single-Mode 100 Mbps Ethernet SFPs<sup>a</sup>

<table>
<thead>
<tr>
<th>SEL Part Number</th>
<th>Ethernet Rate</th>
<th>Distance (km)</th>
<th>Wavelength (nm)</th>
<th>TX Power</th>
<th>RX Sens. MAX (dBm)</th>
<th>RX Sens. MIN (dBm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8105-01</td>
<td>100BASE-LX</td>
<td>20</td>
<td>1310</td>
<td>–8 to –14</td>
<td>–8</td>
<td>–31</td>
</tr>
<tr>
<td>8105-02</td>
<td>100BASE-EX</td>
<td>50</td>
<td>1310</td>
<td>0 to –5</td>
<td>–8</td>
<td>–34</td>
</tr>
<tr>
<td>8105-03</td>
<td>100BASE-ZX</td>
<td>80</td>
<td>1550</td>
<td>0 to –5</td>
<td>–8</td>
<td>–34</td>
</tr>
<tr>
<td>8105-04</td>
<td>100BASE-ZX</td>
<td>120</td>
<td>1550</td>
<td>5 to 0</td>
<td>–8</td>
<td>–34</td>
</tr>
<tr>
<td>8105-05</td>
<td>100BASE-ZX</td>
<td>160</td>
<td>1550</td>
<td>5 to 2</td>
<td>–10</td>
<td>–35</td>
</tr>
<tr>
<td>8105-07</td>
<td>100BASE-ZX</td>
<td>240</td>
<td>1550</td>
<td>8 to 5</td>
<td>–10</td>
<td>–45</td>
</tr>
</tbody>
</table>

<sup>a</sup> These single-mode transceivers are Class 1 laser products. They comply with IEC 60825 and FDA 21 CFR 1040.10 and 1040.11. The transceivers must be operated within the specified temperature and voltage limits. The optical ports of the module are terminated with an optical connector or with a dust plug.
Table 8  Standard Multimode Fast Ethernet SFPs

<table>
<thead>
<tr>
<th>SEL Part Number</th>
<th>Ethernet Rate</th>
<th>Distance (km)</th>
<th>Wavelength (nm)</th>
<th>TX Power</th>
<th>RX Sens. MAX (dBm)</th>
<th>RX Sens. MIN (dBm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8106-01</td>
<td>100BASE-FX</td>
<td>2</td>
<td>1310</td>
<td>–12 to –19</td>
<td>–8</td>
<td>–30</td>
</tr>
</tbody>
</table>

* This multimode transceiver is a Class 1 laser product. It complies with IEC 60825 and FDA 21 CFR 1040.10 and 1040.11. The transceiver must be operated within the specified temperature and voltage limits. The optical ports of the module are terminated with an optical connector or with a dust plug.

Table 9  Single-Fiber Single-Mode Fast Ethernet SFPs

<table>
<thead>
<tr>
<th>SEL Part Number</th>
<th>Ethernet Rate</th>
<th>Distance (km)</th>
<th>Distance (mi)</th>
<th>Wavelength (nm) TX/RX</th>
<th>TX Power</th>
<th>RX Sens. MAX (dBm)</th>
<th>RX Sens. MIN (dBm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8107-02</td>
<td>100BASE-BX10</td>
<td>20</td>
<td>12.4</td>
<td>1310/1550</td>
<td>–8 to –14</td>
<td>–8</td>
<td>–33</td>
</tr>
<tr>
<td>8107-12</td>
<td>100BASE-BX10</td>
<td>20</td>
<td>12.4</td>
<td>1550/1310</td>
<td>–8 to –14</td>
<td>–8</td>
<td>–33</td>
</tr>
</tbody>
</table>

* These single-mode transceivers are Class 1 laser products. They comply with IEC 60825 and FDA 21 CFR 1040.10 and 1040.11. The transceivers must be operated within the specified temperature and voltage limits. The optical ports of the module are terminated with an optical connector or with a dust plug.

Table 10  Standard Single-Mode GigE Ethernet SFPs

<table>
<thead>
<tr>
<th>SEL Part Number</th>
<th>Ethernet Rate</th>
<th>Distance (km)</th>
<th>Wavelength (nm)</th>
<th>TX Power</th>
<th>RX Sens. MAX (dBm)</th>
<th>RX Sens. MIN (dBm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8130-01</td>
<td>1000BASE-LX</td>
<td>10</td>
<td>1310</td>
<td>–3 to –9.5</td>
<td>–3</td>
<td>–21</td>
</tr>
<tr>
<td>8130-02</td>
<td>1000BASE-LX</td>
<td>20</td>
<td>1310</td>
<td>–1 to –6</td>
<td>–3</td>
<td>–22</td>
</tr>
<tr>
<td>8130-03</td>
<td>1000BASE-LX</td>
<td>30</td>
<td>1310</td>
<td>5 to 0</td>
<td>–3</td>
<td>–24</td>
</tr>
<tr>
<td>8130-04</td>
<td>1000BASE-LX</td>
<td>40</td>
<td>1310</td>
<td>3 to –2</td>
<td>–3</td>
<td>–24</td>
</tr>
<tr>
<td>8130-05</td>
<td>1000BASE-XD</td>
<td>50</td>
<td>1550</td>
<td>0 to –5</td>
<td>–3</td>
<td>–24</td>
</tr>
<tr>
<td>8130-06</td>
<td>1000BASE-ZX</td>
<td>80</td>
<td>1550</td>
<td>5 to 0</td>
<td>–3</td>
<td>–24</td>
</tr>
<tr>
<td>8130-08</td>
<td>1000BASE-ZX</td>
<td>160</td>
<td>1550</td>
<td>5 to 1</td>
<td>–10</td>
<td>–36</td>
</tr>
<tr>
<td>8130-10</td>
<td>1000BASE-ZX</td>
<td>200</td>
<td>1550</td>
<td>8 to 5</td>
<td>–10</td>
<td>–36</td>
</tr>
<tr>
<td>8135-01</td>
<td>1000BASE-LX</td>
<td>10</td>
<td>1310</td>
<td>–3 to –9.5</td>
<td>–3</td>
<td>–21</td>
</tr>
<tr>
<td>8135-02</td>
<td>1000BASE-LX</td>
<td>20</td>
<td>1310</td>
<td>–1 to –6</td>
<td>–3</td>
<td>–22</td>
</tr>
<tr>
<td>8135-03</td>
<td>1000BASE-LX</td>
<td>30</td>
<td>1310</td>
<td>5 to 0</td>
<td>–3</td>
<td>–24</td>
</tr>
<tr>
<td>8135-04</td>
<td>1000BASE-LX</td>
<td>40</td>
<td>1310</td>
<td>3 to –2</td>
<td>–3</td>
<td>–24</td>
</tr>
<tr>
<td>8135-05</td>
<td>1000BASE-XD</td>
<td>50</td>
<td>1550</td>
<td>0 to –5</td>
<td>–3</td>
<td>–24</td>
</tr>
<tr>
<td>8135-06</td>
<td>1000BASE-ZX</td>
<td>80</td>
<td>1550</td>
<td>5 to 0</td>
<td>–3</td>
<td>–24</td>
</tr>
</tbody>
</table>

* These single-mode transceivers are Class 1 laser products. They comply with IEC 60825 and FDA 21 CFR 1040.10 and 1040.11. The transceivers must be operated within the specified temperature and voltage limits. The optical ports of the module are terminated with an optical connector or with a dust plug.

Table 11  Standard Multimode GigE Ethernet SFPs

<table>
<thead>
<tr>
<th>SEL Part Number</th>
<th>Ethernet Rate</th>
<th>Distance (km)</th>
<th>Wavelength (nm)</th>
<th>TX Power</th>
<th>RX Sens. MAX (dBm)</th>
<th>RX Sens. MIN (dBm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8131-01</td>
<td>1000BASE-SX</td>
<td>300 m/550 m</td>
<td>850</td>
<td>–2.5 to –9.0</td>
<td>–13.5</td>
<td>–18</td>
</tr>
<tr>
<td>8136-01</td>
<td>1000BASE-SX</td>
<td>300 m/550 m</td>
<td>850</td>
<td>–3 to –9</td>
<td>–13.5</td>
<td>–18</td>
</tr>
</tbody>
</table>

* These Finisar transceivers are Class 1 laser products and comply with US FDA regulations. These products are certified by TÜV and CSA to meet the Class 1 eye safety requirements of EN (IEC) 60825 and the electrical safety requirements of EN (IEC) 60950. Copies of the certificates are available at Finisar Corporation upon request. Copies of the referenced certificates are available at Finisar Corporation upon request.
### Table 12 Single-Fiber Single-Mode GigE Ethernet SFPs

<table>
<thead>
<tr>
<th>SEL Part Number</th>
<th>Ethernet Rate</th>
<th>Distance (km)</th>
<th>Distance (mi)</th>
<th>Wavelength (nm) TX/RX</th>
<th>Tx Power (dBm)</th>
<th>Rx Sens. (dBm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8132-01</td>
<td>1000BASE-BX</td>
<td>10</td>
<td>6.2</td>
<td>1310/1490</td>
<td>–3 to –9</td>
<td>–20</td>
</tr>
<tr>
<td>8132-11</td>
<td>1000BASE-BX</td>
<td>10</td>
<td>6.2</td>
<td>1490/1310</td>
<td>–3 to –9</td>
<td>–20</td>
</tr>
<tr>
<td>8132-02</td>
<td>1000BASE-BX</td>
<td>20</td>
<td>12.4</td>
<td>1310/1490</td>
<td>–3 to –8</td>
<td>–22</td>
</tr>
<tr>
<td>8132-12</td>
<td>1000BASE-BX</td>
<td>20</td>
<td>12.4</td>
<td>1490/1310</td>
<td>–3 to –8</td>
<td>–22</td>
</tr>
<tr>
<td>8132-03</td>
<td>1000BASE-BX</td>
<td>30</td>
<td>24.8</td>
<td>1310/1490</td>
<td>2 to –3</td>
<td>–23</td>
</tr>
<tr>
<td>8132-13</td>
<td>1000BASE-BX</td>
<td>30</td>
<td>24.8</td>
<td>1490/1310</td>
<td>2 to –3</td>
<td>–23</td>
</tr>
<tr>
<td>8132-04</td>
<td>1000BASE-BX</td>
<td>60</td>
<td>37.2</td>
<td>1310/1490</td>
<td>4 to –1</td>
<td>–26</td>
</tr>
<tr>
<td>8132-14</td>
<td>1000BASE-BX</td>
<td>60</td>
<td>37.2</td>
<td>1490/1310</td>
<td>4 to –1</td>
<td>–26</td>
</tr>
</tbody>
</table>

*These single-mode transceivers are Class 1 laser products. They comply with IEC 60825 and FDA 21 CFR 1040.10 and 1040.11. The transceivers must be operated within the specified temperature and voltage limits. The optical ports of the module are terminated with an optical connector or with a dust plug.

### Table 13 Ethernet SFP Compatibility (Sheet 1 of 2)

<table>
<thead>
<tr>
<th>SEL SFP Part Number</th>
<th>SEL-8020-01 (LM)</th>
<th>SEL-8021-01 (PLM)</th>
<th>SEL-8036-01 (EBAM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8105-01</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8105-02</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8105-03</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>8105-04</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>8105-05</td>
<td></td>
<td></td>
<td>x</td>
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<td>8105-07</td>
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<td>x</td>
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<tr>
<td>8106-01</td>
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<td></td>
<td>x</td>
</tr>
<tr>
<td>8107-02</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>8107-12</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>8129-11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8129-15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8130-01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8130-02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8130-03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8130-04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8130-05</td>
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</tr>
<tr>
<td>8130-06</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8130-08</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8130-10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8131-01</td>
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<tr>
<td>8132-01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8132-11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8132-02</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8132-12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8132-03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8132-13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8132-04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8132-14</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Network Management System PC Requirements

SEL-5051 requires a computer and operating system which meet the specifications listed in Table 14.

<table>
<thead>
<tr>
<th>SEL SFP Part Number</th>
<th>SEL-8020-01 (LM)</th>
<th>SEL-8021-01 (PLM)</th>
<th>SEL-8036-01 (EBAM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8135-01</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8135-02</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8135-03</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8135-04</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8135-05</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8135-06</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8136-01</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 14  Network Management System Requirements

<table>
<thead>
<tr>
<th>Processor Speed:</th>
<th>2 GHz or faster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating System:</td>
<td>Microsoft Windows 7 with 4 GB RAM</td>
</tr>
<tr>
<td></td>
<td>Microsoft Windows 8, 8.1 with 4 GB RAM</td>
</tr>
<tr>
<td></td>
<td>Microsoft Windows 10 with 4 GB RAM</td>
</tr>
<tr>
<td>Disk Space:</td>
<td>1 GB</td>
</tr>
<tr>
<td>Monitor:</td>
<td>SVGA 800 x 600 or higher resolution</td>
</tr>
<tr>
<td>Input Device:</td>
<td>Mouse or other pointing device</td>
</tr>
<tr>
<td>Networking:</td>
<td>Ethernet adapter</td>
</tr>
</tbody>
</table>

Table 15  SEL-5052 Network Management System Server Minimum Requirements

<table>
<thead>
<tr>
<th>Processor Speed:</th>
<th>Intel Core i5 or later</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating System:</td>
<td>Microsoft Windows Server 2012 R2 with 2 GB RAM</td>
</tr>
<tr>
<td></td>
<td>Microsoft Windows 7 64-bit with 2 GB RAM</td>
</tr>
<tr>
<td></td>
<td>Microsoft Windows 8 64-bit with 2 GB RAM</td>
</tr>
<tr>
<td></td>
<td>Microsoft Windows 10 64-bit with 2 GB RAM</td>
</tr>
<tr>
<td>Disk Space:</td>
<td>128 GB</td>
</tr>
</tbody>
</table>

Table 16  SEL-5052 Network Management System Server Recommended Requirements

<table>
<thead>
<tr>
<th>Processor Speed:</th>
<th>Intel Core i5 or later</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating System:</td>
<td>Microsoft Windows Server 2012 R2 with 4 GB RAM</td>
</tr>
<tr>
<td></td>
<td>Microsoft Windows 7 64-bit with 4 GB RAM</td>
</tr>
<tr>
<td></td>
<td>Microsoft Windows 8 64-bit with 4 GB RAM</td>
</tr>
<tr>
<td></td>
<td>Microsoft Windows 10 64-bit with 4 GB RAM</td>
</tr>
<tr>
<td>Disk Space:</td>
<td>128 GB SSD</td>
</tr>
</tbody>
</table>
ICON Dimensions

RACK-MOUNT CHASSIS

Figure 20 19-Inch ICON Dimension Diagram
Specifications

Compliance

Designed and manufactured under an ISO 9001 certified quality management system


UL Listed to U.S. and Canadian safety standards (E250788; QQGQ2, QQGQ8), (E231500; NWGQ2, NWGQ8)

Refer to the following matrix for module-specific compliance information.

Line Module (SEL-8020-01)

Line Ports

<table>
<thead>
<tr>
<th>Port</th>
<th>A/B</th>
<th>C/D</th>
<th>E/F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OC-48</td>
<td>OC-48</td>
<td>1000BASE-LX Ethernet</td>
</tr>
</tbody>
</table>

Max VCAT Differential Delay

<table>
<thead>
<tr>
<th>VT1.5</th>
<th>62.5 µs</th>
</tr>
</thead>
<tbody>
<tr>
<td>STS-N (N being STS-1 or STS-3c)</td>
<td>115 µs</td>
</tr>
</tbody>
</table>

Small Form-Factor Pluggable (SFPs)

See Table 2–Table 13.

Note: To meet SEL ICON published performance and environmental specifications, the ICON only supports SEL SFPs.

Figure 21 Half-Width ICON Cube Dimension Diagram
Other Ports

10/100 Ethernet Ports
Connector: RJ45
1000 Mbps Optical Ethernet
Connector: SFP
Unicast MAC Addresses: 16000
Multicast MAC Addresses: 2000
Power Over Ethernet: IEEE 802.3af
IRIG-B Out Connector: BNC

Protected Line Module (SEL-8021-01)

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 Pluggable (SFPs)
See Table 2–Table 13.

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
IRIG-B In Connectors: BNC
Code Format: DCLS equivalent TTL
Network Management Ports: B-type USB connector
Data Ports Connector: RJ45 reserved for future use
Contact In
Connector: Molex 70551 connector
Quantity: 3
Cable: SEL C575 only
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 < 3 ft)
Type: Form C
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

Full-Height Power Module for 19-Inch Rack
Input Voltage Range
SEL-8011-01
Rated Supply Voltage: 120–240 Vac
Input Voltage Range: 102–264 Vac, 50/60 Hz IEC C6 Connector
SEL-8011-02
Rated Supply Voltage: 125–250 Vdc; 120–240 Vac
Input Voltage Range: 88–300 Vdc; 102–264 Vac, 50/60 Hz Terminal Block Connector
SEL-8011-03
Rated Supply Voltage: 24–48 Vdc
Input Voltage Range: 18–56 Vdc
Power Consumption: 92 W max

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
Minimum Wire Gauge: 16 AWG (10 A)
Maximum Burden: 163 VA (65 W)
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
Minimum Wire Gauge: 16 AWG (10 A)
Maximum Burden
AC: 163 VA
DC: 65 W
SEL-8010-03
Rated Supply Voltage: 24–48 Vdc
Input Voltage Range: 19.2–60 Vdc, Terminal Block Connector
Power Consumption: 78 W max

Fuse Ratings
SEL-8010-01: 3.15 A, 250 V Time-lag T, Class H
SEL-8010-02: 3.15 A, 250 V Time-lag T, Class H
Note: Fuses are not user-serviceable. Return units to manufacturer for servicing.

Access Modules

Ethernet Access Module (SEL-8035-01)
10/100 Ethernet Ports: 8
Ethernet Port Connector: RJ45
Power Over Ethernet: 4 ports, IEEE 802.3af compliant

Ethernet Bridging Access Module (SEL-8036-01)
10/100/1000 Copper Ethernet Ports: 4
Copper Ethernet Port Conductor: RJ45
100/1000 Fiber-Optic Ports: 4
Fiber-Optic Ethernet
Connector: SFP

### Nx64F Submodule (Multimode) (SEL-8051-01)
- Data Standard: C37.94
- Fiber: Multimode
- Connector: ST
- Quantity: 1 Rx, 1 Tx
- Data Rate: 64 kbps–768 kbps

### Nx64F Submodule (Single-Mode) (SEL-8051-02)
- Fiber: Single-mode
- Connector: ST
- Quantity: 1 Rx, 1 Tx
- Data Rate: 64 kbps–768 kbps

### G.703 Submodule (SEL-8056-01)
- Connector: One RJ48C
- Quantity: 1
- Data Rate: 64 kbps

### 422 Sync Submodule (SEL-8055-01)
- Connector: RJ45
- Number of Ports: 1
- Data Standard: EIA-422
- Data Rate: 64 kbps

### Async Data Submodule (SEL-8053-01)
- 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

### 4W VF Submodule (SEL-8065-01)
- Connector: RJ45
- Number of Ports: 2

### 4W Bridging VF Submodule (SEL-8065-02)
- Connector: RJ45
- Number of Ports: 1 (with dual connector)

### 2W FXS Submodule (SEL-8066-01)
- Connector: RJ11
- Number of Ports: 1

### 2W FXO Submodule (SEL-8067-01)
- Connector: RJ11
- Number of Ports: 2

### Transfer Trip Module (SEL-8041-01, SEL-8041-04)
- Connector: Compression terminal
- Number of Commands: 4
- Channel Bandwidth: 64 kbps

### DSI Async Submodule (SEL-8057-01)
- Connector: RJ48C
- Number of Ports: 4

### DSI Sync Submodule (SEL-8057-02)
- Connector: RJ48C
- Number of Ports: 4

### DSI PSync Submodule (SEL-8057-03)
- Connector: RJ48C
- Number of Ports: 4 (1x1 protected)

### Crypto Module (SEL-8029-01)
- Connector: LC
- Number of Ports: 4

### 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

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

### Communications Product Testing

#### IEC 61850-3 Performance Class 1

#### IEEE 1613-2009 + A1-2011 Performance Class 1

#### Note:
These standards apply to SEL-8002-01, SEL-8010-01, SEL-8010-02, SEL-8021-01, SEL-8030-01, SEL-8050-01, SEL-8055-01, and SEL-8056-01 when tested at Communication Profile 3 (IEEE 1613)/Profile 2 (IEC 61850-3) with double-shielded cables.

### Type Test Requirements

#### Cold:
IEC 60608-2-1:2007
Test Ad, 16 hours at –20°C

#### Dry Heat:
IEC 60608-2-2:2007
Test Bd, 16 hours at +65°C

#### Damp Heat, Cyclic:
IEC 60608-2-30:2005
95% humidity, 25° to 55°C, 6 cycles

#### Vibration Resistance:
IEEE 1613-2009 Clause 9 Class V.S.X
IEC 60255-21-1:1988
Severity Level: 10–150 Hz, 1 G Response; 2 G Endurance
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

IEC 60255-21-2:1988
Severity Level: Class 2 Response, 10 G
Class 1 withstand, 15 G
Class 1 Bump, 10 G

Seismic: IEC 60255-21-3:1993
Severity Level: Class 2 Response,
2 G Horizontal, 1 G Vertical

Insulation Tests
IEC C37.90-2005
IEC 60255-5:2000

Ripple
(On DC Power Input Port): IEEE 1613-2009
Peak = 5% of voltage rating (but not to go below min. voltage)
IEC 61000-4-17:2009 Severity Level 2:
Peak-to-Peak = 4% of voltage rating
Severity Level 3: Peak-to-Peak = 10% of Voltage Rating
Severity Level 4: Peak-to-Peak = 15% of Voltage Rating

Voltage Interruptions
(On Power Input Port): IEC 61000-4-29:2000 Clause 5 (Table 1b)
Severity Level: 1, 3, 10, 30, 100, 300, 1000 ms

Voltage Dips
(On Power Input Ports): IEC 61000-4-29:2000 Clause 5 (Table 1a)
Severity Level: 40% Rated Voltage for 10, 30, 100, 300, 1000 ms
Severity Level: 70% rated voltage for 10, 30, 100, 300, 1000 ms
IEC 61000-4-11:2004
Severity Level: 0.5 cycle, 1 cycle, 2.5 cycles, 5 cycles, 10 cycles, 25 cycles

Electrostatic Discharge Immunity:
IEEE 1613-2009 Clause 8—Class 1
Severity Level 15 kV air discharge,
8 kV contact discharge
IEC 61000-4-2:2008
Severity Level 4: 15 kV air discharge,
8 kV contact discharge

Radiated RF Immunity:
IEEE 1613-2009 Clause 7—Class 1
Severity Level: 35 V/m (peak)
IEC 61000-4-3:2006
Severity Level: 10 V/m

Conducted RF Immunity
(On Power Input Port):
IEC 61000-4-6:2001
Severity Level: 10 Vrms

Magnetic Field Immunity:
IEC 61000-4-8:2009; Power frequency magnetic field
Severity Level: 5 (1000 A/m for 3 seconds, 100 A/m for 1 minute)
IEC 61000-4-9:2001
Severity Level: 5, 1000 A/m peak

Surge Immunity:
IEC 61000-4-5:2005
Severity Level: 2 kV line-to-earth, 1 kV line-to-line

Surge Withstand Capability:
IEEE 1613-2009 Clause 6—Class 1
Severity Level: 2.5 kV, 1 MHz
Oscillatory; 4 kV, 2.5 kHz Fast
Transient
IEC 60255-22-1
Severity Level: 2.5 kV

Fast Transient Burst:
IEC 60255-22-4:2008
IEC 61000-4-4:2011
Severity Level Class A: ±4 kV, 5 kHz,
±2 kV, 5 kHz on communications ports

IEC 60255-21-2:1988
Severity Level: Class 2 Response, 10 G
Class 1 withstand, 15 G
Class 1 Bump, 10 G

Seismic: IEC 60255-21-3:1993
Severity Level: Class 2 Response,
2 G Horizontal, 1 G Vertical

Insulation Tests
IEC C37.90-2005
IEC 60255-5:2000

Ripple
(On DC Power Input Port): IEEE 1613-2009
Peak = 5% of voltage rating (but not to go below min. voltage)
IEC 61000-4-17:2009 Severity Level 2:
Peak-to-Peak = 4% of voltage rating
Severity Level 3: Peak-to-Peak = 10% of Voltage Rating
Severity Level 4: Peak-to-Peak = 15% of Voltage Rating

Voltage Interruptions
(On Power Input Port): IEC 61000-4-29:2000 Clause 5 (Table 1b)
Severity Level: 1, 3, 10, 30, 100, 300, 1000 ms

Voltage Dips
(On Power Input Ports): IEC 61000-4-29:2000 Clause 5 (Table 1a)
Severity Level: 40% Rated Voltage for 10, 30, 100, 300, 1000 ms
Severity Level: 70% rated voltage for 10, 30, 100, 300, 1000 ms
IEC 61000-4-11:2004
Severity Level: 0.5 cycle, 1 cycle, 2.5 cycles, 5 cycles, 10 cycles, 25 cycles

Electrostatic Discharge Immunity:
IEEE 1613-2009 Clause 8—Class 1
Severity Level 15 kV air discharge,
8 kV contact discharge
IEC 61000-4-2:2008
Severity Level 4: 15 kV air discharge,
8 kV contact discharge

Radiated RF Immunity:
IEEE 1613-2009 Clause 7—Class 1
Severity Level: 35 V/m (peak)
IEC 61000-4-3:2006
Severity Level: 10 V/m

Conducted RF Immunity
(On Power Input Port):
IEC 61000-4-6:2001
Severity Level: 10 Vrms

Magnetic Field Immunity:
IEC 61000-4-8:2009; Power frequency magnetic field
Severity Level: 5 (1000 A/m for 3 seconds, 100 A/m for 1 minute)
IEC 61000-4-9:2001
Severity Level: 5, 1000 A/m peak

Surge Immunity:
IEC 61000-4-5:2005
Severity Level: 2 kV line-to-earth, 1 kV line-to-line

Surge Withstand Capability:
IEEE 1613-2009 Clause 6—Class 1
Severity Level: 2.5 kV, 1 MHz
Oscillatory; 4 kV, 2.5 kHz Fast
Transient
IEC 60255-22-1
Severity Level: 2.5 kV

Fast Transient Burst:
IEC 60255-22-4:2008
IEC 61000-4-4:2011
Severity Level Class A: ±4 kV, 5 kHz,
±2 kV, 5 kHz on communications ports