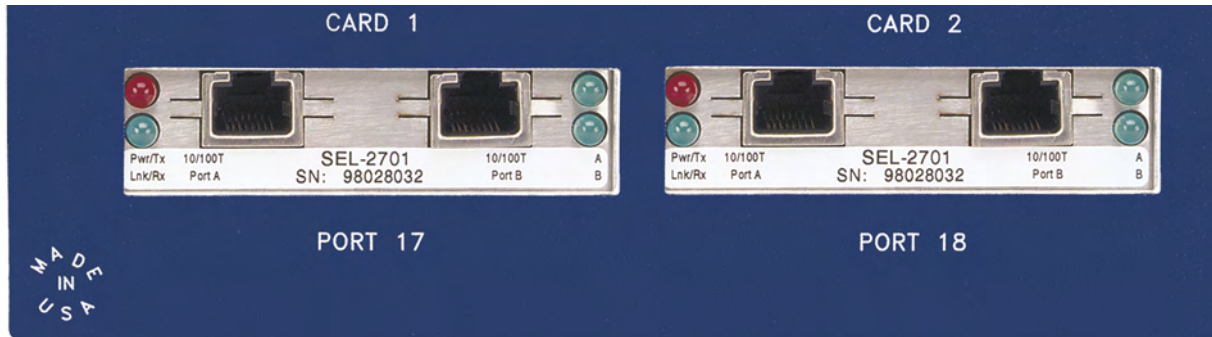




SEL-2701 Ethernet Processor



Major Features and Benefits

The SEL-2701 Ethernet Processor is a substation-hardened Ethernet physical interface and protocol processor. Install the SEL-2701 into SEL host devices, including SEL Communications Processors (SEL-2032 and SEL-2030) and SEL-400 series of protection, automation, and control devices. It provides Ethernet connectivity for the host and devices connected to the host. Use an SEL-2701 in an SEL host to accomplish the following:

- **Move Information Easily and Quickly.** Use metallic wire or optical fiber Ethernet networks, devices, and software applications to move data at 100 Mbps. Engage in virtual terminal Telnet dialogues to change settings or query for meter or status information. Use File Transfer Protocol (FTP) to transfer reports as files, including reports that support protection event analysis.
- **Provide SCADA Connectivity on Ethernet Networks.** Each SEL-2701 Ethernet Processor installed in an SEL-2032 or SEL-2030 Communications Processor can be connected to as many as 10 DNP master devices located in the station or remotely across WAN connections. Use any one of five different user-defined data maps to relay DNP3 information to each master. SER data time stamps recorded by original SEL IEDs are maintained for SOE reporting.
- **Interoperate With UCA2 Systems.** Connect SEL-2701 Ethernet Processors installed in SEL-400 series devices directly to UCA2 networks. Use an SEL-2701 with each SEL-2032 or SEL-2030 to provide UCA2 connectivity for existing SEL products and non-SEL devices.
- **Increase Instrumentation and Control System Availability.** Improve system availability by using SEL components designed and tested for high reliability in substation and plant environments. Improve communications availability by using the SEL-2701 for redundant primary and standby instrumentation and control networks; if the primary network fails, the SEL-2701 switches to the standby network.
- **Insulate Relays From Network Problems and Changes.** Insulate proven protection functions from network problems and changes for protocol advancements. The SEL-2701 microprocessor is dedicated to network communications and protocol support and is separate from the host microprocessor. This separation insulates the host from changes in the SEL-2701.
- **Improve Safety and Reduce Susceptibility to Electrical Interference.** Use fiber-optic networks that are less susceptible to the electrical noise that impacts metallic networks. Optical fiber provides improved safety through isolation from dangerous currents or voltages, including ground-potential rise.

Ethernet

Ethernet is often used as the local area network (LAN) in offices, factories, laboratories, plants, and stations. The SEL-2701 works with networks that use off-the-shelf Ethernet components.

Figure 1 shows a block diagram of an example station LAN using Ethernet. SEL-2701 Ethernet Processors are shown installed in SEL-400 series devices and in an SEL-2032. The SEL-2032 is connected through serial links to other devices.

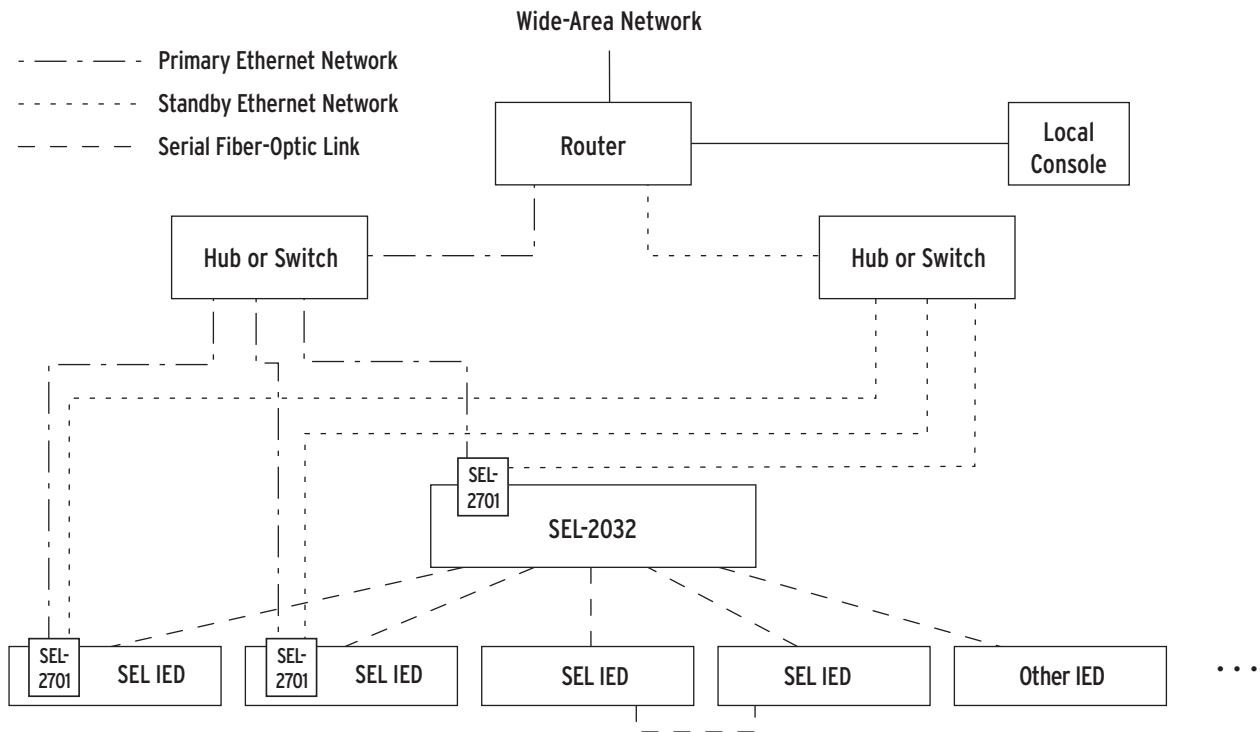


Figure 1 Station Local Area Network

Dedicated Processing Power and Functional Isolation

The SEL-2701 features a microprocessor dedicated to network communications. The SEL-2701 uses an SEL standard interface to communicate with the host. This interface allows the SEL-2701 to access data from the host, establish terminal sessions with the host, and send control points to the host. The processing demands of the Ethernet network and protocols do not degrade performance.

When a relay or an SEL-2032 contains an SEL-2701, the protection and local automation functions are insulated from network problems and changes.

Users expect protective relays to have service lives of longer than a decade, often without any changes to settings or firmware. Network protocols change at a much faster rate.

Generally, protection engineers set, test, and commission each relay to be certain that the relay will perform correctly. If the protocol firmware executes in the same processor as the protection, protection engineers must upgrade the firmware in the relay for new or modified protocols. This upgrade often requires time-consuming re-validation. By contrast, the SEL-2701 has a well-defined interface with the host firmware; engineers can change the firmware in the SEL-2701 without impacting the host.

Primary and Standby Networks

Each SEL-2701 card includes two Ethernet connections to support a primary and standby LAN, as shown in Figure 1. Under normal conditions, the SEL-2701 communicates via the primary LAN. On detecting a link failure on the primary LAN, the SEL-2701 switches to the standby LAN. The SEL-2701 switches back to the primary LAN when it detects a normal primary link status. This capability enables you to design systems with higher availability.

Telnet

Use Telnet software to establish a connection between two devices on an Ethernet network, to simulate a serial-cable connection. Typically one device is a computer, and its keyboard and screen act as a terminal connected directly to a serial port on the remote device.

SEL-2701 as a Telnet Server

Each SEL-2701 shown in *Figure 1* acts as a Telnet server; the SEL-2701 allows a Telnet client to interact with the SEL-2701 or the host. Use Telnet software and a PC with an Ethernet port for a terminal connection. Interact with an Intelligent Electronic Device (IED) connected to the SEL-2032 or with an SEL-2701 host. For example, from the Local Console in *Figure 1*, connect to the SEL-2032, establish a transparent connection to an SEL relay, and type STA for a status report.

SEL-2701, SEL-2032, and Terminal as a Telnet Client

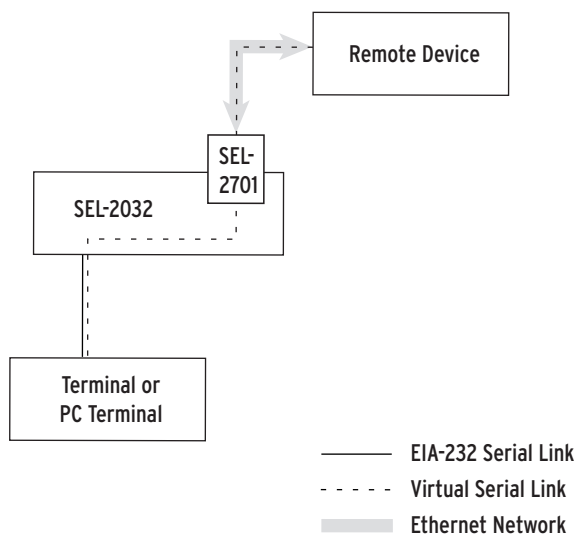


Figure 2 SEL-2701 Telnet Client Example

The SEL-2701, SEL-2032, and terminal shown in *Figure 2* work together as a Telnet client, allowing a terminal with a serial connection to the SEL-2032 to communicate with other devices on the network. Make a serial terminal connection to the SEL-2032, using an ASCII terminal, notebook, or desktop PC. This allows

temporary remote network access, without any Ethernet system administration. For example, while you are in a substation with a PC connected serially to an SEL-2032, view the event history from a relay at the other end of a transmission line.

Use FTP to Retrieve Data Files

Use FTP to move files between two Ethernet devices. FTP software is included with UNIX operating systems and most PC web-browser software. The SEL-2701 simulates a file structure display similar to a PC operating system hierarchal folder structure. Use a web-browser or FTP software to retrieve event and status data files from each relay with an SEL-2701. Retrieve data region files from each SEL-2032, through an SEL-2701.

SCADA and DCS With the SEL-2032 and SEL-2701

Automatic data-gathering and control systems interact with the SEL-2032 to gather analog data, contact status and diagnostics information, and to issue control commands. Example systems include Supervisory Control and Data Acquisition (SCADA), Digital Control Systems (DCS), Substation Automation (SA), and local Human-Machine Interfaces (HMI).

Ethernet allows multiple virtual connections and conversations to coexist on the network. The SEL-2701 and SEL-2032 support these multiple connections. Typically, humans interact through terminals using Telnet and familiar ASCII commands. Automatic systems send control messages and retrieve data through the SEL-2032 database via user-defined commands, ASCII commands, UCA2, or DNP3 messages.

The serial links between SEL-2032 Communications Processors and SEL devices allow interleaved binary and ASCII conversations. This feature enables the multiple virtual Ethernet connections to function independently. The SEL-2032 uses the binary data streams for high-speed control and to gather meter, target, digital input status, contact output status, SER and other data. It stores these data in local SEL-2032 data regions.

The SEL-2032s provide system data from the local database. The ASCII data stream between each SEL-2032 and IED transports Ethernet Telnet dialogues.

Utility Communications Architecture

UCA2 Overview

The Utility Communications Architecture (UCA) is intended to support easy integration of IEDs from many suppliers to simplify substation data acquisition and control. Its architects expect to reduce the integration labor costs and therefore reduce the costs of each integration project.

The document “UCA2 Generic Object Models for Substation & Feeder Equipment (GOMSFE), Version 0.91” specifies generic object models that support information transfer between IEDs. One part of GOMSFE defines a mechanism to transfer binary indications rapidly, defined as “Generic Object Oriented Substation Event (GOOSE).” Self-description features and “model browsers” help reduce the effort to integrate new devices. The model details are generally of interest to system integrators involved in the detail level of HMI tag lists. The underlying mechanisms of UCA2 and other data transfer methods are generally transparent to end-users and system operators.

UCA2 Connectivity for Non-UCA2 IEDs

Figure 1 shows the SEL-2701 Ethernet Processor installed in an SEL-2032 (similar for SEL-2030) connected to IEDs with serial links. Preserve investments in existing IEDs by adding the SEL-2032 and SEL-2701 to existing systems, rather than replacing existing IEDs with Ethernet IEDs. You benefit in new systems because

you can choose the best IED for each task, rather than choosing from only the IEDs that intrinsically support Ethernet and UCA2.

The system can contain a mix of SEL and non-SEL IEDs. The SEL-2032 collects real-time data from the IEDs. The SEL-2701 uses data labels in the SEL-2032 databases to automatically collect and organize data from the SEL-2032 and present these data with UCA2 GOMSFE models. For example, the SEL-2032 gathers meter data through a serial link, from both an SEL device and a separate meter. Regardless of the source device, the SEL-2701 presents meter data using the GOMSFE model for Polyphase Metering data, MMXU.

Figure 3 shows excerpts of two UCA data tree structures. The tree on the left shows data for devices that are directly connected to an SEL-2032. The tree on the right is for a device that is directly connected to the Ethernet. Each device connected to the network or to the SEL-2032 has a “Domain” folder.

UCA2 Connectivity for SEL-400 Series Relays

You can order the SEL-400 series of products with an installed SEL-2701 Ethernet Processor. For SEL-421 and SEL-451 applications, the SEL-2701 provides Telnet server, FTP, and UCA2 GOMSFE models and GOOSE messaging. For SEL-487B applications, the SEL-2701 provides Telnet server, FTP and UCA2 GOOSE messaging.

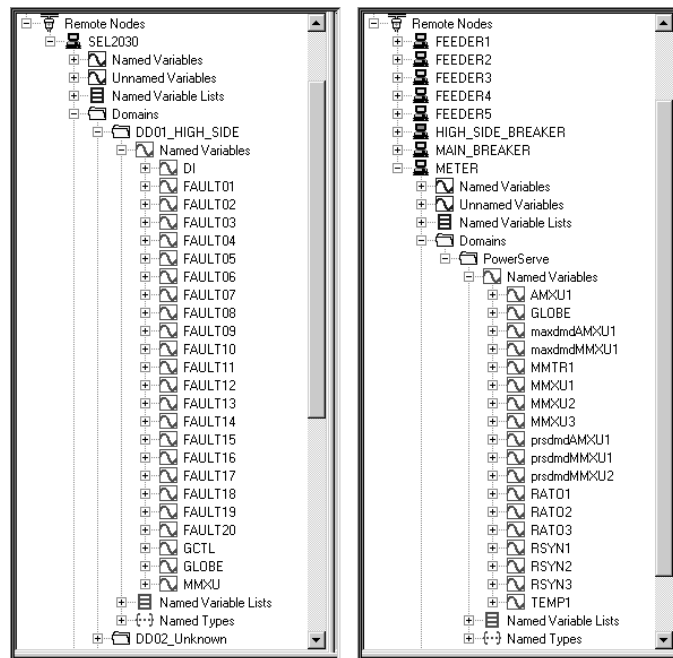


Figure 3 Example UCA Object Lists

DNP3 LAN/WAN

DNP3 Overview

Originally developed for serial SCADA communications, DNP3 is one of the most popular standard protocols for connecting remote stations to SCADA masters and for communicating with station IEDs (Intelligent Electronic Devices). The DNP User's Group has developed a specification for DNP3 operation over LAN/WAN connections.

The SEL-2701 Ethernet Processor DNP3 protocol is available for the SEL-2032 and SEL-2030 Communications Processor, and it is implemented according to DNP3 specifications. The SEL-2701 has been certified as conforming to DNP3 Level 2 by an independent protocol testing facility.

DNP3 Ethernet Connectivity for Serial IEDs

Figure 4 shows a network with serial IEDs connected to the SEL-2032. Preserve investments in existing IEDs by adding the SEL-2701 and SEL-2032 to your system. You benefit in new systems because you can choose the best IED for each task rather than selecting equipment by communications interface.

Serial DNP3 equipment provides access to only one master device for each DNP3-capable serial port. With the SEL-2701, you can provide data and control access to multiple DNP3 masters. The SEL-2701 validates each DNP3 master and provides a setting to enable or disable

control functions. These features coupled with other important security features of the SEL-2032 help you to increase the security, flexibility, and efficiency of your systems.

DNP3 SCADA and Engineering via Ethernet Networks

Communications connections from stations to control centers are increasingly digital systems that use Ethernet or provide Ethernet connectivity. This means that there is increasing demand for Ethernet connectivity from field locations to the SCADA master. There is also increasing demand for engineering access from the engineering offices to field equipment. Installed in an SEL-2032 or SEL-2030 Communications Processor, the SEL-2701 provides both DNP3 connectivity and simultaneous Telnet and FTP engineering connectivity to station equipment.

The SEL-2701 can provide data and control access for up to 10 DNP3 masters, which are uniquely identified by DNP3 and IP addresses. You can configure the SEL-2701 to use the default, or any one of five custom DNP3 data maps, for use with a defined DNP3 master. The SEL-2701 validates each DNP3 master and provides a setting to enable or disable control functions. For SOE reports, SER data time stamps are maintained from initial occurrence at the originating SEL IEDs all the way to the DNP3 master.

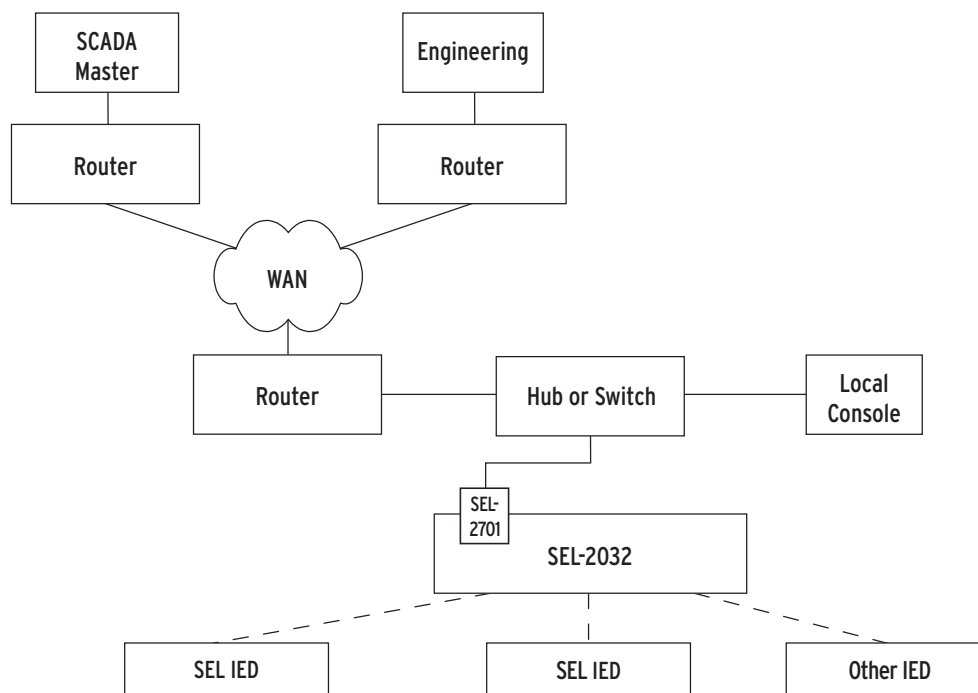


Figure 4 Example DNP3 Ethernet Network

Guideform Specifications for IED Ethernet Communications

Each protective relay and other intelligent electronic device (IED) in the station shall provide a combination of functions including protection, monitoring, control and automation. Device self-diagnostic functions shall be included. Specific requirements include:

- **Ethernet Connection Ability.** Each IED in the system shall either directly accept a plug-in Ethernet module, or an intermediate device shall be provided that connects to the IED and accepts a plug-in Ethernet module.
 - The Ethernet module shall have a microprocessor, and insulate the host IED or intermediate device from network problems or changes.
- **Primary and Standby Networks.** Each device with Ethernet capability shall support two physical Ethernet connections. The user shall be able to set one to primary and the other to standby. The interface shall detect link failure on the primary network, and automatically switch to the standby network. On detecting normal link activity on the primary network, the interface shall switch back to the primary connection.
- **Ethernet Physical Connections.** Ordering options shall allow each primary and standby connection to be any one of the following:
 - 10/100BASE-T Metallic RJ-45 Connector
 - 100BASE-FX Fiber-Optic ST Connector
- **IED Telnet Server Communications.** A user shall be able to use the Ethernet network and Telnet client software to establish a bi-directional ASCII communications connection with any IED on the network. Through this connection, users shall be able to use command and report dialogues, identically to their use of a direct ASCII terminal serial connection to the IED. Each Telnet device must have security features to deter unauthorized access.
- **File Transfer Protocol (FTP).** A user shall be able to establish a bi-directional communications connection through the Ethernet network and FTP client software. Through this FTP connection, a user shall be able to view a list of available data files for

each device in the system, select files from this list, and copy these files to their computer. Each FTP device must have security features to deter unauthorized access.

- **Protocol Stacks.** Each Ethernet-capable device shall support communications using TCP/IP, UDP/IP, and OSI stacks.
- **Utility Communications Architecture.** Through the Ethernet network, data from each IED must be available through standard UCA2 Models, as defined in the UCA2 Generic Object Models for Substation and Feeder Equipment Specification (GOMSFE) Version 0.91 or higher. Each IED with digital outputs shall have control capability through GOMSFE messages. The proposal shall document the models provided for each IED.
- **DNP3 LAN/WAN.** The DNP3 implementation shall be Level 2 Slave and be third party certified as conforming to DNP3 specifications and meeting the applicable requirements of the standard conformance test procedures. Through the Ethernet network, data from each IED must be available through standard DNP3 object types and communications. Each IED with digital outputs shall have control capability through DNP3 commands that can be selectively enabled for each master device. Each master device shall be validated by both the DNP3 address and IP address.
- **Separate Communications Processor.** If any communications processors are provided to connect IEDs to Ethernet networks, then each communications processor shall comply as follows:
 - It shall meet all requirements listed herein for IED Ethernet Communications.
 - It shall support two interleaved virtual serial connections for each connected IED: one for ASCII dialogues and one for data acquisition and control.
 - It shall support serial connection to an ASCII terminal and allow the terminal to be used as a Telnet client.

Network Connection Options and Rear-Panel Diagrams

Early Ethernet networks were implemented using multi-drop connections with coaxial cable. Most modern Ethernet installations use a dedicated link between each network device and a hub or switch. Each metallic link uses two twisted pairs of wires, for a total of four wires. Each fiber-optic connection uses two optical fibers.

Order the SEL-2701 with connections for the following network standards, specified separately for the primary and standby ports:

- **10BASE-T or 100BASE-T Metallic.** This network connection uses two twisted pairs in a standard RJ-45 connector. This link supports data rates of 10 or 100 Mbps.
- **100BASE-FX Fiber-Optic.** This network connection uses two multimode optical fibers with standard ST connectors and supports a data rate of 100 Mbps.

Figure 5 shows the rear panels for the three available configurations of the SEL-2701.

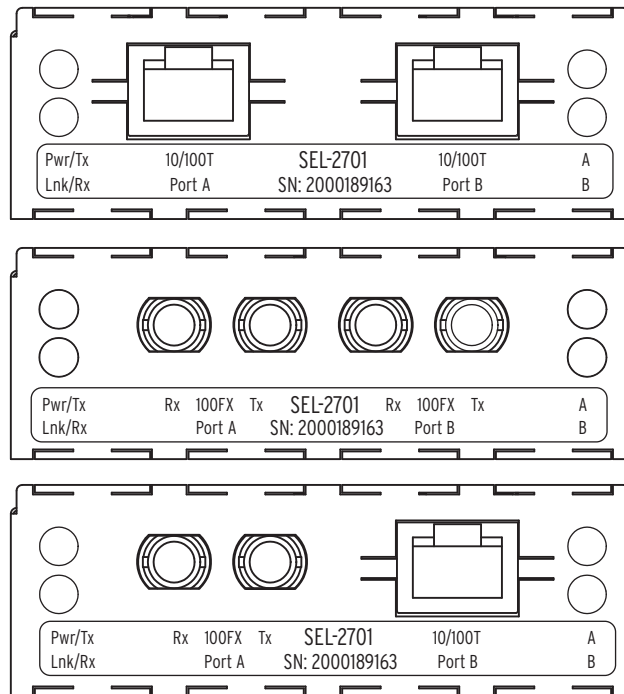


Figure 5 SEL-2701 Rear-Panel Views for Three Configurations

Specifications

Standard Features and Functions

Indicators

Power/Transmit:	Red LED, Power/Tx
Link/Receive:	Green LED, Link/Rx
Port A Enabled:	Green LED, A
Port B Enabled:	Green LED, B

Communication Protocols

Protocol Stacks:	TCP/IP, UDP/IP, OSI
File Exchange:	FTP
Terminal Server:	Telnet
Terminal Client:	Telnet
UCA2:	GOMSFE 0.91
DNP3:	DNP3-2003, Level 2 Cert. V2.3

Connection Counts (Maximum)

DNP/IP	10
FTP	3
Telnet	3
UCA2	15
Subscription to Goose Senders	8

Note: All connections are independent of each other, i.e., a connection of one type does not decrease the available connections of another type.

Optional Features and Functions

Physical Layer

10/100BASE-T:	10/100 Mbps, RJ-45
100BASE-FX:	100 Mbps, ST

Ratings and Type Tests

Environmental Tests (installed in host)

Operating Temp.:	-40° to +70° C (-40° to +158° F)
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Type Tests (installed in host)

Cold:	IEC 60068-2-1 1990, EN 60068-2-1 1993, Test Ad, 16 hours at -40 ± 2°C
Dry Heat:	IEC 60068-2-2 1974, EN 60068-2-2 1993, Test Bd, 16 hours at 70 ± 2°C
Damp Heat, Cyclic:	IEC 60068-2-30 1980 Test Db, 25° to 55°C, 6 cycles, 95% humidity
Vibration:	IEC 60255-21-1 1988 Vibration Endurance Class 1 Vibration Response Class 2
Shock and Bump:	IEC 60255-21-2 1988 Shock Withstand Class 1 Shock Response Class 2 Bump Class 1 IEC 60255-21-3 1993 Class 2 (Single Axis Sine Sweep, 5-35 Hz)
Electrostatic Discharge: (see Note)	IEC 60255-22-2 1996 IEC 61000-4-2 1995 100BASE-FX: Level 4 10/100BASE-T with cable > 92 cm (3 ft): Level 4 10/100BASE-T with cable > 31 cm (1 ft): Level 3
Radiated Radio Frequency:	IEC 60255-22-3 1989 ENV 50140 1993 10 V/m ENV 50204 1995 10 V/m (900 MHz with modulation) IEEE C37.90.2 1995 10 V/m 100BASE-FX: Level 3 10/100BASE-T with STP cable: Level 3
Fast Transient Disturbance:	IEC 60255-22-4 1992 IEC 61000-4-4 1995 Level 4

Note: Some ESD tests may result in an interruption of communications. Operation of the host will not be disrupted. The host and SEL-2701 are not damaged under the test conditions.

Certifications

ISO: Designed and manufactured using ISO-9001 certified quality program.

DNP3 Conformance: DNP3 Level 2 Conformance Tested.

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This product is covered by the standard SEL 10-year warranty. For warranty details, visit www.selinc.com or contact your customer service representative.

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