SEL-2701
Ethernet Processor

Instruction Manual

20190308

SEL SCHWEITZER ENGINEERING LABORATORIES

⚠CAUTION

Equipment components are sensitive to electrostatic discharge (ESD). Undetectable permanent damage can result if you do not use proper ESD procedures. Ground yourself, your work surface, and this equipment before removing any cover from this equipment. If your facility is not equipped to work with these components, contact SEL about returning this device and related SEL equipment for service.

⚠WARNING

Have only qualified personnel service this equipment. If you are not qualified to service this equipment, you can injure yourself or others, or cause equipment damage.

⚠DANGER

Disconnect or de-energize all external connections before opening this device. Contact with hazardous voltages and currents inside this device can cause electrical shock resulting in injury or death.

⚠DANGER

Contact with instrument terminals can cause electrical shock that can result in injury or death.

⚠ATTENTION

Les composants de cet équipement sont sensibles aux décharges électrostatiques (DES). Des dommages permanents non-décelables peuvent résulter de l'absence de précautions contre les DES. Raccordez-vous correctement à la terre, ainsi que la surface de travail et l'appareil avant d'en retirer un panneau. Si vous n'êtes pas équipés pour travailler avec ce type de composants, contacter SEL afin de retourner l'appareil pour un service en usine.

⚠AVERTISSEMENT

Seules des personnes qualifiées peuvent travailler sur cet appareil. Si vous n'êtes pas qualifiés pour ce travail, vous pourriez vous blesser avec d'autres personnes ou endommager l'équipement.

⚠DANGER

Débrancher tous les raccordements externes avant d'ouvrir cet appareil. Tout contact avec des tensions ou courants internes à l'appareil peut causer un choc électrique pouvant entraîner des blessures ou la mort.

⚠DANGER

Tout contact avec les bornes de l'appareil peut causer un choc électrique pouvant entraîner des blessures ou la mort.

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Preface

This instruction manual describes applications for an SEL-2701 Ethernet Processor installed in SEL hosts including an SEL-2032 Communications Processor. Main topics include the following.

- Installing the SEL-2701
- Accessing SEL-2701 settings
- Operating the SEL-2701
- Accessing data in a host with FTP, Telnet, and UCA2

The following list contains other references with additional information about specific topics in this manual:

- *SEL-2032 Instruction Manual*
- IEEE TR 1550–Technical Report UCA2 Draft Specifications
- UCA2 Object Modeling Specifications
- DNP3 Protocol Specifications

Manual Overview

You probably will not need to review the entire manual to perform the specific tasks that are your responsibility. The following is an overview of the sections in this instruction manual:

Preface. Describes how this manual is organized and conventions used in this manual.

Section 1: Introduction. Provides an overview of Ethernet networking and a description of the SEL-2701.

Section 2: Installation. Describes how to install the SEL-2701 in various SEL hosts.

Section 3: Settings and Commands. Describes SEL-2701 operation and configuration.

Section 4: SEL Communications Processor Host. Provides detailed information on how to use the SEL-2701 within the SEL-2032.

Section 5: SEL-400 Series Host. Provides detailed information on how to use the SEL-2701 within the SEL-400 series relays.

Section 6: Troubleshooting. Describes techniques for testing and troubleshooting SEL-2701 installations.

Appendix A: Firmware and Manual Versions. Lists the firmware versions applicable to this manual.

Appendix B: UCA2 GOMSFE Models. Lists rules for how the SEL-2701 populates the UCA2 GOMSFE application layer maps.

Appendix C: GOMSFE Model Example. Illustrates how the SEL-2701 populates the GOMSFE models for an SEL-351S Relay connected to an SEL-2032.

Appendix D: DNP3 Communications. Standard DNP3 device documentation including the Device Profile and Object List.

Conventions

Numbers

This manual generally displays numbers as decimal values. Hexadecimal numbers include the letter "h" appended to the number. For instance, 11 is the decimal number eleven, but 11h is the hexadecimal number eleven, which equals the decimal value 17.

Typographic Conventions

Typographic Conventions

Example	Description
STATUS	Commands you type appear in bold/uppercase
<Enter>	Single keystroke command
<Ctrl + D>	Multiple keystroke command
`SEL-2701 Ethernet Processor`	Command responses

IP Addresses

Enter Internet Protocol (IP) addresses as a series of four values separated by periods (e.g., 199.92.34.109). IP addresses are in the form octet1.octet2.octet3.octet4, where each octet is a value from 0 to 255 in one of the formats shown in the following table.

Octet Entry Formats

Format	Description	Example
yyy	Decimal	163
0xnn	C style hexadecimal	0xA3
nnh	SEL style hexadecimal	A3h

Settings

You can set several SEL-2701 and other SEL device settings to NA. NA is a special value that turns off or disables the setting.

Section 1
Introduction

Introduction

This section introduces the SEL-2701 Ethernet Processor and provides information on the following topics.

- Features
- Model Options
- Applications
- Ethernet Networks
- UCA2
- DNP3
- Specifications

Features

The SEL-2701 is an Ethernet processor card designed for use in SEL hosts including the SEL-2030 and SEL-2032 Communications Processors and SEL-400 series relays. The SEL-2701 provides the following features:

- Powerful processor
- Extended temperature rating
- Ethernet network connection
  - Twisted-pair cable
  - Fiber-optic cable
  - Redundant physical interfaces
- Support for TCP/IP protocol suite
  - FTP (File Transfer Protocol)
  - Telnet
- UCA2 for Field Devices
  - OSI and TCP/IP protocol stacks
  - GOMSFE models
  - GOOSE messages
- DNP3 (Distributed Network Protocol Version 3.0)
  - Access to host analog and binary data
  - Analog and binary controls from DNP3 master

The SEL-2701 is a complete communication processing system with a processor, memory, interface to the host, and Ethernet physical interface. The host and processor card architecture uses the SEL-2701 for all network tasks. The effect of isolating the host processor from communication processing is that network activity does not degrade protection. You can also upgrade or replace the SEL-2701 without disturbing settings or firmware in the host.

The operating temperature range of the SEL-2701 (–40° to +70°C) surpasses that of standard office-grade Ethernet network equipment. The combination of operating temperature range and additional environmental hardening, described in *Specifications on page 1.18*, prepares the SEL-2701 for operation in the harsh environment of substation control houses.

You can connect an SEL-2701 to several different Ethernet media. Use fiber-optic cable to electrically isolate devices and provide a medium immune to most electrical and magnetic interference. Use twisted-pair cable to reduce installation cost where electrical isolation and noise concerns have been addressed in other ways. The SEL-2701 twisted-pair interface is significantly more robust than typical office-grade equipment protecting both the Ethernet processor and its host.

The TCP/IP (Transmission Control Protocol/Internet Protocol) protocol suite is one of the most recognized protocol suites (stack plus application protocols) used on Ethernet networks because it is part of the internet. The SEL-2701 supports the TCP/IP protocol stack. It also supports the TCP/IP application layer protocols, FTP and Telnet.

The SEL-2701 provides a UCA2 (Utility Communication Architecture 2.0) for Field Devices interface for SEL hosts. It also supports the OSI (Open System Interconnect) and TCP/IP protocol stacks for UCA2 operations. The SEL-2701 supports GOMSFE models and GOOSE peer-to-peer messaging.

The SEL-2701 also provides a DNP3 Level 2 slave Ethernet interface. This DNP3 over Ethernet interface may use TCP or UDP transport.

Model Options

The SEL-2701 is available in several configurations. Each configuration reflects a different combination of Ethernet physical interfaces. You can install an SEL-2701 in any SEL host with a card slot. Please refer to *Appendix A: Firmware and Manual Versions* for a list of compatible host and card firmware versions. Order the SEL-2701 Ethernet Processors factory-installed in SEL hosts or individually for field installation or spares. The SEL-2701 Ethernet physical layer configuration options are shown in *Table 1.1*.

Table 1.1 SEL-2701 Network Connection Options

Network Port A	Network Port B
10/100BASE-T	10/100BASE-T
100BASE-FX	100BASE-FX
10/100BASE-T	100BASE-FX

The network port standard terms and corresponding network speeds and media are listed in *Table 1.2*.

Table 1.2 Ethernet Physical Layer Designators

Identifier	Media	Speed
10/100BASE-T	Twisted-pair with RJ45 connector	10 or 100 Mbps
100BASE-FX	Fiber-optic cable with ST connectors	100 Mbps

There are three communications protocol options for the SEL-2701: DNP3, UCA2, and both DNP3 and UCA2. All versions of the SEL-2701 have FTP and Telnet communications capabilities.

See the Model Option Table for the SEL-2701 and your host for complete part number and ordering option information. You can obtain a Model Option Table by contacting SEL through our website at www.selinc.com or through your local SEL representative.

Applications

The SEL-2701 can assist with many substation networking applications. A sampling of applications is listed below to help give you ideas on how to apply the features of the SEL-2701.

Application Features

Each SEL-2701 application contains a combination of major features. The following paragraphs summarize the major features that you can combine in your application.

Redundant Networks

Use the SEL-2701 to connect SEL hosts to redundant Ethernet networks. An example redundant network connection is shown in *Figure 1.1*. The SEL-2701 has two network ports that allow you to connect both the primary network and the standby network to the SEL-2701. You do not have to install two separate SEL-2701 Ethernet Processors to support a redundant network system. The benefit of this arrangement is lower equipment and setup cost because there is only one network card and one set of network settings per host.

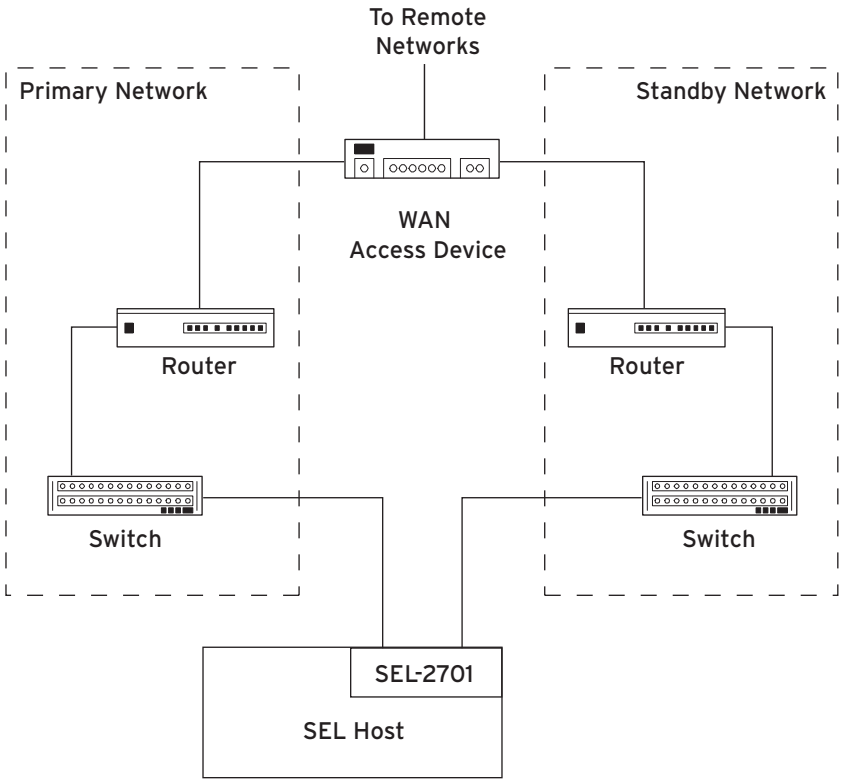

Figure 1.1 Redundant Substation Ethernet Network

When the SEL-2701 is unable to detect normal operation on the primary network, it automatically switches from the primary network to the standby network. The SEL-2701 returns to the primary network when normal operation on the primary network resumes.

Terminal Access

Use the SEL-2701 to provide terminal access over an Ethernet network to SEL hosts and IEDs (intelligent electronic devices) connected to SEL hosts that incorporate an SEL-2701. Similar to connecting a PC (personal computer) with terminal software to the front port of the host, you can use Telnet to connect to the user interface of the host. The computer connecting to the SEL host can be on the substation LAN (local-area network) or a remote LAN with a WAN (wide-area network) connection to the substation LAN.

Many PC operating systems include a free Telnet application. Telnet applications operate similarly to serial terminal applications. With a Telnet application, you must specify an IP address and port number rather than a serial port and baud rate to establish a Telnet session with the remote device. After you start a Telnet session, your Telnet software operates as a terminal program passing your keystrokes across the Ethernet network and displaying responses.

If you have a network with the topology shown in *Figure 1.2*, you can establish a direct Telnet connection from the Engineering Workstation to the SEL-2701 in the SEL-2032, the SEL-2032, or the SEL-400 series relay. You can also use the SEL-2032 transparent connection to reach the SEL relays and IEDs connected to SEL-2032 serial ports. In this arrangement, the Telnet application allows you to operate the user interface of the selected device similarly to a direct serial connection.

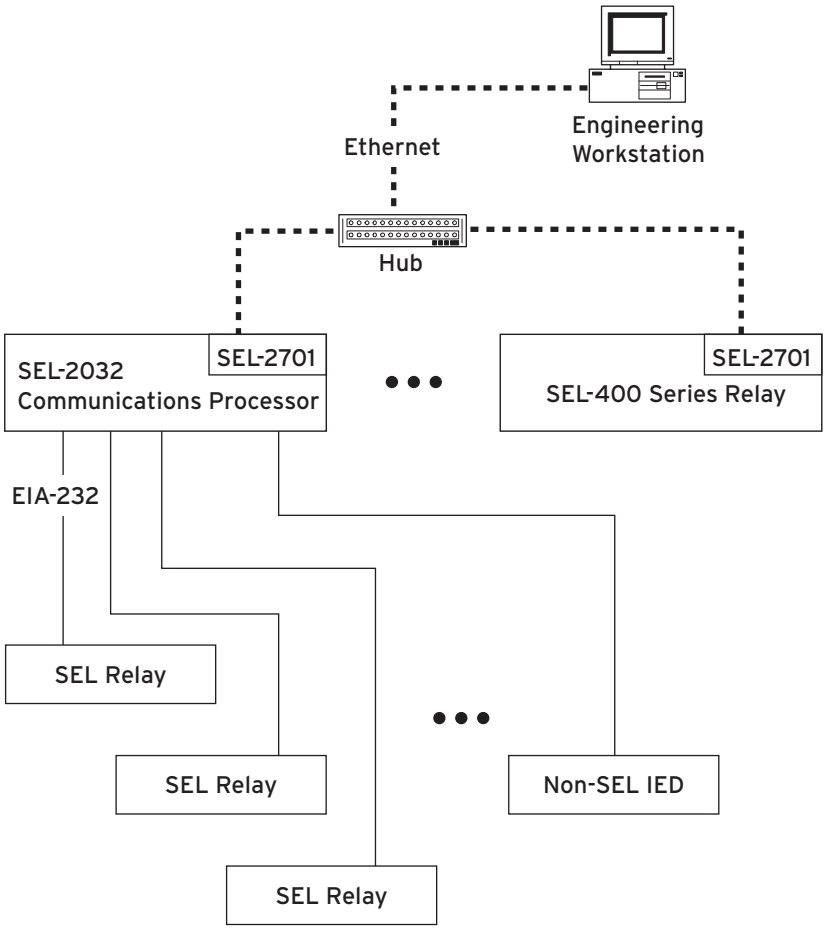

Figure 1.2 Example Ethernet Substation Network

File Exchange

Use the SEL-2701 to exchange files with SEL hosts across an Ethernet network. The SEL-2701 provides FTP access to files in the SEL host. You can use a PC to collect event reports, sequential events recorder (SER) reports, settings, and snapshots of metering data.

As with Telnet, there are free FTP applications included with several operating systems and web browsers. Start the FTP application, log in, and use point and click operations to exchange files with SEL hosts.

UCA2 Networking

Use the SEL-2701 to provide UCA2 connectivity to SEL hosts including the SEL-2032 and SEL-400 series relays. Data in the host are presented in GOMSFE models. In an SEL-400 series relay, the SEL-2701 automatically populates GOMSFE models with relay measurements and other data. For IEDs connected to the SEL-2032, you must configure the SEL-2032 to collect data. Then the SEL-2701 automatically populates GOMSFE models with the available data.

GOOSE peer-to-peer messaging is part of the GOMSFE model called GLOBE. GOOSE is used for peer-to-peer control and protection messages. The SEL-2701 generates outgoing GOOSE messages based on information in the host. The SEL-2701 also monitors incoming GOOSE messages and passes selected information to the host. If your host is an SEL-2032, the GOOSE

messages can be used to transmit information from and pass controls to the connected IEDs.

Application Examples

Networking for Installed SEL Relays Without Card Slots

By adding an SEL-2701 installed in an SEL Communications Processor (SEL-2032 or SEL-2030) to your design or adding an SEL-2701 to your existing SEL-2032 as shown in *Figure 1.3*, you can quickly and inexpensively gain the advantages of Ethernet and UCA2 network connectivity.

- Use Telnet for engineering connections to the SEL-2032 and connected relays.
- Use FTP to collect snapshots of data regions in the SEL-2032 with FTP file exchange.
- Use UCA2 master devices to collect data from the SEL-2032 and connected relays.
- Use GOOSE to exchange control data between relays connected to the SEL-2032 and other UCA2 IEDs.
- Use DNP3 master devices to collect data from the SEL-2032.

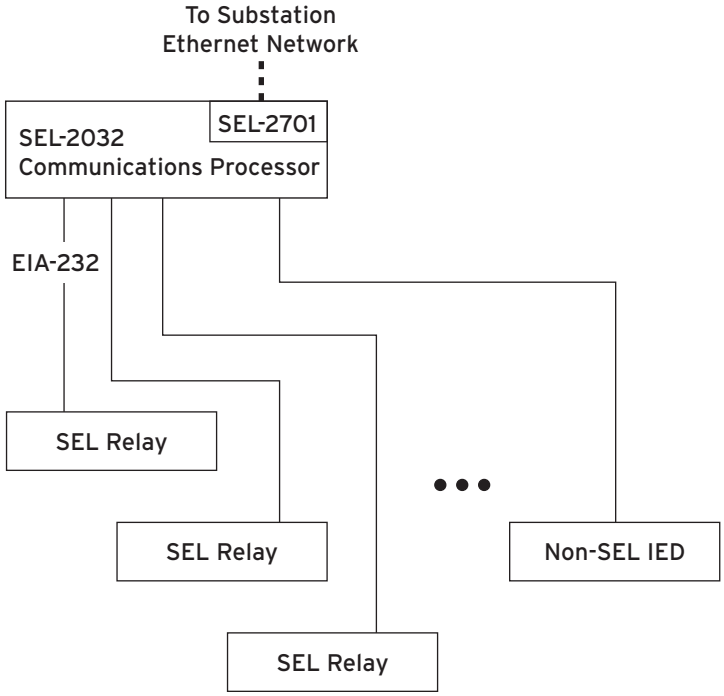

Figure 1.3 SEL Relays on Ethernet Network Using the SEL-2032

Use the SEL-2701 and SEL-2032 to provide Ethernet networking, UCA2, and DNP3 connectivity for installed SEL relays that do not have card slots. It is not necessary to replace protective relays or choose protective relays on the basis of network interfaces to realize many of the benefits of Ethernet networks, UCA2, and DNP3. All SEL-400 series relays have a network card slot. SEL relays from other families and series do not have card slots. Relays without card slots may use serial communication protocols to send data to other substation devices. For example, a relay may have simultaneous serial

connections to another relay, an HMI, and an SEL communications processor. Many installations include SEL-2032 Communications Processors with card slots, but do not have Ethernet network connectivity.

Networking for Non-SEL EIA-232 IEDs

Add an SEL-2032 and SEL-2701 to your design to inexpensively and reliably add Ethernet networking to your serial IEDs and gain the following features.

- Use Telnet for engineering connections to the SEL-2032 and connected IEDs.
- Use FTP to collect snapshots of data regions in the SEL-2032 with FTP file exchange.
- Use UCA2 master devices to collect data from the SEL-2032 and connected relays.
- Use GOOSE to exchange control data between relays connected to the SEL-2032 and other UCA2 IEDs.
- Use DNP3 master devices to collect data from the SEL-2032.

Use the SEL-2701 and SEL-2032 to connect non-SEL IEDs to Ethernet and UCA2 networks as shown in *Figure 1.4*. Many non-SEL IEDs such as protective relays, PLCs, and transformer monitors do not have UCA2 interfaces but do have EIA-232 serial ports. Add an SEL-2032 and SEL-2701 to your network design to connect non-SEL serial devices to your Ethernet network.

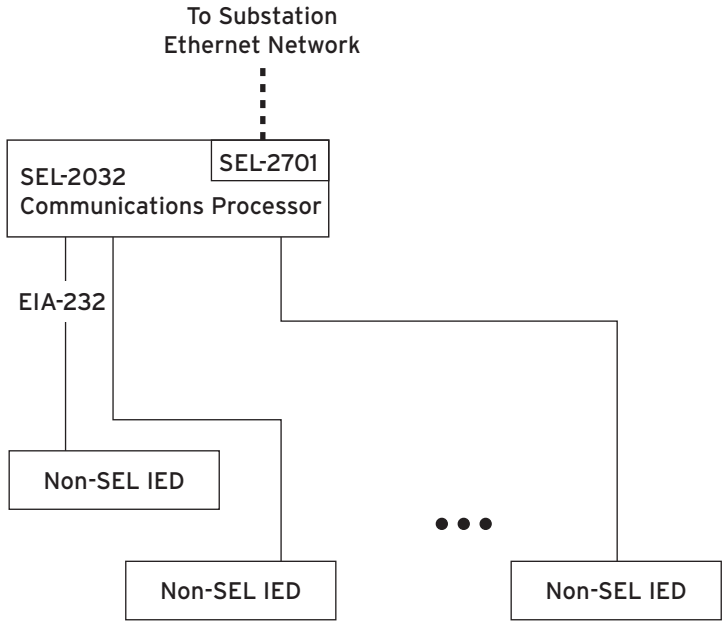

Figure 1.4 Non-SEL EIA-232 IEDs on Ethernet Network Using the SEL-2032

Some other gateway strategies use PCs or other office-grade hardware as the platform for data collection and conversion. The SEL-2032 performs these functions and offers a solution that is hardened for the substation environment without the errors and upgrades inherent in general purpose operating systems.

Networking for SEL Relays With Card Slots

Use the SEL-2701 to provide a direct Ethernet network connection to an SEL-400 series relay. All SEL-400 series relays have a card slot that will support an SEL-2701. Add an SEL-2701 to your SEL-400 series relays to gain the following features.

- Use Telnet for engineering connections to the SEL-400 series relay.
- Use FTP to collect event reports, SER reports, and COMTRADE oscillography directly from the relay.
- Use UCA2 master devices to collect data from SEL-400 series relays.
- Use GOOSE to exchange control data between relays and other UCA2 IEDs.
- Use DNP3 master devices to collect data from SEL-400 Series Relays.

An SEL-2701 installed in an SEL-400 series relay provides Telnet terminal session access to all of the commands, diagnostics, and reporting features available on the relay serial ports. You can connect to the relay from a PC with an Ethernet network in the substation or from your desk in a central engineering office.

The SEL-2701 also provides FTP file access to event reports and other reports. For example, you can point and click in an FTP application to collect event reports in the standard SEL format or the IEEE binary COMTRADE (Common Format for Transient Data Exchange) format.

Full UCA2 connectivity is available with the SEL-2701 installed directly in an SEL-400 series relay. GOMSFE models are automatically populated with measurements and other relay data. The SEL-2701 processes incoming GOOSE messages and delivers data to the relay through a high-speed network card interface. Within milliseconds of state changes in the relay, the SEL-2701 generates outgoing GOOSE messages.

DNP3 Level 2 slave functionality is available with the SEL-2701 installed directly into an SEL-400 Series Relay. Custom data maps may be used for communication sessions with specific DNP3 hosts. The SEL-2701 processes incoming DNP3 messages and delivers data to the relay through a high-speed network card interface.

Substations With Serial and Ethernet IEDs

In a new substation, you can combine the three applications above to provide a substation Ethernet network for the following three types of IEDs.

- SEL relays with serial ports
- Non-SEL IEDs with serial ports
- SEL-400 series relays

You can choose protective relays, equipment monitors, and other substation IEDs based on quality, reliability, and features rather than on the available network interfaces. In retrofit and upgrade projects, you can add the SEL-2032 and SEL-2701 without disturbing existing protective relays and equipment monitors. To add SEL-2701 Ethernet networking, data access, and control

features to your substation protection and control system, develop a network similar to that shown in *Figure 1.2*.

Ethernet Networks

This section introduces Ethernet networks and some general concepts and terms useful in understanding SEL-2701 application and operation. If you are experienced with Ethernet networks, you may want to proceed to *Section 3: Settings and Commands* for details on the SEL-2701.

OSI Seven-Layer Model

No discussion of networking technology would be complete without an introduction to the ISO (International Standards Organization) OSI (Open Systems Interconnect) seven-layer model. The model represents networking (both software and hardware) in an individual network node by dividing tasks into layers that perform specific functions. The OSI model for networking operation on two separate network nodes is shown in *Figure 1.5*.

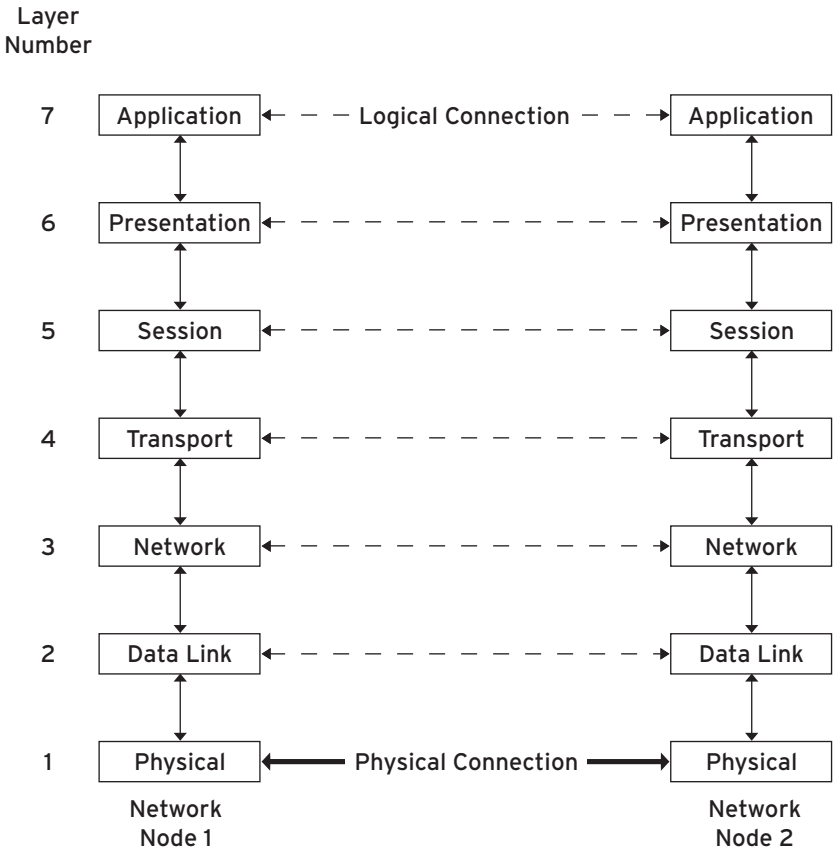

Figure 1.5 OSI Seven-Layer Model

In the OSI model, each layer (for example the data link layer) communicates via a logical connection directly with the same layer in the other device. Actual communication is more complex. Application data, such as characters in a Telnet terminal session or UCA2 GOMSFE models, pass down through the layers and then across the physical medium. Each layer adds some information to the message and forwards it down to the next layer.

Ultimately, the message reaches the lowest layer, the physical layer, and is sent across the physical connection to the second network node. Here the

process operates in reverse. Each layer strips off and uses the layer-specific information and passes the remaining information up the chain until the original data become available to the application user.

As long as there is a defined interface between layers, one layer can be replaced by another that conforms to the interface specification. For example, Ethernet networks can operate over many different media, from wire cables to fiber optics to wireless radio connections. The physical layer can be replaced as long as the interface remains unchanged.

A group of layers designed for a specific application can be defined together and called a "stack." The stack may coexist with other stacks on the network or may operate in a way that requires networks to be segregated based on stacks. See *TCP/IP, UDP/IP, and OSI on page 1.11* for more information on Ethernet stacks.

Ethernet Physical and Data Link Layers

Ethernet networks operate over many different physical layers. Each standard physical layer and corresponding data link layer has a designator (e.g., 10BASE-T) that identifies the layer specifications. The most popular physical layers for LANs within a single building are fiber optics (100BASE-FX) and twisted-pair (10/100BASE-T). For general use networks, 10 and 100 Mbps are the most popular data transmission speeds.

The data transmission speed defines how many bits of information can travel past a certain point on the cable within a second. A bit is the smallest unit of binary data and is either a 1 or a 0. While data transmission speed indicates the relative performance of various networks, it is not a measure of throughput–how quickly useful data travel across the network.

Media Access

With Ethernet networks, the time required for data to move across the network is not guaranteed. This lack of predictable timing must be considered for time-critical applications such as peer-to-peer protection and control messages. In a deterministic system, all events occur with completely predictable timing and sequence. A basic understanding of Ethernet media access rules is important for understanding why Ethernet networks are not considered deterministic.

High-speed bus and multidrop networks can operate over many different physical connections or media (for example, fiber-optic cable or twisted-pair cable). Network operation requires that all devices are connected to a common medium. All network nodes use the same signaling method.

Because only one node at a time can successfully send data, multidrop and bus networks must have media access rules to move data effectively across the network. In networks similar to Modbus®, there is a single master device. All network traffic is either the master requesting information or a response to the master.

A second method of media access control is token rotation. A special message, or token, is controlled by a master or forwarded from each peer to the next. Each node gets the token, acts as the network master, and sends messages to other devices. For lightly loaded networks, token rotation is inefficient because nodes that have no pending network operations still receive the token. A network error may also corrupt or destroy the token message, causing the network to generate a new token. Token generation is very slow, compared to normal network operations.

To overcome both the drawbacks of master-based and token rotation media access control, Ethernet networks use a system called CSMA/CD (carrier sense multiple access/collision detection). In this system, all nodes can send data at any time. For a node to send data, it must first listen for a carrier to

determine that no other node is transmitting. Collisions occur when two nodes both transmit data at the same time. Ethernet network nodes have mechanisms to detect collisions.

When a collision occurs on an Ethernet network, the sending nodes stop transmitting and insert a delay before listening for a carrier and starting the transmission sequence again. This process is called back-off. If collisions persist, the node will eventually abandon the outgoing message and upper protocol layers must cope with the loss of data.

Because of CSMA/CD operation, communication response times on an Ethernet network are not deterministic. Ethernet networks do not have guaranteed delivery times or guaranteed performance. For small, lightly loaded networks, CSMA/CD is efficient and fast. For large networks or during periods of sustained high network traffic, data transport times can become significant.

For most measurement and status data collection, the nondeterministic performance of Ethernet networking is not a cause for concern. For time sensitive data such as peer-to-peer protection and control, Ethernet network performance, loading, and architecture are important network design considerations. An Ethernet switch, for example, can greatly improve Ethernet network determinism and performance for large networks or slow data transmission speeds. See *Hubs, Switches, and Routers on page 1.11* for more discussion on the components of Ethernet networks.

TCP/IP, UDP/IP, and OSI

The three most common stacks used on Ethernet networks are TCP/IP, UDP/IP, and OSI. TCP/IP and UDP/IP are the network stacks that have gained fame as the basis of the internet. Telecommunication equipment is the primary application for the OSI stack. The OSI stack and OSI seven-layer model are two different things. The OSI stack is a network protocol stack that can be modeled using the OSI seven-layer model shown in *Figure 1.5*.

The SEL-2701 operates TCP/IP, UDP/IP, and OSI stacks in parallel to allow future applications to use whatever stack is required. UCA2 operates either on the OSI stack or partially on TCP/IP and OSI. FTP and Telnet are application-layer protocols on the TCP/IP stack.

Hubs, Switches, and Routers

Originally, Ethernet networks were multidrop networks that had a single trunk cable with a tap at each network node. While multidrop networks are simple to imagine, they have two principle drawbacks.

First, multidrop cable systems can fail if a single section of the trunk cable is damaged or severed. Second, it is difficult and expensive to add new nodes. The tap length, for example, is limited. If you want to add a new node 100 feet from the existing trunk cable, you may have to run 100 feet of trunk cable to the new node and 100 feet of trunk cable back to the existing trunk cable. The resulting configuration is shown in *Figure 1.6*.

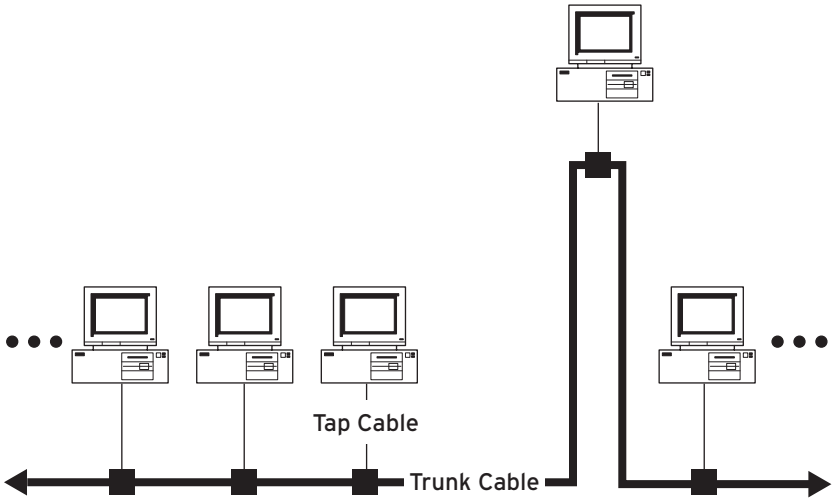

Figure 1.6 Adding a Node to a Multidrop Network

Ethernet networks have evolved into star networks as shown in *Figure 1.7*. A single cable to the central wiring node connects each node to the network. These individual cables are connected using hubs, switches, or routers to form logical multidrop networks.

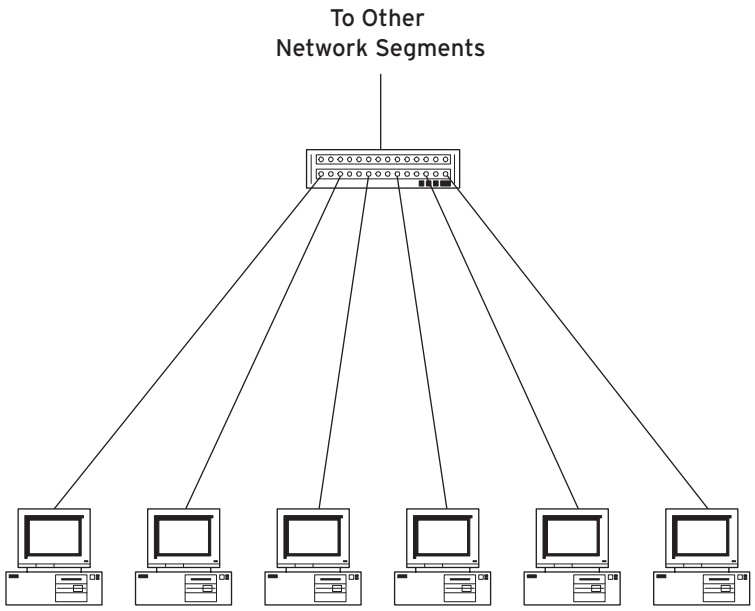

Figure 1.7 Ethernet Star Network

Hubs

A hub is a device that acts like a trunk cable with very short segments that connect each node cable to the network. A hub repeats all incoming network traffic to all nodes. An uplink connection allows the hub to send data up to other hubs, switches, or routers. Hubs are an easy and inexpensive way to connect many devices to an Ethernet network.

Hubs are primarily passive devices. If a node fails and sends a continuous stream of error data onto the network, the hub repeats the error data to all network nodes. One advantage of hubs is that they are quite reliable, compared to switches and routers.

Switches

A switch acts as a hub, connecting nodes to form a network that operates logically as a multidrop network. In addition to repeating data, however, the switch decodes some parts of Ethernet messages and directs traffic on an Ethernet network.

One method for avoiding message collisions on an Ethernet network is to limit the number of network nodes. A group of nodes that share a common medium is called a collision domain. When there are fewer nodes in a collision domain, fewer collisions occur, and the Ethernet network operates more deterministically and efficiently.

A switch reduces the collision domain of each node to the ultimate minimum–two nodes. A switch decodes incoming traffic from each network node and directs network traffic. The switch drastically reduces the number of message collisions, greatly improving Ethernet network performance.

While switches are less reliable than hubs, the increased Ethernet network performance offsets the decreased network reliability. Switches operate at the lowest layers (physical and data link layers) of Ethernet networks and are independent of the network stack or application protocol.

Routers

A router operates similarly to a switch. The difference is that routers keep messages in a local network and send out only messages that need to leave the local network. The router contains tables of how to route messages and decodes some of the Layer 3 or stack information to direct messages. Because routers operate at higher protocol layers than switches and hubs, you must select routers that are compatible with the protocol stacks on your network.

Routers do not forward Ethernet broadcast messages, for example GOOSE messages. Ethernet broadcast messages are not intended for nodes outside of the local network. Some more advanced routers act as network bridges that allow you to route non-routable protocols like GOOSE. You must be very careful if you route broadcast messages because you may drastically increase the traffic across low-bandwidth links between networks. High traffic can significantly diminish the throughput of inter-network connections and significantly increase the charges for metered network access services.

Routers may also act as firewalls. A firewall operates as a security barrier between your local network and the outside world. Used properly, firewalls and device password protection can prevent unauthorized access to critical systems.

UCA2

UCA2 is part of the Utility Communications Architecture suite of protocols. The SEL-2701 provides a UCA2 interface. The following paragraphs describe UCA2 and UCA2 features in the SEL-2701.

UCA History

The UCA for Field Devices Protocol, now known as UCA2 is the result of an EPRI (Electric Power Research Institute) joint development effort that began in the late 1980s. The primary components of UCA are UCA2 and TASE.2 (Telecontrol Application Service Element 2). UCA2 is designed for communication with substation IEDs. TASE.2, also known as ICCP (inter-

control center communication protocol), is designed to move data between real-time databases.

Both TASE.2 and UCA2 are based on an underlying communication protocol, MMS (manufacturing messaging specification). MMS is an industrial automation protocol developed largely by General Motors. General Motors has long served as a research and development center for advanced technologies in industrial automation. While MMS is no longer in wide use in the industrial automation environment, it is a capable protocol that serves as the foundation for both UCA2 and TASE.2.

UCA2

UCA2 is a profile for object-oriented communication with substation IEDs using MMS. CASM (common application service models) defines how objects interact with MMS services. GOMSFE is the object model specification for UCA2.

GOMSFE

GOMSFE is an object model for collecting measurement and status data from substation IEDs. GOMSFE uses an object-oriented abstract to create standard definitions for presenting meters, protective relays, and other devices on UCA2 networks. Unlike previous generations of protocols, UCA2 does not rely on the concept of indices or registers. GOMSFE organizes data into object models called bricks.

GOMSFE describes multifunction devices with several bricks, each describing one function. An example of this is a protective relay. A relay may contain metering data that populate a multiphase metering brick. The protective relay may also function as a circuit breaker interface with a brick for a circuit breaker controller.

GOMSFE bricks, consist of pieces of data with standard names built from standard data types. For example, the polyphase measurement brick (MMXU) includes A-phase current called MXAPhsAf. A-phase current is a value of the type FLT32 (32-bit floating point), as are the other phase currents.

Standard object models alone do not allow individual manufacturers to innovate and add new features. Because of this potential limitation, GOMSFE allows for the extension of bricks and the creation of custom bricks. *Appendix B: UCA2 GOMSFE Models* shows the GOMSFE model bricks available in the SEL-2701 when it is installed in an SEL-2032. The model definitions list the SEL-2701 rules for populating the model from data in the host.

It would be difficult to distribute and update descriptions of GOMSFE models on every UCA2 network master. A powerful feature of GOMSFE, self-description, makes extended bricks and custom bricks easy to use and eliminates the need to store GOMSFE model specification information on every master. A master UCA2 device can query a slave UCA2 device. The slave device then reports a description containing the details of each available standard, extended, or custom brick.

Self-description operates similarly to autoconfiguration of an SEL-2032 port communicating with an SEL IED. The master automatically collects information from the IED on what data are available and how to collect that data. Only a very small amount of user configuration is necessary for the master to begin collecting data.

GOMSFE also utilizes a high-level organizational structure with logical devices and domains. Both logical devices and domains contain GOMSFE bricks. All UCA2 devices have at least one logical device and can include either more logical devices or domains. For a detailed example of GOMSFE

models for a relay connected to an SEL-2032, see *Appendix C: GOMSFE Model Example*.

The SEL-2701 contains all of the information necessary to collect data from the host and populate GOMSFE models. All SEL hosts with an SEL-2701 will have a Logical Device 0 (labeled LN0) that contains at least the DI and GLOBE bricks. There will also be at least 1 domain and as many as 18 domains for the host and any devices connected to the host. Devices connected to the host are called virtual devices. For SEL hosts and SEL relays connected to SEL hosts, the SEL-2701 automatically finds data in the host and populates the GOMSFE models.

In devices that are the primary source of information available for GOMSFE models like the SEL-400 series relays, there is a single domain that contains the DID and GLOBE bricks as well as several other bricks with measurement, status, and control for the host. In devices that collect data from other IEDs such as the SEL-2032, there are virtual domains for the connected devices.

The SEL-2032 can collect data from SEL IEDs and from non-SEL IEDs including protective relays, meters, PLCs (programmable logic controllers), and transformer monitors. The SEL-2701 populates models using data collected from the attached IEDs using the rules shown in *Appendix B: UCA2 GOMSFE Models*.

GOOSE

GOOSE is part of the GOMSFE brick GLOBE. UCA2 IEDs use GOOSE messages for event-driven peer-to-peer communication and control. Each UCA2 device sends a GOOSE message when an internal data-change event occurs. A data-change event occurs when a monitored point changes state, for example, from one to zero or from zero to one. Event-driven messages limit network traffic and improve response speed by sending messages only when data-change events occur. This is a significant improvement over polling mechanisms that burden the network when no new data values are available.

In addition to the event-driven messages, UCA2 devices send GOOSE messages at a default rate of once every minute. Devices that receive GOOSE messages use the default rate messages to track the status of GOOSE senders and collect initial values when joining the network.

Each GOOSE message contains a text ID name of the GOOSE sender and a special Ethernet multicast destination address. UCA2 devices use the Ethernet multicast destination addresses to filter incoming GOOSE messages. Each device accepts and processes only messages containing information it is configured to use.

DNP3

DNP is a communications protocol developed for serial SCADA (supervisory control and data acquisition) applications. DNP is used in several industries and is a popular open standard protocol for substation automation and integration projects.

DNP History

DNP was developed by a SCADA company and became an open standard with the formation of the DNP User's Group in 1993. Originally developed and implemented as a protocol for connecting RTUs (remote terminal units) to SCADA Master Stations, DNP3 is now widely used for local communications between IEDs and local station master devices including protocol gateways, RTUs, and HMIs (human machine interfaces).

The last major revision to the specifications resulted in version 3.0, often called DNP3. While there are major new features added (including specifications for implementation on Ethernet LANs), the base specifications remain at the 3.0 level. The DNP User's Group uses the shortened notation DNP3 for any general DNP implementation and specifies implementation details with the date and version information of the specific specification.

DNP3 LAN/WAN

The DNP3 implementation in the SEL-2701 conforms to the general DNP3 specifications and DNP3 *SPECIFICATION, Volume 7, NETWORKING, Transporting DNP 3 over Local and Wide Area Networks, Version 2.0*.

Appendix D: DNP3 Communications contains the standard DNP3 device profile document and object listing for the SEL-2701. For more information on DNP3 specifications, contact the DNP3 User's Group at www.dnp.org.

DNP3 Concepts

DNP3 is a major advance over simple register based communications protocols like Modbus. A review of several key DNP3 concepts will assist in understanding the implementation in the SEL-2701 and how to apply the SEL-2701 in your system.

- Data types are defined by a set of DNP3 objects that includes everything from simple binary status points to special objects that request multiple data points and data types.
- DNP3 allows special types of efficient data collection.
- DNP3 control points allow remote control of equipment connected to DNP3 devices via either binary or analog (setpoint) controls.
- DNP3 subset levels define a set of required protocol elements for three different levels or degrees of implementation ranging from simple field devices to complex equipment with thousands of pieces of information and control points.
- The DNP3 specifications include conformance testing that defines how to verify that a device conforms to the present DNP3 specifications.

Data Types

DNP3 employs an object-oriented approach to the definition of data types. Because there are usually multiple objects of any given type, these objects are differentiated using an index. For example, 52A may be Object 1, Index 9 where Input 10 is Object 1, Index 22. In the documentation for a DNP device, you should find an object list (available types) and a data map (list of indices for each object type and data contents).

DNP3 items that change are reported as events. A DNP3 event is a data type that contains a new value of a point that has changed and in some cases a time stamp or other diagnostic information. For example, if a binary point turns on, the event data type for that point would contain a 1 and the time stamp 10:15:05.384 2004/03/16.

DNP object types often have several versions called variations. Each variation is a combination of different types of information about the point in question. For example, Object 1 Variation 2 includes an eight-bit status indication while Object 1 Variation 1 does not.

All indices of related object types correspond. For example, if Object 1 Index 9 contains the 52A status then Object 2 Index 9 will be the

corresponding event object. In the case of analog points, Object 30 contains the static value, Object 32 is the event object, and Object 34 is a deadband setting available to the DNP master device.

Some objects are special short-hand commands. For example, polling for Object Type 60 polls for all points of the given class (0-3). DNP also allows more efficient and more complex communication object requests or responses in a single DNP message.

Data Collection

DNP3 supports a basic polling mechanism similar to collecting data within Modbus. A poll of static values (also called a Class 0 poll) is a method of polling for the present value of a point. While this polling method is effective for small systems and small amounts of data, it requires the polling of all data points within each device to determine what has changed and provide that information to SCADA operators.

It would be much more powerful to poll devices in the field in much the same way that you poll an old friend. Rather than asking for the status for each and everything you can remember in his life including his car, dog, spouse, and children, you would probably ask "What's new?" A list of what has changed since you last spoke is much shorter and more practical than a list of the present status of everything.

Event data type items are collected in a buffer called the event buffer. Collecting the contents of this buffer is called an event poll. Events are also sorted and identified as part of one of the event classes. Event classes provide a mechanism to prioritize and group events so that they can be selectively collected. DNP3 specifications do not define the purpose of each event class. An example of how to use event classes is shown in *Table 1.3*.

Table 1.3 Example Class Assignments

Event Class	Data Collection Frequency	Description
0	Daily or whenever device enters service	Present value of all points contained within the device
1	Every second	Binary data for alarms and equipment status
2	Every 2 seconds	Analog data for display of system operating data
3	Daily	Accumulated data for maintenance scheduling

DNP3 contains a mechanism for devices to report event data to the master without a request called unsolicited reporting. Unsolicited reporting provides the most efficient means of getting new changes in field status to the master, but must usually be combined with polling of present value status for initial synchronization of database points in the master with the slave device.

Remote Control

DNP3 has a control capability that allows a master device to send a control to perform operations in the field. For power systems controls are used for opening and closing circuit breakers or enabling and disabling protection functions. You can also use remote control to enable or disable functions for security including engineering access to station devices.

The control functions are implemented as Object 12. A map of control points relates the DNP3 control interface to control points within the device. Refer to the subsequent section on your host for more control point information.

Time Synchronization

The DNP3 LAN/WAN interface does not support time synchronization. However, the host device (through the SEL-2701) will accept messages that contain a Record Current Time (Function Code 24) request and return a Null Response.

Subset Definitions

The level of implementation of the DNP3 protocol is described by implementation to a subset definition as defined in the DNP3 specifications. Level 1 is a very basic level for simple devices. Level 2 devices have more data and more sophisticated communications. Station IEDs including protective relays are typically Level 2. Level 3 contains the largest group of DNP functions and is typically implemented for SCADA master stations and other high-level devices.

The SEL-2701 is a Level 2 device and includes many Level 2 optional features. In addition to Level 2 features, the SEL-2701 includes several object types and variations that are generally implemented at Level 3. This provides additional flexibility for data collection and communication.

Conformance Testing

The SEL-2701 is conformance tested and certified by an independent organization as meeting the Level 2 requirements of the DNP3-*2003 Intelligent Electronic Device (IED) Certification Procedure Subset Level 1 & Level 2, V2.3, Sept. 2003.*

Specifications

Compliance

Designed and manufactured under an ISO 9000 quality management system

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 Count

DNP3 LAN/WAN:	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, RJ45
100BASE-FX:	100 Mbps, ST

Type Tests

Electromagnetic Compatibility Immunity

Digital Radio Telephone RF:	ENV 50204:1995 Severity Level: 10 V/m at 900 MHz and 1.89 GHz
Electrostatic Discharge:	IEC 60255-22-2:1996 IEC 61000-4-2:1995 Severity Level: 2, 4, 6, 8 kV contact; 2, 4, 8, 15 kV air
Fast Transient Disturbance:	IEC 60255-22-4:1992 Severity Level: 4 kV at 2.5 kHz and 5 kHz IEC 61000-4-4:1995 Severity Level: 4 kV, 2.5 kHz on power supply, 2 kV, 5 kHz on I/O, signal, data, and control lines
Radiated Radio Frequency:	ENV 50140:1993 Severity Level: 10 V/m IEC 60255-22-3:1989 Severity Level: 10 V/m; Exception: 4.3.2.2 freq. sweep approx. with 200 freq. steps per octave

Environmental

Cold:	IEC 60068-2-1:1990 + A1:1993 + A2:1994 Severity Level: 16 hours at –40°C
Damp Heat, Cyclic:	IEC 60068-2-30:1980 Severity Level: 25º to 55ºC, 6 cycles, Relative Humidity: 95%
Dry Heat:	IEC 60068-2-2:1974 + A1:1993 + A2:1994 Severity Level: 16 hours at +85°C
Vibration:	IEC 60255-21-1:1988 Severity Level: Class 1 Endurance, Class 2 Response IEC 60255-21-2:1988 Severity Level: Class 1 Shock withstand, Bump, and Class 2 Shock Response IEC 60255-21-3:1993 Severity Level: Class 2 Quake Response

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.

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Section 2
Installation

Introduction

This section includes information and procedures for SEL-2701 Ethernet Processor installation. Effective installation includes the following tasks.

- Installing the SEL-2701
- Performing SEL-2701 initial checkout
- Connecting the SEL-2701 to a network

Installation

NOTE: You will need an SEL host instruction manual and a Phillips screwdriver to complete these installation instructions.

⚠CAUTION
Equipment components are sensitive to electrostatic discharge (ESD). Undetectable permanent damage can result if you do not use proper ESD procedures. Ground yourself, your work surface, and this equipment before removing any cover from this equipment. If your facility is not equipped to work with these components, contact SEL about returning this device and related SEL equipment for service.

To install an SEL-2701 in an SEL host (SEL-2032 or SEL-2030 and SEL-400 series relays), perform the following steps. If your SEL-2701 is already installed, skip the following steps and proceed with *Initial Checkout*.

Case 1. **SEL-2030 Only.** If you are installing the SEL-2701 in an SEL-2030 with firmware R112 or earlier, you must upgrade the SEL-2030 firmware before installing the SEL-2701. Use the SEL-2030 **ID** command to determine the firmware version of your SEL-2030, as shown on the line labeled FID in *Figure 2.1*. See your *SEL-2030 Reference Manual* for more information on the **ID** command.

```
*ID
"FID=SEL-2032-R113-V0-Z000000-D20010122","08BD"
"BFID=SLBT-2032-R103-V0-Z000000-D20010122","094F"
"CID=00F2","0255"
"DEVID=COMMUNICATIONS PROCESSOR-S/N  2001051089","0C59"
"DEVCODE=52","030E"
"PARTNO=","0281"
"CONFIG=000000","0383"
"SPECIAL=","02AE"

*
```

Figure 2.1 SEL-2032 ID Command

Case 2. **SEL-2030 With SEL-2711 Installed Only.** If you have an SEL-2711 installed in your SEL-2030, you may also need to upgrade your SEL-2711 firmware. Contact SEL if you require assistance to determine compatible firmware versions for your application. Use the SEL-2030 **ID 17** or **ID 18** command to display the firmware version of any installed communications cards.

Case 3. **SEL-2030 With Serial Number Less Than 2001088089.** To properly protect the SEL-2701 from an ESD (electrostatic

discharge) on the SEL-2030 IRIG-B port (BNC connector), you must make the following settings changes:

- ➢ Set the SEL-2030 IRIG-B signal setting (IRIG_SIG in Global settings) to M for modulated.
- ➢ If using an IRIG-B source connected to the SEL-2030, configure the IRIG-B source to send a modulated signal to the SEL-2030.
- ➢ If using a time synchronization source other than IRIG-B, temporarily set the SEL-2030 time source setting (TIME_SRC in Global settings) to IRIG to access the IRIG-B signal setting (IRIG_SIG). Change the IRIG_SIG setting to M, then return the SEL-2030 time source setting to its original value.

See the *SEL-2030 Reference Manual* for more information on SEL-2030 settings.

NOTE: These instructions are for replacing existing SEL-2701 cards in SEL-400 Series products. If you are installing an SEL-2701 in an SEL-400 Series relay that did not have one installed previously, please contact SEL for additional instructions on how to configure the relay to accept the card.

SEL Communications Processor (SEL-2032 and SEL-2030 and SEL-400 Series Relay Installation. Remove power from the host. Remove all back-panel external connections from the host main board. These connections include fiber-optic, serial communication, and IRIG-B cables.

⚠DANGER
Disconnect or de-energize all external connections before opening this device. Contact with hazardous voltages and currents inside this device can cause electrical shock resulting in injury or death.

NOTE: In a host with multiple slots, you can install an SEL-2701 in any empty slot.

Step 1. Loosen the screws and remove the front panel from the host, disconnect all internal cables from the host main board (an SEL Communications Processor has two connections to the main board), and carefully pull out the drawout assembly containing the host main board. For more information on removing the main-board assembly from your host, see the instruction manual for your host.

Step 2. Insert the SEL-2701 80-pin connector into an 80-pin receptacle on the underside of the host main board, taking the following precautions:

- ➢ Ensure the connector pins line up with the guide holes on the host main board.
- ➢ Apply firm pressure while inserting the connector pins into the host receptacle, but do not force the connection. Forcing the connection can cause damage to the pins or guide holes. Rocking the SEL-2701 card slightly from side to side may help align the connector pins.
- ➢ If you encounter resistance or all the pins do not protrude evenly on the upper side of the host main board, stop and withdraw the card. Inspect the pins and receptacle for damage. If pins and receptacle are undamaged, take all the precautions outlined above, and try again to insert the card.

Step 3. Use the four screws included with the SEL-2701 to attach it to standoffs on the host main board. Tighten the screws to 8.0 in-lb (0.9 Nm) to prevent stripping the threads in the nylon standoffs.

Step 4. Reinstall the drawout assembly containing the host main board.

Step 5. Reconnect internal cables.

Step 6. Reattach the front panel.

Step 7. Reattach and re-energize all external connections.

Step 8. Proceed to *Initial Checkout* for your specific SEL host.

Initial Checkout

SEL Communications Processor Installations

Use the steps below to verify that the SEL-2701 is installed properly and initializes correctly in an SEL Communications Processor.

Step 1. Apply power to the communications processor. The initial power-up sequence takes at least one minute.

Step 2. Observe the SEL-2032 front-panel card status LEDs.

- ➢ The Card 1 and Card 2 LEDs indicate the status of the protocol cards on Port 17 and Port 18, respectively. When the power-up sequence is complete, the LED will begin to flash if the SEL-2701 is operating correctly. Proceed with *Step 3*.
- ➢ If after several minutes the LED is still on, power up initialization has failed. Proceed with *Step 3* (*Step 5* and *Step 6* may provide additional information about the SEL-2701 status).
- ➢ If you have installed an SEL-2701 and the LED is off, then the host is not detecting the card. Return to *Installation on page 2.1* and follow the steps to verify proper installation.

Step 3. Establish a terminal connection from your PC to the communications processor.

Step 4. Enter the **ACC** command to log in to Access Level 1.

Step 5. Enter the **WHO** command to confirm that the communications processor detects the SEL-2701 correctly on Port 17 or 18. Line 18 of *Figure 2.2* shows the response to the **WHO** command when a single SEL-2701 is installed in an SEL-2032 (Port 18).

```
*>WHO <Enter>

COMMUNICATIONS PROCESSOR-S/N  2001051089    Date: 03/16/01    Time: 15:59:02
FID=SEL-2032-R103-V0-Z000000-D20041222   FID=SLBT-2030-R103-V0-Z000000-D20010122

Port#  Device    Protocol   Parameters  Identification
1      SEL IED   SEL        9600,8,2,N
2      Other IED Ascii      9600,8,2,N
3      Other IED Ascii      9600,8,2,N
4      Other IED Ascii      9600,8,2,N
5      Other IED Ascii      9600,8,2,N
6      Other IED Ascii      9600,8,2,N
7      Other IED Ascii      9600,8,2,N
8      Master    SEL        9600,8,2,N
9      Printer   Ascii      9600,8,2,N
10     Other IED Ascii      9600,8,2,N
11     Other IED Ascii      9600,8,2,N
12     Other IED Ascii      9600,8,2,N
13     Other IED Ascii      9600,8,2,N
14     Other IED Ascii      9600,8,2,N
15     Other IED Ascii      9600,8,2,N
16     Other IED Ascii      9600,8,2,N
18     SEL-2701  Ethernet   VTm:HS,CTl:HS,TIm:S,SBt:S
F*     Master    SEL        9600,8,2,N

*>
```

Figure 2.2 SEL-2032 WHO Command

Step 6. Enter the **STATUS** command to confirm there are no SEL-2701 self-test errors. A report for a functional SEL-2701 displays Normal (0h) for each port where an SEL-2701 is installed, as shown for Port 17 and Port 18 in *Figure 2.3*. If the host reports an error on Port 17 or 18, see *Section 6: Troubleshooting* for a detailed description of the error.

```
*>STATUS <Enter>

COMMUNICATIONS PROCESSOR-S/N  2001051089    Date: 03/16/01    Time: 16:00:03
FID=SEL-2032-R103-V0-Z000000-D20041222 FID=SLBT-2030-R103-V0-Z000000-D20010122

SELF-TESTS

RAM      SRAM     CODE     ARCH     EEPROM   P.S.     SET      BATTERY
512 kb   1024 kb  OK       2048 kb  OK       OK       OK       OK

IRIG-B Input: Absent
I/O Board: Installed

Port   Status           Success Rate   SET M     Database Delays
1      Inactive                        None
2      Active                          None
3      Active                          None
4      Active                          None
5      Active                          None
6      Active                          None
7      Active                          None
8      Active                          None
9      Active                          None
10     Active                          None
11     Active                          None
12     Active                          None
13     Active                          None
14     Active                          None
15     Active                          None
16     Active                          None
17     Normal(0h)           NORM       None
18     Normal(0h)           NORM       None
F      Active               88%        None

*>
```

Figure 2.3 SEL-2032 STATUS Command

Step 7. Proceed to *Section 3: Settings and Commands* for information on network settings needed to operate the SEL-2701 on a network.

SEL-400 Series Relay Installations

Use the steps below to verify that the SEL-2701 is installed properly and initializes correctly in an SEL-400 series relay.

Step 1. Apply power to the relay. The initial power-up sequence takes as long as one minute.

Step 2. Establish a terminal connection from your PC to the SEL-400 series relay.

Step 3. Enter the **ACC** command to log in to Access Level 1.

Step 4. Enter the **STA A** command to confirm that the SEL-400 series relay detects the SEL-2701 and that there are no SEL-2701 self-test errors. If the relay reports an error, see *Section 6* for a detailed description of the error.

Network Connections

Network Ports

The SEL-2701 can use either the connection on Port A or Port B to operate on a network. These ports work together to provide a primary and backup interface, as described in *Network Port Failover Operation on page 3.2*. The following list describes the SEL-2701 network port options.

- **10/100BASE-T.** 10 Mbps or 100 Mbps communications using Cat 5 cable (category 5 twisted-pair) and an RJ45 connector
- **100BASE-FX.** 100 Mbps communications over multimode fiber-optic cable using an ST connector

SEL-2701 Rear-Panel Layout

Rear-panel layouts for the three SEL-2701 network port configurations are shown in *Figure 2.4–Figure 2.6*.

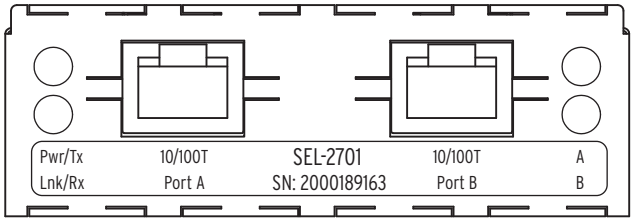

Figure 2.4 Two 10/100BASE-T Port Configuration

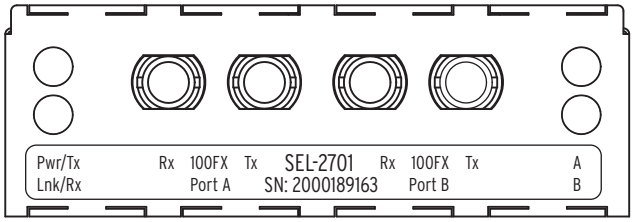

Figure 2.5 Two 100BASE-FX Port Configuration

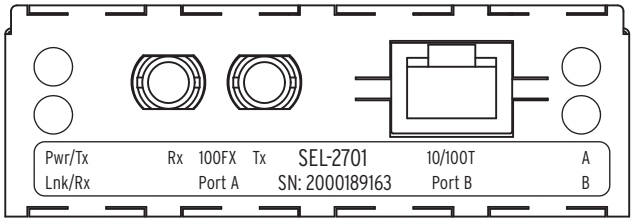

Figure 2.6 100BASE-FX and 10/100BASE-T Port Configuration

Twisted-Pair Networks

While unshielded twisted-pair (UTP) cables dominate office Ethernet networks, shielded twisted-pair (STP) cables are often used in industrial applications. The SEL-2701 is compatible with standard UTP cables for Ethernet networks as well as STP cables for Ethernet networks.

NOTE: Use caution when applying the SEL-2701 with UTP cables as these cables do not provide adequate immunity to interference in electrically noisy environments unless additional shielding measures are employed.

Typically UTP cables are installed in relatively low-noise environments including offices, homes, and schools. Where noise levels are high, you must either use STP cable or shield UTP using grounded ferrous raceways such as steel conduit.

Several types of STP bulk cable and patch cables are available for use in Ethernet networks. If noise in your environment is severe, you should consider using fiber-optic cables. We strongly advise against using twisted-pair cables for segments that leave or enter the control house.

If you use twisted-pair cables, you should use care to isolate these cables from sources of noise to the maximum extent possible. Do not install twisted-pair cables in trenches, raceways, or wireways with unshielded power, instrumentation, or control cables. Do not install twisted-pair cables in parallel with power, instrumentation, or control wiring within panels, rather make them perpendicular to the other wiring.

You must use a cable and connector rated as Category 5 (Cat 5) to operate the twisted-pair interface (10/100BASE-T) at 100 Mbps. Because lower categories are becoming rare and because you may upgrade a 10 Mbps network to 100 Mbps, we recommend using all Cat 5 components.

Some industrial Ethernet network devices use 9-pin connectors for STP cables. The SEL-2701 RJ45 connectors are grounded so you can ground the shielded cable using a standard, externally shielded jack with cables terminating at the SEL-2701.

Section 3
Settings and Commands

Introduction

This section provides information about the SEL-2701 Ethernet Processor settings and commands common to installations in any host. Specifically, it covers the following topics.

- Settings for Ethernet network operation
- Settings for data access through protocols including FTP, Telnet, and UCA2
- Commands for SEL-2701 diagnostics and configuration

Subsequent sections describe how to access SEL-2701 settings and how the SEL-2701 operates in specific hosts.

Ethernet Network Operation Settings

Several settings control how the SEL-2701 operates on an Ethernet network. These settings include IP addressing information, network port failover options, and network speed.

Network Configuration

Use the network configuration settings shown in *Table 3.1* to configure the SEL-2701 for operation on an IP network and to set other parameters affecting the physical Ethernet network interface operation. See *IP Addresses on page viii in Preface* for the proper format of an IP address.

Table 3.1 SEL-2701 Network Configuration Settings

Label	Description	Range	Default
IPADDR	IP network address	IP address	192.92.92.92
SUBNETM	IP network subnet mask	IP address	255.255.255.0
DEFRTR	Default router	IP address	NULL string
NETPORT	Primary network port (D disables all network ports)	A, B, D	A
FAILOVR	Automatic failover enable	Y, N	Y
FTIME	Failover time-out	5–65535 ms	5
NETASPD[a]	Network speed or auto-detect on Port A	A, 10 Mbps, 100 Mbps	A
NETBSPD[a]	Network speed or auto-detect on Port B	A, 10 Mbps, 100 Mbps	A

[a] This setting applies only to twisted-pair ports (10/100BASE-T).

The SEL-2701 uses the IPADDR and SUBNETM settings to determine the local network and SEL-2701 node address. The SUBNETM setting defines the subnet mask. The subnet mask divides the local node IP address into two parts, a network number and a node address on that network. A subnet mask is four bytes of information and is expressed in the same format as an IP address.

The SEL-2701 uses the DEFRTR address setting to determine how to communicate with nodes on other local networks. The SEL-2701 communicates with the default router to send data to nodes on other local networks. If you change the DEFRTR setting from the default value of Null (meaning that there is no default router), then the default router must be on the same local network as the SEL-2701 or the SEL-2701 will reject the DEFRTR setting. You must also coordinate the default router with your general network implementation and administration plan. See *Table 3.2* for examples of how IPADDR and SUBNETM define the network and node and how these settings affect the DEFRTR setting.

Table 3.2 DEFRTR Address Setting Examples

IPADDR	SUBNETM	Network Number	Node Address	DEFRTR
192.92.92.92	255.255.255.0	192.92.92	92	192.92.92.a[a]
192.92.92.92	255.255.0.0	192.92	92.92	192.92.a[a].b[a]
192.92.92.92	255.0.0.0	192	92.92.92	192.a[a].b[a].c[a]
192.92.92.92	0.0.0.0	n/a	192.92.92.92	a[a].b[a].c[a].d[a]

[a] Value in the range 0–255.

The SEL-2701 operates over either twisted-pair or fiber-optic media. Each SEL-2701 is equipped with two network ports. With an initial ordering option, you can select the media for each port (10/100 Mbps twisted-pair or 100 Mbps fiber-optic). Speeds for the physical media are fixed for fiber-optic connections. For twisted-pair connections, the SEL-2701 can auto-detect the network speed or you can set a fixed speed.

Network Port Failover Operation

The SEL-2701 has two network ports. Network port failover mode enables the SEL-2701 to operate as a single network adapter with a primary and standby physical interface. You can connect the two network ports to the same network or different networks depending on your specific Ethernet network architecture. If you have a single network and want to use only one network port, set NETPORT to the port you wish to use and set FAILOVR to N.

Only one network port operates at a time. The failover mode operation determines the active port. To use failover mode, follow the steps listed below.

Step 1. Set NETPORT to the preferred network interface.

Step 2. Set FAILOVR to Y.

Step 3. Set FTIME to the desired network port failover time.

NOTE: If you change settings for the host port where the SEL-2701 is installed and the SEL-2701 standby network port is active, the SEL-2701 resets and returns to operation on the primary port.

If the SEL-2701 detects a link failure on the primary port, it activates the standby port after the failover time, FTIME, elapses. If the link status on the primary link returns to normal before the failover time expires, the failover timer resets; uninterrupted operation continues on the primary network port. The SEL-2701 checks the primary link periodically and continues checking until it detects a normal link status. The SEL-2701 returns to operation on the primary link when it detects a normal link status.

Network Address Resolution

The SEL-2701 can resolve 20 network hostnames to corresponding IP addresses. Settings for Network Address Resolution (NAR) are shown in *Table 3.3*. The SEL-2701 uses address resolution any place settings or commands require an IP network name. NAR is similar to DNS (Domain Name Services) used on the internet, except that NAR uses a local name list rather than a remote name server. You can use names rather than numeric IP addresses for settings like DEFRTR (default router) or when using the SEL-2701 **PING** command. If a remote network hostname (HOST 1–HOST 20) is set NA, then the SEL-2701 ignores the corresponding IP address setting (IPADR 1–IPADR 20).

Table 3.3 SEL-2701 IP Network Address Resolution Settings

Label	Description	Range	Default
HOST1	Remote network hostname	16 characters	NA
IPADR1	Remote network host IP address	IP address	NA
HOST2	Remote network hostname	16 characters	NA
IPADR2	Remote network host IP address	IP address	NA
•			
•			
•			
HOST20	Remote network hostname	16 characters	NA
IPADR20	Remote network host IP address	IP address	NA

Data Access Settings

Access data using either the standard TCP/IP Telnet and FTP interfaces or through the UCA2 interface. You cannot access all data through all interfaces. Please see the appropriate interface section below for details on data access.

FTP

FTP is a standard application-level protocol for exchanging files between computers over a TCP/IP network. The SEL-2701 operates as an FTP server. It presents SEL-2701 and host files to FTP clients. The SEL-2701 can support as many as three simultaneous FTP sessions, allowing simultaneous FTP access to as many as three separate users.

The host maintains the access control list that determines FTP login IDs and passwords. The host also determines which files are available. Some files are available at specific login levels, while other files are read-only access. Subsequent host-specific sections describe access control for each host.

File Structure

The basic file structure common to all hosts is organized as a directory and subdirectory tree similar to that used by Unix, DOS, Windows, and other

operating systems. The root directory is "/" and has at least one subdirectory. The basic file structure is shown in *Table 3.4*.

Table 3.4 Basic File Structure

Host Directory	Subdirectories	Files
/	Host	See the host-specific sections for available files and directories.
	SEL-2701	DIAGNOSTICS.TXT
	DD01_DeviceID	REGION1.TXT
		REGION1.CAS
		•
		•
		•
		REGIONn.TXT
		REGIONn.CAS

The first subdirectory is for the host. Some hosts do not have a subdirectory. The HOST_ID string, if set, determines this subdirectory name. The SEL-2701 strips any leading or following white-space characters. The SEL-2701 then substitutes the "_" character for any white-space or delimiter characters. For example, if the HOST_ID is IED#983 Sub#45, then the host subdirectory name is IED_983_Sub_45. If the converted HOST_ID is longer than 31 characters, the host subdirectory name becomes the first 31 characters of the converted HOST_ID. The host subdirectory contains settings, reports, and diagnostic files for the host.

The next subdirectory is SEL-2701. This subdirectory contains the file DIAGNOSTICS.TXT that contains records for SEL-2701 system failures. The time and date for the diagnostics file are the same as the time and date of the last system failure event.

The SEL-2701 creates a subdirectory for each virtual device in the host. The subdirectory name is DDnn_substring, where nn is the virtual device number and substring is the device name derived from an identification string stored in the host that is associated with the virtual device. The SEL-2701 uses the first identification string that it finds in the PORTID, DEVICEID, and FIDID strings. The same substitution rules that govern substitutions for the host subdirectory name govern creation of the substring. For example, if you have an SEL-351 connected to an SEL-2030 on Port 3 with a PORTID setting of "Feeder 1," the subdirectory name will be "DD03_Feeder_1."

Each virtual device subdirectory contains files that represent valid host data regions associated with the virtual device. Data region files provide snapshots of the corresponding host database regions. When an FTP client requests the file, the SEL-2701 sends a file containing values from the host database region. If the voltage VA is 12.47 kV when you make an FTP request for the METER.TXT file, then the file METER.TXT will contain VA = 12.47. If you request the file at another time, when VA is 12.40, the file will contain VA = 12.40. Two file formats are available, ASCII text and Compressed ASCII (CASCII). Names of the files correspond to the data region name (i.e., METER.TXT, METER.CAS).

Access Control

FTP settings control some basic file access features. The host is responsible for maintaining names and passwords for access control. The special FTP username "anonymous" does not require a password. It has the same access rights as the username in the FTPAUSR setting. For example, if FTPAUSR is set to ACC, the FTP anonymous user has Access Level 1 rights. See the host-specific sections for additional information about access rights. *Table 3.5* lists the settings that affect FTP server operation.

NOTE: SEL advises against enabling anonymous FTP logins (FTPANMS = Y) except under test conditions. The SEL-2701 does not require a password for the special FTP username "anonymous." If you enable anonymous FTP logins, you are allowing unrestricted access to the SEL-2701 and host files.

Table 3.5 SEL-2701 FTP Settings

Label	Description	Range	Default
FTPSERV[a]	FTP session enable	Y, N	N
FTPCBAN	FTP connect banner	254 characters	SEL-2701 FTP SERVER:
FTPIDLE[a]	FTP connection timeout	5–255 minutes	5
FTPANMS[a]	Anonymous login enable	Y, N	N
FTPAUSR	Host user from which anonymous FTP client inherits access rights	See host-specific section	Empty String

[a] If you change these settings and accept the new settings, the SEL-2701 closes all active network connections and briefly pauses network operation.

Telnet

Telnet is also part of the TCP/IP protocol suite. You can use Telnet to establish terminal access to a remote device. A Telnet connection provides access to the user interface of either the host or the SEL-2701. Host user interface access is similar to an ASCII terminal connection to the front port of an SEL device.

You can use Telnet in the SEL-2701 in one of three ways:

1. Connect from your PC to the SEL-2701 user interface.
2. Connect from your PC to the host user interface.
3. Connect from a host to another Telnet server.

To determine which modes are available in your installation, see the host-specific section. The SEL-2701 acts as a Telnet server for connections to the SEL-2701 user interface. The user interface provides access to commands for diagnostics and other special features of the SEL-2701. Telnet settings are listed in *Table 3.6*.

Table 3.6 SEL-2701 Telnet Settings

Label	Description	Range	Default
T1CBAN	Host Telnet connect banner	254 characters	HOST TERMINAL SERVER:
T1INIT	Telnet session from host enable	Y, N	Y
T1RECV	Telnet session to host enable	Y, N	N
T1PNUM[a]	Host Telnet TCP/IP port	1–65534 except 20, 21, 102	23
T2CBAN	SEL-2701 Telnet connect banner	254 characters	SEL-2701 TERMINAL SERVER:
T2RECV	Telnet session to SEL-2701 enable	Y, N	N

Table 3.6 SEL-2701 Telnet Settings

Label	Description	Range	Default
T2PNUM[a]	SEL-2701 Telnet TCP/IP port	1–65534 except 20, 21, 102	1024
TIDLE	Telnet connection timeout (0 prevents timeout)	0–255 minutes	5

[a] If you change these settings and accept the new settings, the SEL-2701 closes all active network connections and briefly pauses network operation.

UCA2 for Field Devices

The SEL-2701 provides a UCA2 interface for the host. The UCA2 interface consists of several components that make up the UCA2 for Field Devices standard. The SEL-2701 supports Generic Object Model for Substation and Feeder Equipment (GOMSFE) and Generic Object-Oriented Substation Event (GOOSE).

UCA2 Settings

Table 3.7 lists UCA2 settings. See the host-specific sections to access UCA2 settings. UCA2 settings are only available if your SEL-2701 includes the optional UCA2 protocol.

Table 3.7 SEL-2701 UCA2 Settings (Sheet 1 of 2)

Label	Description	Range	Default
ENUCA	UCA2 interface enable	Y, N	N
NSAP[a]	Partial Network Service Access Point (NSAP) of SEL-2701	six octets, each 0–FFh	(SEL-2701 MAC address)
ENTXGOS	Outgoing GOOSE message enable	Y[b], N	N
TRMULGR	Outgoing GOOSE multicast group address (xxxxh yyyyh zzzzh)	13 characters	SEL-2701 MAC address with mode bits set to multicast
GOSIED	SEL-2701 GOOSE sender ID	66 characters	Null String
GOSRPTC	GOOSE sending repeat timing coefficient	1.5–1.9	1.9
GOSIED1	GOOSE sender ID for Monitor1	66 characters	Null String
GOSIED2	GOOSE sender ID for Monitor2	66 characters	Null String
•			
•			
•			
GOSIED8	GOOSE sender ID for Monitor8	66 characters	Null String
CTRLB1	Incoming bit pair from GOOSE message 1–8 to control host Control Bit 1	msg: 1–8 bit: 0–160	Null String
CTRLB2	Incoming bit pair from GOOSE message 1–8 to control host Control Bit 2	msg: 1–8 bit: 0–160	Null String
CTRLB3	Incoming bit pair from GOOSE message 1–8 to control host Control Bit 3	msg: 1–8 bit: 0–160	Null String

Table 3.7 SEL-2701 UCA2 Settings (Sheet 2 of 2)

Label	Description	Range	Default
• • •			
CTRLB64	Incoming bit pair from GOOSE message 1–8 to control host Control Bit 64	msg: 1–8 bit: 0–160	Null String

[a] If you change this setting and accept the new setting, the SEL-2701 closes all active network connections and briefly pauses network operation.
[b] Requires ENUCA set to Y to send GOOSE messages.

The NSAP setting specifies the user-configurable portion of the full OSI NSAP. The complete NSAP for SEL devices is 39h 84h 0Fh 80h 11h 38h 06h 00h 00h 00h 03h 00h 01h xxh xxh xxh xxh xxh xxh 01h. Set the six octets labeled xxh with the NSAP setting. Use the SEL-2701 **STATUS** command to display the full NSAP.

The proper format for the incoming control bit (CTRLB1–CTRLB64) settings is *msg:bit*. The *msg* parameter corresponds to one of the eight GOOSE sender ID monitor settings (GOSIED1–GOSIED8). The *bit* parameter indicates either GOOSE monitor network status or a bit pair in the incoming GOOSE message.

A *bit* parameter value from 1 to 160 specifies which bit pair (1–32 DNA, 33–160 User ST) of the incoming GOOSE message drives the corresponding control bit (CTRLB1–CTRLB64). A *bit* parameter of 0 specifies that the corresponding control bit contains the corresponding GOOSE sender monitor status. When the GOOSE sender status is logical 1, the SEL-2701 has not detected the GOOSE sender on the network or has stopped receiving new messages from the GOOSE sender. When the status is logical 0, the SEL-2701 has properly detected the GOOSE sender and considers incoming GOOSE message data valid. You can use this bit to supervise control actions in the host with the network status of the GOOSE sender.

GOMSFE

GOMSFE is a collection of object-based models that provide access to data and control mechanisms in UCA2. GOMSFE operation is host-specific. Detailed descriptions are in host-specific sections. The supported UCA objects (bricks) include the following:

- **GLOBE**: Device status and settings group handling.
- **Device ID**: Device type and versions.
- **Generic Control**: Control points within the host.
- **Polyphase Measurement Unit**: Basic metering data.
- **Circuit Breaker**: Circuit breaker control and status.
- **Polyphase Meter Unit**: Energy data.
- **Fault**: Relay fault history.

GOMSFE bricks are organized into groups called domains. Every SEL-2701 installation includes the LN0 domain. Each SEL-2701 installation also has additional domains for virtual devices (DDnn_substring) or the host (substring). For more information about GOMSFE domains and models in your application, see the host-specific sections.

GOOSE

GOOSE provides services for high-speed peer-to-peer transfer of binary information on a multicast, event-driven basis. Primary uses for GOOSE include protection coordination and high-speed communication during trip events. Outgoing GOOSE messages contain as many as 96 host-initiated control points. Incoming GOOSE message data are routed to the host by SEL-2701 settings. The host-specific sections contain details on GOOSE message operation.

The SEL-2701 processes incoming GOOSE messages from as many as eight different network nodes. The eight network nodes correspond to GOOSE IED names that you enter in SEL-2701 settings. At power up and after settings changes, the SEL-2701 automatically monitors the network for GOOSE messages and resolves the text names into MAC addresses. Devices that receive GOOSE messages use default rate GOOSE messages to resolve text GOOSE ID names into Ethernet broadcast groups and addresses. Resolution of GOOSE ID names is discussed in the description of the **GOOSE** command. Use the **GOOSE** command to display the status of GOOSE IED names.

DNP3

DNP3 Settings

DNP3 provides access to data within the host device as well as remote control. Settings that control the DNP3 operation over Ethernet are listed in *Table 3.8*. DNP3 settings are only available if your SEL-2701 includes the optional DNP3 protocol.

Table 3.8 DNP3 Settings (Sheet 1 of 2)

Label	Description	Range	Default
ENDNP	DNP3 interface enable	Y, N	N
DNPADR	DNP3 address of SEL-2701	0–65519	0
DNPPNUM	Port number for DNP3 communication	1–65534	20000
DNPMAP	Use DNP3 Custom Maps	AUTO, CUSTOM	AUTO
RPADR01	Master 1 DNP3 address	0–65519	1
DNPIP01	Master 1 IP address	IP address	NA
DNPTR01	Master 1 transport protocol	UDP, TCP	TCP
DNPUP01	Master 1 UDP response port [a]	REQ[b], 1–65534	20000
UNSL01	Master 1 unsolicited reporting enable for	Y, N	N
PUNSL01	Master 1 unsolicited reporting enabled at power up	Y, N	N
DNPMP01[c]	Master 1 DNP data map selection	1–5	1
DNPCL01	Master 1 control enable	Y, N	N
.			
.			
.			
RPADR10	Master 10 DNP3 address	0–65519	1
DNPIP10	Master 10 IP address	IP address	NA
DNPTR10	Master 10 transport protocol	UDP, TCP	TCP
DNPUP10	Master 10 UDP response port [d]	REQ[b], 1–65534	20000

Table 3.8 DNP3 Settings (Sheet 2 of 2)

Label	Description	Range	Default
UNSL10	Master 10 unsolicited reporting enable for	Y, N	N
PUNSL10	Master 10 unsolicited reporting enabled at power up	Y, N	N
DNPMP10[c]	Master 1 DNP data map selection	1–5	1
DNPCL10	Master 10 control enable	Y, N	N
ECLASSA	Class for analog event data	0[e]–3	2
ECLASSB	Class for binary event data	0[e]–3	1
ECLASSC	Class for counter event data	0[e]–3	0
DECPL	Data scaling decimal places	0–3	0
ANADB	Data reporting deadband counts	0–32767	100
STIMEO	DNP3 Select-before-operate timeout	0.0–30.0 seconds	1.0
DNPPAIR [f]	Enable use of DNP Trip Close Pairs	Y, N	N
DNPINA	Seconds to send inactive heartbeat	0[g], 1–7200 seconds	120
NUMEVE	Transmit unsolicited event data when this quantity of events collected	1–200	10
AGEEVE	Transmit unsolicited event data when oldest event is this age	0–100000 seconds	2
ETIMEO	Event message application confirmation timeout	1–50 seconds	2
URETRY	Unsolicited message maximum retry attempts	2–10	3
UTIMEO	Unsolicited message offline timeout	1–5000 seconds	60
16BIT	Default variation size for analog inputs	16, 32	16

[a] Fixed at USER; additional selections available in future revisions.
[b] Respond to the requestor on the port on which the request was made.
[c] Setting ignored if DNPMAP is set to AUTO. The mapped points will be created in the host's USER region.
[d] Setting ignored if corresponding master transport protocol set to TCP.
[e] No events collected for this data type.
[f] Setting ignored if DNPMAP is set to CUSTOM.
[g] Off.

The SEL-2701 is capable of maintaining as many as 10 independent, simultaneous connections to DNP3 masters. The SEL-2701 must be configured with each master's IP and DNP3 addresses (RPADR1–10 and DNPADR1–10) to support them. This means that you must carefully coordinate the network and DNP3 addresses of masters that interact with the SEL-2701. The use of dynamic IP addressing (including DHCP) is not recommended.

The control enable setting for each master connection controls whether or not the SEL-2701 will act upon control messages from the corresponding master. If the master control enable is set to N, DNP3 messages containing control requests will be rejected.

Please see *Section 4: SEL Communications Processor Host* and *Section 5: SEL-400 Series Host* for more information on DNP3 settings for Communications Processor Hosts and SEL-400 Series Relays, including customized DNP3 data maps.

Unsolicited Data

The SEL-2701 supports DNP3 unsolicited data transmission. This means that the master device need not poll the SEL-2701 for these data. If the SEL-2701 is set to TCP mode, the master must initiate and maintain a TCP connection so that the SEL-2701 can send unsolicited data.

While automatic unsolicited data transmission on power up is convenient, problems can result if your master is not prepared to start receiving data immediately on power up. If the master does not acknowledge the unsolicited data with an Application Confirm, the SEL-2701 will resend the data until it is acknowledged. On a large system, or in systems where the processing power of the master is limited, you may have problems when several devices simultaneously begin sending data and waiting for acknowledgment messages.

The SEL-2701 allows you to set the conditions for transmitting unsolicited event data on a master connection basis. It also allows you to assign points to event classes on a data type basis.

If the SEL-2701 does not receive an Application Confirm in response to unsolicited data, it will wait for ETIMEO seconds and then repeat the unsolicited message. To prevent clogging of the network with unsolicited data retries, the SEL-2701 uses the URETRY and UTIMEO settings to increase retry time when the number of retries set in URETRY is exceeded. After URETRY has been exceeded, the SEL-2701 pauses UTIMEO seconds and then transmits the unsolicited data again. *Figure 3.1* provides an example with URETRY = 2.

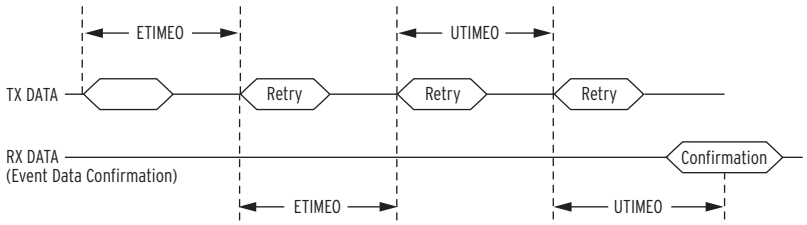

Figure 3.1 Application Confirmation Timing With URETRY = 2

DNP3 Data and Control

The objects implemented in the SEL-2701 are listed in *Table D.2*. The available data and control points vary depending on the host implementation and are listed in the section that applies to your host device.

Either make a Telnet connection directly to the SEL-2701 and use the **DNPMAP** command or use an FTP application to collect the summary file DNPMAP.TXT from the SEL-2701. If custom DNP3 maps are used, the detailed mapping files are available under the naming convention DNPMAP*nn*.TXT, where *nn* is a DNP session number in the range of 01–05.

SEL-2701 Commands

The SEL-2701 user interface accepts SEL-2701 commands. There are two ways you can connect to the SEL-2701. First, if your host allows, you can make a transparent connection to the SEL-2701. Second, you can establish a Telnet connection to the SEL-2701 user interface. See the host-specific sections for more information on connecting to the SEL-2701 user interface. Other connections to the SEL-2701, including FTP, require standard protocol commands and do not respond to the SEL-2701 user-interface commands.

Using Commands

When you type commands, you can type in either the entire command or just use the first three letters. For example, if you type **STATUS <Enter>** or **STA <Enter>**, the SEL-2701 displays status information. Commands are not case sensitive; you may use upper- or lowercase characters. Access level password entry is case sensitive. *Table 3.10* summarizes the user commands.

As with serial ports on SEL devices, you can control character transmission in a Telnet session using control characters. Send the control characters listed in *Table 3.9* to control long transmissions like event reports and SER reports.

Table 3.9 Control Characters

Control Characters	Key Commands	Results
XON	**<CTRL+Q>**	Restart paused transmission and enable subsequent transmissions.
XOFF	**<CTRL+S>**	Pause current transmission and block any subsequent transmissions.
CAN	**<CTRL+X>**	Cancel current transmission or command and return to cursor.

Command Summary

Table 3.10 summarizes the SEL-2701 commands. Subsequent subsections provide full descriptions of each command in alphabetical order.

Table 3.10 SEL-2701 Command Summary

Command	Description	Access Level
2ACCESS	Go to Access Level 2	1
ACCESS	Go to Access Level 1	0 or 2
CAL	Go to Access Level C	2
DATE	View or change date.	1[a] or 2
GOOSE	View/reset UCA network GOOSE ID information	2
HELP	Display available commands or command help	Any
ID	View internal identification parameters for the SEL-2701	1 or 2
MEMORY	Display RAM statistics for the SEL-2701	1 or 2
PING	Ping another node on the network	2
QUIT	Go to Access Level 0	Any
STATUS	Display self-test status	1 or 2
TIME	View or change internal clock	1[a] or 2

[a] Limited functions at this access level. See command description below for details.

Access Levels

Access levels control whether you can perform different operations within SEL products. For example, at Access Level 1, you can view settings. You cannot change settings unless you are at Access Level 2. A complete list of access levels for the SEL-2701 is shown in *Table 3.11*.

Table 3.11 SEL-2701 Access Levels

Access Level	Prompt	Allowed SEL-2701 User-Interface Operations
0	#	Log in to Access Level 1
1	#>	View data and status information
2	#>>	Perform all Access Level 1 functions plus advanced diagnostics and set date/time
C	##>>	Perform Access Level C functions (SEL use only)

Each access level has a password. The SEL-2701 uses passwords set in the host for the same access level. For example, if you have an SEL-2032 and SEL-2701, and have set the SEL-2032 Access Level 2 password to SUB35L2, then SUB35L2 is the password for Access Level 2 on your SEL-2701.

The SEL-2701 uses access levels and passwords in two ways. First, if you are connected to the SEL-2701 user interface, the SEL-2701 limits command access based on your access level. You are connected to the SEL-2701 user interface if you are using a terminal or Telnet program and see one of the prompts shown in *Table 3.11*. For example, if your SEL-2701 is installed in an SEL-2032, you can Telnet to the SEL-2701 or make a transparent connection from one of the SEL-2032 serial ports to the SEL-2701.

Second, the SEL-2701 uses access level names and passwords as usernames and passwords for protocols that require you to log in to establish a connection. For example, if you are making an FTP connection to the SEL-2701, you will be prompted for an FTP username and password. In this case, use host access levels and passwords to connect. Use the host access level for the FTP username and the corresponding password for the FTP password. Access levels are listed with corresponding passwords in *Table 3.12*.

Table 3.12 Access Level Usernames and Passwords

Access Level	Username	Password
0	QUI	None
1	ACC	User-definable
2	2AC	User-definable
C	CAL	User-definable

Connections that are closed manually by ending the network connection or by using the SEL-2701 **QUIT** command are terminated. This means that to reestablish the connection and return to the original access level, you must log in using the access level commands and passwords.

When a connection with the SEL-2701 or the host "times out," the connection is closed and the access level is reduced to 0. There is a timeout setting associated with connections to the SEL-2701 and connections to the host through the SEL-2701. The timeout settings and their specific operation are described in the host-specific sections.

Access failures cause the SEL-2701 to close connections, assert the alarm bit, and prevent connections for a variable delay period.

2ACCESS

Use the **2ACCESS** command to change to Access Level 2. If the current level is not Access Level 1, the SEL-2701 responds with "Invalid access level." When you enter the **2AC** command, the SEL-2701 prompts you to enter the Access Level 2 password. If the password is Null or you enter the password set in the host, the access level changes to Access Level 2. Passwords are case sensitive; you must enter them exactly as set. The host maintains the password and user list. For more details, see the host-specific sections.

If you are unable to enter the correct password after the third failed attempt, the SEL-2701 asserts the ALARM bit in the Status register and terminates the connection for some connection types. See the host-specific sections for more information on how your host uses the ALARM bit from the SEL-2701.

If your connection to the SEL-2701 has an inactivity timeout, the SEL-2701 automatically closes the connection and changes to Access Level 0 when the timeout expires.

ACCESS

Use the **ACCESS** command to change to Access Level 1. For example, if you are at Access Level 0, the SEL-2701 prompts you for the password and moves you to Access Level 1 if you enter the password correctly. For additional details on access level commands, see *2ACCESS*.

CAL

Use the **CAL** command to change to Access Level C (calibration) from Access Level 2. If the current level is not Access Level 2, the SEL-2701 responds with "Invalid access level." When you enter the **CAL** command, the SEL-2701 prompts you to enter the Access Level C password. Passwords for Access Level C follow the same rules as passwords for Access Level 2.

Access Level C is the calibration level and is intended for use by the SEL factory, and for use by SEL field service personnel to help diagnose troublesome installations. A list of commands available at Access Level C is available from SEL upon request.

Do not enter Access Level C except as directed by SEL.

DATE

Table 3.13 illustrates how to use the **DATE** command to view or set the date.

Table 3.13 DATE Command

Command	Description
DATE	Display internal SEL-2701 date.
DATE *mm/dd/yyyy*	Set the date if the date format setting for the host is *mm/dd/yyyy*, where *mm* is the month, *dd* is the day of month, and *yyyy* is the year.
DATE *dd/mm/yyyy*	Set the date if the date setting for the host is *dd/mm/yyyy*.
DATE *yyyy/mm/dd*	Set the date if the date setting for the host is *yyyy/mm/dd*.

The **DATE** command displays the internal clock date. A setting in the host determines the date format. To avoid confusion, the SEL-2701 displays the date format along with the date. For example, if you set the host for a European style date, the SEL-2701 displays the current date and the date format text "dd/mm/yyyy." The date format options are mm/dd/yyyy, dd/mm/yyyy, and yyyy/mm/dd.

Use the **DATE** command with a date to set the internal clock date. Enter the year in four-digit form. Enter the date in a form that matches the date form of the host. Because there is no way to differentiate between mm/dd/yyyy and dd/mm/yyyy for certain dates (02/03/2001 could be February 3 or March 2),

check the date format before entering the date. To see the date format, use the **DATE** command.

DNPMAP

Use the **DNPMAP** command to display the data (object types, indices, default variation and source) and controls (object type, indices and destination) that are accessible via DNP3. The output of the **DNPMAP** command documents the DNP3 data map in the SEL-2701 to help with the configuration of the DNP3 master.

If the DNPMAP setting is set to CUSTOM, then an additional integer parameter corresponding to an assigned DNPMAP number (1–5) must be specified to view each custom DNP3 data map. For example, the command **DNPMAP 2** would be used to view the custom data map for DNP session 2. If a DNPMAP number is not specified, a summary of DNP3 map settings for all configured sessions will be displayed.

Summary and detailed map configurations are also available in the DNPMAP.TXT and DNPMAP*nn*.TXT files from the SEL-2701 FTP interface. The individual file names associated with the detailed custom map settings follow the DNPMAP*nn*.TXT naming convention.

GOOSE

Use the **GOOSE** command to display or reset GOOSE messaging information. The **GOOSE** command variants and options are shown in *Table 3.14*.

Table 3.14 GOOSE Command Variants

Command Variant	Description	Access Level
GOOSE	Display GOOSE information.	2
GOOSE *count*	Display GOOSE information *count* times.	2
GOOSE R	Clear statistics and listen for GOOSE IDs.	2

Also use the **GOOSE** command to display GOOSE monitoring information. You can include an optional parameter for the number of times to display the information. The information displayed for each GOOSE ID is described in *Table 3.15*.

Table 3.15 GOOSE Sender IED Display Information

Information	Description
Multicast Group	GOOSE sender Ethernet multicast group
GOOSE ID	Text name for GOOSE sender
StNum	Hexadecimal state number that increments with each state change
SqNum	Hexadecimal sequence number that increments with each GOOSE message
HoldTime	GOOSE message time to live
Timed Out	GOOSE sender inactive indication string
BackTime	Time in milliseconds since last status change

Because there may be many IEDs on a UCA2 network sending GOOSE messages, each device that receives GOOSE messages implements a filtering mechanism. By filtering messages, the SEL-2701 drastically reduces message processing by ignoring messages that it does not need. This increases overall GOOSE performance of the SEL-2701 and host.

The SEL-2701 filters GOOSE messages according to the Ethernet multicast group in each GOOSE message. The SEL-2701 uses the GOOSE monitor settings in *Table 3.7* to build a table of Ethernet multicast groups that it will monitor. Each GOOSE message contains a text GOOSE ID and an Ethernet multicast address. The SEL-2701 listens for GOOSE messages and captures the Ethernet multicast group associated with each GOOSE device that the SEL-2701 is programmed to monitor. The SEL-2701 then processes only messages from the Ethernet multicast addresses that it has collected.

When you first power up the SEL-2701, use the **GOOSE R** command, or change the SEL-2701 UCA2 settings, the SEL-2701 listens for GOOSE messages for two minutes to build a table of Ethernet multicast addresses. Because each GOOSE device sends a GOOSE message if there is a state change or every minute if there are no state changes, a two-minute listening period is sufficient to detect all active GOOSE devices.

After the SEL-2701 completes the listening process, it only processes Ethernet multicast messages from devices that it identified during the listening process. If a device fails to send a GOOSE message during the listening process, the SEL-2701 will ignore all future messages from the device.

When you use the **GOOSE** command to display GOOSE statistics, the Ethernet multicast group is shown for each IED that the SEL-2701 is monitoring for GOOSE messages. If the SEL-2701 is in listening mode, or if it has not resolved a GOOSE text ID within the two-minute listening process, the SEL-2701 displays $$-$$-$$-$$-$$-$$ for the Ethernet multicast group.

The SEL-2701 tracks GOOSE messages, compiles GOOSE statistics, and decides if the GOOSE ID is inactive. Use the **GOOSE** command to display this information. An example response to the **GOOSE** command is shown in *Figure 3.2*.

```
#>>GOO

GOOSE Monitor Status:
01-03-A7-00-00-01 SEL-2701
 StNum=73   SqNum=2732  HoldTime=54652
01-08-B7-39-AB-02 RELAY 2
 StNum=132   SqNum=1404  HoldTime=72356
01-99-3B-9C-12-F2 RELAY 3
 StNum=0   SqNum=40   HoldTime=83491 Timed out
$$-$$-$$-$$-$$-$$ RELAY 4
 StNum=0   SqNum=0   HoldTime=0  Timed out

GOOSE Sending Status:
01-30-A7-00-00-03 SEL2701GOOSE
 StNum=115   SqNum=2054  HoldTime=157629 BackTime=124937

GOOSE Listening Mode: Completed
#>>
```

Figure 3.2 GOOSE Command Response

Use the **GOOSE R** command to clear statistics and MAC addresses and initiate the process of listening to the network for GOOSE senders. For a more detailed discussion of this process, see *UCA2 for Field Devices on page 3.6*.

HELP

Because only a limited set of commands may be available at your current access level, you may want to display a list of available commands. Use the **HELP** command to display a list of available commands for your current access level. The **HELP** command format and options are shown in *Table 3.16*.

Table 3.16 HELP Command Options

Command	Description
HELP	Display command information for the current access level.
HELP *command*	Display information for a specific *command*.

ID

It may be necessary to identify the firmware version of your SEL-2701 for diagnostic purposes or to verify that it is compatible with the firmware version of your host. Use the **ID** command to identify the firmware version and several other internal parameters for your SEL-2701. The information displayed by the **ID** command is described in *Table 3.17*.

Table 3.17 ID Command Internal Parameters Displayed

Parameter	Description
FID	Firmware ID
BFID	SELBOOT Firmware ID
CID	Firmware Checksum
DEVID	Device ID
PARTNO	Part Number
CONFIG	Configuration ID

MEMORY

The **MEMORY** command is a diagnostic command for determining if the SEL-2701 is using onboard RAM properly. Use the **MEMORY** command to display RAM statistics for the following areas: memory in use, free memory, free memory blocks, and bytes in largest available block.

PING

When you are setting up or testing substation networks, it is helpful to determine if the network is connected properly and if the other devices are powered up and configured properly. Use the **PING** command to determine if another node on the network is available and connected to the network. The SEL-2701 sends ping messages to the remote node until you interrupt the SEL-2701 by pressing ENTER. Command options for the **PING** command are shown in *Table 3.18*.

Table 3.18 PING Command Options

Command	Description
PING *addr*	Ping the address represented by *addr* every second.
PING *addr n*	Ping the address *addr* once every n seconds, where *n* is a value from 1 to 255.

The **PING** command requires the *addr* parameter, which can either be a name in the NAR table for the host, or an actual IP address. In response to the **PING** command, the SEL-2701 displays the status of each ping attempt. When you stop the ping process, the SEL-2701 displays several statistics to summarize the ping attempts.

QUIT

To close your connection to the SEL-2701 and start a connection to another device without closing your terminal application, use the **QUIT** command. For example, use **QUIT** to log out and automatically terminate a Telnet session. You may then open a new Telnet session from your Telnet application. You can also use the **QUIT** command to log out of the SEL-2701 for security purposes when the connection will not be closed. For example, if

you are connected to an SEL-2701 in a host from one of the host serial ports, you can log out without closing the transparent connection to the SEL-2701.

STATUS

Use the **STATUS** command to display the self-test status and configuration of the SEL-2701. The SEL-2701 displays self-test results as either OK or FAIL. The SEL-2701 displays network configuration information and network statistics.

TIME

The **TIME** command is described in *Table 3.19*.

Table 3.19 TIME Command

Command	Description	Access Level
TIME	Display internal clock date.	1 or 2
TIME *hh:mm*	Set internal clock time to *hh* hours (24 hour time), *mm* minutes and 0 seconds.	2
TIME *hh:mm:ss*	Set internal clock time to *hh* hours (24 hour time), *mm* minutes, and *ss* seconds.	2

Some hosts support time synchronization of the SEL-2701 from the host or time synchronization of the host from the SEL-2701. See the host-specific section for more information on time synchronization.

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Section 4

SEL Communications Processor Host

Introduction

This section describes applications where the SEL-2701 Ethernet Processor is installed in an SEL Communications Processor host. This section refers to the SEL-2032 to describe operations in both the SEL-2030 and the SEL-2032. For detailed explanations of SEL-2701 commands and settings, refer to *Section 3: Settings and Commands*. This section contains information on the following topics.

- SEL-2701 settings
- SEL-2701 operation
- Accessing data through the SEL-2701

See *Section 2: Installation* for instructions on how to install an SEL-2701 in a host. See the *SEL-2032 Instruction Manual* for additional information about the SEL-2032. The *SEL-2032 Instruction Manual* also contains information about upgrading SEL-2701 and SEL-2032 firmware.

Features and Capabilities

Installing an SEL-2701 in either card slot of an SEL-2032 (Port 17 or Port 18) provides the following features and capabilities.

- Ethernet Physical Connection
  - 10/100 Mbps on twisted-pair media
  - 100 Mbps on fiber-optic media
  - Redundant network ports with automatic failover
- Telnet
  - Server for connections to SEL-2701
  - Server for connections to SEL-2032
  - Client for connection from an SEL-2032 port to a Telnet server
- FTP Server for data files within the SEL-2032 and SEL-2701
- UCA2
  - GOMSFE models for connected IEDs
  - GOMSFE models for data in an SEL-2032
  - GOOSE messages

- DNP3
  - Access to data from connected IEDs
  - Control of connected IEDs

Settings

Access the settings for the SEL-2701 using the SEL-2032 settings commands and the port number (17 or 18) where the SEL-2701 is installed. These commands provide access to some additional settings that govern how the SEL-2032 interacts with the SEL-2701. This section only describes the SEL-2032 settings and behavior specific to installations that include an SEL-2701. See the *SEL-2032 Instruction Manual* for complete syntax and examples for SEL-2032 commands.

Port Settings

Use the SEL-2032 port settings to set the SEL-2701 for operation on your network. SEL-2032 port settings also include the SEL-2701 settings described in *Section 3: Settings and Commands*.

Access these settings using the **SET P *n*** command, where *n* is the port number (17 or 18) where the SEL-2701 is installed. Port settings for an SEL-2032 port with an installed SEL-2701 are listed in *Table 4.1*. SEL-2032 port control settings with details are listed in *Table 4.2*.

Table 4.1 SEL-2032 Port Settings With SEL-2701 Installed

Settings	Reference
SEL-2032 Port Control	*Table 4.2*
Network Configuration	*Table 3.1*
Network Address Resolution	*Table 3.3*
FTP	*Table 3.5*
Telnet	*Table 3.6*
UCA2	*Table 3.7*
DNP3	*Table 3.8*

Table 4.2 SEL-2032 Port Control Settings With SEL-2701 Installed

Label	Description	Range	Default
SENDTIME	Enable/disable time synchronization of the SEL-2701 from the SEL-2032	Y/N	N
TIMEOUT	Timeout period for Virtual Terminal connection	OFF, 0–30 minutes	OFF
TERTIME1	Length of time the channel must be idle before checking for the termination string	0–600 seconds	1
TERSTRING	Transparent communication termination string		\004 which is CTRL + D
TERTIME2	Length of time the channel must be idle before accepting the termination string	0–600 seconds	0

Automatic Message Settings

The SEL-2032 uses the NOCONN SELOGIC control equation to determine whether to allow external connections to the port in question. Access Automatic Message settings using the **SET A *n*** command, where *n* is the port number (17 or 18) where the SEL-2701 is installed.

The NOCONN setting, shown in *Table 4.3*, controls the following Telnet connections for the SEL-2701.

- Telnet connections to the SEL-2032 through the SEL-2701
- Telnet connections out of the SEL-2032 through the SEL-2701

The *SEL-2032 Instruction Manual* describes SELOGIC control equations and their syntax. SELOGIC control equations are a language for entering Boolean expressions into the SEL-2032. If the SELOGIC control equations expression evaluates to false or logical 0, the SEL-2701 allows Telnet connections. When the expression evaluates to true or logical 1, the SEL-2701 does not allow new connections and terminates any existing Telnet connections.

Table 4.3 SEL-2032 Automatic Message Settings With SEL-2701 Installed

Label	Description	Range	Default
NOCONN	Block external connections to this port.	SELOGIC control equation	NA

Math/Data Movement Settings

Complete User region settings and data storage are available for each port with an installed protocol card. User region data are available to the user for data concentration and manipulation. User region data are also used for some protocols including UCA2. Access Math/Data Movement settings using the **SET M *n*** command where *n* is the port number (17 or 18) where the SEL-2701 is installed.

Outgoing Control Point Settings

Outgoing control points are used by the SEL-2032 to send binary information to the SEL-2701. The SEL-2701 uses these bits for protocol-specific operations. For example, the SEL-2701 generates GOOSE messages using the outgoing control points. Access settings for outgoing control points using the **SET O *n*** command, where *n* is the port number (17 or 18) where the SEL-2701 is installed.

Operation

Access Control

Access Control is the process of deciding who can log in to the SEL-2032 or SEL-2701. The SEL-2032 allows limited functionality at a given access level. The SEL-2032 has the access levels described in *Table 4.4*.

Table 4.4 SEL-2032 Access Levels

Access Level	Primary Operations Allowed
0	Log in to Access Level 1
1	View data and settings and establish transparent connections
2	Perform Access Level 1 functions and change settings
C	Perform Access Level C functions (SEL use only)

The SEL-2701 user interface uses the SEL-2032 access levels and passwords. When you establish a terminal connection directly to the SEL-2701 user interface, use the passwords programmed into the host SEL-2032. You can change a password using the SEL-2032 **PASSWORD** command at Access Level 2. See the *SEL-2032 Instruction Manual* for a full description of the **PASSWORD** command.

To log in as an FTP client, use the usernames and access level passwords shown in *Table 4.5*. You do not need to log in to start a Telnet session. After

you connect, you can use the standard SEL-2032 login process to change access levels.

Table 4.5 SEL-2032 Access Level Usernames and Passwords

Access Level	Username	Password
0	QUI	None
1	ACC	User-definable
2	2AC	User-definable
C	CAL	User-definable

Your connection to the SEL-2701 or SEL-2032 may have an associated timeout setting. For example, the TIMEOUT setting in *Table 4.2* applies to transparent connections to the SEL-2701 from an SEL-2032 port. If there is no activity and the timeout time expires, the SEL-2032 closes the connection and the SEL-2701 automatically returns to Access Level 0.

SEL-2701 User Interface

You can access the SEL-2701 user interface in one of two ways. First, you can connect directly to the SEL-2701 as a Telnet client on the Ethernet network. Second, you can make a transparent connection using the SEL-2032 **PORT *n* 0** command where *n* is the port number (17 or 18) where the SEL-2701 is installed.

Once you are connected to the SEL-2701 user interface, you can use the commands described in *SEL-2701 Commands on page 3.11*.

SEL-2701 settings are included in the SEL-2032 port settings for the port where the SEL-2701 is installed. SEL-2701 settings are not accessible through the SEL-2701 user interface. The SEL-2701 uses the passwords set in the SEL-2032. The access levels and commands to change access levels are identical to those in the SEL-2032.

Control Points

The SEL-2701 and SEL-2032 exchange binary control information via control points. The SEL-2032 sends 64 control points (CCOUT1–CCOUT64) to the SEL-2701. Incoming message data appear in the SEL-2032 as 64 incoming control points (CCIN1–CCIN64).

Outgoing Control Points

The SEL-2701 automatically maps the SEL-2032 control points CCOUT1–CCOUT64 to the SEL-2701 for use in outgoing messages. Use the SEL-2032 output logic settings to control these bits with SELOGIC control equations. Access these settings using the SEL-2032 **SET O *n*** command where *n* is the SEL-2701 port number (17 or 18) where the SEL-2701 is installed. See the *SEL-2032 Instruction Manual* for a full description of the output logic settings.

Incoming Control Points

The SEL-2701 uses the CTRLB1 and CTRLB64 settings to direct control information from incoming messages to the SEL-2032 control points CCIN1–CCIN64. See *Section 3: Settings and Commands* for more information on SEL-2701 settings.

Viewing Control Point Status

Control points do not appear in the SEL-2032 database. The SEL-2032 **MAP** and **VIEW** commands apply only to the SEL-2032 database, so these

commands do not display control point values. Use the SEL-2032 **CARD** command to view control points. See the *SEL-2032 Instruction Manual* for more information on the **CARD** command.

LOCAL Database Region

A new LOCAL database element exists at address 08B1h for each card slot. The database element has the name, ELEMENTS2, and consists of two rows of binary values. *Table 4.6* shows the element contents.

Table 4.6 SEL-2032 LOCAL ELEMENTS2

Row	Element Names							
0	*	*	*	*	*	*	*	NOCONN
1	*	*	*	*	*	*	*	*

Display the status of NOCONN using the SEL-2032 **VIEW** and **TAR** commands. The subsection *Automatic Message Settings on page 4.2* describes the operation and settings associated with the NOCONN bit.

Status Information

The SEL-2032 provides status information on the SEL-2701 in two ways. You can connect to the SEL-2701 or SEL-2032 and use the **STATUS** command to view status messages and error codes. *Section 6: Troubleshooting* lists the possible error codes and status messages. See *Section 6* for more information on collecting status information from the SEL-2701 and host.

SEL-2701 Alarm

The SEL-2701 alarm is automatically included in the SEL-2032 SALARM bit. Conditions that activate an SEL-2701 alarm also activate the SEL-2032 alarm light and output contact. See *Section 6: Troubleshooting* for a list of conditions that assert the SEL-2701 alarm bit. For example, the SEL-2701 sets the alarm bit if you are unsuccessful when changing access levels with the **ACC** or **2AC** command. The **ACC** and **2AC** commands allow you three attempts to enter the password. If you enter an incorrect password on the third attempt, the SEL-2701 automatically sets the access level to 0 and activates the alarm bit.

Data Access

FTP

You can access the file structure and contents in *Table 4.7* after logging in as an FTP client. Files named for database regions contain the most current values at the time you request the files. You cannot write files to the SEL-2032. Files associated with the SEL-2701 are in the SEL-2701 directory, as described in *Section 3: Settings and Commands*.

Table 4.7 SEL-2032 File Structure (Sheet 1 of 2)

Root Directory	Subdirectory	File Names
/	SEL-2701	DIAGNOSTICS.TXT
	DD01_DeviceID	REGION1.TXT
		DNPMAP.TXT[a]
		DNPMAP*nn*.TXT[a,b]
		REGION1.CAS
		•
		•
		•

Table 4.7 SEL-2032 File Structure (Sheet 2 of 2)

Root Directory	Subdirectory	File Names
		REGIONn.TXT
		REGIONn.CAS

[a] Available only if DNP3 protocol option is included on your SEL-2701.
[b] Available only if the DNPMAP setting is set to CUSTOM where *nn* equates to the map number (01-05).

Telnet

You can establish three types of Telnet connections with the SEL-2032 and SEL-2701.

Telnet to the SEL-2032

For the first connection type, use the TCP/IP host port number (see setting T1PNUM in *Table 3.6*) to Telnet to the SEL-2032. This connection emulates the capabilities of a connection to the SEL-2032 front port, except that no automatic help is available. Help is still available using the SEL-2032 **HELP** command. It also makes available all SEL-2032 commands, including access level commands. Use access control rules and the name the SEL-2032 provides at log in to determine the initial access level.

After establishing a Telnet connection to the SEL-2032, you can make a transparent connection to an IED connected to an SEL-2032 serial port. See the *SEL-2032 Instruction Manual* for more information on transparent connections using the **PORT** command.

Use the **QUIT** command to log out and end the Telnet session.

Telnet From the SEL-2701

For the second connection type, use the SEL-2701 to reach across the Ethernet network to other devices. For example, to connect to a remote device on the Ethernet network, connect to an SEL-2032 serial port that is set for SEL protocol and master connection. Use the **PORT *n* "ip p"** command to start a connection to a remote device. For *n*, use the SEL-2032 port number where the SEL-2701 is installed. For ip, enter a network Internet Protocol (IP) address or a text network address from the SEL-2701 network address resolution settings. For p, use the Telnet port number (defaults to standard Telnet port of 23 if not specified).

Use the SEL-2032 transparent connection termination sequence (default is CTRL + D) to close the Telnet connection. If the remote device is an SEL IED you can use the **QUIT** command to log out before closing the Telnet connection.

Telnet to the SEL-2701

For the third connection type, use the TCP/IP port number (see setting T2PNUM in *Table 3.6*), to Telnet directly to the SEL-2701. This is useful for operating the SEL-2701 user interface to collect diagnostic data and perform other operations with the SEL-2701. Use the **QUIT** command to log out and end the Telnet session.

UCA2

The SEL-2701 provides the unique capability to allow both protective relays and other IEDs to integrate into UCA2 systems without the need to install a separate protocol converter and Ethernet network interface on each device. See *Section 3* for a description of UCA2 interface settings.

GOOSE

The SEL-2701 can generate and receive GOOSE messages. Acting as a single source and recipient of GOOSE messages, the SEL-2701 listens for and utilizes data in GOOSE messages from as many as eight GOOSE senders. For a description of SEL-2701 settings for outgoing GOOSE messages and to map incoming messages to specific control bits, see *Section 3*. The SEL-2701 communicates data from incoming GOOSE messages to the SEL-2032 as 64 incoming control points (CCIN1–CCIN64). The SEL-2701 automatically maps the outgoing control points CCOUT1–CCOUT64 to the first 64 outgoing GOOSE message bits.

EXAMPLE 4.1 Outgoing Control Points

The SEL-2701 uses outgoing control points to generate and send outgoing UCA2 GOOSE messages. To send the state of the SEL-2032 ALARM bit as User ST Bit 1 in the outgoing GOOSE message, set the SEL-2032 CCOUT1 setting as shown below. The example assumes that your SEL-2701 is installed on Port 17.

Enter the SEL-2032 SET O 17 command and set CCOUT1.

```
CCOUT1 = ALARM
```

If something either activates or deactivates the SEL-2032 ALARM, the SEL-2701 generates and transmits a new GOOSE message containing a bit pair representing the new state of ALARM. If the state changes to on, the bit pair is 10. If the state changes to off, the bit pair is 01.

EXAMPLE 4.2 Incoming Control Points

In this example, the incoming GOOSE Monitor 1 User ST Bit Pair 1 will control the Port 3 Remote Bit RB1. This example illustrates settings when the SEL-2701 is installed on Port 17 (Card 1). The SEL-2701 settings used to direct information from the incoming GOOSE message to the SEL-2032 and the Port 3 logic settings are shown below.

Port 17, SEL-2701 Settings

```
CTRLB1 = 1:0
CTRLB2 = 1:33
```

Port 3 Logic Settings

```
SRB1 = 17:CCIN2 * !17:CCIN1 + 17:CCIN1
CRB1 = !17:CCIN2 * !17:CCIN1
```

In this example, CTRLB1 is set with the special GOOSE Bit 0. Bit 0 is an alarm that turns on when the hold time for the previous GOOSE message has expired and during GOOSE ID resolution. This bit is used to force RB1 to a controlled state if the SEL-2701 no longer considers the GOOSE monitor active.

The first 32 incoming GOOSE bits form the DNA portion of the GOOSE message. Bit 33 is the first User ST bit in the incoming GOOSE message. Incoming GOOSE messages contain bit pairs that indicate status changes. If the bit pair is 10, it indicates a state change to on and 17:CCIN2 will be set. If the bit pair is 01, it indicates a state change to off and 17:CCIN2 will be cleared.

CTRLB1 and CTRLB2 appear inside the SEL-2032 as 17:CCIN1 and 17:CCIN2, respectively. The SRB1 and CRB1 settings for Port 3 set or clear RB1 based on the incoming message data.

When 17:CCIN1 is on, the SEL-2701 considers data from GOOSE Monitor 1 invalid. The !17:CCIN1 term in the SRB1 and CRB1 settings prevents setting or clearing RB1 if the incoming data are invalid. In the SRB1 setting, the 17:CCIN1 term forces RB1 on when incoming data are invalid.

If the 17:CCIN1 term resides in the CRB1 setting as shown below, RB1 is automatically cleared any time the incoming GOOSE message data are invalid.

```
SRB1 = 17:CCIN2 * !17:CCIN1
CRB1 = !17:CCIN2 * !17:CCIN1 + 17:CCIN1
```

If there is no 17:CCIN1 term in SRB1 or CRB1, RB1 will not change state when the incoming data are invalid.

The SEL-2701 polls the SEL-2032 control bits (CCOUT1–CCOUT32) every 100 ms. You must design your logic so that control bits remain in any new state for at least 100 ms or the SEL-2701 may not recognize the new state. For example, if CCOUT1 changes from a logical 0 to a logical 1 and back to logical 0 in less than 100 ms, the SEL-2701 may not recognize the changes and not send outgoing GOOSE messages. If CCOUT1 remains in the new state for more than 100 ms, the SEL-2701 will recognize the change and send corresponding GOOSE messages. This behavior only affects control bits that you configure with control equations that include remote bits, breaker bits, other control bits, and intermediate logic bits. Data in the User and Data regions are updated at 500 ms or slower and are not affected.

GOMSFE

GOMSFE is a system that contains both standard ways (bricks) to organize and represent data as well as rules for vendor-specific extensions. On a UCA2 network, the SEL-2701 appears as a single Logical Device. The SEL-2032 Logical Device contains one Virtual Device for each connected IED. Each Virtual Device contains standard and extended GOMSFE model bricks to convey available data. The available data and bricks vary based on the connected IEDs. You can observe available data by browsing the UCA2 interface with an MMS browser.

The model description in *Appendix B: UCA2 GOMSFE Models* provides rules for the population of GOMSFE models. SEL-2701 data are based on labels in the SEL-2032. This process is automatic for SEL relays.

For SEL relays, the SEL-2701 populates models based on data collected by the SEL-2032. To populate models with SEL relay data, use the following steps:

Step 1. Configure the SEL-2032 port connected to the relay for SEL protocol and perform an autoconfiguration.

Step 2. Use the GOMSFE tables to determine what SEL-2032 data collection (e.g., 20HISTORY) is necessary for the GOMSFE bricks you want to use.

Step 3. Use “20 message” commands to collect SEL relay data.

When relay data are available in the SEL-2032, the SEL-2701 will automatically collect data from the Data regions and use it to populate available models.

For non-SEL IEDs, the SEL-2701 populates models based on user-entered database register element labels. To populate GOMSFE models for non-SEL IEDs use the following steps:

Step 1. Configure the SEL-2032 to collect data from the IED into database regions.

Step 2. Transfer the data into the SEL-2032 User region using Math/Data Movement commands (**SET M**) and label with the labels listed in *Appendix B: UCA2 GOMSFE Models*.

Step 3. The SEL-2701 will automatically collect data from the labeled registers and use it to populate the available models.

Generic Analog Data

The SEL-2701 maps up to 64 analog values to each GLOBE model. The SEL-2701 maps data in the User region with the labels ANALOG01–ANALOG64 to the MX functional component of GLOBE. Only the data that are labeled are presented in the GLOBE model; if you do not label any data ANALOG01–ANALOG64, then no analog value items appear in GLOBE.

You can format the data as 16-bit integers or 32-bit floating point numbers. Use SEL-2032 math/movement settings to move and format data within the SEL-2032. For example, if you want to map the A-phase current scaled by 10 (as an integer) on Port 1 to the GLOBE item ANALOG01, enter 0h,i;;ANALOG01=1:METER:IA*10. To format the data as a floating point value use 0h,f;;ANALOG01:=1:METER:IA*10. See the *SEL-2032 Instruction Manual* for complete information on the syntax of SEL-2032 math/movement settings.

Using math/movement settings, you can collect, scale, and manipulate data from any port database of the SEL-2032. The SEL-2701 automatically maps data to the GLOBE model. For example, if you have less than 64 items total, you may want to collect all data to the port (Port 17 or 18) where the SEL-2701 is installed. If you wish to have data associated with a local virtual device, then you can program math/movement settings on each port.

Generic Binary Data

The SEL-2701 maps up to 256 binary values to each GLOBE model. The SEL-2701 maps bits from 16 data words to items within the GLOBE model as shown in *Table 4.8*. The Example Setting column shows an example math/movement equation that you could use to pack data into DWORD01 using address 1 of the User region. The remaining bits of DWORD01 are unused and will remain zero. You must include the label for the data word in the last math/movement statement that references the data word where you are packing the binary information (see setting for DWORD01B08$b1 in *Table 4.8*).

Table 4.8 Example GLOBE Generic Binary Data Mapping (Sheet 1 of 2)

Item	Port 2, Target Region Data	Example Setting
DWORD01B01$b1	52a	001h:0;B = 2:TARGET:52A
DWORD01B02$b1	EN	001h:1;B = 2:TARGET:EN
DWORD01B03$b1	IN101	001h:2;B = 2:TARGET:IN101
DWORD01B04$b1	IN102	001h:3;B = 2:TARGET:IN102

Table 4.8 Example GLOBE Generic Binary Data Mapping (Sheet 2 of 2)

Item	Port 2, Target Region Data	Example Setting
DWORD01B05$b1	IN103	001h:4;B = 2:TARGET:IN103
DWORD01B06$b1	IN104	001h:5;B = 2:TARGET:IN104
DWORD01B07$b1	IN105	001h:6;B = 2:TARGET:IN105
DWORD01B08$b1	IN106	001h:7;B;DWORD01 = 2:TARGET:IN106
DWORD01B09$b1	Unused, 0	N/A
DWORD01B10$b1	Unused, 0	N/A
DWORD01B11$b1	Unused, 0	N/A
DWORD01B12$b1	Unused, 0	N/A
DWORD01B13$b1	Unused, 0	N/A
DWORD01B14$b1	Unused, 0	N/A
DWORD01B15$b1	Unused, 0	N/A
DWORD01B16$b1	Unused, 0	N/A

Remote Bits

You can control the remote bits associated with each SEL-2032 port using the UCA2 GCTL brick. GCTL is a generic control brick that appears in each virtual device domain. Each GCTL brick contains 16 ST (Status) and 16 CO (Control) bits that are associated with RB1–RB16 on that port. You can control the remote bits by writing the 2-bit set (10) or clear (01) code to the appropriate CO bit.

DNP3

Standard or customized DNP3 data within the SEL communications processor is available to each DNP3 session configured in the SEL-2701. The DNPMAP setting specifies which type of data is made available to DNP3 on the SEL-2701, i.e., DNPMAP = “AUTO” for standard data, DNPMAP = “CUSTOM” for customized data.

DNPMAP = AUTO

If DNPMAP = AUTO, the SEL communications processor automatically maps data within the SEL-2701 port’s USER region to DNP3 points. This includes all control points (Remote Bits and communications card control points) within the communications processor that are associated with the SEL-2701 port.

User Region Mapping

If the DNPMAP setting is set to its default of AUTO, then the communication processor automatically finds data within the user region associated with the SEL-2701 (Port 17 or Port 18). This process is very similar to the automatic data mapping process for serial DNP3 (Port 16). The SEL-2701 processes data, determining the types within the SEL-2701 and mapping them to data types in DNP3.

Use math/movement settings in the communications processor to move and scale data for DNP3. The data type assigned to the destination register within the User region determines the DNP3 data type. The available data types and mapping are listed in *Table 4.9*.

For numeric types (integer, floating point, etc.), the data are available as every valid variation. For example, if you configure data as an integer, you can use the floating point variation, variation 5 of object 30, to read the value, but it will be truncated. To make floating point data available, type the data as floating point in the math/movement setting as shown in *Table 4.9*.

Table 4.9 DNP3 Data Type Mapping

User Region Data Type	DNP3 Data Type	Example Math/ Movement Setting
Integer	30, 32	0h=1:METER:IA
Floating Point	30, 32	0h;F=1:METER:IA
Binary	1, 2	1h:1;B=1:TARGET:52A
Counter	20, 22	2h;C=1:USER:0

Use the SEL-2701 **DNPMAP** command or collect the DNPMAP.TXT file from the FTP interface to view the DNP3 data map. If labels are included in math/movement settings, they will be displayed in the response to the **DNPMAP** command and in the file.

Control

There are two mechanisms for control within the SEL-2701. First, analog outputs, object 40, allow you to send analog control setpoint values to the communications processor. Second, control relay output blocks, Object 12, can be used to send binary controls to the communications processor.

Object 40 indices 0–255 provide 256 analog outputs from the DNP3 master. Data written to indices 0–255 are available in the Data Region 1 (D1) associated with the port (17 or 18) where the SEL-2701 is installed.

The control map is determined by the DNPPAIR setting. *Table 4.10* shows the control point mapping with the setting DNPPAIR set to N. *Table 4.11* shows the control point mapping with DNPPAIR set to Y. See *Example 4.3* for more information on how to use DNP3 control points to enable and disable functions in SEL devices connected to the communications processor.

If the SEL-2701 receives a DNP3 control command from a recognized master, it will pulse, set, or clear the appropriate control bit in the communications processor. The communications processor will then proceed to perform the commanded operation on the end device. For breaker and remote bit (BR and RB) operations, control bits are pulsed, and do not need to be reset or cleared after a successful operation, nor before the next one.

Table 4.10 Object 12 Control Object Operation, DNPMAP = AUTO, DNPPAIR = N (Sheet 1 of 2)

Indices	Control Points	Trip / Close Pairs		Code Selection Operation			
		Close (0x4X)	Trip (0x8X)	Latch On (3)	Latch Off (4)	Pulse On (1)	Pulse Off (2)
0-63	CCIN1–CCIN64	SET	CLEAR	SET	CLEAR	SET	CLEAR
64	1:RB1	Pulse 1:SRB1	Pulse 1:CRB1	Pulse 1:SRB1	Pulse 1:CRB1	Pulse 1:SRB1	Pulse 1:CRB1
65	1:RB2	Pulse 1:SRB2	Pulse 1:CRB2	Pulse 1:SRB2	Pulse 1:CRB2	Pulse 1:SRB2	Pulse 1:CRB2
66	1:RB3	Pulse 1:SRB3	Pulse 1:CRB3	Pulse 1:SRB3	Pulse 1:CRB3	Pulse 1:SRB3	Pulse 1:CRB3
• • •							
79	1:RB16	Pulse 1:SRB16	Pulse 1:CRB16	Pulse 1:SRB16	Pulse 1:CRB16	Pulse 1:SRB16	Pulse 1:CRB16

Table 4.10 Object 12 Control Object Operation, DNPMAP = AUTO, DNPPAIR = N (Sheet 2 of 2)

Indices	Control Points	Trip / Close Pairs		Code Selection Operation			
		Close (0x4X)	Trip (0x8X)	Latch On (3)	Latch Off (4)	Pulse On (1)	Pulse Off (2)
80	2:RB01	Pulse 2:SRB1	Pulse 2:CRB1	Pulse 2:SRB1	Pulse 2:CRB1	Pulse 2:SRB1	Pulse 2:CRB1
•							
•							
•							
351	18:RB16	Pulse 18:SRB16	Pulse 18:CRB16	Pulse 18:SRB16	Pulse 18:CRB16	Pulse 18:SRB16	Pulse 18:CRB16
352	1:BR1	Pulse 1:CBR1	Pulse 1:SBR1	Pulse 1:SBR1	Pulse 1:CBR1	Pulse 1:SBR1	Pulse 1:CBR1
353	1: BR2	Pulse 1:CBR2	Pulse 1:SBR2	Pulse 1:SBR2	Pulse 1:CBR2	Pulse 1:SBR2	Pulse 1:CBR2
354	1: BR3	Pulse 1:CBR3	Pulse 1:SBR3	Pulse 1:SBR3	Pulse 1:CBR3	Pulse 1:SBR3	Pulse 1:CBR3
•							
•							
•							
367	1:BR16	Pulse 1:CBR16	Pulse 1:SBR16	Pulse 1:SBR16	Pulse 1:CBR16	Pulse 1:SBR16	Pulse 1:CBR16
368	2:BR1	Pulse 2:CBR1	Pulse 2:SBR1	Pulse 2:SBR1	Pulse 2:CBR1	Pulse 2:SBR1	Pulse 2:CBR1
•							
•							
•							
607	16:BR16	Pulse 16:CBR16	Pulse 16:SBR16	Pulse 16:SBR16	Pulse 16:CBR16	Pulse 16:SBR16	Pulse 16:CBR16

Table 4.11 Object 12 Control Object Operation, DNPMAP = AUTO, DNPPAIR = Y (Sheet 1 of 2)

Indices	Control Points	Trip / Close Pairs		Code Selection Operation			
		Close (0x4X)	Trip (0x8X)	Latch On (3)	Latch Off (4)	Pulse On (1)	Pulse Off (2)
0-63	CCIN1–CCIN64	SET	CLEAR	SET	CLEAR	SET	CLEAR
64	1:RB02/RB01	Pulse 1:SRB02	Pulse 1:SRB01	Pulse 1:SRB02	Pulse 1:SRB01	Pulse 1:SRB02	Pulse 1:SRB01
65	1:RB04/RB03	Pulse 1:SRB04	Pulse 1:SRB03	Pulse 1:SRB04	Pulse 1:SRB03	Pulse 1:SRB04	Pulse 1:SRB03
66	1:RB06/RB05	Pulse 1:SRB06	Pulse 1:SRB05	Pulse 1:SRB06	Pulse 1:SRB05	Pulse 1:SRB06	Pulse 1:SRB05
•							
•							
•							
71	1:RB16/RB15	Pulse 1:SRB16	Pulse 1:SRB15	Pulse 1:SRB16	Pulse 1:SRB15	Pulse 1:SRB16	Pulse 1:SRB15
72	2:RB02/RB01	Pulse 2:SRB02	Pulse 2:SRB01	Pulse 2:SRB02	Pulse 2:SRB01	Pulse 2:SRB02	Pulse 2:SRB01
•							
•							
•							
207	18:RB16/RB15	Pulse 18:SRB16	Pulse 18:SRB15	Pulse 18:SRB16	Pulse 18:SRB15	Pulse 18:SRB16	Pulse 18:SRB15
208	1:BR1	Pulse 1:CBR1	Pulse 1:SBR1	Pulse 1:SBR1	Pulse 1:CBR1	Pulse 1:SBR1	Pulse 1:CBR1
209	1:BR2	Pulse 1:CBR2	Pulse 1:SBR2	Pulse 1:SBR2	Pulse 1:CBR2	Pulse 1:SBR2	Pulse 1:CBR2
210	1:BR3	Pulse 1:CBR3	Pulse 1:SBR3	Pulse 1:SBR3	Pulse 1:CBR3	Pulse 1:SBR3	Pulse 1:CBR3
•							
•							
•							
223	1:BR16	Pulse 1:CBR16	Pulse 1:SBR16	Pulse 1:SBR16	Pulse 1:CBR16	Pulse 1:SBR16	Pulse 1:CBR16
224	2:BR1	Pulse 2:CBR1	Pulse 2:SBR1	Pulse 2:SBR1	Pulse 2:CBR1	Pulse 2:SBR1	Pulse 2:CBR1

Table 4.11 Object 12 Control Object Operation, DNPMAP = AUTO, DNPPAIR = Y (Sheet 2 of 2)

Indices	Control Points	Trip / Close Pairs		Code Selection Operation			
		Close (0x4X)	Trip (0x8X)	Latch On (3)	Latch Off (4)	Pulse On (1)	Pulse Off (2)
• • • 463	16:BR16	Pulse 16:CBR16	Pulse 16:SBR16	Pulse 16:SBR16	Pulse 16:CBR16	Pulse 16:SBR16	Pulse 16:CBR16

DNPMAP = CUSTOM

If DNPMAP = CUSTOM, only the data/controls points referenced by the custom DNP maps will be accessible via DNP3.

Custom DNP Mapping

If the DNPMAP setting is set to CUSTOM, then up to five data maps may be created and assigned to any of ten Master station connections. These custom maps allow data sets to be prepared and segregated based on the requestor's DNP3 and IP addresses. Please refer to the appropriate Communications Processor manual for more information.

The easiest way to create custom data maps is via SEL-5020 software. See *Figure 4.1*, *Figure 4.2*, and *Figure 4.3* for sample SEL-5020 screen captures of custom DNP3 maps. You may use absolute addresses or data labels to populate custom DNP3 maps.

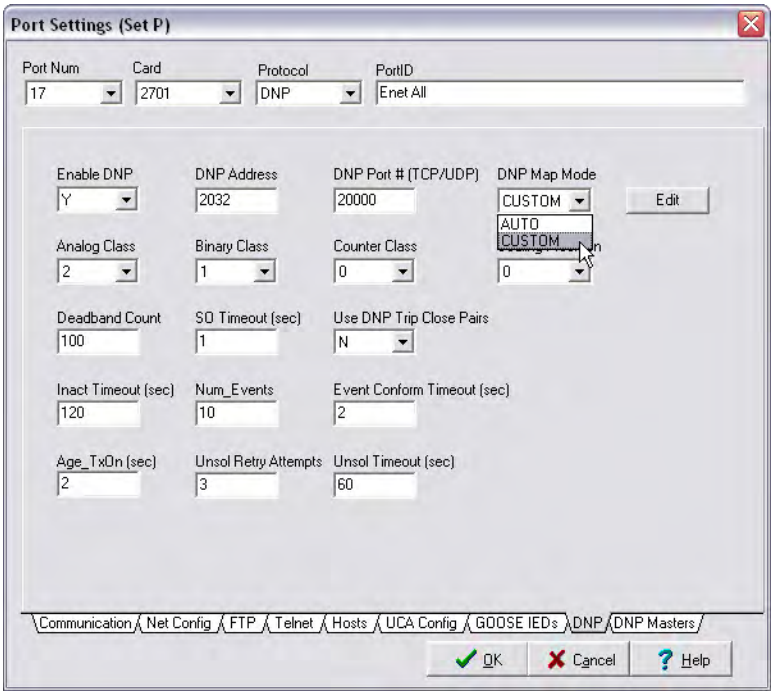

Figure 4.1 Setting CUSTOM DNP Map Mode in SEL-5020

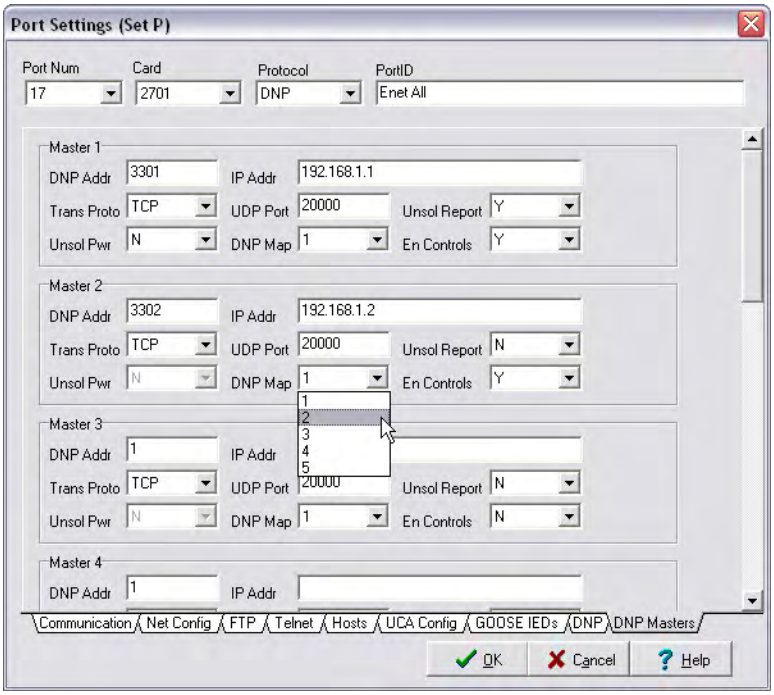

Figure 4.2 Sample Custom DNP Maps by Master in SEL-5020

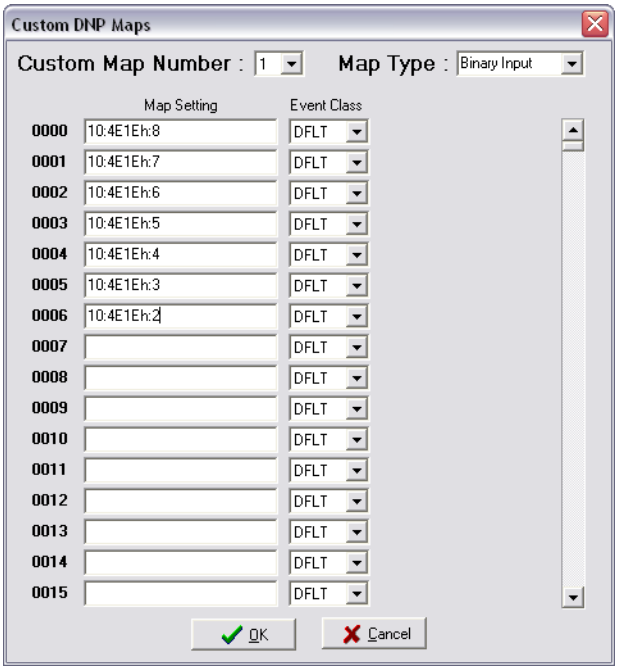

Figure 4.3 Sample Custom Binary Input DNP Map in SEL-5020

All data types supported in AUTO mode are also supported in CUSTOM mode. The CUSTOM math/movement settings have the same available data types and mappings listed in *Table 4.9*. Additionally in CUSTOM mode, analog inputs may be referenced by a database address as well as an optional "treat-as" qualifier. If no "treat-as" qualifier is specified, then the point retains its database type when mapped. Please review *Appendix D: DNP3 Communications* for configuration parameters.

In CUSTOM mode, the **DNPMAP** command is used to provide summary information for all customized DNP3 session maps, including local and

NOTE: You must first establish a virtual terminal session to the appropriate Ethernet processor with the **PORT 17** or **PORT 18** command to use **DNPMAP** for LAN/WAN maps.

master DNP addresses, master IP addresses, transport protocols, and associated maps. The addition of a space and the integer parameter ‘i’ to the **DNPMAP** command is used to view detailed custom map configurations. For example, the command **DNPMAP 3** will return the configuration of the custom DNP3 data map of Session 3, if it exists.

In addition to the **DNPMAP** commands, corresponding text files available through the FTP interface provide summary and detailed custom map configurations. These text files follow the DNPMAP*nn*.TXT naming convention, where *nn* is the two-digit number of the custom map. For example, the custom DNP3 data map configuration of Session 4 is represented in the FTP interface as DNPMAP04.TXT.

Custom Controls

Analog output objects (object 40), and control relay output blocks (object 12), are also supported in custom DNP3 data maps.

The analog outputs that are included in the DNP map must be defined by the custom DNP Map files. The total number of analog output control points allowed per map is 64, and total system capacity for all custom DNP maps is 256 analog output points with unique references. The mapping of the DNP analog output points is restricted to only those registers contained in the D1 data region associated with the SEL-2701.

The binary outputs that are included in the DNP3 map must also be defined by the custom DNP Map files. The total allowed binary output control points per map are 512.

When DNPMAP = CUSTOM, the DNPPAIR setting is ignored. Instead of referring to the DNPPAIR setting for paired or non-paired points, the control point is associated to the Binary Output by a Control Point Identifier (CPId). The CPId represents either a single control point (non-paired) or two control points (paired), and the operation selects the control point. A custom DNP3 map may contain any combination of paired and non-paired Binary Output control points.

If the SEL-2701 receives a DNP3 control command from a recognized master, it will pulse, set, or clear the appropriate control bit in the communications processor. The communications processor will then proceed to perform the commanded operation on the end device. For breaker and remote bit (BR and RB) operations, control bits are pulsed, and do not need to be reset or cleared after a successful operation, nor before the next one.

Table 4.12 Object 12 Control Object Operation, DNPMAP = CUSTOM

Indices (CPId)	Control Points	Trip / Close Pairs		Code Selection Operation			
		Close (0x4X)	Trip (0x8X)	Latch On (3)	Latch Off (4)	Pulse On (1)	Pulse Off (2)
0-63	CCIN01–CCIN 64	SET	CLEAR	SET	CLEAR	SET	CLEAR
64	1:RB1	Pulse 1:SRB1	Pulse 1:CRB1	Pulse 1:SRB1	Pulse 1:CRB1	Pulse 1:SRB1	Pulse 1:CRB1
65	1:RB2	Pulse 1:SRB2	Pulse 1:CRB2	Pulse 1:SRB2	Pulse 1:CRB2	Pulse 1:SRB2	Pulse 1:CRB2
66	1:RB3	Pulse 1:SRB3	Pulse 1:CRB3	Pulse 1:SRB3	Pulse 1:CRB3	Pulse 1:SRB3	Pulse 1:CRB3
•							
•							
•							
79	1:RB16	Pulse 1:SRB16	Pulse 1:CRB16	Pulse 1:SRB16	Pulse 1:CRB16	Pulse 1:SRB16	Pulse 1:CRB16
80	2:RB1	Pulse 2:SRB1	Pulse 2:CRB1	Pulse 2:SRB1	Pulse 2:CRB1	Pulse 2:SRB1	Pulse 2:CRB1
•							
•							
•							
351	18:RB16	Pulse 18:SRB16	Pulse 18:CRB16	Pulse 18:SRB16	Pulse 18:CRB16	Pulse 18:SRB16	Pulse 18:CRB16
352	1:RB02/RB01	Pulse 1:SRB02	Pulse 1:SRB01	Pulse 1:SRB02	Pulse 1:SRB01	Pulse 1:SRB02	Pulse 1:SRB01
353	1:RB04/RB03	Pulse 1:SRB04	Pulse 1:SRB03	Pulse 1:SRB04	Pulse 1:SRB03	Pulse 1:SRB04	Pulse 1:SRB03
354	1:RB06/RB05	Pulse 1:SRB06	Pulse 1:SRB05	Pulse 1:SRB06	Pulse 1:SRB05	Pulse 1:SRB06	Pulse 1:SRB05
•							
•							
•							
359	1:RB16/RB15	Pulse 1:SRB16	Pulse 1:SRB15	Pulse 1:SRB16	Pulse 1:SRB15	Pulse 1:SRB16	Pulse 1:SRB15
360	2:RB02/RB01	Pulse 2:SRB02	Pulse 2:SRB01	Pulse 2:SRB02	Pulse 2:SRB01	Pulse 2:SRB02	Pulse 2:SRB01
•							
•							
•							
495	18:RB16/RB15	Pulse 18:SRB16	Pulse 18:SRB15	Pulse 18:SRB16	Pulse 18:SRB15	Pulse 18:SRB16	Pulse 18:SRB15
496	1:BR1	Pulse 1:CBR1	Pulse 1:SBR1	Pulse 1:SBR1	Pulse 1:CBR1	Pulse 1:SBR1	Pulse 1:CBR1
497	1:BR2	Pulse 1:CBR2	Pulse 1:SBR2	Pulse 1:SBR2	Pulse 1:CBR2	Pulse 1:SBR2	Pulse 1:CBR2
498	1:BR3	Pulse 1:CBR3	Pulse 1:SBR3	Pulse 1:SBR3	Pulse 1:CBR3	Pulse 1:SBR3	Pulse 1:CBR3
•							
•							
•							
511	1:BR16	Pulse 1:CBR16	Pulse 1:SBR16	Pulse 1:SBR16	Pulse 1:CBR16	Pulse 1:SBR16	Pulse 1:CBR16
512	2:BR1	Pulse 2:CBR1	Pulse 2:SBR1	Pulse 2:SBR1	Pulse 2:CBR1	Pulse 2:SBR1	Pulse 2:CBR1
•							
•							
•							
751	16:BR16	Pulse 16:CBR16	Pulse 16:SBR16	Pulse 16:SBR16	Pulse 16:CBR16	Pulse 16:SBR16	Pulse 16:CBR16

Example 4.3 shows how DNP3 control points enable and disable functions in an SEL-351S Relay connected to your communications processor.

EXAMPLE 4.3 Enable/Disable Function in SEL-351S Via DNP3

This example demonstrates how to control a Latch Bit in the SEL-351S relay connected to the SEL-2032 shown in *Figure 4.4*. The example and the settings shown are also valid for an SEL-2030. A latch bit is a nonvolatile (does not lose state if the relay loses power). You can use a latch bit to enable or disable functions in the relay including reclosing and ground overcurrent protection or for status tagging.

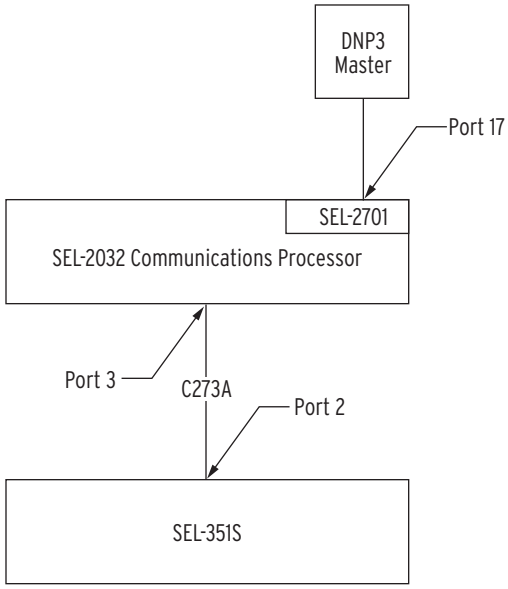

Figure 4.4 Example SEL-2032/SEL-351S System

The DNP3 master uses the Trip/Close pair (DNPPAIR = Y) at Index 80 to control Port 3 Remote Bit 1 (3:RB1) and Port 3 Remote Bit 2 (3:RB2) in the SEL-2032. When the DNP3 master operates one of the remote bits, the SEL-2032 automatically sends a message to the SEL-351S to pulse RB1 or pulse RB2 IF SEND_OPER = YP. These pulse messages either set or clear the latch bit in the relay.

Figure 4.5 illustrates the sequence that occurs when the DNP3 master sets the latch bit in the relay. The DNP3 master sends a CLOSE command to Object 12 Index 80 that results in a set operation for 3:RB2. The set operation for 3:RB2 triggers a message to the relay to pulse RB2 within the relay. The pulse action of RB2 sets Latch Bit 1 in the relay.

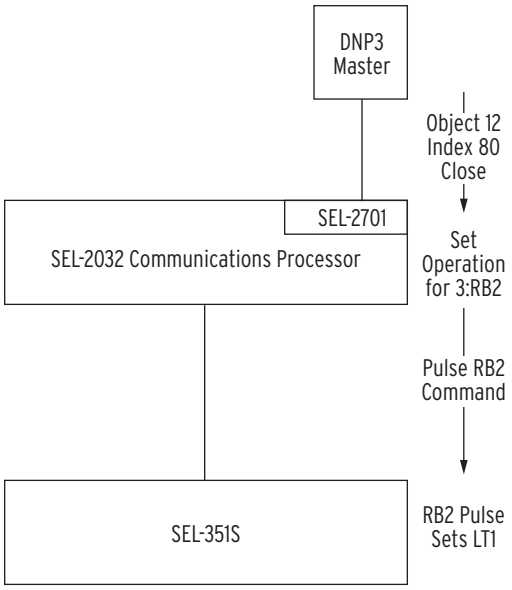

Figure 4.5 Set Latch Bit Control Operation

Figure 4.6 illustrates the sequence that occurs when the DNP3 master clears the latch bit in the relay. The DNP3 master sends a TRIP command to Object 12 Index 80 that results in a set operation for 3:RB1. The set operation for 3:RB1 triggers a message to the relay to pulse RB1 within the relay. The pulse action of RB1 clears Latch Bit 1 in the relay.

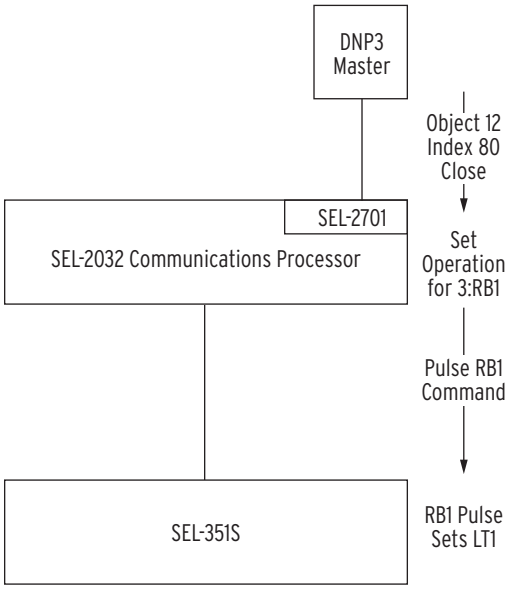

Figure 4.6 Clear Latch Bit Control Operation

For this system to operate, you must configure several settings in the SEL-351S and SEL-2032. In the SEL-351S, you must configure the settings listed in *Table 4.13*. Only the settings required for this example are shown. Other settings may be configured to meet your system requirements or left at the factory default.

Table 4.13 SEL-351S Example Settings

Setting Area	Setting	Description
Port 2	FASTOP = Y	Enable processing of Fast Operate messages
Logic	SET1 = RB2	Set Latch Bit 1 when RB2 pulses
	RST1 = RB1	Clear Latch Bit 2 when RB1 pulses

Table 4.14 lists the settings for the SEL-2032 Communications Processor. Note that there are no settings to reset the remote bits in the communications processor. Fast Operate messages are generated as a result of the request to set the remote bits rather than the state of the remote bits in the SEL-2032. In this example, the DNP3 master is Master 1.

Table 4.14 SEL-2032 Example Settings

Setting Area	Setting	Description
Port 3	SEND_OPER = YP	Send logic pulses
Port 17	ENDNP = Y	Enable DNP3
	DNPADR[a]	DNP3 address of SEL-2701
	DNPPNUM[a]	Port for DNP3 communication
	RPADR01[a]	Master 1 DNP3 address
	DNPIP01[a]	Master 1 IP address
	DNPTR01[a]	Master 1 transport protocol
	DNPUP01[a]	Master 1 UDP response port b
	UNSL01[a]	Master 1 unsolicited reporting enable for
	PUNSL01[a]	Master 1 unsolicited reporting enabled at power up
	DNPCL01 = Y	Enable Master 1 controls
	DNPMP01 = USER	Master 1 DNP data map selection
	DNPPAIR = Y	Enable DNP3 control point pair mode

[a] Set as required for your application.

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Section 5

SEL-400 Series Host

Introduction

This section describes applications where the SEL-2701 Ethernet Processor is installed in an SEL-400 series relay. This section contains information on the following topics.

- Accessing SEL-2701 settings
- Accessing data through the SEL-2701
- Checking SEL-2701 status
- Accessing the SEL-2701 user interface

For detailed explanations of SEL-2701 commands and settings, refer to *Section 3: Settings and Commands*. See *Section 2: Installation* for instructions on how to install an SEL-2701 in a host. See the instruction manual for your relay for additional information about relay commands, settings, and operations. The relay instruction manual also contains information about upgrading SEL-2701 and relay firmware.

Features and Capabilities

Installing an SEL-2701 in an SEL-400 series relay provides the following features and capabilities.

- Ethernet physical connection
  - 10/100 Mbps on twisted-pair media
  - 100 Mbps on fiber-optic media
  - Redundant network ports with automatic failover
- Telnet
  - Server for connections to SEL-2701
  - Server for connections to the relay
- FTP server for data files within the relay and SEL-2701
- UCA2
  - GOMSFE models
  - GOOSE messages
- DNP3 Level 2 Slave

Settings

Access the settings for the SEL-2701 using the relay settings commands and the port number where the SEL-2701 is installed. These commands provide access to some additional settings that govern how the relay interacts with the SEL-2701. This section only describes the relay settings and behavior specific to installations that include an SEL-2701. See the relay instruction manual for complete syntax and examples for relay commands.

Port Settings

Use the relay port settings to set the SEL-2701 for operation on your network. SEL-400 series relay port settings also include the SEL-2701 settings described in *Section 3: Settings and Commands*.

Access these settings with the relay **SET P *n*** command, where *n* is the port number where the SEL-2701 is installed. Port settings for a relay port with an installed SEL-2701 are listed in *Table 5.1*. Relay port control settings with details are listed in *Table 5.2*.

Table 5.1 SEL-400 Series Relay Port Settings With SEL-2701 Installed

Settings	Reference
Relay Port Control	*Table 5.2*
Network Configuration	*Table 3.1*
Network Address Resolution	*Table 3.3*
FTP	*Table 3.5*
Telnet	*Table 3.6*
UCA2	*Table 3.7*
DNP3	*Table 3.8*

Table 5.2 SEL-400 Series Relay Port Control Settings With SEL-2701 Installed

Label	Description	Range	Default
TIMEOUT	Timeout period for virtual terminal connection	Off, 0–60 minutes	5
AUTO	Port auto-message enable	Y, N	Y
FASTOP	Fast Operate message enable	Y, N	Y
TERTIM1	Length of time the channel must be idle before checking for the termination string	0–600 seconds	1
TERSTRN	Transparent communication termination string	Up to 9 characters	\005 which is CTRL + E or \006 which is CTRL + F
TERTIM2	Length of time the channel must be idle before accepting the termination string	0–600 seconds	0

Outgoing Control Points

Outgoing control points are used by the relay to send binary information to the SEL-2701. The SEL-2701 uses these bits for protocol-specific operations. For example, the SEL-2701 generates GOOSE messages using the outgoing control points. Access settings for outgoing control points using the **SET O *n*** command, where *n* is the port number where the SEL-2701 is installed.

Operation

Access Control

Access control is the process of deciding who can log in to the relay or SEL-2701. The relay limits functionality based on access level. Relay access levels are described in *Table 5.3*.

Table 5.3 SEL-400 Series Relay Access Levels

Access Level	Primary Operations Allowed
0	Log in to Access Level 1
1	View data and settings and establish transparent connections
B	Access Level 1 functions and control/monitor circuit breaker
P	Access Level 1 functions plus change Protection settings
A	Access Level 1 functions plus change Automation settings
O	Access Level 1 functions plus change Output settings
2	Access Level 1 functions and change any settings
C	Access Level C functions (SEL use only)

The SEL-2701 user interface uses a subset of the relay access levels and passwords. When you establish a terminal connection directly to the SEL-2701 user interface, use the passwords programmed into the relay for Access Levels 0, 1, and 2. You can change a password using the relay **PASSWORD** command at Access Level 2. See your relay instruction manual for a full description of the **PASSWORD** command.

To log in as an FTP client, use the username and corresponding password for that access level as shown in *Table 5.4*. You do not need to log in to start a Telnet session. After you connect, you can use the standard relay login process to change access levels.

Table 5.4 SEL-400 Series Relay Access Level Usernames and Passwords

Access Level	Username	Password
0	QUI	None
1	ACC	User-definable
B	BAC	User-definable
P	PAC	User-definable
A	AAC	User-definable
O	OAC	User-definable
2	2AC	User-definable
C	CAL	User-definable

SEL-2701 User Interface

You can access the SEL-2701 user interface with a Telnet connection directly to the SEL-2701. Once you are connected to the SEL-2701 user interface, you can use the commands described in *Section 3: Settings and Commands*. SEL-2701 settings are not accessible through the SEL-2701 user interface. Set the SEL-2701 through the relay port settings for the port where the SEL-2701 is installed. Log in to the SEL-2701 access levels using the passwords set in the relay.

Control Points

The SEL-2701 and relay exchange binary control information via control points. The relay sends control points CCOUT1–CCOUT*n* to the SEL-2701 for outgoing protocol data. Incoming message data appear in the relay as incoming control points CCIN1–CCIN*n*. The total number of CCOUT and CCIN points represented by the *n* in the previous references varies in different relay models.

The SEL-2701 automatically uses the CCOUT1–CCOUT*n* control points in outgoing messages. For example, the SEL-2701 uses outgoing control points to generate GOOSE messages. Use the relay output settings to set these bits with SELOGIC control equations. Access these settings using the relay **SET O** command. See your relay instruction manual for a full description of the output logic settings.

Both input and output control points are Relay Word bits. You can use these control points in any SELOGIC control equation in the relay including settings for protection and automation freeform logic. You can view the control point status using the relay **TAR** command.

Status Information

You can obtain status information on the SEL-2701 directly from the SEL-2701 and through the relay. Connect to the SEL-2701 or relay and use the **STATUS** command to view status messages and error codes. See *Section 6: Troubleshooting* for more information on collecting status information from the SEL-2701 and host.

SEL-2701 Alarm

The SEL-2701 alarm is automatically included in the SEL-400 series relay SALARM bit. Conditions that activate an SEL-2701 alarm also activate the SEL-400 series relay alarm light and output contact. See *Alarm Bit on page 6.5* for a list of conditions that assert the SEL-2701 alarm bit. For example, the SEL-2701 sets the alarm bit if you are unsuccessful when changing access levels with the **ACC** or **2AC** command. The **ACC** and **2AC** commands allow you three attempts to enter the password. If you enter an incorrect password on the third attempt, the SEL-2701 automatically sets the access level to 0 and activates the alarm bit.

Testing

Use the SEL-400 series relay command **TEST DB** to test communication with master devices by sending test values to the SEL-2701. The test values replace measured values without disturbing relay protection functions. For example, you can force the value of A-phase current in the database to a test value that you can observe in the UCA2 MMXU model. See the relay instruction manual for details of the **TEST DB** command.

Data Access

FTP

You can access the file structure and contents described in *Table 5.5* after logging in to the SEL-2701 as an FTP client. Files named for database regions contain the most current values at the time you request the files. You can write files to the SEL-400 series relay only if you are logged in at the appropriate level. See your relay instruction manual for more information on files in the SEL-400 series relays. Files associated with the SEL-2701 are in the SEL-2701 directory, as described in *Section 3: Settings and Commands*.

Table 5.5 SEL-400 Series Relay File Structure

Root Directory	Subdirectory	File/Subdirectory Names
/	SEL-2701	DIAGNOSTICS.TXT
	DD01_DeviceID	REGION1.TXT
		REGION1.CAS
		•
		•
		•
		REGIONn.CAS
	DeviceID	SETTINGS subdirectory
		REPORTS subdirectory
		EVENTS subdirectory

Telnet

You can establish two types of Telnet connections with the relay and the SEL-2701.

Telnet to the Relay

For the first connection type, use the TCP/IP host port number (see setting T1PNUM in *Table 3.6*) to Telnet to the relay. This connection emulates the capabilities of a connection to the relay front port. All relay commands are available, including access level commands. Use the **QUIT** command to log out and end the Telnet session.

Telnet to the SEL-2701

For the second connection type, use the SEL-2701 TCP/IP port number (see setting T2PNUM in *Table 3.6*) to Telnet directly to the SEL-2701. This is useful for operating the SEL-2701 user interface to collect diagnostic data and perform other operations with the SEL-2701. Use the QUIT command to log out and end the Telnet session.

UCA2

The SEL-2701 installed directly in an SEL-400 series relay provides a high performance UCA2 network interface that is designed for operation in a substation environment.

GOOSE

The SEL-2701 can generate and receive GOOSE messages. Acting as a single source and recipient of GOOSE messages, the SEL-2701 listens for and utilizes data in GOOSE messages from as many as eight GOOSE senders. For a description of SEL-2701 settings for outgoing GOOSE messages and to map incoming messages to specific control bits, see *Section 3: Settings and Commands*. The SEL-2701 communicates data from incoming GOOSE messages to the relay as incoming control points CCIN1–CCIN*n*. The SEL-2701 automatically maps the outgoing control points CCOUT1–CCOUT*n* to the first User ST outgoing GOOSE message bits. The SEL-2701 does not send any data in the DNA portion of the GOOSE message (first 32 outgoing GOOSE bit pairs).

GOOSE information is sent as bit pairs that can represent four values. The SEL-2701 maps single bits to bit pairs as shown in *Table 5.6*.

Table 5.6 GOOSE Bit Pair Value Mapping

GOOSE Bit Pair Value	CCINn or CCOUTn Action
00	Do Nothing
01	Clear
10	Set
11	Invalid–Not Used

GOMSFE

Relay data are organized into GOMSFE bricks that reside within domains. The domains, bricks, and data available through the UCA2 GOMSFE interface are described in your relay instruction manual.

The GLOBE model contains special extensions that map target and analog data from the SEL-400 series relays. In the MX functional component of GLOBE, the SEL-2701 maps analog values from protection math variables and automation math variables as shown in *Table 5.7*.

Table 5.7 GLOBE MX Data

Item	Math Variables Mapped
ANALOG01–ANALOG32	PMV01–PMV32
ANALOG33–ANALOG64	AMV001–AMV032

The SEL-2701 maps 256 Relay Word bits to the items DWORD01B01–DWORD16B16. For complete details on mapping, see the relay instruction manual.

Remote Bits

You can control the SEL-400 series relay remote bits using the UCA2 GCTL brick. GCTL is a generic control brick that appears in each virtual device domain. Each GCTL brick contains 32 ST (Status) and 32 CO (Control) bits that are associated with RB1–RB32. You can control the remote bits by writing the 2-bit set (10) or clear (01) code to the appropriate CO bit.

DNP3

Installation of the SEL-2701 in an SEL-400 Series Relay provides a high-performance DNP3 Level 2 slave network interface designed for operation in a substation environment. Configuration and implementation of DNP3 on this interface is entirely independent of any DNP3 serial settings that might already exist in the SEL-400 series relay.

Custom Data Mapping and Controls

Default or customized DNP3 data within the SEL-400 Series Relay is available to any of five DNP3 sessions configured in the SEL-2701. The DNPMAP setting specifies which type of data is made available to DNP3 on the SEL-2701, i.e., DNPMAP=AUTO for default data, DNPMAP=CUSTOM for customized data.

The AUTO setting will map all binary and analog outputs (and nothing else) to DNP3 points. For this reason, many users will find that the CUSTOM setting will allow them to retrieve all of their necessary data points.

When the Ethernet port has been configured to use custom DNP3 maps, the SEL-2701 will obtain these maps from the relay's settings subdirectory. Custom setting files have the filename SET_DNP*x*.TXT, where *x* is the map number from 1 to 5. The best way to operate on these settings is by using the

SEL-5030 settings assistant. Please refer to the appropriate SEL-400 series Instruction Manual for more information.

When DNPMAP=CUSTOM, the points that are included in the DNP3 map are defined by the contents of the custom DNP3 map files. The database capacity for each point type per map and system-wide is discussed below.

- The total number of Binary Input points allowed per map is 1024. The total system capacity (all custom DNP3 maps) is 2048 Digital Input points with unique references.
- The total number of Analog Input points allowed per map is 512. The total system capacity is 2048 Analog Inputs with unique references.
- The total number of Binary Output control points allowed per map is 512.
- The total number of Analog Output control points allowed per map is 64. The total system capacity, for all the custom DNP3 maps, is 256 Analog Output points with unique references.

The DNP index for any data point within a custom DNP3 map is assigned based on the associated setting name (i.e., BIM*xxxx* for a Binary Input, where *xxxx* is the DNP index).

Analog deadbands and scaling factors may be set for each individual point. Use the AID*xxxx* setting to impose a deadband of 0–32767. This may be used in conjunction with a scaling factor of 0.000001–1000000.0 entered in AIS*xxxx*.

A Binary Output manipulates a control point. The control point is associated to the Binary Output by a Control Point Identifier (CPId). The CPId represents either a non-paired (single) control point or a paired (two control points) control point, where the operation selects the control point. In the SEL-421, for example, the control points correspond to all remote bits and all breaker controls plus the CCIN*x* and CCOUT*x* bits.

Any of the 256 analog output quantities in the D1 region, RA001–RA256, can be included in a custom data map. Up to 64 analog outputs can be assigned to a custom map. Please note that you must subtract 1 from the analog quantity number to get the correct index. For example, if you want to specify RA064, use index 63.

Use the **DNPMAP** command to display the data (object types, indices, default variation and source) and controls (object type, indices and destination) that are accessible via DNP3. The output of the **DNPMAP** command documents the DNP3 data map in the SEL-2701 to help with the configuration of the DNP3 master.

If the DNPMAP setting is set to CUSTOM, then you can specify an additional integer parameter corresponding to a DNPMAP number (1-5) to view each custom DNP3 data map. For example, the command **DNPMAP 2** would be used to view the custom data map for DNP3 Session 2. If a DNPMAP number is not specified, a summary of DNP3 map settings for all configured sessions will be displayed.

Summary and detailed map configurations are also available in the DNPMAP.TXT and DNPMAP*nn*.TXT files from the SEL-2701 FTP interface. The individual file names associated with the detailed custom map settings follow the DNPMAP*nn*.TXT naming convention.

Please note that if you issue a **DNPMAP** command at the command line, you will get that device's (serial) DNP3 data map, if it exists. But if you issue a **PORT** command (PORT 5 on an SEL-400 Series Relay, Port 17 or Port 18 on an SEL communications processor) to open a transparent session to the SEL-2701 console, then a **DNPMAP [x]**, you will get the DNPMAP from the SEL-2701. The **PORT** command redirects all input from a serial port away from the command parser for the device and sends the stream of data to the SEL-2701. Also, any data that comes from the SEL-2701 is redirected out the serial port.

Testing

Use the **TEST DB** command to test the communications card relay database. The **TEST DB** command can be used to override any value in the relay database. Since the relay database provides data to the communications card interfaces, the **TEST DB** command can also be used to test the data read operations of the DNP3 or UCA2 protocols on an installed SEL-2701. Use the **MAP 1** command and the **VIEW1** command to inspect the relay database. You must be familiar with the relay database structure to use the **TEST DB** command effectively.

Control Point Operation

Use Trip and Close or Code Selection operations with Object 12 control relay output block command messages to operate the 400-series relay binary output points. Only non-paired binary outputs are available to the DNP3 over Ethernet interface. See the relay instruction manual for information on building and operating binary output points in customer DNP3 maps.

Section 6
Troubleshooting

Introduction

This section describes how to determine the operating status of your SEL-2701 and how to troubleshoot SEL-2701 operation. This section contains information on the following topics:

- Determining the firmware ID of your SEL-2701
- Reading the SEL-2701 indicator LEDs
- Determining the status of your SEL-2701
- Interpreting error messages and codes
- Conditions that assert the SEL-2701 alarm bit
- Troubleshooting an SEL-2701 installation

SEL-2701 Firmware IDs

Your SEL-2701 contains internal software known as firmware. This firmware consists of two programs, SELBOOT and the SEL-2701 executable. To determine if your SEL-2701 is compatible with your host, you will need to obtain the host and SEL-2701 firmware IDs. If you contact SEL for assistance with your SEL-2701, you may also be asked for the firmware IDs of your SEL-2701.

If you are unable to use the instructions below to collect the firmware IDs of both the host and the SEL-2701, there may be an installation problem with the SEL-2701. See *Section 2: Installation* for more information on SEL-2701 installation and initial checkout.

SEL Communications Processor Host

If your SEL-2701 is installed in an SEL Communications Processor (SEL-2032 or SEL-2030), follow the steps below to determine the firmware IDs of the host and the SEL-2701.

Step 1. **Connect your PC to the host.** You can either use a Telnet session or connect a C234A cable from your PC serial port to the front port.

Step 2. **Start a terminal program.** If you are using an Ethernet network, use a Telnet application. If you are using a serial port connection, start a terminal application. If you have connected to the host successfully, you will see a prompt that contains an * character when you press ENTER.

Step 3. **Display the SEL-2032 firmware IDs.** Enter the host **ID** command. The response to the **ID** command is in Compressed

ASCII and displays the firmware ID information, and a checksum value for each line. For example, the SEL-2030 executable firmware ID is the string "FID=SEL-2030…," and the SEL-2030 SELBOOT firmware ID is the character string "FID=SLBT-2032…."

Step 4. **Display the** SEL-2701 **firmware IDs.** Use the host command **ID *n*,** where *n* is the port number where the SEL-2701 is installed. The response to the **ID** command is in Compressed ASCII and displays the firmware ID information, and a checksum value for each line. The SEL-2030 executable firmware ID is the string "FID=SEL-2701…," and the SEL-2701 SELBOOT firmware ID is the character string "FID=SLBT-2701…."

SEL-400 Series Relay Host

If your SEL-2701 is installed in an SEL-400 series relay, follow the steps below to determine the firmware IDs of the relay and the SEL-2701.

Step 1. **Connect your PC to the front port of the relay.** You can either use a Telnet session to the SEL-400 series relay or connect a C234A cable from your PC serial port to the SEL-400 series relay front port.

Step 2. **Start a terminal program.** If you are using an Ethernet network, use a Telnet application. If you are using a serial port connection, start a terminal application. If you have connected to the relay successfully, you will see a relay prompt that includes an = character when you press ENTER.

Step 3. **Log in to Access Level 1.** Use the relay **ACC** command and enter the password if prompted.

Step 4. **Display the relay and** SEL-2701 **firmware IDs.** Enter the relay **VERSION** command. The relay executable ID is listed after "FID=." The relay SELBOOT ID is listed after "BFID=." The SEL-2701 information is listed under the "Communications Card" heading.

SEL-2701 Indicator LEDs

There are four indicator LEDs on the SEL-2701. The LEDs and panel label for the dual twisted-pair SEL-2701 are shown in *Figure 6.1*. The operation of each LED is explained in *Table 6.1*.

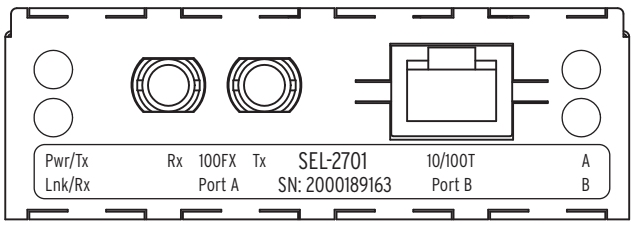

Figure 6.1 Example SEL-2701 Panel

Table 6.1 SEL-2701 LED Indicators

Location	Color	Label	Operation
Upper left	Red	Pwr/Tx	On when card has power and is not transmitting. Flashes off when transmitting Ethernet messages.
Lower left	Green	Lnk/Rx	On when a good link is detected on the active port. Flashes off when receiving Ethernet messages.
Upper right	Green	A	On if Port A is active
Lower right	Green	B	On if Port B is active

The Pwr/Tx indicator flashes off when the SEL-2701 sends out an Ethernet message. The Pwr/Tx indicator is off continuously for extended periods when there is a high outgoing message volume. The Pwr/Tx indicator is on continuously if the host has power, the card is properly installed, and either no Ethernet medium is connected or the port selection setting NETPORT is set to D (disabled).

The Lnk/Rx indicator flashes off for all Ethernet traffic visible to the SEL-2701 regardless of whether the messages are intended for the SEL-2701. During periods of high network traffic volume, the Lnk/Rx indicator is off continuously for sustained periods.

The A and B indicators show which network port is active. If the primary port setting, NETPORT, is set to D, both indicators will be off. If the FAILOVR enable setting is set to No, the A and B indicators reflect the port selected in NETPORT. If FAILOVER is set to Yes, the indicator displays the port selected by the automatic failover operation.

SEL-2701 Status

You can obtain status information about the SEL-2701 from either the SEL-2701 or the host. Use the instructions below to determine the operational status of your SEL-2701. This information will be helpful for troubleshooting and for verifying proper operation.

Direct From SEL-2701

You can obtain status information from the SEL-2701 by establishing a Telnet session from another node on the Ethernet network. This is useful for collecting detailed diagnostic information from the SEL-2701. Follow the steps below to collect status information from the SEL-2701 directly.

Step 1. **Establish a Telnet connection.** For the connection parameters enter the IP set in the SEL-2701 setting IPADDR (the default is 192.92.92.92) and the port number set in T2PNUM. See *Section 3: Settings and Commands* for more information about SEL-2701 settings. If you are connected to the SEL-2701, you will see a "#" character in the prompt after you press ENTER.

Step 2. **Log in to Access Level 1.** Enter the SEL-2701 **ACC** command and enter the password if prompted. The SEL-2701 uses the Access Level 1 password for the host. When you are at Access Level 1, the prompt will become "#>."

Step 3. **Display status information.** Enter the SEL-2701 **STA** command. The response to the status command shows the hardware status of the SEL-2701, network port operation status, and network statistics. Record or print the status information for later reference.

From Host

You can use the host to collect some basic information about the SEL-2701. This is useful for determining if the host has properly recognized the card and for collecting error messages and codes from the SEL-2701. See *Error Messages and Codes* for a detailed explanation of the codes and messages that may be displayed.

Step 1. **Connect your PC serial port to the host front port.** Use a cable number C234A or equivalent.

Step 2. **Start terminal software and connect to the SEL host.** You are connected to the host when you see a prompt after you press ENTER.

Step 3. **Log in to Access Level 1.** Enter the SEL host **ACC** command and enter the password if prompted. When you are at Access Level 1, the prompt will contain a single ">" character ("*>" or "=>").

Step 4. **Display status information using the host status command.** The response to the status command shows the hardware status and diagnostic information for the host. The error code and any messages from the SEL-2701 are also reported. If your SEL-2701 and host are operating normally, the status reported will be "0h" for the error code and "NORMAL" for the error message. If no status for the SEL-2701 is displayed, the host has failed to recognize and properly initialize the card. In an SEL-2030 the status is reported by port, with ports 17 and 18 displaying the communication card slot status. In an SEL-400 series relay, the status will be reported under "Communications Card" heading that only appears if the relay has recognized an installed card.

Error Messages and Codes

The SEL-2701 reports both an error code and error message to the host. The error code is a 16-bit register with an assigned error for each bit. While the error code contains simultaneous reporting of all error conditions, the reported string shows the most severe error. The errors are listed in *Table 6.2* from most to least severe, starting with Bit 0. For example, if a RAM check error and a settings failure are detected, the error code will be 0009h and the error message will be "RAM." If there are no errors, the error code is 0h and the error message is "NORMAL."

Table 6.2 Error Codes and Messages (Sheet 1 of 2)

Bit	Test	Error Message
0	RAM check	RAM
1	Executable code flash check	EXE Code
2	SELBOOT code flash check	SLBT Code
3	Settings check	Settings
4	Executable storage block	Storage
5	MAC address	MAC Addr
6	Shared memory interface failure	SMem Intrf
7	Host commanded read/write test results	R/W Test
8	Goose Sender Unavailable	GOOSE Unav

Table 6.2 Error Codes and Messages (Sheet 2 of 2)

Bit	Test	Error Message
9	Host Access Counter Warn	Cntr Warn
10	Host Error Access Counter	Cntr Fail
11	Host Compatibility Check	Host Incmpt
12-15	Reserved for future use	

Alarm Bit

The conditions listed in *Table 6.3* assert the SEL-2701 alarm bit.

Table 6.3 SEL-2701 Alarm Bit Assertion

Condition	Assertion Type
SEL-2701 diagnostic failure	Continuous
Telnet connection established to the SEL-2701 user interface	Momentary
FTP connection established	Momentary
Successful Level 2 access to the SEL-2701 user interface	Momentary
Access failure to SEL-2701	Momentary

Troubleshooting Procedures

Troubleshooting procedures for common problems are listed in *Table 6.4*. The table lists each symptom and the possible causes and corresponding diagnosis/solutions. Relevant SEL-2701 settings are listed in all capitals. See *Section 3: Settings and Commands* for details of the SEL-2701 settings. Refer to the host-specific section for more information on operation and settings in your host.

Table 6.4 Troubleshooting Procedures (Sheet 1 of 3)

Possible Cause	Diagnosis/Solution
SEL-2701 Does Not Appear in Host Status Report	
Card not installed properly	If the card did not initialize properly and begin communication with the host, it will not be displayed. Perform *Initial Checkout on page 2.3*. Reinstall the card if necessary.
Pwr/Tx LED Off Continuously	
No power to host	Verify that the host has power (check enabled light or press LED Test).
High volume of outgoing Ethernet messages	This situation may occur during normal operation. Temporarily disconnect the Ethernet network cables or change NETPORT setting to D and verify that power indicator LED stays on continuously. If LED does not return to On state, check other possible causes.
Card not installed properly	Perform *Initial Checkout on page 2.3*. Reinstall the card if necessary.

Table 6.4 Troubleshooting Procedures (Sheet 2 of 3)

Possible Cause	Diagnosis/Solution
Lnk/Rx Off Continuously	
No power to host	Verify that the host has power (check enabled light or press LED Test).
High volume of Ethernet messages on network	This situation may occur during normal operation. Temporarily disconnect the Ethernet network cables or change NETPORT setting to D and verify that power indicator LED stays on continuously. If LED does not return to On state, check other possible causes.
All network ports disabled	Verify that either the A or B network port indicator on the SEL-2701 is on. Change NETPORT setting enable an Ethernet network port.
Not properly connected to Ethernet network	Verify connections to the Ethernet network. Verify that the Ethernet network is connected to either the A or B network port indicated by the SEL-2701 LEDs and that the medium/data transmission speeds are correct.
Card not installed properly	Perform *Initial Checkout on page 2.3*. Reinstall the card if necessary.
Cannot Establish Telnet Connection to Host or SEL-2701	
Not properly connected to Ethernet network	Verify connections to the Ethernet network. Verify that the Ethernet network is connected to either the A or B network port indicated by the SEL-2701 LEDs and that the medium/data transmission speeds are correct. Check Pwr/Tx and Lnk/Rx LEDs.
Using incorrect port number or IP address	Verify that you are using the correct Telnet port number (T1PNUM to host and T2PNUM to SEL-2701) and IP address (IPADDR) in your Telnet application.
Virtual terminal sessions disabled in host	Check host settings to verify that the virtual terminal sessions are enabled. For example, check NOCONN setting on the SEL-2030.
Incorrect subnet mask setting (SUBNETM)	Verify that devices you are connecting to are set with the proper subnet mask. Verify that the IP address of both devices places them in the same subnet.
Cannot Log In as FTP Client	
Not properly connected to Ethernet network	Verify connections to the Ethernet network. Verify that the Ethernet network is connected to either the A or B network port indicated by the SEL-2701 LEDs and that the medium/data transmission speeds are correct. Check Pwr/Tx and Lnk/Rx LEDs.
Using incorrect IP address	Verify that you are using the correct IP address (IPADDR).
FTP connections disabled	Verify the SEL-2701 FTPSERV setting.
Incorrect subnet mask setting (SUBNETM)	Verify that devices you are connecting are set with the proper subnet mask. Verify that the IP address of both devices places them in the same subnet.
Cannot Browse With MMS Browser	
Not properly connected to Ethernet network	Verify connections to the Ethernet network. Verify that the Ethernet network is connected to either the A or B network port indicated by the SEL-2701 LEDs and that the medium/data transmission speeds are correct. Check Pwr/Tx and Lnk/Rx LEDs.
Using incorrect OSI network NSAP address	Verify that you are using the correct NSAP address (NSAP).
UCA2 disabled	Verify the SEL-2701 ENUCA setting.

Table 6.4 Troubleshooting Procedures (Sheet 3 of 3)

Possible Cause	Diagnosis/Solution
Does Not React to Incoming GOOSE Messages	
Not properly connected to Ethernet network	Verify connections to the Ethernet network. Verify that the Ethernet network is connected to either the A or B network port indicated by the SEL-2701 LEDs and that the medium/data transmission speeds are correct. Check Pwr/Tx and Lnk/Rx LEDs.
GOOSE message sender not detected by SEL-2701	Verify GOOSE monitor text ID setting (GOSIEDn). Connect to the SEL-2701 user interface and use the SEL-2701 **GOOSE** command to determine if a GOOSE sender was detected. Use the **GOOSE R** command if it is necessary to detect active GOOSE senders.

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Appendix A
Firmware and Manual Versions

Firmware

Table A.1 lists the firmware versions, a description of modifications, and the instruction manual date code that corresponds to firmware versions. The most recent firmware version is listed first.

Table A.1 Firmware Revision History (Sheet 1 of 2)

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
SEL-2701-R113-V0-Z003001-D20190308 SLBT-2701-R102-V0-Z000000-D20051107	➤ Resolved an issue where certain Ethernet traffic could cause the relay to safely restart.	20190308
SEL-2701-R112-V0-Z003001-D20090212 SLBT-2701-R102-V0-Z000000-D20051107	➤ Enhanced DNP AUTO map to allow 5000 binary inputs and 1200 analog inputs. ➤ Enhanced the DNP communications component to prevent certain DNP requests from interrupting communications. ➤ Addressed an issue where malformed UCA traffic may disable Ethernet communications. ➤ Addressed an issue where certain TCP attribute values could disable Ethernet communications. ➤ Addressed an issue where traffic with a spoofed source address may disable Ethernet communications.	20090212
SEL-2701-R111-V0-Z003001-D20070423 SLBT-2701-R102-V0-Z000000-D20051107	➤ Added 16BIT setting to allow user to define the default DNP LAN/WAN analog reporting size as 16 or 32 bits. ➤ Fixed UCA protocol.	20070423
SEL-2701-R110-V0-Z002001-D20060628 SLBT-2701-R102-V0-Z000000-D20051107	➤ Fixed outbound telnet connections for SEL-2030 and SEL-2032 that were introduced in firmware versions R108 and R109. ➤ Shortened response time on incoming controls (e.g., Set A/ Set B) in the SEL-421, SEL-451, and SEL-487B.	20060628
SEL-2701-R109-V0-Z002001-D20060413 SLBT-2701-R102-V0-Z000000-D20051107	➤ Modification to ensure transition of events is accurately captured for time-tagged DNP LAN/WAN binary inputs.	20060413
SEL-2701-R108-V0-Z002001-D20051205 SLBT-2701-R102-V0-Z000000-D20051107	➤ Improvements for manufacturability. This firmware includes all of the enhancements listed under firmware release R106, below.	20051205
SEL-2701-R107-V0-Z002001-D20051123 SLBT-2701-R102-V0-Z000000-D20051107	Note: This firmware version was not released. See firmware release R108 above.	20051123

Table A.1 Firmware Revision History (Sheet 2 of 2)

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
SEL-2701-R106-V0-Z002001-D20051107 SLBT-2701-R102-V0-Z000000-D20051107	Note: This firmware version was not released. See firmware release R108 above. ➤ Allow initiation of Telnet connections on ports higher than 32,767. ➤ Link status message is transmitted only when no other DNP3 traffic is present. ➤ Self-test register indicates which network port is in use. ➤ Added precision time-tagging from FAST SER messages and local data into the data transferred from the host to the SEL-2701. ➤ Added the capability to configure and use up to five custom DNP3 maps.	20051107
SEL-2701-R105-V0-Z001001-D20040618 SLBT-2701-R101-V0-Z000000-D20020425	➤ Added DNP protocol.	20040618
SEL-2701-R104-V0-Z000000-D20031021 SLBT-2701-R101-V0-Z000000-D20020425	➤ Security enhancements. ➤ Modification of alarm bit handling.	20031021
SEL-2701-R103-V0-Z000000-D20020501 SLBT-2701-R101-V0-Z000000-D20020425	➤ All UCA2 control points were made readable. ➤ Default data was set for the UCA2 FAULT model.	20020501
SEL-2701-R102-V0-Z000000-D20010719 SLBT-2701-R101-V0-Z000000-D20010425	➤ Corrected issue related to rapid incoming GOOSE messages. ➤ Eliminated character loss in Virtual Terminal sessions. ➤ Improved handling of Telnet Client attempts to disable unsupported Telnet Options. ➤ Changed for compatibility with SEL-421 Relay modifications. ➤ Allowed Telnet connection for TCP/IP port numbers greater than 32,767.	20010719
SEL-2701-R100-V0-Z000000-D20010302 SLBT-2701-R101-V0-Z000000-D20010425	➤ Corrected firmware load issue.	20010425
SEL-2701-R100-V0-Z000000-D20010302 SLBT-2701-R100-V0-Z000000-D20010302	➤ Initial version.	20010302

Instructions for determining the firmware version of your SEL-2701 Ethernet Processor and host are in *Section 6: Troubleshooting*.

If you purchased your SEL-2701 separately from your host device (SEL-2032 or SEL-400 Series Relay), we recommend upgrading your host device to the latest firmware version before installing your SEL-2701. If you require additional information about compatibility between the SEL-2701 and the SEL host firmware versions, please contact SEL.

Instruction Manual

The date code at the bottom of each page of this manual reflects the creation or revision date.

Table A.2 lists the instruction manual release dates and a description of modifications. The most recent instruction manual revisions are listed at the top.

Table A.2 Instruction Manual Revision History (Sheet 1 of 2)

Revision Date	Summary of Revisions
20190308	**Appendix A** ➤ Updated for firmware version R113.
20180202	**Appendix A** ➤ Revised the Summary of Revisions in *Table A.1* for firmware version R112.
20120126	**Section 3** ➤ Updated *Table 3.10: SEL-2701 Command Summary.* ➤ Updated *Table 3.11: SEL-2701 Access Levels*. ➤ Updated *Table 3.12: SEL-2701 Access Level Usernames and Passwords*. ➤ Added CAL command information in *SEL-2701 Commands.* **Section 4** ➤ Updated *Table 4.4: SEL-2032 Access Levels*. ➤ Updated *Table 4.5: SEL-2032 Access Level Usernames and Passwords*. **Section 5** ➤ Updated *Table 5.3: SEL-400 Series Relay Access Levels*. ➤ Updated *Table 5.3: SEL-400 Series Relay Access Level Usernames and Passwords*.
20090529	**Section 1** ➤ Removed references to 10BASE-FL communications card option. **Section 2** ➤ Removed reference to 10BASE-FL communications card option. ➤ Removed *Figure 2.5: Two 10BASE-FL Port Configuration*, *Figure 2.7: 10BASE-FL and 10/100BASE-T Port Configuration*, and *Figure 2.9: 10BASE-FX and 10BASE-FL Port Configuration*. **Section 3** ➤ Removed reference to 10 Mbps Ethernet fiber-optic connection option. **Section 4** ➤ Removed reference to 10 Mbps Ethernet fiber-optic connection option. **Section 5** ➤ Removed reference to 10 Mbps Ethernet fiber-optic connection option.
20090212	**Appendix A** ➤ Updated for firmware version R112.
20070423	**Section 3** ➤ Added 16BIT setting to *Table 3.8*. **Appendix A** ➤ Updated for firmware version R111.
20060628	**Appendix A** ➤ Updated for firmware version R110.
20060413	**Appendix A** ➤ Updated for firmware version R109.
20051205	**Appendix A** ➤ Updated for firmware version R108.
20051123	**Appendix A** ➤ Updated for firmware version R107.

Table A.2 Instruction Manual Revision History (Sheet 2 of 2)

Revision Date	Summary of Revisions
20051107	Reissued entire manual to include custom DNP3 map support for Communications Processors and SEL-400 series relays.
20040618	Reissued entire manual to include addition of DNP3.
20031021	Section 1 ➤ Corrected 10BASE-FL radiated radio frequency specification to greater than –27 dBm. Section 2 ➤ Added note regarding adding SEL-2701Ethernet Processors to SEL-400 series relays. Section 3 ➤ Corrected generic GOOSE message bit numbering. Added description of ALARM bit operation for failed **ACCESS** and **2ACCESS** commands. Section 4 ➤ Added reference to alarm bit operation table in *Section 6* in *SEL-2701 Alarm*. Section 6 ➤ Added table of alarm bit assertion conditions (*Table 6.3*). Appendix A ➤ Updated for new SEL-2701 release.
20020501	Appendix A ➤ Updated for new SEL-2701 release. Appendix B ➤ All UCA2 control points were made readable. Default data was set for the UCA2 FAULT model.
20010719	Section 3 ➤ Updated default value of SUBNETM setting (*Table 3.1*), added additional discussion of *Network Configuration*, and corrected range for Telnet port settings (*Table 3.6*), added information on ENTXGOS setting (*Table 3.7*). Section 4 ➤ Revised *Table 4.5*, added port parameter to description of SEL-2032 port command in *Telnet From the SEL-2701*. Added discussion of outgoing GOOSE timing issues on *GOOSE*. Section 6 ➤ Correction, changed error code bit 8 to “Reserved for future use” in *Table 6.2*. Appendix A ➤ Updated for new SEL-2701 release.
20010425	Section 3 ➤ Corrected GOOSE sender detection logic. Appendix A ➤ Change to SELBOOT Firmware Version only.
20010302	➤ Initial version.

Appendix B
UCA2 GOMSFE Models

Introduction

The SEL-2701 Ethernet Processor presents data in the host as a series of GOMSFE models (bricks). GOMSFE model information is listed in this appendix in a series of tables organized by domains. The SEL-2701 automatically populates these models using the data in the host. This appendix contains information on the following topics:

- Domains for SEL-2030 hosts
- GOMSFE models in SEL-2030 host domains
- Rules for populating GOMSFE models

Domains and models for SEL-400 series relay hosts vary based on the specific relay model. The domains and models are shown in the instruction manual for your SEL-400 series relay.

GOMSFE Tables

The GOMSFE model table column headings are defined in *Table B.1*. Some items in the Decode Method column contain reference to special translation rules listed in *Table B.18*.

Table B.1 GOMSFE Model Table Column Definitions

Column Label	Definition
FC	Functional Component
Name	Name of element or compound element–names of elements within compound elements indented
r/w	Read/write permission
Description	Description of data as implemented by SEL
m/o	Mandatory/optional m–label is present, data are shown if available, value is null if not available o–label is present only if data are available in the host
Decode Method	Value or label used to retrieve information in device database or reference to *Table B.18*

The Decode Method column contains rules for retrieving information from the host database. The SEL-2701 uses labels to retrieve database values within the specified region. For SEL devices connected to an SEL-2030, the data are typically in data regions (Meter, Target, etc.). Use “20” messages to configure the SEL-2030 to automatically collect, store, and label data in data regions. For example, if the decode method is METER:VA then the value retrieved is

A-phase voltage, labeled VA, in the Meter region. For non-SEL devices, the region is usually the User region. Use SET M equations to move and label data within the User region.

Some items have more than one decode method. If there is more than one decode method, they are listed in priority order. In some cases, additional information about the decode method is listed in *Special Translation Rules on page B.27*. Look up the rule number (for example #3) in *Table B.18* for more information. Some information has been hard coded and does not rely on a data lookup. For example, the protocol value Pro in the DI model (listed in *Table B.4*) always contains the value 11.

SEL-2032 Domains

An SEL-2030 contains the domains shown in *Table B.2*. The SEL-2701 uses each port database to create a virtual device with the domain name DDaa*name*. The SEL-2701 determines the *name* portion of the domain name using the rules described in *Section 3: Settings and Commands*.

Table B.2 SEL-2030 Domains

Domain	Description
LN0	Logical Device 0 domain containing SEL-2030 information
DD01*name*	Virtual Device 1 domain containing data from Port 1 database
DD02*name*	Virtual Device 2 domain containing data from Port 2 database
DD03*name*	Virtual Device 3 domain containing data from Port 3 database
•	•
•	•
•	•
DD17*name*	Virtual Device 17 domain containing information on Port 17 protocol card and from database
DD18*name*	Virtual Device 18 domain containing information on Port 18 protocol card and Port 18 database

SEL-2032 Domain-LN0

Each device on a UCA2 network has a Logical Device 0 domain, LN0. The models in this domain contain data specific to the SEL-2030. Data elements for each model type are listed in *Table B.4* and *Table B.5*. The models in the LN0 domain are listed in *Table B.3*.

Table B.3 Models in LN0 Domain

Model	Description
DI	Device identification data
GLOBE	Basic device and GOOSE information

Table B.4 Device ID Model (DI)–SEL-2030

FC	Name	r/w	Description	m/o	Decode Method
DI		r	Device information		
	Name	r	Relay ID	m	GLOBAL:HOST_ID
	VndID			m	
	Vnd	r	Vendor	m	"SEL"
	Mdl	r	Device model number[a]	m	GLOBAL:FID #1
	SerNum	r	Device serial number	m	GLOBAL:SER_NUM
	SftRev	r	Device software revision[b]	m	GLOBAL:FID #2
	BootRev[c]	r	Boot code software revision	m	GLOBAL:BFID #2
	FID[c]	r	Device firmware ID string	m	GLOBAL:FID
	BootFID[c]	r	Device boot code firmware ID string	m	GLOBAL:BFID
	CommID				
	CommAdr	r	NSAP	m	#3
	CommRev	r	SEL-2701 firmware revision[b]	m	#4
	SftRev[c]	r	SEL-2701 firmware revision	m	#4
	BootRev[c]	r	SEL-2701 SELBOOT revision	m	#5
	Pro	r	Protocol (MMS + CASM)	m	"11"
	Vnd[c]	r	Vendor	m	"SEL"
	Mdl[c]	r	Model	m	"SEL-2701"
	SerNum[c]	r	SEL-2701 serial number	m	#7
	FID[c]	r	SEL-2701 firmware ID	m	#8
	BootFID[c]	r	SEL-2701 SELBOOT code firmware ID	m	#9

[a] Part name and V portion of the FID.
[b] R portion of the FID.
[c] Extension to the GOMSFE Device ID component.

Table B.5 Globe Model (GLOBE)—SEL-2030

FC	Name	r/w	Description	m/o	Decode Method
ST					
	ModeDS	r	Device state	m	#10
	b2	r	Test, offline, available, unhealthy	m	
	LocRemDS	r	Remote/local state	m	"2"
	b2	r	0-invalid, 1-local, 2-remote	m	
	AuxIn1–AuxIn16	r	State of physical inputs	o	GLOBAL:ELEMENTS #11
SP					
	PreSetDNA	rw	Preset value for DNA outputs	m	#12
	ForDNA	rw	Force value for DNA inputs	m	#13
	DefDNA	rw	Default value for DNA inputs	m	#14
	PreSetUserST[a]	rw	Preset value for UserSt outputs	m	#25
	ForUserST[a]	rw	Force value for UserSt inputs	m	#26
	DefUserST[a]	rw	Default value for UserSt inputs	m	#27
CO					
	GOOSERs[a]	rw	Force GOOSE addressing re-acquisition	m	#18
CF					
	ClockTOD	rw	Current date and time–use of UCA time sync is preferred for setting date and time	m	#15
	SelOutDNA	rw	Selection for each DNA output	m	#16
	SelInDNA	rw	Selection for each DNA input	m	#17
	SelOutUserSt[a]	rw	Selection for each UserSt output	m	#28
	SelInUserSt[a]	rw	Selection for each UserSt input	m	#29

[a] Extension to the GOMSFE-specified GLOBE brick.

SEL Relay Virtual Device

The SEL-2701 displays 16 virtual device domains that represent data collected from the 16 SEL-2030 serial ports. The virtual device domain, associated with a port connected to an SEL relay, contains the models listed in *Table B.6*. The required data collection "20" message format for each brick is listed in *Table B.6*. Entries listed as "None" are automatic and do not require additional configuration. The details of each model in this domain are shown in *Table B.7–Table B.11*.

Table B.6 Models in Virtual Device Domain for SEL Relays

Model	Description	Required "20" Message Format
DI	Relay ID information and SEL-2701 information	None
FAULT1–FAULT20	Relay fault history records[a]	20HISTORY
GCTL	Control of remote bits (RB1–RB16) for port	20TARGET (for status display only)
GLOBE	Basic device information	None
MMXU	Relay metering and measurement data	20METER

[a] The SEL-2701 automatically generates the models FAULT1–FAULT20. Each instance of the FAULT model represents a row in the relay history report. The most recent history record is in FAULT1. If the relay does not store 20 records or if the fault history is reset, the FAULT models corresponding to empty history records will contain default data.

Table B.7 Device ID Model (DI)–SEL Relay Connected to an SEL-2030 (Sheet 1 of 2)

FC	Name	r/w	Description	m/o	Decode Method
DI		r	Device information		
	Name	r	Relay ID	m	LOCAL:PORTID
	Class	r		m	"Protection Relay"
	VndID			m	
	Vnd	r	Vendor	m	"SEL"
	Mdl	r	Device model number[a]	m	LOCAL:FID #1
	SerNum	r	Device serial number	m	LOCAL:SER_NUM USER:SER_NUM #24
	SftRev	r	Device software revision[b]	m	LOCAL:FID #2
	BootRev[c]	r	Boot code software revision	o	LOCAL:BFID #2
	FID[c]	r	Device firmware ID string	o	LOCAL:FID
	BootFID[c]	r	Device boot code firmware ID string	o	LOCAL:BFID
	PartNum[c]	r	Device part number	o	LOCAL:PART_NUM
	CfgNum[c]	r	Device configuration code	o	LOCAL:CONFIG
	Cfg2Num[c]	r	Device special configuration code	o	LOCAL:SPECIAL

Table B.7 Device ID Model (DI)—SEL Relay Connected to an SEL-2030 (Sheet 2 of 2)

FC	Name	r/w	Description	m/o	Decode Method
	CommID			m[d]	
	CommAdr	r	NSAP	m	#3
	CommRev	r	SEL-2701 firmware revision[b]	m	#4
	SftRev[c]	r	SEL-2701 firmware revision	m	#4
	BootRev[c]	r	SEL-2701 SELBOOT revision	m	#5
	Pro	r	Protocol (MMS + CASM)	m	"11"
	Med	r	Physical medium	o	#6
	Vnd[c]	r	Vendor	m	"SEL"
	Mdl[c]	r	Model	m	"SEL-2701"
	SerNum[c]	r	SEL-2701 serial number	m	#7
	FID[c]	r	SEL-2701 firmware ID	m	#8
	BootFID[c]	r	SEL-2701 SELBOOT code firmware ID	m	#9

[a] Part name and V portion of the FID.
[b] R portion of the FID.
[c] Extension to the GOMSFE Device ID component.
[d] Same as the CommID of the SEL-2030.

Table B.8 Fault Identification Model (FAULT)—SEL Relay Connected to an SEL-2030 (Sheet 1 of 2)

FC	Name	r/w	Description	m/o	Decode Method
MX					
	FltMagA		Magnitude of fault currents	o	
	PhsAf	r	A-phase fault current	o	HISTORY:IA
	PhsBf	r	B-phase fault current	o	HISTORY:IB
	PhsCf	r	C-phase fault current	o	HISTORY:IC
	Neutf	r	Neutral fault current	o	HISTORY:IN
	q	r	Quality of data	o	#21
	FltMagA1		Magnitude of fault currents	o	
	PhsAf	r	A-phase fault current	o	HISTORY:IA1
	PhsBf	r	B-phase fault current	o	HISTORY:IB1
	PhsCf	r	C-phase fault current	o	HISTORY:IC1
	Neutf	r	Neutral fault current	o	HISTORY:IN1
	q	r	Quality of data	o	#21
	FltMagA2		Magnitude of fault currents	o	
	PhsAf	r	A-phase fault current	o	HISTORY:IA2
	PhsBf	r	B-phase fault current	o	HISTORY:IB2
	PhsCf	r	C-phase fault current	o	HISTORY:IC2
	Neutf	r	Neutral fault current	o	HISTORY:IN2
	q	r	Quality of data	o	#21

Table B.8 Fault Identification Model (FAULT)—SEL Relay Connected to an SEL-2030 (Sheet 2 of 2)

FC	Name	r/w	Description	m/o	Decode Method
	FltMagA3		Magnitude of fault currents	o	
	PhsAf	r	A-phase fault current	o	HISTORY:IA3
	PhsBf	r	B-phase fault current	o	HISTORY:IB3
	PhsCf	r	C-phase fault current	o	HISTORY:IC3
	Neutf	r	Neutral fault current	o	HISTORY:IN3
	q	r	Quality of data	o	#21
	FltMagA4		Magnitude of fault currents	o	
	PhsAf	r	A-phase fault current	o	HISTORY:IA4
	PhsBf	r	B-phase fault current	o	HISTORY:IB4
	PhsCf	r	C-phase fault current	o	HISTORY:IC4
	Neutf	r	Neutral fault current	o	HISTORY:IN4
	q	r	Quality of data	o	#21
	FltMag		Magnitude of fault current	o	
	f	r		o	HISTORY:CURR
	q	r	Quality of data	o	#21
	FltLoc		Location of fault	o	
	f	r		o	HISTORY:LOC HISTORY:FAULT_LOC
	q	r	Quality of data	o	#21
	FltTim	r	Time and date of fault	o	HISTORY:MONTH #30
	FltDur	r	Fault duration in cycles	o	HISTORY:DURR
	FltFrq	r	Frequency at fault	o	HISTORY:FREQ
ST	FltTar	r	Relay targets at time of fault	o	HISTORY:TARGET HISTORY:TARGETS #31
	FltTyp	r	Fault type for common fault types	o	HISTORY:TYPE HISTORY:EVENT #32
	FltTyp2	r	Other fault types	o	HISTORY:TYPE HISTORY:EVENT #33
	FltSht	r	Shot counter at fault	o	HISTORY:SHOT
	FltSG	r	Settings group number at fault	o	HISTORY:GROUP

Table B.9 Generic Control Model (GCTL)—SEL Relay Connected to an SEL-2030

FC	Name	r/w	Description	m/o	Decode Method
ST	OD1–OD16		State last written to this control point	m	RB1–RB16
	b2	r	Status of bit	m	#19
CO	OD1–OD16		Control bit	m	RB1–RB16
	OperDev	rw	Control bit (01 to clear; 10 to set)	m	#20

Table B.10 Globe Model (GLOBE)—SEL Relay Connected to an SEL-2030

FC	Name	r/w	Description	m/o	Decode Method
MX					
	ANALOG01–ANALOG64	r	Analog values	o	USER:ANALOG01–USER:ANALOG64
ST					
	ModeDS	r	Device state	m	
	b2	r	Test, offline, available, unhealthy	m	#10
	LocRemDS	r	Remote/local state	m	
	b2	r	0-invalid, 1-local, 2-remote	m	"2"
	CommSt[a]	r	Communications status		
	b2	r	0-invalid, 1-unavailable, 2-available	m	#34
	DWORD01B01–DWORD01B16				
	b1	r	Binary value	o	USER:DWORD01:0–USER:DWORD01:15
	DWORD02B01–DWORD02B16				
	b1	r	Binary value	o	USER:DWORD02:0–USER:DWORD02:15
	DWORD03B01–DWORD03B16				
	b1	r	Binary value	o	USER:DWORD03:0–USER:DWORD03:15
	•				
	•				
	•				
	DWORD16B01–DWORD16B16				
	b1	r	Binary value	o	USER:DWORD16:0–USER:DWORD16:15

[a] Extension to the GOMSFE-specified GLOBE brick.

Table B.11 Polyphase Measurement Unit Model (MMXU)—SEL Relay Connected to an SEL-2030 (Sheet 1 of 7)

FC	Name	r/w	Description	m/o	Decode Method
MX			Measurement		
	V		Three-phase voltage	o	
	PhsAf	r	A-phase voltage	o	METER:VA METER:va
	PhsBf	r	B-phase voltage	o	METER:VB METER:vb
	PhsCf	r	C-phase voltage	o	METER:VC METER:vc
	Neutf	r	Neutral voltage	o	METER:VN
	q	r	Quality of data	o	#21
	V1		Three-phase voltage	o	
	PhsAf	r	A-phase voltage	o	METER:VA1 METER:VAX
	PhsBf	r	B-phase voltage	o	METER:VB1 METER:VBX
	PhsCf	r	C-phase voltage	o	METER:VC1 METER:VCX
	Neutf	r	Neutral voltage	o	METER:VN1
	q	r	Quality of data	o	#21
	V2		Three-phase voltage	o	
	PhsAf	r	A-phase voltage	o	METER:VA2 METER:VAY
	PhsBf	r	B-phase voltage	o	METER:VB2 METER:VBY
	PhsCf	r	C-phase voltage	o	METER:VC2 METER:VCY
	Neutf	r	Neutral voltage	o	METER:VN2
	q	r	Quality of data	o	#21
	V3		Three-phase voltage	o	
	PhsAf	r	A-phase voltage	o	METER:VA3
	PhsBf	r	B-phase voltage	o	METER:VB3
	PhsCf	r	C-phase voltage	o	METER:VC3
	Neutf	r	Neutral voltage	o	METER:VN3
	q	r	Quality of data	o	#21
	V4		Three-phase voltage	o	
	PhsAf	r	A-phase voltage	o	METER:VA4
	PhsBf	r	B-phase voltage	o	METER:VB4
	PhsCf	r	C-phase voltage	o	METER:VC4
	Neutf	r	Neutral voltage	o	METER:VN4
	q	r	Quality of data	o	#21

Table B.11 Polyphase Measurement Unit Model (MMXU)—SEL Relay Connected to an SEL-2030 (Sheet 2 of 7)

FC	Name	r/w	Description	m/o	Decode Method
	Vseq[a]		Sequence voltages	o	
	Posif	r	Positive-sequence voltage	o	METER:V1
	Negf	r	Negative-sequence voltage	o	METER:V2 METER:3V2 #22
	Zerof	r	Zero-sequence voltage	o	METER:V0 METER:3V0 #22
	q	r	Quality of data	o	#21
	Vseq1[a]		Sequence voltages	o	
	Posif	r	Positive-sequence voltage	o	METER:V1_1
	Negf	r	Negative-sequence voltage	o	METER:V2_1
	Zerof	r	Zero-sequence voltage	o	METER:V0_1
	q	r	Quality of data	o	#21
	Vseq2[a]		Sequence voltages	o	
	Posif	r	Positive-sequence voltage	o	METER:V1_2
	Negf	r	Negative-sequence voltage	o	METER:V2_2
	Zerof	r	Zero-sequence voltage	o	METER:V0_2
	q	r	Quality of data	o	#21
	Vseq3[a]		Sequence voltages	o	
	Posif	r	Positive-sequence voltage	o	METER:V1_3
	Negf	r	Negative-sequence voltage	o	METER:V2_3
	Zerof	r	Zero-sequence voltage	o	METER:V0_3
	q	r	Quality of data	o	#21
	Vseq4[a]		Sequence voltages	o	
	Posif	r	Positive-sequence voltage	o	METER:V1_4
	Negf	r	Negative-sequence voltage	o	METER:V2_4
	Zerof	r	Zero-sequence voltage	o	METER:V0_4
	q	r	Quality of data	o	#21
	AuxV[a]		Auxiliary voltages	o	
	f	r		o	METER:VPL
	q	r	Quality of data	o	#21
	PPV		Delta voltages	o	
	PhsABf	r	AB voltage	o	METER:VAB
	PhsBCf	r	BC voltage	o	METER:VBC
	PhsCAf	r	CA voltage	o	METER:VCA
	q	r	Quality of data	o	#21
	PPV1		Delta voltages	o	
	PhsABf	r	AB voltage	o	METER:VAB1
	PhsBCf	r	BC voltage	o	METER:VBC1
	PhsCAf	r	CA voltage	o	METER:VCA1
	q	r	Quality of data	o	

Table B.11 Polyphase Measurement Unit Model (MMXU)—SEL Relay Connected to an SEL-2030 (Sheet 3 of 7)

FC	Name	r/w	Description	m/o	Decode Method
	PPV2		Delta voltages	o	
	PhsABf	r	AB voltage	o	METER:VAB2
	PhsBCf	r	BC voltage	o	METER:VBC2
	PhsCAf	r	CA voltage	o	METER:VCA2
	q	r	Quality of data	o	#21
	PPV3		Delta voltages	o	
	PhsABf	r	AB voltage	o	METER:VAB3
	PhsBCf	r	BC voltage	o	METER:VBC3
	PhsCAf	r	CA voltage	o	METER:VCA3
	q	r	Quality of data	o	#21
	PPV4		Delta voltages	o	
	PhsABf	r	AB voltage	o	METER:VAB4
	PhsBCf	r	BC voltage	o	METER:VBC4
	PhsCAf	r	CA voltage	o	METER:VCA4
	q	r	Quality of data	o	#21
	A		Three-phase currents	o	
	PhsAf	r	A-phase current	o	METER:IA METER:ia
	PhsBf	r	B-phase current	o	METER:IB METER:ib
	PhsCf	r	C-phase current	o	METER:IC METER:ic
	Neutf	r	Neutral current	o	METER:IR
	q	r	Quality of data	o	#21
	A1		Three-phase currents	o	
	PhsAf	r	A-phase current	o	METER:IA1 METER:IAW1 METER:IAX
	PhsBf	r	B-phase current	o	METER:IB1 METER:IBW1 METER:IBX
	PhsCf	r	C-phase current	o	METER:IC1 METER:ICW1 METER:ICX
	Neutf	r	Neutral current	o	METER:IR1 METER:IRX
	q	r	Quality of data	o	#21

Table B.11 Polyphase Measurement Unit Model (MMXU)—SEL Relay Connected to an SEL-2030 (Sheet 4 of 7)

FC	Name	r/w	Description	m/o	Decode Method
	A2		Three-phase currents	o	
	PhsAf	r	A-phase current	o	METER:IA2 METER:IAW2 METER:IAY
	PhsBf	r	B-phase current	o	METER:IB2 METER:IBW2 METER:IBY
	PhsCf	r	C-phase current	o	METER:IC2 METER:ICW2 METER:ICY
	Neutf	r	Neutral current	o	METER:IR2 METER:IRY
	q	r	Quality of data	o	#21
	A3		Three-phase currents	o	
	PhsAf	r	A-phase current	o	METER:IA3 METER:IAW3
	PhsBf	r	B-phase current	o	METER:IB3 METER:IBW3
	PhsCf	r	C-phase current	o	METER:IC3 METER:ICW3
	Neutf	r	Neutral current	o	METER:IR3
	q	r	Quality of data	o	#21
	A4		Three-phase currents	o	
	PhsAf	r	A-phase current	o	METER:IA4 METER:IAW4
	PhsBf	r	B-phase current	o	METER:IB4 METER:IBW4
	PhsCf	r	C-phase current	o	METER:IC4 METER:ICW4
	Neutf	r	Neutral current	o	METER:IR4
	q	r	Quality of data	o	#21
	Aseq[a]		Sequence currents	o	
	Posif	r	Positive-sequence current	o	METER:I1
	Negf	r	Negative-sequence current	o	METER:I2 METER:3I2 #22
	Zerof	r	Zero-sequence current	o	METER:I0
	q	r	Quality of data	o	#21
	Aseq1[a]		Sequence currents	o	
	Posif	r	Positive-sequence current	o	METER:I1_1
	Negf	r	Negative-sequence current	o	METER:I2_1 METER:3I2X #22
	Zerof	r	Zero-sequence current	o	METER:I0_1
	q	r	Quality of data	o	#21

Table B.11 Polyphase Measurement Unit Model (MMXU)—SEL Relay Connected to an SEL-2030 (Sheet 5 of 7)

FC	Name	r/w	Description	m/o	Decode Method
	Aseq2[a]		Sequence currents	o	
	Posif	r	Positive-sequence current	o	METER:I1_2
	Negf	r	Negative-sequence current	o	METER:I2_2 METER:3I2Y #22
	Zerof	r	Zero-sequence current	o	METER:I0_2
	q	r	Quality of data	o	#21
	Aseq3[a]		Sequence currents	o	
	Posif	r	Positive-sequence current	o	METER:I1_3
	Negf	r	Negative-sequence current	o	METER:I2_3
	Zerof	r	Zero-sequence current	o	METER:I0_3
	q	r	Quality of data	o	#21
	Aseq4[a]		Sequence currents	o	
	Posif	r	Positive-sequence current	o	METER:I1_4
	Negf	r	Negative-sequence current	o	METER:I2_4
	Zerof	r	Zero-sequence current	o	METER:I0_4
	q	r	Quality of data	o	#21
	AuxA1[a]		Auxiliary currents	o	
	f	r		o	METER:IP METER:IPOL
	q	r	Quality of data	o	#21
	W		Per-phase power	o	
	PhsAf	r	A-phase power	o	METER:PA
	PhsBf	r	B-phase power	o	METER:PB
	PhsCf	r	C-phase power	o	METER:PC
	q	r	Quality of data	o	#21
	W1		Per-phase power	o	
	PhsAf	r	A-phase power	o	METER:PA1
	PhsBf	r	B-phase power	o	METER:PB1
	PhsCf	r	C-phase power	o	METER:PC1
	q	r	Quality of data	o	#21
	W2		Per-phase power	o	
	PhsAf	r	A-phase power	o	METER:PA2
	PhsBf	r	B-phase power	o	METER:PB2
	PhsCf	r	C-phase power	o	METER:PC2
	q	r	Quality of data	o	#21
	W3		Per-phase power	o	
	PhsAf	r	A-phase power	o	METER:PA3
	PhsBf	r	B-phase power	o	METER:PB3
	PhsCf	r	C-phase power	o	METER:PC3
	q	r	Quality of data	o	#21

Table B.11 Polyphase Measurement Unit Model (MMXU)—SEL Relay Connected to an SEL-2030 (Sheet 6 of 7)

FC	Name	r/w	Description	m/o	Decode Method
	W4		Per-phase power	o	
	PhsAf	r	A-phase power	o	METER:PA4
	PhsBf	r	B-phase power	o	METER:PB4
	PhsCf	r	C-phase power	o	METER:PC4
	q	r	Quality of data	o	#21
	TotW		Total (Three-phase) power	o	
	f	r	Total power	o	METER:P
	q	r	Quality of data	o	#21
	TotW1		Total (Three-phase) power	o	
	f	r	Total power	o	METER:P1
	q	r	Quality of data	o	#21
	TotW2		Total (Three-phase) power	o	
	f	r	Total power	o	METER:P2
	q	r	Quality of data	o	#21
	TotW3		Total (Three-phase) power	o	
	f	r	Total power	o	METER:P3
	q	r	Quality of data	o	#21
	TotW4		Total (Three-phase) power	o	
	f	r	Total power	o	METER:P4
	q	r	Quality of data	o	#21
	VAr		Per-phase reactive power	o	
	PhsAf	r	A-phase reactive power	o	METER:QA
	PhsBf	r	B-phase reactive power	o	METER:QB
	PhsCf	r	C-phase reactive power	o	METER:QC
	q	r	Quality of data	o	#21
	VAr1		Per-phase reactive power	o	
	PhsAf	r	A-phase reactive power	o	METER:QA1
	PhsBf	r	B-phase reactive power	o	METER:QB1
	PhsCf	r	C-phase reactive power	o	METER:QC1
	q	r	Quality of data	o	#21
	VAr2		Per-phase reactive power	o	
	PhsAf	r	A-phase reactive power	o	METER:QA2
	PhsBf	r	B-phase reactive power	o	METER:QB2
	PhsCf	r	C-phase reactive power	o	METER:QC2
	q	r	Quality of data	o	#21
	VAr3		Per-phase reactive power	o	
	PhsAf	r	A-phase reactive power	o	METER:QA3
	PhsBf	r	B-phase reactive power	o	METER:QB3
	PhsCf	r	C-phase reactive power	o	METER:QC3
	q	r	Quality of data	o	#21

Table B.11 Polyphase Measurement Unit Model (MMXU)—SEL Relay Connected to an SEL-2030 (Sheet 7 of 7)

FC	Name	r/w	Description	m/o	Decode Method
	VAr4		Per-phase reactive power	o	
	PhsAf	r	A-phase reactive power	o	METER:QA4
	PhsBf	r	B-phase reactive power	o	METER:QB4
	PhsCf	r	C-phase reactive power	o	METER:QC4
	q	r	Quality of data	o	#21
	TotVAr		Total reactive power	o	
	f	r	Total reactive power	o	METER:Q
	q	r	Quality of data	o	#21
	TotVAr1		Total reactive power	o	
	f	r	Total reactive power	o	METER:Q1
	q	r	Quality of data	o	#21
	TotVAr2		Total reactive power	o	
	f	r	Total reactive power	o	METER:Q2
	q	r	Quality of data	o	#21
	TotVAr3		Total reactive power	o	
	f	r	Total reactive power	o	METER:Q3
	q	r	Quality of data	o	#21
	TotVAr4		Total reactive power	o	
	f	r	Total reactive power	o	METER:Q4
	q	r	Quality of data	o	#21
	Hz		System frequency	o	
	f	r	System frequency	o	METER:FREQ
	q	r	Quality of data	o	#21
CF					
	All MMXU.MX	r	Configuration of data	m	
	u	r	Units for all items	m	#23

[a] Extension to the GOMSFE MMXU brick.

Communications Card or Non-SEL Virtual Device

The models in domains for ports where a non-SEL device (Port 1–Port 16) or a communications card (Port 17 or 18) is connected contain data from the User region and are listed in *Table B.12*. Use Math/Movement equations in the SEL-2030 to move data elements from the data regions to the User region and label with the required label shown in the Decode Method column.

Table B.12 Models in Virtual Device Domain for Non-SEL IED Connected to an SEL-2030

Model	Description
DI	Relay ID information and SEL-2701 information
GCTL	Control of remote bits (RB1–RB16) for port
GLOBE	Basic device information
MMXU	Relay metering and measurement data
MMTR	Energy metering data

Table B.13 Device ID Model (DI)—Non-SEL IED Connected to an SEL-2030

FC	Name	r/w	Description	m/o	Decode Method
DI		r			
	Name	r	Relay ID	m	LOCAL:PORTID
	VndID				
	Vnd	r	Vendor	m	"Unknown"
	Mdl	r	Device model number[a]	o	USER:MODEL #24
	SerNum	r	Device serial number	m	USER:SER_NUM #24
	SftRev	r	Device software revision[b]	o	USER:SFT_REV #24
	CommID			m[c]	
	CommAdr	r	NSAP	m	#3
	CommRev	r	SEL-2701 firmware revision[b]	m	#4
	SftRev[d]	r	SEL-2701 firmware revision	m	#4
	BootRev[d]	r	SEL-2701 SELBOOT revision	m	#5
	Pro	r	Protocol (MMS + CASM)	m	"11"
	Med	r	Physical medium	o	#6
	MAC	r	Medium access control	o	#7
	Vnd[d]	r	Vendor	m	"SEL"
	Mdl[d]	r	Model	m	"SEL-2701"
	SerNum[d]	r	SEL-2701 serial number	m	#7
	FID[d]	r	SEL-2701 firmware ID	m	#8
	BootFID[d]	r	SEL-2701 SELBOOT code firmware ID	m	#9

[a] Part name and V portion of the FID.
[b] R portion of the FID.
[c] Same as the CommID of the.
[d] Extension to the GOMSFE Device ID component.

Table B.14 Generic Control Model (GCTL)—Non-SEL IED Connected to an SEL-2030

FC	Name	r/w	Description	m/o	Decode Method
ST					
	OD1–OD16		State last written to this control point	m	
	b2	r	Status of bit	m	#19
CO					
	OD1–OD16		Control bit	m	
	OperDev	rw	Control bit (01 to clear; 10 to set)	m	#20

Table B.15 Globe Model (GLOBE)—Non-SEL IED Connected to an SEL-2030

FC	Name	r/w	Description	m/o	Decode Method
MX					
	ANALOG01–ANALOG64	r	Analog values	o	USER:ANALOG01–USER:ANALOG64
ST					
	CommSt[a]	r	Communications status		
	b2	r	0-invalid, 1-unavailable, 2-available	m	#34
	DWORD01B01–DWORD01B16				
	b1	r	Binary value	o	USER:DWORD01:0–USER:DWORD01:15
	DWORD02B01–DWORD02B16				
	b1	r	Binary value	o	USER:DWORD02:0–USER:DWORD02:15
	DWORD03B01–DWORD03B16				
	b1	r	Binary value	o	USER:DWORD03:0–USER:DWORD03:15
	•				
	•				
	•				
	DWORD16B01–DWORD16B16				
	b1	r	Binary value	o	USER:DWORD16:0–USER:DWORD16:15

[a] Extension to the GOMSFE-specified GLOBE brick.

Table B.16 Polyphase Measurement Unit Model (MMXU)—Non-SEL IED Connected to an SEL-2030 (Sheet 1 of 6)

FC	Name	r/w	Description	m/o	Decode Method
MX					
	V		Three-phase voltage	o	
	PhsAf	r	A-phase voltage	o	USER:VA
	PhsBf	r	B-phase voltage	o	USER:VB
	PhsCf	r	C-phase voltage	o	USER:VC
	Neutf	r	Neutral voltage	o	USER:VN
	q	r	Quality of data	o	#21
	V1		Three-phase voltage	o	
	PhsAf	r	A-phase voltage	o	USER:VA1
	PhsBf	r	B-phase voltage	o	USER:VB1
	PhsCf	r	C-phase voltage	o	USER:VC1
	Neutf	r	Neutral voltage	o	USER:VN1
	q	r	Quality of data	o	#21
	V2		Three-phase voltage	o	
	PhsAf	r	A-phase voltage	o	USER:VA2
	PhsBf	r	B-phase voltage	o	USER:VB2
	PhsCf	r	C-phase voltage	o	USER:VC2
	Neutf	r	Neutral voltage	o	USER:VN2
	q	r	Quality of data	o	#21
	V3		Three-phase voltage	o	
	PhsAf	r	A-phase voltage	o	USER:VA3
	PhsBf	r	B-phase voltage	o	USER:VB3
	PhsCf	r	C-phase voltage	o	USER:VC3
	Neutf	r	Neutral voltage	o	USER:VN3
	q	r	Quality of data	o	#21
	V4		Three-phase voltage	o	
	PhsAf	r	A-phase voltage	o	USER:VA4
	PhsBf	r	B-phase voltage	o	USER:VB4
	PhsCf	r	C-phase voltage	o	USER:VC4
	Neutf	r	Neutral voltage	o	USER:VN4
	q	r	Quality of data	o	#21
	Vseq[a]		Sequence voltages	o	
	Posif	r	Positive-sequence voltage	o	USER:V1
	Negf	r	Negative-sequence voltage	o	USER:V2
	Zerof	r	Zero-sequence voltage	o	USER:V0
	q	r	Quality of data	o	#21

Table B.16 Polyphase Measurement Unit Model (MMXU)—Non-SEL IED Connected to an SEL-2030 (Sheet 2 of 6)

FC	Name	r/w	Description	m/o	Decode Method
	Vseq1[a]		Sequence voltages	o	
	Posif	r	Positive-sequence voltage	o	USER:V1_1
	Negf	r	Negative-sequence voltage	o	USER:V2_1
	Zerof	r	Zero-sequence voltage	o	USER:V0_1
	q	r	Quality of data	o	#21
	Vseq2[a]		Sequence voltages	o	
	Posif	r	Positive-sequence voltage	o	USER:V1_2
	Negf	r	Negative-sequence voltage	o	USER:V2_2
	Zerof	r	Zero-sequence voltage	o	USER:V0_2
	q	r	Quality of data	o	#21
	Vseq3[a]		Sequence voltages	o	
	Posif	r	Positive-sequence voltage	o	USER:V1_3
	Negf	r	Negative-sequence voltage	o	USER:V2_3
	Zerof	r	Zero-sequence voltage	o	USER:V0_3
	q	r	Quality of data	o	#21
	Vseq4[a]		Sequence voltages	o	
	Posif	r	Positive-sequence voltage	o	USER:V1_4
	Negf	r	Negative-sequence voltage	o	USER:V2_4
	Zerof	r	Zero-sequence voltage	o	USER:V0_4
	q	r	Quality of data	o	#21
	AuxV[a]		Auxiliary voltages		
	q	r	Quality of data		#21
	PPV		Delta voltages	o	
	PhsABf	r	AB voltage	o	USER:VAB
	PhsBCf	r	BC voltage	o	USER:VBC
	PhsCAf	r	CA voltage	o	USER:VCA
	q	r	Quality of data	o	#21
	PPV1		Delta voltages	o	
	PhsABf	r	AB voltage	o	USER:VAB1
	PhsBCf	r	BC voltage	o	USER:VBC1
	PhsCAf	r	CA voltage	o	USER:VCA1
	q	r	Quality of data	o	#21
	PPV2		Delta voltages	o	
	PhsABf	r	AB voltage	o	USER:VAB2
	PhsBCf	r	BC voltage	o	USER:VBC2
	PhsCAf	r	CA voltage	o	USER:VCA2
	q	r	Quality of data	o	#21

Table B.16 Polyphase Measurement Unit Model (MMXU)—Non-SEL IED Connected to an SEL-2030 (Sheet 3 of 6)

FC	Name	r/w	Description	m/o	Decode Method
	PPV3		Delta voltages	o	
	PhsABf	r	AB voltage	o	USER:VAB3
	PhsBCf	r	BC voltage	o	USER:VBC3
	PhsCAf	r	CA voltage	o	USER:VCA3
	q	r	Quality of data	o	#21
	PPV4		Delta voltages	o	
	PhsABf	r	AB voltage	o	USER:VAB4
	PhsBCf	r	BC voltage	o	USER:VBC4
	PhsCAf	r	CA voltage	o	USER:VCA4
	q	r	Quality of data	o	#21
	A		Three-phase currents	o	
	PhsAf	r	A-phase current	o	USER:IA
	PhsBf	r	B-phase current	o	USER:IB
	PhsCf	r	C-phase current	o	USER:IC
	Neutf	r	Neutral current	o	USER:IR
	q	r	Quality of data	o	#21
	A1		Three-phase currents	o	
	PhsAf	r	A-phase current	o	USER:IA1
	PhsBf	r	B-phase current	o	USER:IB1
	PhsCf	r	C-phase current	o	USER:IC1
	Neutf	r	Neutral current	o	USER:IR1
	q	r	Quality of data	o	#21
	A2		Three-phase currents	o	
	PhsAf	r	A-phase current	o	USER:IA2
	PhsBf	r	B-phase current	o	USER:IB2
	PhsCf	r	C-phase current	o	USER:IC2
	Neutf	r	Neutral current	o	USER:IR2
	q	r	Quality of data	o	#21
	A3		Three-phase currents	o	
	PhsAf	r	A-phase current	o	USER:IA3
	PhsBf	r	B-phase current	o	USER:IB3
	PhsCf	r	C-phase current	o	USER:IC3
	Neutf	r	Neutral current	o	USER:IR3
	q	r	Quality of data	o	#21
	A4		Three-phase currents	o	
	PhsAf	r	A-phase current	o	USER:IA4
	PhsBf	r	B-phase current	o	USER:IB4
	PhsCf	r	C-phase current	o	USER:IC4
	Neutf	r	Neutral current	o	USER:IR4
	q	r	Quality of data	o	#21

Table B.16 Polyphase Measurement Unit Model (MMXU)—Non-SEL IED Connected to an SEL-2030 (Sheet 4 of 6)

FC	Name	r/w	Description	m/o	Decode Method
	Aseq[a]		Sequence currents	o	
	Posif	r	Positive-sequence current	o	USER:I1
	Negf	r	Negative-sequence current	o	USER:I2
	Zerof	r	Zero-sequence current	o	USER:I0
	q	r	Quality of data	o	#21
	Aseq1[a]		Sequence currents	o	
	Posif	r	Positive-sequence current	o	USER:I1_1
	Negf	r	Negative-sequence current	o	USER:I2_1
	Zerof	r	Zero-sequence current	o	USER:I0_1
	q	r	Quality of data	o	#21
	Aseq2[a]		Sequence currents	o	
	Posif	r	Positive-sequence current	o	USER:I1_2
	Negf	r	Negative-sequence current	o	USER:I2_2
	Zerof	r	Zero-sequence current	o	USER:I0_2
	q	r	Quality of data	o	#21
	Aseq3[a]		Sequence currents	o	
	Posif	r	Positive-sequence current	o	USER:I1_3
	Negf	r	Negative-sequence current	o	USER:I2_3
	Zerof	r	Zero-sequence current	o	USER:I0_3
	q	r	Quality of data	o	#21
	Aseq4[a]		Sequence currents	o	
	Posif	r	Positive-sequence current	o	USER:I1_4
	Negf	r	Negative-sequence current	o	USER:I2_4
	Zerof	r	Zero-sequence current	o	USER:I0_4
	q	r	Quality of data	o	#21
	AuxA1[a]		Auxiliary currents		
	q	r	Quality of data		#21
	W		Per-phase power	o	
	PhsAf	r	A-phase power	o	USER:PA
	PhsBf	r	B-phase power	o	USER:PB
	PhsCf	r	C-phase power	o	USER:PC
	q	r	Quality of data	o	#21
	W1		Per-phase power	o	
	PhsAf	r	A-phase power	o	USER:PA1
	PhsBf	r	B-phase power	o	USER:PB1
	PhsCf	r	C-phase power	o	USER:PC1
	q	r	Quality of data	o	#21

Table B.16 Polyphase Measurement Unit Model (MMXU)—Non-SEL IED Connected to an SEL-2030 (Sheet 5 of 6)

FC	Name	r/w	Description	m/o	Decode Method
	W2		Per-phase power	o	
	PhsAf	r	A-phase power	o	USER:PA2
	PhsBf	r	B-phase power	o	USER:PB2
	PhsCf	r	C-phase power	o	USER:PC2
	q	r	Quality of data	o	#21
	W3		Per-phase power	o	
	PhsAf	r	A-phase power	o	USER:PA3
	PhsBf	r	B-phase power	o	USER:PB3
	PhsCf	r	C-phase power	o	USER:PC3
	q	r	Quality of data	o	#21
	W4		Per-phase power	o	
	PhsAf	r	A-phase power	o	USER:PA4
	PhsBf	r	B-phase power	o	USER:PB4
	PhsCf	r	C-phase power	o	USER:PC4
	q	r	Quality of data	o	#21
	TotW		Total (three-phase) power	o	
	f	r	Total power	o	USER:P
	q	r	Quality of data	o	#21
	TotW1		Total (three-phase) power	o	
	f	r	Total power	o	USER:P1
	q	r	Quality of data	o	#21
	TotW2		Total (three-phase) power	o	
	f	r	Total power	o	USER:P2
	q	r	Quality of data	o	#21
	TotW3		Total (three-phase) power	o	
	f	r	Total power	o	USER:P3
	q	r	Quality of data	o	#21
	TotW4		Total (three-phase) power	o	
	f	r	Total power	o	USER:P4
	q	r	Quality of data	o	#21
	Var		Per-phase reactive power	o	
	PhsAf	r	A-phase reactive power	o	USER:QA
	PhsBf	r	B-phase reactive power	o	USER:QB
	PhsCf	r	C-phase reactive power	o	USER:QC
	q	r	Quality of data	o	#21
	Var1		Per-phase reactive power	o	
	PhsAf	r	A-phase reactive power	o	
	PhsBf	r	B-phase reactive power	o	USER:QB1
	PhsCf	r	C-phase reactive power	o	USER:QC1
	q	r	Quality of data	o	#21

Table B.16 Polyphase Measurement Unit Model (MMXU)—Non-SEL IED Connected to an SEL-2030 (Sheet 6 of 6)

FC	Name	r/w	Description	m/o	Decode Method
	Var2		Per-phase reactive power	o	
	PhsAf	r	A-phase reactive power	o	USER:QA2
	PhsBf	r	B-phase reactive power	o	USER:QB2
	PhsCf	r	C-phase reactive power	o	USER:QC2
	q	r	Quality of data	o	#21
	Var3		Per-phase reactive power	o	
	PhsAf	r	A-phase reactive power	o	USER:QA3
	PhsBf	r	B-phase reactive power	o	USER:QB3
	PhsCf	r	C-phase reactive power	o	USER:QC3
	q	r	Quality of data	o	#21
	Var4		Per-phase reactive power	o	
	PhsAf	r	A-phase reactive power	o	USER:QA4
	PhsBf	r	B-phase reactive power	o	USER:QB4
	PhsCf	r	C-phase reactive power	o	USER:QC4
	q	r	Quality of data	o	#21
	TotVAr		Total reactive power	o	
	f	r	Total reactive power	o	USER:Q
	q	r	Quality of data	o	#21
	TotVAr1		Total reactive power	o	
	f	r	Total reactive power	o	USER:Q1
	q	r	Quality of data	o	#21
	TotVAr2		Total reactive power	o	
	f	r	Total reactive power	o	USER:Q2
	q	r	Quality of data	o	#21
	TotVAr3		Total reactive power	o	
	f	r	Total reactive power	o	USER:Q3
	q	r	Quality of data	o	#21
	TotVAr4		Total reactive power	o	
	f	r	Total reactive power	o	USER:Q4
	q	r	Quality of data	o	#21
	Hz		System frequency	o	
	f	r	System frequency	o	USER:FREQ
	q	r	Quality of data	o	#21

[a] Extension to the GOMSFE MMXU brick.

Table B.17 Polyphase Meter Unit Model (MMTR)—Non-SEL IED Connected to an SEL-2030 (Sheet 1 of 4)

FC	Name	r/w	Description	m/o	Decode Method
MX					
	WHr		Per-phase energy	o	
	PhsAf	r	A-phase energy	o	USER:EA
	PhsBf	r	B-phase energy	o	USER:EB
	PhsCf	r	C-phase energy	o	USER:EC
	q	r	Quality of data	o	#21
	WHr1		Per-phase energy	o	
	PhsAf	r	A-phase energy	o	USER:EA1
	PhsBf	r	B-phase energy	o	USER:EB1
	PhsCf	r	C-phase energy	o	SER:EC1
	q	r	Quality of data	o	#21
	WHr2		Per-phase energy	o	
	PhsAf	r	A-phase energy	o	USER:EA2
	PhsBf	r	B-phase energy	o	USER:EB2
	PhsCf	r	C-phase energy	o	USER:EC2
	q	r	Quality of data	o	#21
	WHr3		Per-phase energy	o	
	PhsAf	r	A-phase energy	o	USER:EA3
	PhsBf	r	B-phase energy	o	USER:EB3
	PhsCf	r	C-phase energy	o	USER:EC3
	q	r	Quality of data	o	#21
	WHr4		Per-phase energy	o	
	PhsAf	r	A-phase energy	o	USER:EA4
	PhsBf	r	B-phase energy	o	USER:EB4
	PhsCf	r	C-phase energy	o	USER:EC4
	q	r	Quality of data	o	#21
	TotWHr		Total energy	o	
	f	r	Total energy	o	USER:E
	q	r	Quality of data	o	#21
	TotWHr1		Total energy	o	
	f	r	Total energy	o	USER:E1
	q	r	Quality of data	o	#21
	TotWHr2		Total energy	o	
	f	r	Total energy	o	USER:E2
	q	r	Quality of data	o	#21
	TotWHr3		Total energy	o	
	f	r	Total energy	o	USER:E3
	q	r	Quality of data	o	#21

Table B.17 Polyphase Meter Unit Model (MMTR)—Non-SEL IED Connected to an SEL-2030 (Sheet 2 of 4)

FC	Name	r/w	Description	m/o	Decode Method
	TotWHr4		Total energy	o	
	f	r	Total energy	o	USER:E4
	q	r	Quality of data	o	#21
	PosiWHr[a]		Per-phase energy	o	
	PhsAf	r	A-phase energy	o	USER:PEA
	PhsBf	r	B-phase energy	o	USER:PEB
	PhsCf	r	C-phase energy	o	USER:PEC
	q	r	Quality of data	o	#21
	PosiWHr1[a]		Per-phase energy	o	
	PhsAf	r	A-phase energy	o	USER:PEA1
	PhsBf	r	B-phase energy	o	USER:PEB1
	PhsCf	r	C-phase energy	o	USER:PEC1
	q	r	Quality of data	o	#21
	PosiWHr2[a]		Per-phase energy	o	
	PhsAf	r	A-phase energy	o	USER:PEA2
	PhsBf	r	B-phase energy	o	USER:PEB2
	PhsCf	r	C-phase energy	o	USER:PEC2
	q	r	Quality of data	o	#21
	PosiWHr3[a]		Per-phase energy	o	
	PhsAf	r	A-phase energy	o	USER:PEA3
	PhsBf	r	B-phase energy	o	USER:PEB3
	PhsCf	r	C-phase energy	o	USER:PEC3
	q	r	Quality of data	o	#21
	PosiWHr4[a]		Per-phase energy	o	
	PhsAf	r	A-phase energy	o	USER:PEA4
	PhsBf	r	B-phase energy	o	USER:PEB4
	PhsCf	r	C-phase energy	o	USER:PEC4
	q	r	Quality of data	o	#21
	PosiTotWHr[a]		Total energy	o	
	f	r	Total energy	o	USER:PE
	q	r	Quality of data	o	#21
	PosiTotWHr1[a]		Total energy	o	
	f	r	Total energy	o	USER:PE1
	q	r	Quality of data	o	#21
	PosiTotWHr2[a]		Total energy	o	
	f	r	Total energy	o	USER:PE2
	q	r	Quality of data	o	#21
	PosiTotWHr3[a]		Total energy	o	
	f	r	Total energy	o	USER:PE3
	q	r	Quality of data	o	#21

Table B.17 Polyphase Meter Unit Model (MMTR)—Non-SEL IED Connected to an SEL-2030 (Sheet 3 of 4)

FC	Name	r/w	Description	m/o	Decode Method
	PosiTotWHr4[a]		Total energy	o	
	f	r	Total energy	o	USER:PE4
	q	r	Quality of data	o	#21
	NegWHr[a]		Per-phase energy	o	
	PhsAf	r	A-phase energy	o	USER:NEA
	PhsBf	r	B-phase energy	o	USER:NEB
	PhsCf	r	C-phase energy	o	USER:NEC
	q	r	Quality of data	o	#21
	NegWHr1[a]		Per-phase energy	o	
	PhsAf	r	A-phase energy	o	USER:NEA1
	PhsBf	r	B-phase energy	o	USER:NEB1
	PhsCf	r	C-phase energy	o	USER:NEC1
	q	r	Quality of data	o	#21
	NegWHr2[a]		Per-phase energy	o	
	PhsAf	r	A-phase energy	o	USER:NEA2
	PhsBf	r	B-phase energy	o	USER:NEB2
	PhsCf	r	C-phase energy	o	USER:NEC2
	q	r	Quality of data	o	#21
	NegWHr3[a]		Per-phase energy	o	
	PhsAf	r	A-phase energy	o	USER:NEA3
	PhsBf	r	B-phase energy	o	USER:NEB3
	PhsCf	r	C-phase energy	o	USER:NEC3
	q	r	Quality of data	o	#21
	NegWHr4[a]		Per-phase energy	o	
	PhsAf	r	A-phase energy	o	USER:NEA4
	PhsBf	r	B-phase energy	o	USER:NEB4
	PhsCf	r	C-phase energy	o	USER:NEC4
	q	r	Quality of data	o	#21
	NegTotWHr[a]		Total energy	o	
	f	r	Total energy	o	USER:NE
	q	r	Quality of data	o	#21
	NegTotWHr1[a]		Total energy	o	
	f	r	Total energy	o	USER:NE1
	q	r	Quality of data	o	#21
	NegTotWHr2[a]		Total energy	o	
	f	r	Total energy	o	USER:NE2
	q	r	Quality of data	o	#21
	NegTotWHr3[a]		Total energy	o	
	f	r	Total energy	o	USER:NE3
	q	r	Quality of data	o	#21

Table B.17 Polyphase Meter Unit Model (MMTR)—Non-SEL IED Connected to an SEL-2030 (Sheet 4 of 4)

FC	Name	r/w	Description	m/o	Decode Method
	NegTotWHr4[a]		Total energy	o	
	f	r	Total energy	o	USER:NE4
	q	r	Quality of data	o	#21
CF					
	All MMTR.MX	r	Configuration of all data	m	

[a] Extension to the GOMSFE MMTR brick.

Special Translation Rules

The rules listed in *Table B.18* apply to the GOMSFE models shown in the preceding paragraphs of this appendix.

Table B.18 Special Translation Rules (Sheet 1 of 2)

#	Rule
1	Device model number from FID string
2	Software revision code from FID string
3	Communications address (NSAP)
4	SEL-2701 software revision code
5	SEL-2701 SELBOOT software revision code
6	Current physical medium being used
7	SEL-2701 serial number
8	SEL-2701 FID
9	SEL-2701 SELBOOT FID
10	Status based on Host Status Register and local status
11	Target rows 5 and 6
12	Preset value for DNA outputs
13	Force value for DNA inputs
14	Default value for DNA inputs
15	Access card date and time
16	Selection for DNA outputs
17	Selection for DNA inputs
18	Control to force SEL-2701 to reacquire GOOSE addresses
19	Last value written to control points
20	Operate control points to host
21	Communication failure, Comm Fail, quality indication based on state of port from LOCAL:PORT_STATUS or forced if associated data are forced
22	Quantity scaled down by factor of three
23	Unit quantities based on default units for each item
24	Item at given label treated as a null-terminated string
25	Preset value for UserSt outputs

Table B.18 Special Translation Rules (Sheet 2 of 2)

#	Rule
26	Force value for UserSt inputs
27	Default value for UserSt inputs
28	Selection for UserSt outputs
29	Selection for UserSt inputs
30	Fields labeled MONTH, DAY, YEAR, HOUR, MIN, SEC, and MSEC, converted to date/time
31	Targets bit map as shown in *Table B.19*
32	Fault types as shown in *Table B.20*
33	Common fault types as shown in *Table B.20*
34	Base communications status on LOCAL:PORT_STATUS Bit 9

Table B.19 Relay Target Bit Mapping

Bit	Target Mapping
0[a]	51, LO[b], ALARM, 52A1, Y59I, ALRM, 51N
1	50, RS[c], 52A2, X59I, BKR, 51P
2	Q, RC1, 87, Y59T, G3, 81
3	G, N, RC2, X59T, PH3
4	C, RS[c], 87C, G2
5	B, CY[c], 87B, PH2
6	A, LO[c], G1, 87A
7	EN, CLOS, PH1
8	ZONE4, CY[b]
9	ZONE3
10	ZONE2
11	ZONE1
12	SOTF
13	COMM, Y
14	TIME, X
15	INST

[a] Least significant (right hand) bit.
[b] All relays except SEL-279H.
[c] SEL-279H only.

Table B.20 Event Types (Sheet 1 of 9)

Event	Code for Rule #32	Code for Rule #33
!L	0x8000	61
!M	0x8000	65
?AB	0x000C	7003
?ABC	0x000E	7001
?ABCT	0x100E	7101
?ABG	0x000D	7002
?ABGT	0x100D	7102
?ABT	0x100C	7103

Table B.20 Event Types (Sheet 2 of 9)

Event	Code for Rule #32	Code for Rule #33
?AG	0x0009	7004
?AGT	0x1009	7104
?BC	0x0006	7006
?BCG	0x0007	7005
?BCGT	0x1007	7105
?BCT	0x1007	7106
?BG	0x0005	7007
?BGT	0x1005	7107
?CA	0x000A	7009
?CAG	0x000B	7008
?CAGT	0x100B	7108
?CAT	0x100A	7109
?CG	0x0003	7010
?CGT	0x1003	7110
1AB	0x001C	1003
1ABC	0x001E	1001
1ABCT	0x101E	1101
1ABG	0x001D	1002
1ABGT	0x101D	1102
1ABT	0x101C	1103
1AG	0x0019	1004
1AGT	0x1019	1104
1BC	0x0016	1006
1BCG	0x0017	1005
1BCGT	0x1017	1105
1BCT	0x1016	1106
1BG	0x0015	1007
1BGT	0x1015	1107
1CA	0x001A	1009
1CAG	0x001B	1008
1CAGT	0x101B	1108
1CAT	0x101A	1109
1CG	0x0013	1010
1CGT	0x1013	1110
1OUT	0x8000	88
1OUT X	0x8000	9035
1OUT Y	0x8000	9036
25T1	0x8000	34
25T2	0x8000	35
27B	0x8000	30
27L	0x8000	31

Table B.20 Event Types (Sheet 3 of 9)

Event	Code for Rule #32	Code for Rule #33
2AB	0x002C	2003
2ABC	0x002E	2001
2ABCT	0x102E	2101
2ABG	0x002D	2002
2ABGT	0x102D	2102
2ABT	0x102C	2103
2AG	0x0029	2004
2AGT	0x1029	2104
2BC	0x0026	2006
2BCG	0x0027	2005
2BCGT	0x1027	2105
2BCT	0x1026	2106
2BG	0x0025	2007
2BGT	0x1025	2107
2CA	0x002A	2009
2CAG	0x002B	2008
2CAGT	0x102B	2108
2CAT	0x102A	2109
2CG	0x0023	2010
2CGT	0x1023	2110
2OUT	0x8000	89
2OUT X	0x8000	9037
2OUT Y	0x8000	9038
3AB	0x004C	3003
3ABC	0x004E	3001
3ABCT	0x104E	3101
3ABG	0x004D	3002
3ABGT	0x104D	3102
3ABT	0x104C	3103
3AG	0x0049	3004
3AGT	0x1049	3104
3BC	0x0046	3006
3BCG	0x0047	3005
3BCGT	0x1047	3105
3BCT	0x1046	3106
3BG	0x0045	3007
3BGT	0x1045	3107
3CA	0x004A	3009
3CAG	0x004B	3008
3CAGT	0x104B	3108
3CAT	0x104A	3109

Table B.20 Event Types (Sheet 4 of 9)

Event	Code for Rule #32	Code for Rule #33
3CG	0x0043	3010
3CGT	0x1043	3110
3PC1	0x8000	40
3PC2	0x8000	41
3PRI	0x8000	51
4AB	0x008C	4003
4ABC	0x008E	4001
4ABCT	0x108E	4101
4ABG	0x008D	4002
4ABGT	0x108D	4102
4ABT	0x108C	4103
4AG	0x0089	4004
4AGT	0x1089	4104
4BC	0x0086	4006
4BCG	0x0087	4005
4BCGT	0x1087	4105
4BCT	0x1086	4106
4BG	0x0085	4007
4BGT	0x1085	4107
4CA	0x008A	4009
4CAG	0x008B	4008
4CAGT	0x108B	4108
4CAT	0x108A	4109
4CG	0x0083	4010
4CGT	0x1083	4110
52A1	0x8000	46
52A2	0x8000	47
52BT1	0x8000	48
52BT2	0x8000	49
59B	0x8000	32
59L	0x8000	33
5AB	0x010C	5003
5ABC	0x010E	5001
5ABCT	0x110E	5101
5ABG	0x010D	5002
5ABGT	0x110D	5102
5ABT	0x110C	5103
5AG	0x0109	5004
5AGT	0x1109	5104
5BC	0x0106	5006
5BCG	0x0107	5005

Table B.20 Event Types (Sheet 5 of 9)

Event	Code for Rule #32	Code for Rule #33
5BCGT	0x1107	5105
5BCT	0x1106	5106
5BG	0x0105	5007
5BGT	0x1105	5107
5CA	0x010A	5009
5CAG	0x010B	5008
5CAGT	0x110B	5108
5CAT	0x110A	5109
5CG	0x0103	5010
5CGT	0x1103	5110
6AB	0x020C	8003
6ABC	0x020E	8001
6ABCT	0x120E	8101
6ABG	0x020D	8002
6ABGT	0x120D	8102
6ABT	0x120C	8103
6AG	0x0209	8004
6AGT	0x1209	8104
6BC	0x0206	8006
6BCG	0x0207	8005
6BCGT	0x1207	8105
6BCT	0x1206	8106
6BG	0x0205	8007
6BGT	0x1205	8107
6CA	0x020A	8009
6CAG	0x020B	8008
6CAGT	0x120B	8108
6CAT	0x120A	8109
6CG	0x0203	8010
6CGT	0x1203	8110
79OIT	0x8000	50
79RST	0x8000	52
79SH	0x8000	53
86BFT	0x8000	20
86TR	0x8000	85
86TR X	0x8000	9027
86TR Y	0x8000	9028
A	0x0008	55
AB	0x000C	3
ABC	0x000E	1
ABCT	0x100E	101

Table B.20 Event Types (Sheet 6 of 9)

Event	Code for Rule #32	Code for Rule #33
ABG	0x000D	2
ABGT	0x100D	102
ABT	0x100C	103
AG	0x0009	4
AGT	0x1009	104
B	0x0004	56
BC	0x0006	6
BCG	0x0007	5
BCGT	0x1007	105
BCT	0x1006	106
BFI	0x8000	83
BFI X	0x8000	9023
BFI Y	0x8000	9024
BG	0x0005	7
BGT	0x1005	107
C	0x0002	57
CA	0x000A	9
CAG	0x000B	8
CAGT	0x100B	108
CAT	0x100A	109
CG	0x0003	10
CGT	0x1003	110
CLOSE	0x8000	28
CLOSE X	0x8000	9007
CLOSE Y	0x8000	9008
CLS1	0x8000	36
CLS2	0x8000	37
CYCL	0x8000	43
D	0x8000	58
DT	0x8000	11
E	0x8000	59
ER	0x2000	12
ER1	0x2000	90
ER2	0x2000	91
ET	0x8000	13
ET1	0x8000	71
ET2	0x8000	72
EXT	0x8000	18
EXT X	0x8000	9029
EXT Y	0x8000	9030
EXTC	0x8000	17

Table B.20 Event Types (Sheet 7 of 9)

Event	Code for Rule #32	Code for Rule #33
FAULT	0x8000	75
FAULT X	0x8000	9003
FAULT Y	0x8000	9004
G	0x0001	62
H	0x8000	63
HAB	0x000C	6003
HABC	0x000E	6001
HABCT	0x100E	6101
HABG	0x000D	6002
HABGT	0x100D	6102
HABT	0x100C	6103
HAG	0x0009	6004
HAGT	0x1009	6104
HBC	0x0006	6006
HBCG	0x0007	6005
HBCGT	0x1007	6105
HBCT	0x1007	6106
HBG	0x0005	6007
HBGT	0x1005	6107
HCA	0x000A	6009
HCAG	0x000B	6008
HCAGT	0x100B	6108
HCAT	0x100A	6109
HCG	0x0003	6010
HCGT	0x1003	6110
I	0x8000	64
INT	0x8000	29
LJAM	0x8000	81
LJAM X	0x8000	9019
LJAM Y	0x8000	9020
LLOSS	0x8000	82
LLOSS X	0x8000	9021
LLOSS Y	0x8000	9022
LOCK	0x8000	44
LTCH	0x8000	54
MER	0x8000	70
OPEN	0x8000	14
OPEN X	0x8000	9005
OPEN Y	0x8000	9006
OTT	0x8000	45
PULSE	0x8000	92

Table B.20 Event Types (Sheet 8 of 9)

Event	Code for Rule #32	Code for Rule #33
RETRIP	0x8000	84
RETRIP X	0x8000	9025
RETRIP Y	0x8000	9026
RSET	0x8000	42
RUN	0x8000	76
RUN X	0x8000	9009
RUN Y	0x8000	9010
SPC1	0x8000	38
SPC2	0x8000	39
SPRI	0x8000	74
ST	0x8000	60
START	0x8000	77
START X	0x8000	9011
START Y	0x8000	9012
STL	0x8000	80
STL X	0x8000	9017
STL Y	0x8000	9018
STOP	0x8000	78
STOP X	0x8000	9013
STOP Y	0x8000	9014
THERM	0x8000	79
THERM X	0x8000	9015
THERM Y	0x8000	9016
TIMER1	0x8000	86
TIMER1 X	0x8000	9031
TIMER1 Y	0x8000	9032
TIMER2	0x8000	87
TIMER2 X	0x8000	9033
TIMER2 Y	0x8000	9034
TR	0x8000	16
TRI	0x8000	73
TRIG	0x8000	15
TRIG X	0x8000	9001
TRIG Y	0x8000	9002
TRIP	0x8000	19
TRIP3	0x8000	27
TRIPA	0x8000	21
TRIPAB	0x8000	24
TRIPB	0x8000	22
TRIPBC	0x8000	25
TRIPC	0x8000	23

Table B.20 Event Types (Sheet 9 of 9)

Event	Code for Rule #32	Code for Rule #33
TRIPCA	0x8000	26
TRP1	0x8000	93
TRP2	0x8000	94
TRP3	0x8000	95
W	0x8000	66
X	0x8000	67
Y	0x8000	68
ZT	0x8000	69
other	0x8000	9999

Appendix C
GOMSFE Model Example

Introduction

This appendix illustrates how to use the SEL-2030 Communications Processor and the SEL-2701 Ethernet Processor to provide a UCA2 interface for data collection and control. An example is provided with an SEL-351S Relay connected to an SEL-2030. The step-by-step format will allow you to duplicate this work or adjust it to meet the requirements of your specific project. This appendix contains information on the following topics:

- SEL-2030 data collection settings
- SEL-2030/SEL-2701 network settings
- GOMSFE models of SEL-351S Relay data

Settings

In this example, the SEL-351S Relay is connected to Port 5 of the SEL-2030 with a C273A cable as shown in *Figure C.1*.

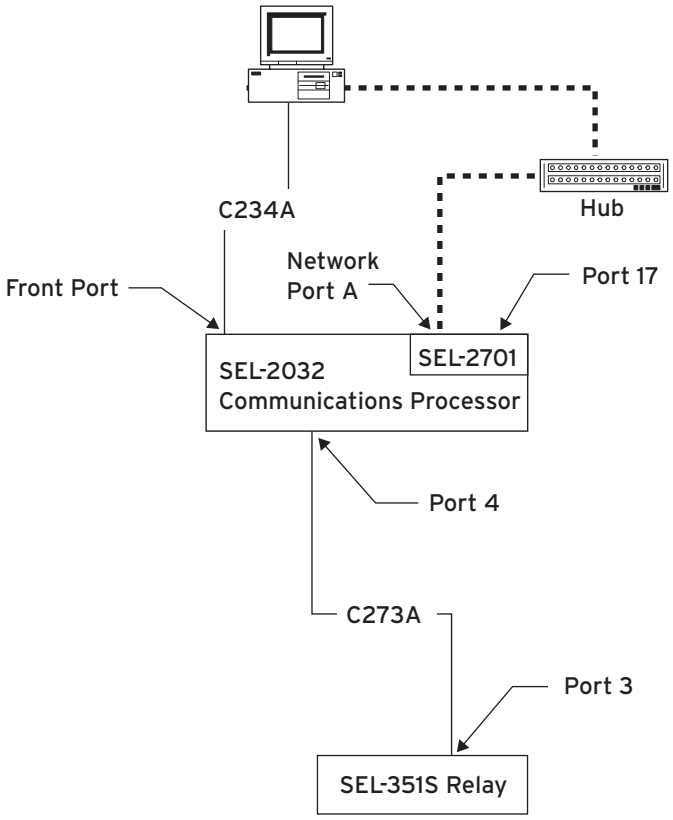

Figure C.1 Example SEL-2030/SEL-351S Relay System

The steps below configure the SEL-2030 to collect data from the relay and configure the SEL-2701 in Card Slot 1 (Port 17) for UCA2.

Step 1. Connect the cables as shown in *Figure C.1*.

Step 2. Apply power to the relay, SEL-2030, and PC.

Step 3. Start a serial port terminal application on the PC and connect to the SEL-2030.

Step 4. Log in to the SEL-2030 at Access Level 2.

Step 5. Configure the SEL-2030 serial port connected to the SEL-351S Relay with the **SET P 4** command. Change the Device Type selection to S for SEL. Start an Autoconfiguration when prompted and accept the remaining port settings.

Step 6. Configure the SEL-2030 automatic messaging to collect data from the SEL-351S Relay with the **SET A 4** command. Set the automatic messaging settings as shown in *Table C.1*. The 20METER and 20TARGET "20" messages collect analog measurement and status data. The 20HISTORY "20" message collects relay event history records.

Table C.1 SEL-2030 Automatic Messaging Settings (Sheet 1 of 2)

Setting	Description
ISSUE1 = P00:00:01.0	Send message every second
MESG1 = 20METER	Collect metering information from the relay with SEL binary Fast Meter
ISSUE2 = P00:00:01.0	Send message every second

Table C.1 SEL-2030 Automatic Messaging Settings (Sheet 2 of 2)

Setting	Description
MESG2 = 20TARGET	Collect target information from the relay with SEL binary Fast Meter
ISSUE3 = P00:15:00.0	Send message every 15 minutes
MESG3 = 20HISTORY	Collect relay history information with standard SEL message

Step 7. Set the SEL-2030 port settings and SEL-2701 settings with the **SET P 17** command. Relevant example settings are shown in *Table C.2*; other settings not shown are not critical for the example.

Table C.2 SEL-2701 Settings

Setting	Description
IPADDR = 10.201.0.16	IP address of SEL-2701
SUBNETM = 255.255.0.0	Subnet mask for SEL-2701 messages
DEFRTR = "10.201.0.1"	Default router for messages not on the same subnet as the SEL-2701
NETPORT = A	Enable network Port A
FAILOVR = Y	Enable automatic failover to Port B if network connected to Port A fails
FTIME = 5	Five-second failover timeout
NETASPD = A	Automatic speed sense (10/100 Mbps) on Port A
NETBSPD = A	Automatic speed sense (10/100 Mbps) on Port B
ENUCA = Y	Enable UCA2 protocol interface
NSAP = 0030.a700.0003	User-configured portion of NSAP

To add control using the GCTL model and a discrete output on the relay, continue the serial port terminal session and follow the steps listed below.

Step 1. Connect transparently to the relay with the **PORT 4** command and enable the relay to respond to Fast Operate commands. Use the relay **SET P 3** command and set FASTOP to Y.

Step 2. Use the **SET L** command to set OUT103, Relay Output 3, to RB3. This makes RB3 control OUT103.

Step 3. Terminate the transparent connection. Use the SEL-2030 transparent connection termination string (default is CTRL + D) to terminate the transparent connection.

Step 4. Enable Fast Operate messages on the SEL-2030 Port 4 with the SEL-2030 **SET A 4** command; set SEND_OPER to Y.

GOMSFE Models

Figure C.2–Figure C.7 show GOMSFE models visible in an MMS browser once you complete the steps above.

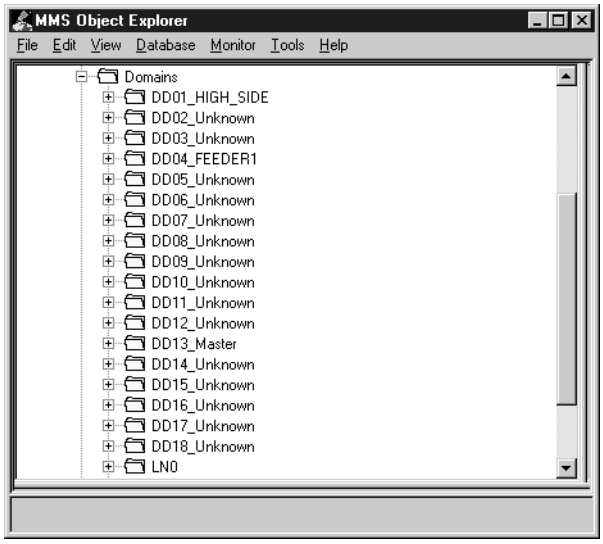

Figure C.2 GOMSFE Domains

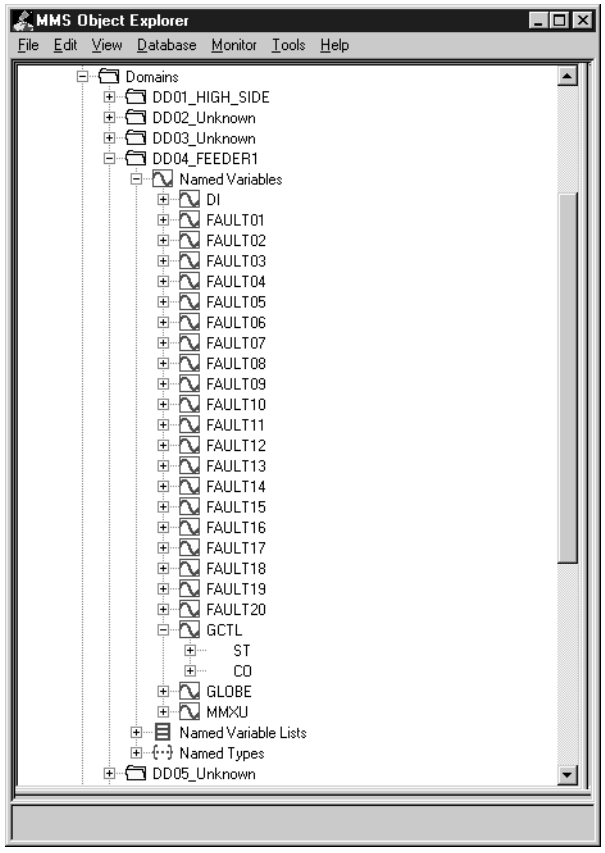

Figure C.3 GOMSFE Models Within DD04_FEEDER1 Domain

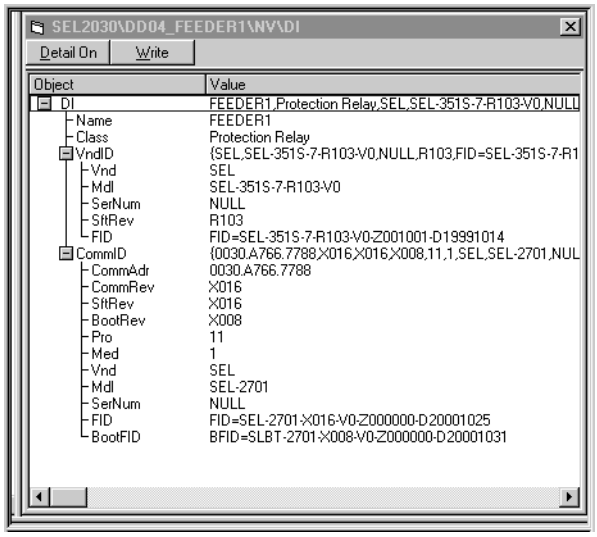

Figure C.4 DI Model

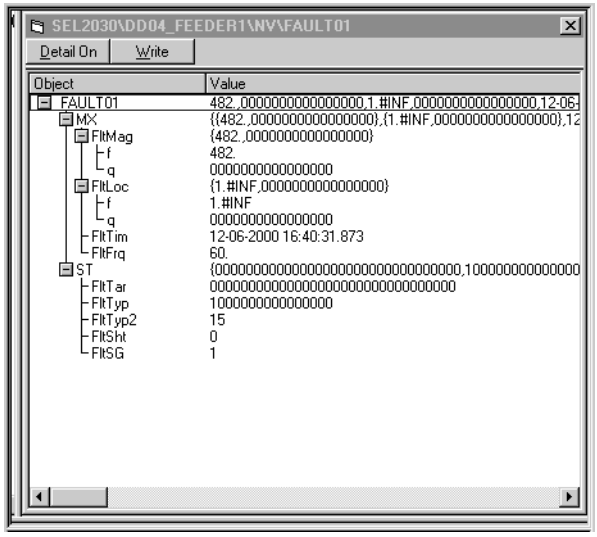

Figure C.5 FAULT Model

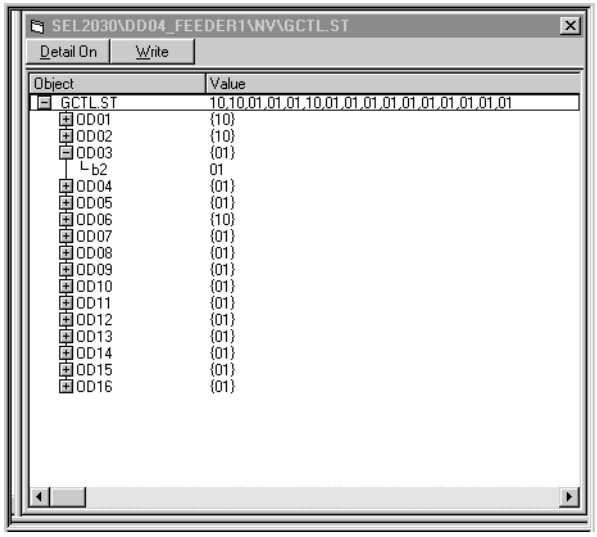

Figure C.6 GCTL Model With RB3 ST (status) Point

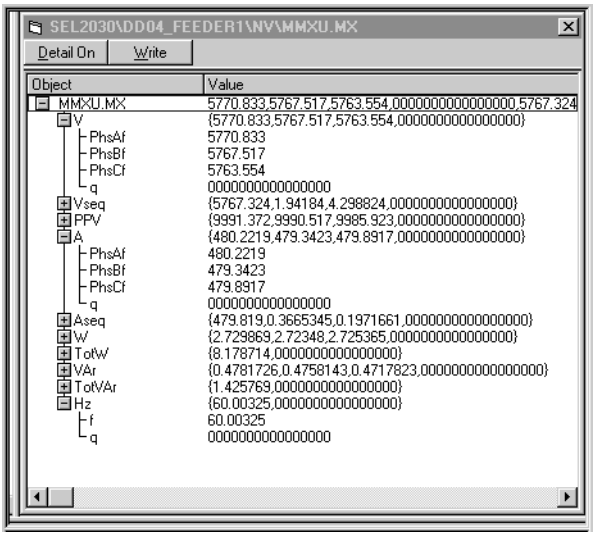

Figure C.7 MMXU Brick

Appendix D
DNP3 Communications

Profile

Table D.1 contains the standard DNP3 device profile information. Rather than check boxes in the example Device Profile in the DNP3 Subset Definitions, only the relevant selections are shown.

Table D.1 SEL-2701 DNP3 Device Profile (Sheet 1 of 2)

Parameter	Value
Vendor name	Schweitzer Engineering Laboratories
Device name	SEL-2701 Ethernet Processor
Highest DNP request level	Level 2
Highest DNP response level	Level 2
Device function	Slave
Notable objects, functions, and/or qualifiers supported	Analog Deadband Objects (Object 34), Supports 10 simultaneous master connections
Maximum DNP3 data link frame size transmitted/received (octets)	292
Maximum data link retries	Configurable, range 0–15
Requires data link layer confirmation	Configurable by setting
Maximum application fragment size transmitted/received (octets)	2048
Maximum application layer retries	None
Requires application layer confirmation	When reporting Event Data
Data link confirm time-out	Configurable
Complete application fragment time-out	None
Application confirm time-out	Configurable
Complete Application response time-out	None
Executes control WRITE binary outputs	Always
Executes control SELECT/OPERATE	Always
Executes control DIRECT OPERATE	Always
Executes control DIRECT OPERATE-NO ACK	Always
Executes control count greater than 1	Never
Executes control Pulse On	Always
Executes control Pulse Off	Always
Executes control Latch Off	Always

Table D.1 SEL-2701 DNP3 Device Profile (Sheet 2 of 2)

Parameter	Value
Executes control Latch Off	Always
Executes control Queue	Never
Executes control Clear Queue	Never
Reports binary input change events when no specific variation requested	Only time-tagged
Reports time-tagged binary input change events when no specific variation requested	Binary Input change with time
Sends unsolicited responses	Configurable with unsolicited message enable settings. Increases retry time (configurable) when a maximum retry setting is exceeded.
Sends static data in unsolicited responses	Never
Default counter object/variation	Object 20, Variation 6
Counter roll-over	16 bits
Sends multifragment responses	No

In response to the delay measurement function code, the SEL-2701 will return a time delay accurate to within 20 milliseconds.

Object List

Table D.2 lists the objects and variations with supported function codes and qualifier codes available in the SEL-2701 Ethernet Processor. The list of supported objects conforms to the format laid out in the DNP3 specifications and includes both supported and unsupported objects. Those that are supported include the function and qualifier codes. The objects that are not supported are shown without any corresponding function and qualifier codes.

Table D.2 SEL-2701 DNP3 Object List (Sheet 1 of 6)

Obj.	Var.	Description	Request[a]		Response[b]	
			Funct. Codes[c]	Qual. Codes[d]	Funct. Codes[c]	Qual. Codes[d]
1	0	Binary Input—All Variations	1	0, 1, 6, 7, 8, 17, 28		
1	1	Binary Input	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
1	2[e]	Binary Input With Status	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
2	0	Binary Input Change—All Variations	1	6, 7, 8		
2	1	Binary Input Change Without Time	1	6, 7, 8	129	17, 28
2	2[e]	Binary Input Change With Time	1	6, 7, 8	129, 130	17, 28
2	3	Binary Input Change With Relative Time	1	6, 7, 8	129	17, 28

Table D.2 SEL-2701 DNP3 Object List (Sheet 2 of 6)

Obj.	Var.	Description	Request[a]		Response[b]	
			Funct. Codes[c]	Qual. Codes[d]	Funct. Codes[c]	Qual. Codes[d]
10	0	Binary Output—All Variations	1	0, 1, 6, 7, 8		
10	1	Binary Output				
10	2[e]	Binary Output Status	1	0, 1, 6, 7, 8	129	0, 1
12	0	Control Block—All Variations				
12	1	Control Relay Output Block	3, 4, 5, 6	17, 28	129	echo of request
12	2	Pattern Control Block				
12	3	Pattern Mask				
20	0	Binary Counter—All Variations	1	0, 1, 6, 7, 8, 17, 28		
20	1	32-Bit Binary Counter				
20	2	16-Bit Binary Counter				
20	3	32-Bit Delta Counter				
20	4	16-Bit Delta Counter				
20	5	32-Bit Binary Counter Without Flag	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
20	6[e]	16-Bit Binary Counter Without Flag	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
20	7	32-Bit Delta Counter Without Flag				
20	8	16-Bit Delta Counter Without Flag				
21	0	Frozen Counter—All Variations				
21	1	32-Bit Frozen Counter				
21	2	16-Bit Frozen Counter				
21	3	32-Bit Frozen Delta Counter				
21	4	16-Bit Frozen Delta Counter				
21	5	32-Bit Frozen Counter With Time of Freeze				
21	6	16-Bit Frozen Counter With Time of Freeze				
21	7	32-Bit Frozen Delta Counter With Time of Freeze				
21	8	16-Bit Frozen Delta Counter With Time of Freeze				
21	9	32-Bit Frozen Counter Without Flag				
21	10	16-Bit Frozen Counter Without Flag				

Table D.2 SEL-2701 DNP3 Object List (Sheet 3 of 6)

Obj.	Var.	Description	Request[a]		Response[b]	
			Funct. Codes[c]	Qual. Codes[d]	Funct. Codes[c]	Qual. Codes[d]
21	11	32-Bit Frozen Delta Counter Without Flag				
21	12	16-Bit Frozen Delta Counter Without Flag				
22	0	Counter Change Event—All Variations	1	6, 7, 8		
22	1	32-Bit Counter Change Event Without Time	1	6, 7, 8	129	17, 28
22	2[e]	16-Bit Counter Change Event Without Time	1	6, 7, 8	129, 130	17, 28
22	3	32-Bit Delta Counter Change Event Without Time				
22	4	16-Bit Delta Counter Change Event Without Time				
22	5	32-Bit Counter Change Event With Time	1	6, 7, 8	129	17, 28
22	6	16-Bit Counter Change Event With Time	1	6, 7, 8	129	17, 28
22	7	32-Bit Delta Counter Change Event With Time				
22	8	16-Bit Delta Counter Change Event With Time				
23	0	Frozen Counter Event—All Variations				
23	1	32-Bit Frozen Counter Event Without Time				
23	2	16-Bit Frozen Counter Event Without Time				
23	3	32-Bit Frozen Delta Counter Event Without Time				
23	4	16-Bit Frozen Delta Counter Event Without Time				
23	5	32-Bit Frozen Counter Event With Time				
23	6	16-Bit Frozen Counter Event With Time				
23	7	32-Bit Frozen Delta Counter Event With Time				
23	8	16-Bit Frozen Delta Counter Event With Time				
30	0	Analog Input—All Variations	1	0, 1, 6, 7, 8, 17, 28		
30	1	32-Bit Analog Input	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28

Table D.2 SEL-2701 DNP3 Object List (Sheet 4 of 6)

Obj.	Var.	Description	Request[a]		Response[b]	
			Funct. Codes[c]	Qual. Codes[d]	Funct. Codes[c]	Qual. Codes[d]
30	2	16-Bit Analog Input	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
30	3	32-Bit Analog Input Without Flag	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
30	4[e]	16-Bit Analog Input Without Flag	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
30	5	Short Floating Point Analog Input	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
30	6	Long Floating Point Analog Input	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
31	0	Frozen Analog Input—All Variations				
31	1	32-Bit Frozen Analog Input				
31	2	16-Bit Frozen Analog Input				
31	3	32-Bit Frozen Analog Input With Time of Freeze				
31	4	16-Bit Frozen Analog Input With Time of Freeze				
31	5	32-Bit Frozen Analog Input Without Flag				
31	6	16-Bit Frozen Analog Input Without Flag				
32	0	Analog Change Event—All Variations	1	6, 7, 8		
32	1	32-Bit Analog Change Event Without Time	1	6, 7, 8	129	17, 28
32	2[e]	16-Bit Analog Change Event Without Time	1	6, 7, 8	129, 130	17, 28
32	3	32-Bit Analog Change Event With Time	1	6, 7, 8	129	17, 28
32	4	16-Bit Analog Change Event With Time	1	6, 7, 8	129	17, 28
32	5	Short Floating Point Analog Change Event	1	6, 7, 8	129	17, 28
32	6	Long Floating Point Analog Change Event	1	6, 7, 8	129	17, 28
33	0	Frozen Analog Event—All Variations				
33	1	32-Bit Frozen Analog Event Without Time				
33	2	16-Bit Frozen Analog Event Without Time				
33	3	32-Bit Frozen Analog Event With Time				

Table D.2 SEL-2701 DNP3 Object List (Sheet 5 of 6)

Obj.	Var.	Description	Request[a]		Response[b]	
			Funct. Codes[c]	Qual. Codes[d]	Funct. Codes[c]	Qual. Codes[d]
33	4	16-Bit Frozen Analog Event With Time				
34	0	Analog Input Reporting Deadband Setting—All Variations	1	1, 6, 7, 8, 17, 28	129	1, 17, 28
34	0	Analog Input Reporting Deadband Setting—All Variations	2	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
34	1[e]	16-Bit Analog Input Reporting Deadband Setting	1	1, 6, 7, 8, 17, 28	129	1, 17, 28
34	1[e]	16-Bit Analog Input Reporting Deadband Setting	2	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
34	2	32-Bit Analog Input Reporting Deadband Setting	1	1, 6, 7, 8, 17, 28	129	1, 17, 28
34	2	32-Bit Analog Input Reporting Deadband Setting	2	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
34	3	Floating Point Analog Input Reporting Deadband Setting	1	1, 6, 7, 8, 17, 28	129	1, 17, 28
34	3	Floating Point Analog Input Reporting Deadband Setting	2	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
40	0	Analog Output Status—All Variations	1	0, 1, 6, 7, 8	139	
40	1	32-Bit Analog Output Status	1	0, 1, 6, 7, 8	129	0, 1, 17, 28
40	2[e]	16-Bit Analog Output Status	1	0, 1, 6, 7, 8	129	0, 1, 17, 28
41	0	Analog Output Block—All Variations				
41	1	32-Bit Analog Output Block	3, 4, 5, 6	17, 28	129	echo of request
41	2	16-Bit Analog Output Block	3, 4, 5, 6	17, 28	129	echo of request
50	0	Time and Date—All Variations				
50	1	Time and Date			129	07, quantity=1
50	2	Time and Date With Interval				
50	3	Time and Date at Last Recorded Time	1	7, 8 index=0	129	07, quantity=1
51	0	Time and Date CTO—All Variations				
51	1	Time and Date CTO				

Table D.2 SEL-2701 DNP3 Object List (Sheet 6 of 6)

Obj.	Var.	Description	Request[a]		Response[b]	
			Funct. Codes[c]	Qual. Codes[d]	Funct. Codes[c]	Qual. Codes[d]
51	2	Unsynchronized Time and Date CTO	07, quantity=1			
52	0	Time Delay—All Variations				
52	1	Time Delay, Coarse				
52	2	Time Delay, Fine			129	07, quantity=1
60	0	All Classes of Data	1, 20, 21	6		
60	1	Class 0 Data	1	6	129	0, 1
60	2	Class 1 Data	1, 20, 21	6, 7, 8	129	17, 28
60	3	Class 2 Data	1, 20, 21	6, 7, 8	129	17, 28
60	4	Class 3 Data	1, 20, 21	6, 7, 8	129	17, 28
70	1	File Identifier				
80	1	Internal Indications	2	0, 1 index=7		
81	1	Storage Object				
82	1	Device Profile				
83	1	Private Registration Object				
83	2	Private Registration Object Descriptor				
90	1	Application Identifier				
100	1	Short Floating Point				
100	2	Long Floating Point				
100	3	Extended Floating Point				
101	1	Small Packed Binary—Coded Decimal				
101	2	Medium Packed Binary—Coded Decimal				
101	3	Large Packed Binary—Coded Decimal				
112	all	Virtual Terminal Output Block				
113	all	Virtual Terminal Event Data				
N/A		No object required for the following function codes: 13 cold start 14 warm start 24 record current time	13, 14, 24			

a. Supported in requests from master.
b. May generate in response to master.
c. Decimal.
d. Hexadecimal.
e. Default variation.

Table D.3 lists the amount of event data the SEL-2701 can store. If more events occur than these limits, then some event data will be lost.

Table D.3 Event Data Buffer Limits

Event Data Type	Maximum Number of Events
Binary Inputs (object 2)	512
Counter (object 22)	128
Analog Inputs (object 32)	512
Virtual Terminal (object 113)	30

Glossary

EPRI Electric Power Research Institute

Ethernet Physical layer of specification for networking contained in IEEE 802.3.

FTP File Transfer Protocol. TCP/IP application layer services for exchanging files between nodes on a TCP/IP network.

GOMSFE Generic Object Model for Substation and Feeder Equipment. Presentation layer for UCA2 used for IED communication.

GOOSE Generic Object-Oriented Substation Event. UCA2 peer-to-peer broadcast messaging for protection.

Host The device into which the SEL-2701 has been installed.

ICCP Inter Control Center Protocol. Part of EPRI's UCA protocol suite.

IED Intelligent Electronic Device. Usually a protective relay or other smart substation monitoring or control device.

ISO International Standards Organization.

LAN Local Area Network

LED Light Emitting Diode.

MAC Media Access Control used in Ethernet.

Node A device connected to the network.

OSI Open System Interface. The seven-layer protocol stack developed by ISO and used in UCA2.

OSI Model Name of generic seven-layer protocol stack model taken from ISO's OSI stack and used to describe modern networking concepts and stacks.

RAM Random Access Memory.

SEL Schweitzer Engineering Laboratories.

TCP/IP Transport Control Protocol/Internet Protocol. The protocol stack commonly used for Ethernet and the internet. TCP/IP maintains and manages connections between devices on a network transparently to the application and presentation layers above.

Telnet TCP/IP application layer protocol for terminal session connections between devices on a TCP/IP network.

UCA Utility Communications Architecture. Suite of utility protocols developed by EPRI including ICCP/TASE.2 and UCA2 for Field Devices.

UCA2 UCA protocol suite version 2.0 developed by EPRI including GOMSFE and GOOSE.

UDP/IP Universal Data-gram Protocol/Internet Protocol. Another protocol stack used for Ethernet and the internet. Unlike TCP/IP, UDP/IP does not maintain connections and allows broadcast messaging.

WAN Wide Area Network

Index

Page numbers appearing in bold mark the location of the topic's primary discussion.

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