

# **SEL-2890**

## **Ethernet Transceiver**

### **Instruction Manual**

**20241206**



**SCHWEITZER ENGINEERING LABORATORIES, INC.**

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# Preface


## Safety Information

### Dangers, Warnings, and Cautions

This manual uses three kinds of hazard statements, defined as follows:







 **DANGER**  
Indicates an imminently hazardous situation that, if not avoided, **will** result in serious death or injury.




 **WARNING**  
Indicates a potentially hazardous situation that, if not avoided, **could** result in death or serious injury.

 **CAUTION**  
Indicates a potentially hazardous situation that, if not avoided, **may** result in minor or moderate injury or equipment damage.

### Safety Symbols







The following symbols are often marked on SEL products.

	 <b>CAUTION</b> Refer to accompanying documents.	 <b>ATTENTION</b> Se reporter à la documentation.
	Earth (ground)	Terre
	Protective earth (ground)	Terre de protection
	Direct current	Courant continu

	Alternating current	Courant alternatif
	Both direct and alternating current	Courant continu et alternatif
	Instruction manual	Manuel d'instructions

## Safety Marks

The following statements apply to this device.

<div><b>DANGER</b></div> <p>Removal of enclosure panels exposes circuitry which may cause electrical shock which can result in injury or death.</p>	<div><b>DANGER</b></div> <p>Le retrait des panneaux du boîtier expose le circuit qui peut causer des chocs électriques pouvant entraîner des blessures ou la mort.</p>
<div><b>WARNING</b></div> <p>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.</p>	<div><b>AVERTISSEMENT</b></div> <p>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.</p>
<div><b>WARNING</b></div> <p>This device is shipped with default passwords. Default passwords should be changed to private passwords at installation. Failure to change each default password to a private password may allow unauthorized access. SEL shall not be responsible for any damage resulting from unauthorized access.</p>	<div><b>AVERTISSEMENT</b></div> <p>Cet appareil est expédié avec des mots de passe par défaut. A l'installation, les mots de passe par défaut devront être changés pour des mots de passe confidentiels. Dans le cas contraire, un accès non autorisé à l'équipement peut être possible. SEL décline toute responsabilité pour tout dommage résultant de cet accès non autorisé.</p>

# Section 1

## Introduction & Specifications

### Introduction

---

This section introduces the SEL-2890 Ethernet Transceiver and provides information on the following topics:

- Features
- Applications
- Specifications

### Features

---

The SEL-2890 is an Ethernet transceiver designed for use with SEL relays, SEL communications processors, and other intelligent electronic devices (IEDs). The SEL-2890 provides the following features:

- Port powered from an SEL relay
- 10BASE-T connection
- Support for TCP/IP (Transmission Control Protocol/Internet Protocol) protocol suite
  - FTP (File Transfer Protocol)
  - Telnet
  - Serial tunneling
  - Serial routing
  - Email
  - HTTP

An Ethernet gateway is provided by an SEL-2890 to relays and other IEDs that are based on EIA-232 serial communications. The SEL-2890 encapsulates serial data into the Ethernet stack. More discussion on Ethernet and protocols is provided later in this section. The benefit of an external Ethernet gateway is that network activity does not degrade relay protection. You can also upgrade or replace the SEL-2890 without disturbing settings or firmware in the host, relay, or communications processor.

# Applications

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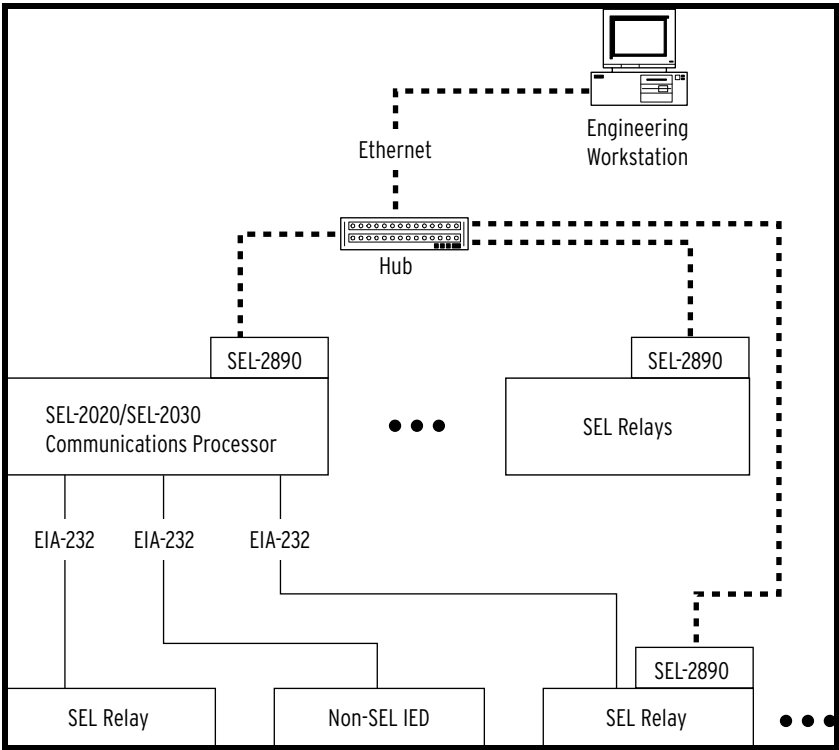
The SEL-2890 can assist with many substation networking applications. A sampling of applications is listed below to help you understand how each feature works. This understanding should also give you ideas on how to apply the SEL-2890. *Section 4: Detailed Application Examples* provides detailed application examples with settings.

## Terminal Access

Use the SEL-2890 to provide terminal access over an Ethernet network to serial devices. Similar to connecting a PC with terminal software to a serial IED, you can use the transceiver to make this connection via an Ethernet network.

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 data rate. After you start a Telnet session, your Telnet software operates similarly to a terminal program by passing your keystrokes across the Ethernet network, through the transceiver, and into the serial device.

*Figure 1.1* displays different connection types from an engineering workstation to SEL relays and a communications processor. This figure is not meant to display a best choice integration architecture for a substation—many other factors need to be considered and are beyond the scope of this manual. In this arrangement, the Telnet application allows you to operate the user interface of the selected device similarly to a direct serial connection. However, it is important to note that you have the ability to Telnet through the SEL-2890 as described above and the ability to Telnet to the SEL-2890 to change settings and control the transceiver. Telnetting to the SEL-2890 and not through it is referred to as a Console session. Telnet port 1025 is the port used for a Console session. Ports 23 and 1026–65534 are used to Telnet through the SEL-2890 and out of its serial port. This type of Telnet connection is common among software and is supported by SEL software.



**Figure 1.1 Example Ethernet Substation Network**

## HTTP Server

The SEL-2890 provides an easy to use HTTP interface to SEL relays and SEL communications processors. The three HTTP options are Custom, SEL, User, and Off. When issuing settings to the transceiver, select one of these four options.

**NOTE:** A Telnet session has higher priority than the HTTP interface. The following message will be sent to the web browser if it is connected when a Telnet session is active: "Unable to access device due to Telnet session from IP: xxx.xxx.xxx.xxx."

## HTTP Files

Use FTP to access the HTTP files in the transceiver. The files are located in folders that are labeled and associated with the Custom, SEL, and User settings. The following information should be selected when connecting with an FTP program.

- Host Type: Select **automatic detect**. If this does not work or is unavailable, select **UNIX**.
- User ID: Enter **sel2890**. The User ID is fixed and is not settable. Anonymous login is not permitted.
- Password: Enter the Access Level 2 (**2AC**) password. Note that this password will change if you change the Access Level 2 password when modifying settings. The default password is furnished in *Section 3: Settings and Commands*.
- Port: The FTP port in the SEL-2890 is 21.

---

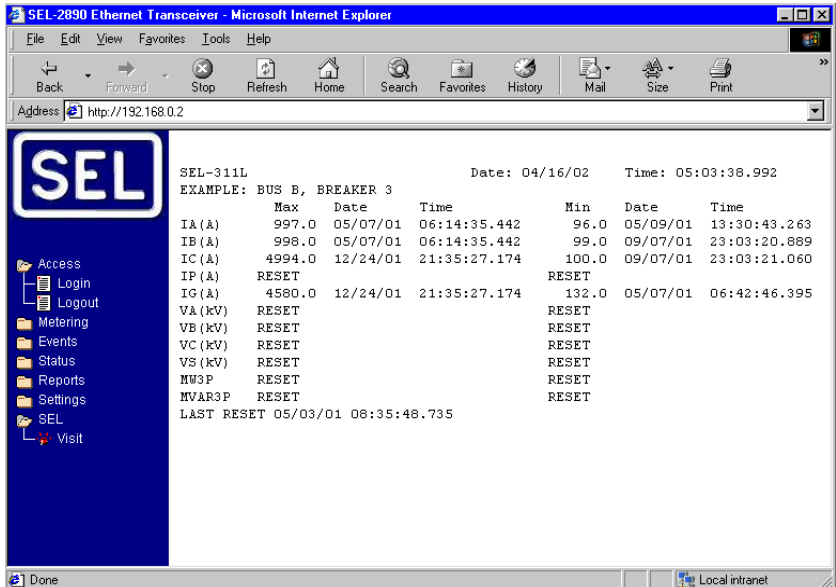
**NOTE:** The SEL-2890 FTP server does not support the **PAS V** (passive transfer) command.

Use the automatic or binary selection for the type of file transfer. Listed below is the FTP file structure for the transceiver.

- Custom (Folder)
  - Images 1–5 in .gif format.
  - Images 6–9 in .jpg format.
  - index.htm
  - app1.zip
  - app2.zip
  - logo.jpg
  - Pages 1–9 in .htm format.
- SEL (Folder)
  - access.htm
  - alitree.zip
  - closed.gif
  - data.htm
  - file.gif
  - index.htm
  - link.gif
  - logo.htm
  - logo.jpg
  - mail.gif
  - menu.htm

- nodelist.txt
- open.gif
- User (Folder)
  - logo.jpg (maximum 16KB)
  - nodelist.txt

First, familiarize yourself with the SEL default HTTP files in *Figure 1.2*. The callout numbers located on the left side of the HTML code are referenced in *Table C.1*.



**Figure 1.2 SEL Default HTTP (WEB=SEL)**

## Email

A Simple Mail Transfer Protocol (SMTP) email client is provided in the SEL-2890. The primary purpose for the email function is to allow unsolicited messages, including summary event reports, to be emailed. An unsolicited message is one that is sent to the SEL-2890 when no Telnet or HTTP session is active. The SEL-2890 will take the unsolicited data and email it to a designated email address. More than one unsolicited message may be contained in an email. Also, an unsolicited message may be broken up into more than one email. Email is sent two seconds after the end of an unsolicited message. The end of an unsolicited message is determined by the MTDELAY setting. The SEL-2890 will send an email message to the email server. If the email server is unavailable the SEL-2890 will retry at a 1-minute, a 10-minute, and a 30-minute interval. The message will be discarded if not successfully sent on the third try.

## Serial Routing

The basic principle of serial routing is the ability to examine unsolicited data coming into the serial port, compare the first 8 bytes of the message with a predefined mask, and then route the message to a specified Internet Protocol (IP) address depending on the examined information. Effectively, you can send messages out of a serial port through the SEL-2890 and they can be routed to different destinations depending on the first 8 bytes of the message. As many as three different routing masks are available in the SEL-2890.

## Serial Tunneling

Serial tunneling is the ability to make a virtual serial connection between two IEDs across an Ethernet network. The object is to create a virtual serial cable that passes all data from point to point across an Ethernet network and have this connection appear to be completely transparent to the end serial devices. You can serial tunnel between the SEL-2890 and port servers, serial hubs, SEL-2701 Ethernet processors, and other SEL-2890 transceivers. However, the SEL-2890 transceivers were designed and tested to provide a robust serial tunnel between each other. Serial tunneling to other devices may have limitations on passing specific binary protocols.

The challenge of serial tunneling lies in the indeterministic nature of the Ethernet network. A master device may send a message to a slave. The slave responds in a timely fashion. But if the Ethernet packet containing the message has a collision, then the packet will get re-sent. This may happen several times. If it happens too often, then the data will return to the master with some appreciable delay. Some masters and associated protocols may not be very tolerant of this timing condition. Typically, serial tunneling is successful and reliable in a properly designed network, but all protocols and all networks are not compatible for serial tunneling. Test and understand your particular application before installing in the field.

Different serial tunnel options are available in the SEL-2890. They are Commanded Mode, Telnet, Transport Control Protocol (TCP), and Broadcast TCP (BTCP).

### Commanded Mode

The Commanded mode of a serial tunnel provides the ability to make serial tunnels dynamically with a command rather than with settings. This provides a convenient way for software to control a network of serial tunnels. The software Telnets into the SEL-2890 console and issues a TUNNEL [IP]:[Port] command, then the SEL-2890 establishes a Telnet tunnel to that device. The IP and Port information is stored in volatile memory and therefore the Telnet tunnel will be set to “Off” if power is cycled on the SEL-2890.



## Telnet Tunnel

An automatic, fixed point-to-point serial connection across an Ethernet network is established with a Telnet tunnel. Use this method when you need a continuous point-to-point connection for serial protocols like Modbus® and DNP3. The settings for this tunnel, IP and Port, are saved in nonvolatile memory and will be retained if power is cycled on the SEL-2890. The SEL-2890 automatically connects to the remote device (it may be another SEL-2890) and allows serial traffic whenever the Ethernet network is operational.

## TCP Tunnel

A TCP tunnel functions almost identically to a Telnet tunnel except that the network connections are opened and closed rather than maintained continuously.

## BTCP Tunnel

A BTCP (broadcast TCP) tunnel functions like a multipoint serial network. *Figure 1.3* shows the physical connection for this type of tunnel service. The Telnet tunnel establishes a connection and then maintains a connection. By contrast, the BTCP tunnel is established between two SEL-2890 transceivers, then data are transmitted and received, and lastly the connection is terminated. The ability to use this type of tunnel for broadcast messages is the important aspect. All devices must be on the same subnet.

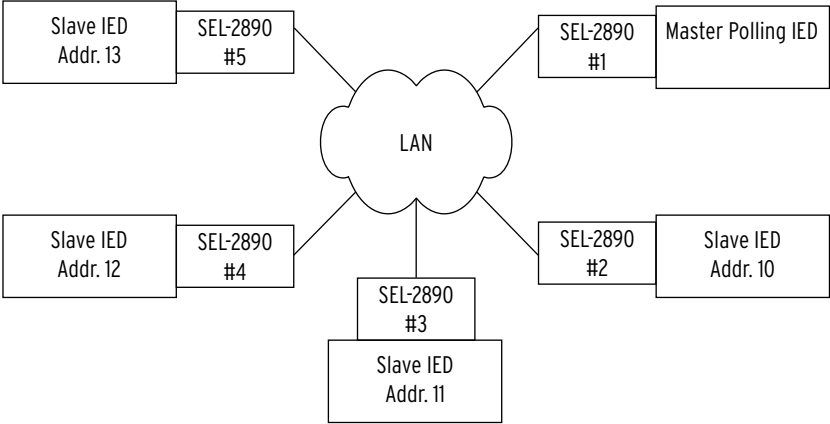
As an example, the master IED device in *Figure 1.3* sends out, via a serial port, a request for data from Slave #1. These serial data are then transmitted to the Ethernet network through the SEL-2890 connected to the master polling IED. All of the other SEL-2890 transceivers receive the request and send it through their respective serial ports. However, only Slave #1 answers and the data are returned to the master polling IED.

It is important to note that the serial protocol described in this method uses an address system. This address system is common in virtually all SCADA type polling protocols. If a non-addressed, serial protocol is used, all of the slaves will answer and the master polling IED will receive the data but may not know which slave it came from. This may be acceptable if the serial data are self-identifying.

Collisions will occur if all the slave devices answer at the same time. The SEL-2890 transceiver's Ethernet processor will make the necessary adjustments and will keep retransmitting until a message is successfully sent. However, the network may be flooded by these retries and network performance will be significantly degraded.

The broadcast method is defined in the Ethernet standard. See your network administrator about using broadcast messages in your network. Details on setting the SEL-2890 for BTCP tunneling using broadcast are furnished in *Section 3: Settings and Commands*, followed by an example in *Section 4: Detailed Application Examples*.

**NOTE:** All devices must be on the same subnet.



**Figure 1.3 BTCP Tunneling Using Broadcast**

# Specifications

Compliance
Designed and manufactured under an ISO 9001 certified quality management system

General
---------

Indicators	
Red LED:	Receive Data
Green LED:	Link

<b>Ethernet Port</b>	
Connector:	RJ45
Data Rate:	10 Mbps
Interface:	10BASE-T

# Communications Protocols

Protocol Stack:	TCP/IP
File Exchange:	FTP
Terminal Server:	Telnet
Terminal Client:	Telnet
Web Server:	HTTP
Email Client:	SMTP
DHCP Client:	DHCP

<b>Serial Port</b>	
Connector:	DB-9 Male
Data Rate:	300 bps to 115200 bps
Interface:	EIA-232

<b>Power Requirements</b>	
4.5 to 5.5 Vdc:	<250 mA
supplied through Pin 1 of the DB-9 connector	

Operating Temperature Range
-40° to +85°C (-40° to +185°F)
5 to 95% humidity (non-condensing)

Dimensions
1.25 inches wide
3.425 inches deep
0.85 inches high

Type Tests
------------

<b>Electromagnetic Compatibility</b>	
Radiated Emissions:	IEC 60255-25-2000, Class A Canada ICES-001(A) / NMB-001(A)

<b>Electromagnetic Compatibility Immunity</b>	
Conducted RF Immunity:	ENV 50141-1993, 10 Vrms IEC 61000-4-6-1996, 10 Vrms

Digital Radio Telephone RF:	ENV 50204-1995, 10 V/m at 900 MHz and 1.89 GHz
Electrostatic Discharge:	IEC 60255-22-2-1996, IEC 61000-4-2-1999, [EN 61000-4-2-1995], Levels 1, 2, 3, 4

Fast Transient Disturbance:	IEC 61000-4-4-1995, IEC 60255-22-4-1992, 4 kV at 2.5 and 5 kHz (Shielded Twisted Pair Category 5 cable required for compliance)
-----------------------------	---

Radiated Radio Frequency:	ENV 50140-1993, IEC 60255-22-3-1989, 10 V/m IEEE C37.90.2-1995, 35 V/m
---------------------------	---

Type Test Compliance Criteria:	1) That the SEL-2890 does not damage or impede relay operation. 2) The SEL-2890 is allowed to lose data during testing events. 3) The SEL-2890 must recover without external intervention.
--------------------------------	--

Environmental	
Cold:	IEC 60068-2-1-1990 [EN 60068-2-1-1993], Test Ad: 16 hrs @ 0°C
Dry Heat:	IEC 60068-2-2-1974 [EN 60068-2-2-1993], Test Bd: 16 hrs @ +70°C

Damp Heat, Cyclic:	IEC 60068-2-30–1980, Test Db: 25°–55°C, 6 cycles, 95% humidity	Vibration:	IEC 60255-21-1–1988, Class 1 IEC 60255-21-2–1988, Class 1 IEC 60255-21-3–1993, Class 2
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# Section 2

## Installation

### Introduction

---

This section includes information and procedures for SEL-2890 installation. Effective installation includes the following tasks:

- Installing the SEL-2890
- Performing SEL-2890 initial checkout

### Installation

---

Perform the following steps to begin communicating with the SEL-2890.

- Step 1. The serial port powers the SEL-2890. *Table 2.1* shows the EIA-232 serial port pinout. Provide +5 Vdc between Pin 1 and Pin 5 on the serial connector with Pin 1 being the positive terminal.

**Table 2.1 SEL-2890 EIA-232 Serial Port Pinout**

Pin	Description
1	+5 Vdc
2	Transmit
3	Receive
4	No Connection
5	Ground
6	No Connection
7	CTS
8	RTS
9	No Connection

The transceiver requires a range of 4.5 to 5.5 Vdc and less than 250 mA of current. Power is normally provided by the SEL relays and communications processors.

The initial setting of IP address, network mask, and network gateway is only permitted via the serial port. To make these settings, connect the SEL-2890 to your computer serial port with optional interface cable SEL-C662 or SEL-C642. This cable provides a 120 Vac to 5 Vdc power supply.

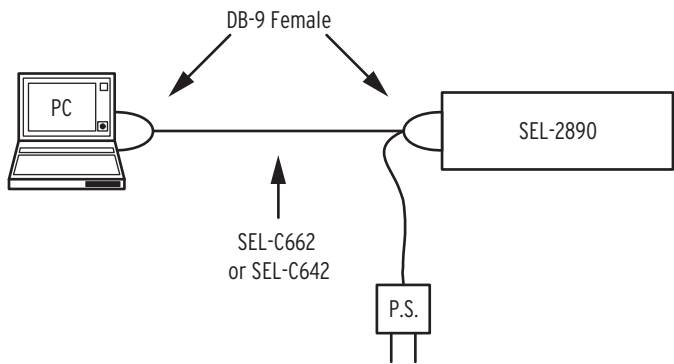


Figure 2.1 Programming Cable Connection

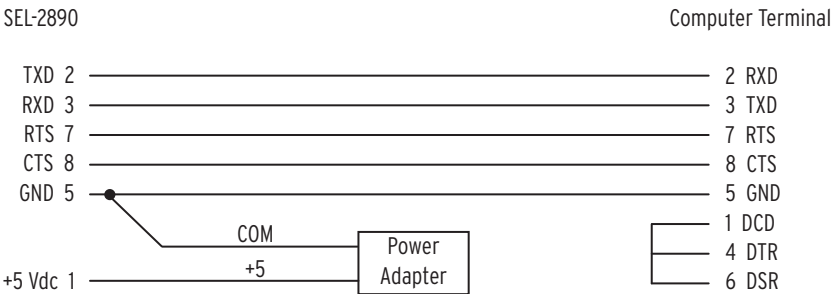


Figure 2.2 SEL-C642 Cable Wiring Diagram

The left, green LED will pulse when the SEL-2890 is first powered up (this may take several seconds). This LED should not remain lit if there is not a functioning Ethernet connection. This is the green “Link” LED. The red LED on the right indicates data transmission in or out of the SEL-2890 and is referred to as the “Data Transmission” LED.

- Step 2. Open an ASCII terminal session to the serial port that is connected to the transceiver. The default data rate is 19200 bps (for firmware versions R101–R103, the default speed is 38400 bps). Do not make an Ethernet connection at this time. At this point, the transceiver will still be in the mode of forwarding serial data to the network. This mode needs to be interrupted with AT+++ entered from the terminal. Note that you have to type the AT+++ string within four seconds from the “A” to the last “+”. The SEL-2890 will respond with #> prompt approximately three seconds after the last character is entered. This

prompt indicates that you are in a Console session Level 1. During a Console session the user communicates with, and NOT through, the SEL-2890. Use the **SHO** command to view the settings.

- Step 3. All settings modifications can be made from the serial port. At this time, we are just interested in the minimum number of settings that will allow you to install the SEL-2890 on your network. A detailed description on an individual setting basis is given in *Section 3: Settings and Commands*. For this step, information will be needed from your network administrator. SEL recommends that your network administrator review the settings options obtained from the **SHO** command. The settings IP, SUBNET\_MASK, and GATEWAY need to be obtained before the transceiver is available on your network. The serial data rate in the SEL-2890 can be set to match the target SEL relay or communications processor that will communicate with the transceiver.
- Step 4. At the Level 1 prompt, #>, gain Level 2 access by issuing a **2AC** command followed by the Level 2 password. See *PASSWORD on page 3.12* for default password information. After issuing the **SET** command, press <Enter> to scroll down through the settings. Enter the serial port data rate (optional) and IP address that you obtained from your network administrator when prompted for these settings. Continue on with the settings for SUBNET\_MASK and GATEWAY. Repeat the carriage return to obtain the “**Save (Y/N)**” question. Save your settings. The Console session will be closed after you save your settings. You can also use the **EXIT** command to close the Console session.

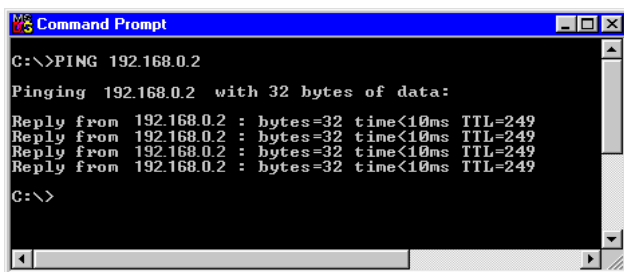
## Initial Checkout

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- Step 1. After following the steps for installation, your SEL-2890 is ready to be connected to an SEL relay or communications processor. Verify that the proper relay or communications processor's jumpers have been installed to enable serial port power. Refer to the respective SEL manuals to locate serial port jumper positions. Once port power is enabled on the SEL equipment, connect the SEL-2890.
- Step 2. Plug the SEL-2890 into the network by using a standard Unshielded Twisted Pair (UTP) or Shielded Twisted Pair (STP) Ethernet cable with RJ45 connectors. Verify that the green (Link) LED is illuminated on the SEL-2890. If not, check cable, connections, and hub or switch. After the green link light is illuminated, use the **PING** command to confirm that the SEL-2890 is available on the network. The **PING** command can be accessed by starting a command line session from the standard Windows Run window as shown below.

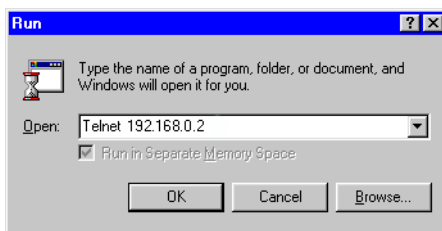


Type **PING octet1.octet2.octet3.octet4** where the octets represent the IP address of your SEL-2890. The response will be in a DOS window similar to the captured window shown below.



This reply indicates that your SEL-2890 is visible on your network.

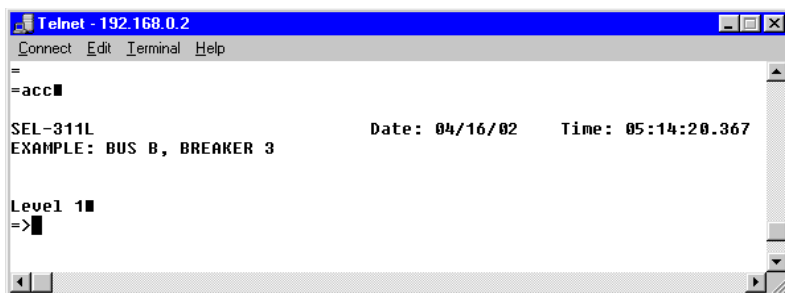
- Step 3. You are now ready to communicate to your SEL product via an Ethernet network. Open a Telnet session through the SEL-2890 to verify communications to your relay. A Telnet session can be started by typing **TELNET**, followed by your SEL-2890 IP address and port, in your Windows Run window or at the DOS prompt as shown below.



If no port number is specified, the default Telnet port number for the SEL-2890 is 23.

Your screen should look similar to the Telnet session as shown in *Figure 2.3*.





**Figure 2.3 Telnet Window**

Press <Enter> a few times to verify that your connection through the SEL-2890 is working. Note that any data entered into the Telnet window at this time will be transmitted out of the SEL-2890 serial port at the set data rate. You can also use terminal programs in SEL software to establish Telnet connections to SEL equipment. ACSELERATOR QuickSet® SEL-5030 Software, SEL-5020 Settings Assistant Software, and SEL-5010 Relay Assistant Software all support Telnet.

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# Section 3

## Settings and Commands

### Introduction

This section provides information about the SEL-2890 settings and commands. Specifically, it covers the following topics:

- Settings for Ethernet network operation
- Settings for data access through Email, Telnet, Tunneling, Serial Routing, and HTTP
- Commands for establishing a dynamic tunnel and a command for viewing raw serial data in a network tunnel

It is important to keep in mind that you can communicate **with** and **through** the SEL-2890. Communicating **with** the SEL-2890 is referred to as a Console session and uses a command line interface with prompts `#>` and `##>`, for Level 1 and Level 2, respectively. This can be accomplished by the serial port or by Telnet port 1025. This section focuses on communicating **with** (not through) the SEL-2890.

*Section 4: Detailed Application Examples* describes how to apply the SEL-2890 in specific applications along with the associated settings.

### Settings

#### Settings Summary

*Table 3.1* lists the settings in the SEL-2890. You can modify settings with the **SET** command in a Console Session (see *Commands on page 3.10*).

**Table 3.1 SEL-2890 Settings Summary** (Sheet 1 of 4)

Setting Name	Description	Range	Default Value
Operational Mode Settings			
PORT	Telnet port for connected device	23, 1026–65534	23
TEL_PROC	Enable Telnet processing	Y, N	Y

Table 3.1 SEL-2890 Settings Summary (Sheet 2 of 4)

Setting Name	Description	Range	Default Value
TUNNEL	Serial tunnel mode	N, Cmd, Telnet, TCP, BTCP	N
TUNNEL_IP	Tunneling remote IP address (hidden if TUNNEL=N or Cmd)	IP address <sup>a</sup>	
UDDELAY	Unsolicited detection delay <sup>b</sup>	1–60 seconds	2
MTDELAY	Message timeout delay <sup>b</sup>	0.0–5.0 seconds	0.8
WEB	HTTP type <sup>b</sup>	SEL, User, Custom, OFF	SEL
DHCP <sup>g</sup>	Enable DHCP <sup>b</sup>	Y, N	N
DNS_IP	Domain name server IP address <sup>b</sup>	IP address <sup>a</sup>	192.168.0.1
DOMAIN	Domain name of the domain name server <sup>b</sup>	Text name setting	Empty <sup>c</sup>
HOST_NAME	Host name for the SEL-2890 <sup>b</sup>	Text name setting	Empty <sup>c</sup>
EMAIL	Enable email <sup>b</sup>	Y, N	N
Email Client Settings (available if EMAIL is set to Y and TUNNEL=N)			
EMAIL_IP	Email server address	IP address <sup>a</sup>	192.168.0.1
EMAIL_DOMAIN	Email domain name	Text name setting, NA if not required	NA
TO	Destination email address	Text setting	Empty <sup>c</sup>
FROM	From line text alias for email	Text setting	SEL2890
SUBJECT	Email subject line	Text setting	Unsolicited
ROUTE	Serial protocol routing enable	Y, N	N
Serial Routing Settings (available if ROUTE is set to Y and TUNNEL=N)			
ROUTE_PORT1 <sup>d</sup>	Routing destination port 1	1026–65535, 0 disables	8001
ACCEPT1 <sup>d</sup>	Accept routing connection	Y, N	N

**Table 3.1 SEL-2890 Settings Summary (Sheet 3 of 4)**

Setting Name	Description	Range	Default Value
ROUTE_IP1 <sup>d,e</sup>	Routing destination 1 address	IP address <sup>a</sup>	192.168.0.3
HEADER1 <sup>d,e</sup>	Routing destination 1 message header	As many as 8 bytes entered in hexadecimal	A5
ROUTE_PORT2	Routing destination port 2	1026–65535, 0 disables	8002
ACCEPT2 <sup>d</sup>	Accept routing connection	Y, N	N
ROUTE_IP2 <sup>d,e</sup>	Routing destination 2 address	IP address <sup>a</sup>	192.168.0.3
HEADER2 <sup>d,e</sup>	Routing destination 2 message header	As many as 8 bytes entered in hexadecimal	A5
ROUTE_PORT3 <sup>d</sup>	Routing destination port 3	1026-65535, 0 disables	0
ACCEPT3 <sup>d</sup>	Accept routing connection	Y, N	N
ROUTE_IP3 <sup>d,e</sup>	Routing destination 3 address	IP address <sup>a</sup>	192.168.0.3
HEADER3 <sup>d,e</sup>	Routing destination 3 message header	As many as 8 bytes entered in hexadecimal	Empty <sup>c</sup>
<b>Serial Port Settings</b>			
SPEED	Serial port data rate (bps)	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	19200
STOP <sup>f</sup>	Stop bits	1, 2	1
PARITY <sup>f</sup>	Parity bit value (hidden and forced to None if BITS+STOP=10)	Odd, Even, None	None
FLOW	Serial flow control mode	Hardware, Software, None	None
RTS_LOW	Force RTS line low (available only if FLOW=NONE)	Y, N	N
IP <sup>g</sup>	IP address of SEL-2890	IP address <sup>a</sup>	192.168.0.2

Table 3.1 SEL-2890 Settings Summary (Sheet 4 of 4)

Setting Name	Description	Range	Default Value
SUBNET_MASK <sup>g</sup>	Subnet mask for network access	IP address <sup>a</sup>	255.255.255.0
GATEWAY <sup>g</sup>	Gateway on local subnet	IP address <sup>a</sup>	192.168.0.1

- <sup>a</sup> Address of the format (0-255).(0-255).(0-255).(0-255) within valid address space for your network configuration.
- <sup>b</sup> Available only when TUNNEL=N.
- <sup>c</sup> Setting is not set in default settings and is empty.
- <sup>d</sup> Hidden if corresponding ROUTE\_PORTn setting is set to 0.
- <sup>e</sup> Hidden if corresponding ACCEPTn setting is set to Y.
- <sup>f</sup> Total byte framing is limited to 10 bits (BITS+STOP+1 if PARITY=EVEN or ODD) ≤10.
- <sup>g</sup> Setting can be changed only through serial port Console Session.

## Settings Description

The following paragraphs provide additional information on the operation of selected settings listed in *Table 3.1*.

### Telnet Port

This setting is the Telnet port setting. Initiating a Telnet connection to this port will allow the transceiver to send the data from the network through the serial port. Telnet port 23 is the default setting. However, choose any other port setting between 1026 and 65534.

### Telnet Processing Enable

The TEL\_PROC setting can be used to enable (YES) or disable (NO) Telnet processing. If TEL\_PROC is set to YES then Telnet connection option negotiation and command processing takes place. If TEL\_PROC is set to NO then no Telnet option negotiation or command processing takes place. All data received from the client is sent to the serial port and all data received from the serial port is set to the client. This is commonly called raw TCP mode or Ethernet Encapsulation. This setting applies to the Telnet Server, Telnet Serial Tunneling and Command Telnet Serial Tunneling modes. This setting will normally be set to YES to communicate with Telnet Clients. Changing this setting to NO provides the capability to communicate with third party products designed to operate with raw TCP terminal servers.

### Serial Tunneling

Making a point-to-point serial data connection between two serial IEDs across an Ethernet network is commonly referred to as serial tunneling.

There are four modes of serial tunneling supported by the SEL-2890: Commanded (Cmd), Telnet, TCP, and BTCP.

Commanded mode tunneling allows the user to Telnet into the Console and issue a tunnel command followed by an IP address and Telnet port. For example, entering the command **TUN 192.168.0.11:3001 <Enter>** will direct the SEL-2890 to establish a Telnet tunnel with IP address 192.168.0.11 and Telnet port 3001. The receiving device may be a port server set in slave mode, a PC, an SEL-2890, or an SEL-2701.

In Telnet tunnel mode, a transceiver will try to establish a Telnet tunnel with another transceiver, port server, PC, or SEL-2701 card. If the transceiver fails to open a connection, it will wait and listen for someone trying to establish a Telnet tunnel with it. The transceiver will toggle between master mode and slave mode until a Telnet tunnel is established. The Ethernet connection for a Telnet tunnel is maintained after it is established. This is the major difference between a Telnet mode or Commanded mode tunnel and a TCP tunnel. The Telnet tunnel is primarily used for point-to-point serial communications that do not often change.

A TCP tunnel operates identically to the Telnet tunnel with one exception: the TCP tunnel will establish an Ethernet connection when needed and will then close the connection when it is finished. The advantage of this is that a transceiver can be set up to broadcast messages and then close the connection and wait for another transceiver to answer and establish an Ethernet connection.

The BTCP tunnel mode is designed for tunneling serial protocols on an Ethernet network including Modbus and DNP3. See *BTCP Tunnel on page 1.7* for a description of this mode of operation. For best BTCP tunnel performance, use the same serial port bps speed for both master and slave connections. *Figure 1.3* shows the physical connection required for this mode of operation.

All other functions such as email, Telnet access to the serial port, HTTP access to the serial port, and serial routing are **disabled** if serial tunneling is enabled. Telnet access to the console session is still enabled. The HTTP server is not allowed to access the serial port when serial tunneling is enabled.

## Unsolicited Detection Delay

The UDDELAY time is used to qualify the end response from the serial device in an HTTP session. Unsolicited message processing is suspended when a Telnet session is active and does not use the UDDELAY setting. The UDDELAY should be set longer than the response time of the connected IED.

## Message Timeout Delay

The MTDELAY time is used to determine the difference between one or multiple messages. The MTDELAY acts similarly to an intercharacter time-out timer. When a message is being transmitted from an IED through an SEL-2890, the transceiver will examine the delays between characters in the serial data stream. The data stream and its message will be broken into two or more messages if there is an intercharacter delay that is greater than the MTDELAY time. The subsequent messages will still be considered solicited unless the delay also exceeds the UDDELAY time.

## Webpages

The SEL-2890 provides an HTTP server with a default webpage. You can use this webpage or create your own. Setting WEB=SEL will enable the SEL default webpage interface for a relay. You can use the SEL default webpage to display data and settings information from an SEL relay connected to the SEL-2890 serial port. For an example webpage, see *Figure 1.2*. Setting WEB=USER will provide a webpage that is identical to the default with the following exceptions: you can download a nodelist.txt and a logo.jpg file that will replace the tree menu and logo on the default webpage. No HTML code is needed to accomplish this task. You can create and download a completely custom webpage interface by setting WEB=CUSTOM. You can also turn this feature off by setting WEB=OFF.

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**NOTE:** You may FTP the Nodelist.txt file out of the SEL folder in the transceiver to view its contents. For more information, contact SEL.

## Enable DHCP

DHCP stands for Dynamic Host Configuration Protocol. Setting DHCP to “Yes” will allow a DHCP server to dynamically assign an IP to the SEL-2890. You should set up a unique host name if you use DHCP. This will allow you to refer to the transceiver by name rather than IP. Refrain from using DHCP if you are using serial tunneling. Use a static IP address instead. When you use DHCP, the following settings are overridden: DNS\_IP, DOMAIN, IP, SUBNET\_MASK, and GATEWAY. If the HOST\_NAME is left blank, the SEL-2890 will request it from the DHCP server. If a HOST\_NAME is entered, it will be provided to the DHCP server. This provides the ability to configure the SEL-2890 HOST\_NAME centrally at the DHCP server.

## Domain Name Server IP

The domain name server (DNS) on a network translates or resolves an IED’s IP address (e.g., 192.168.0.11) from its alphanumeric domain name (e.g., domain.com). Contact your network administrator to obtain a DNS IP. The DNS IP will be automatically set by the DHCP server if DHCP=Y.

## Domain Name

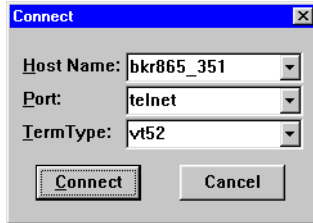
Domain name of the domain name server. Contact your network administrator to obtain a domain name. The domain name will be automatically set by the DHCP server if DHCP=Y. To remove the domain name field, enter a space and press **<Enter>** at the change settings prompt.

## Transceiver Host Name

The host name is the unique, common name that you assign to your transceiver. The host name is virtually required when using DHCP because the IP address is not static. Referring to an IED by host name is more convenient than by IP address. To take advantage of this, your network has to be set up to recognize host names. Then the



network has to resolve the host names into IP addresses. For example, connect an SEL-2890 to a relay and set the transceiver host name to **bkr865\_351**. To Telnet to the SEL-351 Relay on breaker 865, just open a Telnet session to **bkr865\_351** as shown below. To remove the host name field, enter a space and press **<Enter>**. This provides the ability to configure the SEL-2890 HOST\_NAME centrally at the DHCP server.



## Email Enabled

Select **Yes** to allow unsolicited messages to be emailed to a designated email address via SMTP. If the transceiver receives serial data and it did not send serial data to the relay first (in a Telnet or HTTP session), then the transceiver assumes the message is unsolicited. The SEL-2890 will then listen to the serial message, include it in the body of an email message, and send it to a designated email address. For example, when a fault occurs, the relay will send an unsolicited summary event report and the SEL-2890 will email that summary event report. This can also be used with an SEL communications processor to email unsolicited messages.

## Email Server IP Address

Set the IP address of your email server. If you are using a corporate email server, contact your network administrator to obtain this IP. This setting is required if you plan to use email.

## Email Domain

The email domain name may be required for your email system. This setting can contain as many as 79 characters.

## Email To

Enter an email address to which you want the SEL-2890 to send unsolicited messages. The setting can contain as many as 159 characters. A setting of your\_name@company.com is a generic example. While some email servers may allow you to use a list of several emails, most accept only a single email address in this setting. If you need to send email to multiple email addresses, use an email list server program to repeat and broadcast emails to multiple addresses.

## Email From

The SEL-2890 cannot receive email. However, most email servers need a return address for an undeliverable message. This address will also appear in the “From” field of an email message. The email server will return an undeliverable message to the “From” address. Therefore, this address should be to someone who is responsible for the particular SEL-2890. This setting can contain as many as 79 characters.

## Email Subject Line

Email messages commonly include a Subject Line. Enter any message you want in this line and it will be displayed in the subject line when the SEL-2890 sends an email message. The subject line can contain as many as 159 characters.

## Serial Protocol Routing Enable

Serial protocol routing is a method to route unsolicited serial messages to different IPs and associated ports depending on an eight-byte header in the serial message. When unsolicited serial data are received in the SEL-2890 from an IED, the transceiver compares the first eight bytes of the message to a settable descriptive header. If they match, the SEL-2890 will then route the message to the IP address assigned to that message. As an example, assume the following settings have been assigned: ROUTE = Y, ROUTE\_PORT1 = 8001, ACCEPT1 = N, ROUTE\_IP = 192.168.0.11, and HEADER1 = A5. The SEL-2890 will forward a serial message to IP 192.168.0.11 if the first byte received is A5. The A5 is the ASCII-hexadecimal representation of the message header. Use “?” as a wild card character in the mask (e.g., A5?). *Appendix E: ASCII Reference Table* contains an ASCII reference table. The important aspect of serial protocol routing is the ability to send different messages to different locations but use the same serial port. The SEL-2890 allows you three different headers for routing to settable IP addresses. A serial routing example is provided in *Section 4: Detailed Application Examples*.

## Routing Port n

Routing port designations are needed in order to initiate a connection between two IP devices. This port number must match the port number of the Ethernet device that will be receiving the message from the SEL-2890.

## Accept Routing Connection n

Two modes of operation to serial routing are receiving and transmitting. Set ACCEPT $n$  = Y to put the transceiver in receiving mode, which allows the SEL-2890 to receive a serial message routed over the Ethernet. However, setting ACCEPT $n$  = Y will not allow you to initiate a transmission. The SEL-2890 will only accept and reply when in this mode. To put the transceiver in the initiate mode, set ACCEPT $n$  = N.

## Routing IP Address $n$

This setting is only available if  $ACCEPTn = N$ . In this mode, the transceiver will initiate a connection or tunnel across a network to another Ethernet device. The routing IP address is the destination for the serial data the SEL-2890 received and forwarded when it was identical to the descriptive header. After a successful connection, the message will be sent.

## Descriptive Header $n$

The descriptive header is the ASCII-hexadecimal mask that will determine if a serial message should be routed. If the first bytes (as many as 8) of the serial message received by the SEL-2890 serial port match the descriptive header, then the serial message is routed to the IP designated by  $ROUTE\_IPn$ .

Serial routing settings previously described apply to  $n = 1, 2$ , or  $3$ .

## Data Rate

The data rate is the number of bit transitions per second and represents the effective data rate on EIA-232 connections that do not use data compression. Set the data rate to match the serial data transmission speed of the IED that will communicate with the SEL-2890. Available serial port data rates are 300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, or 115200. The default data rate is 19200 bps (for firmware versions R101–R103, the default speed is 38400).

## Parity

Parity refers to summing all the information bits in a serial packet and then adding a parity bit of 1 or 0 to the sum. The parity bit will make the total number always equal to an even or odd number. This is used for error checking. The transceiver will ignore parity if the setting is “None.” Set the parity to match the serial IED that will communicate with the transceiver.

## Stop Bits

EIA-232 serial data transmission is asynchronous. Asynchronous data transmission has time intervals between characters that may be of unequal length. Therefore, start and stop bits are needed to determine when the packet of data starts and stops. Set the stop bits to match the serial IED that will be communicating with the transceiver. Stop bits are forced to 1 if parity is odd or even.

## Flow Control

Flow control is used to prevent data from being transmitted faster than a receiving device can receive the data. Software flow control uses ASCII XON and XOFF characters to tell the sending IED to stop transmitting data while the receiving IED

processes the data that has already been sent. In hardware flow control, a voltage signal on Pin 8 signals the sending device to temporarily quit sending data. Set the flow control to match the IED that will be communicating with the SEL-2890.

## Force RTS Low

The SEL-2890 allows you the option of forcing the Request to Send (RTS) flow control line to either high or low when Flow Control is set to None. The default value of **N** should work for most installations. When using DNP3, set RTS\_Low to **Y** for connecting an SEL-2890 to an SEL IED.

For information on IP, SUBNET\_MASK, and GATEWAY settings, see *Ethernet Network Operation Settings on page 3.14*.

# Commands

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ASCII commands are used to modify settings, troubleshoot problems, and control actions of the SEL-2890. The command prompt is accessed by a terminal session through the network via Telnet or directly through a serial port. Commands are not case sensitive. However, passwords are case sensitive.

## Console Session: Telnet

Access the command prompt for the SEL-2890 by opening a Telnet session to port 1025. Port 1025 is referred to as the Console Port. The Console is the user interface to the SEL-2890. The Level 1 and Level 2 Console prompts are #> and ##>. Accessing different levels is discussed in *ACCESS* and *2ACCESS*.

## Console Session: Serial Port

The serial port can also be used to access the Console. In fact, the serial port is the only connection that can be used to modify the IP, Gateway, and Subnet Mask addresses.

You may need to have an SEL-C662 or SEL-C642 interface cable if your PC does not supply 5 Vdc power from Pin 1. The SEL-C642 cable (shown in *Figure 2.1*) allows the SEL-2890 to be powered from a standard 120 Vac duplex outlet via a wall-mount transformer. The SEL-C662 cable allows the SEL-2890 to be powered from the USB. Neither of these cables will interfere with any serial data transmissions.

To enter the Console, unplug the Ethernet cable and then open an ASCII terminal to establish a serial connection. With firmware version R104 and later, the SEL-2890 overrides the SPEED setting and operates at 19200 bps, no parity, 8 data bits, and 1 stop bit whenever an Ethernet connection is not present (the SEL-2890 always determines the communications speed from the SPEED setting in firmware versions

R101–R103). The SEL-2890 checks for an Ethernet connection every five seconds, so you must disconnect the Ethernet connection for at least five seconds for the default serial configuration to be enabled.

Now, enter **AT+++** within four seconds. The SEL-2890 should respond with the **#>** prompt. You are now in a Console session.

Enter the **EXIT** command at the Console session prompt then reconnect the Ethernet cable and wait for five seconds to return the SEL-2890 to normal operation.

## Command Summary

Table 3.2 summarizes the commands available in a Console session with the SEL-2890. Subsequent sections provide full descriptions of each command in alphabetical order. Commands can be shortened to the first three letters of the command.

**Table 3.2 SEL-2890 Command Summary**

Command	Description	Access Level
<b>2ACCESS</b>	Change to Access Level 2.	1
<b>ACCESS</b>	Change to Access Level 1.	1 or 2
<b>END</b>	Jump to end of settings. Used when in SET mode.	2
<b>EXIT</b>	End the current Console session.	1 or 2
<b>HELP</b>	Display description of available commands.	1 or 2
<b>L_D</b>	Upgrade firmware.	2
<b>R_S</b>	Reset device to factory default.	2
<b>PASSWORD</b>	Change and display Access Level 2 password.	2
<b>QUIT</b>	Change to Access Level 1.	1 or 2
<b>SET</b>	Change and modify transceiver settings.	2
<b>SHOW</b>	Show transceiver settings.	1 or 2
<b>SNOOP</b>	Display transmitted and received data during serial tunneling.	2
<b>TERSE</b>	Do not echo settings after settings are changed.	2
<b>TUNNEL</b>	Display or change serial tunneling IP and Port.	1 or 2
<b>VERSION</b>	Display transceiver version information.	1 or 2

## ACCESS

Access levels control whether you can perform different operations within SEL products. For example, at Access Level 1, you can view settings by using the **SHO** command. You cannot change settings unless you are at Access Level 2. The SEL-2890 contains only Access Levels 1 and 2.

## 2ACCESS

Access Level 2 is password protected. Use Access Level 2 to modify settings in the SEL-2890.

## END

Use the **END** command while in the mode of changing settings to jump to the end of the settings. This avoids scrolling through each individual setting. You will still be prompted to save settings.

## EXIT

The **EXIT** command terminates the Console session. Use the **EXIT** command to close a serial Console session or Telnet Console session. Closing a Telnet window, 15 minutes of inactivity, or entering the **EXIT** command terminates a Console session.

## HELP

Display the description of available commands by using the **HELP** command.

## L\_D

Use the **L\_D** command when in Access Level 2 to upgrade firmware.

## R\_S

Use the **R\_S** command when in Access Level 2 to reset the device to default factory settings.

## PASSWORD

Change or display the Level 2 password with the **PASSWORD** command. For example, enter **PAS TooEasy <Enter>** to change the password to “TooEasy.” The default Level 2 password is “2890.” This default password should be changed as soon as possible in order to maintain secure access to the SEL-2890 settings.

## QUIT

Return from Access Level 2 to Access Level 1 by using the **QUIT** command. **QUIT** will not end a Console session.

## SET

Change or display settings by using the **SET** command. The settings are displayed one at a time. You can jump to the specific setting by using a setting name after the command. For example, enter **SET EMAIL <Enter>** to jump directly to the email enable setting and skip all of the settings before **EMAIL**. You can also use the **END** command to jump from somewhere in the settings to the end of the settings. For example, entering **SET SPEED <Enter>** causes the SEL-2890 to prompt you for the serial data rate. After entering a new data rate, enter the **END** command to jump to the end of the settings. This is much quicker than scrolling through each setting one at a time.

When you connect to the SEL-2890 Console Port over Ethernet, you are not allowed to change some settings. The settings are displayed via the **SHOW** command but are hidden when you use the **SET** command. The hidden settings are the network configuration settings IP, SUBNET\_MASK, and GATEWAY listed in *Table 3.3*.

## SHOW

Use the **SHOW** command to display the current settings in the SEL-2890. **SHOW** is applicable in both Access Level 1 and Access Level 2.

## SNOOP

Use the **SNOOP** command to display the ASCII-hexadecimal representation of the data being transmitted and received by the serial port. The ASCII-hexadecimal bytes are separated into two-byte groups that are further separated by a space. **SNOOP** is only available during serial tunneling. Use **Control-X** to return from Snoop mode to Console session.

## TERSE

Use **TERSE** to suppress the settings echo that appears after a setting is modified. For example, enter **SET SPEED TERSE <Enter>** to receive the prompt for the data rate setting. After modifying the settings, the SEL-2890 will not echo the new settings before asking you to save.

## TUNNEL

Use the **TUNNEL** command to request the SEL-2890 to establish a serial tunnel across a network. The Tunnel setting needs to be set to **Cmd** (Commanded mode) for this command to be accepted. Enter **TUN 192.168.0.11:3001 <Enter>** to have this SEL-2890 establish a serial tunnel to an SEL-2890, SEL-2701, or other port server with IP set at 192.168.0.11 and Telnet port 3001. Issue a **TUN OFF <Enter>** command to terminate the serial tunnel. Note that establishing a Console session does not impede the passing of serial data through an SEL-2890. An example of dynamic serial tunneling is provided in *Section 4: Detailed Application Examples*.

## VERSION

Use the **VERSION** command to display the current information about the SEL-2890.

# Ethernet Network Operation Settings

Several settings control how the SEL-2890 operates on an Ethernet network. These settings include IP addressing information, network mask, and network gateway.

## Network Configuration

Use the network configuration settings shown in *Table 3.3* to configure the SEL-2890 for operation on an IP network and to set other parameters affecting the physical Ethernet network interface operation.

**Table 3.3    SEL-2890 Network Configuration Settings**

Label	Description	Range	Default
IP	IP network address	IP address	192.168.0.2
SUBNET_MASK	IP network subnet mask	IP address	255.255.255.0
GATEWAY	Router gateway	IP address	192.168.0.1

The SEL-2890 uses the IP and SUBNET\_MASK settings to determine the local network and SEL-2890 node address. The SUBNET\_MASK 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-2890 uses the GATEWAY address setting to determine how to communicate with nodes on other local networks. The SEL-2890 communicates with the router to send data to nodes on other local networks. You should also coordinate the router with



your general network implementation and administration plan. See *Table 3.4* for examples of how IP and SUBNET\_MASK define the network and node and how these settings affect the GATEWAY setting.

**Table 3.4 GATEWAY Address Setting Examples**

IP	SUBNET_MASK	Network Number	Node Address	GATEWAY
192.92.92.92	255.255.255.0	192.92.92	92	192.92.92.a <sup>a</sup>
192.92.92.92	255.255.0.0	192.92	92.92	192.92.a <sup>b</sup> .b <sup>a</sup>
192.92.92.92	255.0.0.0	192	92.92.92	192.a <sup>b</sup> .b <sup>b</sup> .c <sup>a</sup>

<sup>a</sup> Value in the range 0-254.

<sup>b</sup> Value in the range 0-255.

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# Section 4

## Detailed Application Examples

### Introduction

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This section contains detailed application examples for the following applications:

- Email
- ACSELERATOR QuickSet® SEL-5030 Software
- Serial tunneling
  - Commanded mode
  - Telnet mode
  - BTCP mode

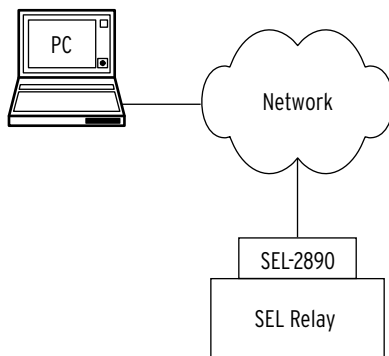
All examples assume that the SEL-2890 transceivers have been properly configured with respect to serial data rates and valid IP addresses.

### Job Done Example 1

---

#### **EXAMPLE 4.1** Email of a Summary Event Report

Figure 4.1 shows a minimal network connection needed to obtain email messages of relay Summary Event Reports.



**Figure 4.1** Minimal Email Network Connection

First assume there is a fault that causes the SEL relay to trip. After the relay trips, it sends out a Summary Event Report. The SEL transceiver recognizes this as an unsolicited message and will send it via email.

A port setting of AUTO=Y in the relay will enable the relay to email unsolicited data to the SEL-2890. The following SEL-2890 settings are needed to allow unsolicited messages to be emailed.

EMAIL=Y to enable email options.

EMAIL\_IP=IP address of email server (i.e., 192.168.0.200).

EMAIL\_DOMAIN=Optional domain name of email server (i.e., your\_company.com).

TO=Email recipient's address (i.e., johndoe@your\_company.com).

FROM=Address to return email message if problems occur (i.e., other@your\_company.com).

SUBJECT=Subject line which will be sent with the email message (i.e., Breaker 865, SEL-421).

Figure 4.2 shows a typical email message of a Summary Event Report.

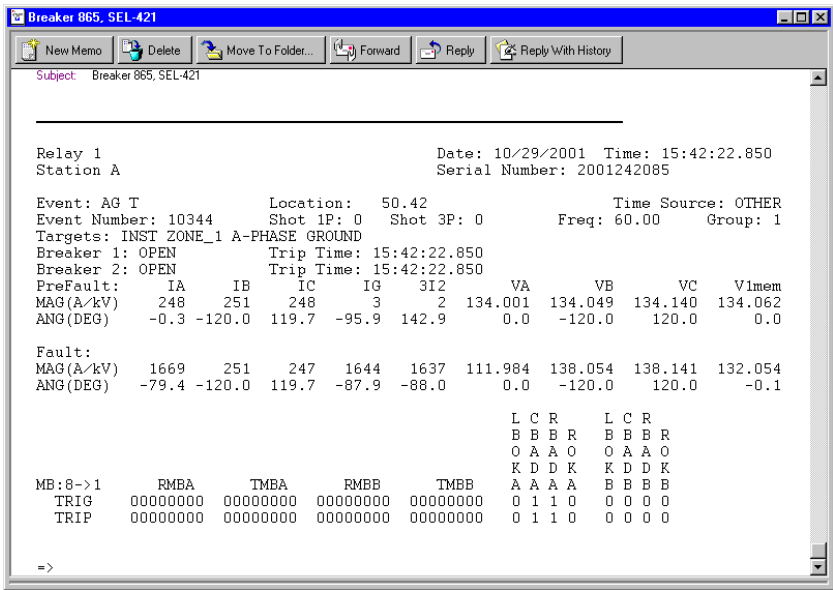
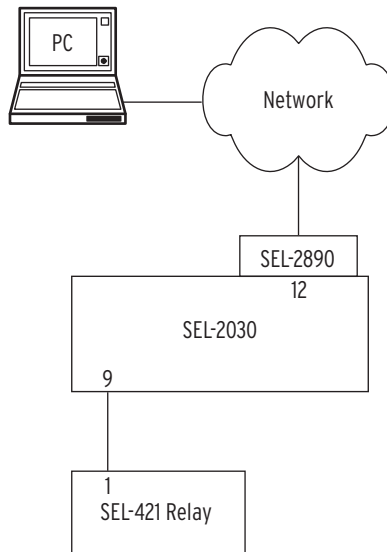


Figure 4.2 Summary Event Report Email From an SEL Relay

## Job Done Example 2

### EXAMPLE 4.2 Telnet Serial Encapsulation–ACSELERATOR QuickSet

The SEL-2890 encapsulates serial communications in a Telnet session over the Ethernet network. This allows you to use a network connection rather than dial-up or other serial leased lines to communicate with serial devices including SEL relays. This example explains the configuration of the Communications Processor, SEL-2890, and Relay settings. First, assume that you have installed the ACSELERATOR QuickSet software on the PC shown in Figure 4.3.



**Figure 4.3 Example Telnet Serial Encapsulation System**

Set the SEL-421 Port 1 as shown below:

Protocol Selection

PROTO:=SEL

Communications Settings

SPEED:=19200 DATABIT:=8 PARITY:=N

STOPBIT:=1

RTSCTS:=N

SEL Protocol Settings

TIMEOUT:=5 AUTO:=Y FASTOP:=N TERTIM1:=1

TERSTRN:="\005"

TERTIM2:=0

Use the following settings to configure Port 9 of the SEL-2030 and perform Autoconfiguration during the port setting process:

```
DEVICE=S
CONFIG=Y
PORTID=(set automatically by autoconfiguration
process)
BAUD=19200
DATABIT=8 STOPBIT=1 PARITY=N
RTS_CTS=N XON_XOF=N
TIMEOUT=5.0
```

Use the following settings to configure Port 12 of the SEL-2030:

```
PORT:12
DEVICE=M
PROTOCOL=S
FAST_OP=N
PORTID="SEL-2890 Port"
MODEM=N
BAUD=19200
DATABIT=8 STOPBIT=1 PARITY=N
RTS_CTS=Y XON_XOFF=N
TIMEOUT=5.0 ECHO=Y
AUTO_HELP=Y
TERTIME1=1
TERSTRING="\004"
TERTIME2=OFF
```

Use the settings below to configure the SEL-2890:

```
PORT=23
TEL_PROC=Y
TUNNEL=N
UDDELAY=2
MTDELAY=0.8
WEB=SEL
DHCP=N
DNS_IP=192.168.0.1
DOMAIN=
HOST_NAME=
EMAIL=N
ROUTE=N
SPEED=19200
STOP=1
PARITY=NONE
FLOW=HARDWARE
IP=192.168.0.100
```

SUBNET\_MASK=255.255.255.0  
GATEWAY=192.168.0.1  
MAC=(not a setting, use factory default)

Next, start the ACSELERATOR QuickSet software and configure it to communicate with your SEL-2890. Open the **Communication** menu and select **Parameters** to display the dialog box shown in Figure 4.4.

Communication Parameters

Active Connection Type  
Network

Serial Network Modem

Connection Name

Host IP Address

Port Number (Telnet)  
23

Port Number (FTP)  
21

File Transfer Option  
☐ FTP ☐ Raw TCP  
☒ Telnet ☐ SSH

User ID

Password

Level One Password  
.....

Level Two Password  
.....

Save to Address Book Default

OK Cancel Apply Help

**Figure 4.4 Network Parameters Dialog Box**

Next, open the Terminal window by selecting **Terminal** on the **Communication** menu. This will connect you to the SEL-2030. If you press return, you will see the SEL-2030 prompt. Log in to Access Level 1 using the **ACC** command and entering the SEL-2030 password. Next, enter the **PORT 9 D** command to establish a direct transparent connection with the relay. The SEL-2030 will not collect SCADA data from the relay while you are connected with a direct transparent connection. You

can now read or send settings, collect event reports, or use the ACCELERATOR QuickSet HMI to communicate with the relay. When you are finished, return to the Terminal window and use the terminate transparent connection keystroke (default is <Ctrl+D>) to terminate the transparent connection before closing ACCELERATOR QuickSet.

## Job Done Example 3

---

### EXAMPLE 4.3 Serial Tunneling

Serial tunneling is the ability to “tunnel” serial data across an Ethernet network. The “tunnel” is meant to be a point-to-point connection between two serial IEDs that may be used for transmitting Modbus, DNP3, SEL binary, and other binary or ASCII data. The SEL-2890 has three modes of tunneling: Commanded, Telnet, and TCP.

#### Commanded Mode

Assume you have two SEL-2890 Ethernet transceivers, designated as #1 and #2, and an SEL-2701. Refer to Figure 4.5. You can now use the **TUNNEL** command in SEL-2890 #1 to dynamically establish a serial tunnel to SEL-2890 #2 or to an SEL-2701. First, issue the following settings in each transceiver and the SEL-2701.

SEL-2890 #1: (IP 192.168.0.2 for this example)

```
SET <Enter>
PORT= 23
TEL_PROC=Y
TUNNEL= CMD
SPEED= 19200
STOP= 1
PARITY= NONE
FLOW= NONE
```

SEL-2890 #2: (IP 192.168.0.3 for this example)

```
SET <Enter>
PORT= 23
TEL_PROC=Y
TUNNEL= N
SPEED= 38400
STOP= 1
PARITY= NONE
FLOW= NONE
```

SEL-2701: (IP 192.168.0.4 for this example)

```
SET P 17 <Enter>
T1RCV:= "Y"
T1PNUM:= 23
```



To establish a serial tunnel between SEL-2890 #1 and SEL-2890 #2, open a Telnet Console session into SEL-2890 #1 and issue a **TUN 192.168.0.3:23 <Enter>** at the #> prompt. Transceiver #1 should try to establish a connection with SEL-2890 #2. You should receive the following message:

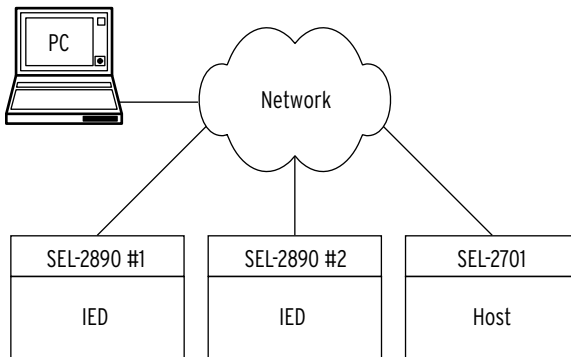
```
#>TUN 192.168.0.3:23
```

```
Commanded Serial Tunneling IP: 192.168.0.3 Port: 23
```

You now have a serial tunnel between SEL-2890 #1 and SEL-2890 #2.

To establish a serial tunnel between SEL-2890 #1 and an SEL-2701, open a Telnet Console session into the SEL-2890 #1 and issue a **TUN 192.168.0.4:23 <Enter>** at the #> prompt. A serial tunnel will be established to the SEL-2701. It is very important to note that all serial data coming from the IED connected to SEL-2890 #1 will now be routed through the SEL-2701 to the Host.

The SEL-2890 #2 and the SEL-2701 do not actively search for a connection. They wait for someone or some device to initiate a connection. Notice that the serial data rates do not have to be the same.



**Figure 4.5 Serial Tunneling Network Connection**

#### **Telnet Mode**

A Telnet mode works similarly to a Commanded mode with the exception that the serial tunnel IP and Port are fixed by the settings and cannot be changed with a command. Listed below are the settings for creating a serial tunnel between SEL-2890 #1 and SEL-2890 #2.

SEL-2890 #1: (IP 192.168.0.2 for this example)

```
SET <Enter>
PORT= 23
TEL_PROC=Y
TUNNEL= TELNET
TUNNEL_IP= 192.168.0.3
```

```
SPEED= 19200
STOP= 1
PARITY= NONE
FLOW= NONE
SEL-2890 #2: (IP 192.168.0.3 for this example)
SET <Enter>
PORT= 23
TUNNEL= TELNET
TUNNEL_IP= 192.168.0.2
SPEED= 38400
STOP= 1
PARITY= NONE
FLOW= NONE
```

In Telnet mode, PORT addresses need to match between both transceivers or Telnet devices and the TUNNEL\_IP settings must be the IP address of the opposite end transceiver or Telnet device. For this example, both transceivers will try to establish a connection by toggling between initiating a connection and passively waiting for the opposite transceiver to initiate a connection. This works well when tunneling between transceivers and port servers of different manufacture. It does not matter if the remote port server is set to master or slave because the SEL-2890 will toggle back and forth until a connection is made. Once a connection is made, the SEL-2890 will stay in that mode until the connection is terminated.

#### **BTCP Mode**

BTCP mode provides the ability to broadcast serial data without establishing a point-to-point connection. Refer to Figure 1.3 for a typical broadcast connection method. Note that all devices must be on the same side of the router. Routers will not broadcast messages outside of the local network. The following list contains the necessary settings to set up broadcast polling.

```
SEL-2890 #1: (IP 192.168.0.2 for this example)
SET <Enter>
PORT= 23
TUNNEL= BTCP
TUNNEL_IP= 192.168.0.255
SEL-2890 #2: (IP 192.168.0.3 for this example)
SET <Enter>
PORT= 23
TUNNEL= BTCP
TUNNEL_IP= 192.168.0.2
```

SEL-2890 #3: (IP 192.168.0.4 for this example)

**SET <Enter>**

PORT= 23

TUNNEL= BTCP

TUNNEL\_IP= 192.168.0.2

SEL-2890 #4: (IP 192.168.0.5 for this example)

**SET <Enter>**

PORT= 23

TUNNEL= BTCP

TUNNEL\_IP= 192.168.0.2

SEL-2890 #5: (IP 192.168.0.6 for this example)

**SET <Enter>**

PORT= 23

TUNNEL= BTCP

TUNNEL\_IP= 192.168.0.2

First, we assume that the master polling IED uses a serial protocol that is addressable. All the slave IEDs understand this protocol and will only respond if they are being polled with respect to their specific serial address.

The master IED sends out a serial message containing something like "Slave with address 10, send me your data." The SEL-2890 #1 receives this serial data and broadcasts the message to all Ethernet devices on the local subnet. The SEL-2890 transceivers #2 through #5 receive the Ethernet message and forward the corresponding serial data through their serial ports. Slave IED with address 10 responds and sends its serial data. When the respective SEL-2890 receives serial data, it will forward the data over the network to the IP furnished in the TUNNEL\_IP setting (192.168.0.2). SEL-2890 #1, whose IP is 192.168.0.2, receives the message and forwards the data out its serial port to the master polling IED. This is repeated in a "round robin" format until all slave IEDs have been polled.

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# Section 5

## Troubleshooting

### Introduction

---

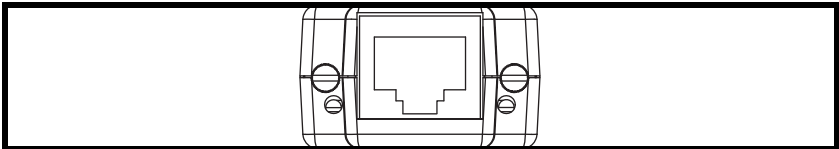
This section describes how to determine the operating status of your SEL-2890 and how to troubleshoot SEL-2890 operation. This section contains information on the following topics:

- Reading the SEL-2890 indicator LEDs
- Troubleshooting an SEL-2890 installation

### SEL-2890 Indicator LEDs

---

There are two indicator LEDs on the SEL-2890. The LEDs and panel label for the dual twisted-pair SEL-2890 are shown in *Figure 5.1*. The operation of each LED is explained in *Table 5.1*.



**Figure 5.1** Example SEL-2890 Panel

**Table 5.1** SEL-2890 LED Indicators

Location	Color	Description	Operation
Left	Red	Tx/Rx	Flashes when transmitting or receiving Ethernet messages.
Right	Green	Link	Illuminated when a good Ethernet link is detected.

The Tx/Rx LED flashes when data are being sent or received via the Ethernet port. The Link LED illuminates and remains illuminated when properly connected to the Ethernet.

# Troubleshooting Procedures

Troubleshooting procedures for common problems are listed in *Table 5.2*. The table lists each symptom and the possible causes and corresponding diagnosis/solutions. Relevant SEL-2890 settings are listed in all capitals. See *Section 3: Settings and Commands* for details of the SEL-2890 settings.

**Table 5.2   Troubleshooting Procedures (Sheet 1 of 2)**

Possible Cause	Diagnosis/Solution
Link LED does not illuminate.	
No power to SEL-2890	Verify that the IED serial port is providing 5 Vdc power on Pin 1 to the SEL-2890. If not, use cable SEL-C662 or SEL-C642 to power the transceiver.
Hub/Switch malfunction	The hub/switch should have power and there should be flashing LEDs. There should also be a Link LED associated with each Ethernet port. Verify that the Link LED on the hub/switch associated with the SEL-2890 connection is illuminated.
Bad cable	If the hub/switch appears to be functioning properly and the transceiver has power, then the problem may be the cable. The crimp ends of the cable can be problematic. Also, the 10BASE-T Ethernet cable may not have the proper pinout. Some cables called “cross-over” cables work in point-to-point connecting Ethernet devices. These “cross-over” cables should not be used for connecting an Ethernet device to a hub/switch.
Tx/Rx LED does not illuminate.	
No power to SEL-2890	Verify that the IED serial port is providing 5 Vdc power on Pin 1 to the SEL-2890. If not, use cable SEL-C662 or SEL-C642 to power the transceiver.
Hub/Switch malfunction	The port on the switch should have a Link LED and a Data Transmission LED. If the Tx/Rx LED is flashing and the corresponding Tx/Rx LED on the SEL-2890 is not flashing, then there is a problem with the cable or the SEL-2890.
Bad cable	If the hub/switch appears to be functioning properly and the transceiver has power, then the problem may be the cable. The crimp ends of the cable can be problematic. Also, the 10BASE-T Ethernet cable may not have the proper pinout. Some cables called “cross-over” cables work in point-to-point connecting Ethernet devices. These “cross-over” cables cannot be used for connecting an Ethernet device to a hub/switch.

**Table 5.2 Troubleshooting Procedures (Sheet 2 of 2)**

Possible Cause	Diagnosis/Solution
<b>Cannot establish Console session from the serial port.</b>	
Incorrect data rate	The SEL-2890 has a default data rate of 19200 bps (for firmware versions R101–R103, the default speed is 38400 bps), 8 bits, no parity, and 1 stop bit. If the communication settings have been previously modified, you may have to try different data rates.
Ethernet still connected	The Ethernet cable needs to be disconnected before the serial Console session can be entered.
Entering AT+++ too slowly	The serial escape command AT+++ needs to be entered within four seconds from the “A” to the last “+”.
Typing characters too soon after last “+”	Wait at least three seconds after the serial escape command AT+++ is entered for the prompt to appear.
Entering AT+++ too soon after powering up the SEL-2890	Wait at least 10 seconds after powering up the SEL-2890 before attempting console access.
<b>Cannot Telnet through transceiver.</b>	
UDDELAY setting is too short	In order for data to be received from the IED through the transceiver, the IED has to respond in less than the UDDelay time period. The data returned by the IED would be routed, emailed, or discarded if adequate time is not provided.
Incorrect data rate	The serial data rate or communication settings between the IED and the SEL-2890 may not be matched.

## Technical Support

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

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2350 NE Hopkins Court  
Pullman, WA 99163-5603 USA  
Tel: +1.509.338.3838  
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Email: info@selinc.com

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# Appendix A

## Firmware and Manual Versions

### Firmware

This manual covers SEL-2890 Ethernet Transceivers containing firmware bearing the firmware version numbers listed in *Table A.1*. This table also lists 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 3)**

Firmware Identification (FID) Number	Summary of Revisions	Date Code
SEL-2890-R108-V0-Z003003-D20190503	<ul style="list-style-type: none"><li>➤ Enhanced the Ethernet driver to respond to ARP requests originating from an IP address of 0.0.0.0.</li><li>➤ Updated the Ethernet driver to use all zeros for padding.</li></ul>	20190503
SEL-2890-R107-V0-Z003003-D20110121	<ul style="list-style-type: none"><li>➤ Improved DHCP functionality to be more persistent with obtaining DHCP leases.</li><li>➤ Improved Telnet and web service interactions.</li><li>➤ Corrected routing issue with applied subnet masks.</li></ul>	20110121
SEL-2890-R106-V0-Z003003-D20060927	<ul style="list-style-type: none"><li>➤ Improved long-term communications, which now support synchrophasor applications.</li><li>➤ Added software flow control.</li><li>➤ Added ability to disable Telnet processing.</li></ul>	20060927

Table A.1    Firmware Revision History (Sheet 2 of 3)

Firmware Identification (FID) Number	Summary of Revisions	Date Code
	<ul style="list-style-type: none"><li>➤ <b>SNOOP</b> command can only be accessed by Level 2.</li><li>➤ Added <b>R_S</b> command.</li><li>➤ Added WEB setting selection to disable the HTTP interface.</li></ul>	
SEL-2890-R105-V0-Z002002-D20031120	<ul style="list-style-type: none"><li>➤ Fixed serial port data format to 8 data bits.</li><li>➤ Serial tunneling mode modified to allow hardware flow control or no flow control.</li><li>➤ Reply mode for serial routing function removed.</li><li>➤ DHCP setting can only be accessed via the serial port console mode.</li></ul>	20031120
SEL-2890-R104-V0-Z001001-D20030130	<ul style="list-style-type: none"><li>➤ Corrected issue with processing of multiple 0xFF characters in tunnel data stream that made high-speed communication unreliable.</li><li>➤ Changed Telnet and HTTP sessions to turn off unsolicited message processing during these sessions.</li><li>➤ Changed default data speed to 19200 bps from 38400 bps.</li><li>➤ Added automatic serial port configuration to 19200, N, 8, 1 when no Ethernet connection is present.</li><li>➤ Added BIN selection for relay.cgi type parameter.</li><li>➤ Changed UDDELAY setting maximum value to 60 seconds.</li></ul>	20030130
SEL-2890-R103-V0-Z001001-D20020628	<ul style="list-style-type: none"><li>➤ Improved operation with ACCELERATOR QuickSet® SEL-5030 software.</li></ul>	20020628

Table A.1    Firmware Revision History (Sheet 3 of 3)

Firmware Identification (FID) Number	Summary of Revisions	Date Code
SEL-2890-R102-V0-Z001001-D20020408	➤ Improved serial tunneling operation with SEL communication processors.	20020408
SEL-2890-R101-V0-Z001001-D20020301	➤ Enhanced reliability of web server.	20020408
SEL-2890-R100-V0-Z001001-D20020208	➤ Initial version.	20020408

# 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 4)

Date Code	Summary of Revisions
20241206	<b>General</b> ➤ Removed the part number.
20241105	<b>General</b> ➤ Updated SEL-C663 references to SEL-C662. <b>Section 2</b> ➤ Added <i>Installation</i> . <b>Section 3</b> ➤ Added <i>Console Session: Serial Port</i> . <b>Section 5</b> ➤ Added <i>Table 5.2 Troubleshooting Procedures</i> . <b>Appendix B</b> ➤ Added <i>Required Equipment and Upgrade Procedure</i> . <b>Appendix G</b> ➤ Added <i>Appendix G: Cybersecurity Features</i> .
20210715	<b>Section 1</b> ➤ Updated <i>Specifications</i> .
20190503	<b>Section 4</b> ➤ Removed <i>Communications Parameters Dialog Box</i> figure. ➤ Updated <i>Figure 4.4: Network Parameters Dialog Box</i> . <b>Appendix A</b> ➤ Updated for firmware version R108.

Table A.2 Instruction Manual Revision History (Sheet 2 of 4)

Date Code	Summary of Revisions
20160601	Appendix F <ul style="list-style-type: none"><li>➤ Added <i>Appendix F: Open Network Ports</i>.</li></ul>
20150216	<ul style="list-style-type: none"><li>➤ Added <i>Preface</i>.</li></ul> Section 1 <ul style="list-style-type: none"><li>➤ Updated <i>Certifications</i>, renamed to <i>Compliance</i>, and moved to top of <i>Specifications</i>.</li></ul>
20110121	Appendix A <ul style="list-style-type: none"><li>➤ Updated for firmware version R107.</li></ul>
20060927	Various Sections <ul style="list-style-type: none"><li>➤ Added C663 as an optional programming cable to <i>Section 2</i>, <i>Section 3</i>, <i>Section 5</i>, and <i>Appendix B</i>.</li></ul> Section 2 <ul style="list-style-type: none"><li>➤ Added <b>SET</b> command instructions to <i>Step 4</i> under <i>Installation</i>.</li><li>➤ Removed <i>Network Connections</i>.</li></ul> Section 3 <ul style="list-style-type: none"><li>➤ Added TEL_PROC setting, WEB=OFF setting range, and software flow control to <i>Table 3.1: SEL-2890 Settings Summary</i>.</li><li>➤ Added <b>R_S</b> command summary to <i>Table 3.2: SEL-2890 Command Summary and R_S</i>.</li></ul> Section 4 <ul style="list-style-type: none"><li>➤ Removed former <i>Job Done Example 3</i>.</li></ul> Section 5 <ul style="list-style-type: none"><li>➤ Updated <i>Table 5.2: Troubleshooting Procedures</i>.</li></ul> Appendix B <ul style="list-style-type: none"><li>➤ Added <i>Step 5</i> under <i>Upgrade Procedure</i>.</li></ul> Appendix C <ul style="list-style-type: none"><li>➤ Moved HTML code information from <i>Section 1: Introduction and Specifications</i>.</li></ul> Appendix D <ul style="list-style-type: none"><li>➤ Modified <i>Alitree Applet</i>.</li><li>➤ Removed former <i>Appendix D: Nodelist Text File</i>.</li></ul>
20040722	All sections <ul style="list-style-type: none"><li>➤ Modified IP address examples.</li></ul>

**Table A.2 Instruction Manual Revision History (Sheet 3 of 4)**

Date Code	Summary of Revisions
20031120	<p><b>Section 1</b></p> <ul style="list-style-type: none"> <li>➤ Added <i>BTCP Tunnel</i>.</li> <li>➤ Revised <i>TCP Tunnel</i>.</li> </ul> <p><b>Section 3</b></p> <ul style="list-style-type: none"> <li>➤ Reorganized section.</li> <li>➤ Reorganized <i>Table 3.1: SEL-2890 Settings Summary</i>.</li> <li>➤ Added BTCP tunnel mode clarification under <i>Serial Tunneling</i>.</li> <li>➤ Modified <i>Enable DHCP</i>.</li> <li>➤ Renamed <i>Email Address List</i> to <i>Email To</i>.</li> <li>➤ Modified <i>Flow Control</i>.</li> </ul> <p><b>Section 4</b></p> <ul style="list-style-type: none"> <li>➤ Modified <i>Job Done Example 2</i> through <i>Job Done Example 4</i>.</li> <li>➤ Removed former <i>Job Done Example 3</i>.</li> </ul> <p><b>Appendix A</b></p> <ul style="list-style-type: none"> <li>➤ Updated for firmware version R105.</li> </ul>
20030320	<p><b>Section 1</b></p> <ul style="list-style-type: none"> <li>➤ Modified description of <i>Email</i> and <i>Serial Tunneling</i>.</li> </ul> <p><b>Section 3</b></p> <ul style="list-style-type: none"> <li>➤ Corrected description of email settings to reflect that the email address list supports only a single email address setting in <i>Email To</i>.</li> <li>➤ Added <i>Table 3.1: SEL-2890 Network Configuration Settings</i> to document all settings and the factory defaults.</li> <li>➤ Clarified description of <i>Serial Tunneling</i>.</li> </ul> <p><b>Section 4</b></p> <ul style="list-style-type: none"> <li>➤ Added Job Done example on using ACSELERATOR QuickSet with the SEL-2890 and SEL-2030 in <i>Job Done Example 2</i>.</li> </ul>
20030130	<p><b>Various Sections</b></p> <ul style="list-style-type: none"> <li>➤ Changed default data speed to 19200 bps from 38400 bps throughout manual.</li> </ul> <p><b>Section 1</b></p> <ul style="list-style-type: none"> <li>➤ Updated nodelist.txt portion of <i>Figure 1.1: Example Ethernet Substation Network</i>.</li> <li>➤ Updated text in the section <i>Email</i>.</li> </ul> <p><b>Section 2</b></p> <ul style="list-style-type: none"> <li>➤ Updated graphics associated with the <b>PING</b> command in <i>Initial Checkout</i>.</li> </ul>

Table A.2 Instruction Manual Revision History (Sheet 4 of 4)

Date Code	Summary of Revisions
	<p>Section 3</p> <p>➤ Updated text in the following subsections: <i>Settings and Commands: Console Session: Serial Port, Baud Rate, Unsolicited Detection Delay, Email Enabled, and Email Server IP Address.</i></p> <p>Section 4</p> <p>➤ Updated <i>Example 4.3: User Webpage Interface</i> and <i>Example 4.4: Serial Tunneling.</i></p> <p>Section 5</p> <p>Updated <i>Table 5.2: Troubleshooting Procedures.</i></p>
20020628	<p>Front Matter</p> <p>➤ Updated warning statements in inside front cover.</p> <p>➤ Deleted <i>Manual Change Information</i> page from manual.</p> <p>Section 5</p> <p>➤ Corrected <i>Factory Assistance.</i></p> <p>Appendix A</p> <p>➤ Revised to include manual change information.</p> <p>➤ Updated for firmware version R103.</p>
20020408	<p>Appendix A</p> <p>➤ Updated for firmware version R102.</p>
20020301	<p>Appendix A</p> <p>➤ Updated for firmware version R101.</p>
20020208	<p>➤ Initial version.</p>

# Appendix B

## Firmware Upgrade Instructions

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### Introduction

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SEL may occasionally offer firmware upgrades to improve the performance of your transceiver. The SEL-2890 transceiver stores firmware in Flash memory; therefore, changing physical components is not necessary. A firmware loader feature is included in the SEL-2890 transceiver. These instructions give a step-by-step procedure to upgrade the transceiver firmware by downloading a file from a personal computer to the transceiver via the serial port.

### Important Note Regarding Settings

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The firmware upgrade procedure may result in lost transceiver settings because of the addition of new features and changes in the way memory is used. It is imperative to have a copy of the original transceiver settings available in case they need to be re-entered. Carefully following these upgrade instructions will minimize the chance of inadvertently losing transceiver settings.

### Required Equipment

---

- Personal computer
- Terminal emulation software that supports text file transfer
- SEL-2890 programming cable (SEL-C662 or SEL-C642)

## Upgrade Procedure

---

The instructions below assume you have a working knowledge of your personal computer terminal emulation software. In particular, you must be able to modify your serial communications parameters (data rate, data bits, parity, etc.), disable any hardware or software flow control in your computer terminal emulation software, and transfer files (e.g., send text files).

- Step 1. Connect the personal computer to the SEL-2890 transceiver serial port via the SEL-C662 or SEL-C642 programming cable and remove the Ethernet cable from the transceiver.

**NOTE:** If you disconnect the Ethernet cable (firmware versions R104 and later), the SEL-2890 forces the communications speed to 19200 bps. The factory-default communications speed is 19200 bps (for firmware versions R101-R103, the default speed is 38400 bps).

- Step 2. Establish a serial Console session by entering **AT+++** in the terminal window.
- Step 3. Go to Access Level 2 by using the **2AC** command and entering the appropriate password.
- Step 4. Execute the Show (**SHO**) command to retrieve the transceiver settings. Record the displayed settings (or save them to a computer file) for possible re-entry after the firmware upgrade.

Issue the Password (**PAS**) command and save the original password settings in case they are needed later.

Normally, the transceiver will preserve the settings during the firmware upgrade. However, depending on the firmware version that was previously installed and the use of transceiver memory, this cannot be ensured. Saving settings is always recommended. If settings are lost because of the firmware upgrade, the transceiver defaults to a data rate of 19200 bps. It is recommended that firmware be downloaded at 19200 so that messages will be properly displayed if the settings are lost.

- Step 5. Set flow control to software (FLOW=Software) by using the **SET** command if necessary. Saving settings will require re-establishing the serial console because it is closed after each settings save.
- Step 6. Go to Access Level 2 by using the **2AC** command and entering the appropriate password.
- Step 7. Issue the **L\_D <Enter>** command to the transceiver to start the firmware upgrade procedure.
- Step 8. Type **Y <Enter>** to the This command will erase current firmware. Continue (Y, N)? prompt.



- Step 9. The transceiver will prompt you to Send HEX file as an ASCII text file. Send the firmware upgrade file by using the **send text file** option of your terminal program.
- Step 10. Progress of firmware upgrade is indicated by the display of periods to the terminal window. If the firmware download was successful you will receive the Download successful. Reprogram transceiver (Y, N)? prompt.

---

**NOTE:** The current transceiver firmware is still programmed into Flash memory at this point and has not been erased or overwritten. Once reprogramming commences, power must remain applied to the transceiver until reprogramming is complete.

- Step 11. Type **Y** <Enter> to reprogram the Flash memory of the transceiver.

---

**NOTE:** If you are upgrading from firmware version R101-R103 to version R104 or later, you must change the communications speed of your computer to 19200 bps to continue with Step 12. This may prevent you from seeing the "Firmware Upgrade Complete" message. You can use the **SHO** command to verify proper installation of the new firmware.

- Step 12. Upon successful reprogramming of the transceiver, you should receive the Firmware Upgrade Complete message within 30 seconds. If you receive this message, check the status of settings by issuing the show (**SHO**) command. If you do not receive this message, go to Step 14. You can verify the correct firmware was loaded by using the version (**VER**) command.
- Step 13. If settings have been lost, go to Access Level 2 by using the **2AC** command and entering the default password. Use the **SET** command to reenter lost settings. The transceiver is now ready for normal use.
- Step 14. If you did not receive the Firmware Upgrade Complete within fifteen minutes of answering **Y** to the Download successful. Reprogram transceiver (Y, N)? perform the following steps.
- a. If the original settings have been lost, the data rate will default back to 19200, 8, N, 1. Change the data rate of your terminal to 19200 and press <Enter>. If you receive a prompt, then check the status of settings by using the **SHO** command. If there is still no response, press **AT+++** to get the attention of the SEL-2890. If still unsuccessful, wait at least 30 seconds and repeat **AT+++**. Repeat the **AT+++** command sequence as many as three separate times with a 10 second delay between each try if needed. Go to Step b if the SEL-2890 is still unresponsive. If the SEL-2890 is responding, use the **SHO** command to verify settings. The transceiver is now ready for normal use.

- b. Restart the SEL-2890. Repeat the **AT+++** sequence three or more times. If the SEL-2890 is still unresponsive and you have tried the original and default data rate of 19200, then go to *Step c*.
- c. The transceiver firmware upgrade was unsuccessful and the transceiver will require factory servicing before it can be returned to service.

# Appendix C

## HTML Code

---

File: index.htm

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.0 Frameset//EN">
<HTML>
1  <HEAD><TITLE>SEL-2890 Ethernet Transceiver</TITLE></HEAD>

    <FRAMESET FRAMEBORDER=0 BORDER=0 NORESIZE COLS= "150, *">
        <!-- left side: logo, menu --!>
        <FRAMESET ROWS="84,*">
2          <FRAME NAME="logo" MARGINWIDTH=0 MARGINHEIGHT=0 SCROLLING=NO SRC="logo.htm">
3          <FRAME NAME="menu" MARGINWIDTH=0 MARGINHEIGHT=0 SRC="menu.htm">
        </FRAMESET>

        <!-- right side: content --!>
4        <FRAME NAME="data" SRC="data.htm">
    </FRAMESET>

</HTML>
```

File: access.htm

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.0 Frameset//EN">
<HTML>
<HEAD>
<TITLE>access</TITLE>
</HEAD>

<BODY>
5  <!-- Login Form -->
    <FORM METHOD = POST ACTION = "access.cgi">
        <h3>
            <P>Command: <INPUT TYPE = "text" NAME = "login" value = "acc" SIZE = "12" MAXLENGTH =
"12"></P>
            <P>Password: <INPUT TYPE = "password" NAME = "password" SIZE = "12" MAXLENGTH = "12"></P>
            <P><INPUT TYPE = "submit" VALUE = "Login"></P>
        </FORM>

</BODY>
</HTML>
```

## File: data.htm

```

1      <!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.0 Frameset//EN">
2      <HTML>
3      <HEAD>
4      <TITLE>Intro</TITLE>
5      <STYLE>
6      BODY {background:white}
7      </STYLE>
8      </HEAD>
9
10     <BODY>
11     </BODY>
12     </HTML>

```

## File: logo.htm

```

1      <!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.0 Frameset//EN">
2      <HTML>
3      <HEAD>
4      <TITLE>Logo</TITLE>
5      <STYLE>
6      BODY {background:#000080}
7      </STYLE>
8      </HEAD>
9
10     <BODY>
11     <CENTER><IMG align=center SRC="logo.jpg"></CENTER>
12     </BODY>
13     </HTML>

```

## File: menu.htm

```

1      <!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.0 Frameset//EN">
2      <HTML>
3      <HEAD>
4      <TITLE>SEL-2890</TITLE>
5      <STYLE>
6      P {color:white}
7      BODY {background:#000080}
8      </STYLE>
9      </HEAD>
10
11     <BODY>
12     <!-- The tree navigation applet -->
13     <applet hspace = "5" vspace = "30"
14         NAME = "AliTree"
15         ARCHIVE = "alintree.zip"
16         CODE = "alintree.class"
17         WIDTH = 135 HEIGHT = 250>

```

```

10      <param name = "ICON0"      value = "closed.gif">
6      <param name = "ICON1"      value = "open.gif">
7      <param name = "ICON2"      value = "file.gif">
      <param name = "ICON3"      value = "mail.gif">
8      <param name = "ICON4"      value = "link.gif">
      <param name = "FONTSIZE"   value = "12">
      <param name = "NODEFILE"   value = "odelist.txt">
      <param name = "TARGET"      value = "data">
      <param name = "LINKTYPE"   value = "TEXT">
      <param name = "EXPANDED"   value = "NO">
      <param name = "BACKGROUND" value = "#000080">
      <param name = "TEXTCOLOUR" value = "#FFFFFF">
      <param name = "CONNCOLOUR" value = "#FFFFFF">
      <param name = "LINKCOLOUR" value = "#FFFF00">
9      <!-- Enter code for non-java-enabled browsers here -->
      <P>You will need to activate java to view this menu.</P>
      </applet>

      </BODY>
    </HTML>

```

#### File: nodelist.txt (partial)

```

11      SEL~0
      Visit~4~SEL~www.selinc.com~http://www.selinc.com

      Metering~0
      Instantaneous~2~Metering~!~relay.cgi?type=SEL&command=MET
      Demand~2~Metering~!~relay.cgi?type=SEL&command=MET+D
      Peak Demand~2~Metering~!~relay.cgi?type=SEL&command=MET+P
      Energy~2~Metering~!~relay.cgi?type=SEL&command=MET+E
      Max / Min~2~Metering~!~relay.cgi?type=SEL&command=MET+M

      Access~0
      Login~2~Access~!~access.htm
      Logout~2~Access~!~relay.cgi?type=SEL&command=QUI
12  _____

```

**Figure C.1 HTML Code Shown in Figure 1.2**

Table C.1 Callout Numbers in Figure C.1

Callout #	Description
1	The HTTP is set to start with the index.htm file. This file contains the <HEAD><TITLE> information and sets the character of the three frames.
2	This code places the logo on the main frameset and references the logo.htm file. The logo.htm file contains display information about the logo.
3	This code places the menu on the main frameset and references the menu.htm file. The menu.htm file contains the tree structured applet.
4	This code places the data display on the main frameset and references the data.htm file. Data.htm contains the selection for the background color.
5	The access.htm file is run by selecting Access/Login from the menu tree in the HTTP. The file, access.htm, provides a form that allows you to gain Level 1 access to a relay via a password.
6	This is ICON1 (icon #1) which is referenced later on in the nodelist.txt file. ICON1 is the folder that appears to be open.
7	This is ICON2 (referenced in nodelist.txt). ICON2 is the document icon that is located under the folder icon.
8	This is ICON4 (referenced in nodelist.txt). ICON4 is the link graphic that connects a folder icon to a document icon.
9	Message that will appear if Java is not activated in the browser.
10	This is ICON0 (referenced in nodelist.txt). ICON0 is the closed folder graphic.
11	A supporting text file, nodelist.txt, is used by the tree structure applet. This text file contains the information needed to create the node name, structure, and commands that are sent to the relays or communications processors. The complete explanation about the parameters needed by the Alitree applet is contained in the file alitree.zip located in the SEL-2890. Only part of the nodelist.txt file is shown above. You may FTP the Nodelist.txt file out of the SEL folder in the transceiver to view its contents. For more information, contact SEL.
12	Use the ! symbol to set the Status Bar text to match the label associated with the tree item.

The HTTP files are stored in two different memory areas in the SEL-2890. Each memory area has a maximum size of 230 kilobytes. The following table shows which HTTP files are grouped together.

Table C.2 HTTP Files (Sheet 1 of 2)

Memory Area 1		Memory Area 2	
File	Directory	File	Directory
logo.jpg	User	page4.htm	Custom
nodelist.txt	User	page5.htm	Custom
index.htm	Custom	page6.htm	Custom

Table C.2 HTTP Files (Sheet 2 of 2)

Memory Area 1		Memory Area 2	
logo.jpg	Custom	page7.htm	Custom
page1.htm	Custom	page8.htm	Custom
page2.htm	Custom	page9.htm	Custom
page3.htm	Custom	image3.gif	Custom
image1.gif	Custom	image4.gif	Custom
image2.gif	Custom	image5.gif	Custom
image6.jpg	Custom	image7.jpg	Custom
app1.zip	Custom	image8.jpg	Custom
		image9.jpg	Custom
		app2.zip	Custom

The following paragraphs describe the use of the Custom HTTP option. Prior HTTP design familiarity is highly recommended. At a minimum, the user should supplement the following information with a manual on basic HTTP design.

## Forms and CGI Scripts

The server provides one CGI (Common Gateway Interface) interface script for passing parameters to the connected device. The file relay.cgi is used with a web form to pass data or commands to a serial device like an SEL relay or communications processor. *Figure C.2* shows example HTML code for a form that passes data through an SEL-2890.

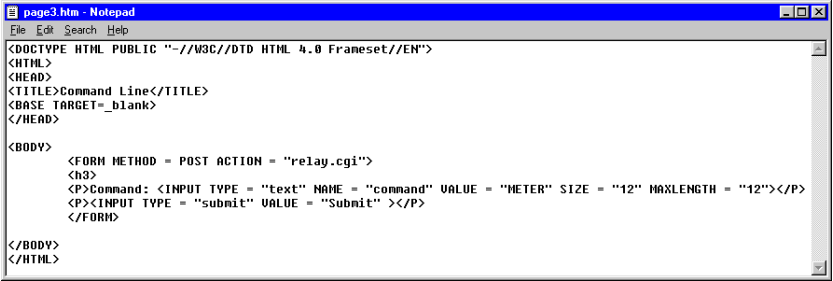


Figure C.2 Example HTML Code

The form in *Figure C.2* uses the POST method with an ACTION option. POST defines which method is used to return the form information or data to the web server. The ACTION option defines which CGI script is called when the **Submit** button is pressed. Relay.cgi or access.cgi can be used with the SEL-2890 Custom HTTP option.

MAXLENGTH determines the maximum length of the value of a NAME-VALUE pair sent to the web server. The relay.cgi program is designed to use NAME-VALUE pairs in the form of command-[VALUE] where [VALUE] is entered in the text box by the user. The HTML code in *Figure C.2* fills in the text box with a default value of METER. When a NAME-VALUE pair is submitted, the SEL-2890 HTTP server may return data to the client. These data will appear in the HTTP form designated by the TARGET option. The BASE TARGET=\_blank option shown in *Figure C.2* specifies that the target location be a new, blank window.

## Application Programs

The SEL-2890 allows two different application programs to be downloaded. File names for the programs are app1.zip and app2.zip. Use of the file structure and associated file names is required. However, it is possible to download a Java applet or other file into any file (i.e., image1.gif). Care must be taken when doing this. The browser must be able to recognize the file by header information rather than by file name. Therefore, if you want to download more than two application files to the SEL-2890 extension, you will have to save the files as something other than app1.zip or app2.zip.

Review the web files located under the SEL folder with Microsoft® Notepad or other web authoring software. This will provide a better understanding of how the SEL-2890 web server works.

The web setting option, SEL, enables the default HTTP that ships with the transceiver and is designed to work on an SEL relay.



# Appendix D

## Alitree Applet

### Introduction

---

The Alitree applet is written by APC Software Ltd. Java 1.0 is the code behind Alitree. This should enable the program to be run on older browsers. The supporting documentation is contained in the file alitree.zip located in the SEL-2890. FTP the alitree.zip file out of the transceiver and unzip. Instructions on how to pass parameters are contained in the file alitree.txt.

# Tree View Java Applet

---

Tree View Java Applet - (c) 2000-2001 ACB Software Ltd.

=====

Purpose:  
-----

Displays hierarchical tree of given data in a variety of user-definable ways using user-specified graphical icons.

Legal Blurb:  
-----

This applet is supplied “as is”. The author will accept no responsibility or liability for any unexpected behavior, damage to computer systems, etc., that this applet may cause. There is absolutely no warranty or guarantee that this applet will perform as described below. Having said that, it has been fairly well tested and hasn't caused any ill effects in general use.

Copyright:  
-----

The applet may be used in any application, commercial or otherwise. The copyright remains with the author and reverse-engineering or any removal of copyright notices is prohibited. If you use this applet, the author would appreciate an email at [ali@squark.demon.co.uk](mailto:ali@squark.demon.co.uk).

Distribution:  
-----

This applet may be freely distributed as long as this file accompanies both of the .class files.

This file, along with the two .class files, may be re-packaged into an archive format (zip, tar, etc.) as required. Permission is given for this applet to appear on a magazine cover CD or other CD-ROM and for it to be uploaded to any online distribution sites such as JARS, TUCOWS or Gamelan.

If you are the owner of said CD or website, the author would again appreciate an email at [ali@squark.demon.co.uk](mailto:ali@squark.demon.co.uk).

# Appendix E

## ASCII Reference Table

Table E.1 ASCII Reference Table (Sheet 1 of 5)

Decimal Code	Hexadecimal Code	Character	Keystroke
0	00	NUL	
1	01	SOH	Ctrl+A
2	02	STX	Ctrl+B
3	03	ETX	Ctrl+C
4	04	EOT	Ctrl+D
5	05	ENQ	Ctrl+E
6	06	ACK	Ctrl+F
7	07	BEL	Ctrl+G
8	08	BS	Ctrl+H
9	09	HT	Ctrl+I
10	0A	LF	Ctrl+J
11	0B	VT	Ctrl+K
12	0C	FF	Ctrl+L
13	0D	CR	Ctrl+M
14	0E	SO	Ctrl+N
15	0F	SI	Ctrl+O
16	10	DLE	Ctrl+P
17	11	DC1 (XON)	Ctrl+Q
18	12	DC2	Ctrl+R
19	13	DC3 (XOFF)	Ctrl+S
20	14	DC4	Ctrl+T
21	15	NAK	Ctrl+U
22	16	SYN	Ctrl+V
23	17	ETB	Ctrl+W
24	18	CAN	Ctrl+X

Table E.1    ASCII Reference Table (Sheet 2 of 5)

Decimal Code	Hexadecimal Code	Character	Keystroke
25	19	EM	Ctrl+Y
26	1A	SUB	Ctrl+Z
27	1B	ESC	Esc
28	1C	FS	
29	1D	GS	
30	1E	RS	
31	1F	US	
32	20	SP	Space
33	21	!	!
34	22		""
35	23	#	#
36	24	\$	\$
37	25	%	%
38	26	&	&
39	27		"
40	28	(	(
41	29	)	)
42	2A	*	*
43	2B	+	+
44	2C	,	,
45	2D	-	-
46	2E	.	.
47	2F	/	/
48	30	0	0
49	31	1	1
50	32	2	2
51	33	3	3
52	34	4	4
53	35	5	5
54	36	6	6
55	37	7	7

Table E.1    ASCII Reference Table (Sheet 3 of 5)

Decimal Code	Hexadecimal Code	Character	Keystroke
56	38	8	8
57	39	9	9
58	3A	:	:
59	3B	;	;
60	3C	<	<
61	3D	=	=
62	3E	>	>
63	3F	?	?
64	40	@	@
65	41	A	A
66	42	B	B
67	43	C	C
68	44	D	D
69	45	E	E
70	46	F	F
71	47	G	G
72	48	H	H
73	49	I	I
74	4A	J	J
75	4B	K	K
76	4C	L	L
77	4D	M	M
78	4E	N	N
79	4F	O	O
80	50	P	P
81	51	Q	Q
82	52	R	R
83	53	S	S
84	54	T	T
85	55	U	U
86	56	V	V

Table E.1    ASCII Reference Table (Sheet 4 of 5)

Decimal Code	Hexadecimal Code	Character	Keystroke
87	57	W	W
88	58	X	X
89	59	Y	Y
90	5A	Z	Z
91	5B	[	[
92	5C	\	\
93	5D	]	]
94	5E	–	–
95	5F	–	–
96	60		``
97	61	a	a
98	62	b	b
99	63	c	c
100	64	d	d
101	65	e	e
102	66	f	f
103	67	g	g
104	68	h	h
105	69	i	i
106	6A	j	j
107	6B	k	k
108	6C	l	l
109	6D	m	m
110	6E	n	n
111	6F	o	o
112	70	p	p
113	71	q	q
114	72	r	r
115	73	s	s
116	74	t	t
117	75	u	u

Table E.1    ASCII Reference Table (Sheet 5 of 5)

Decimal Code	Hexadecimal Code	Character	Keystroke
118	76	v	v
119	77	w	w
120	78	x	x
121	79	y	y
122	7A	z	z
123	7B	{	{
124	7C		
125	7D	}	}
126	7E	~	~
127	7F	DEL	Delete

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# Appendix F

## Open Network Ports

The following information is intended to help security auditors verify that the network hosts and open ports on a control network are what is expected.

The following tables list the network ports that may be presented by the device.

Physical Port	# Ports	Default	Can Be Disabled
Serial Ports	1	Enabled	No
Ethernet Ports	1	Enabled	No

Ethernet Services: Server	Device Function	Protocol	Default Listening Port	Port Settable	Default State	Can Be Disabled
Hypertext Transfer Protocol (HTTP)	Relay Display	TCP	80	No	Enabled	No
Telnet (Server)	Passthrough Mode	TCP	23	Yes	Enabled	Yes
Raw TCP (Server)	Passthrough Mode	TCP	23	Yes	Disabled	Yes
Telnet (Server)	Console	TCP	1025	Yes	Enabled	No
File Transfer Protocol (FTP)	Authentication Proxy	TCP	none	Yes	Enabled	No
Internet Control Message Protocol (ICMP)	System	ICMP	N/A	N/A	Enabled	No

Ethernet Services: Client	Device Function	Protocol	Default Destination Port	Port Settable	Default State	Can Be Disabled
Telnet (Client)	Serial Tunnel Mode (Telnet)	TCP	23	Yes	Disabled	Yes
Telnet (Client)	Serial Tunnel Mode (Cmd)	TCP	23	Yes	Disabled	Yes
Raw TCP (Client)	Serial Tunnel Mode (TCP/BTCP)	TCP	23	Yes	Disabled	Yes
Dynamic Host Configuration Protocol (DHCP) Client	Networking	UDP	68	No	Disabled	Yes
Simple Mail Transfer Protocol (SMTP) <sup>a</sup>	Email Alerting	TCP	25	Yes	Disabled	Yes
Domain Name Service (DNS)	Networking	UDP	53	No	Disabled	Yes

<sup>a</sup> Optional alerting method to send unsolicited messages coming in from the serial port to an email address.

Ethernet Services: Non-IP Protocols	Device Function	Protocol	Default Destination Port	Port Settable	Default State	Can Be Disabled
Address Resolution Protocol (ARP)	Networking	ARP	N/A	N/A	Enabled	No

# Appendix G

## Cybersecurity Features

### Introduction and Security Environment

#### Product Function

The SEL-2890 transceiver is an Ethernet-to-serial device that provides Ethernet access to an EIA-232 serial device.

#### Security Requirements

There are no confidentiality, integrity, or availability cybersecurity controls integrated into the SEL-2890. Access to the configuration of the SEL-2890 is password protected. The SEL-2890 relies on a defense in depth security architecture for security controls to be applied at other layers.

### Version Information

#### Obtaining Version Information

To view the device firmware identification (FID) version number, issue the **VER** command from Access Level 2. The version number will have the format of SEL-2890-Rxxx-Vx-Zxxxxxx-Dxxxxxxx. See *Appendix A: Firmware and Manual Versions* for more details.

### Decommissioning

#### Decommissioning

To delete the SEL-2890 device settings, perform a factory reset by using the console at Access Level 2 and issuing the **R\_S** command.

## External Interfaces

---

### Ports and Services

#### Physical Ports

The SEL-2890 device has one front EIA-232 serial port, and one rear Ethernet port used for serial communications over an Ethernet network. Both ports are enabled by default and cannot be disabled.

#### Logical Ports

See *Appendix F: Open Network Ports*.

## Access Controls

---

### Access Levels

The SEL-2890 device has two access levels. Access Level 1 allows the user to view the device settings or proceed to Access Level 2. Access Level 2 allows the user to make device settings changes.

Access Level 1 is the default access level and can be used to display the device settings, firmware version, available commands, tunneling IP, and port. From Access Level 1 the user can proceed to Access Level 2.

Access Level 2 requires a password to access and can be used to upgrade the firmware, reset the device to default settings, change the password, and change device settings.

### Passwords

The default password for Access Level 2 is 2890. This default password should be changed before putting the device into service. Passwords can have as many as eight characters and can support lower case letters, upper case letters, and special characters. Complex passwords are not enforced. To change the Access Level 2 password, use the **PASSWORD** command. For example, enter **PAS TooEasy <Enter>** to change the password to “TooEasy”.

### Physical Access Controls

The SEL-2890 has no physical access controls.

# Logging Features

---

## Internal Log Storage

The SEL-2890 device does not generate or store logs.

## Alarm Contact

The SEL-2890 device does not provide an alarm contact.

# Malware Protection Features

---

The SEL-2890 operates on embedded firmware and does not have a general-purpose operating system. All firmware updates and fixes are delivered and announced through the established SEL processes.

## Firmware Hash Verification

The SEL-2890 supports digitally signed firmware upgrades. SEL uses the SHA-256 secure hash algorithm to compress and digitally sign firmware upgrade files. See *Appendix B: Firmware Upgrade Instructions* for more information on firmware upgrades.

## Firmware

SEL-2890 devices are embedded devices that do not allow additional software to be installed. The devices include a self-test that continually checks running code against the known version of code in nonvolatile memory.

## Firmware Verification

SEL-2890 devices have the ability to install firmware updates in the field. Verify the authenticity and integrity of firmware updates by using the Firmware Hash page at [selinc.com/products/firmware/](https://selinc.com/products/firmware/).

# Product Updates

---

The latest version of the SEL-2890 firmware is documented on the [selinc.com](https://selinc.com) and in the *SEL-2890 Ethernet Transceiver Instruction Manual*.

If SEL finds a security vulnerability with the SEL-2890 device, it will be disclosed using our standard security notification process. For a full description of this process, see [selinc.com/support/security-notifications/](https://selinc.com/support/security-notifications/).

## Contact SEL

---

For further questions or concerns about product security, contact SEL at [security@selinc.com](mailto:security@selinc.com) or +1.509.332.1890.

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