SEL-2411

Programmable Automation Controller

Instruction Manual

20100122

SCHWEITZER ENGINEERING LABORATORIES, INC.

⚠CAUTION

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

⚠ATTENTION

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

⚠CAUTION

There is danger of explosion if the battery is incorrectly replaced. Replace only with Ray-O-Vac® no. BR2335 or equivalent recommended by manufacturer. Dispose of used batteries according to the manufacturer's instructions.

⚠ATTENTION

Il y a un danger d'explosion si la pile électrique n'est pas correctement remplacée. Utiliser exclusivement Ray-O-Vac® No. BR2335 ou un équivalent recommandé par le fabricant. Se débarrasser des piles usagées suivant les instructions du fabricant.

⚠CAUTION

The device contains devices sensitive to Electrostatic Discharge (ESD). When working on the device with the front panel removed, work surfaces and personnel must be properly grounded or equipment damage may result.

⚠ATTENTION

L'appareil contient des pièces sensibles aux décharges électrostatiques (DES). Quand on travaille sur l'appareil avec le panneau avant enlevé, les surfaces de travail et le personnel doivent être mis à la terre convenablement pour éviter les dommages à l'équipement.

⚠CAUTION

Use of controls or adjustments, or performance of procedures other than those specified herein, may result in hazardous radiation exposure.

⚠ATTENTION

L'utilisation de commandes ou de réglages ou l'application de procédures autres que ceux décrits ci-après peut causer l'exposition à des radiations dangereuses.

⚠WARNING

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.

⚠AVERTISSEMENT

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 accés non-autorisé á l'équipement peut être possible. SEL décline toute responsabilité pour tout dommage résultant de cet accés non-autorisé.

⚠WARNING

Use of this equipment in a manner other than specified in this manual can impair operator safety safeguards provided by this equipment.

⚠AVERTISSEMENT

L'utilisation de cet appareil suivant des procédures différentes de celles indiquées dans ce manuel peut désarmer les dispositifs de protection d'opérateur normalement actifs sur cet équipement.

⚠DANGER

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

⚠DANGER

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

⚠DANGER

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

⚠DANGER

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

PM2411-01

Table of Contents

Section 3: Getting Started

Section 4: Logic Functions

Section 5: Metering and Monitoring

Section 6: Settings

SEL-2411 Settings Sheets

Section 7: Communications

Section 9: Analyzing Events

Section 10: Testing and Troubleshooting

Appendix A: Firmware and Manual Versions

Appendix B: Firmware Upgrade Instructions

Appendix C: SEL Communications Processors

Appendix D: DNP3 Communications

Appendix E: Modbus Communications

Appendix F: IEC 61850 Communications

Appendix G: MIRRORED BITS Communications

Appendix H: Device Word Bits

Appendix I: Analog Quantities

Glossary

Index

SEL-2411 Programmable Automation Controller Command Summary

This page intentionally left blank

Preface

Conventions

Typographic Conventions

There are two ways to communicate with the SEL-2411:

- Using a command line interface on a PC terminal emulation window.
- Using the front-panel menus and pushbuttons.

The instructions in this manual indicate these options with specific font and formatting attributes. The following table lists these conventions:

Example	Description
STATUS	Commands typed at a command line interface on a PC.
<Enter>	Single keystroke on a PC keyboard.
<Ctrl+D>	Multiple/combination keystroke on a PC keyboard.
Start > Settings	PC software dialog boxes and menu selections. The > character indicates submenus.
{CLOSE}	Device front-panel pushbuttons.
ENABLE	Device front- or rear-panel labels.
`MAIN > METER`	Device front-panel LCD menus and device responses visible on the PC screen. The > character indicates submenus.

Safety and General Information

Safety Information

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

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

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

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

Symbols

The following symbols from EN 61010-1 are often marked on SEL products.

Symbol 14		Consult Documentation for Additional Information
Symbol 6		Protective (Safety) Ground Conductor Terminal
Symbol 1		Direct Current
Symbol 2		Alternating Current
Symbol 3		Direct and Alternating Current
Symbol 5		Earth (Ground) Terminal

Hazardous Locations Approvals

The SEL-2411 complies with UL 1604, CSA 22.2 No. 213 and EN 60079-15. In North America, the device is approved for Class 1, Division 2, Groups A, B, C, D, and T4 in the –40° to +70°C temperature range.

To comply with the requirements of the European ATEX standard for hazardous locations, the SEL-2411 must be installed in an enclosure that meets the requirements of an Ex n enclosure rated IP54 or better. The enclosure should be certified to these requirements or be tested for compliance as part of the complete assembly.

The following figure shows the compliance label that is located on the left side of the device.

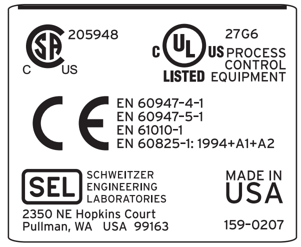
Environmental Conditions and Voltage Information

The following table lists important environmental and voltage information.

Condition	Range/Description
Indoor/outdoor use	Indoor
Altitude	Up to 2000 m
Temperature	
IEC Performance Rating (per IEC/EN 60068-Z-1 and 60068-Z-2	–40 to +85°C
UL/CSA Safety Rating	–40 to +70°C
Relative humidity	5 to 95%
Main supply voltage fluctuations	Up to ±10% of Nominal voltage
Overvoltage	Category II
Pollution	Degree 2
Atmospheric pressure	80 to 110 kPa

Laser/LED Emitter

The SEL-2411 is a Class 1 LED Product and complies with IEC 60825-1:1993 + A1:1997 + A2:2001. The following figure shows the lower portion of the compliance label that is located on the left side of the device (when facing the front of the device).



Class 1 LED Product Compliance Label and Location

The following table shows LED information specific to the SEL-2411 (see *Figure 2.6*–*Figure 2.9* for the location of Port 2, the port using these LEDs, on the device).

SEL-2411 LED Information

Item	Detail
Mode	Multimode
Wavelength	820 nm
Source	LED
Connector type	ST
Output power	–11.7 to –3.7 dBm

Safety Warnings and Precautions

⚠CAUTION
Use of controls or adjustments, or performance of procedures other than those specified herein, may result in hazardous radiation exposure.

- Do not look into the end of an optical cable connected to an optical output.
- Do not look into the fiber ports/connectors.
- Do not perform any procedures or adjustments that are not described in this manual.
- During installation, maintenance, or testing of the optical ports only use test equipment classified as Class 1 laser products.
- Incorporated components such as transceivers and laser/LED emitters are not user serviceable. Units must be returned to SEL for repair or replacement.

Wire Sizes and Insulation

Wire sizes for grounding (earthing), current, voltage, and contact connections are dictated by the terminal blocks and expected load currents. You may use the following table as a guide in selecting wire sizes:

Connection Type	Minimum Wire Size	Maximum Wire Size
Grounding (Earthing) Connection	14 AWG (2.5 mm^2)	10 AWG (4 mm^2)
Current Connection	16 AWG (1.5 mm^2)	10 AWG (4 mm^2)
Potential (Voltage) Connection	18 AWG (0.8 mm^2)	14 AWG (2.5 mm^2)
Contact I/O	18 AWG (0.8 mm^2)	14 AWG (2.5 mm^2)
Other Connection	18 AWG (0.8 mm^2)	14 AWG (2.5 mm^2)

You should use wire with 0.4 mm thick insulation for high voltage connections to allow for contact between adjacent wires. If possible, use 0.4 mm insulated wires for all connections.

Instructions for Cleaning and Decontamination

Use care when cleaning the SEL-2411. Use a mild soap or detergent solution and a damp cloth to clean the chassis. Do not use abrasive materials, polishing compounds, or harsh chemical solvents (such as xylene or acetone) on any surface.

Technical Assistance

Obtain technical assistance from the following address:

Schweitzer Engineering Laboratories, Inc.
2350 NE Hopkins Court
Pullman, WA 99163-5603 USA
Phone: +1.509.332.1890
Fax: +1.509.332.7990
Internet: www.selinc.com
E-mail: info@selinc.com

Section 1

Introduction and Specifications

Overview

The SEL-2411 Programmable Automation Controller provides inputs, logic, outputs, and communications as shown in *Figure 1.1* for many diverse applications. For smaller applications, select the base unit without additional input/output cards (two digital inputs and three contact outputs), or add up to four additional input/output cards to tailor the SEL-2411 to specific applications.

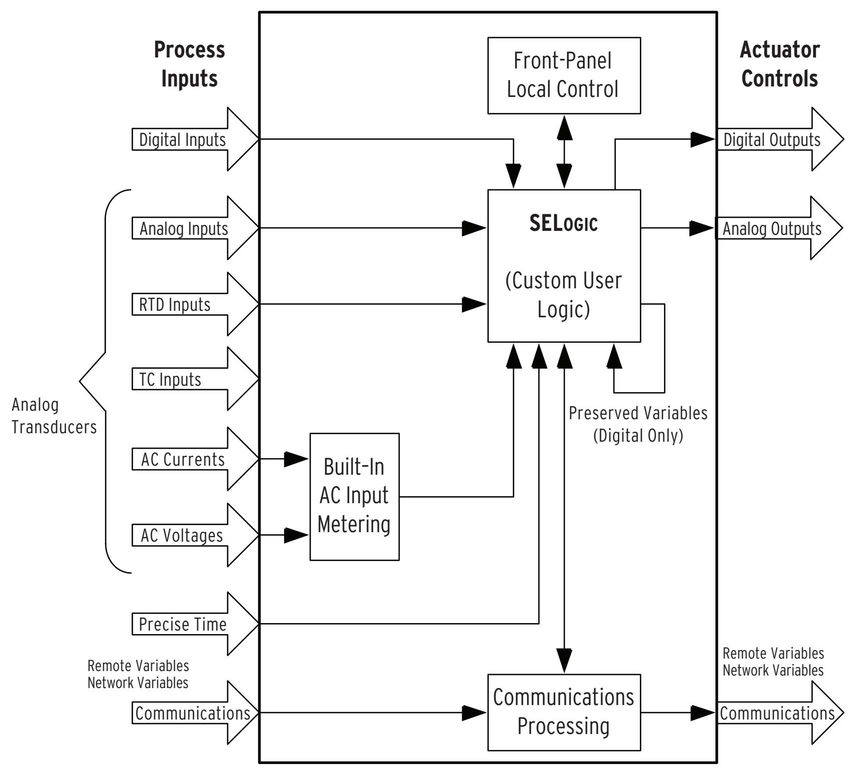


Figure 1.1 Block Diagram

This manual contains information necessary to install, test, operate, and maintain any SEL-2411. It is not necessary to review the entire manual to perform specific tasks.

Features

Physical

Standard
Two isolated dry inputs and three outputs (two Form A and one Form C)
Human-Machine-Interface (HMI)
One front serial port
One rear serial port (compatible with SEL-2810, SEL-2814, SEL-3010, . . .)
IRIG-B input
Optional
Analog inputs and outputs
Digital inputs and outputs
Voltages (wye or open-delta)
Currents
RTDs
Thermocouples
EIA-232 or EIA-485 card
One or two (failover) Ethernet ports
Fiber-optic port (compatible with SEL-2600A, SEL-2600D, SEL-2812)

Monitoring

Standard
Record trend data using the Analog Signal Profile feature (e.g., Ambient, Hot-Spot and Top-Oil Temperatures; Pressure; Oil Water Content; etc.)
Record state changes using the Sequential Event Report (SER) feature:
➤ Trigger on up to 96 change-of-state conditions
➤ Store up to 512 nonvolatile change-of-state records
➤ Time tag resolution ±1 ms
➤ Change-of-state (time of initial state change, not time of state change after debounce)
Record event data using the Event Report feature
Compatible with SEL-3010 Event Messenger

Automation and Control

Standard
Programmable Boolean operators (such as AND, OR, and NOT)
Programmable math operators (add, subtract, multiply, and divide)
Programmable logic functions (timers, counters, and latches)
Programmable analog comparisons
Programmable rising and falling edge trigger
Digital output logic to assign logic outputs to digital outputs
Remote control to close digital outputs and reset latched indicators from remote locations

Metering

Standard
Metering
➤ Fundamental
➤ Energy
➤ Maximum and Minimum
➤ Demand
➤ Analog Input
➤ Math Variable
➤ Remote Analog
Analog Signal Profiling
Optional
Thermal (with the external SEL-2600 RTD Module, internal RTD option, or internal RTD/TC option)

Communications Protocols

Standard	Serial	Ethernet[a]
Modbus®	Yes	Yes
Ethernet FTP and Telnet	Yes	Yes
SEL MIRRORED BITS®	Yes	
SEL ASCII, Compressed ASCII, Fast Meter, Fast Operate, Fast SER, and Fast Message protocols	Yes	
Optional		
DNP3 Level 2 Slave	Yes	Yes
IEC 61850 Communications[a]		Yes

[a] With optional Ethernet port.

Models, Options, and Accessories

Models

This manual does not provide complete ordering information. For complete information, see the latest SEL-2411 Model Option Table (MOT) at www.selinc.com, under SEL Literature, Ordering Information (Model Option Tables).

The SEL-2411-1 surface mount option uses the SEL-2411 and the surface mounting bracket for easy access to the rear connections. The SEL-2411-1 enables mounting in pad mount switch gear where only remote control and rear-panel access is required. The SEL-2411-1 is identical to the SEL-2411 with the exception of the surface mount bracket with front serial port relocation.

Options

The SEL-2411 contains six slots for cards. Slot A must be used for the power supply and Slot B must be used for the mainboard. The other four slots (Slot C, Slot D, Slot E, and Slot Z) may be configured with option cards that, except for the input/output cards, must be installed in specific slots on the device. The input/output cards may be installed in any (or all) of Slot C through Slot Z. *Table 1.1* shows the possible cards configurations (see *Section 2: Installation* for more information).

Table 1.1 Slot Allocations for Different Option Cards

Slot	Description
A	Power Supply (Required in Slot A)
B	CPU Card (Required in Slot B) CPU Card + Rear Fiber Serial Port CPU Card + One or Two (Failover) Rear Ethernet Ports CPU Card + Rear Fiber Serial Port + One or Two (Failover) Rear Ethernet Ports
C	Communications Card (Only supported by Slot C) Input/Output Card (e.g., 8DI, 8DO, 4DI/4DO, 8AI, 4AI/4AO, ...)
D	RTD Card (Only supported by Slot D) Universal Temperature Card (Only supported by Slot D) Input/Output Card (e.g., 8DI, 8DO, 4DI/4DO, 8AI, 4AI/4AO, ...)
E	3PT Voltage Card (Only supported by Slot E) 3PT/3CT Current and Voltage Card (Only supported by Slot E) Input/Output Card (e.g., 8DI, 8DO, 4DI/4DO, 8AI, 4AI/4AO, ...)
Z	4CT Current Card (Only supported by Slot Z) Input/Output Card (e.g., 8DI, 8DO, 4DI/4DO, 8AI, 4AI/4AO, ...)

Accessories

For all SEL-2411 mounting accessories, including adapter plates, visit http://www.selinc.com/accessories. Contact your Technical Service Center or the SEL factory for additional details and ordering information for all other accessories.

Table 1.2 Optional Accessories

Product	Description
SEL-2600A	External RTD Module (Vac Power Supply)
SEL-2600D	External RTD Module (Vdc Power Supply)
C807Z010SSX0001	SEL-2600 Simplex 62.5/125 µm fiber-optic cable with ST® connector
915900007	Rack Mount Kit—For single unit 19” rack-mounting plate
915900008	Rack Mount Kit—For dual unit 19” rack-mounting plate
915900009	Rack Mount Kit—For single unit and a test switch
915900047	Wall Mount Bracket
915900063	Hinged Wall Mount Bracket
915900116	Surface-Mount Kit
9260027	SEL-2411 Configurable Labels
SEL-2401	Precise Timing Source—Satellite-Synchronized Clock
SEL-3010	Event Messenger—Automatic Voice Notification
SEL-3021	Secure Communications—Serial Encrypting Transceiver
SEL-3022	Secure Communications—Wireless Encrypting Transceiver
SEL-2810	Fiber-Optic Transceiver (compatible with serial port)
SEL-2812	Fiber-Optic Transceiver (compatible with fiber-optic port)
SEL-2814	Fiber-Optic Transceiver (compatible with serial port)

Applications

Programmable Logic Controller

Use the SEL-2411 as a hardened Programmable Logic Controller (PLC) in a wide variety of systems. SELOGIC® programming, I/O card flexibility, and advanced communications combine to provide a product that is easy to apply.

Figure 1.2 shows an example application in which we use the SEL-2411 in a batch process application.

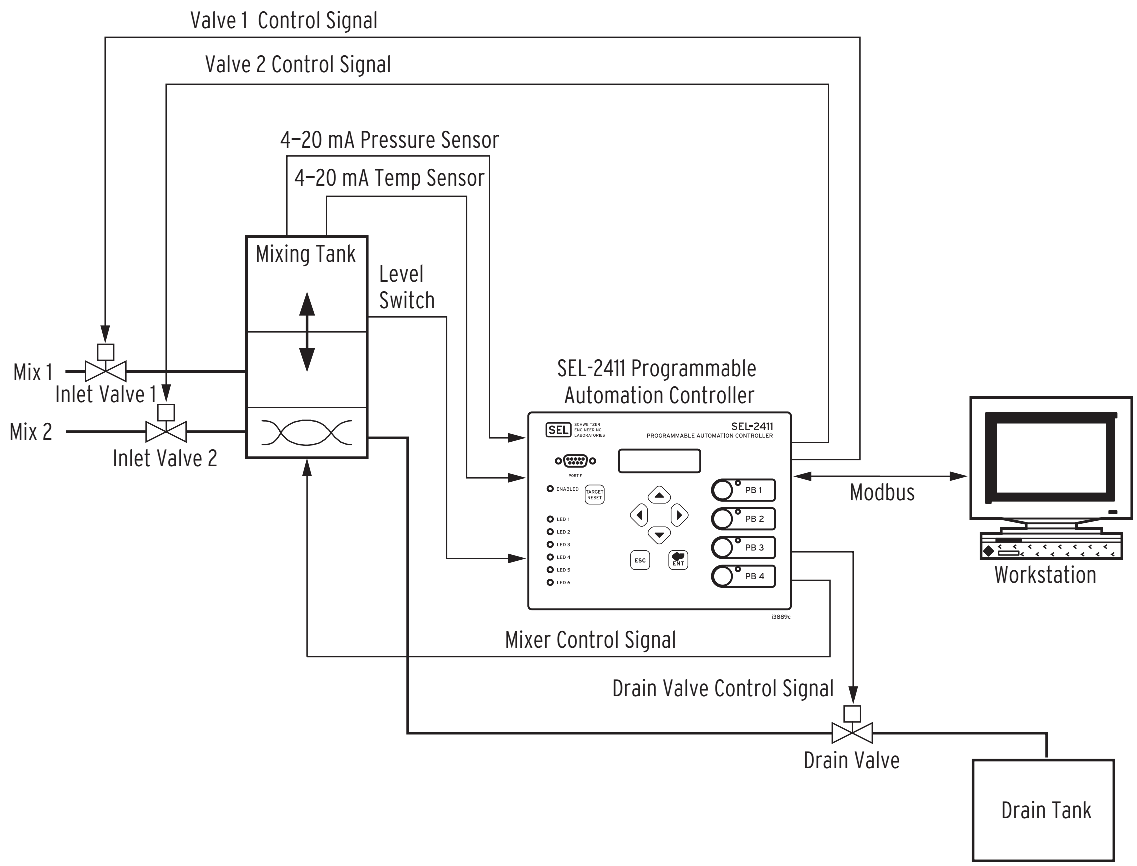


Figure 1.2 Batch Processing PLC

Transformer Monitor

Use the SEL-2411 as a Transformer Monitor to acquire status with digital and analog inputs and provide control with digital outputs. It can also be used to acquire RTD temperature values for transformer thermal monitoring, including hot-spot temperature if the transformer supports a thermowell for an RTD sensor.

Figure 1.3 shows an example application where the SEL-2411 is being used to monitor transformer currents, voltages, and RTD temperatures and also controls a fan bank. The device can be programmed to exercise fan banks on a regular basis (e.g., daily or weekly) to prevent clutter from collecting and the fan banks can be switched periodically when in service to balance the wear between the banks. Program this functionality using SELOGIC with minutes-since-midnight (MINSM), day-of-week (DAYW), and day-of-year (DAYY) variables.

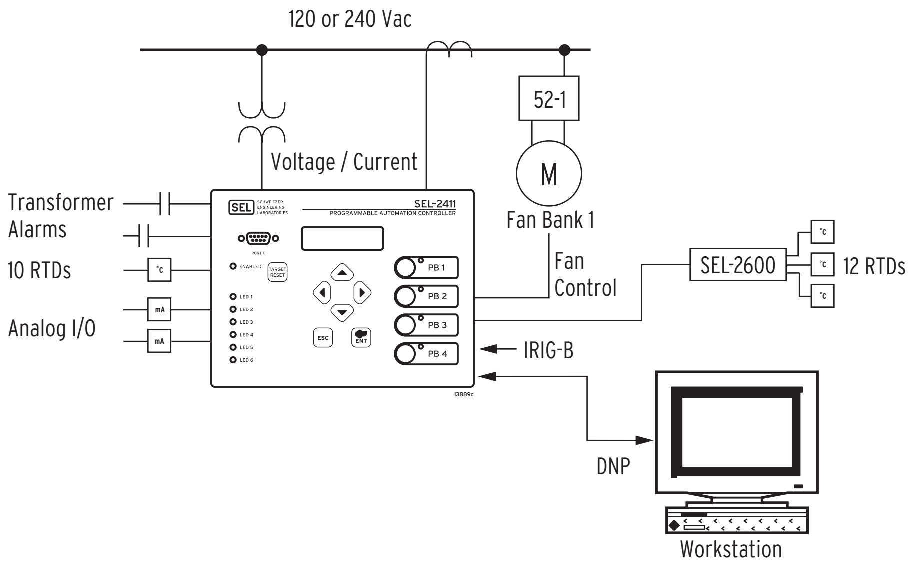


Figure 1.3 Transformer Monitor and Cooling System Control

Specifications

General

Operating Temperature Range

–40° to +85°C (–40° to +185°F), per IEC 60068-2-1 and 60068-2-2.

UL CSA Conformal Coated: –40° to +75°C (–40° to +167°F)

See *Table 1.2* for continuous maximum operation.

Operating Environment

Pollution Degree:	2
Overvoltage Category:	II
Relative Humidity:	5–95%, noncondensing
Maximum Altitude:	2000 m

Dimensions

See *Figure 2.1*, *Figure 2.2*, and *Figure 2.3*.

Weight

2.0 kg (4.4 lbs)

Frequency

System Frequency: 50, 60 Hz

Inputs

AC Current Input

I_{NOM}	5 A	1 A (4 ACI Only)
Rated Range:	0.1–96.0 A (according to IEC 60255-5, 60664-1)	0.02–19.20 A

Note: This is a linearity specification and is not meant to imply continuous operation.

Continuous Thermal Rating:	15 A (according to IEC 60255-6, IEEE C37.90-1989)	3 A
1 Second Thermal:	500 A (according to IEC 60255-6)	100 A
Rated Frequency:	50/60 ±5 Hz	50/60 ±5 Hz
Burden (per phase):	< 0.050 VA	< 0 .002 VA
Measurement Category:	II	

AC Voltage Input

Rated Operating Voltage (U_e):	100–250 Vac
Rated Insulation Voltage:	300 Vac
10-Second Thermal:	600 Vac
Rated Frequency:	50/60 ±5 Hz
Burden:	< 0.1 W

DC Transducer (Analog) Inputs

Input Impedance:	
Current Mode:	200 Ω
Voltage Mode:	>10 kΩ
Input Range (Maximum):	±20 mA ±10 V
Sampling Rate:	At least 5 ms
Accuracy at 25°C:	
ADC:	16 bit
With user calibration:	0.05% of full scale (current mode) 0.025% of full scale (voltage mode)
Without calibration:	Better than 0.5% of full scale at 25°C

Accuracy Variation With Temperature:

±0.015% per °C of full scale (±20 mA or ±10 V)

DC Transducer (Analog) Inputs Extended Range Option

Input Impedance:	
Voltage Mode:	>10 kΩ
Input Range (Maximum):	±300 V
Sampling Rate:	At least 5 ms
Accuracy at 25°C:	
ADC:	16 bit
With user calibration:	0.025% of full scale (voltage mode)
Without calibration:	Better than 0.5% of full scale at 25°C

Accuracy Variation With Temperature:

±0.015% per °C of full scale (±10 V)

CMRR Typical: 65 db at 60 Hz

Optoisolated Control Inputs

When Used With DC Control Signals:

250 V	ON for 200–275 Vdc	OFF below 150 Vdc
220 V	ON for 176–242 Vdc	OFF below 132 Vdc
125 V	ON for 100–135.5 Vdc	OFF below 75 Vdc
110 V	ON for 88–121 Vdc	OFF below 66 Vdc
48 V	ON for 38.4–52.8 Vdc	OFF below 28.8 Vdc
24 V	ON for 15–30 Vdc	OFF for < 5 Vdc

When Used With AC Control Signals:

250 V	ON for 170.6–300 Vac	OFF below 106 Vac
220 V	ON for 150.3–264 Vac	OFF below 93.2 Vac
125 V	ON for 85–150 Vac	OFF below 53 Vac
110 V	ON for 75.1–132 Vac	OFF below 46.6 Vac
48 V	ON for 32.8–60 Vac	OFF below 20.3 Vac
24 V	ON for 14–27 Vac	OFF below 5 Vac

Current Draw at Nominal DC Voltage:	2–4 mA (Except for 240 V, 8 mA)
Rated Insulation Voltage:	300 Vac
Rated Impulse Withstand Voltage (U_{imp}):	4000 V

RTD Input Card

Number of Channels:	Ten 3-wire RTDs
Input Type: Supports the following RTD types on each independent input.	100 Ω platinum (PT100) 100 Ω nickel (NI100) 120 Ω nickel (NI120) 10 Ω copper (CU10)
Measuring Range:	–50°C to 250°C
ADC Resolution:	24 bit
Accuracy:	
CU10:	±1°C typical at 25°C
PT100, NI100, NI120:	±0.1°C typical at 25°C
CU10, PT100, NI100, NI120:	±2°C worst case
Resolution:	±0.1°C
Update Rate:	1 s
CMRR (typical):	100 dBv
Noise Rejection:	Up to 1 Vrms 50/60 Hz

Universal Temperature Input Card

Number of Channels:	Ten (thermocouples or 3-wire RTDs)
Input Type: Supports the following RTD or TC types on each independent input.	100 Ω platinum (PT100) 100 Ω nickel (NI100) 120 Ω nickel (NI120) 10 Ω copper (CU10) J, K, T, E
Measuring Range:	–50°C to 250°C
ADC Resolution:	24 bit

Accuracy

RTDs

CU10:	±1°C typical at 25°C
PT100, NI100, NI120, CU10:	±0.1°C typical at 25°C
CU10, PT100, NI100, NI120:	±2°C worst case

TCs

J, K, T, E:	±1°C with field calibration ±3°C without field calibration
Resolution:	±0.1°C
Update Rate:	<3 s
CMRR (typical):	100 dBv
Noise Rejection:	Up to 1 Vrms 50/60 Hz

Isolation

Number of Banks:	Two Banks (5 channels each)
Max. Working Common Mode:	250 Vdc
Cold Junction Compensation:	Automatic

Time-Code Input

Format:	Demodulated IRIG-B
On (1) State:	$V_{ih} \geq 2.2$ V
Off (0) State:	$V_{il} \leq 0.8$ V
Input Impedance:	2 kΩ
Accuracy:	±3 milliseconds

Outputs

General

OUT103 is Form C Trip Output, all other outputs are Form A.

Dielectric Test Voltage:	2000 Vac
Impulse Withstand Voltage (U_{imp}):	4000 V
Mechanical Durability:	10M no load operations

DC Output Ratings

Electromechanical

Rated Operational Voltage:	250 Vdc
Rated Voltage Range:	19.2–275 Vdc
Rated Insulation Voltage:	300 Vdc
Make:	30 A @ 250 Vdc per IEEE C37.90
Continuous Carry:	6 A @ 70°C; 4 A @ 85°C
Continuous Carry (UL/CSA Derating with All Outputs Asserted):	5 A @ <60°C; 2.5 A 60 to 70°C
Thermal:	50 A for 1 s
Contact Protection:	360 Vdc, 40 J MOV protection across open contacts
Operating Time (coil energization to contact closure, resistive load):	Pickup or Dropout time ≤8 ms typical

Breaking Capacity (10,000 operations) per IEC 60255-0-20:1974:	24 V	0.75 A	L/R = 40 ms
	48 V	0.50 A	L/R = 40 ms
	125 V	0.30 A	L/R = 40 ms
	250 V	0.20 A	L/R = 40 ms
Cyclic Capacity (2.5 cycles/second) per IEC 60255-0-20:1974:	24 V	0.75 A	L/R = 40 ms
	48 V	0.50 A	L/R = 40 ms
	125 V	0.30 A	L/R = 40 ms
	250 V	0.20 A	L/R = 40 ms

Fast Hybrid (high-speed high current interrupting)

Make:	30 A
Carry:	6 A continuous carry at 70°C 4 A continuous carry at 85°C
1 s Rating:	50 A
MOV Protection (maximum voltage):	250 Vac/330 Vdc
Pickup Time:	< 50 µs, resistive load
Dropout Time:	8 ms, resistive load
Update Rate:	1/8 cycle

Breaking Capacity (10000 operations):

48 Vdc	10.0 A	L/R = 40 ms
125 Vdc	10.0 A	L/R = 40 ms
250 Vdc	10.0 A	L/R = 20 ms

Cyclic Capacity (4 cycles in 1 second, followed by 2 minutes idle for thermal dissipation):

48 Vdc	10.0 A	L/R = 40 ms
125 Vdc	10.0 A	L/R = 40 ms
250 Vdc	10.0 A	L/R = 20 ms

Note: Per IEC 60255-23:1994, using the simplified method of assessment.
Note: Make rating per IEEE C37.90-1989.

AC Output Ratings

Electromechanical

Maximum Operational Voltage (U_e) Rating:	240 Vac
Insulation Voltage (U_i) Rating (excluding EN 61010-1):	300 Vac
Utilization Category:	AC-15 (control of electromagnetic loads > 72 VA)
Contact Rating Designation:	B300 (B = 5 A, 300 = rated insulation voltage)
Voltage Protection Across Open Contacts:	270 Vac, 40 J
Rated Operational Current (I_e):	3 A @ 120 Vac 1.5 A @ 240 Vac
Conventional Enclosed Thermal Current (I_{the}) Rating:	5 A
Rated Frequency:	50/60 ±5 Hz
Pickup/Dropout Time:	≤8 ms (coil energization to contact closure)
Electrical Durability Make VA Rating:	3600 VA, cosϕ = 0.3
Electrical Durability Break VA Rating:	360 VA, cosϕ = 0.3

Fast Hybrid (high-speed high current interrupting)

Make:	30 A
Carry:	6 A continuous carry at 70°C 4 A continuous carry at 85°C
1 s Rating:	50 A
MOV Protection (maximum voltage):	250 Vac/330 Vdc
Pickup Time:	< 50 µs, resistive load
Dropout Time:	8 ms, resistive load
Update Rate:	1/8 cycle

Breaking Capacity (10000 operations):

48 Vdc	10.0 A	L/R = 40 ms
125 Vdc	10.0 A	L/R = 40 ms
250 Vdc	10.0 A	L/R = 20 ms

Cyclic Capacity (4 cycles in 1 second, followed by 2 minutes idle for thermal dissipation):

48 Vdc	10.0 A	L/R = 40 ms
125 Vdc	10.0 A	L/R = 40 ms
250 Vdc	10.0 A	L/R = 20 ms

Note: Per IEC 60255-23:1994, using the simplified method of assessment.
Note: Make rating per IEEE C37.90-1989.

Analog Outputs

Current Ranges (Max):	±20 mA
Voltage Ranges (Max):	±10 V
Output Impedance For Current Outputs:	≥100 kΩ
Output Impedance For Voltage Outputs:	≤20 Ω
Maximum Load:	0–750 Ω current mode >2 kΩ voltage mode
Accuracy:	±0.55% of full-scale at 25°C

Communications

Communications Ports

Standard EIA-232 (2 ports)

Location (fixed):	Front Panel Rear Panel
Data Speed:	300–38400 bps

Optional Ethernet port

Single or Dual 10/100BASE-T copper (RJ-45 connector)
Single or Dual 100BASE-FX (LC connector)

Optional multimode fiber-optic serial port

Class 1 LED product
Complies with IEC 60825-1:1993 + A1:1997 + A2:2001

Fiber-Optic Ports Characteristics

Port 1 (or 1A, 1B) Ethernet

Wavelength:	1300 nm
Optical Connector Type:	LC
Fiber Type:	Multimode
Link Budget:	16.1 dB
Typical TX Power:	–15.7 dBm
RX Min. Sensitivity:	–31.8 dBm
Fiber Size:	62.5/125 um
Approximate Range:	~6.4 Km
Data Rate:	100 Mb
Typical Fiber Attenuation:	–2 dB/Km

Port 2 Serial

Wavelength:	820 nm
Optical Connector Type:	ST
Fiber Type:	Multimode
Link Budget:	8 dB
Typical TX Power:	–16 dBm
RX Min. Sensitivity:	–24 dBm
Fiber Size:	62.5/125 µm
Approximate Range:	~1 Km
Data Rate:	5 Mb
Typical Fiber Attenuation:	–4 dB/Km

Optional Communications Card

Standard EIA-232 or EIA-485 (ordering option)

Data Speed:	300–38400 bps

Communications Protocols

Modbus® RTU slave or Modbus TCP
DNP3 Level 2 Slave (LAN/WAN and Serial)
IEC 61850 Communications
Ethernet FTP
Telnet
SEL MIRRORED BITS (MBA, MBB, MB8A, MB8B, MBTB)
Ymodem file transfer on the front and rear port
Xmodem file transfer on the front port
SEL ASCII and Compressed ASCII
SEL Fast Meter
SEL Fast Operate
SEL Fast SER
SEL Fast Message unsolicited write
SEL Fast Message read request
SEL Event Messenger Points

Maximum Concurrent Connections

DNP3 Level 2 Slave:	3[a]
Ethernet FTP:	2
Telnet:	2

[a] Maximum in any combination of serial and/or LAN/WAN links.

Power Supply

Rated Supply Voltage

Low-Voltage Model:	24–48 Vdc
High-Voltage Model:	110–250 Vdc 110–240 Vac, 50/60 Hz

Input Voltage Range

Low-Voltage Model:	18–60 Vdc
High-Voltage Model:	85–275 Vdc 85–264 Vac

Power Consumption

AC:	<40 VA
DC:	<15 W

Interruptions

Low-Voltage Model:	10 ms @ 24 Vdc 50 ms @ 48 Vdc
High-Voltage Model:	50 ms @ 125 Vac/Vdc 100 ms @ 250 Vac/Vdc

AC Metering Accuracies

Current

Phase Current:	±0.5% typical, 25°C, 60 Hz, nominal current
Neutral Current:	±0.5% typical, 25°C, 60 Hz, nominal current
Negative Sequence (3I2):	±0.5% typical, 25°C, 60 Hz, nominal current (calculated)
Residual Ground Current:	±0.5% typical, 25°C, 60 Hz, nominal current (calculated)

Voltage

Line-Neutral Voltage:	±0.08% typical, 25°C, 60 Hz, nominal voltage
Line-Line Voltage:	±0.08% typical, 25°C, 60 Hz, nominal voltage
Negative-Sequence (3V2):	±0.5% typical, 25°C, 60 Hz, nominal voltage (calculated)

Power

Three-Phase Real Power (kW):	±1% typical, 25°C, 60 Hz, nominal voltage and current with 0.70 ≤ PF ≤ 1.00; ± 5% of reading, worst case
Three-Phase Reactive Power (kVAR):	±1% typical, 25°C, 60 hz, nominal voltage and current with 0.00 ≤ PF ≤ 0.30; ± 5% of reading, worst case
Three-Phase Apparent Power (kVA):	±1% typical, 25°C, 60 Hz, nominal voltage and current; ± 2% of reading, worst case

Power Factor

Three-Phase (wye connected):	±1% typical, 25°C, 60 Hz, nominal voltage and current for 0.97 ≤ PF ≤ 1.00; ± 2% of reading, worst case

Sampling and Processing Specifications

Without Voltage Card or Current Card

Analog Inputs

Sampling Rate:	Every 4 ms

Digital Inputs

Sampling Rate:	2 kHz

Contact Outputs

Refresh Rate:	2 kHz
Logic Update:	Every 4 ms

Analog Outputs

Refresh Rate:	Every 4 ms
New Value:	Every 100 ms

With Either Voltage Card, Current Card, or Both Voltage and Current Cards

Analog Inputs

Sampling Rate:	4 times/cycle

Digital Inputs

Sampling Rate:	32 times/cycle

Contact Outputs

Refresh Rate:	32 times/cycle
Logic Update:	4 times/cycle

Analog Outputs

Refresh Rate:	4 times/cycle
New Value:	Every 100 ms

Processing Specifications

AC Voltage and Current Inputs:	16 samples per power system cycle
Frequency Tracking Range:	44–66 Hz
Digital Filtering:	Cycle cosine after low-pass analog filtering. Net filtering (analog plus digital) rejects dc and all harmonics greater than the fundamental.
Control Processing:	4 times per power system cycle or 4 ms if no current or voltage card (except for math variables, which are processed every 100 ms)

Type Tests

Environmental Tests

Enclosure Protection:	IEC 60529:2001 IP65 enclosed in panel IP20 for terminals
Vibration Resistance:	IEC 60255-21-1:1988, Class 1 IEC 60255-21-3:1993, Class 2
Shock Resistance:	IEC 60255-21-2:1988, Class 1
Cold:	IEC 60068-2-1:1990 + A1:1993 + A2:1994 –40°C, 16 hours
Damp Heat, Steady State:	IEC 60068-2-78:2001 40°C, 93% relative humidity, 4 days
Damp Heat, Cyclic:	IEC 60068-2-30:1980 + A1:1985 25–55°C, 6 cycles, 95% relative humidity
Dry Heat:	IEC 60068-2-2:1974 + A1:1993 + A2:1994 85°C, 16 hours

Dielectric Strength and Impulse Tests

Dielectric (HIPOT):	IEC 60255-5:2000 IEEE C37.90-1989 2.0 kVac on analog inputs, contact I/O 2.5 kVac on ac current inputs 2.83 kVdc on power supply and analog outputs
Impulse:	IEC 60255-5:2000 0.5 J, 4.7 kV on power supply, contact I/O, voltage and current inputs 0.5 J, 530 V on analog inputs and analog outputs

RFI and Interference Tests

EMC Immunity

Electrostatic Discharge Immunity:	IEC 61000-4-2:2001 Severity Level 4 8 kV contact discharge 15 kV air discharge
Radiated RF Immunity:	IEC 61000-4-3:2002, 10 V/m IEEE C37.90.2-1995, 35 V/m
Fast Transient, Burst Immunity:	IEC 61000-4-4:1995 + A1:2001 4 kV @ 2.5 kHz 2 kV @ 5.0 kHz for comm. ports IEEE C37.90.1-2002, 2.5 kV Oscillatory, 4 kV fast transient
Surge Immunity:	IEC 61000-4-5:2001 2 kV line-to-line 4 kV line-to-earth
Surge Withstand Capability Immunity:	IEC 60255-22-1:2005 2.5 kV common-mode 2.5 kV differential-mode 1 kV common-mode on comm. ports
Conducted RF Immunity:	IEC 61000-4-6:2004, 10 Vrms
Magnetic Field Immunity:	IEC 61000-4-8:2001 1000 A/m for 3 seconds 100 A/m for 1 minute

EMC Emissions

Conducted Emissions:	EN 55011:1998 + A1:1999 + A2:2002, Class A
Radiated Emissions:	EN 55011:1998 + A1:1999 + A2:2002, Class A

Certifications

ISO:	Equipment is designed and manufactured using ISO 9001 certified quality program.
UL:	UL 61010-1 (with the exception of Universal Temperature Card)
CSA:	CSA C22.2 No. 61010-1
CE:	
CE Mark– EMC Directive:	EN 50263:1999
Low Voltage Directive:	BS EN 61010-1:2001, BS EN 60947-4-1:2001 + A1:2003, BS EN 60947-5-1:2004, BS EN 60255-6:1995
Hazardous Locations Approvals:	Complies with UL1604, CSA 22.2 No. 213, and EN 60079-15.

This page intentionally left blank

Section 2
Installation

Overview

The first steps in applying the SEL-2411 Programmable Automation Controller are installing and connecting the device. This section describes common installation features and requirements and I/O options. To install and connect the device safely and effectively, you must be familiar with device configuration features and options. You should carefully plan the placement, cable connections, and communication. This section contains drawings of typical ac and dc connections to the SEL-2411. Use these drawings as a starting point for planning your particular application.

Device Placement

Proper placement of the SEL-2411 helps make certain that you receive years of trouble-free service. Use the following guidelines for proper physical installation of the SEL-2411.

Physical Location

You can mount the SEL-2411 in a sheltered indoor environment (a building or an enclosed cabinet) that does not exceed the temperature and humidity ratings for the device. The device is EN 61010-1 rated at Installation/Overvoltage Category II and Pollution Degree 2. This rating allows mounting of the device indoors or in an outdoor enclosure where the device is protected against exposure to direct sunlight, precipitation, and full wind pressure, but neither temperature nor humidity are controlled. You can place the device in extreme temperature and humidity locations (see *Specifications on page 1.7*). For EN 61010 certification, the SEL-2411 rating is 2000 m (6560 feet) above mean sea level.

To comply with the requirements of the European ATEX standard for hazardous locations, the SEL-2411 must be installed in an enclosure that meets the requirements of an Ex n enclosure rated IP54 or better. The enclosure should be certified to these requirements or be tested for compliance as part of the complete assembly. In North America, the device is approved for Class 1, Division 2, Groups A, B, C, D, and T4 hazardous locations.

Device Mounting

To flush mount the SEL-2411 in a panel, cut a rectangular hole with the dimensions shown in *Figure 2.1* or *Figure 2.2*.

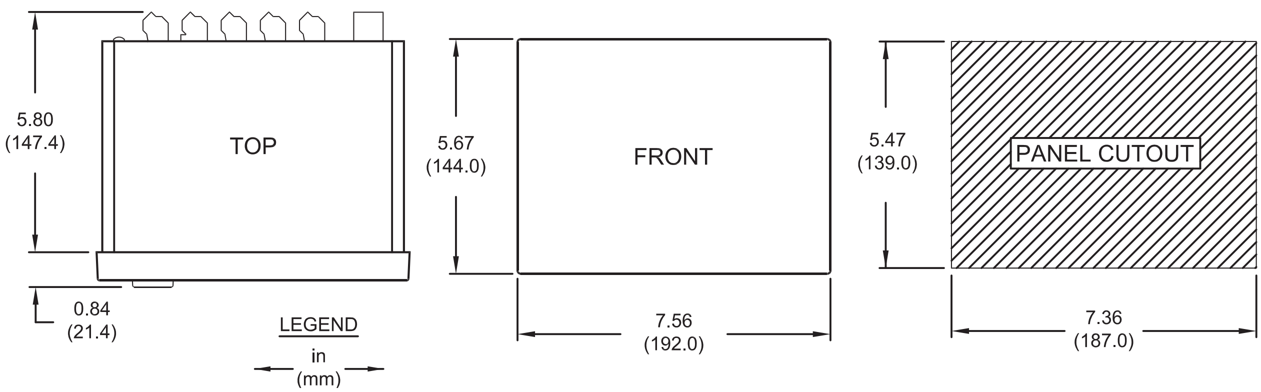


Figure 2.1 Programmable Automation Controller Vertical Panel-Mount Dimensions

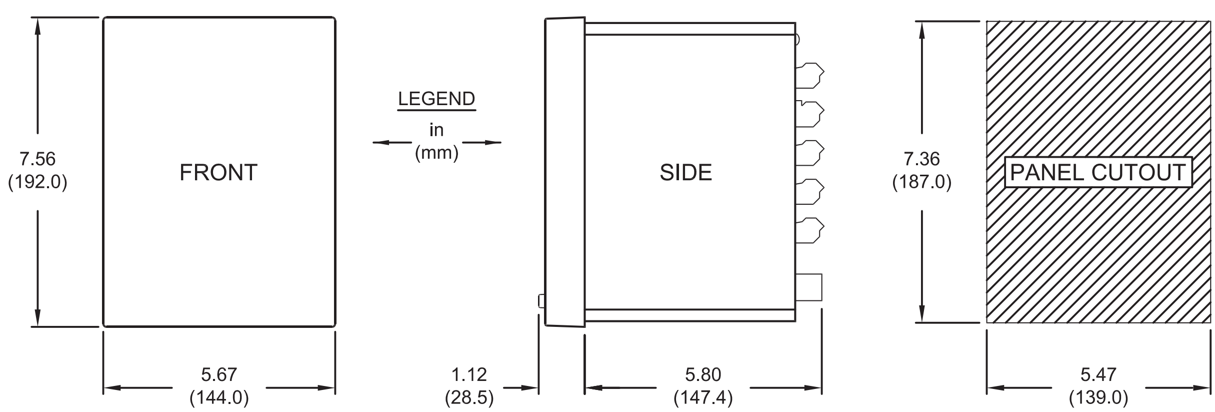


Figure 2.2 Programmable Automation Controller Vertical Panel-Mount Dimensions

To surface mount the SEL-2411, you can select the SEL-2411-1 surface mount option or purchase the surface mount bracket accessory kit (part number 915900116). The mounting dimensions for the SEL-2411-1 surface mount is shown below in *Figure 2.3*.

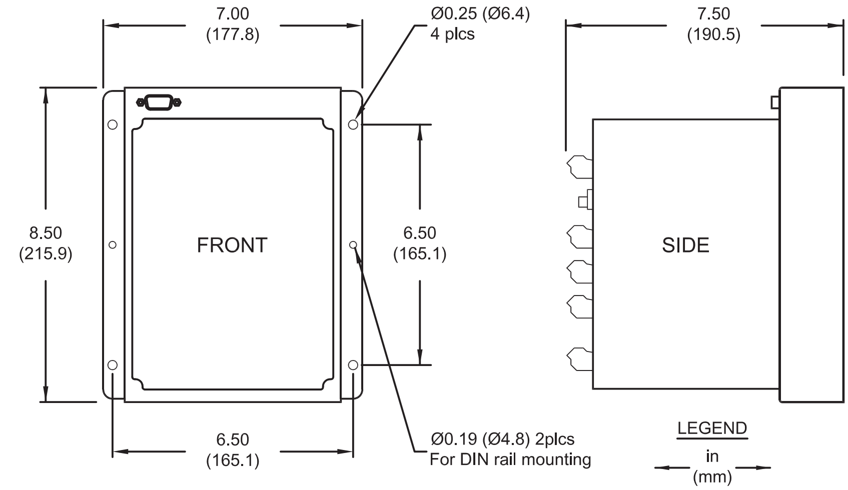


Figure 2.3 Programmable Automation Controller Surface-Mount Dimensions

Card Configuration

Your SEL-2411 offers complete flexibility in tailoring to your specific application. The SEL-2411 has six rear-panel slots, labeled as Slots A, B, C, D, E, and Z. Slot A and Slot B are fixed, but you can install option cards in expansion Slot C through Slot Z. Except for the input/output cards that can be installed in any expansion slot (Slot C through Slot Z), you must install the option cards in specific slots on the device. *Table 2.1* shows the slot allocations for the option cards.

⚠CAUTION
The device contains devices sensitive to Electrostatic Discharge (ESD). When working on the device with the front panel removed, work surfaces and personnel must be properly grounded or equipment damage may result.

Table 2.1 Slot Allocations for Different Option Cards

Rear-Panel Slot	Software Reference	Description
A	1 (e.g., OUT101)	Power Supply (Required in Slot A)
B	N/A	CPU Card (Required in Slot B) CPU Card + Rear Fiber Serial Port CPU Card + One or Two (Failover) Rear Ethernet Ports CPU Card + Rear Fiber Serial Port + One or Two (Failover) Rear Ethernet Ports
C	3 (e.g., IN301)	Communications Card (Only supported by Slot C) Input/Output Card (e.g., 8DI, 8DO, 4DI/4DO, 8AI, 4AI/4AO, ...)
D	4 (e.g., OUT401)	RTD Card (Only supported by Slot D) Universal Termperature Card (Only supported by Slot D) Input/Output Card (e.g., 8DI, 8DO, 4DI/4DO, 8AI, 4AI/4AO, ...)
E	5 (e.g., AI501)	3PT Voltage Card (Only supported by Slot E) 3PT/3CT Current and Voltage Card (Only supported by Slot E) Input/Output Card (e.g., 8DI, 8DO, 4DI/4DO, 8AI, 4AI/4AO, ...)
Z	6 (e.g., OUT601)	4CT Current Card (Only supported by Slot Z) Input/Output Card (e.g., 8DI, 8DO, 4DI/4DO, 8AI, 4AI/4AO, ...)

CPU Card Communications Ports

Required in Slot B, this card provides up to three serial ports. Select the communications ports necessary for your application from those shown in *Table 2.2*. *Table 7.4* shows the protocols supported by each port.

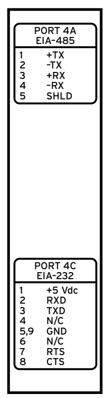
Table 2.2 Communications Ports

Port	Location	Feature	Description
1	Rear Panel	Optional	One or Two (Failover) Rear Ethernet Ports
2	Rear Panel	Optional	Isolated multimode fiber-optic port with ST connectors
3	Rear Panel	Standard	Nonisolated EIA-232 serial port

Communications Card (EIA-232/485)

Supported in Slot C only, this card provides one serial port with two serial port interfaces. Select either EIA-232 or EIA-485 functionality (not both) by means of a jumper on the card. *Table 2.3* shows the port number, interface, and type of connector for the two protocols. *Table 7.4* shows the protocols supported by each port.

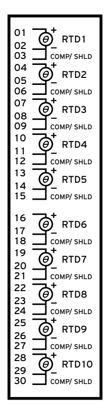
Table 2.3 Communications Card (EIA-232/485) Interfaces and Connectors

Terminals	Label	Description
		Port 4A, an isolated EIA-485 serial port interface on a 5-pin Euro connector Port 4C, a nonisolated EIA-232 serial port interface, supporting the +5 Vdc interface on a D-sub connector

RTD Card (10 RTD)

Supported in Slot D only, this card has 10 RTD inputs that can be individually selected. *Table 2.4* shows the terminal connection.

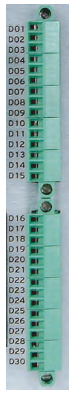
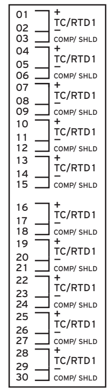
Table 2.4 RTD (10 RTD) Card Terminal Allocation

Terminals	Label	Description
		RTD1, drives analog quantity RTD1 RTD2, drives analog quantity RTD2 RTD3, drives analog quantity RTD3 RTD4, drives analog quantity RTD4 RTD5, drives analog quantity RTD5 RTD6, drives analog quantity RTD6 RTD7, drives analog quantity RTD7 RTD8, drives analog quantity RTD8 RTD9, drives analog quantity RTD9 RTD10, drives analog quantity RTD10

RTD/TC Card (10 RTD/TC)

Supported in Slot D only, this card has 10 RTD or TC inputs that can be individually selected. *Table 2.5* shows the terminal connection.

Table 2.5 RTD (10 RTD) Card Terminal Allocation

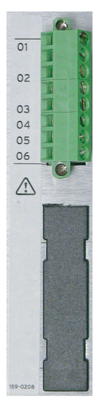
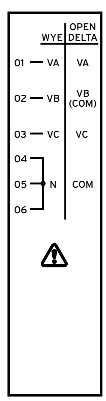
Terminals	Label	Description
		RTD1/TC1, drives analog quantity INTEMP01 RTD2/TC2, drives analog quantity INTEMP02 RTD3/TC3, drives analog quantity INTEMP03 RTD4/TC4, drives analog quantity INTEMP04 RTD5/TC5, drives analog quantity INTEMP05 RTD6/TC6, drives analog quantity INTEMP06 RTD7/TC7, drives analog quantity INTEMP07 RTD8/TC8, drives analog quantity INTEMP08 RTD9/TC9, drives analog quantity INTEMP09 RTD10/TC10, drives analog quantity INTEMP10

Voltage Card (3 AVI)

Supported in Slot E only, order this card when you have either four-wire wye-connected PTs or open-delta connected PTs. With a voltage card installed, the SEL-2411 tracks the frequency (using positive-sequence voltage) and samples at 4 times a cycle—see *Sampling and Processing Specifications on page 1.10* for more information.

NOTE: The device tracks the frequency if 3V1 is greater than 0.75 V.

Table 2.6 Voltage Card (3 AVI) Terminal Designation

Terminals	Label	Description
		VA, Phase A voltage input VB, Phase B voltage input VC, Phase C voltage input N, Common connection for VA, VB, VC

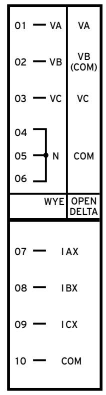
Current/Voltage Card (3 ACI/3 AVI)

Supported in Slot E only, order this card when you have three-phase CTs and either single or three-phase (wye or delta) PTs needed in a single slot. Secondary phase current ratings are 5 A rated. Voltage ratings on the PTs support three regular (300 Vac) inputs or three (8 Vac) low energy analog (LEA) inputs. With a cur-

NOTE: The device tracks the frequency if 3V1 is greater than 0.75 V.

rent and voltage combination card installed, the SEL-2411 tracks the frequency (using positive-sequence current) and samples at 4 times a cycle—see *Sampling and Processing Specifications on page 1.10* for more information.

Table 2.7 Current/Voltage Card (3 ACI/3 AVI) Terminal Designation

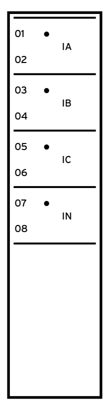
Terminals	Label	Description
		VA, Phase A voltage input VB, Phase B voltage input VC, Phase C voltage input N, Common connection for VA, VB, VC N, Common connection for VA, VB, VC N, Common connection for VA, VB, VC IA, Phase A current input IB, Phase B current input IC, Phase C current input N, current neutral return

Current Card (4 ACI)

Supported in Slot Z only, this card provides current inputs for three-phase CTs and one neutral CT. Secondary phase current ratings are either all 1 A or all 5 A; you cannot order a combination of 1 A and 5 A phase CTs on one card. However, the phase CTs and the neutral CT can be of different current rating. For example, you can order three 5 A phase CTs and a 1 A neutral CT, or three 1 A phase CTs and a 5 A neutral CT. With a current card installed, the SEL-2411 tracks the frequency (using positive-sequence current) and samples at 4 times a cycle—see *Sampling and Processing Specifications on page 1.10* for more information.

NOTE: The device uses 3I1 to track the frequency if 3V1 is not available and 3I1 is greater than 0.25 A (5 A) or 0.05 A (1 A).

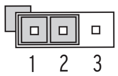
Table 2.8 Current Card (4 ACI) Terminal Designation

Terminals	Label	Description
		IA, Phase A current input IB, Phase B current input IC, Phase C current input IN, neutral current input

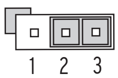
Analog Input Card (8 AI)

NOTE: Jumper *x* (*x* = 1 through 8) determines the nature of each channel.

For current (default), intall jumper on JMPX position 1 - 2.



For voltage, intall jumper on JMPX position 2 - 3.



Supported in any expansion slot (Slot C through Slot Z), this card has eight analog inputs (AI). *Table 2.9* shows the terminal allocation. Please refer to *Specifications* for the DC Analog inputs ranges.

Table 2.9 Eight Analog Input Card (8 AI) Terminal Allocation

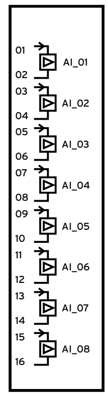
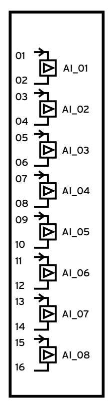
Terminals	Label	Description
		AI*x*01, Transducer Input number 1 AI*x*02, Transducer Input number 2 AI*x*03, Transducer Input number 3 AI*x*04, Transducer Input number 4 AI*x*05, Transducer Input number 5 AI*x*06, Transducer Input number 6 AI*x*07, Transducer Input number 7 AI*x*08, Transducer Input number 8

Table 2.10 Extended Range Analog Input Card Terminal Allocation

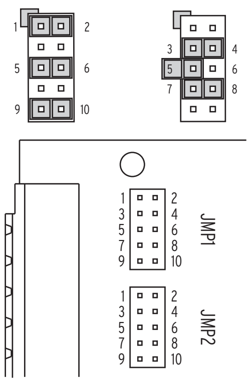
Terminals	Label	Description
		AI*x*01, Transducer Input number 1 AI*x*02, Transducer Input number 2 AI*x*03, Transducer Input number 3 AI*x*04, Transducer Input number 4 AI*x*05, Extended Range Transducer Input number 5 AI*x*06, Extended Range Transducer Input number 6 AI*x*07, Extended Range Transducer Input number 7 AI*x*08, Extended Range Transducer Input number 8

Analog Input Card (4 AI/4 AO)

Supported in any expansion slot (Slot C through Slot Z), this card has four analog inputs and four analog outputs (AO). *Table 2.11* shows the terminal allocation.

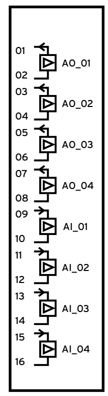
NOTE: Jumper *x* (*x* = 1 through 4) determines the nature of each channel.

For current output (default), install jumpers between pins 1-2, 5-6, and 9-10. For voltage output, install jumpers between pins 3-4 and 7-8.



NOTE: Maximum of one (1) 4 AI/4 AO card per chassis. A 'FAIL' status condition will result otherwise.

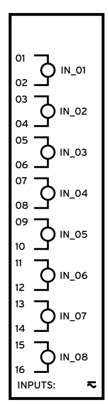
Table 2.11 Four Analog Input/Four Analog Output Card (4 AI/4 AO) Terminal Allocation

Terminals	Label	Description
		AO*x*01, Analog Output number 1 AO*x*02, Analog Output number 2 AO*x*03, Analog Output number 3 AO*x*04, Analog Output number 4 AI*x*01, Transducer Input number 1 AI*x*02, Transducer Input number 2 AI*x*03, Transducer Input number 3 AI*x*04, Transducer Input number 4

Digital Input Card (8 DI)

Supported in any expansion slot (Slot C through Slot Z), this card has eight digital inputs. *Table 2.12* shows the terminal allocation.

Table 2.12 Eight Digital Input Card (8 DI) Terminal Allocation

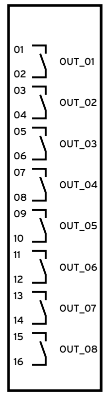
Terminals	Label	Description
		IN01, drives IN*x*01 element IN02, drives IN*x*02 element IN03, drives IN*x*03 element IN04, drives IN*x*04 element IN05, drives IN*x*05 element IN06, drives IN*x*06 element IN07, drives IN*x*07 element IN08, drives IN*x*08 element

Digital Output Card (8 DO)

NOTE: You can run three 8 DO boards at 85 V in accordance with UL 61010-1.

Supported in any expansion slot (Slot C through Slot Z), this card has eight normally open contact outputs. *Table 2.13* shows the terminal allocation.

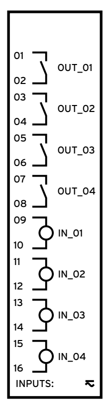
Table 2.13 Digital Output Card (8 DO) Terminal Allocation

Terminals	Label	Description
		OUT01, driven by OUT*x*01 SELOGIC® equation
		OUT02, driven by OUT*x*02 SELOGIC equation
		OUT03, driven by OUT*x*03 SELOGIC equation
		OUT04, driven by OUT*x*04 SELOGIC equation
		OUT05, driven by OUT*x*05 SELOGIC equation
		OUT06, driven by OUT*x*06 SELOGIC equation
		OUT07, driven by OUT*x*07 SELOGIC equation
		OUT08, driven by OUT*x*08 SELOGIC equation

Digital Input/Output Card (4 DI/4 DO)

Supported in any expansion slot (Slot C through Slot Z), this card has four digital inputs and four outputs. The four outputs are either all normally open contact outputs, electromechanical, or fast high-current interrupting outputs. *Table 2.14* shows the terminal allocation.

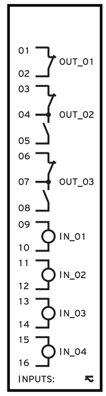
Table 2.14 Four Digital Input/Four Digital Output Card (4 DI/4 DO) Terminal Allocation

Terminals	Label	Description
		OUT01, driven by OUT*x*01 SELOGIC equation
		OUT02, driven by OUT*x*02 SELOGIC equation
		OUT03, driven by OUT*x*03 SELOGIC equation
		OUT04, driven by OUT*x*04 SELOGIC equation
		IN01, drives IN*x*01 element
		IN02, drives IN*x*02 element
		IN03, drives IN*x*03 element
		IN04, drives IN*x*04 element

Digital Input/Output Card (4 DI/3 DO)

Supported in any expansion slot (Slot C through Slot Z), this card has four digital inputs and three outputs. The three outputs are one Form B output and two Form C outputs. *Table 2.15* shows the terminal allocation.

Table 2.15 Four Digital Input/Three Digital Output Card (4 DI/3 DO) Terminal Allocation

Terminals	Label	Description
		OUT01, driven by OUT*x*01 SELOGIC equation OUT02, driven by OUT*x*02 SELOGIC equation OUT03, driven by OUT*x*03 SELOGIC equation IN01, drives IN*x*01 element IN02, drives IN*x*02 element IN03, drives IN*x*03 element IN04, drives IN*x*04 element

Changing Cards

Changing card positions, or expanding on the initial number of cards, requires no card programming; the device detects the new hardware and updates the software accordingly (you still have to program the I/O using the **SET** command).

Following a change in configuration, the device is always disabled until you accept the new device configuration. You can accept the new device configuration in two ways, depending on the AUTO setting (Port settings). In the following steps, *Step 6* describes accepting the new configuration with the AUTO setting = Y, and *Step 7* and *Step 8* describe accepting the new configuration with the AUTO setting = N. To interchange cards, perform the following steps:

Step 1. De-energize the device.

Step 2. Remove the eight rear-panel screws, ground screw, plug-in connectors, and the rear panel.

Step 3. Remove the card from the device.

Step 4. Insert the new card into the slot.

Step 5. Replace the rear panel, reinstall all screws and connectors, and energize the unit.

Step 6. For an AUTO = Y (Port settings), the device displays the following:

```
=>STA <Enter>

SEL-2411                                  Date: 1/29/2002 Time: 17:18:55
DEVICE

Serial Num = 2007036022      FID = SEL-2411-R200-V0-Z002002-D20070810
CID = 211A                   PART NUM = 241101A329X73851140

SELF TESTS (W=Warn)
  FPGA   GPSB   HMI    RAM    ROM    CR_RAM   NON_VOL  CLOCK   INTRTD   CID_FILE   +3.3V
  OK     OK     OK     OK     OK     OK       OK       OK      OK       OK         3.28

  +5.0V  +2.5V   +3.75V  -1.25V  -5.0V  BATT
  4.99   2.48    3.77    -1.27   -4.97  3.37

Option Cards
  CARD_C    CARD_D    CARD_E    CARD_Z
  OK        OK        OK        OK

Offsets
   IA      IB      IC      IN      VA      VB      VC      IAX      IBX      ICX
  OK      OK      OK      OK      OK      OK      OK      OK       OK       OK

Device Disabled
Confirm Hardware Config
Accept & Reboot (Y,N)?
```

Step 7. Type **Y <Enter>** to accept the new configuration. The device reboots (approximately five seconds) and is ready for service.

For an AUTO = N (Port settings) the device communications software returns to the Level 0 prompt. The only indication that the device is disabled is on the front panel, where the **ENABLED** LED is not illuminated and the device displays the following message on the front panel (X indicates the specific slot):

```
STATUS FAIL
Card X Failure
```

Step 8. Go to Level 1 and type **STA <Enter>**, followed by **Y <Enter>** at the prompt (see *Step 6*) to accept the new configuration. The device reboots (approximately five seconds) and is ready for service.

After reconfiguration, the device updates the part number, except for the digits shown in *Figure 2.4*. The digits indicated in *Figure 2.4* remain unchanged, i.e., these digits retain the same character as before the reconfiguration.

241101A0X0X0X0X1000

Figure 2.4 Digits That Remain Unchanged After Device Reconfiguration

Use the Level 2 **PAR <Enter>** (see *Section 7: Communications* for more information) command to update the part number, if required.

Password and SELBOOT Jumper Selection

Figure 2.5 shows the major components of the B-slot card in the base unit. Notice the three sets of pins labeled A, B, and C. Jumper location will vary depending on your main processor board. Shown below are the two most common locations.

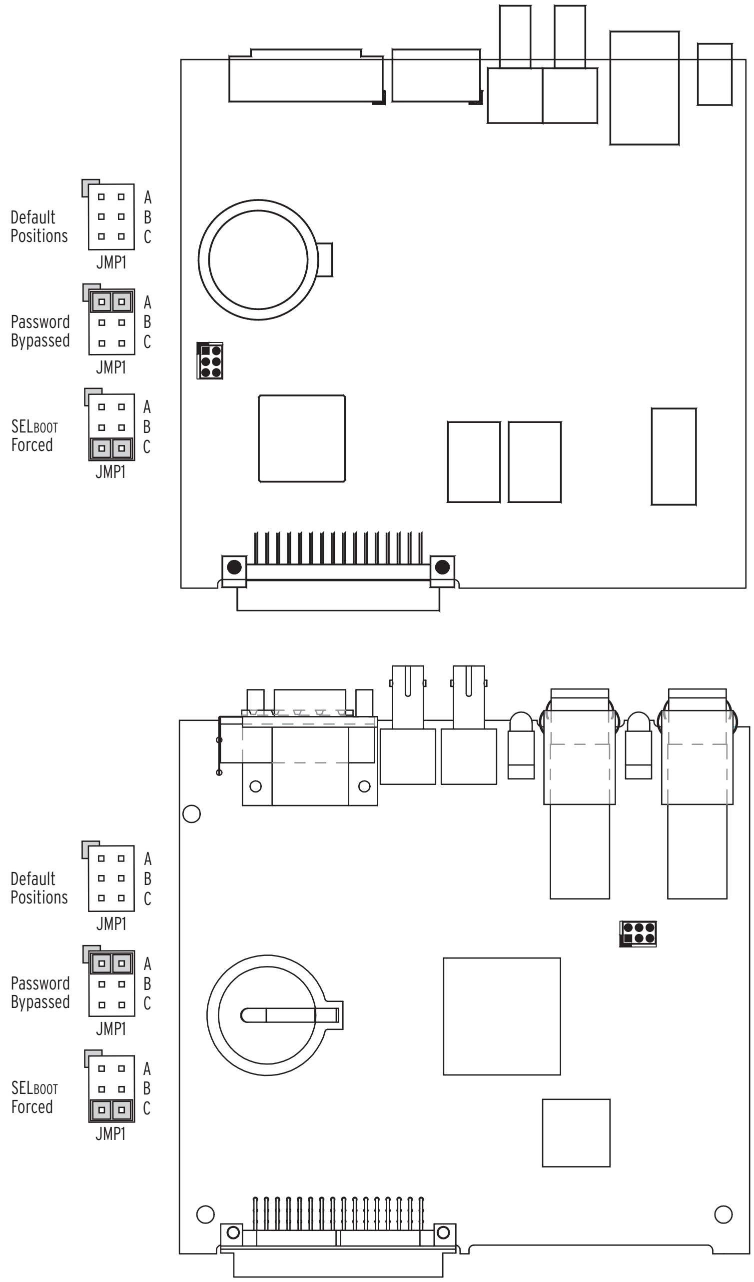


Figure 2.5 Pins for Password Jumper and SELBOOT Jumper

Pins labeled A bypass the password requirement, and pins labeled C force the device to the SEL operating system called SELBOOT (pins labeled B are not used). In the unlikely event that the SEL-2411 suffers an internal failure, communications with the device may be compromised. Forcing the device to SELBOOT provides a means of downloading new firmware. To force the device to SELBOOT, position the jumper in position C, as shown in *Figure 2.5* (SELBOOT forced). When forced to SELBOOT, you can only communicate with the device via the front-panel port.

To gain access to Level 1 and Level 2 command levels without passwords, position the jumper in position A, as shown in *Figure 2.5* (Password bypassed). Although you gain access to Level 2 without a password, the alarm contact still closes momentarily when accessing Level 2. *Table 2.16* tabulates the functions of the three sets of pins and jumper default positions.

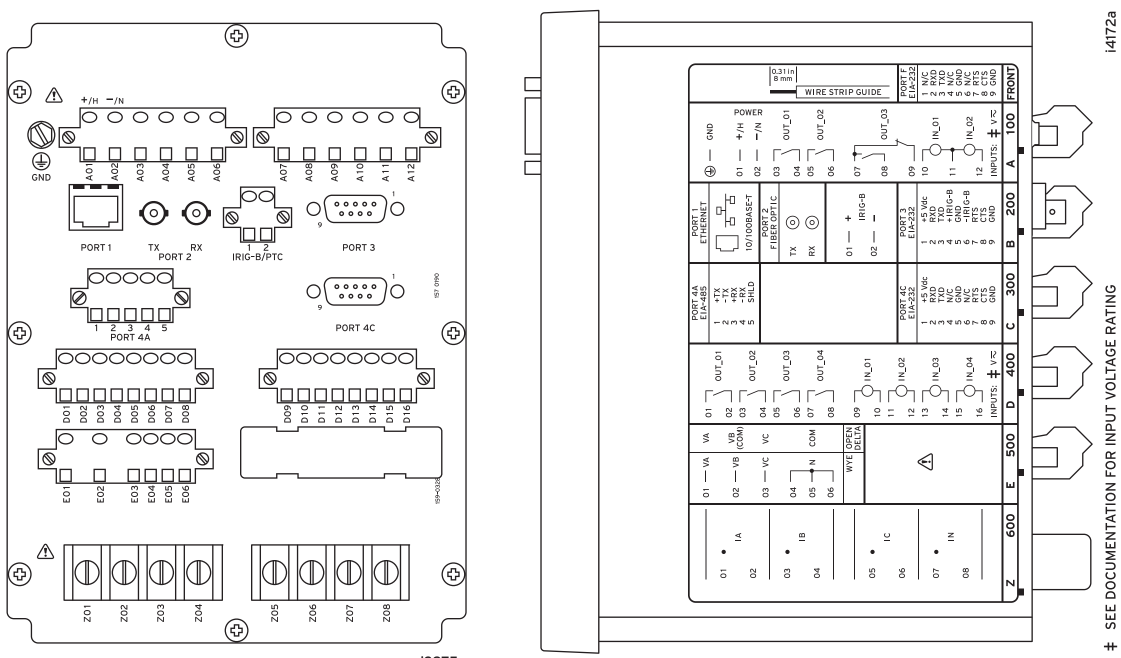
Table 2.16 Jumper Functions and Default Positions

Pins	Jumper Default Position	Description
A	Not bypassed (requires password)	Password bypass
B	Not used	Not used
C	Not bypassed (not forced SELBOOT)	Forced SELBOOT

Rear-Panel Connections

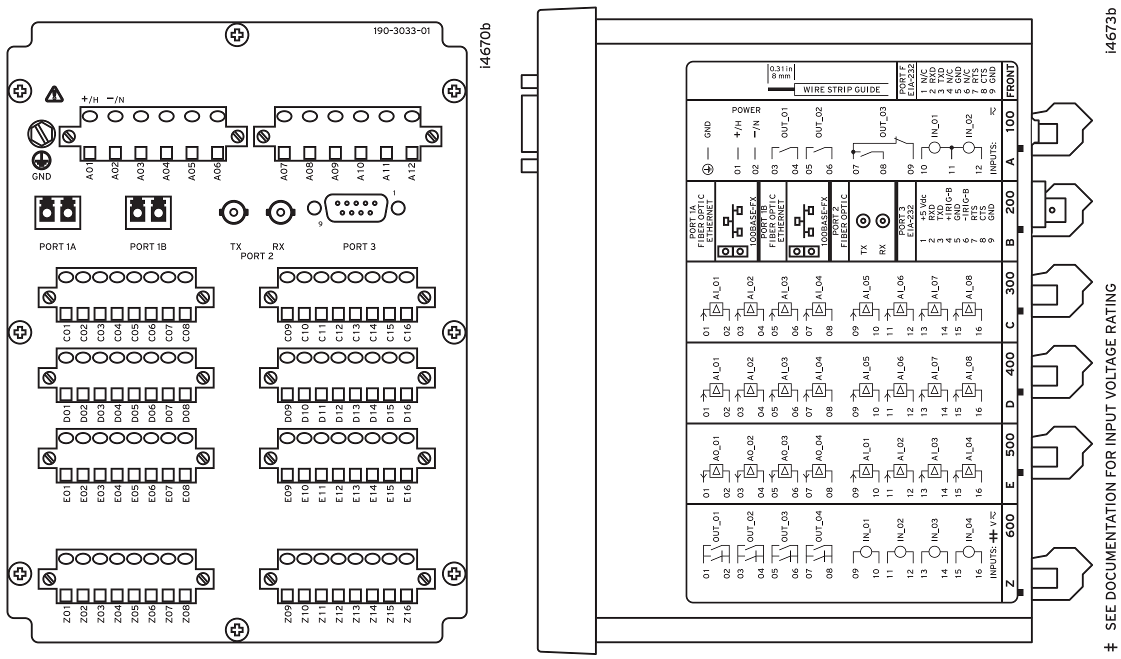
Rear-Panel and Side-Panel Diagrams

The physical layout of the connectors on the rear-panel and side-panel diagrams of four sample configurations of the SEL-2411 are shown in *Figure 2.6*, *Figure 2.7*, *Figure 2.8*, and *Figure 2.9*.



(A) Rear-Panel Layout (B) Side-Panel Input and Output Designations

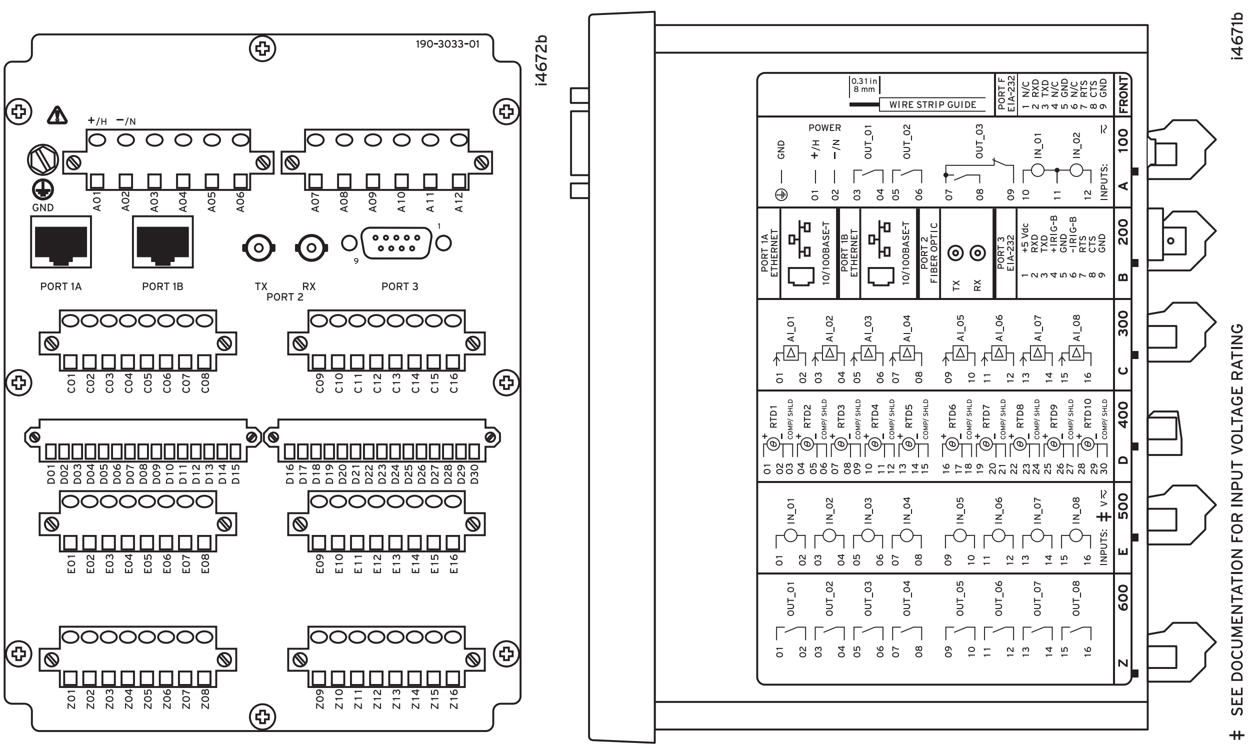
Figure 2.6 IRIG-B, Ethernet, EIA-232 Communication, 4 DI/4 DO, Voltage and Current Option



Rear-Panel Layout

Side-Panel Input and Output Designations

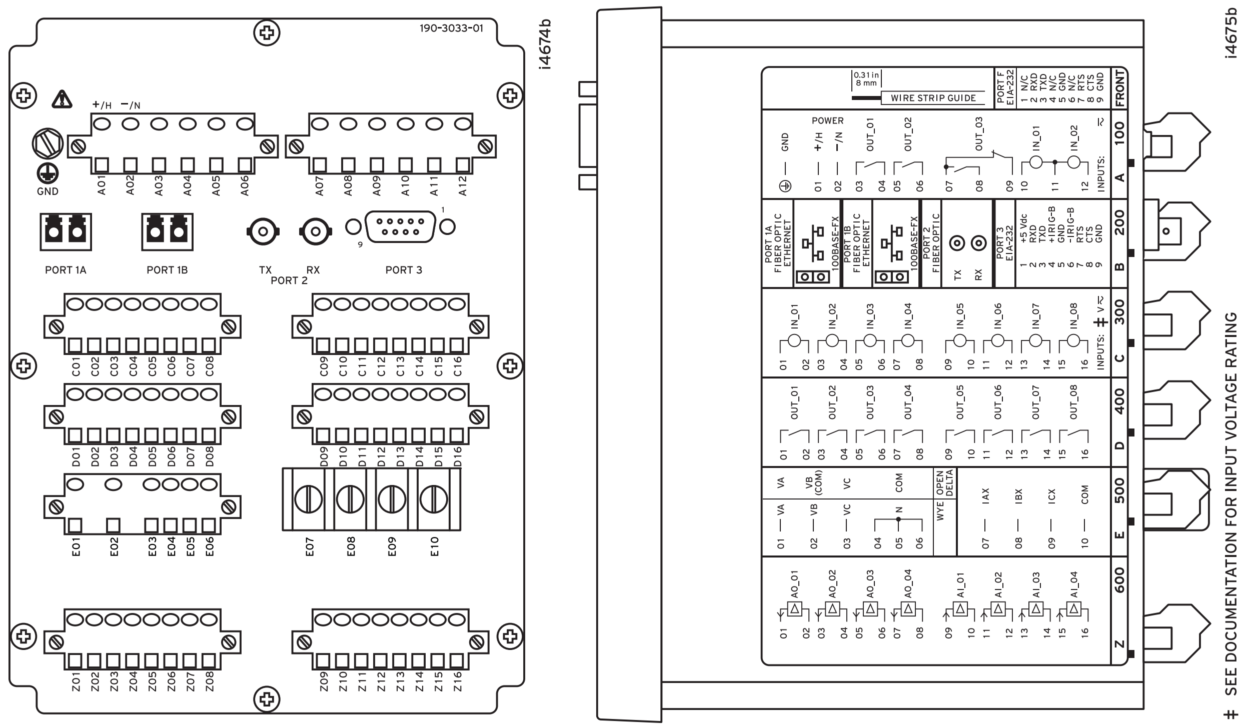
Figure 2.7 Dual Fiber Ethernet, 8AI, 4 AI/4 AO, and Fast Hybrid 4 DI/4 DO Option



Rear-Panel Layout

Side-Panel Input and Output Designations

Figure 2.8 Dual Copper Ethernet, 8 AI, 10 RTD, 8 DI, and 8 DO Option



Rear-Panel Layout

Side-Panel Input and Output Designations

Figure 2.9 Dual Fiber Ethernet, 8 DI, 8 DO, Current and Voltage, 4 AI/4 AO Option

Power Connections

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

The **POWER** terminals on the rear panel (**A01(+/H)** and **A02(—/N)**) must connect to 110–240 Vac or 110–250 Vdc or 24–48 Vdc (see *Power Supply on page 1.9* for complete power input specifications.) The **POWER** terminals are isolated from chassis ground. Use 16–14 AWG (1.5–2.5 mm²) size wire to connect to the **POWER** terminals.

Grounding (Earthing) Connections

Connect the ground terminal labeled **GND** on the rear of the panel to a rack frame or switchgear ground for proper safety and performance. Use 14 AWG (2.5 mm²) wire less than 2 m (6.6 feet) in length for the ground connection.

Communications Ports

Serial Ports

Because all ports (F, 2, 3, and 4) are independent, you can communicate to any combination simultaneously. Although serial Port 4 on the optional communication card consists of an EIA-485 (4A) and an EIA-232 (4C) port, only one port is available at a time. Use the Port 4 communication interface COMMINF setting to select between EIA-485 and EIA-232.

The serial Port 4 EIA-485 plug-in connector accepts wire size AWG 24 through 12. Strip the wires 8 mm (0.31 inches) and install with a small slotted-tip screwdriver. All EIA-232 ports accept 9-pin D-subminiature male connectors. Port 3 includes the IRIG-B time-code signal input (see below).

IRIG-B Time-Code Input

The SEL-2411 accepts a demodulated IRIG-B time signal to synchronize the internal clock with an external source. Two options for IRIG-B signal input are given, but only one may be used at a time. IRIG-B (B01 and B02) inputs or an SEL communications processor via fiber-optic Port 2 or serial Port 3 may be used. See *Table 6.19* for selecting the IRIG source for either Port 2 or Port 3. The available communications processors are the SEL-2032, SEL-2030, SEL-2020, SEL-3332, SEL-3351, and the SEL-2100 Logic Processor.

Ethernet Port

The SEL-2411 can be ordered with optional communications of a 10/100BASE-T or 100BASE-FX Ethernet port. Connect to Port 1 of the device using a standard RJ-45 connector for the copper port and an LC connector for the fiber-optic port.

Fiber-Optic Serial Port

The SEL-2411 can be ordered with an optional multimode fiber-optic port which is compatible with the SEL-2812 Fiber-Optic Transceiver. Connect to the fiber-optic port (Port 2) using the cable shown in *Table 2.17*. The SEL-2411 includes a fiber-optic port which is compatible with the SEL-2812 Fiber-Optic Transceiver and SEL-2600 RTD module.

Cables

Table 2.17 Communications Cables for Connecting the SEL-2411 to Other Devices

EIA-232 Serial Ports	Connect to Device	SEL Cable No.
All EIA-232 ports	Laptop PC, 9-pin Male (DTE)	C287
EIA-232 Port 2 (Fiber)	SEL-2600 RTD Module, SEL-2812/2814 Transceiver	C807Z
EIA-232 Port 3	SEL Communications Processors and SEL-2100 without IRIG-B	C272A
EIA-232 Port 3	SEL Communications Processors and SEL-2100 with IRIG-B	C273A

Digital Inputs

The SEL-2411 optoisolated inputs (e.g., IN102, IN404) are not polarity dependent. With nominal control voltage applied, each optoisolated input draws between 2–6 mA of current. Refer to *Section 1: Introduction and Specifications* for optoisolated input ratings. Inputs can be configured to respond to ac or dc control signals via global settings IN101D–IN102D and IN401D–IN404D.

Digital Outputs

The base unit has standard output contacts only (two Form A and one Form C). Refer to *Section 1: Introduction and Specifications* for output contact ratings. Standard output contacts are not polarity dependent.

Analog Inputs and Outputs

Be sure to connect wiring to the analog inputs and analog outputs with the correct polarity. *Figure 2.10* shows the device symbol representing an analog input. Connect the positive conductor to Terminal 01 (arrow represents conventional current flow). Conventional current flow also applies to the analog outputs. You will not damage the device if you connect the negative conductor to Terminal 01, but connecting the negative conductor to Terminal 01 inverts the polarity of the input.

Figure 2.10 Analog Input and Analog Output

Thermocouple Inputs

The device supports up to ten J, K, T, or E type thermocouple inputs with a measurement range of -50°C to 250°C. Inputs are divided into two isolated banks of five channels each. See *Specifications on page 1.7* for type test performance and compliance.

Each channel provides a plus and minus terminal that will accept wire as large as 18AWG. Thermocouples should be installed according to standardized and accepted practices. All thermocouple cables should be shielded to increase immunity to EMI. Terminate the thermocouple shield in the COMP/SHLD terminal.

Each thermocouple input reading is based on a moving 30-sample average. You can turn off the 30-sample average in the device with the ESAMPAVG setting.

Be sure to connect wiring to the thermocouple inputs with the correct polarity. Refer to *Figure 2.11* for a proper installation example.

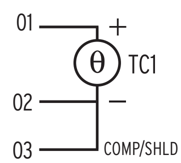


Figure 2.11 RTD Card and Universal Temperature Card 3-Wire RTD Wiring

Thermocouple Calibration

Although the thermocouple inputs have been factory calibrated specific to the SEL-2411 system ordered by the user, it is recommended that the user calibrate the installed system to achieve highest thermocouple accuracy.

In-Field System Calibration Procedure

Step 1. Power-on the unit and let soak for 60 minutes.

Step 2. Connect the installed thermocouples to the unit.

Step 3. Set the channel for the respective type (J, K, T or E).

Step 4. Ensure all channel gain settings are set to 1.0.

Step 5. Ensure all channel offset settings are set to 0.

Step 6. At the maximum possible application temperature, measure the temperature of the thermocouple junction at the far or "hot" end with an independently calibrated temperature measurement unit. Record this as "Set_high". Record the measurement taken by the unit as "Actual_high".

Step 7. Repeat the step above, but at the minimum possible application temperature. Record the data as "Set_low" and "Actual_low".

Step 8. Calculate gain setting: gain = (Set_high - Set_low) / (Actual_high - Actual_low)

Step 9. Calculate offset setting: offset = Set_high - (Actual_low*gain)

Step 10. Set the respective gain and offset channels using the **SET** command with the calculated values.

Step 11. Verify the calibrated accuracy for each channel.

Step 12. Repeat this process for each channel

RTD Inputs

The device supports up to ten PT100, NI100, NI120, or CU10 type RTD inputs with a measurement range of –50°C to 250°C. Inputs are divided into two isolated banks of five channels each. See *Specifications on page 1.7* for type test performance and compliance.

Each channel provides a plus, minus, and return (COMP/SHLD) terminal that will accept wire as large as 18 AWG. The return lead provides a means for lead-resistance compensation. For best lead-resistance compensation, all three leads should be the same length and wire gauge. Maximum lead resistance is 25 Ω. Use 18 to 24 AWG wire gauge for the leads. SEL recommends that you use Belden 8771 or similar cable. Cable shield should be connected to ground at the device (use the COMP/SHLD terminal for shield grounding). Performance to all specifications is guaranteed only when you use shielded RTD cables (twisted leads) no longer than 10 meters. When RTD cables longer than 10 meters are used, conformance to IEC 60255-22-1 and IEC 60255-22-5 is no longer guaranteed. The RTD probe should accommodate any additional isolation necessary for voltages greater than ±2500 Vdc at the tip/measuring point.

Be sure to connect wiring to the RTD inputs with the correct polarity. The 3-wire configuration illustrated in *Figure 2.12* applies to both the RTD card and Universal Temperature card.

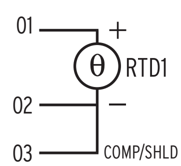


Figure 2.12 RTD Card and Universal Temperature Card 3-Wire RTD Wiring

Current Connections

The default Measurement Category for SEL Products is Measurement Category II (CAT II). For rated maximum voltage and rated maximum current see *Section 1: Introduction and Specifications*. You can install the current option card in Slot Z only. Because the four current channels are independent of each other, be sure to apply a ground to each CT or each group of CTs. *Figure 2.13* shows a three-phase power transformer with the three-phase CTs from the transformer connected to the phase CTs of the device, and the neutral CT from the transformer connected to the neutral CT of the device.

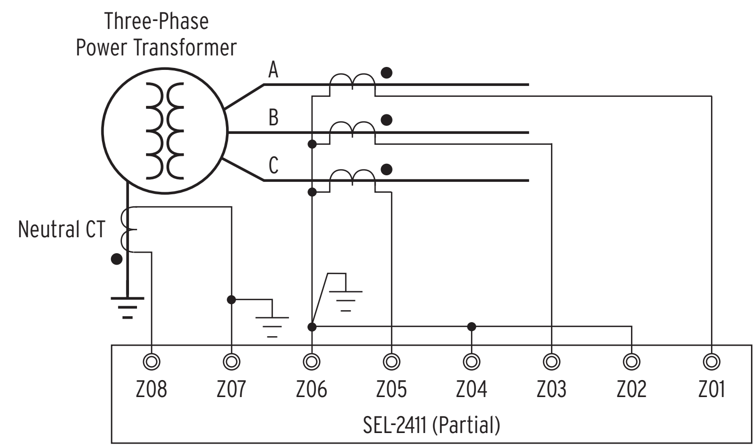


Figure 2.13 Current Connections Through CTs

If the start-up current and full-load current are within the thermal specifications of the SEL-2411, connect loads directly to the device. *Figure 2.14* shows an application where the SEL-2411 monitors four fan motors. Because the SEL-2411 is not a protection device, be sure to protect the fan motors by means of fuses (F1 through F4) or miniature circuit breakers (not shown). Select appropriate fuses with the following device specifications in mind (see *Section 1: Introduction and Specifications* for more information):

- 1 Second Thermal: 500 A (100 A for a 1 A device)
- Rated Continuous: 15 A (3 A for a 1 A device)

NOTE: Because the supply is single-phase only, the device cannot track the frequency (no I1) from the current card. Install an additional voltage card if frequency tracking is necessary.

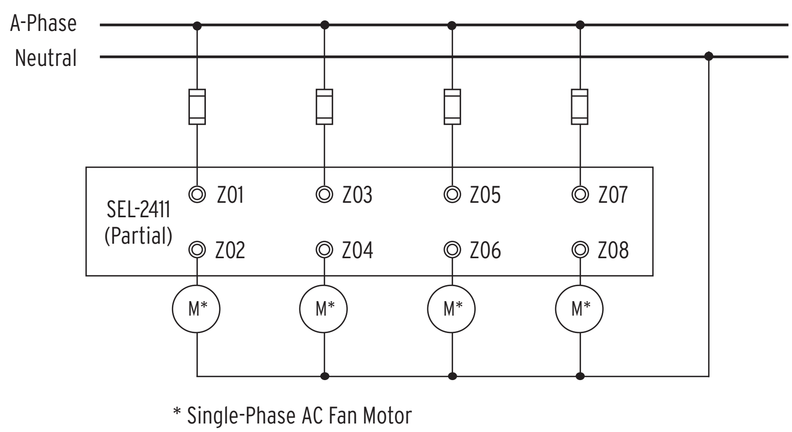


Figure 2.14 Direct Current Connections

Voltage Connections

You can install the voltage option card in Slot E only. Connect voltages from any one of the following three sources to the SEL-2411 (see *Figure 2.15* through *Figure 2.17*):

- Direct connection
- Wye-wye connected VT
- Open-delta connected VT

Select appropriate fuse ratings according to the VT VA rating. For the direct connection (*Figure 2.15*), SEL recommends a fuse rating of 100 mA (see *Section 1: Introduction and Specifications* for the voltage information of the device).

NOTE: Current limiting fuses in direct connected voltage applications are recommended to limit short-circuit arc incident energy.

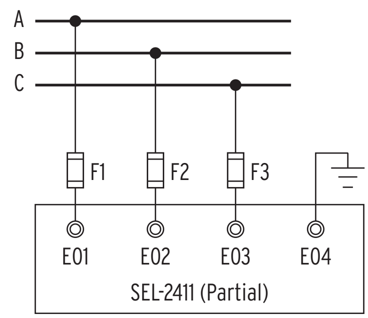


Figure 2.15 Direct Voltage Connection

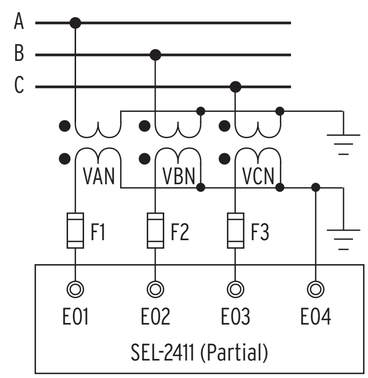


Figure 2.16 Wye-Wye VT Connection

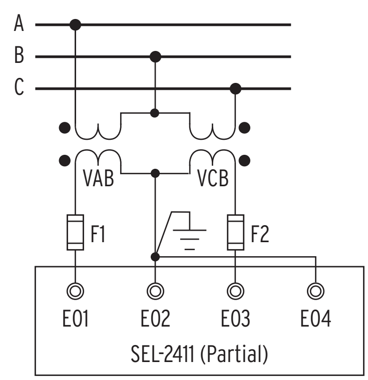


Figure 2.17 Open-Delta VT Connection

Because the SEL-2411 uses the A-phase voltage as reference when displaying metered values (see **MET** command), connecting voltages other than the voltages shown in *Figure 2.15* through *Figure 2.17* to the device can result in incorrect angle values.

Field Serviceability

The SEL-2411 firmware may be upgraded in the field; refer to *Appendix B: Firmware Upgrade Instructions*. Configure an output contact to create a diagnostic alarm for a self-test failure as explained in *Section 4: Logic Functions*. Use the metering functions to determine if the analog front-end (not monitored by self-testing) is functional. Refer to *Section 10: Testing and Troubleshooting* for detailed testing and troubleshooting information.

The only field replaceable components are the power supply fuse and the real-time clock battery. A lithium battery powers the clock (date and time) if the external power source is lost or removed. The battery is a 3 V lithium coin cell, Ray-O-Vac® BR2335 or equivalent. At room temperature (25°C), the battery will operate nominally for 10 years at rated load. When the device is powered from an external source, the battery experiences a low self-discharge rate. Thus, battery life may extend well beyond 10 years. The battery cannot be recharged.

Fuse Replacement

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

⚠CAUTION
The device contains devices sensitive to Electrostatic Discharge (ESD). When working on the device with the front panel removed, work surfaces and personnel must be properly grounded or equipment damage may result.

To replace the power supply fuse, perform the following steps:

Step 1. De-energize the device.

Step 2. Remove the eight rear-panel screws, ground screw, plug-in connectors, and the device rear panel.

Step 3. Remove the Slot A printed circuit board.

Step 4. Locate the fuse on the board.

Step 5. Remove the fuse from the fuse holder.

Step 6. Ensure fuse holder has not been damaged, bent, or deformed.

Step 7. Be sure to reform the fuse holder to ensure proper contact with the new fuse.

Step 8. Replace the fuse with a time delay, 5 x 20 mm, 3.15 A, high breaking capacity, 250 V fuse (T315H 250 V).

Step 9. Insert the printed circuit board into Slot A.

Step 10. Replace the device rear panel, reinstall all screws and connectors, and energize the unit.

Real-Time Clock Battery Replacement

⚠CAUTION
There is danger of explosion if the battery is incorrectly replaced. Replace only with Ray-O-Vac® no. BR2335 or equivalent recommended by manufacturer. Dispose of used batteries according to the manufacturer's instructions.

To replace the real-time clock battery, perform the following steps:

Step 1. De-energize the device.

Step 2. Remove the eight rear-panel screws, ground screw, plug-in connectors, and the device rear panel.

Step 3. Remove the Slot B printed circuit board.

Step 4. Locate the battery clip (holder) on the board.

Step 5. Carefully remove the battery from beneath the clip. Properly dispose of the old battery.

Step 6. Install the new battery with the positive (+) side facing up.

Step 7. Insert the printed circuit board into Slot B.

Step 8. Replace the device rear panel, reinstall all screws and connectors, and energize the unit.

Step 9. Set the device date and time.

This page intentionally left blank

Section 3
Getting Started

Overview

Section 2: Installation describes how to configure and connect the hardware of the device; which might be necessary before getting started operating the device. This section presents the fundamental knowledge you need to operate the SEL-2411, organized by task. These tasks help you become familiar with the device and include the following:

- ➤ Connecting the device
- ➤ Matching device connection parameters
- ➤ Checking device status
- ➤ Editing device settings

Connecting the Device

Connect the power, ground, and communications as shown in *Figure 3.1*. For more details, see *Power Connections on page 2.15* and *Grounding (Earthing) Connections on page 2.15*. Once connected to power, the device does an internal self-check and the **ENABLED** LED illuminates.

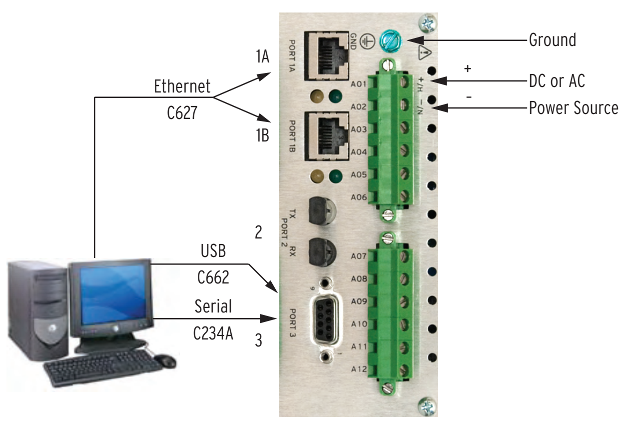


Figure 3.1 Power, Ground, and Communications Connections

QuickSet

Overview

ACSELERATOR QuickSet is a powerful setting, event analysis, and measurement tool that aids in setting, applying and using the SEL-2411. *Table 3.1* shows the suite of ACSELERATOR QuickSet applications provided for the SEL-2411.

Table 3.1 ACSELERATOR QuickSet SEL-5030 Software

Terminal	Provides a direct connection to the SEL device. Use this communication method to interface directly with the device.
Rules Based Settings Editor	Provides on-line or off-line device settings that include interdependency checks. Use this feature to create and manage settings for multiple devices in a database.
Event analysis	Provides oscillography and other event analysis tools.
HMI	Provides metering and control features.
Setting Database Management	ACSELERATOR QuickSet uses a database to manage the settings of multiple devices.
Help	Provides general ACSELERATOR QuickSet and device-specific ACSELERATOR QuickSet context help.

Other PC software applications that support the SEL-2411 Programmable Automation Controller are listed in *Table 3.2*.

Table 3.2 SEL Software Solutions

Part Number	Product Name	Description
SEL-5032	ACSELERATOR Architect® SEL-5032 Software	Configures IEC 61850 communications
SEL-5040	ACSELERATOR® Report Server SEL-5040 Software	This application automatically collects event reports.
SEL-5601	ACSELERATOR® Analytic Assistant SEL-5601 Software	Converts SEL Compressed ASCII event report files to oscillography.

Installation

Install ACSELERATOR QuickSet® on your personal computer. Once ACSELERATOR QuickSet is installed, launch the application and a launchpad similar to *Figure 3.4* will appear.

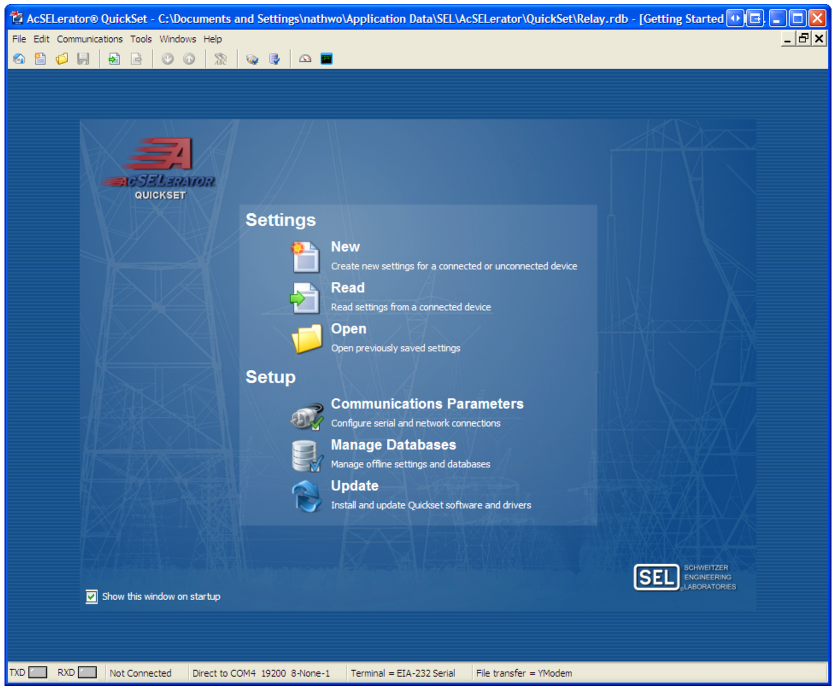


Figure 3.2 ACSELERATOR QuickSet Launchpad

Connection Parameters

The **Connection Parameters** launchpad selection is a shortcut to the **Communications > Parameters** selection on the menu bar. Configure the ACSELERATOR QuickSet communications parameters and passwords to match those in the PAC. The PAC default passwords are shown in *Table 3.3*.

Check the PAC Port 2 parameters by selecting **SET/SHOW > Port > 2 > Communications Settings** on the PAC front panel and then using the UP and DOWN pushbuttons to view all of the parameters.

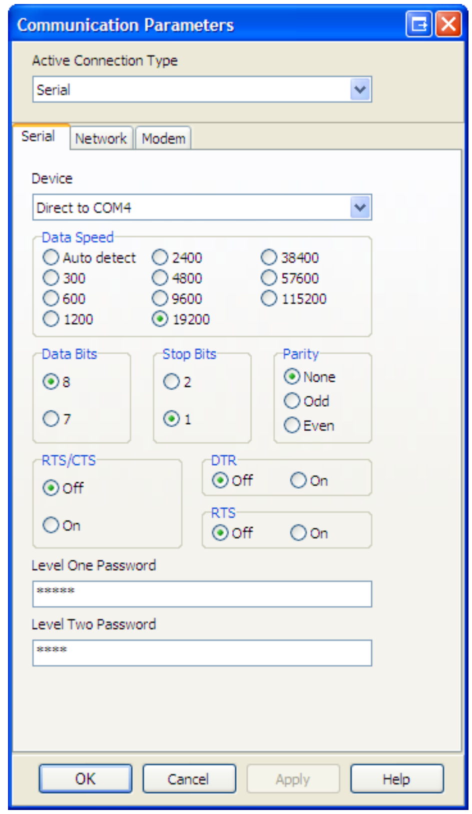


Figure 3.3 Communication Parameters

Table 3.3 Factory Default Passwords

Access Level	Password
0	N/A
1	OTTER
2	TAIL
C	CLARKE

Checking Device Status

View a device status report similar to that shown in *Figure 3.4* by selecting **Tools > HMI > HMI** from the main menu and then selecting **Device Status** from the tree. The beginning of the status report printout contains the device firmware identification string (FID) and checksum string (CID). These strings uniquely identify the device and the version of the operating firmware. The last line in the report states whether the device status is enabled or disabled, which depends on whether any particular status field is failed. *Table 7.46* provides the definition of each status field.

NOTE: With terminal emulation, use the **STA** command to access the device status.

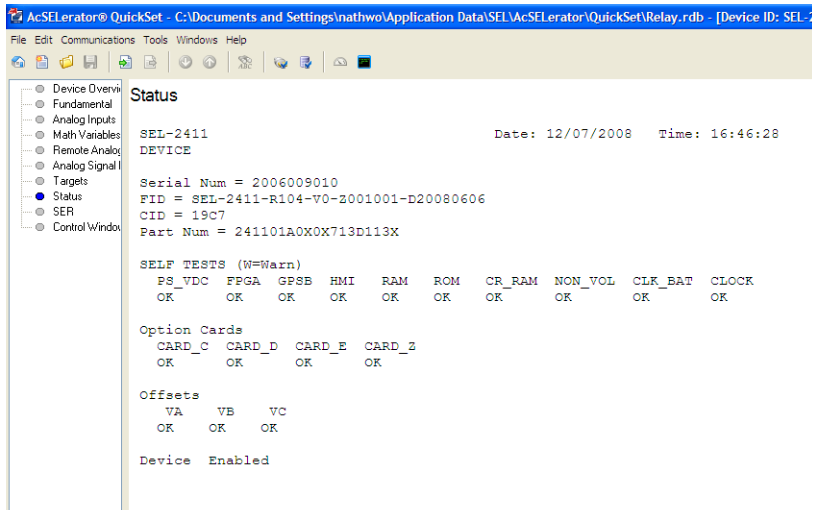


Figure 3.4 Communication Menu

Viewing Device Information

The device overview screen provides an overview of the device. All metering functions are shown whether the current and voltage cards are installed or not. When no current or voltage cards are installed, metering values show `xxxx.xx` instead of current or voltage values.

The Contact I/O portion of the window displays the status of the two inputs and three outputs of the main board. You cannot change these assignments.

You can assign any Device Word bit to the 16 user-defined Target LEDs. To change the present assignment, double-click on the text above the square you want to change. After double-clicking on the text, a box with available Device Word bits appears in the bottom left corner of the screen. Select the appropriate Device Word bit, and click the **Update** button to assign the Device Word bit to the LED. To change the color of the LED, click in the square and make your selection from the color palette.

The front-panel LEDs display the status of the 11 front-panel LEDs. Use the front-panel settings to change the front-panel LED assignment.

Screens between the **Overview** and **Control** screens display the corresponding values.

Click on **Target** to view the status of all the Device Word bits.

With the control screen, you can clear the event history, SER, MIRRORED BITS report, analog profile, and trigger events. You can also reset the targets, synchronize with IRIG, and set the time and date. To control the Remote Bits, click on the appropriate square, then select the operation.

Update

Select **Update** from the launchpad to update the ACSELERATOR QuickSet application, add support for new products (drivers), or update the support for existing products (drivers). This selection will launch SEL Compass™, the SEL software and literature management application.

Manage Databases

Select **File > Database Manager** on the main menu bar to open the database manager or **Manage Databases** from the launchpad. With the manager you can create, copy, and manage databases and manage records within existing databases. The manager gives you access to the **New Database** button and the **Copy/Move Settings Between Databases** tab.

Edit (New, Open, Read) Settings

Begin the settings process by selecting **New**, **Open**, or **Read** from the launchpad shown in *Figure 3.2*, ACSELERATOR QuickSet launchpad, or by selecting **File** > **New**, **File** > **Open**, or **File** > **Read** from the menu bar, as shown in *Figure 3.2*.

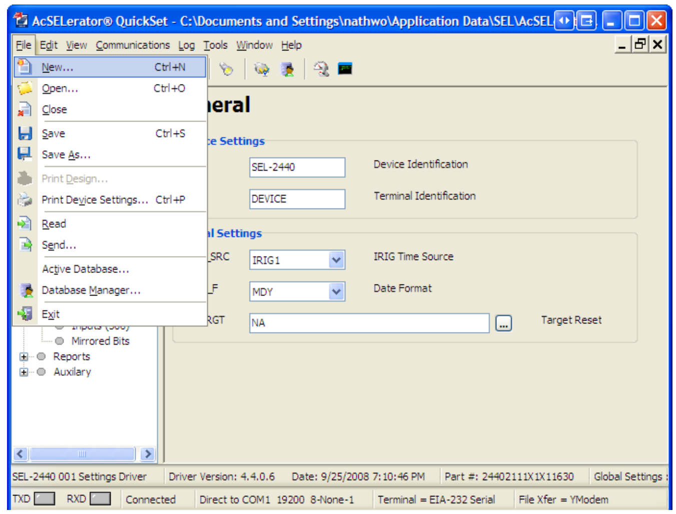


Figure 3.5 Creating a New Settings File

File > New

Selecting the **New** menu item creates new settings files. ACSELERATOR QuickSet makes the new settings files from the driver that you specify in the **Settings Editor Selection** dialog box. ACSELERATOR QuickSet uses the Z-number in the FID string to create a particular version of settings. To get started making SEL-2411 settings with the **Device Editor** in the **Editor Mode**, select **Settings > New** from the main menu bar, and SEL-2411 and **002** from the **Settings Editor Selection** window as shown in *Figure 3.6*.

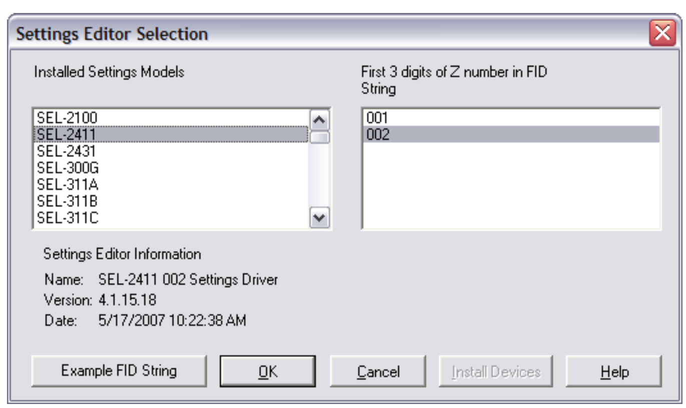


Figure 3.6 Selection of Drivers

After device model and settings driver selection, ACSELERATOR QuickSet presents the **Device Part Number** dialog box. Use this dialog box to configure the Device Editor to produce settings for a device with options determined by the part number, as shown in *Figure 3.7*. Press **OK** when finished.

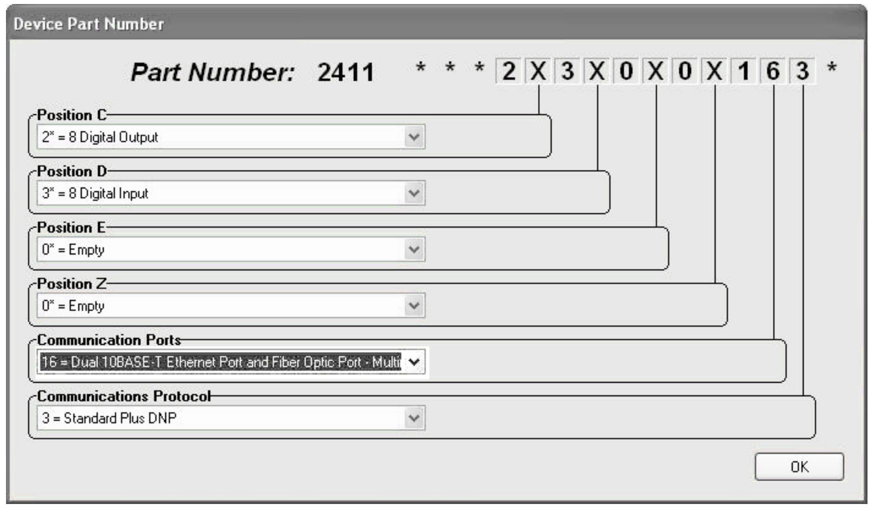


Figure 3.7 Update Part Number

Figure 3.8 shows the **Settings Editor** screen. View the bottom of the Device Editor window to check the **Settings Driver** number. Compare the ACSELERATOR QuickSet Settings Driver number and the first portion of the Z-number in the FID string (this can found by selecting **HMI > Meter & Control... > Status**). These numbers must match. ACSELERATOR QuickSet uses this first portion of the Z-number to determine the correct **Device Editor** to display.

NOTE: Compare the ACSELERATOR QuickSet Settings Driver number and the first portion of the Z-number in the FID string.

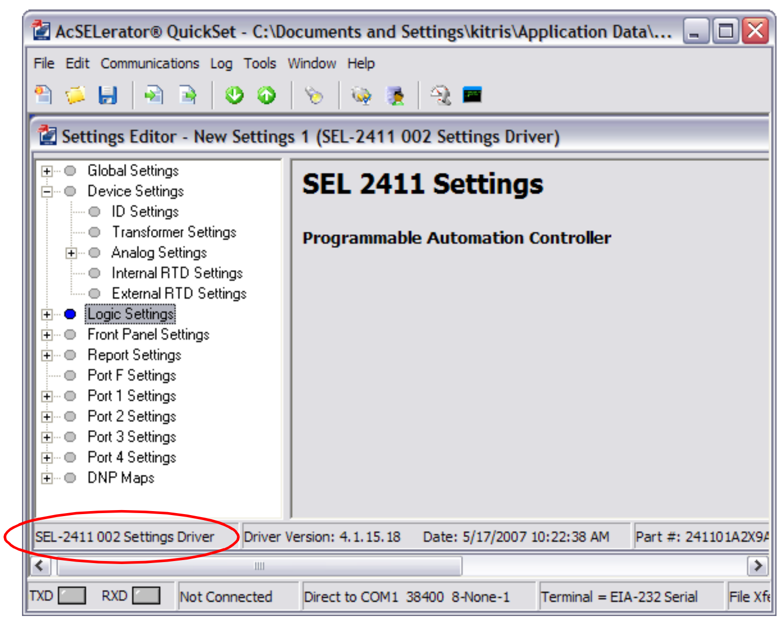


Figure 3.8 New Setting Screen

File > Open

The **Open** menu item opens an existing device from the active database folder. ACSELERATOR QuickSet prompts for a device to load into the **Device Editor**.

File > Read

When the **Read** menu item is selected, ACSELERATOR QuickSet reads the device settings from a connected device. As ACSELERATOR QuickSet reads the device, a **Transfer Status** window appears. ACSELERATOR QuickSet uses serial protocols to read settings from SEL devices.

Help

Various forms of ACSELERATOR QuickSet help are available, as shown in *Table 3.4*. Press **<F1>** to open a context-sensitive help file with the appropriate topic as the default.

Table 3.4 Help

Help	Description
General ACSELERATOR QuickSet	Select **Help** from the main menu bar
Device Editor	Select SEL**-5030 Editor Help** from the **Device Editor** menu bar
SEL-2411 Settings	Select **Settings Help** from the **Device Editor** menu bar
Database manager	Select **Help** from the bottom of the **Database Manager** window

Section 4
Logic Functions

Overview

The SEL-2411 Programmable Automation Controller (PAC) provides digital and analog logic capabilities that operate on physical inputs and outputs and virtual inputs and outputs, as shown in *Figure 4.1 Program Model Overview* and *Figure 4.2 Detailed Program Model*.

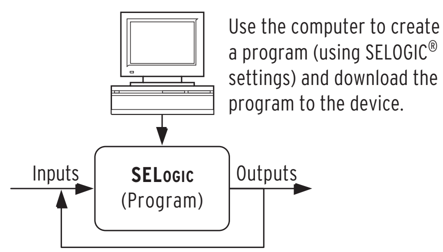


Figure 4.1 Program Model Overview

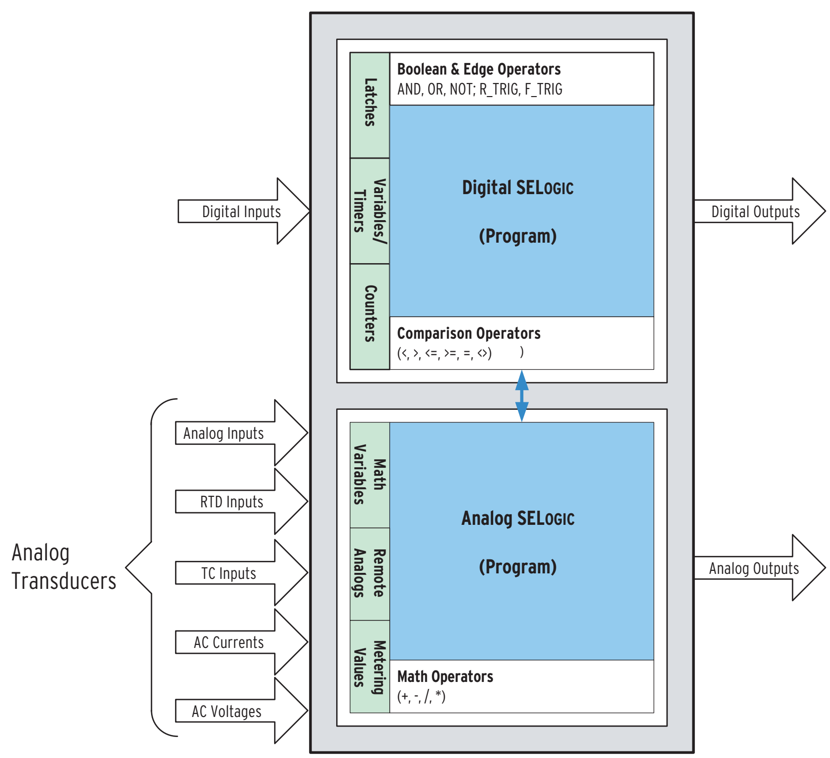


Figure 4.2 Detailed Program Model

The process of reading the physical inputs, evaluating the logic settings using all of the inputs and outputs, and operating the physical outputs is shown in *Figure 4.3*.

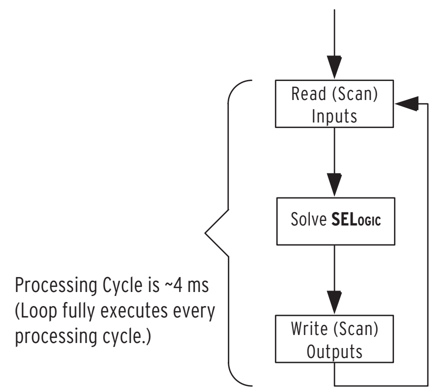


Figure 4.3 Operation Sequence

For ease of setting (programming) the device, the settings are grouped into seven categories as shown in *Table 4.1*. Many of these categories provide application specific SELOGIC equations that are explained in *Section 6: Settings*. However, most of the SELOGIC equations and other general-purpose capabilities are provided by the Logic (SET L) category.

Table 4.1 Setting Categories

Category	Description
Global	Settings for date format and input debounce timers.
Group	Settings associated with analog transducers and current and/or voltage transformer(s).
Logic	Settings associated with latches, timers, counters, and output contacts.
Port	Settings that configure the device front- and rear-panel serial ports (*p* = F or 3 on the base unit, *p* = 4 on optional communications card).
Front-Panel	Settings for the front-panel display and LED control.
Report	Settings for the sequential event reports.
DNP	Settings for DNP communications

Logical Operators

Logical operators can be used in any SELOGIC equation; they are shown in *Table 4.2*. Use the comparison operators with Analog Quantities (e.g., IA, IB, IC); including Math Variables (MV01–MV32). See *SELOGIC Control Equation Operators* for more details.

Table 4.2 Logical Operators (Sheet 1 of 2)

Operation	Operator
Boolean	
Boolean AND	AND
Boolean OR	OR
Complement	NOT
Edge Detection	
Rising edge trigger/detect	R_TRIG
Falling edge trigger/detect	F_TRIG

Table 4.2 Logical Operators (Sheet 2 of 2)

Operation	Operator
Comparison	
Greater Than	>
Greater Than or Equal	>=
Equality	=
Less Than or Equal	<=
Less Than	<
Inequality	<>

Mathematical Operators

Mathematical operators can only be used in SELOGIC Math Variables; the operators are shown in *Table 4.3*. Use the mathematical operators with Analog Quantities (e.g., IA, IB, IC); including Math Variables (MV01–MV32). See *SELOGIC Control Equation Operators* for more details.

Table 4.3 Mathematical Operators (Use in Math Variables)

Operation	Operator
Negation	–
Multiply	*
Divide	/
Add	+
Subtract	-

Function Blocks

Function block outputs can be used in any SELOGIC equation; the function blocks and their outputs are shown in *Table 4.4*. Likewise, logical operators can be used in any of the SELOGIC equations that drive the function blocks. Each function block is described in more detail in *General Logic Functions*.

Table 4.4 Function Blocks

Function	Output
Latches	LT01 – LT32
Variables	SV01 – SV64
Timers	SV01T – SV64T
Counters	SC01 – SC32

General Logic Functions

SELOGIC Enables

Enable settings are provided for latch bits (ELAT), SELOGIC control equations (variables/timers) (ESV), counters (ESC), and Math Variables (EMV). This helps limit the number of settings that you need to make. For example, if you need six timers, only enable six timers.

Latches

SELOGIC latches replace traditional latching devices (see *Figure 4.4*). The PAC latches retain state even when power to the device is lost. If the latch is set to a programmable output contact and power to the device is lost, the state of the latch is stored in nonvolatile memory, but the device de-energizes the output contact. When power to the device is restored, the programmable output contact will go back to the state of the latch after device initialization. Pulse the set input to close (set) the latch or pulse the reset input to open (reset) the latch. The external contacts wired to the latching device inputs are often from remote control equipment (e.g., SCADA, RTU).

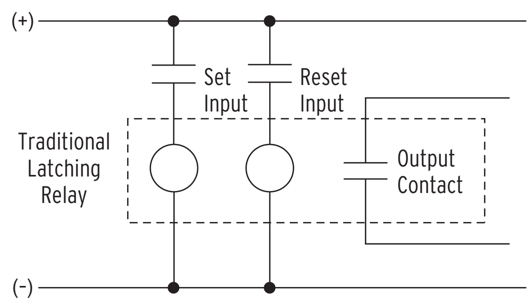


Figure 4.4 Schematic Diagram of a Traditional Latching Device

Thirty-two latches are provided by the PAC. *Figure 4.5* shows the logic diagram of a latch switch. The output of the latch is a Device Word bit (LT01 through LT32) called a latch bit.

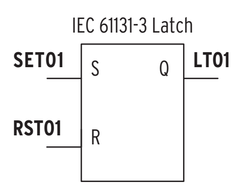


Figure 4.5 Logic Diagram of a Latch Switch

Settings Change

If individual settings are changed, the latch states are retained. If an individual setting change causes a change in a set or reset SELOGIC control equation setting, the retained states of the latch bits can be changed, subject to the newly enabled settings SET*n* or RST*n*.

Make Latches Settings With Care

Latch states are stored in nonvolatile memory so they can be retained during power loss or settings change. Nonvolatile memory is rated for a finite number of writes for all cumulative latch state changes. Exceeding the limit can result in a Flash self-test failure. *An average of 70 cumulative latch bit state changes per day can be made for a 25-year device service life.*

Variables/Timers

Each SELOGIC control equation variable/timer has a SELOGIC control equation setting input and variable/timer outputs as shown in *Figure 4.6*. Timers SV01T through SV32T in *Figure 4.6* have a setting range of 0.000–16000.00 seconds. This timer setting range applies to both pickup and dropout times (SV*n*PU and SV*n*DO; *n* = 1 through 32). You can enter up to 15 elements per SELOGIC equation.

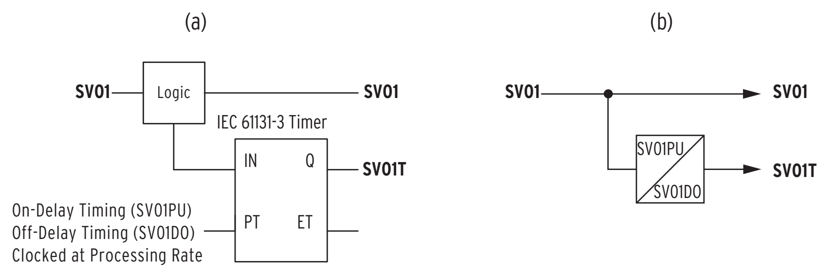


Figure 4.6 SELOGIC Control Equation Variable/Timers SV01/SV01T–SV32T

If the device loses power or settings change, the SELOGIC control equation variables/timers reset. Device Word bits SV*n* and SV*n*T (*n* = 01–32) reset to logical 0 after power restoration or a settings change.

Counters

NOTE: These counter elements conform to the standard counter function block #3 in IEC 61131-3 First Edition 1993-03 International Standard for Programmable Controllers–Part 3: Programming Languages.

NOTE: If setting SCnnCD is set to NA, the entire counter nn is disabled.

SELOGIC counters are up- or down-counting elements, updated every processing interval. Each counter element consists of one count setting, four control inputs, two digital outputs, and one analog output. *Figure 4.7* shows Counter 01, the first of 32 counters available in the device.

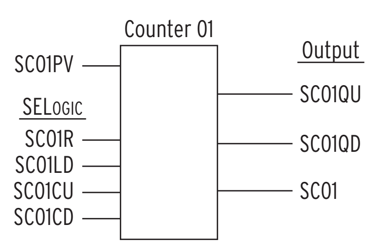


Figure 4.7 Counter 01

Table 4.5 describes the counter operation. Control input precedence is first followed by SC*nn*R, SC*nn*LD, SC*nn*CU, and SC*nn*CD.

Table 4.5 Counter Input/Output Description (Sheet 1 of 2)

Name	Type	Description
SC*nn*LD	Active high input	Load counter with the preset value to assert the output (SC*n*QU) (SELOGIC setting). When SC*nn*LD is asserted, SC*nn*CU and SC*nn*CD are ignored.
SC*nn*PV	Input value	This preset value is loaded when SC*n*LD pulsed. This preset value is the number of counts before the output (SC*n*QU) asserts (SELOGIC setting).
SC*nn*CU	Rising edge input	Count-up increments the counter (SELOGIC setting). When SC*nn*CU has a rising edge, a rising edge on SC*nn*CD is ignored (unless SC*nn* is already at the maximum value SC*nn*PV), in which case SC*nn*CU is ignored and SC*nn*CD is processed.
SC*nn*CD	Rising edge input	Count-down decrements the counter (SELOGIC setting).
SC*nn*R	Active high input	Reset counter to zero (SELOGIC setting). When SC*nn*R is asserted, SC*nn*LD, SC*nn*CU, and SC*nn*CD are ignored.
SC*nn*QU	Active high output	This count-up output asserts when the preset value (maximum count) is reached (SC*n* = SC*n*PV, *n* = 01 to 32).

Table 4.5 Counter Input/Output Description (Sheet 2 of 2)

Name	Type	Description
SC*nn*QD	Active high output	This count-down output asserts when the counter is equal to zero (SC*n* = 0, *n* = 01 to 32).
SC*nn*	Output value	This counter output is an analog value that may be used with analog comparison operators in a SELOGIC control equation and viewed using the **COU** command.

When a counter is disabled by setting, the present count value is forced to 0 (SC*nn* := 0), causing Device Word bit SC*nn*QD to assert, and Device Word bit SC*nn*QU to deassert.

Math Variables

The executed result of a math SELOGIC control equation is stored in a math variable. The storage format of the math variable is a 32-bit fixed point signed integer; 24 bits represent the integer portion, 7 bits represent the fractional portion, and one bit represents the sign. The smallest and largest values a math variable can represent are –16777215.99 and +16777215.99, respectively. If the executed result exceeds these limits, it will be clipped at the limit value. For example, when the MV01:= executed result is –16777219.00, MV01 will be –16777215.99. Similarly, when the MV02 := executed result is +16777238.00, MV02 will be +16777215.99.

Device Word bits provided for math are shown in *Table 4.6*.

Table 4.6 Math Device Word Bits

Device Word Bit	Description
MATHSTRT	Pulses for one processing interval pulse when math starts.
MATHTSK	Asserts while math is running.
MATHERR	Asserts when a math error occurs.

Output Contacts

The PAC provides the ability to use SELOGIC control equations to map logic outputs to the physical outputs. If you do not want to configure an output contact enter 0 as the setting, which is the default setting.

SELOGIC Control Equation Operators

Use the Boolean operators to combine values with a resulting Boolean value. Edge trigger operators provide a pulse output. Combine the operators and operands to form statements that evaluate complex logic. SELOGIC control equations are either Boolean type or math type. Because the equals sign (=) is already used as an equality comparison, both Boolean type and math type of SELOGIC control equation settings begin with an “assignment” operator (:=) instead of with an equals sign.

Boolean SELOGIC control equation settings use logic similar to Boolean algebra logic, combining Device Word bits together with one or more of the Boolean operators listed in *Table 4.7*. Math SELOGIC control equation settings operate on numerical values, using one or more of the Mathematical operators listed in *Table 4.7*. These numerical values can be mathematical variables or actual real numbers.

Operator Precedence

When you combine several operators and operands within a single expression, the SEL-2411 evaluates the operators from left to right, starting with the highest precedence operators and working down to the lowest precedence.

Table 4.7 SELOGIC Control Equation Operators (Listed in Operator Precedence)

Operator	Function	Function Type (Boolean and/or Mathematical)
( )	Parentheses	Boolean and Mathematical (highest precedence)
–	Negation	Mathematical
NOT	NOT	Boolean
R_TRIG	Rising edge trigger/detect	Boolean
F_TRIG	Falling edge trigger/detect	Boolean
* /	Multiply Divide	Mathematical Mathematical
+ -	Add Subtract	Mathematical Mathematical
<, >, <=, >=	Comparison	Boolean
= <>	Equality Inequality	Boolean Boolean
AND	AND	Boolean
OR	OR	Boolean (lowest precedence)

Parentheses Operator ( )

You can use more than one set of parentheses in a SELOGIC control equation setting. Use up to 14 sets of parentheses in a single SELOGIC control equation setting. The parentheses cannot be "nested" (parentheses within parentheses).

Boolean Rising Edge Operator (R_TRIG)

Apply the rising edge operator, R_TRIG, to individual Device Word bits only; you cannot apply R_TRIG to groups of elements within parentheses. When any Device Word bit asserts (going from logical 0 to logical 1), R_TRIG interprets this logical 0 to logical 1 transition as a "rising edge" and asserts to logical 1 for one processing interval.

Boolean Falling Edge Operator (F_TRIG)

Apply the falling edge operator, F_TRIG, to individual Device Word bits only; you cannot apply F_TRIG to groups of elements within parentheses. When the Device Word bit deasserts, F_TRIG interprets this logical 1 to logical 0 transition as a "falling edge" and asserts to logical 1 for one processing interval, as shown in *Figure 4.8*.

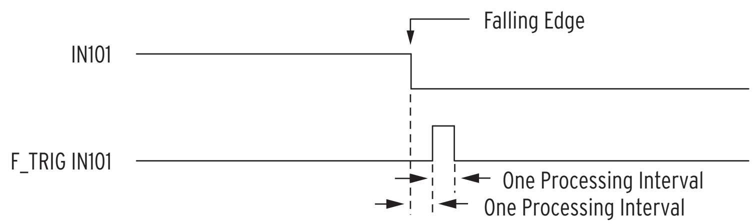


Figure 4.8 Result of Falling Edge Operator on a Deasserting Input

Math Arithmetic Operators (*, /, +, and –)

Device Word bits (which are effectively Boolean resultants, equal to logical 1 or logical 0) may be used in mathematical operations, they are treated as numerical values 0 and 1.

Boolean Comparison Operators (<, >, <=, and >=)

Comparisons are mathematical operations that compare two numerical values, with the result being a logical 0 or logical 1. Thus, what starts out as a mathematical comparison ends up as a Boolean resultant.

Boolean Equality (=) and Inequality (<>) Operators

Equality and inequality operators operate similar to the comparison operators.

Other

Table 4.8 shows other operators and values that you can use in writing SELOGIC control equations.

Table 4.8 Other SELOGIC Control Equation Operators/Values

Operator/ Value	Function	Function Type
0	Set SELOGIC control equation directly to logical 0	Boolean
1	Set SELOGIC control equation directly to logical 1	Boolean
#	Characters entered after the # operator are not processed and deemed as comments	Boolean and Mathematical
\	Indicates that the preceding logic should be continued on the next line ("\" is entered only at the end of a line)	Boolean and Mathematical

Section 5
Metering and Monitoring

Overview

The SEL-2411 Programmable Automation Controller includes metering functions to display the present values of current (if included), voltage (if included), analog inputs (if included), TC measurements (if included), and RTD measurements (with the external SEL-2600 Device RTD Module or an internal RTD card). The device provides the following methods to read the present meter values:

- Front-panel rotating display
- Front-panel menu
- SEL ASCII and CASCII text commands
- ACSELERATOR QuickSet® SEL-5030 Software
- SEL Fast Message Read
- Modbus® RTU via either EIA-485 port or EIA-232 port
- Modbus TCP via Ethernet port
- DNP3 Level 2 Slave via EIA-232 port
- DNP3 Level 2 Slave LAN/WAN via Ethernet port
- IEC 61850 via Ethernet port

Metering

The SEL-2411 meter data fall into the following categories:

- Fundamental metering
- Thermal metering (with RTD or TC values from the Universal Temperature Input card)
- RTD metering (with the external SEL-2600 Module or an internal RTD option)
- Energy metering
- Maximum and minimum metering
- Demand metering
- Analog Input metering

- Math Variable metering
- Remote Analog metering
- Analog Signal Profiling

NOTE: The SEL-2411 performs all power calculations with the understanding that the voltages connected to the device are from a balanced, three-phase supply. Device calculations for single-phase voltages or other unbalanced supply voltages are meaningless.

Because of the flexibility of the SEL-2411, you can configure your device in any combination of analog input, current, and/or voltage cards. As a result of this flexible configuration, displayed metering is a function of the particular device configuration. For example, to display power, you need to install both current (4 ACI) and voltage (3 AVI) cards or use the 3 ACI/3 AVI combination card.

Fundamental Metering

Table 5.1 details each of the eight cycle-averaged meter data types in the SEL-2411. *Section 8: Front-Panel Operations* and *Section 7: Communications* describe how to access the various types of meter data by using the device front-panel and communications ports.

Table 5.1 Fundamental Meter Values

Values		Units	Description
Currents (4 ACI)	Currents (3 ACI / 3 AVI)		
IA, IB, IC, IN	IAX, IBX, ICX	A, deg	Line
IG	IGX	A, deg	Residual Ground
3I2	3I2X	A	Negative-Sequence
Voltages (3 AVI or 3 ACI / 3 AVI)			
VA, VB, VC or VAB, VBC, VCA		V, deg	Line or Line-Line
VG		V, deg	Residual Ground
3V2		V	Negative-Sequence
Power			
P		kW	Real Power
Q		kVAr	Reactive Power
S		kVA	Apparent Power
PF		-	Power Factor
Other			
HZ	HZ	Hz	System Frequency

All angles are displayed between –180 and +180 degrees. The angles are referenced to VAB (for delta-connected PTs) or VAN (for wye-connected PTs) or IA (when only a current card is present). If the AVI card is not installed, or if VAB < 13 V (for delta-connected PTs) or VAN < 13 V (for wye-connected PTs), the angles are referenced to IA current. .

Power Measurement Conventions

The SEL-2411 uses the IEEE convention for power measurement assuming motor action, as shown in *Figure 5.1* and *Figure 5.2*.

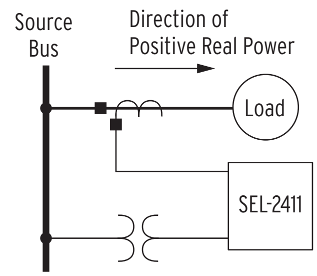


Figure 5.1 Primary Plant Connections

Figure 5.2 shows the grouping of voltage/current relationships into four quadrants (I through IV) as a function of the power factor and the direction of current flow (i) relative to the applied voltage (v).

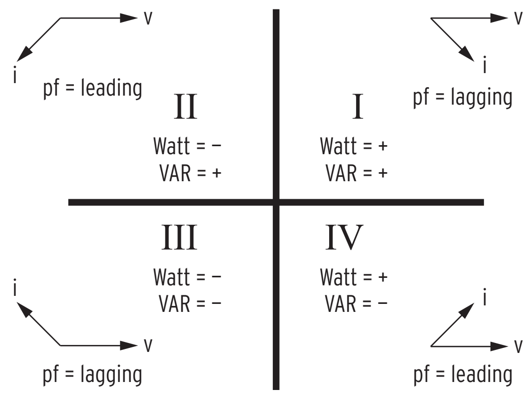


Figure 5.2 Complex Power Measurement Conventions—Motor Action

In the SEL-2411, reported positive real power is always into the load. See *Section 7: Communications* for examples of the device response to power measurement in the four quadrants.

The device uses a nominal system frequency of 50 or 60 Hz to control the sampling (data acquisition) of current and voltage waveforms for use in calculating magnitudes and angles. If the system frequency deviates from the nominal frequency then the metering accuracy might degrade. When the device is connected to a three-phase system then it is able to track the frequency and maintain accuracy.

Thermal Metering

The thermal metering function reports the present values of the RTD input temperatures. *Figure 5.3* shows the device response to the **MET RTD** command. The **MET RTD** command will only work with the dedicated RTD card and not the general purpose RTD/Thermocouple card.

```
=>>MET RTD <Enter>

SEL-2411                                        Date: 01/30/2002   Time: 18:55:00
DEVICE

INTRTD01        0 C
INTRTD02       48 C
INTRTD03        1 C
INTRTD04      166 C
INTRTD05        1 C
INTRTD06      249 C
INTRTD07        1 C
INTRTD08       46 C
INTRTD09       -2 C
INTRTD10      -47 C

=>>
```

Figure 5.3 Device Response to the MET RTD Command

The thermal meter function also reports the state of connected RTDs if any have failed. *Table 5.2* shows failure messages and their meanings.

Table 5.2 RTD Meter Values

Values	Units	Description
EXTRTD01 to EXTRTD12	deg	With External SEL-2600 Series RTD Module
INTRTD01 to INTRTD10	deg	With Internal RTD Option

RTD/TC Metering

The thermal metering function reports the present values of the RTD and/or thermocouple input temperatures when using the internal general purpose RTD/TC card. *Figure 5.4* shows the device response to the **MET TEMP** command.

```
=>>MET TEMP <Enter>

SEL-2411                                        Date: 01/30/2002   Time: 18:55:00
DEVICE

INTEMP01        0 C        PT100
INTEMP02       48 C        NI100
INTEMP03        1 C        NI120
INTEMP04      166 C        CU10
INTEMP05        1 C        J
INTEMP06      249 C        K
INTEMP07        1 C        T
INTEMP08       46 C        E
INTEMP09       -2 C        PT100
INTEMP10      -47 C        NI100

=>>
```

Figure 5.4 Device Response to the MET TEMP Command

Table 5.3 shows the thermal meter values.

Table 5.3 Thermal Meter Values

Device Option	Thermal Values
With Internal RTD/TC Option	INTEMP01 to INTEMP10

The thermal meter function also reports the state of connected RTDs/TCs if any have failed. *Table 5.4* shows failure massages and their meanings.

Table 5.4 RTD/TC Input Status Messages

Message	Status
Open	RTD/TC leads open
Short	RTD/TC leads shorted

Energy Metering

The device provides energy metering when current and voltage inputs are included. Use this form of metering to quantify real, reactive, and apparent energy supplied to the load. Below are the energy meter values.

Table 5.5 Energy Meter Values

Values	Units	Description
MWh3P	MWh	Real 3-Phase Energy (from source to load)
MVARh3P_IN	MVAr	Reactive 3-Phase Energy (from load to source)
MVARh3P_OUT	MVAr	Reactive 3-Phase Energy (from source to load)
MVAh3P	MVA	Apparent 3-Phase Energy

To reset energy meter values, issue the **MET RE** command.

Maximum and Minimum Metering

Maximum and minimum metering allows you to determine maximum and minimum operating quantities such as currents, voltages, power, and frequency. *Table 5.6* lists the max/min metering quantities.

Table 5.6 Maximum/Minimum Meter Values

Values		Units	Description
Currents (4 ACI)	**Currents (3 ACI / 3 AVI)**		
IA, IB, IC, IN	IAX, IBX, ICX	A	Line
IG	IGX	A	Residual Ground
3I2	3I2X	A	Negative-Sequence
Voltages (3 AVI or 3 ACI / 3 AVI)			
VA, VB, VC or VAB, VBC, VCA		V	Line or Line-Line
VG		V	Residual Ground
3V2		V	Negative-Sequence
Power			
P		kW	Real Power
Q		kVAr	Reactive Power
S		kVA	Apparent Power
Other			
FREQ		Hz	System Frequency

All maximum and minimum metering values will have the date and time that they occurred. The analog quantities from *Table 5.6* are checked approximately every 0.5 seconds and, if a new maximum or minimum value occurs, this value is saved along with the date and time that the maximum or minimum value occurred. Maximum and minimum values are only checked if device element FAULT is deasserted (no fault condition exists) for at least one second. Additionally, the following minimum thresholds must also be met:

- ➤ Current values IA, IB, IC, and IN: 3% of the nominal CT rating.
- ➤ Current value IG: IA, IB, and IC all must be above their thresholds.

- Voltage values (phase and phase-to-phase): 7.5 V and 13 V, respectively.
- Power values (real, reactive, and apparent): All three currents (IA, IB, IC) and all three voltages (VA, VB, VC or VAB, VBC, VCA) must be above their thresholds.

To reset maximum/minimum meter values, issue the **MET RM** command. The date and time of the reset are preserved and shown in the max/min meter report.

All maximum and minimum metering values are stored to nonvolatile memory four times per day and within one minute of the maximum and minimum metering values being reset.

Demand Metering

The SEL-2411 provides demand and peak demand metering based on either thermal or rolling demand calculations. The following values are supported if the appropriate cards are installed:

Table 5.7 Demand Meter Values

Values		Units	Description
Currents (4 ACI)	Currents (3 ACI / 3 AVI)		
IA, IB, IC, IN	IAX, IBX, ICX	A	Line
IG	IGX	A	Residual Ground
3I2	3I2X	A	Negative-Sequence

The demand metering settings (in *Table 5.8*) are available via the **SET** command. Also refer to *METER Command (Metering Data) on page 7.16*.

Depending on enable setting EDEM, these demand and peak demand values are thermal demand or rolling demand values. The differences between thermal and rolling demand metering are explained in the following subsection.

Comparison of Thermal and Rolling Demand Meters

The example in *Figure 5.5* shows the response of thermal and rolling demand meters to a step current input. The current input is at a magnitude of zero and then suddenly goes to an instantaneous level of 1.0 per unit (a “step”).

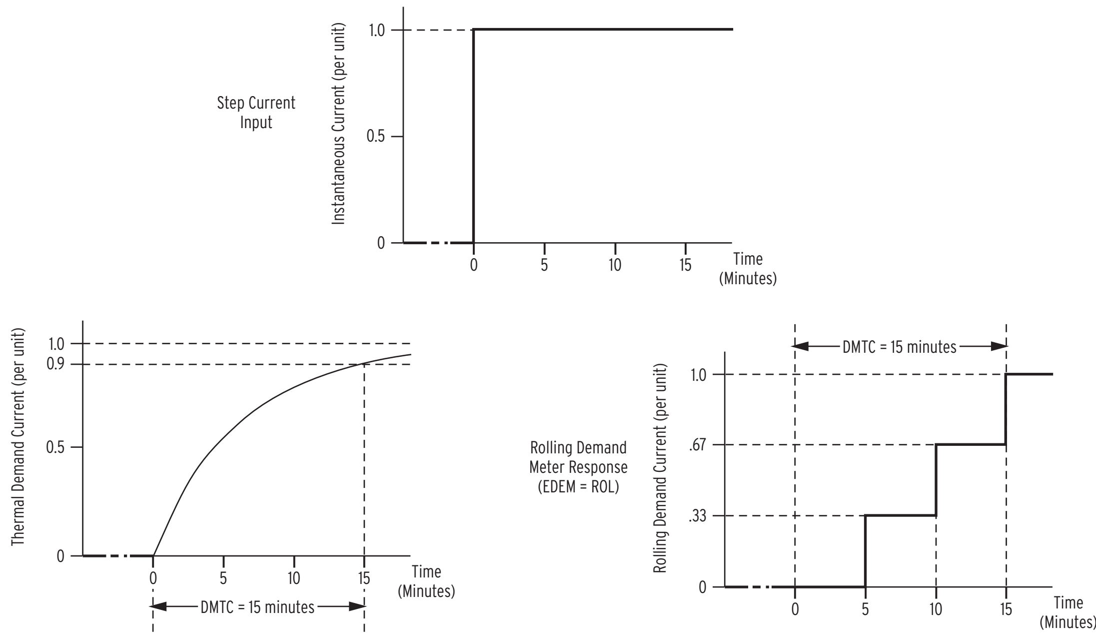


Figure 5.5 Response of Thermal and Rolling Demand Meters to a Step Input (Setting DMTC = 15 Minutes)

Thermal Demand Meter Response (EDEM := THM)

The response of the thermal demand meter in *Figure 5.5* (middle) to the step current input (top) is analogous to the series RC circuit in *Figure 5.6*.

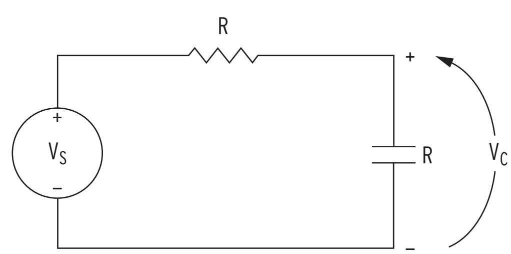


Figure 5.6 Voltage V_S Applied to Series RC Circuit

In the analogy:

Voltage V_S in *Figure 5.6* corresponds to the step current input in *Figure 5.5* (top).

Voltage V_C across the capacitor in *Figure 5.6* corresponds to the response of the thermal demand meter in *Figure 5.5* (middle).

If voltage V_S in *Figure 5.6* has been at zero (V_S = 0.0 per unit) for some time, voltage V_C across the capacitor in *Figure 5.6* is also at zero (V_C = 0.0 per unit). If voltage V_S is suddenly stepped up to some constant value (V_S = 1.0 per unit), voltage V_C across the capacitor starts to rise toward the 1.0 per unit value. This voltage rise across the capacitor is analogous to the response of the thermal demand meter in *Figure 5.5* (middle) to the step current input (top).

NOTE: The examples in this section discuss demand current, but MVA, MW, and MVAR demand values are also available, as stated at the beginning of this subsection.

In general, because voltage V_C across the capacitor in *Figure 5.6* cannot change instantaneously, the thermal demand meter response is not immediate either for the increasing or decreasing applied instantaneous current. The thermal demand meter response time is based on the demand meter time constant setting DMTC (see *Table 5.8*). Note in *Figure 5.5*, the thermal demand meter response (middle) is at 90 percent (0.9 per unit) of full applied value (1.0 per unit) after a time period equal to setting DMTC := 15 minutes, referenced to when the step current input is first applied.

The SEL-2411 updates thermal demand values approximately every 2 seconds.

Rolling Demand Meter Response (EDEM := ROL)

The response of the rolling demand meter in *Figure 5.5* (bottom) to the step current input (top) is calculated with a sliding time-window arithmetic average calculation. The width of the sliding time window is equal to the demand meter time constant setting DMTC (see *Table 5.8*). Note in *Figure 5.5*, the rolling demand meter response (bottom) is at 100 percent (1.0 per unit) of full applied value (1.0 per unit) after a time period equal to setting DMTC := 15 minutes, referenced to when the step current input is first applied.

The rolling demand meter integrates the applied signal, such as step current, input in 5-minute intervals. The integration is performed approximately every 2 seconds. The average value for an integrated 5-minute interval is derived and stored as a 5-minute total. The rolling demand meter then averages a number of the 5-minute totals to produce the rolling demand meter response. In the *Figure 5.5* example, the rolling demand meter averages the three latest 5-minute totals because setting DMTC = 15 (15/5 = 3). The rolling demand meter response is updated every 5 minutes, after a new 5-minute total is calculated.

Demand Meter Settings

Table 5.8 Demand Meter Settings and Settings Range

Setting	Definition	Range
EDEM	Demand meter type	THM = thermal ROL = rolling
DMTC	Demand meter time constant	5, 10, 15, 30, or 60 minutes

View or Reset Demand Metering Information

See *METER Command (Metering Data) on page 7.16*, *MET Demand/Peak Demand Metering on page 7.18*. The **MET D** command displays demand and peak demand metering.

The **MET RD** command resets the demand metering values. The **MET RP** command resets the peak demand metering values.

After demand values are reset, if setting EDEM := ROL, there may be a delay of up to two times the DMTC setting before the demand values are updated.

Demand Metering Updating and Storage

The SEL-2411 updates demand values approximately every two seconds.

The SEL-2411 stores peak demand values to nonvolatile storage once per day and overwrites the previous stored value if it is exceeded. Should the SEL-2411 lose power, it will restore the peak demand values saved by the device at 23:50 hours on the previous day.

Demand metering peak recording is momentarily suspended when SELOGIC® control equation setting FAULT is asserted (= logical 1). See the explanation for the FAULT setting in the following subsection *Maximum and Minimum Metering on page 5.5*.

Analog Input Metering

The SEL-2411 can monitor analog (transducer) quantities that it is measuring if equipped with optional analog inputs. Analog input metering shows transducer values from standard voltage and current transducers. These values can then be used for automation and control applications within an industrial plant or application.

Through the global settings, you can set each type of analog input to the type of transducer that drives that analog input. You also set the range of the transducer output. Analog inputs can accept both current and voltage transducer outputs. Ranges for the current transducers are ±20 mA and ranges for the voltage transducers are ±10 V. You also set the corresponding output of the analog inputs in engineering units. See *Section 4: Logic Functions* for an explanation of how to set up analog inputs for reading transducers. *Figure 5.7* shows an example of analog input metering.

```
=>MET AI <Enter>

SEL-2411                                  Date: 11/28/2005   Time: 16:22:22
DEVICE                                    Time Source: Internal

Input Card 4
AI401 (psi)         99.97
AI402 (mA)           2.013
AI403 (Volts)       -0.0027
AI404 (ft-lbs)     993
AI405 (HP)        1423
AI406 (mA)           9.013
AI407 (mA)          -3.014
AI408 (mA)          -0.013

=>
```

Figure 5.7 Device Response to the METER AI Command

Math Variable Metering

Use math variable metering to verify the values of the math variables. The SEL-2411 includes 32 math variables. When you receive your SEL-2411, no math variables are enabled. To use math variables, enable the number of math variables (between 1 and 32) you require, using the EMV setting in the Logic setting category. *Figure 5.8* shows the device response to the **METER MV M(ath) V(ariable)** command with eight of the 32 math variables enabled.

```
=>>MET MV <Enter>

SEL-2411                                  Date: 02/15/2005   Time: 14:15:43
DEVICE                                    Time Source: Internal

MV01        1.00
MV02   -32767.00
MV03       -1.00
MV04        0.00
MV05     1000.59
MV06    -1000.61
MV07     2411.01
MV08     2410.99

=>>
```

Figure 5.8 Device Response to the MET MV Command

When Global Setting DELTA_Y = DELTA, you still may use the phase-to-neutral voltage quantities (VA, VB, VC) in math variable equations, but the SEL-2411 zeroes these values out.

Remote Analog Metering

Use remote analog metering to verify the values received from an external device. The SEL-2411 includes 128 remote analog variables. In *Appendix C: SEL Communications Processors*, we show how to enter remote analog settings in an

SEL Communications Processor and the SEL-2411. *Figure 5.9* shows the device response to the **METER RA** command for the settings in *Appendix C: SEL Communications Processors*.

```
=>>MET RA <Enter>

SEL-2411                                Date: 02/15/2005   Time: 13:42:23
DEVICE                                  Time Source: External

RA01       1.00
RA02 -32767.00
RA03      -1.00
RA04       0.00
RA05    1000.59
RA06   -1000.61
RA07    2411.01
RA08    2410.99
RA09   98303.00
RA10 -98303.00
RA11 -38400.00
RA12 -65536.00
RA13       0.00
RA14       0.00
RA15       0.00
 •          •
 •          •
 •          •
RA126      0.00
RA127      0.00
RA128      0.00

=>>
```

Figure 5.9 Device Response to the MET RA Command

Analog Signal Profiling

IMPORTANT NOTE: All stored signal data is lost when changing either SPLIST1 or SPLIST2 settings.

Use the analog signal profiling function to record and track values of up to 32 analog channels. This function provides human-readable data in ASCII format (**PRO** command) and machine readable data in CASCII format (**CPR** command) that is compatible to import directly into applications like spreadsheets. Specify the analog quantities for profiling with the SPLIST1 and SPLIST2 report settings (see *Section 6: Settings* for more information).

Signal Profile Settings

IMPORTANT NOTE: All stored signal data is lost when changing either SPLIST1 or SPLIST2.

Enter up to 16 analog quantities, separated by spaces or commas, inter either SPLIST1 or SPLIST2 settings, for a total of 32 analog quantities. Choose from the analog quantities in *Appendix I: Analog Quantities*. *Table 5.9* shows the settings for the Signal Profile List.

Table 5.9 Signal Profile List Settings

Settings Prompt	Description	Setting Range	Default Settings
SPLIST1	Signal Profile List	Up to 16 analog quantities	NA
SPLIST2	Signal Profile List	Up to 16 analog quantities	NA
SPAR	Signal Profile Acquisition Rate	5, 10, 15, 30, 60 min	5
SPEN[a]	Signal Profile Enable	SV	1

[a] Enter up to 14 nested parentheses and up to 15 elements.

At the data acquisition rate of 5 minutes, the SEL-2411 stores at least 10 days of all analog signals selected for profiling in nonvolatile memory. The report includes the time of acquisitions and the magnitude of each selected analog quantity. By defining conditions in the signal profiling enable SELOGIC variable setting (SPEN), you can record analog values only at particular periods or conditions of interest. Depending on the card configuration of the device, you can choose any analog quantity shown in *Appendix I: Analog Quantities*.

Because the data is optimally formatted for machine-to-machine compatibility, use software such as Microsoft® Excel to display the profile data. *Figure 5.10* shows the data and graphed data after importing the data (comma-delimited) into an Excel spreadsheet. Use the **PRO C**(lear) command to clear all profile data.

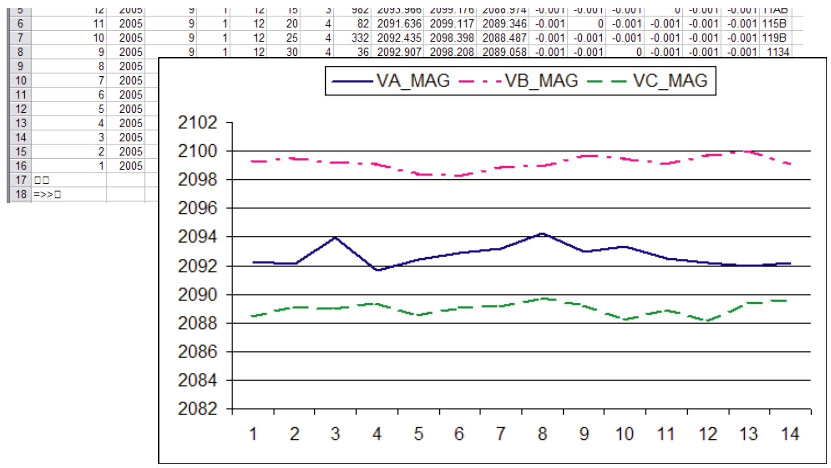


Figure 5.10 Profile Data in an Excel Spreadsheet and Graph

This page intentionally left blank

Section 6
Settings

Overview

The SEL-2411 Programmable Automation Controller stores settings you enter in nonvolatile memory. Settings are divided into seven setting classes (Group, Logic, Global, Port, Front-Panel, Report, and DNP settings). In this section, we discuss the following setting classes (see *Section 4: Logic Functions* settings for Logic settings, and *Appendix D: DNP3 Communications* for DNP settings):

1. Group
2. Global
3. Port *p* (where *p* = F, 1 (Ethernet), 2, 3, or 4)
4. Front-Panel Set
5. Report

Some setting classes have multiple instances. In the above list, there are four port setting instances, one for each port. *Table 6.1* shows the three different ways in which you can view or set the device settings.

Table 6.1 Methods of Accessing Settings

	Serial Port Commands[a]	Front-Panel HMI Set/Show Menu[b]	ACSELERATOR QuickSet® SEL-5030 (PC software)[c]
Display Settings	All settings (**SHO** command)	All settings	All settings
Change Settings	All settings (**SET** command)	All settings	All settings

[a] Refer to *Section 7: Communications* for detailed information on setup and use of the serial communications port.
[b] Refer to *Section 8: Front-Panel Operations* for detailed information on the front-panel layout, menus and screens, and operator control pushbuttons.
[c] Refer to *Section 3: Getting Started* for detailed information.

Setting entry error messages, together with corrective actions, are also presented in this section to assist correct settings entry. The SEL-2411 settings sheets at the end of this section list all SEL-2411 settings.

View/Change Settings Using the Front Panel

You can use the pushbuttons on the front panel to view/change settings. *Section 8: Front-Panel Operations* presents the operating details of the front panel. Enter the front-panel menu by pushing the {ESC} pushbutton. It will display the following message:

```
MAIN
Device
```

Scroll down the menu by using the {Down Arrow} pushbutton until the display shows the following message:

```
MAIN
Set/Show
```

The cursor (underline) should be on the **SET/SHOW** command. Enter the **SET/SHOW** command by pushing the {Enter} pushbutton. The display shows the following message:

```
SET/SHOW
Device
```

Select the underlined `Device` message with the {Enter} pushbutton, and the device will present you with the Device settings as listed in the SEL-2411 settings sheets. Use the {Up Arrow}, {Down Arrow}, {Left Arrow}, and {Right Arrow} pushbuttons to scroll through the Device settings and view/change them according to your needs by selecting and editing them. After viewing/changing the Device settings, press the {ESC} pushbutton until the following message appears:

```
Save Changes?
Yes No
```

Select and enter the appropriate command by pushing the {Enter} pushbutton. Select **Yes** to save the settings changes and **No** to discard the changes.

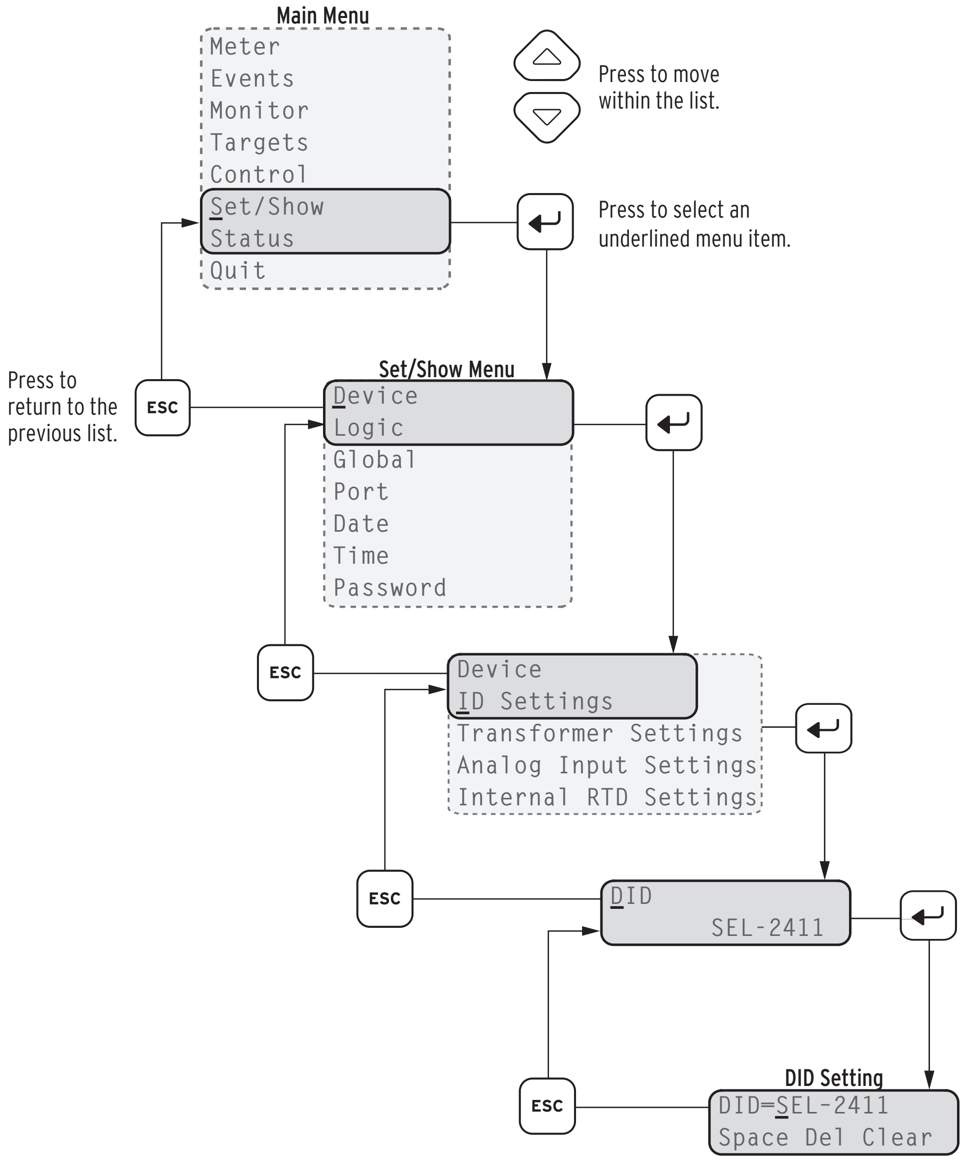


Figure 6.1 Front-Panel Setting Entry Example

View/Change Settings Over Communications Port

Refer to *Section 7: Communications* for information on how to set up and access the device serial or Ethernet port with a personal computer and how to use ASCII commands to communicate with the device.

View Settings

Use the **SHOW** command to view Device settings. The **SHOW** command is available from Access Level 1 and Access Level 2. *Table 6.2* lists the **SHOW** command options.

Table 6.2 SHO Command

Command	Description	Access Level
SHO s	Show Device settings	1
SHO A	Show all device settings: enabled, disabled/hidden	1
SHO L s	Show Logic settings	1
SHO G s	Show Global settings	1
SHO P *n* s	Show serial port settings, *n* specifies either Port F or Ports 1 through 4; defaults to the active port if not listed	1
SHO R s	Show report settings such as Sequential Events Recorder (SER) and Event Report (ER) settings	1
SHO F s	Show front-panel settings	1
SHO DNP s	Show DNP3 settings	1

Append **s** and the specific setting name you want to view in the **SHOW** command to immediately jump to the setting. If **s** (and the setting name) is not included, the device presents settings beginning with the first one in the group. The **SHOW** command displays only the enabled settings. To display all settings, including disabled/hidden settings, append an **A** to the **SHOW** command (e.g., **SHOW A**).

Enter Settings

The **SET** command (available from Access Level 2) allows you to view or change settings. *Table 6.3* lists the **SET** command options.

Table 6.3 SET Command

Command	Description	Access Level
SET s TERSE	Set Device settings	2
SET L s TERSE	Set Logic settings	2
SET G s TERSE	Set Global settings	2
SET P *n* s TERSE	Set serial port settings, depending on the device configuration, *n* specifies either Port F or Ports 1 through 4; defaults to the active port if not listed	2
SET R s TERSE	Set SER report settings	2
SET F s TERSE	Set front-panel settings	2
SET DNP s TERSE	Set DNP3 settings	2

Append **s** and the specific setting name you want to change in the **SET** command to immediately jump to the setting. If **s** (and the setting name) is not included, the device presents settings beginning with the first one in the group. Enter a new setting or press **<Enter>** to accept the existing setting. *Table 6.4* lists the editing keystrokes.

Table 6.4 SET Command Editing Keystrokes

Press Key	Results
<Enter>	Retains the setting and moves to the next setting
^<Enter>	Returns to the previous setting
<<Enter>	Returns to the previous setting category
><Enter>	Moves to the next setting category
END <Enter>	Exits the editing session, then prompts you to save the settings
<Ctrl+X>	Aborts the editing session without saving changes

As you enter Device settings, the device checks the setting entered against the range for the setting as published on the device settings sheets. If any setting entered falls outside the corresponding range for that setting, the device immediately responds `Out of Range` and prompts you to reenter the setting. In addition to the immediate range check, several of the settings have interdependency checks with other settings. The device checks setting interdependencies after you answer **Y** to the `Save Settings?` prompt, but before the settings are stored. If any of these checks fail, the device issues an error message, and returns you to the settings list for a correction.

Group Settings (SET Command)

Under the Group setting category, we set the device and terminal identifiers, settings pertaining to the analog (transducer) input (AI) cards, analog output (AO) cards, and transformers. The SEL-2411 displays the Device and Terminal Identifier strings at the top of responses to serial port commands identifying messages from individual devices. Enter up to 16 characters, including capital letters A–Z, numbers 0–9, periods (.), dashes (-), and spaces. *Table 6.5* shows the device and terminal identifiers settings.

Table 6.5 Device and Terminal Identifiers

Setting Prompt	Setting Range	Setting Name := Factory Default
Device ID	16 Characters	DID := SEL-2411
Terminal ID	16 Characters	TID := DEVICE

Transformer Settings

For devices with a current card, a voltage card, or both current and voltage cards installed, the device prompts for the settings as shown in *Table 6.6*.

Table 6.6 Current and Voltage Transformer Settings (Sheet 1 of 2)

Setting Prompt	Setting Range	Setting Name := Factory Default
Current Transformer Ratio	1–5000	CTR := 250
Neutral Current Transformer Ratio	1–5000	CTRN := 250

Table 6.6 Current and Voltage Transformer Settings (Sheet 2 of 2)

Setting Prompt	Setting Range	Setting Name := Factory Default
Additional Current Transformer Ratio	1–5000	CTRX := 250
Potential Transformer Ratio	1.00–10000.00	PTR := 35.00

Potential Transformer (PT) Ratios

Group setting PTR is the potential transformer ratio from the primary system to the SEL-2411 VT-terminal voltage inputs. See voltage input details in *Figure 2.15*.

For example, on a 12.47 kV phase-to-phase primary system with wye-connected 7200:120 V PTs, the correct PTR setting is 7200 / 120 = 60.00.

Setting PTR Adjustments for Low Energy Analog (LEA) Inputs

The SEL-2411 can be ordered with 3 AC voltage inputs, with a maximum input voltage of 300 V using the 3 ACI/3 AVI card. The SEL-2411 can also be ordered with three 8 Vac low energy analog (LEA) inputs, suitable for high-impedance sensors, such as capacitive screen voltage dividers and resistive voltage dividers. The LEA input option is only available on the terminals of the 3 ACI/3 AVI combination card.

The SEL-2411 does not internally scale the LEA inputs any differently than the 300 V inputs. An 8 V (LEA) input with 4 Vac applied will appear as 3.843 / 7.686 = 50% of full-scale, or 150 Vac on a 300 V base. Any VT-terminal voltage-related settings have the same setting range, regardless of whether the VT-terminal voltage inputs are standard 300 V inputs or LEA (8 V) inputs. When the VT-terminal voltage inputs are LEA (8 V) inputs, the SEL-2411 still thinks it is looking at a 300 V input, even though the LEA inputs have a 7.686 V range.

One step in making the VT-terminal voltage-related settings work when the VT-terminal voltage inputs are LEA (8 V) inputs is to set the VT-terminal PT ratio setting (PTR), as follows:

$$\text{setting PTR} = (\text{PTR}_{\text{LEA}}) \bullet \left(\frac{7.686}{300}\right)$$

Equation 6.1

where PTR_{LEA} is the effective nominal PT ratio of the voltage divider connected between the primary system and the LEA inputs (e.g., PTR_{LEA} = 10000). PTR_{LEA} is also referred to as the marked ratio. Again, the SEL-2411 thinks it is looking at a 300 V range signal, when the LEA inputs actually have only a 7.686 V range. Thus, PTR_{LEA} is corrected by a 7.686 / 300 factor (7.686 V / 300 V = 7.686 / 300) in *Equation 6.1*.

EXAMPLE 6.1 Setting PTR for LEA Inputs

A voltage divider (10000 ratio) is connected between a 12.47 kV system (7.2 kV line-to-neutral) and the LEA inputs (similar to Example 6.5).

PTR_{LEA} = 10000 = marked ratio

Using Equation 6.1:

$$\text{setting PTR} = (\text{PTR}_{\text{LEA}}) \bullet \left(\frac{7.686}{300}\right)$$

$$= 10000 \bullet \left(\frac{7.686}{300}\right) = 256.20$$

Equation 6.2

$$\frac{7200\ \text{V}}{10000} = 0.72\ \text{V}$$ (actual voltage divider output to the LEA inputs; 8 V base)

$$\frac{0.72\ \text{V}}{7.686\ \text{V}} = 0.0937\ \text{per unit output}$$ (9.4% of full scale)

$$0.0937 \bullet 300\ \text{V} = 28.10\ \text{V}$$ (the device thinks it is looking at 28.10 V on a 300 V base, not 0.72 V on an 7.686 V base)

$$\frac{7200\ \text{V}}{28.10\ \text{V}} = 256.20$$ (same as setting PTR in Equation 6.2)

Setting PTR in *Equation 6.1* is used to take these 300 V base secondary voltage values (that the SEL-2411 thinks it sees) and ratio them up to primary values for metering and event reports.

Voltage-Related Settings and Low Energy Analog (LEA) Inputs

Read the setting PTRY/LEA discussion in the preceding *Potential Transformer (PT) Ratios on page 6.6* subsection.

When the VT-terminal voltage inputs are LEA (8 V) inputs, any voltage-related setting tied to the VT-terminal voltage inputs is adjusted by a factor of 300/7.686.

EXAMPLE 6.2 Voltage Setting Conversion to 300 V Base

This example uses much of the same information in Example 6.1. A voltage divider (10000 ratio) is connected between a 12.47 kV system (7.2 kV line-to-neutral) and the LEA inputs.

$$\frac{7200\ \text{V}}{10000} = 0.72\ \text{V}$$ (actual voltage divider output to the LEA inputs; 8 V base)

$$0.72\ \text{V} \bullet \frac{300}{7.686} = 28.103\ \text{V}$$ (the device thinks it is looking at 28 V on a 300 V base, not 0.72 V on an 8 V base)

28 V is the nominal adjusted secondary voltage—adjusted by the 300/8 factor from an 8 V base to a 300 V base. For this same example, if a 0.8 V output of the LEA (8 V base) is deemed an overvoltage condition, then a pickup setting could be set at:

$$0.8\ \text{V} \bullet \frac{300}{7.686} = 31.23\ \text{V} \qquad (300\ \text{V base})$$

Voltage-Related Settings Possibly Limited by RCF Settings

Read the preceding *Voltage Ratio Correction Factors for VT-Terminal Voltage Inputs on page 6.24* subsection.

If most of the voltage range for VT-terminal voltage inputs (ordered as LEA [8 V] inputs) is used in a particular installation (i.e., the nominal applied secondary voltage is close to or equal to 8 V), then a ratio correction factor (RCF) set below unity (RCF < 1.000) can effectively limit the upper setting range of a voltage-related setting.

This subsection, together with *Example 6.2*, discusses making voltage-related settings for LEA (8 V) inputs by applying an adjustment factor of 300/7.686. This adjustment factor puts the setting on a 300 V base. Thus, a 7.686 V signal on an LEA (8 V) input translates to a 300 V signal on a 300 V base. 300 V is the upper setting range for the phase-to-neutral voltage-related settings.

For example, if the RCF for voltage input V2Y is set:

$$\text{global setting VARCF} = 0.900 \qquad (< 1.000\text{; set below unity})$$

and 7.686 V is applied to voltage input VAR, then this applied voltage is normalized to:

$$7.686\text{ V} \bullet 0.900 = 6.9174\text{ V} \quad \text{(normalized voltage from voltage input VAR)}$$

8 V is the upper limit for voltage that can be applied to the VT-terminal voltage inputs. Assuming the above 0.900 RCF is the lowest RCF for the VT-terminal voltage inputs and that the normalized voltages for all the voltage inputs should be 6.9174, then the maximum applied voltages for the other two channels (RCF's > 0.900) must be less than 8 V:

$$\frac{6.9174\text{ V}}{\text{RCF}} < 7.686 \qquad (\text{RCF} > 0.900)$$

The 6.9174 V normalized voltage in this example translates to 270 V on a 300 V base:

$$6.9174\text{ V} \bullet \frac{300}{7.686} = 270\text{ V} \quad \text{(300 V base)}$$

270 V is thus the effective upper setting range for the phase-to-neutral voltage-related settings in this example. A phase-to-neutral voltage-related setting can be set higher (e.g., 290 V), but for voltage input VAR such a setting would be indistinguishable from a 270 V setting, in this example. The VT-terminal voltage inputs (ordered as LEA [8 V] inputs) cannot distinguish voltages above 8 V.

$$7.686\text{ V} \bullet 0.900 \bullet \frac{300}{7.686} = 270\text{ V} \quad \text{(300 V base)}$$

Preceding *Example 6.2* is **not** an example of this possible effective limiting of the upper setting range of voltage-related settings. In *Example 6.2*, the nominal applied secondary voltage to the VT-terminal voltage inputs is 6.9174 V, no where near the 7.686 V upper limit for VT-terminal voltage inputs (ordered as LEA [8 V] inputs).

Analog Inputs

For an SEL-2411 configuration without voltage or current cards, the device samples all analog inputs at a fixed value of 4 ms regardless of the frequency of the power system. When the SEL-2411 configuration includes either voltage or current cards (or both), the device tracks the frequency (using positive-sequence quantities), and samples the analog inputs four times per power system cycle; see *Sampling and Processing Specifications on page 1.10* for more information. For the eight analog inputs, set the following parameters for each input:

- Analog type
- High and low input levels
- Engineering units

Because of the flexibility to install different cards in the rear-panel slot on the device, the setting prompt adapts to the *x* and *y* variables shown in *Figure 6.2*. Variable *x* displays the slot position (3 through 6), and variable *y* displays the transducer (analog) input number (1 through 8).

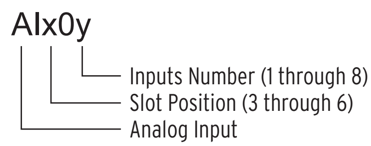


Figure 6.2 Analog Input Names

Analog Input Calibration Process

In the analog input circuit, the dominant error is signal offset. To minimize the signal offset, we adjust each of the device analog input channels by a compensation factor. These compensation factors correct the signal offset errors to within ±1 uA or ±1 mV.

Signal offset compensation factor calculation procedure:

1. Turn the SEL-2411 on and allow it to warm up for a few minutes.
2. Set the analog inputs for each analog channel to the desired range (e.g., ±1 mA), using the AIxxxTYP, AIxxxL, and AIxxxH settings.
3. Short each analog input in turn at the device terminals using short, low resistance leads with solid connections.
4. Issue the command “MET AI 10” to obtain ten measurements for each channel.
5. Record these ten measurements, then calculate the average of the ten measurements by adding the ten values algebraically, and dividing the sum by ten. This is the average offset error (e.g., -0.014 mA).
6. Negate this value (i.e., flip the sign) and add the result to each of the AIxxxL and AIxxxH quantities. For this example, the new AIxxxL and AIxxxH values are -0.986 mA and 1.014 mA.

Analog Input Setting Example

Assume we installed an analog card in Slot 3. On Input 1 of this analog card, we connect a 4–20 mA transducer driven from a device that measures temperature on a transformer load tap changer mechanism. For this temperature transducer, 4 mA corresponds to –50°C, and 20 mA corresponds to 150°C. You have already installed the correct hardware jumper (see *Section 2: Installation* for more information) for Input 1 to operate as a current input. At powerup, allow approximately five seconds for the SEL-2411 to boot up, perform self-diagnostics, and detect installed cards.

Table 6.7 summarizes the steps and describes the settings we will carry out in this example.

Table 6.7 Summary of Steps

	Step	Activity	Terse Description
General	1	SET AI301NAM	Access settings for INPUT 1
	2	TX_TEMP	Enter a Tag name
	3	I	Select type of analog input; "I" for current
Level	4	Degrees C	Enter Engineering unit
	5	–50	Enter Engineering unit value LOW
	6	150	Enter Engineering unit value HIGH
Low Warning/ Alarm	7	OFF	Enter LOW WARNING 1 value
	8	OFF	Enter LOW WARNING 2 value
	9	OFF	Enter LOW ALARM value
High Warning/ Alarm	10	65	Enter HIGH WARNING 1 value
	11	95	Enter HIGH WARNING 2 value
	12	105	Enter HIGH ALARM value

Because the analog card is in Slot 3, type **SET AI301NAM <Enter>** (**SET** with no setting category assumes the device setting category) to go directly to the setting for Slot 3, Input 1. Although the device accepts alphanumeric characters, the name AI*x*0*y*NAM setting must begin with an alpha character (A through Z) and not a number. The device displays the following prompt:

NOTE: The AIx0yNAM setting cannot accept the following:
Analog Quantities
Duplicate Names
Other AI Names

```
AI301 Instrument Tag Name (8 Chars 0-9,A-Z,_)   AI301NAM:= AI301 ?
```

Use the Instrument Tag Name to give the analog quantity a more descriptive name. This tag name appears in reports (EVENT, METER, and SUMMARY) instead of the default name of AI301. SELOGIC® control equations, signal profiles, and Fast Message read use the default names. Use up to eight valid tag name characters to name the analog quantity. Valid tag names characters are: 0–9, A–Z, and the underscore (_). For this example, we assign TX_TEMP as the tag name.

Because this is a 4–20 mA transducer, enter **I <Enter>** (for current driven device) at AI301TYP, the next prompt (enter **V** if this is a voltage-driven device). The next two settings define the lower level (AI301L) and the upper level (AI301H) of the transducer. In this example, the low level is 4 mA and the high level is 20 mA.

```
AI301 Type       (I,V)                          AI301TYP:= I        ?
```

NOTE: Because the SEL-2411 accepts current values ranging from –20.48 to 20.48 mA, be sure to enter the correct range values.

The next three settings define the applicable engineering unit (AI301EU), the lower level in engineering units (AI301EL) and the upper level in engineering units (AI301EH). Engineering units refer to actual measured quantities, i.e., temperature, pressure, etc. Use the 16 available characters to assign descriptive names for engineering units. Because we measure temperature in this example, enter "degrees C" (without quotation marks) as engineering units. Enter –50 for the lower level and 150 for the upper level.

With the levels defined, the next six settings provide two warning settings and one alarm setting for low temperature values, as well as two warning settings and one alarm setting for high temperature values. State the values in engineering units, not the setting range of the transducer. Note the difference between low warnings and alarm functions and high warnings and alarm functions: low warnings and alarm functions assert when the measured value falls below the setting; high warnings and alarm functions assert when the measured values rise above the setting. In this example, we measure the oil temperature of a power transformer, and we want the following three actions to take place at three different temperature values:

- At 65°C, start the cooling fans
- At 95°C, send an alarm
- At 105°C, trip the transformer

Because we are only interested in cases when the temperature values exceed their respective temperature settings (high warnings and alarm functions), we do not use the low warnings and alarm functions. Therefore, set the lower values (AI301LW1, AI301LW2, AI301LAL) to OFF, and the three higher values as shown in *Figure 6.3*. Set inputs connected to voltage driven transducers in a similar way.

```
=>>SET AI301NAM TERSE <Enter>

Analog Input 301 Settings

AI301 Instrument Tag Name (8 characters 0-9,A-Z,_)
AI301NAM:= AI301
? TX_TEMP <Enter>
AI301 Type (I,V)                               AI301TYP:= I        ? <Enter>
AI301 Low Input Value (-20.480 to 20.480 mA)   AI301L  := 4.000    ? <Enter>
AI301 High Input Value (-20.480 to 20.480 mA)  AI301H  := 20.000   ? <Enter>
AI301 Engineering Units (16 characters)
AI301EU := mA
? degrees C <Enter>
AI301 Engineering Unit Low (-99999.000 to 99999.000)
                                               AI301EL := 4.000    ? -50 <Enter>
AI301 Engineering Unit High (-99999.000 to 99999.000)
                                               AI301EH := 20.000   ? 150 <Enter>
AI301 Low Warn Level 1 (OFF,-99999.000 to 99999.000)
                                               AI301LW1:= OFF      ? <Enter>
AI301 Low Warn Level 2 (OFF,-99999.000 to 99999.000)
                                               AI301LW2:= OFF      ? <Enter>
AI301 Low Alarm (OFF,-99999.000 to 99999.000)  AI301LAL:= OFF      ? <Enter>
AI301 High Warn Level 1 (OFF,-99999.000 to 99999.000)
                                               AI301HW1:= OFF      ? 65 <Enter>
AI301 High Warn Level 2 (OFF,-99999.000 to 99999.000)
                                               AI301HW2:= OFF      ? 95 <Enter>
AI301 High Alarm (OFF,-99999.000 to 99999.000) AI301HAL:= OFF      ? 105 <Enter>

Analog Input 402 Settings

AI302 Instrument Tag Name (8 characters 0-9,A-Z,_)
AI302NAM:= AI302
? END <Enter>

Save changes (Y,N)? Y <Enter>
Settings Saved

=>>
```

Figure 6.3 Settings to Configure Input 1 as a 4-20 mA Transducer, Measuring Temperatures Between -50°C and 150°C

Analog Input Settings

Table 6.8 shows the setting prompt, setting range, and factory default settings for an analog input card in Slot 3. For the name setting (AI301NAM, for example), enter only alphanumeric and underscore characters. Characters are not case sensitive, but the device converts all lowercase characters to uppercase. Although the device accepts alphanumeric characters, the name AI301NAM setting must begin with an alpha character (A–Z) and not a number.

Table 6.8 Analog Input Card in Slot 3

Setting Prompt	Setting Range	Setting Name := Factory Default
AI301 Instrument Tag Name	8 characters 0–9, A–Z, _	AI301NAM := AI301
AI301 Type	I, V	AI301TYP := I[a]
AI301 Low Input Value	–20.480 to +20.480 mA	AI301L := 4.000
AI301 High Input Value	–20.480 to +20.480 mA	AI301H := 20.000
AI301 Low Input Value	–10.240 to +10.240 V	AI301L := 0.000
AI301 High Input Value	–10.240 to +10.240 V	AI301H := 10.000
AI301 Engineering Units	16 characters	AI301EU := mA
AI301 Engineering Unit Low	–99999.000 to +99999.000	AI301EL := 4.000
AI301 Engineering Unit High	–99999.000 to +99999.000	AI301EH := 20.000
AI301 Low Warn Level 1	OFF, –99999.000 to +99999.000	AI301LW1 := OFF
AI301 Low Warn Level 2	OFF, –99999.000 to +99999.000	AI301LW1 := OFF
AI301 Low Alarm	OFF, –99999.000 to +99999.000	AI301LAL := OFF
AI301 High Warn Level 1	OFF, –99999.000 to +99999.000	AI301HW1 := OFF
AI301 High Warn Level 2	OFF, –99999.000 to +99999.000	AI301HW2 := OFF
AI301 High Alarm	OFF, –99999.000 to +99999.000	AI301HAL := OFF

[a] Voltage setting range for a voltage transducer, i.e., when AI301TYP := V

Analog Outputs

Because of the flexibility to install different cards in the rear-panel slots of the device, the setting prompt adapts to the *x* and *y* variables shown in *Figure 6.4*. Variable *x* displays the slot position (3 through 6) and variable *y* displays the Analog Output number (1 through 8).

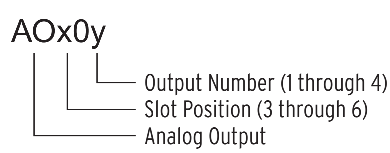


Figure 6.4 Analog Output Names

For an analog input/output card in Slot 3, setting AO301AQ identifies the analog quantity we assign to Analog Output 1 (when set to OFF, the device hides all associated AO*x*0*y* settings and no value appears on the output). You can assign any of the analog values in *Appendix I: Analog Quantities* to an analog output.

Table 6.9 shows the setting prompt, setting range, and factory default settings for an analog card in Slot 3. For the name setting (AI301NAM, for example), enter only alphanumeric and underscore characters. Characters are not case sensitive, but the device converts all lowercase characters to uppercase. Although the device accepts alphanumeric characters, the name AO301NAM setting must begin with an alpha character (A–Z) and not a number.

NOTE: The AOxOyNAM setting cannot accept the following:
- Analog Quantities
- Duplicate Names
- Other AI Names

Table 6.9 Output Setting for a Card in Slot 3

Setting Prompt	Description	Setting Range	Setting Name := Factory Default
AO301AQ	Analog Quantity	Analog Quantity Value	AO301AQ := OFF
AO301NAM	Instrument Tag Name	8 characters 0–9, A–Z, _	AO301NAM := AO30I
AO301TYP	Type	I, V	AO301TYP := I
AO301AQL	Analog Quantity Low	–2147483647.000 to +2147483647.000	AO301AQL := 4.000
AO301AQH	Analog Quantity High	–2147483647.000 to +2147483647.000	AO301AQH := 20.000
[a]AO301L	Low Output Value	–20.480 to +20.480 mA	AO301L := 4.000
[a]AO301H	High Output Value	–20.480 to +20.480 mA	AO301H := 20.000
[b]AO301L	Low Output Value	–10.240 to +10.240 V	AO301L := 0.000
[b]AO301H	High Output Value	–10.240 to +10.240 V	AO301H := 10.000

[a] For AO301TYP = I
[b] For AO301TYP = V

In this example, assume we want to display the transformer temperature measurement from Analog Input AI301 (relabeled TX_TEMP) on an instrument in the station control room that operates on 4–20 mA. We install an analog output card in Slot D, and set the card as shown in *Figure 6.5*.

```
=>>SET A0401AQ TERSE <Enter>

Device

Analog Output 401 Settings

A0401 Analog Quantity (1 analog quantity)
A0401AQ := OFF
? AI301 <Enter>
A0401 Type (I,V)                              A0401TYP:= I         ? <Enter>
A0401 Analog Quantity Low (-2147483647.000 to 2147483647.000)
                                              A0401AQL:= 4.000     ? 4 <Enter>
A0401 Analog Quantity High (-2147483647.000 to 2147483647.000)
                                              A0401AQH:= 20.000    ? 20 <Enter>
A0401 Low Output Value (-20.480 to 20.480 mA) A0401L  := 4.000     ? <Enter>
A0401 High Output Value (-20.480 to 20.480 mA) A0401H  := 20.000   ? <Enter>

Analog Output 402 Settings

A0402 Analog Quantity (1 analog quantity)
A0402AQ := OFF
? END <Enter>
Save changes (Y,N)? Y <Enter>
Settings Saved

=>>
```

Figure 6.5 Analog Output Settings

Internal RTD Inputs

Table 6.10 Input Settings for Internal RTD Card in Slot 3 (Sheet 1 of 2)

Setting Prompt	Description	Setting Range	Setting Name := Factory Default
IRTD1TY	Internal RTD Card	PT100, NI100, NI120, CU10, NONE	None
IRTD2TY	Internal RTD Card	PT100, NI100, NI120, CU10, NONE	None
IRTD3TY	Internal RTD Card	PT100, NI100, NI120, CU10, NONE	None

Table 6.10 Input Settings for Internal RTD Card in Slot 3 (Sheet 2 of 2)

Setting Prompt	Description	Setting Range	Setting Name := Factory Default
IRTD4TY	Internal RTD Card	PT100, NI100, NI120, CU10, NONE	None
IRTD5TY	Internal RTD Card	PT100, NI100, NI120, CU10, NONE	None
IRTD6TY	Internal RTD Card	PT100, NI100, NI120, CU10, NONE	None
IRTD7TY	Internal RTD Card	PT100, NI100, NI120, CU10, NONE	None
IRTD8TY	Internal RTD Card	PT100, NI100, NI120, CU10, NONE	None
IRTD9TY	Internal RTD Card	PT100, NI100, NI120, CU10, NONE	None
IRTD10TY	Internal RTD Card	PT100, NI100, NI120, CU10, NONE	None

Universal Temperature Card Inputs

Table 6.11 Input Settings for Internal General Purpose RTD/TC Card in Slot 3

Setting Prompt	Description	Setting Range	Setting Name := Factory Default
TEMP1TY	Internal RTD/TC Card	PT100, NI100, NI120, CU10, J, K, T, E, NONE	None
TEMP2TY	Internal RTD/TC Card	PT100, NI100, NI120, CU10, J, K, T, E, NONE	None
TEMP3TY	Internal RTD/TC Card	PT100, NI100, NI120, CU10, J, K, T, E, NONE	None
TEMP4TY	Internal RTD/TC Card	PT100, NI100, NI120, CU10, J, K, T, E, NONE	None
TEMP5TY	Internal RTD/TC Card	PT100, NI100, NI120, CU10, J, K, T, E, NONE	None
TEMP6TY	Internal RTD/TC Card	PT100, NI100, NI120, CU10, J, K, T, E, NONE	None
TEMP7TY	Internal RTD/TC Card	PT100, NI100, NI120, CU10, J, K, T, E, NONE	None
TEMP8TY	Internal RTD/TC Card	PT100, NI100, NI120, CU10, J, K, T, E, NONE	None
TEMP9TY	Internal RTD/TC Card	PT100, NI100, NI120, CU10, J, K, T, E, NONE	None
TEMP10TY	Internal RTD/TC Card	PT100, NI100, NI120, CU10, J, K, T, E, NONE	None

External RTD Inputs

Table 6.12 Input Settings for External RTD from SEL-2600 Modules

Setting Prompt	Description	Setting Range	Setting Name := Factory Default
ERTD1TY	External RTD from SEL-2600 Modules	PT100, NI100, NI120, CU10, NONE	None
ERTD2TY	External RTD from SEL-2600 Modules	PT100, NI100, NI120, CU10, NONE	None
ERTD3TY	External RTD from SEL-2600 Modules	PT100, NI100, NI120, CU10, NONE	None
ERTD4TY	External RTD from SEL-2600 Modules	PT100, NI100, NI120, CU10, NONE	None
ERTD5TY	External RTD from SEL-2600 Modules	PT100, NI100, NI120, CU10, NONE	None
ERTD6TY	External RTD from SEL-2600 Modules	PT100, NI100, NI120, CU10, NONE	None
ERTD7TY	External RTD from SEL-2600 Modules	PT100, NI100, NI120, CU10, NONE	None
ERTD8TY	External RTD from SEL-2600 Modules	PT100, NI100, NI120, CU10, NONE	None
ERTD9TY	External RTD from SEL-2600 Modules	PT100, NI100, NI120, CU10, NONE	None
ERTD10TY	External RTD from SEL-2600 Modules	PT100, NI100, NI120, CU10, NONE	None
ERTD11TY	External RTD from SEL-2600 Modules	PT100, NI100, NI120, CU10, NONE	None
ERTD12TY	External RTD from SEL-2600 Modules	PT100, NI100, NI120, CU10, NONE	None

Global Settings (SET G Command)

Use the serial command **SET G <Enter>** to access the Global settings category. In the Global settings category, we set the Messenger Points phase rotation, rated frequency, CT and PT connections, date format, debounce times for each input of each installed digital input I/O card (DI card), data reset, front-panel disable setting, time synchronization source, and voltage correction factor.

General Settings

Table 6.13 General Global Settings

Setting Prompt	Setting Range	Setting Name := Factory Default
Phase Rotation	ABC, ACB	PHROT := ABC
Rated Frequency	50, 60 Hz	FNOM := 60
Transformer Connection	DELTA, WYE	DELTA_Y := WYE
Date Format	MDY, YMD, DMY	DATE_F := MDY

The phase rotation setting tells the device your phase labeling standard. Set PHROT equal to ABC when B-phase lags A-phase by 120 degrees. Set PHROT equal to ACB when B-phase leads A-phase by 120 degrees.

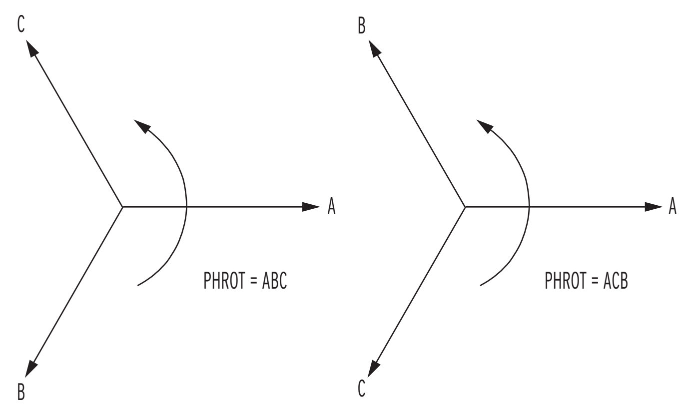


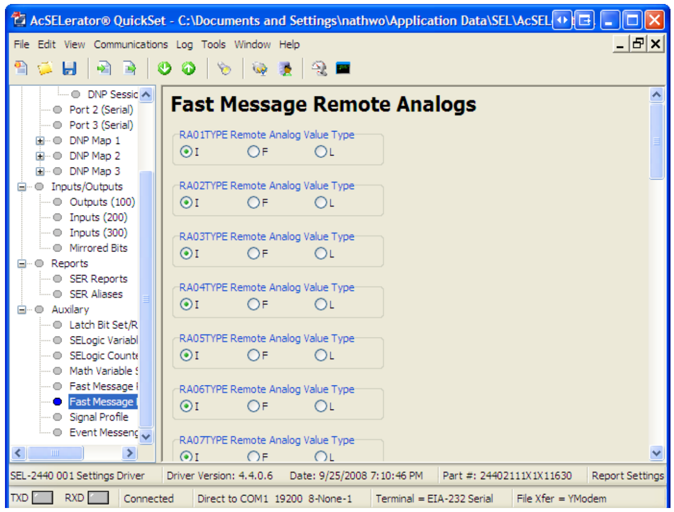
Figure 6.6 Phase Rotation Setting

Set the FNOM setting equal to your system nominal frequency. The DATE_F setting allows you to change the device date presentation format to either North American standard (Month/Day/Year), engineering standard (Year/Month/Day), or European standard (Day/Month/Year).

Fast Message Remote Analogs Settings

NOTE: When Type is set to Float, you cannot write the maximum value of 99999.99 to a remote analog. Instead, use 99999.98 as the maximum number. Similarly, use –99999.98 instead of –99999.99.

Remote devices are able to write analog quantities into the PAC using protocols such as Modbus® and DNP3 (RA001 through RA128) and SEL Fast Message (RA01 through RA32). These analog quantities are available for use in Math Variable equations. If the SEL Fast Message protocol is used then the data type must be declared for each analog quantity (RA01TYPE through RA32TYPE). Choose from the analog quantities in *Appendix I: Analog Quantities*.



Event Messenger Points

Table 6.14 Event Messenger Points

Setting Prompt	Setting Range	Setting Name := Factory Default
MESSENGER POINT TRIGGER	Off, 1 Device Word bit	MPTR1 := OFF
MESSENGER POINT ANALOG QUANTITY	None, 1 analog quantity	MPAQ1 := NONE
MESSENGER POINT TEXT	148 characters	MPTX1 :=
MESSENGER POINT TRIGGER	Off, 1 Device Word bit	MPTR2 := OFF
MESSENGER POINT ANALOG QUANTITY	None, 1 analog quantity	MPAQ2 := NONE
MESSENGER POINT TEXT	148 characters	MPTX2 :=
MESSENGER POINT TRIGGER	Off, 1 Device Word bit	MPTR3 := OFF
MESSENGER POINT ANALOG QUANTITY	None, 1 analog quantity	MPAQ3 := NONE
MESSENGER POINT TEXT	148 characters	MPTX3 :=
MESSENGER POINT TRIGGER	Off, 1 Device Word bit	MPTR4 := OFF
MESSENGER POINT ANALOG QUANTITY	None, 1 analog quantity	MPAQ4 := NONE
MESSENGER POINT TEXT	148 characters	MPTX4 :=
MESSENGER POINT TRIGGER	Off, 1 Device Word bit	MPTR5 := OFF
MESSENGER POINT ANALOG QUANTITY	None, 1 analog quantity	MPAQ5 := NONE
MESSENGER POINT TEXT	148 characters	MPTX5 :=

The SEL-2411 can be configured to automatically send ASCII message on a communications port when trigger condition is satisfied. Use the **SET P** command to set PROTO := EVMSG on the desired port to select the port. This feature is designed to send messages to the SEL-3010 Event Messenger, however, any device capable of receiving ASCII messages can be used.

NOTE: When Event Messenger points are selected for the desired port, all other communications on the selected port are disabled.

Set each of MPTR*x* (*x* = 1–5) to the desired Device Word bits, the rising edge of which defines the trigger condition. Trigger conditions for Event Messenger points are updated every five seconds.

MPAQ*x* is an optional setting and can be used to specify an analog quantity to be formatted into a single message as described next.

Use MPTX*x* to construct the desired message. Note that by default the analog quantity value, if specified, will be added at the end of the message, rounded to the nearest integer value (see *Example 6.3*).

EXAMPLE 6.3 Setting MPTXx Using the Default Location of Analog Quantity

MPTX1 := THE LOAD CURRENT IS

MPAQ1 value = 157.44

Formatted message out when triggered: THE LOAD CURRENT IS 157

Location and resolution of the analog quantity value within the message can be specified by using "%.pf", where,

% defines location of the value

p defines number of digits (up to 6, defaults to 6 if omitted)

f indicates floating point value (use %d if nearest whole number is desired)

EXAMPLE 6.4 Setting MPTXx With a Specified Location of Analog Quantity

MPTX1 := THE LOAD CURRENT IS %.2f AMPERES

MPAQ1 value = 157.44

Formatted message out when triggered: THE LOAD CURRENT IS 157.44 AMPERES

MPTX1 := THE LOAD CURRENT IS %d AMPERES

MPAQ1 value = 157.44

Formatted message out when triggered: THE LOAD CURRENT IS 157 AMPERES

Digital Input Configuration

You can configure the SEL-2411 with up to four DI cards, one in each of the four available slots (slots C, D, E, and Z). Because of the flexibility of inserting I/O cards in any of the assigned slots, each connection has two numbers. The first number refers to the physical position (rear-panel terminal number); the second is a software reference number. To determine the software reference number, the device senses the position of the installed cards and adapts the setting names accordingly. Use the software reference numbers to program the I/O in the device. *Table 6.15* shows the slot number and prompt correlation for a DI card.

Table 6.15 Slot Number and Setting Correlation

Slot Number	Setting Number	Example
C	3	IN301
D	4	IN401
E	5	IN501
Z	6	IN601

Rear-panel terminal numbers are the same for all three types of I/O cards. State the rear-panel terminal numbers on schematic diagrams to show wiring connections. *Table 6.16* shows the rear-panel terminal number and software reference number correlation for a DI card.

Table 6.16 Rear-Panel Terminal Number and Software Reference Number Correlation (DI Card) (Sheet 1 of 2)

Rear-Panel Terminal Number	Software Reference Number[a]
01, 02	IN*x*01
03, 04	IN*x*02
05, 06	IN*x*03
07, 08	IN*x*04

Table 6.16 Rear-Panel Terminal Number and Software Reference Number Correlation (DI Card) (Sheet 2 of 2)

Rear-Panel Terminal Number	Software Reference Number[a]
09, 10	IN*x*05
11, 12	IN*x*06
13, 14	IN*x*07
15, 16	IN*x*08

[a] *x* = 3, 4, 5, or 6 (for example, IN401, IN402, etc. if the card was installed in Slot D).

The device reserves variables and memory for four DI cards, but hides the settings when DI cards are not installed. For example, we install a DI card in Slot D and apply the appropriate settings. We then remove the card from Slot D and install the card into Slot 5. All settings associated with Slot D are stored, but the variables are hidden. We can now enter new settings for the card in Slot E. If we once again install the card (or another DI card) in Slot D, the previously saved Slot D settings apply and the variables are no longer hidden.

Digital Input Debounce

To comply with different control voltages, the SEL-2411 offers dc debounce as well as ac debounce modes. Therefore, if the control voltage is dc, select the dc mode of operation, and if the control voltage is ac, select the ac mode of operation. In general, debounce refers to a qualifying time delay before processing the change of state of a digital input. Normally, this delay applies to both the processing of the debounced input when used in device logic, as well as to the time stamping in the SER. However, in some cases, it is also important to record the time of first assertion of the input. This information is useful to time-align events from two unsynchronized devices when one device operated on receipt of the output from the other device. To this end, the SEL-2411 provides both the time of first assertion information as well as the delayed time information as separate Device Word bits when set to the dc debounce mode. Following is a description of the two modes.

DC Mode Processing (DC Control Voltage)

Figure 6.7 shows the logic for the dc debounce mode of operation. To select the dc mode of debounce, set IN101D to any number between 0 and 65000 ms. In the figure, Input IN101 becomes IN101R (internal variable), after analog-to-digital conversion. On assertion, IN101R starts Debounce Timer 1, producing Device Word bit IN101 after the debounce time delay, and Device Word bit IN101E from the edge detection logic. The debounce timer is a pickup/dropout combination timer, with debounce setting IN101D applying to both pickup (pu) and dropout (do) timers of both Debounce Timer 1 and Debounce Timer 2, i.e., you cannot set any timer individually. For example, a setting of IN101D = 20 ms delays processing of the input signal by 20 ms (pu) and maintains the output of the timer (do) for 20 ms. Device Word bit IN101 is the output of the debounce timer. If you do not want to debounce a particular input, still use Device Word bit IN101 in logic programming, but set the debounce time delay to 0 (IN101D = 0).

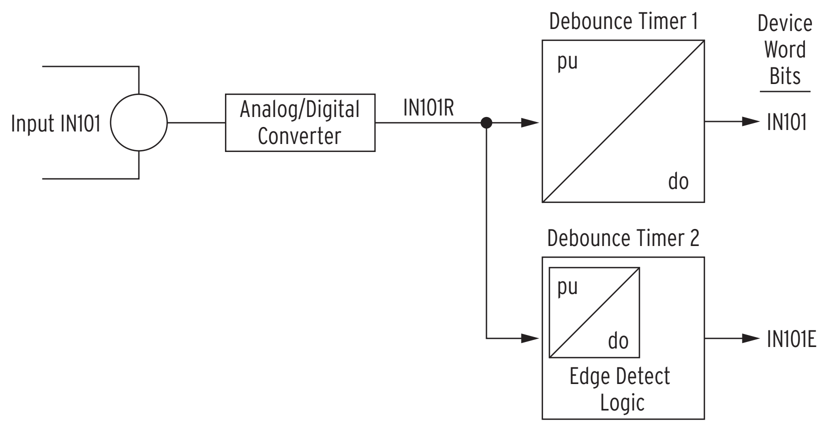


Figure 6.7 DC Mode Processing

Figure 6.8 shows a timing diagram when IN101R changes from the deasserted state to the asserted state. At the first assertion of IN101R, the following takes place:

- Device Word bit IN101E asserts
- Debounce Timer 2 starts
- All edge changes are ignored

If you want to record the time of first assertion of IN101, be sure to enter Device Word bit IN101E in the SER. During the time when Debounce Timer 2 runs, the device ignores all edge changes. At the end of this timing period, the device evaluates the status of IN101R (either logical 0, or logical 1), and sets Device Word bit IN101E to this value. In *Figure 6.8*, IN101R has a status of logical 1 and Device Word bit IN101E remains at logical 1.

Device Word bit IN101 asserts only if IN101R stays asserted for the complete duration of Debounce Timer 1. If IN101R deasserts at any point while Debounce Timer 1 is running, Debounce Timer 1 resets, and starts timing from the beginning at the next rising edge.

When changing from the asserted state to the deasserted state, the inverse operation applies, as shown in *Figure 6.9*.

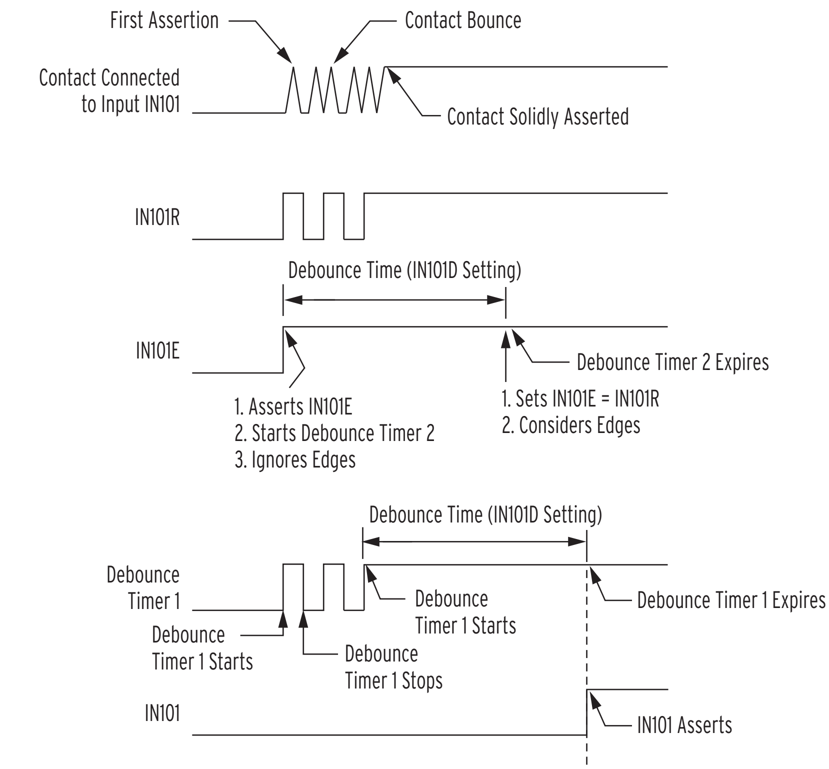


Figure 6.8 Timing Diagram When IN101R Changes From the Deasserted State to the Asserted State

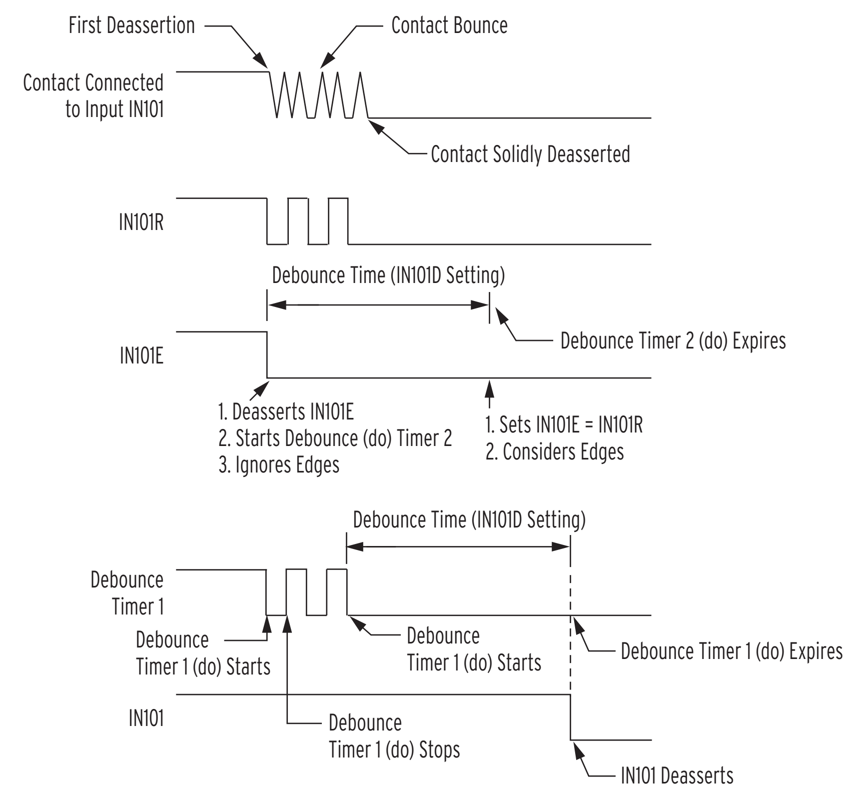


Figure 6.9 Timing Diagram When Input IN101 Changes From the Asserted State to the Deasserted State

AC Mode Processing (AC Control Voltage)

Figure 6.10 shows IN101R from Input IN101 applied to a pickup/dropout timer. Different from the dc mode, only the delayed time information is available in the ac mode. There are also no time settings for the debounce timer in the ac mode: the pickup time delay is fixed at 2 ms, and the dropout time is fixed at 16 ms. Device Word bit IN101 is the output of the debounce timer. To select the ac mode of debounce, set IN101D = AC.

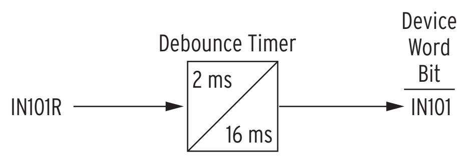


Figure 6.10 AC Mode Processing

Figure 6.11 shows a timing diagram for the ac mode of operation. On the rising edge of IN101R, the pickup timer starts timing (points marked 1 in *Figure 6.11*). If IN101R deasserts (points marked 2 in *Figure 6.11*) before expiration of the pickup time setting, Device Word bit IN101 does not assert, and remains at logical 0. If, however, IN101R remains asserted for a period longer than the pickup timer setting, then Device Word bit IN101 asserts to a logical 1.

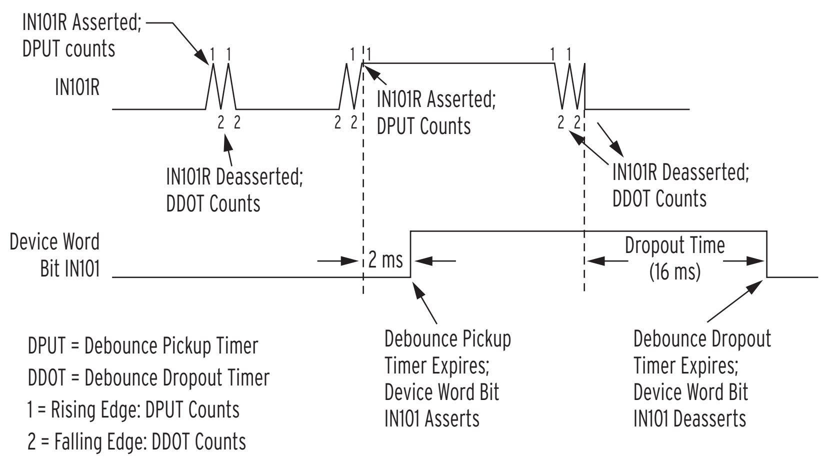


Figure 6.11 Timing Diagram for Debounce Timer Operation When Operating in AC Mode

Deassertion follows the same logic. On the falling edge of IN101R, the dropout timer starts timing. If IN101R remains deasserted for a period longer than the dropout timer setting, then Device Word bit IN101 deasserts to a logical 0.

Table 6.17 shows the settings prompt, setting range, and factory default settings for a card in Slot 3.

Table 6.17 General Global Settings

Setting Prompt	Setting Range	Setting Name := Factory Default
IN301 Debounce	AC, 0–65000 ms	IN301D := 10
IN302 Debounce	AC, 0–65000 ms	IN302D := 10
IN303 Debounce	AC, 0–65000 ms	IN303D := 10
IN304 Debounce	AC, 0–65000 ms	IN304D := 10
IN305 Debounce	AC, 0–65000 ms	IN305D := 10
IN306 Debounce	AC, 0–65000 ms	IN306D := 10
IN307 Debounce	AC, 0–65000 ms	IN307D := 10
IN308 Debounce	AC, 0–65000 ms	IN308D := 10

Data Reset

The RSTTRGT setting resets the front-panel LEDs, provided all LED initiate conditions were cleared. *Table 6.18* shows the settings prompt, setting range, and factory default settings.

Table 6.18 Target Reset Setting

Setting Prompt	Setting Range	Setting Name := Factory Default
Target Reset	SV	RSTTRGT := NA

Time Synchronization Source

This setting is only available when the Device configuration includes a fiber-optic port. Use the Time Synchronization Source Setting to declare the source of the IRIG input. The SEL-2411 accepts IRIG input from either Port 2 or Port 3. If the IRIG source is Port 3, select IRIG1 as the setting. If the IRIG source is Port 2 (fiber-optic port), select IRIG2 as the setting.

Table 6.19 Time Synchronization Source Setting

Setting Prompt	Setting Range	Setting Name := Factory Default
IRIG Time Source	IRIG1, IRIG2	TIME_SRC := IRIG1

Access Control

The DSABLSET setting defines conditions for disabling all setting changes from the front-panel interface. To disable setting changes from the front-panel interface, assign, for example, a contact input (e.g., DSABLSET := IN402) to the DSABLSET setting. When Device Word bit DSABLSET asserts, you can view the device settings from the front-panel interface, but you can only change settings using serial port commands. *Table 6.20* shows the settings prompt, setting range, and factory default settings.

Table 6.20 Setting Change Disable Setting

Setting Prompt	Setting Range	Setting Name := Factory Default
Disable FP Settings Change	SV	DSABLSET := NA

Voltage Ratio Correction Factor

Table 6.21 Voltage Ratio Correction Factor

Setting Prompt	Setting Range	Setting Name := Factory Default
VARCF	0.5 to 1.5	
VBRCF	0.5 to 1.5	
VCRCF	0.5 to 1.5	

Voltage Ratio Correction Factors for VT-Terminal Voltage Inputs

Make the VARCF, VBRCF, and VCRCF ratio correction factor global settings for the voltage inputs (VA, VB, and VC, respectively) when the SEL-2411 is ordered with Low Energy Analog (LEA) voltage inputs on the 3 ACI/3 AVI combination card. Ratio correction factor (RCF) settings compensate for irregularities (on a per-phase basis) of voltage dividers connected between the primary voltage system and the LEA (8 V) inputs. The derivation of the RCF value for a voltage divider for a particular phase is defined as follows:

NOTE: Ratio Correction Factors serve a different purpose than Potential Transformer Ratio settings— see also following subsection Potential Transformer (PT) Ratios on page 6.6.

$$\begin{aligned} RCF &= \frac{\text{true ratio}}{\text{marked ratio}} \\ &= \frac{\text{Vpri.}}{\text{Vsec.}} \bullet \frac{1}{PTR_{LEA}} \\ &= \frac{\text{Vpri.}}{\text{Vsec.} \bullet PTR_{LEA}} \end{aligned} \qquad \textbf{Equation 6.3}$$

where:

Vpri. = test voltage applied to the primary side of the voltage divider

Vsec. = resultant voltage measured on the secondary side of the voltage divider

true ratio = Vpri./Vsec.

marked ratio = PTR_{LEA}

= effective nominal potential transformer (PT) ratio of the voltage divider connected between the primary voltage system and the LEA (8 V) input (e.g., PTR_{LEA} = 10000).

The marked ratio of the voltage divider (PTR_{LEA}) is always provided by the manufacturer and often the per-phase RCF values are also provided.

If the voltage divider is perfect, then:

$$\frac{\text{Vpri.}}{\text{Vsec.}} = PTR_{LEA} \text{ and } RCF = 1.000 \qquad \textbf{Equation 6.4}$$

Thus, the measured voltage divider performance equals the marked ratio of the voltage divider, as given by the manufacturer. But such perfect conditions are usually not the case.

If the voltage divider is putting out more voltage (Vsec.) than nominally expected for an applied voltage input (Vpri.), then:

$$\frac{\text{Vpri.}}{\text{Vsec.}} < PTR_{LEA} \text{ and } RCF < 1.000 \qquad \textbf{Equation 6.5}$$

An example of an RCF value less than 1.000 is found in *Example 6.5*. In this example, setting VARCF := 0.883 brings down the too high voltage on voltage input VA (0.82 V is brought down to nominal 0.72 V).

If the voltage divider is putting out less voltage (Vsec.) than nominally expected for an applied voltage input (Vpri.), then:

$$\frac{\text{Vpri.}}{\text{Vsec.}} > PTR_{LEA} \text{ and } RCF > 1.000 \qquad \textbf{Equation 6.6}$$

An example of an RCF value greater than 1.000 is also found in following *Example 6.5*. In this example, setting VCRCF := 1.112 brings up the too low voltage on voltage input VAC (0.0.65 V is brought up to nominal 0.72 V).

In the SEL-2411 with Low Energy Analog (LEA) voltage inputs, these RCF values (settings VARCF, VBRCF, and VCRCF) are applied to respective voltage inputs VA, VB, and VC. The resultant secondary voltages from these voltage inputs are normalized by the RCF values. These normalized secondary voltages are used throughout the SEL-2411.

NOTE: At the end of the following subsection Voltage-Related Settings and Low Energy Analog (LEA) Inputs on page 6.7 is a discussion concerning RCF values that are less than unity (1.000) and their possible effect on voltage-related settings.

EXAMPLE 6.5 Normalizing Voltages With Ratio Correction Factors

A voltage divider is connected to the LEA (8V) voltage inputs. The RCF values per phase for the voltage divider are given as:

VARCF:= 1.078 (voltage input VA; like Equation 6.6)

VBRCF:= 0.883 (voltage input VB; like Equation 6.5)

VCRCF:= 1.112 (voltage input VC; like Equation 6.6)

The marked ratio of the voltage divider is given as:

$$PTR_{LEA} = 10000$$

What are the true ratios of each phase of the voltage divider?

$$\text{true ratio (for a given phase)} = \frac{\text{Vpri.}}{\text{Vsec.}}$$

Vpri. and Vsec. are measured in manufacturer tests, to derive RCF values as shown in Equation 6.3 and accompanying explanation. From Equation 6.3:

$$RCF \bullet PTR_{LEA} = \frac{\text{Vpri.}}{\text{Vsec.}} = \text{true ratio}$$

1.078 • 10000 = 10780 (true ratio for voltage input V1Y)

0.883 • 10000 = 8830 (true ratio for voltage input V2Y)

1.112 • 10000 = 11120 (true ratio for voltage input V3Y)

Note these true ratios vary from 8830 to 11120, while the marked ratio of the voltage divider is given as 10000.

Consider what is happening in this example. First, assume the primary voltage (Vpri.) is the same magnitude for each phase. When this primary voltage is run through the respective true ratios, the secondary voltage outputs vary widely. Presuming primary voltage of 12.47 kV (7.2 kV line-to-neutral), the resultant secondary voltages are:

7200 V/10780 = 0.67 V (true secondary voltage to voltage input VA)

7200 V/8830 = 0.82 V (true secondary voltage to voltage input VB)

7200 V/11120 = 0.65 V (true secondary voltage to voltage input VC)

Note that the true secondary voltages to voltage inputs VA and VC are running low (below normalized secondary voltage 0.72 V = 7200 V/10000), while the voltage to voltage input VB is running high (above normalized secondary voltage 0.72 V). But, the RCF values adjust these true secondary voltages to normalized secondary voltage:

0.67 V · 1.078 = 0.72 V (normalized voltage from voltage input VA)

0.82 V · 0.883 = 0.72 V (normalized voltage from voltage input VB)

0.65 V · 1.112 = 0.72 V (normalized voltage from voltage input VC)

Again, the normalized secondary voltage (0.72 V) is the same for all three phases in this example, because the primary voltage is assumed the same magnitude for each phase (7200 V). These normalized secondary voltages are used throughout the SEL-2411. The true secondary voltages cannot be seen (via the SEL-2411), unless the RCF values are set to unity (RCF = 1.000).

This page intentionally left blank

SEL-2411 Settings Sheets

These settings sheets include the definition and input range for each setting in the device. You can access the settings from the device front panel and the serial ports.

- Some settings require an optional module (see *Section 4: Logic Functions* for details).
- Some of the settings ranges may be more restrictive than shown, because of settings interdependency checks performed when new settings are saved. The settings are not case sensitive.

Group Settings (SET Command)

Device Settings

Device Identification (16 characters)	**DID**	:= ______
Terminal ID (16 characters)	**TID**	:= ______

Transformer Settings

Current Transformer Ratio (1–5000) (4 ACI)	**CTR**	:= ______
Neutral Current Transformer Ratio (1–5000) (4 ACI)	**CTRN**	:= ______
Additional Current Transformer Ratio (1–5000) (3 ACI/3 AVI)	**CTRX**	:= ______
Potential Transformer Ratio (1.00–10000.00)	**PTR**	:= ______

For the following settings, *x* is the card position (3, 4, 5, or 6);
y indicates input number 1–8 for an 8 AI card or 1–4 for a 4 AI/4 AO card.

Demand Metering

Enable Demand Metering	**EDEM**	:= ______
Demand Meter Time Constant (5, 10, 15, 30, 60 min)	**DMTC**	:= ______

Analog Input x01 Settings

AI*x*01 Instrument Tag Name (8 characters 0–9, A–Z, _)	**AI*x*01NAM**	:= ______
AI*x*01 Type (I, V)	**AIx01TYP**	:= ______

If AI*x*01TYP = I

AI*x*01 Low (–20.480 to +20.480; mA)	**AI*x*01L**	:= ______
AI*x*01 High (–20.480 to +20.480; mA)	**AI*x*01H**	:= ______

If AI*x*01TYP = V

AI*x*01 Low (–10.240 to +10.240 V)	**AI*x*01L**	:= ______
AI*x*01 High (–10.240 to +10.240 V)	**AI*x*01H**	:= ______

NOTE: Set Warn and Alarm to a value between Engr Low and Engr High settings.

AI*x*01 Engineering Units (16 characters)	**AI*x*01EU**	:= ______
AI*x*01 Engineering Unit Low (–99999.000 to +99999.000)	**AI*x*01EL**	:= ______
AI*x*01 Engineering Unit High (–99999.000 to +99999.000)	**AI*x*01EH**	:= ______
AI*x*01 Low Warn Level 1 (OFF, –99999.000 to +99999.000)	**AI*x*01LW1**	:= ______

AI*x*01 Low Warn Level 2 (OFF, –99999.000 to +99999.000)	**AI*x*01LW2**	:= ________
AI*x*01 Low Alarm (OFF, –99999.000 to +99999.000)	**AI*x*01LAL**	:= ________
AI*x*01 High Warn Level 1 (OFF, –99999.000 to +99999.000)	**AI*x*01HW1**	:= ________
AI*x*01 High Warn Level 2 (OFF, –99999.000 to +99999.000)	**AI*x*01HW2**	:= ________
AI*x*01 High Alarm (OFF, –99999.000 to +99999.000)	**AI*x*01HAL**	:= ________

Analog Input x02 Settings

AI*x*02 Instrument Tag Name (8 characters 0–9, A–Z, _)	**AI*x*02NAM**	:= ________
AI*x*02 Type (I, V)	**AI*x*02TYP**	:= ________
If AI*x*02TYP = I		
AI*x*02 Low (–20.480 to +20.480; mA)	**AI*x*02L**	:= ________
AI*x*02 High (–20.480 to +20.480; mA)	**AI*x*02H**	:= ________
If AI*x*02TYP = V		
AI*x*02 Low (–10.240 to +10.240 V)	**AI*x*02L**	:= ________
AI*x*02 High (–10.240 to +10.240 V)	**AI*x*02H**	:= ________
AI*x*02 Engr Units (16 characters)	**AI*x*02EU**	:= ________
AI*x*02 Engr Low (–99999.000 to +99999.000)	**AI*x*02EL**	:= ________
AI*x*02 Engr High (–99999.000 to +99999.000)	**AI*x*02EH**	:= ________
AI*x*02 Low Warn 1 (OFF, –99999.000 to +99999.000)	**AI*x*02LW1**	:= ________
AI*x*02 Low Warn 2 (OFF, –99999.000 to +99999.000)	**AI*x*02LW2**	:= ________
AI*x*02 Low Alarm (OFF, –99999.000 to +99999.000)	**AI*x*02LAL**	:= ________
AI*x*02 Hi Warn 1 (OFF, –99999.000 to +99999.000)	**AI*x*02HW1**	:= ________
AI*x*02 Hi Warn 2 (OFF, –99999.000 to +99999.000)	**AI*x*02HW2**	:= ________
AI*x*02 Hi Alarm (OFF, –99999.000 to +99999.000)	**AI*x*02HAL**	:= ________

Analog Input x03 Settings

AI*x*03 Instrument Tag Name (8 characters 0–9, A–Z, _)	**AI*x*03NAM**	:= ________
AI*x*03 Type (I, V)	**AI*x*03TYP**	:= ________
If AI*x*03TYP = I		
AI*x*03 Low (–20.480 to +20.480; mA)	**AI*x*03L**	:= ________
AI*x*03 High (–20.480 to +20.480; mA)	**AI*x*03H**	:= ________
If AI*x*03TYP = V		
AI*x*03 Low (–10.240 to +10.240 V)	**AI*x*03L**	:= ________
AI*x*03 High (–10.240 to +10.240 V)	**AI*x*03H**	:= ________
AI*x*03 Engr Units (16 characters)	**AI*x*03EU**	:= ________
AI*x*03 Engr Low (–99999.000 to +99999.000)	**AI*x*03EL**	:= ________
AI*x*03 Engr High (–99999.000 to +99999.000)	**AI*x*03EH**	:= ________
AI*x*03 Low Warn 1 (OFF, –99999.000 to +99999.000)	**AI*x*03LW1**	:= ________
AI*x*03 Low Warn 2 (OFF, –99999.000 to +99999.000)	**AI*x*03LW2**	:= ________
AI*x*03 Low Alarm (OFF, –99999.000 to +99999.000)	**AI*x*03LAL**	:= ________
AI*x*03 Hi Warn 1 (OFF, –99999.000 to +99999.000)	**AI*x*03HW1**	:= ________
AI*x*03 Hi Warn 2 (OFF, –99999.000 to +99999.000)	**AI*x*03HW2**	:= ________
AI*x*03 Hi Alarm (OFF, –99999.000 to +99999.000)	**AI*x*03HAL**	:= ________

Analog Input x04 Settings

AI*x*04 Instrument Tag Name (8 characters 0–9, A–Z, _)	**AI*x*04NAM**	:=	
AI*x*04 Type (I, V)	**AI*x*04TYP**	:=	
If AI*x*04TYP = I			
AI*x*04 Low (–20.480 to +20.480; mA)	**AI*x*04L**	:=	
AI*x*04 High (–20.480 to +20.480; mA)	**AI*x*04H**	:=	
If AI*x*04TYP = V			
AI*x*04 Low (–10.240 to +10.240 V)	**AI*x*04L**	:=	
AI*x*04 High (–10.240 to +10.240 V)	**AI*x*04H**	:=	
AI*x*04 Engr Units (16 characters)	**AI*x*04EU**	:=	
AI*x*04 Engr Low (–99999.000 to +99999.000)	**AI*x*04EL**	:=	
AI*x*04 Engr High (–99999.000 to +99999.000)	**AI*x*04EH**	:=	
AI*x*04 Low Warn 1 (OFF, –99999.000 to +99999.000)	**AI*x*04LW1**	:=	
AI*x*04 Low Warn 2 (OFF, –99999.000 to +99999.000)	**AI*x*04LW2**	:=	
AI*x*04 Low Alarm (OFF, –99999.000 to +99999.000)	**AI*x*04LAL**	:=	
AI*x*04 Hi Warn 1 (OFF, –99999.000 to +99999.000)	**AI*x*04HW1**	:=	
AI*x*04 Hi Warn 2 (OFF, –99999.000 to +99999.000)	**AI*x*04HW2**	:=	
AI*x*04 Hi Alarm (OFF, –99999.000 to +99999.000)	**AI*x*04HAL**	:=	

Analog Input x05 Settings

AI*x*05 Instrument Tag Name (8 characters 0–9, A–Z, _)	**AI*x*05NAM**	:=	
AI*x*05 Type (I, V) (Doesn't apply to Extended Range)	**AI*x*05TYP**	:=	
If AI*x*05TYP = I			
AI*x*05 Low (–20.480 to +20.480; mA) (Doesn't apply to Extended Range)	**AI*x*05L**	:=	
AI*x*05 High (–20.480 to +20.480; mA) (Doesn't apply to Extended Range)	**AI*x*05H**	:=	
If AI*x*05TYP = V			
AI*x*05 Low (–10.240 to +10.240 V) (–300 to +300 V Extended Range)	**AI*x*05L**	:=	
AI*x*05 High (–10.240 to +10.240 V) (–300 to +300 V Extended Range)	**AI*x*05H**	:=	
AI*x*05 Engr Units (16 characters)	**AI*x*05EU**	:=	
AI*x*05 Engr Low (–99999.000 to +99999.000)	**AI*x*05EL**	:=	
AI*x*05 Engr High (–99999.000 to +99999.000)	**AI*x*05EH**	:=	
AI*x*05 Low Warn 1 (OFF, –99999.000 to +99999.000)	**AI*x*05LW1**	:=	
AI*x*05 Low Warn 2 (OFF, –99999.000 to +99999.000)	**AI*x*05LW2**	:=	
AI*x*05 Low Alarm (OFF, –99999.000 to +99999.000)	**AI*x*05LAL**	:=	
AI*x*05 Hi Warn 1 (OFF, –99999.000 to +99999.000)	**AI*x*05HW1**	:=	
AI*x*05 Hi Warn 2 (OFF, –99999.000 to +99999.000)	**AI*x*05HW2**	:=	
AI*x*05 Hi Alarm (OFF, –99999.000 to +99999.000)	**AI*x*05HAL**	:=	

Analog Input x06 Settings

AI*x*06 Instrument Tag Name (8 characters 0–9, A–Z, _)	**AI*x*06NAM**	:= ______
AI*x*06 Type (I, V) (Doesn't apply to Extended Range)	**AI*x*06TYP**	:= ______
If AI*x*06TYP = I		
AI*x*06 Low (–20.480 to +20.480; mA) (Doesn't apply to Extended Range)	**AI*x*06L**	:= ______
AI*x*06 High (–20.480 to +20.480; mA) (Doesn't apply to Extended Range)	**AI*x*06H**	:= ______
If AI*x*06TYP = V		
AI*x*06 Low (–10.240 to +10.240 V) (–300 to +300 V Extended Range)	**AI*x*06L**	:= ______
AI*x*06 High (–10.240 to +10.240 V) (–300 to +300 V Extended Range)	**AI*x*06H**	:= ______
AI*x*06 Engr Units (16 characters)	**AI*x*06EU**	:= ______
AI*x*06 Engr Low (–99999.000 to +99999.000)	**AI*x*06EL**	:= ______
AI*x*06 Engr High (–99999.000 to +99999.000)	**AI*x*06EH**	:= ______
AI*x*06 Low Warn 1 (OFF, –99999.000 to +99999.000)	**AI*x*06LW1**	:= ______
AI*x*06 Low Warn 2 (OFF, –99999.000 to +99999.000)	**AI*x*06LW2**	:= ______
AI*x*06 Low Alarm (OFF, –99999.000 to +99999.000)	**AI*x*06LAL**	:= ______
AI*x*06 Hi Warn 1 (OFF, –99999.000 to +99999.000)	**AI*x*06HW1**	:= ______
AI*x*06 Hi Warn 2 (OFF, –99999.000 to +99999.000)	**AI*x*06HW2**	:= ______
AI*x*06 Hi Alarm (OFF, –99999.000 to +99999.000)	**AI*x*06HAL**	:= ______

Analog Input x07 Settings

AI*x*07 Instrument Tag Name (8 characters 0–9, A–Z, _)	**AI*x*07NAM**	:= ______
AI*x*07 Type (I, V) (Doesn't apply to Extended Range)	**AI*x*07TYP**	:= ______
If AI*x*07TYP = I		
AI*x*07 Low (–20.480 to +20.480; mA) (Doesn't apply to Extended Range)	**AI*x*07L**	:= ______
AI*x*07 High (–20.480 to +20.480; mA) (Doesn't apply to Extended Range)	**AI*x*07H**	:= ______
If AI*x*07TYP = V		
AI*x*07 Low (–10.240 to +10.240 V) (–300 to +300 V Extended Range)	**AI*x*07L**	:= ______
AI*x*07 High (–10.240 to +10.240 V) (–300 to +300 V Extended Range)	**AI*x*07H**	:= ______
AIi*x*07 Engr Units (16 characters)	**AI*x*07EU**	:= ______
AI*x*07 Engr Low (–99999.000 to +99999.000)	**AI*x*07EL**	:= ______
AI*x*07 Engr High (–99999.000 to +99999.000)	**AI*x*07EH**	:= ______
AI*x*07 Low Warn 1 (OFF, –99999.000 to +99999.000)	**AI*x*07LW1**	:= ______
AI*x*07 Low Warn 2 (OFF, –99999.000 to +99999.000)	**AI*x*07LW2**	:= ______
AI*x*07 Low Alarm (OFF, –99999.000 to +99999.000)	**AI*x*07LAL**	:= ______
AI*x*07 Hi Warn 1 (OFF, –99999.000 to +99999.000)	**AI*x*07HW1**	:= ______
AI*x*07 Hi Warn 2 (OFF, –99999.000 to +99999.000)	**AI*x*07HW2**	:= ______
AI*x*07 Hi Alarm (OFF, –99999.000 to +99999.000)	**AI*x*07HAL**	:= ______

Analog Input x08 Settings

AI*x*08 Instrument Tag Name (8 characters 0–9, A–Z, _)	**AI*x*08NAM**	:=	
AI*x*08 Type (I, V) (Doesn't apply to Extended Range)	**AI*x*08TYP**	:=	
If AI*x*08TYP = I			
AI*x*08 Low (–20.480 to +20.480; mA) (Doesn't apply to Extended Range)	**AI*x*08L**	:=	
AI*x*08 High (–20.480 to +20.480; mA) (Doesn't apply to Extended Range)	**AI*x*08H**	:=	
If AIx08TYP = V			
AI*x*08 Low (–10.240 to +10.240 V) (–300 to +300 V Extended Range)	**AI*x*08L**	:=	
AI*x*08 High (–10.240 to +10.240 V) (–300 to +300 V Extended Range)	**AI*x*08H**	:=	
AI*x*08 Engr Units (16 characters)	**AI*x*08EU**	:=	
AI*x*08 Engr Low (–99999.000 to +99999.000)	**AI*x*08EL**	:=	
AI*x*08 Engr High (–99999.000 to +99999.000)	**AI*x*08EH**	:=	
AI*x*08 Low Warn 1 (OFF, –99999.000 to +99999.000)	**AI*x*08LW1**	:=	
AI*x*08 Low Warn 2 (OFF, –99999.000 to +99999.000)	**AI*x*08LW2**	:=	
AI*x*08 Low Alarm (OFF, –99999.000 to +99999.000)	**AI*x*08LAL**	:=	
AI*x*08 Hi Warn 1 (OFF, –99999.000 to +99999.000)	**AI*x*08HW1**	:=	
AI*x*08 Hi Warn 2 (OFF, –99999.000 to +99999.000)	**AI*x*08HW2**	:=	
AI*x*08 Hi Alarm (OFF, –99999.000 to +99999.000)	**AI*x*08HAL**	:=	

Analog Output x01 Settings

AO*x*01 Analog Quantity (Analog Quantity Value)	**AO*x*01AQ**	:=	
AO*x*01 Instrument Tag Name (8 characters 0–9, A–Z, _)	**AO*x*01NAM**	:=	
AO*x*01 Type (I, V)	**AO*x*01TYP**	:=	
AO*x*01 Analog Quantity Low (–99999.000 to +99999.000)	**AO*x*01AQL**	:=	
AO*x*01 Analog Quantity High (–99999.000 to +99999.000)	**AO*x*01AQH**	:=	
If AO*x*01TYP = I			
AO*x*01 Low Output Value (–20.480 to +20.480 mA)	**AO*x*01L**	:=	
AO*x*01 High Output (–20.480 to +20.480 mA)	**AO*x*01H**	:=	
If AO*x*01TYP = V			
AO*x*01 Low Output Value (–10.240 to +10.240 V)	**AO*x*01L**	:=	
AO*x*01 High Output Value (–10.240 to +10.240 V)	**AO*x*01H**	:=	

Analog Output x02 Settings

AO*x*02 Analog Quantity (Analog Quantity Value)	**AO*x*02AQ**	:=	
AO*x*02 Instrument Tag Name (8 characters 0–9, A–Z, _)	**AO*x*02NAM**	:=	
AO*x*02 Type (I, V)	**AO*x*02TYP**	:=	
AO*x*02 Analog Quantity Low (–99999.000 to +99999.000)	**AO*x*02AQL**	:=	
AO*x*02 Analog Quantity High (–99999.000 to +99999.000)	**AO*x*02AQH**	:=	

If AO*x*02TYP = I		
AO*x*02 Low Output Value (–20.480 to +20.480 mA)	**AO*x*02L**	:=
AO*x*02 High Output (–20.480 to +20.480 mA)	**AO*x*02H**	:=
If AO*x*02TYP = V		
AO*x*02 Low Output Value (–10.240 to +10.240 V)	**AOx02L**	:=
AO*x*02 High Output Value (–10.240 to +10.240 V)	**AO*x*02H**	:=

Analog Output x03 Settings

AO*x*03 Analog Quantity (Analog Quantity Value)	**AO*x*03AQ**	:=
AO*x*03 Instrument Tag Name (8 characters 0–9, A–Z, _)	**AO*x*03NAM**	:=
AO*x*03 Type (I, V)	**AO*x*03TYP**	:=
AO*x*03 Analog Quantity Low (–99999.000 to +99999.000)	**AO*x*03AQL**	:=
AO*x*03 Analog Quantity High (–99999.000 to +99999.000)	**AO*x*03AQH**	:=
If AO*x*03TYP = I		
AO*x*03 Low Output Value (–20.480 to +20.480 mA)	**AO*x*03L**	:=
AO*x*03 High Output (–20.480 to +20.480 mA)	**AO*x*03H**	:=
If AO*x*03TYP = V		
AO*x*03 Low Output Value (–10.240 to +10.240 V)	**AO*x*03L**	:=
AO*x*03 High Output Value (–10.240 to +10.240 V)	**AO*x*03H**	:=

Analog Output x04 Settings

AO*x*04 Analog Quantity (Analog Quantity Value)	**AO*x*04AQ**	:=
AO*x*04 Instrument Tag Name (8 characters 0–9, A–Z, _)	**AO*x*04NAM**	:=
AO*x*04 Type (I, V)	**AO*x*04TYP**	:=
AO*x*04 Analog Quantity Low (–99999.000 to +99999.000)	**AO*x*04AQL**	:=
AO*x*04 Analog Quantity High (–99999.000 to +99999.000)	**AO*x*04AQH**	:=
If AO*x*04TYP = I		
AO*x*04 Low Output Value (–20.480 to +20.480 mA)	**AO*x*04L**	:=
AO*x*04 High Output (–20.480 to +20.480 mA)	**AO*x*04H**	:=
If AO*x*04TYP = V		
AO*x*04 Low Output Value (–10.240 to +10.240 V)	**AO*x*04L**	:=
AO*x*04 High Output Value (–10.240 to +10.240 V)	**AO*x*04H**	:=

Internal RTD

RTD1 TYPE (PT100, NI100, NI120, CU10, NONE)	**IRTD1TY**	:=
RTD2 TYPE (PT100, NI100, NI120, CU10, NONE)	**IRTD2TY**	:=
RTD3 TYPE (PT100, NI100, NI120, CU10, NONE)	**IRTD3TY**	:=
RTD4 TYPE (PT100, NI100, NI120, CU10, NONE)	**IRTD4TY**	:=
RTD5 TYPE (PT100, NI100, NI120, CU10, NONE)	**IRTD5TY**	:=
RTD6 TYPE (PT100, NI100, NI120, CU10, NONE)	**IRTD6TY**	:=
RTD7 TYPE (PT100, NI100, NI120, CU10, NONE)	**IRTD7TY**	:=
RTD8 TYPE (PT100, NI100, NI120, CU10, NONE)	**IRTD8TY**	:=
RTD9 TYPE (PT100, NI100, NI120, CU10, NONE)	**IRTD9TY**	:=
RTD10 TYPE (PT100, NI100, NI120, CU10, NONE)	**IRTD10TY**	:=

External RTD Via SEL-2600 Devices

RTD1 TYPE (PT100, NI100, NI120, CU10, NONE)	**ERTD1TY**	:=
RTD2 TYPE (PT100, NI100, NI120, CU10, NONE)	**ERTD2TY**	:=
RTD3 TYPE (PT100, NI100, NI120, CU10, NONE)	**ERTD3TY**	:=
RTD4 TYPE (PT100, NI100, NI120, CU10, NONE)	**ERTD4TY**	:=
RTD5 TYPE (PT100, NI100, NI120, CU10, NONE)	**ERTD5TY**	:=
RTD6 TYPE (PT100, NI100, NI120, CU10, NONE)	**ERTD6TY**	:=
RTD7 TYPE (PT100, NI100, NI120, CU10, NONE)	**ERTD7TY**	:=
RTD8 TYPE (PT100, NI100, NI120, CU10, NONE)	**ERTD8TY**	:=
RTD9 TYPE (PT100, NI100, NI120, CU10, NONE)	**ERTD9TY**	:=
RTD10 TYPE (PT100, NI100, NI120, CU10, NONE)	**ERTD10TY**	:=
RTD11 TYPE (PT100, NI100, NI120, CU10, NONE)	**ERTD11TY**	:=
RTD12 TYPE (PT100, NI100, NI120, CU10, NONE)	**ERTD12TY**	:=

RTD/TC from Universal Input Temp Card

TEMP1 TYPE (PT100, NI100, NI120, CU10, J, K, T, E, NONE)	**TEMP1TY**	:=
TEMP2 TYPE (PT100, NI100, NI120, CU10, J, K, T, E, NONE)	**TEMP2TY**	:=
TEMP3 TYPE (PT100, NI100, NI120, CU10, J, K, T, E, NONE)	**TEMP3TY**	:=
TEMP4 TYPE (PT100, NI100, NI120, CU10, J, K, T, E, NONE)	**TEMP4TY**	:=
TEMP5 TYPE (PT100, NI100, NI120, CU10, J, K, T, E, NONE)	**TEMP5TY**	:=
TEMP6 TYPE (PT100, NI100, NI120, CU10, J, K, T, E, NONE)	**TEMP6TY**	:=
TEMP7 TYPE (PT100, NI100, NI120, CU10, J, K, T, E, NONE)	**TEMP7TY**	:=
TEMP8 TYPE (PT100, NI100, NI120, CU10, J, K, T, E, NONE)	**TEMP8TY**	:=
TEMP9 TYPE (PT100, NI100, NI120, CU10, J, K, T, E, NONE)	**TEMP9TY**	:=
TEMP10 TYPE (PT100, NI100, NI120, CU10, J, K, T, E, NONE)	**TEMP10TY**	:=
Enable TC 3—Sample Averager for Thermocouples	**ESAMPAVG**	:= Y

Logic Settings (SET L Command)

SELOGIC Enables

SELOGIC Latches (N, 1–32)	**ELAT**	:=
SELOGIC Variables/Timers (N, 1–64)	**ESV**	:=
SELOGIC Counters (N, 1–32)	**ESC**	:=
SELOGIC Math Variables Equations (N, 1–32)	**EMV**	:=

Latch Bit Set/Reset Equations

SET01	:=
RST01	:=
SET02	:=
RST02	:=
SET03	:=
RST03	:=
SET04	:=
RST04	:=
SET05	:=
RST05	:=
SET06	:=
RST06	:=
SET07	:=
RST07	:=
SET08	:=
RST08	:=
SET09	:=
RST09	:=
SET10	:=
RST10	:=
SET11	:=
RST11	:=
SET12	:=
RST12	:=
SET13	:=
RST13	:=
SET14	:=
RST14	:=
SET15	:=
RST15	:=
SET16	:=
RST16	:=
SET17	:=
RST17	:=
SET18	:=
RST18	:=

SET19	:=	
RST19	:=	
SET20	:=	
RST20	:=	
SET21	:=	
RST21	:=	
SET22	:=	
RST22	:=	
SET23	:=	
RST23	:=	
SET24	:=	
RST24	:=	
SET25	:=	
RST25	:=	
SET26	:=	
RST26	:=	
SET27	:=	
RST27	:=	
SET28	:=	
RST28	:=	
SET29	:=	
RST29	:=	
SET30	:=	
RST30	:=	
SET31	:=	
RST31	:=	
SET32	:=	
RST32	:=	

SELOGIC Variable/Timer Settings

SELOGIC Variable Input (SV)	**SV01**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV01PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV01DO**	:=	
SELOGIC Variable Input (SV)	**SV02**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV02PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV02DO**	:=	
SELOGIC Variable Input (SV)	**SV03**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV03PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV03DO**	:=	
SELOGIC Variable Input (SV)	**SV04**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV04PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV04DO**	:=	
SELOGIC Variable Input (SV)	**SV05**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV05PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV05DO**	:=	

SELOGIC Variable Input (SV)	**SV06**	:=	______
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV06PU**	:=	______
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV06DO**	:=	______
SELOGIC Variable Input (SV)	**SV07**	:=	______
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV07PU**	:=	______
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV07DO**	:=	______
SELOGIC Variable Input (SV)	**SV08**	:=	______
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV08PU**	:=	______
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV08DO**	:=	______
SELOGIC Variable Input (SV)	**SV09**	:=	______
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV09PU**	:=	______
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV09DO**	:=	______
SELOGIC Variable Input (SV)	**SV10**	:=	______
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV10PU**	:=	______
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV10DO**	:=	______
SELOGIC Variable Input (SV)	**SV11**	:=	______
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV11PU**	:=	______
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV11DO**	:=	______
SELOGIC Variable Input (SV)	**SV12**	:=	______
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV12PU**	:=	______
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV12DO**	:=	______
SELOGIC Variable Input (SV)	**SV13**	:=	______
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV13PU**	:=	______
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV13DO**	:=	______
SELOGIC Variable Input (SV)	**SV14**	:=	______
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV14PU**	:=	______
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV14DO**	:=	______
SELOGIC Variable Input (SV)	**SV15**	:=	______
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV15PU**	:=	______
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV15DO**	:=	______
SELOGIC Variable Input (SV)	**SV16**	:=	______
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV16PU**	:=	______
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV16DO**	:=	______
SELOGIC Variable Input (SV)	**SV17**	:=	______
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV17PU**	:=	______
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV17DO**	:=	______
SELOGIC Variable Input (SV)	**SV18**	:=	______
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV18PU**	:=	______
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV18DO**	:=	______
SELOGIC Variable Input (SV)	**SV19**	:=	______
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV19PU**	:=	______
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV19DO**	:=	______
SELOGIC Variable Input (SV)	**SV20**	:=	______
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV20PU**	:=	______
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV20DO**	:=	______
SELOGIC Variable Input (SV)	**SV21**	:=	______
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV21PU**	:=	______

SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV21DO**	:=	
SELOGIC Variable Input (SV)	**SV22**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV22PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV22DO**	:=	
SELOGIC Variable Input (SV)	**SV23**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV23PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV23DO**	:=	
SELOGIC Variable Input (SV)	**SV24**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV24PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV24DO**	:=	
SELOGIC Variable Input (SV)	**SV25**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV25PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV25DO**	:=	
SELOGIC Variable Input (SV)	**SV26**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV26PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV26DO**	:=	
SELOGIC Variable Input (SV)	**SV27**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV27PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV27DO**	:=	
SELOGIC Variable Input (SV)	**SV28**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV28PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV28DO**	:=	
SELOGIC Variable Input (SV)	**SV29**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV29PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV29DO**	:=	
SELOGIC Variable Input (SV)	**SV30**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV30PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV30DO**	:=	
SELOGIC Variable Input (SV)	**SV31**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV31PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV31DO**	:=	
SELOGIC Variable Input (SV)	**SV32**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV32PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV32DO**	:=	
SELOGIC Variable Input (SV)	**SV33**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV33PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV33DO**	:=	
SELOGIC Variable Input (SV)	**SV34**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV34PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV34DO**	:=	
SELOGIC Variable Input (SV)	**SV35**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV35PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV35DO**	:=	
SELOGIC Variable Input (SV)	**SV36**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV36PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV36DO**	:=	

SELOGIC Variable Input (SV)	**SV37**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV37PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV37DO**	:=	
SELOGIC Variable Input (SV)	**SV38**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV38PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV38DO**	:=	
SELOGIC Variable Input (SV)	**SV39**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV39PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV39DO**	:=	
SELOGIC Variable Input (SV)	**SV40**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV40PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV40DO**	:=	
SELOGIC Variable Input (SV)	**SV41**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV41PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV41DO**	:=	
SELOGIC Variable Input (SV)	**SV42**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV42PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV42DO**	:=	
SELOGIC Variable Input (SV)	**SV43**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV43PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV43DO**	:=	
SELOGIC Variable Input (SV)	**SV44**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV44PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV44DO**	:=	
SELOGIC Variable Input (SV)	**SV45**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV45PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV45DO**	:=	
SELOGIC Variable Input (SV)	**SV46**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV46PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV46DO**	:=	
SELOGIC Variable Input (SV)	**SV47**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV47PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV47DO**	:=	
SELOGIC Variable Input (SV)	**SV48**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV48PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV48DO**	:=	
SELOGIC Variable Input (SV)	**SV49**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV49PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV49DO**	:=	
SELOGIC Variable Input (SV)	**SV50**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV50PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV50DO**	:=	
SELOGIC Variable Input (SV)	**SV51**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV51PU**	:=	
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV51DO**	:=	
SELOGIC Variable Input (SV)	**SV52**	:=	
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV52PU**	:=	

SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV52DO**	:=
SELOGIC Variable Input (SV)	**SV53**	:=
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV53PU**	:=
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV53DO**	:=
SELOGIC Variable Input (SV)	**SV54**	:=
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV54PU**	:=
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV54DO**	:=
SELOGIC Variable Input (SV)	**SV55**	:=
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV55PU**	:=
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV55DO**	:=
SELOGIC Variable Input (SV)	**SV56**	:=
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV56PU**	:=
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV56DO**	:=
SELOGIC Variable Input (SV)	**SV57**	:=
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV57PU**	:=
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV57DO**	:=
SELOGIC Variable Input (SV)	**SV58**	:=
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV58PU**	:=
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV58DO**	:=
SELOGIC Variable Input (SV)	**SV59**	:=
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV59PU**	:=
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV59DO**	:=
SELOGIC Variable Input (SV)	**SV60**	:=
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV60PU**	:=
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV60DO**	:=
SELOGIC Variable Input (SV)	**SV61**	:=
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV61PU**	:=
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV61DO**	:=
SELOGIC Variable Input (SV)	**SV62**	:=
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV62PU**	:=
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV62DO**	:=
SELOGIC Variable Input (SV)	**SV63**	:=
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV63PU**	:=
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV63DO**	:=
SELOGIC Variable Input (SV)	**SV64**	:=
SELOGIC Variable Timer Pickup (0.000–16000.000 sec)	**SV64PU**	:=
SELOGIC Variable Timer Dropout (0.000–16000.000 sec)	**SV64DO**	:=

SELOGIC Counter Settings

Counter Preset Value SC*xx*PV (1–65000)	**SC01PV**	:=
Counter Reset Input SC*xx*R (SELOGIC)	**SC01R**	:=
Counter Load PV Input SC*xx*LD (SELOGIC)	**SC01LD**	:=
Count Up Input Sc*xx*CU (SELOGIC)	**SC01CU**	:=
Count Down Input SC*xx*CD (SELOGIC)	**SC01CD**	:=

Counter Preset Value SC*xx*PV (1–65000)	**SC02PV**	:=	________
Counter Reset Input SC*xx*R (SELOGIC)	**SC02R**	:=	________
Counter Load PV Input SC*xx*LD (SELOGIC)	**SC02LD**	:=	________
Count Up Input Sc*xx*CU (SELOGIC)	**SC02CU**	:=	________
Count Down Input SC*xx*CD (SELOGIC)	**SC02CD**	:=	________
Counter Preset Value SC*xx*PV (1–65000)	**SC03PV**	:=	________
Counter Reset Input SC*xx*R (SELOGIC)	**SC03R**	:=	________
Counter Load PV Input SC*xx*LD (SELOGIC)	**SC03LD**	:=	________
Count Up Input Sc*xx*CU (SELOGIC)	**SC03CU**	:=	________
Count Down Input SC*xx*CD (SELOGIC)	**SC03CD**	:=	________
Counter Preset Value SC*xx*PV (1–65000)	**SC04PV**	:=	________
Counter Reset Input SC*xx*R (SELOGIC)	**SC04R**	:=	________
Counter Load PV Input SC*xx*LD (SELOGIC)	**SC04LD**	:=	________
Count Up Input Sc*xx*CU (SELOGIC)	**SC04CU**	:=	________
Count Down Input SC*xx*CD (SELOGIC)	**SC04CD**	:=	________
Counter Preset Value SC*xx*PV (1–65000)	**SC05PV**	:=	________
Counter Reset Input SC*xx*R (SELOGIC)	**SC05R**	:=	________
Counter Load PV Input SC*xx*LD (SELOGIC)	**SC05LD**	:=	________
Count Up Input Sc*xx*CU (SELOGIC)	**SC05CU**	:=	________
Count Down Input SC*xx*CD (SELOGIC)	**SC05CD**	:=	________
Counter Preset Value SC*xx*PV (1–65000)	**SC06PV**	:=	________
Counter Reset Input SC*xx*R (SELOGIC)	**SC06R**	:=	________
Counter Load PV Input SC*xx*LD (SELOGIC)	**SC06LD**	:=	________
Count Up Input Sc*xx*CU (SELOGIC)	**SC06CU**	:=	________
Count Down Input SC*xx*CD (SELOGIC)	**SC06CD**	:=	________
Counter Preset Value SC*xx*PV (1–65000)	**SC07PV**	:=	________
Counter Reset Input SC*xx*R (SELOGIC)	**SC07R**	:=	________
Counter Load PV Input SC*xx*LD (SELOGIC)	**SC07LD**	:=	________
Count Up Input Sc*xx*CU (SELOGIC)	**SC07CU**	:=	________
Count Down Input SC*xx*CD (SELOGIC)	**SC07CD**	:=	________
Counter Preset Value SC*xx*PV (1–65000)	**SC08PV**	:=	________
Counter Reset Input SC*xx*R (SELOGIC)	**SC08R**	:=	________
Counter Load PV Input SC*xx*LD (SELOGIC)	**SC08LD**	:=	________
Count Up Input Sc*xx*CU (SELOGIC)	**SC08CU**	:=	________
Count Down Input SC*xx*CD (SELOGIC)	**SC08CD**	:=	________
Counter Preset Value SC*xx*PV (1–65000)	**SC09PV**	:=	________
Counter Reset Input SC*xx*R (SELOGIC)	**SC09R**	:=	________
Counter Load PV Input SC*xx*LD (SELOGIC)	**SC09LD**	:=	________
Count Up Input Sc*xx*CU (SELOGIC)	**SC09CU**	:=	________
Count Down Input SC*xx*CD (SELOGIC)	**SC09CD**	:=	________

Counter Preset Value SC*xx*PV (1–65000)	**SC10PV**	:=	
Counter Reset Input SC*xx*R (SELOGIC)	**SC10R**	:=	
Counter Load PV Input SC*xx*LD (SELOGIC)	**SC10LD**	:=	
Count Up Input Sc*xx*CU (SELOGIC)	**SC10CU**	:=	
Count Down Input SC*xx*CD (SELOGIC)	**SC10CD**	:=	
Counter Preset Value SC*xx*PV (1–65000)	**SC11PV**	:=	
Counter Reset Input SC*xx*R (SELOGIC)	**SC11R**	:=	
Counter Load PV Input SC*xx*LD (SELOGIC)	**SC11LD**	:=	
Count Up Input Sc*xx*CU (SELOGIC)	**SC11CU**	:=	
Count Down Input SC*xx*CD (SELOGIC)	**SC11CD**	:=	
Counter Preset Value SC*xx*PV (1–65000)	**SC12PV**	:=	
Counter Reset Input SC*xx*R (SELOGIC)	**SC12R**	:=	
Counter Load PV Input SC*xx*LD (SELOGIC)	**SC12LD**	:=	
Count Up Input Sc*xx*CU (SELOGIC)	**SC12CU**	:=	
Count Down Input SC*xx*CD (SELOGIC)	**SC12CD**	:=	
Counter Preset Value SC*xx*PV (1–65000)	**SC13PV**	:=	
Counter Reset Input SC*xx*R (SELOGIC)	**SC13R**	:=	
Counter Load PV Input SC*xx*LD (SELOGIC)	**SC13LD**	:=	
Count Up Input Sc*xx*CU (SELOGIC)	**SC13CU**	:=	
Count Down Input SC*xx*CD (SELOGIC)	**SC13CD**	:=	
Counter Preset Value SC*xx*PV (1–65000)	**SC14PV**	:=	
Counter Reset Input SC*xx*R (SELOGIC)	**SC14R**	:=	
Counter Load PV Input SC*xx*LD (SELOGIC)	**SC14LD**	:=	
Count Up Input Sc*xx*CU (SELOGIC)	**SC14CU**	:=	
Count Down Input SC*xx*CD (SELOGIC)	**SC14CD**	:=	
Counter Preset Value SC*xx*PV (1–65000)	**SC15PV**	:=	
Counter Reset Input SC*xx*R (SELOGIC)	**SC15R**	:=	
Counter Load PV Input SC*xx*LD (SELOGIC)	**SC15LD**	:=	
Count Up Input Sc*xx*CU (SELOGIC)	**SC15CU**	:=	
Count Down Input SC*xx*CD (SELOGIC)	**SC15CD**	:=	
Counter Preset Value SC*xx*PV (1–65000)	**SC16PV**	:=	
Counter Reset Input SC*xx*R (SELOGIC)	**SC16R**	:=	
Counter Load PV Input SC*xx*LD (SELOGIC)	**SC16LD**	:=	
Count Up Input Sc*xx*CU (SELOGIC)	**SC16CU**	:=	
Count Down Input SC*xx*CD (SELOGIC)	**SC16CD**	:=	
Counter Preset Value SC*xx*PV (1–65000)	**SC17PV**	:=	
Counter Reset Input SC*xx*R (SELOGIC)	**SC17R**	:=	
Counter Load PV Input SC*xx*LD (SELOGIC)	**SC17LD**	:=	
Count Up Input Sc*xx*CU (SELOGIC)	**SC17CU**	:=	
Count Down Input SC*xx*CD (SELOGIC)	**SC17CD**	:=	

Counter Preset Value SC*xx*PV (1–65000)	**SC18PV**	:=
Counter Reset Input SC*xx*R (SELOGIC)	**SC18R**	:=
Counter Load PV Input SC*xx*LD (SELOGIC)	**SC18LD**	:=
Count Up Input Sc*xx*CU (SELOGIC)	**SC18CU**	:=
Count Down Input SC*xx*CD (SELOGIC)	**SC18CD**	:=
Counter Preset Value SC*xx*PV (1–65000)	**SC19PV**	:=
Counter Reset Input SC*xx*R (SELOGIC)	**SC19R**	:=
Counter Load PV Input SCxxLD (SELOGIC)	**SC19LD**	:=
Count Up Input ScxxCU (SELOGIC)	**SC19CU**	:=
Count Down Input SCxxCD (SELOGIC)	**SC19CD**	:=
Counter Preset Value SCxxPV (1–65000)	**SC20PV**	:=
Counter Reset Input SCxxR (SELOGIC)	**SC20R**	:=
Counter Load PV Input SCxxLD (SELOGIC)	**SC20LD**	:=
Count Up Input ScxxCU (SELOGIC)	**SC20CU**	:=
Count Down Input SCxxCD (SELOGIC)	**SC20CD**	:=
Counter Preset Value SCxxPV (1–65000)	**SC21PV**	:=
Counter Reset Input SCxxR (SELOGIC)	**SC21R**	:=
Counter Load PV Input SCxxLD (SELOGIC)	**SC21LD**	:=
Count Up Input ScxxCU (SELOGIC)	**SC21CU**	:=
Count Down Input SCxxCD (SELOGIC)	**SC21CD**	:=
Counter Preset Value SCxxPV (1–65000)	**SC22PV**	:=
Counter Reset Input SCxxR (SELOGIC)	**SC22R**	:=
Counter Load PV Input SCxxLD (SELOGIC)	**SC22LD**	:=
Count Up Input ScxxCU (SELOGIC)	**SC22CU**	:=
Count Down Input SCxxCD (SELOGIC)	**SC22CD**	:=
Counter Preset Value SCxxPV (1–65000)	**SC23PV**	:=
Counter Reset Input SCxxR (SELOGIC)	**SC23R**	:=
Counter Load PV Input SCxxLD (SELOGIC)	**SC23LD**	:=
Count Up Input ScxxCU (SELOGIC)	**SC23CU**	:=
Count Down Input SCxxCD (SELOGIC)	**SC23CD**	:=
Counter Preset Value SCxxPV (1–65000)	**SC24PV**	:=
Counter Reset Input SCxxR (SELOGIC)	**SC24R**	:=
Counter Load PV Input SCxxLD (SELOGIC)	**SC24LD**	:=
Count Up Input ScxxCU (SELOGIC)	**SC24CU**	:=
Count Down Input SCxxCD (SELOGIC)	**SC24CD**	:=
Counter Preset Value SCxxPV (1–65000)	**SC25PV**	:=
Counter Reset Input SCxxR (SELOGIC)	**SC25R**	:=
Counter Load PV Input SCxxLD (SELOGIC)	**SC25LD**	:=
Count Up Input ScxxCU (SELOGIC)	**SC25CU**	:=
Count Down Input SCxxCD (SELOGIC)	**SC25CD**	:=

Counter Preset Value SCxxPV (1–65000)	**SC26PV**	:=	______
Counter Reset Input SCxxR (SELOGIC)	**SC26R**	:=	______
Counter Load PV Input SCxxLD (SELOGIC)	**SC26LD**	:=	______
Count Up Input ScxxCU (SELOGIC)	**SC26CU**	:=	______
Count Down Input SCxxCD (SELOGIC)	**SC26CD**	:=	______
Counter Preset Value SCxxPV (1–65000)	**SC27PV**	:=	______
Counter Reset Input SCxxR (SELOGIC)	**SC27R**	:=	______
Counter Load PV Input SCxxLD (SELOGIC)	**SC27LD**	:=	______
Count Up Input ScxxCU (SELOGIC)	**SC27CU**	:=	______
Count Down Input SCxxCD (SELOGIC)	**SC27CD**	:=	______
Counter Preset Value SCxxPV (1–65000)	**SC28PV**	:=	______
Counter Reset Input SCxxR (SELOGIC)	**SC28R**	:=	______
Counter Load PV Input SCxxLD (SELOGIC)	**SC28LD**	:=	______
Count Up Input ScxxCU (SELOGIC)	**SC28CU**	:=	______
Count Down Input SCxxCD (SELOGIC)	**SC28CD**	:=	______
Counter Preset Value SCxxPV (1–65000)	**SC29PV**	:=	______
Counter Reset Input SCxxR (SELOGIC)	**SC29R**	:=	______
Counter Load PV Input SCxxLD (SELOGIC)	**SC29LD**	:=	______
Count Up Input ScxxCU (SELOGIC)	**SC29CU**	:=	______
Count Down Input SCxxCD (SELOGIC)	**SC29CD**	:=	______
Counter Preset Value SCxxPV (1–65000)	**SC30PV**	:=	______
Counter Reset Input SCxxR (SELOGIC)	**SC30R**	:=	______
Counter Load PV Input SCxxLD (SELOGIC)	**SC30LD**	:=	______
Count Up Input ScxxCU (SELOGIC)	**SC30CU**	:=	______
Count Down Input SCxxCD (SELOGIC)	**SC30CD**	:=	______
Counter Preset Value SCxxPV (1–65000)	**SC31PV**	:=	______
Counter Reset Input SCxxR (SELOGIC)	**SC31R**	:=	______
Counter Load PV Input SCxxLD (SELOGIC)	**SC31LD**	:=	______
Count Up Input ScxxCU (SELOGIC)	**SC31CU**	:=	______
Count Down Input SCxxCD (SELOGIC)	**SC31CD**	:=	______
Counter Preset Value SCxxPV (1–65000)	**SC32PV**	:=	______
Counter Reset Input SCxxR (SELOGIC)	**SC32R**	:=	______
Counter Load PV Input SCxxLD (SELOGIC)	**SC32LD**	:=	______
Count Up Input ScxxCU (SELOGIC)	**SC32CU**	:=	______
Count Down Input SCxxCD (SELOGIC)	**SC32CD**	:=	______

Math Variable SELOGIC Equations

MV01 := ________________
MV02 := ________________
MV03 := ________________
MV04 := ________________
MV05 := ________________
MV06 := ________________
MV07 := ________________
MV08 := ________________
MV09 := ________________
MV10 := ________________
MV11 := ________________
MV12 := ________________
MV13 := ________________
MV14 := ________________
MV15 := ________________
MV16 := ________________
MV17 := ________________
MV18 := ________________
MV19 := ________________
MV20 := ________________
MV21 := ________________
MV22 := ________________
MV23 := ________________
MV24 := ________________
MV25 := ________________
MV26 := ________________
MV27 := ________________
MV28 := ________________
MV29 := ________________
MV30 := ________________
MV31 := ________________
MV32 := ________________

Output Contacts (DO Units)

Base Unit

OUT101 := ________________
OUT102 := ________________
OUT103 := ________________

For a card in Slot 3

OUT301 := ____________________
OUT302 := ____________________
OUT303 := ____________________
OUT304 := ____________________
OUT305 := ____________________
OUT306 := ____________________
OUT307 := ____________________
OUT308 := ____________________

For a card in Slot 4

OUT401 := ____________________
OUT402 := ____________________
OUT403 := ____________________
OUT404 := ____________________
OUT405 := ____________________
OUT406 := ____________________
OUT407 := ____________________
OUT408 := ____________________

For a card in Slot 5

OUT501 := ____________________
OUT502 := ____________________
OUT503 := ____________________
OUT504 := ____________________
OUT505 := ____________________
OUT506 := ____________________
OUT507 := ____________________
OUT508 := ____________________

For a card in Slot 6

OUT601 := ____________________
OUT602 := ____________________
OUT603 := ____________________
OUT604 := ____________________
OUT605 := ____________________
OUT606 := ____________________
OUT607 := ____________________
OUT608 := ____________________

MIRRORED BITS

TMB1A := ____________

TMB2A := ____________

TMB3A := ____________

TMB4A := ____________

TMB5A := ____________

TMB6A := ____________

TMB7A := ____________

TMB8A := ____________

TMB1B := ____________

TMB2B := ____________

TMB3B := ____________

TMB4B := ____________

TMB5B := ____________

TMB6B := ____________

TMB7B := ____________

TMB8B := ____________

Global Settings (SET G Command)

General Settings

Phase Rotation (ABC, ACB)	**PHROT**	:=	________
Rated Frequency (50, 60 Hz)	**FNOM**	:=	________
Transformer Connection (DELTA, WYE)	**DELTA_Y**	:=	________
Date Format (MDY, YMD, DMY)	**DATE_F**	:=	________

Input Debounce Settings (Base Unit)

IN101 Debounce (AC, 0–65000 ms)	**IN101D**	:=	________
IN102 Debounce (AC, 0–65000 ms)	**IN102D**	:=	________

Input Debounce Settings (Slot 3)

IN301 Debounce (AC, 0–65000 ms)	**IN301D**	:=	________
IN302 Debounce (AC, 0–65000 ms)	**IN302D**	:=	________
IN303 Debounce (AC, 0–65000 ms)	**IN303D**	:=	________
IN304 Debounce (AC, 0–65000 ms)	**IN304D**	:=	________
IN305 Debounce (AC, 0–65000 ms)	**IN305D**	:=	________
IN306 Debounce (AC, 0–65000 ms)	**IN306D**	:=	________
IN307 Debounce (AC, 0–65000 ms)	**IN307D**	:=	________
IN308 Debounce (AC, 0–65000 ms)	**IN308D**	:=	________

Input Debounce Settings (Slot 4)

IN401 Debounce (AC, 0–65000 ms)	**IN401D**	:=	________
IN402 Debounce (AC, 0–65000 ms)	**IN402D**	:=	________
IN403 Debounce (AC, 0–65000 ms)	**IN403D**	:=	________
IN404 Debounce (AC, 0–65000 ms)	**IN404D**	:=	________
IN405 Debounce (AC, 0–65000 ms)	**IN405D**	:=	________
IN406 Debounce (AC, 0–65000 ms)	**IN406D**	:=	________
IN407 Debounce (AC, 0–65000 ms)	**IN407D**	:=	________
IN408 Debounce (AC, 0–65000 ms)	**IN408D**	:=	________

Input Debounce Settings (Slot 5)

IN501 Debounce (AC, 0–65000 ms)	**IN501D**	:=	________
IN502 Debounce (AC, 0–65000 ms)	**IN502D**	:=	________
IN503 Debounce (AC, 0–65000 ms)	**IN503D**	:=	________
IN504 Debounce (AC, 0–65000 ms)	**IN504D**	:=	________
IN505 Debounce (AC, 0–65000 ms)	**IN505D**	:=	________
IN506 Debounce (AC, 0–65000 ms)	**IN506D**	:=	________
IN507 Debounce (AC, 0–65000 ms)	**IN507D**	:=	________
IN508 Debounce (AC, 0–65000 ms)	**IN508D**	:=	________

Input Debounce Settings (Slot 6)

IN601 Debounce (AC, 0–65000 ms)	**IN601D**	:=
IN602 Debounce (AC, 0–65000 ms)	**IN602D**	:=
IN603 Debounce (AC, 0–65000 ms)	**IN603D**	:=
IN604 Debounce (AC, 0–65000 ms)	**IN604D**	:=
IN605 Debounce (AC, 0–65000 ms)	**IN605D**	:=
IN606 Debounce (AC, 0–65000 ms)	**IN606D**	:=
IN607 Debounce (AC, 0–65000 ms)	**IN607D**	:=
IN608 Debounce (AC, 0–65000 ms)	**IN608D**	:=

Front-Panel Access Control

Data Reset

Target Reset (SV)	**RSTTRGT**	:=
Reset Energy (SV)	**RSTENRGY**	:=
Reset Max/Min (SV)	**RSTMXMN**	:=
Reset Demand (SV)	**RSTDEM**	:=
Reset Peak Demand (SV)	**RSTPKDM**	:=

Access Control

Disable FP Settings Change (SV)	**DSABLSET**	:=

Time-Synchronization Source

TIME_SRC IRIG Time Source (Select: IRIG1, IRIG2)	**TIME_SRC**	:=

Voltage Ratio Correction Factors (only visible when 3 ACI/3 AVI 0–8 Vac card installed)

VARCF Ratio Correction Factor (Range = 0.500–1.500)	**VARCF**	:=
VBRCF Ratio Correction Factor (Range = 0.500–1.500)	**VBRCF**	:=
VCRCF Ratio Correction Factor (Range = 0.500–1.500)	**VCRCF**	:=

Event Messenger Points

MESSENGER POINT TRIGGER (Off, 1 Device Word bit)	**MPTR1**	:=
MESSENGER POINT AQ (None, 1 analog quantity)	**MPAQ1**	:=
MESSENGER POINT TEXT (148 characters)	**MPTX1**	:=
MESSENGER POINT TRIGGER (Off, 1 Device Word bit)	**MPTR2**	:=
MESSENGER POINT AQ (None, 1 analog quantity)	**MPAQ2**	:=
MESSENGER POINT TEXT (148 characters)	**MPTX2**	:=
MESSENGER POINT TRIGGER (Off, 1 Device Word bit)	**MPTR3**	:=
MESSENGER POINT AQ (None, 1 analog quantity)	**MPAQ3**	:=
MESSENGER POINT TEXT (148 characters)	**MPTX3**	:=
MESSENGER POINT TRIGGER (Off, 1 Device Word bit)	**MPTR4**	:=
MESSENGER POINT AQ (None, 1 analog quantity)	**MPAQ4**	:=
MESSENGER POINT TEXT (148 characters)	**MPTX4**	:=

MESSENGER POINT TRIGGER (Off, 1 Device Word bit)	**MPTR5**	:= ______________
MESSENGER POINT AQ (None, 1 analog quantity)	**MPAQ5**	:= ______________
MESSENGER POINT TEXT (148 characters)	**MPTX5**	:= ______________

Port Settings (SET P Command)

Port F

Port Enable (Y, N)	**EPORT**	:=
Maximum Access Level (ACC, 2AC)	**MAXACC**	:=
Speed (300 to 38400 bps)	**SPEED**	:=
Data Bits (7, 8 bits)	**BITS**	:=
Parity (O, E, N)	**PARITY**	:=
Stop Bits (1, 2 bits)	**STOP**	:=
Port Timeout (1–30 min)	**T_OUT**	:=
Send Auto Message (Y, N)	**AUTO**	:=
Hardware Handshaking (Y, N)	**RTSCTS**	:=
Fast Operate Messages (Y, N)	**FASTOP**	:=

Port 1 (Ethernet Port in Slot B)

All Ethernet settings are hidden if an Ethernet option is not available.

Port Enable (Y, N)	**EPORT**	:=
Maximum Access Level (ACC, 2AC)	**MAXACC**	:=
IP ADDRESS (zzz.yyy.xxx.www)	**IPADDR**	:=
SUBNET MASK(zzz.yyy.xxx.www)	**SUBNETM**	:=
DEFAULT ROUTER (zzz.yyy.xxx.www)	**DEFRTR**	:=
Enable TCP Keep-Alive (Y, N)	**ETCPKA**	:=
TCP Keep-Alive Idle Range (1–20 sec) (*Hidden if ETCPKA := N*)	**KAIDLE**	:=
TCP Keep-Alive Interval Range (1–20 sec) (*Hidden if ETCPKA := N*)	**KAINTV**	:=
TCP Keep-Alive Count Range (1–20 sec) (*Hidden if ETCPKA := N*)	**KACNT**	:=
OPERATING MODE (Fixed, Failover, Switched) (*Hidden if not dual redundant Ethernet port option*)	**NETMODE**	:=
FAILOVER TIMEOUT (0.10–65.00 sec) (*Hidden if not dual redundant Ethernet port option or if NETMODE is not FAILOVER*)	**FTIME**	:=
PRIMARY NET PORT (A, B, D) (*Hidden if not dual redundant Ethernet port option*)	**NETPORT**	:=
NETWRK PORTA SPD (Auto, 10, 100 Mbps)	**NETASPD**	:=
NETWRK PORTB SPD (Auto, 10, 100 Mbps) (*Hidden if not dual redundant Ethernet port option*)	**NETBSPD**	:=
Enable Telent (Y,N)	**ETELENT**	:=Y
TELNET PORT (23,1025–65534)	**TPORT**	:=
TELNET TIME-OUT (1–30 min)	**TIDLE**	:=
Enable FTP (Y,N)	**EFTP**	:=Y
FTP USER NAME (20 characters)	**FTPUSER**	:=
Enable Modbus (Y,N)	**EMODBUS**	:=Y
Enable IEC 61850 Protocol (Y, N) (*Hidden if 61850 not supported*)	**E61850**	:=
Enable IEC 61850 GSE (Y, N) (*Hidden if E61850 := N*)	**EGSE**	:=
Enable DNP Sessions (*Hidden if DNP not supported*)	**EDNP**	:=

Port 2

Port Enable (Y, N)	**EPORT**	:=
Maximum Access Level (ACC, 2AC)	**MAXACC**	:=

Protocol (SEL, DNP, MOD, MBA, MBB, MB8A, MB8B, MBTA, MBTB, EVMSG, RTD)	**PROTO**	:= ________
Speed (300 to 38400 bps)	**SPEED**	:= ________
Data Bits (7, 8 bits)	**BITS**	:= ________
Parity (O, E, N)	**PARITY**	:= ________
Stop Bits (1, 2 bits)	**STOP**	:= ________
Minutes to Port Timeout (1–30 min)	**T_OUT**	:= ________
Send Auto Message (Y, N)	**AUTO**	:= ________
Fast Operate Messages (Y, N)	**FASTOP**	:= ________

Port 3

Port Enable (Y, N)	**EPORT**	:= ________
Maximum Access Level (ACC, 2AC)	**MAXACC**	:= ________
Protocol (SEL, DNP, MOD, MBA, MBB, MB8A, MB8B, MBTA, MBTB, EVMSG, RTD)	**PROTO**	:= ________
Speed (300 to 38400 bps)	**SPEED**	:= ________
Data Bits (7, 8 bits)	**BITS**	:= ________
Parity (O, E, N)	**PARITY**	:= ________
Stop Bits (1, 2 bits)	**STOP**	:= ________
Minutes to Port Timeout (1–30 min)	**T_OUT**	:= ________
Send Auto Message (Y, N)	**AUTO**	:= ________
Enable Hardware Handshaking (Y, N)	**RTSCTS**	:= ________
Fast Operate Messages (Y, N)	**FASTOP**	:= ________

Port 4

Port Enable (Y, N)	**EPORT**	:= ________
Maximum Access Level (ACC, 2AC)	**MAXACC**	:= ________
Communication Interface (232, 485)	**COMMINF**	:= ________
Protocol (SEL, DNP, MOD, MBA, MBB, MB8A, MB8B, MBTA, MBTB, EVMSG, RTD)	**PROTO**	:= ________
Speed (300 to 38400 bps)	**SPEED**	:= ________
Data Bits (7, 8 bits)	**BITS**	:= ________
Parity (O, E, N)	**PARITY**	:= ________
Stop Bits (1, 2 bits)	**STOP**	:= ________
Minutes to Port Timeout (1–30 min)	**T_OUT**	:= ________
Send Auto Message (Y, N)	**AUTO**	:= ________
Enable Hardware Handshaking (Y, N)	**RTSCTS**	:= ________
Fast Operate Messages (Y, N)	**FASTOP**	:= ________

MIRRORED BITS

MB Transmit Identifier (1–4)	**TXID**	:= ________
MB Receive Identifier (1–4)	**RXID**	:= ________
MB RX Bad Pickup Time (0–10000 seconds)	**RBADPU**	:= ________
PPM MB Channel Bad Pickup (1–10000)	**CBADPU**	:= ________
MB Receive Default State (8 character string of 1s, 0s, or Xs)	**RXDFLT**	:= ________
RMB1 Pickup Debounce Messages (1–8)	**RMB1PU**	:= ________
RMB1 Dropout Debounce Messages (1–8)	**RMB1DO**	:= ________

RMB2 Pickup Debounce Messages (1–8)	**RMB2PU**	:= ________
RMB2 Dropout Debounce Messages (1–8)	**RMB2DO**	:= ________
RMB3 Pickup Debounce Messages (1–8)	**RMB3PU**	:= ________
RMB3 Dropout Debounce Messages (1–8)	**RMB3DO**	:= ________
RMB4 Pickup Debounce Messages (1–8)	**RMB4PU**	:= ________
RMB4 Dropout Debounce Messages (1–8)	**RMB4DO**	:= ________
RMB5 Pickup Debounce Messages (1–8)	**RMB5PU**	:= ________
RMB5 Dropout Debounce Messages (1–8)	**RMB5DO**	:= ________
RMB6 Pickup Debounce Messages (1–8)	**RMB6PU**	:= ________
RMB6 Dropout Debounce Messages (1–8)	**RMB6DO**	:= ________
RMB7 Pickup Debounce Messages (1–8)	**RMB7PU**	:= ________
RMB7 Dropout Debounce Messages (1–8)	**RMB7DO**	:= ________
RMB8 Pickup Debounce Messages (1–8)	**RMB8PU**	:= ________
RMB8 Dropout Debounce Messages (1–8)	**RMB8DO**	:= ________

Telnet

Telnet Port (23, 1025–65534)	**TPORT**	:= ________
Telnet Port Timeout (1–30 min)	**TIDLE**	:= ________
File Transfer User Name (20 characters)	**FTPUSER**	:= ________
IP Address [zzz.yyy.xxx.www] (15 characters)	**IPADDR**	:= ________
Subnet Mask (15 characters)	**SUBNETM**	:= ________
Default Router Gateway (15 characters)	**DEFRTR**	:= ________

Front-Panel Settings (SET F Command)

General Settings

Enable Display Points (N, 1–32)	**EDP**	:=
Enable Local Bits (N, 1–32)	**ELB**	:=
LCD Timeout (OFF, 1–30; min)	**FP_TO**	:=
LCD Contrast (1–8)	**FP_CONT**	:=

LED Settings

LED 1 LATCH (Y, N)	**T01LEDL**	:=
LED1 EQUATION (SELOGIC)	**T01_LED**	:=
LED 2 LATCH (Y, N)	**T02LEDL**	:=
LED2 EQUATION (SELOGIC)	**T02_LED**	:=
LED 3 LATCH (Y, N)	**T03LEDL**	:=
LED3 EQUATION (SELOGIC)	**T03_LED**	:=
LED 4 LATCH (Y, N)	**T04LEDL**	:=
LED4 EQUATION (SELOGIC)	**T04_LED**	:=
LED 5 LATCH (Y, N)	**T05LEDL**	:=
LED5 EQUATION (SELOGIC)	**T05_LED**	:=
LED 6 LATCH (Y, N)	**T06LEDL**	:=
LED6 EQUATION (SELOGIC)	**T06_LED**	:=
PB01 LED Equation (SELOGIC)	**PB01_ LED**	:=
PB02 LED Equation (SELOGIC)	**PB02_ LED**	:=
PB03 LED Equation (SELOGIC)	**PB03_ LED**	:=
PB04 LED Equation (SELOGIC)	**PB04_ LED**	:=

Display Point Settings

Display Point Settings (maximum 60 characters):
(Boolean): Monitor Word Bit Name, "Alias", "Set String", "Clear String"
(Analog): Analog Quantity Name, "User Text and Formatting"

DP01	:=
DP02	:=
DP03	:=
DP04	:=
DP05	:=
DP06	:=
DP07	:=
DP08	:=
DP09	:=
DP10	:=
DP11	:=
DP12	:=
DP13	:=
DP14	:=
DP15	:=
DP16	:=

DP17	:=	
DP18	:=	
DP19	:=	
DP20	:=	
DP21	:=	
DP22	:=	
DP23	:=	
DP24	:=	
DP25	:=	
DP26	:=	
DP27	:=	
DP28	:=	
DP29	:=	
DP30	:=	
DP31	:=	
DP32	:=	

Local Bit Settings

Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB01**	:=	
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB01**	:=	
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB01**	:=	
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB01**	:=	
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB02**	:=	
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB02**	:=	
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB02**	:=	
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB02**	:=	
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB03**	:=	
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB03**	:=	
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB03**	:=	
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB03**	:=	
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB04**	:=	
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB04**	:=	
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB04**	:=	
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB04**	:=	
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB05**	:=	
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB05**	:=	
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB05**	:=	
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB05**	:=	
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB06**	:=	
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB06**	:=	
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB06**	:=	
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB06**	:=	
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB07**	:=	
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB07**	:=	
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB07**	:=	
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB07**	:=	

Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB08**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB08**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB08**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB08**	:=
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB09**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB09**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB09**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB09**	:=
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB10**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB10**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB10**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB10**	:=
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB11**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB11**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB11**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB11**	:=
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB12**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB12**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB12**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB12**	:=
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB13**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB13**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB13**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB13**	:=
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB14**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB14**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB14**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB14**	:=
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB15**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB15**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB15**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB15**	:=
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB16**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB16**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB16**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB16**	:=
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB17**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB17**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB17**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB17**	:=
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB18**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB18**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB18**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB18**	:=

Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB19**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB19**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB19**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB19**	:=
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB20**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB20**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB20**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB20**	:=
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB21**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB21**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB21**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB21**	:=
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB22**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB22**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB22**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB22**	:=
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB23**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB23**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB23**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB23**	:=
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB24**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB24**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB24**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB24**	:=
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB25**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB25**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB25**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB25**	:=
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB26**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB26**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB26**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB26**	:=
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB27**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB27**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB27**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB27**	:=
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB28**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB28**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB28**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB28**	:=
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB29**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB29**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB29**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB29**	:=

Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB30**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB30**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB30**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB30**	:=
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB31**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB31**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB31**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB31**	:=
Local Bit LB_ Name (14 Char; Enter NA to Null)	**NLB32**	:=
Clear Local Bit LB_ Label (7 Char; Enter NA to Null	**CLB32**	:=
Set Local Bit LB_ Label (7 Char; Enter NA to Null)	**SLB32**	:=
Pulse Local Bit LB_ Label (7 Char; Enter NA to Null)	**PLB32**	:=

Report Settings (SET R Command)

Event Report Settings

Event Trigger (SV)	**ER**	:=
Event Length (15, 64 cyc)	**LER**	:=
Prefault Length (1–10 cyc) or (1–59 cyc)	**PRE**	:=

SER Chatter Criteria

Auto-Removal Enable (Y, N)	**ESERDEL**	:=
Number of Counts (2–20)	**SRDLCNT**	:=
Removal Time (0.1–90.0 seconds)	**SRDLTIM**	:=

SER Trigger Lists

Enter up to 24 Device Word elements separated by spaces or commas in each of the four lists.
Use NA to disable setting.

SER1	:=
SER2	:=
SER3	:=
SER4	:=

Device Word Bit Aliases

15 character maximum per string. Device Word **Bit > Alias–String > Asserted–String > DEASS–String**

Enable ALIAS Settings	**EALIAS**	:=
ALIAS 1	**ALIAS01**	:=
ALIAS 2	**ALIAS02**	:=
ALIAS 3	**ALIAS03**	:=
ALIAS 4	**ALIAS04**	:=
ALIAS 5	**ALIAS05**	:=
ALIAS 6	**ALIAS06**	:=
ALIAS 7	**ALIAS07**	:=
ALIAS 8	**ALIAS08**	:=
ALIAS 9	**ALIAS09**	:=
ALIAS 10	**ALIAS10**	:=
ALIAS 11	**ALIAS11**	:=
ALIAS 12	**ALIAS12**	:=
ALIAS 13	**ALIAS13**	:=
ALIAS 14	**ALIAS14**	:=
ALIAS 15	**ALIAS15**	:=
ALIAS 16	**ALIAS16**	:=
ALIAS 17	**ALIAS17**	:=
ALIAS 18	**ALIAS18**	:=
ALIAS 19	**ALIAS19**	:=
ALIAS 20	**ALIAS20**	:=

Fast Message Read Settings

Enter up to 24 Analog Quantities separated by spaces or commas in each of the four lists.
Use NA to disable setting.

FMR1 NAME (9 characters) **FMR1NAM** := ____
FMR1 := ____
FMR2 NAME (9 characters) **FMR2NAM** := ____
FMR2 := ____
FMR3 NAME (9 characters) **FMR3NAM** := ____
FMR3 := ____
FMR4 NAME (9 characters) **FMR4NAM** := ____
FMR4 := ____

Fast Message Remote Analog Settings

I = Integer, F = Float, L = Long

Remote Analog Value Type (I, F, L) **RA01TYPE** := ____
Remote Analog Value Type (I, F, L) **RA02TYPE** := ____
Remote Analog Value Type (I, F, L) **RA03TYPE** := ____
Remote Analog Value Type (I, F, L) **RA04TYPE** := ____
Remote Analog Value Type (I, F, L) **RA05TYPE** := ____
Remote Analog Value Type (I, F, L) **RA06TYPE** := ____
Remote Analog Value Type (I, F, L) **RA07TYPE** := ____
Remote Analog Value Type (I, F, L) **RA08TYPE** := ____
Remote Analog Value Type (I, F, L) **RA09TYPE** := ____
Remote Analog Value Type (I, F, L) **RA10TYPE** := ____
Remote Analog Value Type (I, F, L) **RA11TYPE** := ____
Remote Analog Value Type (I, F, L) **RA12TYPE** := ____
Remote Analog Value Type (I, F, L) **RA13TYPE** := ____
Remote Analog Value Type (I, F, L) **RA14TYPE** := ____
Remote Analog Value Type (I, F, L) **RA15TYPE** := ____
Remote Analog Value Type (I, F, L) **RA16TYPE** := ____
Remote Analog Value Type (I, F, L) **RA17TYPE** := ____
Remote Analog Value Type (I, F, L) **RA18TYPE** := ____
Remote Analog Value Type (I, F, L) **RA19TYPE** := ____
Remote Analog Value Type (I, F, L) **RA20TYPE** := ____
Remote Analog Value Type (I, F, L) **RA21TYPE** := ____
Remote Analog Value Type (I, F, L) **RA22TYPE** := ____
Remote Analog Value Type (I, F, L) **RA23TYPE** := ____
Remote Analog Value Type (I, F, L) **RA24TYPE** := ____
Remote Analog Value Type (I, F, L) **RA25TYPE** := ____
Remote Analog Value Type (I, F, L) **RA26TYPE** := ____
Remote Analog Value Type (I, F, L) **RA27TYPE** := ____
Remote Analog Value Type (I, F, L) **RA28TYPE** := ____
Remote Analog Value Type (I, F, L) **RA29TYPE** := ____

Remote Analog Value Type (I, F, L)	**RA30TYPE**	:=	________
Remote Analog Value Type (I, F, L)	**RA31TYPE**	:=	________
Remote Analog Value Type (I, F, L)	**RA32TYPE**	:=	________

Signal Profile Settings

Enter up to 16 Analog Quantities separated by spaces or commas in each list. Use NA to null.

Signal Profile List	**SPLIST1**	:=	________________
Signal Profile List	**SPLIST2**	:=	________________
SP Acquisition Rate (5, 10, 15, 30, 60 min)	**SPAR**	:=	________________
Signal Profile Enable (SV)	**SPEN**	:=	________________

DNP3 Settings (SET DNP Command)

DNP3 Communications (*Hidden if DNP not supported*)

Enable DNP Sessions (0–3)	**EDNP**	:=
DNP TCP and UDP Port (1–65534)	**DNPNUM**	:=
Device DNP Address (0–65519)	**DNPADR**	:=

Session 1 Settings

IP Address (zzz.yyy.xxx.www)	**DNPIP1**	:=
Transport Protocol (UDP, TCP)	**DNPTR1**	:=
UDP Response Port (REQ, 1–65534)	**DNPUDP1**	:=
DNP3 address of the Master to send messages to (0–65519)	**REPADR1**	:=
DNP3 Session Map (1–3)	**DNPMAP1**	:=
Analog Input Default Variation (0–6)	**DVARAI1**	:=
Class for binary event data, 0 disables (0–3)	**ECLASSB1**	:=
Class for counter event data, 0 disables (0–3)	**ECLASSC1**	:=
Class for analog event data, 0 disables (0–3)	**ECLASSA1**	:=
Decimal places scaling for Current data (0–3)	**DECPLA1**	:=
Decimal places scaling for Voltage data (0–3)	**DECPLV1**	:=
Decimal places scaling for Miscellaneous data (0–3)	**DECPLM1**	:=
Analog reporting dead band for current (0–32767)	**ANADBA1**	:=
Analog reporting dead band for voltages (0–32767)	**ANADBV1**	:=
Analog reporting dead band for miscellaneous analogs (0–32767)	**ANADBM1**	:=
Time–set request interval, minutes (I, M, 1–32767)	**TIMERQ1**	:=
Select/operate time-out, seconds (0.0–30.0)	**STIMEO1**	:=
Send Data Link Heartbeat, seconds (0.0–7200)	**DNPINA1**	:=
Data link retries (0–15)	**DRETRY1**	:=
Data link time-out, seconds (0.0–5.0)	**DTIMEO1**	:=
Event message confirm time-out, seconds (1–50)	**ETIMEO1**	:=
Enable unsolicited reporting (Y, N)	**UNSOL1**	:=
Enable unsolicited reporting at power up (Y, N)	**PUNSOL1**	:=
Number of events to transmit on (1–200)	**NUMEVE1**	:=
Oldest event to transmit on, seconds (0.0–99999.0)	**AGEEVE1**	:=
Unsolicited messages maximum retry attempts (2–10)	**URETRY1**	:=
Unsolicited messages offline timeout, seconds (1–5000)	**UTIMEO1**	:=

Session 2 Settings

IP Address (zzz.yyy.xxx.www)	**DNPIP2**	:=
Transport Protocol (UDP, TCP)	**DNPTR2**	:=
UDP Response Port (REQ, 1–65534)	**DNPUDP2**	:=
DNP3 address of the Master to send messages to (0–65519)	**REPADR2**	:=
DNP3 Session Map (1–3)	**DNPMAP2**	:=
Analog Input Default Variation (0–6)	**DVARAI2**	:=
Class for binary event data, 0 disables (0–3)	**ECLASSB2**	:=
Class for counter event data, 0 disables (0–3)	**ECLASSC2**	:=
Class for analog event data, 0 disables (0–3)	**ECLASSA2**	:=

Decimal places scaling for Current data (0–3)	**DECPLA2**	:=	________
Decimal places scaling for Voltage data (0–3)	**DECPLV2**	:=	________
Decimal places scaling for Miscellaneous data (0–3)	**DECPLM2**	:=	________
Analog reporting dead band for current (0–32767)	**ANADBA2**	:=	________
Analog reporting dead band for voltages (0–32767)	**ANADBV2**	:=	________
Analog reporting dead band for miscellaneous analogs (0–32767)	**ANADBM2**	:=	________
Time-set request interval, minutes (I, M, 1–32767)	**TIMERQ2**	:=	________
Select/operate time-out, seconds (0.0–30.0)	**STIMEO2**	:=	________
Send Data Link Heartbeat, seconds (0.0–7200)	**DNPINA2**	:=	________
Data link retries (0–15)	**DRETRY2**	:=	________
Data link time-out, seconds (0.0–5.0)	**DTIMEO2**	:=	________
Event message confirm time-out, seconds (1–50)	**ETIMEO2**	:=	________
Enable unsolicited reporting (Y, N)	**UNSOL2**	:=	________
Enable unsolicited reporting at power up (Y, N)	**PUNSOL2**	:=	________
Number of events to transmit on (1–200)	**NUMEVE2**	:=	________
Oldest event to transmit on, seconds (0.0–99999.0)	**AGEEVE2**	:=	________
Unsolicited messages maximum retry attempts (2–10)	**URETRY2**	:=	________
Unsolicited messages offline timeout, seconds (1–5000)	**UTIMEO2**	:=	________

Session 3 Settings

IP Address (zzz.yyy.xxx.www)	**DNPIP3**	:=	________
Transport Protocol (UDP, TCP)	**DNPTR3**	:=	________
UDP Response Port (REQ, 1–65534)	**DNPUDP3**	:=	________
DNP3 address of the Master to send messages to (0–65519)	**REPADR3**	:=	________
DNP3 Session Map (1–3)	**DNPMAP3**	:=	________
Analog Input Default Variation (0–6)	**DVARAI3**	:=	________
Class for binary event data, 0 disables (0–3)	**ECLASSB3**	:=	________
Class for counter event data, 0 disables (0–3)	**ECLASSC3**	:=	________
Class for analog event data, 0 disables (0–3)	**ECLASSA3**	:=	________
Decimal places scaling for Current data (0–3)	**DECPLA3**	:=	________
Decimal places scaling for Voltage data (0–3)	**DECPLV3**	:=	________
Decimal places scaling for Miscellaneous data (0–3)	**DECPLM3**	:=	________
Analog reporting dead band for current (0–32767)	**ANADBA3**	:=	________
Analog reporting dead band for voltages (0–32767)	**ANADBV3**	:=	________
Analog reporting dead band for miscellaneous analogs (0–32767)	**ANADBM3**	:=	________
Time-set request interval, minutes (I, M, 1–32767)	**TIMERQ3**	:=	________
Select/operate time-out, seconds (0.0–30.0)	**STIMEO3**	:=	________
Send Data Link Heartbeat, seconds (0.0–7200)	**DNPINA3**	:=	________
Data link retries (0–15)	**DRETRY3**	:=	________
Data link time-out, seconds (0.0–5.0)	**DTIMEO3**	:=	________
Event message confirm time-out, seconds (1–50)	**ETIMEO3**	:=	________
Enable unsolicited reporting (Y, N)	**UNSOL3**	:=	________
Enable unsolicited reporting at power up (Y, N)	**PUNSOL3**	:=	________
Number of events to transmit on (1–200)	**NUMEVE3**	:=	________
Oldest event to transmit on, seconds (0.0–99999.0)	**AGEEVE3**	:=	________

Unsolicited messages maximum retry attempts (2–10)	**URETRY3**	:= ________
Unsolicited messages offline timeout, seconds (1–5000)	**UTIMEO3**	:= ________

Serial Port Settings

Minimum delay from DCD to TX, seconds (0.00–1.00)	**MINDLY**	:= ________
Maximum delay from DCD to TX, seconds (0.00–1.00)	**MAXDLY**	:= ________
Settle time from RTS on to TX; Off disables PSTDLY (OFF, 0.00–30.00)	**PREDLY**	:= ________
Settle time from TX to RTS off (0.00–30.00)	**PSTDLY**	:= ________

DNP3 Serial Modem Settings

Modem connected to port (Y, N)	**MODEM**	:= ________
Modem startup string (Up to 30 characters)	**MSTR**	:= ________
Primary phone number for dial-out (Up to 30 characters)	**PH_NUM1**	:= ________
Secondary phone number for dial-out (Up to 30 characters)	**PH_NUM2**	:= ________
Primary phone number for dial-out (Up to 30 characters)	**PH_NUM1**	:= ________
Retry attempts for primary dial-out (1–20)	**RETRY1**	:= ________
Retry attempts for secondary dial-out (1–20)	**RETRY2**	:= ________
Retry attempts for secondary dial-out (1–20)	**RETRY2**	:= ________
Time from initiating call to failure due to no connection, seconds (5–300)	**MDTIME**	:= ________
Time between dial-out attempts (5-3600)	**MDRET**	:= ________

This page intentionally left blank

Section 7
Communications

Overview

This section lists commands (ASCII and CASCII formats) you can use to communicate with the device to obtain information, reports, data, or perform control functions. You enter all commands on a keyboard when communicating via the serial port.

Commands, command options, and command variables to enter are shown in bold. Lowercase italic letters and words in a command represent command variables that are determined based on the application. Command options appear with brief explanations about the command function. Refer to the references listed with the commands for more information on the control function corresponding to the command or examples of the control response to the command.

You can simplify the task of entering commands by shortening any command to the first three characters; for example, **ACCESS** becomes **ACC**. Always send a carriage return **<CR>** character or a carriage return character followed by a line feed character **<CR><LF>** to execute the command. Usually, most terminals and terminal programs interpret the Enter key as a **<CR>**. For example, to send the **ACCESS** command, type **ACC <Enter>**.

Tables in this section show the access level(s) where the command or command option is available. Access levels in this device are Access Level 0, Access Level 1, and Access Level 2.

Communications

Communications Ports

Table 7.1 shows the physical interfaces of the SEL-2411 Programmable Automation Controller. Several options are available to provide alternative physical interfaces, including EIA-485 and fiber-optic cable (see *Section 2: Installation* for more information on the interface cards).

Table 7.1 Communications Port Physical Interfaces (Sheet 1 of 2)

Port Type	Port Interface	Usage
Port F (Serial)	EIA-232 (Nonisolated)	Use the EIA-232 port for communications distances of ≤15 m (50 feet) in low noise environments.
Port 1A, 1B (Ethernet)	10/100BASE-T (Copper & 100BASE-FX [Fiber])	*Table 7.5* shows the available Ethernet protocols. Use Telnet to emulate serial communications in a network environment.
Port 2 (Serial)[a]	ST fiber	Use the fiber-optic port for safety (electrical isolation) and long (500 m to 8 km) communications distances.

Table 7.1 Communications Port Physical Interfaces (Sheet 2 of 2)

Port Type	Port Interface	Usage
Port 3, 4A (Serial)	EIA-232 (Nonisolated)	Use the EIA-232 port for communications distances of ≤15 m (50 feet) in low noise environments.
Port 4C (Serial)	EIA-485	Use the EIA-485 port for communications distances ≤1200 m (4000 feet). To achieve this performance, ensure proper line termination at the receiver.

[a] This port can receive RTD measurement information from the optional external SEL-2600 devices. Refer to the applicable SEL-2600 Instruction Manual for information on the fiber-optic interface.

IRIG-B

Two physical interfaces are available for the demodulated IRIG-B time-code input. One physical interface is via terminals (**B01** and **B02**), and the other is part of the serial Port 3 physical interface. Only one interface can be used at a time. When using serial Port 3, connect to an SEL communications processor with Cable C273A (see the cable diagrams that follow in this section or use the SEL-5801 Cable Selector software).

+5 Vdc Power Supply

NOTE: Although the +5 Vdc power supply is available at more than one port, the total 5 V load from any combination of ports cannot exceed 0.5 A.

Serial port power provides as much as 0.5 A total from all of the +5 Vdc pins (Port F, Port 3, and Port 4A). Some SEL communications devices require the +5 Vdc power supply. This +5 Vdc is available in any combination of Pins 1, 3, and 7 without the need for hardware jumpers.

Port Connector and Communications Cables

Figure 7.1 shows the front-panel EIA-232 serial port DB-9 connector pin numbering for the SEL-2411.

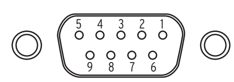


Figure 7.1 EIA-232 DB-9 Connector Pin Numbers

Table 7.2 shows the pin functions for the EIA-232 serial ports.

Table 7.2 EIA Serial Port Pin Functions

Pin[a]	Port 3 EIA-232	Port 4C EIA-232	Port 4A EIA-485	Port F EIA-232
1	+5 Vdc	+5 Vdc	+TX	N/C
2	RXD	RXD, RX	–TX	RXD
3	TXD	TXD, TX	+RX	TXD
4	IRIG+	N/C	–RX	N/C
5	GND	GND	Shield	GND
6	IRIG–	N/C		N/C
7	RTS	RTS		RTS
8	CTS	CTS		CTS
9	GND	GND		GND

[a] For EIA-485, the pin numbers represent device terminals C01 through C05.

The following cable diagrams show several types of EIA-232 serial communications cables that connect the SEL-2411 to other devices. These and other cables are available from SEL.

SEL-2411 Cable Connections to Communications Devices

Table 7.3 Communications Cables

Interface	Device 1 (SEL-2411)	Device 2	Connection Description	Cable
EIA-232	DTE: 9-Pin Male D	DTE: 9-Pin Male D	Comm. Proc. without IRIG-B	C272A
EIA-232	DTE: 9-Pin Male D	DTE: 9-Pin Male D	Comm. Proc. with IRIG-B	C273A
EIA-232	DTE: 9-Pin Male D	DTE: 9-Pin Female D	Computer	C234A
EIA-232	DTE: 9-Pin Male D	DTE: 25-Pin Female D	Computer	C227A
EIA-232	DTE: 9-Pin Male D	DCE: 9-Pin Male	Wireless encrypting transceiver	C285
EIA-232	DTE: 9-Pin Male D	DCE: 9-Pin Female D	Serial encrypting transceiver	C245A
EIA-232	DTE: 9-Pin Male D	DCE: 25-Pin Female D	Modem	C222
EIA-485	DTE: 9-Pin Male D	8-Pin Compression	Multidrop network	C675
Ethernet	RJ-45 Ethernet	RJ-45 Ethernet	Copper Ethernet	C627
IRIG-B	DTE: 9-Pin Male D	BNC Female	Demodulated IRIG-B	C256
USB 2.0	DTE: 9-Pin Male D	USB Type A	EIA-232 to USB adapter	C662
USB 2.0	USB Type B	USB Type A	Computer	C664

Communications Protocols

Hardware Flow Control

All EIA-232 serial ports support RTS/CTS hardware handshaking (hardware flow control).

Port Setting	Effect
RTSCTS := N	Disables hardware handshaking. Permanently asserts the RTS line.
RTSCTS := Y	Deasserts RTS when unable to receive characters. Blocks character transmission until the CTS input is asserted.

Protocols

A rich collection of protocols is available with the PAC; however, not all protocols are available on all ports.

Table 7.4 Serial Port Protocols (Sheet 1 of 2)

Protocol	Description
SEL Communications Protocols	
SEL ASCII	Use this protocol to send ASCII commands and receive ASCII responses that are human readable with an appropriate terminal emulation program.
Compressed ASCII	This protocol provides compressed versions of some of the ASCII commands. See *Appendix C: SEL Communications Processors* for details.
Fast Meter	This protocol supports binary messages to transfer metering and digital element messages.
Fast Operate	This protocol supports binary messages to transfer operation messages.

Table 7.4 Serial Port Protocols (Sheet 2 of 2)

Protocol	Description
Fast SER	This protocol is used to receive binary Sequential Events Recorder unsolicited responses.
Fast Message Read	This protocol uses binary messages to transmit data to an SEL Communications Processor. See *Appendix C: SEL Communications Processors* for details.
Fast Message Unsolicited Write	This protocol uses binary messages to receive data from an SEL Communications Processor. See *Appendix C: SEL Communications Processors* for details.
Other SEL Communications Protocols	
MIRRORED BITS®	This protocol is used to receive binary Sequential Events Recorder unsolicited responses. See *Appendix C: SEL Communications Processors* for details.
Event Messenger	This protocol supports transmitting messages to SEL-3010 Event Messenger. See *Table 6.14 on page 6.17* for details.
Industry Standard Communications Protocols	
Modbus®	Modbus is a simple manufacturer-developed, hardware independent communications protocol. See *Appendix E: Modbus Communications*.
DNP3	DNP3 is an object-oriented manufacturer-developed, hardware independent communications protocol. See *Appendix D: DNP3 Communications*.

Ethernet Protocols (Port 1A, 1B)

A wide collection of Ethernet protocols is available with the PAC; *Table 7.5* shows protocols available on the Ethernet ports.

Table 7.5 Ethernet Protocols

Protocol	Sessions/ Messages	Description
FTP Server	1	Use FTP to access the following files: ➤ CFG.XML (Configuration RO file) ➤ CFG.TXT (Configuration RO file) ➤ ERR.TXT (Error RO file) ➤ SET_61850.CID (IEC 61850 CID RO file) ➤ SET_*xx*.TXT (Setting RW files) FTP is a standard TCP/IP protocol for exchanging files.
Telnet Server	1	Use Telnet to connect to the device to use SEL protocols (SEL ASCII, Compressed ASCII, Fast Meter, and Fast Operate). Telnet is a terminal connection across a TCP/IP network that operates in a manner very similar to a direct serial port connection to one of the device ports. As with FTP, Telnet is a part of TCP/IP.
Ping Server	1	Use a ping client with the device ping server to verify that your network configuration is correct. ping is an application based on ICMP over an IP network.
IEC 61850	MMS: 6 GOOSE: 16 Incoming 8 Outgoing	Use as MMS over a TCP network to exchange data with the device. Use GOOSE to do real-time data exchange. For more details on the IEC 61850 protocol, see *Appendix F: IEC 61850 Communications*.

Device Access

Change the Default Passwords

It is extremely important that you change the factory default passwords programmed in the SEL-2411. Setting unique passwords for the relay access levels increases the security of your substation and the power system.

Access Levels

To provide security, commands are available on different password-protected access levels. Each command description throughout this section indicates the access level at which the command is available. There are three access levels in the device that offer varying levels of control, as shown in *Table 7.6*.

Table 7.6 Access Level

Level	Prompt	Capability
0	=	Access Level 0 commands are at the lowest security level and they support SEL Communications Processors and the **ACC** command. Entering the **ACC** command at the Access Level 0 prompt takes the PAC to Access Level 1.[a]
1	=>	Access Level 1 commands are primarily for reviewing information, not changing it. Entering the **2AC** command at the Access Level 1 prompt takes the PAC to Access Level 2.[a]
2	=>>	Access Level 2 commands are primarily for changing device settings, resetting accumulated device information, or resetting saved data.[a]

[a] See the *SEL-2411 Programmable Automation Controller Command Summary* at the end of this manual for the commands available at a particular level.

Access Commands (ACCESS and 2ACCESS)

The **ACC** and **2AC** commands provide entry to the multiple access levels, as shown in *Table 7.7*. Different commands are available at the different access levels, as shown in the *SEL-2411 Programmable Automation Controller Command Summary* at the end of this manual. Commands **ACC** and **2AC** are explained together because they operate similarly.

Table 7.7 Access Commands

Command	Description	Access Level
ACC	Moves from Access Level 0 to Access Level 1	0
	Moves from Access Level 2 to Access Level 1	2
2AC	Moves from Access Level 1 to Access Level 2	1

Password Requirements

After enabling the password function, you need to enter passwords to access each access level. See *PASSWORD Command (View/Change Passwords) on page 7.19* for the list of default passwords and for more information on changing and disabling passwords.

ASCII Commands

The following is an alphabetical listing and discussion of all the ASCII commands available in the SEL-2411.

ANALOG Command (Test Analog Outputs)

Use the **ANA** command to test an analog output by temporarily assigning a value to an analog output channel. After entering the **ANA** command, the device suspends normal operation of the analog output channel and scales the output to a percentage of full scale. After assigning the specified value for the specified time, the device returns to normal operation. Entering any character (including pressing the space key) ends the command before reaching the specified interval completion. You can test the analog output in one of the following two modes:

- ➤ Fixed percentage: Outputs a fixed percentage of the signal for a specified duration
- ➤ Ramp: Ramps the output from minimum to maximum of full scale over the time specified

Table 7.8 ANALOG Command

Command	Description	Access Level
ANA *c p t*	Temporarily assigns a value to an analog output channel.	2

Table 7.9 ANALOG Command Format

Parameter	Description
c	Parameter *c* is the analog channel (either the channel name, e.g., AO301, or the channel number, e.g., 301).
p	Parameter *p* is either percentage of full scale, or the letter R or r to indicate ramp mode.
t	Parameter *t* is the duration (in decimal minutes) of the test.

When parameter *p* is a percentage, the device displays the following message during the test:

```
Outputting xx.xx [units] to Analog Output Port for y.y minutes.
Press any key to end test
```

where:

`xx.xx` is the calculation of percent of full scale
`[units]` is either mA or V, depending on the channel type setting
`y.y` is the time in minutes

When parameter *p* is a ramp function, the device displays the following message during the test:

```
Ramping Analog Output at xx.xx [units]/min; full scale in y.y minutes.
Press any key to end test
```

where:

`xx.xx` is the calculation based upon range/time t
`[units]` is either mA or V, depending on the channel type setting
`y.y` is the time in minutes

NOTE: 0% = low span, 100% = high span. For a scaled output from 4–20 mA, 0 percent is 4 mA and 100 percent is 20 mA.

For either mode of operation (percentage or ramp), when the time expires, or upon pressing a key, the analog output port returns to normal operation and the device displays the following message:

```
Analog Output Port Test Complete
```

Example 1

The following is an example of the device response to the **ANA** command in the percentage mode. For this example, we assume the analog output signal type is 4–20 mA, and we want to test the analog output at 75 percent of rating for 5.5 minutes. To check the device output, calculate the expected mA output as follows:

$$\text{Output} = \left[(20.00\text{ mA} - 4.00\text{ mA}) \bullet \frac{75}{100}\right] + 4.00\text{ mA} = 16.00\text{ mA}$$

To start the test, enter **ANA A0301 75 5.5** at the Access Level 2 prompt:

```
=>>ANA A0301 75 5.5 <Enter>
Outputting 16.00 mA to Analog Output Port for 5.5 minutes.
Press any key to end test
```

Example 2

The following is an example of the ramp mode when the analog output signal type is 4–20 mA for a 9.0 minute test.

To check the device output, calculate the current/time (mA/min) output as follows:

$$\text{Output} = \left[\frac{20.00\text{ mA} - 4.00\text{ mA}}{9.0\text{ min}}\right] = 1.78\text{ mA/min}$$

To start the test, enter **ANA AO301 R 9.0** at the Access Level 2 prompt:

```
=>>ANA A0301 R 9.0 <Enter>
Ramping Analog Output at 1.78 mA/min; full scale in 9.0 minutes.
Press any key to end test
```

BNAMES Command (Binary Names)

Use the **BNA** command to produce the names of all device status bits reported in the Fast Meter Data Block (A5D1) message in Compressed ASCII format, as shown in *Table 7.10*. This command is only available as Compressed ASCII response.

Table 7.10 BNAMES Command

Command	Description	Access Level

BNA	Displays names of all device status bits, as shown below:
	`=BNA <Enter>`
	`"*","*","*","STSET","*","*","*","*","0639"`
		0

CAL Command

Use the **CAL** command to gain access to Access Level C. See *Access Levels* for more information. Only go to Level C to modify the default password or under the direction of an SEL employee. The additional commands available at Level C are not intended for normal operational purposes.

Table 7.11 CAL Command

Command	Description	Access Level
CAL	Go to Access Level C.	2, C

CASCII Command (Compressed ASCII)

Use the **CAS** command to produce the Compressed ASCII configuration message. This configuration instructs an external computer on the method for extracting data from other Compressed ASCII commands, as shown in *Table 7.12*. This command is only available as Compressed ASCII response.

Table 7.12 CASCII Command

Command	Description	Access Level

CAS	Return the Compressed ASCII configuration message—shown below is an extract:
	`=CAS <Enter>`
	`"CAS",113,"0208"`
	`"CMETER FUNDAMENTAL",1,"05DC"`
		0

Upon receiving the **CAS** command, the device responds with the configurations of all Compressed ASCII commands: **CME**, **CST**, **CHI**, and **CSU**.

CEVENT Command (Compressed Event Report)

Use the **CEV** command (*Table 7.13*) to obtain event report data in a Compressed ASCII response. These data are similar to those data produced by the **EVENT** command. When using the **CEV** command to retrieve event reports, the event data is in a format suitable for use by PC software to display the event in oscillographic form. See *Section 9: Analyzing Events* for further details on event reports. When the **CEV** command includes any of the parameters listed in *Table 7.13* (e.g., **CEV *n***), the report length is the number of cycles specified by the LER setting (15 or 64 cycles). When using the **CEV** command without parameters, the report length is 15 cycles.

Table 7.13 CEVENT Command

Command	Description	Access level
CEV *n*	Return the filtered ac analog data, 4 sample/cycle event report number *n*.	1
CEV *n* R	Return the raw (unfiltered) ac analog data, 16 sample/cycle raw event report number *n*. Raw reports include an extra cycle of data at the beginning of the report.	1

Parameter *n* specifies the event report number. Use the **HIS** command to determine the event report number of the event you want to display. If *n* is not specified, the device displays Event Report 1.

CHISTORY Command (Compressed History)

The device generates the Compressed ASCII history in response to the **CHI** command, as shown in *Table 7.14*.

Table 7.14 CHISTORY Command (Compressed History)

Command	Description	Access Level
CHI *x*	Generates the compressed history report	1

Parameter *x* is the number of events you want displayed. The device shows fewer than *x* events if *x* is less than the number of stored events. If *x* is greater than the number of stored events, the device displays all of the stored events.

CMETER Command (Compressed METER)

NOTE: Information displayed in parenthesis is optional.

The device generates the Compressed ASCII meter of fundamental, analog input, math variable, remote analog, and signal profile data in response to the **CME *x*** (*x* = FUN, ANA, MAT, REM) command, as shown in *Table 7.15*.

Table 7.15 CMETER Command

Command	Description	Access Level
CME F(UN)[a]	Display fundamental meter data in compressed format	1
CME A(NA)	Display analog input (transducer) data compressed format	1
CME M(AT)	Display SELOGIC® math variable data compressed format	1
CME R(EM)	Display remote analog data compressed format	1

[a] You can omit FUN (just type CME <Enter>) to display the fundamental meter data.

COMMUNICATIONS Command

The **COM *x*** command displays communications statistics for the MIRRORED BITS communications channels. For more information on MIRRORED BITS communications, see *Appendix G: MIRRORED BITS Communications*. The summary report includes information on the failure of ROKA or ROKB. The Last error field displays the reason for the most recent channel error, even if the channel was already failed. We define failure reasons as one of the following error types:

- Device disabled
- Framing error
- Parity error
- Overrun
- Re-sync
- Data error
- Loopback
- Underrun

Table 7.16 COM Command

Command	Description	Access Level
COM S A or COM S B	Return a summary report of the last 255 records in the communications buffer for either MIRRORED BITS communications Channel A or Channel B when only one channel is enabled.	1
COM A	Return a summary report of the last 255 records in the communications buffer for MIRRORED BITS communications Channel A.	1
COM B	Return a summary report of the last 255 records in the communications buffer for MIRRORED BITS communications Channel B.	1
COM L A	Appends a long report to the summary report of the last 255 records in the communications buffer for MIRRORED BITS communications Channel A.	1
COM L B	Appends a long report to the summary report of the last 255 records in the communications buffer for MIRRORED BITS communications Channel B.	1
COM C	Clears all communications records. If both MIRRORED BITS channels are enabled, omitting the channel specifier (A or B) clears both channels.	1
COM C A	Clears all communications records for Channel A.	1
COM C B	Clears all communications records for Channel B.	1

CONTROL Command (Control Remote Bit)

Use the **CON** command to control remote bits (Device Word bits RB01–RB32). You can use the **CON** function from the front panel (`Control > Outputs`) to pulse the outputs. Remote bits are device variables that you set via serial port communication only; you cannot navigate Remote Bits via the front-panel HMI. You can select the control operation from three states: set, clear, or pulse, as described in *Table 7.18*.

Table 7.17 CONTROL Command

Command	Description	Access Level
CON RB*nn*[a] *k*	First step of a two-command sequence. The SEL-2411 prompts for the second step (subcommand) shown below.	2

[a] Parameter *nn* is a number from 01 to 32, representing RB01 through RB32. *k* is S, C, or P.

Table 7.18 Three Remote Bit States

Subcommand	Description	Access Level
S	Set Remote bit (ON position)	2
C	Clear Remote bit (OFF position)	2
P	Pulse Remote bit for ¼ cycle (MOMENTARY position)	2

For example, use the following steps to set Remote bit RB05:

```
=>>CON RB32 S <Enter>
```

COUNTER Command (Counter Values)

The device generates the values of the 32 counters in response to the **COU** command, as shown in *Table 7.19*.

Table 7.19 COUNTER Command

Command	Description	Access Level
COU *n*	Display the values of the SELOGIC counters *n* times	1

CPROFILE Command (Compressed Signal Profile Values)

The **CPR** command retrieves analog signal profile data in Compressed ASCII format, as shown in *Table 7.20*.

Table 7.20 CPROFILE Command

Command	Description	Access Level
CPR	Display analog signal profile data	1

CSTATUS Command (Compressed Status)

The **CST** command generates a device status report in Compressed ASCII format, as shown in *Table 7.21*.

Table 7.21 CSTATUS Command

Command	Description	Access Level
CST	Return the device status in Compressed ASCII format	1

CSUMMARY Command (Compressed Summary)

The **CSU** command retrieves the event summary information from the last event report in Compressed ASCII format, as shown in *Table 7.22*.

Table 7.22 CSUMMARY Command

Command	Description	Access Level
CSU	Return the most recent event summary (with label lines) in Compressed ASCII format	1

DATE Command (View/Change Date)

Use the **DATE** command to view and set the device date, as shown in *Table 7.23*.

Table 7.23 DATE Command

Command	Description	Access Level
DAT	Display the internal clock date	1
DAT date	Set the internal clock date (DATE_F set to MDY, YMD, or DMY)	1

The device can overwrite the date entered by using other time sources such as IRIG. Enter the **DATE** command with a date to set the internal clock date. Separate the month, day, and year parameters with slashes. Set the year in 4-digit form (for dates 2000–2099). Global setting DATE_F sets the date format.

EVENT Command (Event Reports)

Use the **EVE** command to view event reports. See *Section 9: Analyzing Events* for further details on retrieving and analyzing event reports, as shown in *Table 7.24*. See *HISTORY Command (Events List) on page 7.12* for details on clearing event reports.

Table 7.24 EVENT Command

Command	Description	Access Level
EVE *n*	Return event report number *n* with 4 samples/cycle data	1
EVE *n* R	Return event report number *n* with raw (unfiltered) 16 samples/cycle analog data and 4 samples/cycle digital data	1

Parameter *n* specifies the event report number. Use the **HIS** command to determine the event report number of the event you want to display. If *n* is not specified, the device displays Event Report 1.

FILE Command (Manage Settings Files)

The **FIL** command provides a safe and efficient means of transferring settings files between intelligent electronic devices (IEDs) and external support software (ESS). Use the **FIL** commands for sending settings to the SEL-2411 and receiving settings from the device, as shown in *Table 7.25*.

Table 7.25 FILE Command

Command	Description	Access Level
FIL DIR	Return a list of files	1
FIL READ *filename*	Transfer settings file *filename* from the device to the PC	1
FIL WRITE *filename*	Transfer settings file *filename* from the PC to the device	2
FIL SHOW *filename*	Displays the contents of the file *filename*	1

HELP Command

In response to the **HEL *XXX*** command, the device displays a short description of the ASCII command. Parameter ***XXX*** is any ASCII command, **HEL CON** for example.

HISTORY Command (Events List)

Use the **HIS** command to view a list of one-line descriptions of device events or clear the list (and corresponding event reports) from nonvolatile memory, as shown in *Table 7.26*.

Table 7.26 HISTORY Command

Command	Description	Access Level
HIS	Return event histories with the oldest at the bottom of the list and the most recent at the top of the list	1
HIS *n*	Return event histories with the oldest at the bottom of the list and the most recent at the top of the list, beginning at event *n*.	1
HIS C	Clear/reset the event history and all corresponding event reports from nonvolatile memory.	1

For more information on event reports, see *Section 9: Analyzing Events*.

GOOSE Command

Use the **GOOSE** command to display transmit and receive GOOSE messaging information, which can be used for troubleshooting. The **GOOSE** command variants and options are shown in *Table 7.27*.

Table 7.27 GOOSE Command Variants

Command Variant	Description	Access Level
GOOSE	Display Goose information.	1
GOOSE count	Display GOOSE information count times.	1

The information displayed for each GOOSE IED is described in the following table.

IED	Description
`Transmit GOOSE Control Reference`	This field represents the GOOSE control reference information that includes the IED name, ldInst (Logical Device Instance), LN0 lnClass (Logical Node Class), and GSEControl name (GSE Control Block Name) (e.g., SEL_2411_1CFG/LLN0GOGooseDSet13).
`Receive GOOSE Control Reference`	This field represents the goCbRef (GOOSE Control Block Reference) information that includes the iedName (IED name), ldInst (Logical Device Instance), LN0 lnClass (Logical Node Class), and cbName (GSE Control Block Name) (e.g., SEL_2411_1CFG/LLN0GOGooseDSet13).
`MultiCastAddr` (Multicast Address)	This hexadecimal field represents the GOOSE multicast address.
`Ptag`	This three-bit decimal field represents the priority tag value, where spaces are used if the priority tag is unknown.
`Vlan`	This 12-bit decimal field represents the virtual LAN (Local Area Network) value, where spaces are used if the virtual LAN is unknown.
`StNum` (State Number)	This hexadecimal field represents the state number that increments with each state change.
`SqNum` (Sequence Number)	This hexadecimal field represents the sequence number that increments with each GOOSE message sent.
`TTL` (Time to Live)	This field contains the time (in ms) before the next message is expected.
`Code`	This text field contains warning or error condition text when appropriate that is abbreviated as follows: **Code Abbreviation** — **Explanation** OUT OF SEQUENC — Out of sequence error CONF REV MISMA — Configuration Revision mismatch NEED COMMISSIO — Needs Commissioning TEST MODE — Test Mode MSG CORRUPTED — Message Corrupted TTL EXPIRED — Time to live expired HOST DISABLED — Optional code for when the host is disabled or becomes unresponsive after the **GOO** command has been issued
`TransmitDataSet Reference`	This field represents the DataSetReference (Data Set Reference) that includes the IED name, LN0 lnClass (Logical Node Class), and GSEControl datSet (Data Set Name) (e.g., SEL_2411_1/LLN0$DSet13).
Receive Data Set Reference	This field represents the datSetRef (Data Set Reference) that includes the iedName (IED name), ldInst (Logical Device Instance), LN0 lnClass (Logical Node Class), and datSet (Data Set Name) (e.g., SEL_2411_1CFG/LLN0$DSet13).

IDENTIFICATION Command

Available as a compressed command only, use the **ID** command to extract device identification codes, as shown in *Table 7.28*.

Table 7.28 IDENTIFICATION Command

Command	Description	Access Level

ID	Return a list of device identification codes, as shown below:
	`=ID <Enter>`
	`"FID=SEL-2411-R200-V0-Z002002-D20070810","08C8"`
	`"BFID=BOOTLDR-X300-V0-Z000000-D20050221","0947"`
	`"CID=C7D8","0273"`
	`"DEVID=SEL-2411","03F2"`
	`"DEVCODE=62","030F"`
	`"PARTNO=241101A0X5X7185100","0666"`
	`"CONFIG=111120","0389"`
	The following is also displayed if 61850 is available:
	`"iedName=SEL_2411_1","05FB"`
	`"type=SEL_2411","047A"`
	`"configVersion=ICD-SEL-2411-R200-V0-Z002002-D20070730","0E52"`
		0

IRIG Command

Use the **IRI** command to read the demodulated IRIG-B time code at the serial port or IRIG-B input, and to force immediate synchronization of the internal clock with the IRIG-B signal (see *Table 7.29*). If an IRIG-B signal is present at the serial port or IRIG-B input, the device automatically synchronizes the internal clock with the IRIG-B signal in a time period not exceeding one minute. It is not necessary to issue the **IRI** command for this automatic one-minute synchronization. If you are testing the device and do not want to wait for the one-minute synchronization, then issue the **IRI** command to immediately force the device to synchronize with the IRIG-B signal. You can also use the **IRI** command to determine if the device is properly reading the IRIG-B signal.

Table 7.29 IRIG Command

Command	Description	Access Level
IRI	Force synchronism of internal control clock to IRIG-B time-code input.	1

To force the device to synchronize to IRIG-B, enter the following command:

```
=>IRI <Enter>
```

If the device successfully synchronizes to IRIG, it sends the following header and access level prompt:

```
SEL-2411                                   Date: 04/12/2005   Time: 15:41:29
DEVICE
=>
```

If no IRIG-B code is present at the serial port input or if the code cannot be read successfully, the device responds:

```
IRIG-B DATA ERROR
=>
```

L_D Command (Load Firmware)

Use the **L_D** command to load firmware, as shown in *Table 7.30*. See *Appendix A: Firmware and Manual Versions* for information on changes to the firmware and instruction manual. See *Appendix B: Firmware Upgrade Instructions* for further details on downloading firmware.

Table 7.30 L_D Command

Command	Description	Access Level
L_D	Download firmware to the device (front panel only)	2

LOOPBACK Command

The **LOO** command is used for testing the MIRRORED BITS communications channel for proper communication. For more information on MIRRORED BITS, see *Appendix G: MIRRORED BITS Communications*. With the transmitter of the communications channel physically looped back to the receiver, the MIRRORED BITS addressing will be wrong and ROK will be deasserted. The **LOO** command tells the MIRRORED BITS software to temporarily expect to see its own data looped back as its input. In this mode, LBOK will assert if error-free data are received. The **LOO** command with just the channel specifier, enables looped back mode on that channel for 5 minutes, while the inputs are forced to the default values.

Table 7.31 LOO Command

Command	Description	Access Level
LOO	Enable loopback testing of MIRRORED BITS channels	2
LOO A	Enable loopback on MIRRORED BITS Channel A for the next 5 minutes.	2
LOO B	Enable loopback on MIRRORED BITS Channel B for the next 5 minutes.	2

```
=>>LOO A <Enter>
Loopback will be enabled on Mirrored Bits channel A for the next 5 minutes.
The RMB values will be forced to default values while loopback is enabled.
Are you sure (Y/N)?

=>>
```

If only one MIRRORED BITS port is enabled, the channel specifier (A or B) may be omitted. To enable loopback mode for other than the 5-minute default, enter the desired number of minutes (1–5000) as a command parameter. To allow the loopback data to modify the RMB values, include the **DATA** parameter.

```
=>>LOO 10 DATA <Enter>
Loopback will be enabled on Mirrored Bits channel A for the next 10 minutes.
The RMB values will be allowed to change while loopback is enabled.
Are you sure (Y/N)? N <Enter>
Canceled.

=>>
```

To disable loopback mode before the selected number of minutes, re-issue the **LOO** command with the **R** parameter. The **R** parameter returns the device to normal operation. If both MIRRORED BITS channels are enabled, omitting the channel specifier in the disable command will cause both channels to be disabled.

```
=>>LOO R <Enter>
Loopback is disabled on both channels.

=>>
```

MAC Command

Use the **MAC** command to display the MAC addresses of **PORT 1**, as shown below.

```
Port 1 MAC Address:  00-30-A7-00-00-00
```

MAP Command (Display DNP3 Maps)

The **MAP** command is only available if DNP3 has been selected as the protocol on a serial or Ethernet port. The **MAP** command accesses the port DNP3 settings and is similar to the **SHOW DNP** command. However, unlike the **SHOW DNP** command, the **MAP** command displays DNP3 information by port number. You can issue the **MAP** command with the ***port*** parameter (from 1 to 4) to view the DNP3 settings for that port number. If you specify port number 1, you must also include the ***session*** number (from 1 to 3) to display.

Table 7.32 MAP Command

Command	Description	Access Level
MAP *port*	Show the serial DNP3 settings for port ***port*** (similar to **SHOW DN**).	1, 2
MAP 1 *session*	Show the DNP3 settings for Ethernet port 1 and session ***session*** (similar to **SHOW DN**).	1, 2

To observe Port 1 DNP3 maps and settings for session 1, type **MAP 1 1 <Enter>**.

METER Command (Metering Data)

The **MET** commands provide access to metering data. To make the extensive amount of meter information manageable, the device divides the displayed information into several groups.

- Analog Input
- RTD Temperature
- RTD/TC Temperature
- Remote Analog
- Math Variable
- Fundamental
- Demand
- Maximum/Minimum
- Energy

Because you can configure the SEL-2411 with different cards, display values in response to the **MET** command is a function of the specific card combination. When a card is not installed, the headings and values are hidden.

Metering data retrieval and display is described in the following subsections. See *Section 5: Metering and Monitoring* for details on metering.

MET A Analog Input Metering

Use the **MET A** command to display values measured by one or more Analog Input cards.

MET A Analog Input Metering

Use the **MET A** command to display values measured by one or more Analog Input cards.

Command	Description	Access Level
MET A *n*	Display Analog Input (AI) values.	1

Because values for different analog inputs vary in length, the device adapts the display format for each analog input by using the input maximum or minimum setting (whichever has the larger magnitude) in engineering units. The display format uses up to five digits to show the scaled maximum magnitude of the input without using exponential notation (for example, –0.0732, 961.82, 21936, or 18493).

MET RTD Metering

Use the **MET RTD** command to display values measured by an internal RTD card or external SEL-2600 device.

Command	Description	Access Level
MET RTD *n*	Display RTD values.	1

MET Temp Metering

Use the **MET Temp** command to display TC or RTD values measured by the Universal Temperature Input card.

Command	Description	Access Level
MET Temp *n*	Display RTD/TC values from the Universal Temperature Input card.	1

MET RA Remote Analog Metering

Use the **MET RA** command to display remote analog values sent by a remote device.

Command	Description	Access Level
MET RA *n*	Display Remote Analog (RA) values.	1

MET MV Math Variable Metering

Use the **MET MV** command to display math variable values calculated by the device.

Command	Description	Access Level
MET MV	Display Math Variable (MV) values.	1

The **MET F *k*** command displays instantaneous magnitudes, and angles if applicable, of the following quantities:

- Currents
- Voltages
- Power
- Power Factor
- Sequence
- Frequency

To view instantaneous metering values, use the **MET F *k*** command, where F is an optional parameter to specify fundamental and *k* is an optional parameter to specify the number of times (1–32767) to repeat the meter display. The device displays the meter report once if *k* is not specified.

MET Demand/Peak Demand Metering

Use the following commands to view or reset demand and peak demand metering values.

Command	Description	Access Level
MET D	Display demand and peak demand metering data.	1
MET RD	Reset demand metering data.	1
MET RP	Reset peak demand metering data.	1

The **MET D** command displays the demand and peak demand values of the following quantities along with the last reset times:

- Currents
- Power

MET M Maximum/Minimum Metering

Use the following commands to view or reset maximum or minimum metering values.

Command	Description	Access Level
MET M	Display maximum and minimum metering data.	1
MET RM	Reset maximum and minimum metering data. All values will display RESET until new maximum/ minimum values are recorded.	1

The **MET M** command displays the maximum and minimum values of the following quantities along with the last reset times:

- Currents
- Voltages
- Power

For more information on device maximum/minimum metering quantity calculations, see *Maximum and Minimum Metering on page 5.5*.

MET E Energy Metering

Use the following commands to view or reset energy metering values.

Command	Description	Access Level
MET E	Display energy metering data.	1
MET RE	Reset energy metering data.	1

For more information on device energy metering quantity calculations, see *Energy Metering on page 5.5*.

Device accumulated energy metering values function like those in an electromechanical energy meter. The SEL-2411 starts over at 0 after energy metering reaches 99999 MWh or 99999 MVARh.

PASSWORD Command (View/Change Passwords)

Use the **PAS** command to inspect or change existing passwords, as shown in *Table 7.33* and *Table 7.34*.

Table 7.33 PASSWORD Command[a]

Command	Description	Access Level
PAS *level new password*	Set a password *new password* for Access Level *level*.	2

[a] Parameter level represents the device Access Levels 1 or 2

Table 7.34 Factory Default Passwords

Access level	Password
1	OTTER
2	TAIL

⚠WARNING
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.

To change the password for Access Level 2 from the default password TAIL to new password Ot3579, enter the following:

```
=>>PAS 2 <Enter>
Old PW: ? **** <Enter> (Enter TAIL)
New PW: ? ****** <Enter>  (Enter Ot3579)
Confirm PW: ? ****** <Enter>  (Enter Ot3579)
Password Changed

CAUTION: This password can be strengthened.  Strong passwords do not include a
name, date, acronym, or word.  They consist of the maximum allowable
characters, with at least one special character, number, lower-case letter, and
upper-case letter.  A change in password is recommended.

=>>
```

Similarly, use **PAS 1** to change Level 1 passwords.

Passwords can contain as many as 12 characters. Uppercase and lowercase letters are treated as different characters. Strong passwords consist of 12 characters, with at least one special character or digit and mixed-case sensitivity, but do not form a name, date, acronym, or word. Passwords formed in this manner are less susceptible to password guessing and automated attacks. Examples of valid, distinct, and strong passwords are shown below:

- #0t3579!
- $A24.68&
- (Ih2dcs)
- *4u-Iwg+

Table 7.35 Valid Password Characters

Alpha	A B C D E F G H I J K L M N O P Q R S T U V W X Y Z a b c d e f g h i j k l m n o p q r s t u v w x y z
Numeric	0 1 2 3 4 5 6 7 8 9
Special	! " # $ % & ' ( ) * + , - . / : ; < = > ? @ [\ ] ^ _ ` { | } ~

If you forget your password, you can re-issue a new password as follows:

> **⚠CAUTION**
> The device contains devices sensitive to Electrostatic Discharge (ESD). When working on the device with the front panel removed, work surfaces and personnel must be properly grounded or equipment damage may result.

➤ In accordance with the appropriate safety regulations, power down the device and remove the rear cover.

➤ Disable the password function by locating Jumper JMP1 on the card in the B-slot of the base unit (see *Password and SELBOOT Jumper Selection on page 2.12*) and placing JMP1 in position A.

➤ Replace all covers and power up the device.

➤ Go to the appropriate access level and issue the **PAS *x*** (*x* = 1 or 2) command to enter a new password.

➤ In accordance with the appropriate safety regulations, power down the device, remove the rear cover and remove Jumper JMP1 to activate the password function.

➤ Replace all covers and power up the device.

PING Command

When you are setting up or testing networks, it is helpful to determine if the network is connected properly and if the other devices are powered up and configured properly. Use the **PING** command to determine if another node on the network is available and connected to the network. The SEL-2411 sends ping messages to the remote node until interrupted by pressing "Q" (if you want ping statistics) or CTRL-X (if you don't want ping statistics) on the keyboard. The SEL-2411 will support only one ping command per IED from any available port.

Command options for the **PING** command are shown in *Table 7.36*.

Table 7.36 Command Options for PING Command

Command	Description	Access Level
PING *addr*	Ping the IP address represented by *addr* every second	2
PING *addr n*	Ping the IP address once every *n* seconds, where *n* is a value from 1-255	2

PROFILE Command (Signal Profile Values)

Use the **PRO** command to display or clear analog signal profile data, as shown in *Table 7.37*.

Table 7.37 PROFILE Command

Command	Description	Access Level
PRO	Display analog signal profile data	1
PRO C	Clear analog signal profile data	1

PULSE Command (Test Outputs)

Use the **PUL** command to temporarily change the state of an output contact for 1 second. This command overrides the present settings for the particular output under test, as shown in *Table 7.38*.

Table 7.38 PULSE Command

Command	Description	Access Level

PUL *n*	Pulse output contact *n* for 1 second, as shown below:
	`=>PUL OUT101 <Enter>`
	`Pulse Output`
	`Are you sure (Y,N)? Y <Enter>`
	
	`=>`
		2

QUIT Command

Use the **QUIT** command to revert to Access Level 0 from either Level 1 or Level 2, as shown in *Table 7.39*.

Table 7.39 QUIT Command

Command	Description	Access Level
QUI	Go to Access Level 0	0

Access Level 0 is the lowest access level; the SEL-2411 performs no password check to descend to this level (or to remain at this level).

SER Command (Sequential Events Recorder Report)

Use the **SER** commands to view and manage the Sequential Events Recorder report, as shown in *Table 7.40* and *Table 7.41*.

Table 7.40 SER Command (Sequential Events Reorder Report)

Command	Description	Access Level
SER	Use the **SER** command to display a chronological progression of all available SER rows (up to 512 rows). Row 1 is the most recent triggered row and Row 512 is the oldest.	1
SER *row1* **SER *row1 row2*** **SER *date1*** **SER *date1 date2***	Use the **SER** command with parameters (*row* or *date*) to display a chronological or reverse chronological subset of the SER rows, see *Table 7.41* below).	1
SER C	Use this command to clear/reset the SER records.	2

If the requested SER report rows do not exist, the device responds with the following:

```
No SER data
```

Table 7.41 SER Command Format (Sheet 1 of 2)

Parameter	Description
row 1	Append *row 1* to return a chronological progression of the first *row 1* rows. For example, use **SER 5** to return the first five rows.
row 1 row 2	Append *row 1* and *row 2* to return all rows between *row 1* and *row 2*, beginning with *row 1* and ending with *row 2*. Enter the smaller number first to display a numeric progression of rows through the report. Enter the larger number first to display a reverse numeric progression of rows. For example, use **SER 1 10** to return the first ten rows in numeric order, or **SER 10 1** to return the same items in reverse numeric order.

Table 7.41 SER Command Format (Sheet 2 of 2)

Parameter	Description
date 1	Append *date 1* to return all rows with this date. For example, use **SER 1/1/2005** to return all records for January 1, 2005.
date 1 date 2	Append *date 1* and *date 2* to return all rows between *date 1* and *date 2*, beginning with *date 1* and ending with *date 2*. Enter the oldest date first to display a chronological progression through the report. Enter the newest date first to display a reverse chronological progression of rows. Date entries are dependent on the date format setting DATE_F. For example, with DATE_F set to MDY (Month Day Year), **SER 1/5/2005 1/7/2005** returns all records for January 5, 6, and 7, 2005.

SET Command (Change Settings)

The **SET** command is for viewing or changing the device settings, as shown in *Table 7.42*. Append **TERSE** to skip the settings display after the last setting. Use this parameter to speed up the **SET** command. If you want to review the settings before saving, do not use the **TERSE** option.

Table 7.42 SET Command

Command	Description	Access Level
SET *s* TERSE	Set Device settings	2
SET L *s* TERSE	Set Logic settings	2
SET G *s* TERSE	Set Global settings	2
SET POR *n s* TERSE	Set serial port settings, depending on the device configuration, *n* specifies either Port F or Ports 2 through 4; defaults to the active port if not listed.	2
SET R *s* TERSE	Set SER report settings	2
SET F *s* TERSE	Set front-panel settings	2
SET DN *s* TERSE	Set DNP3 settings	2

Append *s* and the specific setting name you want to change in the **SET** command to immediately jump to the setting. For example if *s* is not entered, the device starts at the first setting. For example, to directly jump to the FMR1 setting in the Report setting category, enter **SET R FMR1 TERSE <Enter>**.

When you issue the **SET** command, the device presents a list of settings one at a time. Enter a new setting or press **<Enter>** to accept the existing setting, as shown in *Table 7.43*.

Table 7.43 SET Command Editing Keystrokes

Press Key	Results
<Enter>	Retains the setting and moves to the next setting
^ <Enter>	Returns to the previous setting
< <Enter>	Returns to the previous setting category
> <Enter>	Moves to the next setting category
END <Enter>	Exits the editing session, then prompts you to save the settings
<Ctrl+X>	Aborts the editing session without saving changes

The device checks each setting to ensure that it is within the allowed range. If the setting is not within the allowed range, the device generates an `Out of Range` message and prompts you for the setting again. When all the settings are entered, the device displays the new settings and prompts you for approval to enable them. Answer **Y <Enter>** to enable the new settings. The device is disabled for no longer than one second while saving the new settings. The SALARM Device Word bit asserts momentarily and the ENABLED LED extinguishes while the device is disabled.

SHOW Command (Show/View Settings)

When showing settings, the device displays the settings label and the present value from nonvolatile memory for each setting class as shown in *Table 7.44*.

Table 7.44 SHO Command

Command	Description	Access Level
SHO *s*	Show Device settings	1
SHO L *s*	Show Logic settings	1
SHO G *s*	Show Global settings	1
SHO POR *n s*	Show serial port settings, *n* specifies either Port F or Ports 1 through 4; defaults to the active port if not listed.	1
SHO R *s*	Show report settings such as Sequential Events Recorder (SER) and Event Report (ER) settings	1
SHO F *s*	Show front-panel settings	1
SHO DN *s*	Show DNP3 settings	1

Append *s* and the specific setting name you want to view in the **SHOW** command to immediately jump to the setting. If *s* (and the setting name) is not included, the device presents settings beginning with the first one in the group.

SNS Command (Displays SER Settings)

Available as a compressed command only, the **SNS** command displays the SER settings in Compressed ASCII format, as shown in *Table 7.45*.

Table 7.45 SNS Command

Command	Description	Access Level
SNS	The **SNS** command displays the SER trigger elements (entered with the SET R SER*n* (*n* = 1 through 4) command) in Compressed ASCII format.	0

The SER trigger elements are gathered in groups of eight elements to be displayed on each line of the report. The last line of the report may have fewer than eight elements. Each line is formatted as a comma-separated list of quoted SER trigger elements, followed by a quoted hexadecimal representation of the checksum. The checksum is calculated from the first quote mark of the line up to the last comma before the checksum. If there are no SER trigger elements (i.e., all SER settings are NA), no lines are generated for the report.

STATUS Command (Device Self-Test Status)

The **STA** command displays the status report, as shown in *Table 7.46*.

Table 7.46 STATUS Command (Device Self-Test Status)

Command	Description	Access Level
STA *n*	Displays the device self-test information *n* times (*n* = 1–32767). Defaults to 1 if *n* is not specified.	1
STA S	Displays the memory and execution utilization for the SELOGIC control equations.	1
STA R	Reboots the device and clears self-test warning and failure status results.	2

Refer to *Section 10: Testing and Troubleshooting* for self-test thresholds and corrective actions, as well as hardware configuration conflict resolution. When voltage and current cards are installed, the response includes analog offset for the current and voltage channels.

As with all microprocessor devices, increasing the number of functions increases the processor burden. Use the **STA S** command to see the remaining processor capacity for counters and SELOGIC equations. The SEL-2411 shows the available processing capacity for programming counters and SELOGIC equations as Execution %. With no counters or SELOGIC equations running, the processor capacity (Execution (%)) is 100 percent.

Programming counters and SELOGIC equations reduce available processing capacity, and the Execution % value reflects the lower available processing capacity. When the Execution % value reaches one percent, no more processing capacity is available.

Other values indicate the available storage capacity for the different setting categories: Logic settings (Logic), Global settings (Global), Front-Panel settings (FP) and Report settings (Report).

SUMMARY Command (Summary)

The **SUM** command retrieves the event summary information from the last event report in ASCII format, as shown in *Table 7.47*.

Table 7.47 SUMMARY Command

Command	Description	Access Level
SUM *n*	Return event summary number *n* (omitting *n* returns event summary number 1) in ASCII format.	1

TARGET Command (Display Device Word Bit Status)

The **TAR** command displays the status of front-panel target LEDs or Device Word bits, whether these LEDs or Device Word bits are asserted or deasserted, as shown in *Table 7.48*.

Table 7.48 TAR Command Definitions (Sheet 1 of 2)

Command	Description	Access Level
TAR	Use TARGET without parameters to display Device Word row 0.	1
TAR ROW	Adding ROW to the command (e.g. **TAR 23**) displays the eight Device Word bits in row 23 of the Device Word bits list (see *Appendix H: Device Word Bits*).	1

Table 7.48 TAR Command Definitions (Sheet 2 of 2)

Command	Description	Access Level
TAR *n k*	Show Device Word row number *n* (0–103) and heading, and repeat the status (0 or 1) of the eight Device Word bits in row *n k* times (1–32767). See *Appendix H: Device Word Bits* for the Device Word bit table.	1
TAR R	Displays Device Word row 0.	1

The elements are represented as Device Word bits and are listed in rows of eight, called Device Word rows. All Device Word rows are described in *Appendix H: Device Word Bits*. Device Word bits are used in SELOGIC control equations. The **TAR** command does not remap the front-panel target LEDs, as is done in some previous SEL products.

TIME Command (View/Change Time)

The **TIME** command returns information about the SEL-2411 internal clock, as shown in *Table 7.49*. You can also set the clock if you specify hours and minutes (seconds data are optional). Separate the hours, minutes, and seconds with colons.

Table 7.49 TIM Command Definitions

Command	Description	Access Level
TIME	Display the present internal clock time	1
TIME *hh:mm*	Set the internal clock to hh:mm	2
TIME *hh:mm:ss*	Set the internal clock to hh:mm:ss	2

Use the **TIME *hh:mm*** and **TIME *hh:mm:ss*** commands to set the internal clock time. The value *hh* is for hours from 0–23; the value *mm* is for minutes from 0–59; the value *ss* is for seconds from 0–59. If you enter a valid time, the device updates and saves the time in the nonvolatile memory, and displays the time you just entered. If you enter an invalid time, the SEL-2411 responds with `Invalid Time`.

TRIGGER Command (Trigger Event Report)

Use the **TRI** command to trigger an event report, as shown in *Table 7.50*.

Table 7.50 TRIGGER Command (Trigger Event Report)

Command	Description	Access Level
TRI	Trigger event report data capture.	1

When you issue the **TRI** command, the SEL-2411 responds, `Triggered`. If the event did not trigger within 1 second, the device responds, `Did not trigger`. See *Section 9: Analyzing Events* for further details on event reports.

This page intentionally left blank

Section 8
Front-Panel Operations

Front-Panel Overview

The SEL-2411 Programmable Automation Controller front panel makes data collection and control quick and efficient. Use the front panel to analyze operating information, view and change device settings, and perform control functions. The SEL-2411 features a straightforward menu-driven control structure presented on the front-panel liquid crystal display (LCD). Front-panel targets and other LED indicators provide a fast means of checking operation status.

Figure 8.1 shows the many features of the versatile front-panel.

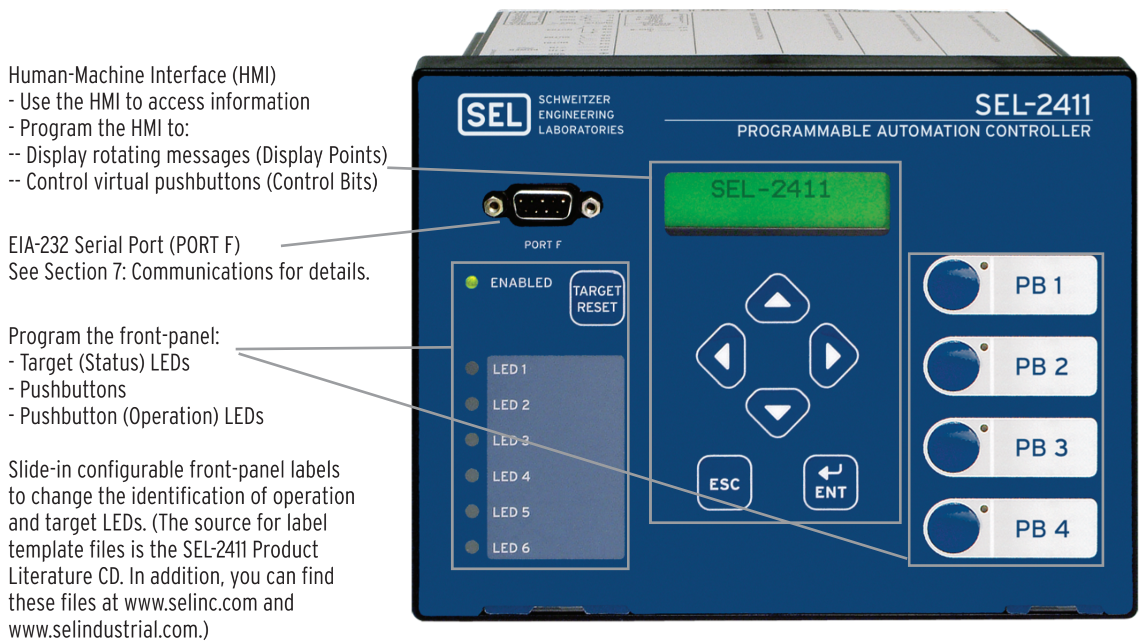


Figure 8.1 Front-Panel Overview

Human-Machine Interface

Front-Panel Automatic Messages

The device displays automatic messages (type of latest failure) when detecting any failure (see *Section 10: Testing and Troubleshooting*).

Display Points

NOTE: Valid string characters are 0-9, A-Z, -, /, ", {, }, space.

Configure the digital (Boolean) and analog information you want to view on the 2x16 LCD screen by setting Display Points. Although the LCD displays a maximum of 16 characters at a time, you can enter up to 60 valid characters. For text exceeding 16 characters, the LCD displays the first 16 characters, then scrolls through the remaining text.

When your SEL-2411 arrives, two display points are already configured with defaults, the results of these defaults are shown in *Figure 8.3*.

Figure 8.2 LCD Default Display

Boolean Display Point

Boolean information is the status of Device Word bits (see *Appendix H: Device Word Bits*). In general, the syntax for Boolean display points consists of the following four fields or strings, separated by commas:

Device Word Bit Name, "Alias", "Set String", "Clear String"

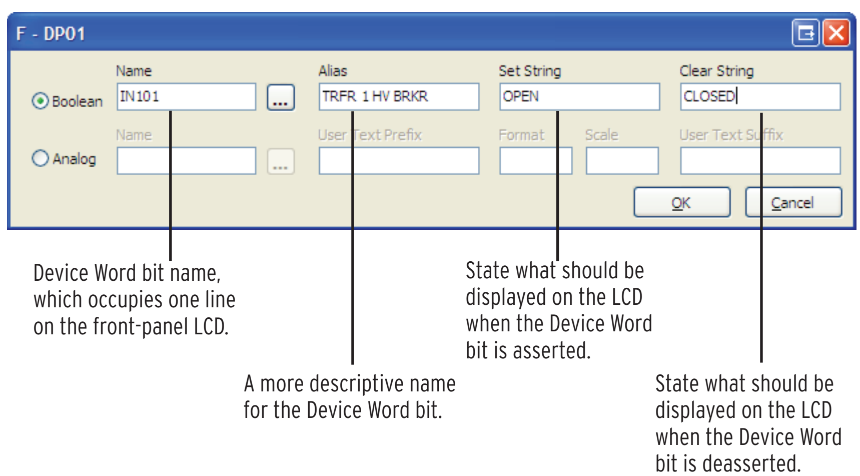


Figure 8.3 Quickset—Settings for an Device Word bit (Boolean)

Examples using the settings in *Table 8.1* are shown in *Figure 8.4* and *Figure 8.5*.

Table 8.1 Entries for the Four Strings

Name	Alias	Clear String	Set String
IN101	TRFR 1 HV BRKR	OPEN[a]	CLOSED[b]
IN102	TRFR 1 LV BRKR	OPEN	CLOSED

[a] When the circuit breaker is closed the form a [normally open] status output closes, which sets or asserts Device Word bit IN101.

[b] When the circuit breaker is open the form a [normally open] status output opens, which clears or deasserts Device Word bit IN101.

Figure 8.4 shows the display when both HV and LV breakers are open (both IN101 and IN102 deasserted). *Figure 8.5* shows the display when the HV breaker is closed, and the LV breaker is open (IN101 asserted, but IN102 still deasserted).

Figure 8.4 Front-Panel Display—Both HV and LV Breakers Open

Figure 8.5 Front-Panel Display—HV Breaker Closed, LV Breaker Open

Display Points are not always displayed on the LCD. *Table 8.2* shows the rules for making sure the desired information is always or conditionally displayed. *Table 8.3* shows the rules for when Display Points will always be hidden, which is usually a setting mistake.

Table 8.2 When Display Points Are Conditionally Hidden

Name	Alias	Set String	Clear String	Comment	Example
1	•	Empty	Empty	Never hidden	DP01:=1,ALIAS1
•	•	–	–	Never hidden	DP01:=IN101,ALIAS1
•	•	Null	•	Hidden if true	DP01:=IN101,ALIAS1,,CLEAR
•	•	•	Null	Hidden in false	DP01:=IN101,ALIAS1,SET,
•	•	•	•	Never hidden	DP01:=IN101,ALIAS1,SET,CLEAR

Table 8.3 When Display Points Are Always Hidden

Name	Alias	Set String	Clear String	Comment	Example
0	–	–	–	Always hidden	DP01:=0
–	–	–	–	Always hidden	DP01:=
•	Null	Null	Null	Always hidden	DP01:=IN101,,,
•	•	Null	Null	Always hidden	DP01:=IN101,ALIAS1,,

Analog Display Point

In general, the syntax for analog display points consists of the following two fields or strings: Name, “User Text and Formatting.” Unlike binary quantities, the device displays analog quantities on both display lines.

NOTE: The format field specifies the total width of the numeric value (includes the sign character and decimal point) and the optional scale field specifies the number of places after the decimal point.

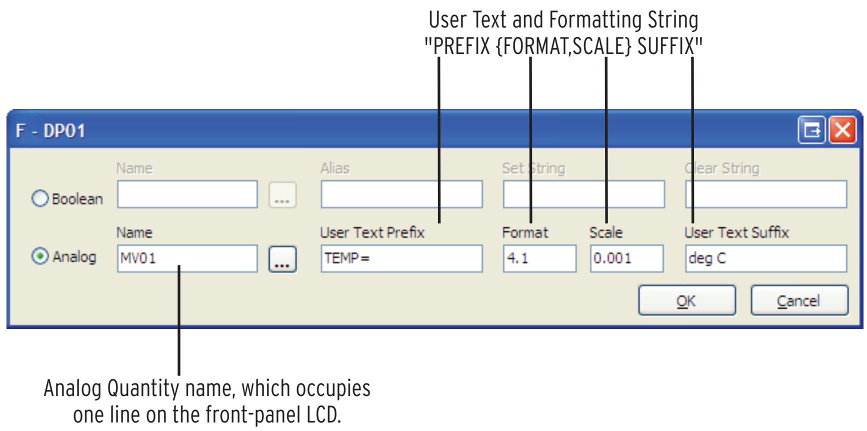


Figure 8.6 Quickset—Settings for an Analog Quantity

Figure 8.7 shows the front-panel display for a setting with a Name string only. If the User Text and Formatting string is left void then the analog quantity name will always be displayed on the first line and the value and units (if available) will always be displayed on the second line.

Figure 8.8 shows the front-panel display for a setting with a Name string, a “TEMPERATURE” User Text Prefix string, and known engineering units.

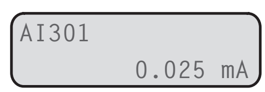


Figure 8.7 Front-Panel Display for an Analog Entry in the Name String Only

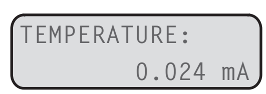


Figure 8.8 Analog Name and User Text and Formatting Strings

Table 8.4 Example Settings and Displays

Example Display Point Setting Value	Example Display
MV01,"TEMP {4}deg C"	TEMP 1234 deg C
MV01,"TEMP = {4.1}"	TEMP =xx.x
MV01,"TEMP = {5}"	TEMP = 1230
MV01,"TEMP={4.2,0.001} C"	TEMP=1.23 C
MV01,"TEMP HV HS1={4,1000}"	TEMP HV HS1=1234
1,{}	Empty line

NOTE: Format and Scale
The format value includes the decimal point and sign character, if applicable. The scale value is optional; if omitted, the scale factor is 1. If the numeric value is smaller than the string size requested, the string is padded with spaces to the left of the number. If the numeric value does not fit within the string width given, the string grows (to the left of the decimal point) to accommodate the number.

NOTE: If the message length is maximized then $$$$ are displayed when the number is too large to display

Rotating Display

With more than two display points enabled, the device scrolls through all enabled display points, thereby forming a rotating display, as shown in *Figure 8.9*.

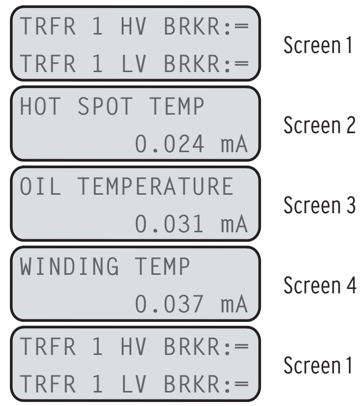


Figure 8.9 Rotating Display

Local Bits

Local bits are variables (LB*nn*, where *nn* means LB01 through LB32) that are controlled from front-panel pushbuttons. Use local bits to replace traditional panel switches. Each local bit requires three of the following four settings, using a maximum of 14 valid characters for the NLB*nn* setting, and a maximum seven valid characters (0–9, A–Z, -, /, ., space) for the remainder:

- NLB*nn*: Name the switch (normally the function that the switch performs, such as SWITCH) that will appear on the LCD display.
- CLB*nn*: Clear local bit. Enter the text that describes the intended operation of the switch (this text appears on the display) when LB*nn* deasserts (OPEN, for example).
- *SLB*nn*: Set local bit. Enter the text that describes the intended operation of the switch (this text appears on the display) when LB*nn* asserts (CLOSE, for example).
- *PLB*nn*: Pulse local bit. When selecting the pulse operation, LB*nn* asserts for only one processing interval before deasserting again. Enter the text that describes the intended operation when LB*nn* asserts (START, for example).
- *Omit either SLB*nn* or PLB*nn* (never CLB*nn*) by setting the omitted setting to NA. If SLB*nn* and PLB*nn* are both set then PLB*nn* is ignored.

For the transformer in our example, configure two local bits: one to replace a supervisory switch, and the other to start a fan motor. Local bit 1 replaces a supervisory switch (SWITCH) and we use the clear/set combination. Local bit 2 starts a fan motor (START) that only needs a short pulse to seal itself in, and we use the clear/pulse combination.

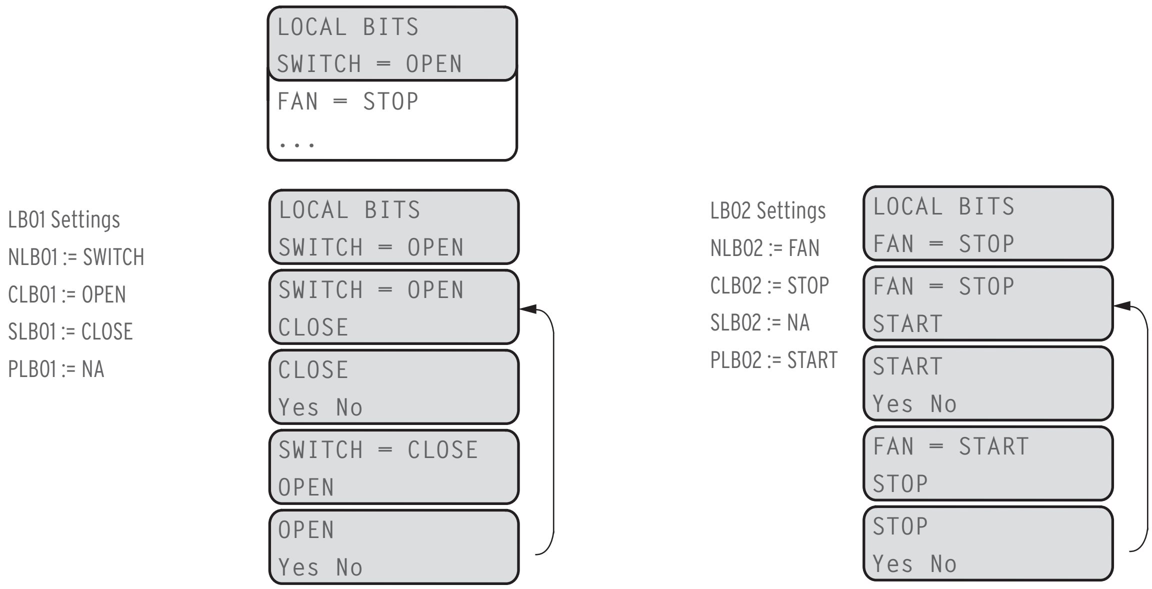


Figure 8.10 Local Bit Examples

Contrast

You can adjust the LCD screen contrast to suit your viewing angle and lighting conditions. To change screen contrast, press and hold the **{ESC}** pushbutton for two seconds. The SEL-2411 displays a contrast adjustment box. Pressing the **{Right Arrow}** pushbutton increases the contrast. Pressing the **{Left Arrow}** pushbutton decreases the screen contrast. When you are finished adjusting the screen contrast, press the **{ENT}** pushbutton; this process is a shortcut for changing the LCD contrast setting FP_CONT in the front-panel settings.

Table 8.5 shows the timeout and contrast settings. Use the front-panel LCD timeout setting (FP_TO) as a security measure. If the display is within an Access Level 2 function when a timeout occurs, the function is automatically terminated. After terminating the function, the front-panel display returns to the default display. To disable the front-panel timeout function, set the LCD timeout equal to OFF. Use the front-panel LCD contrast setting (FP_CONT) to adjust the contrast of the liquid crystal display.

Table 8.5 LCD Display Settings

Setting	Setting Prompt	Range	Default
FP_TO	LCD Timeout (OFF,1–30; min)	OFF, 1–30; min	15
FP_CONT	LCD Contrast (1–8)	1–8	5

Front-Panel Security

Front-Panel Access Levels

The SEL-2411 front panel typically operates at Access Level 1 and provides viewing of device measurements and settings. Some activities, such as editing settings and controlling output contacts, are restricted to those operators who know the Access Level 2 password.

Before you can perform a front-panel menu activity that requires Access Level 2, you must enter the correct Access Level 2 password. After you have correctly entered the password, you can perform other Access Level 2 activities without reentering the password.

Access Level 2 Password Entry

When you try to perform an Access Level 2 activity, the device determines whether you have entered the correct Access Level 2 password since the front-panel inactivity timer expired. If you have not, the device displays the screen shown in *Figure 8.11* for you to enter the password.

```
Password=
Del Clr Accept
A B C D E F G H
I J K L M N O P
Q R S T U V W X
Y Z . . . . . .
a b c d e f g h
i j k l m n o p
q r s t u v w x
y z . . . . . .
0 1 2 3 4 5 6 7
8 9 . . . . . .
! " # $ % & ' (
) * + , - . / :
; < = > ? @ [ \
] ^ _ ` { | } ~
```

Figure 8.11 Password Entry Screen

See *PASSWORD Command (View/Change Passwords) on page 7.19* for the list of default passwords and for more information on changing passwords.

Front-Panel Time-Out

To help prevent unauthorized access to password-protected functions, the SEL-2411 provides a front-panel time-out, setting FP_TO. A timer (5 minutes default setting) is reset every time a front-panel pushbutton is pressed. Once the time-out period has expired, the access level is reset to Access Level 1.

Front-Panel Menus and Screens

Navigating the Front-Panel Menus

The SEL-2411 front panel gives you access to most of the information that the device measures and stores. You can also use front-panel controls to view or modify device settings. All of the front-panel functions are accessible through use of the six-button keypad and LCD display, as shown in *Figure 8.12*.

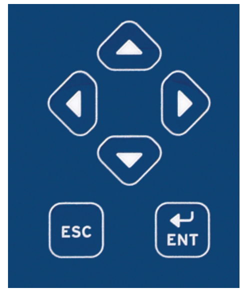


Figure 8.12 Front-Panel Navigation Pushbuttons

Use the Front-Panel keypad pushbuttons to maneuver within the front-panel menu structure. *Table 8.6* describes the function of each front-panel navigation pushbutton.

Table 8.6 Front-Panel Pushbutton Functions

Pushbutton	Function
{Up Arrow}	Move up within a menu or data list. While editing a setting value, increase the value of the underlined digit. Holding this key down moves the cursor up one line every 1.3 seconds.
{Down Arrow}	Move down within a menu or data list. While editing a setting value, decrease the value of the underlined digit. Holding this key down moves the cursor down one line every 1.3 seconds.
{Left Arrow}	Move the cursor to the left. Holding this key down repeats the cursor left movement every 1.3 seconds.
{Right Arrow}	Move the cursor to the right. Holding this key down repeats the cursor right movement every 1.3 seconds.
ESC {ESC}	Escape from the present menu or display without saving changed information. Move from the default display to the **MAIN** display. Hold for 2 seconds to display contrast adjustment screen.
ENT {ENT}	Move from the default display to the **MAIN** display. Select the menu item at the cursor. Select the displayed setting to edit that setting.

The SEL-2411 automatically scrolls information that requires more space than provided by a 16-character LCD line. Use the **{Left Arrow}** and **{Right Arrow}** pushbuttons to suspend automatic scrolling and enable manual scrolling of this information.

Menu Structure

Figure 8.13 shows the `MAIN` menu screen. Using the **{Up Arrow}** or **{Down Arrow}** and **{ENT}** pushbuttons, you can navigate to specific menu item in the `MAIN` menu. Each menu item is explained in detail in the following paragraphs.

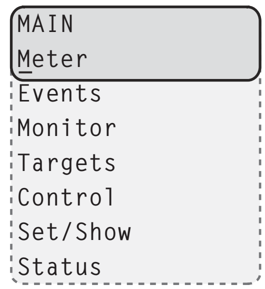


Figure 8.13 Main Menu

Meter Menu

Select the **Meter** menu item on the **MAIN** menu to access the analog metering data. Metered values are the 6-cycle average of the transducer values. See *METER Command (Metering Data) on page 7.16* for formatting information.

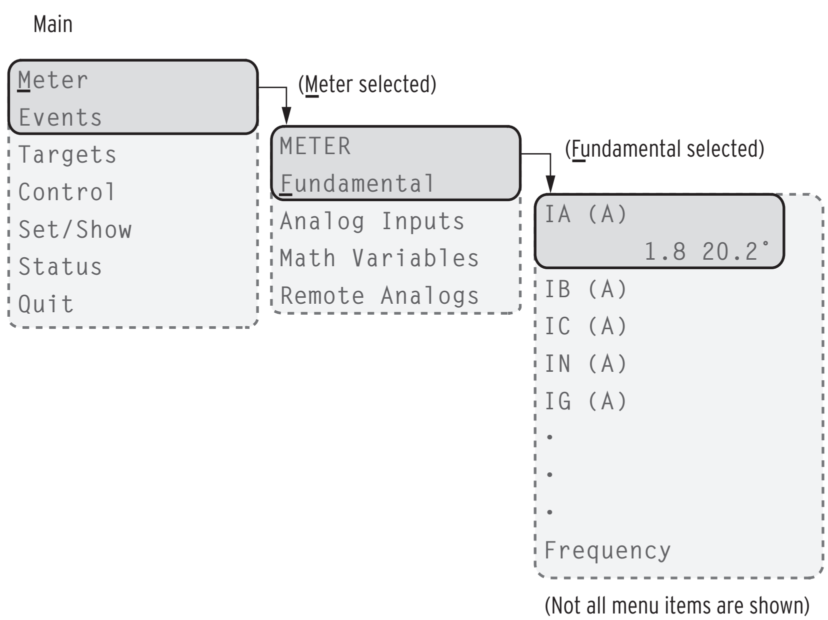


Figure 8.14 Main Menu and Meter Submenu

If the device contains no analog cards, then the device displays the message shown in *Figure 8.15*.

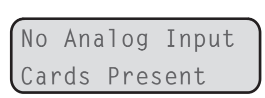


Figure 8.15 Device Response When No Analog Cards Are Installed

Events Menu

NOTE: For the next selection, Math Variables, only values of enabled math variables and remote analogs appear. Enable math variables and remote analogs under the **Set/Show Logic** menu, or the **SET L** serial port command.

Figure 8.16 shows the **Events** menu of the SEL-2411. With this selection you can see an event summary, trigger an event and clear existing events.

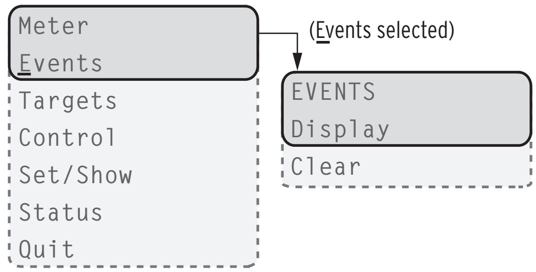


Figure 8.16 Main Menu and Events Submenu

If there is no event data available, the device displays `No Data Available` on the LCD display.

Use the **{Left Arrow}** and **{Right Arrow}** pushbuttons to read the date and time of the event.

Use the **Clear Events** command to clear all saved events in the device

Targets Menu

Figure 8.17 shows the **Targets** menu item on the **MAIN** menu and the submenus to access the target rows (Device Word bits).

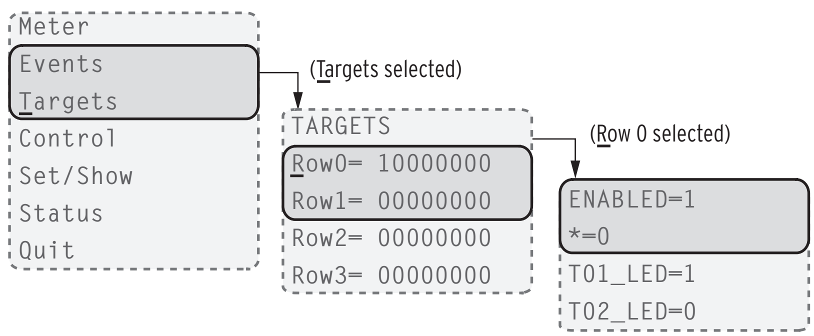


Figure 8.17 Main Menu and Target Submenu

Device Word bits are variables that are either asserted (logical 1) or deasserted (logical 0). *Table 8.7* shows an extract from the Device Word bit table (*Appendix H*). Target rows display eight Device Word bits from left to right as these appear in *Appendix H*. For example, Row 2 shows RB01 through RB09 and Row 3 shows RB09 through RB16, as shown in *Table 8.7*.

Table 8.7 Row 2 and Row 3 of the Device Word Bits

Row	7	6	5	4	3	2	1	0
2	RB01	RB02	RB03	RB04	RB05	RB06	RB07	RB08
3	RB09	RB10	RB11	RB12	RB13	RB14	RB15	RB16

Control Menu

The SEL-2411 provides a means to assert selected output contact through the **MAIN > Control** menu as shown in *Figure 8.18*. For control from the front panel, the device uses variables known as local bits. Local bits take the place of traditional panel switches, and perform isolation, open, close or pulse operations. With the settings as per the example in *Section 6* (see *Local Bits on page 8.5* for more information), Local bit 1 replaces a supervisory switch. *Figure 8.18* shows the screens in closing the supervisory switch. In this operation, Local bit LB01 is deasserted (SUPER SW = OPEN), and changes to asserted (SUPER SW = CLOSE) as shown in the final screen of *Figure 8.18*.

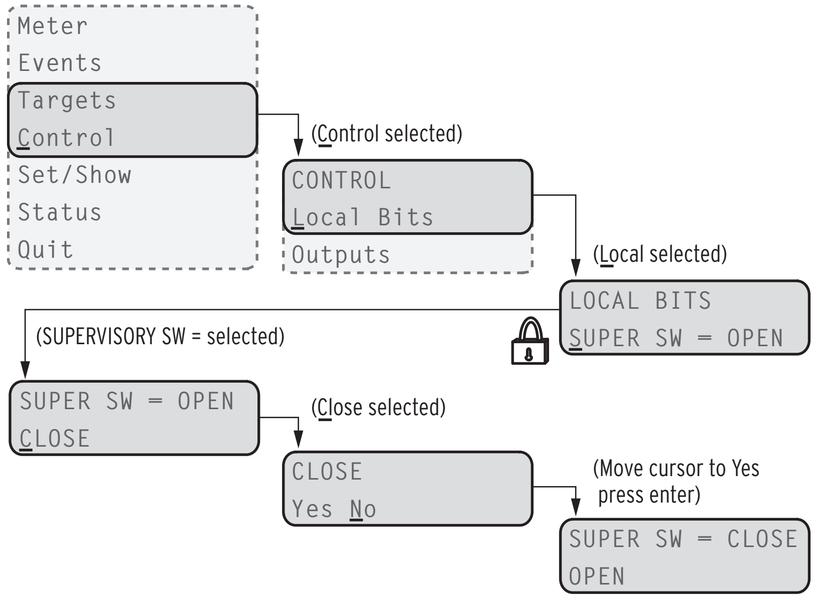


Figure 8.18 Main Menu and Control Submenu

Set/Show Menu

Figure 8.19 shows the **SET/SHO** menu of the SEL-2411.

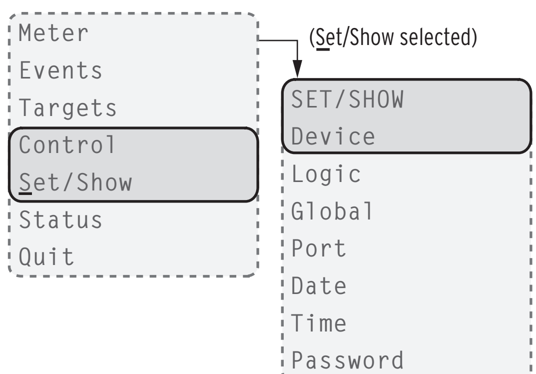


Figure 8.19 Main Menu and SET/SHO Submenu

Each settings class includes headings that create subgroups of associated settings. Select the heading that contains the setting of interest, then navigate to the particular setting. View or edit the setting by pressing **{ENT}**. For text settings, use the four navigation pushbuttons to scroll through the available alphanumeric and special character settings matrix. For numeric settings, use the **{Left Arrow}** and **{Right Arrow}** pushbuttons to select the digit to change and the **{Up Arrow}** and **{Down Arrow}** pushbuttons to change the value. Press **{ENT}** to enter the new setting. Setting changes can also be made using the ASCII **SET** commands via a communications port.

Status

Display SEL-2411 status indicators or reboot the device as shown in *Figure 8.20*.

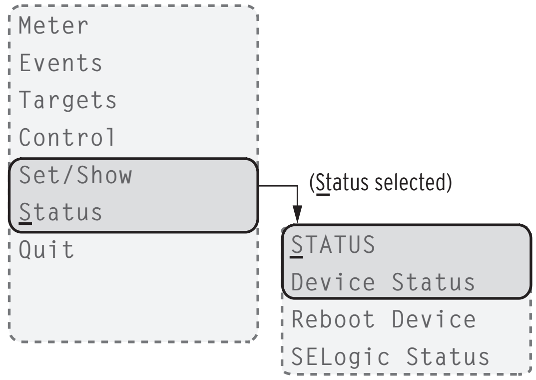


Figure 8.20 Main Menu and Status Submenu

Quit

Exit the present access level and return to Access Level 1.

Operation and Target LEDs

Enabled LED

An illuminated **ENABLED** LED indicates that the supply voltage is present, the device is healthy, and processing is enabled. When the **ENABLED** LED is not illuminated, one of the following could be the cause:

- ➤ Supply voltage absent
- ➤ Firmware upload or download
- ➤ Self-test failure

When the **ENABLED** LED is not illuminated, the device displays a message on the LCD describing why the LED is not illuminated.

Programmable LEDs

The SEL-2411 provides quick confirmation of device conditions via four operation and six target LEDs. You can program all ten LEDs using SELOGIC control equations, the only difference being that the target LEDs also include a latch function. *Figure 8.21* shows this region with factory default text on the front-panel configurable labels.

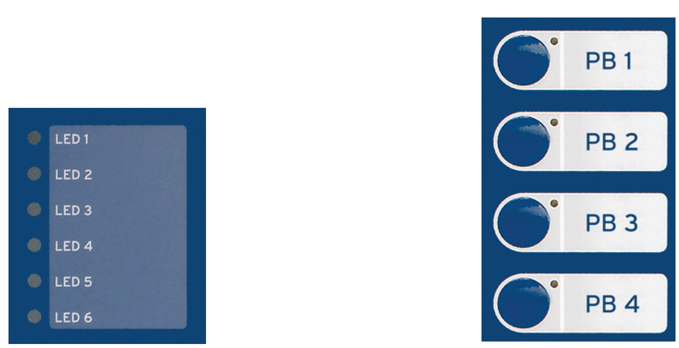


Figure 8.21 Factory Default Front-Panel LEDs

Target LEDs

Settings T*n*_LEDL (*n* = 01 through 06) and T*n*_LED (*n* = 01 through 06) control the six front-panel LEDs. With T*n*_LEDL set to Y, the LEDs latch after assertion. To reset these latched LEDs, the corresponding LED equation must be deasserted (logical 0) and one of the following takes place:

1. Pressing **{TARGET RESET}** on the front panel.
2. Issuing the serial port command **TAR R**.
3. The assertion of the SELOGIC equation RSTTRGT.

With T*n*LEDL settings set to N, the LEDs do not latch and directly follow the state of the associated SELOGIC control equation (SV) setting.

Enter any of the Device Word bits (or combinations of Device Word bits) as conditions in the T*n*_LED SELOGIC control equation (SV) settings. When these Device Word bits assert, the corresponding LED also asserts.

Table 8.8 Target LED Settings

Settings Prompt	Setting Range	Default Settings
LED 1 LATCH T01LEDL :=	(Y, N)	Y
LED1 EQUATION T01_LED := [Present Setting]	(SELOGIC)	0

Pushbutton LEDs

Enter any of the Device Word bits (or combinations of Device Word bits) as conditions in the PB*p*_LED (*p* = 01 through 04) SELOGIC control equation (SV) settings. When these Device Word bits assert, the corresponding LED also asserts. *Figure 8.9* shows the setting prompts, setting ranges, and default settings.

Table 8.9 Pushbutton LED Settings

Settings Prompt	Setting Range	Default Settings
PB01 LED Equation PB01_LED := [Present Setting]	(SELOGIC)	0

TARGET RESET Pushbutton

TARGET RESET

Use the **{TARGET RESET}** pushbutton to reset latched target LEDs. When a new event occurs and the previously latched trip targets have not been reset, the device clears the latched targets and displays the new targets. Pressing and holding the **{TARGET RESET}** pushbutton illuminates all the LEDs. Upon release of the **{TARGET RESET}** pushbutton, two possible situations can exist: the conditions that caused the LED to illuminate have cleared or the conditions remain present at the device inputs. If the conditions have cleared, the latched target LEDs turn off. If the conditions remain, the device re-illuminates the corresponding target LEDs.

Lamp Test

The **{TARGET RESET}** pushbutton also provides a front-panel lamp test. Pressing and holding the **{TARGET RESET}** pushbutton illuminates all the front-panel LEDs, and these LEDs remain illuminated for as long as **{TARGET RESET}** is pressed. The target LEDs return to a normal operational state after release of the **{TARGET RESET}** pushbutton.

Other Target Reset Options

Use the ASCII command **TAR R** to reset the target LEDs; see *TARGET Command (Display Device Word Bit Status) on page 7.24* for more information. Programming specific conditions in the SELOGIC® control equation RSTTRGT is another method for resetting target LEDs. Access RSTTRGT in the Global settings (Data Reset Control).

Section 9
Analyzing Events

Overview

The SEL-2411 Programmable Automation Controller provides several tools (listed below) to analyze the cause of device operations. Use these tools to help diagnose the cause of device operations.

- Event Reporting
  - Summary Reports
  - History Reports
  - Event Reports
- Sequential Events Recorder Report
  - Resolution: 1 ms
  - Accuracy: ±1/4 cycle

All reports are stored in nonvolatile memory, ensuring that a loss of power to the SEL-2411 will not result in lost data (see *Event Reporting* for more information on number and length of reports).

Event Reporting

Analyze events with the following event reporting functions:

- Event Summaries—A summary provides a quick overview of an event. You can retrieve the stored summaries by using the **SUMMARY** command. With the automatic messaging enabled (port setting AUTO := Y), the device sends event summaries out a serial port when an event occurs.
- Event History—The SEL-2411 stores an indexed history of event reports in nonvolatile memory. Use the **HISTORY** command to obtain the event history. The event history includes some of the event summary information with which you can identify a specific event report.
- Event Reports—These detailed reports are stored in nonvolatile memory for later retrieval and detailed analysis. Use the Event *n* command to obtain an event report.

Each time an event occurs, the device creates a new event summary, event history record, and event report. Event report information includes the following:

- Date and time of the event
- Individual sample analog inputs (currents and voltages, if installed)
- Digital states of selected Device Word bits (listed in *Appendix H*)

- Event summary, including the front-panel target states at the time of trigger
- Device, Logic, and Global settings (that were in service when the event was recorded)

Compressed ASCII Event Reports, Event Summaries, and History

The SEL-2411 provides Compressed ASCII event reports to facilitate event report storage and display. SEL communications processors and the ACSELERATOR® Analytic Assistant SEL-5601 software take advantage of the Compressed ASCII format, as shown in *Table 9.1*.

Table 9.1 Compressed ASCII Event Commands

Command	Description
CHI	Displays Compressed ASCII event history information.
CSU *n*	Displays Compressed ASCII event summary information.
CEV *n*	Displays Compressed ASCII event reports.

See the *CEVENT Command (Compressed Event Report) on page 7.8* and *SEL Compressed ASCII Commands on page C.1* for further information. Compressed ASCII Event Reports contain all of the Device Word bits.

Sequential Events Recorder (SER)

The SER report captures detailed digital element state changes. Settings allow up to 96 Device Word bits to be monitored, in addition to the automatically generated triggers for device power up and settings changes. State changes are time-tagged to the nearest millisecond. SER report data are useful in commissioning tests and during operation for system monitoring and control. SER information is stored when state changes occur.

Event Reporting

Length

IMPORTANT NOTE: Changing the LER setting clears all events in memory. Be sure to save critical event data prior to changing the LER setting.

The SEL-2411 provides selectable event report length (LER) and prefault length (PRE). Filtered event report length is either 15 or 64 cycles. Raw event reports display one extra cycle of data at the beginning of the report. Prefault length is the first part of the total event report length and precedes the event report triggering point. Prefault length is 1–10 cycles for LER = 15 and 1–59 cycles for LER = 64. See the *Event Reports on page 9.4* and *Report Settings (SET R Command) on page SET.32* of the *SEL-2411 Settings Sheets* for instructions on setting the LER and PRE settings. Changing the PRE setting has no effect on the stored reports.

Triggering

The SEL-2411 triggers (generates) an event report when any of the following occur:

- Programmable SELOGIC® control equation setting ER asserts to logical 1 (in Report settings)
- The device receives the serial port command **TRI** (Trigger Event Reports)

Programmable SELogic Control Equation Setting ER

Enter up to 15 elements (up to 14 nested parentheses) in the programmable SELogic control equation event report trigger setting ER to trigger event reports (**SET R**). When any of the elements in the ER equation asserts from a logical 0 to logical 1, the device generates an event report (if the SEL-2411 is not already generating a report that encompasses the new transition).

TRI (Trigger Event Report) Command

The sole function of the **TRI** serial port command is to generate event reports, primarily for testing purposes. See *TRIGGER Command (Trigger Event Report) on page 7.25* for more information on the **TRI** (Trigger Event Report) command.

Event Summaries

For every triggered event, the device generates and stores an event summary. The device stores the most recent 17 (if event report length setting LER := 15) or 4 (if LER := 64) event summaries. When the device stores a new event summary, it discards the oldest event and event summary if the event memory is full. Event summaries contain the following information:

- Device and Terminal Identification (DID and TID)
- Event number, date, time, and event type (event type is either Trigger or ER Trigger)
- The primary magnitudes of line and neutral currents, optional current inputs card required
- The primary magnitudes of the line to neutral voltage (if DELTA_Y := WYE) or phase-to-phase voltages (if DELTA_Y := DELTA), optional voltage inputs card required
- The device includes the event summary in the event report. The identifiers, date, and time information is at the top of the event report, and the remaining information follows at the end.

The device sends event summaries to all serial ports with setting AUTO := Y each time an event triggers.

Currents and Voltages

With an optional current card installed, the Currents fields display the primary current magnitudes at the instant the ER equation asserted. The currents displayed are listed below:

- Line Currents (IA, IB, IC)
- Line Currents (IAX, IBX, ICX) with 3 ACI/3 AVI Combination Card
- Neutral Current (IN)
- Ground Current (IG) with 3 ACI/3 AVI Combination Card

With an optional voltage card installed, the Voltages fields display the primary voltage magnitudes at the instant the ER equation asserts. The voltages displayed are listed below:

- DELTA_Y := WYE

  Phase-to-Neutral Voltages (VAN, VBN, VCN)
- DELTA_Y := DELTA

  Phase-to-Phase Voltages (VAB, VBC, VCA)

Event History

The event history report gives you a quick look at recent activity. The SEL-2411 labels each new event in reverse chronological order with 1 as the most recent event. Use this report to view the events that are presently stored in the SEL-2411. The event history contains the following:

- Standard report header
  - Device and terminal identification
  - Date and time of report
- Event number, date, time, event (type), current, frequency, and targets
- Because the device generates an event resulting from either assertion of **ER** or the **TRIGGER** command, the Event field in the Event History report contains either of these functions.

Viewing the Event History

Access the history report from the communications ports, using the **HIS** command or the analysis menu within ACSELERATOR QuickSet® SEL-5030 Software. View and download history reports from Access Level 1 and higher.

Use the **HIS** command from a terminal to obtain the event history. You can specify the number of the most recent events that the device returns (see *HISTORY Command (Events List) on page 7.12* for more information on the **HIS** command).

Use the front-panel **MAIN > Events > Display** menu to display event history data on the SEL-2411 front-panel display.

Clearing

IMPORTANT NOTE: Clearing the history report with the **HIS C** command also clears all event data within the SEL-2411 event memory.

Use the **HIS C** command to clear or reset history data from Access Levels 1 and higher. Clear/reset history data at any communications port. This will clear all event summaries, history records, and reports.

Event Reports

The latest event reports are stored in nonvolatile memory. Each event report includes four sections:

- Analog values of current and voltage
- Digital states of the protection and control elements, including overcurrent, and voltage elements, plus status of digital output and input states
- Event Summary
- Settings in service at the time of event trigger, consisting of Group, Logic, Global, and Report settings classes

Use the EVE command to retrieve the reports. There are several options to customize the report format.

Because you can configure the SEL-2411 in many different ways, the event report is not fixed, but a function of the device configuration. For example, if the device configuration excludes a voltage card, the event report also excludes voltage information.

Filtered and Unfiltered Event Reports

The SEL-2411 provides both filtered and unfiltered (raw) event reports, either at 16 (raw) samples per cycle or 4 samples (filtered) per cycle; each event report includes the following:

- Analog (current and/or voltage)/Digital Section
- Event Summary (including transducer information)
- Global Settings
- Group Settings
- Logic Settings

Depending on the PT connections, the report shows either phase-to-ground voltages (VA, VB, VC) or line-to-line voltages (VAB, VBC, VCA).

Both raw and filtered event reports show values for either phase-to-ground voltages or line-to-line voltages VA [VAB], VB [VBC], VC [VCA], and IA, IB, IC, IN. For the 16-samples-per-cycle filtered event reports, the digital outputs are repeated for four 1/16-cycle rows to make up the 1/4-cycle information.

Column Definitions

To optimize data reporting, the event report generally provides only one placeholder for more than one digital variable. For example, there is only one "dot" in the event report for both output contact OUT101 and output contact OUT102. To indicate device operation, the placeholder displays one of the following (applicable to all input and output cards):

- 1—only output contact OUT101 asserted
- 2—only output contact OUT102 asserted
- b—both output contact OUT101 and output contact OUT102 asserted

Table 9.2 shows the digital column definitions for the base unit (100) and the optional I/O boards (300 through 600).

Table 9.2 Digital Column Definitions (Sheet 1 of 3)

Column Designation	Column Symbols	Description
100 OUT 12	1 2 b	OUT101 OUT102 Both
100 OUT 3	3	OUT103
100 IN 12	1 2 b	IN101 IN102 Both
300 IN 12	1 2 b	IN301 IN302 Both
300 IN 34	3 4 b	IN303 IN304 Both
300 IN 56	5 6 b	IN305 IN306 Both

Table 9.2 Digital Column Definitions (Sheet 2 of 3)

Column Designation	Column Symbols	Description
300 IN 78	7 8 b	IN307 IN308 Both
400 IN 12	1 2 b	IN401 IN402 Both
400 IN 34	3 4 b	IN403 IN404 Both
400 IN 56	5 6 b	IN405 IN406 Both
400 IN 78	7 8 b	IN407 IN408 Both
500 IN 12	1 2 b	IN501 IN502 Both
500 IN 34	3 4 b	IN503 IN504 Both
500 IN 56	5 6 b	IN505 IN506 Both
500 IN 78	7 8 b	IN507 IN508 Both
600 IN 12	1 2 b	IN601 IN602 Both
600 IN 34	3 4 b	IN603 IN604 Both
600 IN 56	5 6 b	IN605 IN606 Both
600 IN 78	7 8 b	IN607 IN608 Both
300 OUT 12	1 2 b	OUT301 OUT302 Both
300 OUT 34	3 4 b	OUT303 OUT304 Both
300 OUT 56	5 6 b	OUT305 OUT306 Both
300 OUT 78	7 8 b	OUT307 OUT308 Both
400 OUT 12	1 2 b	OUT401 OUT402 Both

Table 9.2 Digital Column Definitions (Sheet 3 of 3)

Column Designation	Column Symbols	Description
400 OUT 34	3 4 b	OUT403 OUT404 Both
400 OUT 56	5 6 b	OUT405 OUT406 Both
400 OUT 78	7 8 b	OUT407 OUT408 Both
500 OUT 12	1 2 b	OUT501 OUT502 Both
500 OUT 34	3 4 b	OUT503 OUT504 Both
500 OUT 56	5 6 b	OUT505 OUT506 Both
500 OUT 78	7 8 b	OUT507 OUT508 Both
600 OUT 12	1 2 b	OUT601 OUT602 Both
600 OUT 34	3 4 b	OUT603 OUT604 Both
600 OUT 56	5 6 b	OUT605 OUT606 Both
600 OUT 78	7 8 b	OUT607 OUT608 Both

Example 15-Cycle Event Report

The trigger row includes a “>” character following immediately after the last analog column to indicate the trigger point. This row is also used for the event summary information.

Because you can configure your SEL-2411 to suit your application, the format of the event report adapts to the specific configuration of the device. For installations where less than four cards are necessary, the event report displays only the information for installed cards. *Figure 9.1* shows the event report when the SEL-2411 configuration includes a current card, a voltage card, an analog card and a digital input card. This is a composite event report that shows the data for both wye-connected and delta-connected PTs (shaded heading); you will see only one of these rows in an actual installation.

```
=>>EVE <Enter>

SEL-2411                                Date: 05/30/2005 Time: 06:51:33.307
DEVICE


Serial Number=2005XXXXXXXXXXX
FID=SEL-2411-R200-V0-Z002002-D20070810 CID=D5A7

                                                   100    400       ← DI Card in Slot 4
                                                   OUT IN IN
Currents (Amps Pri)          Voltages (V Pri) 13  1  1357
   IA     IB     IC     IN     VA    VB    VC  2   2  2468
   IA     IB     IC     IN     VAB   VBC   VCA 2   2  2468

[1]
  923.3 1588.3-2503.3    0.0 -1621  -406  2017 ..  .  ....       ← No outputs or
-2358.3 1970.8  414.2    0.1  1381 -2089   673 ..  .  ....         inputs asserted
 -921.7-1589.2 2498.3   -0.1  1620   407 -2017 ..  .  ....
 2355.0-1971.7 -420.0   -0.1 -1383  2086  -673 ..  .  ....
[2]
  915.8 1593.3-2499.2    0.0 -1619  -408  2019 ..  .  ....
-2358.3 1965.8  414.2    0.0  1383 -2088   672 ..  .  ....
 -921.7-1599.2 2493.3    0.0  1619   408 -2022 ..  .  ....
 2352.5-1969.2 -417.5   -0.1 -1385  2087  -671 ..  .  ....
[3]
  918.3 1593.3-2499.2   -0.1 -1621  -411  2019 ..  .  ....
-2358.3 1970.8  416.7    0.0  1385 -2088   668 ..  .  ....
 -914.2-1596.7 2493.3    0.0  1619   411 -2020 ..  .  ....
 2357.5-1969.2 -420.0   -0.2 -1387  2086  -669 ..  .  ....
[4]
  909.2 1595.8-2496.7    0.0 -1617  -412  2021 ..  .  ....
-2360.8 1963.3  414.2    0.2  1387 -2086   667 ..  .  ....
 -914.2-1600.8 2498.3   -0.1  1616   412 -2022 ..  .  ....
 2362.5-1966.7 -420.0   -0.1 -1388  2087  -666>..  .  ....       ← Trigger row
.
.
.

[15]
  883.3 1616.7-2499.2    0.0 -1600  -438  2029 ..  .  ....
-2367.5 1947.5  445.0    0.0  1405 -2080   645 ..  .  ....
 -886.7-1615.0 2488.3   -0.1  1600   437 -2030 ..  .  ....
 2364.2-1950.0 -450.0    0.0 -1406  2081  -644 ..  .  ....
EVENT = Trigger
TARGETS = 00000000
FREQ (Hz) =  60.0

Current Mag
        IA       IB       IC       IN
(A)    2531.9   2534.6   2541.8    0.05

Voltage Mag
       VA     VB     VC
(V)    2130   2128   2127

Analog Input Slot 3
AI301 (mA)    0.000 ← Analog Card in Slot 3
AI302 (mA)    0.000
AI303 (mA)    0.000
AI304 (mA)    0.000
AI305 (mA)    0.000
AI306 (mA)    0.000
AI307 (mA)    0.000
AI308 (mA)    0.000


PARTNO=2411XXXXXXXXXXXXXXX

Global Settings

PHROT   := ABC     FNOM    := 60
DELTA_Y := WYE
DATE_F  := MDY
IN101D  := 10      IN102D  := 10
IN401D  := 10      IN402D  := 10      IN403D  := 10      IN404D  := 10
IN405D  := 10      IN406D  := 10      IN407D  := 10      IN408D  := 10
RSTTRGT := NA

DSABLSET:= NA
```

Figure 9.1 Event Report for a Current Card, a Voltage Card, an Analog Card, and a Digital Input Card (Sheet 1 of 2)

```
Group Settings

DID     := SEL-2411
TID     := DEVICE

CTR     := 250
CTRN    := 250
PTR     := 35.00
AI301NAM:=AI301    AI301TYP:= I       AI301L  := 4.000   AI301H  := 20.000
AI301EU := mA               AI301EL := 4.000   AI301EH := 20.000  AI301LW1:= OFF

AI301LW2:= OFF     AI301LAL:= OFF     AI301HW1:= OFF     AI301HW2:= OFF
AI301HAL:= OFF
AI302NAM:=AI302    AI302TYP:= I       AI302L  := 4.000   AI302H  := 20.000
AI302EU := mA               AI302EL := 4.000   AI302EH := 20.000  AI302LW1:= OFF

AI302LW2:= OFF     AI302LAL:= OFF     AI302HW1:= OFF     AI302HW2:= OFF
AI302HAL:= OFF
AI303NAM:=AI303    AI303TYP:= I       AI303L  := 4.000   AI303H  := 20.000
AI303EU := mA               AI303EL := 4.000   AI303EH := 20.000  AI303LW1:= OFF

.
.
.

AI308LW2:= OFF     AI308LAL:= OFF     AI308HW1:= OFF     AI308HW2:= OFF
AI308HAL:= OFF

Logic Settings

ELAT    := N       ESV     := N       ESC     := N       EMV     := N


OUT101  := HALARM OR SALARM
OUT102  := RB01
OUT103  := 0


=>>
```

Figure 9.1 Event Report for a Current Card, a Voltage Card, an Analog Card, and a Digital Input Card (Sheet 2 of 2)

Sequential Events Recorder (SER) Report

The SEL-2411 SER (Sequential Events Recorder) report gives you detailed information on device element state changes over an extended period of time. The SER captures and time tags state changes of Device Word bits and device conditions. These conditions include power up, device enable and disable, settings changes, and SER automatic removal and reinsertion.

The SER records up to 512 state changes of up to 96 Device Word bits listed in the SER trigger equations. SER data are stored in nonvolatile memory, ensuring that a loss of power to the SEL-2411 will not result in lost data.

Inputs

The SER guaranteed timestamp accuracy is ±1 microsecond for physical inputs.

The PAC samples at 250 Hz or as a function of frequency; you select frequency tracking by installing either an optional current card or an optional voltage card (or both).

Chatter Filtering

The SER includes a filter function to prevent overfilling of the SER buffer with chattering information. When enabled, the device automatically deletes these oscillating items from SER recording.

Setting SRDLTIM declares a time interval during which the device qualifies an input by comparing the changes of state of each input against the SRDLCNT setting. When an item changes state more than SRDLCNT times in an SRDLTIM interval, the device automatically removes these Device Word bits from SER recording.

SER Triggering

Settings SER1 through SER4 are used to select entries in the SER report. To capture device state changes in the SER report, the Device Word bits must be programmed into one of the four SER trigger equations. Each of the four programmable trigger equations allows entry of as many as 24 Device Word bits; the SER report can monitor a total of 96 Device Word bits.

The device adds a message to the SER to indicate power up or settings change conditions.

Each entry in the SER includes the SER row number, date, time, element name, and element state.

SER Aliases

Aliases are provided for the name, asserted state, and deasserted state of Device Word bits selected for SER recording. These aliases simplify analysis of sequences. Up to 96 Device Word bits can be selected as triggers and up to 20 of these can be assigned aliases.

Define the alias by using the following format, where each field can be up to 15 characters long: name assert deassert. You can use capital letters (A–Z), numbers (0–9), and the underscore character (_) within each string. Do not use a space within a string because the device will interpret a space as the break between two strings. If you wish to clear a string, simply type **NA**.

Viewing and Clearing SER Reports

The device displays the SER records in ASCII format. To retrieve SER information, type **SER <Enter>** at Access Level 1 or higher. Type **SER <Enter>** to clear the SER report.

Example SER Report

Figure 9.2 shows the data contained in the SER report.

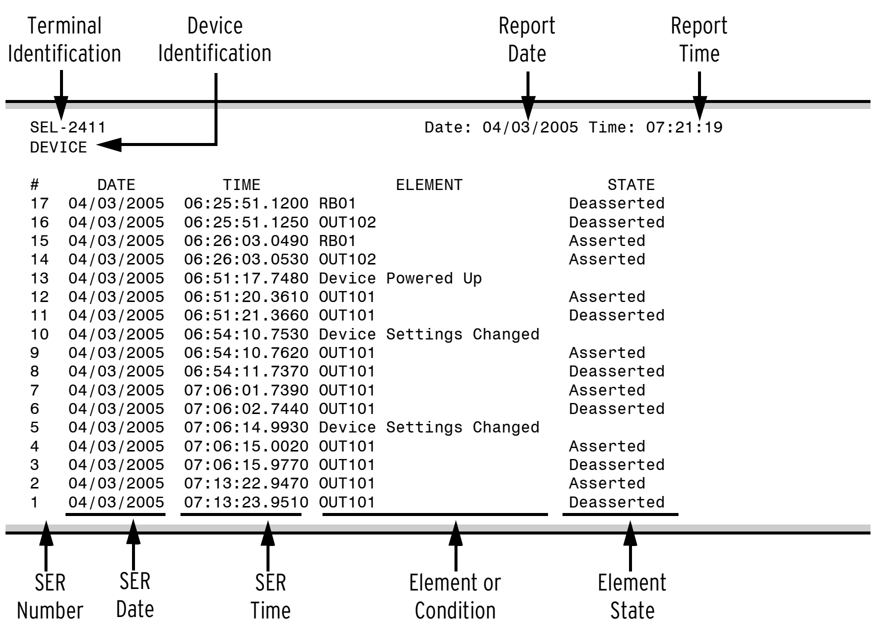


Figure 9.2 Sample SER Report

Each entry in the SER includes the SER row number, date, time, element name, and element state. In the SER report, the oldest information has the highest number, i.e., the newest information is the Number 1 entry (RB01 in *Figure 9.2*). When using a computer terminal you can change the order of the SER records in the SER report. See *SER Command (Sequential Events Recorder Report) on page 7.21* for more information.

Section 10

Testing and Troubleshooting

Overview

Device testing is typically divided into two categories:

- Tests performed at the time the device is installed or commissioned.
- Tests performed periodically once the device is in service.

This section provides information on both types of testing for the SEL-2411 Programmable Automation Controller. Because the SEL-2411 is equipped with extensive self-tests, traditional periodic test procedures may be eliminated or greatly reduced. Should a problem arise during either commissioning or periodic tests, the section on *Troubleshooting on page 10.13* provides a guide to isolating and correcting the problem.

Testing

Because the SEL-2411 is equipped with extensive self-tests, the most effective maintenance task is to monitor the front-panel messages after a self-test failure. In addition, each device event report generated by a fault should be reviewed. Such reviews frequently reveal problems with equipment external to the device, such as instrument transformers and control wiring.

The SEL-2411 does not require specific routine tests, but your operation standards may require some degree of periodic device verification. If you need or want to perform periodic device verification, the following checks are recommended.

Device Status Verification

Use the front-panel **STATUS** or serial port **STATUS** command to verify that the device self-tests have not detected any WARN or FAIL conditions.

Meter Verification

Verify that the device is correctly measuring current and voltage (if included) by comparing the device meter readings to separate external meters.

Input Verification

Using the front-panel **MAIN > TARGETS > ROW 48** function, check the control input status in the device. As you apply rated voltage to each input, the position in Row 48 corresponding to that input should change from zero (0) to one (1).

Output Verification

For each output contact, set the input to Logic 1. This causes the output contact to close. For example, setting OUT101 = 1 causes the output **OUT101** contact to close. Repeat the process for all contact outputs.

Make sure that each contact closure does what you want it to do in the annunciation, control, or trip circuit associated with that contact closure.

METER Command

Use the **MET** command to display fundamental, analog input, math variable, remote analog and signal profile data, as shown in *MET F k Fundamental Metering on page 7.17*. Because you can configure the SEL-2411 with different cards, display values in response to the **MET** command is a function of the specific card combination. When a card is not installed, the headings and values are hidden. Compare these quantities against other devices of known accuracy. The **METER** command is available at the serial ports and front-panel display.

EVENT Command

The device generates a 15- or 64-cycle event report in response to faults or disturbances. Each report contains current and voltage information, and input/output contact information. If you question the device response or your test method, use the event report for more information. The **EVENT** command is available at the serial ports. See *Table 7.24*.

SER Command

The device provides a Sequential Events Recorder (SER) event report that time-tags changes in device element and input/output contact states. The SER provides a convenient means to verify the pickup/dropout of any element in the device. *Table 7.40* shows the **SER** commands to view and manage the Sequential Events Recorder report. The **SER** command is available at the serial ports.

TARGET Command

Use the **TARGET** command to view the state of device control inputs, device outputs, and device elements individually during a test. The **TAR** command displays the status of front-panel target LEDs or Device Word bits, whether these LEDs or Device Word bits are asserted or deasserted, as shown in *Table 7.48*. The **TARGET** command is available at the serial ports and the front panel.

The elements are represented as Device Word bits and are listed in rows of eight, called Device Word rows. All Device Word rows are described in *Appendix H: Device Word Bits*. The **TAR** command does not remap the front-panel target LEDs, as is done in some previous SEL products.

Low-Level Test Interface

The SEL-2411 has a low-level test interface on the current (4 CT) and voltage (3 AVI) input printed circuit boards. You can test the device in either of two ways: conventionally, by applying ac signals to the device inputs or by applying low magnitude ac voltage signals to the test interface on the printed circuit boards.

The 3 ACI/3 AVI card is not configured for low level test interface support. A 3 ACI/3 AVI card with the low level test interface support is available. See the I/O Card ordering document.

The SEL-RTS Low-Level Device Test System can be used to provide the signals to test the device. *Figure 10.1* shows the Test Interface connectors.

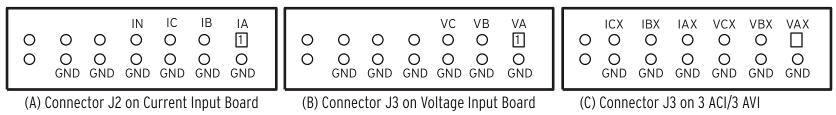


Figure 10.1 Low-Level Test Interfaces

Table 10.1 through *Table 10.3* show the signal scale factor information for the calibrated inputs. The SEL-5401 Test System software uses these scale factors.

Table 10.1 Scale Factors for a 1 A Device

Channel Label	Circuit Board and Connector	SEL-5401 Channel No.	Nominal Input	Output	Scale Factors
IA	CT Board / J2	1	1 A	28.78 mV	34.7
IB	CT Board / J2	2	1 A	28.78 mV	34.7
IC	CT Board / J2	3	1 A	28.78 mV	34.7
IN	CT Board / J2	4	1 A	274.7 mV	3.64

Table 10.2 Scale Factors for a 5 A Device

Channel Label	Circuit Board and Connector	SEL-5401 Channel No.	Nominal Input	Output	Scale Factors
IA	CT Board / J2	1	5 A	28.78 mV	173.7
IB	CT Board / J2	2	5 A	28.78 mV	173.7
IC	CT Board / J2	3	5 A	28.78 mV	173.7
IN	CT Board / J2	4	5 A	274.7 mV	18.2

Table 10.3 Scale Factors for a Voltage Card

Channel Label	Circuit Board and Connector	SEL-5401 Channel No.	Nominal Input	Output	Scale Factors
VA	Voltage / J3/J4	7	250 V	700.0 mV	357.1
VB	Voltage / J3/J4	8	250 V	700.0 mV	357.1
VC	Voltage / J3/J4	9	250 V	700.0 mV	357.1

Table 10.4 Scale Factors for an ACI/AVI Card

Channel Label	Circuit Board and Connector	SEL-5401 Channel No.	Nominal Input	Output	Scale Factors
IAX	CT/PT Board / TB1	4	5 A	28.33 mV	176.5 A/V
IBX	CT/PT Board / TB1	5	5 A	28.33 mV	176.5 A/V
ICX	CT/PT Board / TB1	6	5 A	28.33 mV	176.5 A/V
VAX, 8 V Channel	CT/PT Board / J1	1	6.405 V	703.3 mV	9.107 V/V
VBX, 8 V Channel	CT/PT Board / J1	2	6.405 V	703.3 mV	9.107 V/V
VCX, 8 V Channel	CT/PT Board / J1	3	6.405 V	703.3 mV	9.107 V/V
VAX, 300 V Channel	CT/PT Board / J1	1	250 V	700.0 mV	357.1 V/V
VBX, 300 V Channel	CT/PT Board / J1	2	250 V	700.0 mV	357.1 V/V
VCX, 300 V Channel	CT/PT Board / J1	3	250 V	700.0 mV	357.1 V/V

Access the low-level test interface connections by using the following procedure.

⚠CAUTION
The device contains devices sensitive to Electrostatic Discharge (ESD). When working on the device with the front panel removed, work surfaces and personnel must be properly grounded or equipment damage may result.

Step 1. Loosen eight (8) mounting (and one ground) screws on the back and remove the back cover.

Step 2. Remove the CT board from Slot Z.

Step 3. Locate jumpers **JMP1** through **JMP4** and change them from the position labeled CT (Normal position) to position labeled AMS, as shown in *Figure 10.2* (Low-Level Test position).

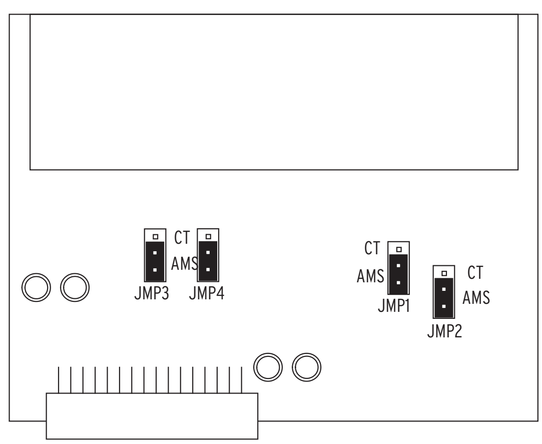


Figure 10.2 Jumpers on Current Card to Change to Low-Level Injection

NOTE: The 14-pin connectors of the SEL-RTS ribbon cable C750A can be used. The connectors are not keyed; make sure Pin 1 is connected to the IA/VA channel on the CT and voltage board, respectively.

Step 4. Locate connector J2 and connect low-level signal connector (e.g., ribbon cable connector of SEL-RTS Test System).

Step 5. Insert the CT board back in its Slot Z.

Step 6. Remove the voltage board from Slot E.

Step 7. Locate connector J4 and connect low-level signal connector (e.g., ribbon cable connector of SEL-RTS Test System).

Step 8. Insert the voltage board back into Slot E.

Refer to the *SEL-RTS Instruction Manual* for additional detail.

Using the Low-Level Test Interface When Setting DELTA_Y := DELTA

When simulating a delta PT connection with the low-level test interface referenced in *Figure 10.1*, apply the following signals:

Step 1. Apply low-level test signal VAB to Pin VA.

Step 2. Apply low-level test signal –VBC (equivalent to VCB) to Pin VC.

Step 3. Do not apply any signal to pin VB.

Testing

Commissioning Tests

Introduction

Before any SEL-2411 devices leave our factory, SEL performs a complete functional check and calibration of each device. This helps to ensure that you receive a device that operates correctly and accurately.

Commissioning tests should verify that the device is properly connected to the auxiliary equipment. In order to verify control signal inputs and outputs use an ac connection check to verify that the device current and voltage inputs are of the proper magnitude and phase rotation.

Brief functional tests ensure that the device settings are correct. It is not necessary to test every element, timer, and function in these tests.

The following procedure is a guideline to help you enter settings into the SEL-2411 and to verify that it is properly connected. Modify the procedure as necessary to conform to your standard practices. Use this procedure at initial device installation; you should not need to repeat it unless major changes are made to the device electrical connections.

Required Equipment

- ➤ The SEL-2411, installed and connected according to your design.
- ➤ PC with serial port, terminal emulation software, and serial communications cable.
- ➤ SEL-2411 Settings Sheets with settings appropriate to your application and protection design.
- ➤ AC and dc elementary schematics and wiring diagrams for this device installation.

- Continuity tester.
- Protective device ac test source:
  - Minimum: single-phase voltage and current with phase angle control.
  - Preferred: three-phase voltage and current with phase angle control.

Procedure

Step 1. Remove control voltage and ac signals from the SEL-2411 by opening the appropriate breaker(s) or removing fuses.

Step 2. For safety, isolate the device output contacts assigned to control external equipment.

⚠CAUTION
The device contains devices sensitive to Electrostatic Discharge (ESD). When working on the device with the front panel removed, work surfaces and personnel must be properly grounded or equipment damage may result.

Step 3. Verify correct ac and dc connections by performing point-to-point continuity checks on the associated circuits.

Step 4. Apply ac or dc control voltage to the power supply of the SEL-2411. After the device is energized, the front-panel green **ENABLED** LED must illuminate.

Step 5. Use the appropriate serial cable (SEL Cable C234A or equivalent) to connect a PC to the device.

Step 6. Start the PC terminal emulation software and establish communication with the device (refer to *Section 7: Communications* for more information on serial port communications).

Step 7. Set the correct device time and date by using either the front-panel or serial port commands.

Step 8. Using the **SET**, **SET P**, **SET G**, **SET R**, **SET F**, and **SET L** serial port commands, enter the device settings from the settings sheets for your application.

Step 9. If you are connecting a fiber-optic cable, follow the substeps below; otherwise continue with the next step.

a. Connect the fiber-optic cable to the module fiber-optic output.

b. Plug the device end of the fiber-optic cable into the device fiber-optic input.

Step 10. Verify the device ac connections.

Step 11. Connect the ac test source current or voltage to the appropriate device terminals.

IMPORTANT NOTE: Make sure the current transformer secondary windings are shorted before they are disconnected from the device.

Disconnect the current transformer and voltage transformer (if present) secondaries from the device prior to applying test source quantities.

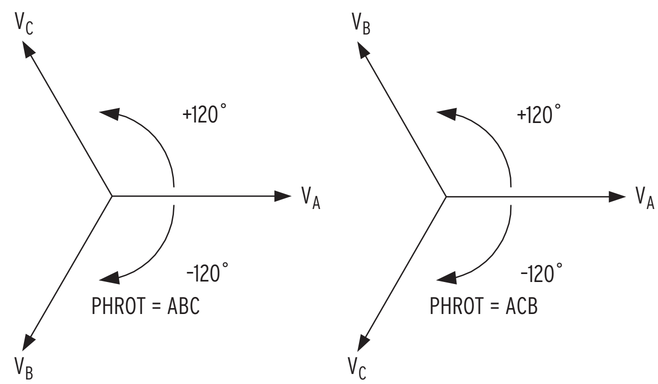
If you set the device to accept phase-to-ground voltages (DELTA_Y = wye), set the voltage phase angles as shown in *Figure 10.3*.

If you set the device to accept delta voltages (DELTA_Y = Delta), set the current and/or voltage phase angles as shown in *Figure 10.4*.

Step 12. Apply rated current (1 A or 5 A).

Step 13. If the device is equipped with voltage inputs, apply rated voltage for your application.

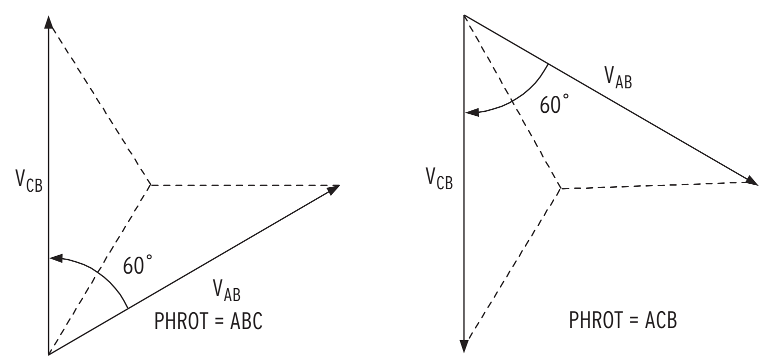
Step 14. Use the front-panel **METER > Fundamental** or serial port **METER F** command to verify that the device is measuring the magnitude and phase angle of both voltage and current correctly, taking into account the device PTR and CTR settings and the fact that the quantities are displayed in primary units.



When setting PHROT = ABC, set angle V_a = angle I_a = 0°
set angle V_b = angle I_b = -120°
set angle V_c = angle I_c = 120°

When setting PHROT = ACB, set angle V_a = angle I_a = 0°
set angle V_b = angle I_b = 120°
set angle V_c = angle I_c = -120°

Figure 10.3 Three-Phase Wye AC Connections



When setting PHROT = ABC, set angle I_a = 0°
set angle I_b = -120°
set angle I_c = 120°
set angle V_{ab} = +30°
set angle V_{cb} = +90°

When setting PHROT = ACB, set angle I_a = 0°
set angle I_b = 120°
set angle I_c = -120°
set angle V_{ab} = -30°
set angle V_{cb} = -90°

Figure 10.4 Three-Phase Open-Delta AC Connections

Step 15. If you are using the neutral CT, apply a single-phase current (A-Phase) to the **IN** terminals. Do not apply voltage.

Step 16. Verify that the device is measuring the magnitude and phase angle correctly.

Step 17. Verify control input connections. Using the front-panel **MAIN > TARGETS > ROW** commands, check the control input status in the device. As you apply rated voltage to each input, the position in Row 48 corresponding to that input should change from zero (0) to one (1).

Step 18. Verify output contact operation by asserting each output using the **PULSE** command. Make sure that each contact closure does what you want it to do in the annunciation, control, or trip circuit associated with that contact closure.

Step 19. Use the serial port commands in *Table 10.5* to clear the device data buffers and prepare the device for operation. This prevents data generated during commissioning testing from being confused with operational data collected later.

Step 20. Remove all injection set connections and connect the device for duty.

Table 10.5 Serial Port Commands That Clear Device Data Buffers

Serial Port Command	Task Performed
SER C	Resets SER buffer
HIS C	Clears/resets the event history and all corresponding event reports from nonvolatile memory

The SEL-2411 is now ready for continuous service.

Selected Functional Tests

Phase Current Measuring Accuracy

The following shows tests for current, voltage, phase angle, and power measurements.

Step 1. Connect the current source to the device, as shown in *Figure 10.5*.

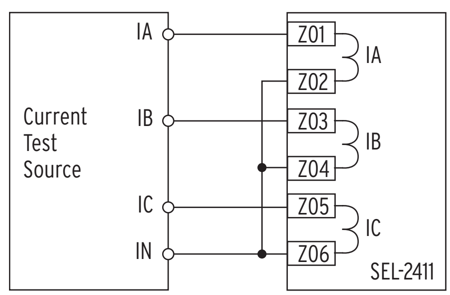


Figure 10.5 Current Source Connections

Step 2. Using the front-panel or the serial port **SHOW** command, record the CTR and PHROT setting values.

Step 3. Set the phase current angles to apply balanced three-phase currents in accordance with the PHROT setting. Refer to *Figure 10.3*.

Step 4. Set each phase current magnitude equal to the values listed in Column 1 of *Table 10.6*.

Complete *Table 10.6* by using the front-panel to view the phase current values. The device should display the applied current magnitude times the CTR setting.

Table 10.6 Test Values, Expected Values, and Actual Values

Applied Secondary Current[a]	Expected Reading (CTR • Applied Current)	A-Phase Reading (A Primary)	B-Phase Reading (A Primary)	C-Phase Reading (A Primary)
$0.2 \cdot I_{NOM}$				
$0.9 \cdot I_{NOM}$				
$1.6 \cdot I_{NOM}$				

[a] I_{NOM} = rated secondary amps (1 or 5)

Power and Power Factor Measuring Accuracy

Wye-Connected Voltages

Perform the following steps to test wye-connected voltages:

Step 1. Connect the current source to the device, as shown in *Figure 10.5*.

Step 2. Connect the voltage source to the device, as shown in *Figure 10.6*. Make sure that DELTA_Y = Wye.

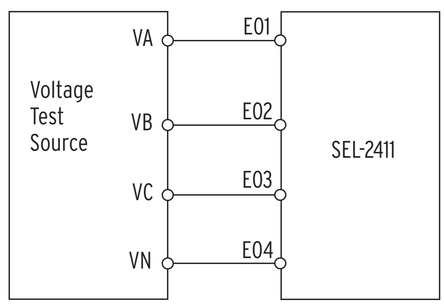


Figure 10.6 Wye Voltage Source Connections

Step 3. Using the front-panel **SET/SHOW** or the serial port **SHOW** command, record the CTR1, PTR, and PHROT setting values.

Step 4. Apply the current and voltage quantities shown in column 1 of *Table 10.7*. and *Table 10.8*.

Table 10.7 Current and Voltage Quantities for PHROT = ABC

Applied Currents and Voltages	Real Power (kW)	Reactive Power (kVAR)	Power Factor (pf)
IA = 2.5 ∠ –26 IB = 2.5 ∠ –146 IC = 2.5 ∠ 94	Expected P = 0.4523 • CTR • PTR	Expected Q = 0.219 • CTR • PTR	Expected pf = 0.9 lag
VA = 67 ∠ 0 VB = 67 ∠ –120 VC = 67 ∠ 120	Measured:	Measured:	Measured:

Table 10.8 Current and Voltage Quantities for PHROT = ACB (Sheet 1 of 2)

Applied Currents and Voltages	Real Power (kW)	Reactive Power (kVAR)	Power Factor (pf)
IA = 2.5 ∠ –26 IB = 2.5 ∠ 94 IC = 2.5 ∠ –146	Expected P = 0.4523 • CTR • PTR	Expected Q = 0.219 • CTR • PTR	Expected pf = 0.9 lag

Table 10.8 Current and Voltage Quantities for PHROT = ACB (Sheet 2 of 2)

Applied Currents and Voltages	Real Power (kW)	Reactive Power (kVAR)	Power Factor (pf)
VA = 67 ∠ 0 VB = 67 ∠ 120 VC = 67 ∠ –120	Measured:	Measured:	Measured:

Step 5. Use the front-panel **METER** function or the serial port **MET** command to verify the results.

Delta-Connected Voltages

When using delta-connected PTs, the device reports the current angle with reference to VAB. Perform the following steps to test delta-connected voltages:

Step 1. Connect the current source to the device as shown in *Figure 10.5*.

Step 2. Connect the voltage source to the device as shown in *Figure 10.7*. Make sure that the voltage setting is set to DELTA_Y = Delta.

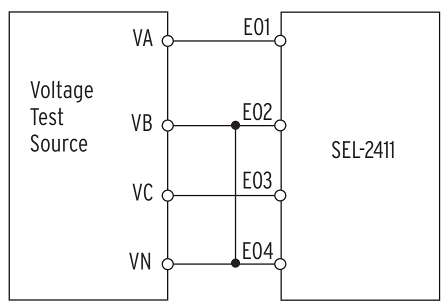


Figure 10.7 Delta Voltage Source Connections

Step 3. Using the front-panel **SET/SHOW** or the serial port **SHOW** command, record the CTR, PTR, and PHROT setting values.

Step 4. Apply the current and voltage quantities shown in column 1 of *Table 10.9* and *Table 10.10*. Values are given for PHROT = ABC and PHROT = ACB.

Step 5. Use the front-panel **METER** function or the serial port **MET** command to verify the results.

Table 10.9 Current and Voltage Quantities for PHROT = ABC

Applied Currents and Voltages	Real Power (kW)	Reactive Power (kVAR)	Power Factor (pf)
IA = 2.5 ∠ –26 IB = 2.5 ∠ –146 IC = 2.5 ∠ 94	Expected P = 0.4677 • CRT1 • PTR	Expected Q = 0.2265 • CTR • PTR	Expected pf = 0.9 lag
VAB = 120 ∠ 30 VBC = 120 ∠ 30	Measured:	Measured:	Measured:

Table 10.10 Current and Voltage Quantities for PHROT = ACB

Applied Currents and Voltages	Real Power (kW)	Reactive Power (kVAR)	Power Factor (pf)
IA = 2.5 ∠ –26 IB = 2.5 ∠ 94 IC = 2.5 ∠ –146	Expected P = 0.4677 • CTR • PTR	Expected Q = 0.2265 • CTR • PTR	Expected pf = 0.9 lag
VAB = 120 ∠ –30 VBC = 120 ∠ 90	Measured:	Measured:	Measured:

Self-Test

The SEL-2411 runs a variety of self-tests. Two Device Word bits, HALARM and SALARM, signal self-test problems. SALARM is pulsed for software-programmed conditions such as settings changes, access level changes, and three consecutive unsuccessful password entry attempts. HALARM is pulsed for hardware self-test warnings. HALARM is continuously asserted (set to logical 1) for hardware self-test failures.

NOTE: After a device failure, all digital output contacts revert to their de-energized state, i.e., all normally open contacts (a contacts) open and all normally closed contacts (b contacts) close.

Table 10.11 lists hardware self-tests. In the Alarm Status column, Latched indicates that HALARM is continuously asserted, Not Latched indicates that HALARM is pulsed for 5 seconds, and NA indicates that HALARM is not asserted. All hardware self-test failures generate a front-panel message that is automatically sent to the serial port. All hardware self-test failures (Latched entry in Alarm Status column) disable the device.

Table 10.11 Device Self-Tests (Sheet 1 of 3)

Self-Test	Description	Automation Disabled on Failure	Alarm Status	Status Command	Front-Panel Message
Mainboard FPGA (power up)	Fail if mainboard Field Programmable Gate Array does not accept program	Yes	Latched	FPGA OK/FAIL	`Status Fail` `FPGA Failure`
Mainboard FPGA (run time)	Fail on lack of data acquisition interrupts	Yes	Latched	FPGA OK/FAIL	`Status Fail` `FPGA Failure`
GPSB (back-plane) communications	Fail if GPSB is busy on entry to processing interval	Yes	Latched	GPSB OK/FAIL	`Status Fail` `GPSB Failure`
Front-Panel HMI (power up)	Fail if ID registers do not match expected or if FPGA programming is unsuccessful	No	Not Latched	HMI OK/WARN	
External RAM (power up)	Performs a read/write test on system RAM	Yes	Latched	RAM OK/FAIL	`Status Fail` `RAM Failure`
External RAM (run time)	Performs a read/write test on system RAM	Yes	Latched	RAM OK/FAIL	`Status Fail` `RAM Failure`
Internal RAM (power up)	Performs a read/write test on system CPU RAM	Yes	Latched	RAM OK/FAIL	`Status Fail` `RAM Failure`
Internal RAM (run time)	Performs a read/write test on system CPU RAM	Yes	Latched	RAM OK/FAIL	`Status Fail` `RAM Failure`
Code Flash (power up)	SELBOOT qualifies code with a checksum	NA	NA	NA	
Code Flash (run time)	Checksum is computed on the entire code base	Yes	Latched	ROM OK/FAIL	`Status Fail` `ROM Failure`

Table 10.11 Device Self-Tests (Sheet 2 of 3)

Self-Test	Description	Automation Disabled on Failure	Alarm Status	Status Command	Front-Panel Message
Data Flash (power up)	Checksum is computed on critical data	Yes	Latched	NON_VOL OK/FAIL	`Status Fail Non_Vol Failure`
Data Flash (run time)	Checksum is computed on critical data	Yes	Latched	NON_VOL OK/FAIL	`Status Fail Non_Vol Failure`
Critical RAM (settings)	Performs a checksum test on the active copy of settings	Yes	Latched	CR_RAM OK/FAIL	`Status Fail CR_RAM Failure`
Critical RAM (run time)	Verifies instruction (code) matches Flash image	Yes	Latched	CR_RAM OK/FAIL	`Status Fail CR_RAM Failure`
Clock Battery	Check battery voltage level	No	Not Latched	BATT OK/WARN	
Clock Chip	Unable to communicate with clock or fails time keeping test	No	Not Latched	CLOCK OK/WARN	
Clock Chip RAM	Clock chip static RAM fails	No	Not Latched	CLOCK OK/WARN	
Internal RTDs (run time)	Fail if the RTD card has a failed power supply, there is an open RTD, or there is a shorted RTD	NA	NA	INTRTD OK/FAIL	`Status Fail`
Internal RTDs/TC (run time)	Fail if the RTD card has a failed power supply, there is an open RTD, or there is a shorted RTD	NA	NA	INTEMP OK/FAIL	
External RTDs (run time)	Fail if unable to communicate with the external RTD device, the external RTD device has a failed power supply, there is an open RTD , or there is a shorted RTD.	NA	NA	EXTRTD OK/FAIL	`Status Fail`
CID (Configured IED Description) file (access)	Fail if unable to access/read the file.	NA	NA	CID_FILE OK/FAIL	`Status Fail`
+3.3 V Warn	Monitor +3.3 V power supply 3.16 to 3.43 V	No	Pulse, 5 sec	+3.3 V OK/WARN	
+3.3 V Fail	Monitor +3.3 V power supply 3.07 to 3.53 V	Yes	Latched	+3.3 V OK/FAIL	`Status Fail +3.3 V Failure`
+5 V Warn	Monitor +5 V power supply 4.75 to 5.25 V	No	Pulse, 5 sec	+5 V OK/WARN	
+5 V Fail	Monitor +5 V power supply 4.65 to 5.35 V	Yes	Latched	+5 V OK/FAIL	`Status Fail +5 V Failure`
+2.5 V Warn	Monitor +2.5 V power supply 2.40 to 2.6 V	No	Pulse, 5 sec	+2.5 V OK/WARN	
+2.5 V Fail	Monitor +2.5 V power supply 2.32 to 2.68 V	Yes	Latched	+2.5 V OK/FAIL	`Status Fail +2.5 V Failure`
+3.75 V Warn	Monitor +3.75 V power supply 3.6 to 3.9 V	No	Pulse, 5 sec	+3.75 V OK/WARN	
+3.75 V Fail	Monitor +3.75 V power supply 3.48 to 4.02 V	Yes	Latched	+3.75 V OK/FAIL	`Status Fail +3.75 V Failure`
–1.25 V Warn	Monitor -1.25 V power supply –1.2 to –1.30 V	No	Pulse, 5 sec	–1.25 V OK/WARN	
–1.25 V Fail	Monitor -1.25 V power supply –1.16 to –1.34 V	Yes	Latched	–1.25 V OK/FAIL	`Status Fail -1.25 V Failure`
–5 V Warn	Monitor -5 V power supply –4.75 to –5.25 V	No	Pulse, 5 sec	–5 V OK/WARN	

Table 10.11 Device Self-Tests (Sheet 3 of 3)

Self-Test	Description	Automation Disabled on Failure	Alarm Status	Status Command	Front-Panel Message
–5 V Fail	Monitor -5 V power supply –4.65 to –5.35 V	Yes	Latched	–5 V OK/FAIL	`Status Fail` `-5 V Failure`
CT Board A/D Offset Warn	Measure dc offset at each input channel >50 mV	No	Not Latched	OFFSETS OK/WARN	
VT Board A/D Offset Warn	Measure dc offset at each input channel >50 mV	No	Not Latched	OFFSETS OK/WARN	
I/O Board Failure (power up)	Check if ID register matches part number	Yes	Latched	CARD_C CARD_D CARD_E CARD_Z OK/FAIL	`Status Fail` `I/OCardFailure`
Exception Vector	CPU Error	Yes	Latched	NA	`Vector nn` `Disabled`

Troubleshooting

Refer to *Table 10.12* for troubleshooting instructions for particular situations.

Table 10.12 Troubleshooting

Problem	Possible Cause	Solution
The device **ENABLED** front-panel LED is dark.	Input power is not present or a fuse is blown.	Verify that input power is present.
	Self-test failure.	View the self-test failure message on the front-panel display.
The device front-panel display does not show characters.	The device front panel has timed out.	Press the **{ESC}** pushbutton to activate the display.
	The device is de-energized.	Verify input power and fuse continuity.
The device does not accurately measure transducer values.	Wiring error.	Verify input wiring.
	Incorrect AI settings (Group settings).	Verify AI settings.
The device does not respond to commands from a device connected to the serial port.	Cable is not connected.	Verify the cable connections.
	Cable is the incorrect type.	Verify the cable pinout.
	The device of communicating device has communications mismatch(es).	Verify device communications parameters.
	The device serial port has received an XOFF, halting communications.	Type **<Ctrl+Q>** to send the device XON and restart communications.

This page intentionally left blank

Appendix A

Firmware and Manual Versions

Firmware

Determining the Firmware Version in Your Device

To find the firmware version number in your SEL-2411 Programmable Automation Controller, use the **STA** command (see *STATUS Command (Device Self-Test Status) on page 7.24* for more information on the **STA** command). The firmware revision number is after the R, and the release date is after the D. For example, the following is firmware revision number 200, release date August 10, 2007.

FID=SEL-2411-R200-V0-Z002002-D20070810

Table A.1 lists the firmware versions for R300 series firmware (see *Table A.2* and *Table A.4* for R200 and R100 series firmware, respectively), 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 for R300 Series Firmware

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
SEL-2411-R302-V0-Z004004-D20100115	➤ Added support for Universal Temperature Input card (this includes type J, K, T, & E thermocouples). ➤ Added DNP Frozen Counters. ➤ Added protocol enables for FTP, Telnet, and Modbus. ➤ Corrected an occasional IEC 61850 communications defect where the firmware incorrectly reads an opcode from Flash memory and results in a vector.	20100115
SEL-2411-R300-V0-Z003003-D20090910	➤ No functional changes. Revised firmware for processor update. Previous versions cannot be upgraded to R300.	20090910

Table A.2 Firmware Revision History for R200 Series Firmware (Sheet 1 of 2)

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
SEL-2411-R209-V0-Z003003-D20100122	➤ Increased metering accuracies with system calibration. ➤ Fixed TCP socket issue to prevent possible vectors.	20100122
SEL-2411-R208-V0-Z003003-D20090724	➤ Corrected analog output tracking logic. ➤ The FMR settings assigned the wrong type for analog quantities MV01–MV08 and SC01–SC08. This error resulted in a Fast Message Read receiving INTEGER data for MV01–MV08 and FLOAT32 data for SC01–SC08.	20090724
SEL-2411-R207-V0-Z003003-D20090717	➤ Added analog quantities for delta two-voltage, two-current power calculation method.	20090717
SEL-2411-R206-V0-Z003003-D20090302	➤ Improved IEC 61850 security (see www.selinc.com/privacy.htm for details).	20090302
SEL-2411-R205-V0-Z003003-D20081111	➤ Manual update only (see *Table A.5*).	20090123

Table A.2 Firmware Revision History for R200 Series Firmware (Sheet 2 of 2)

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
SEL-2411-R205-V0-Z003003-D20081111	➤ Updated library version number in IEC 61850 library for new control capabilities.	20081111
SEL-2411-R204-V0-Z003003-D20081030	➤ Updated IEC 61850 firmware to streamline MMS processing and improve TCP/IP connections. ➤ Improved security (see www.selinc.com/privacy.htm for details).	20081030
SEL-2411-R203-V0-Z003003-D20080828	➤ Added support for optional dual copper Ethernet and single/dual fiber Ethernet communications. ➤ Added IEC 61850 Select Before Operate capabilities. ➤ Corrected analog signal-profiling storage time to match instruction manual.	20080828
SEL-2411-R202-V0-Z003003-D20080715	➤ Enhanced ac metering capabilities to include demand, peak demand, minimum and maximum, and energy. ➤ Added Time of Day/Month analog quantities for scheduling. ➤ Added alias support for device word bits in the SER record. ➤ Added support for SELECT 4 DI/3 DO card. ➤ Added port security features to include maximum access level and port enable/disable. ➤ Updated MIRRORED BITS Communications statistics calculation. ➤ Updated MIRRORED BITS channel drop out between devices connected on serial port 2 and serial port 3. ➤ Added ping command for testing network connectivity to another device.	20080715
SEL-2411-R201-V0-Z002002-D20080108	➤ Manual update only (see *Table A.5*).	20080325
SEL-2411-R201-V0-Z002002-D20080108	➤ Resolved operating MMS controls may cause operation failure. ➤ Corrected MMS write failures.	20080108
SEL-2411-R200-V0-Z002002-D20070810	➤ Added internal and external SEL-2600 RTD device support. ➤ Added SELECT 3 ACI/3 AVI I/O card support. ➤ Added IEC 61850 support.	20070810

Newer SEL-2411 firmware (R201 and higher) uses a different IEC 61850 software library from earlier versions and is unable to process version 001 CID files. ACSELERATOR Architect® SEL-5032 Software generates CID files from ICD files so the ICD file version number and CID file version number will be the same. If downloaded to the SEL-2411, an incompatible CID file will generate file parse errors during processing and disable the IEC 61850 protocol.

If you perform an SEL-2411 firmware upgrade that spans different file version compatibilities, the device may not be able to process the stored CID file. See the *Firmware Upgrade Instructions* for CID file conversion procedures.

See *Table A.3* for compatibilities between ACSELERATOR Architect, ICD/CID file, and Ethernet port firmware versions.

Table A.3 ACSELERATOR Architect CID File Compatibility

ACSELERATOR Architect Software Version	ACSELERATOR Architect ICD/CID File Version	Ethernet Port Firmware
All versions	Ver 001 or Ver 002L	R200
1.1.69.0 or higher	Ver 002	R201 or higher

Table A.4 Firmware Revision History for R100 Series Firmware

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
SEL-2411-R104-V0-Z001001-D20080606	➤ Manual update only (see *Table A.5*).	20090123
SEL-2411-R104-V0-Z001001-D20080606	➤ Resolved issue with infrequent and random dropouts of IRIGOK. ➤ Addressed issues in the MIRRORED BITS availability calculation.	20080606
SEL-2411-R103-V0-Z001001-D20070907	➤ Manual update only (see *Table A.5*).	20071116
SEL-2411-R103-V0-Z001001-D20070907	➤ Improved SEL-2411 XON/XOFF handshaking with SEL-2032 during auto-configuration. ➤ Improved MIRRORED BITS communications using Pulsar modems. ➤ Corrected potential for a vector when a DNP LAN/WAN session disconnects during a request. ➤ Improved DNP LAN/WAN session communication to not drop an existing connection when a new connection request is received.	20070907
SEL-2411-R102-V0-Z001001-D20070725	➤ Improved SEL-2411 XON/XOFF handshaking with SEL-2032 during auto-configuration. ➤ Improved SEL-2411 Fast SER state change condition with SEL-2032 during power up.	20070725
SEL-2411-R101-V0-Z001001-D20060223	➤ Manual update only (see *Table A.5*).	20061017
SEL-2411-R101-V0-Z001001-D20060223	➤ Manual update only (see *Table A.5*).	20060607
SEL-2411-R101-V0-Z001001-D20060223	➤ Manual update only (see *Table A.5*).	20060404
SEL-2411-R101-V0-Z001001-D20060223	➤ Added check for SELECT 4 AI/4 AO.	20060223
SEL-2411-R100-V0-Z001001-D20051202	➤ Initial version.	20051202

Instruction Manual

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

Table A.5 lists the instruction manual release dates and a description of modifications. The most recent instruction manual revisions are listed at the top.

Table A.5 Instruction Manual Revision History (Sheet 1 of 5)

Revision Date	Summary of Revisions
20100122	**Section 1** ➤ Updated metering accuracy information in *Specifications*. **Appendix A** ➤ Updated for firmware revision R209.
20100115	**Section 1** ➤ Added Universal Temperature Input card to *Table 1.1: Slot Allocations for Different Option Cards.* ➤ Added Universal Temperature Input card specifications to *Specifications*. ➤ Updated RTD Input card specifications. **Section 2** ➤ Added picture of the vertical chassis. ➤ Added *Figure 2.2: Programmable Automation Controler Vertical Panel-Mount Dimensions.* ➤ Added Universal Temperature Input card to *Table 2.1: Slot Allocations for Different Option Cards.* ➤ Added Universal Temperature Input card diagram. ➤ Added Thermocouple Inputs description and calibration procedure. ➤ Updated RTD Input description section.

Table A.5 Instruction Manual Revision History (Sheet 2 of 5)

Revision Date	Summary of Revisions
	Section 4 ➤ Added DNP setting category in *Table 4.1: Setting Categories*. ➤ Updated Math Variable description. Section 5 ➤ Added Thermal Metering meter **MET TEMP** command. Section 6 ➤ Added *Table 6.11: Universal Temperature Card Inputs*. Settings Sheets ➤ Added Universal Temperature Card input settings. ➤ Removed Display Point default settings. Appendix A ➤ Updated for firmware version R302. Appendix E ➤ Corrected Address numbers in *Table E.4: SEL-2411 Inputs*. ➤ Clarified 03h, 04h, 05h, 06h, and 10h instruction descriptions.
20090910	Section 2 ➤ Updated *Figure 2.4: Pins for Password Jumper and SELBOOT Jumper*. ➤ Updated the following panel diagrams: ➢ *Figure 2.6: Dual Fiber Ethernet, 8AI, 4 AI/4 AO, and Fast Hybrid 4 DI/4 DO Option* ➢ *Figure 2.7: Dual Copper Ethernet, 8 AI, 10 RTD, 8 DI, and 8 DO Option* ➢ *Figure 2.8: Dual Fiber Ethernet, 8 DI, 8 DO, Current and Voltage, 4 AI/4 AO Option* ➤ Updated *Figure 2.14: Open-Delta VT Connection*. Section 3 ➤ Updated *Figure 3.1: Power, Ground, and Communications Connections* and *Figure 3.7: Update Part Number*. Section 5 ➤ Removed RTD and Analog Input information from *Maximum and Minimum Metering* and *Table 5.4: Maximum/ Minimum Meter Values*. Section 7 ➤ Updated *Table 7.1: Communications Port Physical Interfaces*. Appendix A ➤ Updated for firmware version R300. Appendix E ➤ Updated Device Status information in *Table E.15: Modbus Register Map*.
20090724	Appendix A ➤ Updated for firmware version R208.
20090717	Section 1 ➤ Modified Real Power, Reactive Power, and Apparent Power and Power Factor values in *Specifications*. Appendix A ➤ Updated for firmware version R207.
20090302	Appendix A ➤ Updated for firmware version R206.
20090123	Section 3 ➤ Changed from a *PC Software* section to a *Getting Started* section. Section 5 ➤ Clarified metering values. Section 6 ➤ Removed redundant information. Section 8 ➤ Clarified front-panel operations, which included rewriting *Display Points*.

Table A.5 Instruction Manual Revision History (Sheet 3 of 5)

Revision Date	Summary of Revisions
20081111	Appendix A ➤ Updated for firmware version R205.
20081030	Appendix A ➤ Updated for firmware version R204.
20080828	Section 7 ➤ Added *Ethernet* under *Communications*. Appendix A ➤ Updated for firmware version R203. Appendix F ➤ Added *Controls* under *IEC 61850 Operation*.
20080715	Revised entire manual to include the following: ➤ Energy Metering. ➤ Maximum and Minimum Metering. ➤ Demand and Peak Demand Metering. Section 1 ➤ Clarified *Features and Models*, *Options*, and *Accessories*. Section 2 ➤ Clarified *Card Configuration*. Section 4 ➤ Revised entire section for clarity. Section 6 ➤ Added *SER Aliases* under *Report Settings (SET R Command)*. Setting Sheets ➤ Added EPORT and MAXACC to Port F and Ports 1 through 4 under *Port Settings*. Appendix A ➤ Updated for firmware version R202.
20080606	Appendix A ➤ Updated for firmware version R104.
20080325	Preface ➤ Added *Hazardous Locations Approvals*. Section 1 ➤ Updated *Operating Temperature Range* in *Specifications*. ➤ Updated *Mechanical Durability* under *Outputs* in *Specifications*. ➤ Added *Hazardous Locations Approvals* under *Certifications* in *Specifications*. Section 2 ➤ Updated Physical Location information. Appendix E ➤ Updated *Table E.23: SEL-2411 Modbus Command Region* to correct the Field column. ➤ Updated *Table E.25: Modbus Register Map* to correct Address in Hex for the 184–199 address. ➤ Updated *Table E.25: Modbus Register Map* to correct Max and Name/Enums for the 950 address.

Table A.5 Instruction Manual Revision History (Sheet 4 of 5)

Revision Date	Summary of Revisions
20080108	Section 2 ➤ Updated *Table 2.12: Four Digital Input/Four Digital Output Card (SELect 4 DI/4 DO) Terminal Allocation* to show proper digital input (DI) terminal allocation on SELECT 4 DI/4 DO cards. Appendix A ➤ Updated for firmware version R201. ➤ Separated firmware revision histories for R100 series and R200 series firmware. Appendix B ➤ Added *Optional Equipment*. ➤ Added *IEC 61850 CID File Upgrade Instructions*. Appendix F ➤ Added *SEL ICD File Versions*. ➤ Updated and added tables to document new ICD file versions supported by ACSELERATOR Architect Revision 1.1.69.0. ➢ Added *Table F.7: Logical Nodes Summary*. ➢ Updated *Table F.10: Logical Device: MET (Metering)*, *Table F.11: Logical Device: CON (Control)*, and *Table F.12: Logical Device: ANN (Annunciation)*.
20071116	Section 1 ➤ Removed reference to solid-state options in *Overview*. ➤ Updated *AC Current Input (SELect 4 ACI)* information in *Specifications*. ➤ Updated *DC Transducer (Analog) Inputs Extended Range Option* information in *Specifications*. ➤ Updated *RTD Inputs* information in *Specifications*. ➤ Removed solid-state contact information in *DC Output Ratings* and *AC Output Ratings* in *Specifications*. Section 2 ➤ Removed reference to solid-state options in *DI Card (SELect 4 DI/4 DO)*. ➤ Updated *Figure 2.12* to replace solid-state card with fast hybrid card.
20070907	Appendix A ➤ Updated for firmware version R103.
20070810	Revised entire manual to include the following: New and Updated SELECT I/O Cards ➤ Updated eight analog input with extended voltage range to support –300 to +300 V. ➤ Added support for three ac current input/three-phase ac voltage input combination card. ➤ Added 10 RTD temperature card. ➤ Added 4 DI/4 DO with fast, high-current interrupting outputs. New External SEL Support ➤ Added SEL-3010 Event Messenger. ➤ Added SEL-2600 devices, 12 input external RTD. New Mounting Options ➤ Added SEL-2411-1, surface-mountable version. New or Updated Firmware Features ➤ Added IEC 61850 communications. ➤ Increased remote analogs. ➤ Added multiple CT card support with SELECT 4 CT and SELECT ACI/AVI combination card. ➤ Added voltage ratio correction factor for low energy analog inputs on SELECT 3 ACI/3 AVI combination card. ➤ Increased DNP points to support more analog and binary inputs. Appendix A ➤ Updated for firmware version R200.
20070725	Appendix A ➤ Updated for firmware version R102.

Table A.5 Instruction Manual Revision History (Sheet 5 of 5)

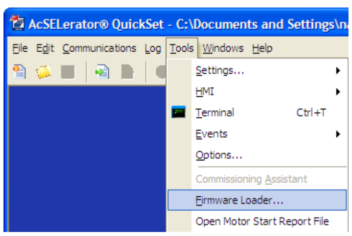
Revision Date	Summary of Revisions
20061017	Section 1 ➤ Updated *Specifications*. Section 2 ➤ Updated the order of Analog Cards in *Table 2.9*. ➤ Updated Figure 2.5 to show orientation. ➤ Updated Figure 2.19 to show correct terminal block numbers for OUT101 and OUT102. Section 6 ➤ Updated *Step 5* in *Table 6.7*. ➤ Updated *Figure 6.9*. ➤ Updated *Fast Message Read Settings*.
20060607	Preface ➤ Updated *Class 1 LED Product Compliance Label and Location*. Section 1 ➤ Corrected *Contact Protection* in *Specifications*. ➤ Added UL/CSA information. Section 2 ➤ Updated AWG specifications in *Power Connections*. Appendix E ➤ Corrected Note under *Reference Data Map*. Command Summary ➤ Added **SET DNP** and **SHO DNP** commands.
20060404	Appendix E ➤ Clarified DNP binary event timestamping.
20060223	Entire Manual ➤ Changed name of product. ➤ Updated naming for SELECT I/O cards. Section 1 ➤ Updated *Specifications*. Appendix F ➤ Clarified Modbus TCP support.
20051202	➤ Initial version.

This page intentionally left blank

Appendix B

Firmware Upgrade Instructions

Select **Tools > Firmware Loader** from the ACSELERATOR® menu bar to launch a wizard that walks you through the steps to load firmware into your SEL device.

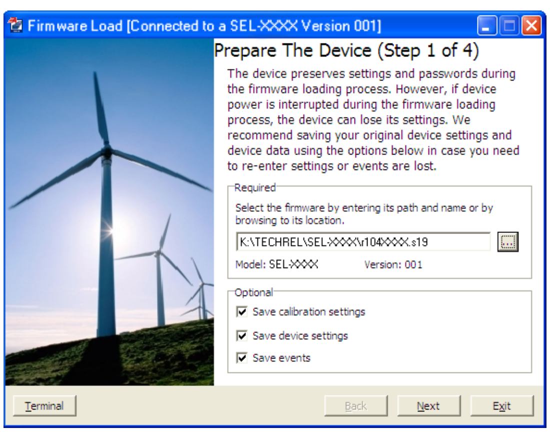


Firmware Loader will not start if:

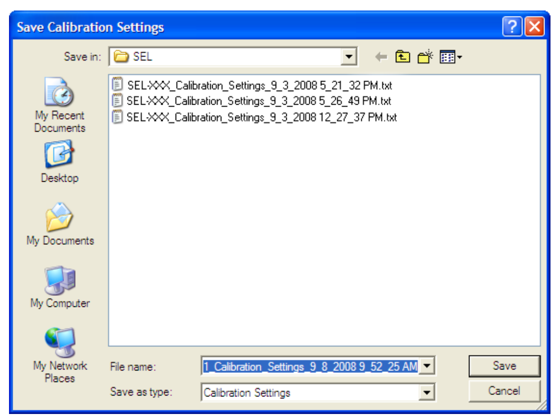
- ➤ The device is unsupported by ACSELERATOR.
- ➤ The device is not connected to the computer with a communications cable.
- ➤ The connected port does not support SELBOOT.
- ➤ The device is disabled.

Step 1: Prepare Device

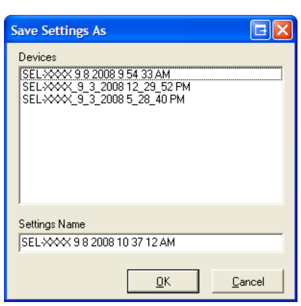
a) Select the firmware to be loaded using the browse control and select whether you want to save calibration settings, device settings, and event report files. Select **Next** to continue the wizard.



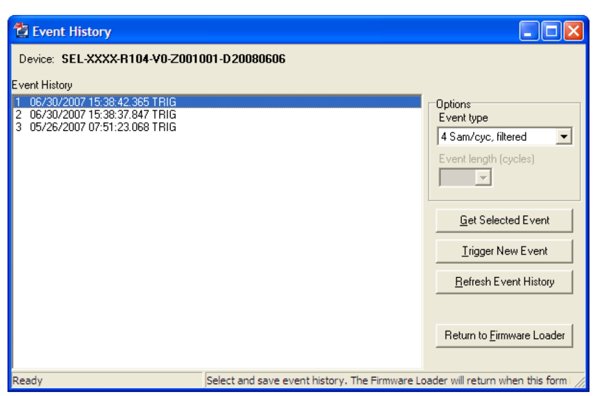
b) Select a file name and path to save the settings or accept the defaults as shown. Click **Save**.



c) After the device settings are downloaded, select a file name and path to save the settings or accept the default, as shown.



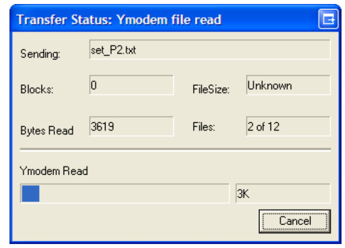
d) Click **Return to Firmware Loader** since this product does not have event reports.



Step 2: Transfer Firmware

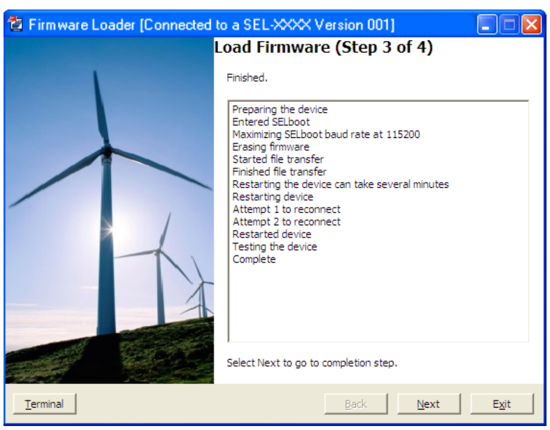
Click **Next** to begin the firmware transfer.

The **Transfer Status: Ymodem file read** window shows the transfer progress of the firmware file. Clicking **Cancel** will stop the transfer.



Step 3: Prepare Device

During this step, the device will be put in SELBOOT. The transfer speed will be maximized and the firmware transfer begun.



Step 4: Verify Device

Four verification options are provided and when enabled these options perform as follows.

Test Device Communications. If the device cannot be restarted then device power should be cycled and the device reset. Once the device is enabled, this option will reconnect and re-initialize the device.

Compare Device Settings. This option verifies settings by reading them from the device and comparing them with settings saved to the database.

Restore Device Settings. This option restores settings by writing settings saved to the database to the device, settings will be converted automatically if needed.

Load Firmware into Another Device. Returns the wizard to *Step 1: Prepare Device* to repeat the firmware loading process with another device.

IEC 61850 CID File Upgrade Instructions

Verify or Restart IEC 61850 Operation (Optional)

SEL-2411 series devices with optional IEC 61850 protocol require the presence of one valid CID file to enable the protocol. You should only transfer a CID file to the device if you want to implement a change in the IEC 61850 configuration or if new SEL-2411 firmware does not support the current CID file version. If you transfer an invalid CID file, the device will disable the IEC 61850 protocol, as it no longer has a valid configuration. To restart IEC 61850 protocol operation, you must transfer a valid CID file to the device.

Perform the following steps to verify that the IEC 61850 protocol is still operational after an SEL-2411 firmware upgrade and if not, re-enable it. This procedure assumes that IEC 61850 was operational with a valid CID file immediately before initiating an SEL-2411 firmware upgrade.

Step 1. Establish an FTP connection to the SEL-2411 Ethernet port.

Step 2. Open the ERR.TXT file for reading.

If the ERR.TXT file contains error messages relating to CID file parsing, this indicates that the device has disabled the IEC 61850 protocol. If this file is empty, the device found no errors during CID file processing and IEC 61850 should remain enabled. Skip to *Step 3* if ERR.TXT is empty.

If the IEC 61850 protocol has been disabled because of an upgrade-induced CID file incompatibility, you can use ACSELERATOR Architect® SEL-5032 Software to convert the existing CID file and make it compatible again.

a. Install the ACSELERATOR Architect software upgrade that supports your required CID file version.

b. Run ACSELERATOR Architect and open the project that contains the existing CID file for the device.

c. Download the CID file to the device.

Upon connecting to the device, ACSELERATOR Architect will detect the upgraded SEL-2411 firmware and prompt you to allow it to convert the existing CID file to a supported version. Once converted, downloaded, and processed, the valid CID file allows the device to re-enable the IEC 61850 protocol in its original configuration.

Step 3. In the Telnet session, type **GOO <Enter>** or you can also execute **GOO** from a **2AC** prompt on a serial port connection.

Step 4. View the GOOSE status and verify that the transmitted and received messages are as expected.

This page intentionally left blank

Appendix C
SEL Communications Processors

SEL Communications Protocols

The SEL-2411 Programmable Automation Controller supports SEL protocols and command sets shown in *Table C.1*.

Table C.1 Supported Serial Command Sets

Command Set	Description
SEL ASCII	Use this protocol to send ASCII commands and receive ASCII responses that are human readable with an appropriate terminal emulation program.
SEL Compressed ASCII	Use this protocol to send ASCII commands and receive Compressed ASCII responses that are comma-delimited for use with spreadsheet and database programs or for use by intelligent electronic devices.
SEL Fast Meter	Use this protocol to send binary commands and receive binary meter and target responses.
SEL Fast Operate	Use this protocol to receive binary control commands.
SEL Fast SER	Use this protocol to send binary Sequential Events Recorder unsolicited responses.
SEL Fast Message	Use this protocol to write Remote Analog data via unsolicited writes.

SEL ASCII Commands

We originally designed SEL ASCII commands for communication between the device and a human operator via a keyboard and monitor or a printing terminal. A computer with a serial port can also use the SEL ASCII protocol to communicate with the device, collect data, and issue commands.

SEL Compressed ASCII Commands

The SEL-2411 supports a subset of SEL ASCII commands identified as Compressed ASCII commands. Each of these commands results in a comma-delimited message that includes a checksum field. Most spreadsheet and database programs can directly import comma-delimited files. Devices with embedded processors connected to the device can execute software to parse and interpret comma-delimited messages without expending the customization and maintenance labor needed to interpret nondelimited messages. The device calculates a checksum for each line by numerically summing all of the bytes that precede the checksum field in the message. The program that uses the data can detect transmission errors in the message by summing the characters of the received message and comparing this sum to the received checksum.

Most commands are available only in SEL ASCII or Compressed ASCII format. Selected commands have versions in both standard SEL ASCII and Compressed ASCII formats. Compressed ASCII reports generally have fewer characters than conventional SEL ASCII reports because the compressed reports reduce blanks, tabs, and other white space between data fields to a single comma.

Table C.2 lists the Compressed ASCII commands and contents of the command responses.

Table C.2 Compressed ASCII Commands

Command	Response	Access Level
BNAME	ASCII names of Fast Meter status bits	0
CASCII	Configuration data of all Compressed ASCII commands available at access level 1 and above	1
CEVENT	Event report	1
CHISTORY	List of events	1
CMETER	Metering data, including fundamental, analog inputs, math variables, remote analogs, and signal profile data	1
CSTATUS	Device status	1
CSUMMARY	Summary of event report	1
DNAME	ASCII names of digital I/O reported in Fast Meter	0
ID	Device identification	0
SNS	ASCII names for SER data reported in Fast Meter	0

Interleaved ASCII and Binary Messages

SEL devices have two separate data streams that share the same physical serial port. Human data communications with the device consist of ASCII character commands and reports that you view through use of a terminal or terminal emulation package. The binary data streams can interrupt the ASCII data stream to obtain information; the ASCII data stream continues after the interruption. This mechanism uses a single communications channel for ASCII communication (transmission of an event report, for example) interleaved with short bursts of binary data to support fast acquisition of metering data. The device connected to the other end of the link requires software that uses the separate data streams to exploit this feature. However, you do not need a device to interleave data streams to use the binary or ASCII commands. Note that XON, XOFF, and CAN operations operate on only the ASCII data stream.

An example of using these interleaved data streams is when the SEL-2411 communicates with an SEL communications processor. These SEL communications processors perform autoconfiguration by using a single data stream and SEL Compressed ASCII and binary messages. In subsequent operations, the SEL communications processor uses the binary data stream for Fast Meter and Fast Operate messages to populate a local database and to perform SCADA operations. At the same time, you can use the binary data stream to connect transparently to the SEL-2411 and use the ASCII data stream for commands and responses.

SEL Fast Meter, Fast Operate, Fast SER, and Unsolicited Write

SEL Fast Meter is a binary message that you solicit with binary commands. Fast Operate is a binary message for control. The device can also send unsolicited SEL Fast Message (used in the SEL-2411 for Remote Analogs) and Fast SER messages automatically. If the device is connected to an SEL communications processor, these messages provide the mechanism that the communications processor uses for SCADA or DCS functions that occur simultaneously with ASCII interaction.

SEL Communications Processor

SEL offers SEL communications processors, powerful tools for system integration and automation. The SEL-2030 series and the SEL-2020 communications processors are similar, except that the SEL-2030 series has two slots for network protocol cards. These devices provide a single point of contact for integration networks with a star topology, as shown in *Figure C.1*.

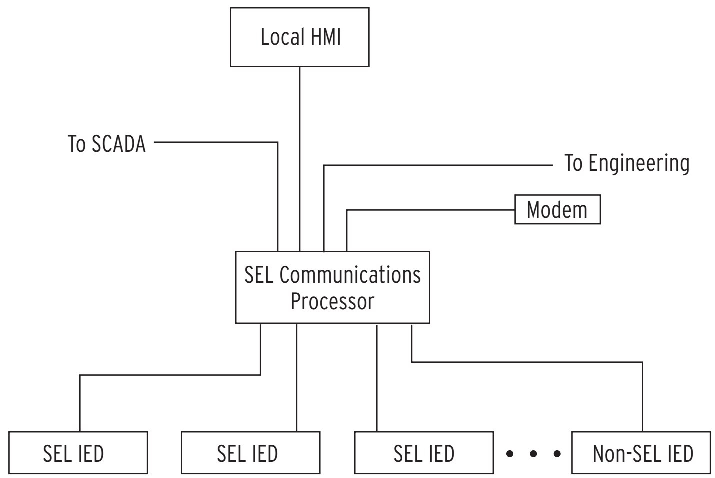


Figure C.1 SEL Communications Processor Star Integration Network

In the star topology network in *Figure C.1* the SEL communications processor offers the following substation integration functions:

- Collection of real-time data from SEL and non-SEL IEDs
- Calculation, concentration, and aggregation of real-time IED data into databases for SCADA, HMI, and other data consumers
- Access to the IEDs for engineering functions including configuration, report data retrieval, and control through local serial, remote dial-in, and Ethernet network connections
- Distribution of IRIG-B time synchronization signal to IEDs based on external IRIG-B input, internal clock, or protocol interface
- Simultaneous collection of SCADA data and engineering connection to SEL IEDs over a single cable
- Automated dial-out on alarms

SEL communications processors have 16 serial ports plus a front port. This port configuration does not limit the size of a substation integration project, because you can create a multitiered solution as shown in *Figure C.2*. In this multitiered system, the lower-tier SEL communications processors forward data to the upper-tier SEL communications processor that serves as the central point of access to substation data and substation IEDs.

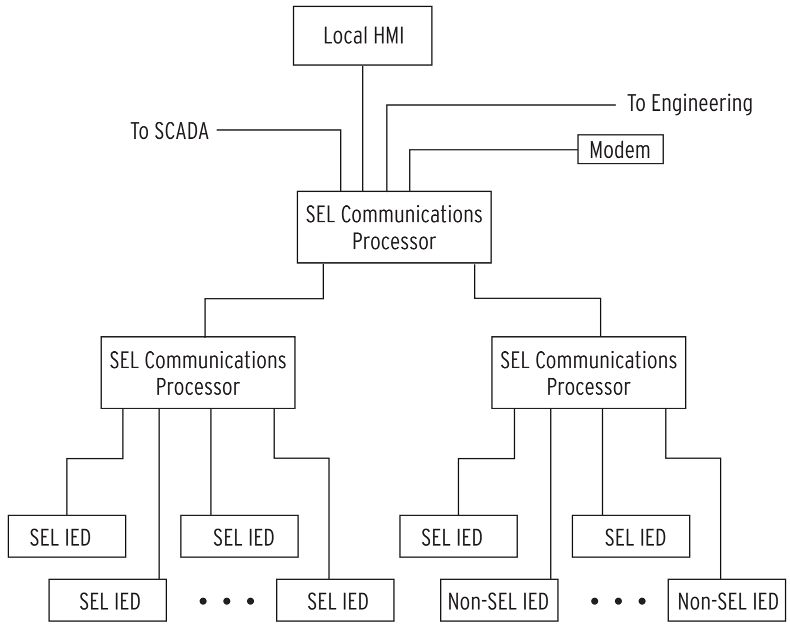


Figure C.2 Multitiered SEL Communications Processor Architecture

You can add additional communications processors to provide redundancy and eliminate possible single points of failure. SEL communications processors provide an integration solution with a reliability comparable to that of SEL relays. In terms of MTBF (mean time between failures), SEL communications processors are 100 to 1000 times more reliable than computer-based and industrial technology-based solutions.

Configuration of an SEL communications processor is different from other general-purpose integration platforms. You can configure SEL communications processors with a system of communication-specific keywords and data movement commands rather than programming in C or another general-purpose computer language. SEL communications processors offer the protocol interfaces listed in *Table C.3*.

Table C.3 SEL Communications Processors Protocol Interfaces

Protocol	Connect to
DNP3 Level 2 Slave	DNP3 masters
Modbus® RTU Protocol	Modbus masters
SEL ASCII/Fast Message Slave	SEL protocol masters
SEL ASCII/Fast Message Master	SEL protocol slaves including other communications processors and SEL devices
ASCII and Binary auto messaging	SEL and non-SEL IED master and slave devices
Modbus Plus®[a]	Modbus Plus peers with global data and Modbus Plus masters
FTP (File Transfer Protocol)[b]	FTP clients
Telnet[b]	Telnet servers and clients
UCA2 GOMSFE[b]	UCA2 protocol masters
UCA2 GOOSE[b]	UCA2 protocol and peers

[a] Requires SEL-2711 Modbus Plus protocol card.
[b] Requires SEL-2701 Ethernet Processor.

SEL Communications Processor and Device Architecture

You can apply SEL communications processors and SEL devices in a limitless variety of applications that integrate, automate, and improve station operation. Most system integration architectures utilizing SEL communications processors involve either developing a star network or enhancing a multidrop network.

Developing Star Networks

Figure C.1 shows the simplest architecture using both the SEL-2411 and an SEL communications processor. In this architecture, the SEL communications processor collects data from the SEL-2411 and other station IEDs. The SEL communications processor acts as a single point of access for local and remote data consumers (local HMI, SCADA, engineers). The communications processor also provides a single point of access for engineering operations including configuration and the collection of report-based information.

By configuring a data set optimized to each data consumer, you can significantly increase the utilization efficiency on each link. A system that uses an SEL communications processor to provide a protocol interface to an RTU will have a shorter lag time (data latency); communication overhead is much less for a single data exchange conversation to collect all substation data (from a communications processor) than for many conversations required to collect data directly from each individual IED. You can further reduce data latency by connecting any SEL communications processor directly to the SCADA master and eliminating redundant communication processing in the RTU.

The SEL communications processor is responsible for the protocol interface, so you can install, test, and even upgrade the system in the future without disturbing protective devices and other station IEDs. This insulation of the protective devices from the communications interface assists greatly in situations where different departments are responsible for SCADA operation, communication, and protection.

SEL communications processors equipped with an SEL-2701 Ethernet Processor can provide a UCA2 interface to the SEL-2411 and other serial IEDs. The SEL-2411 data appear in models in a virtual device domain. The combination of the SEL-2701 with an SEL communications processor offers a significant cost savings because you can use existing IEDs or purchase less expensive IEDs. For full details on applying the SEL-2701 with an SEL communications processor, see the *SEL-2701 Ethernet Processor Instruction Manual*.

The engineering connection can use either an Ethernet network connection through the SEL-2701 or a serial port connection. This versatility will accommodate the channel that is available between the station and the engineering center. SEL software can use either a serial port connection or an Ethernet network connection from an engineering workstation to the devices in the field.

Enhancing Multidrop Networks

You can also use an SEL communications processor to enhance a multidrop architecture similar to the one shown in *Figure C.3*. In this example, the SEL communications processor enhances a system that uses the SEL-2701 with an Ethernet HMI multidrop network. In the example, there are two Ethernet networks, the SCADA LAN and the Engineering LAN. The SCADA LAN provides real-time data directly to the SCADA Control Center via a protocol gateway and to the HMI (Human Machine Interface).

In this example, the SEL communications processor provides the following enhancements when compared to a system that employs only the multidrop network:

- ➤ Ethernet access for IEDs with serial ports
- ➤ Backup engineering access through the dial-in modem
- ➤ IRIG-B time signal distribution to all station IEDs
- ➤ Integration of IEDs without Ethernet
- ➤ Single point of access for real-time data for SCADA, HMI, and other uses
- ➤ Significant cost savings by use of existing IEDs with serial ports

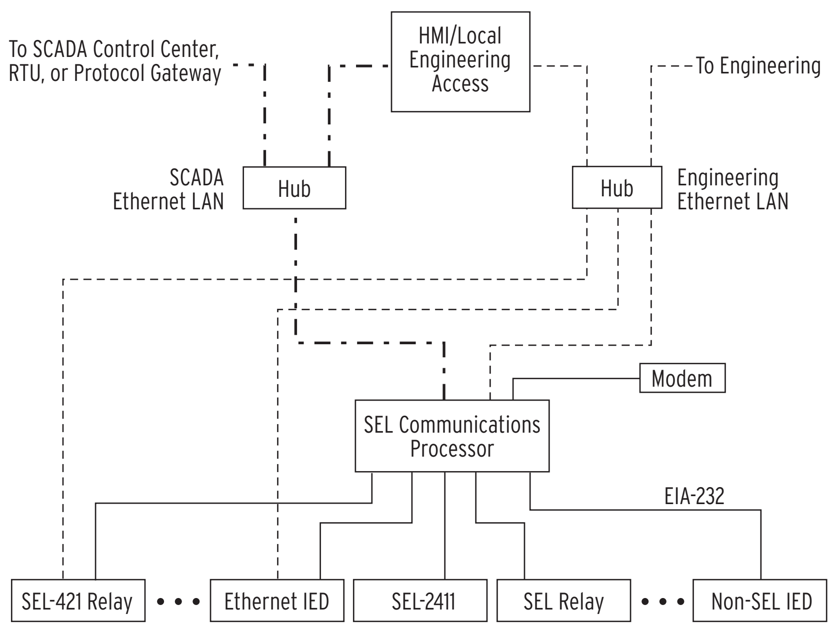


Figure C.3 Enhancing Multidrop Networks With SEL Communications Processors

SEL Communications Processor Example

This example demonstrates the data and control points available in the SEL communications processor when you connect an SEL-2411. The physical configuration used in this example is shown in *Figure C.4*.

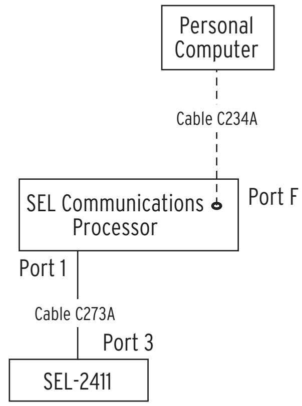


Figure C.4 Example SEL Device and SEL Communications Processor Configuration

Table C.4 shows the Port 1 settings for the SEL communications processor.

Table C.4 SEL Communications Processor Port 1 Settings

Setting Name	Setting	Description
DEVICE	S	Connected device is an SEL device
CONFIG	Y	Allow autoconfiguration for this device
PORTID	Device 1	Name of connected device[a]
BAUD	19200	Channel speed of 19200 bits per second[a]
DATABIT	8	Eight data bits[a]
STOPBIT	1	One stop bit
PARITY	N	No parity
RTS_CTS	N	Hardware flow control enabled
TIMEOUT	30	Idle timeout that terminates transparent connections of 30 seconds

[a] Automatically collected by the SEL communications processor during autoconfiguration.

Data Collection

The SEL communications processor is configured to collect data from the SEL-2411, using the list in *Table C.5*.

Table C.5 SEL Communications Processor Data Collection Auto-Messages

Message	Data Collected
20METER	Power system metering data (Binary)
20TARGET	Selected Device Word bit elements (Binary)
20HISTORY	History Command (CASCII)
20STATUS	Status Command (CASCII)

Table C.6 shows the SEL communications processor automessage (Set A) settings for data collection from the SEL-2411.

Table C.6 SEL Communications Processor Port 1 Automatic Messaging Settings

Setting Name	Setting	Description
AUTOBUF	Y	Save unsolicited messages
STARTUP	ACC\nOTTER\n	Automatically log-in at Access Level 1
SEND_OPER	Y	Send Fast Operate messages for remote bit control
REC_SER	N	Automatic sequential event recorder data collection disabled
NOCONN	NA	No SELOGIC® control equation entered to selectively block connections to this port
MSG_CNT	2	Two automessages
ISSUE1	P00:00:01.0	Issue Message 1 every second
MESG1	20METER	Collect metering data
ISSUE2	P00:00:01.0	Issue Message 2 every second
MESG2	20TARGET	Collect Device Word bit data
ARCH_EN	N	Archive memory
USER	0	No USER region registers reserved

Table C.7 shows the map of regions in the SEL communications processor for data collected from the SEL-2411. Use the **MAP *n*** command to view these data.

Table C.7 SEL Communications Processor Port 1 Region Map

Region	Data Collection Message Type	Region Name	Description
D1	Binary	METER	Device metering data
D2	Binary	TARGET	Device Word bit data
D3–D8	n/a	n/a	Unused
A1–A3	n/a	n/a	Unused
USER	n/a	n/a	Unused

Device Metering Data

Table C.8 shows the list of meter data available in the SEL communications processor and the location and data type for the memory areas within D1 (Data Region 1) for a device configured with both voltage (wye-connected) and current cards. The type field indicates the data type and size. The *int* type is a 16-bit integer. The *float* type is a 32-bit IEEE floating point number. Use the **VIE *n*:D1** (*n* = port number) command to view these data.

Table C.8 Communications Processor METER Region Map for Both Voltage (Wye-Delta Connected) and Current Cards (AVI and 4 CT)

Item	Starting Address	Type
_YEAR	2000h	int
DAY_OF_YEAR	2001h	int
TIME(ms)	2002h	Int[2]
MONTH	2004h	char
DATE	2005h	char
YEAR	2006h	char
HOUR	2007h	char
MIN	2008h	char
SECONDS	2009h	char
MSEC	200Ah	int
IA	200Bh	float
IB	200Dh	float
IC	200Fh	float
IN	2011h	float
IG	2013h	float
3I2	2015h	float
VA / VAB	2017h	float
VB / VBC	2019h	float
VC / VCA	201Bh	float
VG / (0 for delta)	201Dh	float
3V2	201Fh	float
P	2021h	float
Q	2023h	float
S	2025h	float
PF	2027h	float
FREQ	2029h	float

Table C.9 Communications Processor METER Region Map for Both Voltage (Wye-Connected) and Current Using the ACI/AVI Combination Input Card (Sheet 1 of 2)

Item	Starting Address	Type
_YEAR	2000h	int
DAY_OF_YEAR	2001h	int
TIME(ms)	2002h	Int[2]
MONTH	2004h	char
DATE	2005h	char
YEAR	2006h	char
HOUR	2007h	char

Table C.9 Communications Processor METER Region Map for Both Voltage (Wye-Connected) and Current Using the ACI/AVI Combination Input Card (Sheet 2 of 2)

Item	Starting Address	Type
MIN	2008h	char
SECONDS	2009h	char
MSEC	200Ah	int
IAX	200Bh	float
IBX	200Dh	float
ICX	200Fh	float
VA	2011h	float
VB	2013h	float
VC	2015h	float
VG	2017h	float
3V2	2019h	float
PX	201Bh	float
QX	201Dh	float
SX	201Fh	float
PFX	2021h	float
FREQ	2023h	float

Table C.10 Communications Processor SEL-2411 METER Region Map for Both Voltage (Wye-Connected) and Current Using the ACI/AVI Combination Input Card and an Additional Current Card (4 CT) (Sheet 1 of 2)

Item	Starting Address	Type
_YEAR	2000h	int
DAY_OF_YEAR	2001h	int
TIME(ms)	2002h	Int[2]
MONTH	2004h	char
DATE	2005h	char
YEAR	2006h	char
HOUR	2007h	char
MIN	2008h	char
SECONDS	2009h	char
MSEC	200Ah	int
IA	200Bh	float
IB	200Dh	float
IC	200Fh	float
IN	2011h	float
IG	2013h	float
312	2015h	float
IAX	2017h	float
IBX	2019h	float
ICX	201Bh	float

Table C.10 Communications Processor SEL-2411 METER Region Map for Both Voltage (Wye-Connected) and Current Using the ACI/AVI Combination Input Card and an Additional Current Card (4 CT) (Sheet 2 of 2)

Item	Starting Address	Type
VA	201Dh	float
VB	201Fh	float
VC	2021h	float
VG	2023h	float
3V2	2025h	float
P	2027h	float
Q	2029h	float
S	202Bh	float
PF	202Dh	float
PX	202Fh	float
QX	2031h	float
SX	2033h	float
PFX	2035h	float
FREQ	2037h	float

Table C.11 shows the list of SEL-2411 meter data available in the SEL communications processor and the location and data type for the memory areas within D1 (Data Region 1) for a device configured with voltage card only.

Table C.11 Communications Processor SEL-2411 METER Region Map for Voltage Cards Only (Wye-Delta Connected PTs)

Item	Starting Address	Type
_YEAR	2000h	int
DAY_OF_YEAR	2001h	int
TIME(ms)	2002h	Int[2]
MONTH	2004h	char
DATE	2005h	char
YEAR	2006h	char
HOUR	2007h	char
MIN	2008h	char
SECONDS	2009h	char
MSEC	200Ah	int
VA / VAB	200Bh	float
VB / VBC	200Dh	float
VC / VCA	200Fh	float
VG / (0 for delta)	2011h	float
3V2	2013h	float
FREQ	2015h	float

Table C.12 shows the list of SEL-2411 meter data available in the SEL communications processor and the location and data type for the memory areas within D1 (Data Region 1) for a device configured with current card only.

Table C.12 Communications Processor SEL-2411 METER Region Map for Current Cards Only

Item	Starting Address	Type
_YEAR	2000h	int
DAY_OF_YEAR	2001h	int
TIME(ms)	2002h	Int[2]
MONTH	2004h	char
DATE	2005h	char
YEAR	2006h	char
HOUR	2007h	char
MIN	2008h	char
SECONDS	2009h	char
MSEC	200Ah	int
IA	200Bh	float
IB	200Dh	float
IC	200Fh	float
IN	2011h	float
IG	2013h	float
3I2	2015h	float
FREQ	2017h	float

Device Word Bits Information

Table C.13 lists the Device Word bit data available in the SEL communications processor TARGET data region 2 (D2).

Table C.13 Communications Processor TARGET Region

Address	Device Word Bits (in Bits 7–0)							
	7	6	5	4	3	2	1	0
2804h				STSET				
2805h	See *Table H.1*, Row 0							
2806h	See *Table H.1*, Row 1							
2807h	See *Table H.1*, Row 2							
2808h	See *Table H.1*, Row 3							
2809h	See *Table H.1*, Row 4							
280Ah	See *Table H.1*, Row 5							
280Bh	See *Table H.1*, Row 6							
280Ch	See *Table H.1*, Row 6							
280Dh	See *Table H.1*, Row 8							
280Eh	See *Table H.1*, Row 9							
280Fh	See *Table H.1*, Row 10							
• • •	• • •							
2866h	See *Table H.1*, Row 119							

Control Points

The SEL communications processor can automatically pass control messages, called Fast Operate messages, to the SEL-2411. You must enable Fast Operate messages by using the FASTOP setting in the SEL-2411 port settings for the port connected to the SEL communications processor. You must also enable Fast Operate messages in the SEL communications processor by setting the automessage setting SEND_OPER equal to Y.

When you enable Fast Operate functions, the SEL communications processor automatically sends messages to the device for changes in remote bits RB1–RB16 on the corresponding SEL communications processor port. In this example, if you set RB1 on Port 1 in the SEL communications processor, it automatically sets RB1 in the SEL-2411.

There are no breaker bits in the SEL-2411.

SEL Communications Processor to SEL-2411 Unsolicited Write Remote Analog Example

From the perspective of the SEL-2411, Remote Analogs (RA01 through RA32) are specific, pre-allocated memory addresses. These memory addresses are available to accept and store values from remote devices such as an SEL-2032, SEL-2030, or SEL-2020 Communications Processor. Once these values from the remote devices are written into the memory addresses in the SEL-2411, you can use these values similar to any other analog quantity in the SEL-2411. When using the SEL communications processor to send the Remote Analogs to the SEL-2411, we use the Unsolicited Write setting string and send the information using the SEL Fast Message protocol. This example shows how to configure the Unsolicited Write message in the SEL communications processor to move data stored in the USER region of Port 6 of the SEL communications processor to an SEL-2411 connected to Port 3 of the SEL communications processor. We also show how to select the correct Remote Analog data type in the SEL-2411 to match the information in the Fast Message.

Although the SEL communications processor caters to static and dynamic data, this example uses static data in the SEL communications processor (entering the Unsolicited Write setting string is the same for static and dynamic data; see the SEL communications processor manual for dynamic data storing techniques). Assume the data is already stored in the USER region of Port 6 in the SEL communications processor. The Unsolicited Write message must be set in the Automatic messages on the SEL communications processor port to which the SEL-2411 is connected. Because the SEL-2411 is connected to Port 3 of the SEL communications processor, we use the Unsolicited Write Automatic (MESG1) message setting of Port 3 to build the Fast Message string, as shown in *Figure C.5* (see the SEL communications processor manual for in-depth discussions regarding the SEL communications processor Automatic message settings)

Setting the SEL Communications Processor

```
*>>SET A 3 <Enter>

Automatic message settings for Port 3


Save Unsolicited Messages (Y/N)              AUTOBUF = Y     ? <Enter>

Port Startup String
STARTUP ="?"
 ? <Enter>

Enable Automatic Sequential Events Recorder Collection (Y/N)REC_SER = N     ? <Enter>

Block external connections to this port
NOCONN  = NA
 ? <Enter>


Auto-message Settings

How many auto-message sequences (0-12)       MSG_CNT = 0     ? 1 <Enter>

Item 1 trigger D1
ISSUE1  = NA
 ? R1 <Enter>

Item 1 message
MESG1   = ""
 ? \W;06:USER:0000h;20,03:USER:0000h/ <Enter>


Archive Settings

Enable use of archive data items (Y/N)       ARCH_EN = N     ? END <Enter>

AUTOBUF = Y
STARTUP ="?"
REC_SER = N
NOCONN  = NA

MSG_CNT = 1

ISSUE1  = R1
MESG1   = "\W;06:USER:0000h;20,03:USER:0000h/"

ARCH_EN = N

USER    = 0

Save changes (Y/N) ? Y <Enter>

Port 3 Settings Changed


*>>
```

Figure C.5 Unsolicited Write Settings

The Unsolicited Write message string \W;06:USER:0000h;20,03:USER:0000h/ contains all the information necessary to send the remote analog data to the SEL-2411. Following is a discussion on the elements of the Unsolicited Write message string.

- **\W** indicates this is an Unsolicited Write Message
- **06:User:0000H** indicates where the data is stored in the SEL communications processor (06 is the User regions port number where the data is stored, the beginning of the User region starts at F800H on each port, 0000H indicates what register in the User region to start at).
- **;20** indicates how many 16-bit registers from the SEL communications processor User region to send.
- **,03:USER:** is an SEL communications processor Unsolicited Write message compatibility requirement. 03 is the SEL communications processor port the SEL-2411 is connected and the second parameter should always be USER, or F800h.

- **0000H/** indicates the first SEL-2411 Remote Analog to begin writing to (0000H = RA01 – 003EH = RA32)
- The \ and / frames the message.

See the SEL communications processor manual for more information regarding the Unsolicited Write message string.

Below are 16-bit register data that are stored in the User region of port 6 which we will send to the SEL-2411 on Port 3. Remember that F800H is synonymous with the start of the USER region in the SEL communications processor. One register stores one Integer and 2 registers store one Float or Long data type.

```
*>>VIE 6:F800h NR 20 <Enter>

6:F800h

7FFFh 8001h FFFFh 0000h 447Ah 25C3h C47Ah 270Ah
4516h B029h 4516h AFD7h 0001h 7FFFh FFFEh 8001h
FFFFh 6A00h FFFFh 0000h

Starting at register 0000h, the first 4 registers contain 4 Integer data values
7FFFh 8001h FFFFh 0000h

Starting at register 0004h the next 8 registers contain 4 Float data values
447Ah 25C3h C47Ah 270Ah 4516h B029h 4516h AFD7h

Starting at register 000Ch the next 8 registers contain 4 Long data Values.
0001h 7FFFh FFFEh 8001h FFFFh 6A00h FFFFh 0000h
```

Setting the SEL-2411

The SEL-2411 interprets Remote Analogs as Integer, Float, or Long data types. For correct remote analog data transfer, the data type sent from the SEL communications processor must match the data type of each of the SEL-2411 Remote Analogs. Use the RA*nn*TYPE settings (Report settings) to declare the Remote Analog type (I = Integer, F = Float, L = Long). Assume in our example we need only RA01 through RA12. In this example, we send 4 Integers, 4 Floats, and 4 Longs to the SEL-2411. *Figure C.6* shows the correct settings for RA01 through RA13 accordingly, starting at RA01.

```
=>>SET R TERSE <Enter>

Report

SER Chatter Criteria

Auto-Removal EN (N,Y)                         ESERDEL := N        ? <Enter>

SER Trigger Lists
SERn = Up to 24 Device-Word elements separated by spaces or commas.
Use NA to disable setting.


SER Trigger List SER1 (24 Device Word bits)
SER1    := NA
? <Enter>
SER Trigger List SER2 (24 Device Word bits)
SER2    := NA
? <Enter>
SER Trigger List SER3 (24 Device Word bits)
SER3    := NA
? <Enter>
SER Trigger List SER4 (24 Device Word bits)
SER4    := NA
? <Enter>

Event Report Set

Event Trigger (SELogic)
ER      := NA
? <Enter>
Event Length (15,64 cyc)                      LER     := 15       ? <Enter>
Prefault Length (OFF,1-10 cyc)                PRE     := 4        ? <Enter>

Fast Message Remote Analog Settings

Remote Analog Value Type (I,F,L)              RA01TYPE:= I        ? I <Enter>
Remote Analog Value Type (I,F,L)              RA02TYPE:= I        ? I <Enter>
Remote Analog Value Type (I,F,L)              RA03TYPE:= I        ? I <Enter>
Remote Analog Value Type (I,F,L)              RA04TYPE:= I        ? I <Enter>
Remote Analog Value Type (I,F,L)              RA05TYPE:= I        ? F <Enter>
Remote Analog Value Type (I,F,L)              RA06TYPE:= I        ? F <Enter>
Remote Analog Value Type (I,F,L)              RA07TYPE:= I        ? F <Enter>
Remote Analog Value Type (I,F,L)              RA08TYPE:= I        ? F <Enter>
Remote Analog Value Type (I,F,L)              RA09TYPE:= I        ? L <Enter>
Remote Analog Value Type (I,F,L)              RA10TYPE:= I        ? L <Enter>
Remote Analog Value Type (I,F,L)              RA11TYPE:= I        ? L <Enter>
Remote Analog Value Type (I,F,L)              RA12TYPE:= I        ? L <Enter>
Remote Analog Value Type (I,F,L)              RA13TYPE:= I        ? END <Enter>
Save changes (Y,N)? Y <Enter>
Settings Saved

=>>
```

Figure C.6 Setting Remote Analogs RA01 Through RA13

Now every time the ISSUE1 condition in the Automatic Messages on Port 3 is true, the SEL communications processor will send an Unsolicited Write message to the SEL-2411 and populate Remote Analogs 1–12 with the corresponding stored data in the SEL communications processor User region on Port 6.

Execute a **MET RA** or **CME RA** in the SEL-2411 to retrieve the Remote Analog data.

Appendix D

DNP3 Communications

Overview

The SEL-2411 Programmable Automation Controller (PAC) provides a Distributed Network Protocol Version 3.0 (DNP3) Level 2 Outstation interface for direct serial and LAN/WAN network connections to the device.

The DNP Users Group maintains and publishes DNP3 standards. See the DNP Users Group website, www.dnp.org, for more information on standards, implementers, and tools for working with DNP3.

Objects

DNP3 object types, commonly referred to as objects, specifies the type of data the object carries. An object can include a single value or more complex data.

If there can be more than one instance of an object type, then each instance has an index that makes it unique. Each object also includes multiple versions called variations. A master initiates all DNP3 message exchanges except unsolicited data, with all points described from the perspective of the master.

Function Codes

Each DNP3 message includes a function code. Each object has a limited set of function codes that a master may use to manipulate the object. The most common DNP3 function codes are listed in *Table D.1*.

Table D.1 Selected DNP3 Function Codes

Function Code	Function	Description
1	Read	Request data from the remote
2	Write	Send data to the remote
3	Select	First part of a select-before-operate operation
4	Operate	Second part of a select-before-operate operation
5	Direct operate	One-step operation with reply
6	Direct operate, no reply	One-step operation with no reply

Qualifier Codes and Ranges

DNP3 masters use qualifier codes and ranges to make requests for specific objects by index. Qualifier codes specify the style of range, and the range specifies the indices of the objects of interest. DNP3 masters use qualifier codes to compose the shortest, most concise message possible when requesting points from a DNP3 remote.

DNP3 in the SEL-2411

The PAC is a DNP3 Level 2 Outstation device. See *DNP3 Communications* for additional documentation describing DNP3.

Data Access

NOTE: Because unsolicited messaging is problematic in most circumstances, SEL recommends using the polled report-by-exception access method to maximize performance and minimize risk of configuration problems.

NOTE: In the settings below, the suffix n represents the DNP3 session number from 1 to 3. All settings with the same numerical suffix comprise the complete DNP3 session configuration.

Table D.2 lists DNP3 data access methods along with corresponding PAC settings. You must select a data access method and configure each DNP3 master for polling as specified.

Table D.2 DNP3 Access Methods

Access Method	Master Polling	SEL-2411 Settings
Polled static	Class 0	Set ECLASSB*n*, ECLASSC*n*, ECLASSA*n* to 0; UNSOL*n* to No
Polled report-by-exception	Class 0 occasionally, Class 1, 2, 3 frequently	Set ECLASSB*n*, ECLASSC*n*, ECLASSA*n* to the desired event class; UNSOL*n* to No
Unsolicited report-by-exception	Class 0 occasionally, optional Class 1, 2, 3 less frequently; mainly relies on unsolicited messages	Set ECLASSB*n*, ECLASSC*n*, ECLASSA*n* to the desired event class; set UNSOL*n* to Yes and PUNSOL*n* to Yes or No
Quiescent	Class 0, 1, 2, 3 never; relies completely on unsolicited messages	Set ECLASSB*n*, ECLASSC*n*, ECLASSA*n* to the desired event class; set UNSOL*n* and PUNSOL*n* to Yes.

If the master does not acknowledge the unsolicited data with an Application Confirm, the device will resend the data until it is acknowledged. It will wait for ETIMEO*n* seconds and then repeat the unsolicited message. In order to prevent clogging of the network with unsolicited data retries, the PAC uses the URETRY*n* and UTIMEO*n* settings to increase retry time when the number of retries set in URETRY*n* is exceeded. After URETRY*n* has been exceeded, the PAC pauses UTIMEO*n* seconds and then transmits the unsolicited data again. *Figure D.1* provides an example with URETRY*n* = 2.

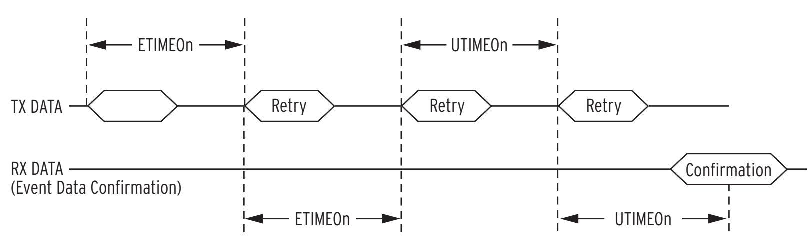


Figure D.1 Application Confirmation Timing With URETRY*n* = 2

Collision Avoidance

If your application uses unsolicited reporting on a serial network, you must select a half-duplex medium or a medium that includes carrier detection to avoid data collisions. EIA-485 two-wire networks are half-duplex. EIA-485 four-wire networks do not provide carrier detection, while EIA-232 systems can support carrier detection. DNP3 LAN/WAN uses features of the IP suite for collision avoidance.

The PAC uses Application Confirmation messages to guarantee delivery of unsolicited event data before erasing the local event data buffer. Data collisions are typically resolved when messages are repeated until confirmed.

The PAC pauses for a random delay between the settings MAXDLY and MINDLY when it detects a carrier through data on the receive line or the CTS pin. For example, if you use settings of 0.05 and 0.10 s, the PAC will insert a random delay of 50 to 100 ms as shown in *Figure D.2*.

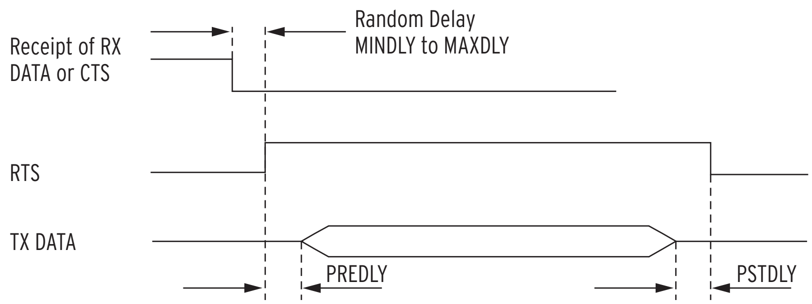


Figure D.2 Message Transmission Timing

Transmission Control

NOTE: PREDLY and POSTDLY settings are only available for EIA-232 and EIA-485 serial port sessions.

If you use a media transceiver (for example, EIA-232 to EIA-485) or a radio system for your DNP3 network, you may need to adjust data transmission properties. Use the PREDLY and POSTDLY settings to provide a delay between RTS signal control and data transmission (see *Figure D.2*). For example, an EIA-485 transceiver typically requires 10 to 20 ms to change from receive to transmit. If you set the pre-delay to 30 ms, you will avoid data loss resulting from data transmission beginning at the same time as RTS signal assertion.

Event Data

DNP3 event data objects contain change-of-state and time-stamp information that the PAC collects and stores in a buffer. Points assigned in the Binary Input Map that are also assigned in the Sequential Events Recorder (SER) settings carry the time stamp of actual occurrence. Binary input points not assigned in the SER settings will carry a time stamp based on the DNP map scan time. This may be significantly delayed from when the original source changed and should not be used for sequence-of-events determination. The DNP map is scanned approximately once per second to generate events. You can configure the PAC to either report the data without a polling request from the master (unsolicited data) or hold the data until the master requests it with an event poll message.

The PAC uses the NUMEVE*n* and AGEEVE*n* settings to decide when to send unsolicited data to the master. The device sends an unsolicited report when the total number of events accumulated in the event buffer for master *n* reaches NUMEVE*n*. The device also sends an unsolicited report if the age of the oldest event in the master *n* buffer exceeds AGEEVE*n*. The PAC has the buffer capacities listed in *Table D.3*.

Table D.3 PAC Event Buffer Capacity

Type	Maximum Number of Events
Binary	1024
Analog	100
Counters	32

Time Synchronization

By default, the PAC accepts and ignores time set requests (TIMERQ*n* = I). (This mode allows the PAC to use a high accuracy, IRIG time source, but still interoperate with DNP3 masters that send time synchronization messages.) It can be set to request time synchronization periodically by setting the TIMERQ*n* setting to the desired period. It can also be set to not request, but accept time synchronization (TIMERQ*n* = M).

Configurable Data Mapping

One of the most powerful features of the PAC implementation is the ability to remap DNP3 data and, for analog values, specify per-point scaling and dead bands. Remapping is the process of selecting data from the reference map and organizing it into a data subset optimized for your application. The PAC uses object and point labels, rather than point indices, to streamline the remapping process. This enables you to quickly create a custom map without having to search for each point index in a large reference map.

You may use any of the three available DNP3 maps simultaneously with up to three unique DNP3 masters. Each map is initially populated with default data points, as described in *Default Data Map on page D.11*.

Device Profile

Table D.4 contains the standard DNP3 device profile information. Rather than checkboxes in the example Device Profile in the DNP3 Subset Definitions, only the relevant selections are shown.

Table D.4 SEL-2411 DNP3 Device Profile (Sheet 1 of 2)

Parameter	Value
Vendor name	Schweitzer Engineering Laboratories
Device name	SEL-2411
Highest DNP request level	Level 2
Highest DNP response level	Level 2
Device function	Slave
Notable objects, functions, and/or qualifiers supported	Analog Dead-Band Objects (object 34)
Maximum data link frame size transmitted/ received (octets)	292
Maximum data link retries	Configurable, range 0–15
Requires data link layer confirmation	Configurable by setting
Maximum application fragment size transmitted/ received (octets)	2048
Maximum application layer retries	None
Requires application layer confirmation	When reporting Event Data
Data link confirm time-out	Configurable
Complete application fragment time-out	None
Application confirm time-out	Configurable
Complete Application response time-out	None
Executes control WRITE binary outputs	Always
Executes control SELECT/OPERATE	Always
Executes control DIRECT OPERATE	Always
Executes control DIRECT OPERATE-NO ACK	Always
Executes control count greater than 1	Never
Executes control Pulse On	Always
Executes control Pulse Off	Always
Executes control Latch Off	Always
Executes control Latch On	Always
Executes control Queue	Never
Executes control Clear Queue	Never
Reports binary input change events when no specific variation requested	Only time-tagged
Reports time-tagged binary input change events when no specific variation requested	Binary Input change with time
Sends unsolicited responses	Configurable with unsolicited message enable settings. Increases retry time (configurable) when a maximum retry setting is exceeded.

Table D.4 SEL-2411 DNP3 Device Profile (Sheet 2 of 2)

Parameter	Value
Sends static data in unsolicited responses	Never
Default counter object/variation	Object 20, Variation 6
Counter roll-over	16 bits
Sends multifragment responses	No

In response to the delay measurement function code, the SEL-2411 will return a time delay accurate to within 50 milliseconds.

Object List

Table D.5 lists the objects and variations with supported function codes and qualifier codes available in the SEL-2411. The list of supported objects conforms to the format laid out in the DNP specifications and includes both supported and unsupported objects. Those that are supported include the function and qualifier codes. The objects that are not supported are shown without any corresponding function and qualifier codes.

Table D.5 SEL-2411 DNP Object List (Sheet 1 of 4)

Obj.	Var.	Description	Request[a]		Response[b]	
			Funct. Codes[c]	Qual. Codes[d]	Funct. Codes[c]	Qual. Codes[d]
1	0	Binary Input—All Variations	1	0, 1, 6, 7, 8, 17, 28		
1	1	Binary Input	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
1	2[e]	Binary Input With Status	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
2	0	Binary Input Change—All Variations	1	6, 7, 8		
2	1	Binary Input Change Without Time	1	6, 7, 8	129	17, 28
2	2[e]	Binary Input Change With Time	1	6, 7, 8	129, 130	17, 28
2	3	Binary Input Change With Relative Time	1	6, 7, 8	129	17, 28
10	0	Binary Output—All Variations	1	0, 1, 6, 7, 8		
10	1	Binary Output				
10	2[e]	Binary Output Status	1	0, 1, 6, 7, 8	129	0, 1
12	0	Control Block—All Variations				
12	1	Control Relay Output Block	3, 4, 5, 6	17, 28	129	echo of request
12	2	Pattern Control Block				
12	3	Pattern Mask				
20[f]	0	Binary Counter—All Variations	1, 7, 8, 9, 10	0, 1, 6, 7, 8, 17, 28		
20	1	32-Bit Binary Counter	1, 7, 8, 9, 10	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
20	2	16-Bit Binary Counter	1, 7, 8, 9, 10	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
20	3	32-Bit Delta Counter				
20	4	16-Bit Delta Counter				
20	5	32-Bit Binary Counter Without Flag	1, 7, 8, 9, 10	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
20	6[e]	16-Bit Binary Counter Without Flag	1, 7, 8, 9, 10	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
20	7	32-Bit Delta Counter Without Flag				
20	8	16-Bit Delta Counter Without Flag				
21	0	Frozen Counter—All Variations	1	0, 1, 6, 7, 8, 17, 28	129	
21	1	32-Bit Frozen Counter	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
21	2	16-Bit Frozen Counter	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
21	3	32-Bit Frozen Delta Counter	1		129	
21	4	16-Bit Frozen Delta Counter	1		129	
21	5	32-Bit Frozen Counter With Time of Freeze	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
21	6	16-Bit Frozen Counter With Time of Freeze	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
21	7	32-Bit Frozen Delta Counter With Time of Freeze	1		129	

Table D.5 SEL-2411 DNP Object List (Sheet 2 of 4)

Obj.	Var.	Description	Request[a] Funct. Codes[c]	Request[a] Qual. Codes[d]	Response[b] Funct. Codes[c]	Response[b] Qual. Codes[d]
21	8	16-Bit Frozen Delta Counter With Time of Freeze	1		129	
21	9	32-Bit Frozen Counter Without Flag	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
21	10	16-Bit Frozen Counter Without Flag	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
21	11	32-Bit Frozen Delta Counter Without Flag				
21	12	16-Bit Frozen Delta Counter Without Flag				
22	0	Counter Change Event—All Variations	1	6, 7, 8		
22	1	32-Bit Counter Change Event Without Time	1	6, 7, 8	129	17, 28
22	2[e]	16-Bit Counter Change Event Without Time	1	6, 7, 8	129, 130	17, 28
22	3	32-Bit Delta Counter Change Event Without Time				
22	4	16-Bit Delta Counter Change Event Without Time				
22	5	32-Bit Counter Change Event With Time	1	6, 7, 8	129	17, 28
22	6	16-Bit Counter Change Event With Time	1	6, 7, 8	129	17, 28
22	7	32-Bit Delta Counter Change Event With Time				
22	8	16-Bit Delta Counter Change Event With Time				
23	0	Frozen Counter Event—All Variations	1	6, 7, 8		
23	1	32-Bit Frozen Counter Event Without Time	1	6, 7, 8	129	17, 28
23	2	16-Bit Frozen Counter Event Without Time	1	6, 7, 8	129, 130	17, 28
23	3	32-Bit Frozen Delta Counter Event Without Time				
23	4	16-Bit Frozen Delta Counter Event Without Time				
23	5	32-Bit Frozen Counter Event With Time	1	6, 7, 8	129	17, 28
23	6	16-Bit Frozen Counter Event With Time	1	6, 7, 8	129	17, 28
23	7	32-Bit Delta Counter Change Event With Time				
23	8	16-Bit Delta Counter Change Event With Time				
30	0	Analog Input—All Variations	1	0, 1, 6, 7, 8, 17, 28		
30	1	32-Bit Analog Input	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
30	2	16-Bit Analog Input	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
30	3	32-Bit Analog Input Without Flag	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
30	4[e]	16-Bit Analog Input Without Flag	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
30	5	Short Floating Point Analog Input	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
30	6	Long Floating Point Analog Input	1	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
31	0	Frozen Analog Input—All Variations				
31	1	32-Bit Frozen Analog Input				
31	2	16-Bit Frozen Analog Input				
31	3	32-Bit Frozen Analog Input With Time of Freeze				
31	4	16-Bit Frozen Analog Input With Time of Freeze				
31	5	32-Bit Frozen Analog Input Without Flag				
31	6	16-Bit Frozen Analog Input Without Flag				
31	7	Short Floating Point Frozen Analog Input				
31	8	Long Floating Point Frozen Analog Input				

Table D.5 SEL-2411 DNP Object List (Sheet 3 of 4)

Obj.	Var.	Description	Request[a] Funct. Codes[c]	Request[a] Qual. Codes[d]	Response[b] Funct. Codes[c]	Response[b] Qual. Codes[d]
32	0	Analog Change Event—All Variations	1	6, 7, 8		
32	1	32-Bit Analog Change Event Without Time	1	6, 7, 8	129	17, 28
32	2[e]	16-Bit Analog Change Event Without Time	1	6, 7, 8	129, 130	17, 28
32	3	32-Bit Analog Change Event With Time	1	6, 7, 8	129	17, 28
32	4	16-Bit Analog Change Event With Time	1	6, 7, 8	129	17, 28
32	5	Short Floating Point Analog Change Event	1	6, 7, 8	129	17, 28
32	6	Long Floating Point Analog Change Event	1	6, 7, 8	129	17, 28
32	7	Short Floating Point Analog Change Event With Time	1	6, 7, 8	129	17, 28
32	8	Long Floating Point Analog Change Event With Time	1	6, 7, 8	129	17, 28
33	0	Frozen Analog Event—All Variations				
33	1	32-Bit Frozen Analog Event Without Time				
33	2	16-Bit Frozen Analog Event Without Time				
33	3	32-Bit Frozen Analog Event With Time				
33	4	16-Bit Frozen Analog Event With Time				
33	5	Short Floating Point Frozen Analog Event				
33	6	Long Floating Point Frozen Analog Event				
33	7	Short Floating Point Frozen Analog Event With Time				
33	8	Long Floating Point Frozen Analog Event With Time				
34	0	Analog Deadband—All Variations				
34	1[e]	16-Bit Analog Input Reporting Deadband Object	1, 2	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
34	2	32-Bit Analog Input Reporting Deadband Object	1, 2	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
34	3	Floating Point Analog Input Reporting Deadband Object	1, 2	0, 1, 6, 7, 8, 17, 28	129	0, 1, 17, 28
40	0	Analog Output Status—All Variations	1	0, 1, 6, 7, 8	129	
40	1	32-Bit Analog Output Status	1	0, 1, 6, 7, 8	129	0, 1, 17, 28
40	2[e]	16-Bit Analog Output Status	1	0, 1, 6, 7, 8	129	0, 1, 17, 28
40	3	Short Floating Point Analog Output Status	1	0, 1, 6, 7, 8	129	0, 1, 17, 28
40	4	Long Floating Point Analog Output Status	1	0, 1, 6, 7, 8	129	0, 1, 17, 28
41	0	Analog Output Block—All Variations				
41	1	32-Bit Analog Output Block	3, 4, 5, 6	17, 28	129	echo of request
41	2[e]	16-Bit Analog Output Block	3, 4, 5, 6	17, 28	129	echo of request
41	3	Short Floating Point Analog Output Block	3, 4, 5, 6	17, 28	129	echo of request
50	0	Time and Date—All Variations				
50	1	Time and Date	1, 2	7, 8 index=0	129	07, quantity=1
50	2	Time and Date With Interval				
50	3	Time and Date Last Recorded	2	7, 8		
51	0	Time and Date CTO—All Variations				
51	1	Time and Date CTO				
51	2	Unsynchronized Time and Date CTO			129	07, quantity=1
52	0	Time Delay—All Variations				
52	1	Time Delay, Coarse				
52	2	Time Delay, Fine			129	7, quantity=1
60	0	All Classes of Data	1, 20, 21	6, 7, 8		
60	1	Class 0 Data	1, 20, 21	6, 7, 8		
60	2	Class 1 Data	1, 20, 21	6, 7, 8		

Table D.5 SEL-2411 DNP Object List (Sheet 4 of 4)

Obj.	Var.	Description	Request[a]		Response[b]	
			Funct. Codes[c]	Qual. Codes[d]	Funct. Codes[c]	Qual. Codes[d]
60	3	Class 2 Data	1, 20, 21	6, 7, 8		
60	4	Class 3 Data	1, 20, 21	6, 7, 8		
70	1	File Identifier				
70	2	Authentication Object				
70	3	File Command Object				
70	4	File Command Status Object				
70	5	File Transport Object				
70	6	File Transport Status Object				
70	7	File Descriptor Object				
80	1	Internal Indications	1, 2	0, 1 index=7		
81	1	Storage Object				
82	1	Device Profile				
83	1	Private Registration Object				
83	2	Private Registration Object Descriptor				
90	1	Application Identifier				
100	1	Short Floating Point				
100	2	Long Floating Point				
100	3	Extended Floating Point				
101	1	Small Packed Binary-Coded Decimal				
101	2	Medium Packed Binary-Coded Decimal				
101	3	Large Packed Binary-Coded Decimal				
110	all	Octet String				
111	all	Octet String Event				
112	All	Virtual Terminal Output Block	2	6	129	
113	All	Virtual Terminal Event Data	1	6	129, 130	17, 28
N/A		No object required for the following function codes:13 cold start14 warm start23 delay measurement	13, 14, 23			

[a] Supported in requests from master
[b] May generate in response to master
[c] Decimal
[d] Hexadecimal
[e] Default variation
[f] Qualifier 17 and 28 are not supported for freeze function codes 7, 8, 9, 10.

Reference Data Map

Table D.6 shows the SEL-2411 reference data map. The reference map shows the data available to a DNP3 master. You can use the default map or the custom DNP3 mapping functions of the SEL-2411 to retrieve only the points required by your application.

NOTE: Dead-band changes via Object 34 are not stored in nonvolatile memory. Make sure to reissue the Object 34 dead bands after a warm (**STA C**) or cold start (power cycle).

The SEL-2411 scales analog values by the indicated settings or fixed scaling indicated in the description. Analog dead bands for event reporting use the indicated settings, or ANADBM if you have not specified a setting.

Table D.6 DNP3 Reference Data Map[a] (Sheet 1 of 4)

Object	Labels	Description	
Binary Inputs			
01, 02	STFAIL	Device Diagnostic Failure	
01, 02	STWARN	Device Diagnostic Warning	
01, 02	STSET	Device Settings Changed Warning	
01, 02	Enabled–T06_LED	Device Word Elements, Row 0, Targets (See *Table H.1*)	
01, 02	PB01_LED to VB128	Device Word Elements, Row 1 to Row 119 (See *Table H.1*)	

Table D.6 DNP3 Reference Data Map[a] (Sheet 2 of 4)

Object	Labels	Description	
01, 02	PFL	Power Factor Leading for Three-Phase Currents	b
01, 02	PFLX	Power Factor Leading for Three-Phase Currents	c
01, 02	PFL_*x*	Power Factor Leading for Single-Phase Currents (*x* = A, B, and C)	b
01, 02	PFL_*x*X	Power Factor Leading for Single-Phase Currents (*x* = A, B, and C)	c
Binary Outputs			
10, 12	RB*xx*	Remote Bits (RB01 to RB32)	
Counters			
20, 22	SC*xx*	SELOGIC Counter Values (SC01 to SC32)	
Analog Inputs			
General Analog Inputs			
30, 32, 34	AI30*x*	Analog Inputs (AI301 to AI308)—Slot C	
30, 32, 34	AI40*x*	Analog Inputs (AI401 to AI408)—Slot D	
30, 32, 34	AI50*x*	Analog Inputs (AI501 to AI508)—Slot E	
30, 32, 34	AI60*x*	Analog Inputs (AI601 to AI608)—Slot Z	
30, 32, 34	RA*xxx*	Remote Analogs (RA001 to RA032)	
30, 32, 34	RA*xxx*	Remote Analogs (RA033 to RA064)	
30, 32, 34	RA*xxx*	Remote Analogs (RA065 to RA096)	
30, 32, 34	RA*xxx*	Remote Analogs (RA097 to RA128)	
30, 32, 34	INTRTD*xx*	Internal RTDs—Slot D	d
30, 32, 34	EXTRTD*xx*	External RTDs	e
30, 32, 34	INTEMP*xx*	Internal RTDs/TC from general purpose temp card (INTEMP01–INTEP10)—Slot D only	f
30, 32, 34	MV*xx*	Math Variables (MV01 to MV32)	
Fundamental Metering			
30, 32, 34	FREQ	Instantaneous, Frequency	c, g
30, 32, 34	V*x*_MAG	Instantaneous, Voltage Magnitude (x = A, B, C and G)	c, h
30, 32, 34	V*x*_ANG	Instantaneous, Voltage Angle (x = A, B, C and G)	c, h
30, 32, 34	3V2	Instantaneous, Negative-Sequence Voltage	c, h
30, 32, 34	I*x*_MAG	Instantaneous, Current Magnitude (x = A, B, C, N and G)	g
30, 32, 34	I*x*_ANG	Instantaneous, Current Angle (x = A, B, C, N and G)	g
30, 32, 34	P	Instantaneous, Three-Phase Real Power	b
30, 32, 34	Px	Instantaneous, Real Power (x = A, B and C)	b
30, 32, 34	Q	Instantaneous, Three-Phase Reactive Power	b
30, 32, 34	Q*x*	Instantaneous, Reactive Power (x = A, B and C)	b
30, 32, 34	S	Instantaneous, Three-Phase Apparent Power	b
30, 32, 34	S*x*	Instantaneous, Apparent Power (x = A, B and C)	b
30, 32, 34	PF	Instantaneous, Three-Phase Power Factor	b
30, 32, 34	PF*x*	Instantaneous, Power Factor (x = A, B and C)	b
30, 32, 34	3I2	Instantaneous, Current, Negative-Sequence	g
30, 32, 34	I*x*X_MAG	Instantaneous, Current Magnitude (x = A, B, C and G)	c
30, 32, 34	I*x*X_ANG	Instantaneous, Current Angle (x = A, B, C and G)	c
30, 32, 34	PX	Instantaneous, Three-Phase Real Power	c
30, 32, 34	P*x*X	Instantaneous, Real Power (x = A, B and C)	c
30, 32, 34	QX	Instantaneous, Three-Phase Reactive Power	c
30, 32, 34	Q*x*X	Instantaneous, Reactive Power (x = A, B and C)	c
30, 32, 34	SX	Instantaneous, Three-Phase Apparent Power	c
30, 32, 34	S*x*X	Instantaneous, Apparent Power (x = A, B and C)	c
30, 32, 34	PFX	Instantaneous, Three-Phase Power Factor	c
30, 32, 34	PF*x*X	Instantaneous, Power Factor (x = A, B and C)	c
30, 32, 34	3I2X	Instantaneous, Current, Negative-Sequence	c

Table D.6 DNP3 Reference Data Map[a] (Sheet 3 of 4)

Object	Labels	Description	
Demand Metering			
30, 32, 34	I*x*D	Demand, Current Magnitude (x = A, B, C, N and G)	g
30, 32, 34	3I2D	Demand, Current, Negative Sequence	g
30, 32, 34	I*x*XD	Demand, Current Magnitude X (x = A, B, C and G)	c
30, 32, 34	3I2XD	Demand, Current, Negative Sequence X	c
Peak Demand Metering			
30, 32, 34	I*x*PD	Peak Demand, Current Magnitude (x = A, B, C, N and G)	g
30, 32, 34	3I2PD	Peak Demand, Current, Negative Sequence	g
30, 32, 34	I*x*XPD	Peak Demand, Current Magnitude X (x = A, B, C and G)	c
30, 32, 34	3I2XPD	Peak Demand, Current, Negative Sequence X	c
Energy Metering			
30, 32, 34	MWH3PI	Energy, Real (MWh), In: energy flow towards busbar	b
30, 32, 34	MQH3PI	Energy, Reactive (MVArh) In	b
30, 32, 34	MSH3PI	Energy, Apparent (MVAh) In	b
30, 32, 34	MWH3PO	Energy, Real (MWh), Out: energy flow from busbar away	b
30, 32, 34	MQH3PO	Energy, Reactive (MVArh) Out	b
30, 32, 34	MSH3PO	Energy, Apparent (MVAh) Out	b
30, 32, 34	MWH3PIX	Energy, Real (MWh) In	c
30, 32, 34	MQH3PIX	Energy, Reactive X (MVArh) In	c
30, 32, 34	MSH3PIX	Energy, Apparent X (MVAh) In	c
30, 32, 34	MWH3POX	Energy, Real X (MWh) Out	c
30, 32, 34	MQH3POX	Energy, Reactive X (MVArh) Out	c
30, 32, 34	MSH3POX	Energy, Apparent X (MVAh) Out	c
Maximum Metering			
30, 32, 34	FREQMX	Maximum Frequency	c, g
30, 32, 34	V*x*MX	Maximum, Voltage (x = A, B and C)	c, h
30, 32, 34	V*xx*MX	Maximum, Voltage (xx = AB, BC and CA)	c, h
30, 32, 34	I*x*MX	Maximum, Current Magnitude (x = A, B, C, N and G)	g
30, 32, 34	3I2MX	Maximum, Current, Negative Sequence	g
30, 32, 34	KS3PMX	Maximum, Apparent Power	b
30, 32, 34	KW3PMX	Maximum, Real Power	b
30, 32, 34	KQ3PMX	Maximum, Reactive Power	b
30, 32, 34	I*x*XMX	Maximum, Current Magnitude X (x = A, B, C and G)	c
30, 32, 34	3I2XMX	Maximum, Current, Negative Sequence X	c
30, 32, 34	KS3PXMX	Maximum, Apparent Power X	c
30, 32, 34	KW3PXMX	Maximum, Real Power X	c
30, 32, 34	KQ3PXMX	Maximum, Reactive Power X	c
Minimum Metering			
30, 32, 34	FREQMN	Minimum Frequency	c, g
30, 32, 34	V*x*MN	Minimum, Voltage (x = A, B and C)	c, h
30, 32, 34	V*xx*MN	Minimum, Voltage (xx = AB, BC and CA)	c, h
30, 32, 34	I*x*MN	Minimum, Current Magnitude (x = A, B, C, N and G)	g
30, 32, 34	3I2MN	Minimum, Current, Negative Sequence	g
30, 32, 34	KS3PMN	Minimum, Apparent Power	b
30, 32, 34	KW3PMN	Minimum, Real Power	b
30, 32, 34	KQ3PMN	Minimum, Reactive Power	b
30, 32, 34	I*x*XMN	Minimum, Current Magnitude X (x = A, B, C and G)	c
30, 32, 34	3I2XMN	Minimum, Current, Negative Sequence X	c
30, 32, 34	KS3PXMN	Minimum, Apparent Power X	c
30, 32, 34	KW3PXMN	Minimum, Real Power X	c
30, 32, 34	KQ3PXMN	Minimum, Reactive Power X	c

Table D.6 DNP3 Reference Data Map[a] (Sheet 4 of 4)

Object	Labels	Description	
Analog Outputs			
40, 41	RA*xxx*	Remote Analogs (RA001 to RA032)	
40, 41	RA*xxx*	Remote Analogs (RA033 to RA064)	
40, 41	RA*xxx*	Remote Analogs (RA065 to RA096)	
40, 41	RA*xxx*	Remote Analogs (RA097 to RA128)	

[a] Although not shown as part of the reference maps, you may use any Device Word bit label when creating custom maps.
[b] Valid data only if 4 CT and 3 PT cards are installed in Slots E and Z respectively.
[c] Valid data only if 3 CT/3 PT card is installed in Slot E.
[d] Valid data only if 10 RTD card is installed in Slot D.
[e] Valid data only if SEL-2600 Device is connected via fiber port.
[f] Valid data only if 10 RTD/TC card is intalled in Slot D.
[g] Valid data only if 4 CT card is installed in Slot Z.
[h] Valid data only if 3 PT card is installed in Slot E.

Default Data Map

The default data map is an automatically generated subset of the reference map. All data maps are initialized to the default values, based on the SEL-2411 part number. *Table D.7* shows the SEL-2411 default data map. If the default maps are not appropriate, you can also use the custom DNP mapping commands **SET DN** and **SHOW DN** to create the map required for your application.

Table D.7 DNP3 Default Data Map

Object	Default Index	Point Label
01, 02	0	ENABLED
	1	T01_LED
	2	T02_LED
	3	T03_LED
	4	T04_LED
	5	T05_LED
	6	T06_LED
	7	STFAIL
	8	STWARN
	9	IN101
	10	IN102
	11–200	A portion of these binary inputs can have default values as described in the Binary Inputs section. Outside that scope, they contain the value NA.
10, 12	0–31	RB01–RB32 Remote Bits
20, 22	0–7	SC01–SC08 Counters
	8–31	NA
30, 32, 34	0–200	Analog inputs have default values as described in the Analog Inputs section. Outside that scope, they contain the value NA.
40, 41	0–31	RA001–RA008 Remote Analogs

Binary Inputs

The SEL-2411 dynamically creates the default Binary Input map after you issue an R_S command. The SEL-2411 uses the Part Number to determine the presence of Digital Input cards in slots 3, 4, 5, and 6. If present, each digital input point label, IN*x*01–IN*x*08 (where *x* is the slot number), is added to the default map in numerical order.

Analog Inputs

NOTE: Dead-band changes via Object 34 are stored in nonvolatile memory. Make sure to reissue the Object 34 dead bands after a warm (STA C) or cold start (power cycle).

The SEL-2411 dynamically creates the default Analog Input map after you issue an R_S command. The SEL-2411 uses the Part Number to determine the presence of Analog Input cards in slots 3, 4, 5, and 6. If present, the SEL-2411 adds each analog input point label, AI*x*0*y* (where *x* is the slot and *y* is the point number), to the default map in numerical order. The SEL-2411 then looks for a Current Card, and if it finds one, adds IA_MAG, IB_MAG, IC_MAG, and IN_MAG to the DNP map. Then, the SEL-2411 checks for a voltage card, and if one is installed, adds VA_MAG, VB_MAG, and VC_MAG to the default DNP map. The firmware will check to determine if an internal RTD card exists, and if one does exist, INTRTD01–10 is added to the default DNP map. Lastly, the firmware will check to determine if an internal general purpose RTD/TC card exists. If one does exist, INTEMP01–INTEP10 is added to the default DNP map.

Binary and Analog Outputs

The default binary output data map is populated with the RB01–RB32 point labels. Similarly, point labels RA001–RA008 fill the first 8 positions in the default analog output data map.

Control Point Operation

You can define any two RB points as a pair for Trip/Close or Code Selection operations with Object 12 control device output block command messages. The SEL-2411 assigns some special operations to the code portion of the control device output block command. The example in *Table D.8* demonstrates how you may use this functionality for both paired and non-paired points. Because the SEL-2411 allows only one control bit to be pulsed at a time, you should send consecutive control bits in consecutive messages. Pulse operations provide a pulse with duration of one protection-processing interval.

Table D.8 Example Object 12 Trip/Close or Code Selection Operation

Control Points	Trip / Close		Code Selection Operation			
	Close (0x4X)	Trip (0x8X)	Latch On (3)	Latch Off (4)	Pulse On (1)	Pulse Off (2)
RB01:RB02	PULSE ON RB02	PULSE ON RB01	PULSE ON RB02	PULSE ON RB01	PULSE ON RB02	PULSE ON RB01
RB03	SET RB03	CLEAR RB03	SET RB03	CLEAR RB03	SET RB03	CLEAR RB03
RB04	SET RB04	CLEAR RB04	SET RB04	CLEAR RB04	SET RB04	CLEAR RB04
RB05:RB06	PULSE ON RB06	PULSE ON RB05	PULSE ON RB06	PULSE ON RB05	PULSE ON RB06	PULSE ON RB05
RB07	SET RB07	CLEAR RB07	SET RB07	CLEAR RB07	SET RB07	CLEAR RB07
RB08	SET RB08	CLEAR RB08	SET RB08	CLEAR RB08	SET RB08	CLEAR RB08
RB14:RB15	PULSE ON RB15	PULSE ON RB14	PULSE ON RB15	PULSE ON RB14	PULSE ON RB15	PULSE ON RB14
RB18:RB21	PULSE ON RB21	PULSE ON RB18	PULSE ON RB21	PULSE ON RB18	PULSE ON RB21	PULSE ON RB18

Appendix E
Modbus Communications

Overview

This appendix describes Modbus® RTU and Modbus TCP communications features supported by the SEL-2411 (PAC). Complete specifications for the Modbus protocol are available from the Modbus website at www.modbus.org.

Modbus TCP is automatically available with the Ethernet port. Modbus TCP uses the device IP address as the Modbus identifier and accesses the data in the PAC using the same function codes and data maps as Modbus RTU. The TCP port for Modbus TCP is 502.

Modbus Queries

Modbus RTU master devices initiate all exchanges by sending a query. The SEL-2411 SLAVEID setting defines the device address. Set this value to a unique number for each device on the Modbus network. For Modbus communication to operate properly, each slave device must have a different address.

Modbus Responses

The slave device sends a response message after it performs the action the query specifies. If the slave device cannot execute the query command for any reason, it sends an error response. Otherwise the slave device response is formatted similarly to the query and includes the slave address, function code, data (if applicable), and a cyclical redundancy check value.

Supported Modbus Function Codes

The SEL-2411 supports the Modbus function codes shown in *Table E.1*.

Table E.1 SEL-2411 Modbus Function Codes

Codes	Modbus Description	Device Description
01h	Read Discrete Output Coil Status	Read the status of the digital output and remote bits.
02h	Read Discrete Input Status	Read the status of the digital inputs.
03h	Read Holding Registers	Read data from the Modbus map.
04h	Read Input Register	Read data from the Modbus map similarly to function code 03.
05h[a]	Force Single Coil	Control the status of the digital outputs and remote bits.
06h[a]	Preset Single Register	Write data directly to a single register in the Modbus map.
08h	Diagnostic Command	Test the Modbus communications channel.
10h[a]	Preset Multiple Register	Preset Multiple Register.

[a] The SEL-2411 supports the Broadcast function on these functions.

Function Code Details

01h Read Discrete Output Coil Status Command

Use function code 01h to read the On/Off status of the selected bits (coils) (see the Modbus Register Map shown in *Table E.15*). Note that the SEL-2411 coil addresses start at 0 (e.g., Coil 1 is located at address zero). The coil status is packed one coil per bit of the data field. The Least Significant Bit (LSB) of the first data byte contains the starting coil address in the query. The other coils follow towards the high order end of this byte and from low order to high order in subsequent bytes.

To build the response, the SEL-2411 calculates the number of bytes required to contain the number of bits requested. If the number of bits requested is not evenly divisible by eight, the device adds one more byte to maintain the balance of bits, padded by zeroes to make an even byte. *Table E.2* includes the coil number and lists all possible coils (identified as Outputs and Remote bits) available in the device. Note that the command depends on the device hardware configuration; the device responds only to installed cards.

Table E.2 01h SEL-2411 Outputs

Coil Address in Decimal	Coil Address in Hex	Function Code Supported	Coil Description	Note
0	0	01h	OUT101	
1	1	01h	OUT102	
2	2	01h	OUT103	
3–10	3–0A	01h	OUT301–OUT308	a
11–18	B–12	01h	OUT401–OUT408	a
19–26	13–1A	01h	OUT501–OUT508	a
27–34	1B–22	01h	OUT601–OUT608	a
35–50	23–32	01h	RB01–RB16	
51–66	33–42	01h	RB17–RB32	

[a] Returns 0 if not installed.

The device responses to errors in the query are shown in *Table E.3*.

Table E.3 Response to 01h Read Discrete Output Coil Status Query Errors

Error	Error Code Returned	Communication Counter Increments
Invalid bit to read	Illegal Data Address (02h)	Invalid Address
Invalid number of bits to read	Illegal Data Value (03h)	Illegal Register
Format error	Illegal Data Value (03h)	Bad Packet Format

02 Read Input Status Command

Use function code 02h to read the On/Off status of the selected bits (inputs). You can read the status of as many as 2000 bits per query. Note that input addresses start at 0 (e.g., Input 1 is located at address zero). The input status is packed one input per bit of the data field. The LSB of the first data byte contains the starting input address in the query. The other inputs follow towards the high order end of this byte, and from low order to high order in subsequent bytes.

To build the response, the device calculates the number of bytes required to contain the number of bits requested. If the number of bits requested is not evenly divisible by eight, the device adds one more byte to maintain the balance of bits, padded by zeroes to make an even byte.

In each row, the input numbers are assigned from the right-most input to the left-most input (i.e., Input 1 is N and Input 8 is EN). Input addresses start at 0000 (i.e., Input 1 is located at Input Address 0000). *Table E.4* includes the coil address in decimal and hex and lists all possible inputs (Device Word bits) available in the device. Note that the command depends on the device hardware configuration; the device responds only to installed cards. The device responses to errors in the query are shown in *Table E.5*.

Table E.4 SEL-2411 Inputs

Coil Address in Decimal	Coil Address in Hex	Function Code Supported	Coil Description	Notes
0–7	0–7	02h	Device Element Status Row 0	The input numbers are assigned from the right-most input to the left-most input in the device row as shown in an example below. Address 7 = Enabled Address 6 = * Address 5 = T01_LED Address 4 = T02_LED Address 3 = T03_LED Address 2 = T04_LED Address 1 = T05_LED Address 0 = T06_LED
8–15	8–F	02h	Device Element Status Row 1	
16–959	10–3BF	02h	Device Element Status Row 2–119[a]	

[a] Returns 0 if associated hardware is not installed.

Table E.5 Responses to 02h Read Input Query Errors

Error	Error Code Returned	Communication Counter Increments
Invalid bit to read	Illegal Data Address (02h)	Invalid Address
Invalid number of bits to read	Illegal Data Value (03h)	Illegal Register
Format Error	Illegal Data Value (03h)	Bad Packet Format

03h Read Holding Register Command

Use function code 03h to read directly from the Modbus Register Map shown in *Table E.15*.

You can read a maximum of 125 registers at once with this function code. Most masters use 4X references with this function code. For five-digit addressing, add 40001 to the standard database address.

The device responses to errors in the query are shown in *Table E.6*.

Table E.6 Responses to 03h Read Holding Registry Query Errors

Error	Error Code Returned	Communication Counter Increments
Invalid register to read	Illegal Data Address (02h)	Invalid Address
Invalid number of registers to read	Illegal Data Value (03h)	Illegal Register
Format Error	Illegal Data Value (03h)	Bad Packet Format

04h Read Input Register Command

Use function code 04h to read directly from the Modbus Register Map shown in *Table E.15*. You can read a maximum of 125 registers at once with this function code. Most masters use 4X references with this function code. For five-digit addressing, add 40001 to the standard database address.

The device responses to errors in the query are shown in *Table E.7*.

Table E.7 Responses to 04h Read Holding Registry Query Errors

Error	Error Code Returned	Communication Counter Increments
Invalid register to read	Illegal Data Address (02h)	Invalid Address
Invalid number of registers to read	Illegal Data Value (03h)	Illegal Register
Format Error	Illegal Data Value (03h)	Bad Packet Format

05h Force Single Coil Command

Use function code 05h to set or clear a coil. In *Table E.8*, the command response is identical to the command request.

Table E.8 lists the coil numbers supported by the SEL-2411. The physical coils (coils 1–34) are self-resetting. Pulsing a Set remote bit (decimal address 68 through 99) causes the remote bit to be cleared at the end of the pulse.

Table E.8 05 Force Single Coil Command

Coil Address in Decimal	Coil Address in Hex	Function Code Supported	Coil Description
0–34	0–22	05h	Pulse OUT101–OUT608 1 second
35–66	23–42	05h	RB01–RB32
67–98	43–62	05h	Pulse RB01–RB32 (1 SELOGIC Processing Interval)

Coil addresses start at 0000 (i.e., Coil 1 is located at Coil address 0000). If the device is disabled it will respond with error code 4 (Device Error). In addition to Error Code 4, the device responses to errors in the query are shown in *Table E.9*.

Table E.9 Responses to 05h Force Single Coil Query Errors

Error	Error Code Returned	Communication Counter Increments
Invalid bit (coil) to read	Illegal Data Address (02h)	Invalid Address
Invalid bit state requested	Illegal Data Value (03h)	Illegal Register
Format Error	Illegal Data Value (03h)	Bad Packet Format

06h Preset Single Register Command

The SEL-2411 uses this function to allow a Modbus master to write directly to a database register. Refer to the Modbus Register Map in *Table E.15* for a list of registers that can be written by using this function code. For six-digit addressing, add 400001 to the standard database addresses.

The device responses to errors in the query are shown in *Table E.10*.

Table E.10 Responses to 06h Preset Single Register Query Errors

Error	Error Code Returned	Communication Counter Increments
Invalid register address	Illegal Data Address (02h)	Invalid Address Illegal Write
Illegal register value	Illegal Data Value (03h)	Illegal Write
Format Error	Illegal Data Value (03h)	Bad Packet Format

10h Preset Multiple Registers Command

This function code works much like code 06h, except that it allows you to write multiple registers at once, up to 100 per operation. For six-digit addressing, simply add 400001 to the standard database addresses.

The device responds to errors in the query as shown in *Table E.11*.

Table E.11 10h Preset Multiple Register Query Error Messages

Error	Error Code Returned	Communication Counter Increments
Illegal register to set	Illegal Data Address (02h)	Invalid Address Illegal Write
Illegal number of registers to set	Illegal Data Value (03h)	Illegal Register Illegal Write
Incorrect number of bytes in query data region	Illegal Data Value (03h)	Bad Packet Format Illegal Write
Invalid register data value	Illegal Data Value (03h)	Illegal Write

Reading History Data Using Modbus

Through use of the Modbus Register Map (*Table E.15*), you can download a complete history of the last five events via Modbus. The history contains the date and time stamp, type of event that triggered the report, currents, and voltages at the time of the event. Refer to the Historical Data section in the map.

To use Modbus to download history data, write the event number (1–5) to the EVENT LOG SEL register at address 0176h. Then read the history of the specific event number you requested from the registers shown in the Historical Data section of the Modbus Register Map (*Table E.15*).

Controlling Output Contacts and Remote Bits Using Modbus

The SEL-2411 Modbus Register Map (*Table E.15*) includes three fields that allow a Modbus master to force the device to perform a variety of operations. Use Modbus function codes 06h or 10h to write the appropriate command codes and parameters into the registers shown in *Table E.12*. If function code 06h is used to write to a command code that has parameters, the parameters must be written before the command code. After issuing a command, parameters 1 and 2 are cleared and must be rewritten prior to the next command. *Table E.12* defines the command codes in decimal and hex and their functions and associated parameter(s).

Table E.12 Device Outputs

Command Code in Decimal	Command Code in Hex	Function	Parameter 1	Parameter 2
1	1	Reset Targets	N/A	N/A
2	2	Trigger	N/A	N/A
3–5	3–5	Pulse OUT101–OUT103	[a]	N/A
6–13	6–D	Pulse OUT301–OUT308	[a]	N/A
14–21	E–15	Pulse OUT401–OUT408	[a]	N/A
22–29	16–1D	Pulse OUT501–OUT508	[a]	N/A
30–37	1E–25	Pulse OUT601–OUT608	[a]	N/A
38	26	Reset Data Regions	[b]	N/A
39	27	Control Remote Bits 1–16	[c]	[d]
40	28	Control Remote Bits 17–32	[c]	[d]
41	29	Reset Demand	N/A	N/A
42	2A	Reset Peak Demand	N/A	N/A
43	2B	Reset Energy	N/A	N/A
44	2C	Reset Min/Max	N/A	N/A

[a] Pulse output for 1–30 s, default is 1 s.
[b] This parameter determines the type of operation with the following values: 01—History Buffer, 02—SER, 03—Modbus Communication Counters.
[c] This parameter determines the type of operation with the following values: 01 Set, 02 Clear, 03 Pulse (one processing interval).
[d] This parameter is bitmasked for the remote bits. If more than one bit occurs in the parameter, then the highest numbered bit will be controlled. For example, for a parameter 2 value of 0003h, only RB02 will be controlled.

Table E.13 SEL-2411 Modbus Command Region

Parameter 2 for Command Code 39	Parameter 2 for Command Code 40
0000 0000 0000 0001—RB01	0000 0000 0000 0001—RB17
0000 0000 0000 0010—RB02	0000 0000 0000 0010—RB18
0000 0000 0000 0100—RB03	0000 0000 0000 0100—RB19
0000 0000 0000 1000—RB04	0000 0000 0000 1000—RB20
0000 0000 0001 0000—RB05	0000 0000 0001 0000—RB21
0000 0000 0010 0000—RB06	0000 0000 0010 0000—RB22
0000 0000 0100 0000—RB07	0000 0000 0100 0000—RB23
0000 0000 1000 0000—RB08	0000 0000 1000 0000—RB24
0000 0001 0000 0000—RB09	0000 0001 0000 0000—RB25
0000 0010 0000 0000—RB10	0000 0010 0000 0000—RB26
0000 0100 0000 0000—RB11	0000 0100 0000 0000—RB27
0000 1000 0000 0000—RB12	0000 1000 0000 0000—RB28
0001 0000 0000 0000—RB13	0001 0000 0000 0000—RB29
0010 0000 0000 0000—RB14	0010 0000 0000 0000—RB30
0100 0000 0000 0000—RB15	0100 0000 0000 0000—RB31
1000 0000 0000 0000—RB16	1000 0000 0000 0000—RB32

Table E.14 shows the Modbus Command Region.

Table E.14 SEL-2411 Modbus Command Region

Decimal Address	HEX Address	Function Code Supported	Field
2000	7D0	06h, 10h	Parameter 2
2001	7D1	06h, 10h	Parameter 1
2002	7D2	06h, 10h	Command Code

Conversion Table

One way to present data in a suitable range and resolution is to scale the data before transmission, normally by dividing or multiplying by powers of 10. Use the information in *Table E.16* to convert the units of the received data into the appropriate scale for further processing or display.

Modbus Register Map

Table E.15 Modbus Register Map (Sheet 1 of 15)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
Device ID								
0–21	00–15	03h, 04h	12				FID Char (1–44)	
22–43	16–2B	03h, 04h	12				BFID Char (1–44)	
44–45	2C–2D	03h, 04h	12				CID Char (1–4)	
46–53	2E–35	03h, 04h	12				DEVID Char (1–16)	
54	36	03h, 04h	1				DEVCODE	
55–64	37–40	03h, 04h	12				Part Number Char (1–20)	
65–67	41–43	03h, 04h	12				Config (1–6)	
68–149	44–95	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	
Device Status								
150	96	03h, 04h	0	0	1		IA Status 0-OK, 1-WARN	
151	97	03h, 04h	0	0	1		IB Status 0-OK, 1-WARN	
152	98	03h, 04h	0	0	1		IC Status 0-OK, 1-WARN	
153	99	03h, 04h	0	0	1		IN Status 0-OK, 1-WARN	
154	9A	03h, 04h	0	0	1		VA Status 0-OK, 1-WARN	
155	9B	03h, 04h	0	0	1		VB Status 0-OK, 1-WARN	
156	9C	03h, 04h	0	0	1		VC Status 0-OK, 1-WARN	
157	9D	03h, 04h	0	8000	8000	8000	Reserved = 8000 Hex	
158	9E	03h, 04h	0	0	1		FPGA Status 0-OK, 2-FAIL	
159	9F	03h, 04h	0	0	1		GPSB Status 0-OK, 2-FAIL	
160	A0	03h, 04h	0	0	1		HMI Status 0-OK, 1-WARN	
161	A1	03h, 04h	0	0	1		RAM Status 0-OK, 2-FAIL	
162	A2	03h, 04h	0	0	1		ROM Status 0-OK, 2-FAIL	
163	A3	03h, 04h	0	0	1		CR_RAM Status 0-OK, 2-FAIL	
164	A4	03h, 04h	0	0	1		NON_VOL Status 0-OK, 2-FAIL	
165	A5	03h, 04h	0	0	1		CLK_BAT Status 0-OK, 1-WARN	

Table E.15 Modbus Register Map (Sheet 2 of 15)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
166	A6	03h, 04h	0	0	1		CLOCK Status 0-OK, 1-WARN	
167	A7	03h, 04h	0	0	1		CARD C Status 0-OK, 2-FAIL	
168	A8	03h, 04h	0	0	1		CARD D Status 0-OK, 2-FAIL	
169	A9	03h, 04h	0	0	1		CARD E Status 0-OK, 2-FAIL	
170	AA	03h, 04h	0	0	1		CARD Z Status 0-OK, 2-FAIL	
171	AB	03h, 04h	0	0	1		ENABLED 0-Enabled, 2-Disabled	
172	AC	03h, 04h	0	0	1		IAX Status 0-OK, 1-Warn	
173	AD	03h, 04h	0	0	1		IBX Status 0-OK, 1-Warn	
174	AE	03h, 04h	0	0	1		ICX Status 0-OK, 1-Warn	
175	AF	03h, 05h	0	0	1		INTRTD or INTEMP Status 0-OK, 2-Fail	
176	B0	03h, 04h	0	0	1		EXTRTD Status 0-OK, 2-Fail	
177	B1	03h, 04h	0	0	1		CID FILE Status 0-OK, 2-Fail	
178	B2	03h, 04h	0	0	1		3.3V Status 0-OK, 1-Warn, 2-Fail	
179	B3	03h, 04h	0	0	1		5.0V Status 0-OK, 1-Warn, 2-Fail	
180	B4	03h, 04h	0	0	1		2.5V Status 0-OK, 1-Warn, 2-Fail	
181	B5	03h, 04h	0	0	1		3.75V Status 0-OK, 1-Warn, 2-Fail	
182	B6	03h, 04h	0	0	1		-1.25V Status 0-OK, 1-Warn, 2-Fail	
183	B7	03h, 04h	0	0	1		-5.0V Status 0-OK, 1-Warn, 2-Fail	
184	B8	03h, 04h	0	0	1		0.9V Status 0-OK, 1-Warn, 2-Fail	
185	B9	03h, 04h	0	0	1		1.2V Status 0-OK, 1-Warn, 2-Fail	
186	BA	03h, 04h	0	0	1		1.5V Status 0-OK, 1-Warn, 2-Fail	
187	BB	03h, 04h	0	0	1		1.8V Status 0-OK, 1-Warn, 2-Fail	
188–199	BC–C7	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	
Current Data								
200	C8	03h, 04h	1	0	65535	0	IA Magnitude	A
201	C9	03h, 04h	7	–1800	1800	0	IA Angle	Deg
202	CA	03h, 04h	1	0	65535	0	IB Magnitude	A
203	CB	03h, 04h	7	–1800	1800	0	IB Angle	Deg
204	CC	03h, 04h	1	0	65535	0	IC Magnitude	A
205	CD	03h, 04h	7	–1800	1800	0	IC Angle	Deg
206	CE	03h, 04h	1	0	65535	0	IN Magnitude	A
207	CF	03h, 04h	7	–1800	1800	0	IN Angle	deg
208	D0	03h, 04h	1	0	65535	0	IG Magnitude	A

Table E.15 Modbus Register Map (Sheet 3 of 15)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
209	D1	03h, 04h	7	–1800	1800	0	IG Angle	deg
210	D2	03h, 04h	1	0	65535	0	3I2 Magnitude	A
211	D3	03h, 04h	1	0	65535	0	IAX Magnitude	A
212	D4	03h, 04h	7	-1800	1800	0	IAX Angle	deg
213	D5	03h, 04h	1	0	65535	0	IBX Magnitude	A
214	D6	03h, 04h	7	-1800	1800	0	IBX Angle	deg
215	D7	03h, 04h	1	0	65535	0	ICX Magnitude	A
216	D8	03h, 04h	7	-1800	1800	0	ICX Angle	deg
217	D9	03h, 04h	1	0	65535	0	IGX Magnitude	A
218	DA	03h, 04h	7	-1800	1800	0	IGX Angle	deg
219	DB	03h, 04h	1	0	65535	0	312X Magnitude	A
220–249	D3–F9	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	
Voltage Data								
250	FA	03h, 04h	13	0	5200000	0	VAB Magnitude—UW[a]	V
251	FB	03h, 04h				0	VAB Magnitude—LW[b]	V
252	FC	03h, 04h	7	–1800	1800	0	VAB Angle	deg
253	FD	03h, 04h	13	0	5200000	0	VBC Magnitude—UW	V
254	FE	03h, 04h				0	VBC Magnitude—LW	V
255	FF	03h, 04h	7	–1800	1800	0	VBC Angle	deg
256	100	03h, 04h	13	0	5200000	0	VCA Magnitude—UW	V
257	101	03h, 04h				0	VCA Magnitude—LW	V
258	102	03h, 04h	7	–1800	1800	0	VCA Angle	deg
259	103	03h, 04h	13	0	5200000	0	VAN Magnitude—UW	V
260	104	03h, 04h				0	VAN Magnitude—LW	V
261	105	03h, 04h	7	–1800	1800	0	VAN Angle	deg
262	106	03h, 04h	13	0	5200000	0	VBN Magnitude—UW	V
263	107	03h, 04h				0	VBN Magnitude—LW	V
264	108	03h, 04h	7	–1800	1800	0	VBN Angle	deg
265	109	03h, 04h	13	0	5200000	0	VCN Magnitude—UW	V
266	10A	03h, 04h				0	VCN Magnitude—LW	V
267	10B	03h, 04h	7	–1800	1800	0	VCN Angle	deg
268	10C	03h, 04h	13	0	5200000	0	VG Magnitude—UW	V
269	10D	03h, 04h				0	VG Magnitude—LW	V
270	10E	03h, 04h	7	–1800	1800	0	VG Angle	deg
271	10F	03h, 04h	13	0	5200000	0	3V2 Magnitude—UW	V
272	110	03h, 04h				0	3V2 Magnitude—LW	V
273–299	111–12B	03h, 04h	5	8000	8000	0	Reserved = 8000 Hex	
Power Data								
300	12C	03h, 04h	13	–200000000	200000000	0	Real Power—UW	kW
301	12D	03h, 04h					Real Power—LW	kW
302	12E	03h, 04h	13	–200000000	200000000	0	Reactive Power—UW	kVAR
303	12F	03h, 04h				0	Reactive Power—LW	kVAR
304	130	03h, 04h	13	–200000000	200000000	0	Apparent Power—UW	kVA
305	131	03h, 04h				0	Apparent Power—LW	kVA
306	132	03h, 04h	8	–100	100	0	Phase A Power Factor	
307	133	03h, 04h	13	–200000000	200000000	0	Phase B Real Power—UW	kW
308	134	03h, 04h				0	Phase B Real Power—LW	kW
309	135	03h, 04h	13	–200000000	200000000	0	Phase B Reactive Power—UW	kVAR
310	136	03h, 04h				0	Phase B Reactive Power—LW	kVAR

Table E.15 Modbus Register Map (Sheet 4 of 15)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
311	137	03h, 04h	13	–200000000	200000000	0	Phase B Apparent Power—UW	kVA
312	138	03h, 04h				0	Phase B Apparent Power—LW	kVA
313	139	03h, 04h	8	–100	100	0	Phase B Power Factor	
314	13A	03h, 04h	13	–200000000	200000000	0	Phase C Real Power—UW	kW
315	13B	03h, 04h				0	Phase C Real Power—LW	kW
316	13C	03h, 04h	13	–200000000	200000000	0	Phase C Reactive Power—UW	kVAR
317	13D	03h, 04h				0	Phase C Reactive Power—LW	kVAR
318	13E	03h, 04h	13	–200000000	200000000	0	Phase C Apparent Power—UW	kVA
319	13F	03h, 04h				0	Phase C Apparent Power—LW	kVA
320	140	03h, 04h	8	–100	100	0	Phase C Power Factor	
321	141	03h, 04h	13	–200000000	200000000	0	3 Phase Real Power—UW	kW
322	142	03h, 04h				0	3 Phase Real Power—LW	kW
323	143	03h, 04h	13	–200000000	200000000	0	3 Phase Reactive Power—UW	kVAR
324	144	03h, 04h				0	3 Phase Reactive Power—LW	kVAR
325	145	03h, 04h	13	–200000000	200000000	0	3 Phase Apparent Power—UW	kVA
326	146	03h, 04h				0	3 Phase Apparent Power—LW	kVA
327	147	03h, 04h	8	–100	100	0	3 Phase Power Factor	
328	148	03h, 04h	13	–200000000	200000000	0	Phase A Real PowerX^c—UW	kW
329	149	03h, 04h				0	Phase A Real PowerX^c—LW	kW
330	14A	03h, 04h	13	–200000000	200000000	0	Phase A Reactive PowerX^c—UW	kVAR
331	14B	03h, 04h				0	Phase A Reactive PowerX^c—LW	kVAR
332	14C	03h, 04h	13	–200000000	200000000	0	Phase A Apparent PowerX^c—UW	kVA
333	14D	03h, 04h				0	Phase A Apparent PowerX^c—LW	kVA
334	14E	03h, 04h	8	–100	100	0	Phase A PowerX^c Factor	
335	14F	03h, 04h	13	–200000000	200000000	0	Phase B Real PowerX^c—UW	kW
336	150	03h, 04h				0	Phase B Real PowerX^c—LW	kW
337	151	03h, 04h	13	–200000000	200000000	0	Phase B Reactive PowerX^c—UW	kVAR
338	152	03h, 04h				0	Phase B Reactive PowerX^c—LW	kVAR
339	153	03h, 04h	13	–200000000	200000000	0	Phase B Apparent PowerX^c—UW	kVA
340	154	03h, 04h				0	Phase B Apparent PowerX^c—LW	kVA
341	155	03h, 04h	8	–100	100	0	Phase B PowerX^c Factor	

Table E.15 Modbus Register Map (Sheet 5 of 15)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
342	156	03h, 04h	13	–200000000	200000000	0	Phase C Real PowerX^c—UW	kW
343	157	03h, 04h				0	Phase C Real PowerX^c—LW	kW
344	158	03h, 04h	13	–200000000	200000000	0	Phase C Reactive Pow-erX^c—UW	kVAR
345	159	03h, 04h				0	Phase C Reactive Pow-erX^c—LW	kVAR
346	15A	03h, 04h	13	–200000000	200000000	0	Phase C Apparent Pow-erX^c—UW	kVA
347	15B	03h, 04h				0	Phase C Apparent Pow-erX^c—LW	kVA
348	15C	03h, 04h	8	–100	100	0	Phase C PowerX^c Factor	
349	15D	03h, 04h	13	–200000000	200000000	0	3 Phase Real PowerX^c—UW	kW
350	15E	03h, 04h				0	3 Phase Real PowerX^c—LW	kW
351	15F	03h, 04h	13	–200000000	200000000	0	3 Phase Reactive PowerX^c—UW	kVAR
352	160	03h, 04h				0	3 Phase Reactive PowerX^c—LW	kVAR
353	161	03h, 04h	13	–200000000	200000000	0	3 Phase Apparent Pow-erX^c—UW	kVA
354	162	03h, 04h				0	3 Phase Apparent Pow-erX^c—LW	kVA
355	163	03h, 04h	8	-100	100	0	3 Phase PowerX^c Factor	
356–379	164–17B	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	
Frequency								
380	17C	03h, 04h	7	440	660	600	Frequency	Hz
381–399	17D–18F	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	
Historical Data								
400	190	03h, 04h	1	0	30	0	Number of Event Records	
401	191	03h, 04h, 06h, 10h	1	0	30	0	Event Summary Record Selected	
402	192	03h, 04h	3	0	5999	0	Event Time ss.ss	
403	193	03h, 04h	1	0	59	0	Event Time mm	
404	194	03h, 04h	1	0	23	0	Event Time hh	
405	195	03h, 04h	1	1	31	1	Event Day DD	
406	196	03h, 04h	1	1	12	1	Event Month MM	
407	197	03h, 04h	1	0	2999	0	Event Year YYYY	
408	198	03h, 04h	10	0	2	0	Event Type 0 = No Event 1 = Trigger 2 = ER Trigger	
409	199	03h, 04h	3	4400	6600		Event Frequency	Hz
410	19A	03h, 04h	1	0	65535	0	Event IA	A
411	19B	03h, 04h	1	0	65535	0	Event IB	A
412	19C	03h, 04h	1	0	65535	0	Event IC	A
413	19D	03h, 04h	1	0	65535	0	Event IN	A
414	19E	03h, 04h	13	0	5200000	0	Event VAB/VAN—UW	V
415	19F	03h, 04h				0	Event VAB/VAN—LW	V
416	1A0	03h, 04h	13	0	5200000	0	Event VBC/VBN—UW	V

Table E.15 Modbus Register Map (Sheet 6 of 15)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
417	1A1	03h, 04h				0	Event VBC/VBN—LW	V
418	1A2	03h, 04h	13	0	5200000	0	Event VCA/VCN—UW	V
419	1A3	03h, 04h				0	Event VCA/VCN—LW	V
420	1A4	03h, 04h	10	0	1	0	0 = Delta 1 = Wye	
421	1A5	03h, 04h	16	–2147483648	+2147483647	0	Event AI301—UW	EU[d]
422	1A6	03h, 04h				0	Event AI301—LW	EU
423	1A7	03h, 04h	16	–2147483648	+2147483647	0	Event AI302—UW	EU
424	1A8	03h, 04h				0	Event AI302—LW	EU
425	1A9	03h, 04h	16	–2147483648	+2147483647	0	Event AI303—UW	EU
426	1AA	03h, 04h				0	Event AI303—LW	EU
427	1AB	03h, 04h	16	–2147483648	+2147483647	0	Event AI304—UW	EU
428	1AC	03h, 04h				0	Event AI304—LW	EU
429	1AD	03h, 04h	16	–2147483648	+2147483647	0	Event AI305—UW	EU
430	1AE	03h, 04h				0	Event AI305—LW	EU
431	1AF	03h, 04h	16	–2147483648	+2147483647	0	Event AI306—UW	EU
432	1B0	03h, 04h				0	Event AI306—LW	EU
433	1B1	03h, 04h	16	–2147483648	+2147483647	0	Event AI307—UW	EU
434	1B2	03h, 04h				0	Event AI307—LW	EU
435	1B3	03h, 04h	16	–2147483648	+2147483647	0	Event AI308—UW	EU
436	1B4	03h, 04h				0	Event AI308—LW	EU
437	1B5	03h, 04h	16	–2147483648	+2147483647	0	Event AI401—UW	EU
438	1B6	03h, 04h				0	Event AI401—LW	EU
439	1B7	03h, 04h	16	–2147483648	+2147483647	0	Event AI402—UW	EU
440	1B8	03h, 04h				0	Event AI402—LW	EU
441	1B9	03h, 04h	16	–2147483648	+2147483647	0	Event AI403—UW	EU
442	1BA	03h, 04h				0	Event AI403—LW	EU
443	1BB	03h, 04h	16	–2147483648	+2147483647	0	Event AI404—UW	EU
444	1BC	03h, 04h				0	Event AI404—LW	EU
445	1BD	03h, 04h	16	–2147483648	+2147483647	0	Event AI405—UW	EU
446	1BE	03h, 04h				0	Event AI405—LW	EU
447	1BF	03h, 04h	16	–2147483648	+2147483647	0	Event AI406- UW	EU
448	1C0	03h, 04h				0	Event AI406—LW	EU
449	1C1	03h, 04h	16	–2147483648	+2147483647	0	Event AI407—UW	EU
450	1C2	03h, 04h				0	Event AI407—LW	EU
451	1C3	03h, 04h	16	–2147483648	+2147483647	0	Event AI408—UW	EU
452	1C4	03h, 04h				0	Event AI408—LW	EU
453	1C5	03h, 04h	16	–2147483648	+2147483647	0	Event AI501—UW	EU
454	1C6	03h, 04h				0	Event AI501—LW	EU
455	1C7	03h, 04h	16	–2147483648	+2147483647	0	Event AI502—UW	EU
456	1C8	03h, 04h				0	Event AI502—LW	EU
457	1C9	03h, 04h	16	–2147483648	+2147483647	0	Event AI503—UW	EU
458	1CA	03h, 04h				0	Event AI503—LW	EU
459	1CB	03h, 04h	16	–2147483648	+2147483647	0	Event AI504—UW	EU
460	1CC	03h, 04h				0	Event AI504—LW	EU
461	1CD	03h, 04h	16	–2147483648	+2147483647	0	Event AI505—UW	EU
462	1CE	03h, 04h				0	Event AI505—LW	EU
463	1CF	03h, 04h	16	–2147483648	+2147483647	0	Event AI506—UW	EU
464	1D0	03h, 04h				0	Event AI506—LW	EU
465	1D1	03h, 04h	16	–2147483648	+2147483647	0	Event AI507—UW	EU
466	1D2	03h, 04h				0	Event AI507—LW	EU

Table E.15 Modbus Register Map (Sheet 7 of 15)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
467	1D3	03h, 04h	16	–2147483648	+2147483647	0	Event AI508—UW	EU
468	1D4	03h, 04h				0	Event AI508—LW	EU
469	1D5	03h, 04h	16	–2147483648	+2147483647	0	Event AI601—UW	EU
470	1D6	03h, 04h				0	Event AI601—LW	EU
471	1D7	03h, 04h	16	–2147483648	+2147483647	0	Event AI602—UW	EU
472	1D8	03h, 04h				0	Event AI602—LW	EU
473	1D9	03h, 04h	16	–2147483648	+2147483647	0	Event AI603—UW	EU
474	1DA	03h, 04h				0	Event AI603—LW	EU
475	1DB	03h, 04h	16	–2147483648	+2147483647	0	Event AI604—UW	EU
476	1DC	03h, 04h				0	Event AI604—LW	EU
477	1DD	03h, 04h	16	–2147483648	+2147483647	0	Event AI605—UW	EU
478	1DE	03h, 04h				0	Event AI605—LW	EU
479	1DF	03h, 04h	16	–2147483648	+2147483647	0	Event AI606—UW	EU
480	1E0	03h, 04h				0	Event AI606—LW	EU
481	1E1	03h, 04h	16	–2147483648	+2147483647	0	Event AI607—UW	EU
482	1E2	03h, 04h				0	Event AI607—LW	EU
483	1E3	03h, 04h	16	–2147483648	+2147483647	0	Event AI608—UW	EU
484	1E4	03h, 04h				0	Event AI608—LW	EU
485	1E5	03h, 04h	16	–2147483648	+2147483647	0	Event AO301—UW	EU
486	1E6	03h, 04h				0	Event AO301—LW	EU
487	1E7	03h, 04h	16	–2147483648	+2147483647	0	Event AO302—UW	EU
488	1E8	03h, 04h				0	Event AO302—LW	EU
489	1E9	03h, 04h	16	–2147483648	+2147483647	0	Event AO303—UW	EU
490	1EA	03h, 04h				0	Event AO303—LW	EU
491	1EB	03h, 04h	16	–2147483648	+2147483647	0	Event AO304—UW	EU
492	1EC	03h, 04h				0	Event AO304—LW	EU
493	1ED	03h, 04h	16	–2147483648	+2147483647	0	Event AO401—UW	EU
494	1EE	03h, 04h				0	Event AO401—LW	EU
495	1EF	03h, 04h	16	–2147483648	+2147483647	0	Event AO402—UW	EU
496	1F0	03h, 04h				0	Event AO402—LW	EU
497	1F1	03h, 04h	16	–2147483648	+2147483647	0	Event AO403—UW	EU
498	1F2	03h, 04h				0	Event AO403—LW	EU
499	1F3	03h, 04h	16	–2147483648	+2147483647	0	Event AO404—UW	EU
500	1F4	03h, 04h				0	Event AO404—LW	EU
501	1F5	03h, 04h	16	–2147483648	+2147483647	0	Event AO501—UW	EU
502	1F6	03h, 04h				0	Event AO501—LW	EU
503	1F7	03h, 04h	16	–2147483648	+2147483647	0	Event AO502—UW	EU
504	1F8	03h, 04h				0	Event AO502—LW	EU
505	1F9	03h, 04h	16	–2147483648	+2147483647	0	Event AO503—UW	EU
506	1FA	03h, 04h				0	Event AO503—LW	EU
507	1FB	03h, 04h	16	–2147483648	+2147483647	0	Event AO504—UW	EU
508	1FC	03h, 04h				0	Event AO504—LW	EU
509	1FD	03h, 04h	16	–2147483648	+2147483647	0	Event AO601—UW	EU
510	1FE	03h, 04h				0	Event AO601—LW	EU
511	1FF	03h, 04h	16	–2147483648	+2147483647	0	Event AO602—UW	EU
512	200	03h, 04h				0	Event AO602—LW	EU
513	201	03h, 04h	16	–2147483648	+2147483647	0	Event AO603—UW	EU
514	202	03h, 04h				0	Event AO603—LW	EU
515	203	03h, 04h	16	–2147483648	+2147483647	0	Event AO604—UW	EU
516	204	03h, 04h				0	Event AO604—LW	EU
517	205	03h, 04h	1	0	65535	0	Event IAX	A

Table E.15 Modbus Register Map (Sheet 8 of 15)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
518	206	03h, 04h	1	0	65535	0	Event IBX	A
519	207	03h, 04h	1	0	65535	0	Event ICX	A
520-549	208-225	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	
Analog Inputs								
550	226	03h, 04h	16	–2147483648	+2147483648	0	AI301—UW	EU
551	227	03h, 04h				0	AI301—LW	EU
552	228	03h, 04h	16	–2147483648	+2147483648	0	AI302—UW	EU
553	229	03h, 04h				0	AI302—LW	EU
554	22A	03h, 04h	16	–2147483648	+2147483648	0	AI303—UW	EU
555	22B	03h, 04h				0	AI303—LW	EU
556	22C	03h, 04h	16	–2147483648	+2147483648	0	AI304—UW	EU
557	22D	03h, 04h				0	AI304—LW	EU
558	22E	03h, 04h	16	–2147483648	+2147483648	0	AI305—UW	EU
559	22F	03h, 04h				0	AI305—LW	EU
560	230	03h, 04h	16	–2147483648	+2147483648	0	AI306—UW	EU
561	231	03h, 04h				0	AI306—LW	EU
562	232	03h, 04h	16	–2147483648	+2147483648	0	AI307—UW	EU
563	233	03h, 04h				0	AI307—LW	EU
564	234	03h, 04h	16	–2147483648	+2147483648	0	AI308—UW	EU
565	235	03h, 04h				0	AI308—LW	EU
566	236	03h, 04h	16	–2147483648	+2147483648	0	AI401—UW	EU
567	237	03h, 04h				0	AI401—LW	EU
568	238	03h, 04h	16	–2147483648	+2147483648	0	AI402—UW	EU
569	239	03h, 04h				0	AI402—LW	EU
570	23A	03h, 04h	16	–2147483648	+2147483648	0	AI403—UW	EU
571	23B	03h, 04h				0	AI403—LW	EU
572	23C	03h, 04h	16	–2147483648	+2147483648	0	AI404—UW	EU
573	23D	03h, 04h				0	AI404—LW	EU
574	23E	03h, 04h	16	–2147483648	+2147483648	0	AI405—UW	EU
575	23F	03h, 04h				0	AI405—LW	EU
576	240	03h, 04h	16	–2147483648	+2147483648	0	AI406—UW	EU
577	241	03h, 04h				0	AI406—LW	EU
578	242	03h, 04h	16	–2147483648	+2147483648	0	AI407—UW	EU
579	243	03h, 04h				0	AI407—LW	EU
580	244	03h, 04h	16	–2147483648	+2147483648	0	AI408—UW	EU
581	245	03h, 04h				0	AI408—LW	EU
582	246	03h, 04h	16	–2147483648	+2147483648	0	AI501—UW	EU
583	247	03h, 04h				0	AI501—LW	EU
584	248	03h, 04h	16	–2147483648	+2147483648	0	AI502—UW	EU
585	249	03h, 04h				0	AI502—LW	EU
586	24A	03h, 04h	16	–2147483648	+2147483648	0	AI503—UW	EU
587	24B	03h, 04h				0	AI503—LW	EU
588	24C	03h, 04h	16	–2147483648	+2147483648	0	AI504—UW	EU
589	24D	03h, 04h				0	AI504—LW	EU
590	24E	03h, 04h	16	–2147483648	+2147483648	0	AI505—UW	EU
591	24F	03h, 04h				0	AI505—LW	EU
592	250	03h, 04h	16	–2147483648	+2147483648	0	AI506—UW	EU
593	251	03h, 04h				0	AI506—LW	EU
594	252	03h, 04h	16	–2147483648	+2147483648	0	AI507—UW	EU
595	253	03h, 04h				0	AI507—LW	EU
596	254	03h, 04h	16	–2147483648	+2147483648	0	AI508—UW	EU

Table E.15 Modbus Register Map (Sheet 9 of 15)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
597	255	03h, 04h				0	AI508—LW	EU
598	256	03h, 04h	16	–2147483648	+2147483648	0	AI601—UW	EU
599	257	03h, 04h				0	AI601—LW	EU
600	258	03h, 04h	16	–2147483648	+2147483648	0	AI602—UW	EU
601	259	03h, 04h				0	AI602—LW	EU
602	25A	03h, 04h	16	–2147483648	+2147483648	0	AI603—UW	EU
603	25B	03h, 04h				0	AI603—LW	EU
604	25C	03h, 04h	16	–2147483648	+2147483648	0	AI604—UW	EU
605	25D	03h, 04h				0	AI604—LW	EU
606	25E	03h, 04h	16	–2147483648	+2147483648	0	AI605—UW	EU
607	25F	03h, 04h				0	AI605—LW	EU
608	260	03h, 04h	16	–2147483648	+2147483648	0	AI606—UW	EU
609	261	03h, 04h				0	AI606—LW	EU
610	262	03h, 04h	16	–2147483648	+2147483648	0	AI607—UW	EU
611	263	03h, 04h				0	AI607—LW	EU
612	264	03h, 04h	16	–2147483648	+2147483648	0	AI608—UW	EU
613	265	03h, 04h				0	AI608—LW	EU
614-649	266-289	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	
RTDs								
							Values for RTDs	
							Typically –50 to 250°C	
							0x7FFF	Open
							0x8000	Short
							0x7FFC	Comm Fail
							0x7FF8	Stat Fail
							0x7FFE	Fail
							0x7FF0	Not Attached
650	28A	03h, 04h	1	-32768	32767	0	INTRTD01	deg C
651	28B	03h, 04h	1	-32768	32767	0	INTRTD02	deg C
652	28C	03h, 04h	1	-32768	32767	0	INTRTD03	deg C
653	28D	03h, 04h	1	-32768	32767	0	INTRTD04	deg C
654	28E	03h, 04h	1	-32768	32767	0	INTRTD05	deg C
655	28F	03h, 04h	1	-32768	32767	0	INTRTD06	deg C
656	290	03h, 04h	1	-32768	32767	0	INTRTD07	deg C
657	291	03h, 04h	1	-32768	32767	0	INTRTD08	deg C
658	292	03h, 04h	1	-32768	32767	0	INTRTD09	deg C
659	293	03h, 04h	1	-32768	32767	0	INTRTD10	deg C
660	294	03h, 04h	1	-32768	32767	0	EXTRTD01	deg C
661	295	03h, 04h	1	-32768	32767	0	EXTRTD02	deg C
662	296	03h, 04h	1	-32768	32767	0	EXTRTD03	deg C
663	297	03h, 04h	1	-32768	32767	0	EXTRTD04	deg C
664	298	03h, 04h	1	-32768	32767	0	EXTRTD05	deg C
665	299	03h, 04h	1	-32768	32767	0	EXTRTD06	deg C
666	29A	03h, 04h	1	-32768	32767	0	EXTRTD07	deg C
667	29B	03h, 04h	1	-32768	32767	0	EXTRTD08	deg C
668	29C	03h, 04h	1	-32768	32767	0	EXTRTD09	deg C
669	29D	03h, 04h	1	-32768	32767	0	EXTRTD10	deg C
670	29E	03h, 04h	1	-32768	32767	0	EXTRTD011	deg C
671	29F	03h, 04h	1	-32768	32767	0	EXTRTD12	deg C
672	2A0	03h, 04h	6	–32768	32767	0	INTEMP01	deg C

Table E.15 Modbus Register Map (Sheet 10 of 15)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
673	2A1	03h, 04h	6	–32768	32767	0	INTEMP02	deg C
674	2A2	03h, 04h	6	–32768	32767	0	INTEMP03	deg C
675	2A3	03h, 04h	6	–32768	32767	0	INTEMP04	deg C
676	2A4	03h, 04h	6	–32768	32767	0	INTEMP05	deg C
677	2A5	03h, 04h	6	–32768	32767	0	INTEMP06	deg C
678	2A6	03h, 04h	6	–32768	32767	0	INTEMP07	deg C
679	2A7	03h, 04h	6	–32768	32767	0	INTEMP08	deg C
680	2A8	03h, 04h	6	–32768	32767	0	INTEMP09	deg C
681	2A9	03h, 04h	6	–32768	32767	0	INTEMP10	deg C
682-699	2AA–2BB	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	
Math Variables								
700–731	2BC–2DB	03h, 04h	15	–1677721599	+1677721599	0	MV01 [0: UW], [1: LW] to MV16 [0: UW], [1: LW]	
732–763	2DC–2FB	03h, 04h	15	–1677721599	+1677721599	0	MV17 [0: UW], [1: LW] to MV32 [0: UW], [1: LW]	
764–899	2FC–383	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	
Device Counters								
900–915	384–393	03h, 04h	1	0	65000	0	SC01–SC16	
916–931	394–3A3	03h, 04h	1	0	65000	0	SC17–SC32	
932–949	3A4–3B5	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	
Device Date/Time								
950	3B6	03h, 04h, 06h, 10h	3	0	59		ss	
951	3B7	03h, 04h, 06h, 10h	1	0	59		mm	
952	3B8	03h, 04h, 06h, 10h	1	0	23		HH	
953	3B9	03h, 04h, 06h, 10h	1	1	31		DD	
954	3BA	03h, 04h, 06h, 10h	1	1	12		MM	
955	3BB	03h, 04h, 06h, 10h	1	2000	2999		YY	
956–999	3BC–3E7	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	
Device Element Status								
1000	3E8	03h, 04h	11	0	65281		Row 0 Bit 0 = 1 if any bits 1–15 are asserted Bits 1–7 = 0 Bit 8 = T06_LED Bit 9 = T05_LED Bit 10 = T04_LED Bit 11 = T03_LED Bit 12 = T02_LED Bit 13 = T01_LED Bit 14 = * Bit 15 = Enabled	
1001–1119	3E9–45F	03h, 04h	11	0	65281		Row 1–119	
1120–1149	460–47D	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	
Modbus Communications Counters								
1150	47E	03h, 04h	11	0	65535	0	Number of Message Received	

Table E.15 Modbus Register Map (Sheet 11 of 15)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
1151	47F	03h, 04h	11	0	65535	0	Number of Messages to Other devices	
1152	480	03h, 04h	11	0	65535	0	Invalid Address	
1153	481	03h, 04h	1	0	65535	0	Bad CRC	
1154	482	03h, 04h	1	0	65535	0	UART Error	
1155	483	03h, 04h	1	0	65535	0	Illegal Function	
1156	484	03h, 04h	1	0	65535	0	Illegal Register	
1157	485	03h, 04h	1	0	65535	0	Illegal Write	
1158	486	03h, 04h	1	0	65535	0	Bad Packet Format	
1159	487	03h, 04h	1	0	65535	0	Bad Packet Length	
1160–1199	488–4AF	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	
Remote Analogs								
1200–1263	4B0–4EF	03h, 04h, 06h, 10h	15	–9999999	9999999	0	RA001 [0: UW], [1: LW] to RA032 [0: UW], [1: LW]	
1264–1327	440–52F	03h, 04h, 06h, 10h	15	–9999999	9999999	0	RA033 [0: UW], [1: LW] to RA064 [0: UW], [1: LW]	
1328–1391	530–56F	03h, 04h, 06h, 10h	15	–9999999	9999999	0	RA065 [0: UW], [1: LW] to RA096 [0: UW], [1: LW]	
1392–1455	570–5AF	03h, 04h, 06h, 10h	15	–9999999	9999999	0	RA097 [0: UW], [1: LW] to RA128 [0: UW], [1: LW]	
1456-1999	5B0-7CF	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	
Command Region								
2000	7D0	03h, 04h, 06h[e], 10h	11				Parameter 2[f]	
2001	7D1	03h, 04h, 06h[e], 10h	11				Parameter 1[f]	
2002	7D2	03h, 04h, 06h[e] 10h	11				Command Code[f]	
Demand Data								
2100	834	03h, 04h	1	0	65535	0	Demand IA	A
2101	835	03h, 04h	1	0	65535	0	Demand IB	A
2102	836	03h, 04h	1	0	65535	0	Demand IC	A
2103	837	03h, 04h	1	0	65535	0	Demand IN	A
2104	838	03h, 04h	1	0	65535	0	Demand IG	A
2105	839	03h, 04h	1	0	65535	0	Demand 3I2	A
2106	83A	03h, 04h	1	0	65535	0	Demand IAX	A
2107	83B	03h, 04h	1	0	65535	0	Demand IBX	A
2108	83C	03h, 04h	1	0	65535	0	Demand ICX	A
2109	83D	03h, 04h	1	0	65535	0	Demand IGX	A
2110	83E	03h, 04h	1	0	65535	0	Demand 3I2X	A
2111–2149	83F–865	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	
Peak Demand Data								
2150	866	03h, 04h	1	0	65535	0	Peak Demand IA	A
2151	867	03h, 04h	1	0	65535	0	Peak Demand IB	A
2152	868	03h, 04h	1	0	65535	0	Peak Demand IC	A
2153	869	03h, 04h	1	0	65535	0	Peak Demand IN	A
2154	86A	03h, 04h	1	0	65535	0	Peak Demand IG	A
2155	86B	03h, 04h	1	0	65535	0	Peak Demand 3I2	A
2156	86C	03h, 04h	1	0	65535	0	Peak Demand IAX	A
2157	86D	03h, 04h	1	0	65535	0	Peak Demand IBX	A

Table E.15 Modbus Register Map (Sheet 12 of 15)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
2158	86E	03h, 04h	1	0	65535	0	Peak Demand ICX	A
2159	86F	03h, 04h	1	0	65535	0	Peak Demand IGX	A
2160	870	03h, 04h	1	0	65535	0	Peak Demand 3I2X	A
2161–2199	871–897	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	
Min/Max Data								
2200	898	03h, 04h	1	0	65535	0	IA MAX	A
2201	899	03h, 04h	1	0	65535	0	IA MIN	A
2202	89A	03h, 04h	1	0	65535	0	IB MAX	A
2203	89B	03h, 04h	1	0	65535	0	IB MIN	A
2204	89C	03h, 04h	1	0	65535	0	IC MAX	A
2205	89D	03h, 04h	1	0	65535	0	IC MIN	A
2206	89E	03h, 04h	1	0	65535	0	IN MAX	A
2207	89F	03h, 04h	1	0	65535	0	IN MIN	A
2208	8A0	03h, 04h	1	0	65535	0	IG MAX	A
2209	8A1	03h, 04h	1	0	65535	0	IG MIN	A
2210	8A2	03h, 04h	1	0	65535	0	3I2 MAX	A
2211	8A3	03h, 04h	1	0	65535	0	3I2 MIN	A
2212	8A4	03h, 04h	1	0	65535	0	IAX MAX	A
2213	8A5	03h, 04h	1	0	65535	0	IAX MIN	A
2214	8A6	03h, 04h	1	0	65535	0	IBX MAX	A
2215	8A7	03h, 04h	1	0	65535	0	IBX MIN	A
2216	8A8	03h, 04h	1	0	65535	0	ICX MAX	A
2217	8A9	03h, 04h	1	0	65535	0	ICX MIN	A
2218	8AA	03h, 04h	1	0	65535	0	IGX MAX	A
2219	8AB	03h, 04h	1	0	65535	0	IGX MIN	A
2220	8AC	03h, 04h	1	0	65535	0	3I2X MAX	A
2221	8AD	03h, 04h	1	0	65535	0	3I2X MIN	A
2222	8AE	03h, 04h	13	0	5200000	0	VAB MAX – Upper Word	V
2223	8AF	03h, 04h		0		0	VAB MAX – Lower Word	V
2224	8B0	03h, 04h	13	0	5200000	0	VAB MIN – Upper Word	V
2225	8B1	03h, 04h		0		0	VAB MIN – Lower Word	V
2226	8B2	03h, 04h	13	0	5200000	0	VBC MAX – Upper Word	V
2227	8B3	03h, 04h		0		0	VBC MAX – Lower Word	V
2228	8B4	03h, 04h	13	0	5200000	0	VBC MIN – Upper Word	V
2229	8B5	03h, 04h		0		0	VBC MIN – Lower Word	V
2230	8B6	03h, 04h	13	0	5200000	0	VCA MAX – Upper Word	V
2231	8B7	03h, 04h		0		0	VCA MAX – Lower Word	V
2232	8B8	03h, 04h	13	0	5200000	0	VCA MIN – Upper Word	V
2233	8B9	03h, 04h		0		0	VCA MIN – Lower Word	V
2234	8BA	03h, 04h	13	0	5200000	0	VA MAX – Upper Word	V

Table E.15 Modbus Register Map (Sheet 13 of 15)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
2235	8BB	03h, 04h		0		0	VA MAX – Lower Word	V
2236	8BC	03h, 04h	13	0	5200000	0	VA MIN – Upper Word	V
2237	8BD	03h, 04h		0		0	VA MIN – Lower Word	V
2238	8BE	03h, 04h	13	0	5200000	0	VB MAX – Upper Word	V
2239	8BF	03h, 04h		0		0	VB MAX – Lower Word	V
2240	8C0	03h, 04h	13	0	5200000	0	VB MIN – Upper Word	V
2241	8C1	03h, 04h		0		0	VB MIN – Lower Word	V
2242	8C2	03h, 04h	13	0	5200000	0	VC MAX – Upper Word	V
2243	8C3	03h, 04h		0		0	VC MAX – Lower Word	V
2244	8C4	03h, 04h	13	0	5200000	0	VC MIN – Upper Word	V
2245	8C5	03h, 04h		0		0	VC MIN – Lower Word	V
2246	8C6	03h, 04h	13	–200000000	200000000	0	3-Phase Real Power MAX – Upper Word	kW
2247	8C7	03h, 04h		0		0	3-Phase Real Power MAX – Lower Word	kW
2248	8C8	03h, 04h	13	–200000000	200000000	0	3-Phase Real Power MIN – Upper Word	kW
2249	8C9	03h, 04h		0		0	3-Phase Real Power MIN – Lower Word	kW
2250	8CA	03h, 04h	13	–200000000	200000000	0	3-Phase Reactive Power MAX – Upper Word	kVAR
2251	8CB	03h, 04h		0		0	3-Phase Reactive Power MAX – Lower Word	kVAR
2252	8CC	03h, 04h	13	–200000000	200000000	0	3-Phase Reactive Power MIN – Upper Word	kVAR
2253	8CD	03h, 04h		0		0	3-Phase Reactive Power MIN – Lower Word	kVAR
2254	8CE	03h, 04h	13	–200000000	200000000	0	3-Phase Apparent Power MAX – Upper Word	kVA
2255	8CF	03h, 04h		0		0	3-Phase Apparent Power MAX – Lower Word	kVA
2256	8D0	03h, 04h	13	–200000000	200000000	0	3-Phase Apparent Power MIN – Upper Word	kVA
2257	8D1	03h, 04h		0		0	3-Phase Apparent Power MIN – Lower Word	kVA
2258	8D2	03h, 04h	13	–200000000	200000000	0	3-Phase Real Power X MAX – Upper Word	kW
2259	8D3	03h, 04h		0		0	3-Phase Real Power X MAX – Lower Word	kW
2260	8D4	03h, 04h	13	–200000000	200000000	0	3-Phase Real Power X MIN – Upper Word	kW

Table E.15 Modbus Register Map (Sheet 14 of 15)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
2261	8D5	03h, 04h		0		0	3-Phase Real Power X MIN – Lower Word	kW
2262	8D6	03h, 04h	13	–200000000	200000000	0	3-Phase Reactive Power X MAX – Upper Word	kVAR
2263	8D7	03h, 04h		0		0	3-Phase Reactive Power X MAX – Lower Word	kVAR
2264	8D8	03h, 04h	13	–200000000	200000000	0	3-Phase Reactive Power X MIN – Upper Word	kVAR
2265	8D9	03h, 04h		0		0	3-Phase Reactive Power X MIN – Lower Word	kVAR
2266	8DA	03h, 04h	13	–200000000	200000000	0	3-Phase Apparent Power X MAX – Upper Word	kVA
2267	8DB	03h, 04h		0		0	3-Phase Apparent Power X MAX – Lower Word	kVA
2268	8DC	03h, 04h	13	–200000000	200000000	0	3-Phase Apparent Power X MIN – Upper Word	kVA
2269	8DD	03h, 04h		0		0	3-Phase Apparent Power X MIN – Lower Word	kVA
2270	8DE	03h, 04h	1	440	660	0	Frequency MAX	Hz
2271	8DF	03h, 04h	1	440	660	0	Frequency MIN	Hz
2272–2499	8E0-9C3	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	
Energy Data								
2500	9C4	03h, 04h	13	0	1000000	0	Real Energy 3-Phase Real Power In – Upper Word	MWh
2501	9C5	03h, 04h					Real Energy 3-Phase Real Power In – Lower Word	MWh
2502	9C6	03h, 04h	13	0	1000000	0	Real Energy 3-Phase Real Power Out – Upper Word	MWh
2503	9C7	03h, 04h					Real Energy 3-Phase Real Power Out – Lower Word	MWh
2504	9C8	03h, 04h	13	0	1000000	0	Reactive Energy 3-Phase Reactive Power In – Upper Word	MVARh
2505	9C9	03h, 04h					Reactive Energy 3-Phase Reactive Power In – Lower Word	MVARh
2506	9CA	03h, 04h	13	0	1000000	0	Reactive Energy 3-Phase Reactive Power Out – Upper Word	MVARh
2507	9CB	03h, 04h					Reactive Energy 3-Phase Reactive Power Out – Lower Word	MVARh
2508	9CC	03h, 04h	13	0	1000000	0	Real Energy 3-Phase Real Power X In – Upper Word	MWh
2509	9CD	03h, 04h					Real Energy 3-Phase Real Power X In – Lower Word	MWh
2510	9CE	03h, 04h	13	0	1000000	0	Real Energy 3-Phase Real Power X Out – Upper Word	MWh
2511	9CF	03h, 04h					Real Energy 3-Phase Real Power X Out – Lower Word	MWh
2512	9D0	03h, 04h	13	0	1000000	0	Reactive Energy 3-Phase Reactive Power X In – Upper Word	MVARh

Table E.15 Modbus Register Map (Sheet 15 of 15)

Address in Decimal	Address in Hex	Function Code Supported	Conversion	Min	Max	Default	Name/Enums	Units
2513	9D1	03h, 04h					Reactive Energy 3-Phase Reactive Power X In – Lower Word	MVARh
2514	9D2	03h, 04h	13	0	1000000	0	Reactive Energy 3-Phase Reactive Power X Out – Upper Word	MVARh
2515	9D3	03h, 04h					Reactive Energy 3-Phase Reactive Power X Out – Lower Word	MVARh
2516–3999	9D4–F9F	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	
4000–65535	FA0–FFFF	03h, 04h	5	8000	8000	8000	Reserved = 8000 Hex	

[a] UW = Upper Word.
[b] LW = Lower Word.
[c] Available if 3 ACI/3 AVI I/O card is installed in Slot E.
[d] EU = Engineering Units.
[e] If function code 6 is used to write to the command code region that has parameters, the parameters must be written first.
[f] Once the command code is written, the parameters 1 and 2 are cleared and must be rewritten prior to the next command.

Table E.16 Conversion Table

Index[a]	Type	Multiply	Divide	Offset	Base
0	Boolean	1	1	0	1
1	Unsigned Integer	1	1	0	1
2	Unsigned Integer	1	10	0	1
3	Unsigned Integer	1	100	0	1
4	HEX	1	1000	0	1
5	Integer	1	1	0	1
6	Integer	1	1	0	1
7	Integer	1	10	0	1
8	Integer	1	100	0	1
9	Integer	1	1000	0	1
10	Enumeration	1	1	0	1
11	Bit Enumeration	1	1	0	1
12	Two 8 bit ASCII characters	1	1	0	1
13	Long Integer	1	1	0	1
14	Long Integer	1	10	0	1
15	Long Integer	1	100	0	1
16	Long Integer	1	1000	0	1

[a] Refers to the conversion column in *Table E.15*.

This page intentionally left blank

Appendix F
IEC 61850 Communications

Features

The SEL-2411 device supports the following features using Ethernet and IEC 61850:

SCADA. Use as many as six MMS sessions of buffered and unbuffered reports. Remote bits (RB01–RB32) are mapped to the RBGGIO Logical Node. See *Table F.5* and *Table F.3* for details on the logical nodes associated with these bits. This information is useful for issuing controls with an MMS browser. Control inputs only support the direct-with-normal-security control model.

Real-Time Status and Control. Use GOOSE with as many as 16 incoming (receive) and as many as 8 outgoing (transmit) messages. Controls only support the direct-with-normal-security control model. Remote Bits (RB01–RB32), Virtual Bits (VB001–VB128) and Remote Analogs (RA001–RA128) can also be mapped from GOOSE receive messages using ACSELERATOR Architect® SEL-5032 Software.

Configuration. Use FTP client software or ACSELERATOR Architect to transfer the Substation Configuration Language (SCL) Configured IED Description (CID) files to the device.

NOTE: The SEL-2411 supports one CID file, which should be transferred only if a change in the device configuration is required. If an invalid CID file is transferred, the device will no longer have a valid IEC 61850 configuration, and the protocol will stop operating. To restart protocol operation, a valid CID must be transferred to the device.

Commissioning and Troubleshooting. Use software such as MMS Object Explorer and AX-S4 MMS from Sisco, Inc., to browse the device logical nodes and verify functionality.

IEC 61850 Configuration

ACSELERATOR Architect

The ACSELERATOR Architect software enables protection and integration engineers to design and commission IEC 61850 substations containing SEL IEDs.

Engineers can use ACSELERATOR Architect to:

- Organize and configure all SEL IEDs in a substation project
- Configure incoming and outgoing GOOSE messages
- Read non-SEL IED Capability Description (ICD) and Configured IED Description (CID) files and determine the available IEC 61850 messaging options
- Load device settings and IEC 61850 CID files into SEL IEDs
- Generate ICD files that will provide SEL IED descriptions to other manufacturer's tools so they can use SEL GOOSE messages and reporting features
- Configure protection, logic, control, and communication settings of all SEL IEDs in the substation

ACSELERATOR Architect provides a Graphical User Interface (GUI) for engineers to select, edit, and create IEC 61850 GOOSE messages important for substation protection, coordination, and control schemes.

Logical Node Extensions

The following logical nodes and data classes were created in this device as extensions to the IEC 61850 standard, in accordance with IEC 61850 guidelines.

Table F.1 Metering and Measurement Logical Nodes

Logical Node	IEC 61850	Description or Comments
Thermal Measurement for equipment or ambient temperature readings	MTHI MTHE	To acquire values from RTDs and thermocouples to calculate thermal capacity and usage mainly used for Thermal Monitoring.

Table F.2 defines the data class, Thermal Metering Data. This class is a collection of simultaneous measurements (or evaluations) that represent the RTD thermal metering values. Valid data depends on the presence and configuration of the internal and external RTD module(s).

Table F.2 Thermal Metering Data (Sheet 1 of 2)

Attribute Name	Type	Explanation	T	M/O
MTHI/E Class				
LNName		Shall be inherited from Logical-Node Class (see IEC 61850-7-2).		
Data				
Common Logical Node Information				
		LN shall inherit all Mandatory Data from Common Logical Node Class.		M
EEHealth	INS	External equipment health (RTD Communications Status)		O
Measured Values				
InTmp01	MV	Temperature 1		O
InTmp02	MV	Temperature 2		O
InTmp03	MV	Temperature 3		O

Table F.2 Thermal Metering Data (Sheet 2 of 2)

Attribute Name	Type	Explanation	T	M/O
InTmp04	MV	Temperature 4		O
InTmp05	MV	Temperature 5		O
InTmp06	MV	Temperature 6		O
InTmp07	MV	Temperature 7		O
InTmp08	MV	Temperature 8		O
InTmp09	MV	Temperature 9		O
InTmp10	MV	Temperature 10		O
ExTmp01	MV	Temperature 1		O
ExTmp02	MV	Temperature 2		O
ExTmp03	MV	Temperature 3		O
ExTmp04	MV	Temperature 4		O
ExTmp05	MV	Temperature 5		O
ExTmp06	MV	Temperature 6		O
ExTmp07	MV	Temperature 7		O
ExTmp08	MV	Temperature 8		O
ExTmp09	MV	Temperature 9		O
ExTmp10	MV	Temperature 10		O
ExTmp11	MV	Temperature 11		O
ExTmp12	MV	Temperature 12		O

Logical Nodes

Table F.5 through *Table F.3* show the logical nodes (LNs) supported in the SEL-2411 and the associated Device Word bits or Measured Values mapped to those LNs. Any differences between ICD file versions are also indicated in the tables.

Table F.3 shows the LNs associated with annunciation element defined as Logical Device ANN.

Table F.3 Logical Device: ANN (Annunciation) (Sheet 1 of 2)

Logical Nodes	Status or Measurand	Device Word Bits or Analog Quantities
Analog Quantities		
MVGGIO12	AnIn01.mag to AnIn32.mag	Math Variables (MV01 to MV32)
AINCGGIO26	AnIn01.mag to AnIn08.mag	Analog Inputs (AI301 to AI308)—Slot C
AINCGGIO27	AnIn01.mag to AnIn08.mag	Analog Inputs (AI401 to AI408)—Slot D
AINCGGIO28	AnIn01.mag to AnIn08.mag	Analog Inputs (AI501 to AI508)—Slot E
AINCGGIO29	AnIn01.mag to AnIn08.mag	Analog Inputs (AI601 to AI608)—Slot Z
RAGAIO30	Ra001.instMag to Ra032.instMag	Remote Analogs (RA001 to RA032)
RAGAIO31	Ra033.instMag to Ra064.instMag	Remote Analogs (RA033 to RA064)
RAGAIO32	Ra065.instMag to Ra096.instMag	Remote Analogs (RA065 to RA096)
RAGAIO33	Ra097.instMag to Ra128.instMag	Remote Analogs (RA097 to RA128)
SCGGIO34	AnIn01.instMag to AnIn32.instMag	SELOGIC Counters (SC01 to SC32)
Device Word Bits		
INAGGIO1	Ind01.stVal to Ind02.stVal	Digital Inputs (IN101 to IN102)—Slot A
OUTAGGIO2	Ind01.stVal to Ind03.stVal	Digital Outputs (OUT101 to OUT103)—Slot A
SVGGIO3	Ind01.stVal to Ind32.stVal	SELOGIC Variables (SV01 to SV32)
SVTGGIO4	Ind01.stVal to Ind32.stVal	SELOGIC Variable Timers (SV01T to SV32T)
LTGGIO5	Ind01.stVal to Ind32.stVal	Latch Bits (LT01 to LT32)
TLEDGGIO6	Ind01.stVal to Ind07.stVal	Target LEDs (ENABLED, TLED_01 to TLED_06)

Table F.3 Logical Device: ANN (Annunciation) (Sheet 2 of 2)

Logical Nodes	Status or Measurand	Device Word Bits or Analog Quantities
PBLEDGGIO7	Ind01.stVal to Ind04.stVal	Pushbutton LEDs (PB01_LED to PB04_LED)
RMBAGGIO8	Ind01.stVal to Ind08.stVal	Receive MIRRORED BITS (RMBA1 to RMBA8)
TMBAGGIO9	Ind01.stVal to Ind08.stVal	Transmit MIRRORED BITS (TMBA1 to TMBA8)
RMBBGGIO10	Ind01.stVal to Ind08.stVal	Receive MIRRORED BITS (RMBB1 to RMBB8)
TMBBGGIO11	Ind01.stVal to Ind08.stVal	Transmit MIRRORED BITS (TMBB1 to TMBB8)
INCGGIO13	Ind01.stVal to Ind08.stVal	Digital Inputs (IN301 to IN308)—Slot C
INCEGGIO14	Ind01.stVal to Ind08.stVal	Edge Trigger Operator (IN301E to IN308E)—Slot C
OUTCGGIO15	Ind01.stVal to Ind08.stVal	Digital Outputs (OUT301 to OUT308)—Slot C
INDGGIO16	Ind01.stVal to Ind08.stVal	Digital Inputs (IN401 to IN408)—Slot D
INDEGGIO17	Ind01.stVal to Ind08.stVal	Edge Trigger Operator (IN401E to IN408E)—Slot D
OUTDGGIO18	Ind01.stVal to Ind08.stVal	Digital Outputs (OUT401 to OUT408)—Slot D
INEGGIO19	Ind01.stVal to Ind08.stVal	Digital Inputs (IN501 to IN508)—Slot E
INEEGGIO20	Ind01.stVal to Ind08.stVal	Edge Trigger Operator (IN501E to IN508E)—Slot E
OUTEGGIO21	Ind01.stVal to Ind08.stVal	Digital Outputs (OUT501 to OUT508)—Slot E
INZGGIO22	Ind01.stVal to Ind08.stVal	Digital Inputs (IN601 to IN608)—Slot Z
INZEGGIO23	Ind01.stVal to Ind08.stVal	Edge Trigger Operator (IN601E to IN608E)—Slot Z
OUTZGGIO24	Ind01.stVal to Ind08.stVal	Digital Outputs (OUT601 to OUT608)—Slot Z
VBGGIO25	Ind001.stVal to Ind128.stVal	Virtual Bits (VB001 to VB128)

Table F.4 shows the LNs associated with control elements defined as Logical Device CON.

Table F.4 Logical Device: CON (Control)

Logical Nodes	Status and Control	Device Word Bits
RBGGIO1	**Status** SPCSO01.stVal to SPCSO32.stVal **Control** SPCSO01.ctlVal to SPCSO32.ctlVal	Remote Bits (RB01 to RB32)

Table F.5 shows the LNs associated with measuring elements defined as Logical Device MET.

Table F.5 Logical Device: MET (Metering) (Sheet 1 of 4)

Logical Nodes	Measurand	Comment	
Thermal (RTD) Metering			
RTDMTHI1	InTmp01.instMag to InTmp10.instMag	Internal RTDs—Slot D	a
UTCMTHI1	InTmp01.instMag to InTmp10.instMag	General Purpose Internal RTD/TCs—Slot D	b
THERMMTHE1	ExTmp01.instMag to ExTmp10.instMag	External RTDs	c
Note that THERM_MTHI1 and THERM_MTHE1 are used in version 001 and 002L and that THERMMTHI1 and THERMMTHE1 are used in version 002 and later.			
Fundamental Metering			
METMMXU1	Hz.instMag	Instantaneous, Frequency	d, e
METMMXU1	A.phsA.instCVal.mag	Instantaneous, Current Magnitude, Phase A	d
METMMXU1	A.phsB.instCVal.mag	Instantaneous, Current Magnitude, Phase B	d
METMMXU1	A.phsC.instCVal.mag	Instantaneous, Current Magnitude, Phase C	d
METMMXU1	A.neut.instCVal.mag	Instantaneous, Current Magnitude, Neutral	d
METMMXU1	A.res.instCVal.mag	Instantaneous, Current Magnitude, Residual	d
METMMXU1	A.nseq.instCVal.mag	Instantaneous, Current Magnitude, Negative Sequence	d
METMMXU1	A.phsA.instCVal.ang	Instantaneous, Current Angle, Phase A	d
METMMXU1	A.phsB.instCVal.ang	Instantaneous, Current Angle, Phase B	d
METMMXU1	A.phsC.instCVal.ang	Instantaneous, Current Angle, Phase C	d
METMMXU1	A.neut.instCVal.ang	Instantaneous, Current Angle, Neutral	d
METMMXU1	A.res.instCVal.ang	Instantaneous, Current Angle, Residual	d

Table F.5 Logical Device: MET (Metering) (Sheet 2 of 4)

Logical Nodes	Measurand	Comment	
METXMMXU1	A.phsA.instCVal.mag	Instantaneous, Current Magnitude, Phase A	e
METXMMXU1	A.phsB.instCVal.mag	Instantaneous, Current Magnitude, Phase B	e
METXMMXU1	A.phsC.instCVal.mag	Instantaneous, Current Magnitude, Phase C	e
METXMMXU1	A.res.instCVal.mag	Instantaneous, Current Magnitude, Residual	e
METXMMXU1	A.nseq.instCVal.mag	Instantaneous, Current Magnitude, Negative Sequence	e
METXMMXU1	A.phsA.instCVal.ang	Instantaneous, Current Angle, Phase A	e
METXMMXU1	A.phsB.instCVal.ang	Instantaneous, Current Angle, Phase B	e
METXMMXU1	A.phsC.instCVal.ang	Instantaneous, Current Angle, Phase C	e
METXMMXU1	A.res.instCVal.ang	Instantaneous, Current Angle, Neutral	e
METMMXU1	PhV.phA.instCVal.mag	Instantaneous, Voltage Magnitude, Phase A	e, f
METMMXU1	PhV.phB.instCVal.mag	Instantaneous, Voltage Magnitude, Phase B	e, f
METMMXU1	PhV.phC.instCVal.mag	Instantaneous, Voltage Magnitude, Phase C	e, f
METMMXU1	PhV.res.instCVal.mag	Instantaneous, Voltage Magnitude, Residual	e, f
METMMXU1	PhV.nseq.instCVal.mag	Instantaneous, Voltage Magnitude, Negative Sequence	e, f
METMMXU1	PhV.phA.instCVal.ang	Instantaneous, Voltage Angle, Phase A	e, f
METMMXU1	PhV.phB.instCVal.ang	Instantaneous, Voltage Angle, Phase B	e, f
METMMXU1	PhV.phC.instCVal.ang	Instantaneous, Voltage Angle, Phase C	e, f
METMMXU1	PhV.res.instCVal.ang	Instantaneous, Voltage Angle, Residual	e, f
METMMXU1	PhV.phsAB.instCVal.mag	Instantaneous, Voltage Magnitude, AB	e, f
METMMXU1	PhV.phsBC.instCVal.mag	Instantaneous, Voltage Magnitude, BC	e, f
METMMXU1	PhV.phsCA.instCVal.mag	Instantaneous, Voltage Magnitude, CA	e, f
METMMXU1	PhV.phsAB.instCVal.ang	Instantaneous, Voltage Angle, AB	e, f
METMMXU1	PhV.phsBC.instCVal.ang	Instantaneous, Voltage Angle, BC	e, f
METMMXU1	PhV.phsCA.instCVal.ang	Instantaneous, Voltage Angle, CA	e, f
METMMXU1	TotW.instMag	Instantaneous, Three-Phase Real Power	g
METMMXU1	PhAW.instMag	Instantaneous, Real Power A	g
METMMXU1	PhBW.instMag	Instantaneous, Real Power B	g
METMMXU1	PhCW.instMag	Instantaneous, Real Power C	g
METMMXU1	TotVAr.instMag	Instantaneous, Three-Phase Reactive Power	g
METMMXU1	PhAVAr.instMag	Instantaneous, Reactive Power A	g
METMMXU1	PhBVAr.instMag	Instantaneous, Reactive Power B	g
METMMXU1	PhCVAr.instMag	Instantaneous, Reactive Power C	g
METMMXU1	TotVA.instMag	Instantaneous, Three-Phase Apparent Power	g
METMMXU1	PhAVA.instMag	Instantaneous, Apparent Power A	g
METMMXU1	PhBVA.instMag	Instantaneous, Apparent Power B	g
METMMXU1	PhCVA.instMag	Instantaneous, Apparent Power C	g
METMMXU1	TotPF.instMag	Instantaneous, Three-Phase Power Factor	g
METMMXU1	PhAPF.instMag	Instantaneous, Power Factor A	g
METMMXU1	PhBPF.instMag	Instantaneous, Power Factor B	g
METMMXU1	PhCPF.instMag	Instantaneous, Power Factor C	g
METXMMXU1	TotW.instMag	Instantaneous, Three-Phase Real Power	e
METXMMXU1	PhAW.instMag	Instantaneous, Real Power A	e
METXMMXU1	PhBW.instMag	Instantaneous, Real Power B	e
METXMMXU1	PhCW.instMag	Instantaneous, Real Power C	e
METXMMXU1	TotVAr.instMag	Instantaneous, Three-Phase Reactive Power	e
METXMMXU1	PhAVAr.instMag	Instantaneous, Reactive Power A	e
METXMMXU1	PhBVAr.instMag	Instantaneous, Reactive Power B	e
METXMMXU1	PhCVAr.instMag	Instantaneous, Reactive Power C	e
METXMMXU1	TotVA.instMag	Instantaneous, Three-Phase Apparent Power	e
METXMMXU1	PhAVA.instMag	Instantaneous, Apparent Power A	e
METXMMXU1	PhBVA.instMag	Instantaneous, Apparent Power B	e
METXMMXU1	PhCVA.instMag	Instantaneous, Apparent Power C	e
METXMMXU1	TotPF.instMag	Instantaneous, Three-Phase Power Factor	e

Table F.5 Logical Device: MET (Metering) (Sheet 3 of 4)

Logical Nodes	Measurand	Comment	
METXMMXU1	PhAPF.instMag	Instantaneous, Power Factor A	e
METXMMXU1	PhBPF.instMag	Instantaneous, Power Factor B	e
METXMMXU1	PhCPF.instMag	Instantaneous, Power Factor C	e
Note that MET_MMXU1 is used in version 001 and 002L and that METMMXU1 is used in version 002 and later.			
Demand Metering			
METMDST1	DmdA.phsA.instMag	Demand, Phase A Current	d
METMDST1	DmdA.phsB.instMag	Demand, Phase B Current	d
METMDST1	DmdA.phsC.instMag	Demand, Phase C Current	d
METMDST1	DmdA.neut.instMag	Demand, Current, Neutral	d
METMDST1	DmdA.res.instMag	Demand, Current, Residual	d
METMDST1	DmdA.SeqA.instMag	Demand, Current, Negative Sequence	d
METXMDST2	DmdA.phsA.instMag	Demand, Current, Phase AX	e
METXMDST2	DmdA.phsB.instMag	Demand, Current, Phase BX	e
METXMDST2	DmdA.phsC.instMag	Demand, Current, Phase CX	e
METXMDST2	DmdA.res.instMag	Demand, Current, Residual X	e
METXMDST2	DmdA.SeqA.instMag	Demand, Current, Negative Sequence X	e
Peak Demand Metering			
METMDST1	PkDmdA.phsA.instMag	Peak Demand, Current, Phase A	d
METMDST1	PkDmdA.phsB.instMag	Peak Demand, Current, Phase B	d
METMDST1	PkDmdA.phsC.instMag	Peak Demand, Current, Phase C	d
METMDST1	PkDmdA.neut.instMag	Peak Demand, Current, Neutral	d
METMDST1	PkDmdA.res.instMag	Peak Demand, Current, Residual	d
METMDST1	PkDmdA.SeqA.instMag	Peak Demand, Current, Negative Sequence	d
METXMDST2	PkDmdA.phsA.instMag	Peak Demand, Current, Phase AX	e
METXMDST2	PkDmdA.phsB.instMag	Peak Demand, Current, Phase BX	e
METXMDST2	PkDmdA.phsC.instMag	Peak Demand, Current, Phase CX	e
METXMDST2	PkDmdA.res.instMag	Peak Demand, Current, Residual X	e
METXMDST2	PkDmdA.SeqA.instMag	Peak Demand, Current, Negative Sequence X	e
Energy Metering			
METMDST1	SupWh.actVal	Energy, Real (MWh), Default direction: energy flow towards busbar.	g
METMDST1	SupVArh.actVal	Energy, Reactive (MVArh)	g
METMDST1	SupVAh.actVal	Energy, Apparent (MVAh)	g
METMDST1	DmdWh.actVal	Energy, Real (MWh), Default direction: energy flow from busbar away.	g
METMDST1	DmdVArh.actVal	Energy, Reactive (MVArh)	g
METMDST1	DmdVAh.actVal	Energy, Apparent (MVAh)	g
METXMDST2	SupWh.actVal	Energy, Real (MWh)	e
METXMDST2	DmdWh.actVal	Energy, Real (MWh)	e
METXMDST2	SupVAh.actVal	Energy, Apparent (MVAh)	e
METXMDST2	SupVArh.actVal	Energy, Reactive (MVArh)	e
METXMDST2	DmdVArh.actVal	Energy, Reactive (MVArh)	e
METXMDST2	DmdVAh.actVal	Energy, Apparent (MVAh)	e
Maximum Metering			
METMDST1	MaxHz	Maximum Frequency	d, e
METMDST1	MaxA.phsA.instMag	Maximum, Current, A-phase	d
METMDST1	MaxA.phsB.instMag	Maximum, Current, B-phase	d
METMDST1	MaxA.phsC.instMag	Maximum, Current, C-phase	d
METMDST1	MaxA.neut.instMag	Maximum, Current, Neutral	d
METMDST1	MaxA.res.instMag	Maximum, Current, Residual	d
METMDST1	MaxA.SeqA.instMag	Maximum, Current, Negative Sequence	d
METXMDST2	MaxA.phsA.instMag	Maximum, Current, AX-phase	e
METXMDST2	MaxA.phsB.instMag	Maximum, Current, BX-phase	e

Table F.5 Logical Device: MET (Metering) (Sheet 4 of 4)

Logical Nodes	Measurand	Comment	
METXMDST2	MaxA.phsC.instMag	Maximum, Current, CX-phase	e
METXMDST2	MaxA.res.instMag	Maximum, Current, Residual X	e
METXMDST2	MaxA.SeqA.instMag	Maximum, Current, Negative Sequence X	e
METMDST1	MaxPhV.phA.instMag	Maximum, Voltage, A-phase-to-neutral	e, f
METMDST1	MaxPhV.phB.instMag	Maximum, Voltage, B-phase-to-neutral	e, f
METMDST1	MaxPhV.phC.instMag	Maximum, Voltage, C-phase-to-neutral	e, f
METMDST1	MaxPPV.phAB.instMag	Maximum, Voltage, A-to-B-phase	e, f
METMDST1	MaxPPV.phBC.instMag	Maximum, Voltage, B-to-C-phase	e, f
METMDST1	MaxPPV.phCA.instMag	Maximum, Voltage, C-to-A-phase	e, f
METMDST1	MaxVA	Maximum, Apparent Power	g
METMDST1	MaxW	Maximum, Real Power	g
METMDST1	MaxVAr	Maximum, Reactive Power	g
METXMDST2	MaxVA	Maximum, Apparent Power X	e
METXMDST2	MaxW	Maximum, Real Power X	e
METXMDST2	MaxVAr	Maximum, Reactive Power X	e
Minimum Metering			
METMDST1	MinHz	Minimum Frequency	d, e
METMDST1	MinA.phsA.instMag	Minimum, Current, A-phase	d
METMDST1	MinA.phsB.instMag	Minimum, Current, B-phase	d
METMDST1	MinA.phsC.instMag	Minimum, Current, C-phase	d
METMDST1	MinA.neut.instMag	Minimum, Current, Neutral	d
METMDST1	MinA.res.instMag	Minimum, Current, Residual	d
METMDST1	MinA.SeqA.instMag	Minimum, Current, Negative Sequence	d
METXMDST2	MinA.phsA.instMag	Minimum, Current, AX-phase	e
METXMDST2	MinA.phsB.instMag	Minimum, Current, BX-phase	e
METXMDST2	MinA.phsC.instMag	Minimum, Current, CX-phase	e
METXMDST2	MinA.res.instMag	Minimum, Current, Residual X	e
METXMDST2	MinA.SeqA.instMag	Minimum, Current, Negative Sequence X	e
METMDST1	MinPhV.phA.instMag	Minimum, Voltage, A-phase-to-neutral	e, f
METMDST1	MinPhV.phB.instMag	Minimum, Voltage, B-phase-to-neutral	e, f
METMDST1	MinPhV.phC.instMag	Minimum, Voltage, C-phase-to-neutral	e, f
METMDST1	MinPPV.phAB.instMag	Minimum, Voltage, A-to-B-phase	e, f
METMDST1	MinPPV.phBC.instMag	Minimum, Voltage, B-to-C-phase	e, f
METMDST1	MinPPV.phCA.instMag	Minimum, Voltage, C-to-A-phase	e, f
METMDST1	MinVA	Minimum, Apparent Power	g
METMDST1	MinW	Minimum, Real Power	g
METMDST1	MinVAr	Minimum, Reactive Power	g
METXMDST2	MinVA	Minimum, Apparent Power X	e
METXMDST2	MinW	Minimum, Real Power X	e
METXMDST2	MinVAr	Minimum, Reactive Power X	e

[a] Valid data only if 10 RTD card is installed in Slot D.
[b] Valid data only if internal general purpose RTD/TC card is installed in Slot D.
[c] Valid data only if SEL-2600 Device is connected via fiber port.
[d] Valid data only if 4 CT card is installed in Slot Z.
[e] Valid data only if 3 CT/3 PT card is installed in Slot E.
[f] Valid data only if 3 PT card is installed in Slot E.
[g] Valid data only if 4 CT and 3 PT cards are installed in Slots E and Z respectively.

Protocol Implementation Conformance Statement

The following tables are as shown in the IEC 61850 standard, Part 8-1, Section 24. Note that since the standard explicitly dictates which services and functions must be implemented to achieve conformance, only the optional services and functions are listed.

Table F.6 PICS for A-Profile Support

Profile		Client	Server	Value/Comment
A1	Client/Server	N	Y	
A2	GOOSE/GSE management	Y	Y	Only GOOSE, not GSSE Management
A3	GSSE	N	N	
A4	Time Sync	N	N	

Table F.7 PICS for T-Profile Support

Profile		Client	Server	Value/Comment
T1	TCP/IP	N	Y	
T2	OSI	N	N	
T3	GOOSE/GSE	Y	Y	Only GOOSE, Not GSSE
T4	GSSE	N	N	
T5	Time Sync	N	N	

Refer to the ACSI Conformance statements in the Reference Manual for information on the supported services.

MMS Conformance

The Manufacturing Messaging Specification (MMS) stack provides the basis for many IEC 61850 Protocol services. *Table F.8* defines the service support requirement and restrictions of the MMS services in the SEL-2411 series products supporting IEC 61850. Generally, only those services whose implementation is not mandatory are shown. Refer to the IEC 61850 standard Part 8-1 for more information.

Table F.8 MMS Service Supported Conformance (Sheet 1 of 3)

MMS Service Supported CBB	Client-CR Supported	Server-CR Supported
status		Y
getNameList		Y
identify		Y
rename		
read		Y
write		Y
getVariableAccessAttributes		Y
defineNamedVariable		
defineScatteredAccess		
getScatteredAccessAttributes		
deleteVariableAccess		
defineNamedVariableList		
getNamedVariableListAttributes		Y
deleteNamedVariableList		
defineNamedType		
getNamedTypeAttributes		
deleteNamedType		
input		

Table F.8 MMS Service Supported Conformance (Sheet 2 of 3)

MMS Service Supported CBB	Client-CR Supported	Server-CR Supported
output		
takeControl		
relinquishControl		
defineSemaphore		
deleteSemaphore		
reportPoolSemaphoreStatus		
reportSemaphoreStatus		
initiateDownloadSequence		
downloadSegment		
terminateDownloadSequence		
initiateUploadSequence		
uploadSegment		
terminateUploadSequence		
requestDomainDownload		
requestDomainUpload		
loadDomainContent		
storeDomainContent		
deleteDomain		
getDomainAttributes		Y
createProgramInvocation		
deleteProgramInvocation		
start		
stop		
resume		
reset		
kill		
getProgramInvocationAttributes		
obtainFile		
defineEventCondition		
deleteEventCondition		
getEventConditionAttributes		
reportEventConditionStatus		
alterEventConditionMonitoring		
triggerEvent		
defineEventAction		
deleteEventAction		
alterEventEnrollment		
reportEventEnrollmentStatus		
getEventEnrollmentAttributes		
acknowledgeEventNotification		
getAlarmSummary		
getAlarmEnrollmentSummary		
readJournal		
writeJournal		
initializeJournal		
reportJournalStatus		
createJournal		
deleteJournal		
fileOpen		
fileRead		
fileClose		
fileRename		
fileDelete		

Table F.8 MMS Service Supported Conformance (Sheet 3 of 3)

MMS Service Supported CBB	Client-CR Supported	Server-CR Supported
fileDirectory		
unsolicitedStatus		
informationReport		Y
eventNotification		
attachToEventCondition		
attachToSemaphore		
conclude		Y
cancel		Y
getDataExchangeAttributes		
exchangeData		
defineAccessControlList		
getAccessControlListAttributes		
reportAccessControlledObjects		
deleteAccessControlList		
alterAccessControl		
ReconfigureProgramInvocation		

Table F.9 lists specific settings for the MMS parameter Conformance Building Block (CBB).

Table F.9 MMS Parameter CBB

MMS Parameter CBB	Client-CR Supported	Server-CR Supported
STR1		Y
STR2		Y
VNAM		Y
VADR		Y
VALT		Y
TPY		Y
VLIS		Y
CEI		

The following Variable Access conformance statements are listed in the order specified in the IEC 61850 standard, Part 8-1. Generally, only those services whose implementation is not mandatory are shown. Refer to the IEC 61850 standard Part 8-1 for more information.

Table F.10 Alternate Access Selection Conformance Statement

Alternate Access Selection	Client-CR Supported	Server-CR Supported
accessSelection		Y
component		Y
index		
indexRange		
allElements		
alternateAccess		Y
selectAccess		Y
component		Y
index		
indexRange		
allElements		

Table F.11 VariableAccessSpecification Conformance Statement

VariableAccessSpecification	Client-CR Supported	Server-CR Supported
listOfVariable		Y
variableSpecification		Y
alternateAccess		Y
variableListName		Y

Table F.12 VariableSpecification Conformance Statement

VariableSpecification	Client-CR Supported	Server-CR Supported
name		Y
address		
variableDescription		
scatteredAccessDescription		
invalidated		

Table F.13 Read Conformance Statement

Read	Client-CR Supported	Server-CR Supported
Request		
specificationWithResult		
variableAccessSpecification		
Response		
variableAccessSpecification		Y
listOfAccessResult		Y

Table F.14 GetVariableAccessAttributes Conformance Statement

GetVariableAccessAttributes	Client-CR Supported	Server-CR Supported
Request		
name		
address		
Response		
mmsDeletable		
address		
typeSpecification		

Table F.15 DefineNamedVariableList Conformance Statement

DefineNamedVariableList	Client-CR Supported	Server-CR Supported
Request		
variableListName		
listOfVariable		
variableSpecification		
alternateAccess		
Response		

Table F.16 GetNamedVariableListAttributes Conformance Statement

GetNamedVariableListAttributes	Client-CR Supported	Server-CR Supported
Request		
ObjectName		
Response		
mmsDeletable		Y
listOfVariable		Y
variableSpecification		Y
alternateAccess		Y

Table F.17 DeleteNamedVariableList Statement

DeleteNamedVariableList	Client-CR Supported	Server-CR Supported
Request		
Scope		
listOfVariableListName		
domainName		
Response		
numberMatched		
numberDeleted		
DeleteNamedVariableList-Error		

GOOSE Services Conformance Statement

Table F.18 GOOSE Conformance

	Subscriber	Publisher	Value/Comment
GOOSE Services	Y	Y	
SendGOOSEMessage		Y	
GetGoReference			
GetGOOSEElementNumber			
GetGoCBValues		Y	
SetGoCBValues			
GSENotSupported			
GOOSE Control Block (GoCB)		Y	

ACSI Conformance Statements

Table F.19 ACSI Basic Conformance Statement (Sheet 1 of 2)

		Client/Subscriber	Server/Publisher	SEL-2411 Support
Client-Server Roles				
B11	Server side (of Two-Party Application-Association)	-	cl[a]	YES
B12	Client side (of Two-Party Application-Association)	cl[a]	-	
SCMS Supported				
B21	SCSM: IEC 61850-8-1 used			YES
B22	SCSM: IEC 61850-9-1 used			
B23	SCSM: IEC 61850-9-2 used			
B24	SCSM: other			
Generic Substation Event Model (GSE)				
B31	Publisher side	-	O[b]	YES
B32	Subscriber side	O[b]	-	YES

Table F.19 ACSI Basic Conformance Statement (Sheet 2 of 2)

		Client/Subscriber	Server/Publisher	SEL-2411 Support
Transmission of Sampled Value Model (SVC)				
B41	Published side	-	O[b]	
B42	Subscriber side	O[b]	-	

[a] c1 shall be mandatory if support for LOGICAL-DEVICE model has been declared.
[b] O = Optional.

Table F.20 ACSI Models Conformance Statement (Sheet 1 of 2)

		Client/Subscriber	Server/Publisher	SEL-2411 Support
If Server Side (B11) Supported				
M1	Logical device	c2[a]	c2[a]	YES
M2	Logical node	c3[b]	c3[b]	YES
M3	Data	c4[c]	c4[c]	YES
M4	Data set	c5[d]	c5[d]	YES
M5	Substation	O[e]	O[e]	
M6	Setting group control	O[e]	O[e]	
Reporting				
M7	Buffered report control	O[e]	O[e]	YES
M7-1	sequence-number			YES
M7-2	report-time-stamp			YES
M7-3	reason-for-inclusion			YES
M7-4	data-set-name			YES
M7-5	data-reference			YES
M7-6	buffer-overflow			YES
M7-7	entryID			YES
M7-8	BufTm			YES
M7-9	IntgPd			YES
M7-10	G1			YES
M8	Unbuffered report control	O[e]	O[e]	YES
M8-1	sequence-number			YES
M8-2	report-time-stamp			YES
M8-3	reason-for-inclusion			YES
M8-4	data-set-name			YES
M8-5	data-reference			YES
M8-6	BufTm			YES
M8-7	IntgPd			YES
M-8-8	GI			YES
Logging		O[e]	O[e]	
M9	Log control	O[e]	O[e]	
M9-1	IntgPd			
M10	Log	O[e]	O[e]	
M11	Control	M[f]	M[f]	YES
If GSE (B31/32) Is Supported				
M12	GOOSE	O[e]	O[e]	YES
M12-1	entryID			YES
M12-2	DataReflnc			YES
M13	GSSE	O[e]	O[e]	

Table F.20 ACSI Models Conformance Statement (Sheet 2 of 2)

		Client/Subscriber	Server/Publisher	SEL-2411 Support
If GSE (B41/42) Is Supported				
M14	Multicast SVC	O[e]	O[e]	
M15	Unicast SVC	O[e]	O[e]	
M16	Time	M[f]	M[f]	
M17	File Transfer	O[e]	O[e]	

[a] c2 shall be "M" if support for LOGICAL-NODE model has been declared.
[b] c3 shall be "M" if support for DATA model has been declared.
[c] c4 shall be "M" if support for DATA-SET, Substitution, Report, Log Control, or Time model has been declared.
[d] c5 shall be "M" if support for Report, GSE, or SV models has been declared.
[e] O = Optional.
[f] M = Mandatory.

Table F.21 ACSI Services Conformance Statement (Sheet 1 of 3)

Services		AA: TP/MC	Client/ Subscriber	Service/ Publisher	SEL-2411 Support
Server (Clause 6)					
S1	ServerDirectory	TP		M[a]	YES
Application Association (Clause 7)					
S2	Associate		M[a]	M[a]	YES
S3	Abort		M[a]	M[a]	YES
S4	Release		M[a]	M[a]	YES
Logical Device (Clause 8)					
S5	LogicalDeviceDirectory	TP	M[a]	M[a]	YES
Logical Node (Clause 9)					
S6	LogicalNodeDirectory	TP	M[a]	M[a]	YES
S7	GetAllDataValues	TP	O[b]	M[a]	YES
Data (Clause 10)					
S8	GetDataValues	TP	M[a]	M[a]	YES
S9	SetDataValues	TP	O[b]	O[b]	YES
S10	GetDataDirectory	TP	O[b]	M[a]	YES
S11	GetDataDefinition	TP	O[b]	M[a]	YES
Data Set (Clause 11)					
S12	GetDataSetValues	TP	O[b]	M[a]	YES
S13	SetDataSetValues	TP	O[b]	O[b]	YES
S14	CreateDataSet	TP	O[b]	O[b]	
S15	DeleteDataSet	TP	O[b]	O[b]	
S16	GetDataSetDirectory	TP	O[b]	O[b]	YES
Substitution (Clause12)					
S17	SetDataValues	TP	M[a]	M[a]	
Setting Group Control (Clause 13)					
S18	SelectActiveSG	TP	O[b]	O[b]	
S19	SelectEditSG	TP	O[b]	O[b]	
S20	SetSGvalues	TP	O[b]	O[b]	
S21	ConfirmEditSGVal	TP	O[b]	O[b]	
S22	GetSGValues	TP	O[b]	O[b]	
S23	GetSGCBValues	TP	O[b]	O[b]	
S24	Report	TP	c6[c]	c6[c]	YES
S24-1	data-change (dchg)				YES
S24-2	qchg-change (qchg)				YES
S24-3	data-update (dupd)				
S25	GetBRCBValues	TP	c6[c]	c6[c]	YES
S26	SetBRCBValues	TP	c6[c]	c6[c]	YES

Table F.21 ACSI Services Conformance Statement (Sheet 2 of 3)

Services		AA: TP/MC	Client/ Subscriber	Service/ Publisher	SEL-2411 Support
Unbuffered Report Control Block (URCB)					
S27	Report	TP	c6[c]	c6[c]	YES
S27-1	data-change (dchg)				YES
S27-2	qchg-change (qchg)				YES
S27-3	data-update (dupd)				
S28	GetURCBValues	TP	c6[c]	c6[c]	YES
S29	SetURCBValues	TP	c6[c]	c6[c]	YES
Logging (Clause 14)					
Log Control Block					
S30	GetLCBValues	TP	M[a]	M[a]	
S31	SetLCBValues	TP	O[b]	M[a]	
LOG					
S32	QueryLogByTime	TP	c7[d]	M[a]	
S33	QueryLogByEntry	TP	c7[d]	M[a]	
S34	GetLogStatusValues	TP	M[a]	M[a]	
Generic Substation Event Model (GSE) (Clause 14.3.5.3.4)					
GOOSE-Control-Block					
S35	SendGOOSEMessage	MC	c8[e]	c8[e]	YES
S36	GetReference	TP	O[b]	c9[f]	
S37	GetGOOSEElement				
Number	TP	O[b]	c9[f]		
S38	GetGoCBValues	TP	O[b]	O[b]	YES
S39	SetGoCBValues	TP	O[b]	O[b]	Client/Sub
ONLY					
GSSE-Control-Block					
S40	SendGSSEMessage	MC	c8[e]	c8[e]	
S41	GetReference	TP	O[b]	c9[f]	
S42	GetGSSEElement				
Number	TP	Ob	c9[f]		
S43	GetGsCBValues	TP	O[b]	O[b]	
S44	GetGsCBValues	TP	O[b]	O[b]	
Transmission of Sample Value Model (SVC) (Clause 16)					
Multicast SVC					
S45	SendMSVMessage	MC	c10[g]	c10[g]	
S46	GetMSVCBValues	TP	O[b]	O[b]	
S47	SetMSVCBValues	TP	O[b]	O[b]	
Unicast SVC					
S48	SendUSVMessage	MC	c10[g]	c10[g]	
S49	GetUSVCBValues	TP	O[b]	O[b]	
S50	SetUSVCBValues	TP	O[b]	O[b]	
Control (Clause 16.4.8)					
S51	Select		M[a]	O[b]	YES
S52	SelectWithValue	TP	Ma	O[b]	YES
S53	Cancel	TP	O[b]	M[a]	YES
S54	Operate	TP	M[a]	M[a]	YES
S55	Command-Termination	TP	M[a]	M[a]	YES
S56	TimeActivated-Operate	TP	O[b]	O[b]	
File Transfer (Clause 20)					
S57	GetFile	TP	O[b]	M[a]	
S58	SetFile	TP	O[b]	O[b]	
S59	DeleteFile	TP	O[b]	O[b]	
S60	GetFileAttributeValues	TP	O[b]	M[a]	

Table F.21 ACSI Services Conformance Statement (Sheet 3 of 3)

Services		AA: TP/MC	Client/ Subscriber	Service/ Publisher	SEL-2411 Support
Time (Clause 5.5)					
T1	Time resolution of internal clock (nearest negative power of 2 in seconds)			2–10 (1 ms)	T1
T2	Time accuracy of internal clock				10/9
	T1				YES
	T2				YES
	T3				YES
	T4				YES
T3	Supported TimeStamp resolution (nearest negative power of 2 in seconds)			2–10 (1 ms)	10

[a] M = Mandatory.
[b] O = Optional.
[c] c6 shall declare support for at least one (BRCB or URCB).
[d] c7 shall declare support for at least one (QueryLogByTime or QueryLogAfter).
[e] c8 shall declare support for at least one (SendGOOSEMessage or SendGSSEMessage).
[f] c9 shall declare support if TP association is available.
[g] c10 shall declare support for at least one (SendMSVMessage or SendUSVMessage).

Appendix G

Mirrored Bits Communications

Overview

IMPORTANT: Be sure to configure the port before connecting to a Mirrored Bits device. If you connect an unconfigured port to a Mirrored Bits device, the device will appear to be locked up.

Mirrored Bits® is a direct device-to-device communications protocol that allows IEDs to exchange information quickly, securely, and with minimal expense. Use Mirrored Bits for functions such as remote control and remote sensing. The SEL-2411 Programmable Automation Controller supports two Mirrored Bits communications channels, designated A and B. Use the port setting PROTO to assign one of the Mirrored Bits communications channels to a serial port; PROTO := MBA for Mirrored Bits communications Channel A or PROTO := MBB for Mirrored Bits communications Channel B. Mirrored Bits are either Transmit Mirrored Bits (TMB) or Received Mirrored Bits (RMB). Transmit Mirrored Bits include TMB1A–TMB8A (channel A) and TMB1B–TMB8B (channel B). The last letter (A or B) designates with which channel the bits are associated. Received bits include RMB1A–RMB8A and RMB1B–RMB8B. Control the transmit Mirrored Bits in SELogic® control equations. Use the received Mirrored Bits as arguments in SELogic control equations. The channel status bits are ROKA, RBADA, CBADA, LBOKA, ROKB, RBADB, CBADB, and LBOKB. You can also use these channel status bits as arguments in SELogic control equations. Use the **COM** command (see *Section 7: Communications*) for additional channel status information.

Because of different applications, the SEL product range supports several variations of the Mirrored Bits communications protocol. Through port settings, you can set the SEL-2411 for compatible operation with SEL-300 series devices, SEL-2505 Remote I/O Modules, and SEL-2100 Logic Processors. When communicating with an SEL-400 series relay, be sure to set the transmission mode setting in the SEL-400 series relay to paced transmission (TXMODE: = P).

Operation

Message Transmission

In the SEL-2411, the Mirrored Bits transmission rate is a function of both the baud rate and the power system cycle. At baud rates below 9600, the SEL-2411 transmits Mirrored Bits as fast as possible for the given baud. At rates at and above 9600 baud the SEL-2411 self-paces, using a technique similar to the SEL-400 series pacing mode. There are no settings to enable or disable the self-pacing mode; the SEL-2411 automatically enters the self-pacing mode at baud rates of 9600, 19200, and 38400. *Table G.1* shows the transmission rates of the Mirrored Bits messages at different baud.

Table G.1 Number of MIRRORED BITS Messages for Different Baud

Baud Rate	Transmission Rate of MIRRORED BITS Packets
2400	15 ms
4800	7.5 ms
9600	4 times a power system cycle (automatic pacing mode)
19200	4 times a power system cycle (automatic pacing mode)
38400	4 times a power system cycle (automatic pacing mode)

Transmitting at longer intervals for baud rates above 9600 avoids overflowing devices that receive MIRRORED BITS at a slower rate.

Message Reception Overview

During synchronized MIRRORED BITS communications with the communications channel in normal state, the device decodes and checks each received message. If the message is valid, the device sends each received logic bit (RMB*n*, where *n* = 1 through 8) to the corresponding pickup and dropout security counters, that in turn set or clear the RMB*n*A and RMB*n*B device element bits.

Message Decoding and Integrity Checks

Set the RX_ID of the local SEL-2411 to match the TX_ID of the remote SEL-2411. The SEL-2411 provides indication of the status of each MIRRORED BITS communications channel with Device Word bits ROKA (receive OK) and ROKB. During normal operation, the device sets the ROK*c* (*c* = A or B). Upon detecting any of the following conditions, the device clears the ROK*c* bit:

- The device is disabled.
- MIRRORED BITS are not enabled.
- Parity, framing, or overrun errors.
- Receive message identification error.
- No message received in the time three messages have been sent when PROTO = MB*c*, or seven messages have been sent when PROTO = MB8*c*.
- Loopback is enabled.

The device asserts ROK*c* only after successful synchronization as described below and two consecutive messages pass all of the data checks described above. After ROK*c* is reasserted, received data may be delayed while passing through the security counters described below.

While ROK*c* is deasserted, the device does not transfer new RMB data to the pickup-dropout security counters described below. Instead, the device sends one of the user-definable default values to the security counter inputs. For each RMB*n*, use the RXDFLT setting to determine the default state the MIRRORED BITS should use in place of received data if an error condition is detected. The setting is a mask of 1s, 0s, and/or Xs (for RMB1A–RMB8A), where X represents the most recently received valid value. The positions of the 1s and 0s correspond to the respective positions of the MIRRORED BITS in the Device Word bits (see *Appendix H: Device Word Bits*). *Table G.2* is an extract of *Appendix H: Device Word Bits*, showing the positions of the MIRRORED BITS.

Table G.2 Positions of the MIRRORED BITS

Bit/Row	7	6	5	4	3	2	1	0
97	RMB8A	RMB7A	RMB6A	RMB5A	RMB4A	RMB3A	RMB2A	RMB1A
99	RMB8B	RMB7B	RMB6B	RMB5B	RMB4B	RMB3B	RMB2B	RMB1B

Table G.3 MIRRORED BITS Values for a RXDFLT Setting of 10100111

Bit/Row	7	6	5	4	3	2	1	0
97	1	0	1	0	0	1	1	1

Table G.3 shows an example of the values of the MIRRORED BITS for a RXDFLT setting of 10100111.

Individual pickup and dropout security counters supervise the movement of each received data bit into the corresponding RMB*n* element. You can set each pickup/dropout security counter from 1 to 8. A setting of 1 causes a security counter to pass every occurrence, while a setting of 8 causes a counter to wait for eight consecutive occurrences in the received data before updating the data bits. The pickup and dropout security count settings are separate. Control the security count settings with the settings RMB*n*PU and RMB*n*DO.

A pickup/dropout security counter operates identically to a pickup/dropout timer, except that the counter uses units of counted received messages instead of time. Select a setting for the security counter in accordance with the transmission rate (see *Table G.1*). For example, when transmitting at 2400 baud, a security counter set to 2 counts delays a bit by about 30 ms. However, when operating at 9600 baud, a setting of 2 counts delays a bit by about 8.5 ms.

You must consider the impact of the security counter settings in the receiving device to determine the channel timing performance, particularly when two devices of different processing rates are communicating via MIRRORED BITS, such as an SEL-321 and an SEL-2411. The SEL-321 processes power system information each 1/8 power system cycle, but, when transmitting at 19200 baud, the SEL-2411 processes MIRRORED BITS messages at 4.15 ms at 60 Hz (4 times per power system cycle at 60 Hz). Although the SEL-321 processes power system information each 1/8 power system cycle, the device processes the MIRRORED BITS pickup/dropout security counters as MIRRORED BITS messages are received. Because the SEL-2411 transmits messages at approximately 1/4-cycle processing interval (9600 baud and above, see *Table G.1*), a counter set to two in the SEL-321 delays a received bit by another approximately 1/2 cycle. However, a security counter in the SEL-2411 with a setting of two delays a received bit from the SEL-321 by 1/4 cycle, because the SEL-2411 is receiving new MIRRORED BITS messages each 1/8 cycle from the SEL-321.

Channel Synchronization

When an SEL-2411 detects a communications error, it deasserts ROKA or ROKB. If an SEL-2411 detects two consecutive communications errors, it transmits an attention message, which includes the TXID setting. The device transmits an attention message until it receives an attention message that includes a match to the TXID setting value. If the attention message is successful, the device has properly synchronized and data transmission resumes. If the attention message is not successful, the device repeats the attention message until it is successful.

In summary, when a device detects an error, it transmits an attention message until it receives an attention message with its own TX_ID included. If three or four devices are connected in a ring topology, the attention message will go all the way around the loop until the originating device receives it. The message then dies and data transmission resumes. This method of synchronization allows the devices to reliably determine which byte is the first byte of the message. It also forces unsynchronized UARTs to become resynchronized. On the down side, this method takes down the entire loop for a receive error at any device in the loop. This decreases availability. It also makes one-way communications impossible.

Loopback Testing

Use the **LOOP** command to enable loopback testing. In the loopback mode, you loop the transmit port to the receive port of the same device to verify transmission messages. While in loopback mode, ROK*c* is deasserted, and another user accessible Device Word bit, LBOK*c* (Loop Back OK) asserts and deasserts based on the received data checks (see the *Section 7: Communications* for the ASCII commands).

Channel Monitoring

Based on the results of data checks (described above), the device collects information regarding the 255 most recent communications errors. Each record contains at least the following fields:

- DATE—Date when the dropout occurred
- TIME—Time when the dropout occurred
- RECOVERY_DATE—Date when the channel returned to service (if the channel is currently failed, it is displayed and included in the calculations, as if its recovery were to occur at the time the report was requested)
- RECOVERY_TIME—Time when the channel returned to service (if the channel is currently failed, it is displayed and included in the calculations, as if its recovery were to occur at the time the report was requested)
- DURATION—Time elapsed during dropout
- CAUSE—Reason for dropout (see *Message Decoding and Integrity Checks on page G.2*)

There is a single record for each outage, but an outage can evolve. For example, the initial cause could be a data disagreement, but framing errors can extend the outage. If the channel is currently failed, it is displayed and included in the calculations, as if its recovery were to occur at the time the report was requested.

NOTE: Combine error conditions including RBADA, RBADB, CBADA, and CBADB with other alarm conditions using SELOGIC control equations. You can use these alarm conditions to program the device to take appropriate action when it detects a communications channel failure.

When the duration of an outage on Channel A or B exceeds a user-definable threshold, the device asserts a user-accessible Device Word bit, RBADA or RBADB. When channel unavailability exceeds a user-definable threshold for Channel A or B, the device asserts a user-accessible Device Word bit, CBADA or CBADB. Use the **COMM** command to generate a long or summary report of the communications errors.

Use the RBADPU setting to determine how long a channel error must last before the meter element RBADA is asserted. RBADA is deasserted when the channel error is corrected. RBADPU is accurate to ±1 second.

Use the CBADPU setting to determine the ratio of channel down time to the total channel time before the meter element CBADA is asserted. The times used in the calculation are those that are available in the COM records. See the *COMMUNICATIONS Command on page 7.9* for more information.

MIRRORED BITS Protocol for the Pulsar 9600 Baud Modem

To use a Pulsar MBT modem, set setting PROTO := MBTA or MBTB (Port settings). Setting PROTO := MBTA or MBTB hides setting SPEED (forces the baud to 9600), hides setting PARITY (forces parity to a value of 0), hides setting RTSCTS (forces RTSCTS to a value of N), and forces the transmit time to be faster than double the power system cycle. *Table G.4* shows the difference in message transmission periods when not using the Pulsar modem (PROTO ≠ MBTA or MBTB), and using the Pulsar MBT modem (PROTO = MBTA or MBTB).

NOTE: You must consider the idle time in calculations of data transfer latency through a Pulsar MBT modem system.

Table G.4 MIRRORED BITS Communications Message Transmission Period

Baud	PROTO ≠ MBTA or MBTB	PROTO = MBTA or MBTB
38400	4 times a power system cycle	n/a
19200	4 times a power system cycle	n/a
9600	4 times a power system cycle	2 times a power system cycle
4800	7.5 ms	n/a

The device sets RTS to a negative voltage at the EIA-232 connector to signify that MIRRORED BITS communications matches this specification.

Appendix H

Device Word Bits

Overview

The protection and control element results are represented by Device Word bits in the SEL-2411. Each Device Word bit has a label name and can be in either of the following states:

- 1 (logical 1)
- 0 (logical 0)

Logical 1 represents an element being picked up or otherwise asserted. Logical 0 represents an element being dropped out or otherwise deasserted. *Table H.1* and *Table H.2* show a list of Device Word bits and corresponding descriptions. The Device Word bit row numbers correspond to the row numbers used in the **TAR** command (see *TARGET Command (Display Device Word Bit Status) on page 7.24*).

Use any Device Word bit (except Row 0) in SELOGIC® control equations (see *Section 4: Logic Functions*) and the Sequential Events Recorder (SER) trigger list settings (see *Section 9: Analyzing Events*).

Table H.1 SEL-2411 Device Word Bits (Sheet 1 of 3)

Bit/ Row	Device Word Bits							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
TAR 0	ENABLED	*	T01_LED	T02_LED	T03_LED	T04_LED	T05_LED	T06_LED
1	PB01_LED	PB02_LED	PB03_LED	PB04_LED	*	SALARM	IRIGOK	HALARM
2	RB01	RB02	RB03	RB04	RB05	RB06	RB07	RB08
3	RB09	RB10	RB11	RB12	RB13	RB14	RB15	RB16
4	RB17	RB18	RB19	RB20	RB21	RB22	RB23	RB24
5	RB25	RB26	RB27	RB28	RB29	RB30	RB31	RB32
6	LB01	LB02	LB03	LB04	LB05	LB06	LB07	LB08
7	LB09	LB10	LB11	LB12	LB13	LB14	LB15	LB16
8	LB17	LB18	LB19	LB20	LB21	LB22	LB23	LB24
9	LB25	LB26	LB27	LB28	LB29	LB30	LB31	LB32
10	SV01	SV02	SV03	SV04	SV05	SV06	SV07	SV08
11	SV01T	SV02T	SV03T	SV04T	SV05T	SV06T	SV07T	SV08T
12	SV09	SV10	SV11	SV12	SV13	SV14	SV15	SV16
13	SV09T	SV10T	SV11T	SV12T	SV13T	SV14T	SV15T	SV16T
14	SV17	SV18	SV19	SV20	SV21	SV22	SV23	SV24
15	SV17T	SV18T	SV19T	SV20T	SV21T	SV22T	SV23T	SV24T
16	SV25	SV26	SV27	SV28	SV29	SV30	SV31	SV32
17	SV25T	SV26T	SV27T	SV28T	SV29T	SV30T	SV31T	SV32T
18	SV33	SV34	SV35	SV36	SV37	SV38	SV39	SV40
19	SV33T	SV34T	SV35T	SV36T	SV37T	SV38T	SV39T	SV40T
20	SV41	SV42	SV43	SV44	SV45	SV46	SV47	SV48

Table H.1 SEL-2411 Device Word Bits (Sheet 2 of 3)

Bit/ Row	Device Word Bits							
	7	6	5	4	3	2	1	0
21	SV41T	SV42T	SV43T	SV44T	SV45T	SV46T	SV47T	SV48T
22	SV49	SV50	SV51	SV52	SV53	SV54	SV55	SV56
23	SV49T	SV50T	SV51T	SV52T	SV53T	SV54T	SV55T	SV56T
24	SV57	SV58	SV59	SV60	SV61	SV62	SV63	SV64
25	SV57T	SV58T	SV59T	SV60T	SV61T	SV62T	SV63T	SV64T
26	SET01	SET02	SET03	SET04	SET05	SET06	SET07	SET08
27	RST01	RTS02	RST03	RST04	RST05	RST06	RST07	RST08
28	SET09	SET10	SET11	SET12	SET13	SET14	SET15	SET16
29	RST09	RST10	RST11	RST12	RST13	RST14	RST15	RST16
30	SET17	SET18	SET19	SET20	SET21	SET22	SET23	SET24
31	RST17	RST18	RST19	RST20	RST21	RST22	RST23	RST24
32	SET25	SET26	SET27	SET28	SET29	SET30	SET31	SET32
33	RST25	RST26	RST27	RST28	RST29	RST30	RST31	RST32
34	LT01	LT02	LT03	LT04	LT05	LT06	LT07	LT08
35	LT09	LT10	LT11	LT12	LT13	LT14	LT15	LT16
36	LT17	LT18	LT19	LT20	LT21	LT22	LT23	LT24
37	LT25	LT26	LT27	LT28	LT29	LT30	LT31	LT32
38	SC01QU	SC02QU	SC03QU	SC04QU	SC05QU	SC06QU	SC07QU	SC08QU
39	SC01QD	SC02QD	SC03QD	SC04QD	SC05QD	SC06QD	SC07QD	SC08QD
40	SC09QU	SC10QU	SC11QU	SC12QU	SC13QU	SC14QU	SC15QU	SC16QU
41	SC09QD	SC10QD	SC11QD	SC12QD	SC13QD	SC14QD	SC15QD	SC16QD
42	SC17QU	SC18QU	SC19QU	SC20QU	SC21QU	SC22QU	SC23QU	SC24QU
43	SC17QD	SC18QD	SC19QD	SC20QD	SC21QD	SC22QD	SC23QD	SC24QD
44	SC25QU	SC26QU	SC27QU	SC28QU	SC29QU	SC30QU	SC31QU	SC32QU
45	SC25QD	SC26QD	SC27QD	SC28QD	SC29QD	SC30QD	SC31QD	SC32QD
46	*	DSABLSET	RSTTRGT	ER	TRGTR	SPEN	*	*
47	RELAY_EN	*	*	*	MATHERR	ERTDIN	ERTDFLT	IRTDFLT[a]
48	IN101	IN102	*	*	*	*	*	*
49	IN301	IN302	IN303	IN304	IN305	IN306	IN307	IN308
50	IN401	IN402	IN403	IN404	IN405	IN406	IN407	IN408
51	IN501	IN502	IN503	IN504	IN505	IN506	IN507	IN508
52	IN601	IN602	IN603	IN604	IN605	IN606	IN607	IN608
53	OUT101	OUT102	OUT103	*	*	*	*	*
54	OUT301	OUT302	OUT303	OUT304	OUT305	OUT306	OUT307	OUT308
55	OUT401	OUT402	OUT403	OUT404	OUT405	OUT406	OUT407	OUT408
56	OUT501	OUT502	OUT503	OUT504	OUT505	OUT506	OUT507	OUT508
57	OUT601	OUT602	OUT603	OUT604	OUT605	OUT606	OUT607	OUT608
58	AILW1	AILW2	AILAL	*	AIHW1	AIHW2	AIHAL	*
59	AI301LW1	AI301LW2	AI301LAL	*	AI301HW1	AI301HW2	AI301HAL	*
60	AI302LW1	AI302LW2	AI302LAL	*	AI302HW1	AI302HW2	AI302HAL	*
61	AI303LW1	AI303LW2	AI303LAL	*	AI303HW1	AI303HW2	AI303HAL	*
62	AI304LW1	AI304LW2	AI304LAL	*	AI304HW1	AI304HW2	AI304HAL	*
63	AI305LW1	AI305LW2	AI305LAL	*	AI305HW1	AI305HW2	AI305HAL	*
64	AI306LW1	AI306LW2	AI306LAL	*	AI306HW1	AI306HW2	AI306HAL	*
65	AI307LW1	AI307LW2	AI307LAL	*	AI307HW1	AI307HW2	AI307HAL	*
66	AI308LW1	AI308LW2	AI308LAL	*	AI308HW1	AI308HW2	AI308HAL	*
67	AI401LW1	AI401LW2	AI401LAL	*	AI401HW1	AI401HW2	AI401HAL	*
68	AI402LW1	AI402LW2	AI402LAL	*	AI402HW1	AI402HW2	AI402HAL	*
69	AI403LW1	AI403LW2	AI403LAL	*	AI403HW1	AI403HW2	AI403HAL	*
70	AI404LW1	AI404LW2	AI404LAL	*	AI404HW1	AI404HW2	AI404HAL	*
71	AI405LW1	AI405LW2	AI405LAL	*	AI405HW1	AI405HW2	AI405HAL	*

Table H.1 SEL-2411 Device Word Bits (Sheet 3 of 3)

Bit/ Row	Device Word Bits							
	7	6	5	4	3	2	1	0
72	AI406LW1	AI406LW2	AI406LAL	*	AI406HW1	AI406HW2	AI406HAL	*
73	AI407LW1	AI407LW2	AI407LAL	*	AI407HW1	AI407HW2	AI407HAL	*
74	AI408LW1	AI408LW2	AI408LAL	*	AI408HW1	AI408HW2	AI408HAL	*
75	AI501LW1	AI501LW2	AI501LAL	*	AI501HW1	AI501HW2	AI501HAL	*
76	AI502LW1	AI502LW2	AI502LAL	*	AI502HW1	AI502HW2	AI502HAL	*
77	AI503LW1	AI503LW2	AI503LAL	*	AI503HW1	AI503HW2	AI503HAL	*
78	AI504LW1	AI504LW2	AI504LAL	*	AI504HW1	AI504HW2	AI504HAL	*
79	AI505LW1	AI505LW2	AI505LAL	*	AI505HW1	AI505HW2	AI505HAL	*
80	AI506LW1	AI506LW2	AI506LAL	*	AI506HW1	AI506HW2	AI506HAL	*
81	AI507LW1	AI507LW2	AI507LAL	*	AI507HW1	AI507HW2	AI507HAL	*
82	AI508LW1	AI508LW2	AI508LAL	*	AI508HW1	AI508HW2	AI508HAL	*
83	AI601LW1	AI601LW2	AI601LAL	*	AI601HW1	AI601HW2	AI601HAL	*
84	AI602LW1	AI602LW2	AI602LAL	*	AI602HW1	AI602HW2	AI602HAL	*
85	AI603LW1	AI603LW2	AI603LAL	*	AI603HW1	AI603HW2	AI603HAL	*
86	AI604LW1	AI604LW2	AI604LAL	*	AI604HW1	AI604HW2	AI604HAL	*
87	AI605LW1	AI605LW2	AI605LAL	*	AI605HW1	AI605HW2	AI605HAL	*
88	AI606LW1	AI606LW2	AI606LAL	*	AI606HW1	AI606HW2	AI606HAL	*
89	AI607LW1	AI607LW2	AI607LAL	*	AI607HW1	AI607HW2	AI607HAL	*
90	AI608LW1	AI608LW2	AI608LAL	*	AI608HW1	AI608HW2	AI608HAL	*
91	*	*	*	*	*	*	*	*
92	IN101E	IN102E	*	*	*	*	*	*
93	IN301E	IN302E	IN303E	IN304E	IN305E	IN306E	IN307E	IN308E
94	IN401E	IN402E	IN403E	IN404E	IN405E	IN406E	IN407E	IN408E
95	IN501E	IN502E	IN503E	IN504E	IN505E	IN506E	IN507E	IN508E
96	IN601E	IN602E	IN603E	IN604E	IN605E	IN606E	IN607E	IN608E
97	RMB8A	RMB7A	RMB6A	RMB5A	RMB4A	RMB3A	RMB2A	RMB1A
98	TMB8A	TMB7A	TMB6A	TMB5A	TMB4A	TMB3A	TMB2A	TMB1A
99	RMB8B	RMB7B	RMB6B	RMB5B	RMB4B	RMB3B	RMB2B	RMB1B
100	TMB8B	TMB7B	TMB6B	TMB5B	TMB4B	TMB3B	TMB2B	TMB1B
101	LBOKB	CBADB	RBADB	ROKB	LBOKA	CBADA	RBADA	ROKA
102	PB01	PB02	PB03	PB04	*	*	*	*
103	PB01_PUL	PB02_PUL	PB03_PUL	PB04_PUL	*	*	*	*
104	VB001	VB002	VB003	VB004	VB005	VB006	VB007	VB008
105	VB009	VB010	VB011	VB012	VB013	VB014	VB015	VB016
106	VB017	VB018	VB019	VB020	VB021	VB022	VB023	VB024
107	VB025	VB026	VB027	VB028	VB029	VB030	VB031	VB032
108	VB033	VB034	VB035	VB036	VB037	VB038	VB039	VB040
109	VB041	VB042	VB043	VB044	VB045	VB046	VB047	VB048
110	VB049	VB050	VB051	VB052	VB053	VB054	VB055	VB056
111	VB057	VB058	VB059	VB060	VB061	VB062	VB063	VB064
112	VB065	VB066	VB067	VB068	VB069	VB070	VB071	VB072
113	VB073	VB074	VB075	VB076	VB077	VB078	VB079	VB080
114	VB081	VB082	VB083	VB084	VB085	VB086	VB087	VB088
115	VB089	VB090	VB091	VB092	VB093	VB094	VB095	VB096
116	VB097	VB098	VB099	VB100	VB101	VB102	VB103	VB104
117	VB105	VB106	VB107	VB108	VB109	VB110	VB111	VB112
118	VB113	VB114	VB115	VB116	VB117	VB118	VB119	VB120
119	VB121	VB122	VB123	VB124	VB125	VB126	VB127	VB128

[a] IRTDFLT also applies to internal general purpose RTD/TC card.

Definitions

Table H.2 Device Word Bit Definitions (Sheet 1 of 4)

Row	Bit	Definition
0	ENABLED	Device Enabled
	*	Reserved
	T01_LED	SELOGIC Equation: Drives LED 3
	T02_LED	SELOGIC Equation: Drives LED 4
	T03_LED	SELOGIC Equation: Drives LED 5
	T04_LED	SELOGIC Equation: Drives LED 6
	T05_LED	SELOGIC Equation: Drives LED 7
	T06_LED	SELOGIC Equation: Drives LED 8
1	PB01_LED	SELOGIC Equation: Drives LED9
	PB02_LED	SELOGIC Equation: Drives LED10
	PB03_LED	SELOGIC Equation: Drives LED11
	PB04_LED	SELOGIC Equation: Drives LED12
	*	Reserved
	SALARM	Software Alarms: invalid password, changing access levels, settings changes
	IRIGOK	IRIG-B Time Synchronism-Check Input Data is valid
	HALARM	Diagnostics Failure
2	RB01–RB08	Remote Bits RB01 through RB08
3	RB09–RB16	Remote Bits RB09 through RB16
4	RB17–RB24	Remote Bits RB17 through RB24
5	RB25–RB32	Remote Bits RB25 through RB32
6	LB01–LB08	Local Bits LB01 through LB08
7	LB09–LB16	Local Bits LB09 through LB16
8	LB17–LB24	Local Bits LB17 through LB24
9	LB25–LB32	Local Bits LB25 through LB32
10	SV01–SV08	SELOGIC variables SV01 through SV08
11	SV01T–SV08T	SELOGIC variables SV01T through SV08T with settable pickup and dropout time delay
12	SV09–SV16	SELOGIC variables SV09 through SV16
13	SV09T–SV16T	SELOGIC variables SV09T through SV16T with settable pickup and dropout time delay
14	SV17–SV24	SELOGIC variables SV17 through SV24
15	SV17T–SV24T	SELOGIC variables SV17T through SV24T with settable pickup and dropout time delay
16	SV25–SV32	SELOGIC variables SV25 through SV32
17	SV25T–SV32	SELOGIC variables SV25T through SV32T with settable pickup and dropout time delay
18	SV33–SV40	SELOGIC variables SV33 through SV40
19	SV33T–SV40T	SELOGIC variables SV33T through SV40T with settable pickup and dropout time delay
20	SV41–SV48	SELOGIC variables SV41 through SV48
21	SV41T–SV48T	SELOGIC variables SV41T through SV48T with settable pickup and dropout time delay
22	SV49–SV56	SELOGIC variables SV49 through SV56
23	SV49T–SV56T	SELOGIC variables SV49T through SV56T with settable pickup and dropout time delay
24	SV57–SV64	SELOGIC variables SV57 through SV64
25	SV57T–SV64T	SELOGIC variables SV57T through SV64T with settable pickup and dropout time delay
26	SET01–SET08	SELOGIC Set latch bit variables SET01 through SET08
27	RST01–RST08	SELOGIC Reset latch bit variables RST01 through RST08
28	SET09–SET16	SELOGIC Set latch bit variables SET09 through SET16
29	RST09–RST16	SELOGIC Reset latch bit variables RST09 through RST16
30	SET17–SET24	SELOGIC Set latch bit variables SET17 through SET24
31	RST17–RST24	SELOGIC Reset latch bit variables RST17 through RST24
32	SET25–SET32	SELOGIC Set latch bit variables SET25 through SET32
33	RST25–RST32	SELOGIC Reset latch bit variables RST25 through RST32

Table H.2 Device Word Bit Definitions (Sheet 2 of 4)

Row	Bit	Definition
34	LT01–LT08	Latch bit variables LT01 through LT08
35	LT09–LT16	Latch bit variables LT09 through LT16
36	LT17–LT25	Latch bit variables LT17 through LT24
37	LT25–LT32	Latch bit variables LT25 through LT32
38	SC01QU–SC08QU	SELOGIC Counters 01 through 08 asserted when counter = preset value
39	SC01QD–SC08QD	SELOGIC Counters 01 through 08 asserted when counter = 0
40	SC09QU–SC16QU	SELOGIC Counters 09 through 16 asserted when counter = preset value
41	SC09QD–SC17QU	SELOGIC Counters 09 through 16 asserted when counter = 0
42	SC17QU–SC24QU	SELOGIC Counters 17 through 24 asserted when counter = preset value
43	SC17QD–SC24QD	SELOGIC Counters 17 through 24 asserted when counter = 0
44	SC25QU–SC32QU	SELOGIC Counters 25 through 32 asserted when counter = preset value
45	SC25QD–SC32QD	SELOGIC Counters 25 through 32 asserted when counter = 0
46	*	Reserved
	DSABLSET	SELOGIC Equation: Do not allow settings changes from the front panel when asserted.
	RSTTRGT	SELOGIC Equation: Reset targets when asserted. (Remote target reset via rising-edge of this RW)
	ER	SELOGIC Equation ER.
	TRGTR	Target Reset. Asserts for one-quarter cycle if front-panel or serial port target reset is executed.
	SPEN	SELOGIC Equation SPEN. (Enables Signal Profiling when set).
	*	Reserved
	*	Reserved
47	RELAY_EN	61850 Data Quality Bit
	*	Reserved
	*	Reserved
	*	Reserved
	MATHERR	SELOGIC control equation math error: asserts when there is an overflow, NAN or divide by zero condition.
	ERTDIN	State of contact input on external RTD unit (2600A).
	ERTDFLT	Asserts on if any failure on any external RTD.
	IRTDFLT	Asserts on if any failure on any internal RTD card or internal general purpose RTD/TC card.
48	IN101	Digital input slot 1 input 101
	IN102	Digital input slot 1 input 102
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved
49	IN301–IN308	Digital inputs slot 3
50	IN401–IN408	Digital inputs slot 4
51	IN501–IN508	Digital inputs slot 5
52	IN601–IN608	Digital inputs slot 6
53	OUT101	Digital output slot 1 output 101
	OUT102	Digital output slot 1 output 102
	OUT103	Digital output slot 1 output 103
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved

Table H.2 Device Word Bit Definitions (Sheet 3 of 4)

Row	Bit	Definition
54	OUT301–OUT308	Digital outputs slot 3
55	OUT401–OUT408	Digital outputs slot 4
56	OUT501–OUT508	Digital outputs slot 5
57	OUT601–OUT608	Digital outputs slot 6
58	AILW1	Analog inputs Low Warning, Level 1. If any AIxxxLW1 = 1, then AILW1 = 1.
	AILW2	Analog inputs Low Warning, Level 2. If any AIxxxLW2 = 1, then AILW2 = 1.
	AILAL	Analog inputs Low Alarm Limit. If any AIxxxLAL = 1, then AILAL = 1.
	*	Reserved
	AIHW1	Analog inputs High Warning, Level 1. If any AIxxxHW1 = 1, then AIHW1 = 1.
	AIHW2	Analog inputs High Warning, Level 2. If any AIxxxHW2 = 1, then AIHW2 = 1.
	AIHAL	Analog inputs High Alarm Limit. If any AIxxxHAL = 1, then AIHAL = 1.
	*	Reserved
59–90		Analog inputs 301-608 Warnings/Alarms (where xxx = 301–608)
	AIxxxLW1	Low Warning, Level 1
	AIxxxLW2	Low Warning, Level 2
	AIxxxLAL	Low Alarm Limit
	*	Reserved
	AIxxxHW1	High Warning, Level 1
	AIxxxHW2	High Warning, Level 2
	AIxxxHAL	High Alarm Limit
	*	Reserved
91	*	Reserved—Pad Byte
92	IN101E	Edge detect digital input slot 1 input 101
	IN102E	Edge detect digital input slot 1 input 102
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved
93	IN301E–IN308E	Edge detect digital inputs slot 3
94	IN401E–IN408E	Edge detect digital inputs slot 4
95	IN501E–IN508E	Edge detect digital inputs slot 5
96	IN601E–IN608E	Edge detect digital inputs slot 6
97	RMB8A–RMB1A	Channel A receive MIRRORED BITS® RMB1A through RMB8A
98	TMB8A–TMB1A	Channel A transmit MIRRORED BITS TMB1A through TMB8A
99	RMB8B–RMB1B	Channel B receive MIRRORED BITS RMB1B through RMB8B
100	TMB8B–TMB1B	Channel B transmit MIRRORED BITS TMB1B through TMB8B
101	LBOKB	Channel B, looped back ok
	CBADB	Channel B, channel unavailability over threshold
	RBADB	Channel B, outage duration over threshold
	ROKB	Channel B, received data ok
	LBOKA	Channel A, looped back ok
	CBADA	Channel A, channel unavailability over threshold
	RBADA	Channel A, outage duration over threshold
	ROKA	Channel A, received data ok

Table H.2 Device Word Bit Definitions (Sheet 4 of 4)

Row	Bit	Definition
102	PB01	Front-panel pushbutton 1 bit
	PB02	Front-panel pushbutton 2 bit
	PB03	Front-panel pushbutton 3 bit
	PB04	Front-panel pushbutton 4 bit
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved
103	PB01_PUL	Front-panel pushbutton 1 pulse bit (asserted for one processing interval when PB01 is pressed)
	PB02_PUL	Front-panel pushbutton 2 pulse bit (asserted for one processing interval when PB02 is pressed)
	PB03_PUL	Front-panel pushbutton 3 pulse bit (asserted for one processing interval when PB03 is pressed)
	PB04_PUL	Front-panel pushbutton 4 pulse bit (asserted for one processing interval when PB04 is pressed)
	*	Reserved
	*	Reserved
	*	Reserved
	*	Reserved
104	VB001–VB008	Virtual Bits used for Incoming GOOSE messages
105	VB009–VB016	Virtual Bits used for Incoming GOOSE messages
106	VB017–VB024	Virtual Bits used for Incoming GOOSE messages
107	VB025–VB032	Virtual Bits used for Incoming GOOSE messages
108	VB033–VB040	Virtual Bits used for Incoming GOOSE messages
109	VB041–VB048	Virtual Bits used for Incoming GOOSE messages
110	VB049–VB056	Virtual Bits used for Incoming GOOSE messages
111	VB057–VB064	Virtual Bits used for Incoming GOOSE messages
112	VB065–VB072	Virtual Bits used for Incoming GOOSE messages
113	VB073–VB080	Virtual Bits used for Incoming GOOSE messages
114	VB081–VB088	Virtual Bits used for Incoming GOOSE messages
115	VB089–VB096	Virtual Bits used for Incoming GOOSE messages
116	VB097–VB104	Virtual Bits used for Incoming GOOSE messages
117	VB105–VB112	Virtual Bits used for Incoming GOOSE messages
118	VB113–VB120	Virtual Bits used for Incoming GOOSE messages
119	VB121–VB128	Virtual Bits used for Incoming GOOSE messages

This page intentionally left blank

Appendix I

Analog Quantities

NOTE: AC metering quantities are listed as primary values.

NOTE: Analog quantities are only available if the appropriate analog cards are installed.

Table I.1 shows the analog quantities available in the device.

Table I.1 Available Analog Quantities (Sheet 1 of 2)

Analog Quantity	Description	
Analog Input and Miscellaneous Quantities		
AI301–AI308	Analog inputs for an analog card in Slot C	
AI401–AI408	Analog inputs for an analog card in Slot D	
AI501–AI508	Analog inputs for an analog card in Slot E	
AI601–AI608	Analog inputs for an analog card in Slot Z	
INTRTD01–INTRTD10	Internal RTD inputs for an RTD card in Slot D, Degree C	a
EXTRTD01–EXTRTD12	External RTD inputs from an SEL-2600 device, Degree C	b
INTEMP01–INTEMP10	Internal general purpose RTD/TC card in Slot D, Degree C	c
RA001–RA128	Remote Analog inputs	
MV01–MV32	Math Variables	
SC01–SC32	SELOGIC Counters	
FID	Firmware Identifier	
Date/Time Quantities		
YEAR	Year number (0000-9999)	
DAYY	Day of Year number (1-366)	
WEEK	Week number (1-52)	
DAYW	Day of Week number (1-7)	
MINSM	Minutes since Midnight	
Instantaneous (Fundamental) Metering Quantities		
I*x*_MAG	Current Magnitude (x = A, B, C, N, and G)	d
I*x*_ANG	Current Angle (x = A, B, C, N, and G)	d
3I2	Current, negative-sequence, magnitude	d
I*x*X_MAG	Current X Magnitude (x = A, B, C, and G)	e
I*x*X_ANG	Current X Angle (x = A, B, C, and G)	e
3I2X	Current X, negative-sequence, magnitude	e
V*x*_MAG	Voltage Magnitude (x = A, B, C, and G)	e, f
V*x*_ANG	Voltage Angle (x = A, B, C, and G)	e, f
V*xx*_MAG	Voltage Magnitude (x = AB, BC, and CA)	e, f
V*xx*_ANG	Voltage Angle (x = AB, BC, and CA)	e, f
3V2	Voltage, negative-sequence, magnitude	e, f
P*x*	Real power magnitude (x = A, B, and C)	g
Q*x*	Reactive power magnitude (x = A, B, and C)	g
S*x*	Apparent power magnitude (x = A, B, and C)	g
PF*x*	Power factor, magnitude(x = A, B, and C)	g
P	Real power magnitude, 3-phase	g
Q	Reactive power magnitude, 3-phase	g
S	Apparent power magnitude, 3-phase	g
PF	Power factor, magnitude, 3-phase	g
P*x*X	Real power X, magnitude (x = A, B, and C)	e
Q*x*X	Reactive power X, magnitude (x = A, B, and C)	e

Table I.1 Available Analog Quantities (Sheet 2 of 2)

Analog Quantity	Description	
S*x*X	Apparent power X, magnitude (x = A, B, and C)	e
PF*x*X	Power factor X, magnitude (x = A, B, and C)	e
PX	Real power X, magnitude, 3-phase	e
QX	Reactive power X, magnitude, 3-phase	e
SX	Apparent power X, magnitude, 3-phase	e
PFX	Power factor X, magnitude, 3-phase	e
FREQ	Frequency	d, e
Demand Metering Quantities		
I*x*D	Current Demand (x = A, B, C, N, and G)	d
3I2D	Negative-Sequence Current Demand	d
I*x*PD	Current Peak Demand (x = A, B, C, N, and G)	d
3I2PD	Negative-Sequence Current Peak Demand	d
I*x*XD	Current X Demand (x = A, B, C, and G)	e
3I2XD	Negative-Sequence Current X Demand	e
I*x*XPD	Current Peak X Demand (x = A, B, C, and G)	e
3I2XPD	Negative-Sequence Current Peak X Demand	e
Maximum/Minimum Metering Quantities		
I*x*MX	Current, maximum magnitude (x = A, B, C, N, and G)	d
3I2MX	Current, negative sequence, maximum magnitude	d
I*x*XMX	Current, maximum magnitude (x = A, B, C, and G)	e
3I2XMX	Current, negative sequence, maximum magnitude	e
I*x*MN	Current, minimum magnitude (x = A, B, C, N, and G)	d
3I2MN	Current, negative sequence, minimum magnitude	d
I*x*XMN	Current, minimum magnitude (x = A, B, C, and G)	e
3I2XMN	Current, negative sequence, minimum magnitude	e
V*xx*MX	Voltage, maximum magnitude (xx = AB, BC, and CA)	e, f
V*x*MX	Voltage, maximum magnitude (x = A, B, and C)	e, f
V*xx*MN	Voltage, minimum magnitude (xx = AB, BC, and CA)	e, f
V*x*MN	Voltage, minimum magnitude (x = A, B, and C)	e, f
K*x*3PMX	Power magnitude, 3-phase, maximum (x = S, W, and Q)	g
K*x*3PMN	Power magnitude, 3-phase, minimum (x = S, W, and Q)	g
K*x*3PXMX	Power magnitude, 3-phase, maximum (x = S, W, and Q)	e
K*x*3PXMN	Power magnitude, 3-phase, minimum (x = S, W, and Q)	e
FREQMX	Maximum frequency	d, e
FREQMN	Minimum frequency	d, e
Energy Metering Quantities		
MWHI	Real energy, 3-phase IN	g
MWHO	Real energy, 3-phase OUT	g
MVARHI	Reactive energy, 3-phase IN	g
MVARHO	Reactive energy, 3-phase OUT	g
MWHXI	Real energy X, 3-phase IN	e
MWHXO	Real energy X, 3-phase OUT	e
MVARHXI	Reactive energy X, 3-phase IN	e
MVARHXO	Reactive energy X, 3-phase OUT	e

[a] Valid data only if 10 RTD card is installed in Slot D.
[b] Valid data only if SEL-2600 Device is connected via fiber port.
[c] Valid data only if internal general purpose 10 RTD/TC card is installed in Slot D.
[d] Valid data only if 4 CT card is installed in Slot Z.
[e] Valid data only if 3 CT/3 PT card is installed in Slot E.
[f] Valid data only if 3 PT card in installed in Slot E.
[g] Valid data only if 4 CT and 3 PT cards are installed in Slots E and Z, respectively.

Glossary

A Abbreviation for amps or amperes; units of electrical current magnitude.

ACSELERATOR Architect® SEL-5032 ACSELERATOR Architect is an add-on to the ACSELERATOR Suite that utilizes the IEC 61850 Substation Configuration Language to configure SEL IEDs.

ACSELERATOR QuickSet® SEL-5030 A Windows®-based program that simplifies settings and provides analysis support.

Apparent Power, S Complex power expressed in units of volt-amps (VA), kilovolt-amps (kVA), or megavolt-amps (MVA). Accounts for both real (P) and reactive (Q) power dissipated in a circuit: $S = P + jQ$.

Analog In this instruction manual, Analog is synonymous with Transducer.

ASCII Abbreviation for American Standard Code for Information Interchange. Defines a standard way to communicate text characters between two electronic devices. The SEL-2411 uses ASCII text characters to communicate using the device front- and rear-panel EIA-232 serial ports.

Assert To activate; to fulfill the logic or electrical requirements needed to operate a device. To apply a short-circuit or closed contact to an SEL-2411 input. To set a logic condition to the true state (logical 1). To close a normally-open output contact. To open a normally-closed output contact.

AX-S4 MMS "Access for MMS" is an IEC 61850, UCA2, and MMS client application produced by SISCO, Inc., for real-time data integration in Microsoft Windows-based systems supporting OPC and DDE. Included with AX-S4 MMS is the interactive MMS Object Explorer for browser-like access to IEC 61850 / UCA2 and MMS device objects.

Checksum A numeric identifier of the firmware in the device. Calculated by the result of a mathematical sum of the device code.

CID Abbreviation for Checksum Identifier. The checksum of the specific firmware installed in the device.

CID File IEC 61850 Configured IED Description file. XML file that contains the configuration for a specific IED.

CR_RAM Abbreviation for Critical RAM. Refers to the area of device Random Access Memory (RAM) where the device stores mission critical data.

CT Abbreviation for current transformer.

Data Object In the IEC 61850 protocol, part of a logical node representing specific information (status or measurement, for example). From an object-oriented point of view, a data object is an instance of a data class.

Deassert To deactivate; to remove the logic or electrical requirements needed to operate a device. To remove a short-circuit or closed contact from an SEL-2411 input. To clear a logic condition to the false state (logical 0). To open a normally-open output contact. To close a normally-closed output contact.

Delta (Open) A phase-to-phase connection of voltage transformers for electrical measuring purposes. Typically, two voltage transformers are used with one primary lead of the first transformer connected to A-phase and the other lead connected to B-phase. The second voltage transformer is connected to measure the voltage from B-phase to C-phase. When two transformers are used, this connection is frequently called "Open-Delta."

Dropout Time The time measured from the removal of an input signal until the output signal deasserts. The time can be settable, as in the case of a logic variable timer, or can be a result of the characteristics of an element algorithm, as in the case of an overcurrent element dropout time.

Device Word The collection of device element and logic results. Each element or result is represented by a unique identifier, known as a Device Word bit.

Device Word Bit A single device element or logic result that the device updates once each processing interval. A Device Word bit can be equal to either logical 1 or logical 0. Logical 1 represents a true logic condition, picked up element, or asserted contact input or contact output. Logical 0 represents a false logic condition, dropped out element, or deasserted contact input or contact output. You can use Device Word bits in SELOGIC® control equations to control event triggering, output contacts, as well as other functions.

EEPROM Abbreviation for Electrically Erasable Programmable Read-Only Memory. Nonvolatile memory where device settings, event reports, SER records, and other nonvolatile data are stored.

EIA-232 Electrical definition for point-to-point serial data communications interfaces, based on the standard EIA/TIA-232. Formerly known as RS-232.

EIA-485 Electrical standard for multidrop serial data communications interfaces, based on the standard EIA/TIA-485. Formerly known as RS-485.

Event History A quick look at recent device activity that includes a standard report header; event number, date, time, and type; maximum fault phase current; and targets.

Event Report A text-based collection of data stored by the device in response to a triggering condition, such as a fault or command. The data show device measurements before and after the trigger, in addition to the states of protection elements, device inputs, and device outputs each processing interval. After an electrical system fault, use event reports to analyze device and system performance.

Event Summary A shortened version of stored event reports. An event summary includes items such as event date and time, event type, fault voltages, currents, etc. The device sends an event report summary (if auto messaging is enabled) to the device serial port a few seconds after an event.

Fast Hybrid Control Output A control output similar to, but faster than, the hybrid control output. The fast hybrid output uses an insulated gate bipolar junction transistor (IGBT) to interrupt (break) high inductive dc currents and to very rapidly make and hold the current until a metallic contact operates, at which time the IGBT turns off and the metallic contact holds the current. Unlike the hybrid control output, this output is not polarity sensitive; reversed polarity causes no misoperations.

Fast Meter, Fast Operate Binary serial port commands that the device recognizes at the device front-and rear-panel EIA-232 serial ports. These commands and the responses from the device make device data collection by a communications processor faster and more efficient than transfer of the same data through use of formatted ASCII text commands and responses.

FID Device firmware identification string. Lists the device model, firmware version and date code, and other information that uniquely identifies the firmware installed in a particular device.

Firmware The nonvolatile program stored in the device that defines device operation.

Flash A type of nonvolatile device memory used for storing large blocks of nonvolatile data, such as load profile records.

Function In IEC 61850, task(s) performed by the substation automation system, i.e., by application functions. Generally, functions exchange data with other functions. Details are dependent on the functions involved.

Functions are performed by IEDs (physical devices). A function may be split into parts residing in different IEDs but communicating with each other (distributed function) and with parts of other functions. These communicating parts are called logical nodes.

Fundamental Frequency The component of the measured electrical signal for which frequency is equal to the normal electrical system frequency, usually 50 or 60 Hz. Generally used to differentiate between the normal system frequency and any harmonic frequencies present.

Fundamental Meter Type of meter data presented by the SEL-2411 that includes the present values measured at the device ac inputs. The word “Fundamental” is used to indicate that the values are Fundamental Frequency values and do not include harmonics.

GOOSE IEC 61850 Generic Object Oriented Substation Event. GOOSE objects can quickly and conveniently transfer status, controls, and measured values among peers on an IEC 61850 network.

IA, IB, IC Measured A-, B-, and C-phase currents with the 4 ACI card.

IAX, IBX, ICX Measured A-, B-, and C-phase currents with the 3 ACI/3 AVI card.

ICD File IEC 61850 IED Capability Description file. XML file that describes IED capabilities, including information on logical node and GOOSE support.

IEC 61850 Internationally standardized method of communications and integration conceived with the goal of supporting systems of multivendor IEDs networked together to perform protection, monitoring, automation, metering, and control.

IG Residual current, calculated from the sum of the phase currents with the 4 ACI card. In normal, balanced operation, this current is very small or zero.

IGX Residual current, calculated from the sum of the phase currents with the 3 ACI/3 AVI card. In normal, balanced operation, this current is very small or zero.

IN Neutral current measured by the device IN input with the 4 ACI card.

IRIG-B A time code input that the device can use to set the internal device clock.

LCD Abbreviation for Liquid Crystal Display. Used as the device front-panel alphanumeric display.

LED Abbreviation for Light-Emitting Diode. Used as indicator lamps on the device front panel.

MAC Address The Media Access Control (hardware) address of a device connected to a shared network medium, most often used with Ethernet networks.

NEMA Abbreviation for National Electrical Manufacturers Association.

Nominal Frequency Normal electrical system frequency, usually 50 or 60 Hz.

Nonvolatile Memory Device memory that is able to correctly maintain data it is storing even when the device is de-energized.

Phase Rotation The sequence of voltage or current phasors in a multiphase electrical system. In an ABC phase rotation system, the B-phase voltage lags the A-phase voltage by 120 degrees and the C-phase voltage lags B-phase voltage by 120 degrees. In an ACB phase rotation system, the C-phase voltage lags the A-phase voltage by 120 degrees and the B-phase voltage lags the C-phase voltage by 120 degrees.

Pickup Time The time measured from the application of an input signal until the output signal asserts. The time can be settable, as in the case of a logic variable timer, or can be a result of the characteristics of an element algorithm, as in the case of an overcurrent element pickup time.

Pinout The definition or assignment of each electrical connection at an interface. Typically refers to a cable, connector, or jumper.

Power, P Real part of the complex power (S) expressed in units of Watts (W), kilovoltwatts (kW), or megawatts (MW).

Power Factor The cosine of the angle by which phase current lags phase voltage in an ac electrical circuit. Power factor equals 1.0 for power flowing to a resistive load.

PT Abbreviation for potential transformer. Also referred to as a voltage transformer or VT.

RAM Abbreviation for Random Access Memory. Volatile memory where the device stores intermediate calculation results, Device Word bits, and other data that are updated every processing interval.

Power, Q Reactive part of the complex power (S) expressed in units of Vars (Var), kilovars (kVar), or megavars (MVar).

Remote Bit A Device Word bit for which state is controlled by serial port commands, including the CONTROL command, binary Fast Operate command, or Modbus® RTU, Modbus TCP, DNP3, or DNP3 LAN/WAN command.

Residual Current The sum of the measured phase currents. In normal, balanced operation, this current is very small or zero. When a motor ground fault occurs, this current can be large.

RMS Abbreviation for Root-Mean-Square. Refers to the effective value of the sinusoidal current and voltage measured by the device, accounting for the fundamental frequency and higher order harmonics in the signal.

ROM Abbreviation for Read-Only Memory. Nonvolatile memory where the device firmware is stored.

RTD Abbreviation for Resistance Temperature Device. An RTD is made of a metal having a precisely known resistance and temperature coefficient of resistance. The SEL-2411 (and the SEL-2600 Device RTD Modules) can measure the resistance of the RTD, and thus, determine the temperature at the RTD location. Typically embedded in the motor windings or attached to the races of bearings.

SCD File IEC 61850 Substation Configuration Description file. XML file that contains information on all IEDs within a substation, communications configuration data, and a substation description.

SCL File IEC 61850 Substation Configuration Language. An XML-based configuration language that supports the exchange of database configuration data among different software tools that can be from different manufacturers. There are four types of SCL files used within IEC 61850: CID, ICD, SCD, and SSD.

Self-Test A function that verifies the correct operation of a critical device subsystem and indicates if an out-of-tolerance condition is detected. The SEL-2411 is equipped with self-tests that validate the device power supply, microprocessor, memory, and other critical systems.

SELOGIC® Control Equation A device setting that allows you to control a device function (such as an output contact) by using a logical combination of device element outputs and fixed logic outputs. Logical AND, OR, INVERT, rising edge [/], and falling edge [\] operators, plus a single level of parentheses are available to use in each control equation setting.

Sequential Events Recorder A device function that stores a record of the date and time of each assertion and deassertion of every Device Word bit in a settable list. Provides a useful way to determine the order and timing of events following a device operation.

SER Abbreviation for Sequential Events Recorder or the device serial port command to request a report of the latest 512 sequential events.

SSD File IEC 61850 System Specification Description file. XML file that describes the single-line diagram of the substation and the required logical nodes.

Terminal Emulation Software Personal computer (PC) software that can be used to send and receive ASCII text messages via the PC serial port.

TC Abbreviation for Thermoucouple. A TC is made of two differnet metals that produce a voltage related to a temperature difference. The SEL-2414 can measure the voltage of the TC, and thus determine the temperature at the TC location. Typically widely used in industrial areas but have been used on older utility transformers instead of RTDs.

Transducer Device that converts the input to the device to an analog output quantity of either current (±1, 2.5, 5, 10 and 20 mA, or 4–20 ma), or voltage (±1, 2.5, 5, or 10 V).

UCA2 Utility Communications Architecture. A network-independent protocol suite that serves as an interface for individual intelligent electronic devices.

Unbuffered Report IEC 61850 IEDs can issue immediate unbuffered reports of internal events (caused by trigger options data-change, quality-change, and data-update) on a “best efforts” basis. If no association exists, or if the transport data flow is not fast enough to support it, events may be lost.

V Abbreviation for volts or voltage; units of electrical voltage magnitude.

VA, VB, VC Measured A-, B-, and C-phase-to-neutral voltages.

VAB, VBC, VCA Measured or calculated phase-to-phase voltages.

VG Residual voltage calculated from the sum of the three phase-to-neutral voltages, if connected.

VT Abbreviation for voltage transformer. Also referred to as a potential transformer or PT.

Wye As used in this instruction manual, a phase-to-neutral connection of voltage transformers for electrical measuring purposes. Three voltage transformers are used with one primary lead of the first transformer connected to A-phase and the other lead connected to ground. The second and third voltage transformers are connected to measure the voltage from B-phase and C-phase-to-ground, respectively. This connection is frequently called "four-wire wye," alluding to the three phase leads plus the neutral lead.

Z-Number That portion of the device FID string that identifies the proper ACSELERATOR QuickSet software device driver version when creating or editing device settings files.

Index

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

O

P

R

S

T

U

V

SEL-2411 Programmable Automation Controller Command Summary

The table below lists the front serial port ASCII commands associated with particular activities. The commands are shown in uppercase letters, but they can also be entered using lowercase letters.

Serial Port Command	Command Description
Access Level 0 Commands	
ACC	Go to Access Level 1.
BNA	Display ASCII names of all the Device Word bits returned in the Fast Meter Data Block.
CAS	Return the Compressed ASCII configuration message.
DNA	Display ASCII names of Device Word bits reported in Fast Meter.
ID	Device identification code.
QUI	Go to Access Level 0.
SNS	Display SER settings in Compressed ASCII format.
Access Level 1 Commands	
2AC	Go to Access Level 2.
CEV *n*	Display compressed event report, 15 cycles (*n* is the event report).
CEV *n* R	Display compressed event report with raw (unfiltered) data, 16 or 65 cycles.
CHI	Display compressed history report.
CME A	Display fundamental metering data in compressed format.
CME F	Display fundamental metering data in compressed format.
CME M	Display math variable metering data in compressed format.
CME RE	Display remote analog metering data in compressed format.
COM A	Return a summary report of the last 255 records in the communications buffer for MIRRORED BITS® communications Channel A.
COM B	Return a summary report of the last 255 records in the communications buffer for MIRRORED BITS communications Channel B.
COM C	Clears all communications records. If both MIRRORED BITS channels are enabled, omitting the channel specifier (A or B) clears both channels.
COM C A	Clears all communications records for Channel A.
COM C B	Clears all communications records for Channel B.
COM L	Appends a long report to the summary report of the last 255 records in the MIRRORED BITS communications buffer.
COM L A	Appends a long report to the summary report of the last 255 records in the communications buffer for MIRRORED BITS communications Channel A.

Serial Port Command	Command Description
COM L B	Appends a long report to the summary report of the last 255 records in the communications buffer for MIRRORED BITS communications Channel B.
COM S	Return a summary report of the last 255 records in the MIRRORED BITS communications buffer.
COU *n*	Display the values of the SELOGIC® counters *n* times.
CPR	Display analog signal profile data.
CST	Display compressed status report.
CSU	Display compressed event summary.
DAT	View the date.
DAT *dd/mm/yyyy*	Enter date in DMY format if DATE_F setting is DMY.
DAT *mm/dd/yyyy*	Enter date in MDY format if DATE_F setting is MDY.
DAT *yyyy/mm/dd*	Enter date in YMD format if DATE_F setting is YMD.
EVE *n*	Show event report *n* with 4 samples per cycle. If *n* is omitted, most recent report is displayed.
EVE *n*R	Show event report *n* with raw (unfiltered) 16 samples per cycle analog data and 4 samples per cycle digital data.
FIL DIR	Return a list of files.
FIL READ *filename*	Transfer settings file *filename* from the device to the PC.
FIL SHOW *filename*	Filename 1 displays contents of the file filename.
GOO *k*	Display transmit and receive GOOSE messaging information. Enter number *k* to scroll the GOOSE data *k* times on the screen.
HEL	Display a short description of selected commands.
HIS *n*	Show summary of *n* latest event reports, where *n* = 1 is the most recent entry. If *n* is not specified, all event report summaries are displayed.
HIS C or R	Clear or reset history buffer.
IRIG	Force synchronization of internal control clock to IRIG-B time-code input.
MAC	Display the MAC address of the Ethernet port (PORT 1).
MAP *x y*	Display DNP3 map for port *x*, session *y*.
MET	Display instantaneous metering data.
MET A	Display analog input metering data.
MET D	Display demand and peak demand metering data.
MET E	Display energy metering data.
MET F *k*	Display fundamental metering data *k* times, where *k* is between 1 and 32767.
MET MATH	Display math variable metering data.
MET MAX	Display maximum/minimum metering data.
MET RA	Display remote analog metering data.
MET RD	Reset demand metering data.
MET RE	Reset energy metering data.
MET RM	Reset maximum/minimum metering data.

Serial Port Command	Command Description
MET RP	Reset peak demand metering data.
MET RTD	Display internal and external RTD metering data.
MET TEMP	Display internal general purpose RTD/TC metering data.
PRO	Display analog signal profile data.
PRO C	Clears analog signal profile data.
SER	Display all Sequential Events Recorder (SER) data.
SER *date1*	Display all **SER** records made on *date1*.
SER *date1 date2*	Display all **SER** records made from dates *d2* to *d1*, inclusive, starting with *d2*.
SER *row1*	Display the *n* most recent SER records starting with record *n*.
SER *row1 row2*	Display SER records *n2* to *n1*, starting with *n2*.
SER C or R	Clear/Reset SER data.
SER D	Delete SER data.
SHO	Show device settings.
SHO DN	Show DNP3 settings
SHO F	Show front-panel settings.
SHO G	Show global settings.
SHO L	Show general logic settings.
SHO P *n*	Show serial port settings, where *n* specifies the port (3, 4, or F); *n* defaults to the active port if not listed.
SHO R	Show report (event and SER) settings.
STA	Display device self-test status.
STA S	Display SELOGIC usage status report.
SUM	Display an event summary.
TAR	Display Device Word Row 0 (front-panel target LEDs).
TAR *n k*	Display Device Word Row *n* (*n* = 0 to 65). Repeat *k* times (1–32767).
TAR *name k*	Display Device Word Row containing Device Word *name*. Repeat *k* times.
TAR R	Reset front-panel trip/target LEDs.
TAR … ROW	Adding ROW to the command displays the Device Word Row number at the start of each line.
TIM	View time.
TIM *hh:mm:ss*	Set time by entering **TIM** followed by hours, minutes, and seconds, as shown (24-hour clock).
TRI	Trigger an event report data capture.
Access Level 2 Commands	
ANA *p t*	Test analog output port where *p* is a percentage of full scale between 0–100% and *t* is time in 1.0–10.0 minutes
CAL	Go to Access Level C.
CON *n*	Set, clear, or pulse an internal remote bit (*n* is the remote bit number from 1–32).
FIL WRITE *filename*	Transfer settings file *filename* from the PC to the device.

Serial Port Command	Command Description
L_D	Load new firmware.
LOO	Enables loopback testing of MIRRORED BITS channels.
LOO A	Enable loopback on MIRRORED BITS Channel A for the next 5 minutes.
LOO B	Enable loopback on MIRRORED BITS Channel B for the next 5 minutes.
PAS	Show existing Access Level 1 and Level 2 passwords.
PAS 1 *xxxxxxxxxxxx*	Change Access Level 1 password to *xxxxxxxxxxxx*.
PAS 2 *xxxxxxxxxxxx*	Change Access Level 2 password to *xxxxxxxxxxxx*.
PUL *n*	Pulse output contact *n* for 1 second.
SET	Enter/change devicesettings.
SET DN	Enter/change DNP3 settings.
SET F	Enter/change front-panel settings.
SET G	Enter/change global settings.
SET L	Enter/change SELOGIC variable and timer settings.
SET *name*	For all **SET** commands, jump ahead to a specific setting by entering the setting name.
SET P *n*	Enter/change serial Port *n* settings (*n* = 2, 3, 4, or F; if not specified, the default is the active port).
SET R	Enter/change report (event and SER) settings.
SET … TERSE	For all **SET** commands, **TERSE** disables the automatic **SHO** command after the settings entry.
STA R or C	Clear self-test status and restart device.

SEL-2411 Programmable Automation Controller Command Summary

The table below lists the front serial port ASCII commands associated with particular activities. The commands are shown in uppercase letters, but they can also be entered using lowercase letters.

Serial Port Command	Command Description
Access Level 0 Commands	
ACC	Go to Access Level 1.
BNA	Display ASCII names of all the Device Word bits returned in the Fast Meter Data Block.
CAS	Return the Compressed ASCII configuration message.
DNA	Display ASCII names of Device Word bits reported in Fast Meter.
ID	Device identification code.
QUI	Go to Access Level 0.
SNS	Display SER settings in Compressed ASCII format.
Access Level 1 Commands	
2AC	Go to Access Level 2.
CEV *n*	Display compressed event report, 15 cycles (*n* is the event report).
CEV *n* R	Display compressed event report with raw (unfiltered) data, 16 or 65 cycles.
CHI	Display compressed history report.
CME A	Display fundamental metering data in compressed format.
CME F	Display fundamental metering data in compressed format.
CME M	Display math variable metering data in compressed format.
CME RE	Display remote analog metering data in compressed format.
COM A	Return a summary report of the last 255 records in the communications buffer for MIRRORED BITS® communications Channel A.
COM B	Return a summary report of the last 255 records in the communications buffer for MIRRORED BITS communications Channel B.
COM C	Clears all communications records. If both MIRRORED BITS channels are enabled, omitting the channel specifier (A or B) clears both channels.
COM C A	Clears all communications records for Channel A.
COM C B	Clears all communications records for Channel B.
COM L	Appends a long report to the summary report of the last 255 records in the MIRRORED BITS communications buffer.
COM L A	Appends a long report to the summary report of the last 255 records in the communications buffer for MIRRORED BITS communications Channel A.

Serial Port Command	Command Description
COM L B	Appends a long report to the summary report of the last 255 records in the communications buffer for MIRRORED BITS communications Channel B.
COM S	Return a summary report of the last 255 records in the MIRRORED BITS communications buffer.
COU *n*	Display the values of the SELOGIC® counters *n* times.
CPR	Display analog signal profile data.
CST	Display compressed status report.
CSU	Display compressed event summary.
DAT	View the date.
DAT *dd/mm/yyyy*	Enter date in DMY format if DATE_F setting is DMY.
DAT *mm/dd/yyyy*	Enter date in MDY format if DATE_F setting is MDY.
DAT *yyyy/mm/dd*	Enter date in YMD format if DATE_F setting is YMD.
EVE *n*	Show event report *n* with 4 samples per cycle. If *n* is omitted, most recent report is displayed.
EVE *n*R	Show event report *n* with raw (unfiltered) 16 samples per cycle analog data and 4 samples per cycle digital data.
FIL DIR	Return a list of files.
FIL READ *filename*	Transfer settings file *filename* from the device to the PC.
FIL SHOW *filename*	Filename 1 displays contents of the file filename.
GOO *k*	Display transmit and receive GOOSE messaging information. Enter number *k* to scroll the GOOSE data *k* times on the screen.
HEL	Display a short description of selected commands.
HIS *n*	Show summary of *n* latest event reports, where *n* = 1 is the most recent entry. If *n* is not specified, all event report summaries are displayed.
HIS C or R	Clear or reset history buffer.
IRIG	Force synchronization of internal control clock to IRIG-B time-code input.
MAC	Display the MAC address of the Ethernet port (PORT 1).
MAP *x y*	Display DNP3 map for port *x*, session *y*.
MET	Display instantaneous metering data.
MET A	Display analog input metering data.
MET D	Display demand and peak demand metering data.
MET E	Display energy metering data.
MET F *k*	Display fundamental metering data *k* times, where *k* is between 1 and 32767.
MET MATH	Display math variable metering data.
MET MAX	Display maximum/minimum metering data.
MET RA	Display remote analog metering data.
MET RD	Reset demand metering data.
MET RE	Reset energy metering data.
MET RM	Reset maximum/minimum metering data.

Serial Port Command	Command Description
MET RP	Reset peak demand metering data.
MET RTD	Display internal and external RTD metering data.
MET TEMP	Display internal general purpose RTD/TC metering data.
PRO	Display analog signal profile data.
PRO C	Clears analog signal profile data.
SER	Display all Sequential Events Recorder (SER) data.
SER *date1*	Display all **SER** records made on *date1*.
SER *date1 date2*	Display all **SER** records made from dates *d2* to *d1*, inclusive, starting with *d2*.
SER *row1*	Display the *n* most recent SER records starting with record *n*.
SER *row1 row2*	Display SER records *n2* to *n1*, starting with *n2*.
SER C or R	Clear/Reset SER data.
SER D	Delete SER data.
SHO	Show device settings.
SHO DN	Show DNP3 settings
SHO F	Show front-panel settings.
SHO G	Show global settings.
SHO L	Show general logic settings.
SHO P *n*	Show serial port settings, where *n* specifies the port (3, 4, or F); *n* defaults to the active port if not listed.
SHO R	Show report (event and SER) settings.
STA	Display device self-test status.
STA S	Display SELOGIC usage status report.
SUM	Display an event summary.
TAR	Display Device Word Row 0 (front-panel target LEDs).
TAR *n k*	Display Device Word Row *n* (*n* = 0 to 65). Repeat *k* times (1–32767).
TAR *name k*	Display Device Word Row containing Device Word *name*. Repeat *k* times.
TAR R	Reset front-panel trip/target LEDs.
TAR … ROW	Adding ROW to the command displays the Device Word Row number at the start of each line.
TIM	View time.
TIM *hh:mm:ss*	Set time by entering **TIM** followed by hours, minutes, and seconds, as shown (24-hour clock).
TRI	Trigger an event report data capture.
Access Level 2 Commands	
ANA *p t*	Test analog output port where *p* is a percentage of full scale between 0–100% and *t* is time in 1.0–10.0 minutes
CAL	Go to Access Level C.
CON *n*	Set, clear, or pulse an internal remote bit (*n* is the remote bit number from 1–32).
FIL WRITE *filename*	Transfer settings file *filename* from the PC to the device.

Serial Port Command	Command Description
L_D	Load new firmware.
LOO	Enables loopback testing of MIRRORED BITS channels.
LOO A	Enable loopback on MIRRORED BITS Channel A for the next 5 minutes.
LOO B	Enable loopback on MIRRORED BITS Channel B for the next 5 minutes.
PAS	Show existing Access Level 1 and Level 2 passwords.
PAS 1 *xxxxxxxxxxxx*	Change Access Level 1 password to *xxxxxxxxxxxx*.
PAS 2 *xxxxxxxxxxxx*	Change Access Level 2 password to *xxxxxxxxxxxx*.
PUL *n*	Pulse output contact *n* for 1 second.
SET	Enter/change devicesettings.
SET DN	Enter/change DNP3 settings.
SET F	Enter/change front-panel settings.
SET G	Enter/change global settings.
SET L	Enter/change SELOGIC variable and timer settings.
SET *name*	For all **SET** commands, jump ahead to a specific setting by entering the setting name.
SET P *n*	Enter/change serial Port *n* settings (*n* = 2, 3, 4, or F; if not specified, the default is the active port).
SET R	Enter/change report (event and SER) settings.
SET … TERSE	For all **SET** commands, **TERSE** disables the automatic **SHO** command after the settings entry.
STA R or C	Clear self-test status and restart device.